POLITECNICO DI MILANO

Faculty of Engineering

Polo Regionale di Lecco

Master of Science in Architectural Engineering

Master's Thesis

Re-development and Arrangement of Waterfront Space as The Iconic Area of Makassar, Indonesia

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Contents

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Ahmad Nadhil Edar Arifin (Indonesia)

Magome Ayumu (Japan)

Zhang Tong (China)

1. Introduction

1.1 Overview

Astronomical layout Indonesia is 6° North Latitude - 11° South Latitude) and between 95° East Longitude - 141° East Longitude. If we can see from the position of astronomical Indonesia which is located in the tropical climate and is located in the eastern hemisphere of the earth.

Indonesia is in Southeast Asia, it is in the tropics area, it makes Indonesia is always exposed to the sun throughout the year. Indonesia only has twice a year changing of the seasons, namely dry and rainy seasons. Countries that have a typical tropical climate of outstanding natural overflowing. High rainfall will make the soil fertile. Flora and fauna is also very diverse.

Fig. 1.1. Location of Indonesia

Indonesia is a huge archipelagic country extending 5120 kilometers from east to west and 1760 kilometers from north to south. It encompasses 13667 islands (some sources say as many as 18000), only 6000 of which are inhabited. There are five main islands which are Sumatra, Jawa, Kalimantan, Sulawesi, and Irian Jaya.

Indonesian territory is composed of 34 provinces. A province is the highest tier of the local government divisions of Indonesia. Provinces are further divided into regencies and cities which are in turn subdivided into sub-districts. The current population of **Indonesia** is **262791599** as of Tuesday, April 4, 2017, based on the latest United Nations estimates.

Fig. 1.2. Map of Indonesia

Fig. 1.3. Location of Makassar

Sulawesi, formerly known as Celebes is an island in Indonesia. One of the four Greater Sunda Islands, and the world's eleventh-largest island. Sulawesi Island is composed by five provinces. They are Central Sulawesi, Gorontalo, South Sulawesi, North Sulawesi, West Sulawesi, and Southeast Sulawesi. And, each province has capital province.

The exact location for this project is in Makassar city which is the capital province of South Sulawesi Province.

Makassar territory is roughly between 5° and 7° S, and 119°20′ and 120°30′ E, including the island of Salayar. The Makassar inhabit the volcanic mountainous area around Mount Bawakaraeng/Lompobattang, which is traversed by a number of rivers, as well as the coastal plains, where most settlements are inhabited by a mixed Bugis-Makassar population. Except for the areas east of the volcano massif, where rainfalls are more evenly distributed over the year, the rainy season lasts from October to April.

Makassar is divided by 13 areas according to the main function for each area. So, each area has different main function, for example there are industrial area, city center area, tourism area, and so on.

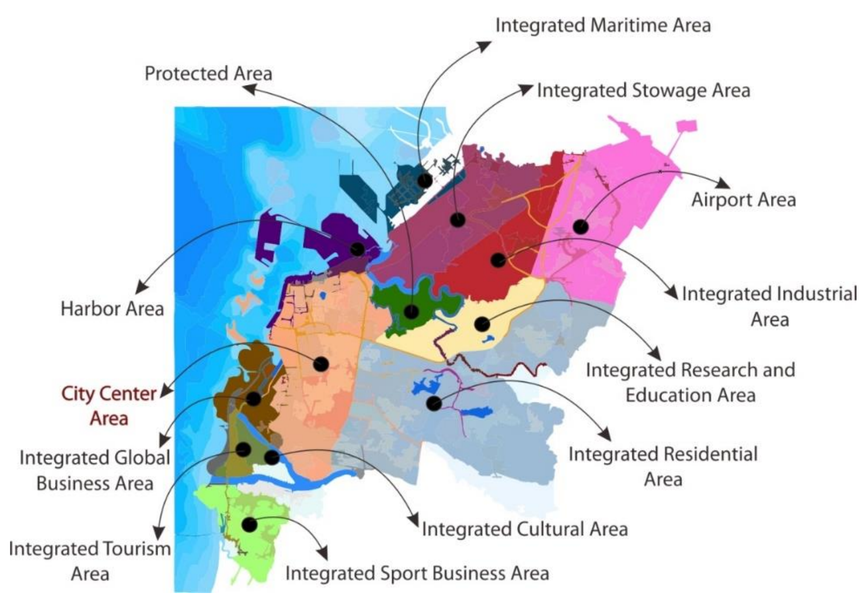


Fig. 1.4. Districts Function of Makassar

Makassar is composed by 14 districts and they are:

1. Biring Kanaya
2. Bontoala
3. Makassar
4. Mamajang
5. Manggala
6. Mariso
7. Panakkukang
8. Rappocini
9. Tallo
10. Tamalanrea
11. Tamalate
12. **Ujung Pandang (The Location of our project)**
13. Ujung Tanah
14. Wajo

1.2 Base Research

1.2.1 Geography

The site project area is about 30000 m^2 and our main project that we want to work deeply and more details is around 6600 m^2.

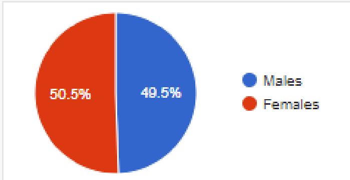
Fig. 1.5. The Site of Project

1.2.2 Population

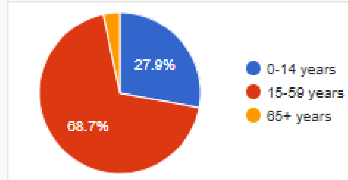
Name	**Status**	**Population** Census 2010-05-01
Kota Makassar	**City**	**1,338,663**
Biring Kanaya	District	167,843
Bontoala	District	54,268
Makassar	District	81,901
Mamajang	District	59,133
Manggala	District	117,303
Mariso	District	56,313
Panakkukang	District	141,524
Rappocini	District	151,357
Tallo	District	133,815
Tamalanrea	District	101,669
Tamalate	District	169,890
Ujung Pandang	District	27,206
Ujung Tanah	District	46,771
Wajo	District	29,670
Sulawesi (Celebes)	**Geographical Unit**	**15,787,955**

Source: Badan Pusat Statistik, Republik Indonesia (web).

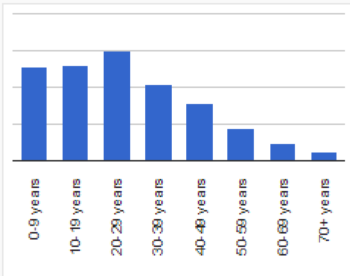
Fig. 1.6. Makassar's Districts Population



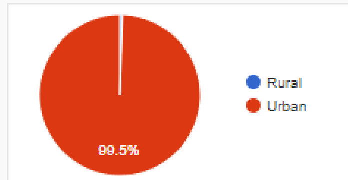
Gender (C 2010)	
Males	662,009
Females	676,654



Age Groups (C 2010)	
0-14 years	373,778
15-59 years	919,858
65+ years	44,810



Age Distribution (C 2010)	
0-9 years	255,202
10-19 years	260,425
20-29 years	300,874
30-39 years	207,272
40-49 years	154,065
50-59 years	87,720
60-69 years	47,861
70+ years	25,027



Urbanization (C 2010)	
Rural	7,272
Urban	1,331,391

Source: Badan Pusat Statistik, Republik Indonesia (web).

Fig. 1.7. Population according to Gender, Age, and Urbanization

Makassar is a multi-ethnic city, populated mostly by Makassarese and Buginese. The remainder come from Toraja, Mandar, Buton, China, Java, and other areas. The population development of Makassar as well as related to information and services (Wikipedia, Google, images).

1.2.3 Climate

- On average, the temperatures are always high.
- A lot of rain (rainy season) falls in the months: January, February, March, April, May, June, July, August, September, October, November and December.
- May is the wettest month. This month should be avoided if you don't like too much rain.
- October is the driest month.

Hottest Month	October (28 °C avg)
Coldest Month	January (27 °C avg)
Wettest Month	January (247.3 mm avg)
Windiest Month	September (7 km/h avg)
Annual Rainfall	1089.2 mm (per year)

Fig. 1.8. General Climate Overview of Makassar

1.2.3.1 temperature

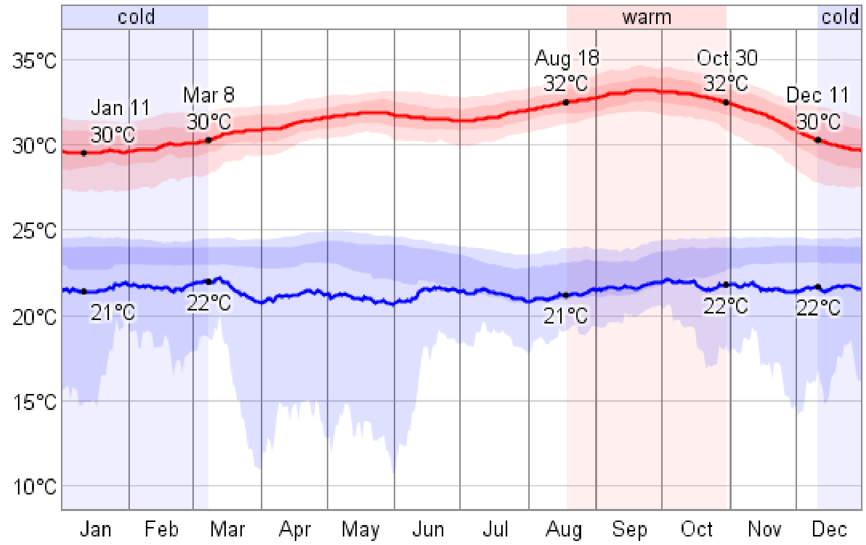


Fig. 1.9. Average Temperature of Makassar in a Year

Climate data for Makassar [hide]													
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average high °C (°F)	30.7 (87.3)	31 (87.8)	31.3 (88.3)	32 (89.6)	32.1 (89.8)	32.5 (90.5)	32.4 (90.3)	34.3 (93.7)	34.8 (94.6)	34.6 (94.3)	33.5 (92.3)	31.3 (88.3)	32.6 (90.6)
Average low °C (°F)	23.2 (73.8)	22.7 (72.9)	23.3 (73.9)	23.6 (74.5)	23.4 (74.1)	22.9 (73.2)	21.7 (71.1)	20.1 (68.2)	21.2 (70.2)	21.7 (71.1)	22.7 (72.9)	23 (73.4)	22.4 (72.4)
Average precipitation mm (inches)	734 (28.9)	533 (20.98)	391 (15.39)	235 (9.25)	127 (5)	66 (2.6)	48 (1.89)	15 (0.59)	83 (3.27)	83 (3.27)	273 (10.75)	549 (21.61)	3,086 (121.5)
Source: Weatherbase[18]													

Fig. 1.10. Climate Data of Makassar

From the climate data,within one year,the range of the temperature is from 20℃ to 35℃, the difference between the dry season and rain season is not very big.we can know that in Makassar the temperature during the whole year is more than 25℃,and August, september and october have the high temperature during year,which suggest us to considering shading ,cooling aspects during our design process,so we can get the largest thermal comfort when people go through with our building

1.2.3.2 Humidity

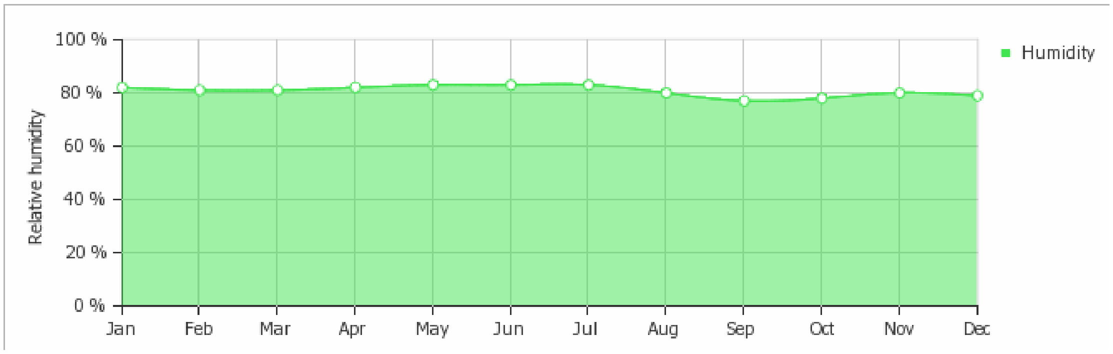


Fig. 1.11. Relative Humidity of Makassar in a Year

The range of raletive humidity is from 74.5% to 85% over the course of the year which considering wet and will make people feel uncomfortable.

The driest date is in september which is end of dry sensong during one year,the wetest date is in January which is in wet season.

1.2.3.3 Rainfall

In Makassar there is two seasons which are dry season (from april to september) and wet season (from october to march).

Considering the rainfall quantity is a big amount during the rain season

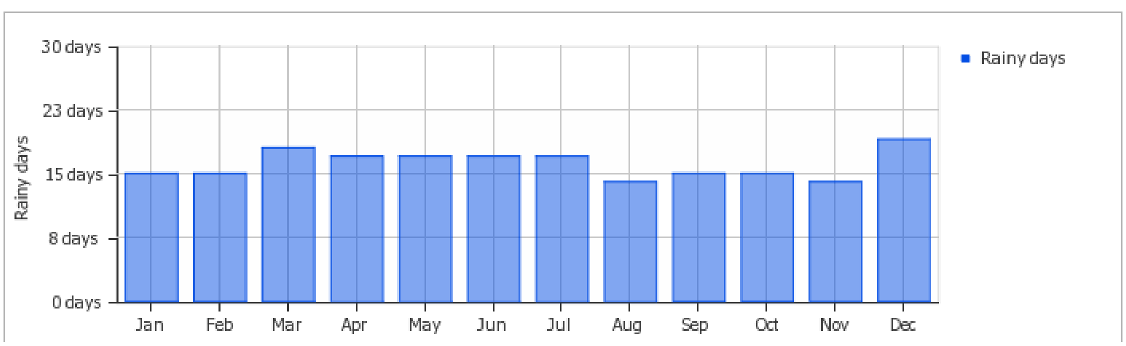


Fig. 1.12. Rainfall Quantity of Makassar in a Year

Design from the base background, combined with the characteristics of the traditional mophology, embody the regional characteristics and cultural history. From the spatial disorder to the regular arrangement.

1.2.4.4 wind

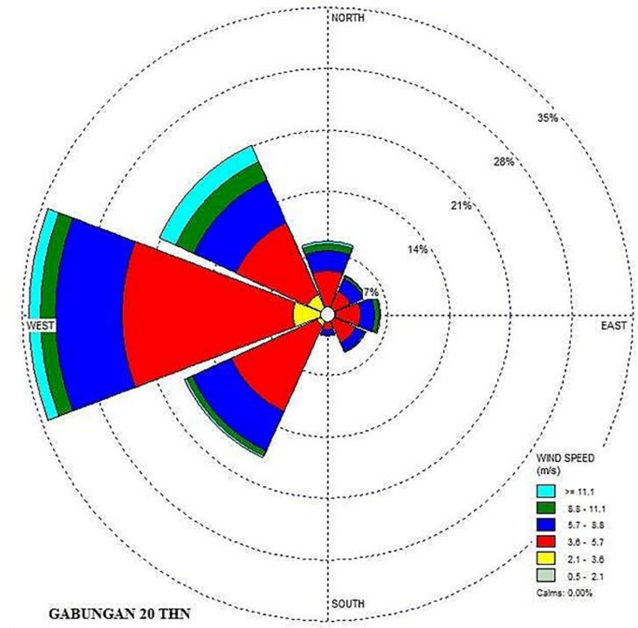


Fig. 1.13. Wind Rose Diagram

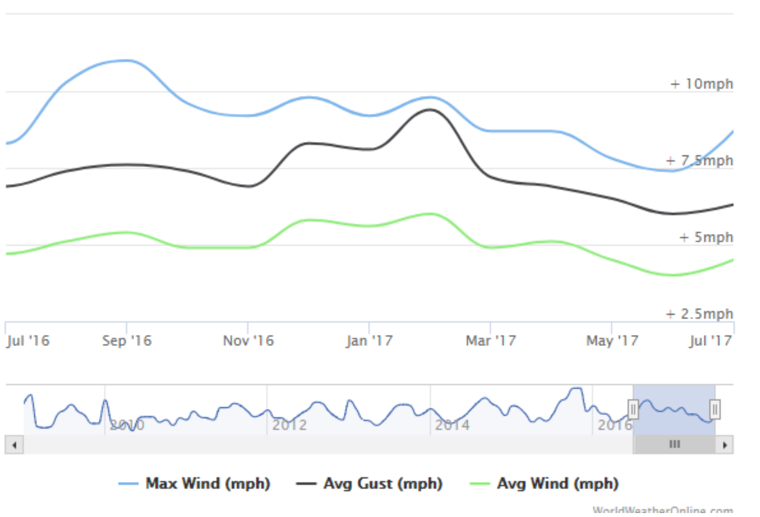


Fig. 1.14. Wind Average of Makassar in a Year

Within one year,the typical wind speds vary from 5.7m/s to 11.7 m/s. Averge and max wind speed and gust (mph).

1.2.4.5 Solar radiation

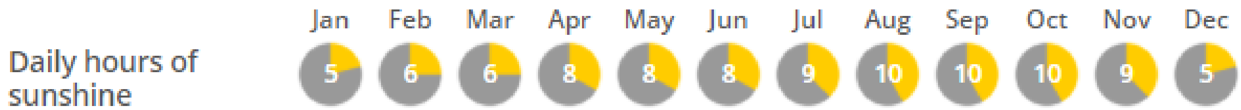


Fig. 1.15. Daily Hours of Sunshine in Makassar

From this graph we can see that during one year January has the least daliy sunshine hours which is 5 hours,and august, september and october has the longest daily sunshine hours which is 10 hours,the average daily sunshine hours during the whole year is 7.83h per day.which also give us a great potential of using solar energy.

1.2.4 History of Makassar

When the Portuguese, the first western visitors, reached Sulawesi in 1511, they found Makassar a thriving cosmopolitan entre-port where Chinese, Arabs, Indians, Siamese, Javanese, and Malays came to trade their manufactured metal goods and fine textiles for precious pearls, gold, copper, camphor and, of course, the invaluable spices - nutmeg, cloves and mace which were brought from the interior and from the neighbouring Spice Islands, the present day Moluccas.

By the 16th century, Makassar had become Sulawesi's major port and centre of the powerful Gowa and Tallo sultanates which between them had a series of 11 fortresses and strongholds and a fortified sea wall which extended along the coast.

Makassar quickly became known as a cosmopolitan, tolerant and secure entrepôt that allowed traders to bypass the Dutch monopoly over the spice trade in the east – a considerable concern to the Dutch. In 1660 the Dutch sunk six Portuguese ships in Makassar harbour, captured the fort and forced Gowa’s ruler, Sultan Hasanuddin, into an alliance in 1667. Eventually, the Dutch managed to exclude all other foreign traders from Makassar, effectively shutting down the port.

Even after Indonesia won its independence, ongoing civil strife hampered Sula-wesi’s attempts at post-war reconstruction until well into the 1960s. A period of uninterrupted peace delivered unprecedented and accelerating development, particularly evident in the ever-growing Makassar metropolis.

Tragically, the Poso region in Central Sula-wesi fell into a cycle of inter-communal violence in 1998 and troubles linger on today. The situation in the region remains tense.

Makassar is southern Sulawesi's primary port, with regular domestic and international shipping connections.

1.2.5 Tourism

Makassar is home to several prominent landmarks including:

- Dutch fort Fort Rotterdam(the 17th century)

Fig. 1.16. Fort Rotterdam Makassar View

- Trans Studio Makassar—The third largest indoor theme park in the world

Fig. 1.17. Trans Studio Makassar View

- Karebosi Link—The first underground shopping center in Indonesia

Fig. 1.18. Karebosi Link Shopping Makassar View

- The floating mosque located at Losari Beach.

Fig. 1.19. The Floating Mosque View

- Bantimurung - Bulusaraung National Park well-known karst area, famous for the remarkable collection of butterflies in the local area, is nearby to Makassar (around 40 km to the north).

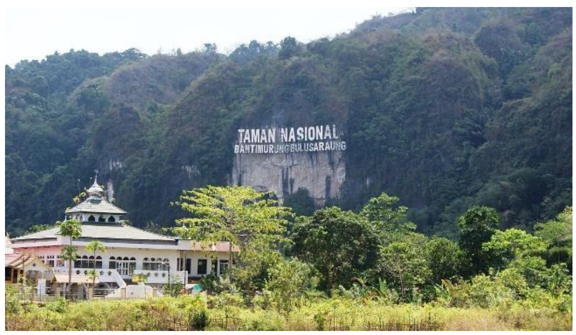


Fig. 1.20. Bantimurung-Bulusaraung National Park Makassar View

1.3 Transportation

Makassar's strategic location as a trading hub to east Indonesia will add more pressure on its transport network in the future.

1.3.1 The Airport

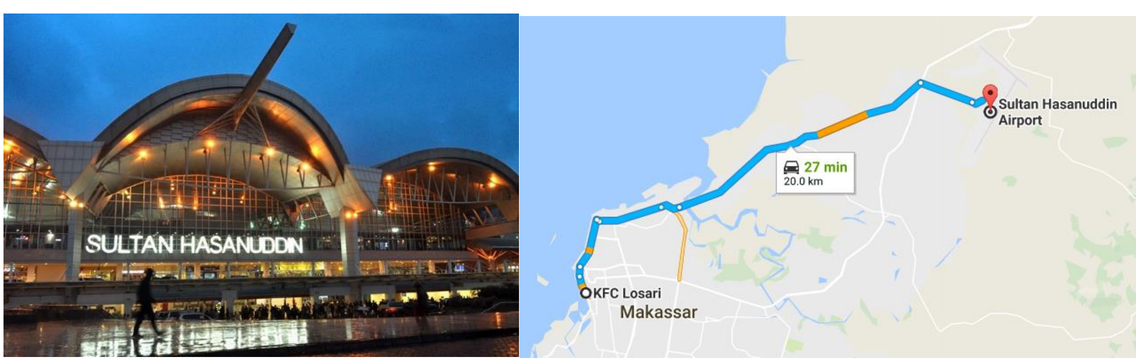


Fig. 1.21. Sultan Hasanuddin International Airport Location

This airport is the main gateway for flights to the eastern part of Indonesia. The UPG airport is really near to our site,the distance just 20KM.It takes 27 mins by car when there is no traffic jam.

1.3.2 The Port

Makassar is served by Soekarno-Hatta Sea Port. In January 2012 it was announced that due to limited capacity of the current dock at Soekarno-Hatta sea port, it will be expanded to 150x30 square meters to avoid the need for at least two ships to queue every day.

Fig. 1.22. Soekarno-Hatta Port Makassar

1.3.3 Modern and Traditional of Public Transportation

Makassar has traditional public transportation system called “Pete-Pete” which can carry up to 10 people typically. The other is called “Becak”. It can carry only 2-3 people maximum.

(a) (b)

Fig. 1.23. Traditional Public Transportation: Pete-Pete (a), Becak (b)

1.4 Site Condition

The municipality already considered that this area as the city center of Makassar, and also the iconic and tourism area. Because of the location of this city which is in the middle of I ndonesia, so The President of Indonesia also considered and decided that this city, especially this area will be the center point of Indonesia. Thus, this is one of the visions of the municipality.

In 2016, the municipality decided to redesign and re-develop some areas which not only really looks very messy, dirty, and so unorganized well, but also always happened the traffic jam in that area, that is why until now, most of the spaces on that area is really bad in terms of city and architectural consideration.

Fig. 1.24. The Main Problems on The Site Area

These are the main problems, so many street venders are along this area which make this area looks like very messy and dirty. On the other hand, the area is full of public and private vehicles that make super crowded and traffic jam almost everyday.

Fig. 1.25. Existing Condition Surrounding The Site

Meanwhile, these are the things that make all people not only Makassar people, but also people from the other city in Indonesia, even the tourists from the other country make this area as the first choice to visit when they are going to Makassar. There are some interest or tourism points around this area such as Losari Beach ("Pantai Losari" in Indonesian Languange).

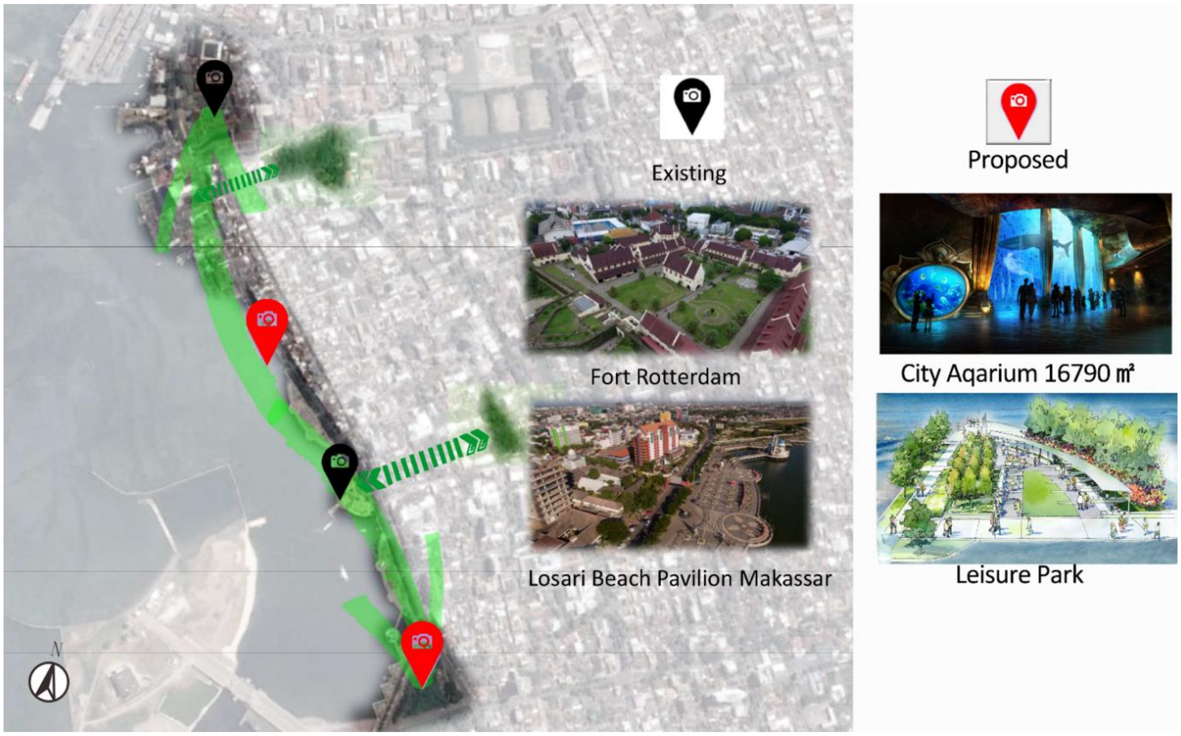


Fig. 1.26. Existing Interest Points and Some Proposed Ideas from us according to Municipality Vision to This Area

2. Urban Design

2.1 Study Cases

2.1.1 Case 1

Located between Haeundae Beach and Gwangalli Beach, the Millak Waterfront Park is the first park in Korea to combine the oceanfront with public rest and leisure facilities. The park (about 33,000 ㎡) can accommodate up to 40,000 people and boasts convenience facilities such as gardens, shaded rest areas, and benches. The 3,040 ㎡ platform from which visitors can overlook the beach also serves as a place where people can dip their feet in the ocean when the tide is high.

Once a small harbor city, Busan has grown rapidly into South Korea's second largest urban center. The port is situated at the cross section of the sea, the new town, and the dense residential neighborhoods located at the base of the Choryang Mountain. Drawing from the complexities of the site, the master plan of the Interactive Pier aims to achieve three distinct goals: integrate the original quay wall into a new pier to commemorate the history of the old city; provide a unique form of infrastructure offering a cultural, educational, and artistic platform for social interaction; and reintroduce man to nature.

The urban pier, consisting of an "Independent Platform" and "Flexible Platform," is designed as a marine landscape featuring a series of promenades. The platform forges the initial connection between the port and city center. A cafe and various marketplaces allow for gathering crowds to invigorate the space with energy and programmatic diversity. Bollards and "Color Poles" perform double-duty as infrastructure during cultural events. An "Emotional Pier" features the "North Port Story Memorial," gangway, "Harbor Block Garden" and "Nomad Park." The memorial consists of a six part exhibition, preserved quay wall, and large-scale ship sculptures.

A shallow square pond, miniature gardens, and an urban plaza and "Slope Stand" carve out open space for performances and social events. The urban core run alongs the waterfront and is composed of multiple levels featuring a beach, container, core room, plaza, and dock. These spaces house exhibitions, shops, cafes, an observatory, management center and pop-up stalls. Open air marketplaces attract artists and city-dwellers alike.

Materiality is fairly consistent with the existing concrete of North Port piers and bollards, interspersed with greenery and natural landscaping. The Nomad Park provides sandy beaches and a natural meadow, and functions both as a park for users, and a water purification system.

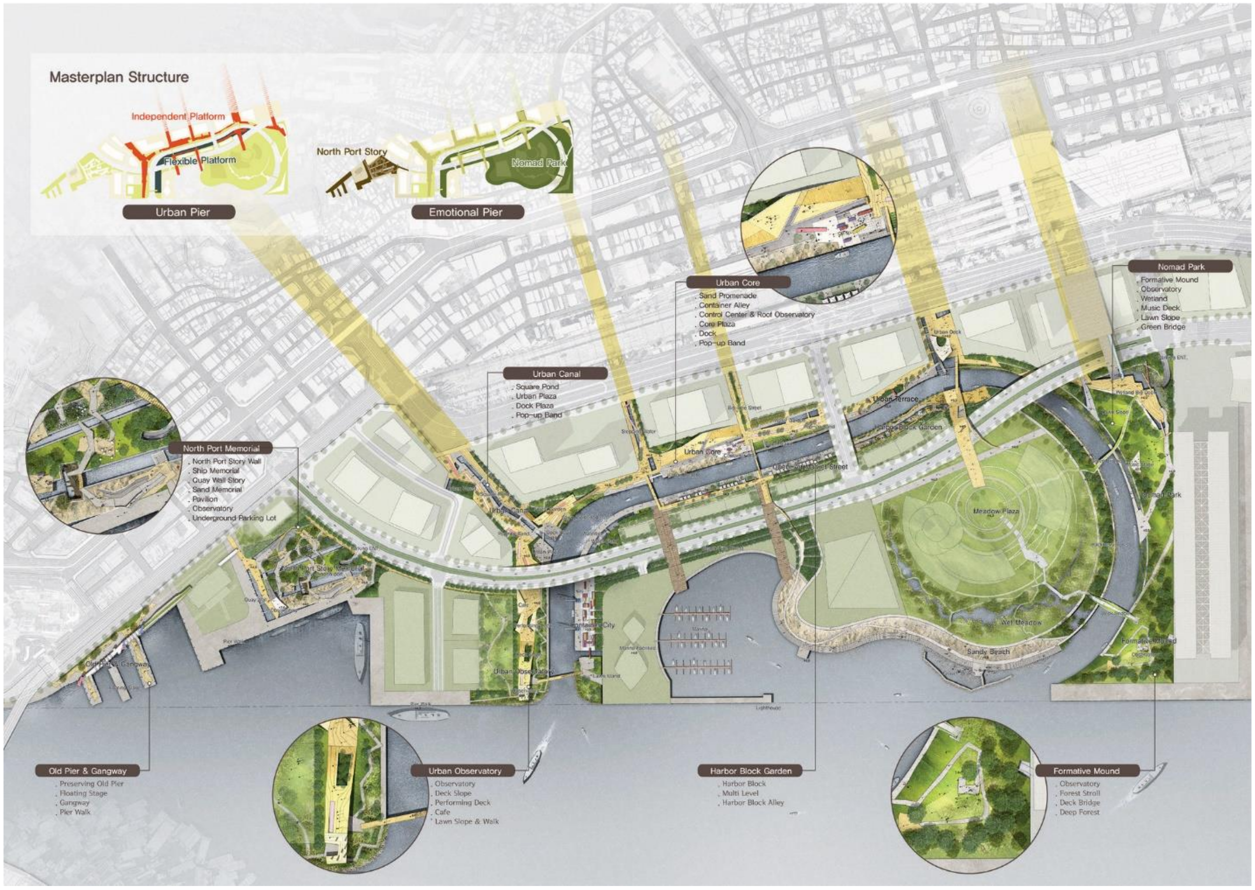

Masterplan Structure
Independent Platform
Flexible Platform
Urban Pier
North Port Story
Nomad Park
Emotional Pier
Urban Core
. Sand Promenade
. Container Alley
. Control Center & Roof Observatory
. Core Plaza
. Dock
. Pop-up Band
Nomad Park
. Formative Mound
. Observatory
. Wetland
. Music Deck
. Lawn Slope
. Green Bridge
Urban Canal
. Square Pond
. Urban Plaza
. Dock Plaza
. Pop-up Band
North Port Memorial
. North Port Story Wall
. Ship Memorial
. Quay Wall Story
. Sand Memorial
. Pavilion
. Observatory
. Underground Parking Lot
Urban Terrace
Harbor Block Garden
Urban Core
Meadow Plaza
Sandy Beach
Lighthouse
Old Pier & Gangway
. Preserving Old Pier
. Floating Stage
. Gangway
. Pier Walk
Urban Observatory
. Observatory
. Deck Slope
. Performing Deck
. Cafe
. Lawn Slope & Walk
Harbor Block Garden
. Harbor Block
. Multi Level
. Harbor Block Alley
Formative Mound
. Observatory
. Forest Stroll
. Deck Bridge
. Deep Forest

Fig. 2.1.1 Busan North Port Redevelopment Waterfront Park, Busan – South Korea

2.1.2 Case 2

Bjarke Ingels has unveiled a vision to transform the harbour of Denmark's second largest city into a public plaza featuring a waterside theatre, swimming baths, beach huts and maritime allotments.

Named Bassin 7, the design by Ingels' firm BIG proposes a pair of overlapping promenades for Aarhus. These will stretch from the Nikoline Kochs Plads town square to the tip of the waterfront, improving connections between the city centre and the boat harbour.

The first of the two promenades will offer a direct route, while the second will create a meandering zigzag that will frame some of the proposed amenities, including bathing pools, beach zones and green spaces.

Around these, the studio proposes adding seven residential buildings in a range of heights. Each of these is designed with a courtyard at its centre.

"By designing the public space as the first step, the masterplan carefully mixes public programs with private residences, creating a new dynamic urban area where public and private realms converge," said BIG in a statement.

The masterplan also includes an assortment of cafes and restaurants, as well as a kayak port and several viewing platforms.

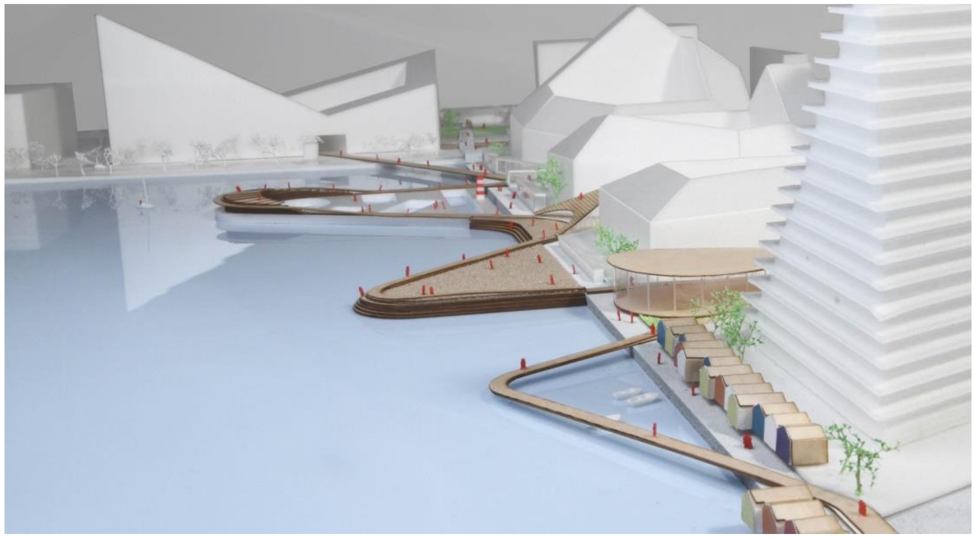


Fig. 2.1.2 Aarhus Harbour with swimming baths and beach huts, Aarhus - Denmark

2.2 Site Analysis

2.2.1 Function

The area of the project locates coastal area of Makassar, Indonesia and has several types of land use. Along the seashore, constructing artificial islands is still going which are used for commercial and touristic functions which has hotels and harbor for import and export in northern part, in the other hand, used for public space in southern part. Especially, the biggest artificial island is going to be a central business district which has hotel, university, food district, new commercial area and so on. Besides the artificial islands, there is wide street for mainly cars and bikes, and in the other side, green area exists as windbreak.

Originally, this area is used for commercial districts which has indigenous small shop, kiosk and merchandise stores and at the same time, behind of the area, owners of the each shops has also storages and housing spaces. The area which is far away from the ocean is mainly filled for residencial area and the other parts are for religious buildings and historical areas. Especially in the northern part of the area, there is archeological site with walls of a castle.

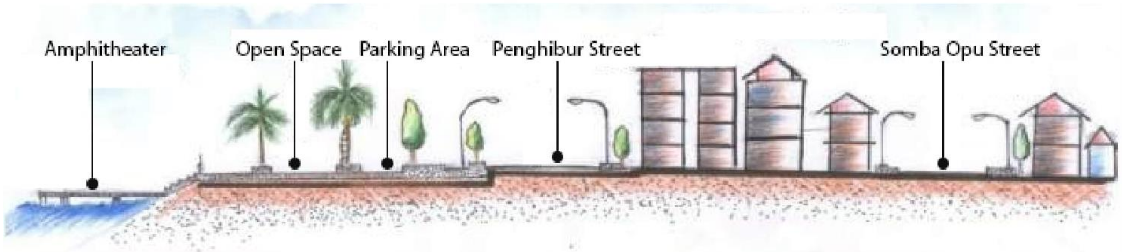


Fig. 2.2.1. Site Section Existing Function

Fig. 2.2.2. Lan-Use Map

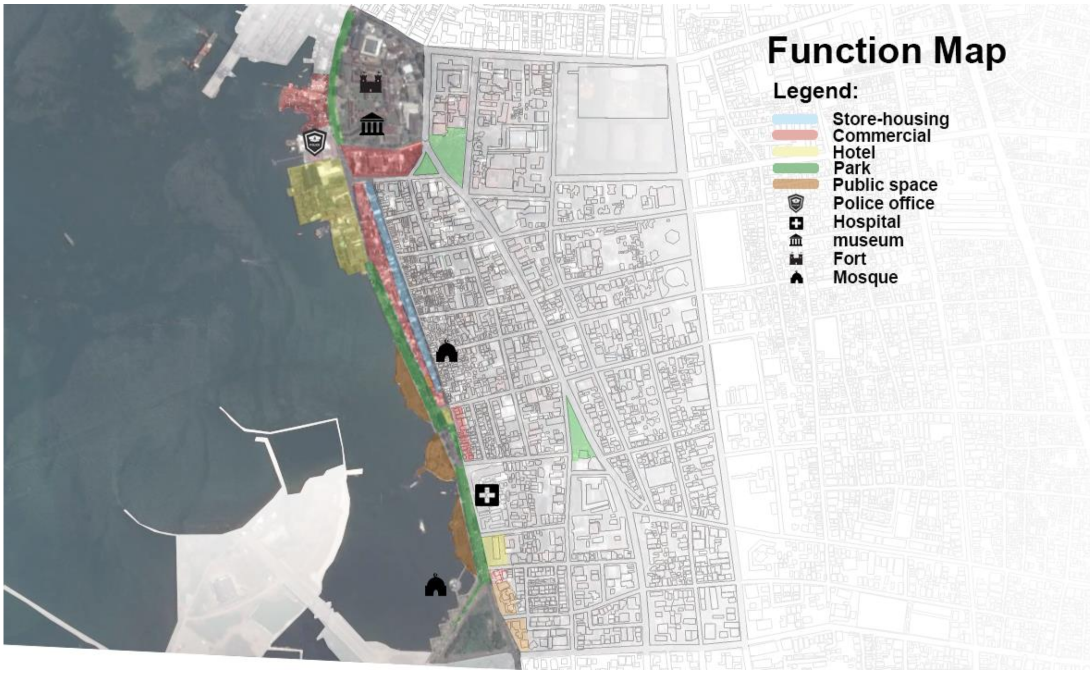


Fig. 2.2.3. Function Map

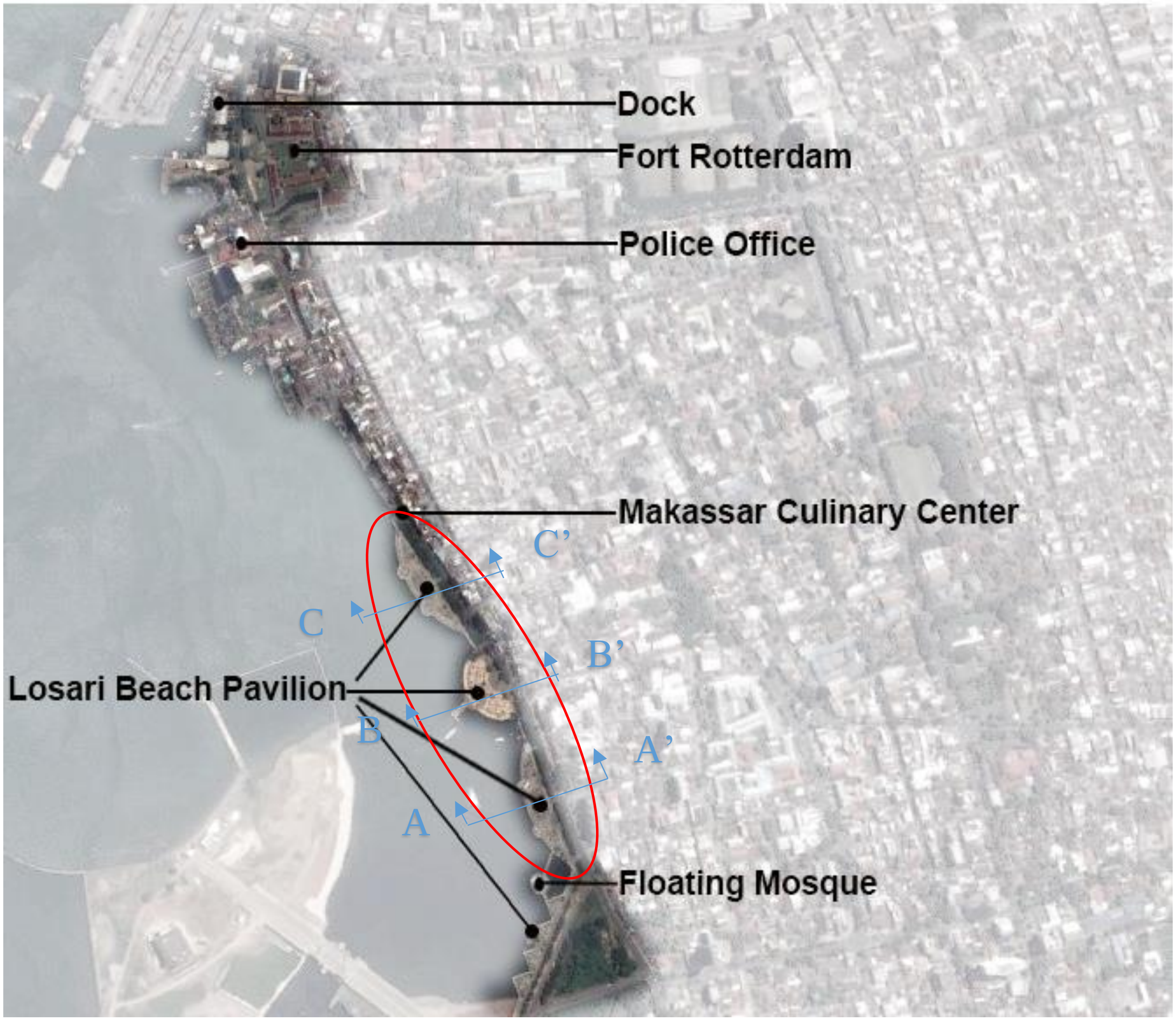


Fig. 2.2.4. The Main Focus of Development of Municipality Vision

A-A′

B-B′

C-C’

Fig. 2.2.5. Site Sections (Proposed Ideas and Existing)

2.2.2 Transportation

This area has already transportation network which is basecally used for private car and bikes because of lack of public transportations. When situations in weekdays and weekends are compared, congestion of traffic more happens and is heavier in weekends. In addition to compared with morning around 8 am, in evening 6 pm traffic would be heavier. In front of the project site, the traffic would heaviest around the site.

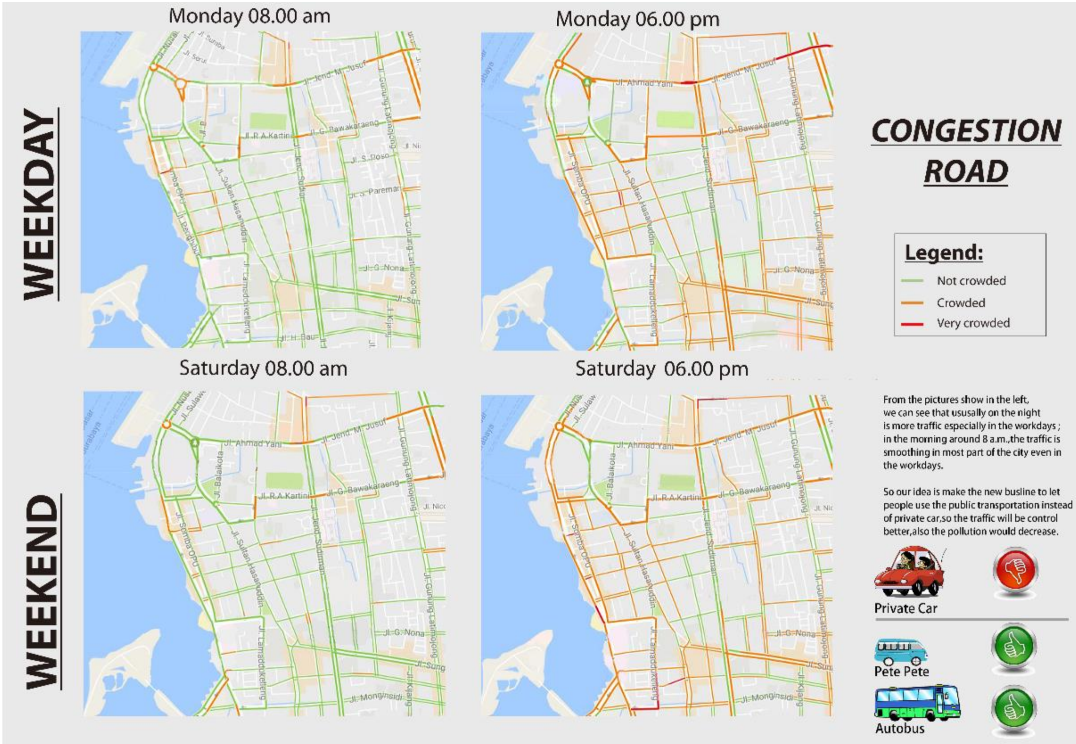


Fig. 2.2.6. Congestion Road Map

After getting the results, the project will propose new public transportation network which is Bus for reducing the number of private cars and bikes. For the information, this idea will be the first bus as the public transportation in this city.

