HIGHRISE IN TROPICS: ANALYSES AND SYNTHESES ON CORE SYSTEM OF RESIDENTIAL HIGHRISE BUILDINGS IN TROPICAL REGION

Miss Khin Thu Thu Kyaw Nyunt

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for the Degree of Master of Architecture in Architectural Design
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อาคารสูงในเขตร้อนชื้น บทวิเคราะห์และบทสังเคราะห์เรื่องพื้นที่สัญจรและบริการในแนวแกนตั้ง ของอาคารสูง ในภูมิภาคอากาศร้อนชื้น

น.ส.ขิ่น ทู ทู ยอว นึน

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาสถาปัตยกรรมศาสตรมหาบัณฑิต
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คณะสถาปัตยกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
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By	Miss Khin Thu Thu Kyaw Nyunt
Field of Study	Architectural Design
Thesis Advisor	Associate Professor M.L. CHITTAWADI CHITRABONGS, Ph.D.

Accepted by the FACULTY OF ARCHITECTURE, Chulalongkorn University in Partial Fulfillment of the Requirement for the Master of Architecture

.... Dean of the FACULTY OF ARCHITECTURE

(Associate Professor PINRAJ KHANJANUSTHITI, Ph.D.)

THESIS COMMITTEE

.... Chairman

(Assistant Professor VORAPAT INKAROJRIT, Ph.D.)

.... Thesis Advisor

(Associate Professor M.L. CHITTAWADI CHITRABONGS, Ph.D.)

.... Examiner

(Assistant Professor CHOMCHON FUSINPAIBOON, Ph.D.)

.... Examiner

(PAT SEEUMPORNROJ, Ph.D.)

.... External Examiner

(Nicholas S Taylor)

ขิ่น ทู ทู ยอว นึน : อาคารสูงในเขตร้อนชื้น บทวิเคราะห์และบทสังเคราะห์เรื่องพื้นที่สัญจรและบริการในแนวแกนตั้งของอาคารสูง ในภูมิภาคอากาศร้อนชื้น. (HIGHRISE IN TROPICS: ANALYSES AND SYNTHESES ON CORE SYSTEM OF RESIDENTIAL HIGHRISE BUILDINGS IN TROPICAL REGION) อ.ที่ปรึกษาหลัก : รองศาสตราจารย์ ม.ล.จิตตวดี จิตรพงศ์

วิทยานิพนธ์เล่มนี้ ชื่อ “อาคารสูงในเขตร้อนชื้น บทวิเคราะห์และบทสังเคราะห์เรื่องพื้นที่สัญจรและบริการในแนวแกนตั้งของอาคารสูง ในภูมิภาคอากาศร้อนชื้น” เป็นการศึกษาการเรียบเรียง ที่ว่าง ระบบทางสัญจรของอาคารสูง เพื่อนำเสนอแบบที่พักอาศัยอาคารสูงของโครงการที่มีอยู่จริง เรียกว่า สตาร์ ซิตี้ ณ เมืองย่างกุ้ง ความพยายามนี้คือการเริ่มทำความเข้าใจความแตกต่างระหว่าง ตำแหน่งของแกนหนักอาคาร และการเรียบเรียง ที่ว่างของทางสัญจร ที่อาจส่งผลต่อคุณภาพของ ที่ว่าง โดยเฉพาะในเชิง แสงสว่างทางธรรมชาติและการระบายอากาศ วิทยานิพนธ์นี้เริ่มต้นจากแนวทาง เชิงประวัติศาสตร์ ในการศึกษาวิธีเรียบเรียงแกนหลักของอาคารสูงในปลายศตวรรษที่ 19 ถึงต้นศตวรรษที่ 20 โดยเฉพาะในประเทศอเมริกา อาคารและหนังสือที่ออกแบบและเขียนโดย หลุยส์ ซัลลิแวน จึงถูกเลือกมาเป็นส่วนหนึ่งของบทวิเคราะห์ ภูมิอากาศเป็นปัจจัยของที่ตั้งตามธรรมชาติ การที่จะเรียบเรียงอาคารที่พักอาศัยสูงให้ประเทศในเขตร้อนชื้น เช่น พม่า มีความจำเป็นต้องศึกษาการเรียบเรียงที่ว่างในประเทศที่อยู่เหนือเส้นรุ้งที่อยู่ห่างจากเส้นศูนย์สูตรไปทางเหนือ อาคารวินเซล นราธิวาส ออกแบบโดย เควิน มาร์ค โล และ เดอะ เมท ออกแบบโดย บริสัทโวฮา ในกรุงเทพ เป็นสองกรณีศึกษาที่แสดงถึงความเป็นไปได้ในการเรียบเรียงองค์ประกอบสถาปัตยกรรม ที่ต้อนรับแสงธรรมชาติและการระบายอากาศในทางสัญจรหลักของอาคารสูง แม้ว่าราคาของที่พักอาศัยในโครงการดังกล่าวจะสูงกว่าสตาร์ ซิตี้ ธานยิน ก็ตาม ความหวังของวิทยานิพนธ์เล่มนี้คือการนำเสนอความเป็นไปได้ของการเรียบเรียง ที่ว่างในเชิงสถาปัตยกรรม ของที่พักอาศัยประเภทอาคารสูงในเขตร้อนชื้น

สาขาวิชา	การออกแบบสถาปัตยกรรม	ลายมือชื่อ
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Khin Thu Thu Kyaw Nyunt : HIGHRISE IN TROPICS: ANALYSES AND SYNTHESES ON CORE SYSTEM OF RESIDENTIAL HIGHRISE BUILDINGS IN TROPICAL REGION. Advisor: Assoc. Prof. M.L. CHITTAWADI CHITRABONGS, Ph.D.

This thesis entitled “High-rise in Tropics: Analyses and Syntheses on Core System of Residential High-rise Buildings in Tropical Region” is the study on the space composition of core and circulation systems of high-rise buildings to propose a design of residential high-rise building in the existing project called Star City Thanlyin in Yangon. This attempt is to begin to understand the differences between the positions of core and the composition of circulation systems that may effect the quality of spaces, especially in terms of natural light and ventilation. This thesis begins with a historical approach to study compositions of core system of late 19th century and early 20th century high-rise built mostly in the US. Louis Sullivan’s buildings and texts are therefore chosen to be parts of the analysis. Climate is the given context of the site. In order to propose a residential high-rise for a tropical country like Myanmar, it is necessary to study how the compositions have been done in the countries located above the Tropic of Cancer. Windshell Naradhiwas, designed by Kevin Mark Low and the MET designed by WOHA in Bangkok are two main case studies of possibilities in composing architectural elements that welcome natural light and ventilation in the main circulation spaces. Even though the price per apartment of the projects are higher than Star City Thanlyin, it is hoped that this thesis can bring more possibilities to compose architectural spaces for residential high-rise in the tropical region.

Field of Study:	Architectural Design	Student's Signature ....
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Khin Thu Thu Kyaw Nyunt

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Introduction

1.1. Problem Statement and Research Significance

Living in residential high-rise in Myanmar was not a desirable life. As a 13-year-old girl, I was afraid of the dark corridor. I felt that I could not breathe in a space that lacked light and ventilation. After becoming an architect working Myanmar, I would like to find a way to design residential high-rise in the tropical climate for good life. Light and natural ventilation, to me, are intangible architectural elements of life. They are temporal and beautiful. The objective of this research is to study the core and circulation systems in relation to architectural space composition that allow natural light and ventilation to improve life of high-rise buildings. Of course, air-conditioning system is not being refused. Air-conditioning system is also included in this study. Natural ventilation is an option. Literature Reviews of this thesis begins with a historical approach to study an architectural typology called high-rise buildings including the issues of function and space composition. Louis H. Sullivan mentioned the importance of natural instinct to the early high-rise building in one of chapters in ***Kindergarten Chats and Other Writings***. He stated that people have to think about the relationship of nature and building. We cannot only depend on the modern technology of construction when designing the building. In ***Translations from Drawings to Buildings***, Robin Evans discussed about the importance of circulation space in architectural drawing plans by comparing with the paintings. He talked about the passages of plans in ***Figures, Doors, and Passages*** chapter. Mies van der Rohe has shown his idea in Mansion House Square project in London about study in feasibility of high-rise building by designing different composition and size of core in various floor plans as the author named Jack Self explains in ***Mies in London***.

In Case Studies, the vertical circulation or core system of a building by concerning with a natural light and ventilation I choose to study two residential high-rise buildings in Bangkok. It is hard to find a good example in my country to study residential tropics high-rise building by an understanding of nature resources. I am aware of that the price of

WINDSHELL Naradhiwas and The MET condominium is higher than the typical residential high-rise. But I choose to study these buildings to understand the space composition of tropical high-rise buildings that, in my judgement, provide good quality of life.

The main point of my study is exhibited in Figure 15 and Figure 16 in Chapter 3. I draw the analytical diagrams to study core area ratio in comparison to the total area of each floor plates. In Figure 15, it includes 16 floor plans of three buildings, WINDSHELL Naradhiwas, The MET Condominium and Mansion House Square. In this study, I put various floor plans of Mansion House Square project designed by Mies van der Rohe from ***Mies in London*** book. Mies van de Rohe's building in London is unbuilt. But his studies of how to compose the core system is valuable. It is difficult to find a book that clearly exhibit the design process of master architect through detailed architectural drawings. In ***Mies in London***, there are 8 schematic designs of the main floor plan in relation to core system. I have learnt that the core system is very important not only for the quality of space composition but also for the structure point of view. The core system of a building is like a spine of human body. Proportion wise, the area should be as small as possible and at the same time provide the strength to a building. In Figure 16, it includes 9 floor plans of existing building in the selected site, Galaxy Towers. I studied about this building because I can understand the pros and cons of existing composition of a building from this study.

The positions of core system in my analytical diagram can be divided into two types: the central core and the core at one side of a building. WINDSHELL Naradhiwas, study A to C, D of Mansion House Square and existing building from Galaxy Towers can be defined as central core. Other buildings, The MET Condominium and study D to G of Mansion House Square were designed the core at the side of a building. Firstly, I calculated the total floor area and core area of the plans. As a result of calculation, the core area ratio percentages have come out from this. The floor plans of WINDSHELL Naradhiwas have shown the minimum core area ratio of 7% and maximum 11%. The core area ratio of The MET Condominium is 13% and 16%. Out of all study plans in Mansion House Square, the minimum ratio of core area is 13% and maximum is 19%. In existing building of Galaxy Towers has shown the core area ratio as 14% and 17%. All in all, the minimum percentage of core area ratio is 7% and the maximum is in 19% out of all the plans. The less percentage of core area per floor plate is better because of financial reasons. The core area and the circulation spaces of the building cannot be rent to the inhabitants, therefore these unrentable spaces should be minimal in reference to the laws and regulations in Myanmar.

1.2. Purpose of the Study

I began to think about joining a higher education in architecture after I graduated an architecture bachelor degree in Myanmar. Unfortunately, Yangon Technological University only provided the programs on urban planning and heritage architecture. These programs are not what I would like to pursue. I wanted to study architectural design, so i+mARCH program at Chulalongkorn University in Bangkok was chosen. Design is the key. Myanmar is one of the tropical countries. The core system of typical residential high-rise in Myanmar is normally dark and no ventilation in that space. It is not uncomfortable for people who wants to use the space. The purpose of this research is to find the possibilities of composing architectural elements of residential high-rise buildings in the tropical region.

1.3. Scope of the Study

The selected site in this thesis is located in Thanlyin township. Thanlyin is a major port city of Myanmar and connected to Yangon by bridge through Bago river. The population of Thanlyin city is about 1.6% less than Yangon city. The selected site is named by Galaxy Towers. It is located under the project called Star City Thanlyin. The corporation of this project is Yoma Strategic Holdings and they are targeting from middle to higher income people. In Galaxy Towers, it was supposed to build 6-towers of residential high-rise in total. Currently, 3-towers has been completed and the others are still in under construction. The selected site is not far away from the city of Yangon and can avoid the crowded population. All the buildings within the site are new contemporary residential high-rise buildings. The orientation of the selected site is located near the river to receive nature resources such as natural light and ventilation.

I choose the case studies on the core system of residential high-rise building in tropics according to the importance of natural light and ventilation. In this thesis, all the selected case studies are in Bangkok. It is rarely seen a residential high-rise building that has been built with an understanding of tropical climate factors in my country. According to understanding of research studies, I will apply the knowledge and design a contemporary residential high-rise building within the selected site. The program of new residential high-rise building is derived from the program analysis of the existing building in the site. After the design process, I will do a comparative study of two residential high-rise buildings that are my final design and existing building in Galaxy Towers.

1.4. Research Methodology

The methodology in this research is composed by literature reviews, case studies and design process. The literature reviews are to gain the historical precedent knowledge and practice from master architects as Louis H. Sullivan, Robin Evans and Mies van der Rohe. Louis H. Sullivan mentioned about the existence of natural instincts, form and functional requirements in architecture by using specific example of modern building.

In case studies, the knowledge achieved from literature reviews are applied in the following cases: WINDSHELL Naradhiwas and The MET condominium in Bangkok. The analytical diagrams shown in this part are analyzed by composition of the core and circulation, natural light and shadow and the simulation of ventilation from virtual wind flow by using a software named Autodesk flow design.

Design process is started with site analysis, user analysis and program analysis. After this analysis parts, design development is based on the knowledge achieved from literature reviews and case studies and applied them in the design. The comparative study of final design and existing building in Galaxy Towers is shown after design process. This part is analyzed by using the same method and technique that are applied in the case studies part. The analysis is started from circulation, a natural light and shadow and the simulation of natural ventilation to the building.

1.5. Benefit of the Study

The research interest has started from the memory of my personal experience that is remembered as an uncomfortable space in residential high-rise building where I used to live in my childhood. Based on this memory and experience, I decided to do research about this space which is called the core system of a residential high-rise building in this thesis. I wanted to analyze about the composition of core system and in addition to apply a natural light and ventilation to become better improvement to this space.

In a residential high-rise building, the core system is one of the important parts. This part is a display of strength in a building. As I have mentioned earlier, this space cannot be rentable or saleable therefore generally people do not have any interest in this core. The core system is also known as the vertical circulation of a building. It is participated in daily lives of people. Usually, people use the service in the core system such as elevators or physical stairs.

This research helps me to understand more about mainly on the core system of a residential high-rise building. According to the research findings, I have learnt widely about the importance of natural light and ventilation not only the core but also to the building. The knowledge achieved from literature reviews and case studies help me to gain the understanding about the social values in architecture and every part of a building is important and it has effects to the people lives.

This research is shown the different view and idea upon the core system of a residential high-rise building. This space can be noticed as an importance part of building and awareness to the people. According to research findings, to achieve the better core system in a residential high-rise building is to improve people's lifestyle in tropics. The resources given by nature can add to this space of a building it is not only good for the residents in a building but also good for the society. In need of accommodation for people, the residential high-rise buildings are emerged by the rate of population growth in the city. The truth is that we, people, cannot control the population growth and cannot stop the demand for the accommodation space. But we can improve the building system somehow by adding an abundance of resources from nature. By this way, we can control the reliance on mechanism in our daily lives.

Chapter 2

Literature Reviews

In this thesis "High-rise in Tropics: Analyses and Syntheses on Core System of Residential High-rise Buildings in Tropical Region", I have categorized the selected literature reviews into three parts. The first category is an historical account of a building typology called "high-rise" buildings that emerged after the industrial revolution in Western Europe, especially in the 19th century. I have drawn a table of iconic high-rise buildings to be a starting point to discuss this historical account. Within this category, Louis H. Sullivan's book ***Kindergarten Chats and Other Writings*** and his high-rise buildings will be discussed. The second category concerns a cultural dimension of having a "good life". Robin Evans' ***Translations from Drawing to Building and Other Essays*** is the key text. The last category is the analysis upon preliminary architectural drawings of a high-rise building in London that show the design process of a master architect named Ludwig Mies van der Rohe. It is difficult to find a book that documents the architect's design process through his architectural drawings. Jack Self's ***Mies in London*** is valuable for this thesis because he successfully published 9 plans of "Mansion House Square" by Mies van der Rohe even if the building is not built.

2.1. Highrise Buildings and the Core System

I have selected high-rise buildings, designed by American architects during the late 19th century and the early 20th century, in order to begin to understand an architectural typology called 'high-rise' buildings. The point that I am interested is how the core system and the circulation spaces are thought of in the West, how thought is similar or different from the composition of high-rise buildings in Myanmar. These selected buildings are built at the beginning of high-rise buildings in architecture after the industrial revolution. The following Table 1, 2 and 3 described these high-rise buildings, designed by master architects, in different periods. A reason why these buildings are selected is to study the compositions of core and circulation system, structures, and spaces without giving the importance to the operation. Some of these selected high-rise buildings are residential and some of them are office buildings.

In the late 19^{th} century, the buildings tend to have steel framed structure with at least 10-storeys in height. This type of buildings is called “skyscraper”. Later on, in …… century, the term “skyscraper” has changed to call the buildings that are higher than 150 meters. Louis Henry Sullivan, an American architect who is also known as a father of skyscrapers, designed his first high-rise building in 1889. It is an auditorium building for public and the height is about 72 meters. The core system in this building is located at the center of the space. In 1891, he designed modern office building named Wainwright building. The height of the building is 41 meters and the composition of core system is at the center of the building. Garrick (Schiller) Theatre is one of his high-rise building for public in 1892. The height is about 73 meters and the core is also located at the center. Prudential (Guaranty) Building is a government office during 1894 to 1896 by him. The building height is 46 meters and the core system of the building is at the side of a building. In 1899, “Carson, Pirie and Scott” company building has been built for office and retail. The height of the building is about 63 meters and the location of core system is at the side of a plan. In total of five high-rise buildings in Table 1, the core system is located at the center in three of these high-rise buildings and two of them are located at the side of the buildings.

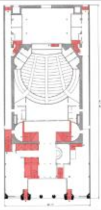
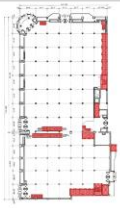
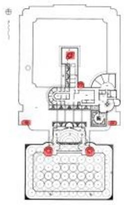
Architect	Louis Henry Sullivan (1856-1924)					Frank Lloyd Wright (1867-1959)
Year	1889	1891	1892	1894 - 1896	1899	1950
Name of Builiding	Auditorium Building	Wainwright Building	Garrick (Schiller) Theatre	Prudential (Guaranty) Building	Carson, Pirie, Scott Company Building	S.C. Johnson Research Tower
Type of Builiding	Public	Office	Theatre	Office	Office, Retail	Office
Location	Chicago, USA	St. Louis, Missouri, USA	Chicago, USA	Buffalo, New York, USA	Chicago, USA	Racine, USA
Height	72 m	41 m	73 m	46 m	63 m	51 m
Plan						
Building						

Table 1: Comparison of high-rise buildings designed by master architects in the late 19th century and in the early 20th century, drawn by the author.

Frank Lloyd Wright is one of the American architects in late 19th century. S. C. Johnson Research Tower has built in 1950. The height is about 51 meters in total and the composition of core is at the center. In 1956, he designed Price Tower Arts Center with 67 meters in height. The building is now using for residential, hotel and office building. The core system is located at the center of this building. The Rookery building has built in 1988. The purpose is to use for office building. The height of the building is about 55 meters and the position of core is at the center. To conclude his high-rise buildings, he designed the core system mostly at the center of the space.

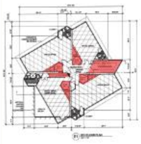
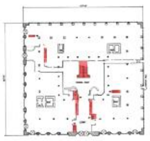
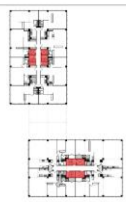
Architect	Frank Lloyd Wright (1867-1959)		Ludwig Mies van der Rohe (1886-1969)			
Year	1956	1988	1949	1951	1956	1958
Name of Builiding	Price Tower Arts Center	The Rookery	Promontory Apartments	860 & 880 North Lake Shore Drive	Esplanade Apartments I & II	Seagram Building
Type of Builiding	Residential, Hotel, Office	Office	Residential	Residential	Residential	Office
Location	Bartlesville, USA	Chicago, USA	Chicago, USA	Chicago, USA	Chicago, USA	New York, USA
Height	67 m	55 m	67 m	82 m	79 m	157 m
Plan						
Building						

Table 2: Comparison of high-rise buildings designed by master architects in the late 19th century and in the early 20th century, drawn by the author.

Ludwig Mies van der Rohe is an American architect and also regarded as one of the pioneers of modernist architecture. In 1949, he designed the promontory apartments and they are for residential use. The core system in this building is located at the center of the space. The height of these buildings are 67 meters in total. In 1951, 860 and 880 North Lake Shore Drive residential buildings are built in Chicago. Mies designed the buildings' core system at the center. The height of the buildings are 82 meters. Esplanade Apartments I and II designed by Mies are built in 1956. These are for residential use and the core system of these buildings is located at the center. Total height of these buildings are 79 meters. In New York, Seagram office building is built in 1958 and the total height is about 157 meters. The core system is located at the center of this building. In 1958, Mies designed Lafayette Pavilion Apartments for residential use in Detroit. The height is about 67 meters and the core is located at the center of the space. One Charles Center is built in 1963 and it is an office building. The height is 82 meters in total and the core system is located at the center. In 1970, Mies designed One Illinois Center office building in Chicago. The core system of this building is located at the center and total height of this building is 110 meters. The core system in all of his high-rise buildings is located at the center. Most of his buildings are for residential and office.

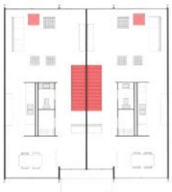
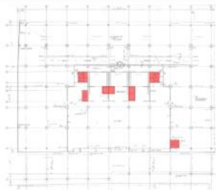
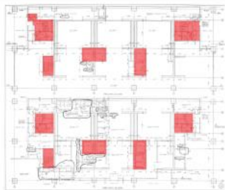
Architect	Ludwig Mies van der Rohe (1886-1969)		
Year	1958	1963	1970
Name of Builiding	Lafayette Pavilion Apartments	One Charles Center	One Illinois Center
Type of Builiding	Residential	Office	Office
Location	Detroit, USA	Baltimore, USA	Chicago, USA
Height	67 m	82 m	110 m
Plan			
Building			

Table 3: Comparison of high-rise buildings designed by master architects in the late 19th century and in the early 20th century, drawn by the author.

2.2. ***Kindergarten Chats and Other Writings*** by Louis H. Sullivan

Louis H. Sullivan was an American architect and also known as “father of skyscrapers” or “father of modernism” in Chicago. The increasing demand in tall office building (early modern high-rise) is the result from the development of society. The result causes the problem which is how modern buildings (higher) take in all of the culture from previous buildings (lower). “It is my belief that it is of the very essence of every problem that it contains and suggests its own solution. This I believe to be natural law."[1] He talked about every problem has their own solution in itself. The conventionality process of every tall office building started from a story below-ground until it reached to the attic.

Sullivan stated that modern office buildings plan has an aesthetic value only when they have the lighting court which is external or becomes an internal feature. Practically, no matter horizontal or vertical office which is based on comfortable area, height, size of a room and window openings size. He suggests that we should follow our natural instincts to design what we need rather than only rely on the educational knowledges.

As following his suggestion, the natural instincts in tall office buildings are started with the first story, second story, and it brings to the attic. In the problem study Sullivan mentioned about four design principle for modern office buildings which are social demand, function needs, sensibility of the buildings, and sentimentality on architectural expression. In addition, we also have to think about one more thing it is the emotion of humanity. In the philosophic observation, most of the people criticize about true theory of tall office buildings is the classical column, consisting of base, shaft, and capital.[2] Theorizers describe about trinity with nature, art and beauty by dividing three parts in the day and body. Intellectuals distinguish in the nature of a logical statement. Scholars claim in the vegetable terms such as organic or inorganic. Other experts assert in the power of a unit than to a grace of a trinity. But they all pointed out that the tall office buildings should be in three parts vertically. "All of these critics and theorists agree, however, positively, unequivocally, in this, that tall office building should not, must not, be made a field for the display of architectural knowledge in the encyclopedic sense; that too much learning in this instance is fully as dangerous, as obnoxious, as too little learning; that miscellany is abhorrent to their sense; that the sixteen story building must not consist of sixteen separate, distinct and unrelated buildings piled one upon the other until the top of the pile

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[1] Retrieve from Sullivan, L. H. (1979). ***Kindergarten Chats and Other Writings*** (Page. 203). Courier Corporation.

[2] Retrieve from Sullivan, L. H. (1979). ***Kindergarten Chats and Other Writings***. Courier Corporation.

is reached."[3] Further to explain about natural law, things were born in its contemporary context and keep growing. When the changes going to fade away until disappear is the death. Birth and death are like a bubble and keep rotating in this process. The past knowledge is the air rises the bubble up so people can see it. Sullivan belief is that form ever follows function and he said this is the law. "Where function does not change form does not change."[4] High-rise residential building in Yangon is a bubble rising by nowadays social conditions, how to make the bubble be paid attention by people, how the bubble can enrich the lives of people is like Sullivan mentioned in this book. We need to search out the change by using natural law to think the design of modern high-rise buildings. "Nature is our friend, not our implacable enemy-…"[5] As he stated that we, the people, need to think about the relationship between nature and building. When we design modern high-rise buildings, we should not only depend on the modern technology such as air-conditioning, artificial lighting and mechanical facilities but also consider the natural stuffs such as wind, sunlight. "An architecture that will soon become a fine art in the true, the best sense of the word, an art that will live because it will be of the people, for the people, and by the people." (Sullivan, 1979)

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[3] Retrieve from Sullivan, L. H. (1979). ***Kindergarten Chats and Other Writings*** (Page. 207). Courier Corporation.

[4] Retrieve from Sullivan, L. H. (1979). ***Kindergarten Chats and Other Writings*** (Page. 208). Courier Corporation.

[5] Retrieve from Sullivan, L. H. (1979). ***Kindergarten Chats and Other Writings*** (Page. 213). Courier Corporation.

Figure 1: Plans of First and Sixth Floors, ***Wainwright Building, St. Louis,*** *retrieve from* ***Kindergarten Chats and Other Writings,*** *(Page. 204).*

2.3. ***Translations from Drawing to Building and Other Essays*** by Robin Evans

Circulation, such an important term in architectural field. It seems one of the natural properties of architecture. It is like the vessels spread all over human's body, even people who does not have much knowledge in medicinal field will not question its importance to the human body. Obviously, as the tangible form, passages could be regarded as the vessels of buildings to connect different spaces. For example, the corridor connecting different rooms, and the stairs linking vertical floors. Just like people to make a detailed inquiry why God designed vessels in human's body, it is hard to question that how passages appeared in architecture. Robin Evans (1944-1993), an architect, a teacher, and also a historian, shown his concern in his article called ***Figures, Doors, and Passages.*** He said, "The history of the corridor as a device for removing traffic from rooms has yet to be written. From the little evidence I have so far managed to glean…"[6] Although in this article, Robin Evans did not give a convinced answer, however, he provided an impressive opinion is, the drawings reflected the status of people's lives. The drawings are not only including paintings, but also architectural drawings, such as the plans. The idea of Robin Evans is a stepping-stone to evoke people to think the relationship between drawings and everyday life of people.

[6] Retrieve from Evans, R. (1997). ***Translations from Drawing to Building and Other Essays*** (Page. 57). London: Architectural Association.

At first, Robin Evans used two paintings as the comparison. One is named ***Virgin and Saints,*** created by Ercole de' Roberti, 1480, Figure 2 (Left). Another one is called ***Madonna dell'Imapannata*** by Raphael, 1514, Figure 2 (Right).

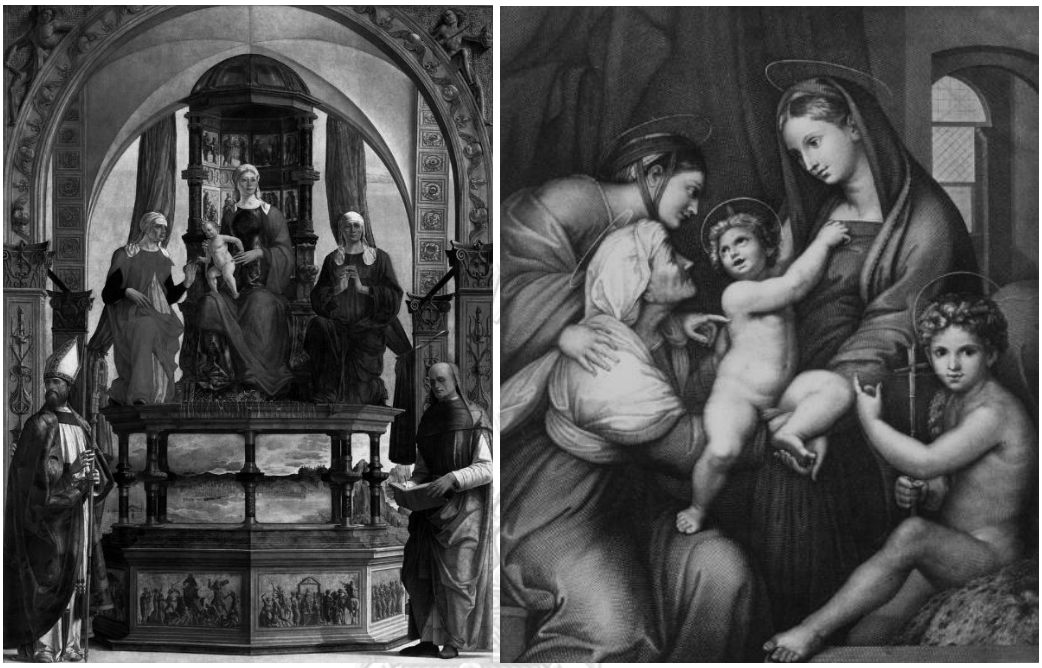


Figure 2: (Left) ***Virgin and Saints,*** *by Ercole de' Roberti, 1480 and (Right)* ***Madonna dell'Imapannata,*** *by Raphael, 1514, retrieve from* ***Translations from Drawing to Building and Other Essays,*** *(Page. 58 & 59).*

Robin Evans described Raphael's work like this, "In Raphael's Madonna, figures are not so much composed in space as joined together despite it. They look closely on one another, stare myopically into eyes and at flesh, grasp, embrace, hold, and finger each other's bodies as if their recognition rested more firmly on touch than on sight."[7] On the other hand, Robin Evans used "holy" and "untouchable" to define what he has seen in Ercole de' Roberti's work. Although these descriptions are only for paintings, and two different attitudes for the social life, it is clear that the ambition of Robin Evans is more than that. Further, the difference about touch and out of touch will project to people's daily life by plan.

[7] Retrieve from Evans, R. (1997). ***Translations from Drawing to Building and Other Essays*** (Page. 59). London: Architectural Association.

There are two plans mentioned by Robin Evans, one is the plan of ***Palazzo Antonini, Udine*** by Andrea Palladio, 1556, Figure36 (Left) and another is the plan of ***Amesbury House, Wiltshire*** by John Webb, 1661, Figure 3 (Right).

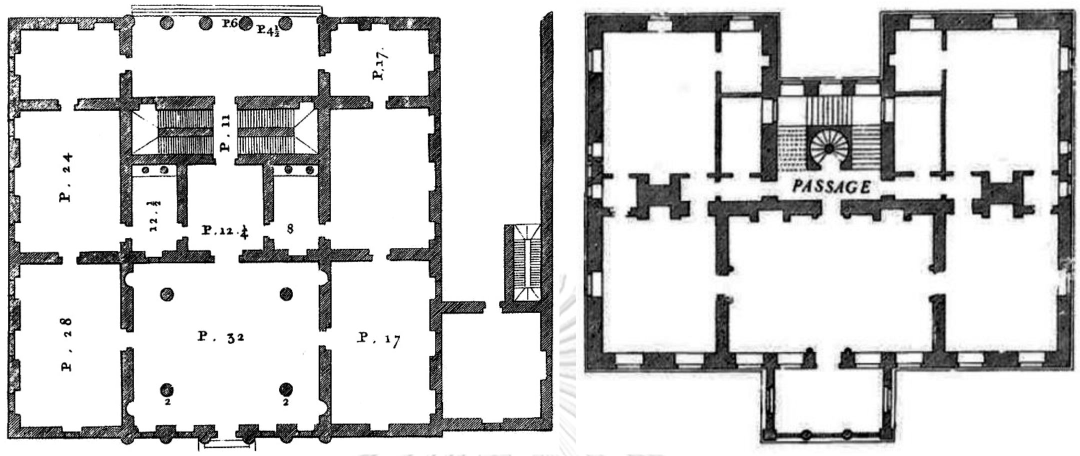


Figure 3: (Left) ***Palazzo Antonini, Udine*** *by Andrea Palladio, 1556 and (Right)* ***Amesbury House, Wiltshire*** *by John Webb, 1661, retrieve from* ***Translations from Drawing to Building and Other Essays,*** *(Page. 62 & 73).*

For ***Palazzo Antonini,*** all rooms have more than one door, the rooms are connected to each other by these doors. The plan is like a big net. In the plan of ***Amesbury House,*** the rooms can be more independent. People can reach all rooms by using passages in the middle, rather than crossing other rooms. According to Robin Evan's descriptions, the passage was designed for servants. The aim is to avoid servants cross the room when the master and guests using it. Also, it is convenient to use different rooms at the same time. If the plan of ***Palazzo Antonini*** is like the painting ***Madonna dell'Impannata,*** then the plan of ***Amesbury House*** could be regarded as the painting ***Virgin and Saints***. They represent two different status of family's life. This change is due to people's emphasis on morality and personal privacy.

Passage is like the backbone of plan to support the houses of 19^{th} century. Even William Morris, the advocate of the Arts and Crafts Movement, the Red House designed by him still use the corridor to connect each room, Figure 4. Rather than making the plan of the Red House draw back to 15^{th} century.

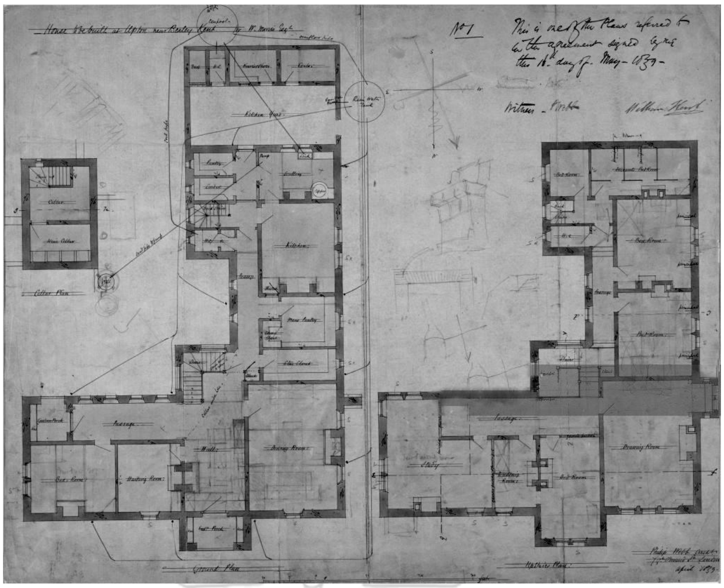


Figure 4: ***The Red House, Bexley Heath,*** *by Philip Webb and William Morris, 1859, retrieve from* ***Translations from Drawing to Building and Other Essays,*** *(Page. 81).*

However, Robin Evans doubted with the house plan that has dominated architectural design since the 19th century. He said, "The cumulative effect of architecture during the last two centuries has been like that of a general lobotomy performed on society at large, obliterating vast areas of social experience…. incidentally reducing daily life to a private shadow-play."[8] Robin Evans tried to lead people to think people's attributes in society, he is acutely aware of the collective consciousness which is being stripped out from people's mind by the contemporary society. In such a context, what he advocated is as he said, "Plans have been scrutinized for characteristics that could provide the preconditions for the way people occupy space, on the assumption that buildings accommodate what pictures illustrate and what words describe in the field of human relationship." The drawings reflect the phenomenon of people's lives and the society project the lives of people. These are connected to each other, and social values has started from this.

[8] Retrieve from Evans, R. (1997). ***Translations from Drawing to Building and Other Essays*** (Page. 90). London: Architectural Association.

2.4. ***Mies in London*** by Jack Self: a feasibility study for a high-rise building

The modernist architect Ludwig Mies van der Rohe designed Mansion House Square for the City of London, a spectacular amber glass and steel office tower in the early 1960s. But after two decades of planning, the building was cancelled between political intrigue and controversy. If completed it would have been the geographic center of the City. For almost forty years, the project archive has been inaccessible and unpublished, as the commissioner Lord Peter Palumbo, a well-known developer and patron of architecture in the United Kingdom, held the only copies of all Mie's work. In this book, we can see floor plans, sections, elevations, details, objects designed specifically for the building, door handles, ashtrays etc., extensive photographs of both study and final models as well as beautiful photo collages. Mies has created as proposal plans for this building. From all of the drawings on this book, we can see how details he made on core system of the building such as heating system, ventilation, air-conditioning (HVAC) and lighting systems.

Figure 5: Photocollage of Mansion House Square Project by John Donat for Mies van der Rohe, retrieve from ***Mies in London.***

Figure 6: Photocollage of Mansion House Square Project by John Donat for Mies van der Rohe, retrieve from ***Mies in London.***

This part is divided into two parts about the core system of high-rise buildings: natural light and ventilation. There are four days in a year changing the shades of lighting. There is summer solstice, winter solstice, spring equinox, and fall equinox. The analysis will apply to the final design based on these factors.

In terms of ventilation, there are divided into five regions in the world climate system: tropical climate, dry climate, temperate climate, continental climate, and polar climate. As a tropical climate, it is subdivided into three parts: tropical rainforest, tropical monsoon and tropical savanna climate. Tropical monsoon is the intermediate climate between tropical rainforest and tropical savanna. A tropical monsoon tends to see more rainfall than a tropical savanna climate.

Ventilation is the process of air circulation of a space especially enclosed maintaining the required air quality. In ventilation system, there are two parts: natural and mechanical. As a natural ventilation system, wind speed, pressure, inside and outside temperature, controllable openings as strategic positions and buoyancy are the natural forces to make outside air flow and distribute the fresh air inside. Natural ventilation uses the natural forces of wind to supply fresh air without using mechanical devices. In tropical climate, the orientation of the building in consideration of prevailing winds and controllable openings can help to achieve the air flow inside.

According to the studies, Javanese architecture in Indonesia and traditional Vietnamese architecture were mainly used these following factors:

1. Building's form accelerate air into the building for ventilation.

2. Strategic positioning of openings to allow the airflow at body level.

3. Open interior spaces for proper ventilation.

4. Elevated floor level to catch the wind of higher velocity.

5. Strategic plantation to allow the wind flow through the building.

6. Light weight construction material.

As natural ventilation principles and strategies, orientation, spatial organization, shading devices, cross ventilation, use of smart material, thermal mass, evaporative cooling, use of color and texture, roof gardens, strategic plantation etc. are some of the strategies to achieve the thermal comfort level of the interior. The strategy is allowing fresh air to enter inside enclosed space and taking it out. In natural ventilation system, there are three different categories namely single sided ventilation, cross ventilation, and stack ventilation system. Malaysian architect, Dr. Ken Yeang is known for his principles for bioclimatic towers in tropical climate. In high-rise buildings he extensively used innovative ventilation strategy by manipulating flow of prevailing wind and wind wing-wall is the most interesting building element designed by him. This device is a short wall placed perpendicular to an opening and used with orifice as a pocket device to collect or direct the winds into the building.

There are design factors for natural ventilation in tropical climate such as building orientation and form, position and size of openings, and internal management system. According to studies, orientation helps to take air flow by utilizing prevailing winds and reduce solar gain. Orientation depends on physical factors like site orientation, access point and view from site, and shading devices, louvers, and verandahs affect solar heat gain and air circulation. Inlet openings face inward wind direction and keep at an angle of 45 is the better way to achieve indoor air flow. Controllable windows accelerate air driven ventilation. The size of openings has minimal effect on overall ventilation condition.

The residential layout plan should focus on usability and requirement of ventilation space. The air flow can be obtained more where partitions are nearer to outlet than compare with inlet.

