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FACULTY OF ENGINEER

POLO REGIONE DI LECCO

MASTER OF SCIENCE IN ARCHITECTURE ENGINEERING

URBAN REGENERATION OF PUNTA SANTA ANNA:

THE GREEN HUB

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I. Introduction

The Philippines is a country in Southeast Asia in the western Pacific Ocean. The neighbors are Taiwan to the north, Malaysia and Indonesia to the south, Vietnam to the west, and China to the northwest (Map 1). It is composed of 7.107 islands between the South China Sea on the west and the Philippine Sea on the east which is the largest groups of islands in the world. Among these islands the major ones are Luzon in the north, the Visayan Islands in the middle, and Mindanao in the south.[1]

[1] City of Manila Socio Economic and Physical Profil 2005, City Planning and Development Office

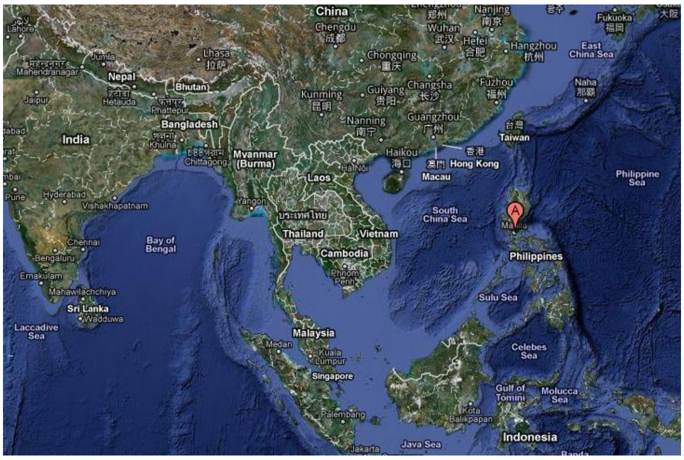


Fig. 2 Location of the Philippines

The city of Manila, which is located at the largest Island of the archipelago, Luzon, is the capital of the Philippines. It is located at the central eastern portion of Metro Manila.

Location

Manila has a land area of 4045.8 hectares including all reclaimed areas along Manila Bay with a coastline length of 190 km.[2] The neighbor cities are Caloocan, Quezon City, San Juan, Mandaluyong, Makati, and Pasay City (Map 2). In the east side of the City Manila, there is Manila Bay. Furthermore, Pasig River traverses the city. These two properties make unique City Manila from other cities in the Metro Manila.(Fig. 3)

[2] *City of Manila Socio Economic and Physical Profil 2005,* City Planning and Development Office

Fig. 4 Map of the Metro Manila

Brief History

Before the arrival of the Spaniards in the 16th century, there already existed a small settlement at the mouth of the Pasig River. At the time of Spanish contact, Maynilad was already a thriving community Archaeological evidences and ancient documents reveal that Manila was an established entrepot and a political and military nerve center of the region around the Manila Bay long before the coming of the Spaniards.

Recognizing the strategic position of Maynila as atrading center and military outpost, Legaspi promptly declared the area the capital of Spain's new colonies on June 24, 1571. The King of Spain, delighted over its new territory, awarded the City a coat of arms and the grandiose title "The Noble and Ever Loyal City." A plan for the City was first drafted based on King Philip II's Royal Ordinance issued on July 3, 1573 in San Lorenzo, Spain.

Spanish colonization was carried out not just by the sword but by the cross. In fact, the establishment of Spanish settlements all over the country were entrusted to and carried out by missionaries. The first community to be brought under the bells" outside of Intramuros was Sapa which the colonizers renamed Santa Ana.

In order for the Spanish to build the large stone walls of intramuros they employed the assistance of the large Chinese population around the area. This in turn developed into a thriving Chinese community grew outside of the city's walls. A flea market in the Chinese quarter outside its northeast gate supplied the residents with food and other necessities.

In time Intramuros became crowded; some of its residents, grown wealthy from the lucrative Manila-Acapulco trade, established secondary homes in choice locations to escape the congestion of the city. Thus were laid the seeds of new towns that eventually became the suburbs of Intramuros.

More than 300 hundred years under Spanish reign came to an end after the islands were ceded to the Americans after the Spanish American war.

Under the Americans, Manila remained the seat of political power. Further developments were brought on by the adoption of Daniel Burnham plan for manila.

Burnham's plan for Manila was in many respects patterned after his design for San Francisco, using the same planning principles that had been applied on the Chicago Fair and the city of Washington D.C. Generally, the Burnham Plan put great emphasis on the Civic Center, linked to various points of the city through wide radial boulevards.[3]

During the 2nd world war manila became one of the most devastated capitals in the Asian pacific region. Redevelopment began shortly after the war.

Expectedly, the city experiences the problems that accompany exceedingly high concentrations of people: housing shortages, unemployment, traffic congestion, problems regarding safety, peace and order, health and sanitation.