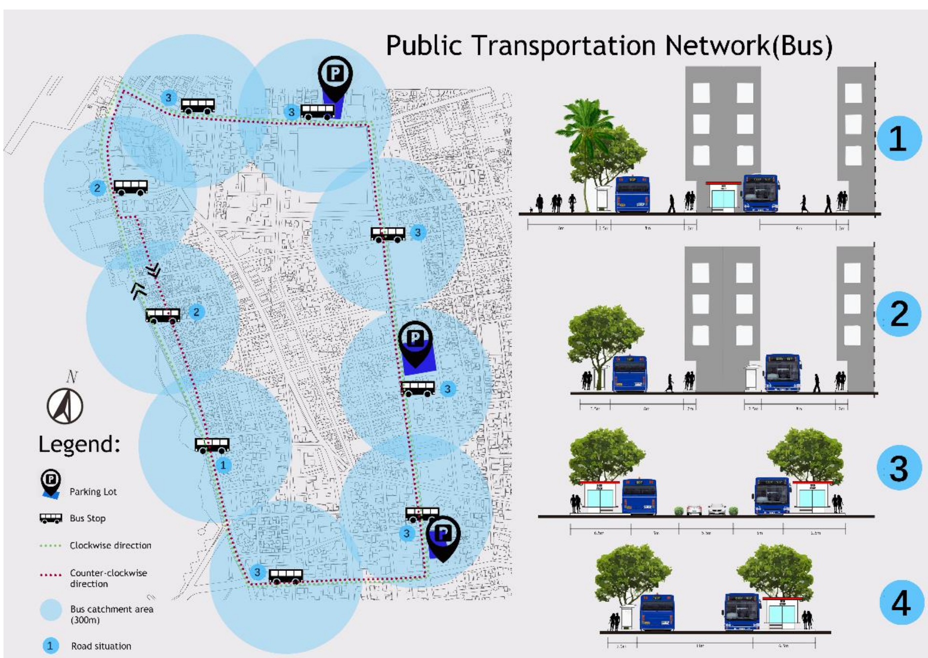


Fig. 2.2.7. Bus Network Concept

2.2.3 Green Space

As we have known Makassar is really hot city because of topical climate, so the green space has really important role either to make the city cool and comfort for the people or to help pedestrians walking without getting hot from the sun and the air temperature.

Fig. 2.2.8. Green Spaces Around The Site

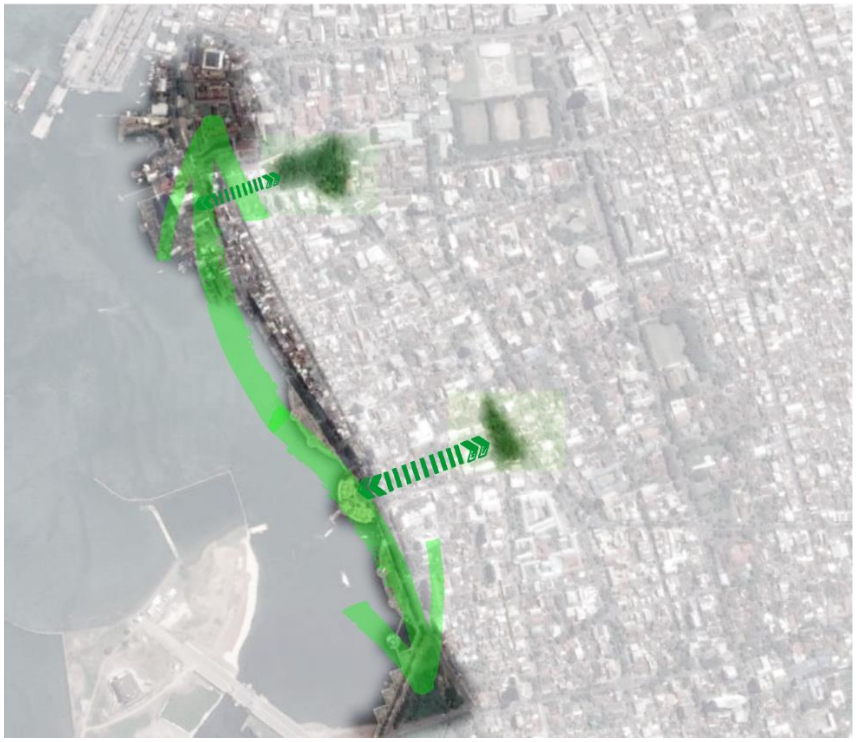


Fig. 2.2.9. Green Spaces Connection Concept to The Site

Using the green corridor idea, we can connect either from the green space to the other green space or from the green space to the site.

Fig. 2.2.10. Green Corridor

In front of the main building, according to The municipality also about adding green spaces in this city, so we decided to design leisure park that we are hoping to become the city park also.

Fig. 2.2.11. Leisure Park Idea

In the leisure park, there are kinds of small bars, the park itself, open public space like amphiteather, and we are thinking also to put the energy storage space to the main building the the surrounding area nearby. We are thinking that we can collect thergy from the nature such as from wind, sea, the sun, and so on. Thus, we put also the small wind turbines and solar panel inside leisure park.

Fig. 2.2.12. Wind Turbinnes and Solar Panels Concept in Leisure Park

3. Architectural Design

3.1 Functional Layout

Basecally, the each functions in the project followed existing ones in the site and commercial functions which include merchandise stores, sourvenior shops and so on are placed on the ground floor, on the other hand cafes and restaurants which relate with food are placed on the first floor. About the vertical connection, six stairs and seven elevators are planed from a disastrous point of view and also several voids would work for visual connection, ventilation and daylight. From functional point of view, three toilets are planed on each floor and storages and the management office for both of building and landscape, on the other hand, mechanical room and garbage storage are planed besides parking space because of needs for carrying in and out.

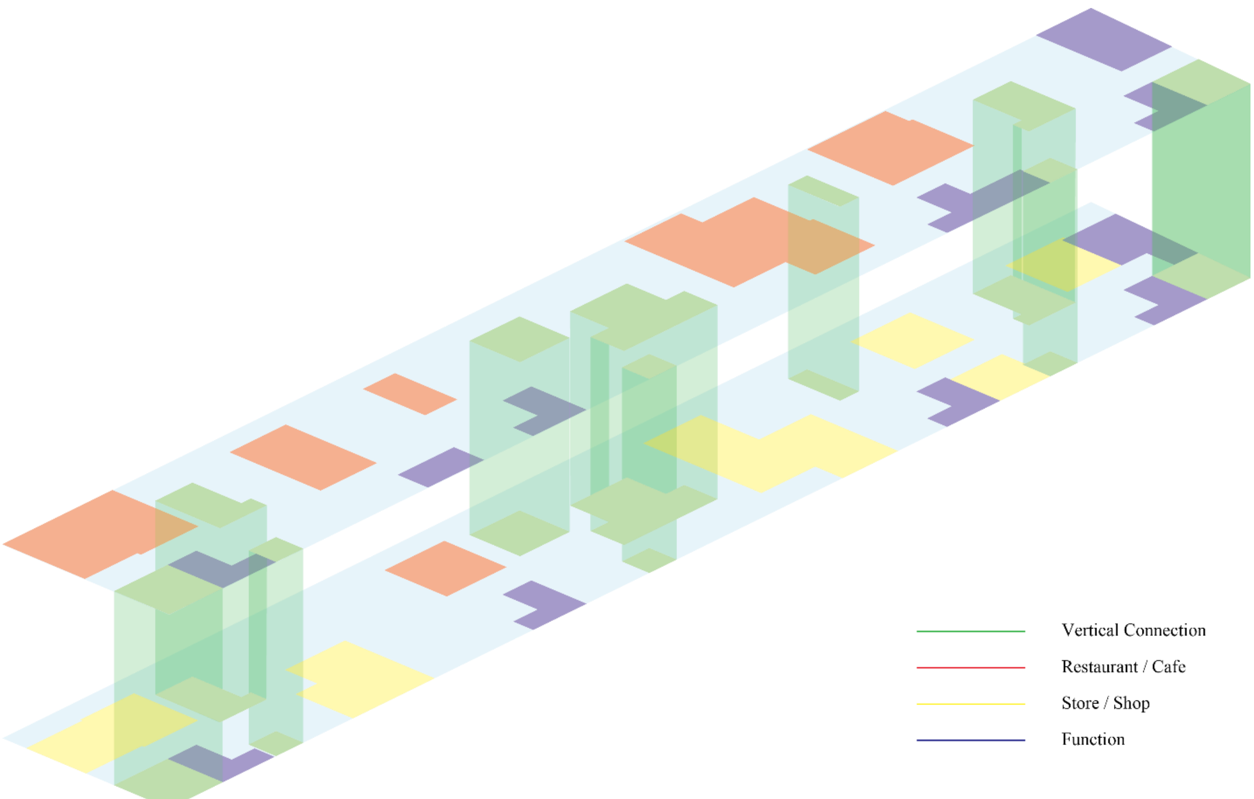


Fig. 3.1. Functional Layout

3.2 Plan

We decided the building is composed by 2 levels which are Ground Floor and First Floor. On The Ground Floor, the main function is Retails or Shops, while on The First Floor, the main is Restaurants.

Since the site is faced with two main roads through from north to south, there are few solid wall on east and west facade. These two open facade could work for not only physical and visual connection but also for natural ventilation which would work for controlling room temperature without air conditioning machine. Wooden material is introduced as an architectural material for both of structure and floor finish because it is already used for architectural material for traditional buildings.

On both of north and south edge are surrounded with solid walls and have management office and other offices. In between these two edges, basecally functions follow the existing commercial ones which are kinds of shops, merchendise stores, kiosks and boutiques because the new architecture has an aim which is not completely replacing the existing atmospheres but keeping functions and making the site better. Each of shops are mainly surrounded by glass curtain walls working for attracting visitors and showing what is in the spaces. In addition to, these shops are placed not in a line but designing curving circulation which would work for attracting visitors as if they were in a commercial street during walking insideSome toilets with ones for disabled people are placed along the east facade which is backside of the architecture. On westside facade, four entrances are designed which are indicated with a pavement and each of them has staircases. The pavement and staircases indicate a connection between ground floor and open spaces and first floor. Especially, southside has wider entrance because this side is near from well-developed area for new makassar city center planed by the municipality.

From functional point of view, the first floor would be filled with functions relating with foods which are cafe, restaurant, foodcourt and so on because basecally the site has a number of existing fast food place, restaurant and these should be remained from designer's intention which these would be one of the important factors for inviting and attracting both of tourists and local residents. Because one of the aims of this architecture project is promoting indigenous cultures which relating foods, the first floor would be regarded as a main part of whole project. In the same design reason of ground floor, positions of each functions would no tbe in a line for creating curving and attracting circulations for visitors. Positions of management offices would follow with ones in ground floor and these areas would be sorrounded by solid walls. Other areas would have few walls and mainly be open because not only natural ventilation which are same reason with one in ground floor but also visual connections from restaurants to makassar city, Java sea and an open space which would be included in the design project and infront of the architecture. Especially along the west side, balcony spaces would be designed which would be used for terrace seats for restaurants and public observatory spaces.

Fig. 3.2. Ground Floor Plan

Fig. 3.3. First Floor Plan

Fig. 3.4. Roof Plan

3.3 Elevation

Fig. 3.5. Example Traditional House of Makassar

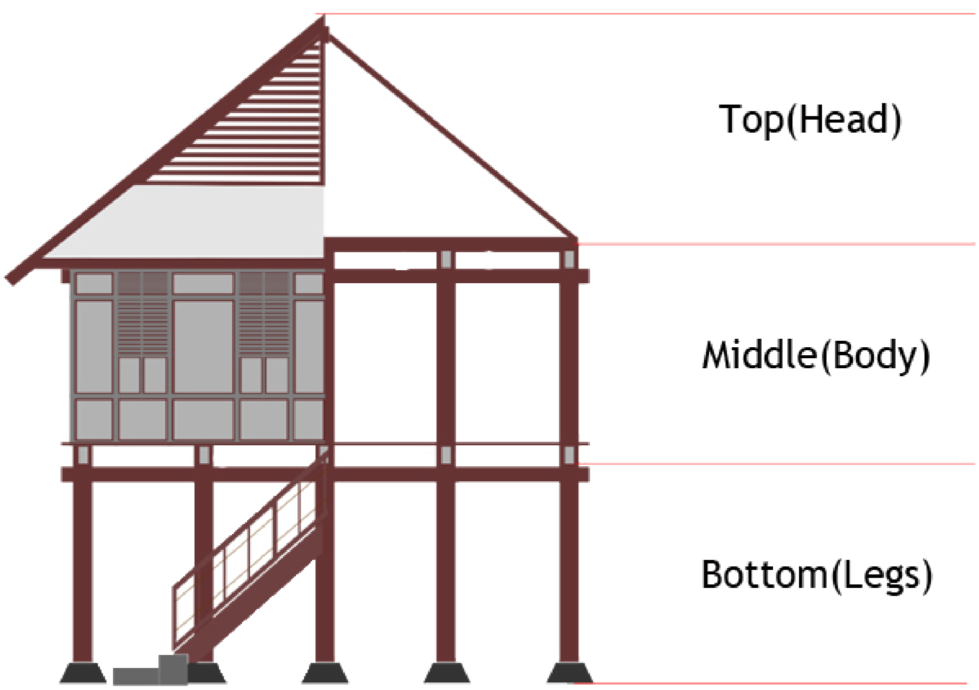
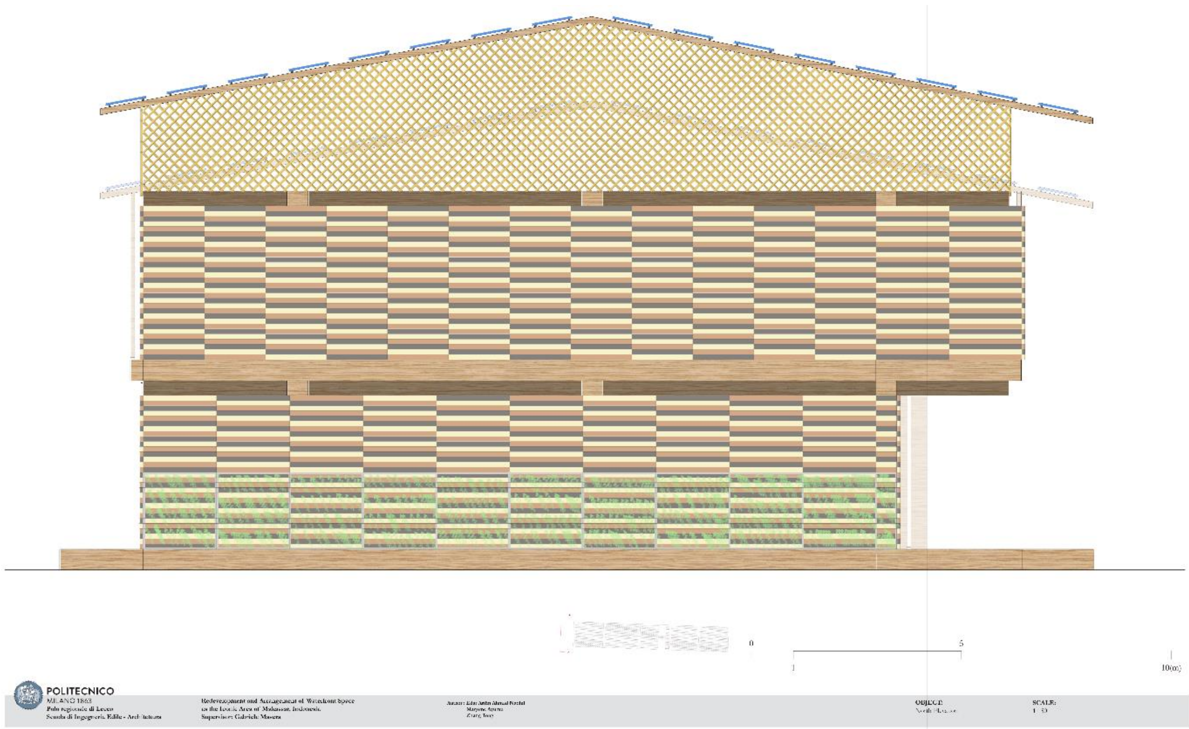


Fig. 3.6. Concept of Traditional House of Makassar

A typical image of Makassar traditional house which inspired us to design the building and its elevation. These are local wooden buildings and there are found a plenty number of these also in around Indonesia. As we seen above, elevations of the traditional house could be categolyzed into three different layers which are Bottom (Legs), Middle (Body) and Top (Head). Bottom part is bacically without any functions and just could be consisted from structural materials which include pillars, beams and basement blocks and staircases and radders as vertical connection to first floor. Middle part which is main part of the building is first floor and living space of families. This part is surrounded with decorated walls for protecting residents from heavy rains and winds. These walls could allow winds penetrate properly for natural ventilations. Finally, the Top part has roof and vacant spaces which could work for also natural ventilation not living spaces.

Through these analyses of traditional architectures, design concepts were desided as i) using vacant spacial design not only for natural ventilations but also physical and visual connections with surrounding situations such as main street in the makassar city, Java Sea with open spaces, ii) regarding first floor as main part of the project which was functions relating with foods, communities, relaxtions, and enjoying views, and so on.) following traditional design languages such as morphological shapes, material and so on.

Fig. 3.7. East (Top) and West (Bottom) Elevations



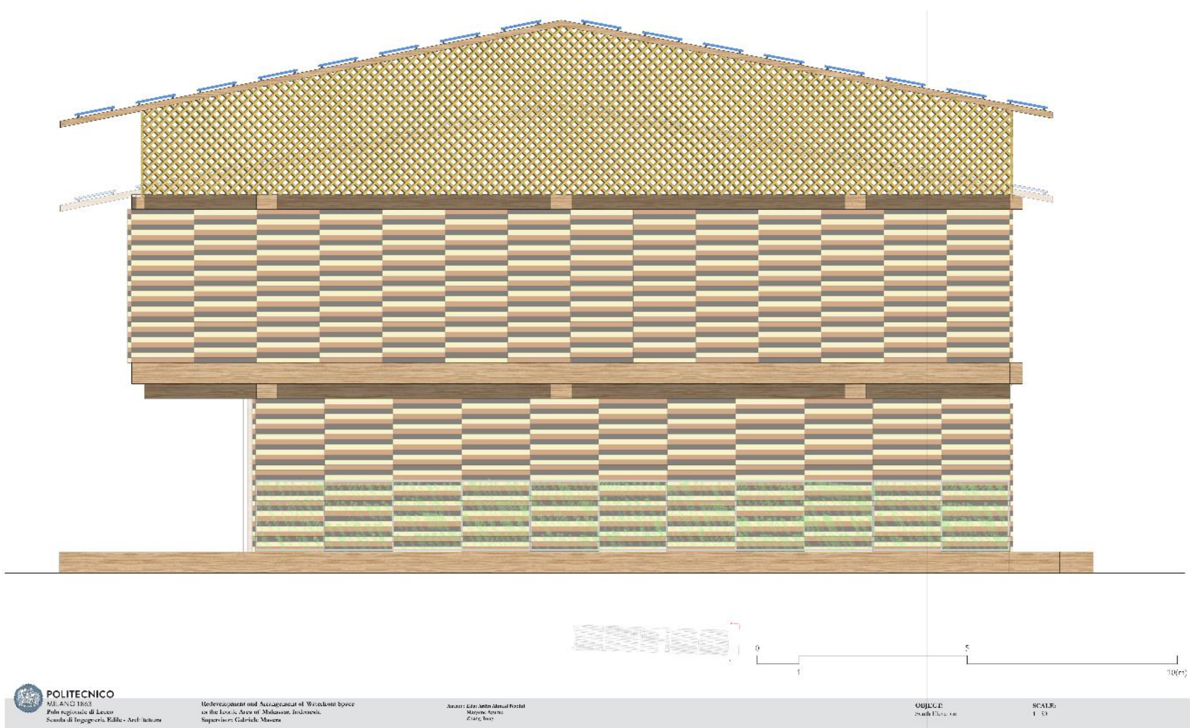


Fig. 3.8. North (Top) and South (Bottom) Elevations

The westside and eastside elevations would be main facades of this architecture. Mainly, facade design would be see-through with clear glass curtain wall and no solid walls because of natural ventilations and both of physical and visual connections. Several activities which would happen in both of inside and outside of the architecture would affect each other through these facades and these are designer's main intention. Concrete pillars and beams as the structural material would be shown also in the facades but we made kind of illusion that shows pillars and beams are made by wooden material, because we used the finishing material with the paint looks like a wood. We decided to be inspired by the traditional architecture of Makassar.

The roof which would have two skylights in the center of the architecture would be mainly covered with traditional roof tile and PV panel (photovoltaic panel) for following the traditional design language and at the same time, improving energy production.

North and south side elevations would not be main facades of the architecture. In a case of traditional buildings, these short facades which were regarded as main facades were more decorated and had openings and vertical connections, but the project site had long shape from north to south side and these side faced to main streets of the area and open spaces with the sea and those were these sides would not be main facades. From these sides, both of ground floor and first floor would have solid walls and only beneath the roof would allow to people enjoying view from inside to outside and even vice versa and to winds penetrating to inside for natural ventirations without too much sunshine. Along the westside facades, volumes of first floor would come out and on first floor, these spaces would be used for terrace seats for restaurants and public viewing places for open spaces and the sea.

In the case of ground floor, coming volume of first floor would work for eaves which would cover the spaces of ground floor from rain and sunshine and the spaces themself would work such as porticoes. These portico spaces would work as in between spaces of outside and inside for visitors enjoying shopping along shopping mall and even just pedestrians who would not enter the architecture but go through the street could enjoy more comfortable walkway without rain, sunshine and wind.

For cover material of solid wall, we proposed Rockpanel Wood as the finishing material. We decided to use with three color patterns of the material which had cream, dark grey, and dark brown. We had been inspired these several colors from one of traditional houses and would try to remind both of tourists and local residents indeginous culture. These panels would be attached directly on exterior walls with either wooden sub frame or alminium sub frame.

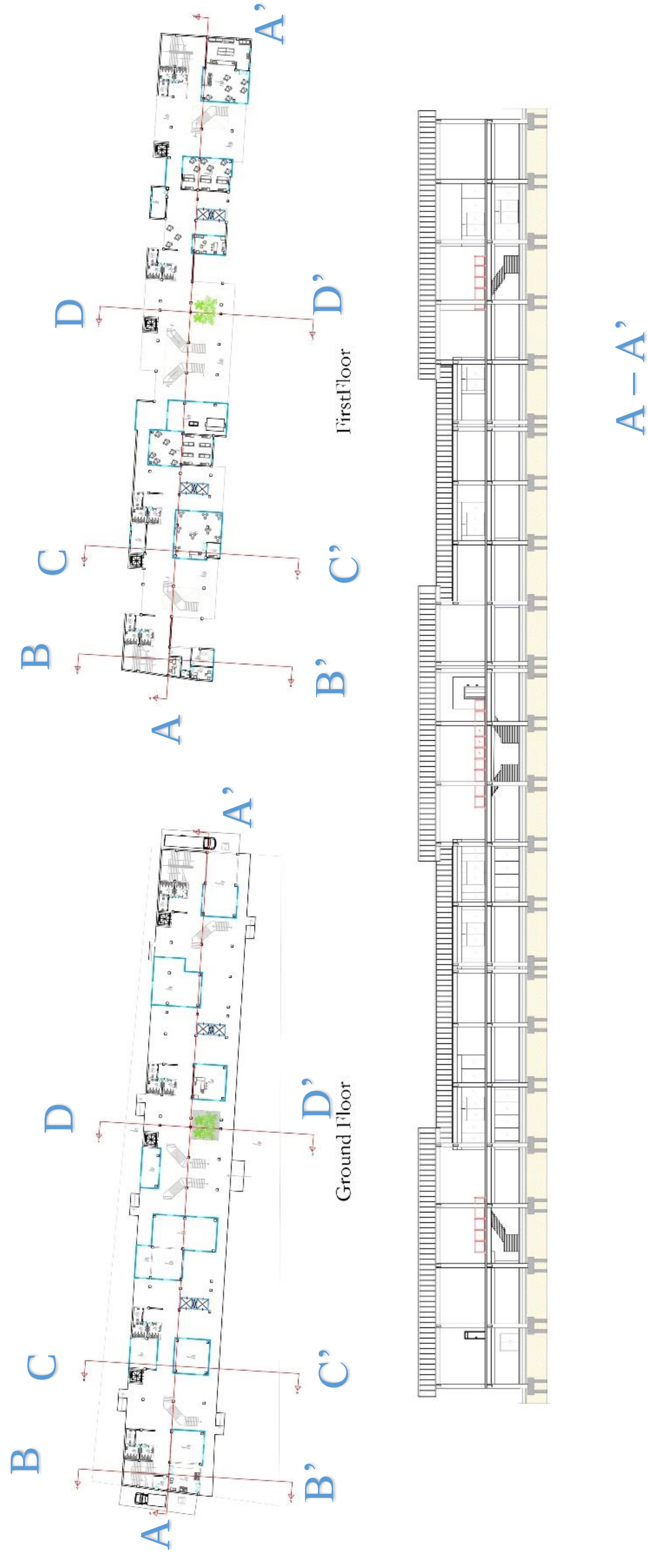
In between the roof and walls of first floor, the shading system would be introduced. In addition to general two meters overhangs, the desingers would propose cross-woven rattan cane shading panels. This system would work to invite proper wind for ventilations and block heavy rain and sunshine from westside. Compared with bamboo material which was one of cheap local material, we decided to use the proposed one has much more elasticity and flexibility and lighter. These are one of the typical local materials which are used for furniture and designers expected people to remind an indeginous culture through the local material.

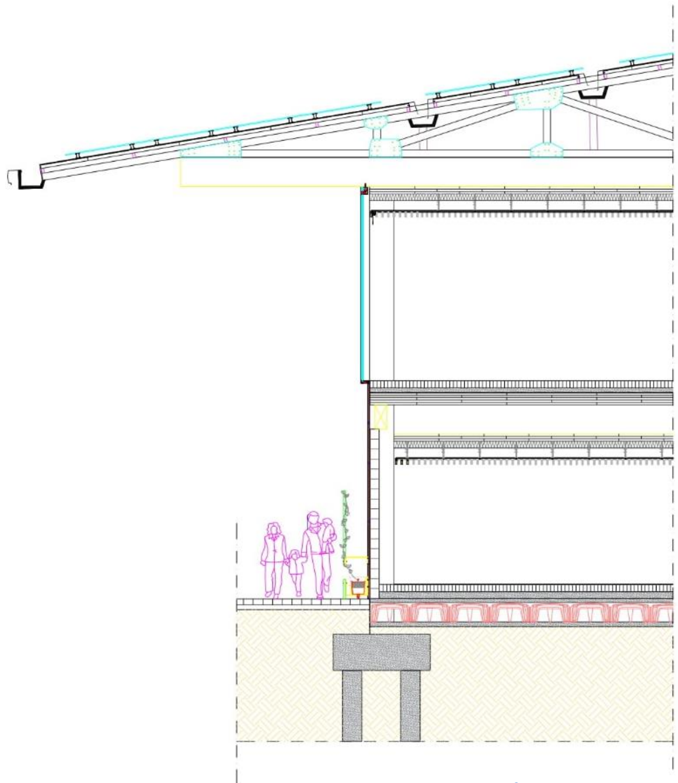
3.3 Section

The longside section through middle of the architecture from north to southside. Vertical connections such as staircases and high ceiling spaces would work as both of physical connections with staircases and elevators and visual connections in entrance hall with trees. In addition to these design intentions, from a sustainable point of view, these spaces woud work as ways for winds from the sea through the ground floor to the first floor. After that winds could stay underneath of roof and go out through the cross shading panel. This wind circulations would be as natural ventilation systems which would be a help to decrease loads of machinery ventilation with air conditioning systems.

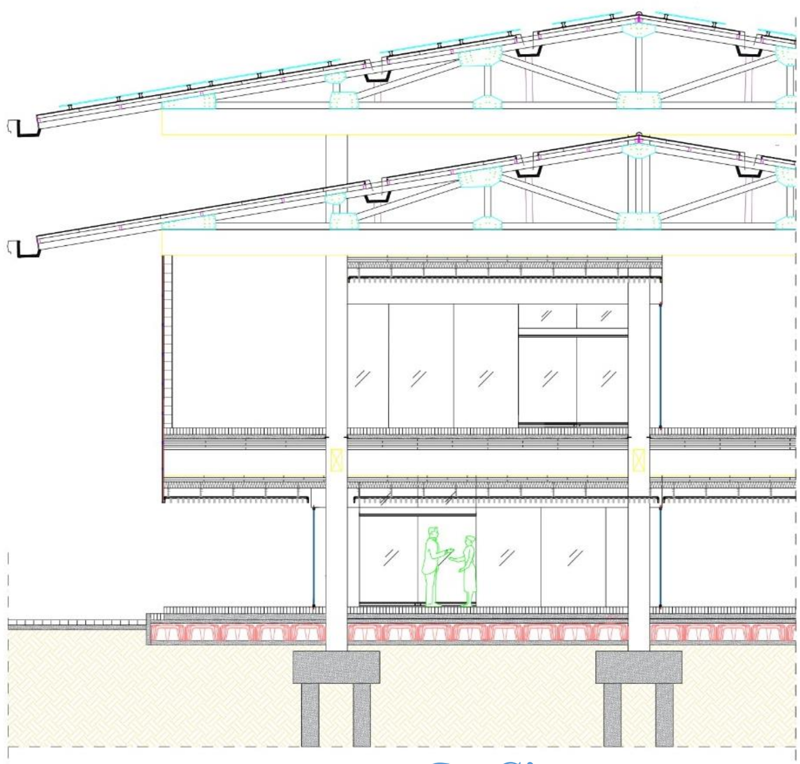
A part of short side sections from west to east sides. The architecture would be constructed with seven meter spans of 500mm*500mm pillars with beams and wooden truss structures of roofs. Finishes of ceilings would be using false ceiling system so we have some space there for some functional equipments such as artificial lights, ventilations and air conditioning systems, and so on.

The groundfloor level would be placed higher for two steps around 30 cm from level of soil and in front of the main entrance, have high ceiling spaces with trees for inviting visitors around these and letting them to have communities and spaces for relaxation.

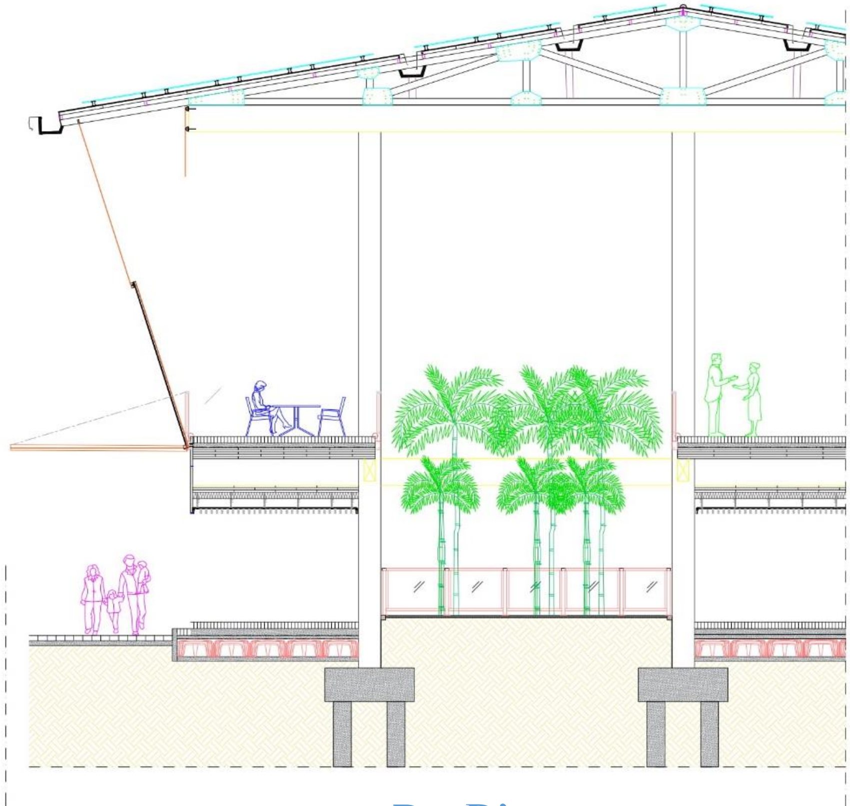




B – B’



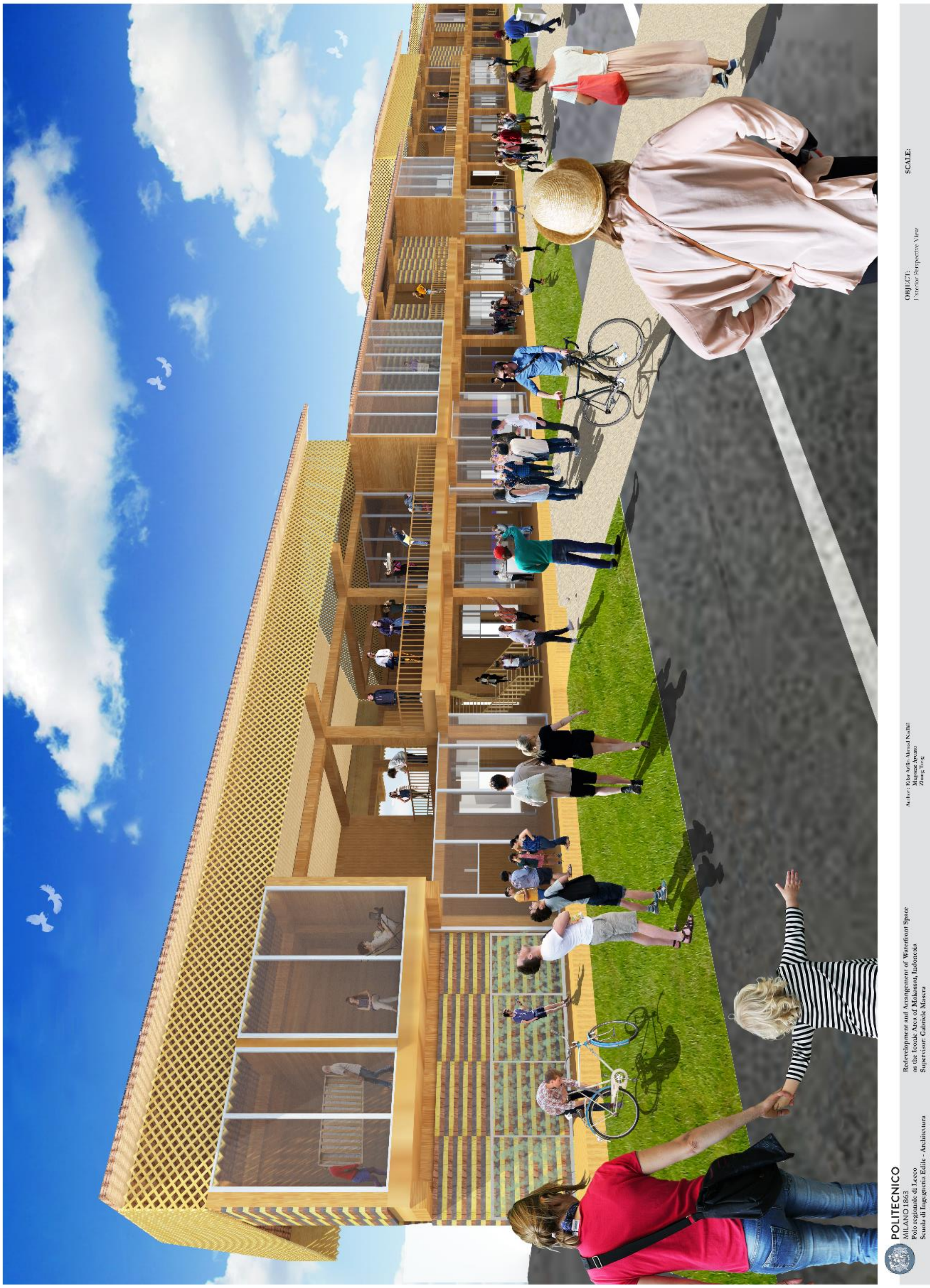
C – C’

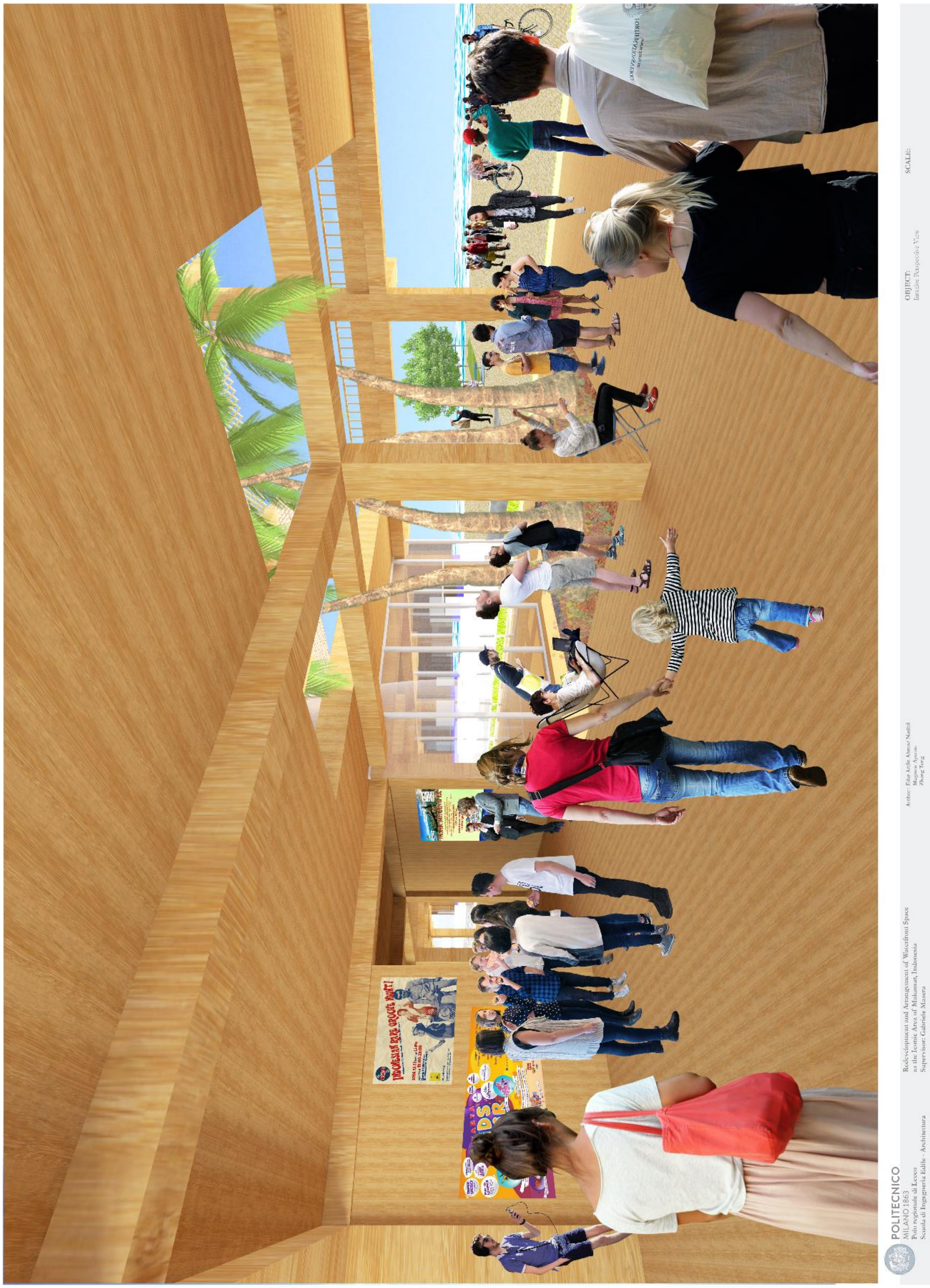


D – D’

Fig. 3.9. Sections

3.4 Renders




POLITECNICO
MILANO 1863
Polo regionale di Lecco
Scuola di Ingegneria Edile - Architettura
Redevelopment and Arrangement of Waterfront Space
as the Iconic Area of Makassar, Indonesia
Supervisor: Gabriele Masera
OBJECT:
Interior Perspective View
SCALE:


POLITECNICO
MILANO 1863
Polo regionale di Lecco
Scuola di Ingegneria Edile - Architettura
OBJECT:
Interior Perspective View
SCALE:

Fig. 3.10. Renders

4. Structural Design

Introduction

In this chapter,shows the process of strctural design about different elements in this building.

The structural design of the different components that make up the system is shown in this section to provide the ability to withstand all loads.

It consists of the use and composition of the building. Horizontal loads are not included in the calculation, but rather the location of the elements, such as shear walls and supports (which should be further verified based on the results of this section). According to the climate analysis, at the location of the project, horizontal loads are controlled by wind forces, because Marcus's seismic hazard is very low, wind speeds reach very high values, and wind speeds throughout the year are quite large. Because this building is the building that has been studied in detail in the previous section (sustainable design) and the time limit for achieving this work, it was decided.

4.1 Sequence of construction process of the building

1. The first step is the realization of the foundation and walls and columns of the Underground level
2. Construction of bearing structure of the Ground level – concrete columns
3. Construction of bearing structure of the Ground level - primary beams
4. Construction of bearing structure of the Ground level - secondary beams
5. Put CLT X laminitaed Timber slab of the Ground level
6. Construction of bearing structure of the First level - concrete columns
7. Construction of bearing structure of the First level - primary beams
8. Construction of bearing structure of the First level - secondary beams
9. Put CLT X laminitaed Timber slab of the First level
10. Construction of bearing structure of the second level for surpporting roof- concrete columns
11. Construction of bearing structure of the second level for surpporting roof - primary beams
12. Construction of bearing structure of the second level for surpporting roof - secondary beams
13. Construction of wooden truss
14. Construction of the roof
15. Construction of external walls

After finishing of the construction process of the structural part, the installation of the systems and erecting of internal walls will take part. Afterwards the finnishing of internal surfaces will be done will installation of the furniture.

4.2 General description

The building area of the building is about 5,523 square meters. According to the requirements of architectural design and earthquake resistance, a reasonable structural form and structural arrangement plan are determined, and the form of the framework and foundation is determined. A reinforced concrete structure was used as required.

In this design, a main frame and floor and roof panels are selected for cross-section design and reinforcement calculation. First, the dimensions of each component are determined according to the layout of the frame, and statistics of dead load, live load, and wind load are performed. Structural design, frame structure design mainly includes: structural selection, beam, column, wall and other component size determination, gravity load calculation, internal force and lateral displacement calculation of frame structure under lateral horizontal action, internal force of transverse frame under vertical load Analysis, internal force combination, section design, basic design. Among them, the basic design includes basic selection, basic layout, and foundation calculation.

In the design process, I strictly follow the latest specifications and relevant regulations, and the calculations used.

The methods are based on the relevant books.

4.3 Selection of structural schemes and structural arrangement

4.3.1 Determination of the structural plan

The load-bearing scheme of the frame of the project is the horizontal frame load-bearing scheme. The structural plane and the elevation are simple and regular in shape, so that the rigidity of each part is uniform, the symmetrical structure is adopted to reduce the possibility of twisting, the aspect ratio of the structure is controlled, and the horizontal load is reduced. Side shift.

4.3.2 Determination of the basic type

Pile foundation

4.3.3 Structural arrangement

The frame of structure of the building is realized in concrete .

The foundation for the building is pile foundation also realized in concrete.

The structure of slab is realized by the system of primary and secondary

The size of the primary beam depends on the span which is 7m.

The structure of the roof is made of wooden truss with height 2m. The elements for wooden truss top chord section with the size 40*140mm,bottom chord and web section with the size 40*90mm.

Roof has 130(1200mm) number of truss for supporting also for the decoratrion.

- Concrete characteristic cubic compressive strength: $R_{ck} = 37MPa$
- Steel characteristic yielding strength for the bar: $f_{yk} = 450MPa$
- The horizontal actions for the calculations were neglected
- The calculation for bearing capabilities against seismic actions is not foreseen.

4.3.4 Structural requirements :

The thickness of the raft plate is generally not less than 1/20 of the maximum span of the column grid and is not less than 200mm which is 350 mm , and shall be calculated according to the punching shear resistance. The cantilever portion should be set along the width of the building. No less than c20, 100mm thick cushion. Rebar protective layer is not less than 35mm.

Expansion joints: deformation joints provided to prevent cracking of structural components due to thermal expansion and contraction when buildings are relatively long.

The expansion joints are divided into two separate parts: building elements such as walls, floors, and roofs (excluding wooden roofs) above the foundation

4.4 Steel and concrete indicators

C 30 C (20,25,30,35,40,45,50,55) Concrete grade

fc＝ 0.0 (N/mm2) Concrete compressive strength design value fck

ft＝0.00 (N/mm2) Concrete tensile strength design value ft

Ec＝ 0 (N/mm2) Concrete modulus of elasticity Ec

βc＝ 1.00 Concrete strength factor 1.0<C50<βc<C80<0.8

HRB 450 HRB(300,335,400,500) Longitudinal reforcement strength level

fy＝ 0 (N/mm2) Longitudinal reinforcement tensile strength design value fy

Es＝ 0 (N/mm2)

α1＝ 1.00 Pressure zone equivalent 1.0<C50<α1<C80<0.94

β1＝ 0.80 Rectangular stress coefficient 0.8<C50<β1<C80<0.74

ξb＝ 0.48 ξb＝β1/(1+fy/0.0033Es)

αE＝ 6.67 αE＝Es/Ec

HRB 335 HRB(300,335,400) Stirrup strength level fy＝ 0 (N/mm2) Sitrrup tensile strength design value fy

4.5 Pre - Dimensioning

It is important to recall the arrangement of the Steel decking, riddles and beams in plan (which were shown previously in the Building's plan) in order to understand the rest of the design developed). The pre – dimensioning was done according to the experience of the designers on previous works, also based on the requirements of the building, realizing that the elements will cover a considerable span as well as the need for big open spaces inside the building demanding a low roof which was one of the reasons why a composite R/C and steel slab was considered instead of the typical lightened one. Additionally as big spans were set, the best solution was to have steel 'I' Profies which due to its geometry provide a good Inertia to be able to withstand the bending moment imposed by the use of the building. This led to the decision to include also Steel columns that require less space to withstand the same load as the material has a higher strength. All the steel profies are hot rolled, and their connections are intended to be bolted avoiding any bad connection due to a low quality welding performed on site. Shear anchors, bolts and steel plates were added and use as connectors between the different elements to be able to have a structure which functions as a whole by transferring the stresses in the proper way. The beams are thought to be interrupted when it meets the column, but they are able to transfer the moment and shear in order to behave as a continuous element. As the foundation was thought to be in concrete, anchors and plates were also placed to make a correct transition from steel to concrete. The Piles were placed in each of the footings, following the recommendation given by the geotechnical study provided as an appendix with the competition brief.

4.6 Loads

The first step of the structural analysis is the evaluation of loads.

4.6.1 Self-weight of structural and non-structural elements

Design information

2 floors wooden frame structure commercial center,design usage year is 50 yearsL=150m,W=24m,H=9.8m .

(1) Design elevation: Interior Design Height 0.000m , Indoor and outdoor height difference 300mm.

(2) Wall Detail: The rockpanel wood is 8 mm,wood battens for the support is 30mm , gasket before the batten with 2mm, insulation material is 4mm,bricks is 200mm,insulation material again is 4mm.

The following loads refer to a square meter of a typical floor.

4.6.1.1 External Wall

NO.	LAYERS	THICKNESS(M)	SPECIFIC WEIGHT(KN/M3)	WEIGHT(KN/M2)
1	PAINTING	0.001	0	0
2	ROCKPANEL WOOD	0.008	0.65856	0.0053
3	WOOD BATTENS	0.03	5.75	0.1725
5	INSULATION	0.004	0.032	0
6	BRICKS	0.215	17.6	3.8
7	INSULATION	0.004	0.032	0
8	PAINTING	0.001	0	0
TOTAL				3.98

Table. 4.1. External Wall Layers

The load of the external walls is directly applied on
the beams along the perimeter and it is not shared out with slabs.