Chapter 3

Case Studies

3.1. Selected Cases

3.1.1. (2020) WINDSHELL Naradhiwas: Tropical Stacking Home, Bangkok

Project: WINSHELL Naradhiwas

Designer: Small Projects: Kevin Mark Low

Architect: ACS Design Studio Co., Ltd

Year: 2020

Height: 160 m

Number of Floors: 28-storeys

Location: 53 Naradhiwat Rajanagarindra Road, Sathon, Bangkok

Climate: Tropical Warm and Humid

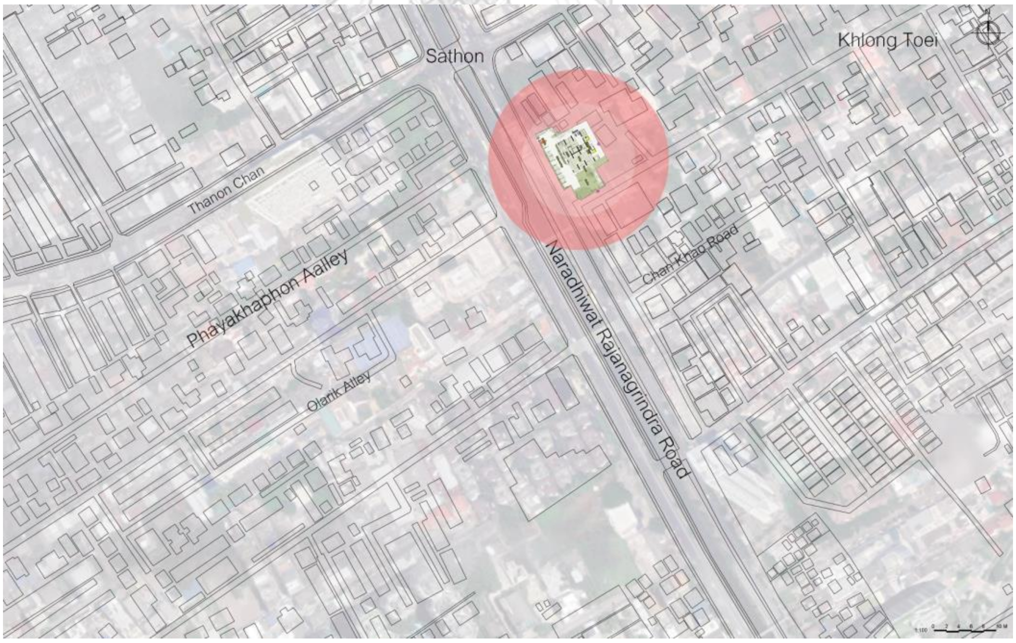
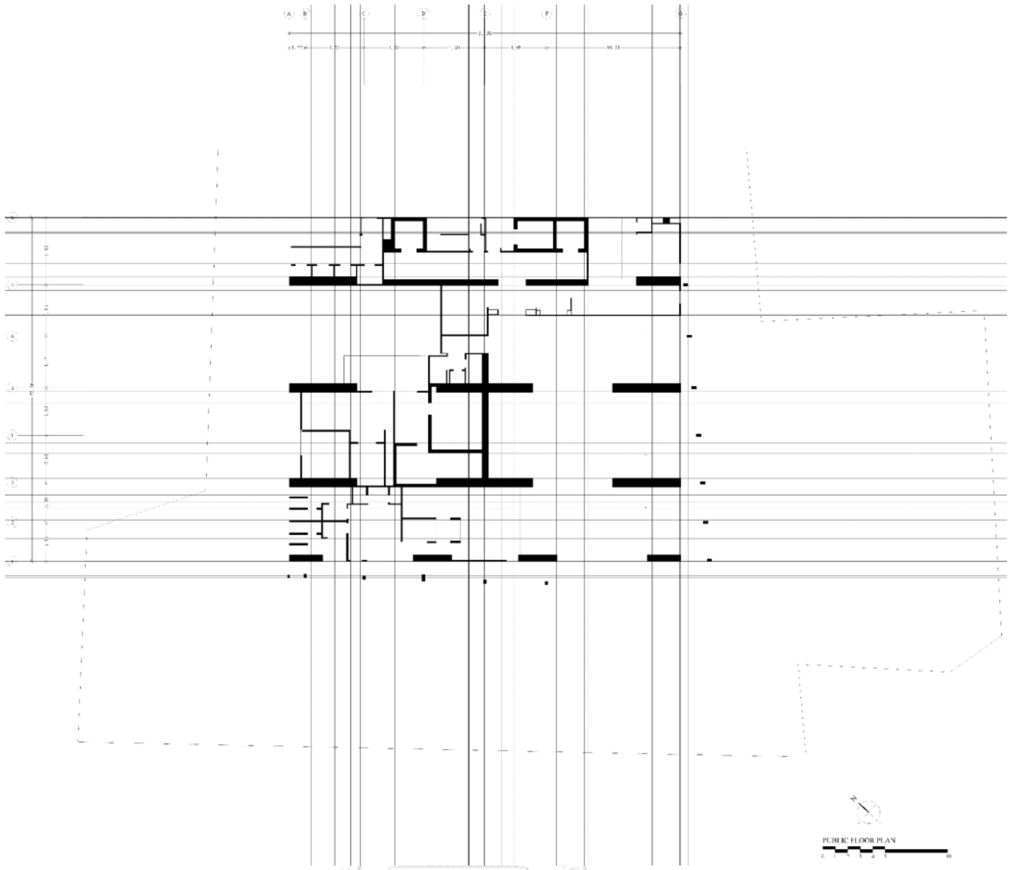


*Figure 7: Location of **WINDSHELL Naradhiwas** in Sathon, drawn by the author.*



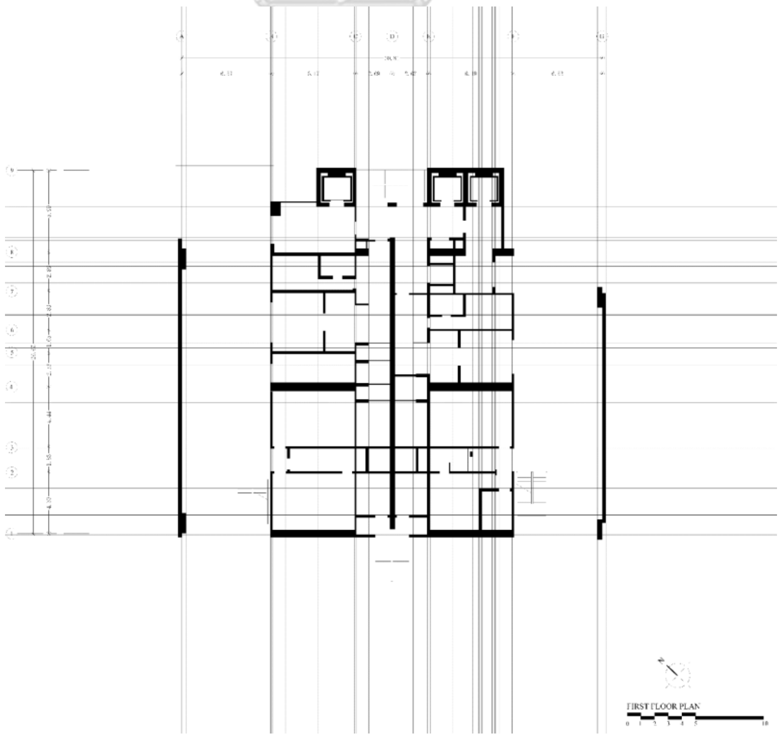


*Figure 8: Main floor plan and first floor plan (residential plan) of **WINDSHELL Naradhiwas,** redrawn by the author.*

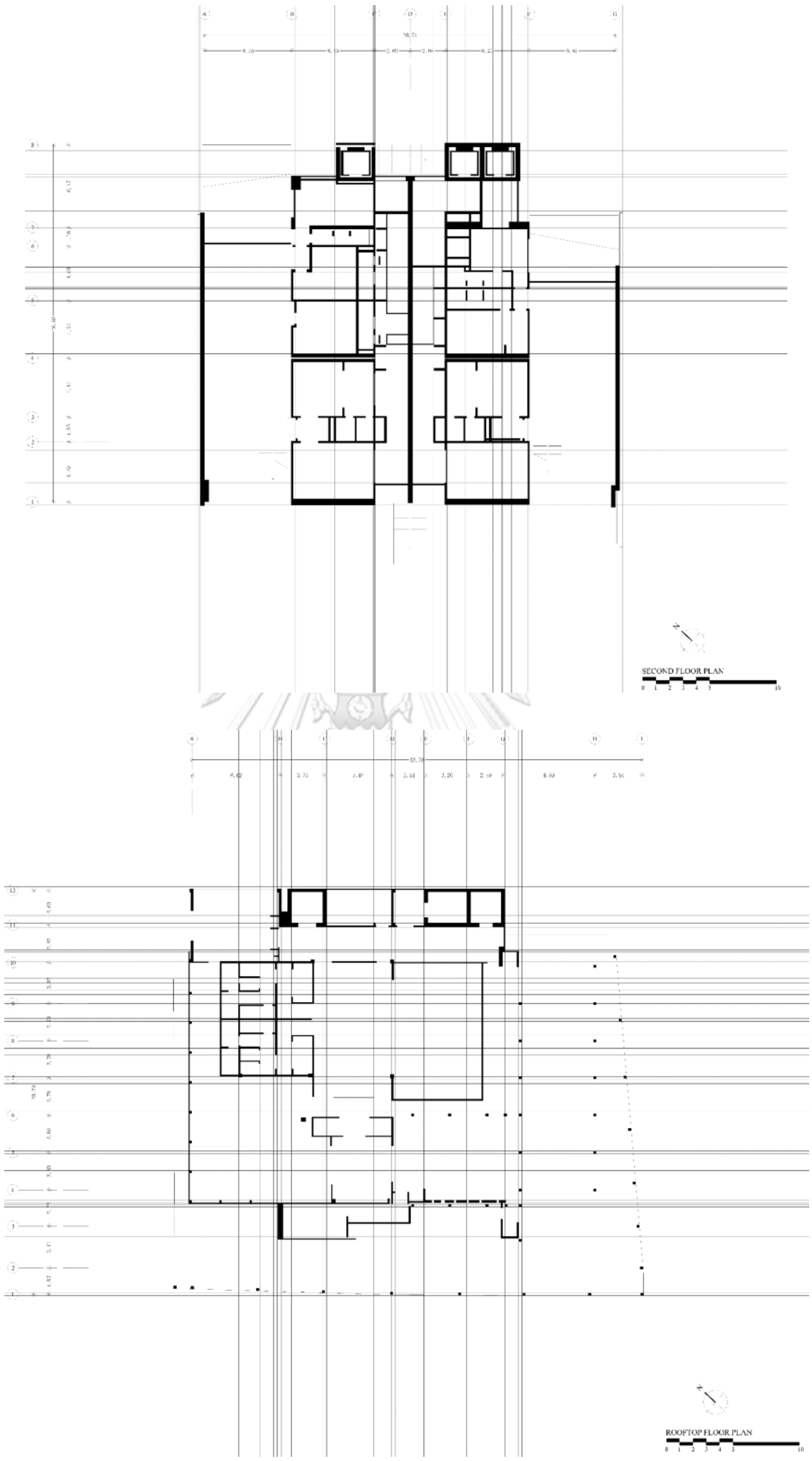


*Figure 9: Second floor plan (residential plan) and rooftop plan of **WINDSHELL Naradhiwas,** redrawn by the author.*

The building is located on the main road near intersection at Narathiwat and Chan Road about 100 m away from BRT station. The idea for this building was in the form of tropical stackin home or houses mixed with condominium. This is a 28-storeys building and 160 m in total height. The exterior design of the building focuses on use of material and structure as a shear wall or load bearing wall which has long term durability. Shear wall which uses in each layer to support forces generated by vertical and horizontal. There are no pillars or beams use in the room. The entire projects have 36 units. All the rooms are made of large duplex and 7 m ceiling height.

Figure 10: The Building of ***WINDSHELL Naradhiwas,*** *photograph by the author.*

The layout is the same on every floor and there are only two units on each floor with two elevators for serving the residents. Each room has a large balcony from 30 to 50 sq-m with garden area in front and back of the house. There is a service area at the behind and maid can use service lift from back of the house to avoid passing the room. The project has preserved large existing trees and grown more trees within the site.

The building is designed by using natural cross ventilation. Doors and openings are designed to get the wind and it was supposed not to rely on air-conditioning system. Moreover, doors and windows are up to 5 m high and designed as a sliding glass with folding function. According to these design concept, the name of WINDSHELL is like wind stands for the wind and the shell is from bare shell. The building is designed with consideration of wind direction and bare shell.

3.1.2. (2009) The MET Condominium, Bangkok

Project: The Met

Architect: WOHA, Landscape Architect: Cicada Pts. Ltd.

Year: 2009

Height: 231 m

Number of Floors: 66-storeys

Location: 123 South Sathon Road, Sathon, Bangkok

Climate: Tropical Warm and Humid

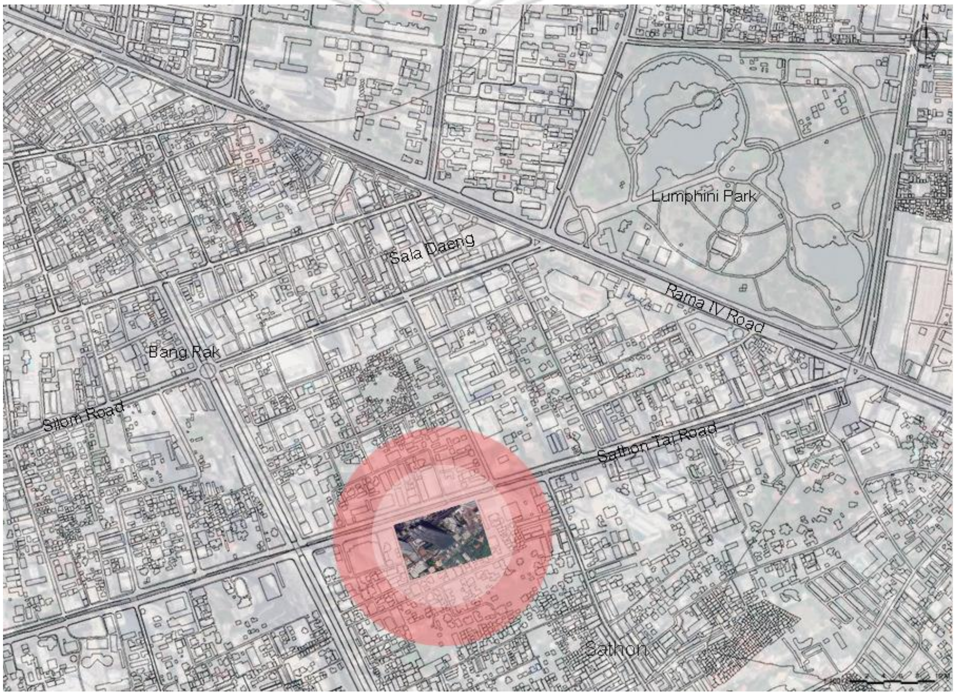


*Figure 11: Location of **The MET Condominium** in Sathon, drawn by the author.*

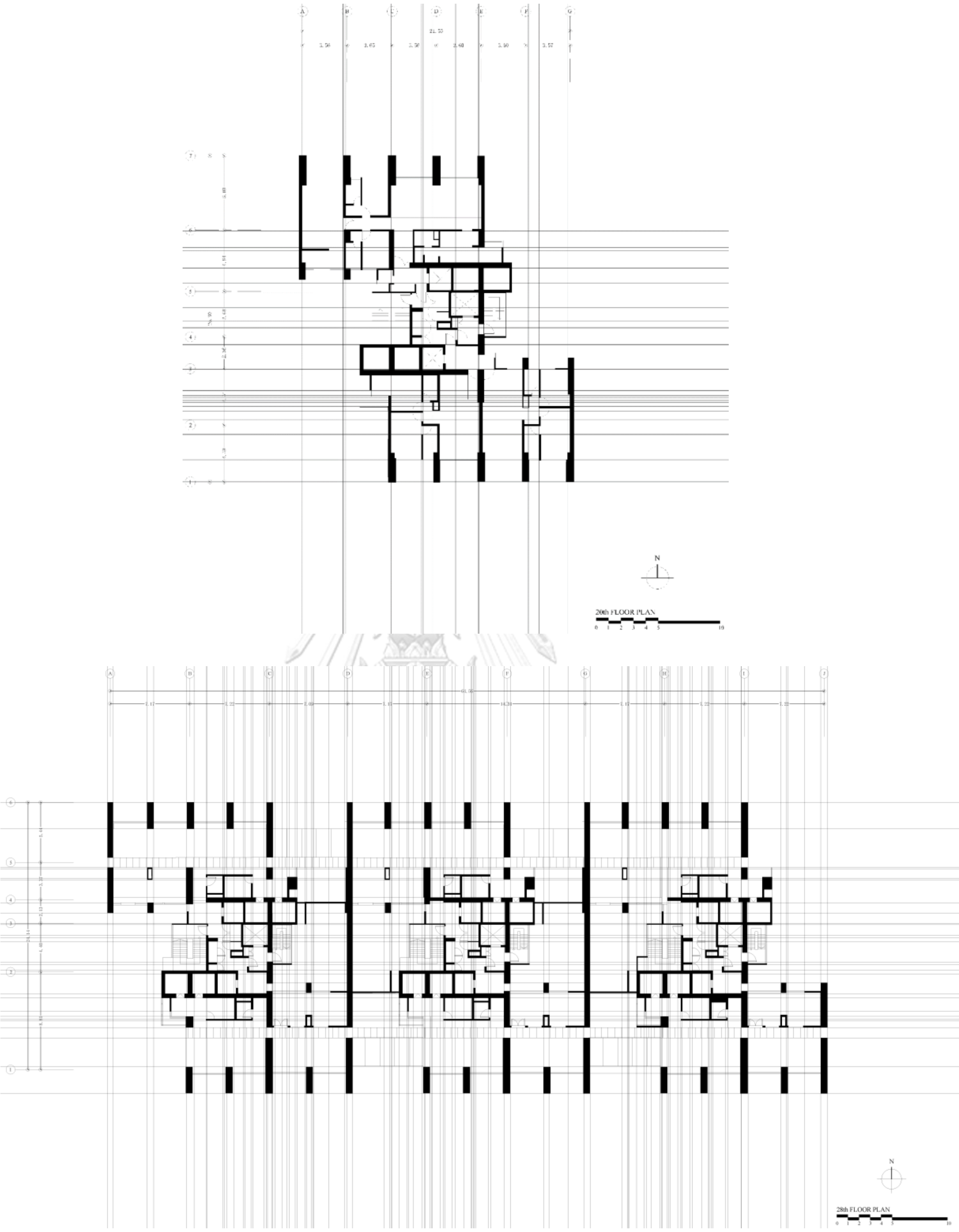


*Figure 12: 20th and 28th floor plan of **The MET Condominium,** redrawn by the author.*

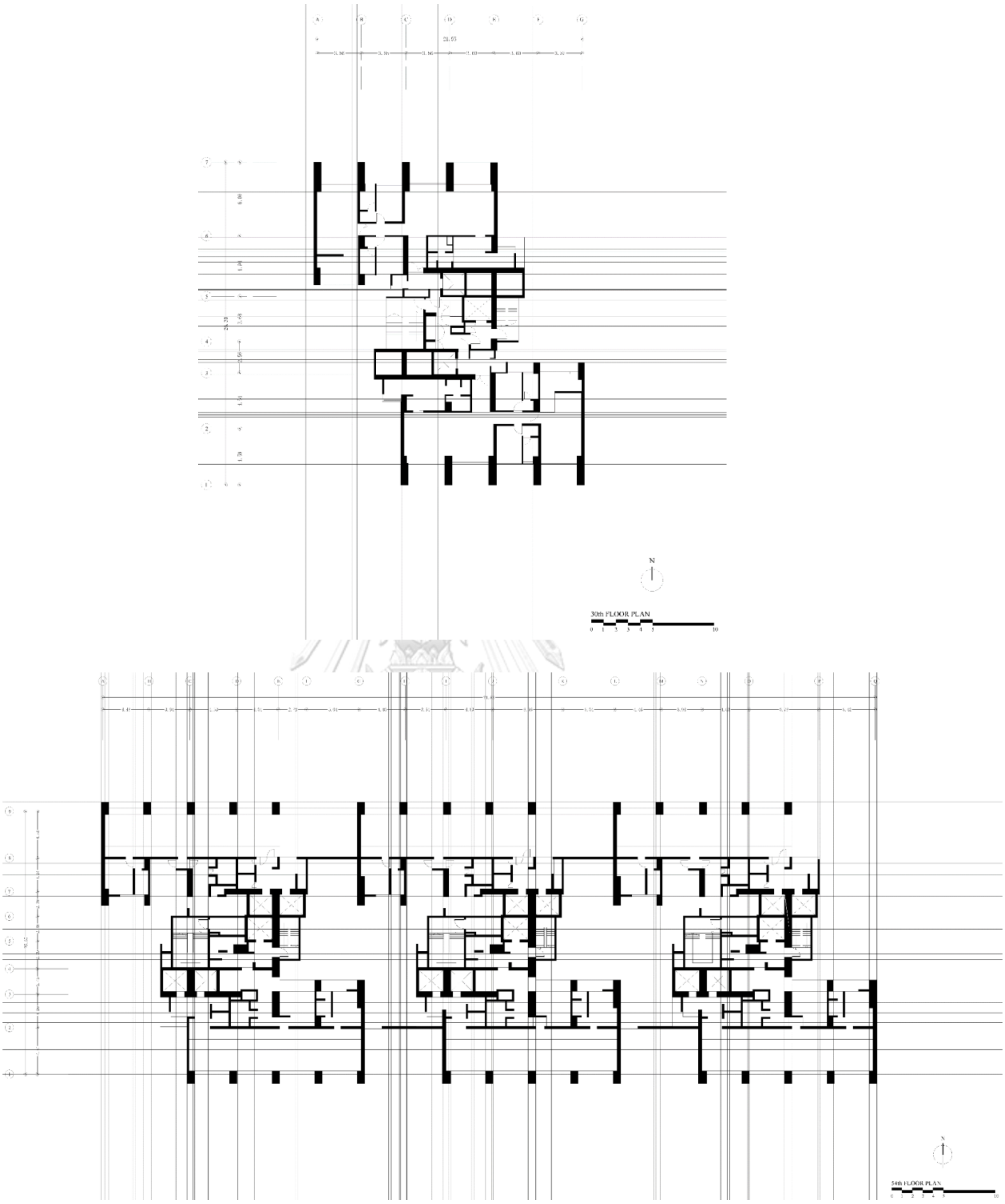


Figure 13: 30th and 54th floor plan of ***The MET Condominium,*** *redrawn by the author.*

The design concept of the building is to develop an advanced from of high-rise living for the tropics, developed less from western temperate models than from research on possibilities of low-wind, tropical climate in dense urban conditions. This project implemented several ideas developed originally for a competition in Singapore for public housing. The building has 66-storeys and 231 m in height. The rooms are in ceiling height 3 m and the lowest is 2.6 m. It is provided garden and other facilities in a building. The interior of the rooms interacts strongly with exterior with full height glazing, balconies and gardens. Sun-shading and overhang are for weather protection and screen or filtering strong tropical light. Greenery walls provide sun-shading that convert heat into oxygen and improve local air quality.

The design incorporates a staggered arrangement of blocks that allow cross ventilation, views to the river and enhance the breezes by funneling between towers. The gaps between towers are bridged with sky gardens which provide exterior entertaining areas directly. The orientation of staggered blocks allows the sun to penetrate between the blocks on its regular tropical sun-path.

Figure 14: The Building of ***The MET Condominium,*** *photograph by the author.*

3.1.3. Evaluation of Case Studies Framework

Utilize the high-rise building located in the design site compares with the three literature cases to analyze the core system. Via this comparison in terms of ventilation, lighting and circulation to find good design strategies of core system in high-rise buildings. For example, in terms of circulation, according to calculate the rate of the circulation areas in each floor to figure out a property rate about how many percentages of core area in high-rise buildings. According to the analysis, the layout of circulation in the floor plans such as position of elevators, stairs, fire escapes, corridors to analyze a good layout about the circulation system in residential high-rise buildings. In order to synthesis of the core system, the 3D model will be built to analyze the size, position and proportion.

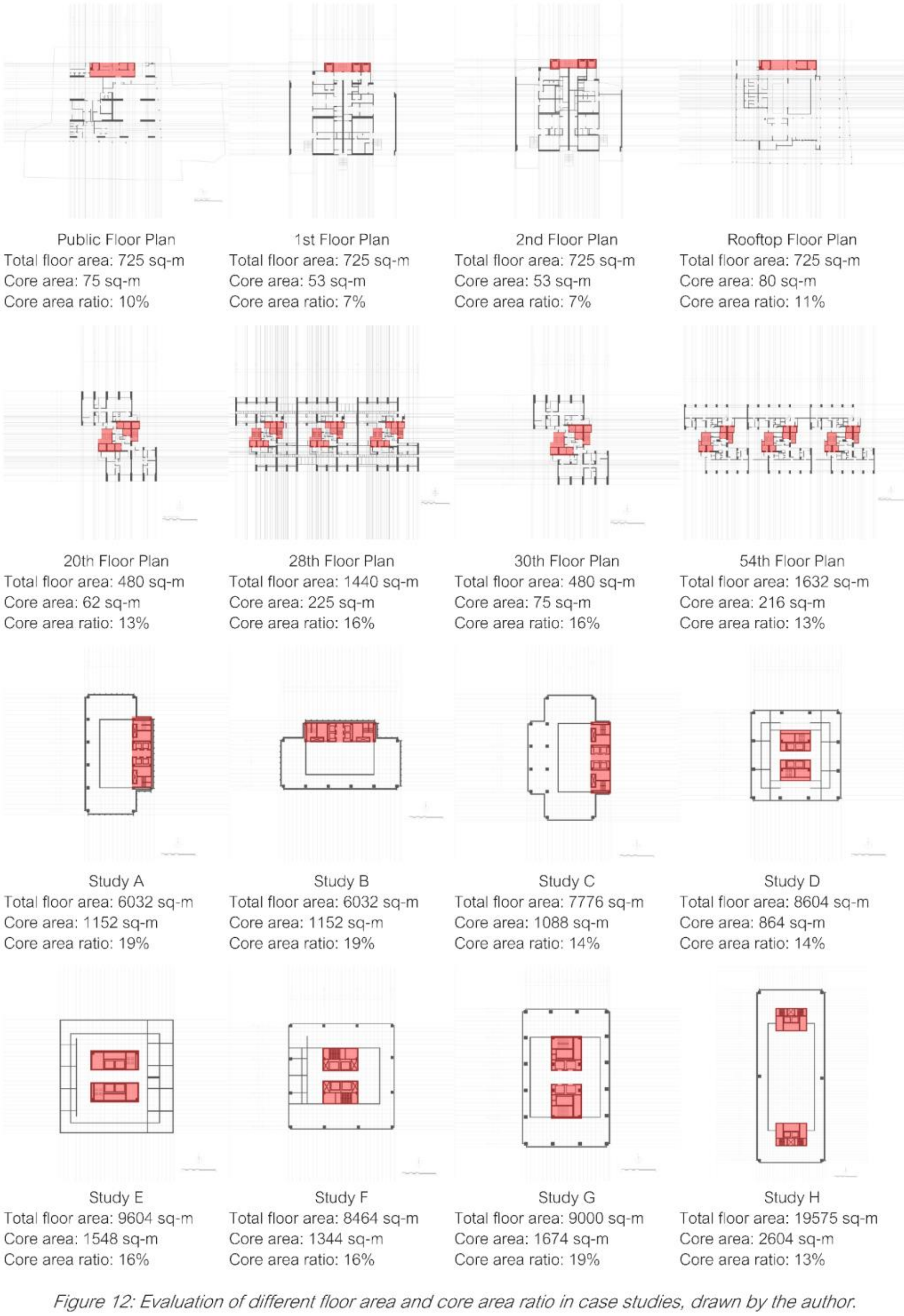


Figure 15: Evaluation of Different Floor Area and Core Area Ratio in Case Studies, drawn by the author.

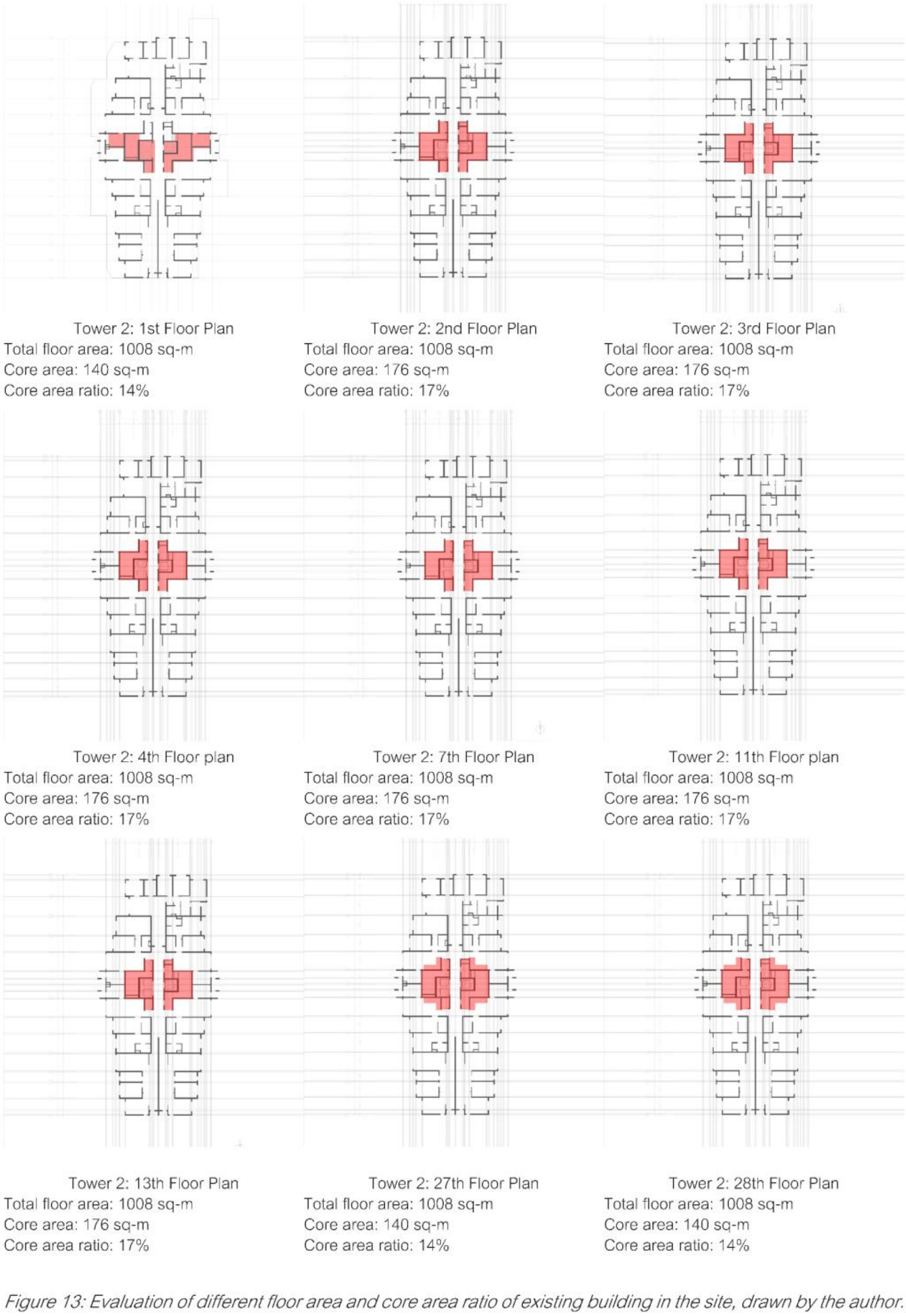


Figure 16: Evaluation of Different Floor Area and Core Area Ratio in Existing Building in the Selected Site, drawn by the author.

Chapter 4

Design Process

This design process chapter is divided by three parts. In the first part, the background of design, site analysis, user's analysis and explanation for design programs are provided. The second part is about the process of forming design solution and development and final design drawings are included in this part. The final part is the analysis of new design and existing building in the site and analytical drawings are provided in the last part of this chapter.

4.1. Introduction of Design

4.1.1. Background of Design

The design process is to apply the knowledges achieved from literature reviews and case studies, while it is a possible solution to solve the problems that Yangon is confronting.

Yangon is an important commercial city of Myanmar and a city with a population of over 7 million people. Since the past days most of the people come to find a job at Yangon to get a higher life rather than other cities. The more people come to work at city center the more accommodation places are needed at the same time. The contractors tried to sell and rent residential buildings with poor facilities for the sake of their business profit to the people who need a space to live. The over population growth made a lot of social problems and people are facing the worse traffic jam every day in the city. In the current situation, the government is trying to expand new cities into outside of downtown areas to solve the problems.

According to these facts, the problems are buildings that are not provided enough facilities, too many people gathering in the city center, lack of social meaning and life and depends on mechanical stuffs instead of nature. The significance of this research design is based on these factors and composed the design with the solution in the next design part.

4.1.2. Site Analysis

Thanlyin is a major port and nearest city which links Yangon through Bago river and not far away from commercial places. Nowadays the city is becoming more popular because it handles the majority of shipped import and export to/from the country. Most of the people are moving to this city in terms of escape the crowds.

The selected site is located at Thanlyin city. From the main road junction of Thanlyin bridge to the location of the site is about 3 km. The selected site is called Galaxy Towers and the area of the site is around 7,000 sq-m. It supposed to build 6 buildings in the site at the beginning. Currently, three buildings are built and the construction of the site has stopped. This is the existing conditions of the site until now. This site is a good option to meet the requirements for my research topic and to experience the design idea that achieved from this research.

Figure 17: Location of Selected Site in Yangon, drawn by the author.

1) Surroundings

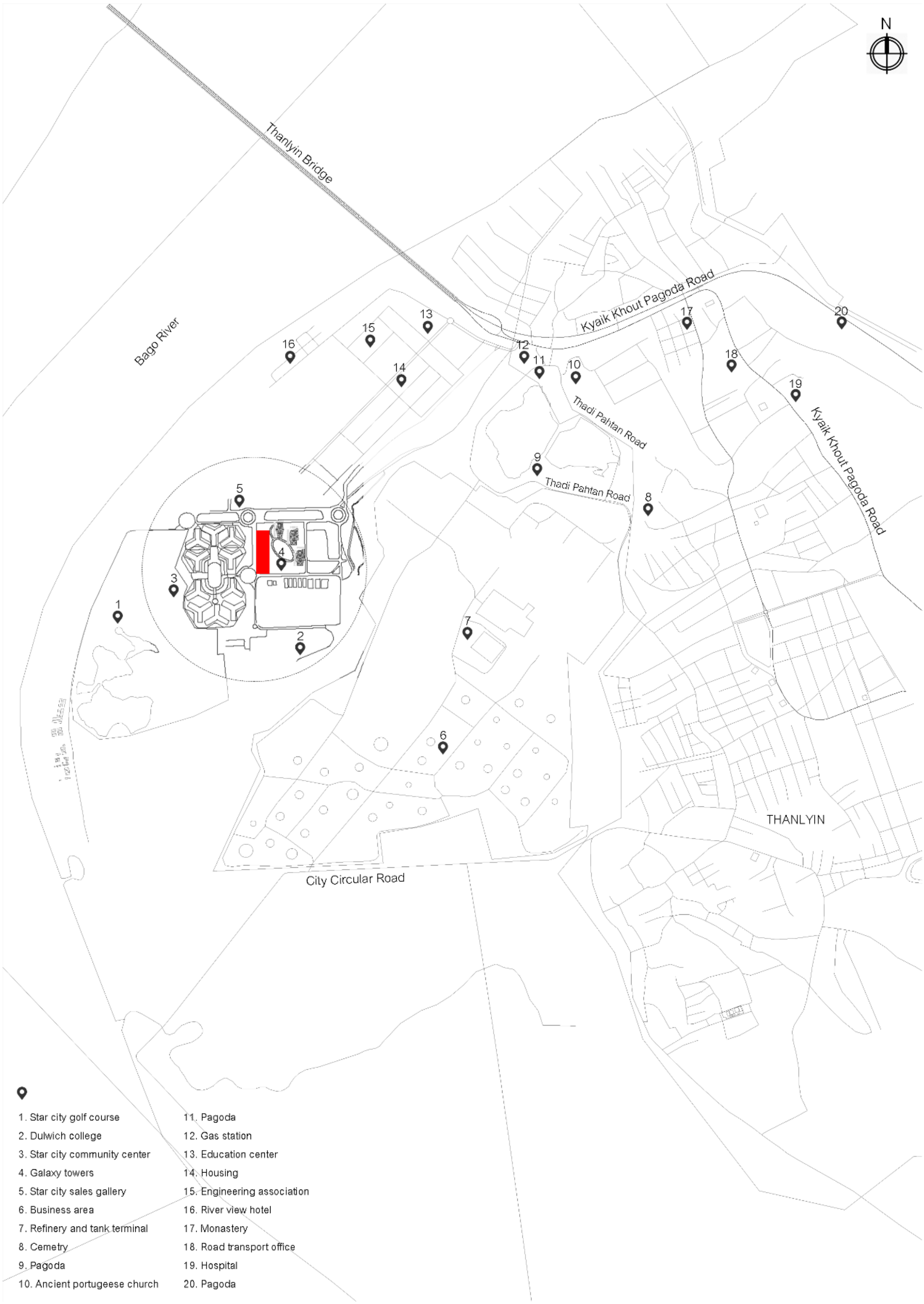


Figure 18: Macro Site Plan of Selected Site in Yangon, Scale 1:400, drawn by the author.

2) Available transportation system for site accessibility

There are two ways to reach new residential building. The first way is to use the public transportation system: bus and another one is to get a cab.

3) Laws and Regulations

a) Setback Law

If the residential building in this area is over 15-storeys, the limitation for FAR (Floor Area Ratio) is 2 and BCR (Building Coverage Ratio) is 0.4. The setback requirements are front 12 ft (3.6 m), sides and back are 8 ft (2.4 m) in the law of Yangon city development council.

*FAR = Total building floor area/ Plot area

BCR = Building footprint area/ Plot area

b) Parking lot

Minimum size of 16 ft (4.8 m) long and 8 ft (2.4m) wide parking lot shall be provided in accordance with the law. Accessible parking lots shall be located as close as possible to accessible entrance. The slope for car ramp ratio is 1:6 and 9 degree. For residential buildings, the quantity of parking lot shall be one vehicle for one unit and plus 20%.

c) Stairs

Height of the riser shall not be more than 150 mm (0.15 m) and width of the tread 300 mm (0.3 m). The steps shall not have abrupt (square) nosing.

d) Means of egress

Building or portions of any occupied portions shall be provided with the means of egress systems: the exit access and the exit and the exit discharge. Minimum ceiling heights of the exit routes shall not less than 7 feet 6 inches (2286 mm). Surface of floors of means of egress shall be a slip resistant surface. Elevators, escalators and moving walks shall not be used in required means of egress system. In residential, the number of occupants shall be computed as 200 gross floor area in sq-ft (18.5 sq-m) per person.

e) Balconies

3 feet (0.9 m) height railings shall be provided for balconies, landings, or porches which are more than 30 inches (0.8 m) above exterior ground level.

4.1.3. Users and Design Program

a) Users

It can be divided into three main groups of users who get access to building and site. There are two entry to get into the site, nevertheless people can use both access and usage of entry depends on how people come into the building by different options. In the first group of users, receptionist, security guard, shopkeeper maintenance staff, and mechanic technician, and housemaid are divided as staffs. The second group is a visitor group, and it included guests who come to the residents, customer from cafeteria, convenience store, pharmacy, laundry shop, and bookstore. The last group is the residents who get fully access to both entry of site.

GROUP 1 STAFF	A	B
1. Receptionist	●	
2. Security guard	●	
3. Shopkeeper	●	
4. Maintenance staff/ mechanic technician	●	○
5. Housemaid		●
GROUP 2 VISITORS		
1. Guest of residents	●	○
2. Cafeteria customer		●
3. Convenience store customer		●
4. Pharmacy customer		●
5. Laundry shop customer		●
5. Bookstore customer		●
GROUP 3 RESIDENTS		
1. For using facilities	●	●

A For people who get access to site from Entrance 1

B For people who get access to site from Entrance 2

● Daily access

○ Occasional access

Table 4: Analysis of Users and Their Approach, drawn by the author.

b) Design program

The program of new residential high-rise building is based on the existing building within the selected site. The author would like to maintain the functional requirements of the existing building and composed the program of new design as follows:

Car Park: The parking space is provided in basement and ground floor. It is calculated as the ratio of residential units in the building, and plus extra 20% to the ratio. These floors require natural lighting and air flow.

Main Floor: This floor is where the relation of outsider and insider has met in the building. Reception, cafeteria, bookstore, convenience store, pharmacy, and laundry shop are included in this main floor. Reception is to inquire the information about the building and residents for the outsider who come to this building. The reason why cafeteria is provided in this floor is for people who visit and, they can wait at lounge or this refreshing area. They can also have a look at bookstore that has in this floor. Convenience store, and pharmacy must have in residential building. Laundry shop is provided in this floor.

Residential Floors: For each residential unit, living room, bedrooms, restrooms, housemaid room, and terraces are included. The elevator is provided for each unit as each one and the physical fire escape stairs are beside of each unit and it has easy access to get out from the building when it comes in danger.

Service Areas: There are two entry access to the site and security guards are provided in both. The machine room is provided in each floor to maintain and check every machine that are installed in this building. Restrooms are provided in public areas such as car park and main floor for the outsider.

	Program			
	Type of room	Quantity	Area (sq-m)	Users
Basement and ground floor	1. Parking lot	84	1310.4	Residents, guests
	2. Machine room/ maintenance room	2	101	Staffs/ mechanic technician
	3. Restrooms	4	33	Staffs, guests, residents
		Sub Total	1444.4 sq-m	
Main floor	1. Reception	1	-	Residents, guests, staffs
	2. Lounge	1	-	Residents, guests, staffs
	3. Cafeteria	1	-	Staffs, guests, residents
	4. Bookstore	1	-	Residents, guests, staffs
	5. Convenience store	1	-	Residents, guests, staffs
	6. Pharmacy	1	-	Residents, guests, staffs
	7. Laundry shop	1	-	Residents, guests, staffs
		Sub Total	2447.43 sq-m	
Residents floor: studio	1. Bedroom area	12	191.28	Residents
	2. Kitchen	12	136.8	Residents
	3. WC	12	78.96	Residents
	4. Terrace	12	612	Residents
		Sub Total	1019.04 sq-m	
Residents floor: one bedroom	1. Bedroom	12	287.4	Residents
	2. Kitchen	12	136.8	Residents
	3. WC	12	78.96	Residents
	4. Terrace	12	612	Residents
		Sub Total	1115.16 sq-m	
Residents floor: two bedroom	1. Living room	16	462.56	Residents
	2. Master bedroom with shower/ WC attached	16	644.48	Residents
	3. Maid room with shower/ WC attached	16	562.72	Maid
	4. Kitchen/ dining	16	219.84	Residents, maid
	5. Common WC	16	53.96	Residents, maid
	6. Terrace	16	1128.96	Residents, maid
		Sub Total	3072.52 sq-m	

	Program			
	Type of room	Quantity	Area (sq-m)	Users
Residents floor: three bedroom	1. Living room	16	462.56	Residents
	2. Master bedroom with shower/ WC attached	32	10311.68	Residents
	3. Maid room with shower/ WC attached	16	562.72	Maid
	4. Dining room	16	352.96	Residents, maid
	5. Kitchen	16	112.48	Residents, maid
	5. Common WC	16	53.96	Residents, maid
	6. Terrace	16	468.16	Residents, maid
		Sub Total	12324.52 sq-m	
Residents floor: three bedroom	1. Living room	12	865.68	Residents
	2. Master bedroom with shower/ WC attached	24	966.72	Residents
	3. Double bedroom with shower/ WC attached	12	483.36	Residents
	4. Maid room with shower/ WC attached	12	422.04	Maid
	5. Dining room	12	264.72	Residents, maid
	6. Kitchen	12	84.36	Residents, maid
	7. Common WC	12	39.72	Residents, maid
	8. Terrace	12	1084.32	Residents, maid
		Sub Total	4210.92 sq-m	
Rooftop floor	1. Swimming pool	1	232.03	Residents
	2. Shower room	2	8.92	Residents
	3. Common WC	4	21.44	Residents
		Sub Total	262.39 sq-m	
	Total		25,896.38 sq-m	

Table 5: The Relationship of Program and Areas Use in Design, drawn by the author.

4.2. Process of Forming Design

This design started from analyzing the existing problems in the selected site. According to these problems, the author wanted to figure out the possible solution, then via compared to get the final design.

4.2.1. Existing Problems

By examining the existing building in the site, the composition of core is placed in the middle of plans and enclosed with the other rooms beside. There has no lighting can get into this area. In each floor, at least 8 units of residents are staying in and there has total

29-storeys in a building. The elevators are provided two for residents and one for the service. The configuration of circulation in a building is less and insufficient for people by this quantity. For the new design of residential high-rise building, the author started from these factors that are not compatible with the people.

4.2.2. Design Solution and Development

The main concept of designing new residential high-rise building in the selected site is to design the building with better core system that is suitable in the tropics. The main approach is to catch natural ventilation, lighting, and circulation flow into the whole building as much as possible. In addition, the author composed the façade of the building concern with ventilation and lighting. The circulation for the new design is constructed from the study of composition of circulation from case studies and literature reviews.

Firstly, the author started with the configuration of taxis in actual buildings from the study of this research. The purpose of this approach is to interpret the circulation flow and lighting of the existing building, and composition core in different space. The author constructed the different space composition plans by following the regulating taxis and space, as shown in the studies of design process figures. In the final design, the selected composition of taxis, circulation flow and frameworks from this study are applied. The figures are shown in the next pages.