[3] ibid

II. Statement of the Problem

Metro Manila is considered as a unique example of the mega-city in the Asia-Pacific region. A megacity is usually defined as a recognized metropolitan area with a total population in excess of 10 million people. Some definitions also set a minimum level for population density (at least 2,000 persons/square km)

Manila is the hub of a thriving metropolitan area home to over 15 million people.

fig. 5 Manila Skyline

Fueled by internal migration, Manila's rapid population has left the Philippine capital unable to provide basic services to the city's population, with an annual growth rate of 2.3. The number of migrants to the city has steadily increased over the last 20 years; a recent study indicates that 1/2 of the population currently living in the Manila metropolitan area was born in the province. The growth that began in the 1970 has coincided with increases in the birth rate.. The rapidly growing population has made it difficult for the government to provide adequate food, water systems, and other services. Most of the migrants come to the city looking for employment and opportunity, but many are left economically trapped, working in low-paying and often grueling jobs. Realizing the dangers associated with the massive urban growth, the government has begun to address the problem.[4]

1- Vulnerability

The Philippines is considered as one of the most disaster-prone countries in the world. Disasters occur frequently, they have a large coverage in areas and severe damages and losses. The following are the hazards experienced by the country, and definitely the City of Manila share or may share the effects.

· The Philippines is located along the typhoon belt in the Pacific. About 22 typhoons visit the country every year, and about five bring about considerable damage

Typhoons

The Philippines is one of the ten most afflicted countries in the world in terms of the number of lives and property lost as a result of damage due to climate, and other disasters these are mainly in

[4] Yamson WN. Manila, mega city

the form of increasing intensities of typhoons visiting the islands annually.

Each year on the average 100 tropical storms form in the world. About two-thirds of them grow into 74 mph or stronger hurricanes, typhoons or cyclones. 30% of these tropical storms in the world form at Western North Pacific Ocean where Philippines located. Map 3 shows the distribution of tropical cyclones.

Because of typhoons Filipinos have been forced to relocate to urban centers, further congesting and expanding informal settlements.

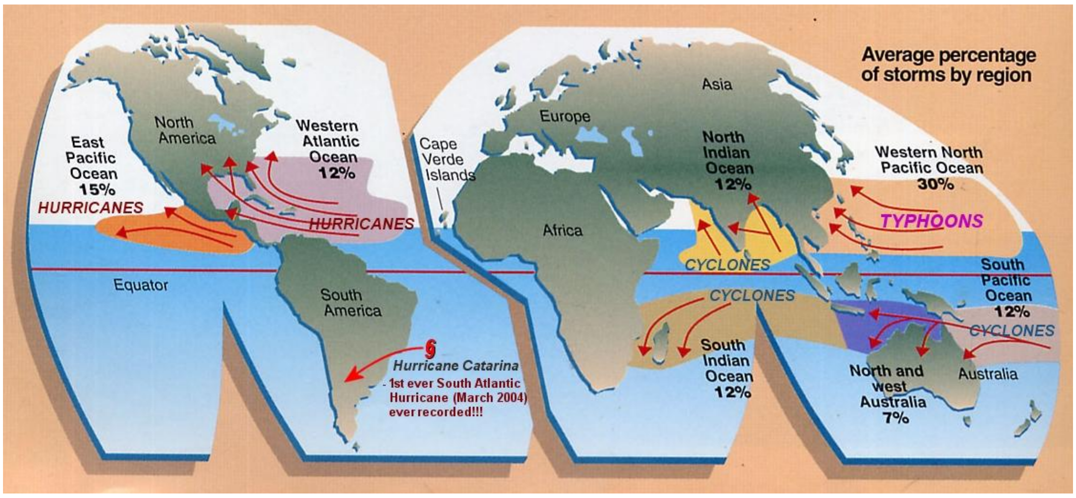


fig. 6 Distribuitions of typhoons around the world

· Aside from typhoons, the South West Monsoon may bring about heavy rain and cause flooding. · El Niño Phenomenon, which is an extensive drought and causes food and water shortage.

· Tsunamis affect the country's coastal areas. The coastal areas of southwest Mindanao are most vulnerable and Metro Manila is likewise susceptible when 7.5 magnitude earthquakes occur.

Earthquakes

Earthquakes are actually experienced everyday, (only with a low magnitude) with 5 quakes per day and 1,825 quakes per year.

Manila is similarly subject to earthquakes on nearby crustal faults, as well as earthquakes on more distant plate-boundary faults. The city has been heavily damaged by earthquakes at least six times in the past 400 years, but the specific sources for the earthquakes are uncertain. The Marikina Valley fault system, on the northeastern edge of the Manila metropolitan area is likely the source one or more of these earthquakes. The proximity to the active fault region, rapid urbanization and population expansion has posed a great threat to the city.

fig. 7 Fault Line System

2- Reasons for Increasing Risk

- Increasing vulnerable constructions,
- Poor building construction regulation and maintenance puts a more increasing risks to life and property.
- unplanned growth of the city near the high hazardous areas
- increasing informal settlements in the form of slums and squatters,

Which Factors Made the City Increasingly Vulnerable?