4.6.1.2 Internal Wall

NO.	LAYERS	THICKNESS(M)	SPECIFIC WEIGHT(KN/M3)	WEIGHT(KN/M2)
1	PAINTING	0.001	0	0
2	BRICK	0.215	17.6	3.8
3	PAINTING	0．001	0	0

TOTAL	**3.8**

Table. 4.2. Internal Wall Layers

Average dead load for external walls

Floor height of 3.9 m, considering the openings incidence as 20%, at floor level per unit length of wall:

(4.0×3.9)× (1.00 - 0.2) = **12.5 kN/m**

Average load for simple internal wall:

Floor height of 3.9 m, at floor level per unit length of wall:

3.8×3.9 = **14.8 kN/m**

Assuming the span of internal walls is 2.5m, in accordance with the assumptions of EN 1991-1-1, the correspondent equivalent uniformly distributed load is:

14.8÷2.5 = **6.0 kN/m²**

(3) Floor Detail: The dead load standard value of floor structural layer is 1.56 kN/m2; the standard value of floor live load is 2.5 kN/m2.

(4) Roofing Detail: The roof is flexible and waterproof, the dead load standard value of the roofing structural layer is 3.24 kN/m2; the roofing is the master roof, and the live load standard value is 2.0 kN/m2.

(5) Door and window Detail: wooden frame glass window weight 0.3kN/m2, wooden door weight 0.2kN/m2.

(6) Geological data: Located in the seaside of the city Makassar, totally 2 floors.

(7) Basic wind pressure: $\omega_0 = 0.4 \quad kN/m^2$ 。

4.6.1.3 Roof

NO.	LAYERS	THICKNESS(M)	SPECIFIC WEIGHT(KN/M3)	WEIGHT(KN/M2)
1	solar panels	-	-	0,117
2	INSULATION	0.004	0.032	0
3	Wooden truss	-	-	6.726
4	TILES	0.011	0.00704	0.64
TOTAL				7.483

Table. 4.3. Roof Layers

Total load from the roof:

Qroof = 7.483 x 3561 m2 / 66 = 403,7 kN

3561 m2 - area of the roof;

66 - number of columns

4.6.1.4 Floor

NO.	LAYERS	THICKNESS(M)	SPECIFIC WEIGHT(KN/M3)	WEIGHT(KN/M2)
1	FLOOR PANEL(CLT)	0.25	4.8	1.2
2	RC ribs	0.2×0.1÷0.5=0.04	25	1
3	Ceiling plaster	0.02	20	0.4
4	Veneered MDF Ceiling	-	-	-
TOTAL				2.6

Table. 4.4. Floor Layers

4.6.2 Imposed loads

The imposed load for floors in shopping area (D1:area i n general retail shops) is [EN 1991-1-1 §6.3.1.2, Tables 6.1 e 6.2, in accordance with National Annex]

4.00 kN/ m^2

4.7 Slab

Structural analysis – ULS verification

Design of the composite R/C and Steel Slab

In this part is design for the typical floor slab of building (ground &1st floor) will be presented. To be precise, it is located between the axis 1-3.
Structural analysis and dimensioning for the slab between the ground and the first floor.

The structural analysis will be carried out using liner analysis based on the theory of elasticity, considering the combination of actions for Ultimate Limit States. [EC2 –5.1.3(1)P] that is [EC0 – Expression 6.10] and [National Annex of Italy]

$$\Sigma_{j\geq1}\gamma_{Gj}G_{kj} \quad + \quad \gamma_{Q1}Q_{k1} + \quad \Sigma_{i>1}\gamma_{Qi}\Psi_{0i}Q_{ki}$$

Loads

For the studied slab, taking into account the geometry and the components of the slab, plus the action of the live loads and inside partition weight (determined by the code):

Permanent actions: floor weight with finishes

- CLT floor self-weight: $G_1 = 2.6 \ \frac{kN}{m2}$; $\gamma_G = 1.35$

Variable actions:

- Live loads: $Q_1 = 4 \ \frac{kN}{m2}$; $\gamma_Q = 1.5$
- Internal walls self-weight: $Q_2 = 6 \ \frac{kN}{m2}$; $\gamma_Q = 1.5$; $\Psi_Q = 0.3$

Load combinations

This load cases were applied for both Ultimate Limit State (using the amplification factors provided by the code) and Serviceability Limit State condition in order to obtain the most unfavorable condition with which the elements would be designed. Moreover, they are thought to obtain the maximum and minimum values according to the position of the variable loads.

Combination 1

Permanent loads: $\Upsilon_G \times G_1 = 1.35 \times 2.6 = 3.51 \ \frac{kN}{m}$ on all spans for ULS

Variable loads: $\Upsilon_Q \times (Q_1 + Q_2) = 1.5 \times (4 + 6) = \ 15 \ \frac{kN}{m}$ on all spans for SLS

$= 18.51 \ \frac{kN}{m}$

Length of span: $l_{ab} = 3m$ $l_{bc} = 7m$; $l_{cd} = 7m$; $l_{de} = 4m$;

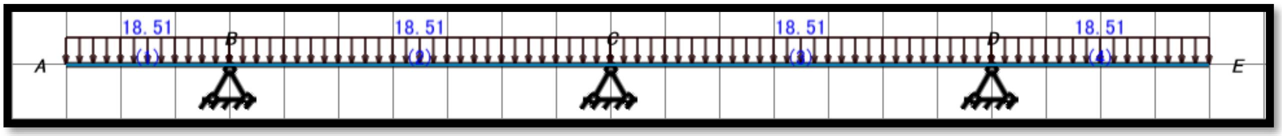


Fig. 4.1. Loads of Combination 1

Combination 2

For ULS:
Left span:1.35·G+1.5·Q=18.51 kN/m^2

Right span:1.35·G = 3.51 kN/m^2
For SLS:
Left span:G+Q=12.6 kN/m^2
Right span:G=2.6 kN/m^2

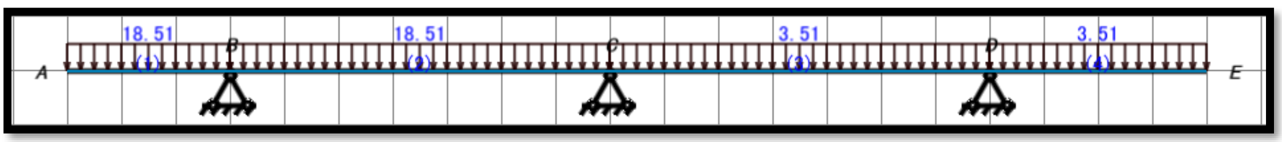


Fig. 4.2. Loads of Combination 2

Combination 3

For ULS:
Left span:1.35·G=3.51 kN/m^2
Right span:1.35·G+1.5· Q = 18.51 kN/m^2
For SLS:
Left span:G = 2.6 kN/m^2
Right span:G+Q = 12.6 kN/m^2

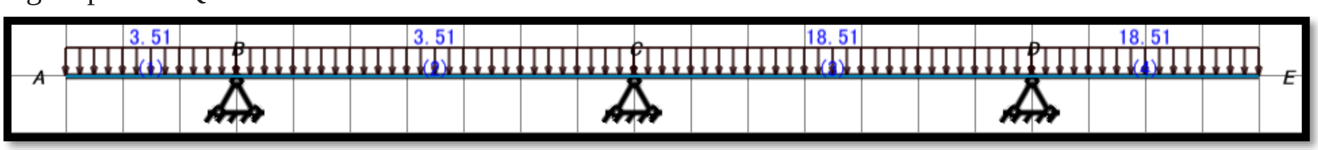


Fig. 4.3. Loads of Combination 3

Analysis

Loads combination 1

To obtain the maximum moment.

Moment

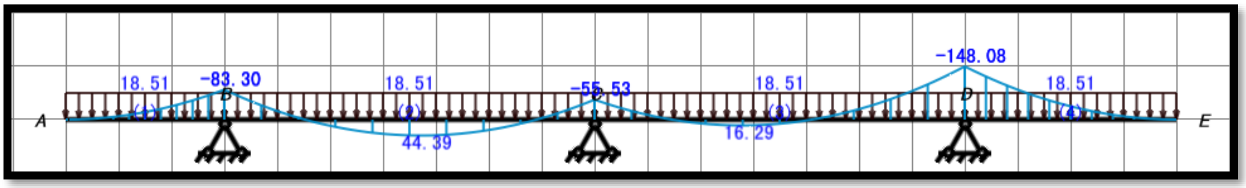


Fig. 4.4. Loads of Combination 1 in Moment

Shear

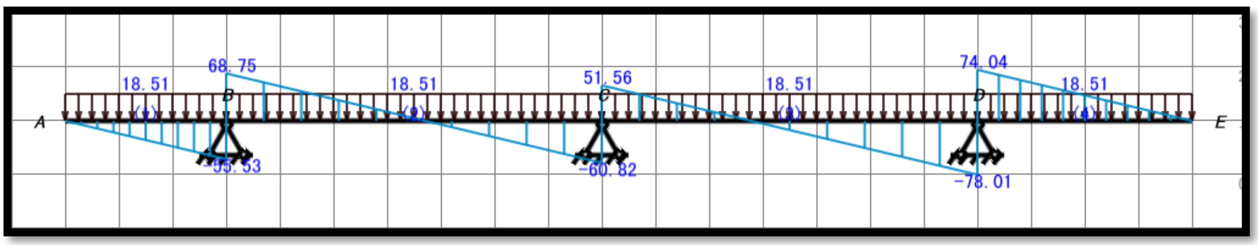


Fig. 4.5. Loads of Combination 1 in Shear

Loads Combinatin 2

To obtain the minimum moment.

Moment

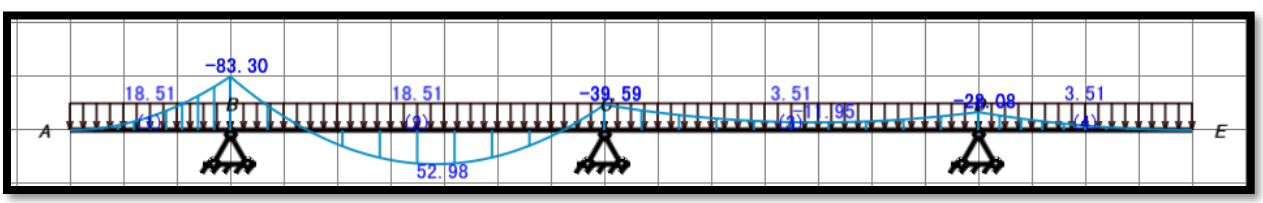


Fig. 4.6. Loads of Combination 2 in Moment

Shear

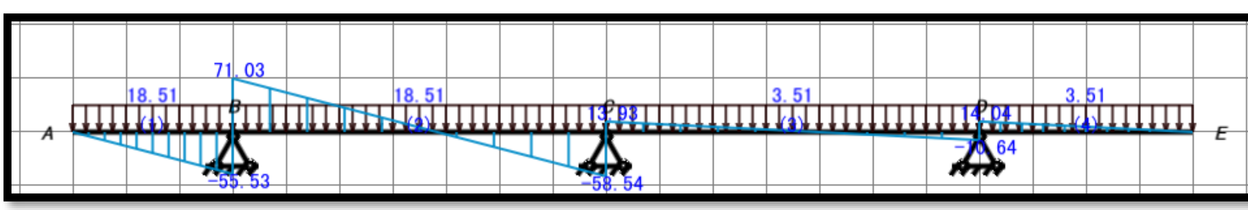


Fig. 4.7. Loads of Combination 2 in Shear

Loads Combination 3

Moment

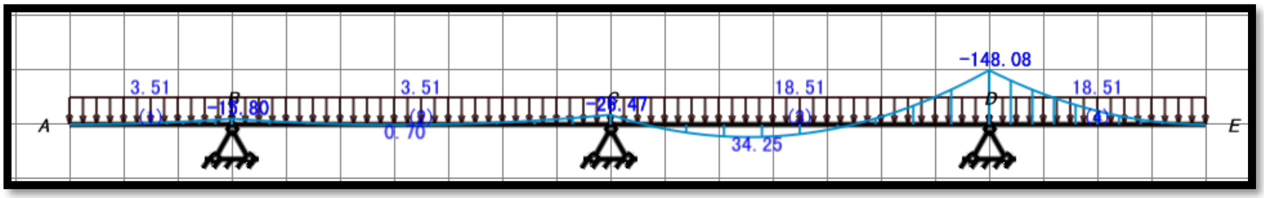


Fig. 4.8. Loads of Combination 3 in Moment

Shear

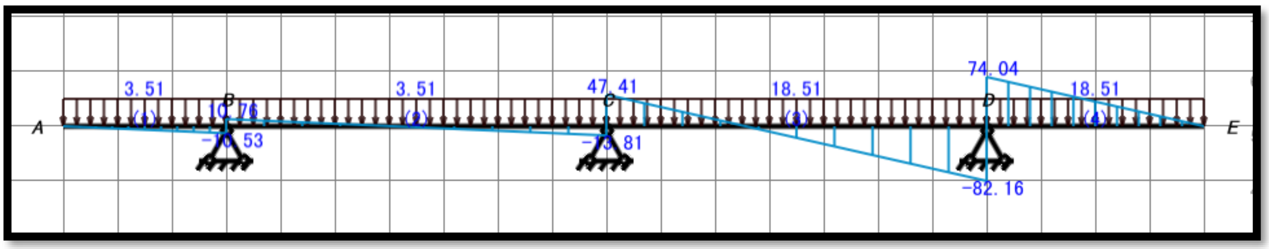


Fig. 4.5. Loads of Combination 3 in Shear

Biaxial Force Slab

Continuous beam l/50=140

thickness of slab=140mm.

reforcement ratio（0.236%)=330.4

fcm =16.5Design value of concrete bending compressive strength: C30:16.5.

fy=300 Note: The design value of the strength of the steel bar is Class I 270, Class II 300.

Economic reinforcement ratio 0.30%-0.8%

	Bending moment	load	span	moment M		0.2x	as	ys	As
Mx'	0.115	12	7	-67.62		-13.52	0.2846	0.8282	2268.0
My'	0	12	7	0.00		0.00	0.0000	1.0000	0.0
Mx	0.0585	12	7	34.398	35.93	6.88	0.1512	0.9176	1087.6
My	0.013	12	7	7.644	14.52	1.53	0.0611	0.9684	416.6

Table. 4.5. Biaxial Foce Slab Calculation Result

Plate reinforcement plan

reforcement As=692mm2

diameter=14 mm

distance=222mm

reforcement area Ass

diameter12   Ass 754

distance 150

Floor load

Dead load factor = 1.35

Live load factor = 1.5

Floor dead load = 2.6

Floor live load =4.0

Design value= 1.35*2.6+15*4=9.5KN(m2)

Column compression bearing capacity NC=3575000.0 KN

Vertical load of column N=790.3 KN

4.8 bending in beam

Size of the primary beam cross section			
b=	250	(mm)	Beam width b
h=	600	(mm)	Beam height h
ca=	30	(mm)	Concrete cover thickness ca
h0=	570	(mm)	Beam effective height h0=h-ca
Bending			Longitudinal reinforcement： 4φ18
N=	4		Number of longitudinal reinforcements N
φ=	18	(mm)	Longitudinal diameter φ
As=	1018	(mm2)	Longitudinal reinforcement area As=N*(Pi*φ^2/4)
ϱ=	0.71%		Longitudinal reinforcement ratio ϱ=As/(b*h0)
Ny=	2		number of erection steel reinforment Ny
φy=	16	(mm)	diameter of erection steel reinforment φy
Asy=	402	(mm2)	area of erection steel reinforment Asy=Ny*(Pi*φy^2/4)
ϱy=	0.28%		erection steel reinforment ratio ϱy=Asy/(b*h0)
ξ=	0.131		Relative compression zone height ξ=ϱ*fy/(α1*fc)
ξ<ξb			
x=	75	(mm)	compression zone height x=ξ*h0
x > 2ca			
Mu=	142.6	(kN-m)	Single rib rectangular section flexural capacity Mu

Table. 4.6. Basic Information of Primary Beam Cross Section in Bending

Size of the secondary beam cross section			
b=	**250**	(mm)	Beam width b
h=	**500**	(mm)	Beam height h
ca=	**30**	(mm)	Concrete cover thickness ca
h0=	**470**	(mm)	Beam effective height h0=h-ca
Bending			**Longitudinal reinforcement: 4φ18**
N=	**4**		Number of longitudinal reinforcements N
φ=	**16**	(mm)	Longitudinal diameter φ
As=	**1018**	(mm2)	Longitudinal reinforcement area As=N*(Pi*φ^2/4)
ρ=	**0.87%**		Longitudinal reinforcement ratio ρ=As/(b*h0)
Ny=	**2**		number of erection steel reinforment Ny
φy=	**12**	(mm)	diameter of erection steel reinforment φy
Asy=	**402**	(mm2)	area of erection steel reinforment Asy=Ny*(Pi*φy^2/4)
ρy=	**0.34%**		erection steel reinforment ratio ρy=Asy/(b*h0)
ξ=	**0.159**		Relative compression zone height ξ=ρ*fy/(α1*fc)
ξ<ξb			
x=	**75**	(mm)	compression zone height x=ξ*h0
x > 2ca			
Mu=	**115.9**	(kN-m)	Single rib rectangular section flexural capacity Mu

Table. 4.7. Basic Information of Secondary Beam Cross Section in Bending

4.9 shear in beam

Section size verification

hw/b=1.88

Rectangular section hw=ho

Thick web Vu=420.0625 KN

Vu=420.0625KN

Section shear load bearing value (KN)

Vmax=16 KN   Vu>Vmax！

Calculation of only stirrups under distribute load

stirrups:

10@80

S=80

N=2

φ＝10

nAsv1/s =-0.001

real stirrups=nAsv1/s=1.963

ρsv=0.785%

ρsvmin=0.000%   Minimum reinforcement ratio is satisfied

Section size (secondary beam)

Beam width b ＝250 (mm)

Beam height h ＝500 (mm)

Concrete cover thickness

ca＝30 (mm)

Beam effective height

h0=h-ca＝570 (mm)

Rectangular section subjected to torsional plastic resistance moment

Wt=1.6E+07(mm^3)

Core area of the section

Acor=102600(mm^2)

Design bending moment

M=110(KN·M)

Design shear strength

V=90(KN)

Design torsion strength

T=10(KN·M)

βt=0.50

concrete 's Capacity reduction coefficient is greater than 1 we use 1, less than 0.5 we use 0.5

ξ=1.2

Ratio between Longitudinal and stirrup reforcement is (0.6~1.7), recommended value is 1.2

Ccross section core perimeter Ucor=1460(mm)

4.10 torsion in beam

Section size (Primary beam)			
b=	250	(mm)	Beam width b
h=	600	(mm)	Beam height h
ca=	30	(mm)	Concrete cover thickness ca
h0=	570	(mm)	Beam effective height h0=h-ca
Wt=	1.6E+07	(mm^3)	Rectangular section subjected to torsional plastic resistance moment
Acor=	102600	(mm^2)	Core area of the section
M=	110	(KN·M)	Design bending moment
V=	90	(KN)	Design shear strength
T=	10	(KN·M)	design torsion strength
βt=	0.50		concrete 's Capacity reduction coefficient is greater than 1 we use 1, less than 0.5 we use 0.5
ξ=	1.2		ratio between Longitudinal and stirrup reforcement is (0.6~1.7), recommended value is 1.2
Ucor=	1460	(mm)	cross section core perimeter

Section size (Secondary beam)			
b=	250	(mm)	Beam width b
h=	500	(mm)	Beam height h
ca=	30	(mm)	Concrete cover thickness ca
h0=	470	(mm)	Beam effective height h0=h-ca
Wt=	1.3E+07	(mm^3)	Rectangular section subjected to torsional plastic resistance moment
Acor=	83600	(mm^2)	Core area of the section
M=	110	(KN·M)	Design bending moment
V=	90	(KN)	Design shear strength
T=	10	(KN·M)	design torsion strength
βt=	0.50		concrete 's Capacity reduction coefficient is greater than 1 we use 1, less than 0.5 we use 0.5
ξ=	1.2		ratio between Longitudinal and stirrup reforcement is (0.6~1.7), recommended value is 1.2
Ucor=	1260	(mm)	cross section core perimeter

Table. 4.8. Basic Information of Primary and Secondary Beam Cross Section in Torsion

1. Check the section size						
hw/b	2.28	V/(bho)+T/(0.8Wt)			1.41	(N/mm^2)
Section meets conditions,OK						
2. Check whether the shear force and torsion should be inglected or not.						
Can't ignore shear						
Can't ignore torsion						
3. Check whether it is equipped with anti-twist and shear reinforcement						
V/(bho)+T/Wt		1.25	Shear and torsion bars should be configured as calculated			
4. Calculate the amount of stirrups			Stirrup:10@150			
Ast1/s	0.049	(mm^2/mm)	Twisted steel bar			
Asv1/s	0.042	(mm^2/mm)	Shear reinforcement			
total:	0.090	(mm^2/mm)	Torsion and shear reinforcement			
stirrupΦ	10	Stirrup distance S	870.2882989	150	OK	
ϱsv	0.42%	The minimum hoop rate meets the specification requirements				
5. Calculate the amount of torsion bar			Anti-twist longitudinal reinforcement: 4Φ10:4Φ10			
AstL	58.9	(mm^2)	N=	4	Φ=	10
Astl~	314.2	(mm^2)	ϱtl	0.21%	OK	
ϱtl,min		0.00%	Meet the specification requirements, calculation continues,OK			
6 Calculate the amount of bending longitudinal reinforcement						
ξ	0.000	Relative compression zone height		As	0	(mm^2)
7. Determine the total amount of longitudinal reinforcement			Bottom longitudinal reinforcement:3Φ22			
Bottom longitudinal reinforcement N=		3	Φ=	22	real As	1140
Bottom longitudinal reinforcement As		157	(mm^2)	meets the requirement，GAMEOVER		

Checking conditions	
Design bending moment：110KN·M	Design shear strength：90KN
design torsion strength：10KN·M	Stirrup:10@150 HPB
Top (middle) longitudinal reinforcement：2Φ10 HRB450	
Bottom longitudinal reinforcement：3Φ22 HRB450	

Table. 4.9. Calculation Primary Beam Cross Section in Torsion

Minimum percentage of reinforcement of longitudinally tensioned steel bars of		
Seismic rating	position in beam	
	Support	middle
First level	0.40	0.31
Second level	0.31	0.26
ree and four lev	0.26	0.21

Table. 4.10. Minimum Percentage of Reinforcement of Longitudinally Tension Steel Bars

Minimum reinforcement ratio of tensile reinforcement on one side of a bent, eccentric, and axial tension member

Reinforcement strength rating is 2

Concrete label=C30

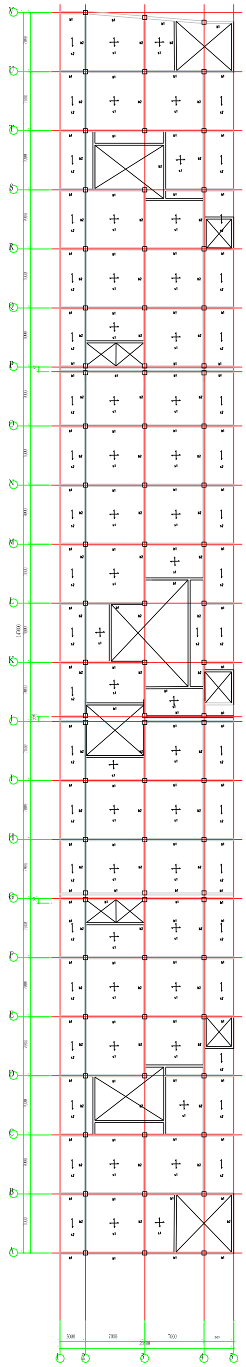
45ft/fy= 0.21%

MAX(0.2,45ft/fy)= 0.21%

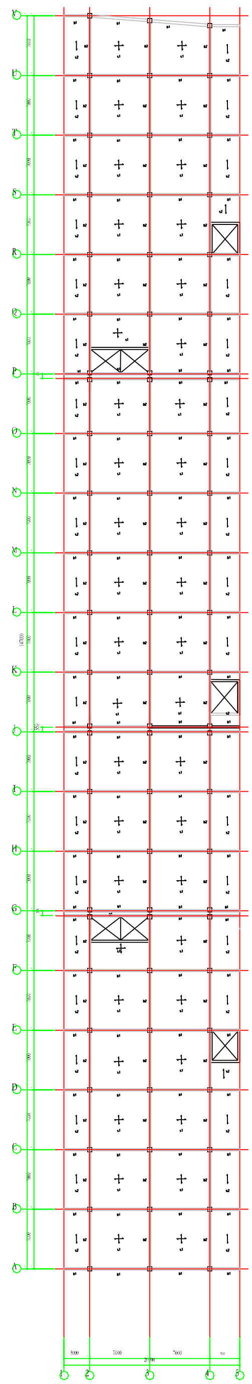
C30		support	middle
ft=1. 43	First level	0. 40	0. 30
fy=360	Second level	0. 30	0. 25
	Three and four levels	0. 25	0. 20

Table. 4.11. Minimum Reinforcement Ratio of Frame Beam to Tensile Reiforcement

4.11 Plan and Section Drawings

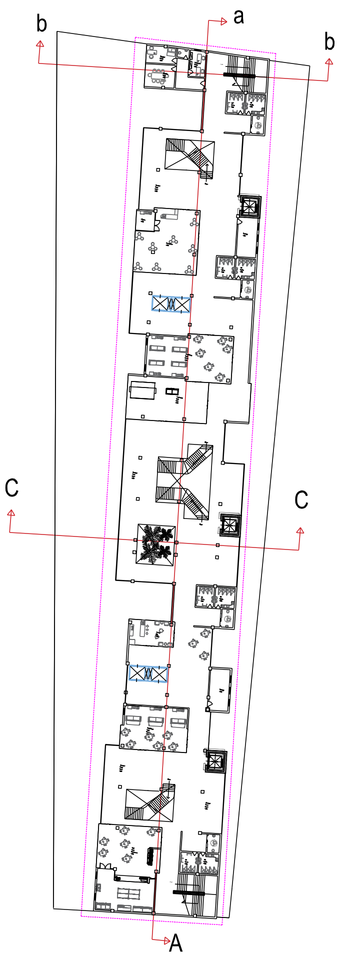


ground floor structure grid 1:200

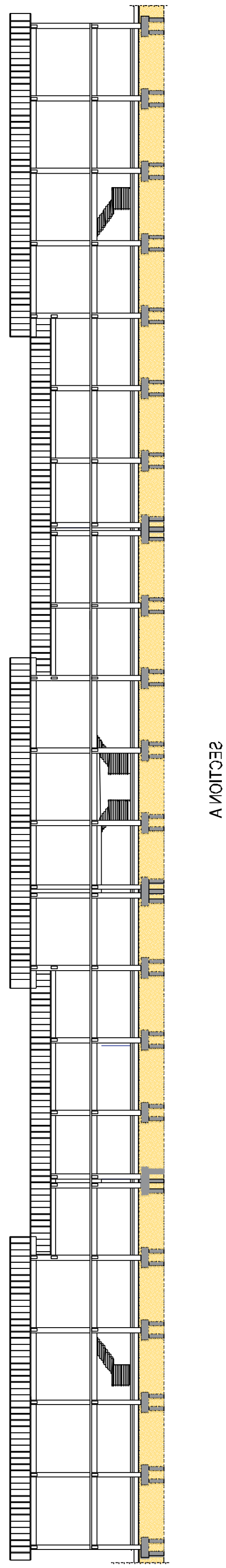


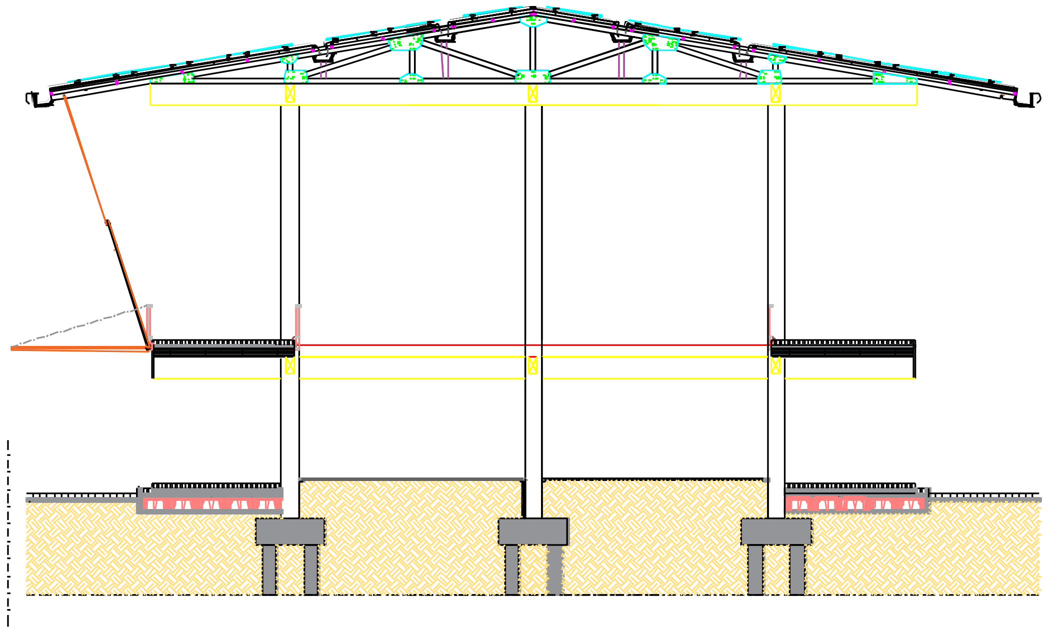
first floor structure grid 1:200

Fig. 4.6. Structural Plan

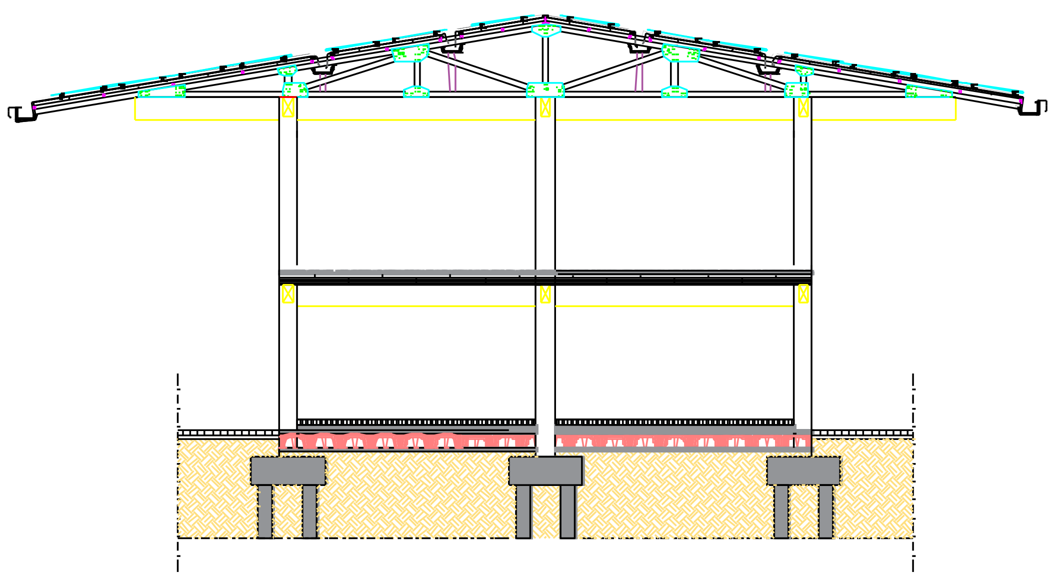


keyplan





SECTION b-b



SECTION c-c

Fig. 4.7. Structural Section

4.12 shear wall

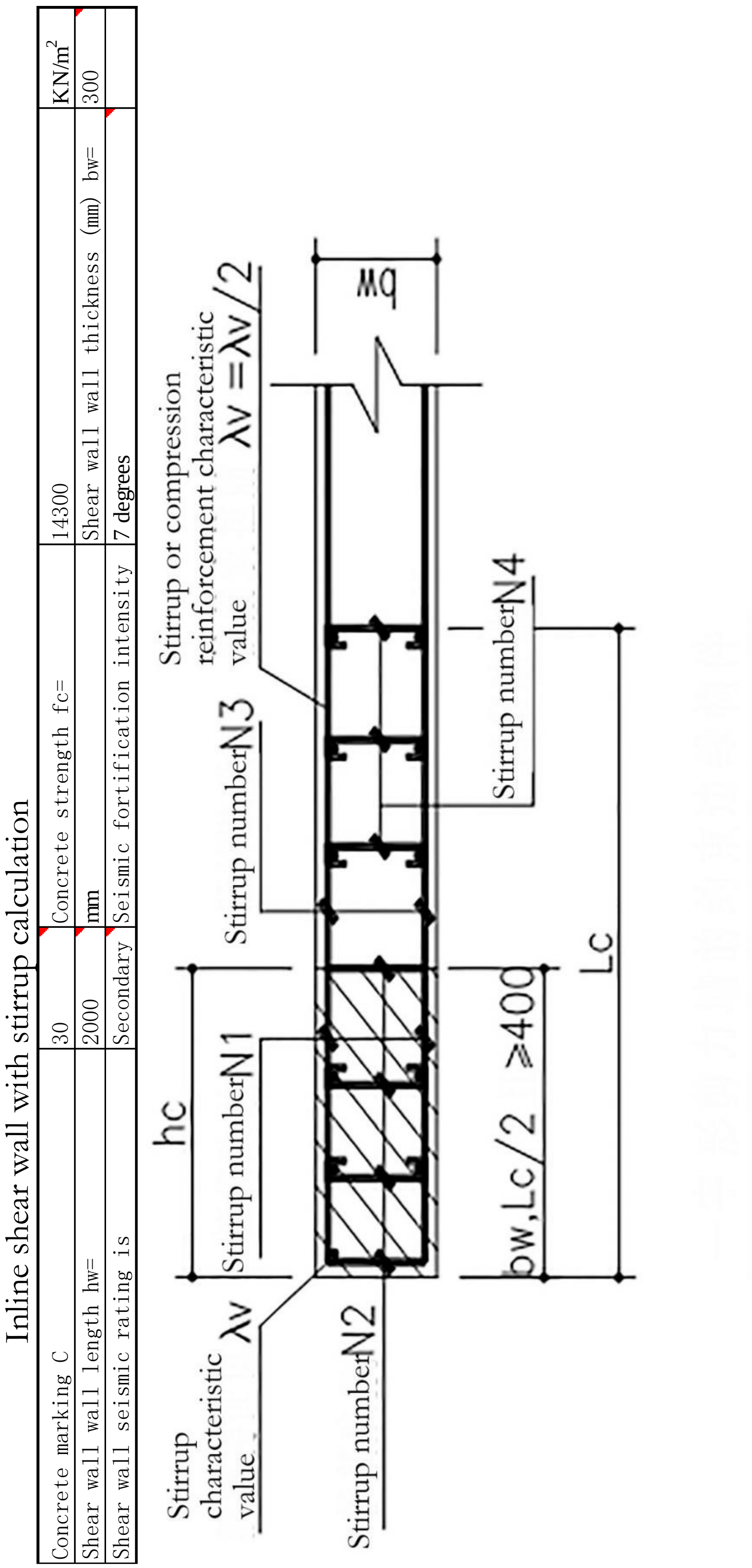


Fig. 4.8. Inline Shear Wall Calculation with Stirrups

Calculation of the stirrup at the hatches area:

The hoop characteristic value of the constraining edge member

λv=0.2

Constraining the edge member along the length of the wall (mm)

Lc= 400

1.5bw=450.000

Stirrup strength design value (N/mm2)=210

Calculate the length of the wall limb according to the specification (mm)

Lc= 450.000

Stirrup diameter (mm) d=12

Actually take the length along the wall limb (mm)

Lc= 900.000

fulfil requirements

Actually take the shadow of the dark column length

hc= 450.000 mm

Calculate the volumetric hoop rate according to the formula (7.2.16) of the High Regulations $\rho v=\lambda v fc/fyv$= 1.3619%

Stirrup spacing (mm)

S1=100

Number of stirrups

N1=2

Number of stirrups

N2=3.5

Volume hoop ratio of stirrups

ρv=1.8362%

Real stirrup diameter

d=12@100

fulfil requirements

Calculation of longitudinal reinforcement at the shadow:

Constraining edge member longitudinal steel reinforcement ratio

$\rho smin$= 1.0%

According to the "high gauge" construction requirements, the number of longitudinal steel bars needs to be matched. 6

Longitudinal steel bar diameter

d=14mm

Longitudinal reinforcement area As= 0

Actual length of vertical steel bar n= 8

Actual longitudinal steel bar diameter d=16 mm

Real distribution of longitudinal steel area As= 1608.495411

fulfil requirements

Non-hatches stirrup calculation:

Stirrup spacing (mm) S1=150mm

Stirrup diameter (mm) d=10 mm

Number of stirrups N3=2

Number of stirrups N4=4

Non-shadowed hoop characteristic value

λv=0.1

Calculate the volumetric hoop rate according to the formula (7.2.16) of the High Regulations $\rho v=\lambda v fc/fyv$= 0.6810%

Volume hoop ratio of stirrups

ρv=0.9117%

Real stirrup diameter

d=10@150

fulfil requirements

4.13 column

Section type one	
Type 1 column section b=	500
Type 1 column section h=	500
Type 1 column protection layer c=	35
Hoop diameter =	8
Stirrup spacing S=	100
Volumetric hoop ratio =	0.47%

Table. 4.12. Column Information

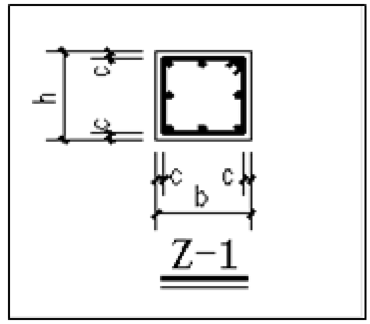


Fig. 4.9. Column Cross Section

Basis: Article 1.4.16 of GB 50010-2010

Applied formula:

vertical load assumed by the column: Nmax=BLqnγ

Compressive bearing capacity of the column: NC=bhfc

Column axial compression ratio: μ ≥ Nmax / Nc

Minimum reinforcement ratio of beams and columns

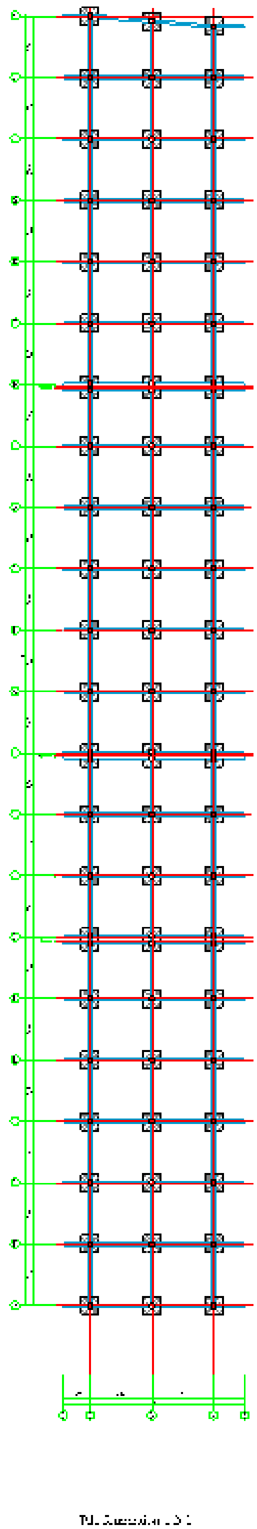
Percentage of minimum reinforcement of all longitudinally loaded steel bars				
Column type	Seismic rating			
	First level	Second leve	Third lever	Fourth level
Middle column,side colu	0.9（1）	0.7（0.8）	0.6（0.7）	0.5（0.6）
Corner post	1.1	0.9	0.8	0.7

Table. 4.13. Minimum Reinforcement Ratio of Beams and Columns

note:

The minimum percentage of reinforcement of the longitudinally stressed steel bars of the column. The values in parentheses apply to the frame column. When 335MPa, 400MPa grade longitudinally loaded steel bars are used, the values in the table increase by 0.1 and 0.05.

4.14 Pile foundation



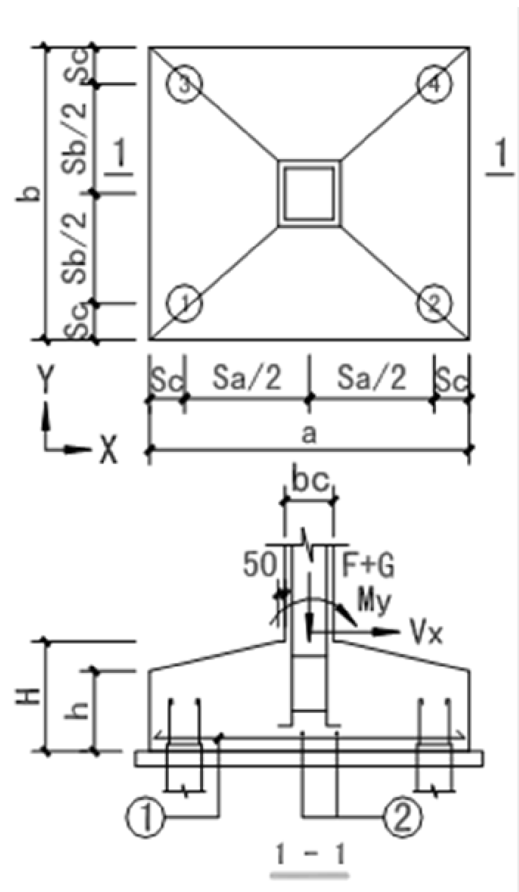


Fig. 4.10. Foundation Plan and   Sections

layer number	type of the soil	Compression modulus-Es(Mpa)	gravity mass(KN/m³)	qsik(Kpa)	qpk(Kpa)	Resistance soil thickness(m) C30
2-1	Heavy silty clay	3.10	17.80	30.0	1500	1.60
2-2	silty clay	9.98	19.40	15.0	2500	3.70
3-1	Heavy silty clay	3.1	17.80	30.0	1500	0.00
3-2	Heavy silty clay	2.23	17.10	50.0	2000	6.75
3-3	Silty clay sand	3.49	17.90	0.0	2500	0.00
4	Residual soil	4.27	18.00	0.0	2500	
5-1	Weathered argillaceous si	7.84	20.20	0.0	2500	0.00

Table. 4.14. Layers of Soil

Empirical parameter method

Quk=Qsk+Qpk=u∑qsikLi+qpkAp

Rd = Rsk/γs+Rpk/γp = UpΣfsiLi/γs+fpAp/γp

length of the pile (m)=12.05

diameter of the pile (m)=0.400

qpk(Kpa) =3000

Qpk(KN)=376.99

Qsk=UpΣqsiLi(KN)=554.18

Quk(KN)=931.17

Rd(KN)=581.98

γs =1.6

γp =1.6

u(m)=1.257

Ap(m²)=0.1257

First, the bending calculation:

1. the calculation of the vertical force design value of the pile (without considering the bearing effect):

Number of piles (four pile caps arranged symmetrically):

n=4

Square pile length (round pile conversion side width 0.8d) (m):

bp=0.64

Column section long side dimension (m):

hc= 0.7 (X direction)

Column section short side dimension (m):

bc= 0.7 (Y direction)

The vertical force design value (kN) acting on the pile foundation:

F=18800

Self-weight design value (kN) of pile foundation cap and pile cap soil:

G=0.0

The external force acting on the pile group on the X-axis passing through the center of gravity of the pile group

Mfx=150

Torque design value (kN-m):

The external force acting on the pile group on the Y-axis passing through the center of gravity of the pile group

Mfy=150

Torque design value (kN-m):

The distance from the pile i to the Y axis passing through the center of gravity of the pile group (m):

xi0=1.2

The distance (m) from the pile i to the X axis passing through the center of gravity of the pile group:

yi0=1.2

When considering Mfx, the vertical reaction force design value (kN) of the i-th pile:

Niy=4731.3

When considering Mfy, the vertical reaction force design value (kN) of the i-th pile:

Nix=4731.3

The maximum vertical reaction force design value (kN) of the corner pile:

Nimax= 4762.5 <=1.2 times pile vertical bearing capacity design value

2. calculate the upper limit by bending:

The distance from the pile axis to the corresponding calculated section of the vertical Y-axis direction (m):

xi= 0.9

The distance from the pile axis to the corresponding calculated section of the vertical X-axis direction (m):

yi=0.9

Calculate the bending moment design value (kN) of the vertical Y-axis section:

Mx=8043.1

Calculate the bending moment design value (kN) of the vertical X-axis section:

My=8043.1

Head height (mm):

h=1900

concrete bending compressive strength design value (N / mm ^ 2):

fcm=16.5

Rebar strength design value (N / mm ^ 2):

fy=310

Component size (mm):

b=4000

h=1900

The distance from the longitudinal tension of the longitudinal strength steel bar to the proximal side of the section (mm): as= 60

Effective section height (mm):

h0= 1840

Bending moment (kN-m)

Mx=8043.1

Equation 4.1.5-1 (concrete Specification)

det=3141868.94

x=67.47

yetb*h0=1001.6

Equation 4.1.5-2 (concrete specification) Asy=14364

Reinforcement rate (%) roy=0.20

Bending moment (kN-m) My=8043.1

Formula 4.1.5-1

det=3141868.94

x= 67.47

yetb*h0=1001.6

Formula 4.1.5-2 Asx=14364

Reinforcement rate (%) rox=0.20

Second, the stamping calculation:

1. Calculate the bearing capacity after column stamping:

The horizontal distance from the short side of the column to the nearest pile edge (m):

aox=0.53

The horizontal distance from the long side of the column to the nearest pile edge (m):

aoy=0.53

Formula (5.6.6-3) alfaox=1.48 lmtaox= 0.29 Between0.2~1.0

Formula (5.6.6-3) alfaoy=1.48 lmtaoy= 0.29 Between0.2~1.0

The importance factor of the pile foundation: gamo= 1.0

Tensile strength design value (N / mm ^ 2) ft=1.5

Formula (5.6.6-4) gamoFl=18800

Design value (kN) of the bearing capacity of the column punching cover:

R= 20033.1 >=gamoFl=18800

Meet the bearing capacity requirements of column punching.

2, the bearing capacity of the pile is stamped by the pile:

Guide the 45 degree press line from the inner edge of the pile bottom to the top surface of the top cover

a1x=0.53

A= 1.79

B=0.53

The horizontal distance A from the intersection to the inner edge of the corner pile, and the water from the edge of the column to the inside of the pile

a1y=0.53

A= 1.79

B=0.53

Flat distance B, whichever is smaller (m):

Distance from the inner edge of the corner post to the outer edge of the cap (m):

c1= 1.12

c2= 1.12

Formula (5.6.7-2) alfa1x=0.98 lmta1x= 0.29 Between 0.2 and 1.0

Formula (5.6.7-2) alfa1y=0.98 lmta1y= 0.29 Between 0.2 and 1.0

The importance factor of the pile foundation: gamo=1.0

Tensile strength design value (N / mm ^ 2) ft= 1.5

Formula (5.6.7-1) gamoNl=4762.5

Design value (kN) of the bearing capacity of the pile cap subjected to punching:

R= 7519.2 >=gamoNl= 4762.5

Meet the bearing capacity requirements of piling.