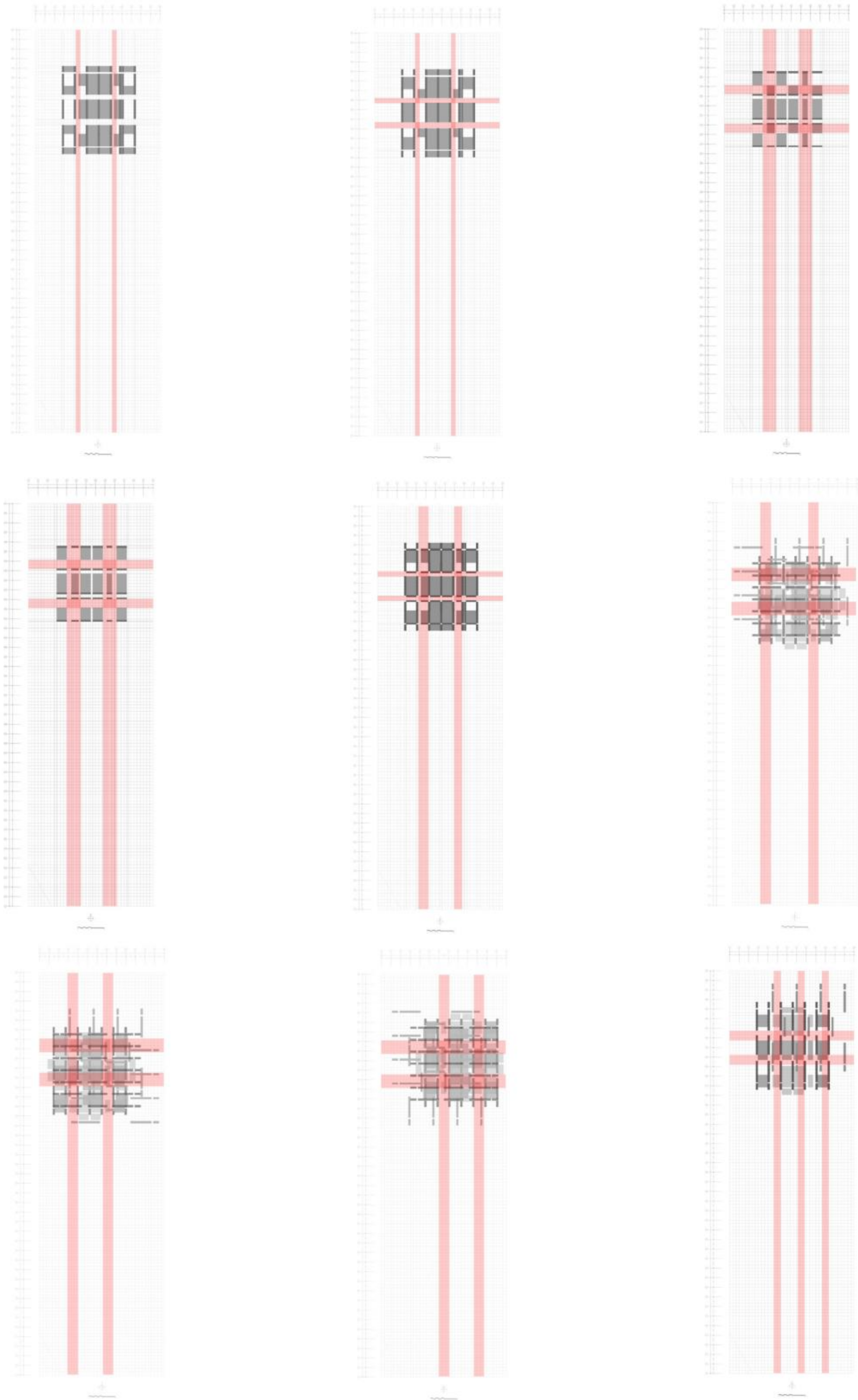


Figure 19: Study of circulation and space composition A style on existing case studies from Chapter 3, drawn by the author.

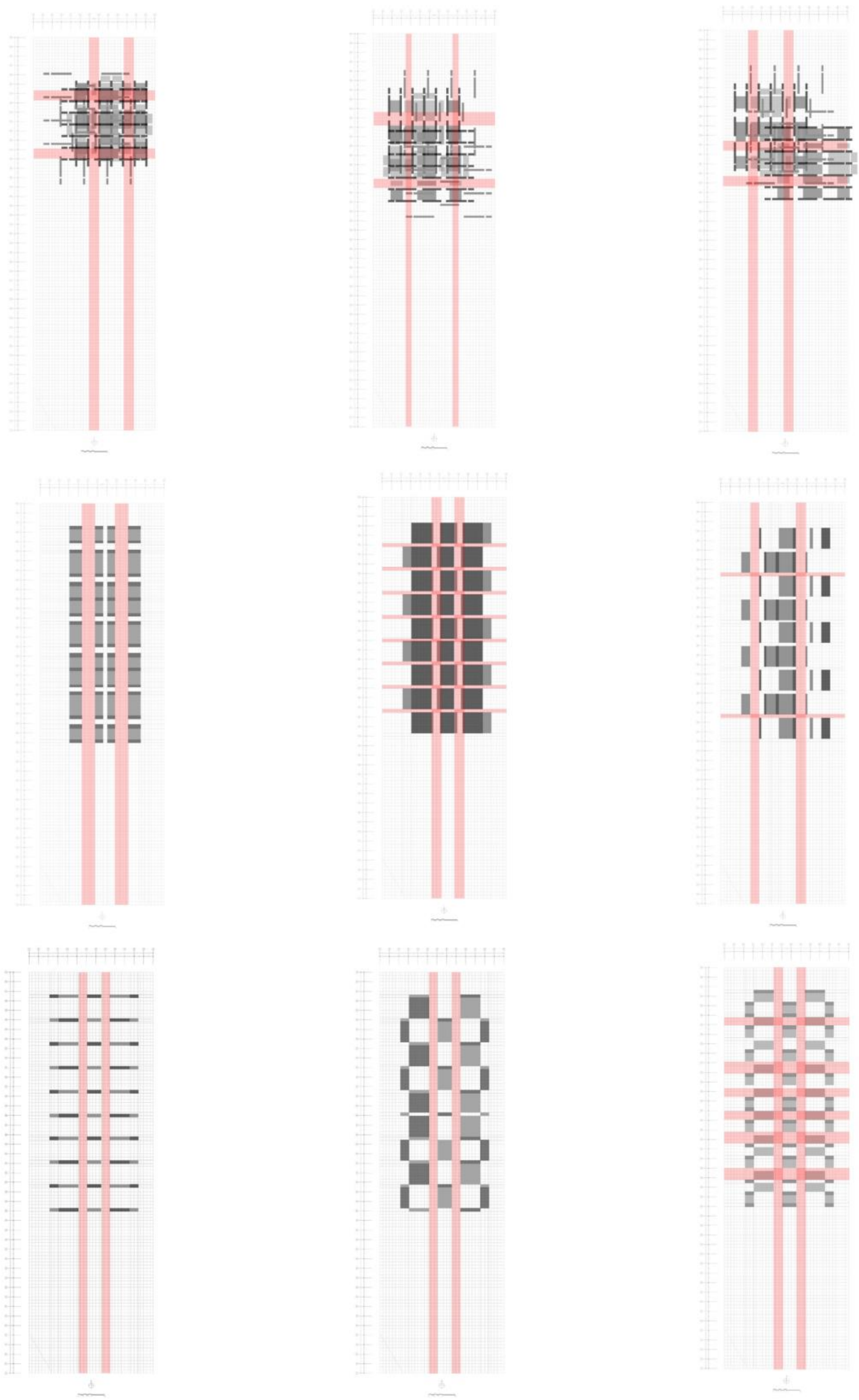


Figure 20: Study of circulation and space composition A style (above) and B style (below) on existing case studies from Chapter 3, drawn by the author.

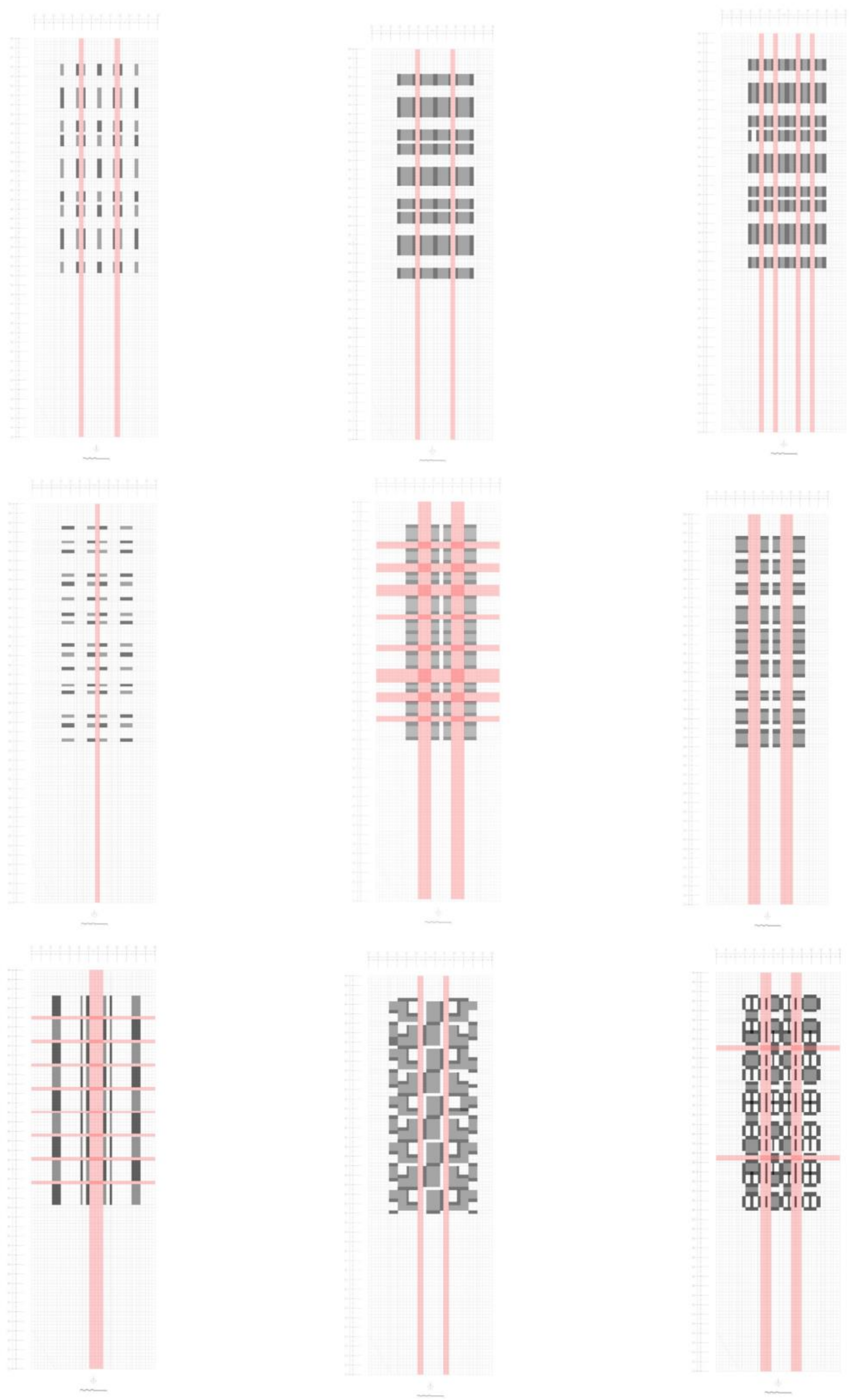


Figure 21: Study of circulation and space composition B style on existing case studies from Chapter 3, drawn by the author.

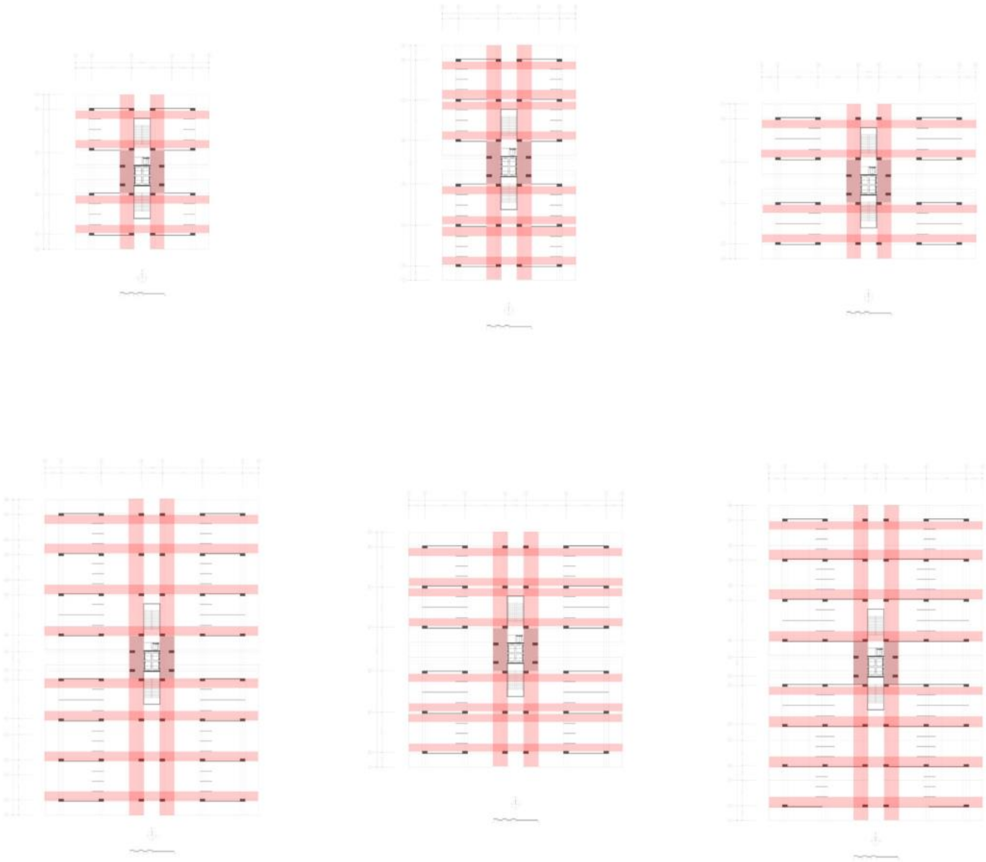


Figure 22: Study of circulation and space composition C style on existing case studies from Chapter 3, drawn by the author.

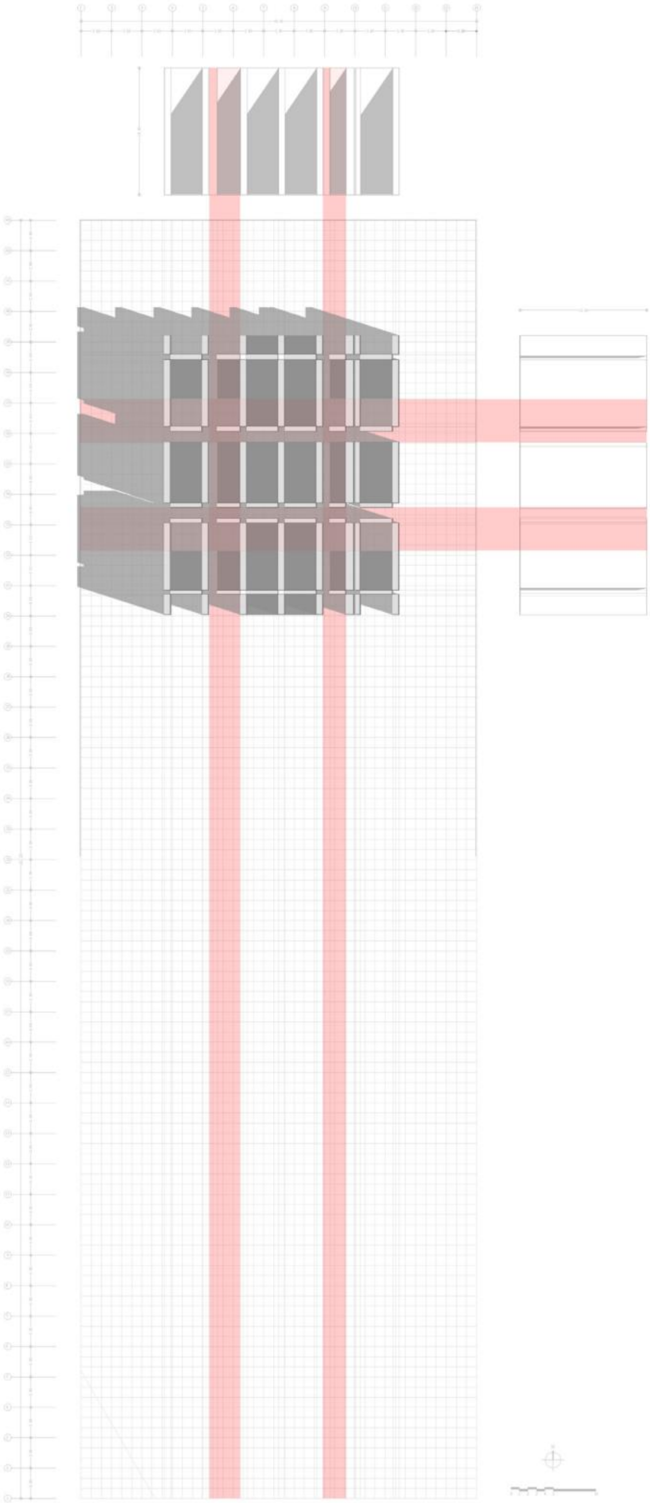


Figure 23: Study of circulation and space composition A style on existing case studies from Chapter 3, drawn by the author.

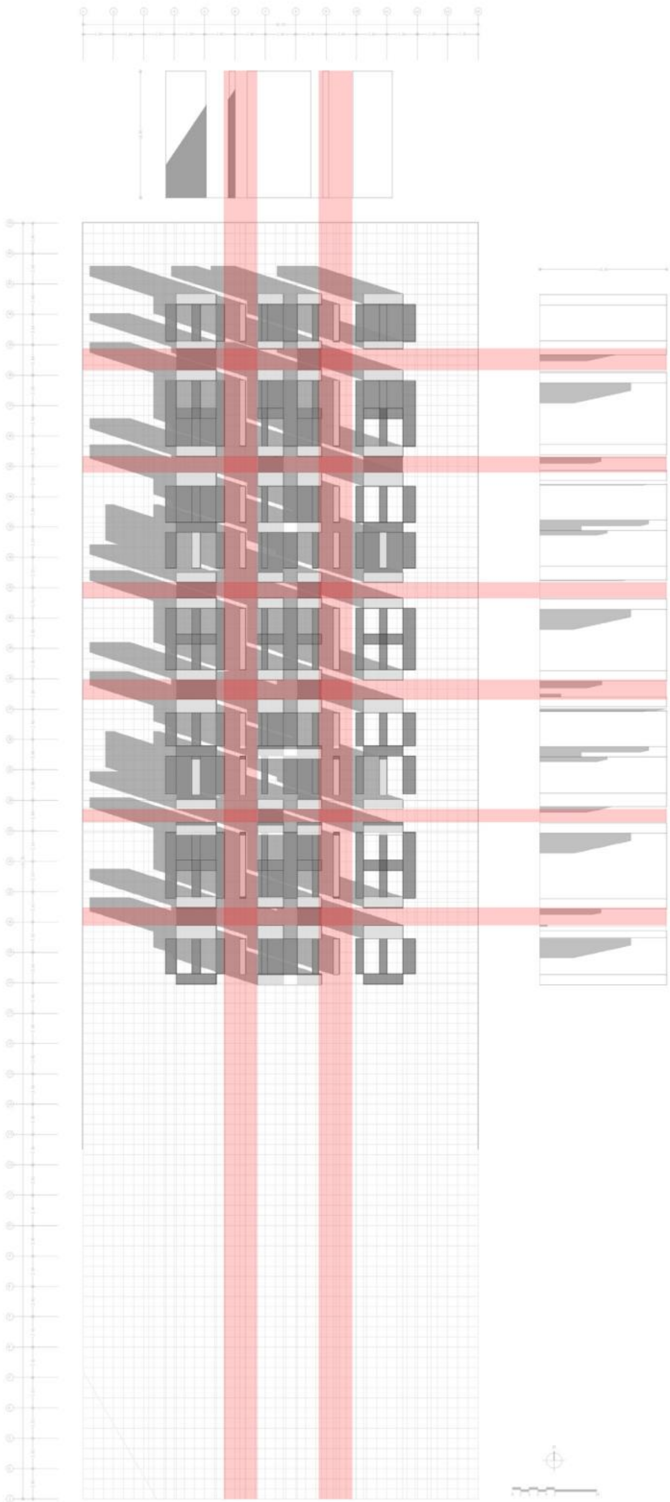


Figure 24: Study of circulation and space composition B style on existing case studies from Chapter 3, drawn by the author.

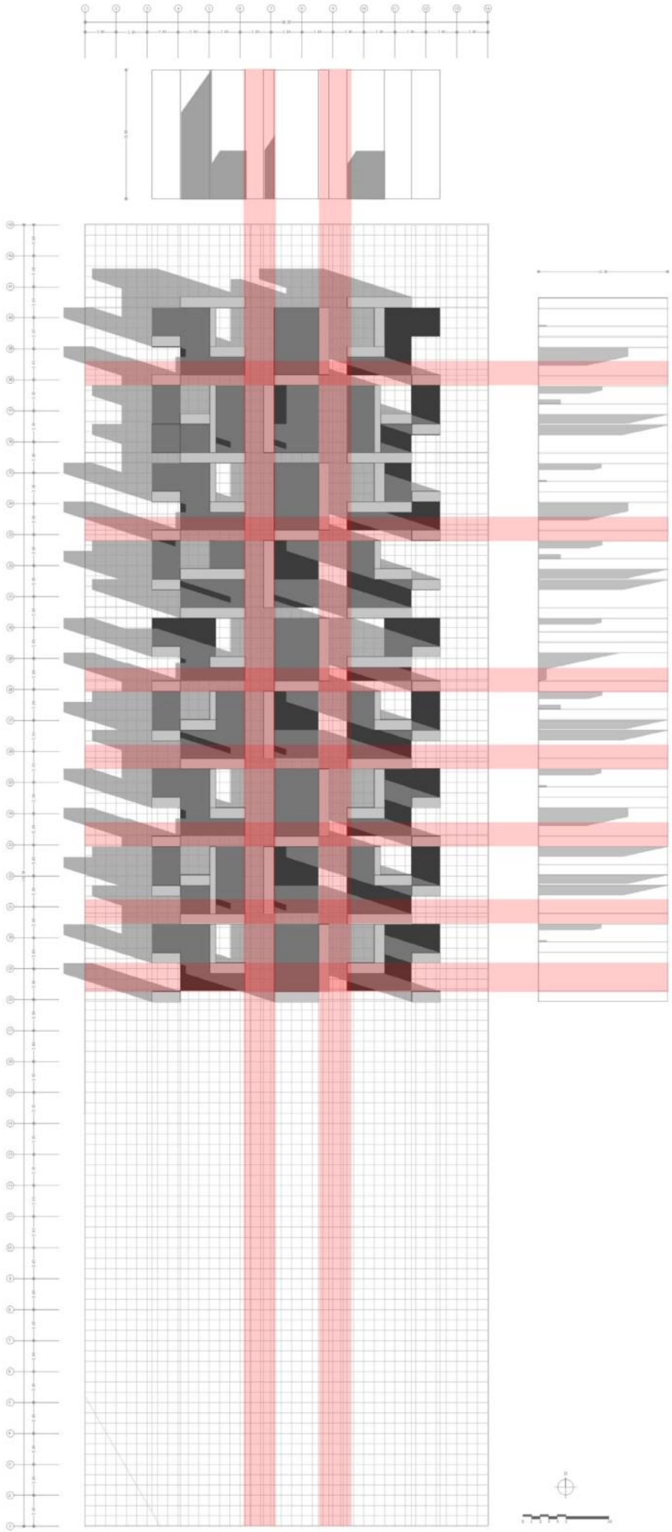


Figure 25: Study of circulation and space composition B style on existing case studies from Chapter 3, drawn by the author.

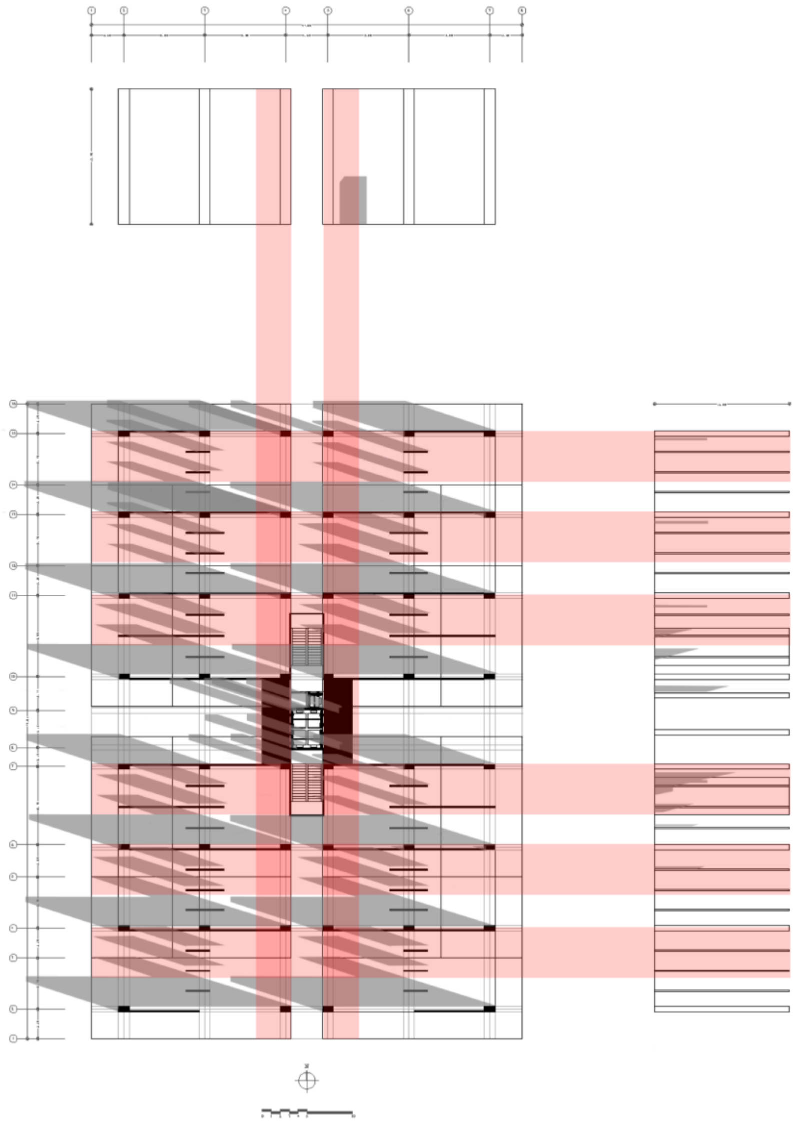


Figure 26: Study of circulation and space composition C style on existing case studies from Chapter 3, drawn by the author.

This part illustrates how the selected space composition is constructed step by step to form final design. The main axis of the selected site is preserved the shape of new design building. When the design comes to form, the author started the composition of circulation and position of core: elevators and stairs. The elevators and stairs are chosen by concerning with the laws and regulations. The elevators are provided one for each unit residents and one service elevator for fireman with machine room. The two physical fire escape stairs are 1.5 m wide and provided with smoke stop lobby.

	Elevators		Staircase 1.5 m
Service core		 Service elevator	
Load (kg)	1000 kg (13 persons)	630 kg (8 persons)	Riser 0.17 m (17 cm) Tread 0.3 m (30 cm) Length 8.82 m Steps 29 steps
Well	Width 2.3 m Depth 2 m	Width 1.95 m Depth 1.95 m	
Car	Width 1.67 m Depth 1.44 m Height 5.0 m	Width 1.06 m Depth 1.30 m Height 5.0 m	
Velocity	1.0 m/s	0.5 m/s	
Landing doors	Width 0.95 m Height 5.0 m	Width 0.94 m Height 5.0 m	

Table 6: The details of elevators and stairs that are provided in design, drawn by the author.

The basement and ground floor are for parking lot and in need of natural lighting and air flow, the author designed the retaining walls for the basement and constructed as openings until ground floor. The residential floors are divided as different unit and system in each floor. Terraces of different length are composed in 1st floor to 6th floor. The transfer floor is at 7th floor and all the outdoor unit of VRV air conditioning system for the whole building are placed in this floor. From 12th to 15th floor, the author designed different system for windows that are suited for the tropics and it can be opened by using mechanism at one time. The rooftop is included swimming pool and rooftop garden. For façade design, the glasses are composed as sliding doors and windows in the whole building.

The core: elevators and stairs are placed in the middle of the building and not enclosed. These are concerned with the design strategy to get natural ventilation and light directly. The author exposed skin of the building: structural system and it shows the overall appearance of whole building. In the aspect of structural system, the author composed reinforced concrete columns and I-beams as vertical and horizontal support of the building. Each column stands 8 or 9 m apart and based on this structure the author extended the cantilever as 3 m distance for terraces in each floor.

There has two access to get into the building. From the main entrance, people can drive through into the basement and ground floor directly and pedestrian is provided to arrive main floor. Another entrance is only provided pedestrians to reach main floor. The security is provided for both entries. The details of design are shown in the design drawings part.

4.2.3. Organization of Utility

The organization of utility in this thesis is different from the characteristics of Parisian Haussmann style apartments, those are first floor was reserved for merchants and shops, second floor was for the wealthiest family, third, fourth and fifth floors were for well-off Parisians under the lower ceiling height and sixth floor was reserved for the servants. In this thesis, the organization of utility can be described as follows.

Basement is for the car park and the mechanical system of the building. Ground floor is for the garden, the car park, the main and the subordinary circulation spaces that lead the inhabitants and the users to the main floor. Main floor is, like Haussmann style apartment is reserved for merchants and shops. The ceiling height is 10 meters high. First to third floors are the smallest room type, the Studio. Fourth to sixth floors are 1-bedroom type. Seventh floor is the transferred floor for mechanical system of the building. Eight to eleventh floors are 2-bedrooms type. Twelve to fifteenth floors are 3-bedrooms type. Sixteen to eighteenth floors are 4-bedrooms type, reserved for the wealthiest family. The rooftop is for leisure: swimming pool and garden.

The organization of utility as described above is based mainly on the idea of utilizing the floor plates of the upper floor to be a shading device of the lower floor. It is true to say that this thesis proposes the wealthiest to be living above the well-off inhabitants, for a better view of the sky, it is necessary to think about privacy, such as the elevators reserved for high zone. For quality of space, such as ceiling height, the objective is that all types are equal in a sense of architectural elements and structural composition, for a better residential high rise in the tropics.

4.2.4. Final Design Drawings

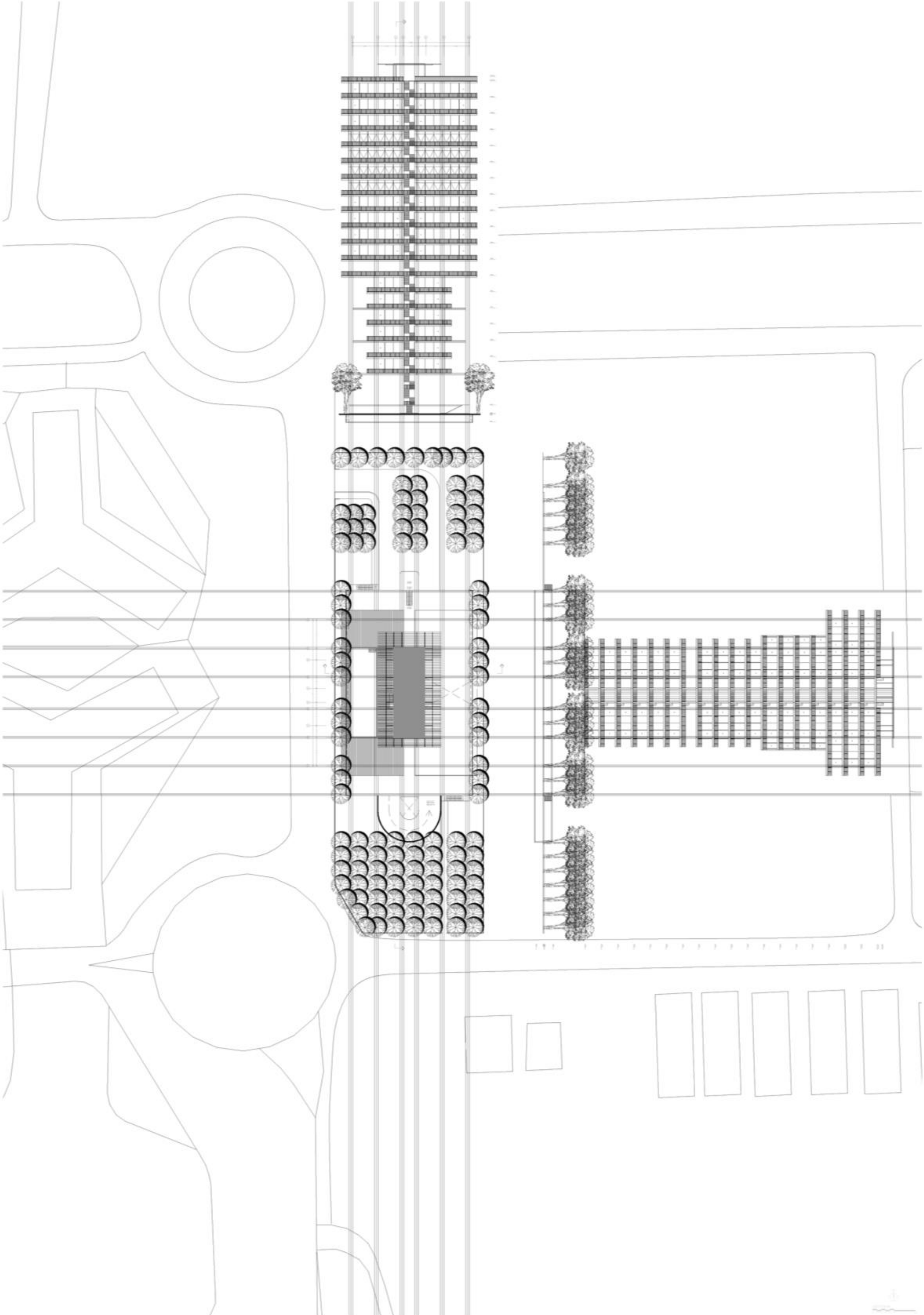


Figure 27: Site Plan Layout, drawn by the author.

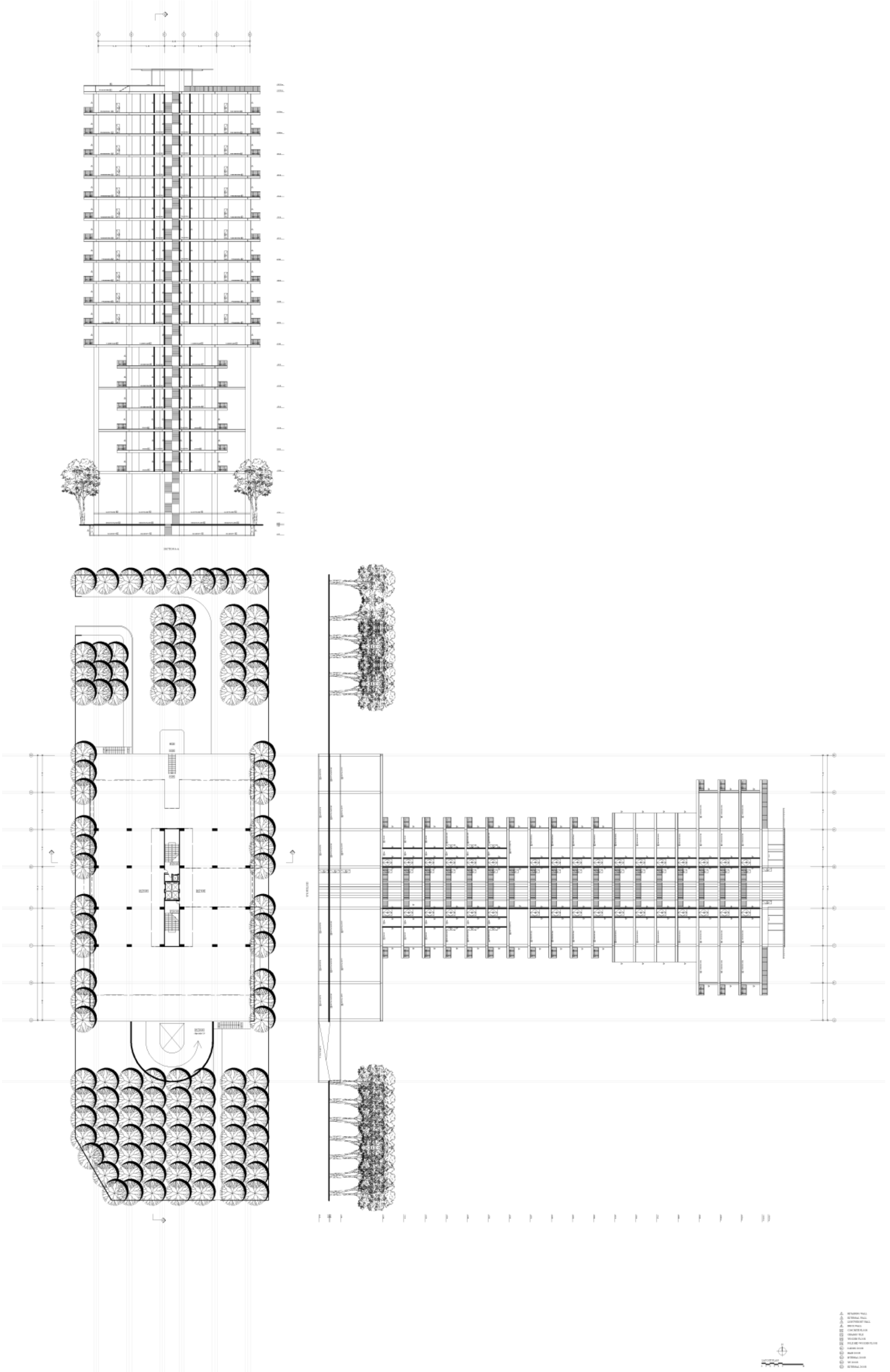


Figure 28: Layout Plan 1, drawn by the author.

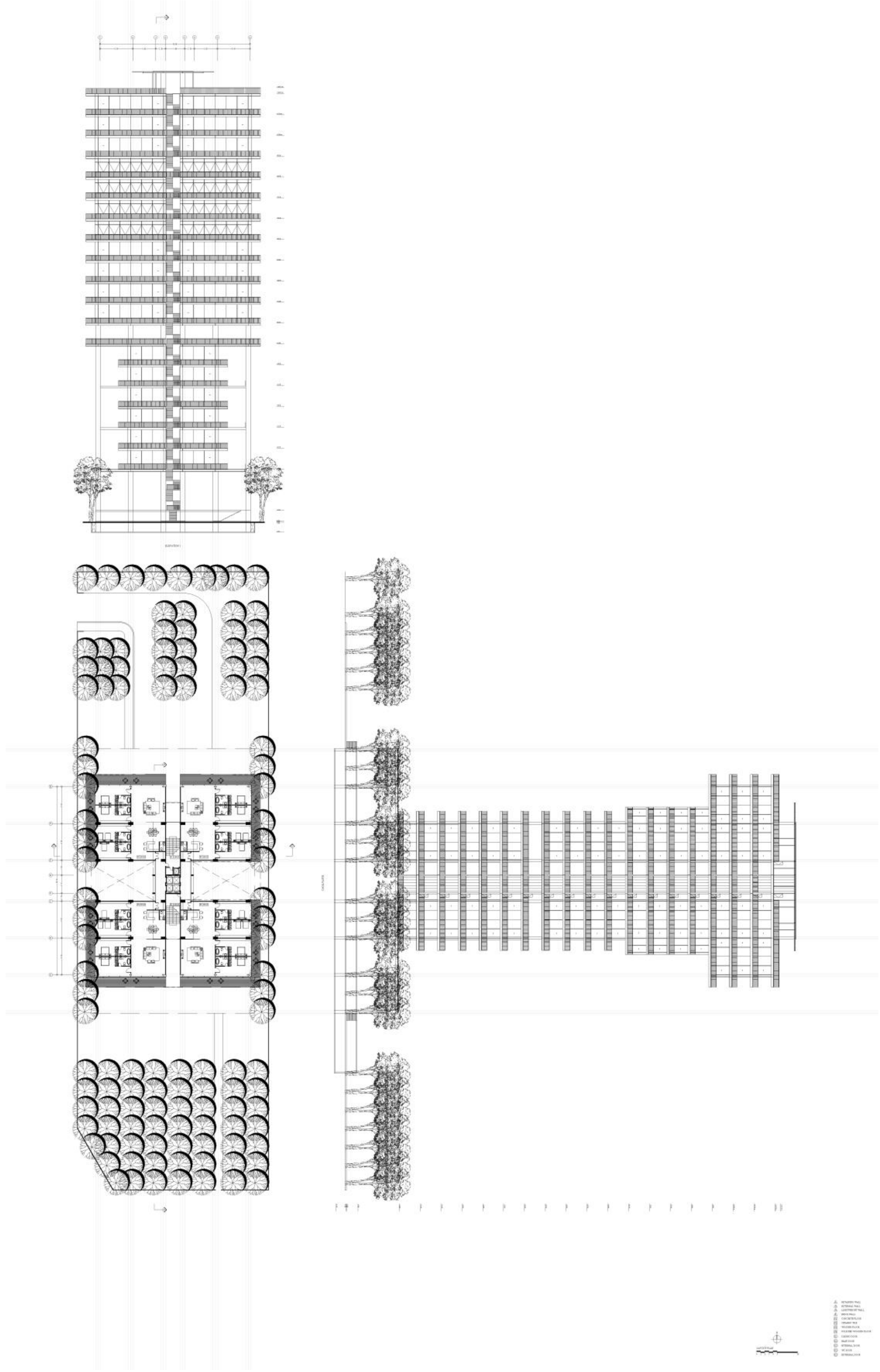


Figure 29: Layout Plan 2, drawn by the author.

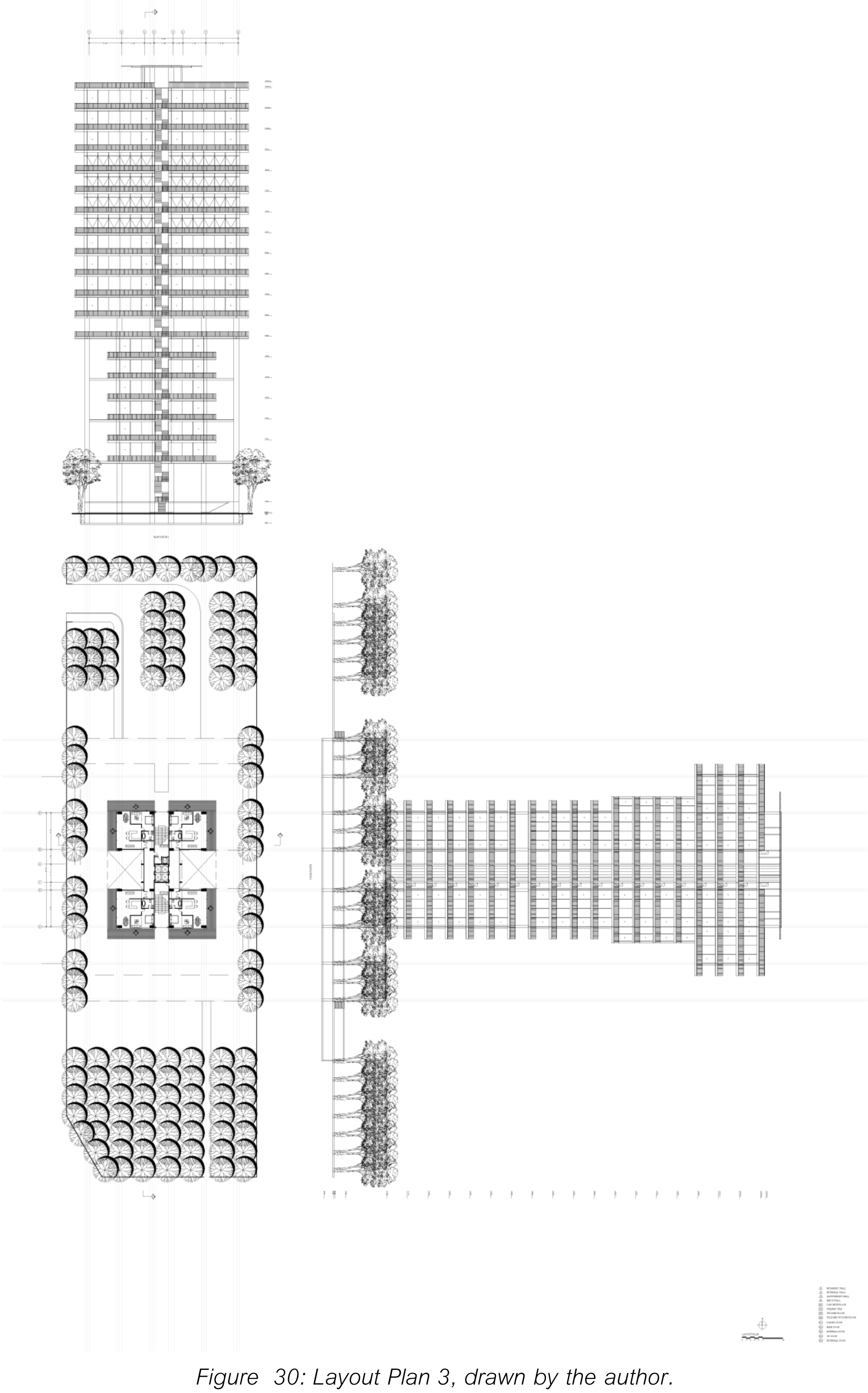


Figure 30: Layout Plan 3, drawn by the author.