- Rapidly increasing population and large number of transient population

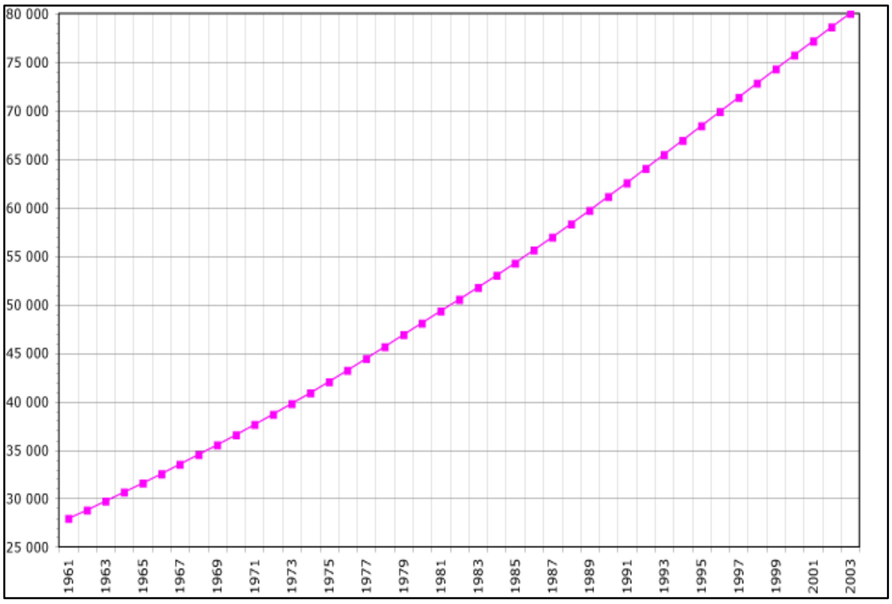


fig. 8 Projected Growth of population

Year	Both Sexes	Male	Female
2000	76,946,500	38,748,500	38,198,000
2005	85,261,000	42,887,300	42,373,700
2010	94,013,200	47,263,600	46,749,600
2015	102,965,300	51,733,400	51,231,900
2020	111,784,600	56,123,600	55,661,000
2025	120,224,500	60,311,700	59,912,800
2030	128,110,000	64,203,600	63,906,400
2035	135,301,100	67,741,300	67,559,800
2040	141,669,900	70,871,100	70,798,800

fig. 9 Projected Population by 2040

- Concentration of industry and economic activities

  The outcome of this concentration is more migrants from the provinces moving towards an already crowded city.

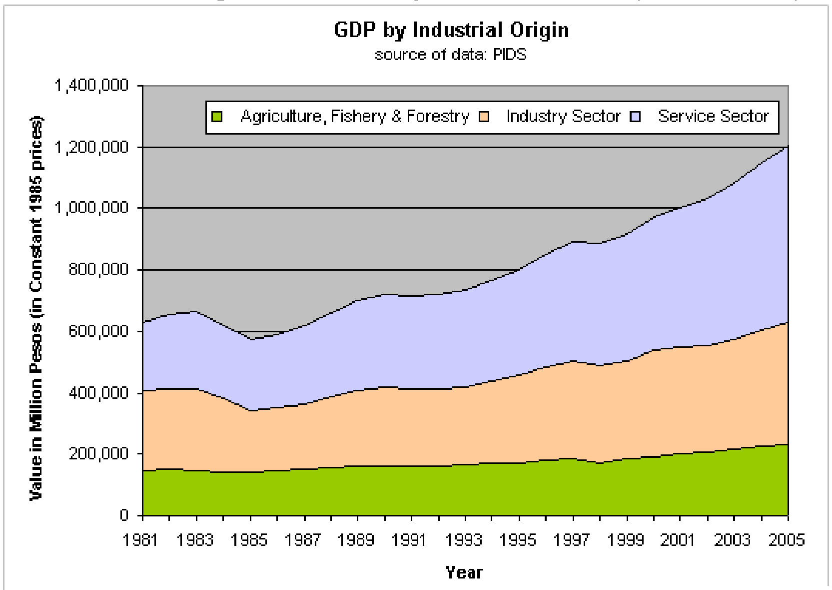
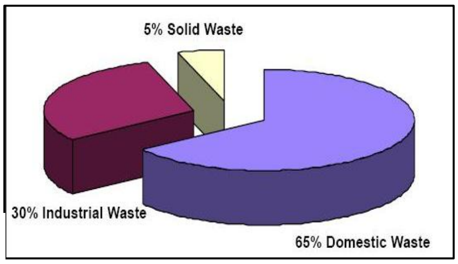


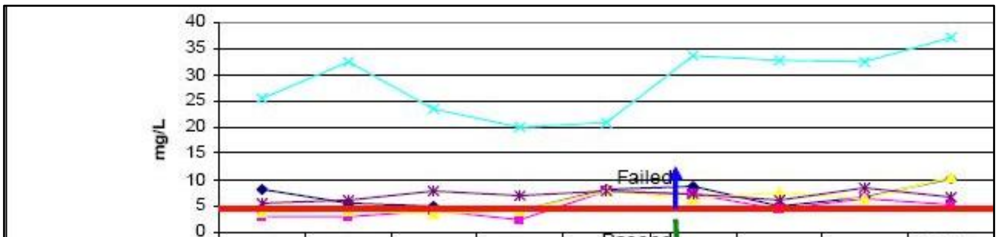
fig. 10 Comparison of growth for each sector

- Increasing number of squatters and slum dwellers.
- Environmental degradation

The graphs below show the water quality of Pasig River. DO is the dissolved oxygen level while BOD is the biochemical oxygen demand which is the measure of the approximate quantity of dissolved oxygen that will be required by bacteria to stabilize organic matter in waste water or surface water. Department of Environment and Natural Resources standard levels are 5 and 7 mg/L for DO and BOD, respectively. However, as it can be seen from the graphs these levels are higher for the Pasig River. The domestic waste contribution has the highest share for the pollution of Pasig River.