Third, the upper limit is calculated by shearing:

Horizontal distance (m) from the edge of the column to the edge of the pile in the X direction:

ax= 0.53

Horizontal distance (m) from the edge of the column to the edge of the pile in the Y direction:

ay= 0.53

Formula (5.6.8-2) betax=0.20 lmtax=0.29

Formula (5.6.8-2) betay=0.20 lmtay=0.29

The importance factor of the pile foundation:

gamo=1.0

Compressive strength design value (N / mm ^ 2) fc= 16.5

Formula (5.6.8-1) gamoVx= 9462.5

Bearing capacity design value (kN) of the cap shear:

Rx=24781.8 >=gamoVx= 9462.5

Formula (5.6.8-1) gamoVy=9462.5

Bearing capacity design value (kN) of the cap shear:

Ry=24781.8 >=gamoVy= 9462.5

Meet the shear bearing capacity requirements.

Fourth, the partial pressure calculation of the cap (according to the concrete specification):

concrete Partially compressed net area (m2):

Aln=0.49

concrete Local pressure area (m2):

Al= 0.49

Calculate the calculated bottom area (m ^ 2) for partial compression:

Ab=4.41   (by the third sketch to calculate the bottom area)

Formula (4.5.1-2)   beta=3.00

Formula (4.5.1-1)   Fl= 18800

concrete Local stress bearing capacity design value (kN):

R= 36382.5 >=Fl=18800

Meet the local carrying capacity requirements.

4.15 stairs calculation

Three-fold staircase calculation			
Gk2	Gk1	Gk3	
4	8.21	4	
Qk2	Qk1	Qk3	
3.5	3.5	3.5	**load**
Design value calculation result			
q2	q1	q3	
9.7	14.752	9.7	

L2	L1	L3	**span**
3.6	4.5	2.15	

RA	RB	
62.68751463	59.47148537	**Support reaction**

q3*L3	20.855	q2*L2	34.92	

V=0 is within the range of q1, and the distance from the B end is x.。

The value of X is: 4.767712

The maximum bending moment in the middle: Mmax= **178.0983376**

Table. 4.15. Three-Fold Staircase Calculation

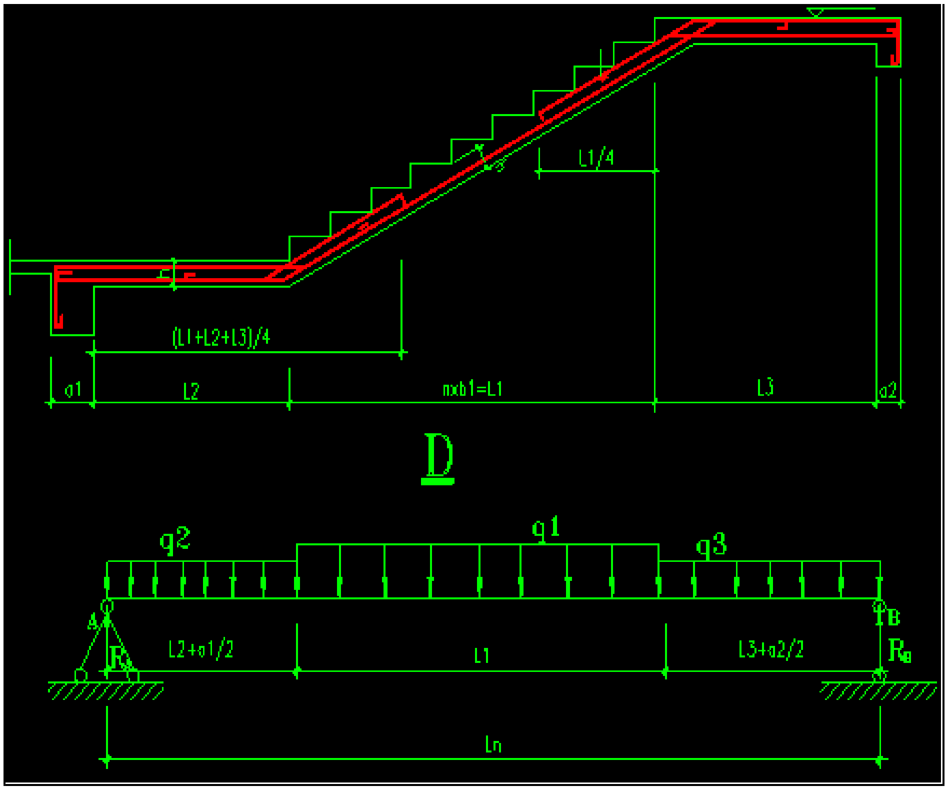


Fig. 4.11. Section and Load of Three-Fold Staircase

4.16 Gutter

Stainless steel middle gutter

1． Gutter parameter input:

Gutter height: Ht=100mm

Gutter width:Wt=400mm

Gutter drainage slope:st= 0.2

Rainfall intensity: Hm=400mm/h

2.. Gutter drainage system calculation:

Gutter hydraulic radius:

Rt=Wt*Ht/(2*Ht+Wt)

=66.667 mm

Gutter average flow rate:

Vt=(1/0.013)*(Rt/1000)2/3*st1/2

=1.789 m/s

Gutter drainage capacity:

Qt=Wt*Ht*Vt / 106

=0.072 m3/s

Water area:

S= 3600*Qt / (Hm/1000)

=643.9m2

3 Downpipe drainage system calculation:

Maximum allowable catchment area and drainage Water Flow

Maximum allowable catchment area and drainage flow of riser							
Water catchment area	360	680	1510	2700	4300	6100	m^2
Discharge meter	10	19	42	75	120	170	L/s
Pipe diameter	75	100	150	200	250	300	mm

Table. 4.16. Maximum Allowable Catchment Area and Drainge Water Flow

Converting the catchment area: Sl= S*(Hm/100)

=2575.6 m2

Required downpipe diameter: d= 200 mm

5. Technological and Sustainable Design

This section deals with technologies applied to our project beginning with the review of weather information of Makassar City and passive strategies that we have used to improve the concept to design. Initial simulation and analysis have guided our technological design in an extensive and deep way to add or subtract elements from architectural design with the main purpose of tackling these issues early on in the design.

5.1 Weather Information

The climate here is tropical. There is significant rainfall in most months of the year. The dry season has little impact on the climate as a whole. The climate here is classified as Am based on the Köppen-Geiger system. The average temperature in Makassar is 26.2 ° C. The precipitation here averages 2875 mm.

WEATHER DATA SUMMARY

LOCATION: **Makassar, -, IDN**
Latitude/Longitude: 5.13° South, 119.49° East, **Time Zone from Greenwich** 8
Data Source: MN6 999 WMO Station Number, **Elevation** 55 m

MONTHLY MEANS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Global Horiz Radiation (Avg Hourly)	244	303	385	454	424	442	453	464	486	480	411	277	Wh/sq.m
Direct Normal Radiation (Avg Hourly)	103	133	227	350	350	392	437	384	373	355	266	119	Wh/sq.m
Diffuse Radiation (Avg Hourly)	172	206	220	202	176	179	163	197	214	220	221	201	Wh/sq.m
Global Horiz Radiation (Max Hourly)	999	1099	1143	1078	1078	931	920	1014	1086	1049	1121	945	Wh/sq.m
Direct Normal Radiation (Max Hourly)	882	989	984	1014	996	950	945	921	967	934	1050	856	Wh/sq.m
Diffuse Radiation (Max Hourly)	529	540	548	479	435	436	430	488	481	509	519	523	Wh/sq.m
Global Horiz Radiation (Avg Daily Total)	2998	3697	4630	5396	4992	5185	5327	5495	5831	5830	5033	3406	Wh/sq.m
Direct Normal Radiation (Avg Daily Total)	1263	1618	2734	4160	4124	4595	5128	4549	4472	4312	3263	1471	Wh/sq.m
Diffuse Radiation (Avg Daily Total)	2121	2516	2653	2409	2076	2099	1920	2333	2568	2678	2715	2473	Wh/sq.m
Global Horiz Illumination (Avg Hourly)	280	346	436	511	476	493	503	511	538	537	464	316	lux
Direct Normal Illumination (Avg Hourly)	86	117	205	318	326	357	413	353	340	320	241	97	lux
Dry Bulb Temperature (Avg Monthly)	26	26	26	26	27	26	26	27	27	28	26	26	degrees C
Dew Point Temperature (Avg Monthly)	23	23	23	23	23	22	21	19	19	22	23	23	degrees C
Relative Humidity (Avg Monthly)	85	85	83	83	78	77	73	64	64	72	81	84	percent
Wind Direction (Monthly Mode)	260	270	250	180	100	60	80	180	180	160	250	290	degrees
Wind Speed (Avg Monthly)	2	2	2	1	1	1	1	2	2	2	2	2	m/s
Ground Temperature (Avg Monthly of 1 Depths)	27	26	26	26	27	27	27	27	27	27	27	27	degrees C

Fig. 5.1.1. The Weather Data Summary of Makassar City, South Sulawesi Province, Indonesia by Climate Consultant V 6.0

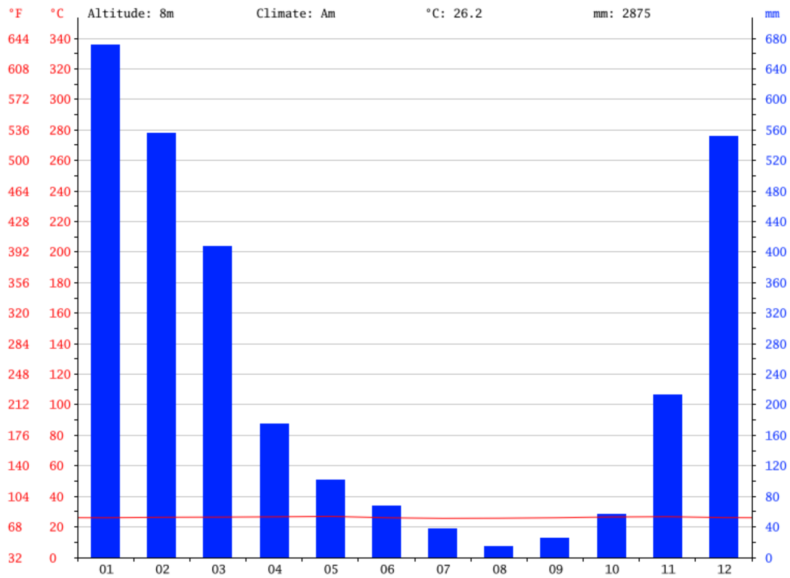


Fig. 5.1.2. The Graph of Makassar Climate in a year by Climate-Data.org

The driest month is August, with 14 mm of rain. With an average of 671 mm, almost all precipitation falls in January.

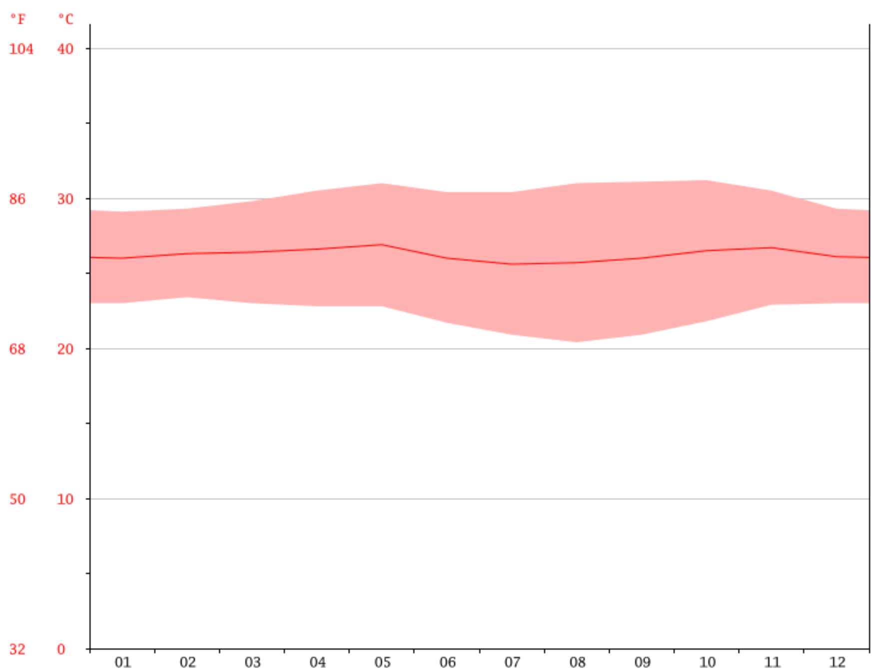


Fig. 5.1.3. The Graph of Makassar Temperature in a year by Climate-Data.org

May is the hottest month of the year. Temperatures in May averaged 26.9 ° C. Meanwhile, July has the lowest average temperature in a year which is 25.6 ° C.

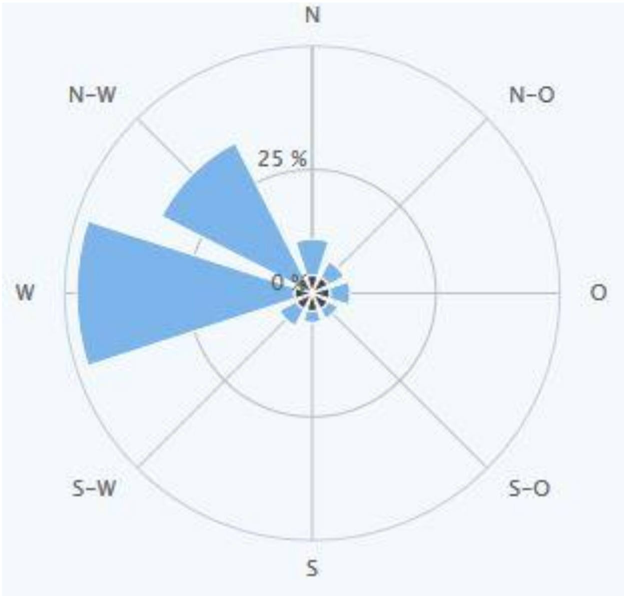


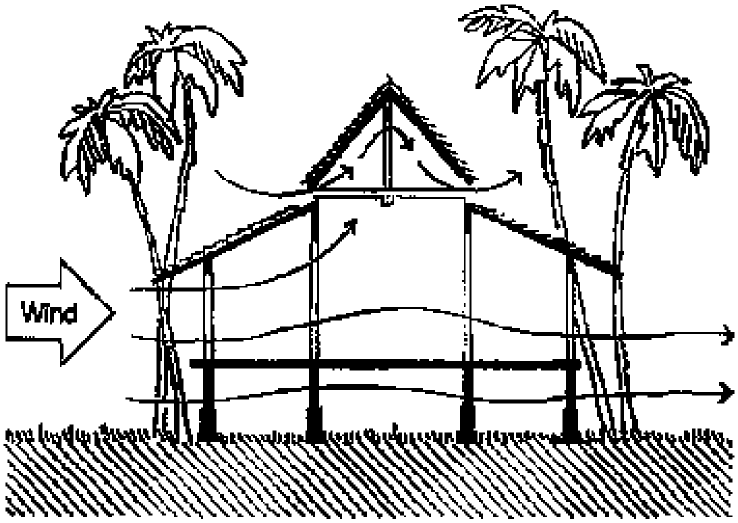
Fig. 5.1.4. Wind Rose by world-weather.com.de

5.2 General Strategies

To meet the challenges of a tropical climate on our local built environment which is without winter season, we are trying to get as well as the best energy demands for our building which use passive design to take advantages the natures and the climate itself.

In general, there are some strategies to achieve energy efficient according to our climate condition:

- Minimization of energy demands
- Minimization of solar gains
- Minimization electricity demands for natural lighting



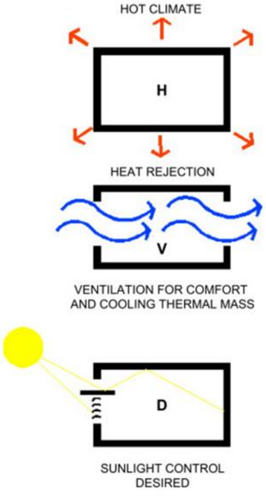


Fig. 5.2.1. Wind Flow, design490.org

Fig. 5.2.2. Passive Design Strategies Science Direct

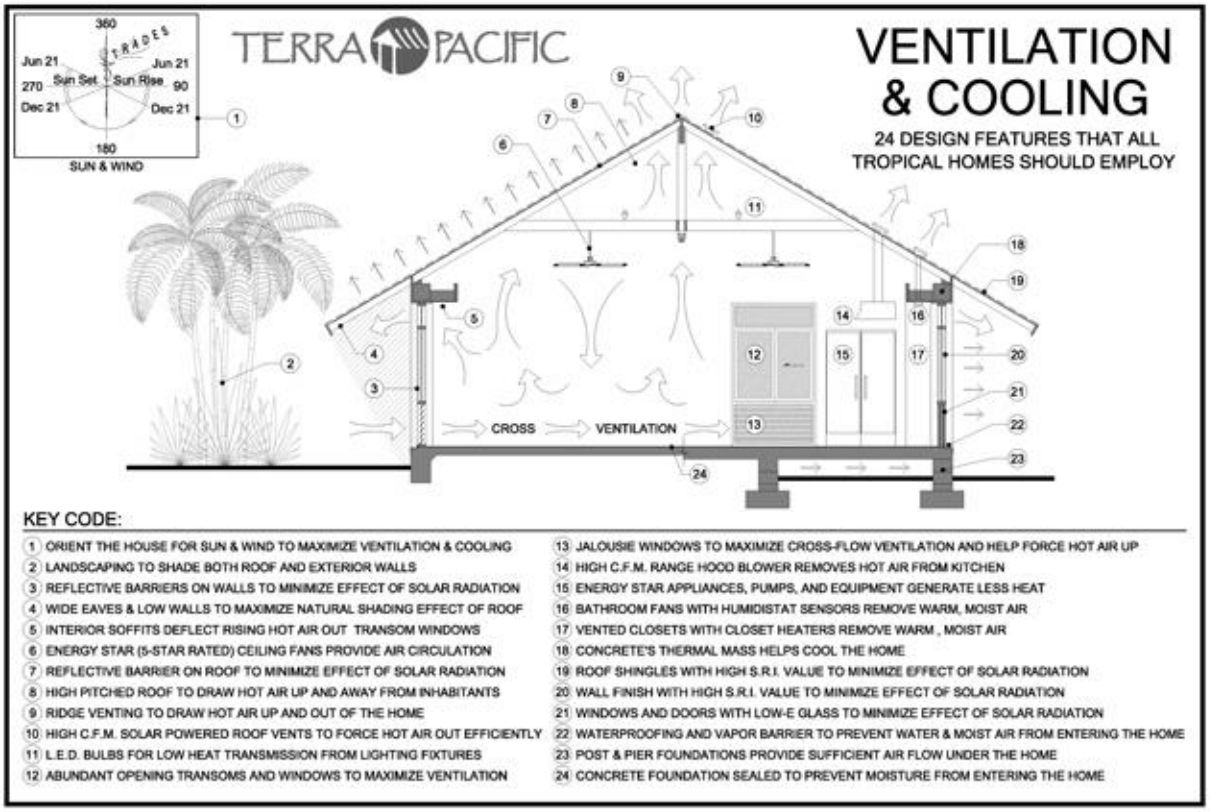


Fig. 5.2.3. Ventilation and Cooling Design Features for Tropical Climate by Terra Pacific

For Tropical Climate, there are some building design considerations:

- Movement of air is an important
- Open up houses as much as possible
- Use lightweight materials for the walls and roof
  - So they do not store much heat and shed heat quickly
  - ie steel or timber stud frame with metal, timber or fibre cement claddings
  - Avoid Heavy mass products, such as brick and block
    - Such mass re-radiate the heat they have stored during the day, which keeps the house hot after sunset
    - If must use, ensure they are well shaded
    - Windows should be shaded from the sun and protected from rain

- The roof and/or ceiling should be insulated and roof space is well vented
- Living room + bedroom has at least two openings
- The building should be engineered to withstand cyclones
- Develop a long, thin floor plan with as many rooms as possible having windows or openings on at least two walls to achieve maximum cross-ventilation
- Provide covered external living areas that are positioned to catch the prevailing breezes in both the wet and dry seasons
- Insulate the eastern and western walls
- Using lighter, more reflective colours on roofs and walls
- Raise the ceiling height to greater than 2700mm or using sloping ceilings with a minimum height of 2400mm
- Choose windows that catch the breeze and can be left open in wet conditions,
    - ie louvres, casements or awning windows
    - Use awnings to shade windows and provide rain protection
    - Put high level windows or vents in all rooms, to let out the hot air and draw in cooler air
        - However, it is important that windows or vents can be closed in storms
        - Avoid shrubs and dense planting up to 2100mm high that will block breezes, make internal rooms darker, and provide breeding areas for mosquitoes and other pests

Design for natural ventilation:

- Use the breeze for cross ventilation through openings in opposite walls and internal partitions
- Maximize the area of windows (e.g. louvres) that can be opened
- Orientate house to catch the breeze (whilst still minimizing sun on east and west walls)
- A long narrow floor plan catches the breeze best.
- Trees and shrubs act to cool the air passing through the house.
- Do not use exposed concrete on ground immediately outside the house as it heats the air.
- Roof space ventilation draws the heat out.
- Dirty flyscreens block more breeze. Consider using openable/removable flyscreen shutters

and we need minimum insulation standard

- Light coloured well ventilated roofs: foil/insulation
- Other roofs: Roof batts and foil/sisalation
- Full shading of wall is much more important than wall R-value. Unshaded, masonry walls store heat and release it well into the night.
- Shelter windows with louvres, canopies, shutters or fixed overhangs – then you can enjoy the cooling effect of rain.

5.3 Shadow Analysis

The relative position of the sun is a major factor in the heat gain of buildings and in the performance of solar energy systems. Accurate location specific knowledge of sun path and climatic conditions is essential for economic decisions about solar collector area, orientation, landscaping, summer shading, and the cost effective use of solar trackers. We are trying to analysis the shadow to our building in 3 times difference in a day. Moreover, every season in this country almost has the same sun path a year.

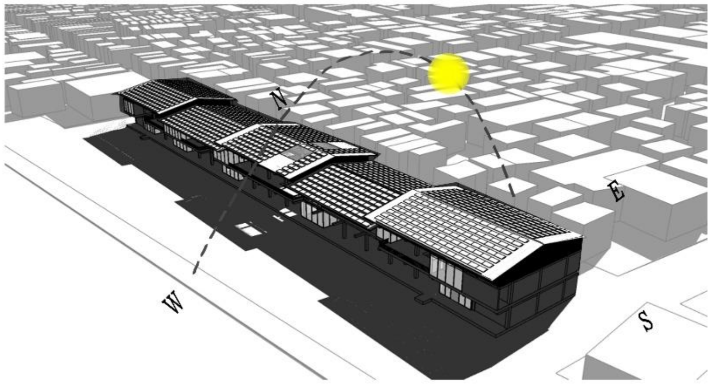


Fig. 5.3.1. Shadow Analysis – 09.00 AM

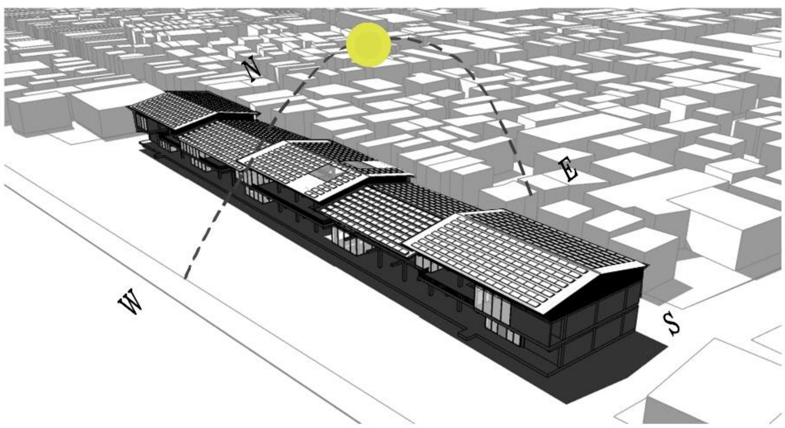


Fig. 5.3.2. Shadow Analysis – 13.00 PM

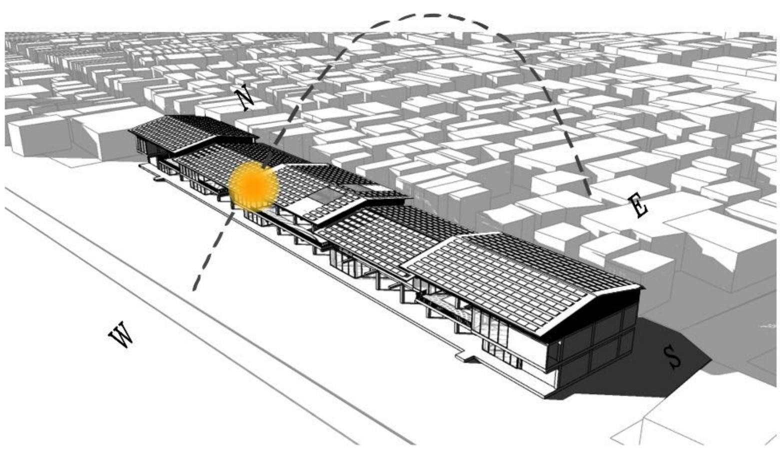
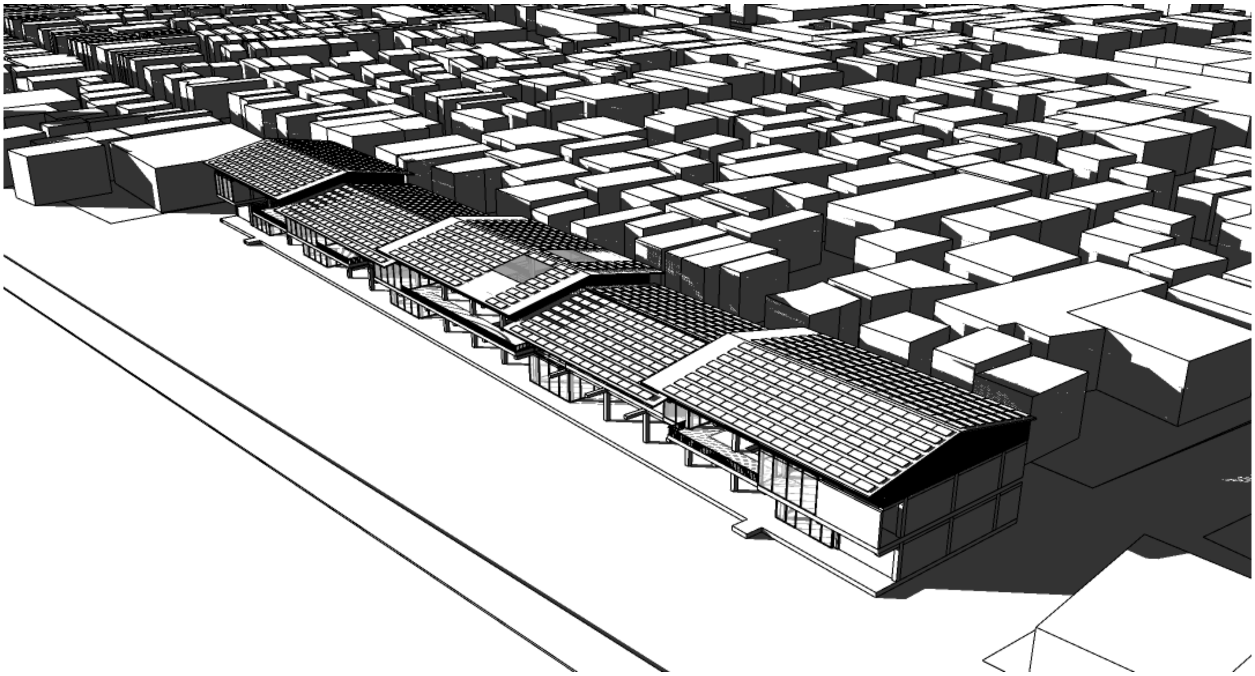
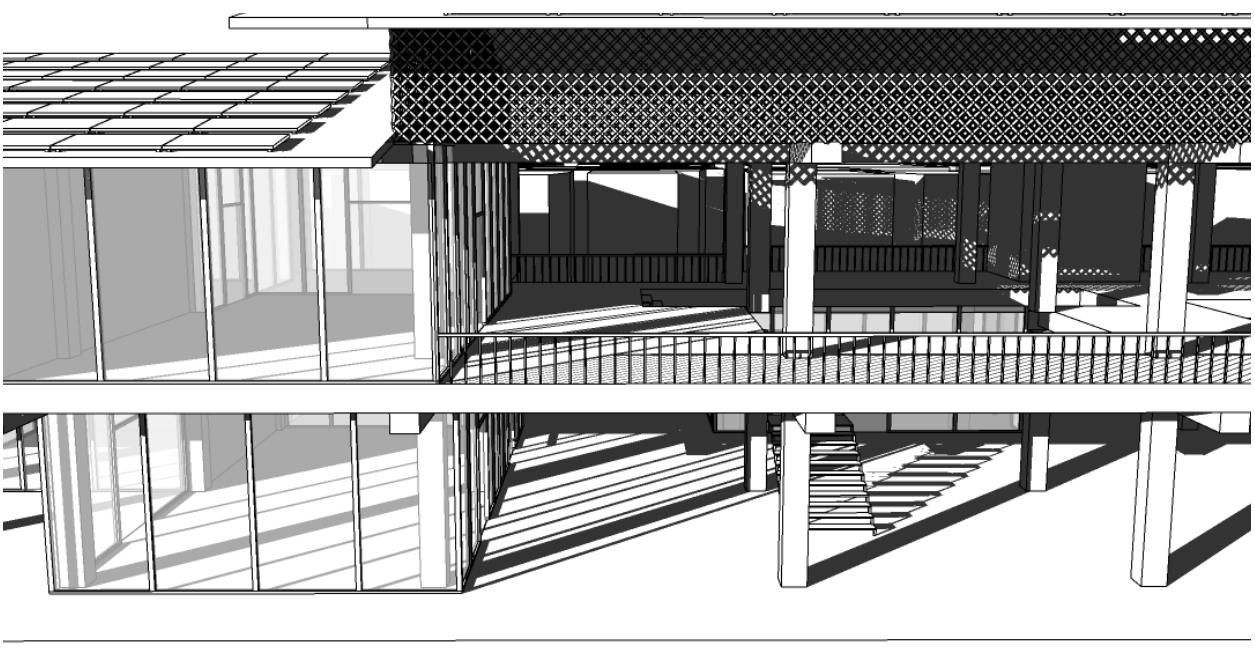


Fig. 5.3.3. Shadow Analysis – 17.00 PM





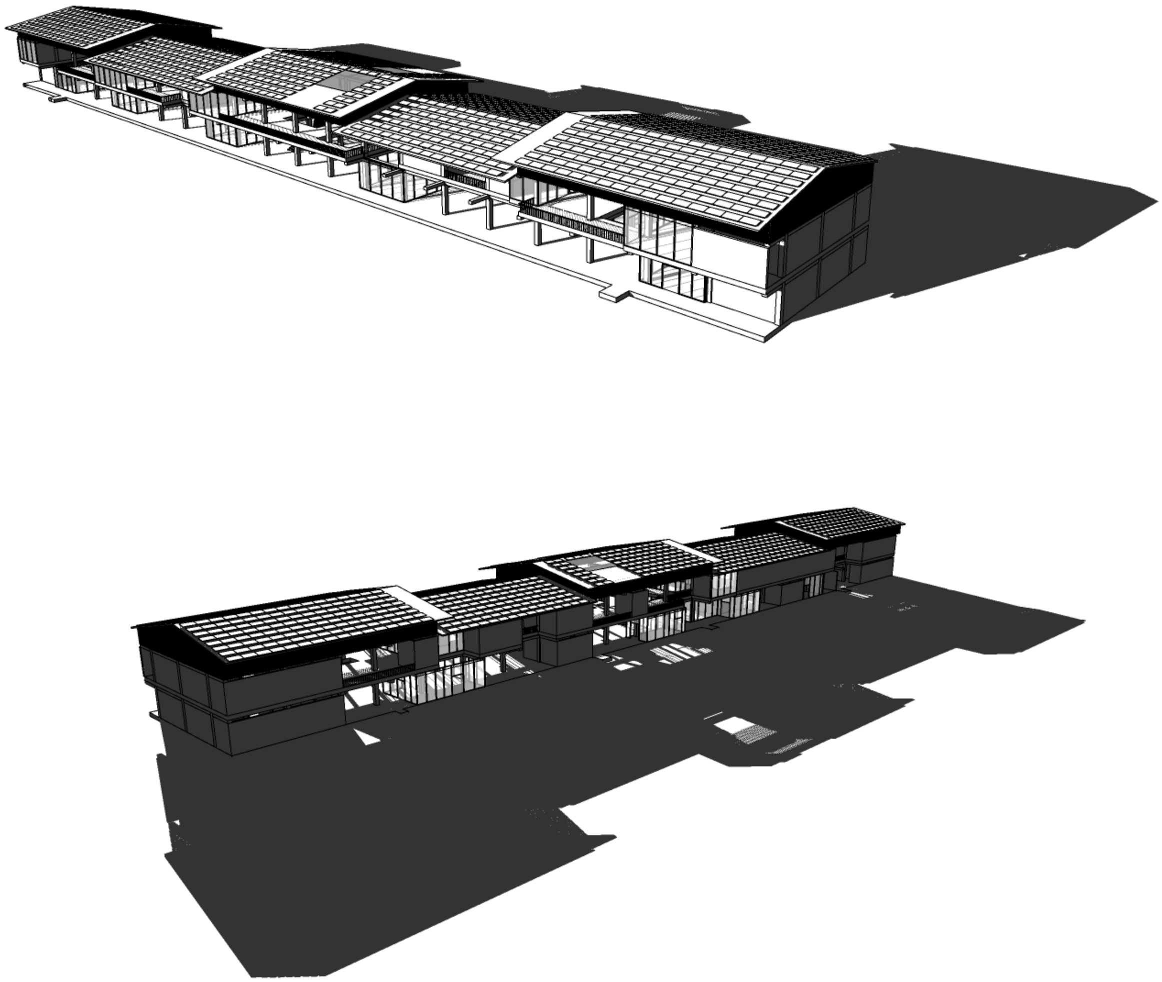


Fig. 5.3.4. Shadow Analysis in General

5.4 Energy and Daylight Analysis

5.4.1. Energy Analysis

In tropical and subtropical areas, cooling in buildings has become essential for thermal comfort, particularly in public buildings such as offices, supermarkets, sport centres, etc., where energy consumption accounts for over 50% of building’s energy demands.

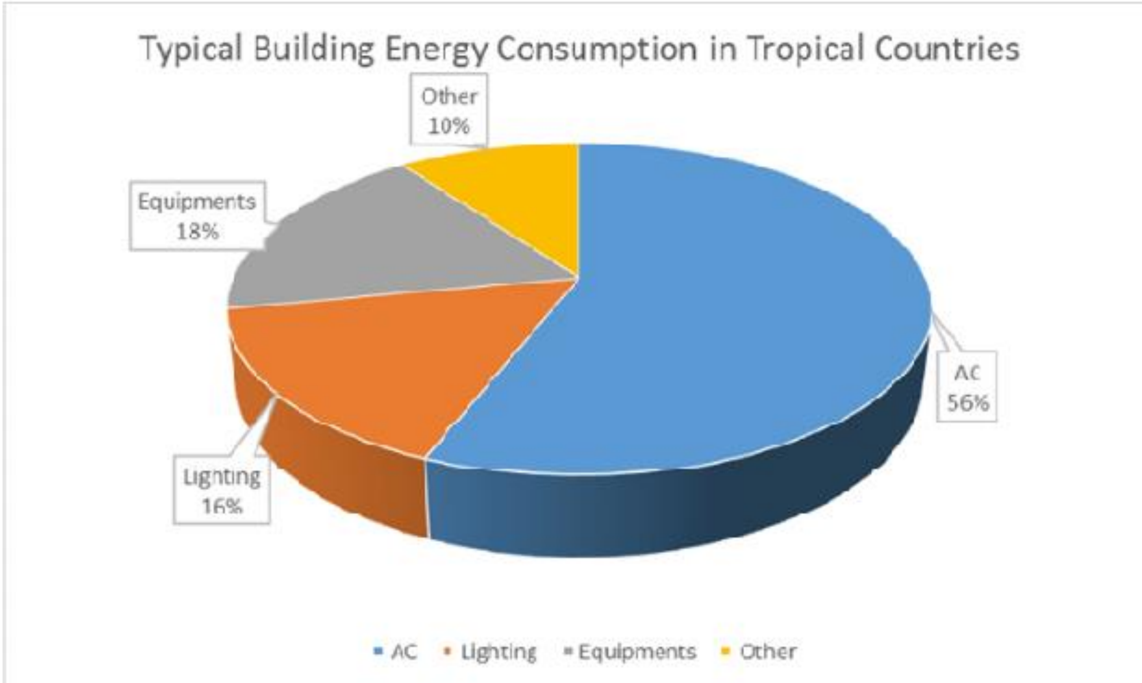


Fig. 5.4.1. Typical Building Energy Consumption in Tropical Countries

We used the software named "Sefaira" to analyze the energy and daylight for the building. With this software, we tried to compare two cases according to two baselines and two systems to apply into the final model of the building.

First baseline, we started using the default of this software and with the simple base model of the building. The parameters of the default are:

- Wall, U-value: 0.36 W/m2K (Insulated)
- Floor, U-value: 0.36 W/m2K (Insulated)
- Roof, U-value: 0.36 W/m2K (Insulated)
- Glazing U-factor: 2.4 W/m2K (2 panes low-e)
- Visible light transmittance: 0.42 (2 panes)
- Solar heat gain coefficient: 0.60 (Clear double glazing)
- Infiltration rate: 9.72 m3/m2h (Normal practice)
- Ventilation rate: 10 L/s-person (Typical ventilation)
- Equipment: 15 W/m2 (Standard)
- Lighting: 20 W/m2 (Poor)

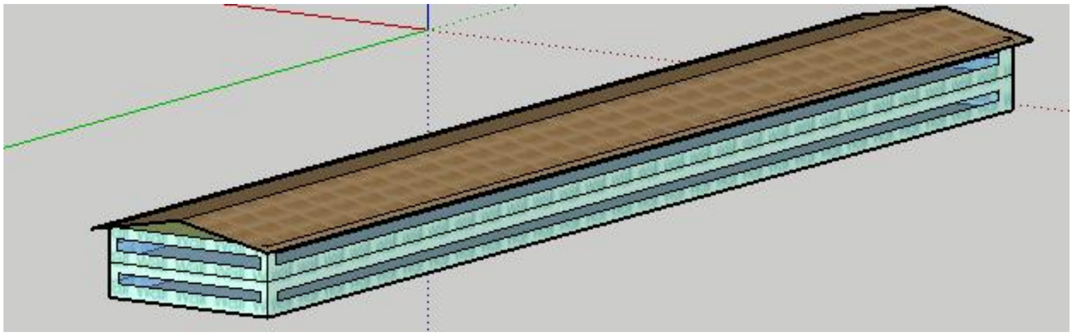


Fig. 5.4.2. Base 1 Model

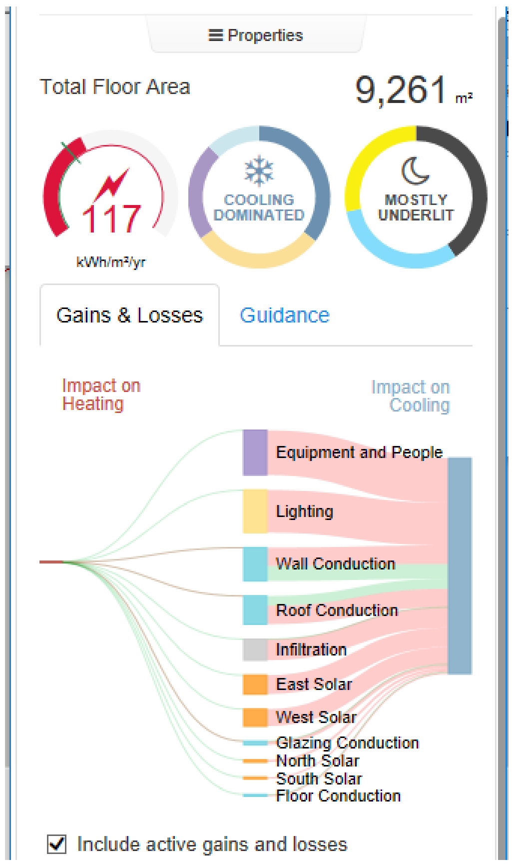


Fig. 5.4.3. Base 1 Model Result with Default Baseline

The obtained results for energy are as follows:

- Total energy consumption for building: 117(kwh/m 2)/year
- The building is cooling dominated which cooling load is more than 40% of the total energy consumption (Due to the tropical climate)
- The equipment and people (occupants), lighting, and wall and roof conduction influence a lot to the cooling energy on the site, orientation and the shape.

Then, we used our fix model to compare with the base model before with still using the default of Sefaira Software.

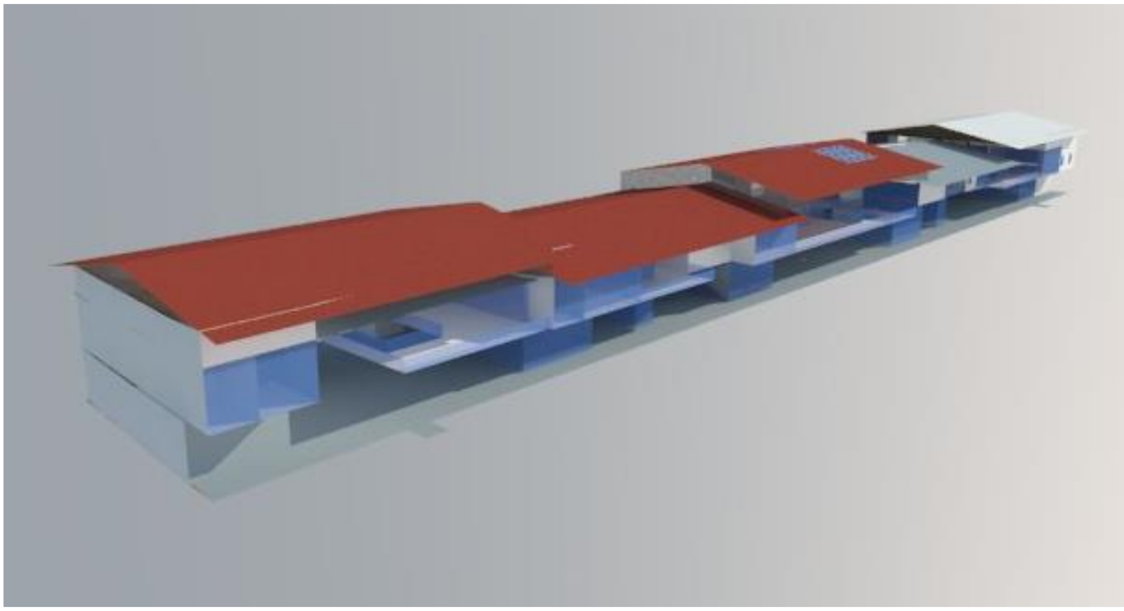


Fig. 5.4.4. Fix Model

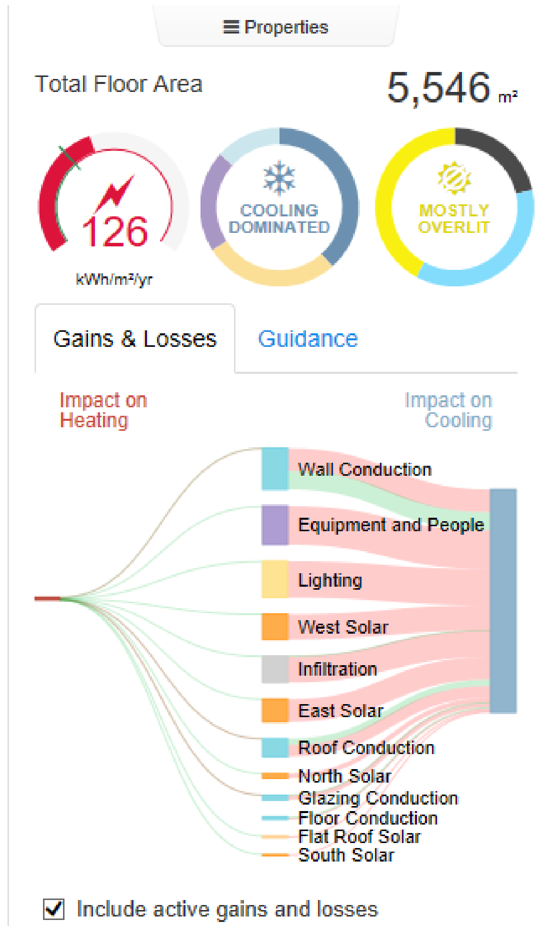


Fig. 5.4.5. Fix Model Result with Default Baseline

We obtained the total energy consumption is a little bit more than the base 1. It is around 126 kWh/m2/year due to the fix model has a lot of open space (outdoor space) in the building and also surely because it is still using the default system.

After we knew the result of our fix model, we are trying to put all our own values, no default values anymore. In order to have the best performance energy efficient for the building, we designed and calculated each elements of the building. The values that we got are:

- Wall, U-value: 0.50 W/m2K (Insulated)
- Floor, U-value: 0.10 W/m2K (Well Insulated)
- Roof, U-value: 0.60 W/m2K (Insulated)
- Glazing U-factor: 0.59 W/m2K (2 panes low-e)
- Visible light transmittance: 0.37 (2 panes)
- Solar heat gain coefficient: 0.20 (Internal blinds)
- Infiltration rate: 4.96 m3/m2h (Best practice)
- Ventilation rate: 30 L/s-person (High ventilation)
- Equipment: 5 W/m2 (Excellent)

- Lighting: 3.7 W/m2 (Excellent)

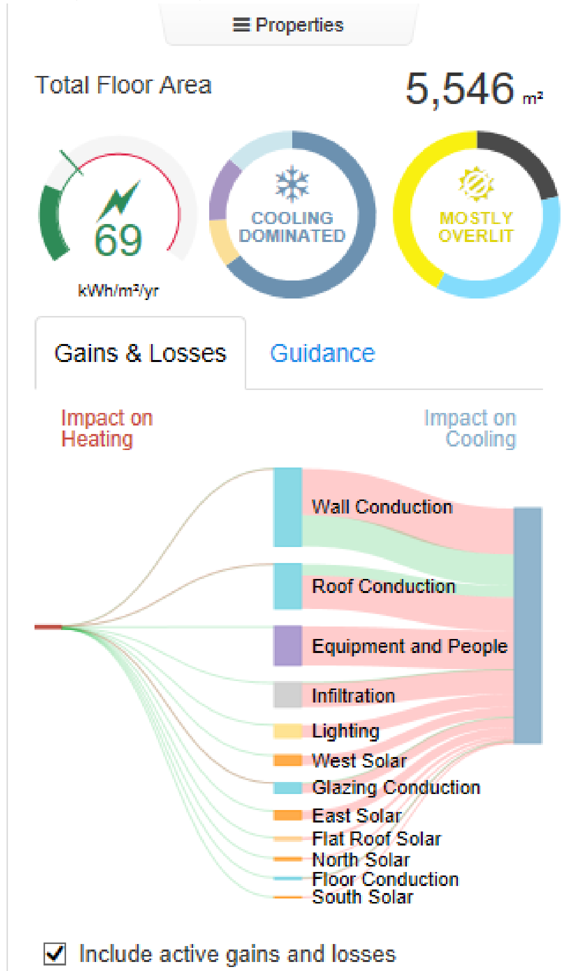


Fig. 5.4.6. Fix Model Result with Design Baseline

Eventually, we got well energy performance which obtained only 69 kWh/m2/year for the total energy consumption of the building. Now, the cooling load is around more than 60% of total energy consumption.

Then, we have known the results. Thus, we uploaded this model with this baseline to Website of Sefaira Software. Here, we compared again with two system for our building which are Fan Coil Units and Central Plants System, and Split System.