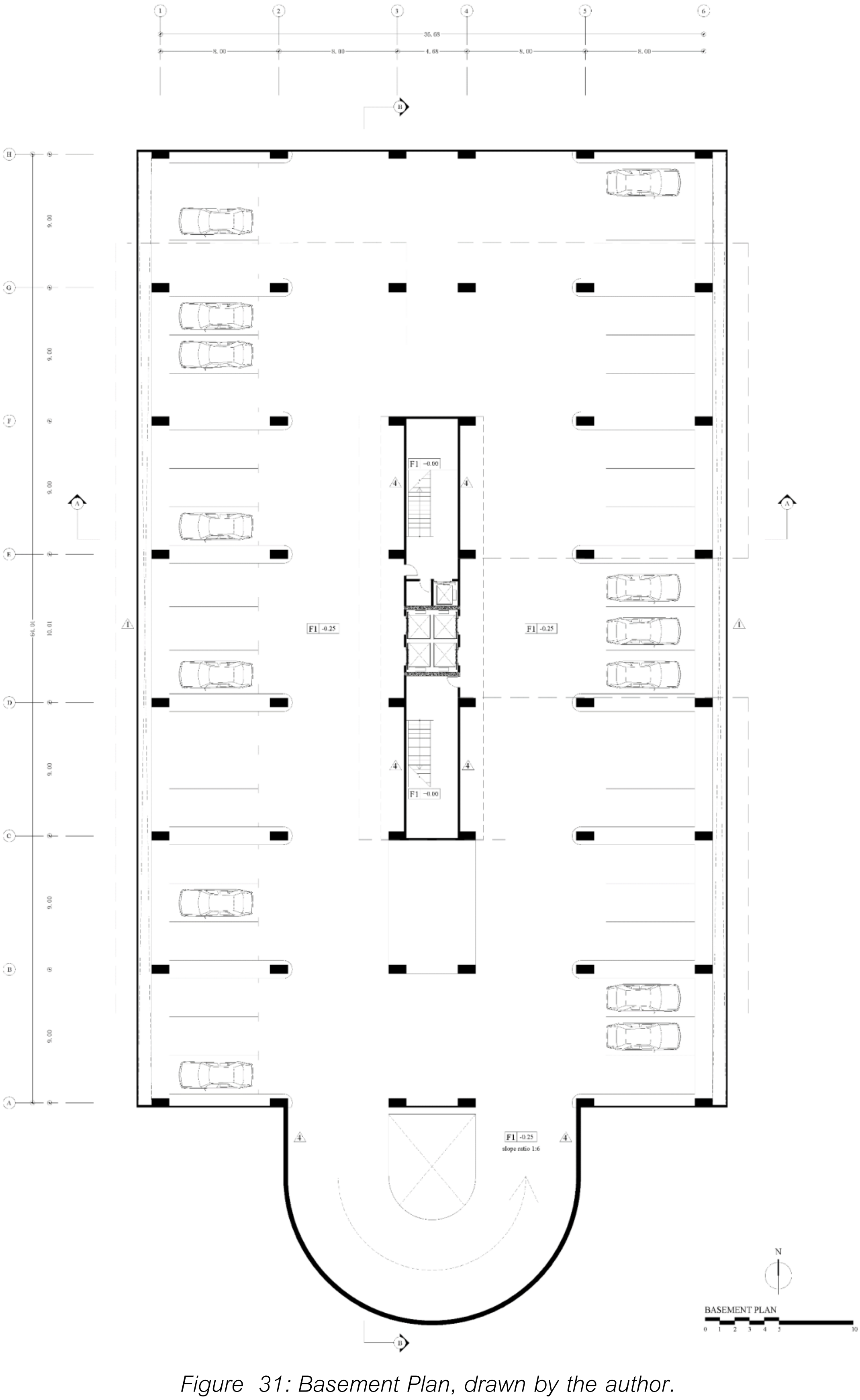


Figure 31: Basement Plan, drawn by the author.

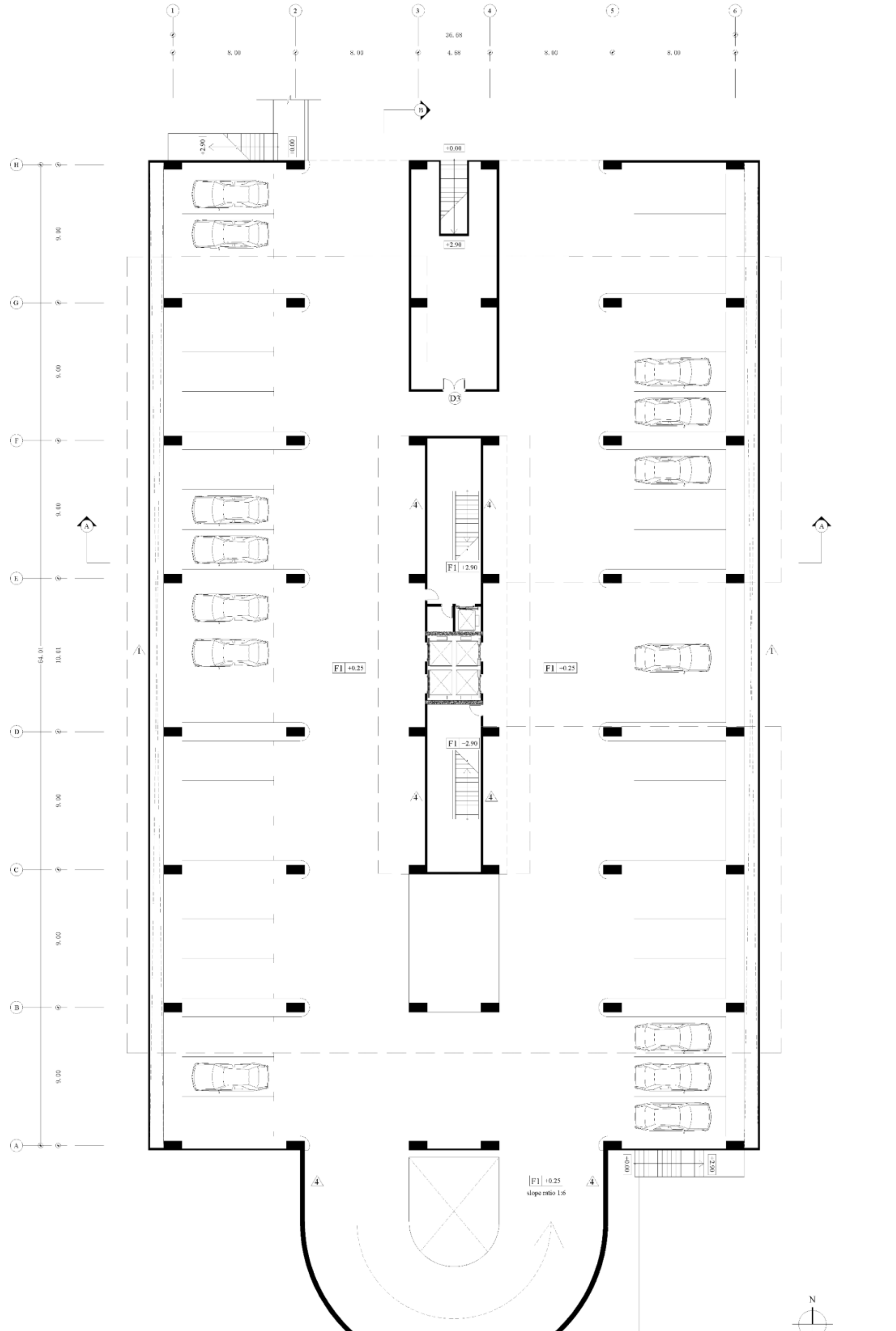


Figure 32: Ground Floor Plan, drawn by the author.

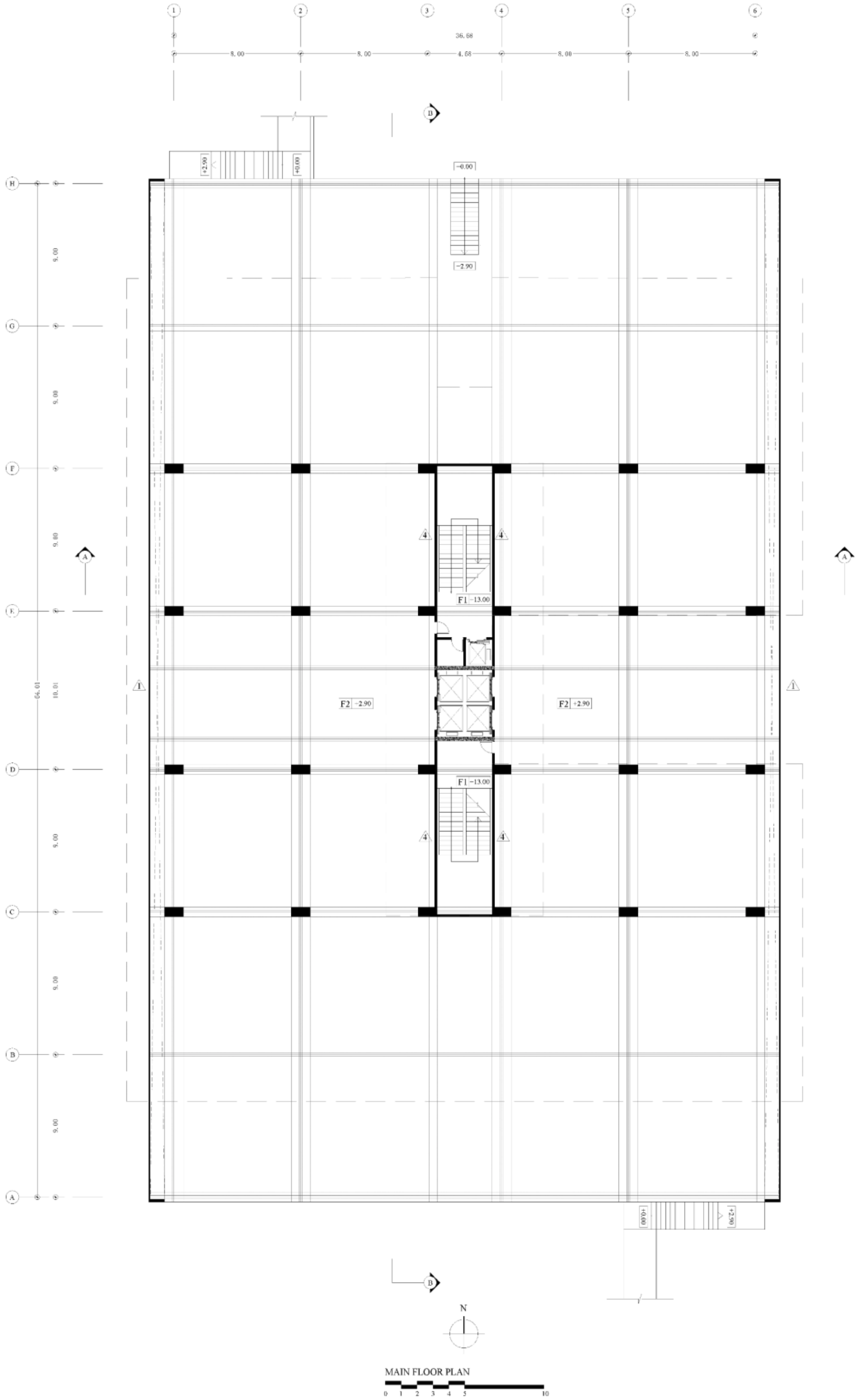


Figure 33: Main Floor Plan, drawn by the author.

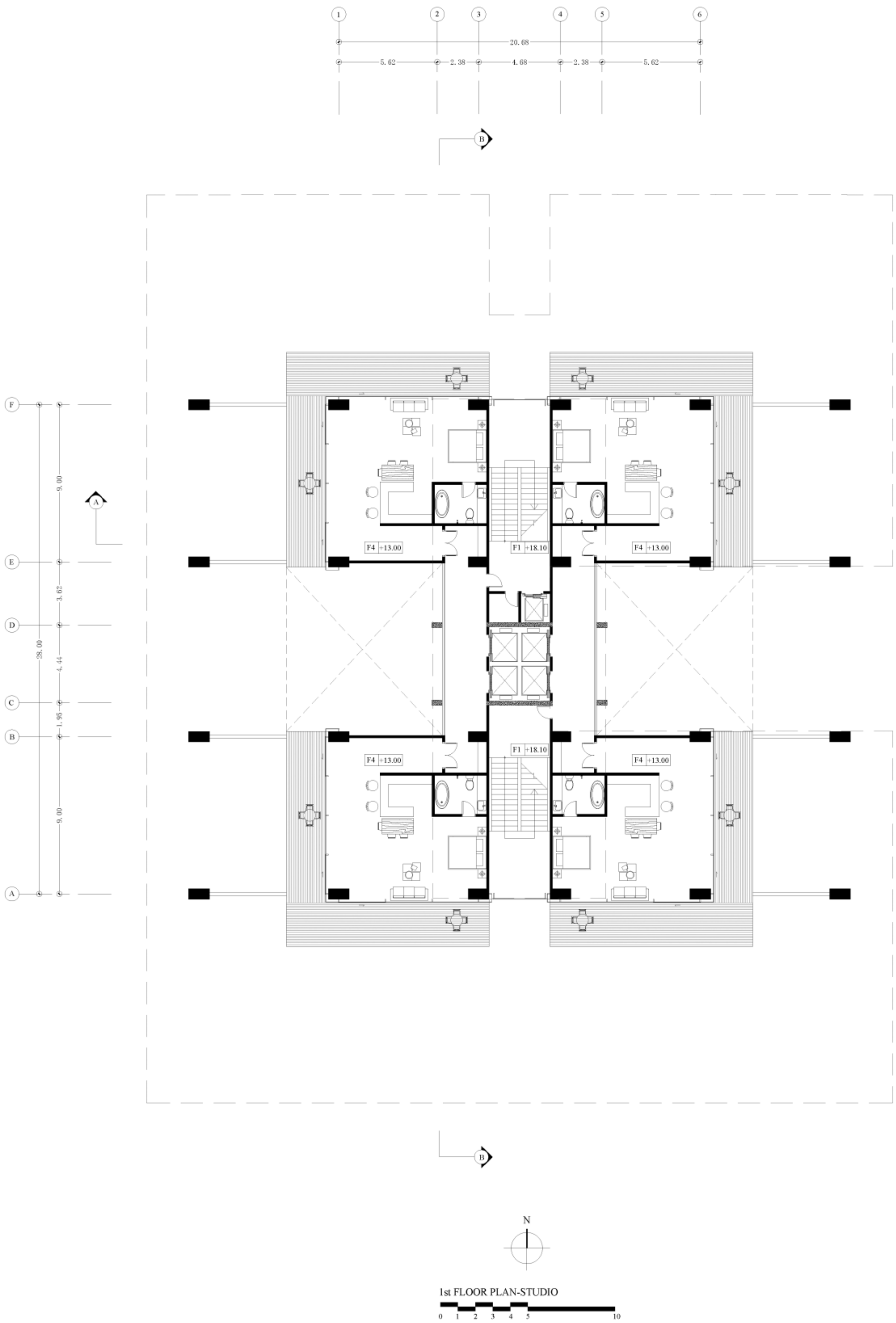


Figure 34: 1st to 3rd Floor Plan: Studio Unit, drawn by the author.

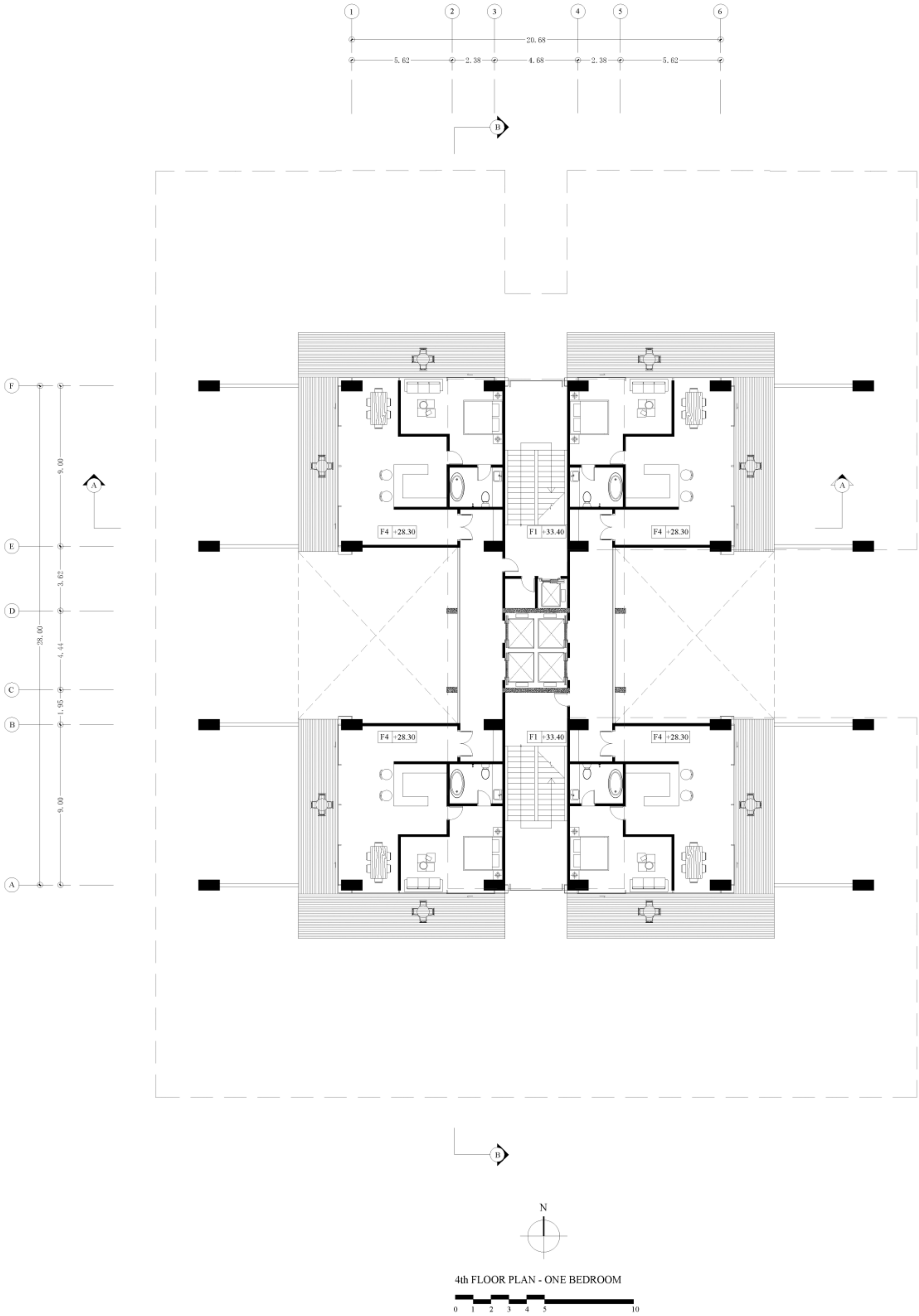


Figure 35: 4th to 6th Floor Plan: One Bedroom Unit, drawn by the author.

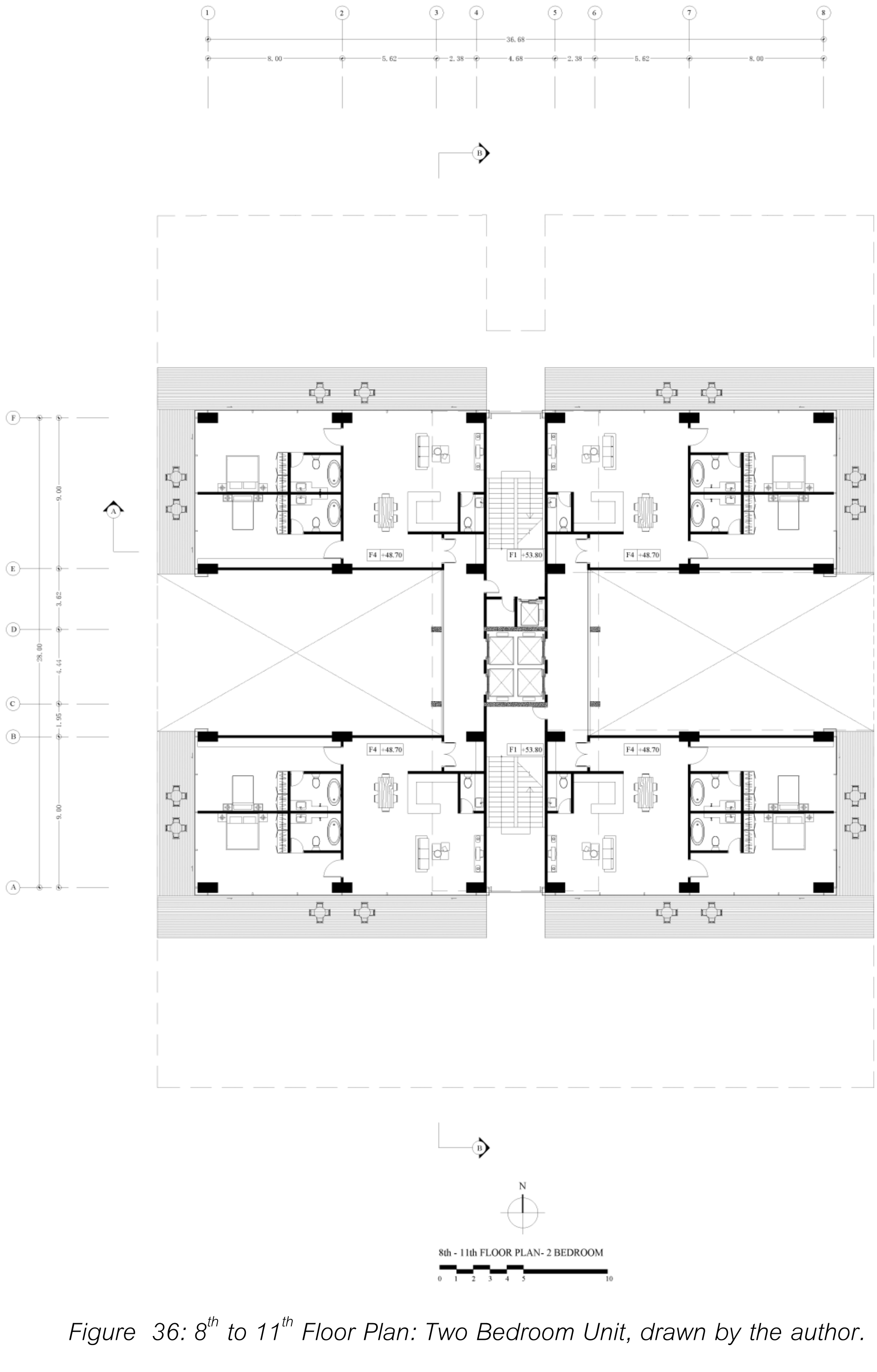


Figure 36: 8th to 11th Floor Plan: Two Bedroom Unit, drawn by the author.

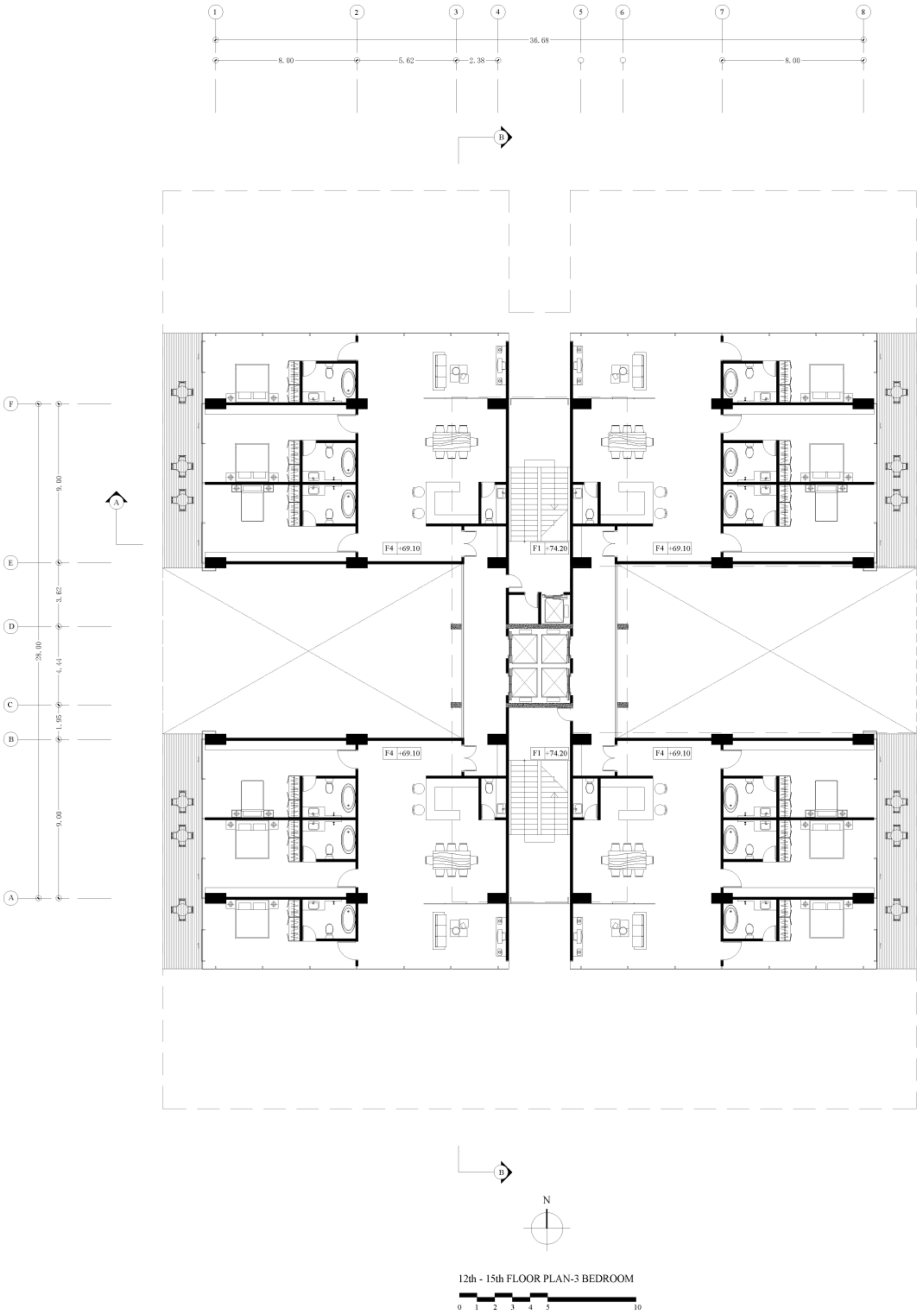


Figure 37: 12th to 15th Floor Plan: Three Bedroom Unit, drawn by the author.

Figure 38: 16th to 18th Floor Plan: Four Bedroom Unit, drawn by the author.

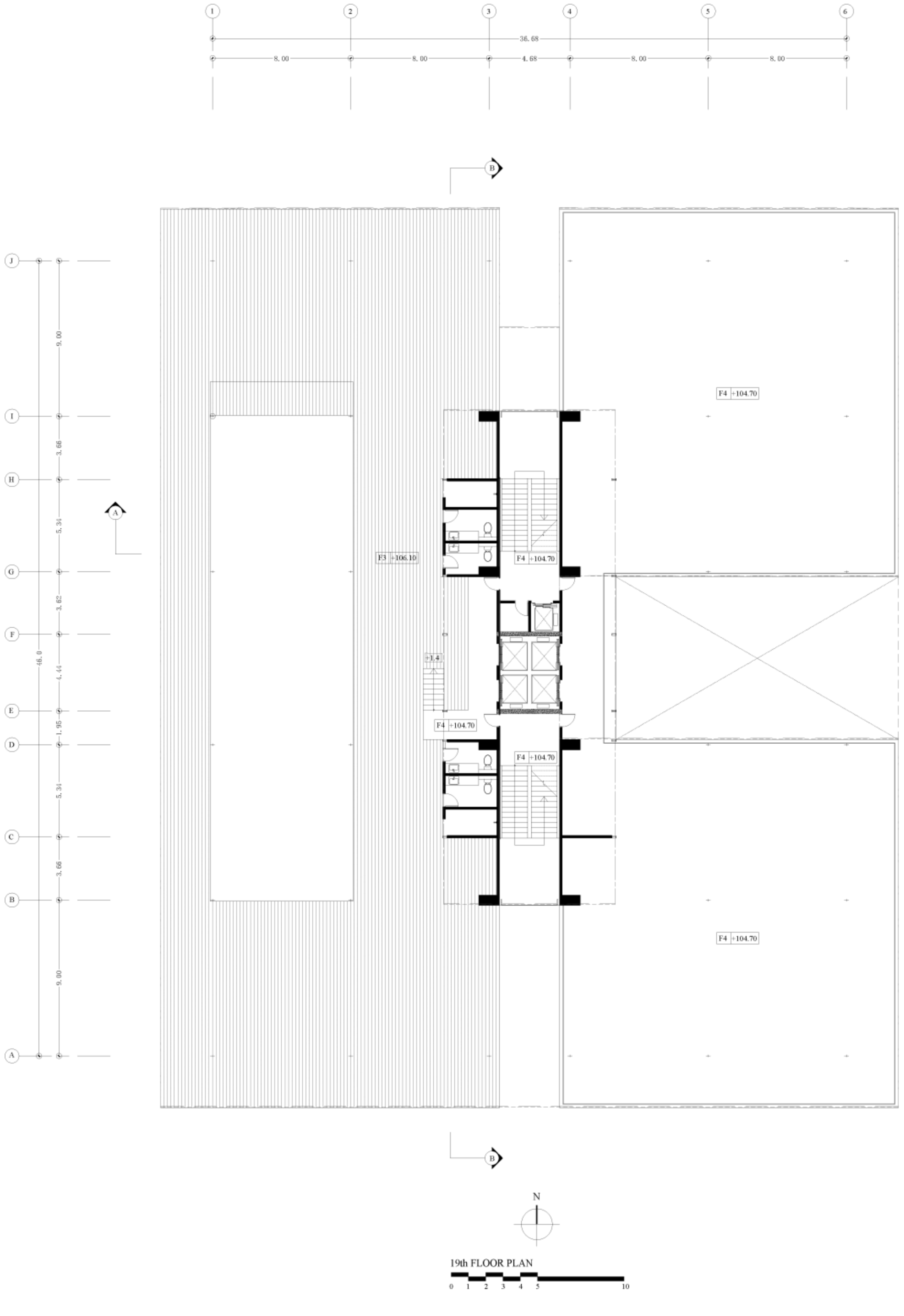


Figure 39: 19th Floor Plan: Rooftop, drawn by the author.

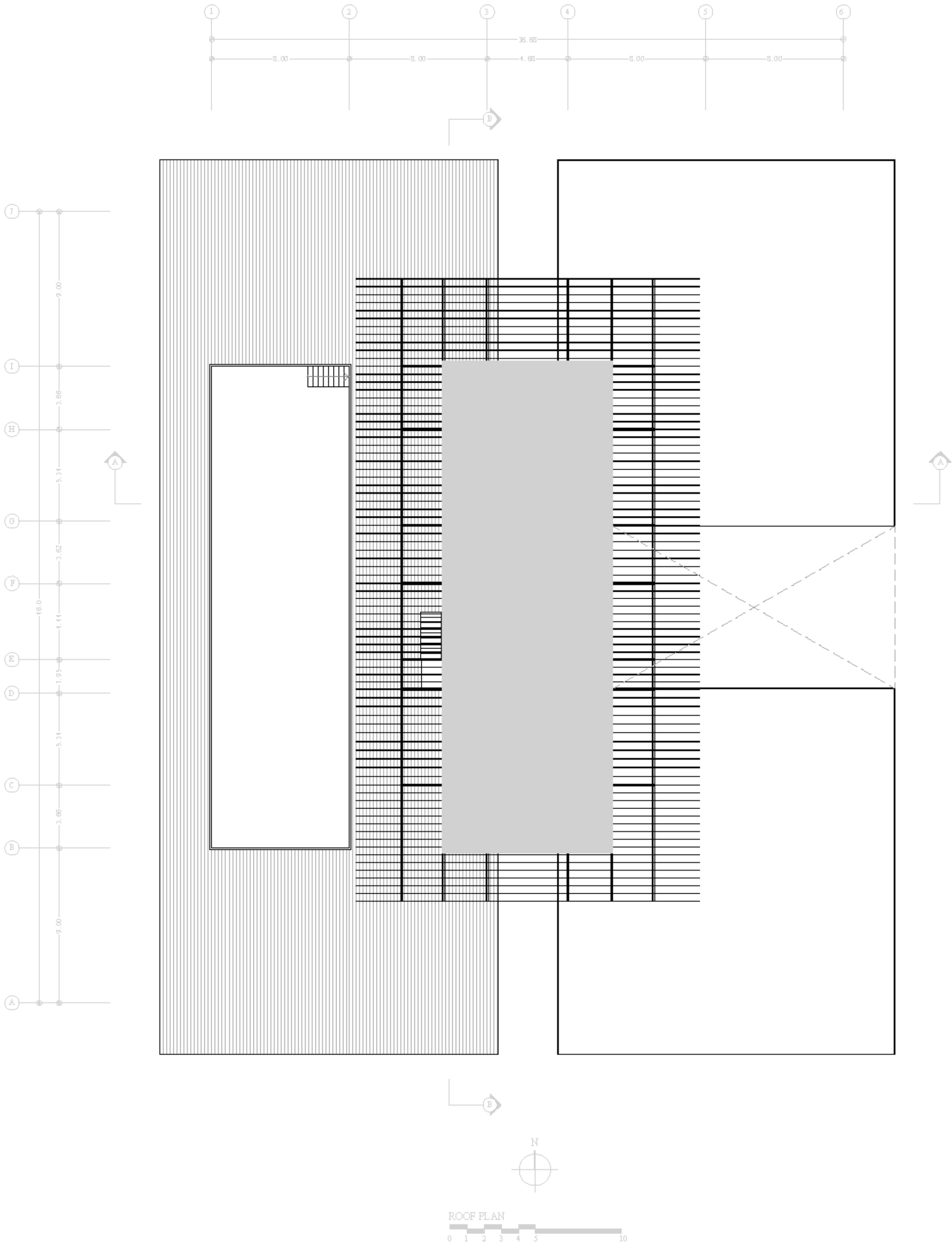


Figure 40: Roof Plan, drawn by the author.

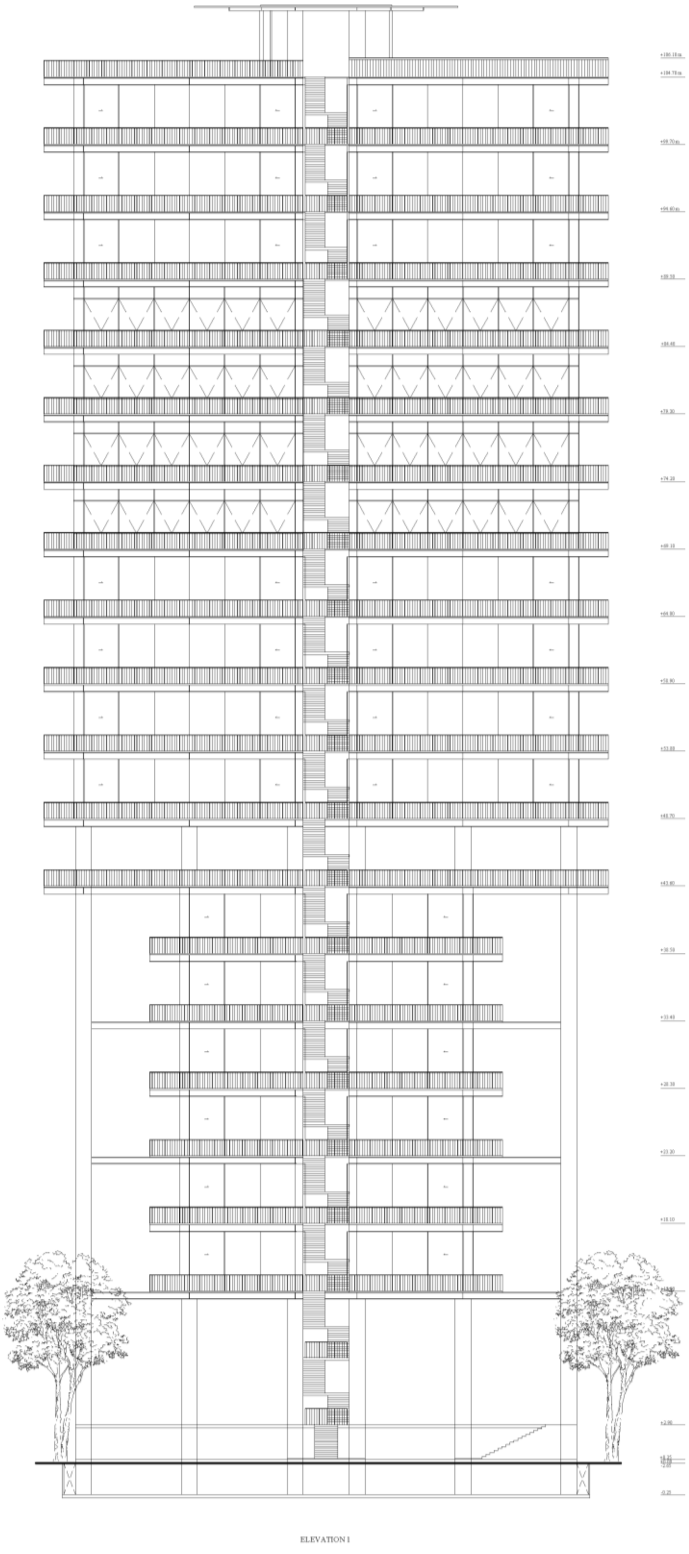


Figure 41: North Elevation, drawn by the author.

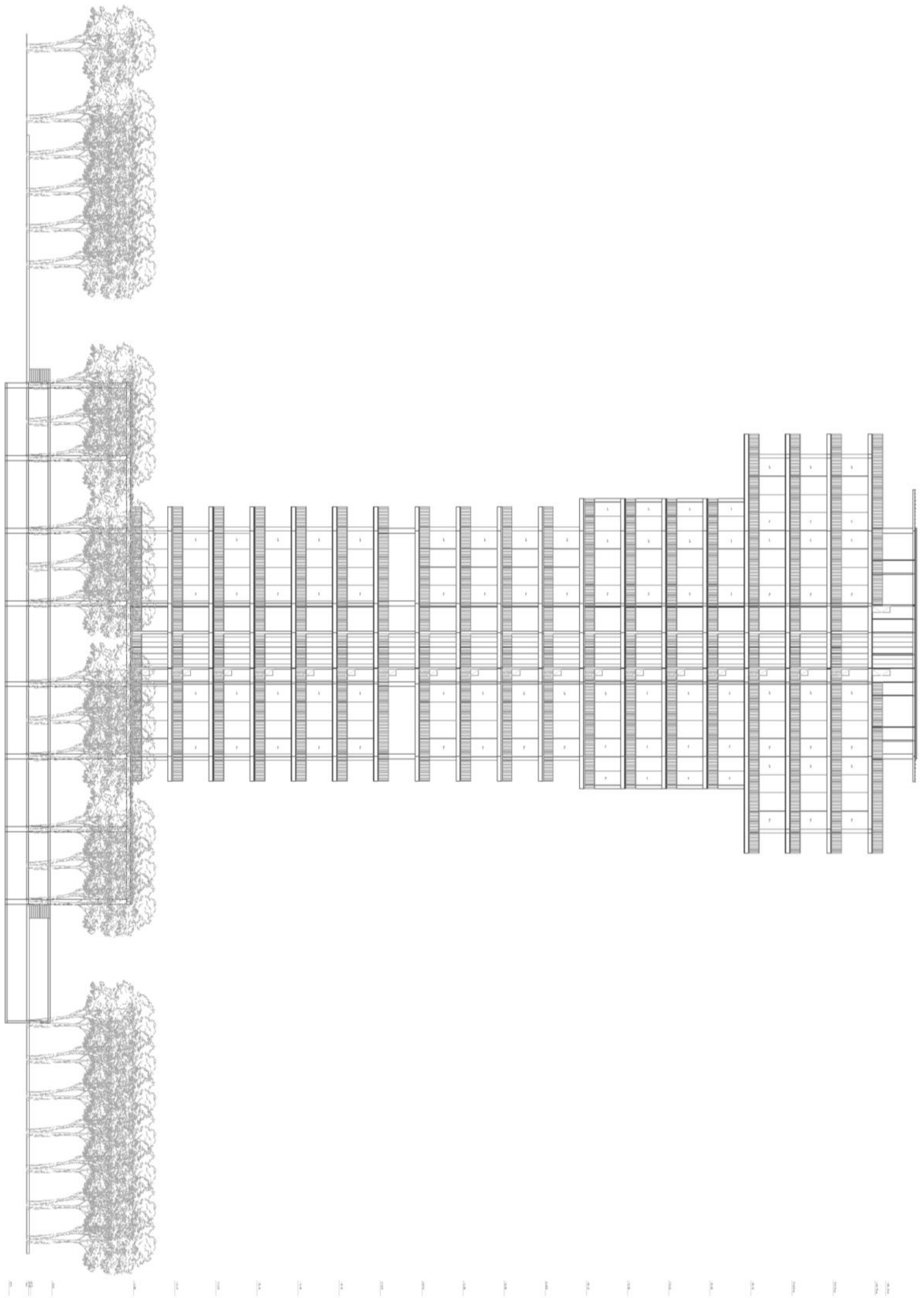


Figure 42: East Elevation, drawn by the author.