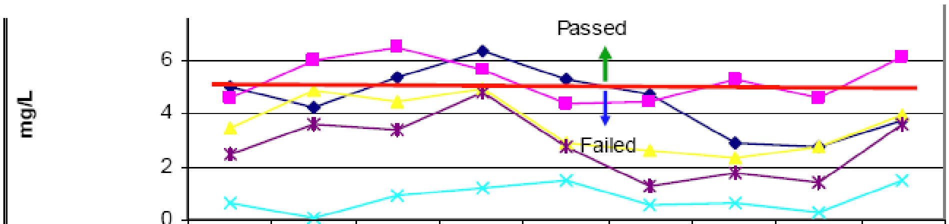
fig. 11Gross domestic waste in river





	1999	2000	2001	2002	2003	2004	2005	2006	2007 as of 2nd Qtr
Marikina	8	5.43	4.83	4	8	8.56	5	6.58	10.17
Bambang	2.93	2.93	3.92	2.40	7.92	7.11	4.46	6.42	5.17
Lambingan	3.75	4.14	3.45	4.11	7.83	6.33	7.54	6.33	10.33
Sanchez	25.42	32.33	23.60	20.00	21.00	33.56	32.67	32.37	37.00
Jones	5.54	6.21	7.75	7.10	7.92	7.22	5.98	8.42	6.67

fig. 12Pasig River Annual Average BOD Level



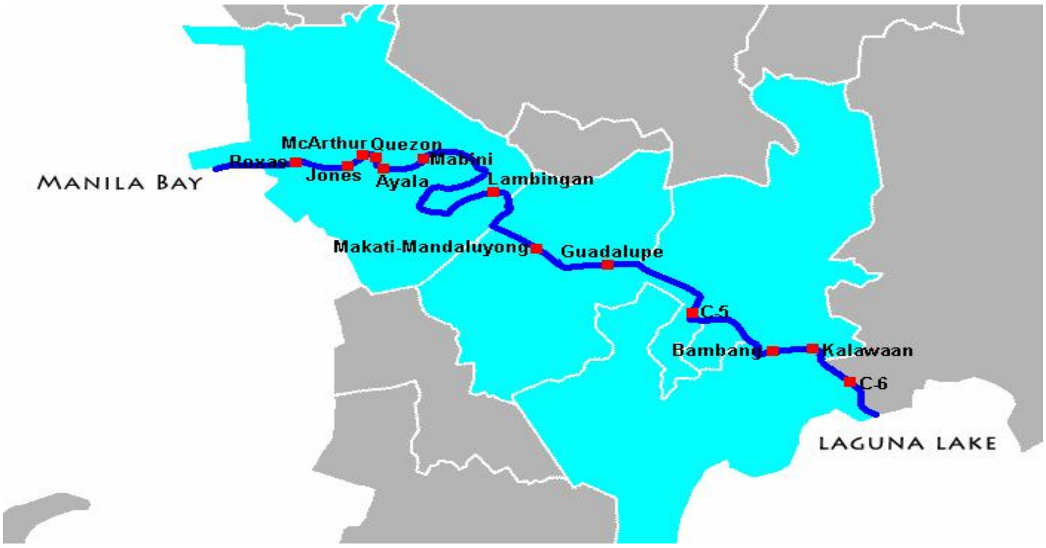
	1999	2000	2001	2002	2003	2004	2005	2006	2007 as of 2nd Qtr
Marikina	5	4.2	5.36	6.34	5.26	4.71	2.85	2.74	3.7
Bambang	4.59	5.97	6.43	5.60	4.32	4.45	5.24	4.58	6.13
Lambingan	3.41	4.84	4.42	4.93	2.90	2.57	2.31	2.76	3.93
Sanchez	0.65	0.04	0.91	1.20	1.49	0.55	0.62	0.28	1.45
Jones	2.47	3.56	3.37	4.79	2.77	1.29	1.76	1.37	3.60

fig. 13Pasig River Annual Average DO Level

- Location of central business districts in the hazard prone areas,
- Construction practices and building stocks,
- Low level of hazard and risk awareness and preparedness,
- Inadequate facilities and planning for emergency responses.

3- Information about Pasig River

The Pasig River is one of the major rivers in the Philippines and, together with Manila Bay and Laguna de Bay, forms the most important natural water system in Metro Manila. It flows north-northwest through the market town of Pasig and bisects Manila, then enters the bay between the North and South harbors.



Map 4: Pasig River

The Pasig River is believed to be the cradle of Tagalog civilization. During the Spain colonial, the river was a main gateway for developing commercial, industrial, and economic system.

Before the mass urbanization of Manila, the Pasig River served as an important means of transport and functioned as the city's lifeline and center of economic activity. Some of the most prominent kingdoms in early Philippine history, including the kingdoms of Namayan, Maynila, and Tondo sprang up along the banks of this river, drawing their life and source of wealth from it. When the Spanish established Manila as the capital of their colonial properties in the Far East, they built the walled city ofIntramuros on the southern bank of Pasig River near the mouth.