A fan coil unit (FCU) contains a fan which draws the air in a space into the unit then blows it over a cooling or heating coil. The air comes out of the FCU either cooler or hotter than before. They are used in some office buildings and shopping centres and typically specified where there are multiple small spaces requiring individual control. Typically an individual FCU serves only up to 150m², so there can be tens or even hundreds in a building. FCUs are, however, most commonly used as a supplement to a building for which other HVAC systems provide the majority of the air-conditioning. FCUs will generally have a chilled water coil for cooling and either a hot water coil for heating or an electric heating element. Chilled water is provided from a chiller located in the central plant, and hot water form a boiler. Each FCU is provided with a small supply of outside air to ensure adequate ventilation.

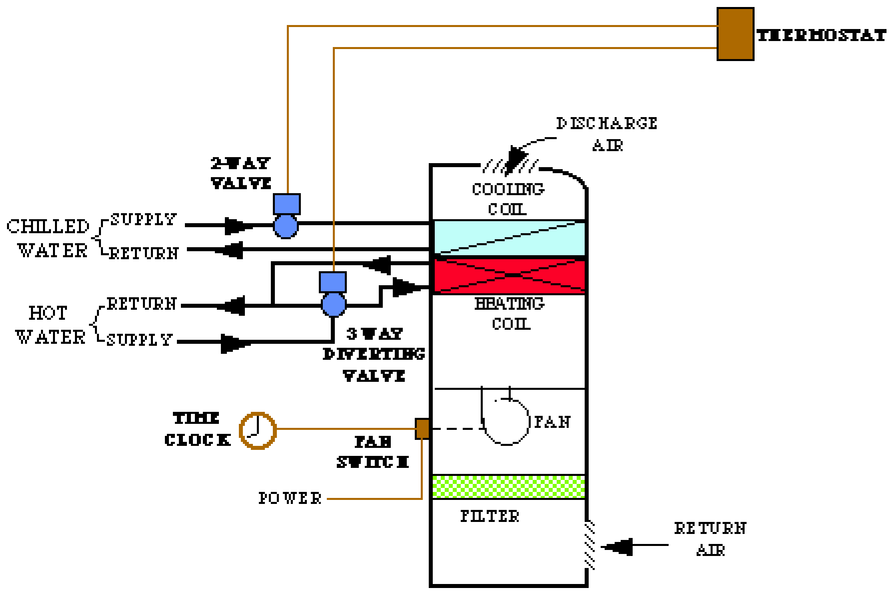


Fig. 5.4.7. Fan Coil Unit Schematic

A split system is a combination of an indoor air handling unit and an outdoor condensing unit. The indoor air handling unit contains a supply air fan and an air-to-refrigerant heat exchanger (or cooling coil), and the expansion device. The outdoor condensing unit consists of a compressor and a condenser coil. Split-systems are typically found in residential or small commercial buildings. These systems have the highest energy efficiency rating (EER) of all the available AC systems. Manufacturers are required to take the EER rating a step further and provide a seasonal energy efficiency rating (SEER) for use by consumers. SEER ratings vary widely and range from 10 to 20. The higher the SEER rating, the more efficient the AC system operates. If heating is required, an alternate method of heating the interior of the building must be used, usually in the form of electric or gas heating.

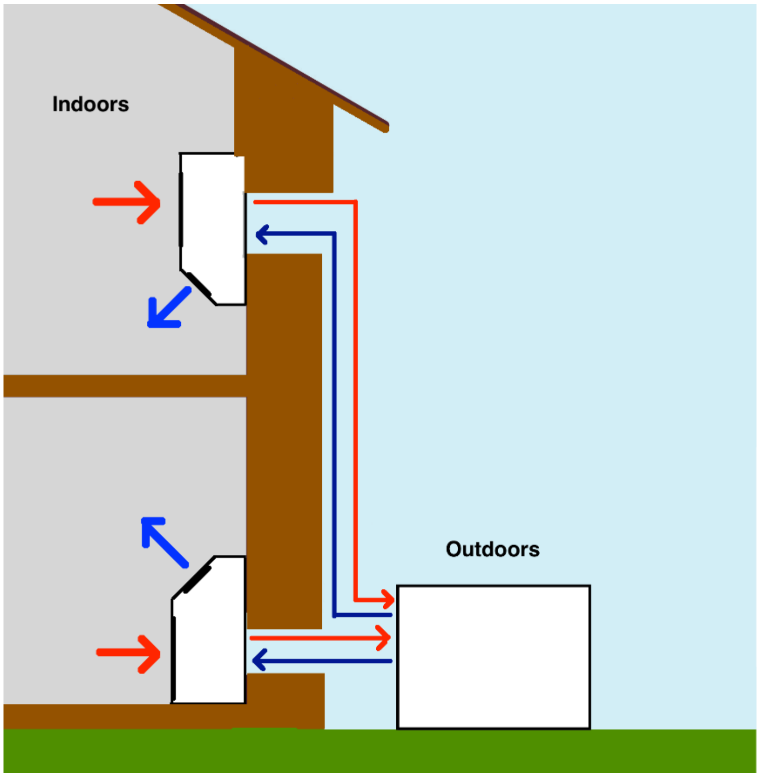


Fig. 5.4.8. Typical Split System Schematic

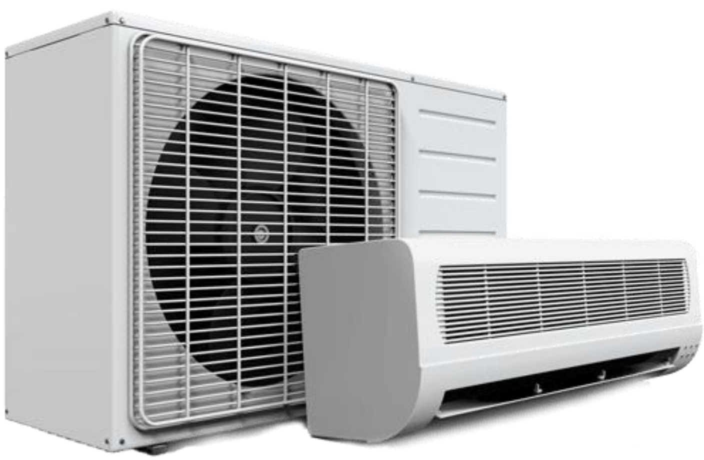


Fig. 5.4.9. Typical Split System Air Conditioning

Then, before simulating, we set the some parameters for each system that we want to compare. There are some part that we have to set according to our design. They are the envelope, the shading, the net vent, and the PV (solar photovoltaic) if we have.

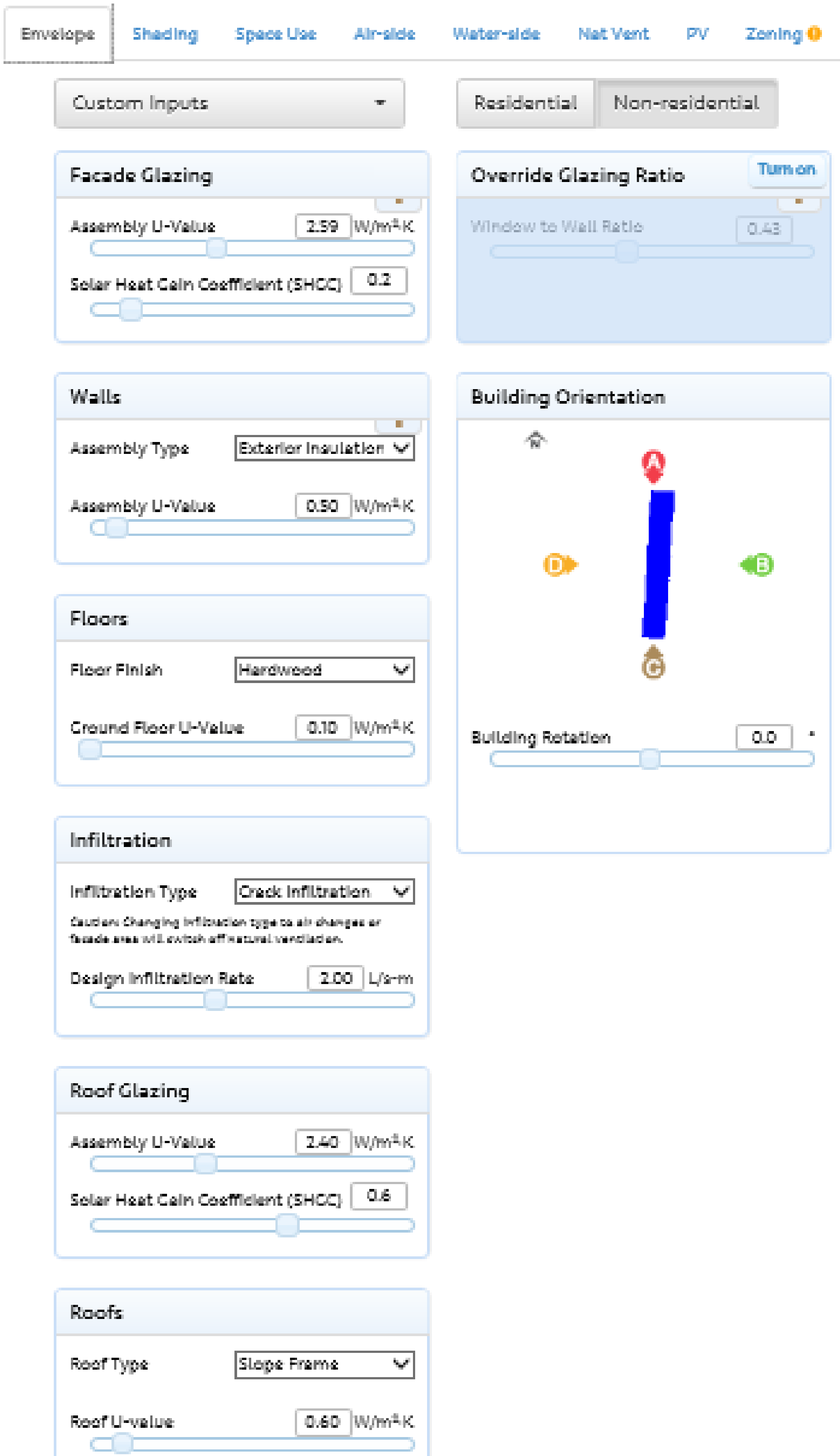


Fig. 5.4.10. The Envelope

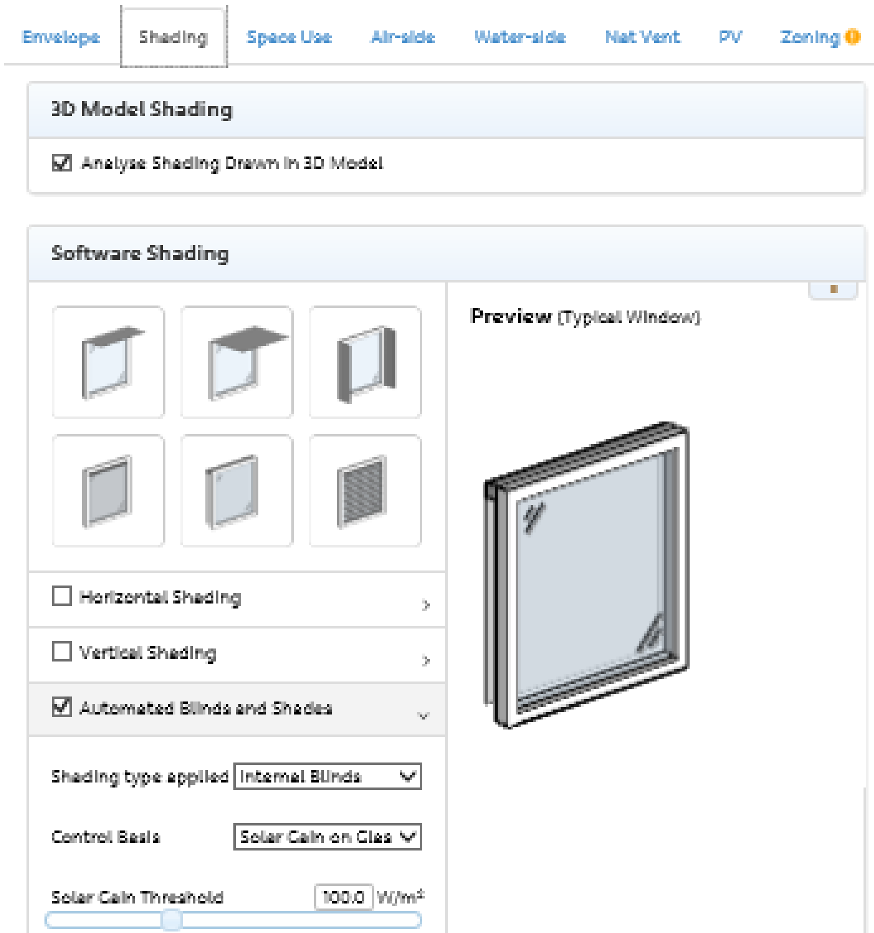


Fig. 5.4.11. The Shading

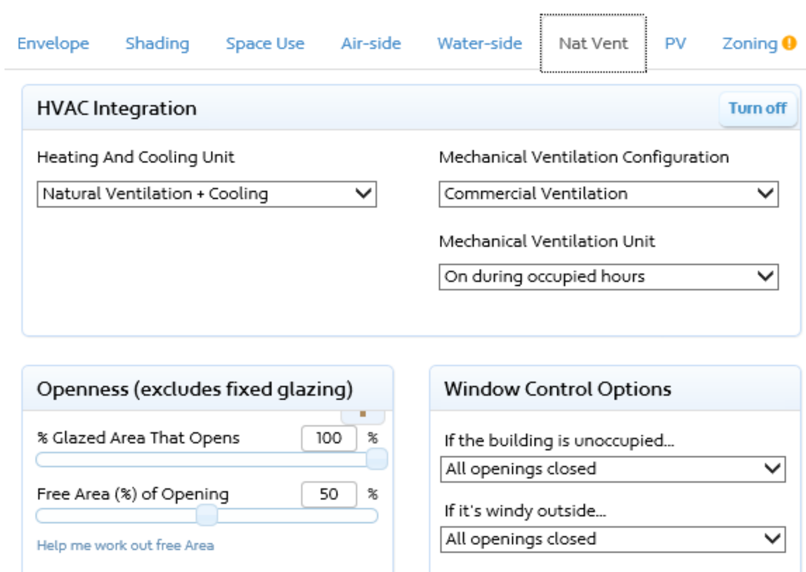


Fig. 5.4.12. The Net Vent

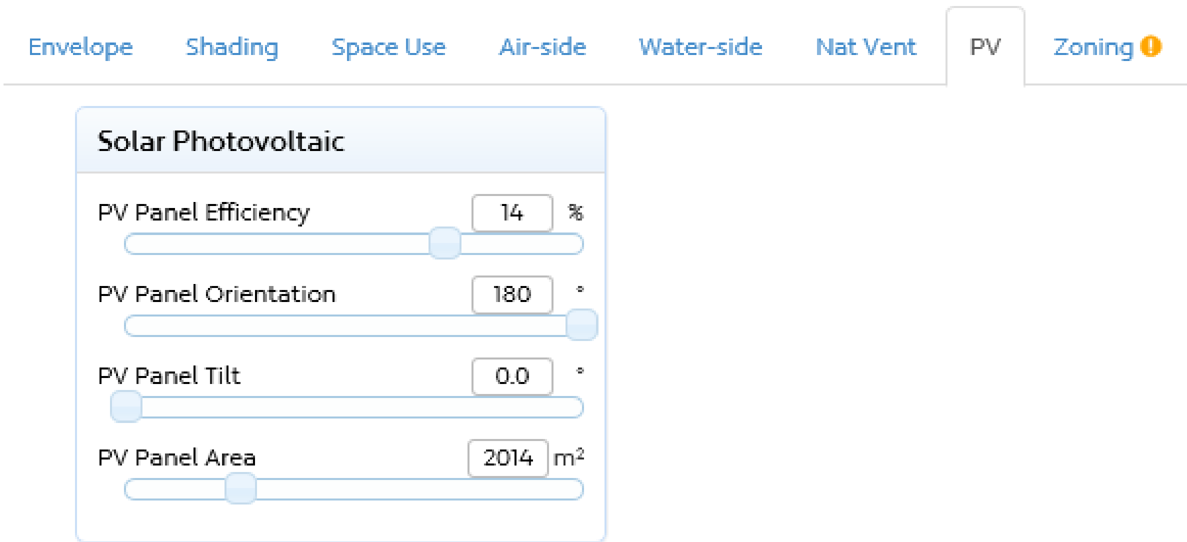
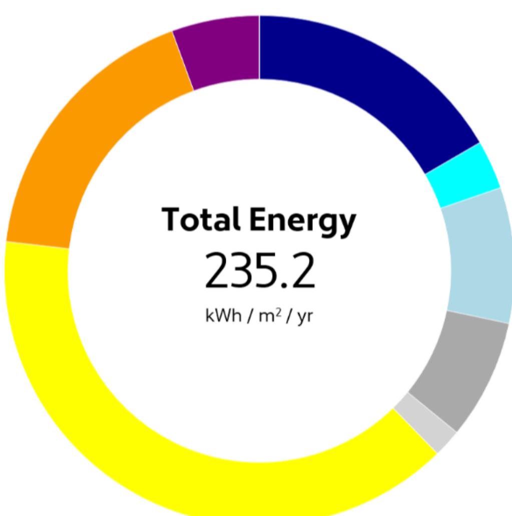


Fig. 5.4.13. The Solar Photovoltaic

And then, we started simulating with those parameters that we have set before. First simulating, we used the Fan Coil Units and Central Plants System.

Annual Energy Use

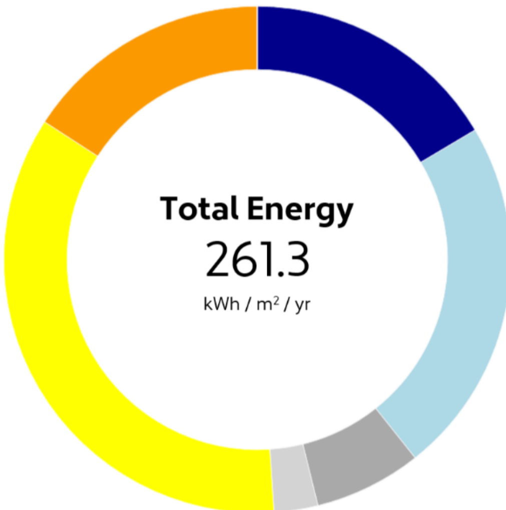


Segment	kWh / m² / yr	% of total use
Heating	**0.0**	**0 %**
AHU	0.0	0 %
Zones	0.0	0 %
Humidification	0.0	0 %
Cooling	**66.6**	**28 %**
AHU	39.1	17 %
Heat Rejection	7.3	3 %
Zones	20.2	9 %
Fans	**22.1**	**9 %**
AHU	17.9	8 %
Zones	4.2	2 %
Interior	**133.4**	**57 %**
Lighting	92.0	39 %
Equipment	41.4	18 %
Pumps	**13.1**	**6 %**

real case - Baseline Concept. Produced by TONG ZHANG from Politecnico di Milano, 6 Jul 2018 @ 22:54:49

Fig. 5.4.14. The Annual Energy Use Result for Fan Coil System

Annual Energy Use

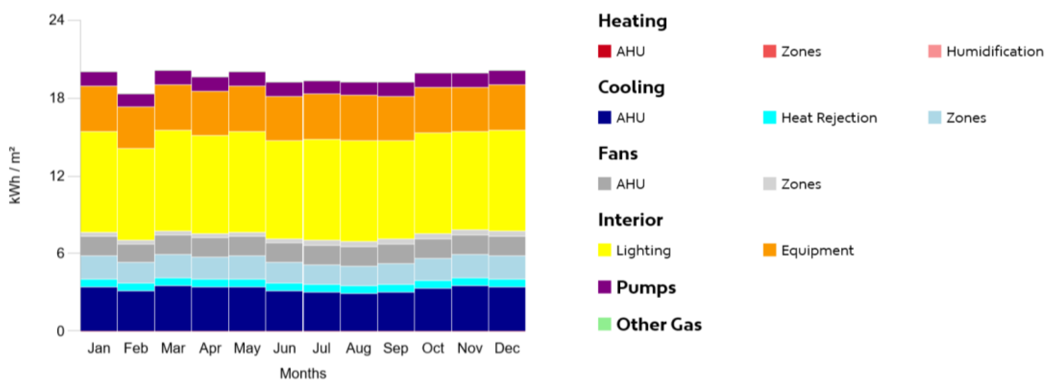


Segment	kWh / m² / yr	% of total use
Heating	**0.0**	**0 %**
AHU	0.0	0 %
Zones	0.0	0 %
Humidification	0.0	0 %
Cooling	**102.7**	**39 %**
AHU	43.0	16 %
Heat Rejection	0.0	0 %
Zones	59.7	23 %
Fans	**25.2**	**10 %**
AHU	17.9	7 %
Zones	7.3	3 %
Interior	**133.4**	**51 %**
Lighting	92.0	35 %
Equipment	41.4	16 %
Pumps	**0.0**	**0 %**

real case - Baseline Concept. Produced by TONG ZHANG from Politecnico di Milano, 7 Jul 2018 @ 00:23:44

Fig. 5.4.15. The Annual Energy Use Result for Split System

Monthly Energy Use



real case - Baseline Concept. Produced by TONG ZHANG from Politecnico di Milano, 6 Jul 2018 @ 22:55:51

Fig. 5.4.16. The Monthly Energy Use Result for Fan Coil System

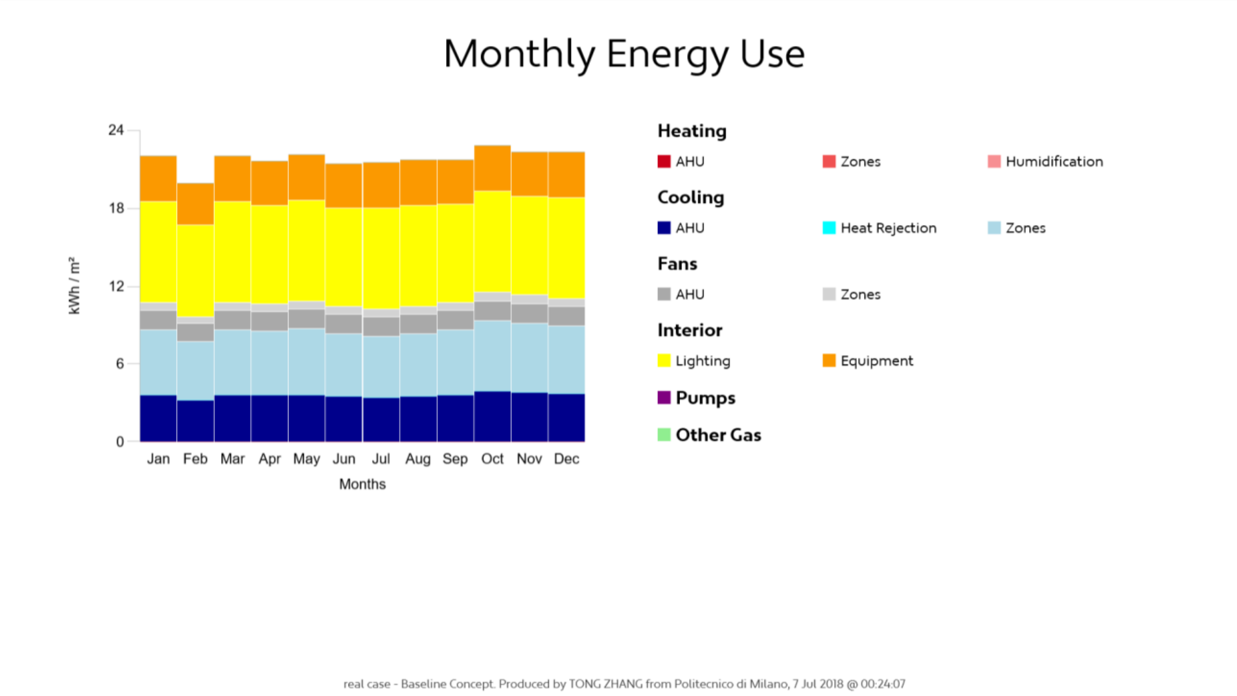


Fig. 5.4.17. The Monthly Energy Use Result for Split System

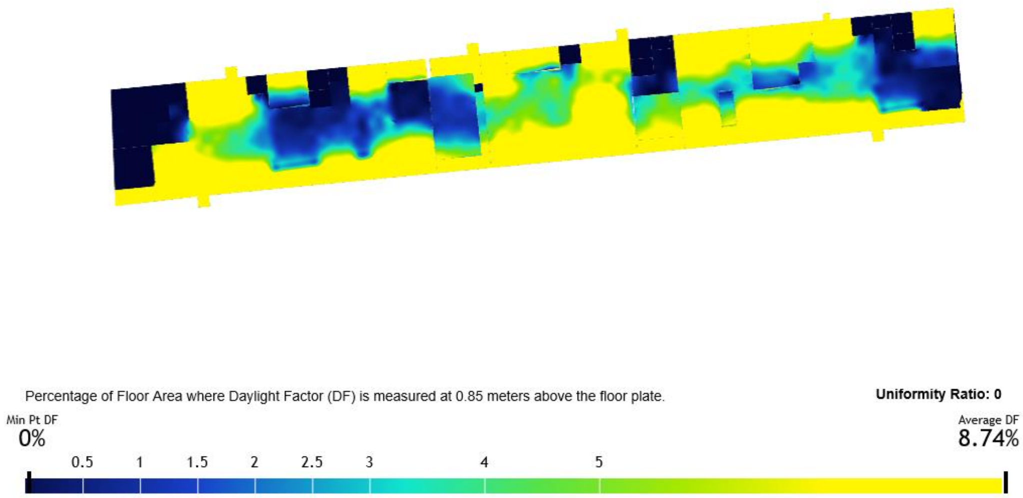
Eventually, the result of fan coil units and central plants system is better than split system. Thus, actually for commercial building (retails and restaurants) plus the location of the project which is in tropical country, that we need cooling only, using split system is much better than fan coil units. It will save much more energy consumption. Moreover, Sefaira is not pretty reliable because we only use very simple model to analysis. So, we decided to use Split System with air conditioning to our building system.

5.4.2. Daylight Analysis

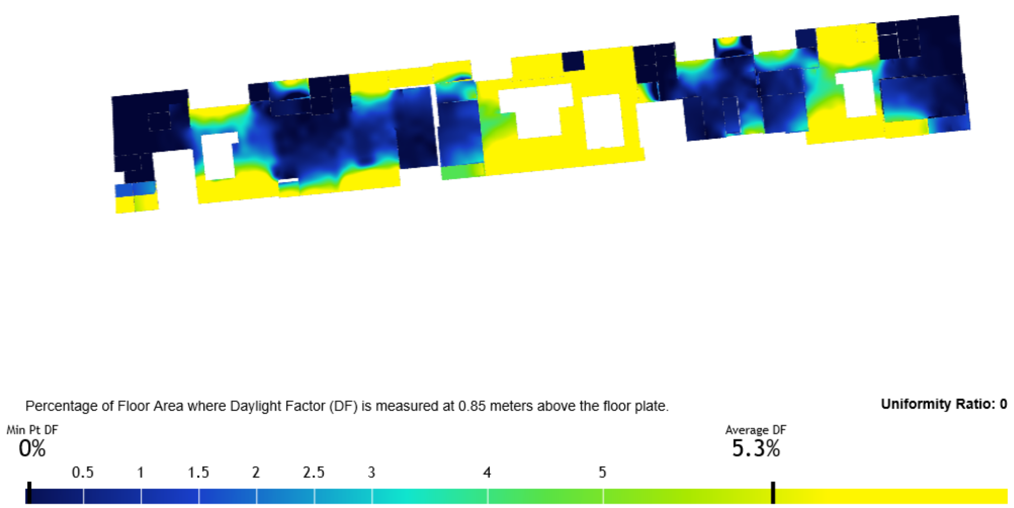
We use also Sefaira Software to analyze daylight. Daylighting improvement required to understand in deep and use the daylight analysis using the following methods:

- Daylight Factor (DF)
- Over-lit and Under-lit

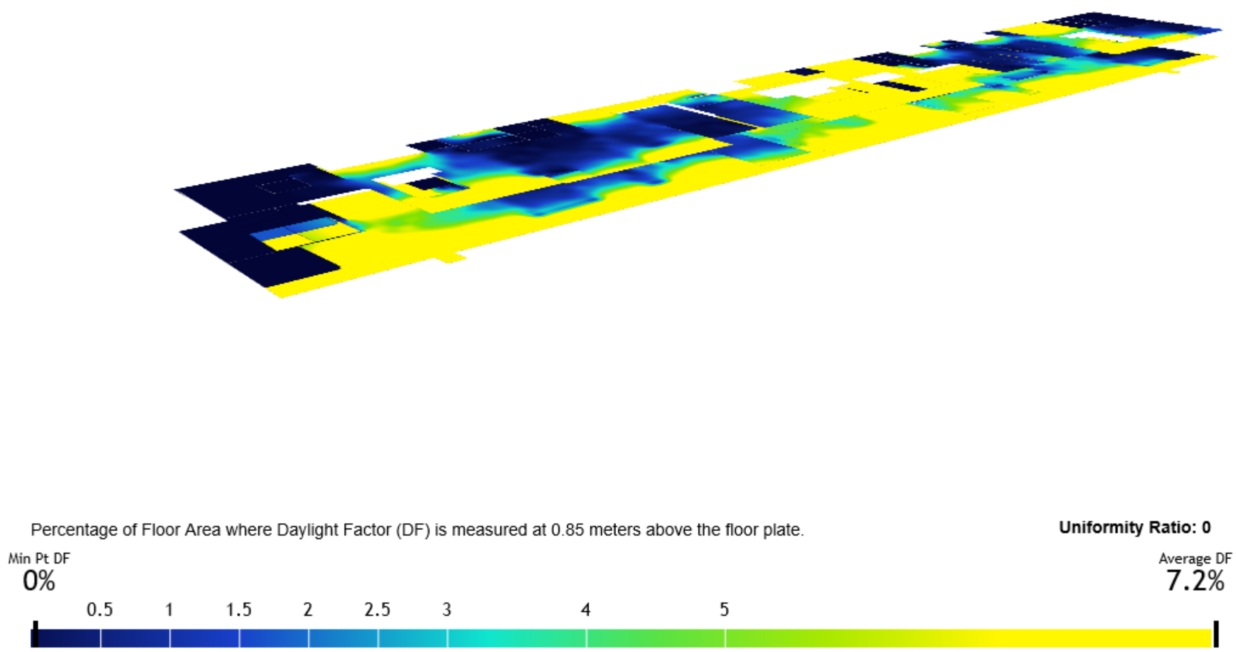
The daylight factor is the ratio of interior to exterior illuminance under an overcast sky. The daylight factor do not use a weather file in analysis so it is not quit accurate and predictive of actual building lighting performance. It can be just related to the building itself instead of link the building to the real location. The daylight factor is presented in this analysis to get an idea of the worst case.


Percentage of Floor Area where Daylight Factor (DF) is measured at 0.85 meters above the floor plate.
Uniformity Ratio: 0
Min Pt DF
0%
Average DF
8.74%
0.5
1
1.5
2
2.5
3
4
5

(a)


Percentage of Floor Area where Daylight Factor (DF) is measured at 0.85 meters above the floor plate.
Uniformity Ratio: 0
Min Pt DF
0%
Average DF
5.3%
0.5
1
1.5
2
2.5
3
4
5

(b)



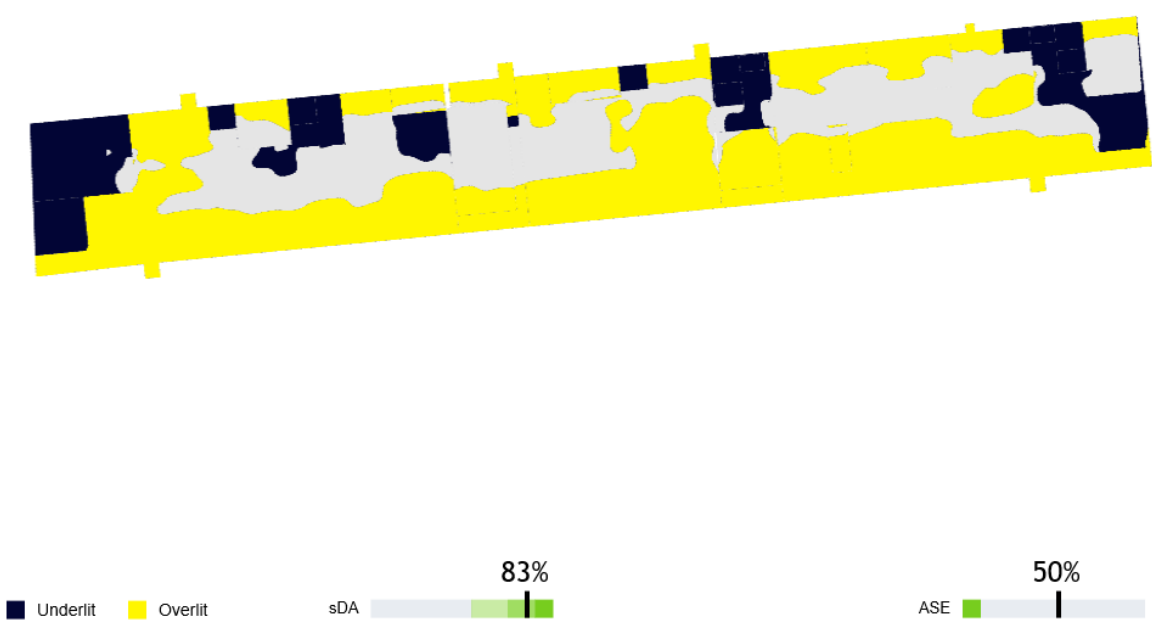
(c)

Fig. 5.4.18. Daylight Factor: Ground Floor (a) - First Floor (b) – Both Floors Together (c) of Fix Model

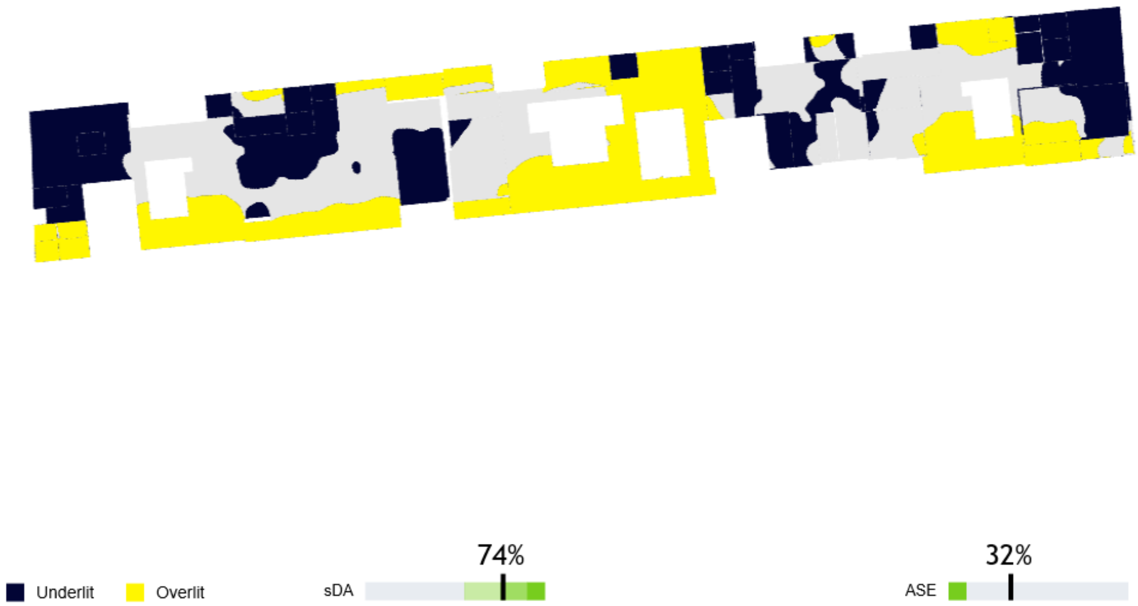
Quality level - FD [%]	Score
FD ≤ 0,5	-2
0,5 < FD ≤ 1,25	-1
1,25 < Fd ≤ 2,0	0
2,0 < FD ≤ 2,5	1
2,5 < FD ≤ 3,0	2
3,0 < FD ≤ 3,5	3
3,5 < FD ≤ 4,0	4
FD > 4,0	5

Fig. 5.4.19. Daylight Factor Standard for Commercial Building

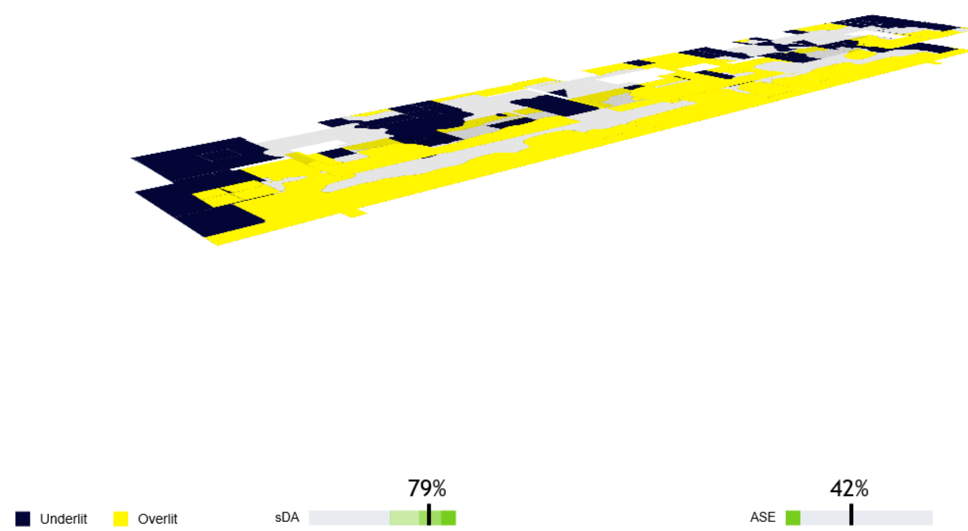
The Sefaira Software also provides visualizations of over-lit & under-lit spaces to help in understanding which sections of our design need more light or experience glare. Over-lit: is over 1000 Lux of direct light for more than 250 occupied hours per year. While, Under-lit: is less than 300 Lux for more than 50% of occupied hours. Also for each floor and whole building the Spatial Daylight Autonomy (SDA) and annual Sunlight exposure (ASE) are shown in this analysis to predict how the space performs. Spatial Daylight Autonomy (SDA): describes how much of a space receives sufficient daylight. Specifically, it describes the percentage of floor area that receives at least 300 lux for at least 50% of the annual occupied hours. Whilst, Annual Sun Exposure (ASE): describes how much of space receives too much direct sunlight, which can cause visual discomfort (glare) or increase cooling loads. Specifically, ASE measures the percentage of floor area that receives at least 1000 lux for at least 250 occupied hours per year. Here, we also compared between the simple base model and the fix model for both of methods.



(a)



(b)



(c)

Fig. 5.4.20. Over-lit and Under-lit: Ground Floor (a) - First Floor (b) – Both Floors Together (c) of Fix Model

5.5 Shading System

There are many different reasons to want to control the amount of sunlight that is admitted into a building. In warm, sunny climates excess solar gain may result in high cooling energy consumption.

Well-designed sun control and shading devices can dramatically reduce building peak heat gain and cooling requirements and improve the natural lighting quality of building interiors. Depending on the amount and location of fenestration, reductions in annual cooling energy consumption of 5% to 15% have been reported. Sun control and shading devices can also improve user visual comfort by controlling glare and reducing contrast ratios. This often leads to increased satisfaction and productivity. Shading devices offer the opportunity of differentiating one building facade from another. This can provide interest and human scale to an otherwise undistinguished design.

The use of sun control and shading devices is an important aspect of many energy-efficient building design strategies. In particular, buildings that employ passive solar heating or daylighting often depend on well-designed sun control and shading devices.

hading can be provided by natural landscaping or by building elements such as awnings, overhangs, and trellises. Some shading devices can also function as reflectors, called light shelves, which bounce natural light for daylighting deep into building interiors. The design of effective shading devices will depend on the solar orientation of a particular building facade. For example, simple fixed overhangs are very effective at shading south-facing windows in the summer when sun angles are high. However, the same horizontal device is ineffective at blocking low afternoon sun from entering west-facing windows during peak heat gain periods in the summer.

Exterior shading devices are particularly effective in conjunction with clear glass facades. However, high-performance glazings are now available that have very low shading coefficients (SC). When specified, these new glass products reduce the need for exterior shading devices. Thus, solar control and shading can be provided by a wide range of building components including:

- Landscape features such as mature trees or hedge rows
- Exterior elements such as overhangs or vertical fins
- Horizontal reflecting surfaces called light shelves
- Low shading coefficient (SC) glass
- Interior glare control devices such as Venetian blinds or adjustable louvers

There are both interior and exterior shade options which can be used to protect windows not otherwise shaded from the sun. In general, it is best to block the sun before it reaches the window. The variety of shading strategies shown below is effective at accomplishing that goal.

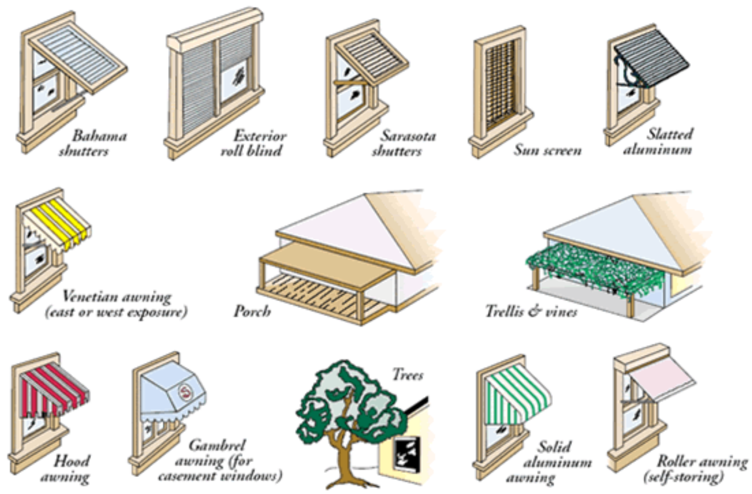


Fig. 5.5.1. Shading Strategies

Interior shades can also be effective, in some situations. They need to be brightly reflecting toward the outside, so that solar radiation admitted through the glass is reflected by the shade back out through the window. Thus little of the sun's radiant heat can remain inside the building. Draperies, Venetian blinds, vertical blinds, roll up shades, and a variety of other interior attachments are common additions to residential windows. They are used more for aesthetics and privacy than for solar heat gain prevention, but they can be effective heat blockers just the same.

The key to success in this function is their *solar reflectance* on the window-facing side. The higher this reflectance the greater the quantity of solar radiation entering the window that can be reflected back through that window to the outside. You can have any color and pattern you want for the room-side of the shade, but it should be quite bright on the other side. White or near-white is best.

Also, interior shades are more effective at reflecting solar radiation if the glazing system they cover is highly transparent, but they will reflect whatever beam radiation they receive back toward the window. Some of that radiation will transmit through the window and therefore not enter the room as heat gain.

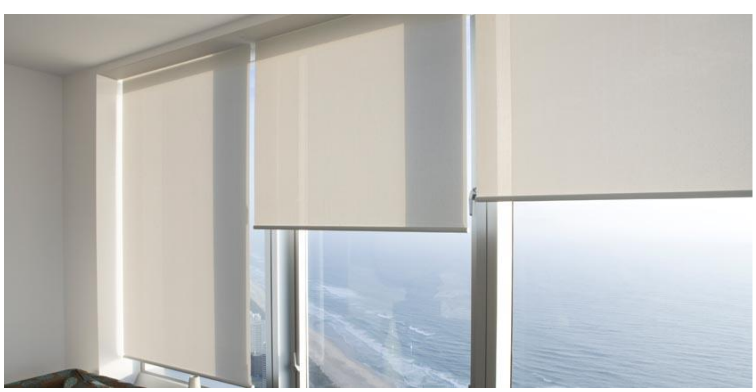


Fig. 5.5.2. Internal Roller Blind

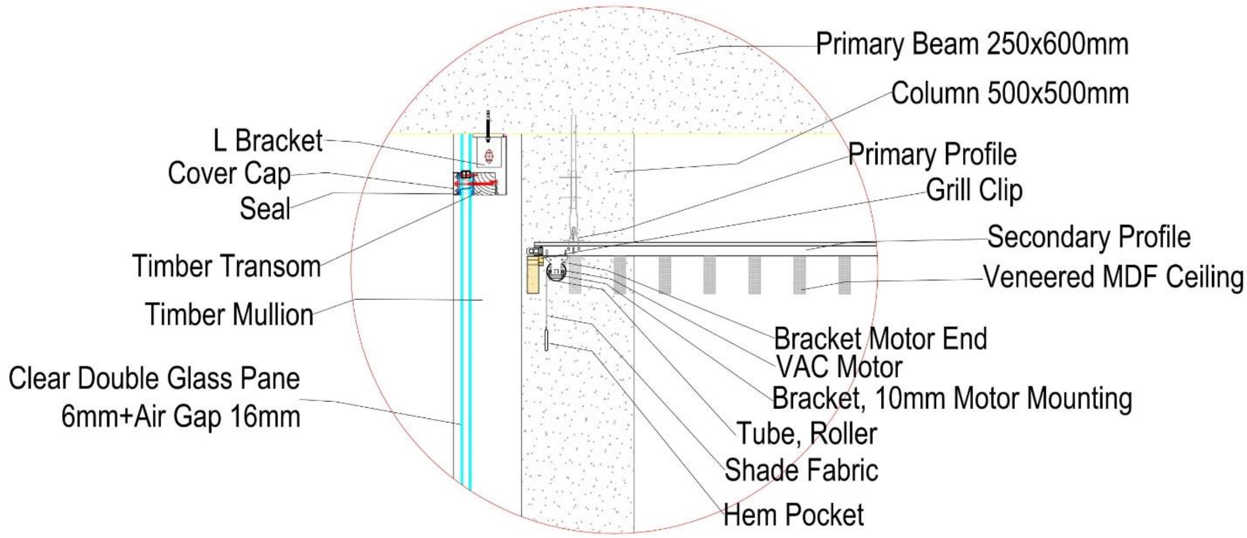


Fig. 5.5.3. Internal Roller Blind Detail

Exterior shades catch the sun and reflect some of it away from the window. Some exterior shades are partially transparent, so some of the incident radiation passes through them to the window. The rest is absorbed by the shade material. Heat absorbed by the exterior shade is largely carried away from the window by radiation and air borne convection currents.

Some exterior shades are operable, meaning that they can be raised and lowered, or otherwise altered in their coverage and degree of protection of the window. For otherwise unshaded east-facing windows, operable shades are a real advantage, because they can be lowered in the morning when the sun is rising, yet raised when the sun is on the other side of the building, thereby affording unobstructed views to the east. The same is true of west-facing windows in the afternoon. Some exterior shades serve a secondary window protection function. They can be lowered to fully cover the window and protect it from wind-blown debris or other consequences of adverse weather.

For this project, we are trying to use the local material in traditional way in this country. Since the past, the people of this country is usually use rattan cane as the material to make some furniture even the shading devices for their home. They tend to use that material because rattan case is really easy to find in this country, even buying from the market, it is so cheap. If comparing it with bamboo, rattan cane is much more elastic and flexible, much lighter, and the density only around 0.3 gr/cm3.