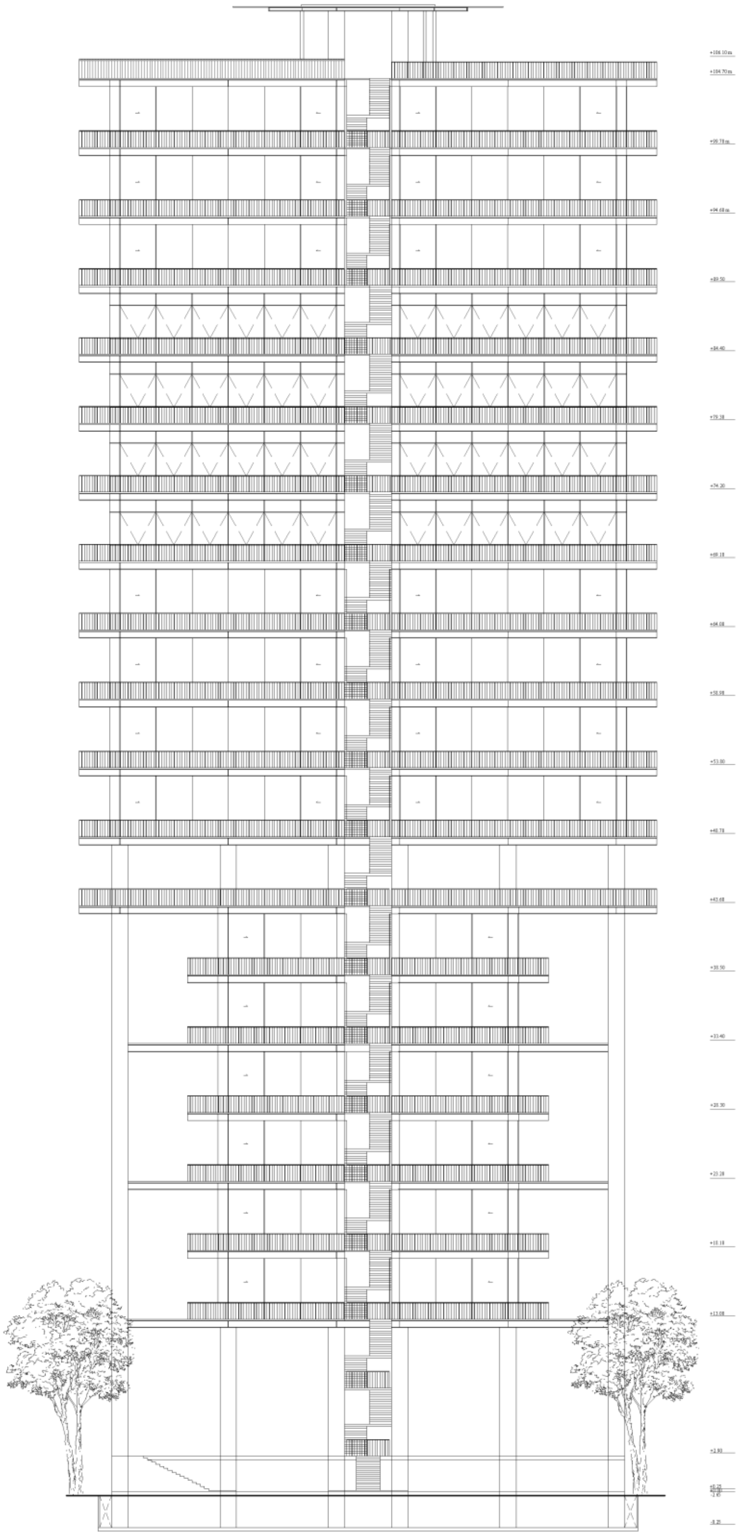


Figure 43: South Elevation, drawn by the author.

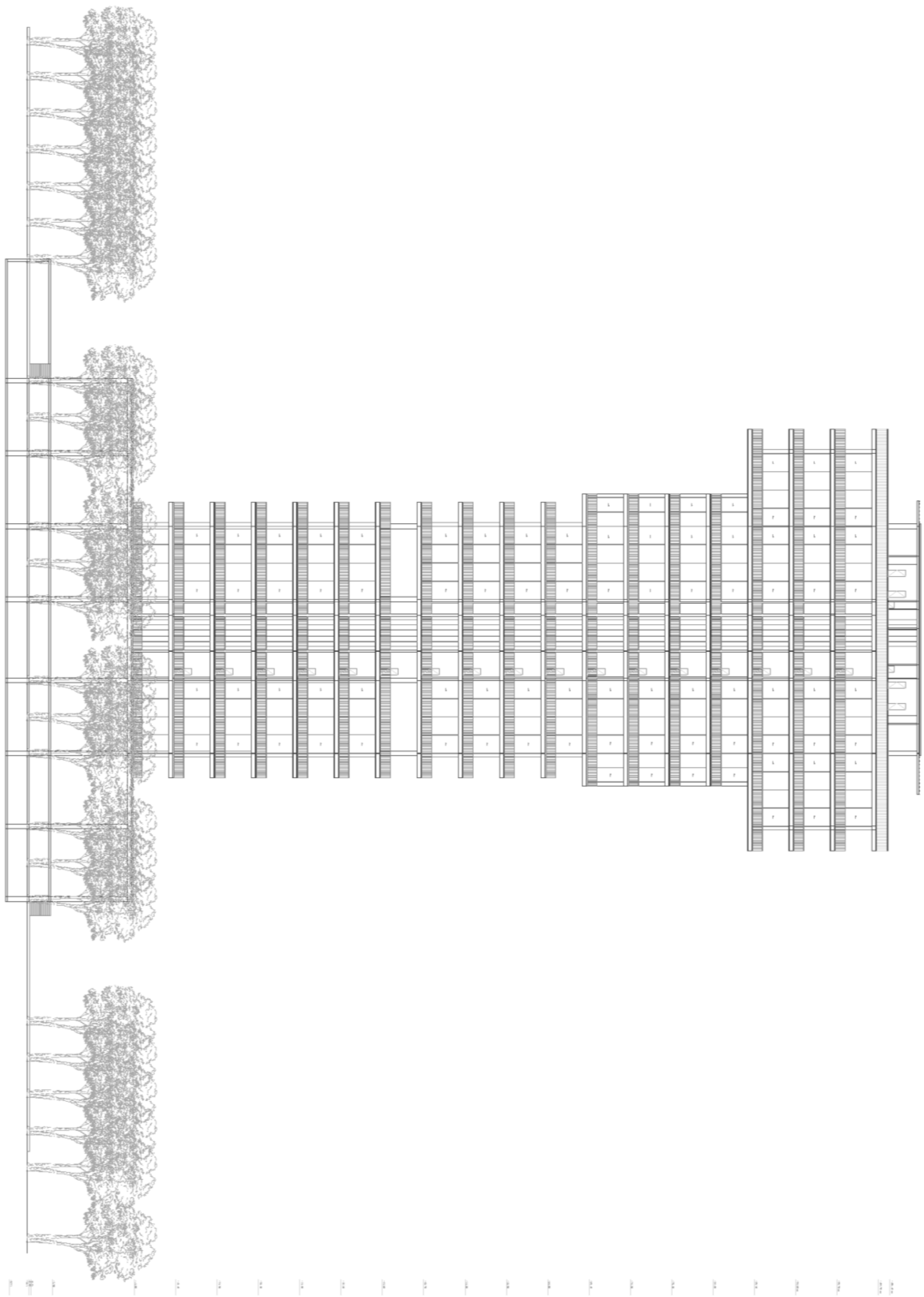


Figure 44: West Elevation, drawn by the author.

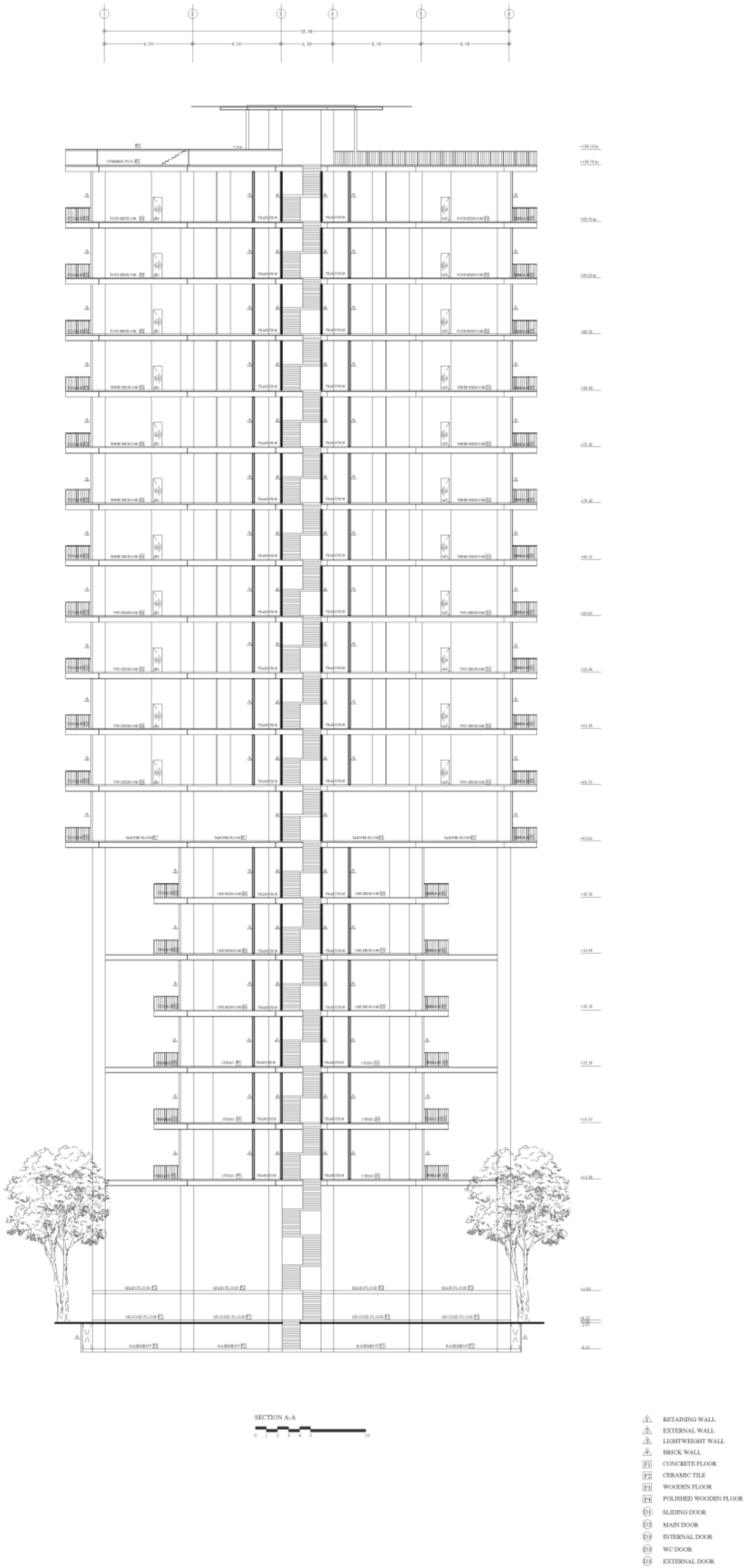


Figure 45: Section A-A, drawn by the author.

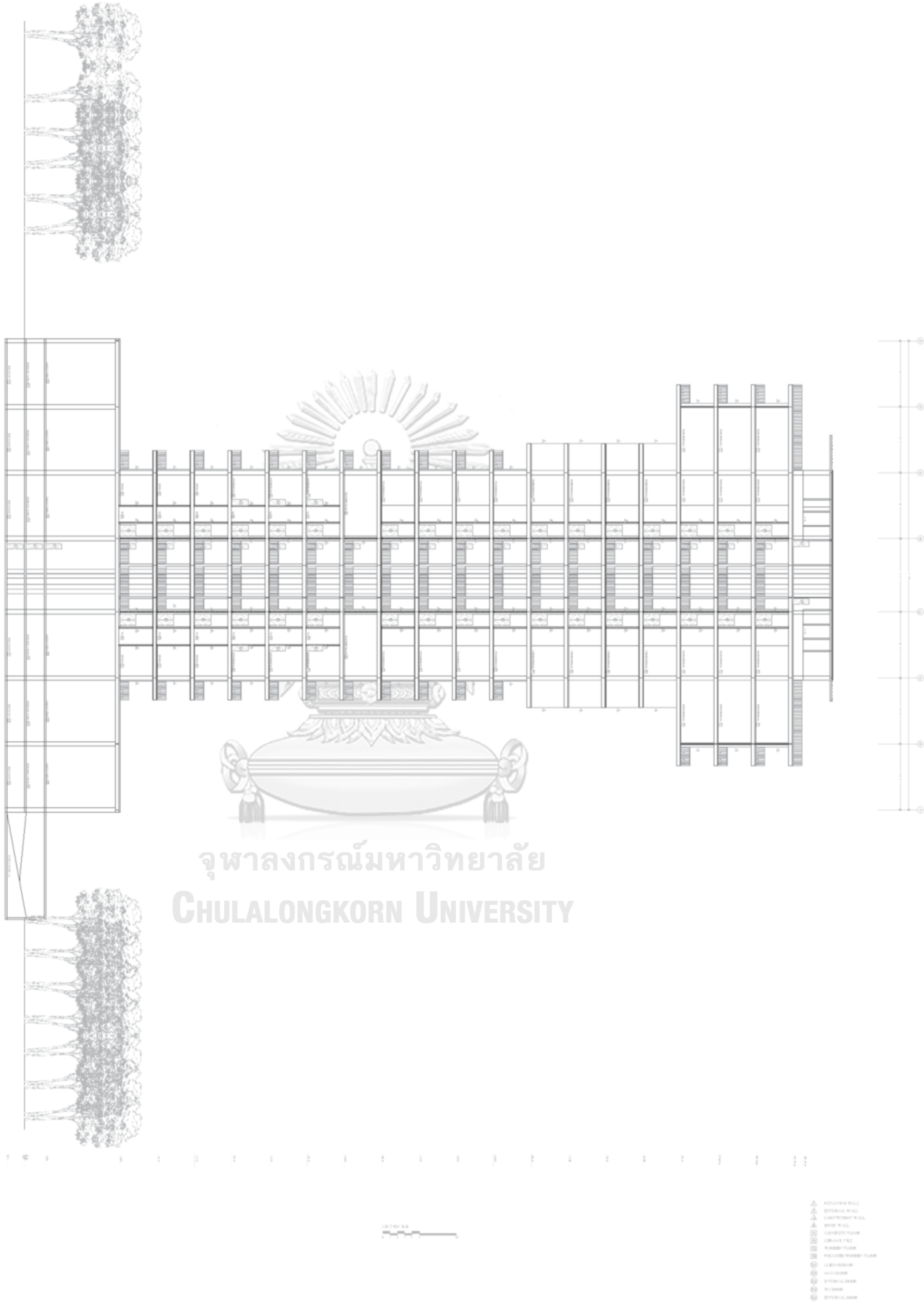


Figure 46: Section B-B, drawn by the author.

Figure 47: North-West Exterior Perspective View, drawn by the author.

Figure 48: North-East Exterior Perspective View, drawn by the author.

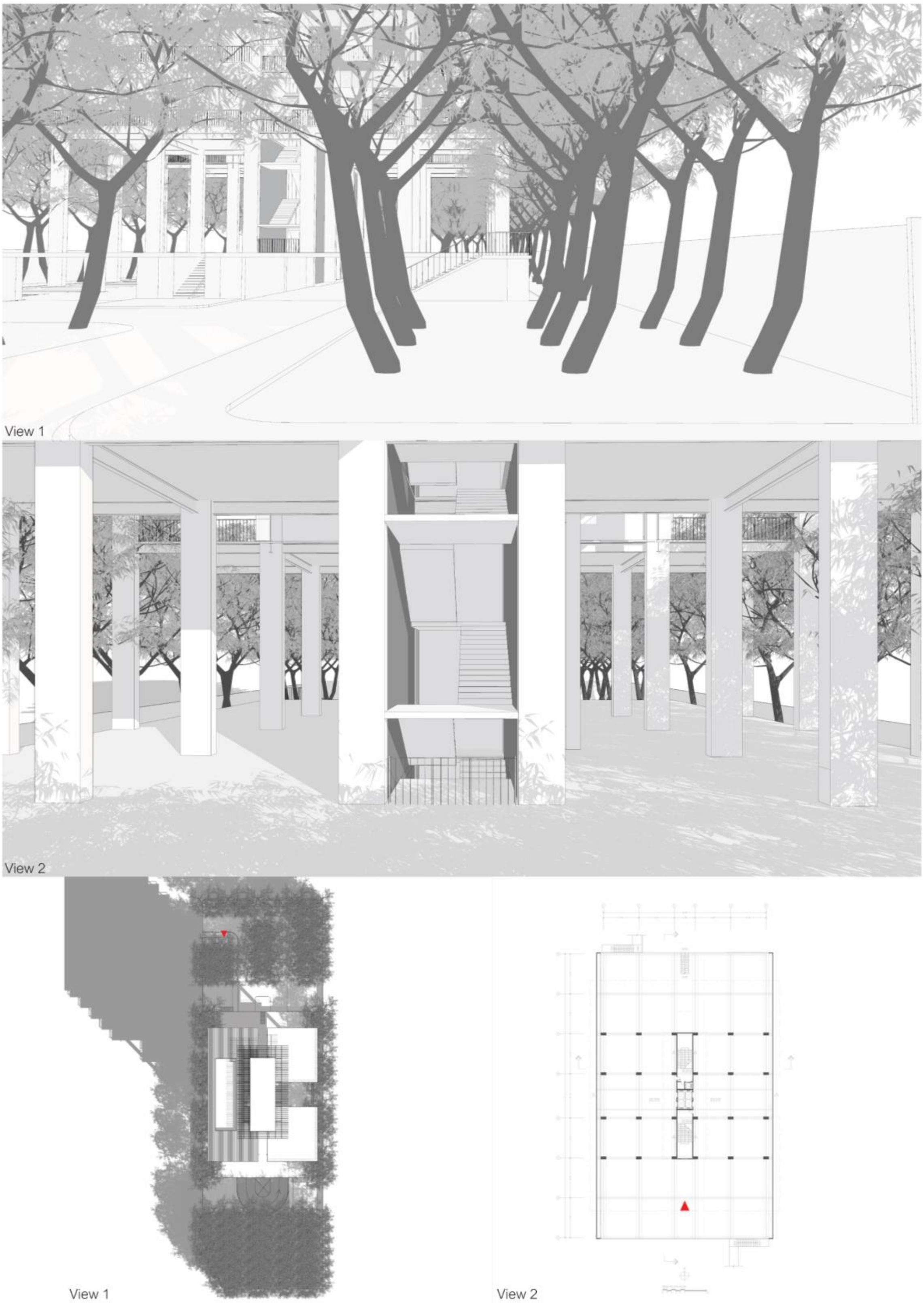


Figure 49: Perspective viewpoint 1 and 2 recorded on 21st September 10:00 AM, drawn by the author.

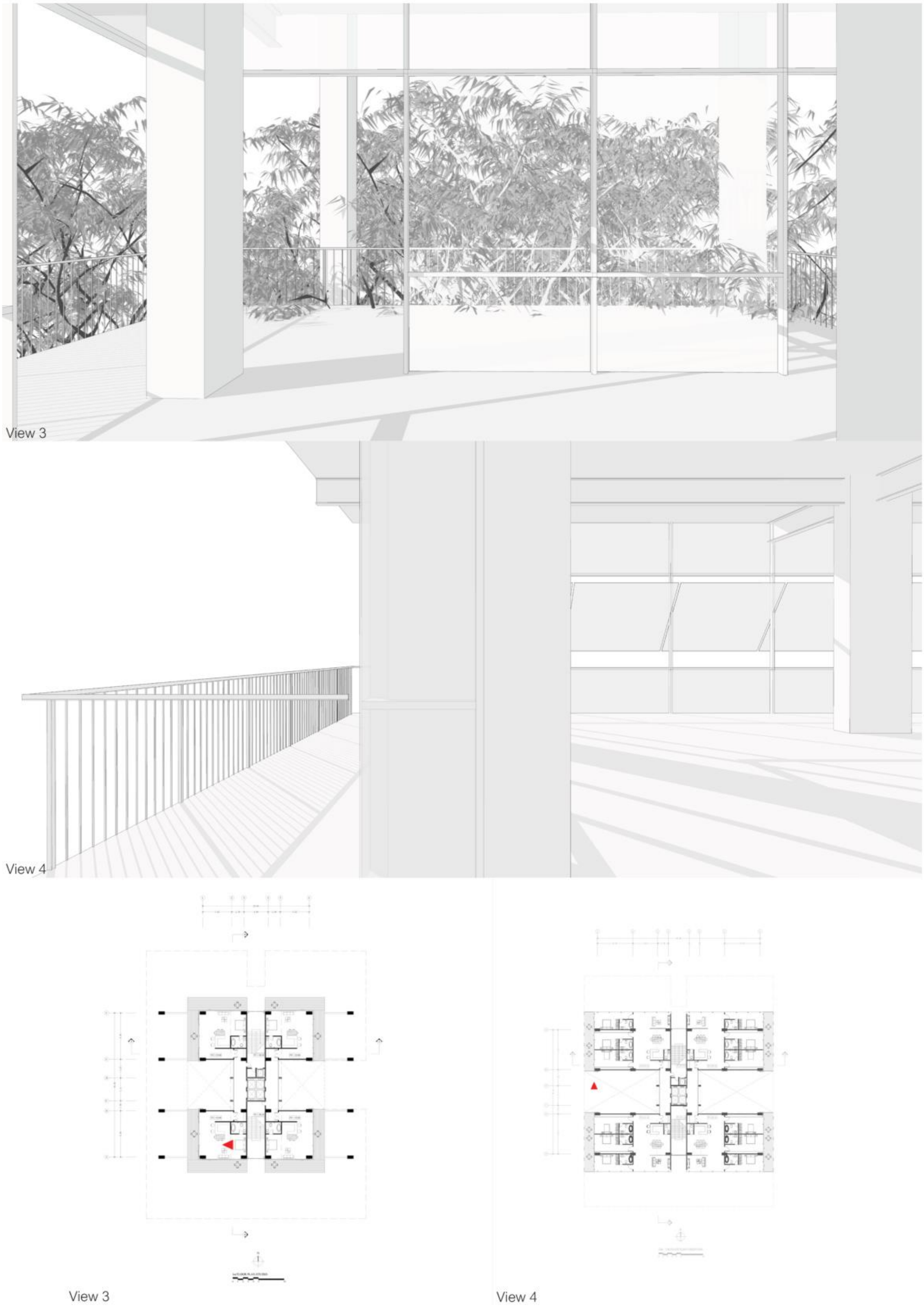


Figure 50: Perspective view 3 and 4 recorded on 21st September 10:00 AM, drawn by the author.

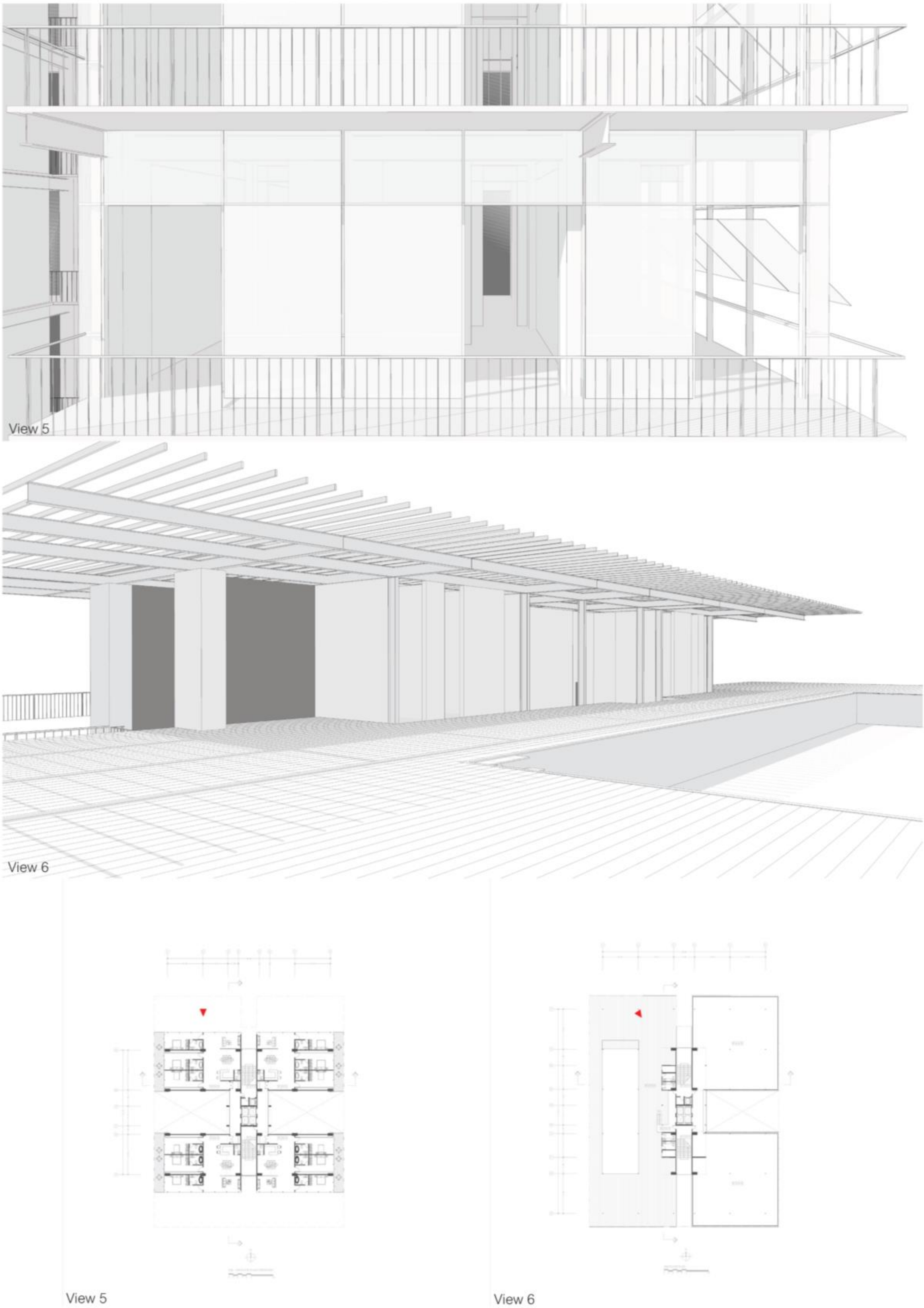


Figure 51: Perspective view 5 and 6 recorded on 21st September 10:00 AM, drawn by the author.

4.3. Analysis

This part is a comparison between the existing condominium at the Galaxy Towers and my design with regards to circulation and core system and natural light and ventilation. The analysis is to show the performance of this design in terms of core system and circulation spaces, a natural light and ventilation. As the evidence, all the data assist to make choices about the design.

The visible materials, such as reinforced concrete columns and brick walls, aren't the only ones used in the construction of architectural elements in this case. Natural light, shadows, and wind are among the intangible components of nature. The study's goal is to figure out how intangible elements, spaces, and three-dimensional structures in architecture interact.

The study's goal is to figure out how wind interacts with architectural features like walls and voids under the arrangement of three-dimensional structures in architecture. Reading the simulation of wind speed in Autodesk flow design (Figure 78-91) using the Beaufort Wind Force Scale (Table 7) to understand the traveling of wind direction and wind speed throughout the spaces in relation to the floor plan and structural system. According to the Beaufort Wind Force Scale (Table 7), the simulation giving windspeed of 10 m/s is deemed “fresh breeze,” while any number greater than 10 m/s is regarded “strong wind.” The viewpoint of windspeed and direction can be related to land descriptions using the Beaufort Wind Force Scale. For example, a “fresh breeze” can be described as “small trees in the leaf begin to sway.”

The wind flow test has run with 2D and 3D model simulated with Autodesk flow design program. The wind flow test is to explore how air moves over between and around structures. In this analysis flow lines show the air movement throughout virtual wind tunnel until a clear story about the flow pattern wake formation and circulation regions. There are several types of flow lines in this analysis they are lines and tubes. Lines show discrete flow paths moving through the wind tunnel. In 2D simulations flow lines are drawn on the plane of the simulation. (See Figure 78-82 and 87). Tubes are similar to lines but a three-dimensional. In 3D simulations flow lines are displayed throughout the entire wind tunnel. (See Figure 83-91). It is a good idea to analyze with the different to determine the one that works best for the flow around my model. Flow lines give as a detailed view of how the air moves around the model, they reveal a wide range of flow patterns including separation reattachment and circulation.

I understood that the simulation may be partially true because this new style of residential high-rise structure has not yet to be completed, but the simulations show how humans perceive different locations at different times based on seasonal changes, sunlight, shadows, and wind movement perception. Humans are at the heart of architecture. This fundamental understanding entails seeing the possibilities and relationships.

The study of lights and shadows are based on different seasons within a year. It can be divided as summer solstice, winter solstice, spring equinox and fall equinox. The summer solstice occurs on 21st June and the winter solstice is on 21st December. The spring equinox and fall equinox are on 21st March and 21st September. The changes of light and shadow in this analysis are followed by these days.

Beaufort Wind Force	Wind Average	Speed Range	American Term	British Term	Land Description
0	0	<1 mph 0-0.2 m/s <1 km/h	Light	Calm	Smoke rises vertically.
1	2 mph 0.8 m/s 3 km/h	1-3 mph 0.3-0.5 m/s 1-5 km/h	Light	Light Air	Direction shown by smoke but not by wind vanes.
2	4-7 mph 2.4 m/s 6-11 km/h	4-7 mph 1.6-3.3 m/s 6-11 km/h	Light	Light Breeze	Wind felt on face, leaves rustle, ordinary vane moved by wind.
3	10 mph 4.3 m/s 16 km/h	8-12 mph 3.4-5.4 m/s 12-19 km/h	Gentle	Gentle Breeze	Leaves and small twigs in constant motion, wind extends light flag.
4	16 mph 6.7 m/s 24 km/h	13-18 mph 5.5-7.9 m/s 20-28 km/h	Moderate	Moderate Breeze	Raises dust and loose paper, small branched are moved.
5	22 mph 9.3 m/s 34 km/h	19-24 mph 8.0-10.7 m/s 29-38 km/h	Fresh	Fresh Breeze	Small trees in the leaf begin to sway.
6	28 mph 12.3 m/s 39-49 km/h	25-31 mph 10.8-13.8 m/s 39-49 km/h	Strong	Strong Breeze	Large branches in motion, inconvenience felt when walking against the wind.
7	35 mph 15.5 m/s 56 km/h	32-38 mph 13.9-17.1 m/s 50-61 km/h	Strong	Near Gale	Whole trees in motion, inconvenience felt when walking against the wind.
8	43 mph 18.9 m/s 68 km/h	39-46 mph 17.2-20.7 m/s 62-74 km/h	Gale	Gale	Breaks twigs off trees, generally impedes progress.
9	51 mph 22.6 m/s 82 km/h	47-54 mph 20.8-24.4 m/s 75-88 km/h	Gale	Strong Gale	Slight structural damages, chimneypots and slates removed.
10	59 mph 26.4 m/s 96 km/h	55-63 mph 24.5-28.4 m/s 89-102 km/h	Whole Gale	Storm	Trees uprooted, considerable structural damage.
11	68 mph 30.5 m/s 110 km/h	64-72 mph 28.5-32.6 m/s <1 km/h	Whole Gale	Violent Storm	Widespread damage: very rarely experiences.
12	78 mph n/a 124 km/h	72-82 mph >= 32.7 m/s 118-132 km/h	Hurricane	n/a	Countryside is devastated.

Table 7: Beaufort Wind Force Scale, redrawn by the author.

4.3.1. Circulation

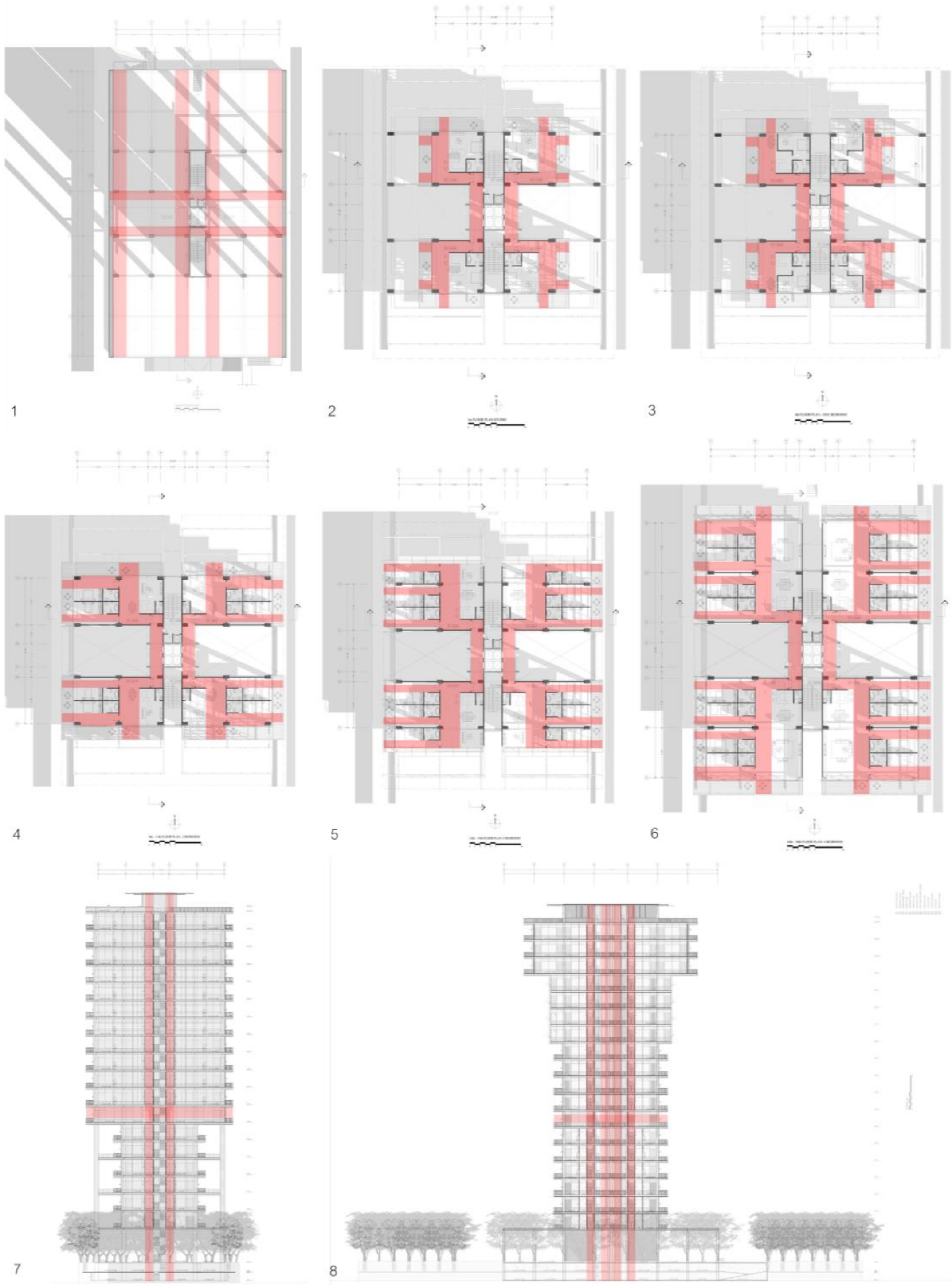


Figure 52: Analytical diagram of circulation in final design from top to below, 1. Main Floor Plan 2. Studio 3. One Bedroom 4. Two Bedroom 5. Three Bedroom 6. Four Bedroom 7. Section A-A 8. Section B-B, drawn by the author.

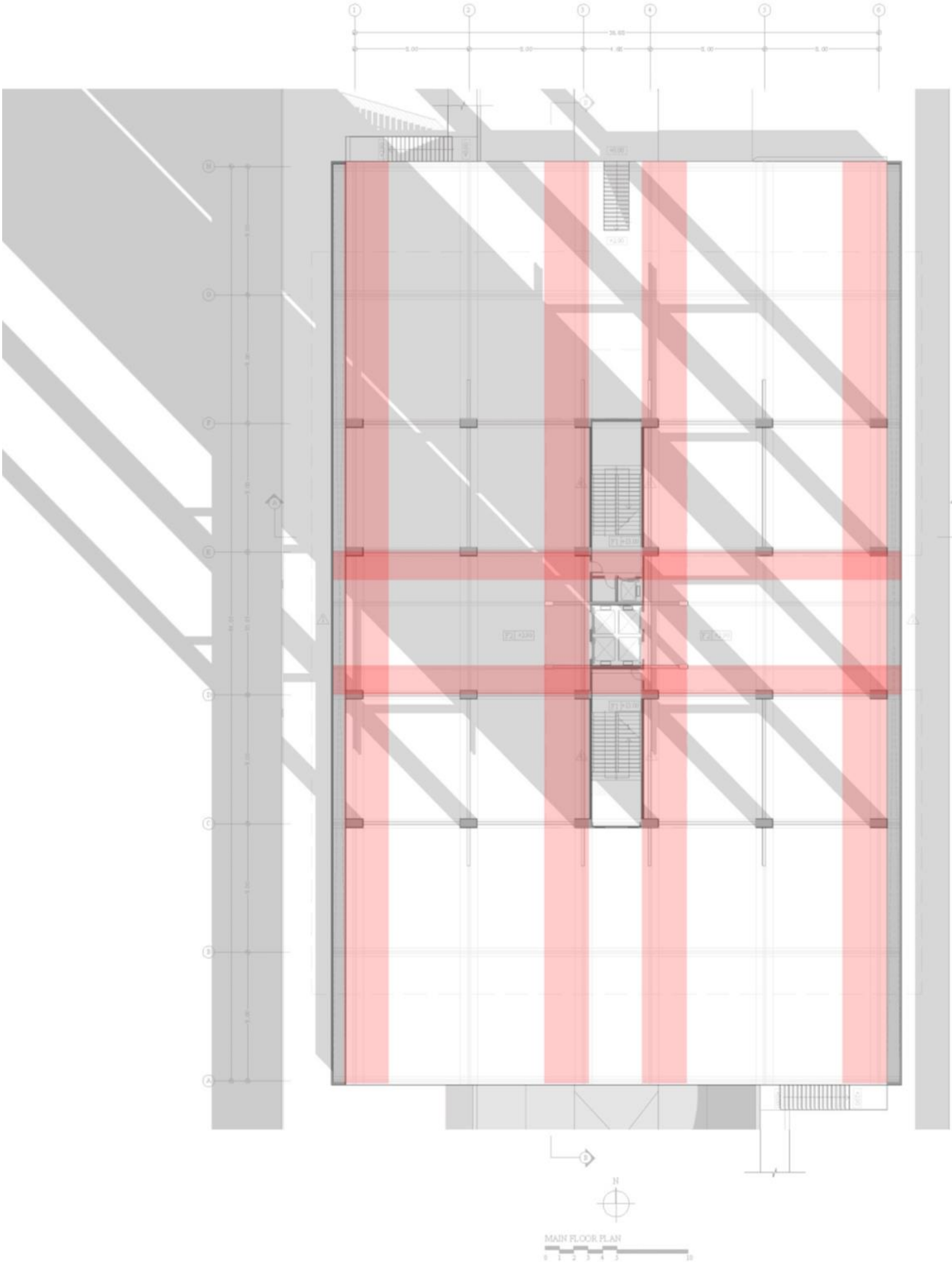


Figure 53: Analytical diagram of circulation from main floor plan in final design, drawn by the author.

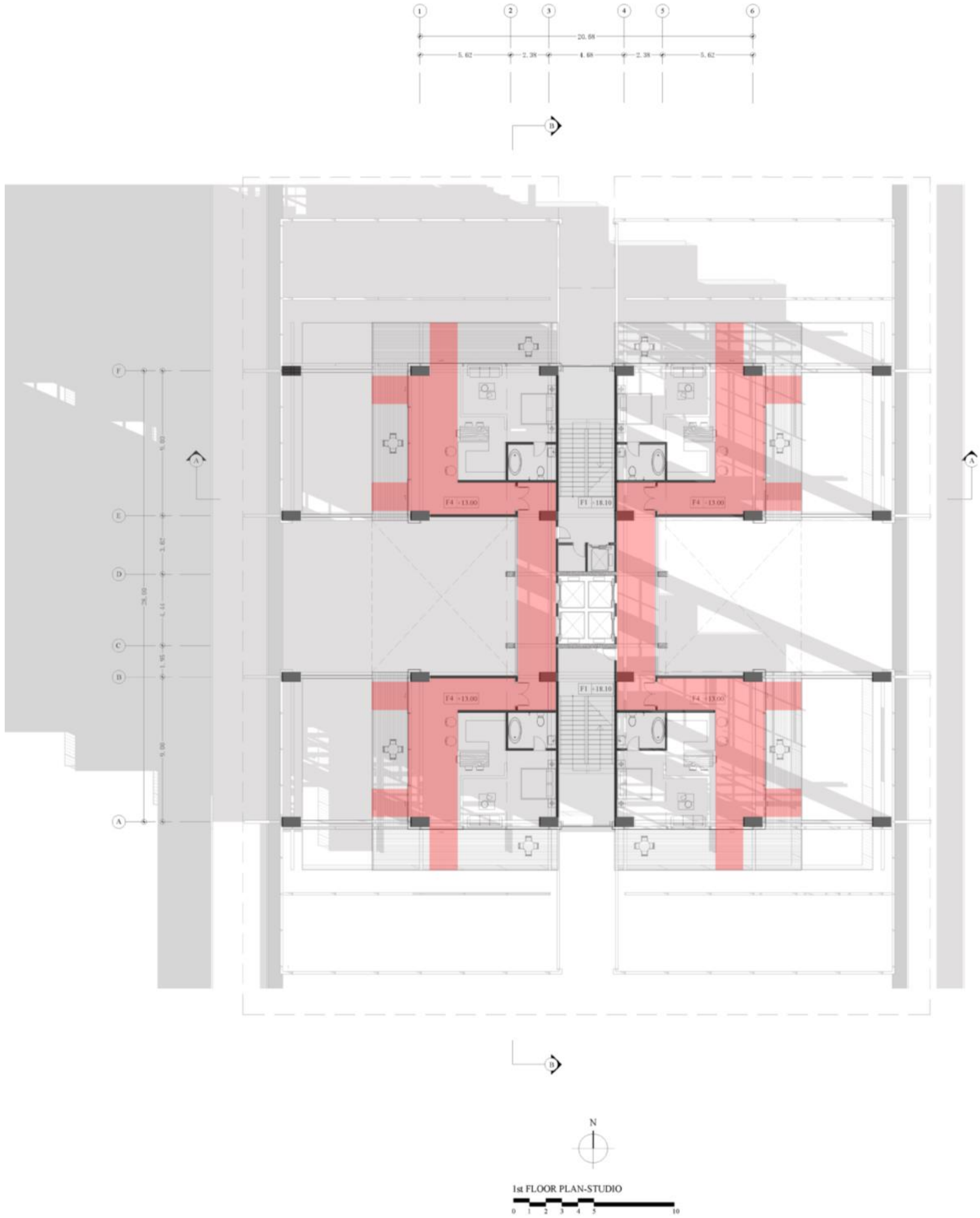


Figure 54: Analytical diagram of circulation from 1st to 3rd unit floor plan in final design, drawn by the author.

Figure 55: Analytical diagram of circulation from 4th to 6th unit floor plan in final design, drawn by the author.