Pollution increase

After World War II, massive population growth, infrastructure construction, and the dispersal of economic activities to Manila's suburbs left the river abandoned. The banks of the river attracted informal settlers and remaining factories dumped their wastes into the river, making it effectively a huge sewer system.

Influx of population brought about by industrialization and urbanization of the metro resulted in transforming into sewage and effluents depot

The increasing pollution in the river was first noticed in the 1930s when it was observed that fish migration from Laguna de Bay diminished. People ceased using the river's water for laundry in the 1960s and ferry transport declined. By the 1970s, the river started to give offensive smells and in the 1980s, fishing in the river became nonviable. Pasig River was considered biologically dead in the 1990s.

1850	Spanish dwellers noticed the waters of Pasig River slowly losing its pristine quality. They resorted to a method of using sand and charcoal to maintain its potability.
1930	Decreased in fish migration
1950	Noticeable drop in the people's bathing activities
1960	Obvious drop in both bathing and washing activities
1970	The river began to smell bad and water quality fell below Class "C" level
1980	All fishing activities stopped
1990	Was declared biologically dead

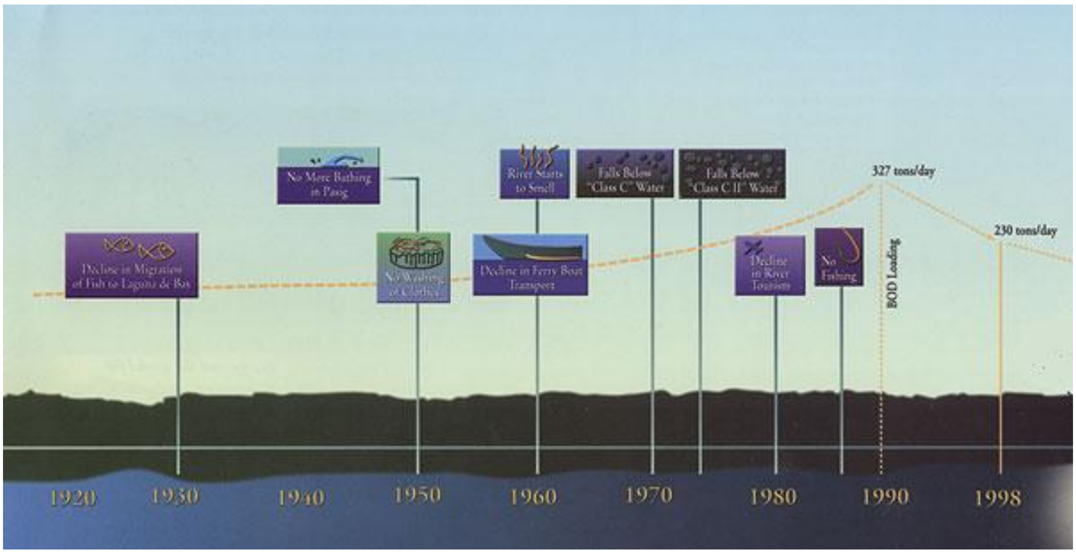
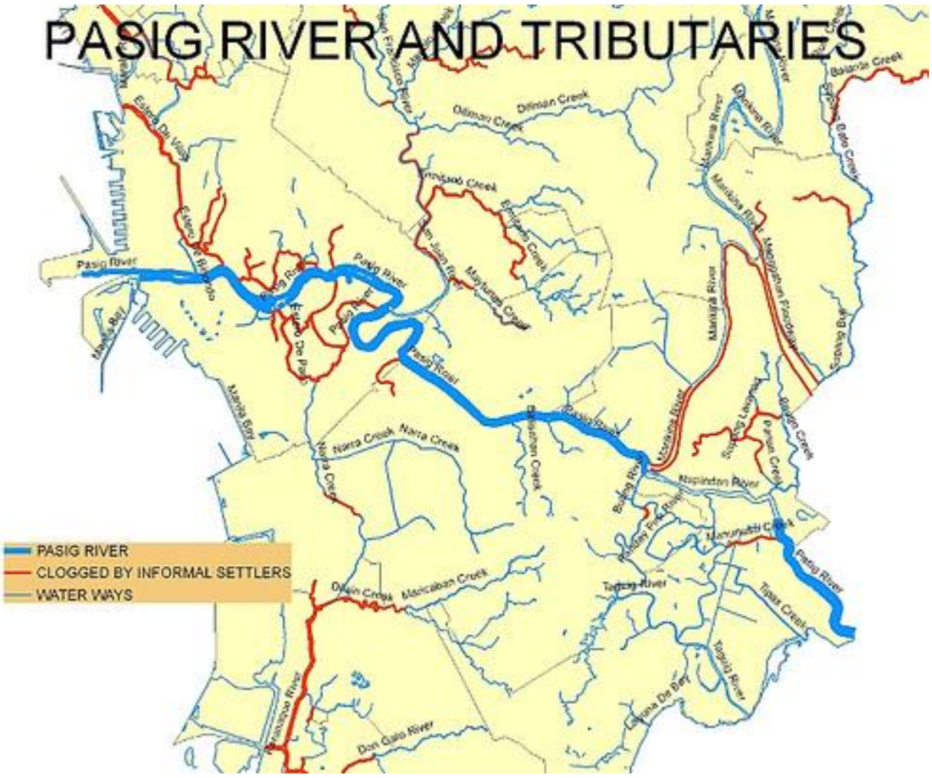


fig. 14 Choronology of Pasig River

fig. 15 Pasig River in the 1990s

The banks of the Pasig River are lined by squatter colonies consisting of approximately 12.000 households. About 2,000 families live in houses on stilts or under the bridges, in sub-human conditions, where they present a danger to themselves and to the vessels using the river. These settlements have no sanitary facilities and their liquid and solid wastes are discharged straight into the river.