Fig. 5.5.4. Rattan Cane as Local Material

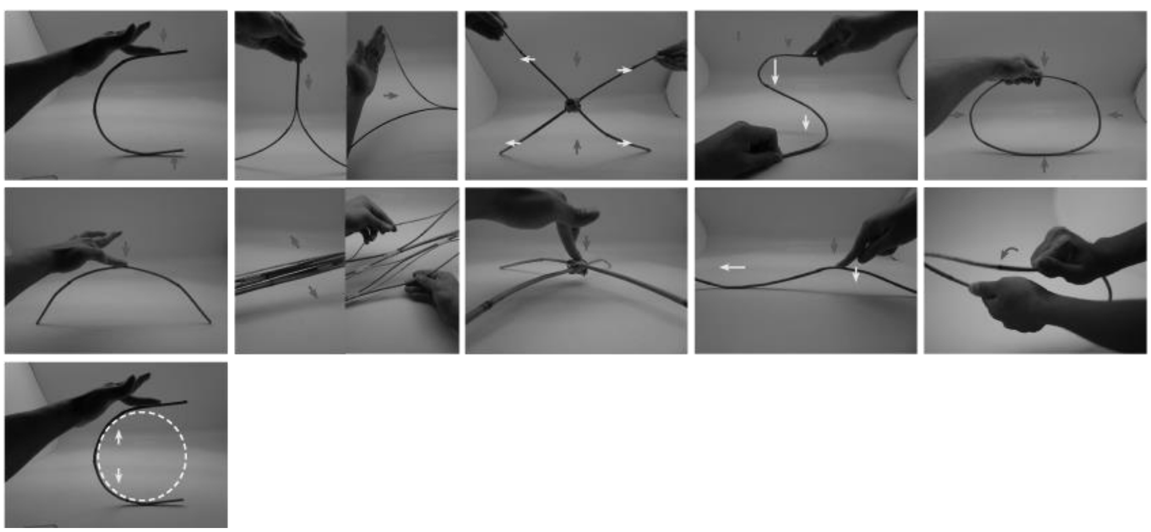


Fig. 5.5.5. Rattan Cane Flexible Study

In this project, we are using this technic with this kind of material to have rain and sun solution. So, with this idea, we are trying to either avoid the over sun and glare to the room or space in the building or avoid the rain water entering the building which is driven by the wind from sea especially.

Our idea is this kind of shading can be operable manually. But actually, we are using this kind of shading device especially to avoid the rain water driven by the wind entering the building, but the wind still can enter to the building, because the shading has some holes. We just put this shading along the open space (outdoor space) on the first floor, because we know that the building is exactly in front of the sea which the wind is coming most from the sea. We put the shading diagonally along outdoor space which attach on the overhang of the roof for the head, while the bottom part attach to the railing (parapet) part. This Shadings are connected by the nylon line and we put every panel of this shading along between the span of the column. Meanwhile, in Sunny Day, if we do not need to use the shading device, it can be set to become horizontal shading like a porch to shell the pedestrians are walking in front of the building on ground floor

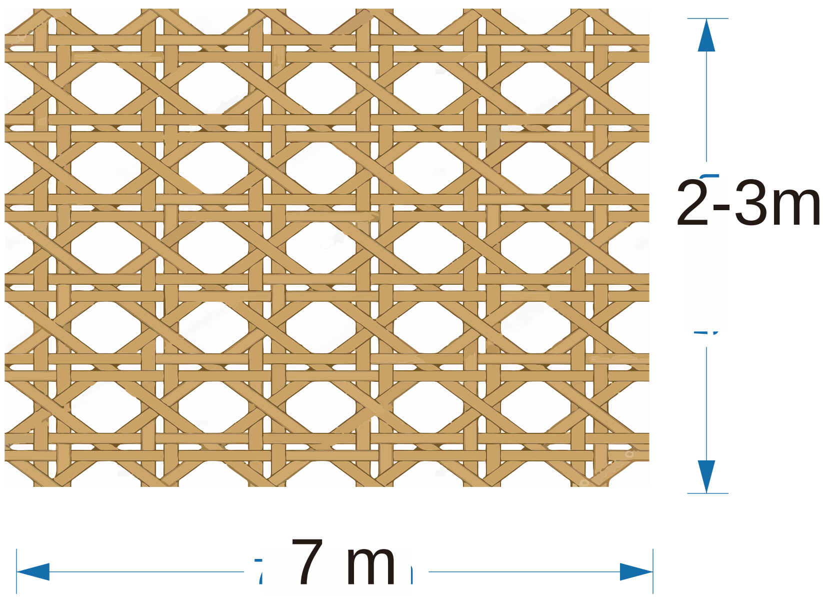


Fig. 5.5.6. Shading Panel

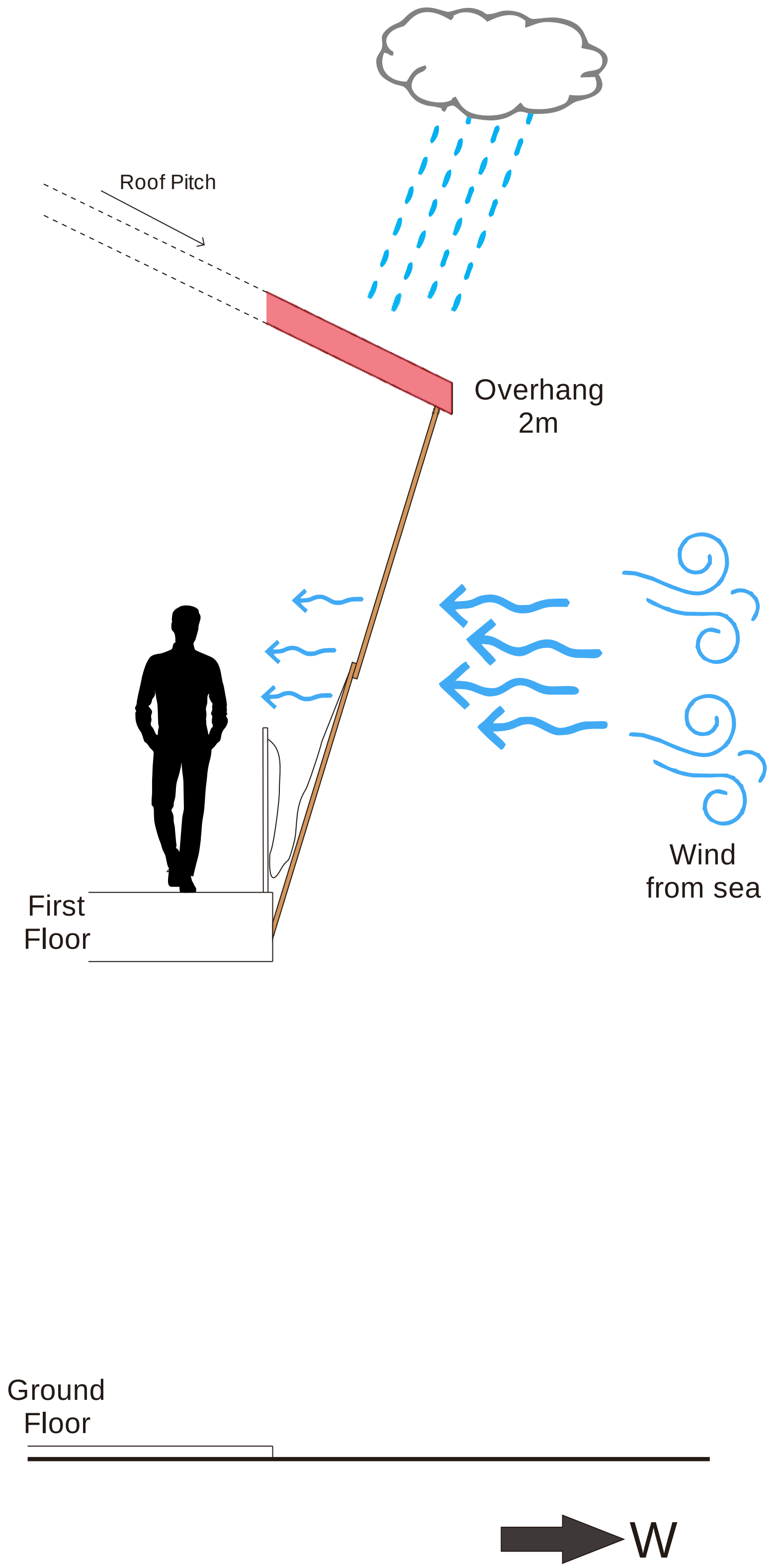


Fig. 5.5.7. Schematic Concept in Rainy Day

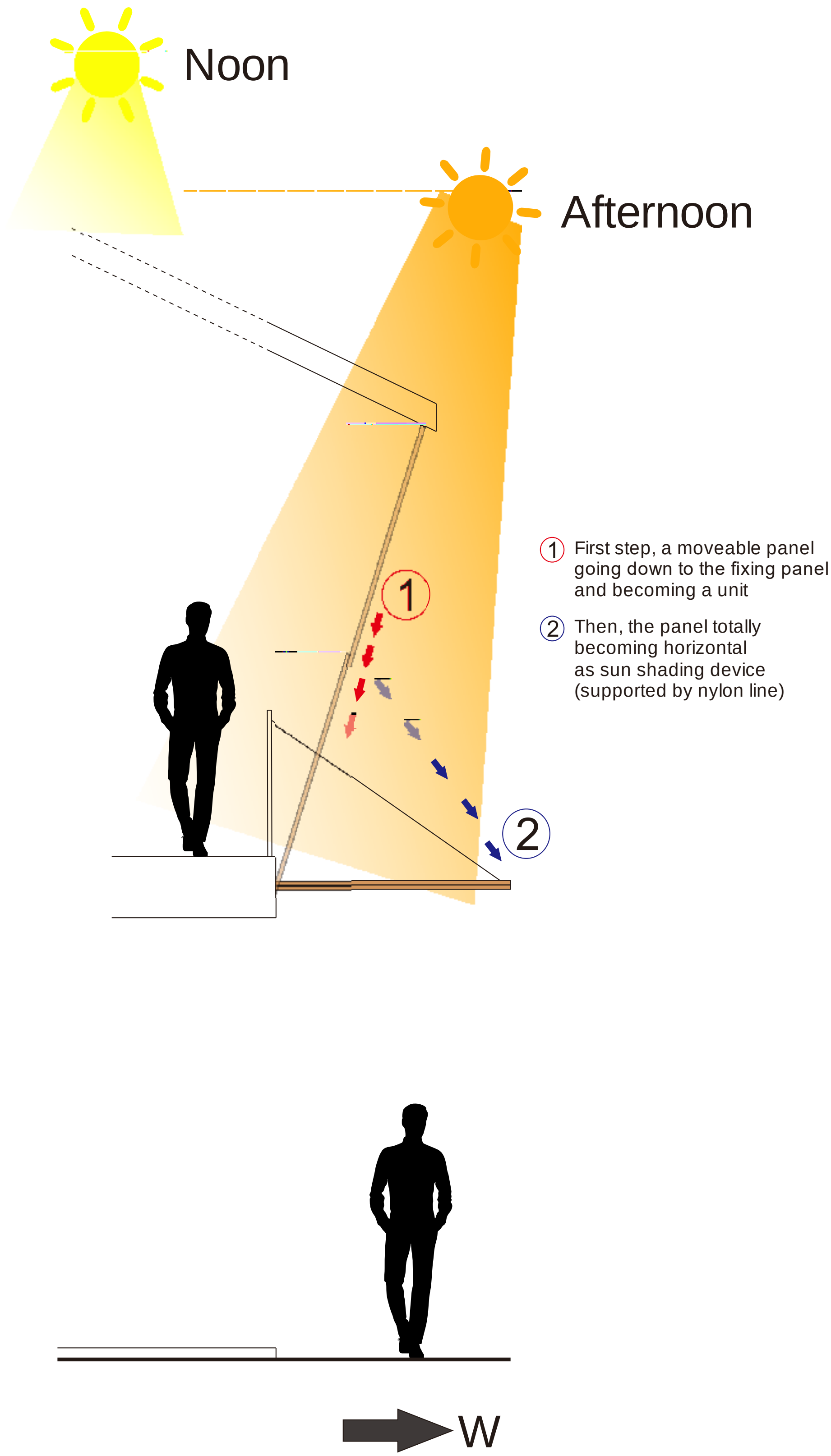


Fig. 5.5.8. Schematic Concept in Sunny Day

5.6 Building Envelope and Internal Elements Technology Analysis

The building envelope acts as a filter to the penetration of the solar radiation, wind, humidity, and the rain, modulating the exchange of heat between inside and outside. The appropriate solutions therefore should consider the climatic, geophysical, and urban conditions to achieve the comfort of the occupants. In effect, the initial approaches of the façade design of a commercial building will define its future behavior in relation to energy demand. The potentially of establishing this behavior is greater at the beginning of the design process, it diminishes as the process advances and it becomes almost nil when concluding the construction and the installation of equipment.

5.6.1. Opaque Facade

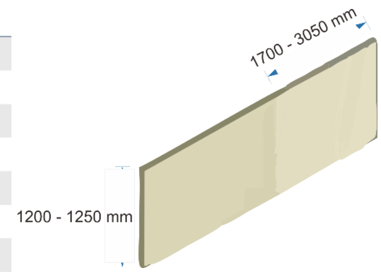
For The opaque façade, we are using cladding system which we use Rockpanel woods as the material. Rockpanel Woods is a highly durable board material which has been specifically developed for use in façade cladding, roofline applications and for building detailing. It can be used for facade and rainscreen cladding in ventilated constructions. Rockpanel Woods provides a building with a natural and harmonious feel. Each panel is unique because they are manufactured through a careful and innovative production process that ensures there is no repetition of wood grain patterns in each design.

Due to this process the boards can scarcely be differentiated from real wood. Rockpanel Woods is available in various oak and ebony finishes alongside the range of standard, natural look non-repeating wood finishes.

Fig. 5.6.1. Rockpanel Woods Façade Example

Dimensions and weight

Property	Durable	Xtreme	FS-Xtra
Panel dimensions (mm)	3050	3050	3050
Panel width (mm)	1200	1200	1200
Panel thinckness (mm)	8	8	9
Weight	8 mm: 8.4 kg/m^2	9.6 kg/m^2	11.25 kg/m^2
Density	1050 kg/m^3	1200 kg/m^3	1250 kg/m^3
length/width tolerance (mm)	+2/-2	+2/-2	+2/-2
Thinkness tolerance (mm)	8 mm: + 0.5 mm / -0.5 mm	+0.5/-0.5	+0.5/-0.5
Weight tolerance	8 mm: -1.65 / +1.80 kg/m^2	-1.35 / +1.45 kg/m^2	-1.47 / +1.58 kg/m^2
Density tolerance	±150 kg/m^3	±100 kg/m^3	±100 kg/m^3



Physical properties*

Property	Durable	Xtreme	FS-Xtra
Thermal conductivity	0.35 W/m·k	0.51 W/m·k	0.55 W/m·k
Water vapour permeability 23 °c and 85% RH (S_d)	< 3.5 m	< 3.5 m	n.a.
coefficient of thermal expansion (α)	$11x10^{-3}$mm/m ·k	$13x10^{-3}$mm/m ·k	$9.7x10^{-3}$mm/m ·k
coefficient of moisture expansion 23 °c/50% RH to 95% RH (after 4 days)	0.310 mm/m	0.29 mm/m	0.206 mm/m

Fig. 5.6.2. Dimensions and Weight Panel – Physical Properties

Rockpanel Woods are prefabricated compressed mineral wool boards with synthetic binders. The surface is treated with a four layers water borne polymer emulsion paint on one side, and comes standard with a special protection finish. Rockpanel Woods are suitable as façade cladding, fascias and soffits, infill boards and external ceilings.

The influence on air quality and release of dangerous substances to soil and water has been determined to achieve the technical approval standard. The analysis showed that Rockpanel Woods contain no dangerous materials such as biocides, and the manufacture of Rockpanel Woods does not involve the use of flame retardents or cadmium.

For the maintenance, depending on the surface treatment, the boards can be cleaned with ordinary cleaning agents such as car shampoo dissolved in lukewarm water. Organic solvents for boards with the special protection finish in general also allowed.

The boards can be fastened to timber or metal sub-frames. Fastening to the timber sub-frame is carried out with corrosion resistant nail or screws or by bonding. Fastening to the metal one is carried out with corrosion rivets or by bonding. Mechanical fasteners, gaskets, adhesives with primers, strips for bonding, and aluminium profiles by the company.

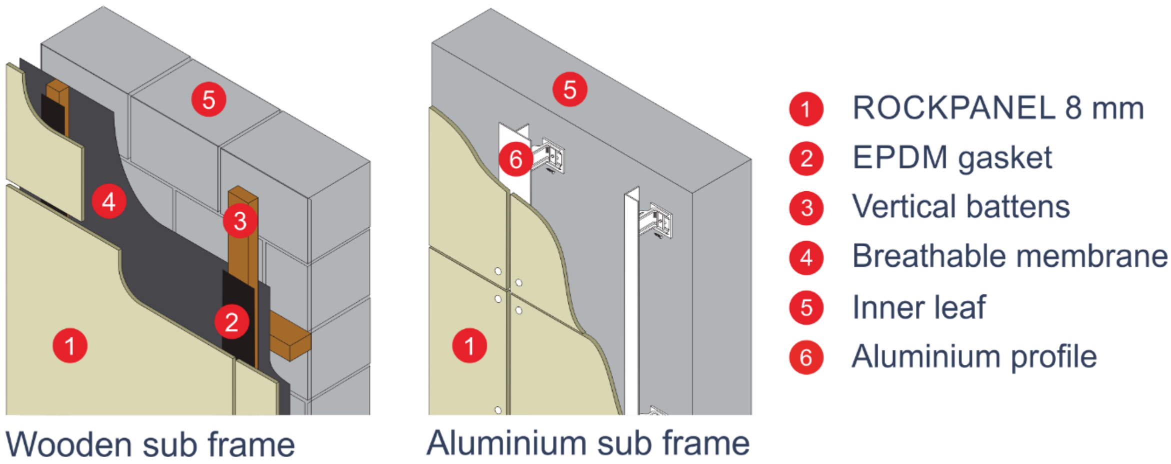


Fig. 5.6.3. Perspective Details

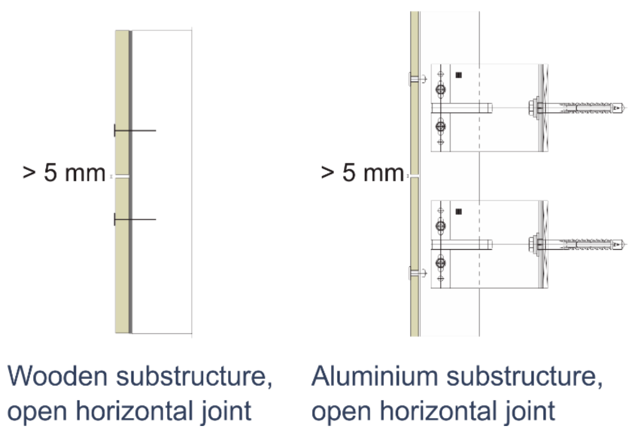


Fig. 5.6.4. Vertical Details

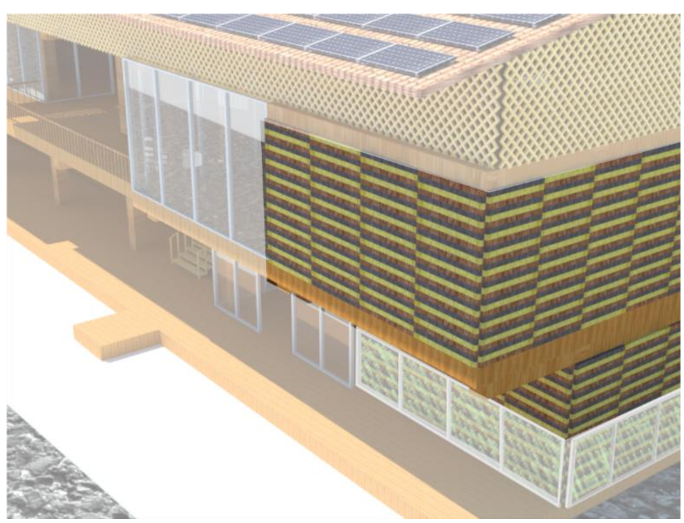


Fig. 5.6.5. Opaque Façade View

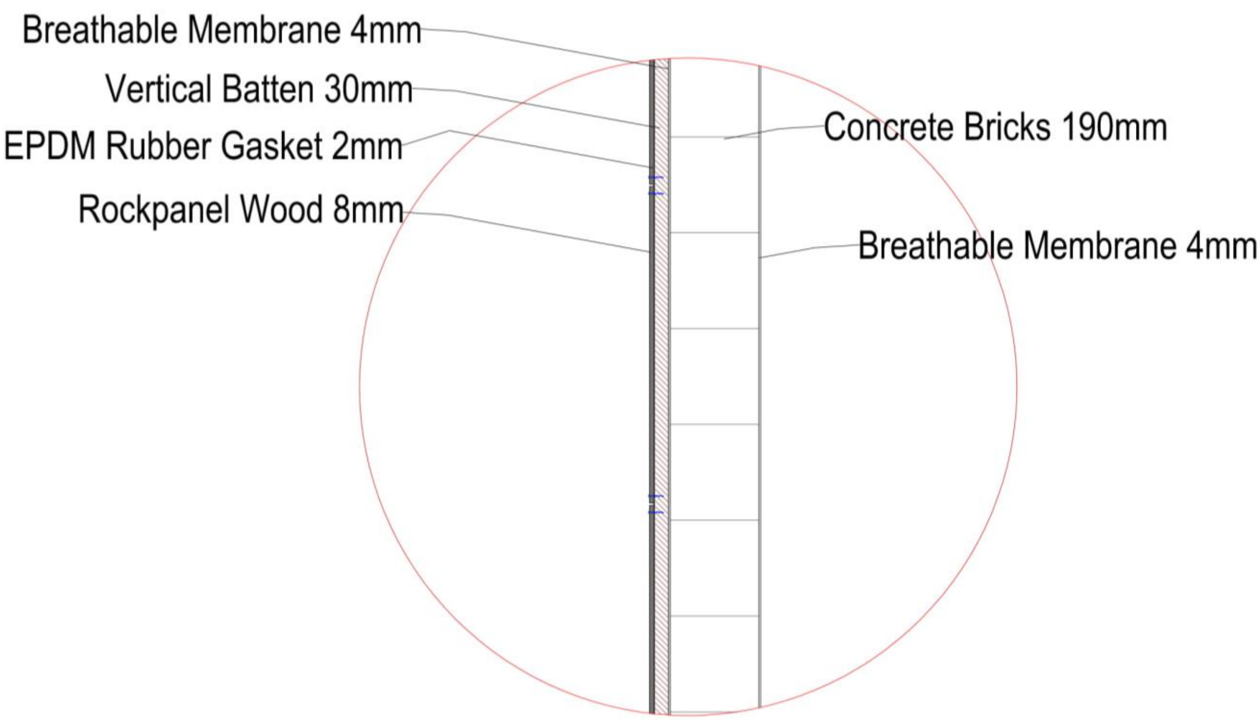


Fig. 5.6.6. External Opaque Wall Vertical Section Detail

We calculated also the U-Value of the external opaque wall. U-values (sometimes referred to as heat transfer coefficients or thermal transmittances) are used to measure how effective elements of a building's fabric are as insulators. That is, how effective they are at preventing heat from transmitting between the inside and the outside of a building. And at the end, we reached the U-value is around 0.5 W/m2K.

5.6.2. Green Façade

With infinite benefits such as improved air quality, aesthetic improvement, reduction of urban heat island effect and energy efficiency, building structures are now covered with greenery. From the freestanding trellis system of green facades to the in-built wall modules of the living wall system, architectural facades are now brimming with life literally and figuratively.

In our we are trying to use green wall only on all bottom part of opaque façade on ground floor in order to keep the wall façade still safety and clean such as from human, animal, rain water, and so on. So many systems that we can use for making green wall into our façade.

Fig. 5.6.7. Green Wall System connections

In this project, we are using Container Planter Systems. This system is closest to the balcony box planters. In a container green wall system the planters are placed in multiple lines above the each other. The pots may be made of metal, wood, plastic in a wide variety of sizes and designs. It has to be water and weatherproof, thus in respect of the usable material the same questions arise as in the case of modular systems, which are of similar price. The use of hydroculture is also recommended for this technology, and although soil based mediums can be used, all of the previously mentioned disadvantages have to be considered.

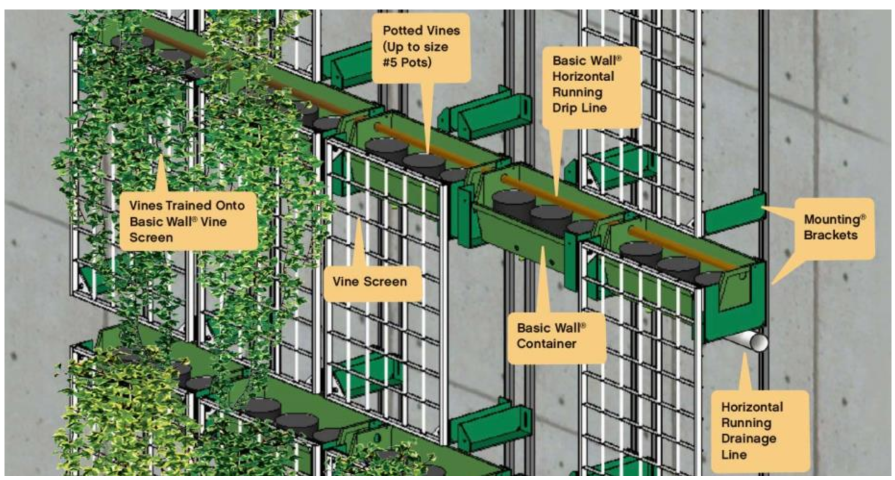


Fig. 5.6.8. Technical System Design

In a container green wall system the planters are placed in multiple lines above the each other. The pots may be made of metal, wood, plastic in a wide variety of sizes and designs. It has to be water and weatherproof, thus in respect of the usable material the same questions arise as in the case of modular systems, which are of similar price. The use of hydroculture is also recommended for this technology, and although soil based mediums can be used, all of the previously mentioned disadvantages have to be considered.

The Green Wall is designed to provide solid and continuous screening year round. Sections range from 16 to 32 sq ft. and are typically installed using one vine type, creating a monolithic pattern. In larger wall applications, it is possible to intersperse blooming and colorful foliage vines into the design, or customize it according to the project. Size, climate and wall orientation are all taken into consideration when choosing the appropriate vine for the project.

Fig. 5.6.9. Example Green Wall System

Green walls provide multilayer protection, in winter they slow down the heat dissipation of the walls and in the summer, the warming process. This effect is due to their multi-layered shading and airing characteristics as well as the thermal inertia of the carrying structure. The transpiration of the plants and the cooling effect of the cold irrigation water flowing through the system are significant temperature reducing factors. There is an example for an external green façade being successfully used as an active cooling element, with the help of water as the transport medium and an internal heat exchanger, for the cooling of a server room.

For Acoustic case, Green walls are able to absorb high frequency sounds; the low ones can even be blocked, if the system has sufficient mass of the planting medium (some of the container and modular systems).

The irrigation and nutrient supply of green walls uses the well-proven technologies developed for hydroponics adapted to vertical surfaces. Various approaches exist: Irrigation can take place with a single horizontally positioned dripping pipe at the top of the plant wall; this may result in water and nutrient deficiency for the lower plants, or conversely, over watering. Not only is this wasteful, but the large quantity of unused fertiliser also presents a significant environmental pressure. The other extreme model is irrigation with water-delivery-regulation for each plant, this does work in practice and presents unwanted costs and technical risks. As a compromise, the multilevel irrigation became common, in which case the irrigation pipes are located approximately at meter heights, thus ensuring satisfactorily homogenous water distribution and manageable levels of technological devices.

Irrigation of the plants can be carried by connecting the irrigation system into the public utilities system, from a well or by the utilisation of grey water or rainwater. Grey or well water needs to be filtered and treated if necessary. The solution that is most environmentally friendly and best for the plants is the utilisation of the collected rainwater, where an additional appropriately scaled water tank is included in the system. Although available space and costs need to be considered carefully, in this case, in areas prone to flooding or where environmental schemes are in effect, the use of rainwater storage maybe supported.

Nutrient supply to the plants can take place by dosing the irrigation water, the exact regulation of the quantity and composition of the medium falls within the competence of a gardening professional. The technical arrangement for providing the nutrients for the plants can be varied, it can be carried out by a single item of equipment, or in the case of very diverse planting, up to four different injectors can be integrated into the system. (Three are needed for precise dosing of nutrients that cannot be mixed with each other, and one is used to adjust the pH). Two further methods exist for feeding the plants, one is the application of foliar fertiliser (applied by a sprayer onto the foliage), which although suitable for quickly remedying any occasional nutrient deficiency, cannot replace the long-term balanced supply to the roots. The other option is the use of individual slow release fertiliser to each plant, which is a costly and labour intensive process and in many systems practically not possible.

Positioning the structural elements of the drainage system is covered in the section on dimensions, the actual implementation is as varied as the number of existing systems. The majority of even the advanced systems still allow for the drain water to flow through the entire height of the system.

The low point drainage can be resolved by a "leaking pipe" and drainage system at the bottom of the green façade. For design and implementation, see the detail drawing under "Nodes". To reduce water usage and further improve sustainability, it is advisable to design a recirculation system that reduces the quantity of drainage water and unused nutrients to a minimum. The quality of the recirculated water should be regularly monitored to avoid an excessive increase in the EC value as well as the accumulation of certain nutrients that might prevent the plant from absorbing those that it requires. Beneficially, "tired" mediums are still suitable for the irrigation of other green areas, which is an ideal recycling choice.

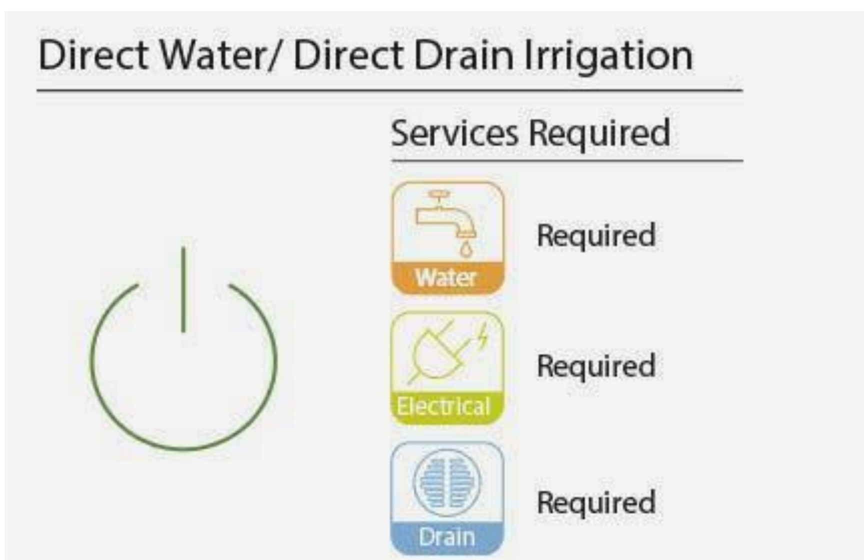


Fig. 5.6.10 Water Drainage and Irrigation System

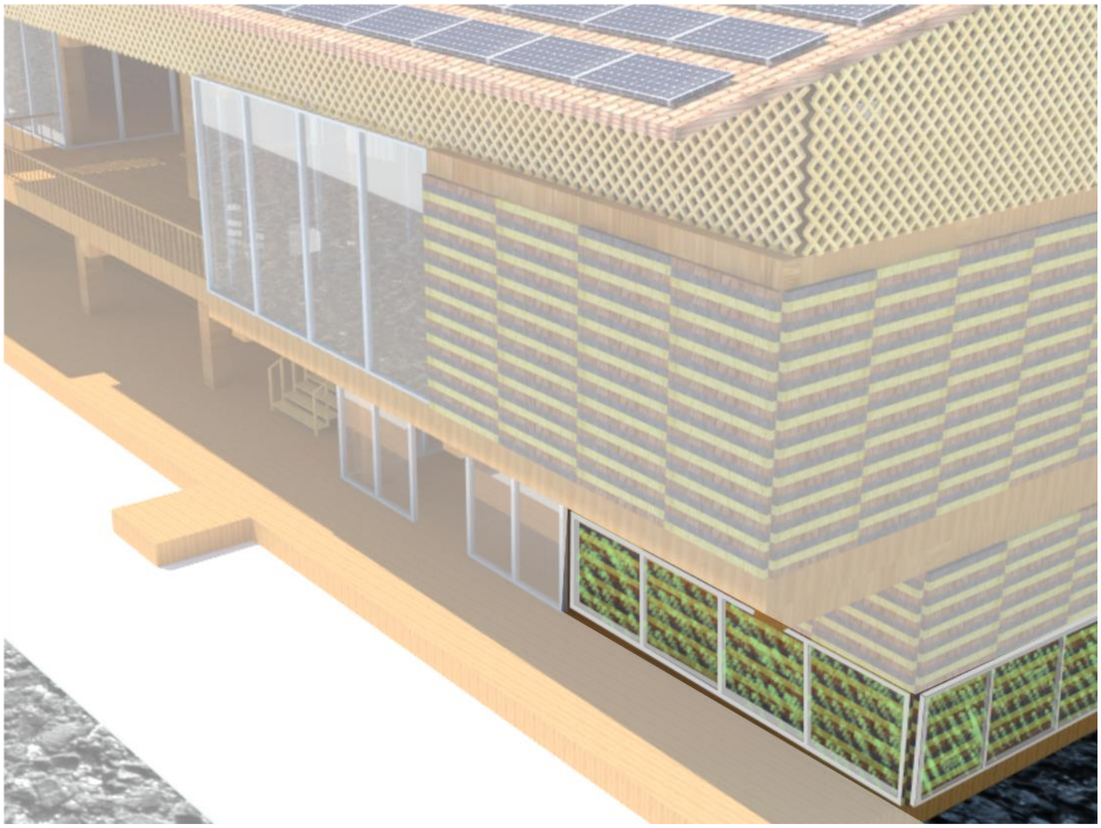


Fig. 5.6.11. Green Wall View

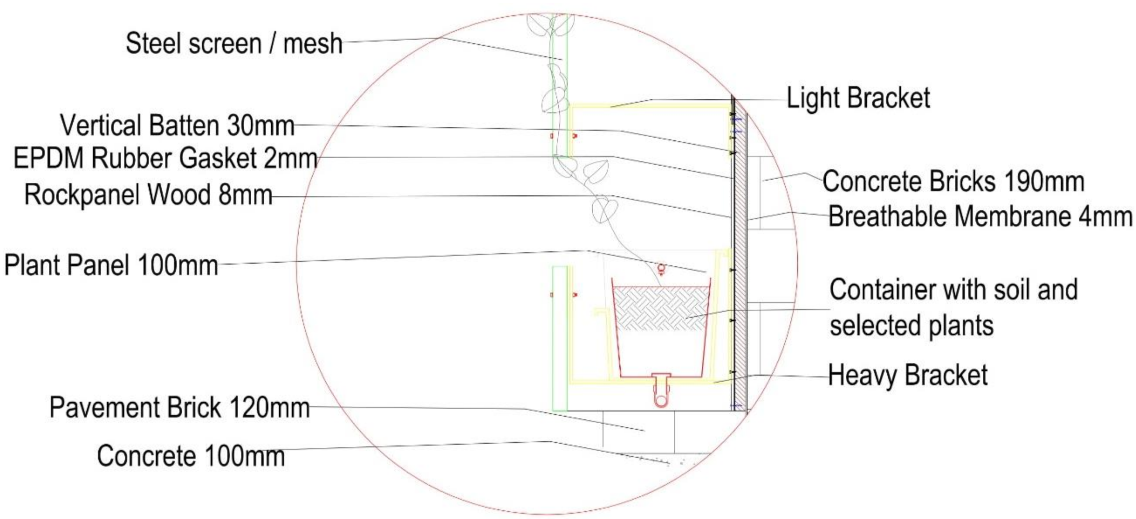


Fig. 5.6.12. Green Wall Vertical Section Detail

5.6.3. Transparent Façade

From storefronts and window panes to the most stunning state-of-the-art buildings around the world, the role of glass in architecture has evolved immensely over the years. The ubiquity of glass facades and structures is echoed on glass' abilities to enhance, diffuse, reflect and transfer light as a result of its transparency. In recent years, glass has taken on new life on account of its structural properties. Beyond other known techniques, such as structural glazing and point-fixed glass systems, structural glass systems use glass as a true load bearing element. This notion of supporting a structure solely with glass has opened up new possibilities and challenges in contemporary architectural design.

Driven by the desire for more transparent structures, the expanses of glass continue to grow larger and consequently more complex. In structural glass systems, the primary challenge for load-bearing glass is material integrity. While in engineering glass facades, the two essential design criteria are stress - the structural strength of the glass when subjected to various loads; and deflection - how much the glass will move when subjected to forces such as wind. The latest improvements in fabrication coupled with innovations in glass technology have amplified the inherent strength of the material and have led to daring advances in glass engineering.

Recently, the use of this environmentally friendly material has been developing in construction due to the following reasons:

- Very high compressive strength
- Resistance to corrosion
- Being recyclable
- Reducing energy consumption
- Recent advances in glass coatings
- The growing demand in architecture for thinner and more transparent structures

A curtain wall is defined as thin, usually aluminum-framed wall, containing in-fills of glass, metal panels, or thin stone. The framing is attached to the building structure and does not carry the floor or roof loads of the building. The wind and gravity loads of the curtain wall are transferred to the building structure, typically at the floor line.

Curtain wall systems range from manufacturer's standard catalog systems to specialized custom walls. Custom walls become cost competitive with standard systems as the wall area increases. This section incorporates comments about standard and custom systems. It is recommended that consultants be hired with an expertise in custom curtain wall design for projects that incorporate these systems.

Curtain walls can be classified by their method of fabrication and installation into the following general categories: stick systems and unitized (also known as modular) systems. In the stick system, the curtain wall frame (mullions) and glass or opaque panels are installed and connected together piece by piece. In the unitized system, the curtain wall is composed of large units that are assembled and glazed in the factory, shipped to the site and erected on the building. Vertical and horizontal mullions of the modules mate together with the adjoining modules. Modules are generally constructed one story tall and one module wide but may incorporate multiple modules. Typical units are five to six feet wide.

Both the unitized and stick-built systems are designed to be either interior or exterior glazed systems. Interior and exterior glazed systems offer different advantages and disadvantages. Interior glazed systems allow for glass or opaque panel installation into the curtain wall openings from the interior of the building. Details are not provided for interior glazed systems because air infiltration is a concern with interior glazed systems. Interior glazed systems are typically specified for applications with limited interior obstructions to allow adequate access to the interior of the curtain wall. For low rise construction with easy access to the building, outside glazing is typically specified. For high-rise construction interior glazing is sometimes used due to access and logistics of replacing glass from a swing stage.

In exterior glazed systems, glass and opaque panels are installed from the exterior of the curtain wall. Exterior glazed systems require swing stage or scaffolding access to the exterior of the curtain wall for repair or replacement. Some curtain wall systems can be glazed from either the interior or exterior.

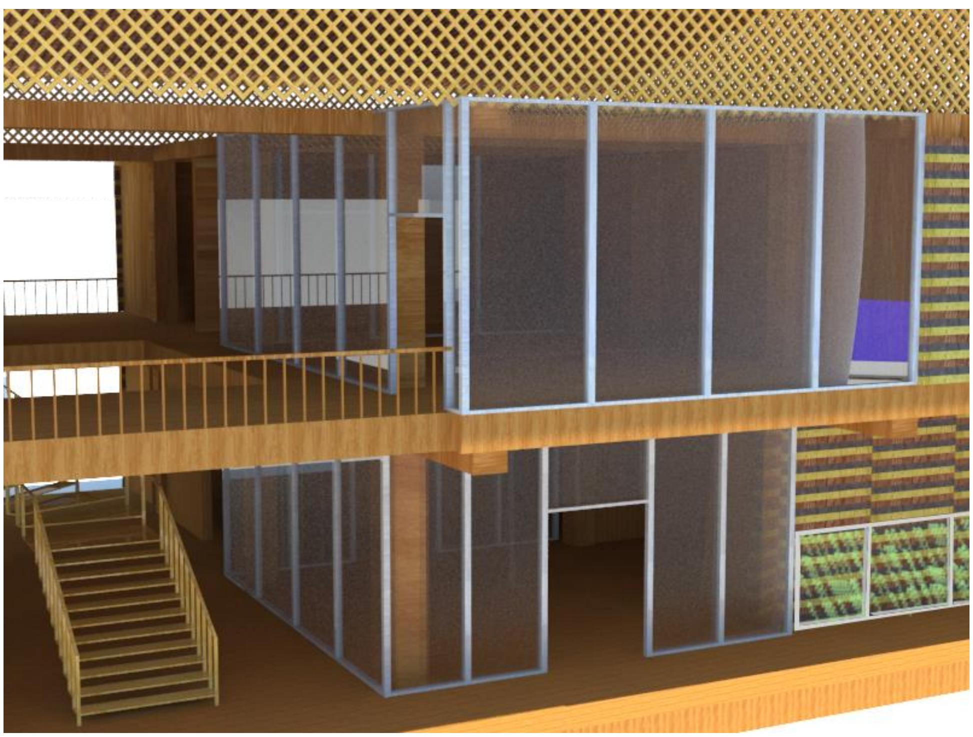


Fig. 5.6.13. Curtain Wall View

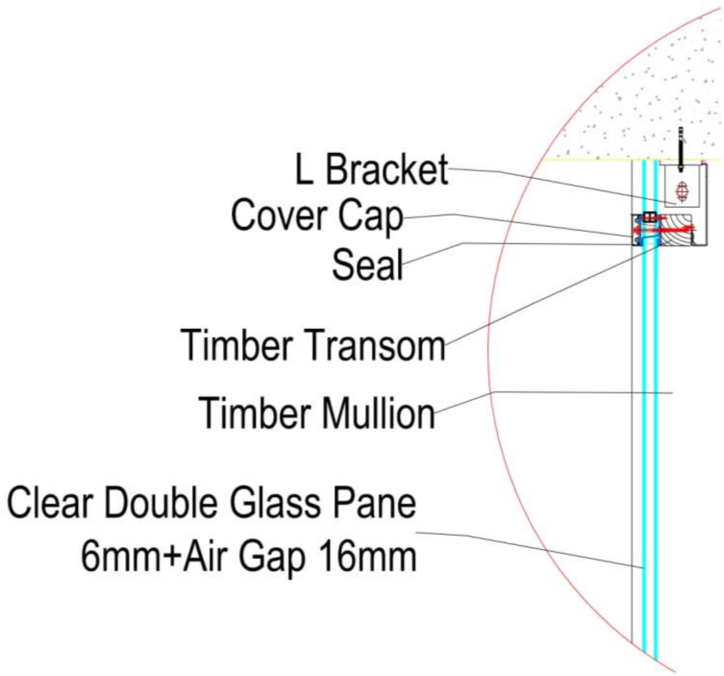


Fig. 5.6.14. Curtain Wall Vertical Section Detail

We calculated also the U-Value of the curtain wall. And at the end, we reached the U-value is around 0.45 W/m2K.

5.6.4. Roof

Solar panels installed on both flat and angled roofs are the most commonly recognized type of solar roofing, and the original type of solar technology for roofing. These panels are fairly easy to install, and can be rack mounted on flat roofs or on the sunny sides of pitched roofs; but they can also be expensive, and very heavy. Since the advent of solar roof panels, technology has advanced to offer numerous other types of solar and thermal roofing systems that provide the benefit of energy generation in different kinds of roofing installations.