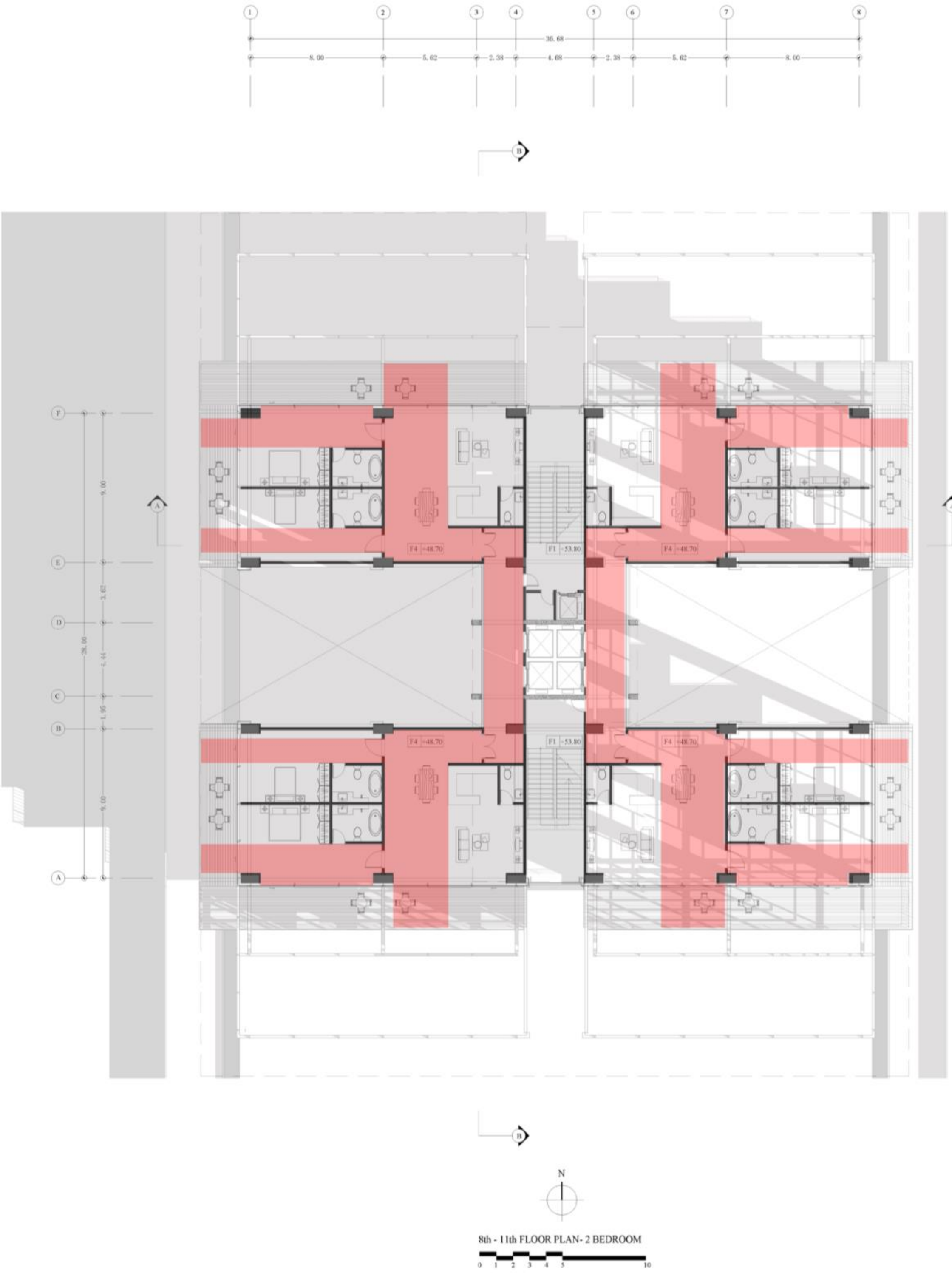


Figure 56: Analytical diagram of circulation from 8th to 11th unit floor plan in final design, drawn by the author.

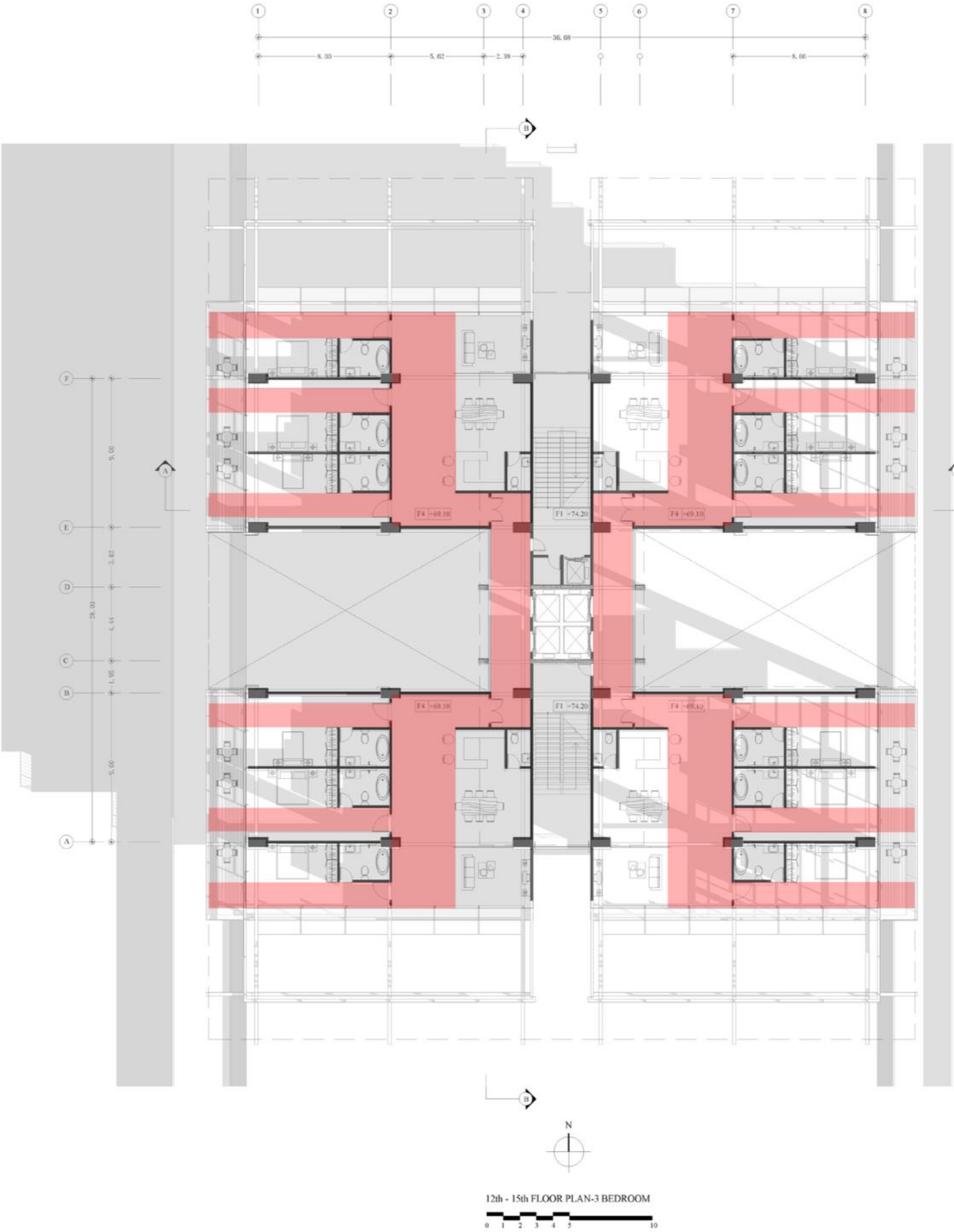


Figure 57: Analytical diagram of circulation from 12th to 15th unit floor plan in final design, drawn by the author.

Figure 58: Analytical diagram of circulation from 16th to 18th unit floor plan in final design, drawn by the author.

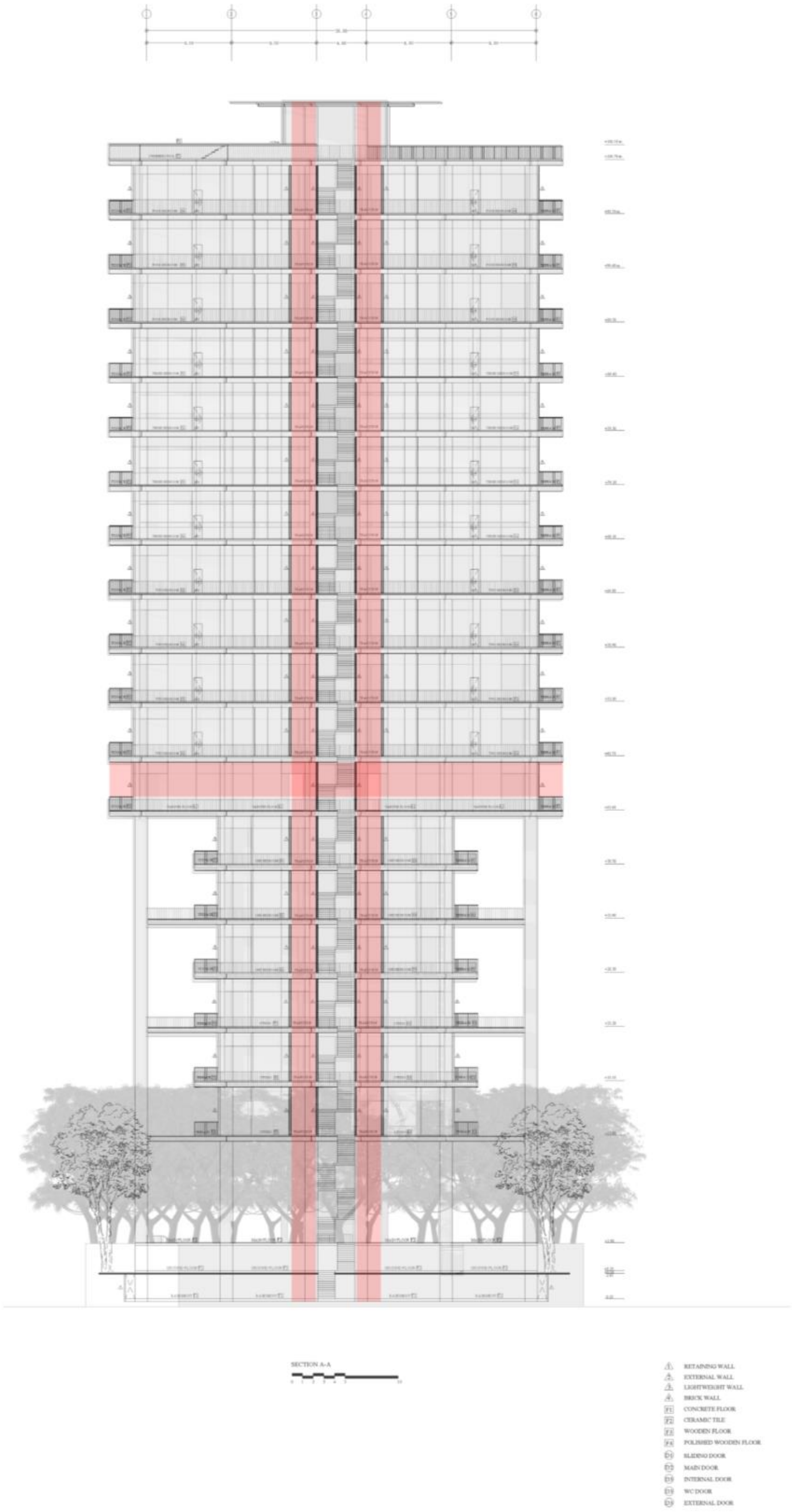


Figure 59: Analytical diagram of circulation from section A-A in final design, drawn by the author.

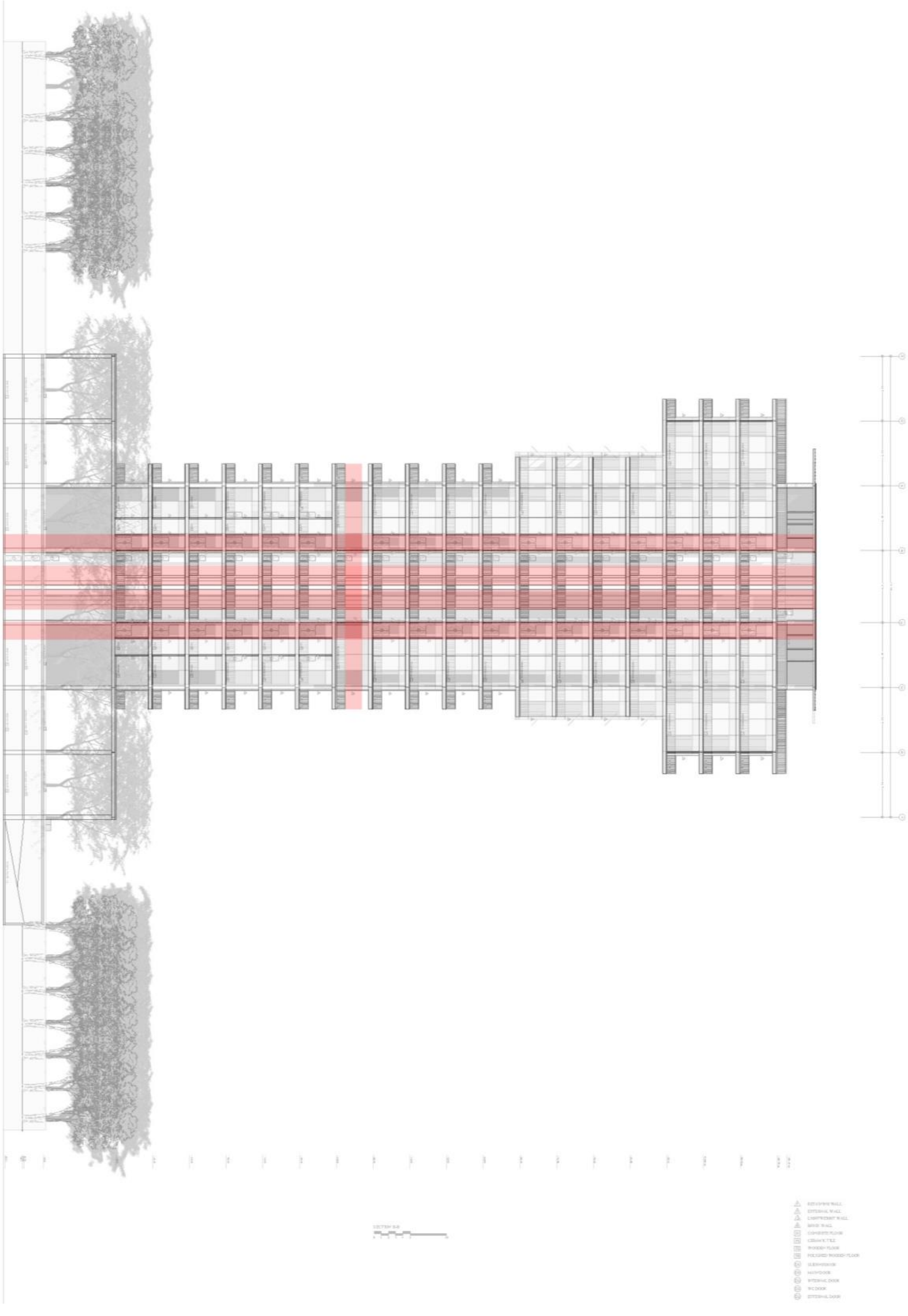


Figure 60: Analytical diagram of circulation from section B-B in final design, drawn by the author.

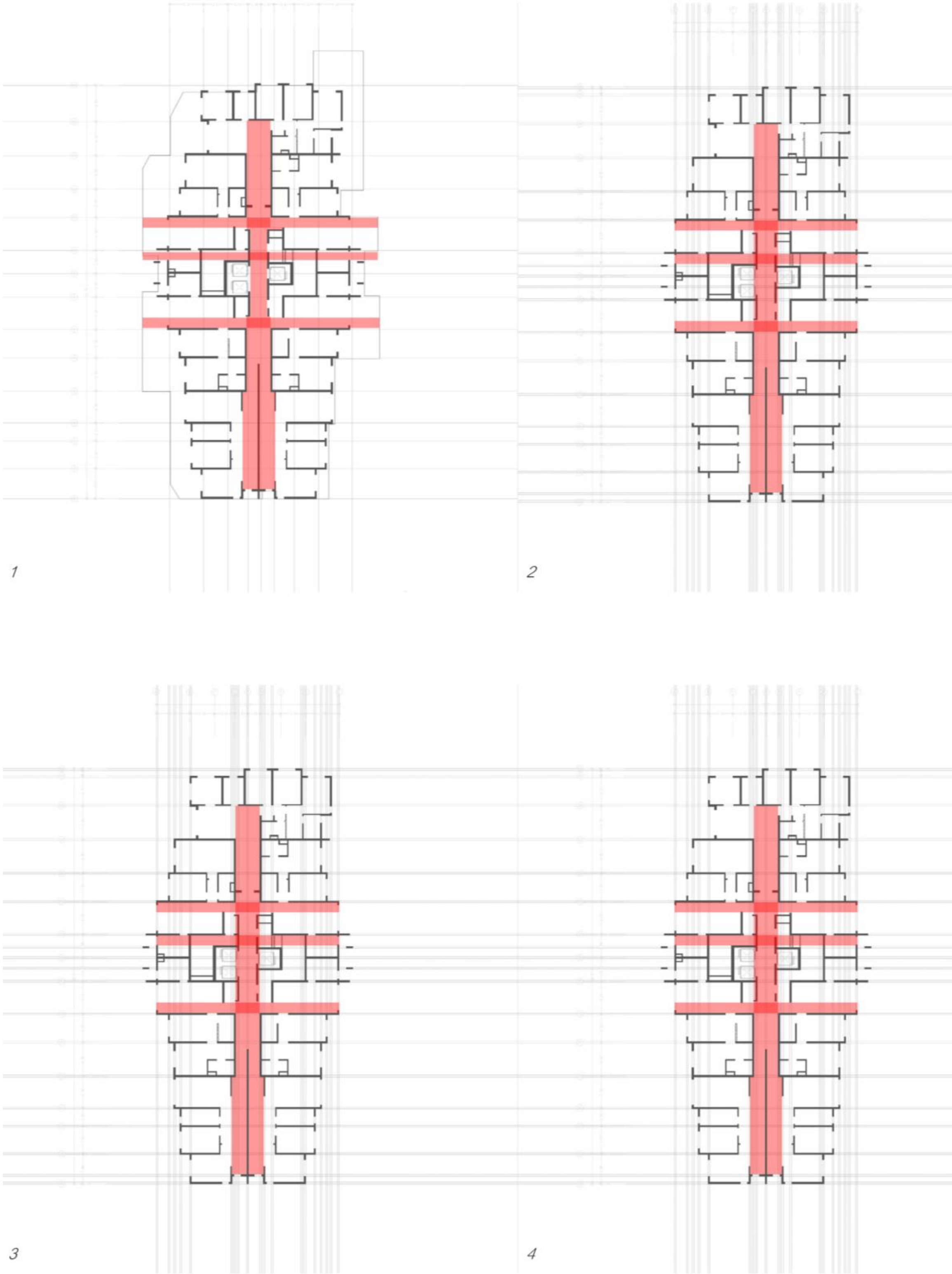


Figure 61: Analytical diagram of circulation from floor plans in existing building from top to below, 1. First storey 2. Second storey 3. Third storey 4. Fourth storey, redrawn by the author.

4.3.2. Natural Light and Shadow

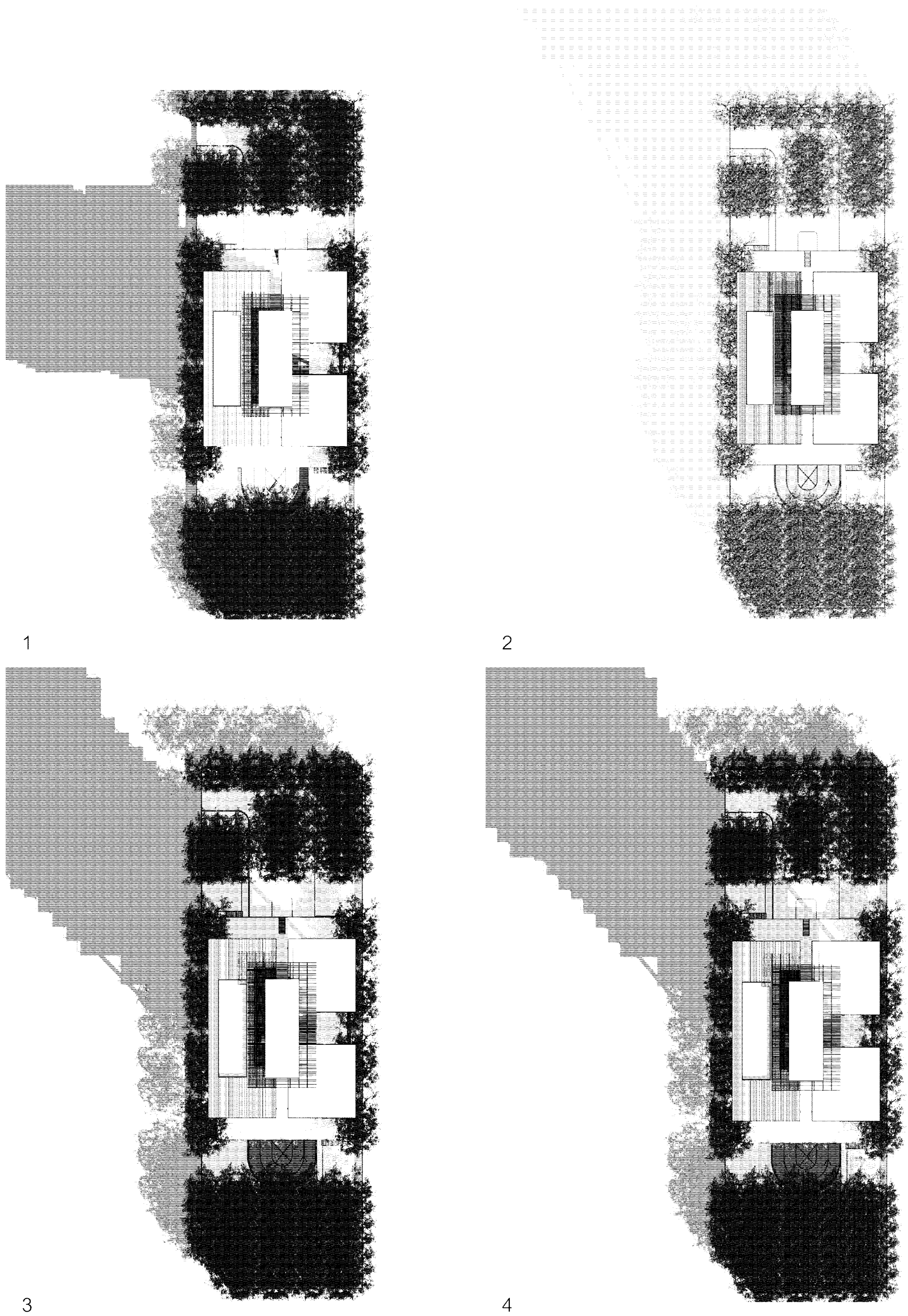


Figure 62: Light and shadow diagram from top to below, 1. Summer Solstice (21^{st} June 10 AM), 2. Winter Solstice (21^{st} December 10 AM), 3. Spring Equinox (21^{st} March 10 AM), 4. Fall Equinox (21^{st} September 10 AM) Plan Views, drawn by the author.

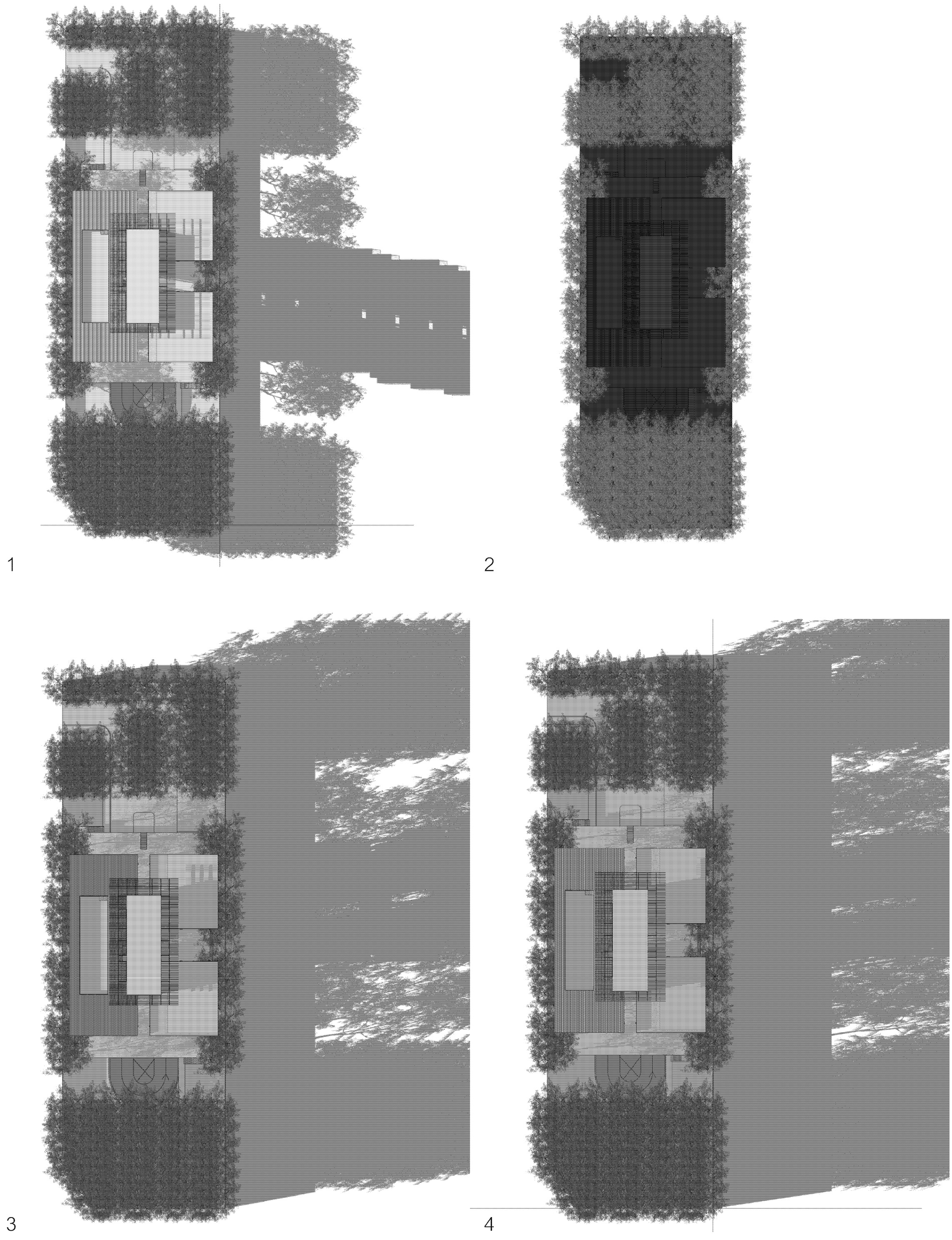


Figure 63: Light and shadow diagram from top to below, 1. Summer Solstice (21st June 5 PM), 2. Winter Solstice (21st December 5 PM), 3. Spring Equinox (21st March 5 PM), 4. Fall Equinox (21st September 5 PM) Plan Views, drawn by the author.

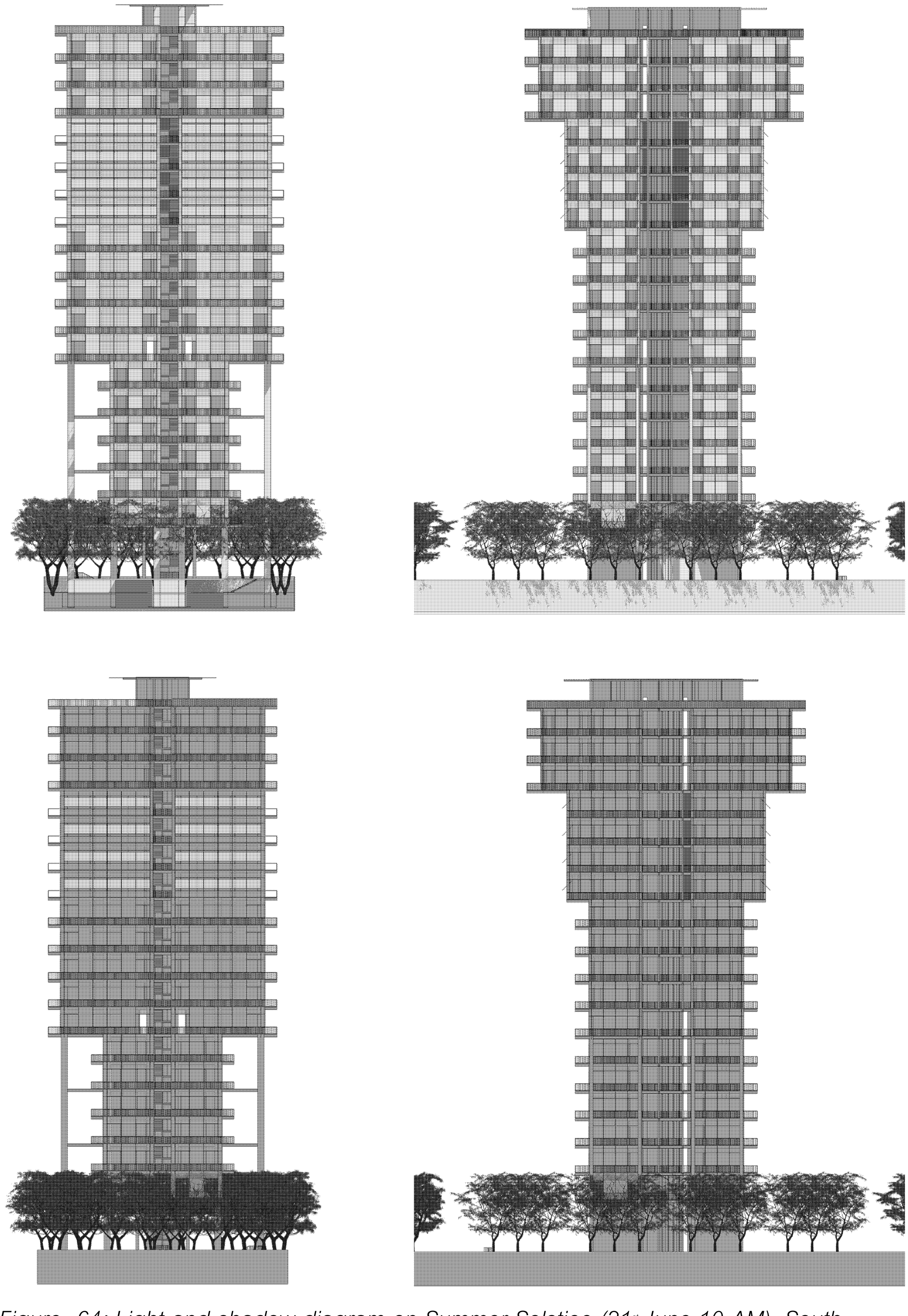


Figure 64: Light and shadow diagram on Summer Solstice (21st June 10 AM), South, East, North and West Elevations from top to below, drawn by the author.

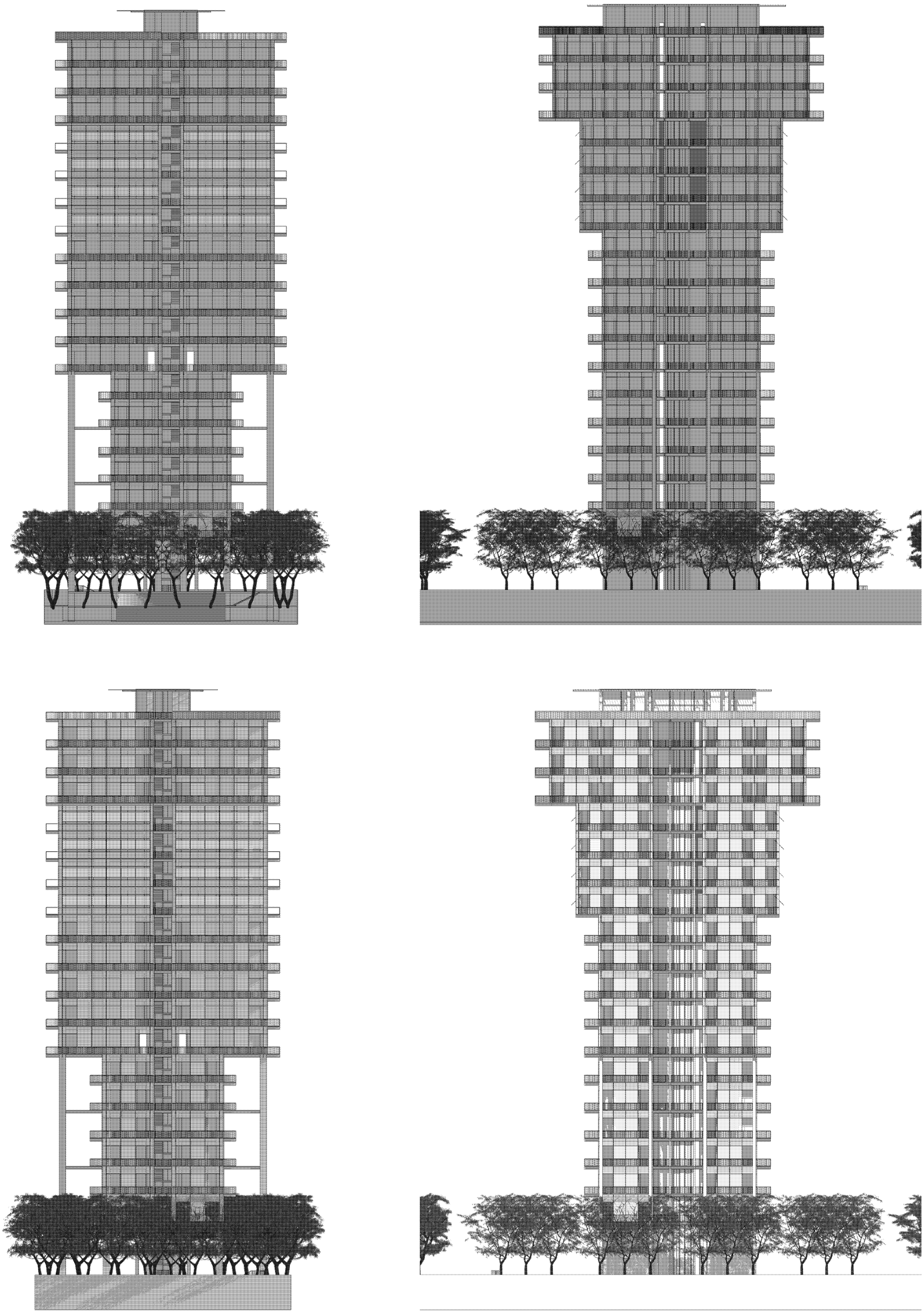


Figure 65: Light and shadow diagram on Summer Solstice (21st June 5 PM), South, East, North and West Elevations from top to below, drawn by the author.

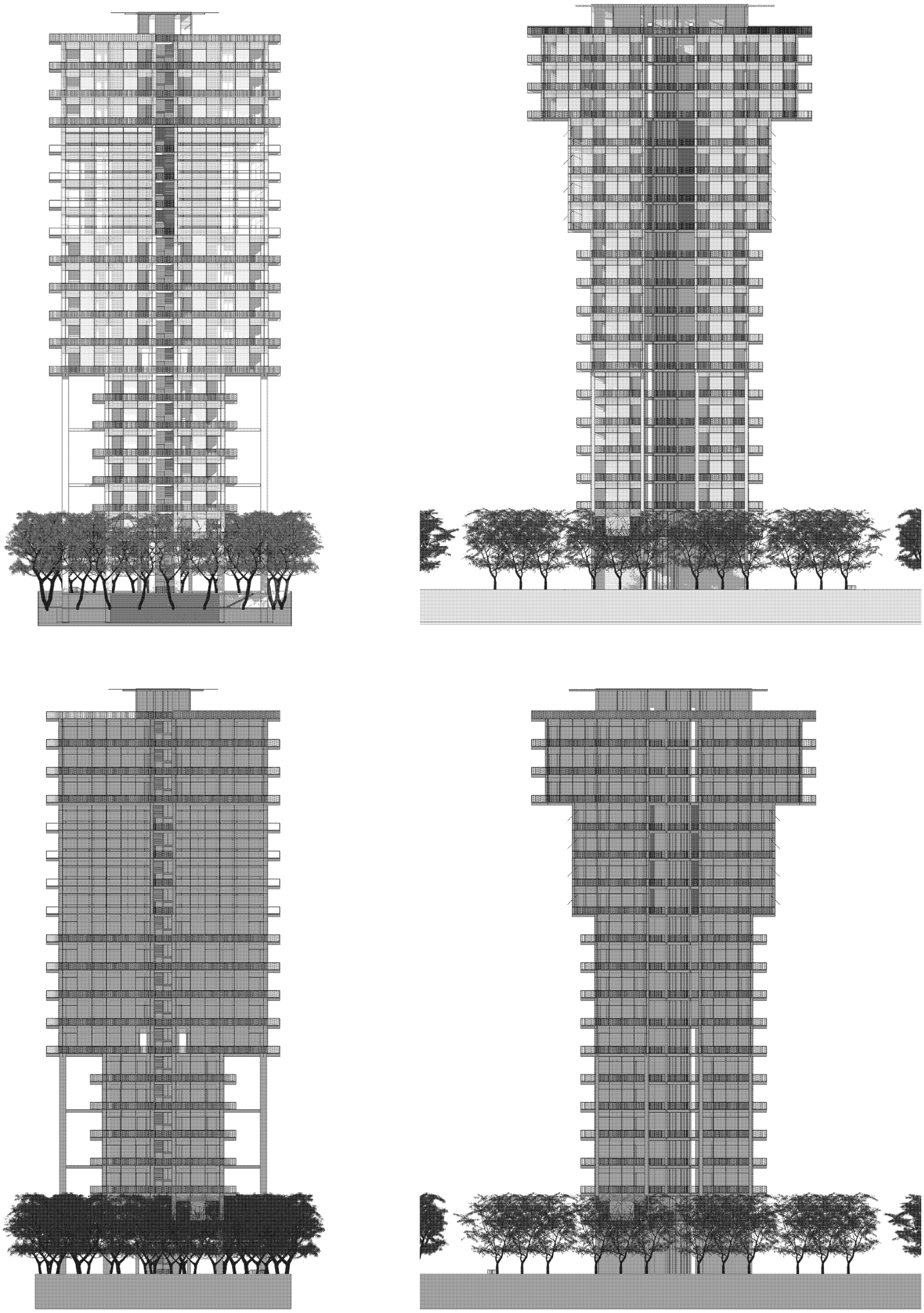


Figure 66: Light and shadow diagram on Winter Solstice (21st December 10 AM), South, East, North and West Elevations from top to below, drawn by the author.

Figure 67: Light and shadow diagram on Winter Solstice (21st December 5 PM), South, East, North and West Elevations from top to below, drawn by the author.

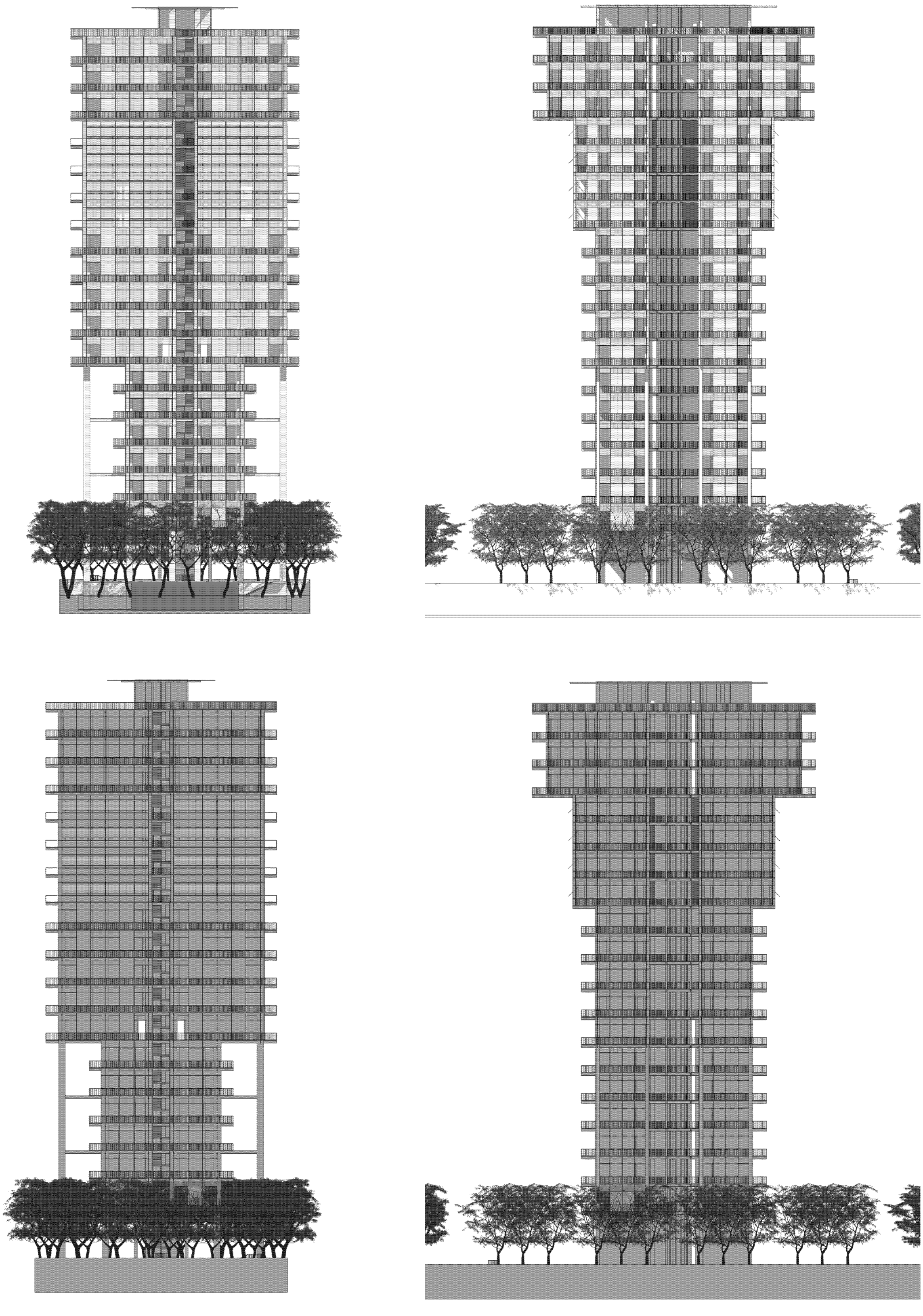


Figure 68: Light and shadow diagram on Spring Equinox (21st March 10 AM), South, East, North and West Elevations from top to below, drawn by the author.

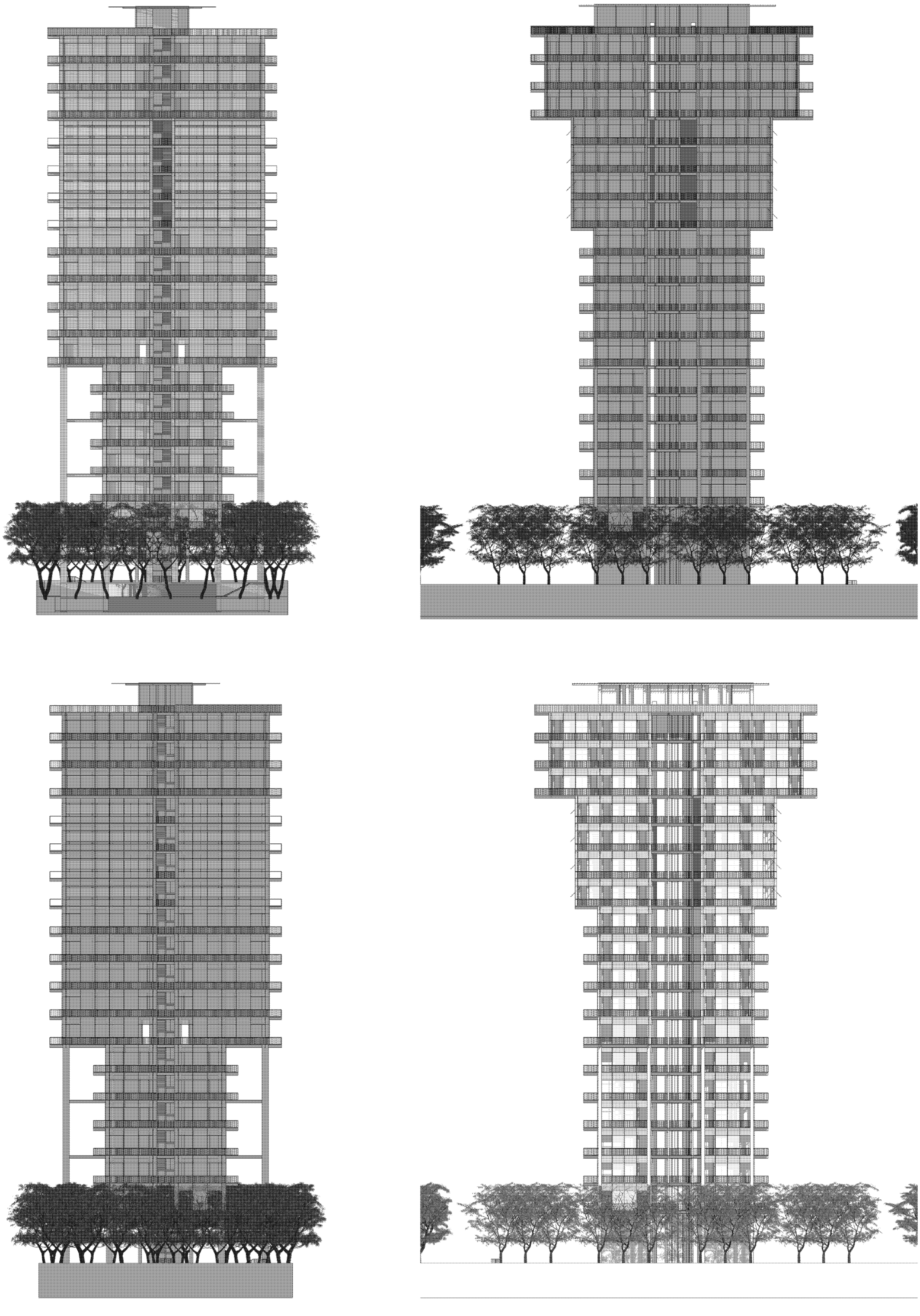


Figure 69: Light and shadow diagram on Spring Equinox (21st March 5 PM), South, East, North and West Elevations from top to below, drawn by the author.