Pasig River is shimmering with oil slicks, has unpleasant odor, dark colored water, hyacinth blooms, and floating garbage and feces. The river is also known to have high organic loads and contaminate with heavy metals, pesticides, nitrates, and phosphates (NPCC, 1981 & 1985; RRS, 1991 & 1998).



Map 5: Informal Settlers Distribution around Pasig River

The combination of old drains and rubbish result in blockages in the system. In a flood in 1986, the whole of Metro Manila was submerged in water reaching a depth of 2.1 meters in some areas. The situation was realized during the 2009 Ondoy Typhoon.

fig. 16 Effect of river flooding

Rehabilitation

In December 1989, the government began working on a comprehensive rehabilitation program for Pasig with Denmark. The Pasig River Rehabilitation Program (PRRP), was an integrated effort to bring back ecological health to the river system.

Past efforts to rehabilitate Pasig River were unsuccessful because they failed to take into account the larger context of the urban environment of which Pasig River is a part.

The most successful project so far is the establishment of the Pasig river ferry.

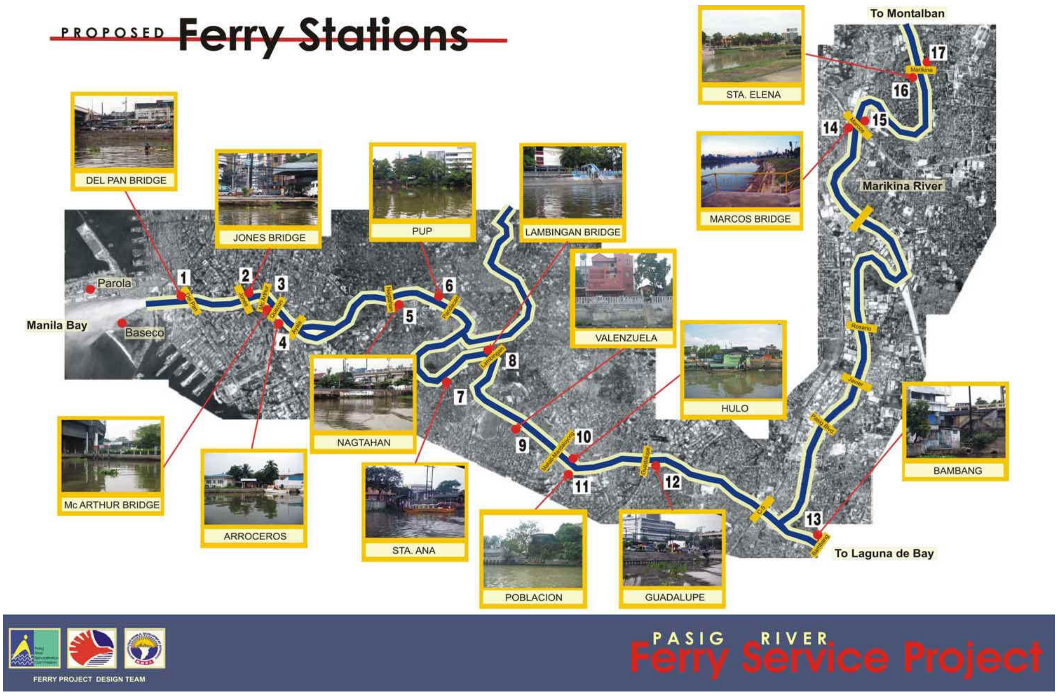


fig. 17 Map of all the ferry stations

III. Project Proposal

"Urban regeneration of areas around the river Pasig."

The proposal looks into the importance of the river to the city and its negative effect to it, at its present condition. There is a high possibility to be regenerated due to the current government programs such as the PRRP and the introduction of URA(Urban Renewal Areas)

The proposal is to present an urban regeneration project for the sites along Pasig River. The sites are abandoned or not abandoned industrial sites, the sites that were heavily affected by the recent natural disasters and, the sites that are either damaged by the typhoon affected by it or the generally run down areas.