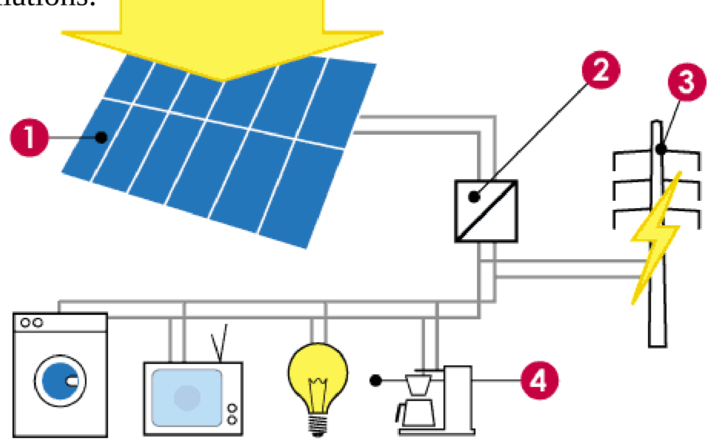


Fig. 5.6.15. Solar Panel Diagram Work

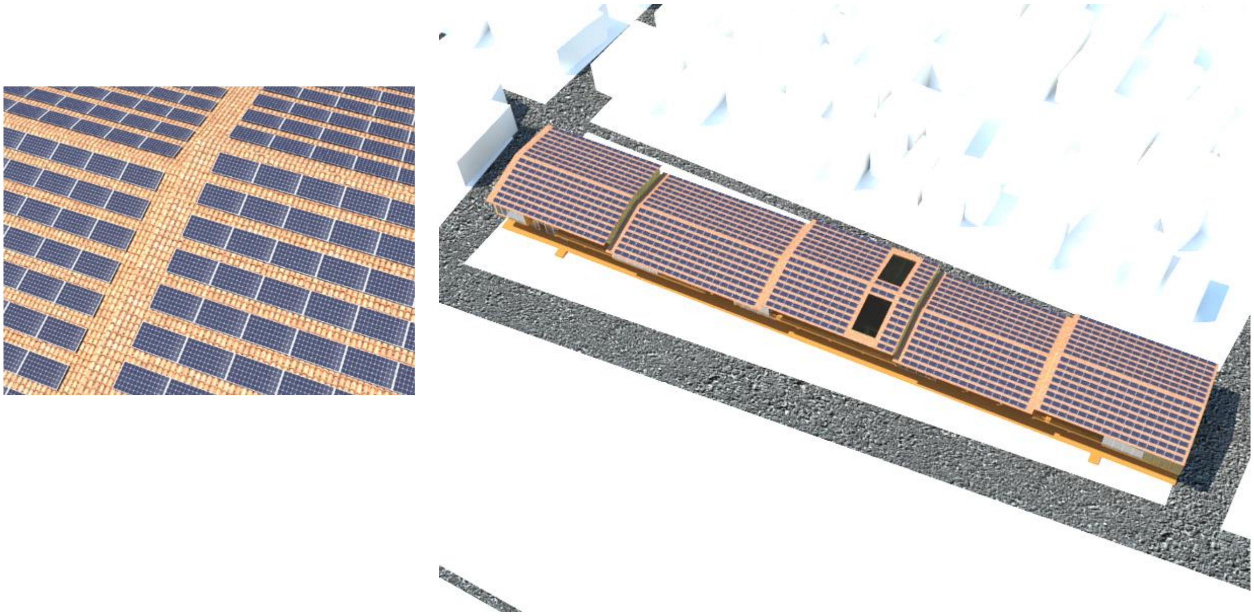


Fig. 5.6.16. Solar Panel Roof Views

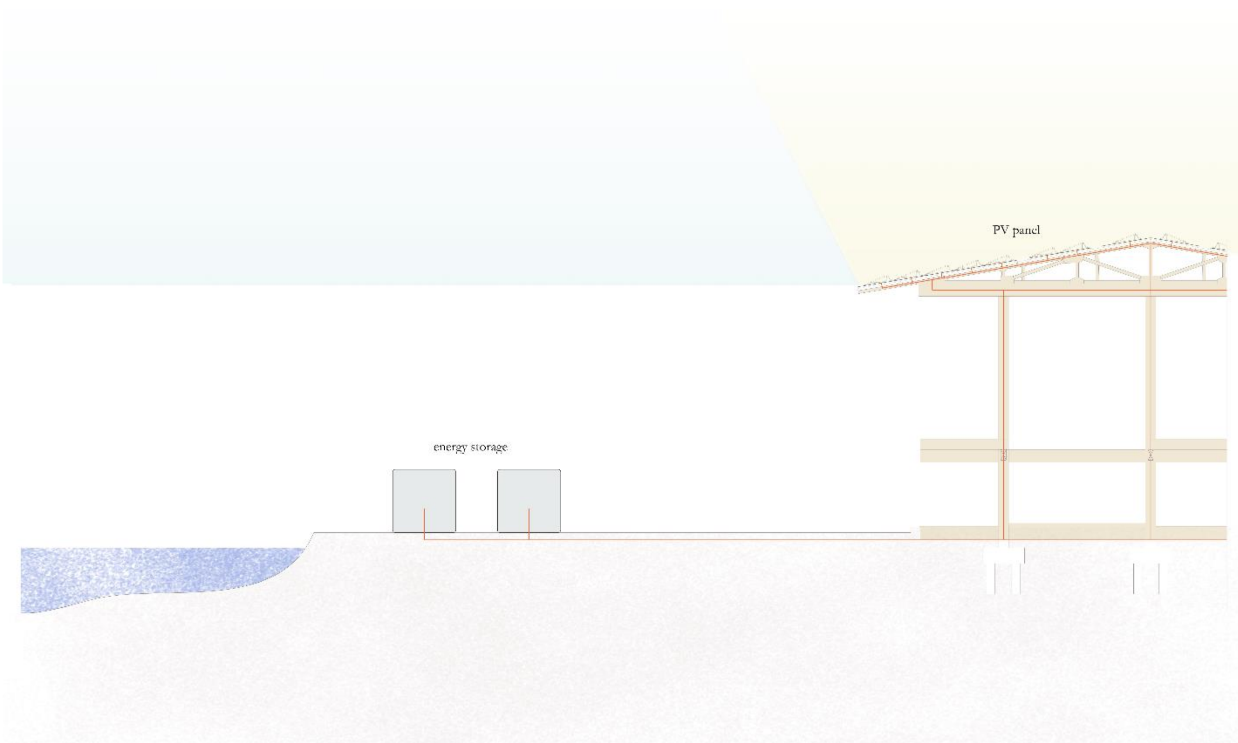


Fig. 5.6.17. Schematic Design for Solar Panel Roof Work

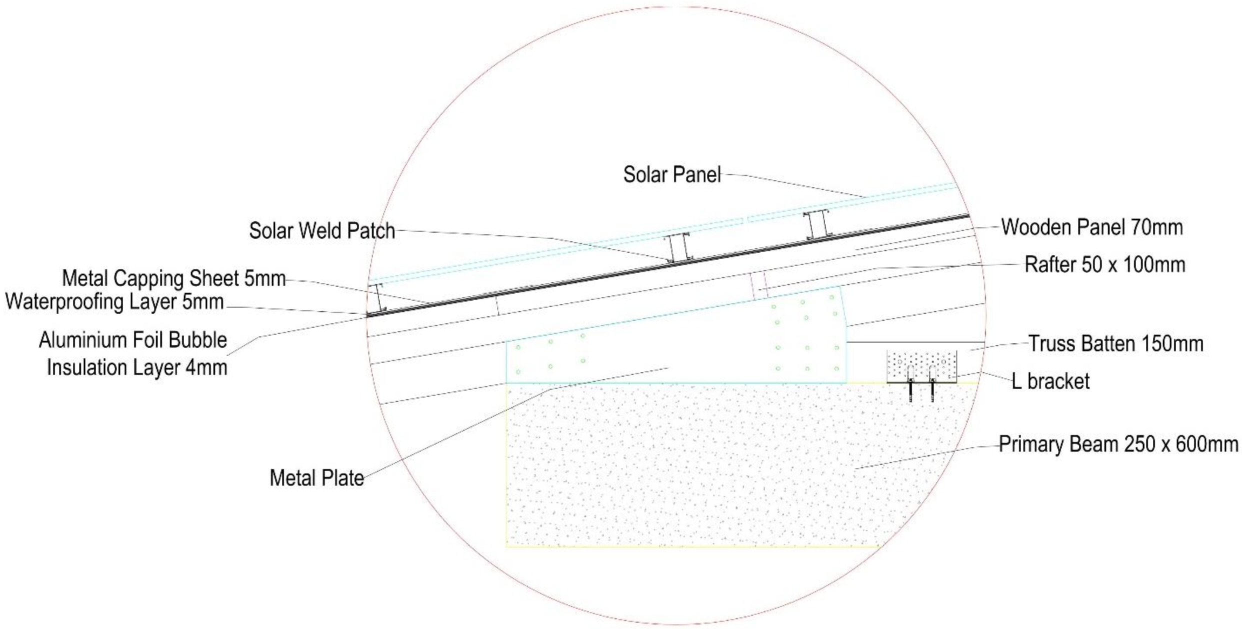


Fig. 5.6.18. Roof Detail

We calculated the thermal transmittance of the roof which is around 0.6 W/m2K. In the roof layers, we put inside the thin waterproofing and Aluminium Foil Bubble Layers as well as we put in the wall and the floor.

The Aluminium Foil Bubble Insulation is a heat-retaining foil insulation (two-sided foil) on the building of the premium class, by using a layer of bubble water (plastic air bubbles). All layers of heat-retaining material is formed and combined with the heating method using an adhesive high quality and reliable technology, so as to produce the metalizing aluminum foil bubble insulation with high quality which has a range of strong and not easy to tear which has 4 mm thickness. It is specifically designed to reflect heat radiation and UV sun rays up to 97%, so as to keep the room in the building to be cool and comfortable. It can be used as a *heat retaining* insulation in roofs and walls of buildings, especially in the tropics.

Fig. 5.6.19. Aluminium Foil Bubble Insulation

On the roof we also have The Skylight which there is the oparable glazing and there is the fixed one. For the U-value, we got 1.1 W/m2K. these skylights has good thermal and sound insulation, and can provide the maximum daylight for entering the building.

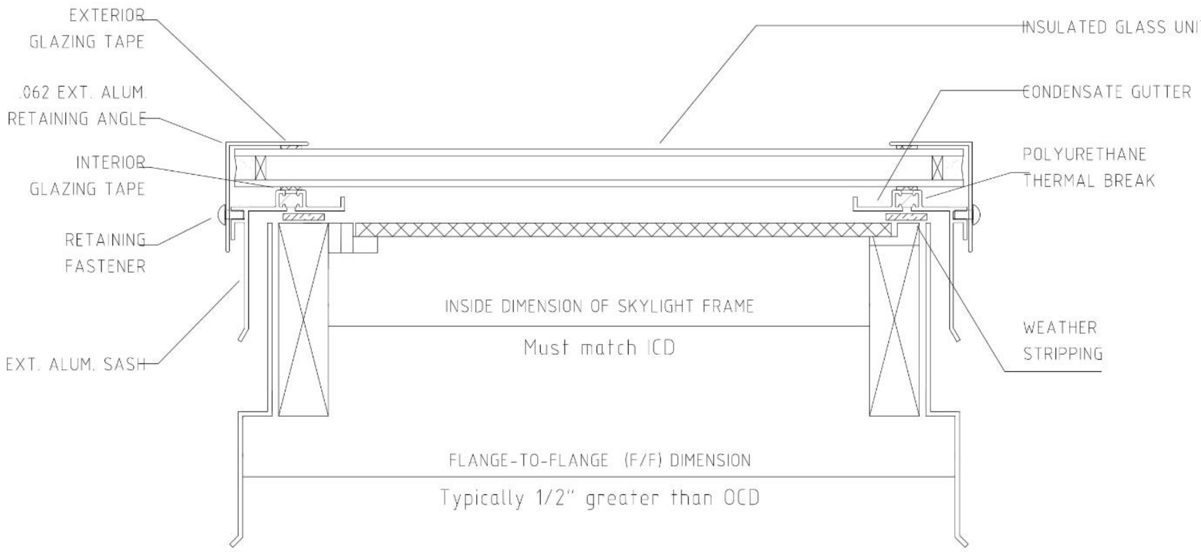


Fig. 5.6.20. Fixed Glazing Skylight Roof Detail

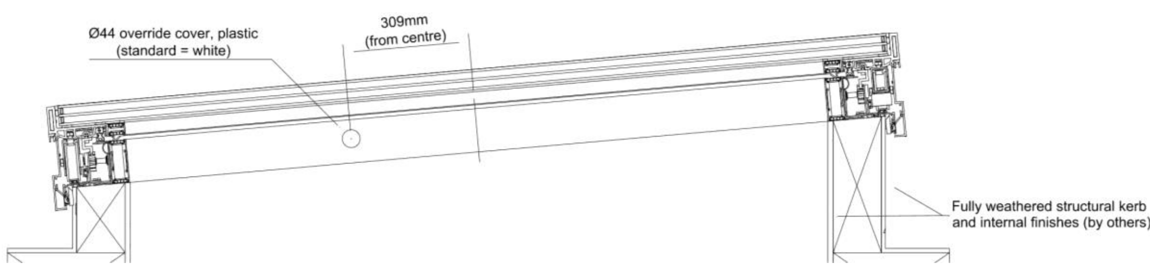


Fig. 5.6.21. Operable Glazing Skylight Roof Detail

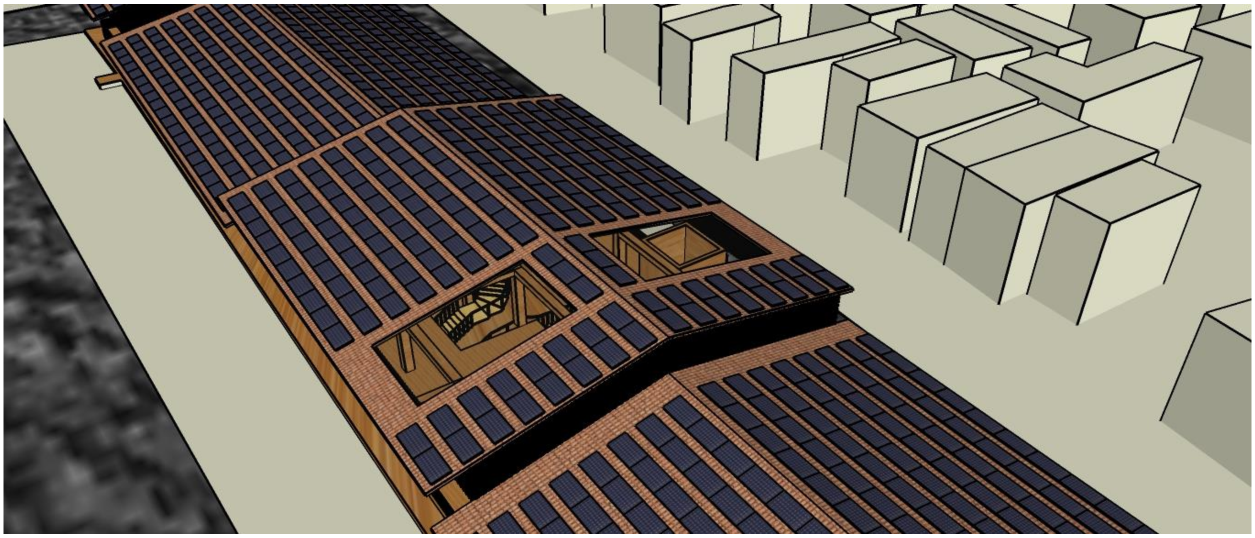


Fig. 5.6.22. Left: Operable Skylight – Right: Fixed Skylight

5.6.5. Internal Wall (Partition)

For internal Wall, we are having Drywall Construction. Drywall construction, a type of construction in which the interior wall is applied in a dry condition without the use of mortar. It contrasts with the use of plaster, which dries after application.

The materials used in drywall construction are gypsum board, plasterboard, plywood, fibre-and-pulp boards, and asbestos-cement boards. The large, rigid sheets are fastened directly to the frame of the building with nails, screws, or adhesives or are mounted on furring (strips of wood nailed over the studs, joists, rafters, or masonry, which allow free circulation of air behind the interior wall)

There is metal stud and metal track which the galvanized lightweight steel for the structure frames inside the wall, where a vertical stud framing for partitions and wall linings, meanwhile, the other one as head and floor track members for drywall systems.

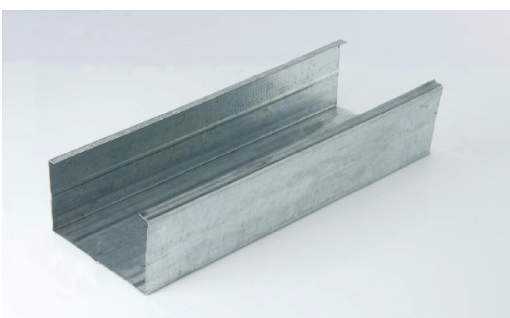


Fig. 5.6.23. C Metal Stud

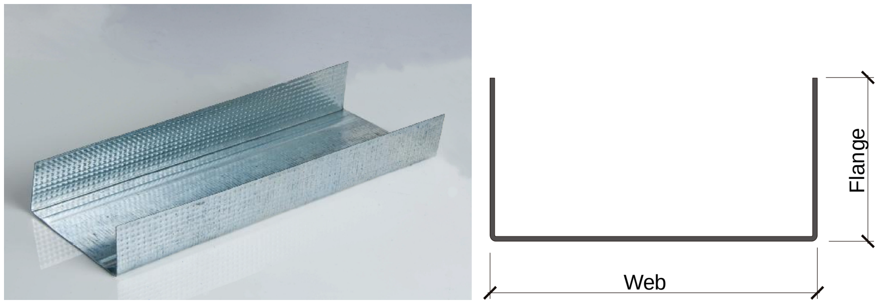


Fig. 5.6.24. U Metal Track

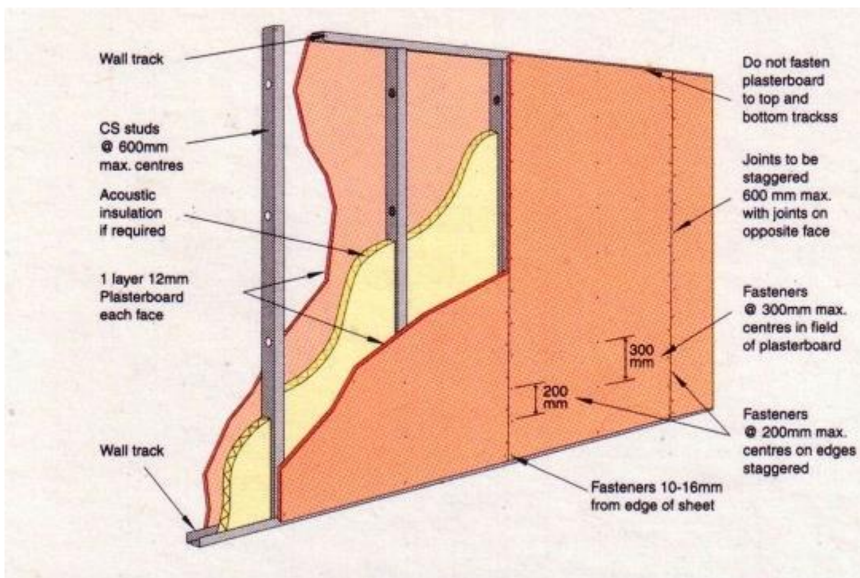


Fig. 5.6.25. Drywall Partition System

5.6.6. Floor

On ground floor, the floor system is using the modular iglu formworks with filled by concrete and uses the hardwood block as the finishing material. The plastic modular iglu formwoks, side by side in sequence according to a predefined direction, make it easy to quickly create a self-supporting pedestrian platform above which a layer of is cast in order to easily and economically create a ventilated slab placed on pillars with the below cavity area available for the passage of systems but above all ventilated to counteract rising humidity and radioactive gases.

Fig. 5.6.26. The Modular Iglu Formworks View

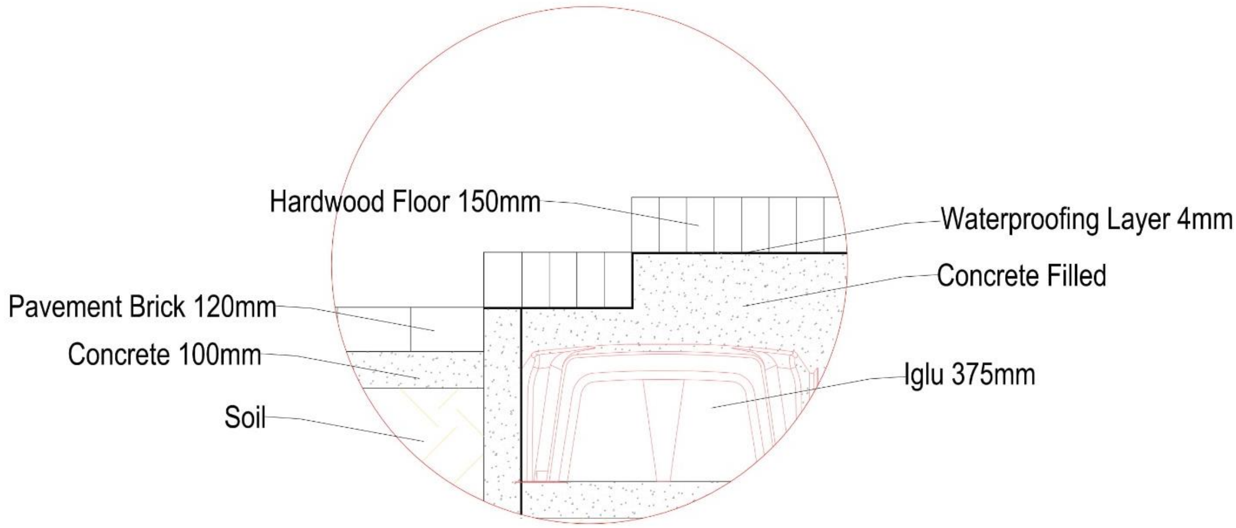


Fig. 5.6.27. Ground floor Detail

Meanwhile, on the First Floor, we are using CLT (Cross Laminated Timeber) System as the base and then filled with concrete, and using the hardwood blocks again for the finishing material. A cross-laminated timber panel (aka 'Crosslam' or 'Xlam') is a method of construction that uses timber to form load-bearing solid timber wall, floor and roof panels. Structural openings, such as doors and windows, are incorporated within the panels. In many cases only insulation and cladding is added to the external face to achieve high standards of thermal performance.

The more common cross-laminated panels are characterised by placing and gluing boards across each other in layers; Another, visually distinctive, technique is to assemble a solid panel through gluing or dowelling together a series of timber ‘posts’. Panels are commonly fabricated up to around 4m in width and 15m in height, according to technique and manufacturer. The traditional key advantages of prefabricated components are speed, efficiency and precise tolerances.

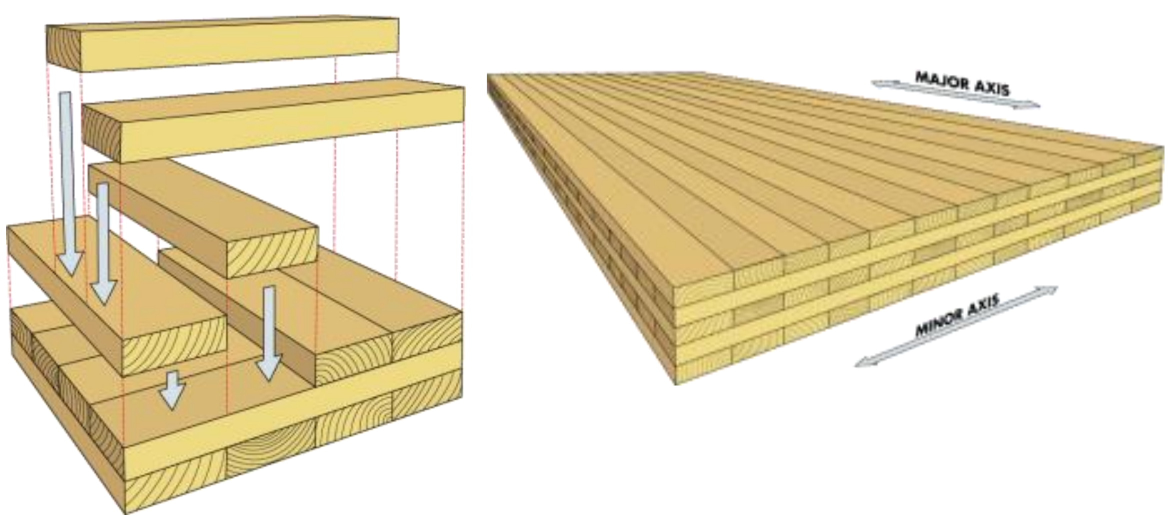


Fig. 5.6.28. CLT Lay-up and Paneling

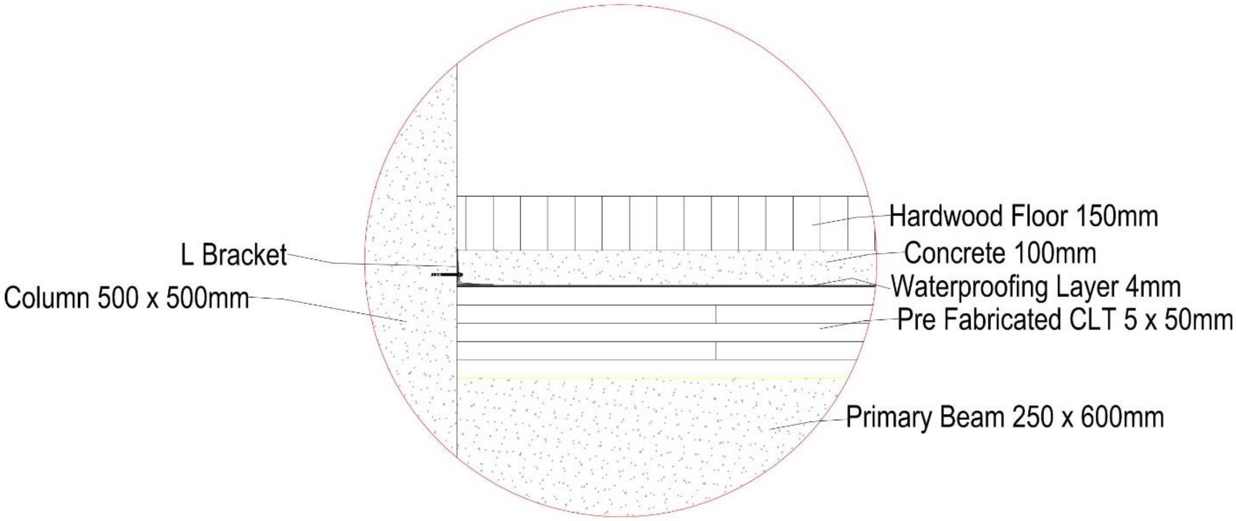


Fig. 5.6.29. First Floor Detail

5.6.7. Ceiling

The Veneered Wooden Grill system consists of wooden slats that are secured to each other with an aluminium dowel. These assembled slats form the grill panel, which can be produced in various lengths and widths. A wide range of wood veneers is available, all with their own characteristics. The system is easy to install and allows the ceiling to be demountable and provides easy access to the plenum. Due to the freedom of choosing the own grill dimensions, a unique ceiling can be created.

Playing with the panel width and gap will, can provide the necessary acoustic performance for different atmospheres. Optionally, the panels can also be perforated. By impregnating wood, a reaction to fire classification of B-s1,d0 can be achieved. In some cases higher classifications can also be achieved. Due to a special treatment to the wooden panels, some wood species are perfectly suitable for humid areas, such as swimming pools and near the sea.

Fig. 5.6.30 Veneered Wooden Grill Ceiling View

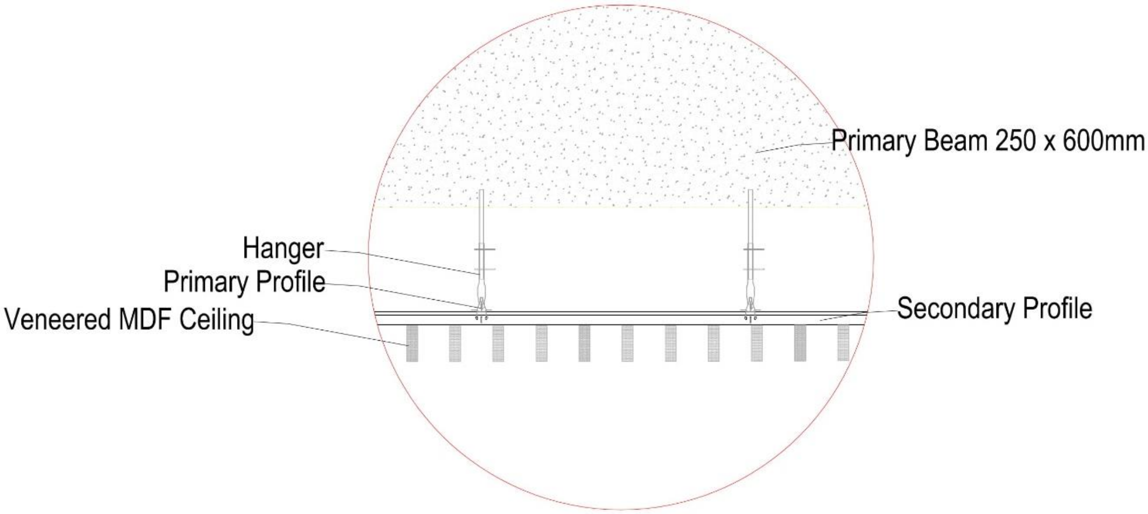


Fig. 5.6.31. Ceiling Detail

5.7 Blow Up and Detail Drawing

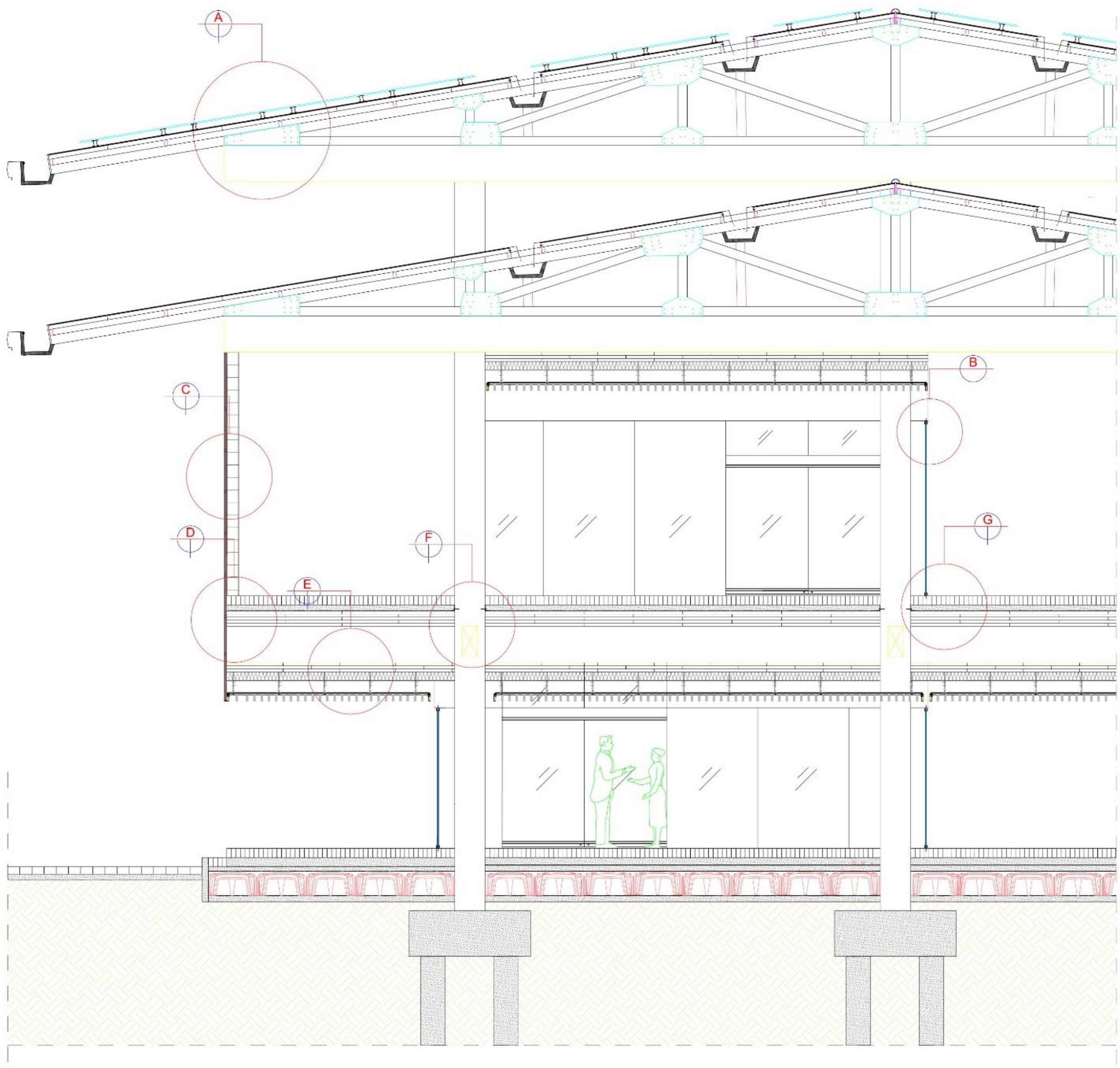
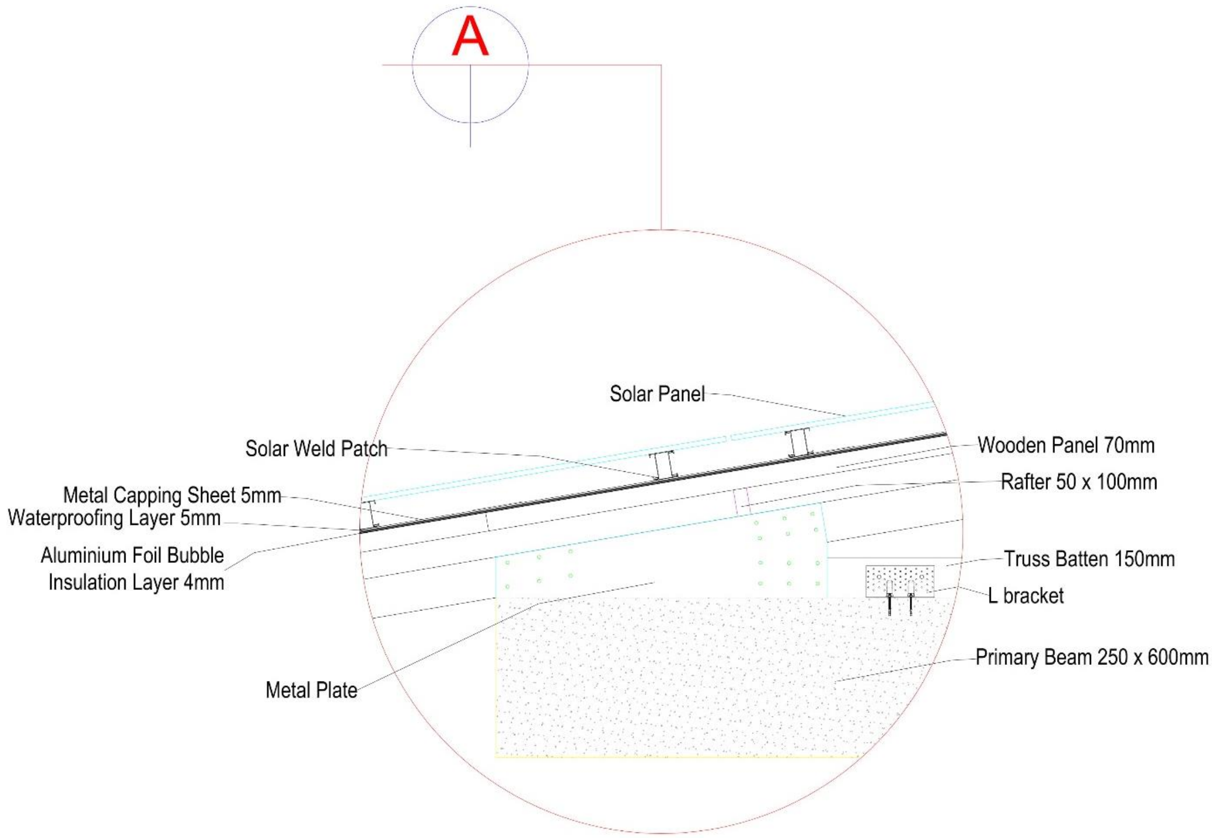
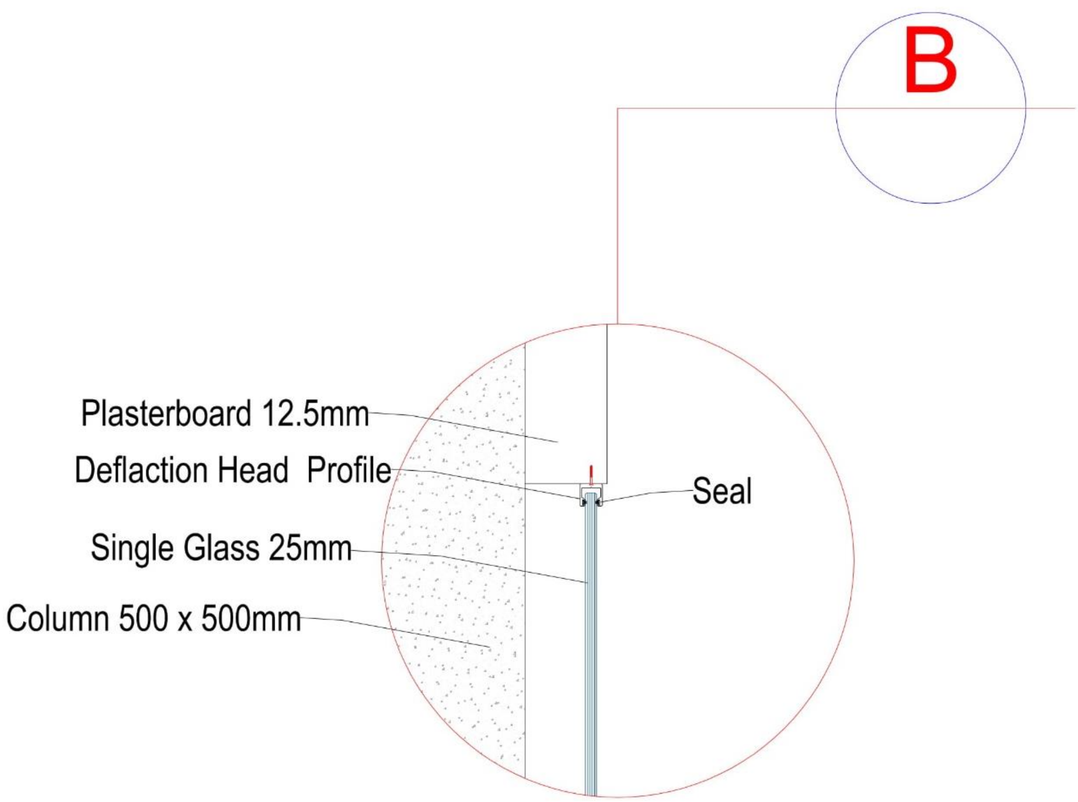
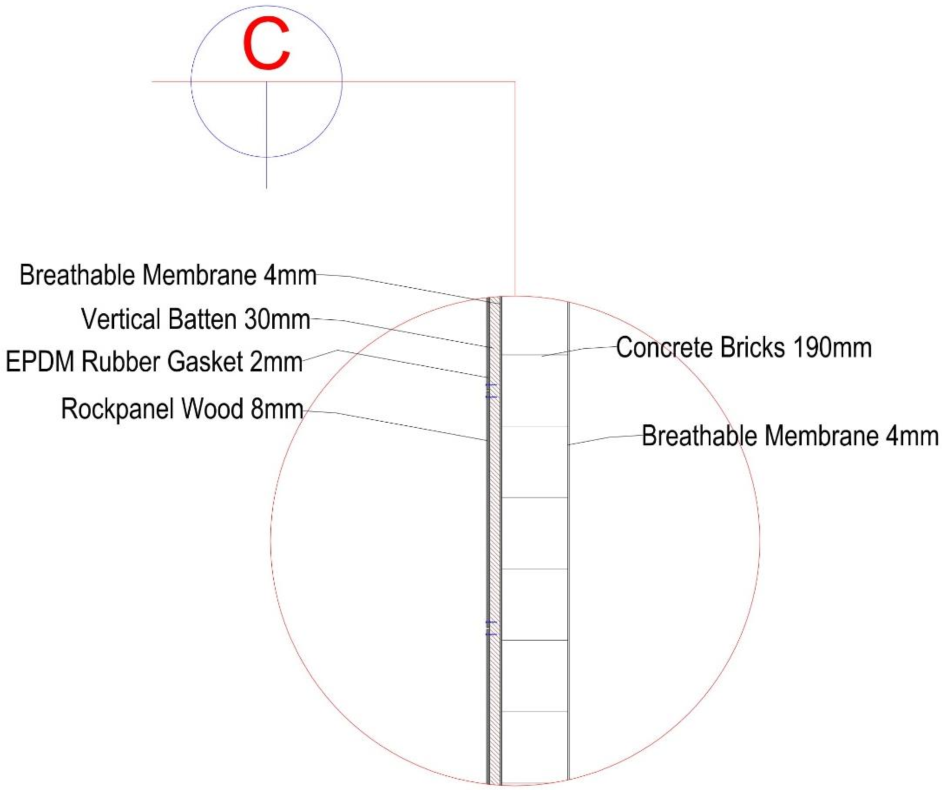
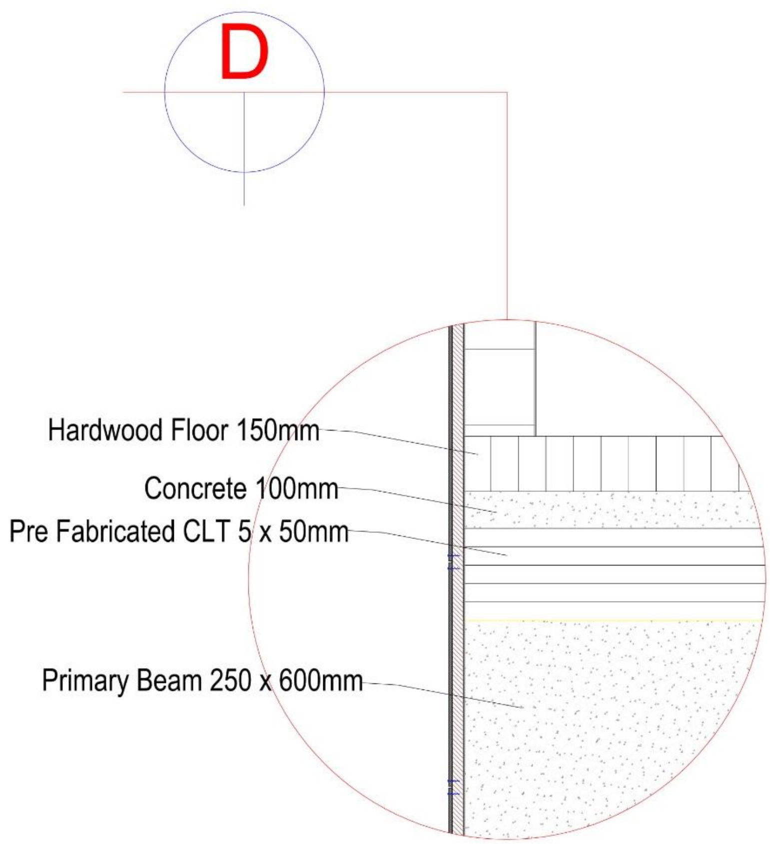


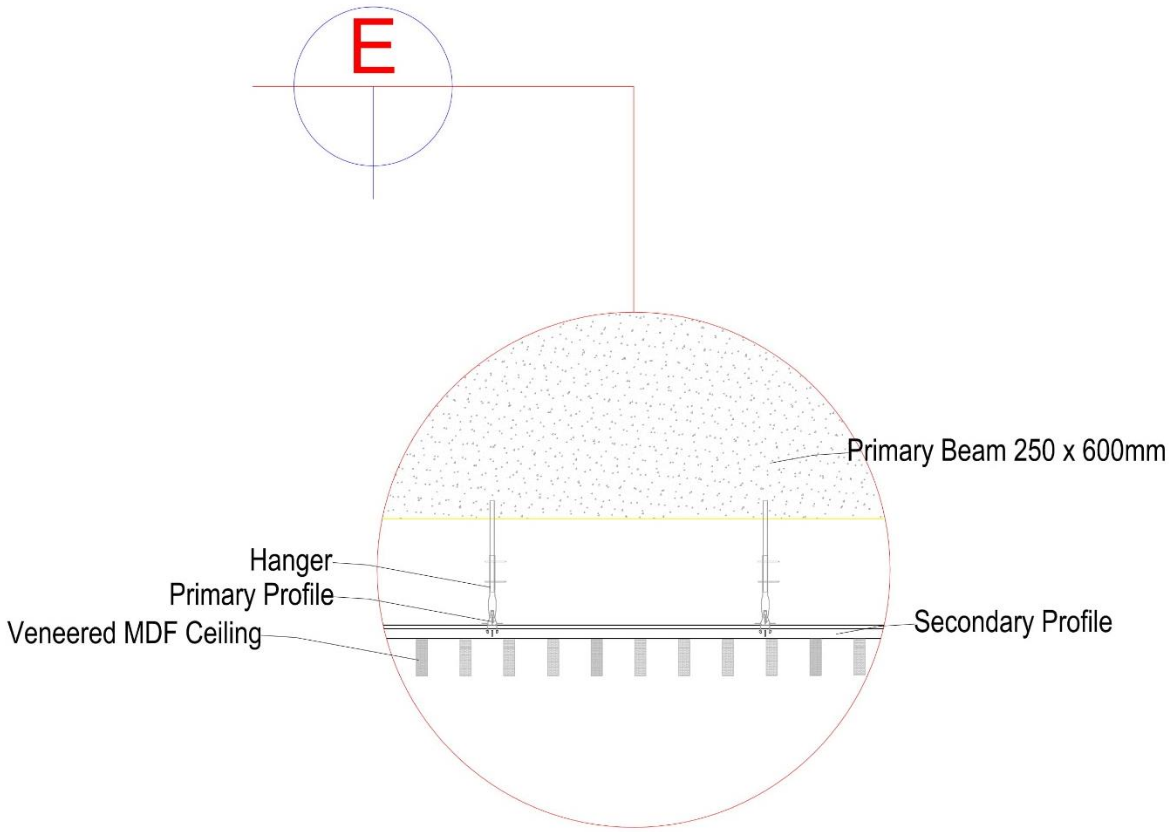
Fig. 5.7.1. Blow Up 1

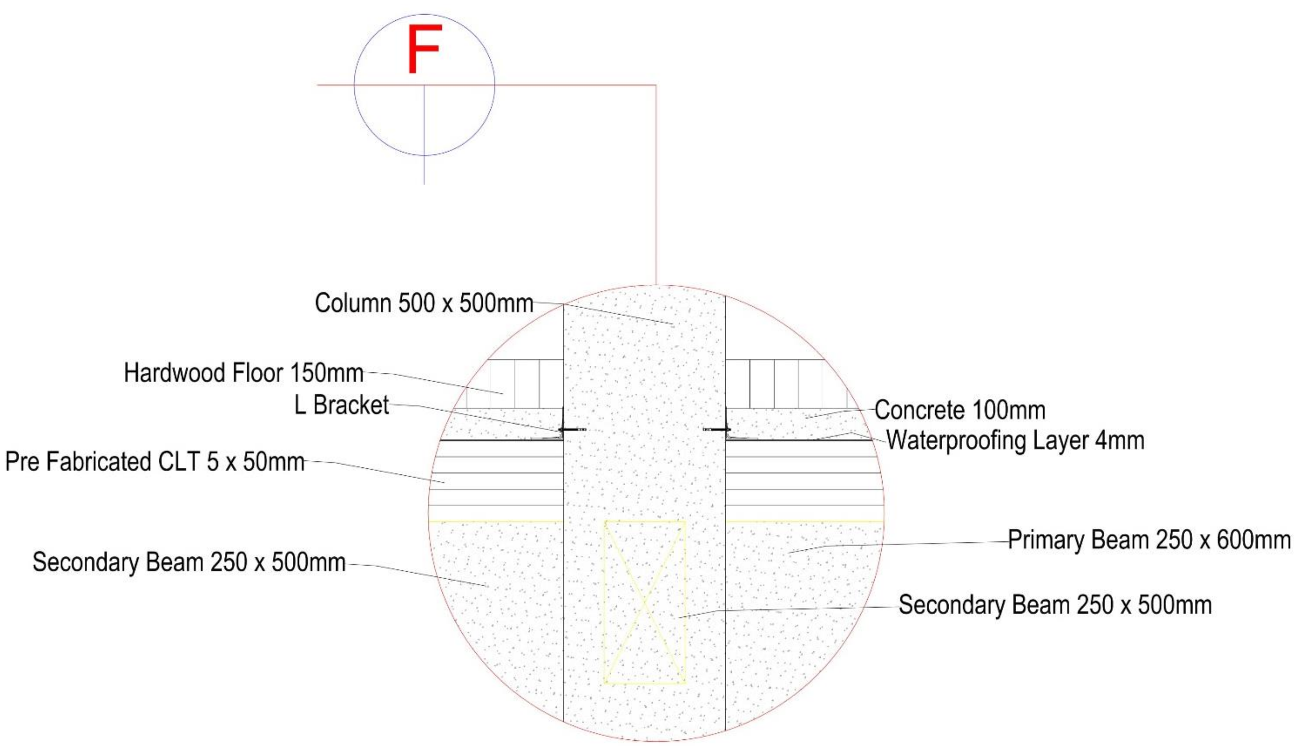

A
Solar Panel
Solar Weld Patch
Wooden Panel 70mm
Rafter 50 x 100mm
Metal Capping Sheet 5mm
Waterproofing Layer 5mm
Aluminium Foil Bubble
Insulation Layer 4mm
Truss Batten 150mm
L bracket
Primary Beam 250 x 600mm
Metal Plate


B
Plasterboard 12.5mm
Deflaction Head Profile
Seal
Single Glass 25mm
Column 500 x 500mm


C
Breathable Membrane 4mm
Vertical Batten 30mm
EPDM Rubber Gasket 2mm
Rockpanel Wood 8mm
Concrete Bricks 190mm
Breathable Membrane 4mm


D
Hardwood Floor 150mm
Concrete 100mm
Pre Fabricated CLT 5 x 50mm
Primary Beam 250 x 600mm


E
Primary Beam 250 x 600mm
Hanger
Primary Profile
Veneered MDF Ceiling
Secondary Profile


F
Column 500 x 500mm
Hardwood Floor 150mm
L Bracket
Pre Fabricated CLT 5 x 50mm
Secondary Beam 250 x 500mm
Concrete 100mm
Waterproofing Layer 4mm
Primary Beam 250 x 600mm
Secondary Beam 250 x 500mm