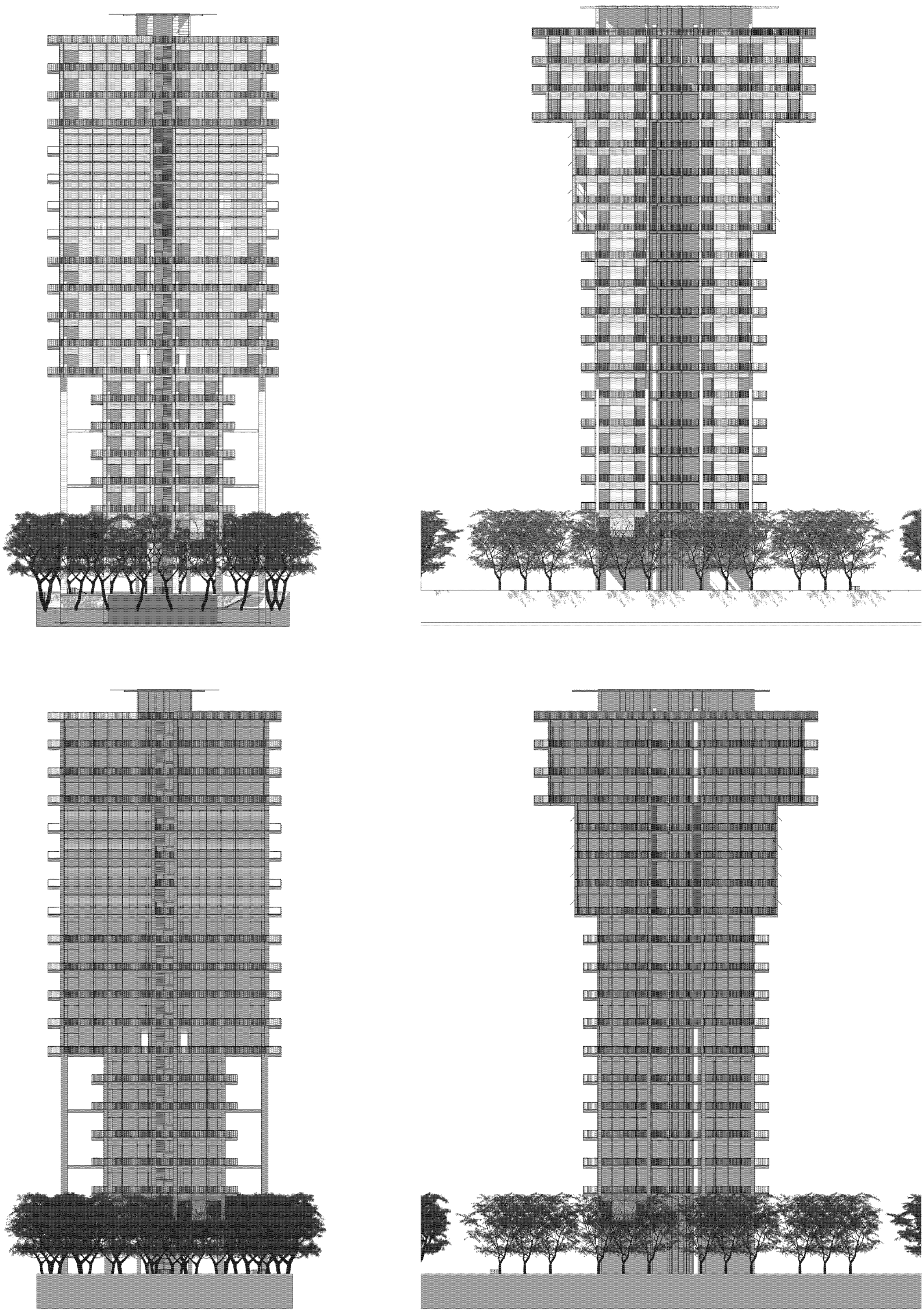


Figure 70: Light and shadow diagram on Fall Equinox (21st September 10 AM), South, East, North and West Elevations from top to below, drawn by the author.

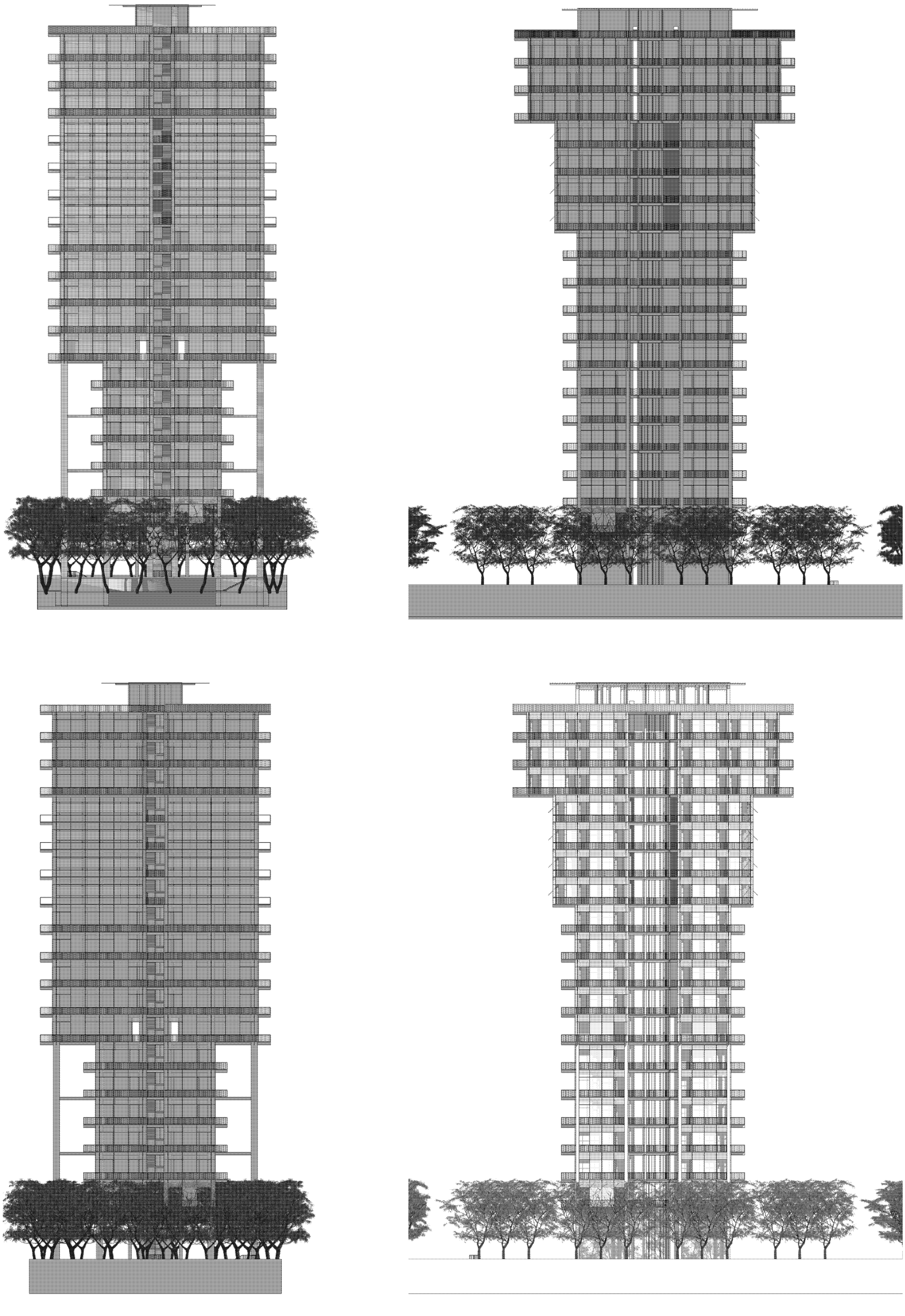


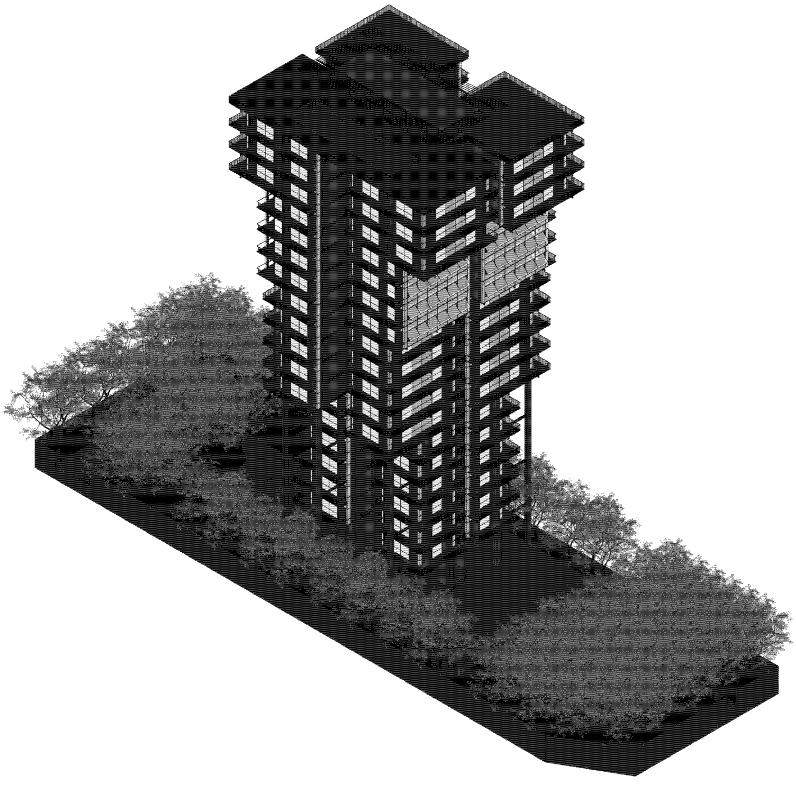
Figure 71: Light and shadow diagram on Fall Equinox (21st September 5PM), South, East, North and West Elevations from top to below, drawn by the author.

1

2

Figure 72: Light and shadow diagram from top to below, Summer Solstice (21st June) 1. North-East 10:00 AM 2. South-West 5:00 PM, Isometric Views, drawn by the author.

1



2

Figure 73: Light and shadow diagram from top to below, Winter Solstice (21st December) 1. North-East 10:00 AM 2. South-West 5:00 PM, Isometric Views, drawn by the author.

1

2

Figure 74: Light and shadow diagram from top to below, Spring Equinox (21st March) 1. North-East 10:00 AM 2. South-West 5:00 PM, Isometric Views, drawn by the author.

1

2

Figure 75: Light and shadow diagram from top to below, Fall Equinox (21st September) 1. North-East 10:00 AM 2. South-West 5:00 PM, Isometric Views, drawn by the author.

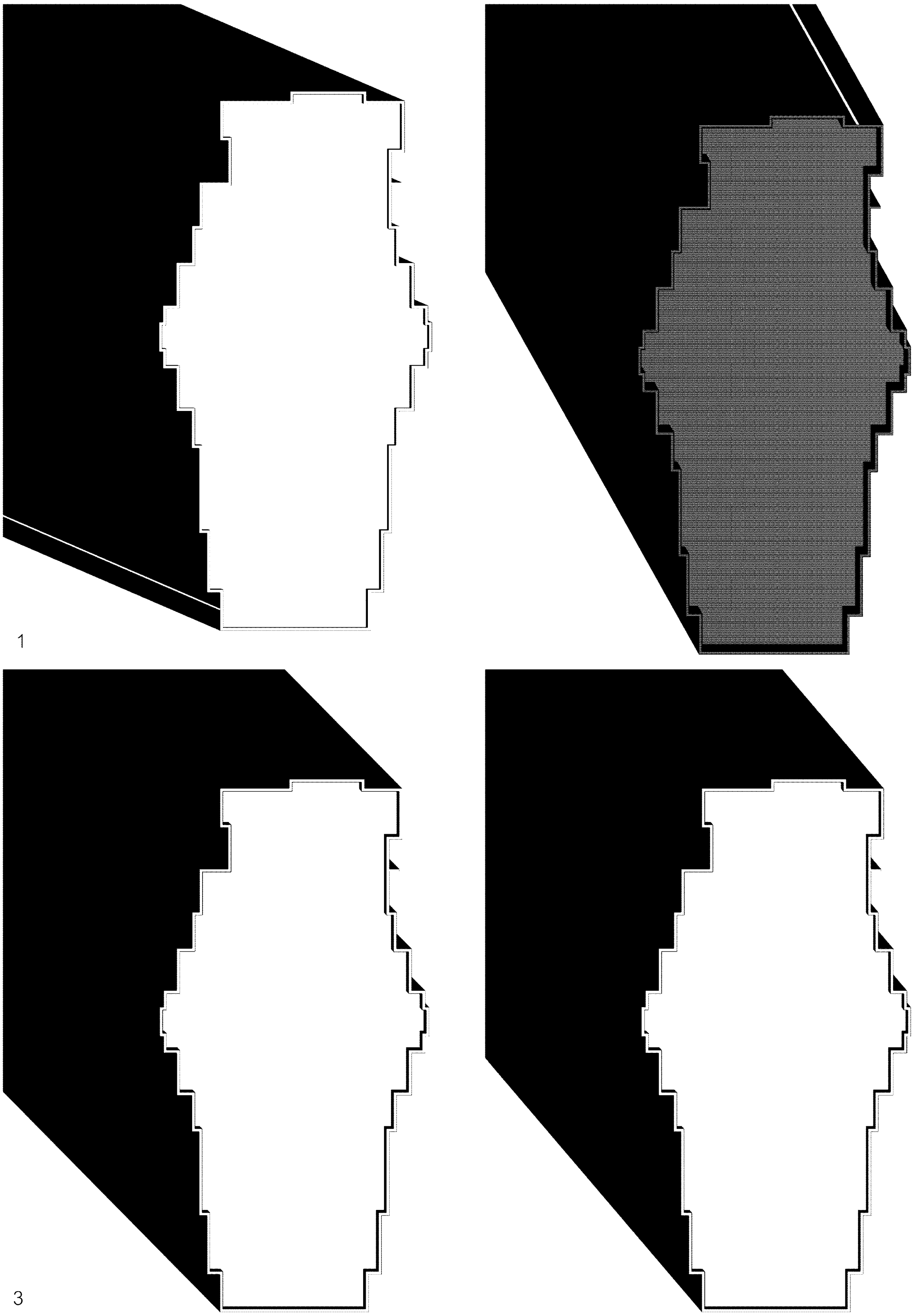


Figure 76: Light and shadow diagram of existing building from top to below, 1. Summer Solstice (21st June 10 AM), 2. Winter Solstice (21st December 10 AM), 3. Spring Equinox (21st March 10 AM), 4. Fall Equinox (21st September 10 AM) Plan Views, redrawn by the author.

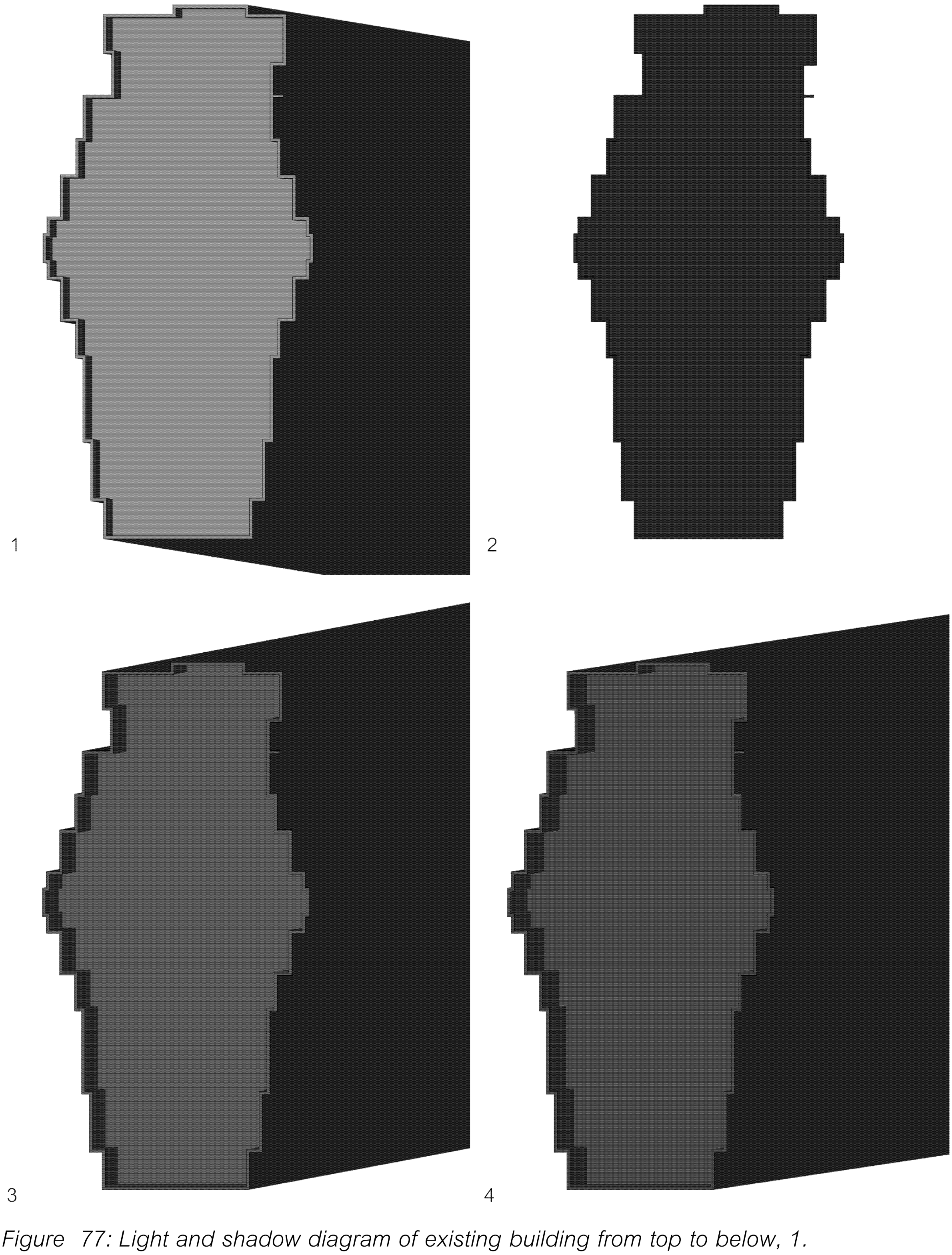
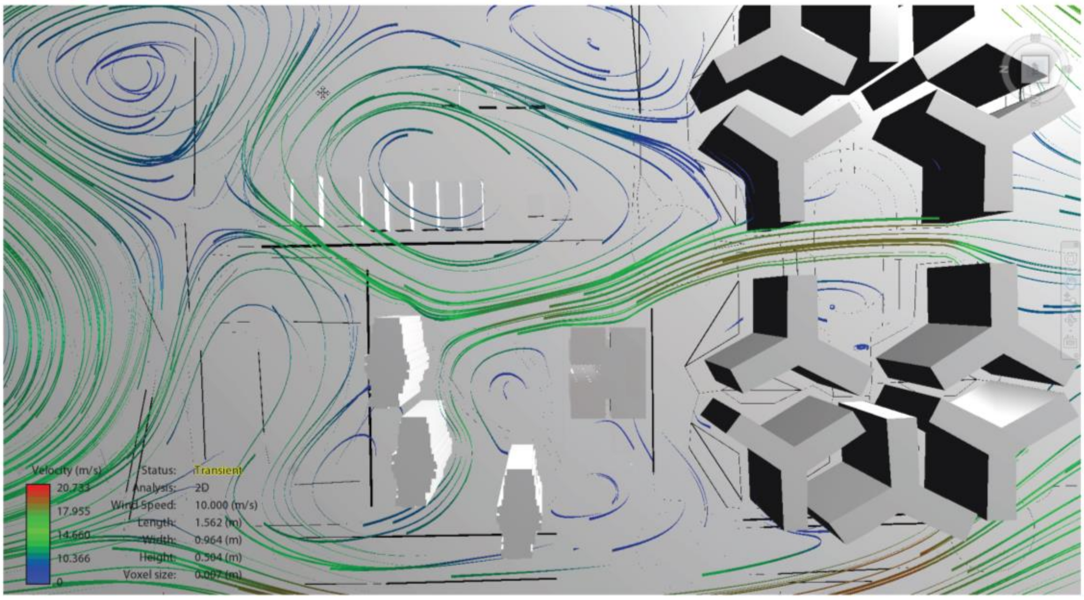


Figure 77: Light and shadow diagram of existing building from top to below, 1. Summer Solstice (21st June 5 PM), 2. Winter Solstice (21st December 5 PM), 3. Spring Equinox (21st March 5 PM), 4. Fall Equinox (21st September 5 PM) Plan Views, redrawn by the author.

4.3.3. Ventilation



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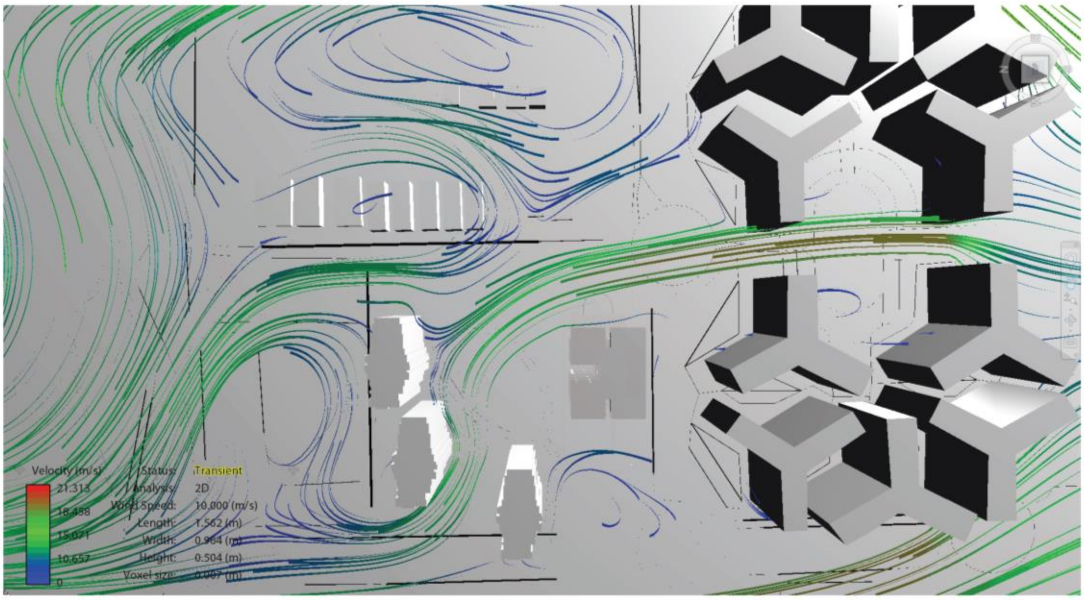
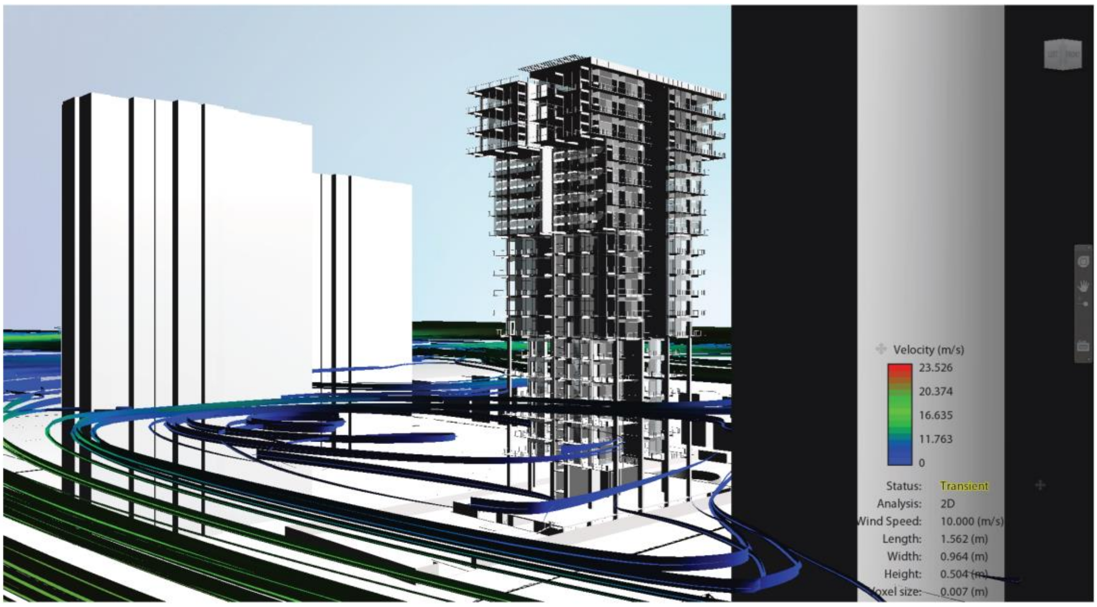


2

Figure 78: Analytical diagram of wind flow speed and direction in final design from top to below, simulated at wind speed 10 m/s with Autodesk flow design program, drawn by the author.



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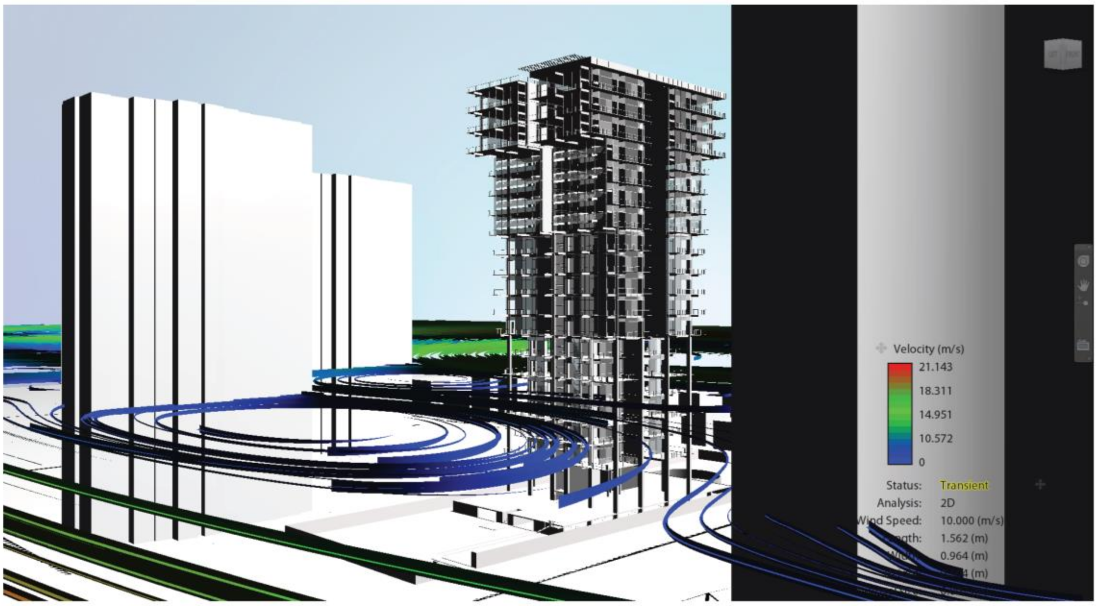
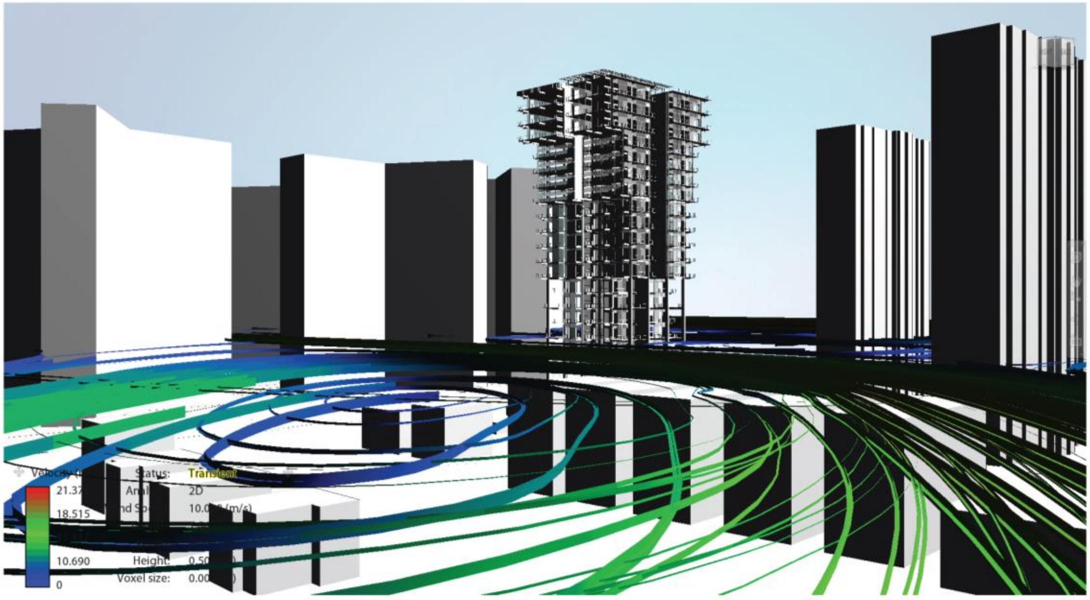


4

Figure 79: Analytical diagram of wind flow speed and direction in final design from top to below, Isometric Views, drawn by the author.



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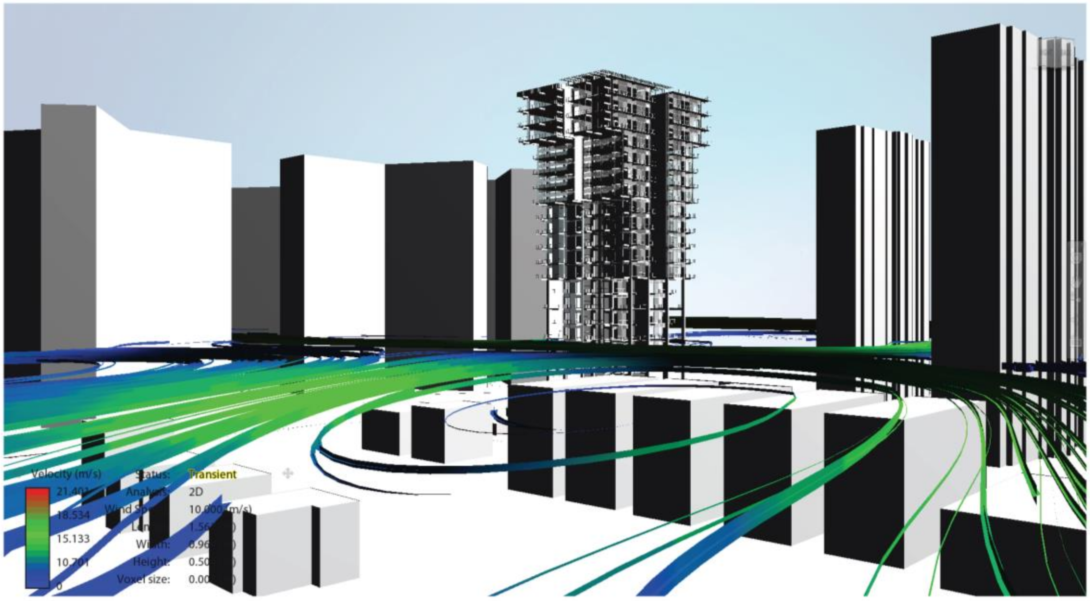

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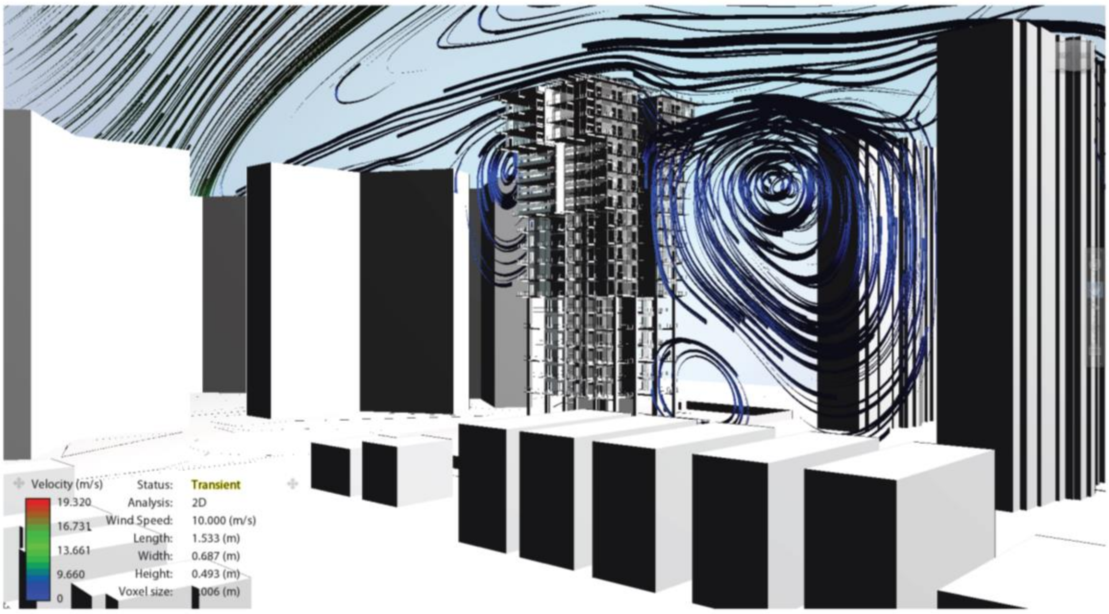
Figure 80: Analytical diagram of wind flow speed and direction in final design from top to below, Isometric Views, drawn by the author.



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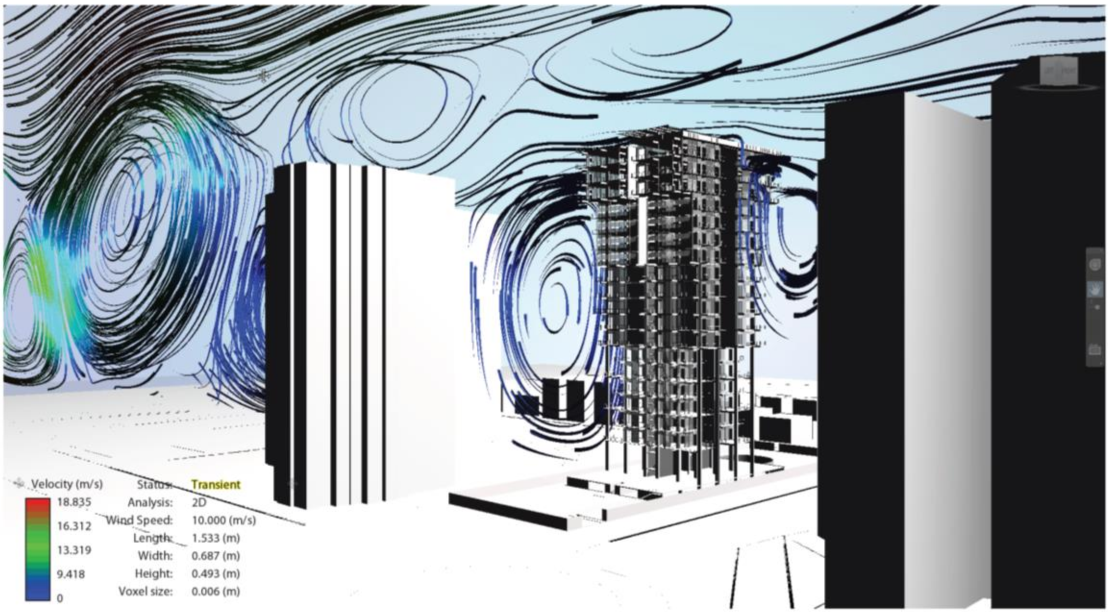


4

Figure 81: Analytical diagram of wind flow speed and direction in final design from top to below, Isometric Views, drawn by the author.

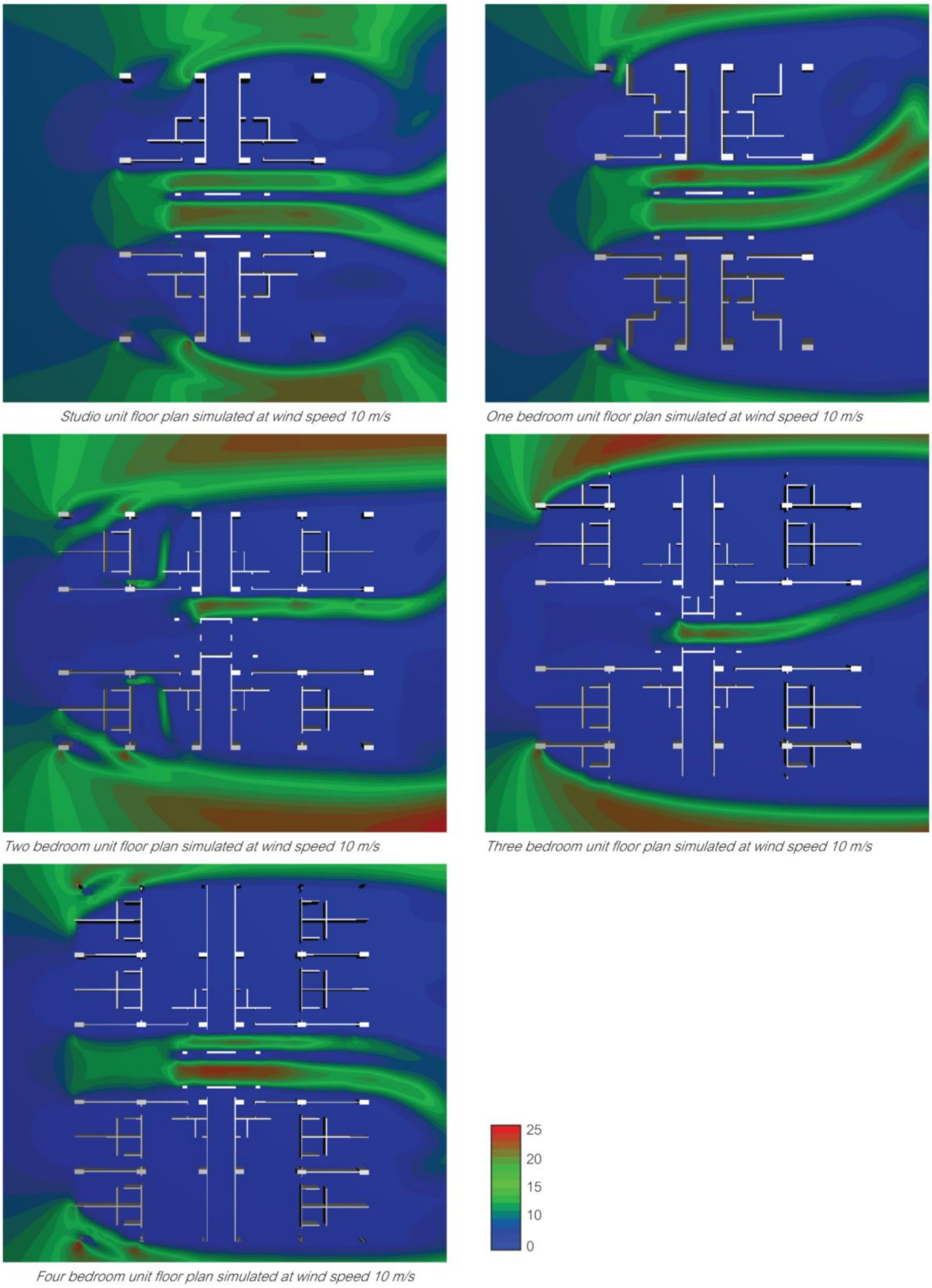
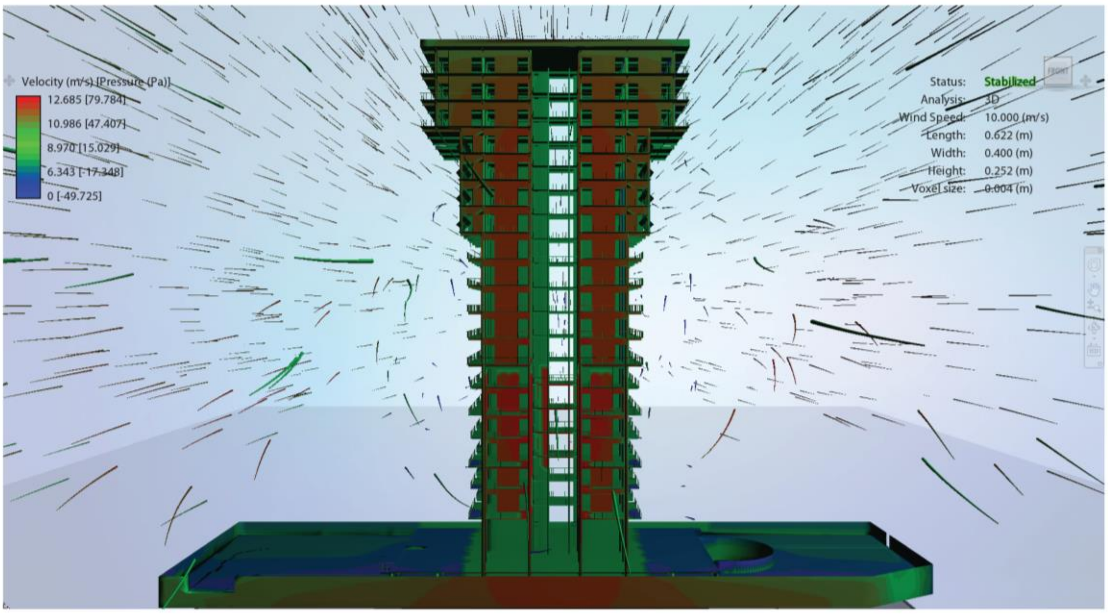


Figure 82: Analytical diagram of wind flow speed and direction in final design from top to below, simulated at wind speed 10 m/s with Autodesk flow design program, drawn by the author.