fig. 18 The River and the City

IV. Project Objectives

Greening the river banks

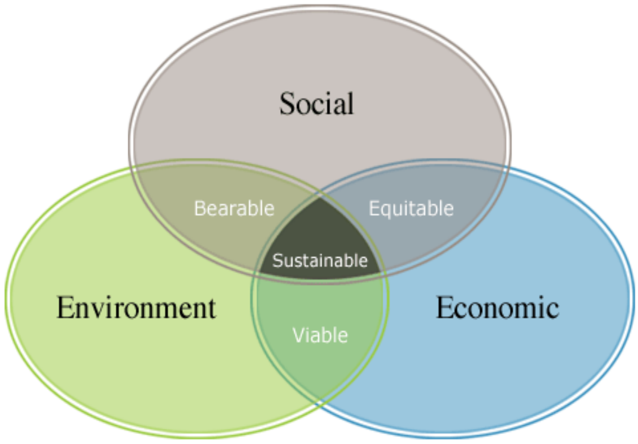
Recreation and tourism development

Reconnect Pasig River to urban context

Utilizing the river in transportation,

New quality of urban life, Change the identity of the river

Sustainability in the building environment and community,



V. Site Selection Criteria

For the Proposal three project sites went under consideration. The sites selected are described with the following criteria:

The Site should be:

- Site Along the Pasig river
- Site is of adequate size for an urban planning study
- Sites considered defined different typologies of development
- Sites considered are found in different development zones

Zones around the river:

  - Forest zone
  - Upland zone
  - Urban zone
  - Coastal zone.

- Sites are well connected to the entire metro manila
- Sites with a high potential to be developed
- Sites with social and cultural significance (this point will help with the point above)
- Site should be classified for urban development

VI. Site Selection

For this project we have observed three different site areas along the Pasig River, henceforth named 'The Gateway', 'Lakeshore City' and 'The Green Hub'. After analyzing each site areas, it has been decided to focus on the third site which is 'The Green Hub'. The summary and the detailed information of each site areas are as follows:

AREA 1: THE GATEWAY

The gateway is located along the coast of manila bay. Its is therefore classified as in a coastal zone. The present land use classification of the area is of industrial use. At present, the site is inhabited by informal settlers. Only a minor part of the peninsula is used by the sea port adjacent to it.

the gate way site is located at the mouth of the pasig river. Historically this is the entrance point of trade ships that once served the river. The site also is adjacent to the historical city of intramuros. The development of this site offers a wide range of possibilities.

The site offers a significant amount of cultural significance and for this reason it has a very high possibility for development.

The site being located along the bay and the river gives the gateway a unique connection to the city. Access to other parts of the city can easy be achieved through water based transport.

nnected to the roxas blvd. roxas blvd is the coastal road that runs along the coast of manila bay. This blvd connects the southern provinces of manila to the center.

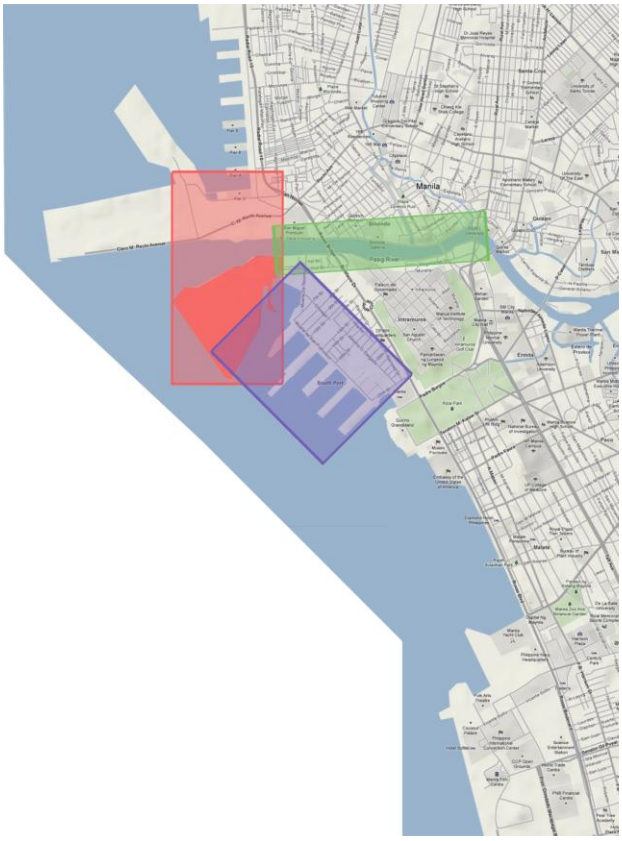
It is also worth noting that recent developments along the manila bay coast have increased in the past few years. Within close vicinity to the gateway site is a newly built underwater aquarium.

Introductions of new touristic spots combined with the historical location of the site are the primary consideration taken for the site selection justification.

The scale of the site can be observed in the image below. The outline of the site is compared to the size of the center of lecco.

fig. 19 Scale of area 1

fig. 20 Images of Area 1



Project program proposals are as follows :

District 1: Sea Port Terminal

- Create a new gateway to the country

District 2: Mixed use Area

-New Commercial and Business area integrated with the historic business district and new sea port

- Cultural facilities to support the historical Spanish city Intramuros

District 3: Linear Parks

- Development of Linear Parks to reconnect the river to the urban fabric.

AREA 2: THE LAKESHORE CITY

The lake shore district is the largest site selected for consideration compared the site to the dimension of lecco, it is nearly three times bigger.

The lakeshore site offers some interesting points of development. Currently the site is not connected to the metro. Although a new arterial highway is being constructed and it would run across the site.

The lakeshore site is also located on the mouth of pasig river on the lake side. this enables the site to be directly connected to the metropolitan via the river.