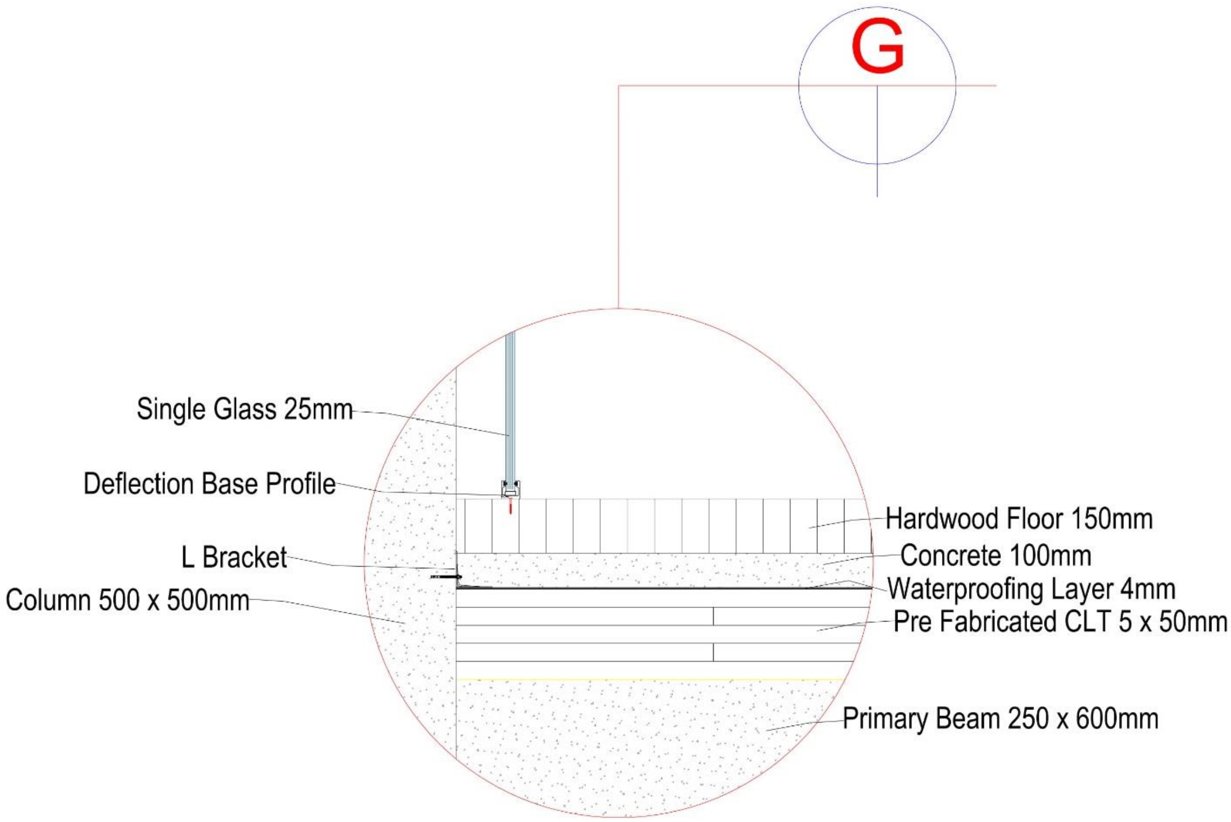


Fig. 5.7.2. Details of Blow Up 1

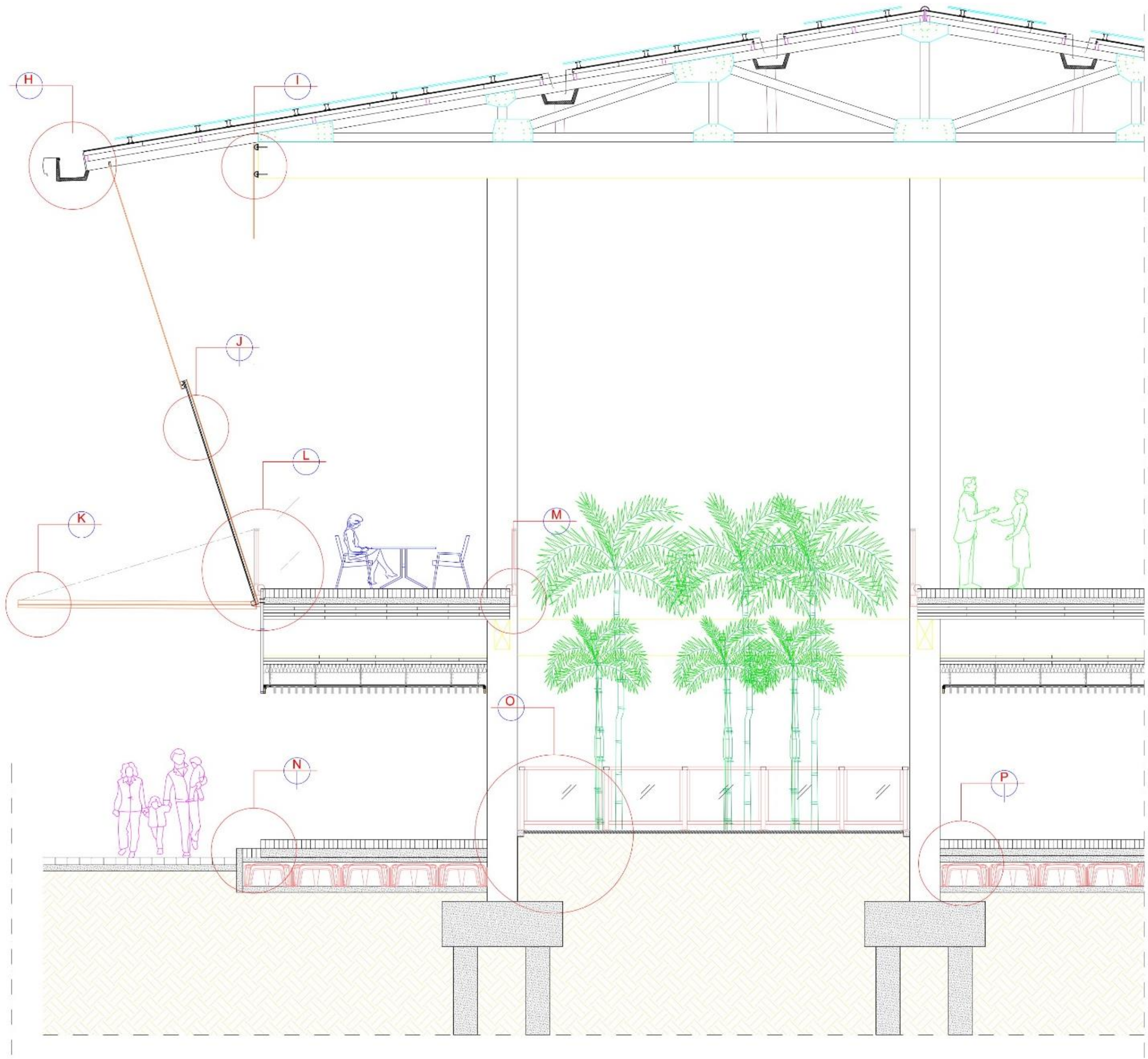
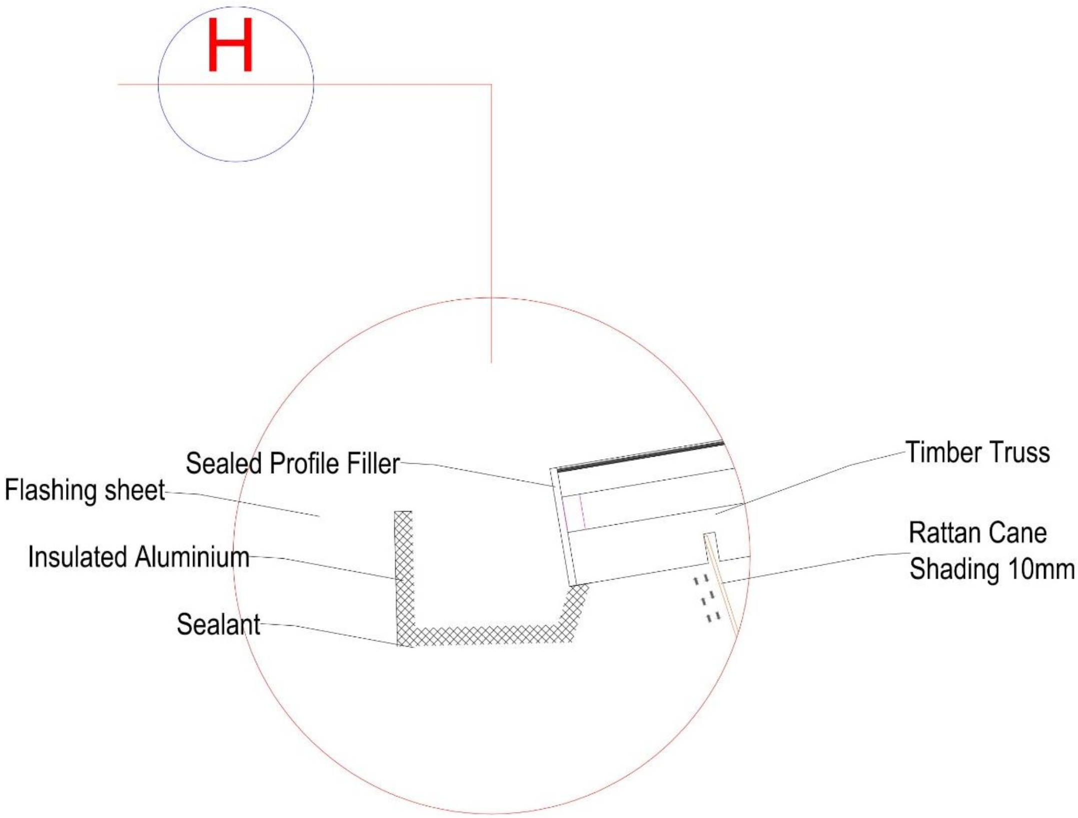
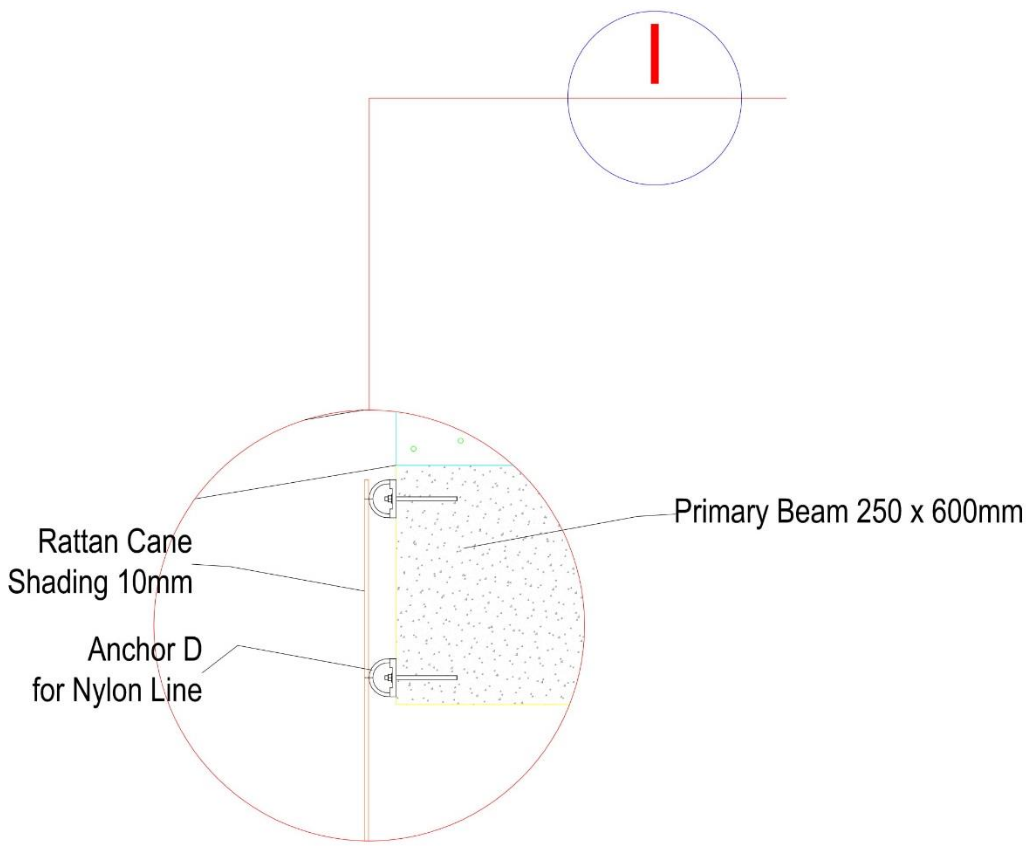
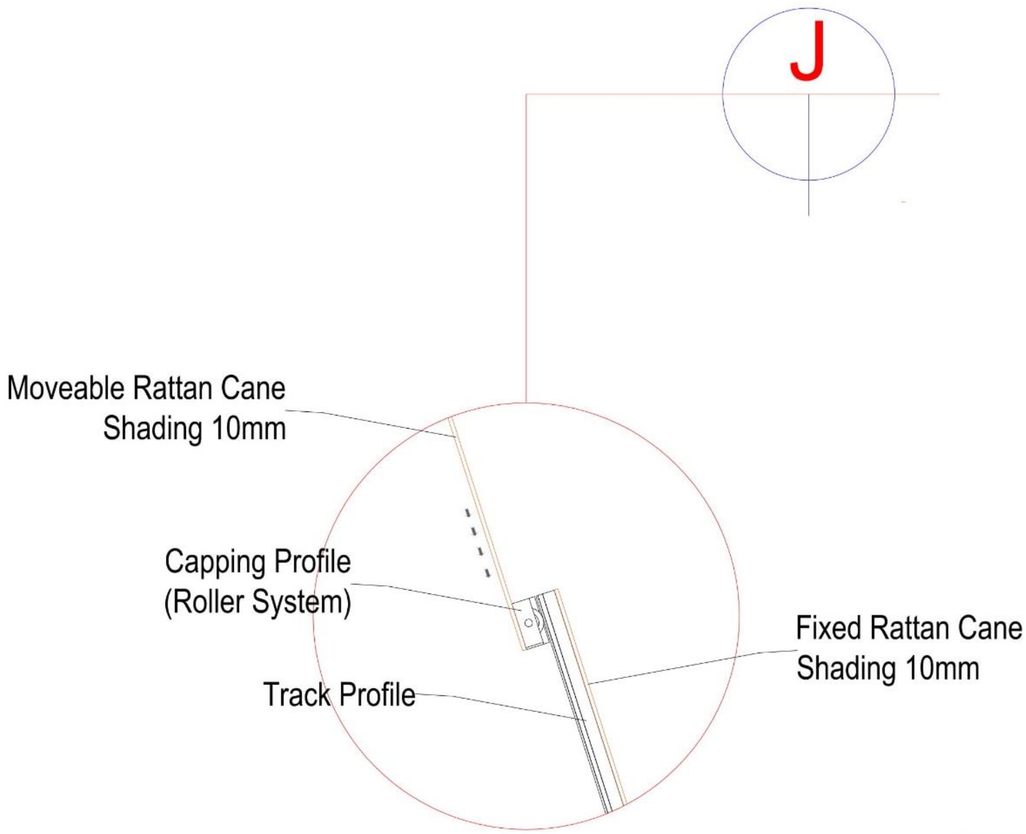
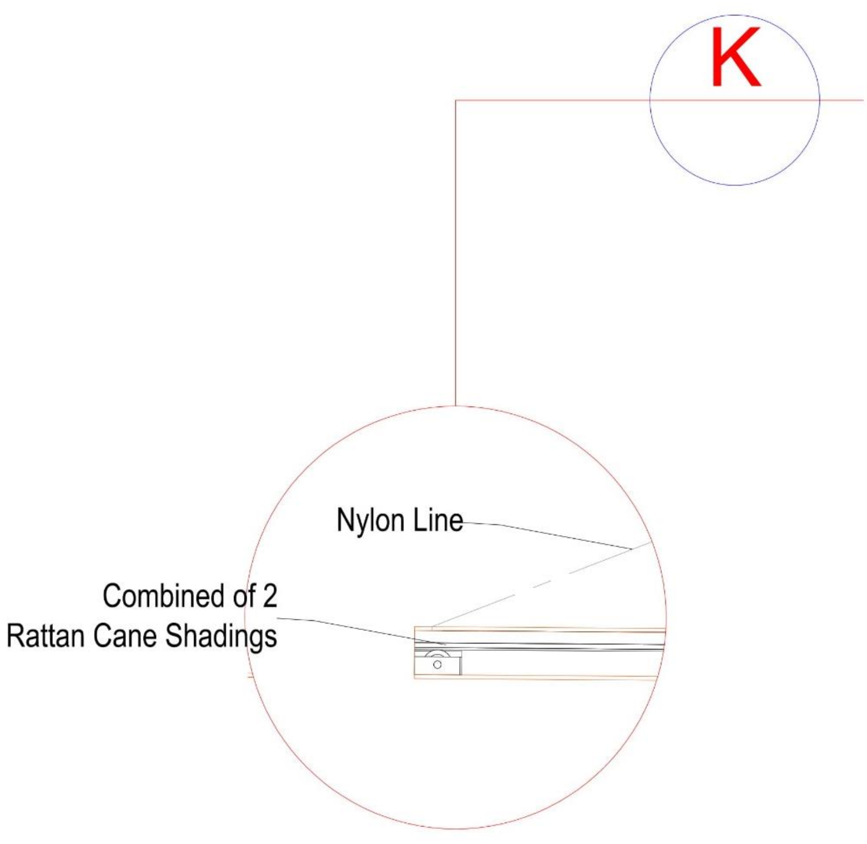


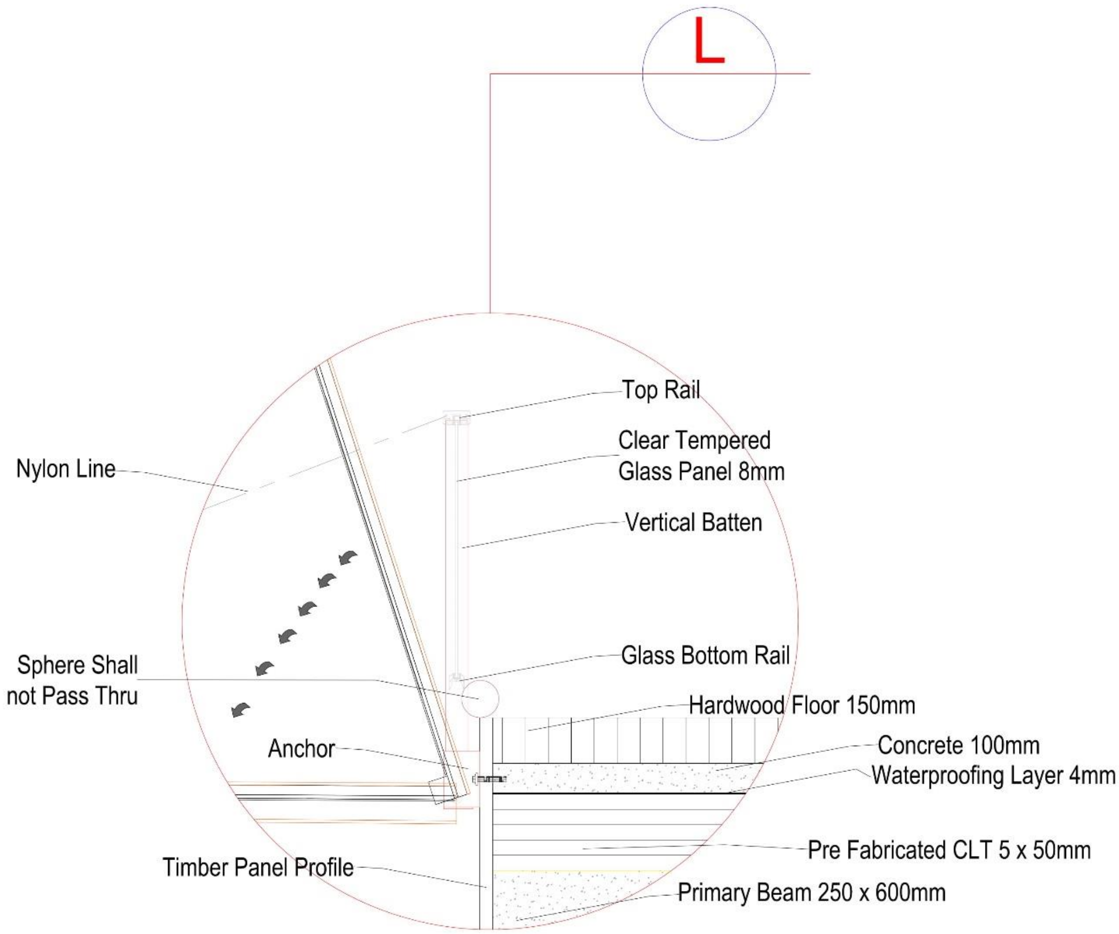
Fig. 5.7.3. Blow Up 2

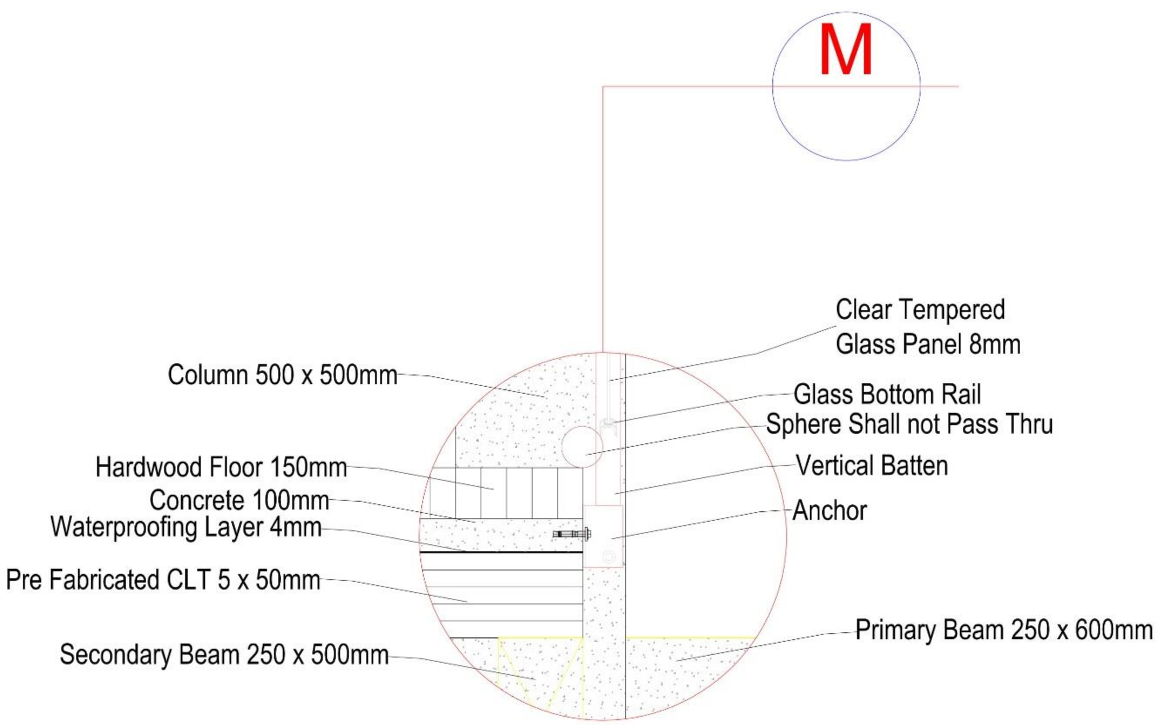

H
Sealed Profile Filler
Flashing sheet
Insulated Aluminium
Sealant
Timber Truss
Rattan Cane
Shading 10mm

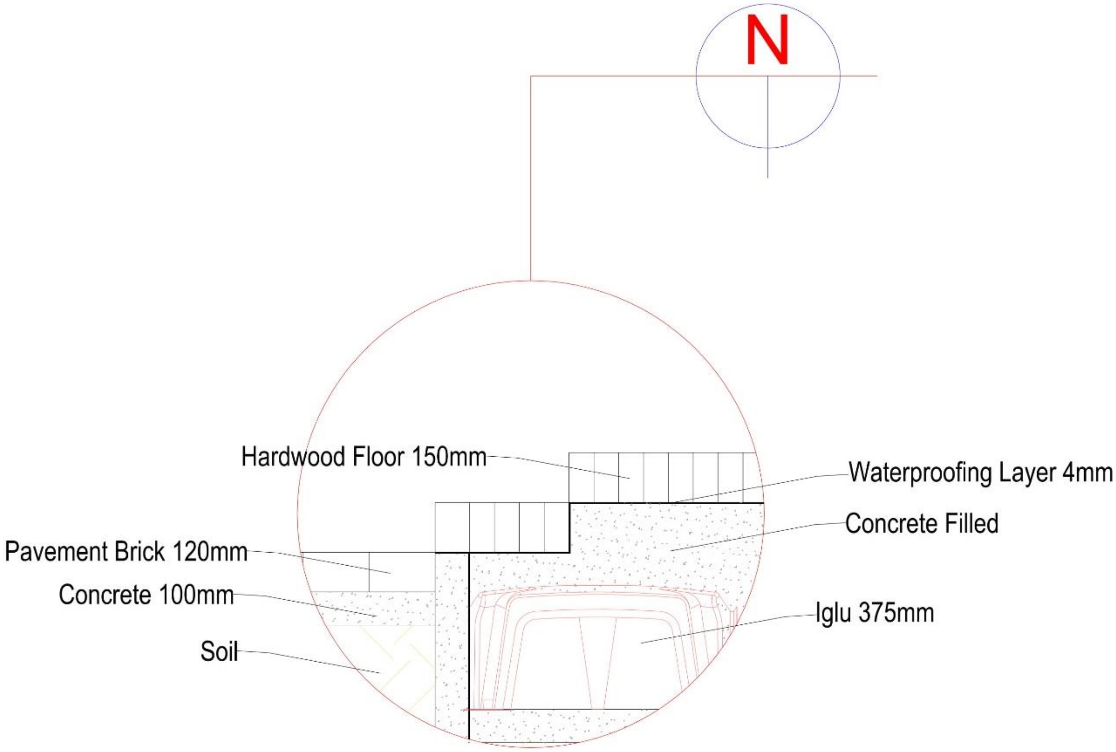

I
Primary Beam 250 x 600mm
Rattan Cane
Shading 10mm
Anchor D
for Nylon Line

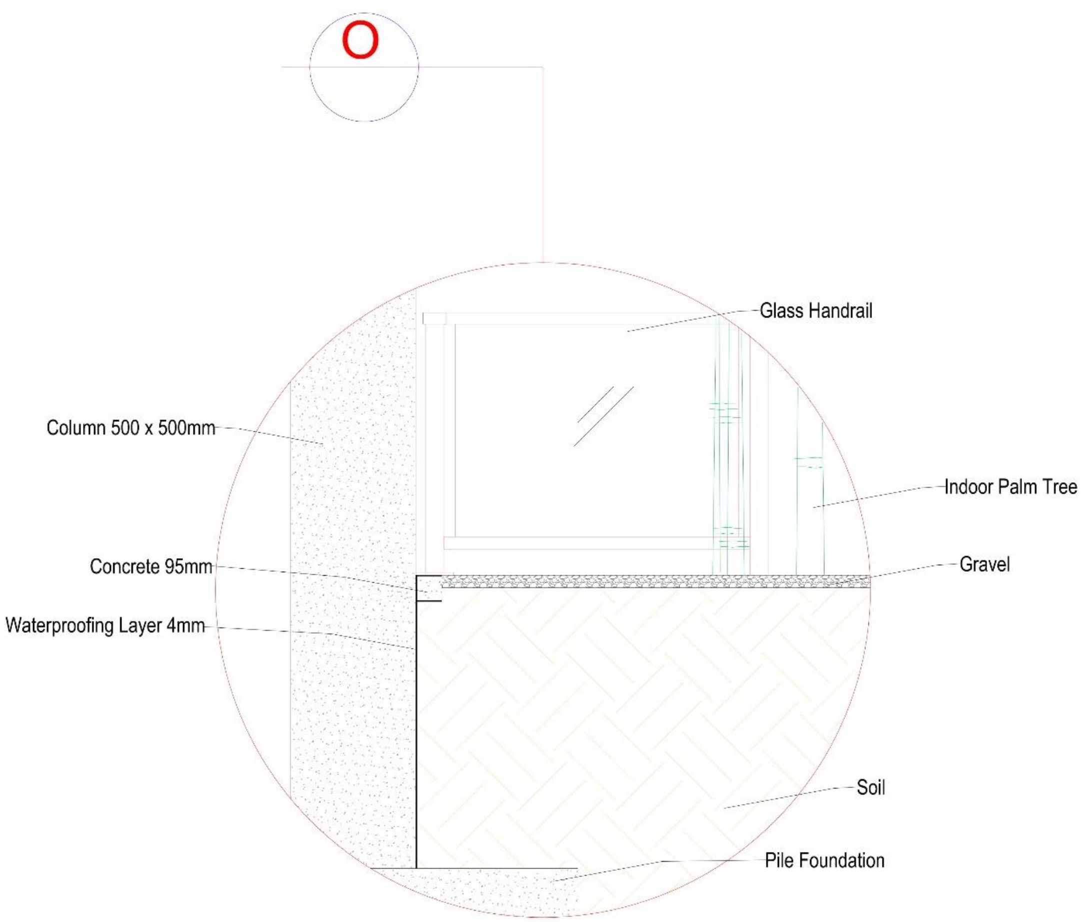

J
Moveable Rattan Cane
Shading 10mm
Capping Profile
(Roller System)
Track Profile
Fixed Rattan Cane
Shading 10mm


K
Nylon Line
Combined of 2
Rattan Cane Shadings


L
Top Rail
Clear Tempered
Glass Panel 8mm
Nylon Line
Vertical Batten
Sphere Shall
not Pass Thru
Glass Bottom Rail
Hardwood Floor 150mm
Anchor
Concrete 100mm
Waterproofing Layer 4mm
Pre Fabricated CLT 5 x 50mm
Timber Panel Profile
Primary Beam 250 x 600mm


M
Clear Tempered
Glass Panel 8mm
Column 500 x 500mm
Glass Bottom Rail
Sphere Shall not Pass Thru
Hardwood Floor 150mm
Vertical Batten
Concrete 100mm
Anchor
Waterproofing Layer 4mm
Pre Fabricated CLT 5 x 50mm
Primary Beam 250 x 600mm
Secondary Beam 250 x 500mm


N
Hardwood Floor 150mm
Waterproofing Layer 4mm
Concrete Filled
Pavement Brick 120mm
Concrete 100mm
Iglu 375mm
Soil


O
Glass Handrail
Column 500 x 500mm
Indoor Palm Tree
Concrete 95mm
Gravel
Waterproofing Layer 4mm
Soil
Pile Foundation

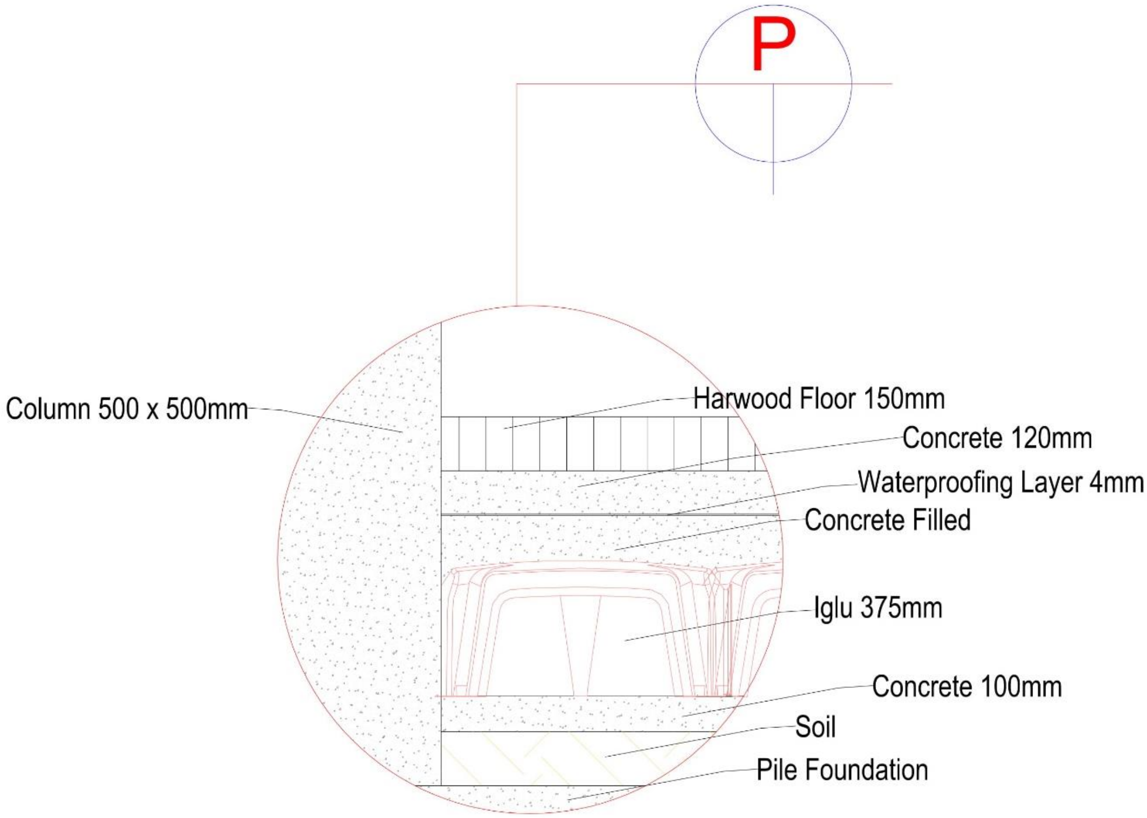


Fig. 5.7.4. Details of Blow Up 2

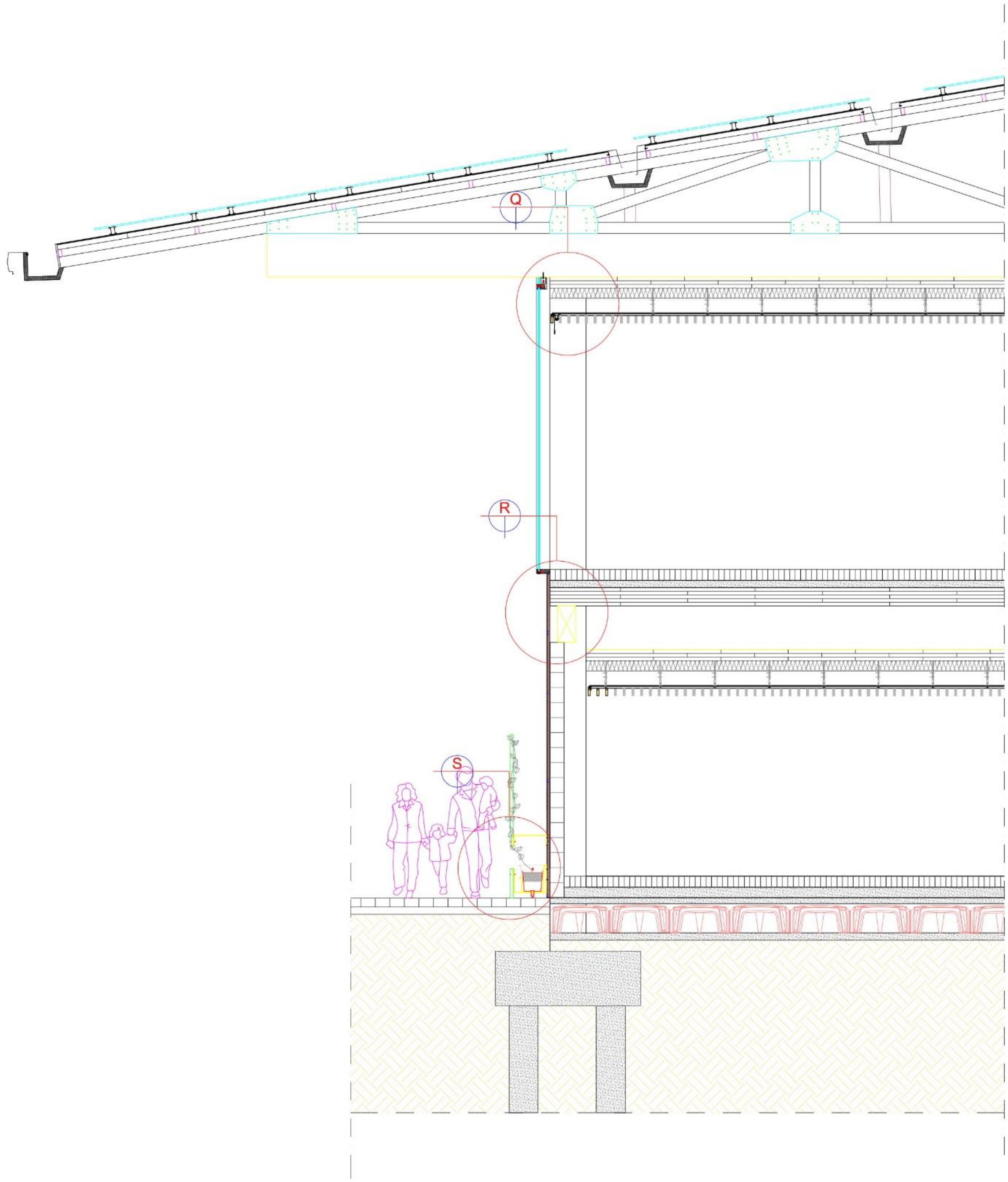
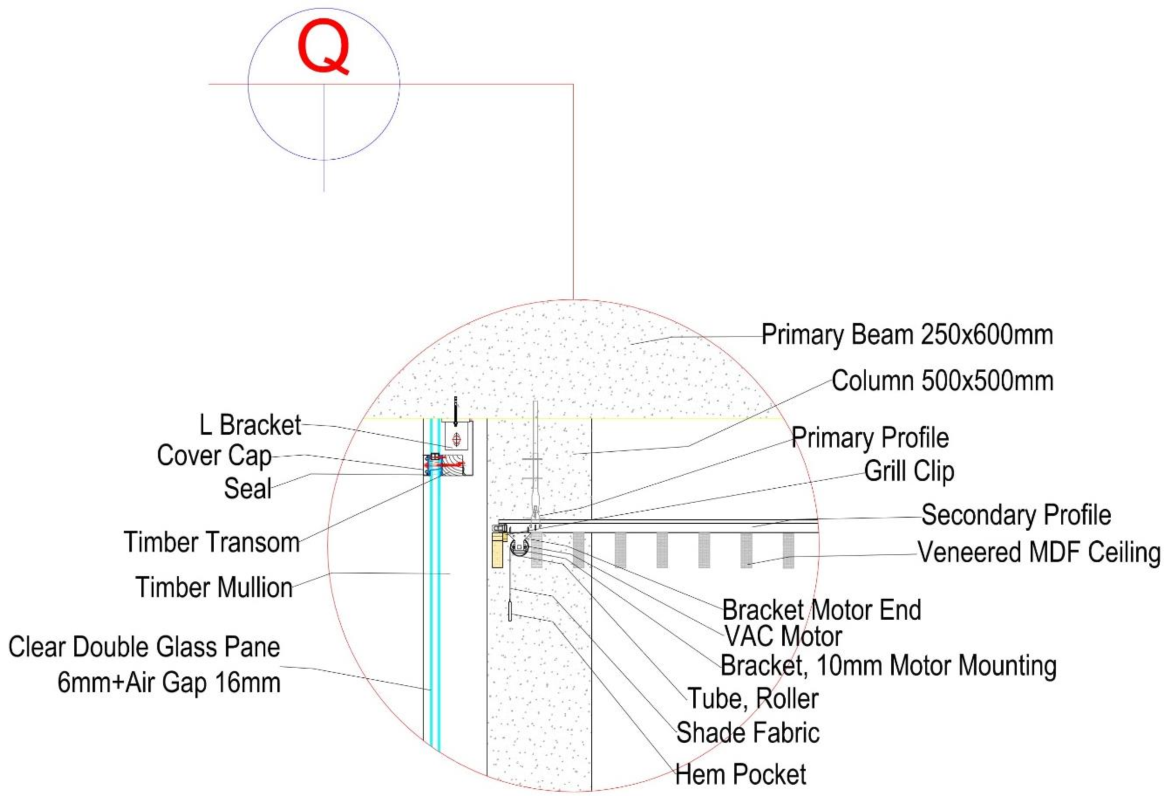
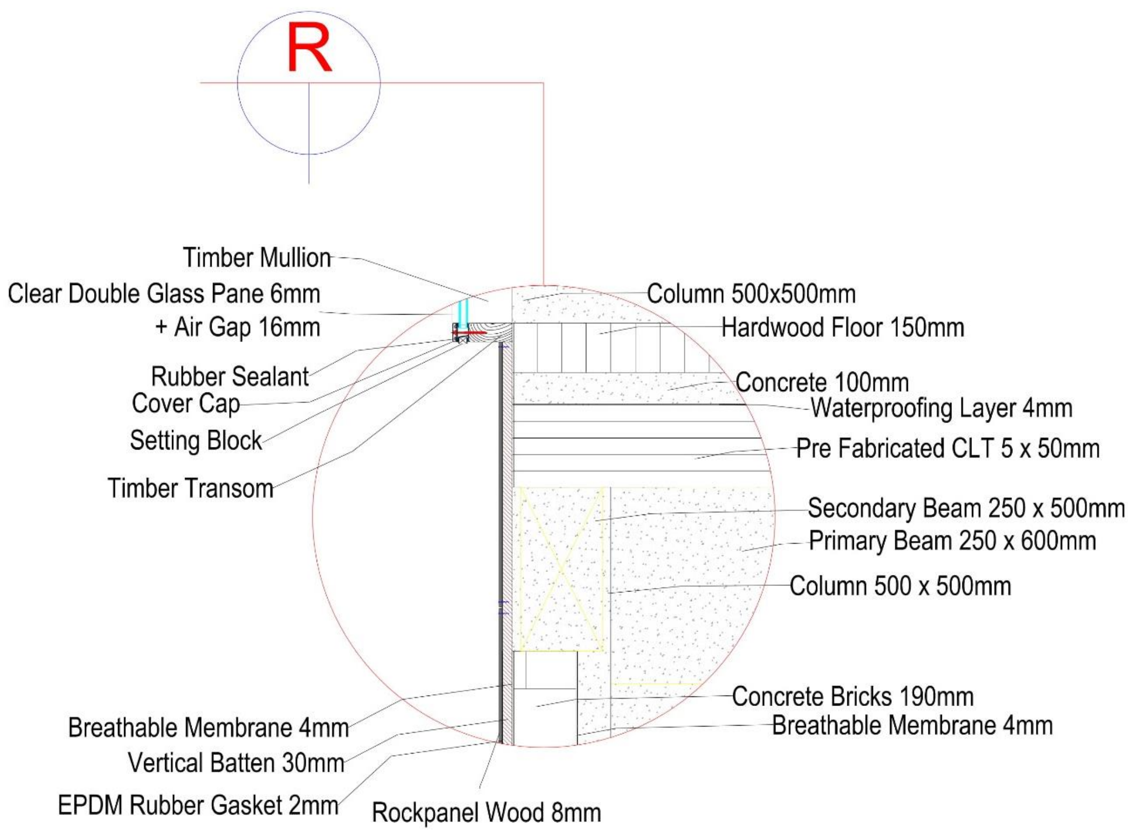


Fig. 5.7.5. Blow Up 3


Q
Primary Beam 250x600mm
Column 500x500mm
L Bracket
Cover Cap
Seal
Primary Profile
Grill Clip
Secondary Profile
Timber Transom
Veneered MDF Ceiling
Timber Mullion
Bracket Motor End
VAC Motor
Clear Double Glass Pane
6mm+Air Gap 16mm
Bracket, 10mm Motor Mounting
Tube, Roller
Shade Fabric
Hem Pocket


R
Timber Mullion
Clear Double Glass Pane 6mm
+ Air Gap 16mm
Column 500x500mm
Hardwood Floor 150mm
Rubber Sealant
Cover Cap
Concrete 100mm
Waterproofing Layer 4mm
Setting Block
Pre Fabricated CLT 5 x 50mm
Timber Transom
Secondary Beam 250 x 500mm
Primary Beam 250 x 600mm
Column 500 x 500mm
Concrete Bricks 190mm
Breathable Membrane 4mm
Breathable Membrane 4mm
Vertical Batten 30mm
EPDM Rubber Gasket 2mm
Rockpanel Wood 8mm

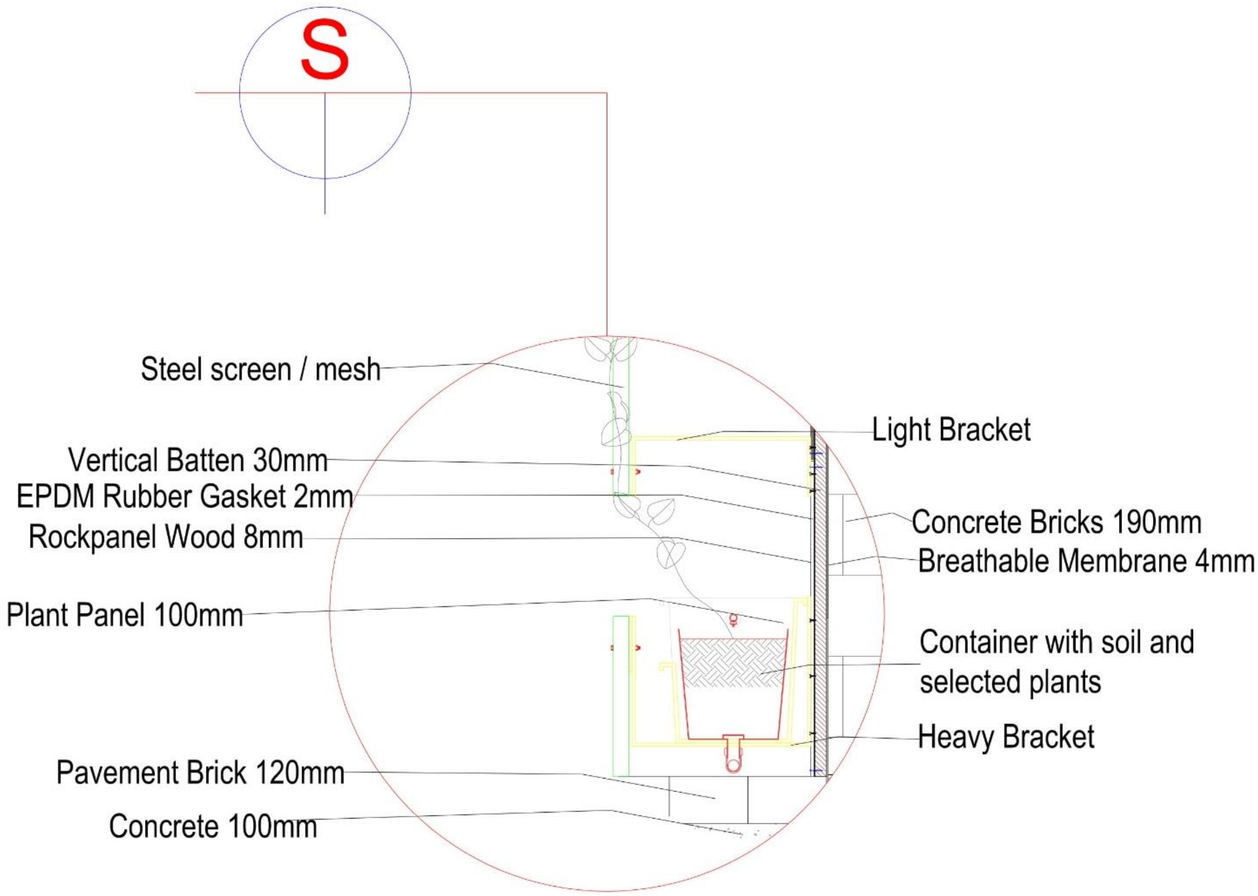


Fig. 5.7.6. Details of Blow Up 3

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12. Design490.org
13. Science Direct
14. Terra Pacific
15. Shadow Analysis Plugin
16. ResearchGate
17. Sefaira Software
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23. Rockwool Company
24. Greenwall.pro
25. Timber Construction Manual
26. Kerto Company
27. Glaazing Vision
28. Indotrading
29. Triplan Danish Quality