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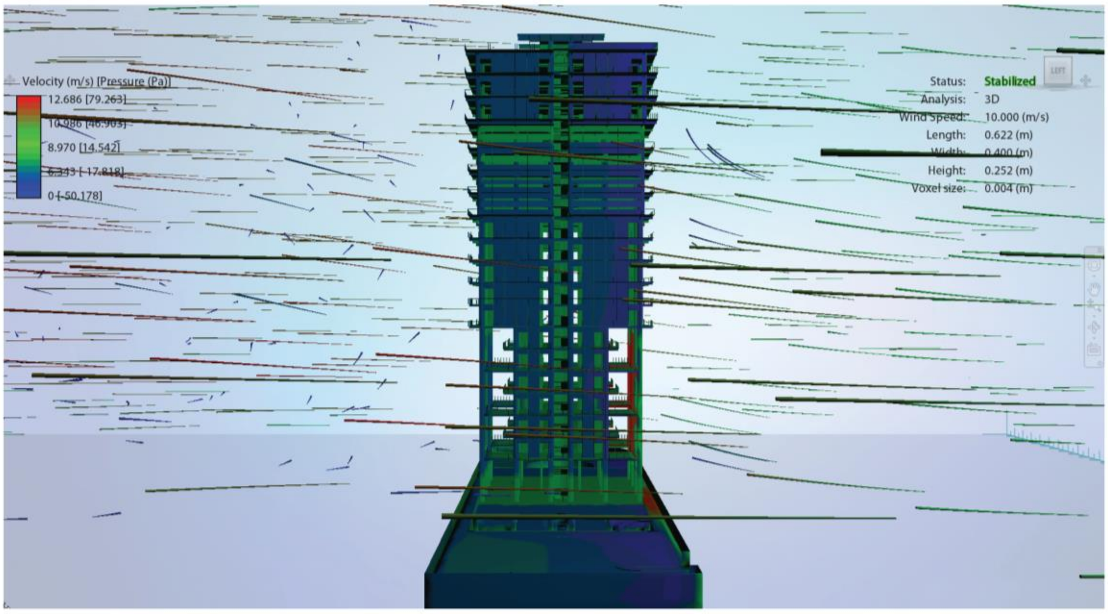
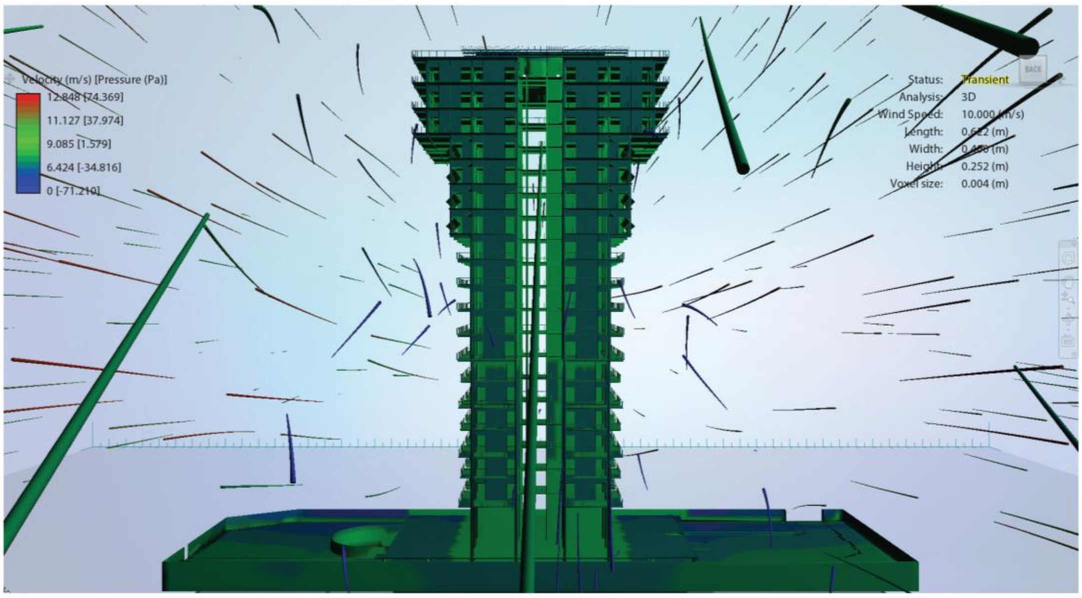


2

Figure 83: Analytical diagram of wind flow speed and direction in final design from top to below, 1. West Elevation 2. North Elevation simulated with Autodesk flow design program, drawn by the author.



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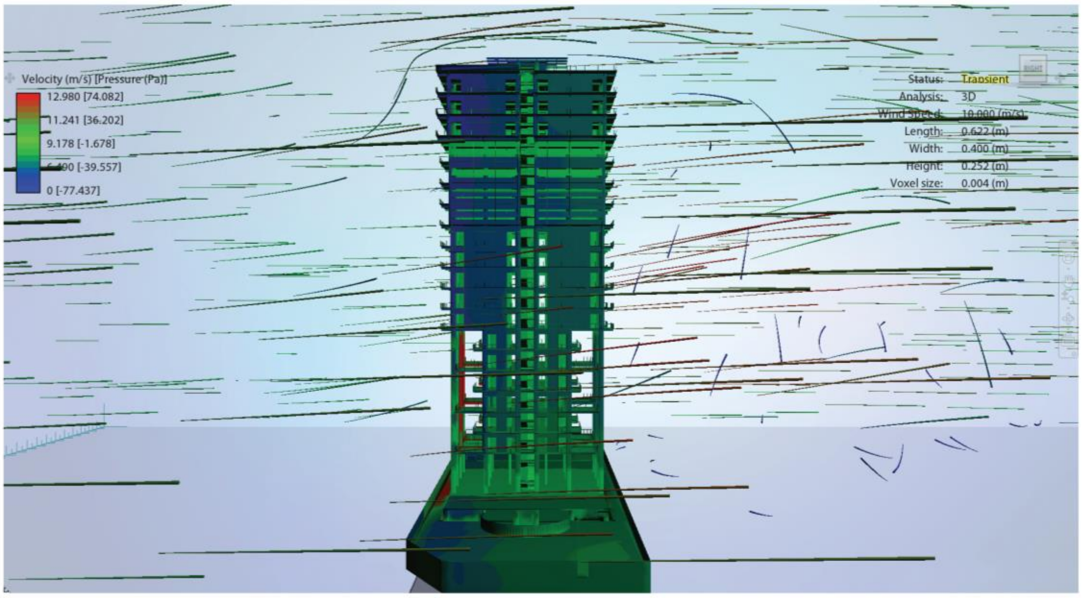

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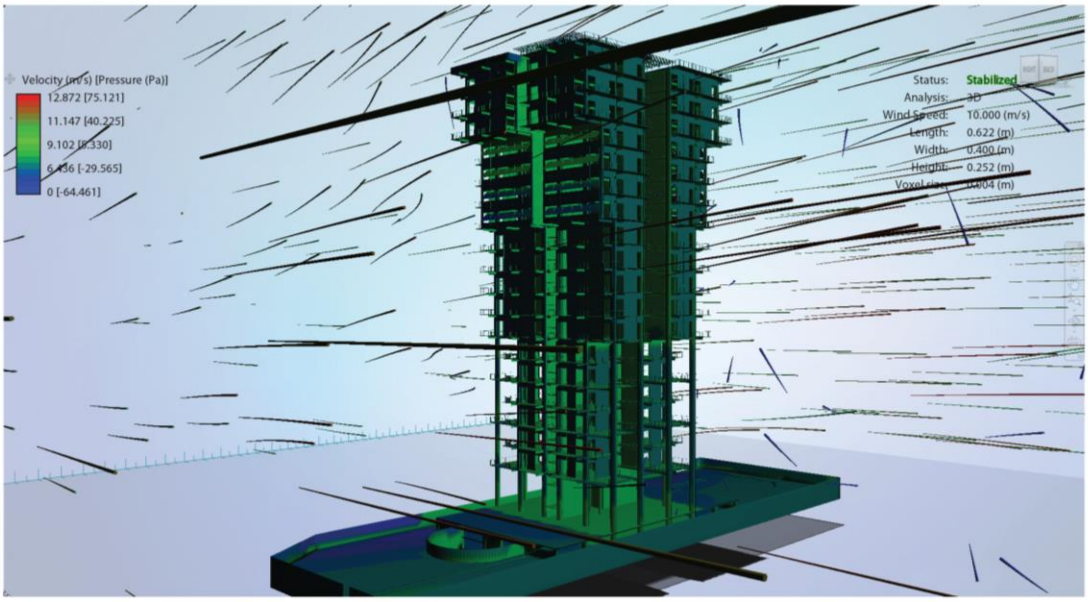
Figure 84: Analytical diagram of wind flow speed and direction in final design from top to below, 3. East Elevation 4. South Elevation simulated with Autodesk flow design program, drawn by the author.



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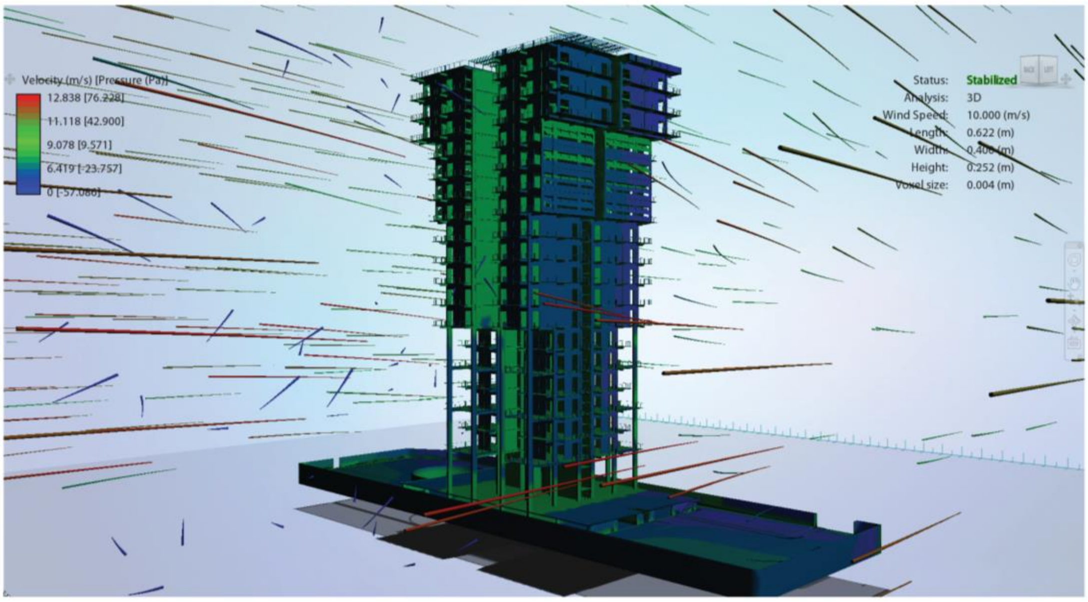
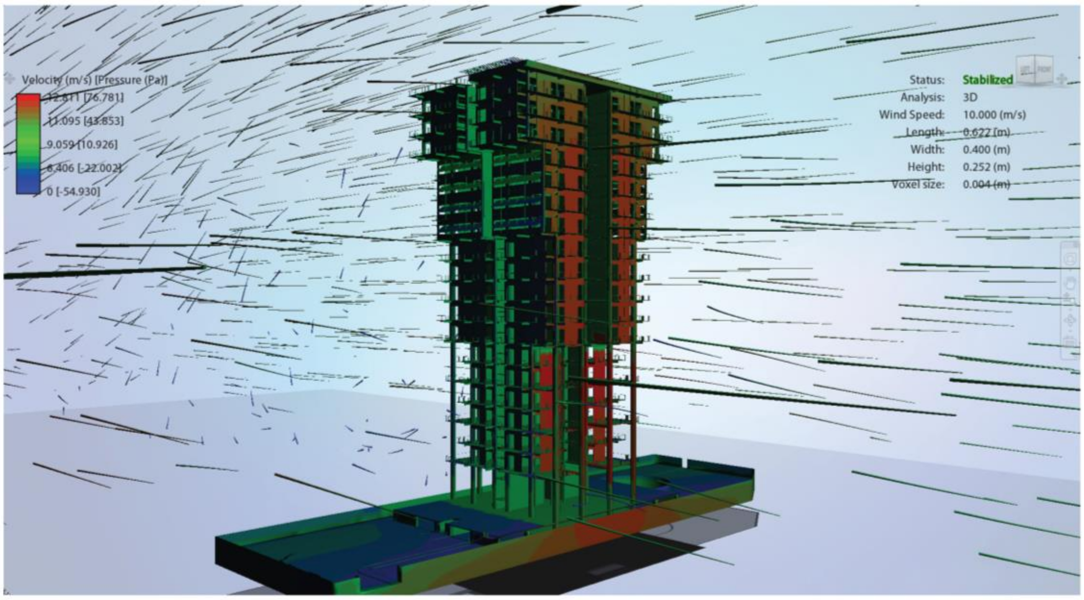


2

Figure 85: Analytical diagram of wind flow speed and direction in final design from top to below, 1. South-East 2. North-East, Isometric Views, drawn by the author.



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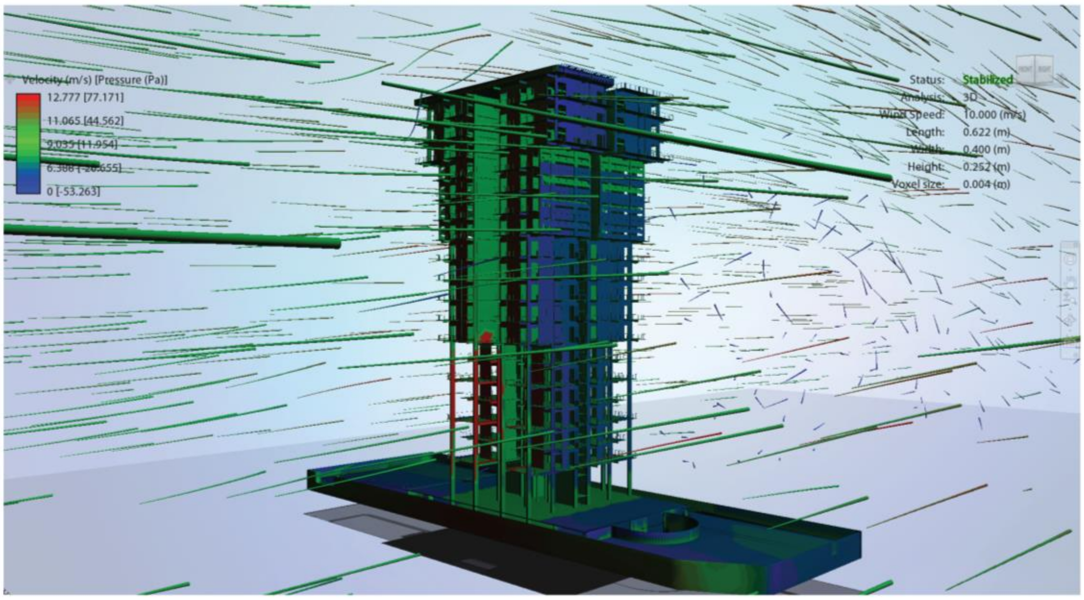
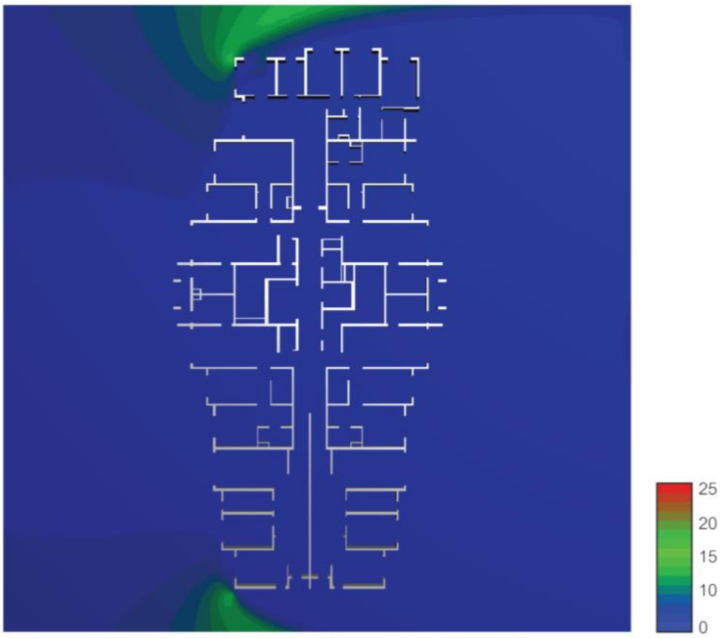
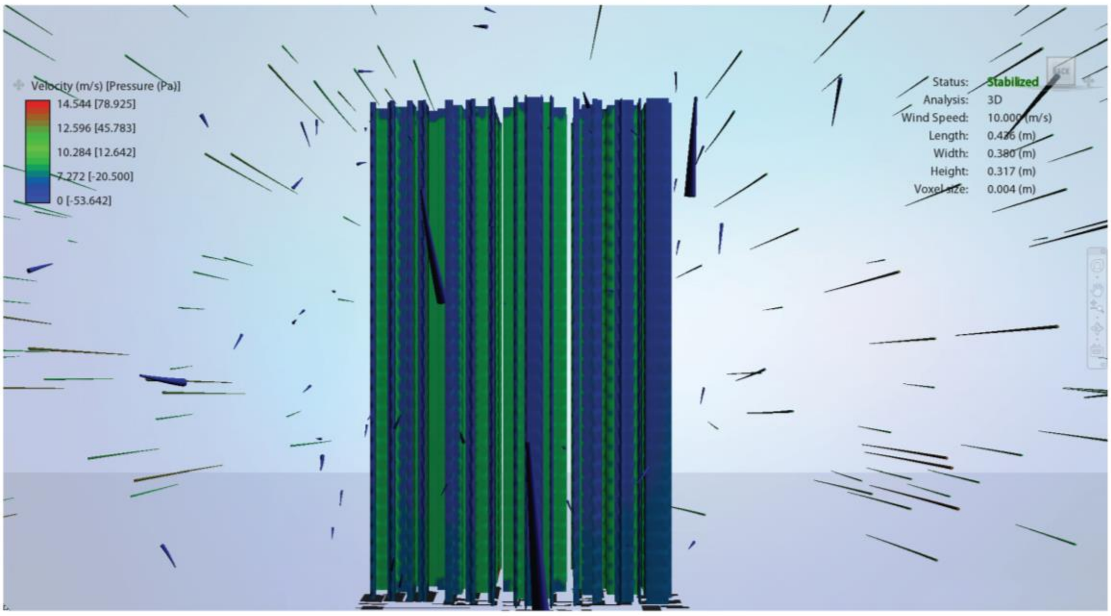


4

Figure 86: Analytical diagram of wind flow speed and direction in final design from top to below, 3. North-West 4. South-West, Isometric Views, drawn by the author.

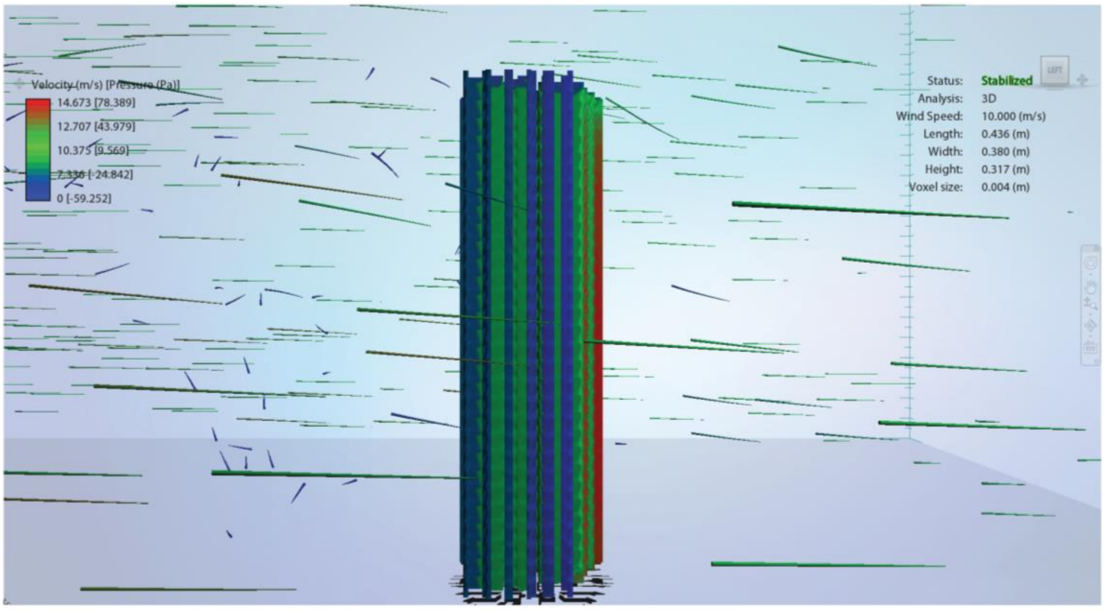


Residents unit floor plan simulated at wind speed 10 m/s



1

Figure 87: Analytical diagram of wind flow speed and direction in existing building from top to below, 1. West Elevation simulated at wind speed 10 m/s with Autodesk flow design program, drawn by the author.



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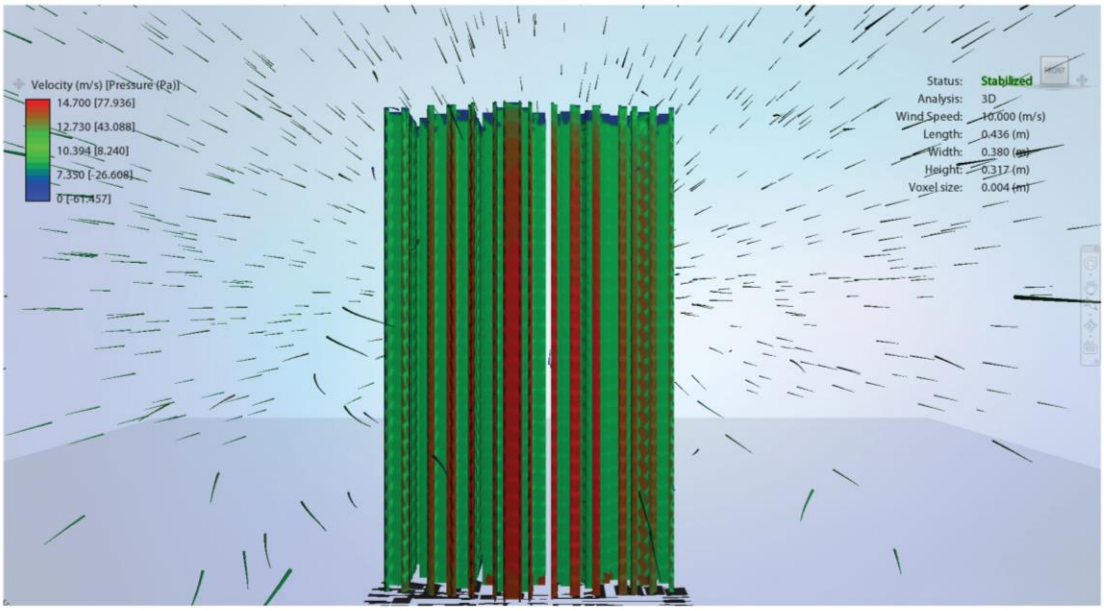
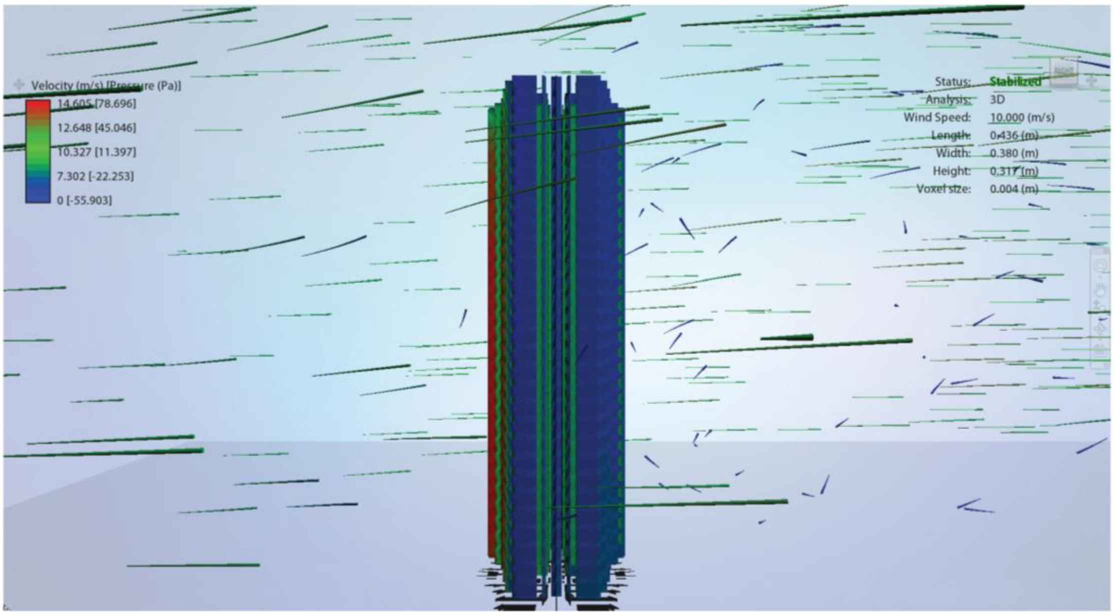


3

Figure 88: Analytical diagram of wind flow speed and direction in existing building from top to below, 2. North Elevation 3. East Elevation simulated at wind speed 10 m/s with Autodesk flow design program, drawn by the author.



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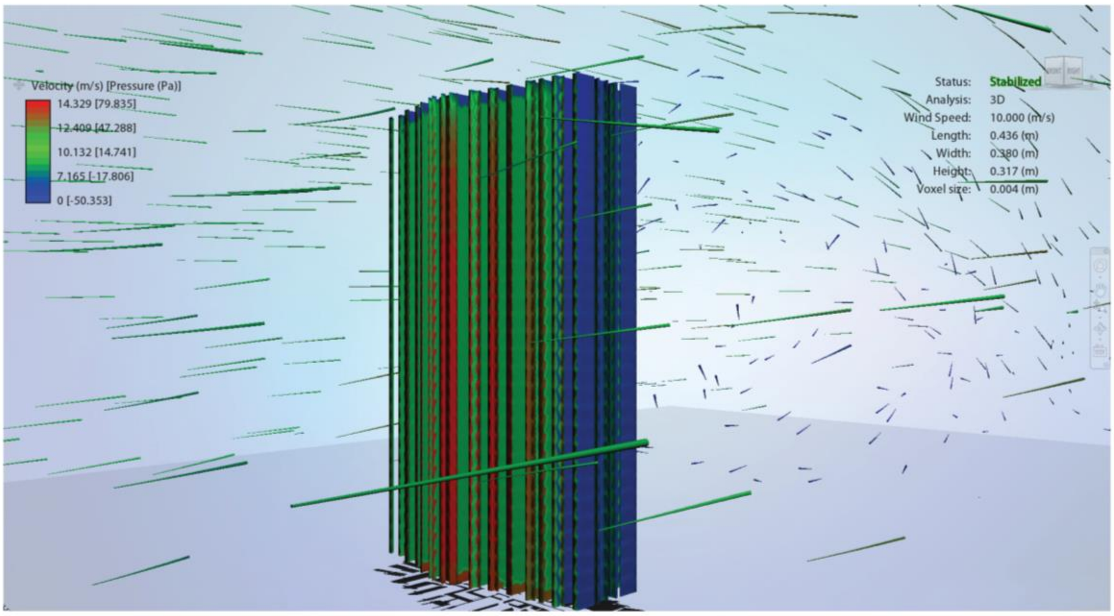
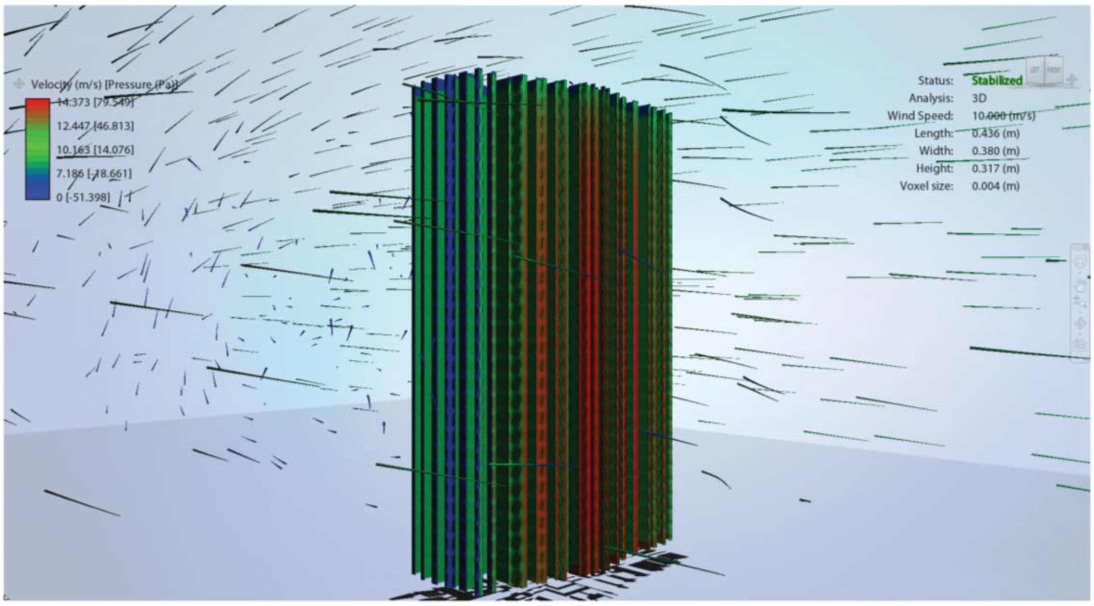


1

Figure 89: Analytical diagram of wind flow speed and direction in existing building from top to below, 4. South Elevation, 1. South-East Isometric Views simulated at wind speed 10 m/s with Autodesk flow design program, drawn by the author.



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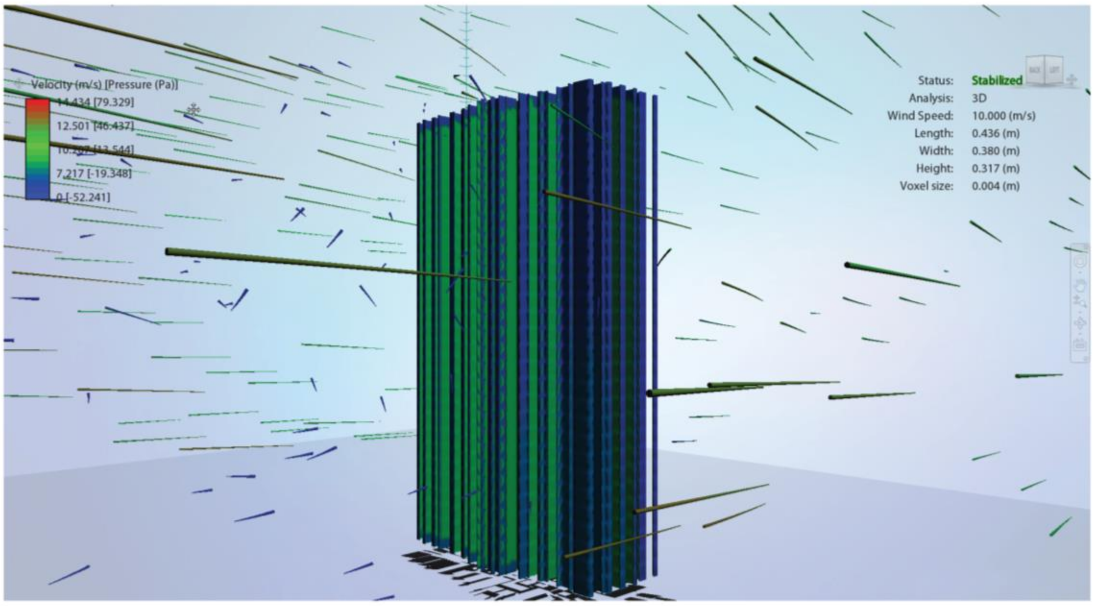
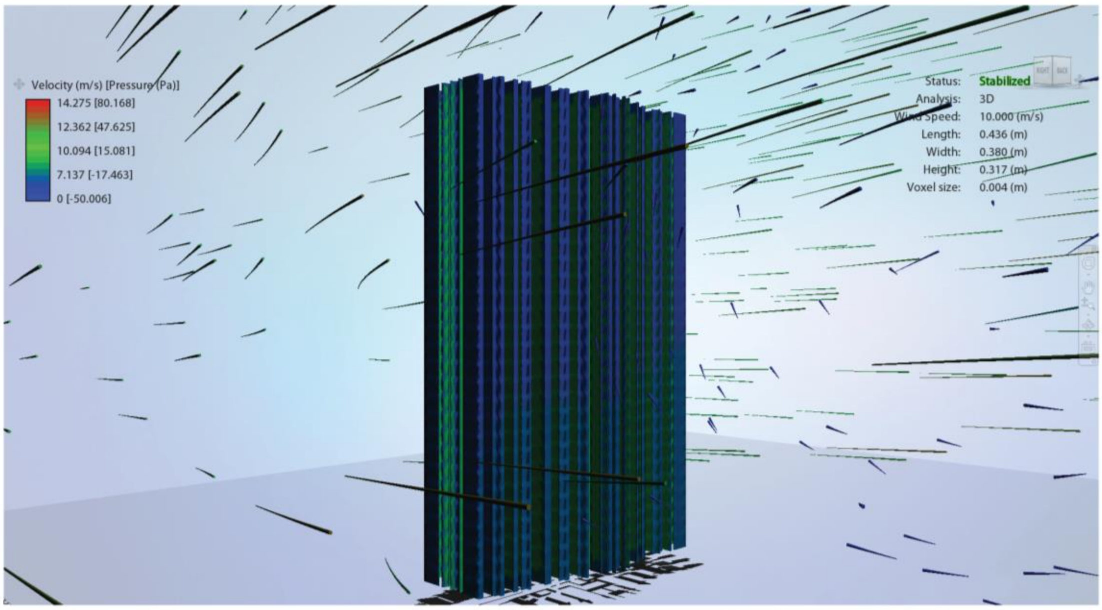


3

Figure 90: Analytical diagram of wind flow speed and direction in existing building from top to below, 2. North-East 3. North-West, Isometric Views simulated at wind speed 10 m/s with Autodesk flow design program, drawn by the author.



4

Figure 91: Analytical diagram of wind flow speed and direction in existing building from top to below, 4. South-West Isometric Views simulated at wind speed 10 m/s with Autodesk flow design program, drawn by the author.

4.4. Summary

To conclude, these analytical drawings are to compare the existing condominium of the Galaxy Towers, Yangon, and my residential design, with regards to circulation and core system, natural light factors and ventilation. The result comes out as the follows.

The circulation and core system of the existing condominium of the Galaxy Towers is 19% of the floor area. In terms of natural light, the circulation of the existing condominium is dark. It is a double corridor without the void to receive light. (See figure 53-58 and 61). For the ventilation, the different colors are shown the velocity of wind flow into the building. The strongest air flow is in rate of 25 m/s represented in red color in the diagram. In contrast, the color of blue is in the lowest air flow which means the velocity 0 m/s. The reading of the existing building ventilation is therefore generally good on the east side of the building and rather poor on the opposite side. (See figure 87-91).

In my design, the circulation and core system is 9% of the floor area, meaning that it is better than the existing one. It has abundant light and the service of each residence can be accessed from the outside of the private area. In terms of ventilation, the west side of my design can get the strongest air flow and the other sides are in the middle of the velocity rate 10 to 20 m/s. (See figure 83-86).

All in all, the author realizes that this is a beginning of the study of residential high-rise in the tropics. The point that has been presented throughout this thesis is the interrelationships between space composition, circulations (horizonal and vertical, main and secondary) and intangible elements such as light, shade, shadow and wind. They are all important to architecture, which man is at the center. The analysis still excludes many factors, such as feasibility, the wind load, the earthquake. These factors are beyond the scope of my thesis.

Chapter 5

Conclusion

My interest in residential high-rise in the tropical climate started when I worked as an architect in Myanmar. In Yangon, there is one university that teaches architecture, but it does not provide a master course that allows me to design a building, so i+mARCH Program at Chulalongkorn University in Bangkok is chosen. It is my wish to combine the study of climate factors with the design of a building. The studies of core system and circulation spaces then become relevant. It is necessary to categorize the typology of core system and circulation spaces as presented in Figure 15 -16, Chapter 3. The composition of core system and circulation spaces is important in residential high-rise buildings. The composition of core system can be generally divided into two types, the central one and the core system on the one side of the building. For example, the existing condominium in the Galaxy Towers is composed as the central core but the space is dark and no ventilation at all because of the enclosed order of space. Another example is one of the case studies from Bangkok called WINDSHELL Naradhiwas. Its core system is at the side of the building. WINDSHELL's circulation spaces receive natural light and ventilation. This spatial organization is special, compared with typical condominiums in Myanmar. Based on these studies, I choose to compose the central core system in my design in order to minimize the circulation spaces and to catch natural light and ventilation.

In literature reviews, *Robin Evans's* ***Translations from Drawing to Building*** mentioned about the importance of the connection of drawings and the lives of people. He pointed out to the connection between plans of a building and life of the inhabitants. Architectural drawing, called "plan", embodies life of the household and the society in which it belongs. In this sense, when the residential high-rise is designed, it is important to care for a better living conditions and the visual effects that a building may create within the urban. Architecture does not exist within itself. It connects with the urban infrastructure. It belongs to the life of a city.

This thesis is my first step to understand residential high-rise in tropics. It helps me out to explore and expand my knowledge concerning the importance of climate factors, core system and circulation spaces in a residential building. As the climate factors, natural light and shadow are the concerns to reduce the energy consumption. By doing the analysis on ventilation, the orientation of a building influences the different velocity ratio of air flow get into the building by different time. I have studied the composition of core system (stairs, elevators, mechanical rooms) together with the structural system of a building. A building's core is not only about the functions. It is also about the structure, how the wall may receive loads and so on. In addition to this, I have also studied the composition of solid and void in architectural design with the concerns of natural light and ventilation.

All in all, this thesis is valuable for my future development as an architect. It is the awareness of nature that I find important. I would like to further study the system of building façade along with this idea of nature. I would like to find the possibilities of façade compositions based on structures, materials and the ways in which materials may have changed architectural effects upon the inhabitants and the beholders.

REFERENCES

Ahmadi, F., Malekpour-Kolbadinezhad, S., Mortezaei, A., & Ghafari, F. (2018). Assessment of Building Façade Performance in-terms of Daylighting and Associated Energy Consumption in Architectural Spaces. **Journal of Applied Sciences and Environmental Management**, 22(8), 1281–1284.

Al-Tamimi, N. A., & Fadzil, S. F. S. (2011). **The Potential of Shading Devices for Temperature Reduction in High-Rise Residential Buildings in the Tropics**. Procedia Engineering, 21, 273–282.

Ali, Z. F. No1 Moulmein Rise.

American Society of Heating, Refrigerating and Air-Conditioning Engineers. (2010). **ASHRAE Standard: Thermal Environmental Conditions for Human Occupancy**. ASHRAE.

Bellia, L., Marino, C., Minichiello, F., & Pedace, A. (2014). **An Overview on Solar Shading Systems for Buildings**. Energy Procedia, 62, 309–317.

Chua, K. J., & Chou, S. K. (2010). **Evaluating the Performance of Shading Devices and Glazing Types to Promote Energy Efficiency of Residential Buildings**. Building Simulation, 3(3), 181–194.

Corrado, V., Serra, V., & Vosilla, A. (2004). Performance Analysis of external Shading Devices. 6.

Elsland, R., Peksen, I., & Wietschel, M. (2014). **Are Internal Heat Gains Underestimated in Thermal Performance Evaluation of Buildings?** Energy Procedia, 62, 32–41.

Etheridge, D. W., & Ford, B. (2008, March). **Natural Ventilation of Tall Buildings Options and Limitations**. In CTBUH 8th world congress (pp. 3-5).

Evans, R. (1997). **Translations from Drawing to Building and Other Essays**: Architectural Association London.

Firlag, S., & Zawada, B. (2013). **Impacts of Airflows, Internal Heat and Moisture Gains on Accuracy of Modeling Energy Consumption and Indoor Parameters in Passive Building**. Energy and Buildings, 64, 372–383.

Gratia, E., & De Herde, A. (2007). **The Most Efficient Position of Shading Devices in a**

Double-skin Facade. Energy and Buildings, 39(3), 364–373.

Haase, M., Marques da Silva, F., & Amato, A. (2009). **Simulation of Ventilated Facades in**

Hot and Humid Climates. Energy and Buildings, 41(4), 361–373.

Hien, W. N., & Istiadji, A. D. (2003, August). **Effects of External Shading Devices on**

Daylighting and Natural Ventilation. In Proceedings of the 8th International IBPSA

Conference, Eindhoven, The Netherlands (pp. 475-482).

Harriman, L. G., & Lstiburek, J. W. (2009). **The ASHRAE Guide for Buildings in Hot and Humid Climates**. Atlanta: American Society of Heating, Refrigerating and Air Conditioning Engineers.

Hassan, A., & Ramli, M. (2010). Natural Ventilation of Indoor Air Temperature: A Case Study of the Traditional Malay House in Penang. **American Journal of Engineering and Applied Sciences**, 3.

Ismail, A. M. (2010). **Prospect of Wind-driven Natural Ventilation in Tall Buildings**.

Lee, H. Y. (2002). **The Kampong House: An Evolutionary History of Peninsular Malaysia's**

Vernacular Houseform. Asia's Old Dwellings: Tradition, Resilience, and Change.

Liping, W., & Hien, W. N. (2007). **The Impacts of Ventilation Strategies and Facade on Indoor Thermal Environment for Naturally Ventilated Residential Buildings in Singapore**. Building and Environment, 42(12), 4006–4015.

MOHANTY, P. O., FORD, B., & LAU, B. (2013). **Effectiveness of Natural Ventilation in Tall**

Residential Building in Tropical Climate. In PLEA.

Monstvilas, E., Banionis, K., Stankevicius, V., Karbauskaite, J., & Bliudžius, R. (2010). Heat Gains in Buildings-Limit Conditions for Calculating Energy Consumption. **Journal of Civil Engineering and Management**, 16(3), 439-450.

Na, L. T. H., & Park, J. H. (2009). **Emphasis on Passive Design for Tropical High-rise Housing in Vietnam**. Jurnal Ilmiah.

Priyadarsini, R., Cheong, K. W., & Wong, N. H. (2004). **Enhancement of Natural**

Ventilation in High-rise Residential Buildings Using Stack System. Energy and Buildings, 36(1), 61–71.

Rahgozar, R., & Sharifi, Y. (2009). **An Approximate Analysis of Combined System of Framed Tube, Shear Core and Belt Truss in High-rise Buildings.** The Structural Design of Tall and Special Buildings, 18(6), 607–624.

SELF, JACK. R., YULIA. (2018). **Mies In London**. REAL.

Sha, H., & Qi, D. (2020). **A Review of High-Rise Ventilation for Energy Efficiency and Safety. Sustainable Cities and Society**, 54, 101971.

Sullivan, L. H. (1979). **Kindergarten Chats and Other Writings**: Courier Corporation.

Wong, P. (2008). **Natural Ventilation in Double-skin Façade Design for Office Buildings in**

Hot and Humid Climate. University of New South Wales, Australia.

Wong, N. H., & Li, S. (2007). **A Study of the Effectiveness of Passive Climate Control in Naturally Ventilated Residential Buildings in Singapore**. Building and Environment, 42(3), 1395–1405.

Yeang, K. (1996). **The Skyscraper Bioclimatically Considered: A Design Primer**. Academy Editions Ltd.

VITA

NAME	Miss Khin Thu Thu Kyaw Nyunt
DATE OF BIRTH	5 June 1995
PLACE OF BIRTH	Yangon, Myanmar
INSTITUTIONS ATTENDED	Thanlyin Technological University, Yangon, Myanmar.
HOME ADDRESS	Suwanna Apartment, 70 Rama 1 Road, Pathumwan District, Bangkok 10330.