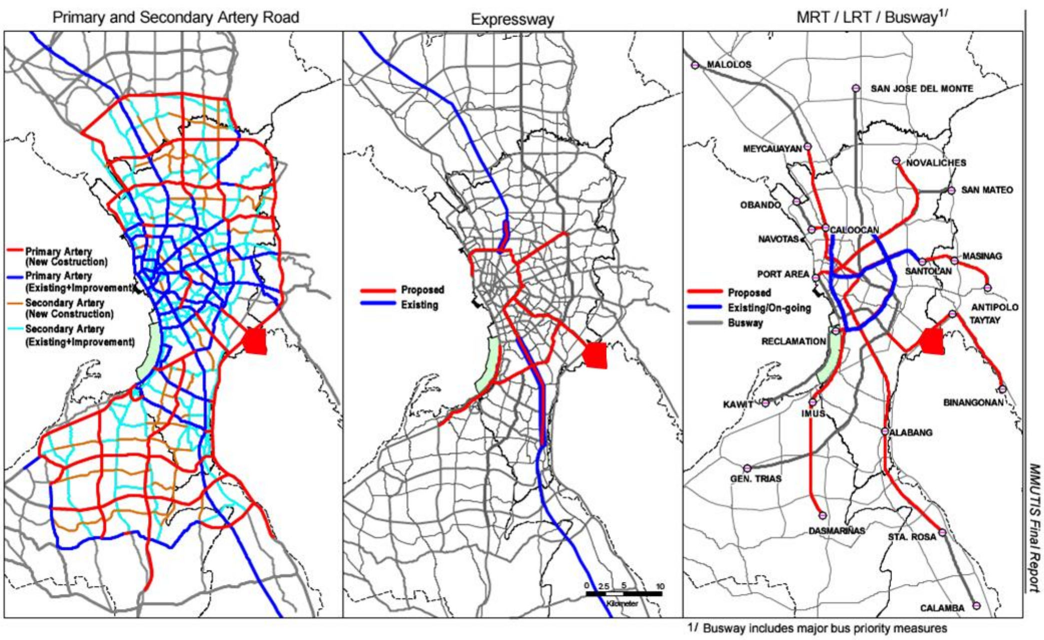
An old historic town is also within close vicinity to the site.

The development of this area is almost certain. Once the new highway is finished this district will undergo dramatic transformations from its present condition. Currently the site area is classified as an agriculture zone. Although because of the construction of the new highway, informal settlers have take the chance to set up shanty homes along this area.

Historically the city of manila has not been directly connected to the lake. The only connection before was the river. An establishment of a new city center in this zone may provide the opportunity to finally create a direct connection between the citizens of manila to the laguna lake

fig. 21 Site 2 Scale

fig. 22 Proposed Transport

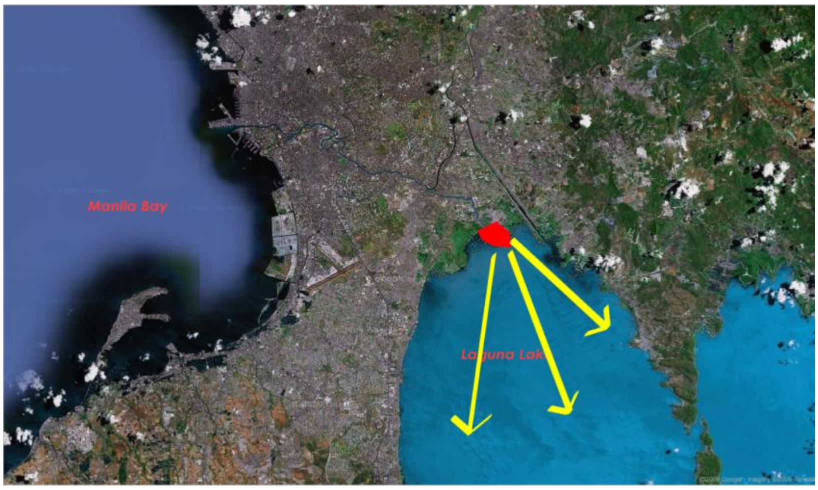


The proposed project programs are as follows :

-Create the first Green City in Manila

-Establish a new relationship to the Lake.

-Re-establish old connections with the Spanish towns along the lake



AREA 3: THE GREEN HUB

The third site is the green hub. In line with the criteria proposed, the site is located along the river. It is also located within the district of manila, in Santa ana . its current land classification is industrial, but the actual site condition is mixed.

The site scale is similar to that of lecco. Its central location makes it ideal for an urban planning study.

This area selected is also located in a historic district. Santa Ana is as mentioned the second town established by the Spanish after intramuros.

The site is well connected by the river, rail network, and road network of manila.

The site is also classified as an urban renewal area by the PRRC.

The proposed project programs are as follows:

The criteria for the selection of the programs are discussed in the following chapters.

-Mixed used Residential/Cultural/Educational Facilities

-Develop Support facilities for the schools and Universities around the University-belt (such as libraries, theatres, dormitories, and gymnasium).

-Develop a large urban park integrated with the linear parks

-Create a central meeting place, a “Cultural Hub”, for the metro Manila

Site selection Justification

The selected site for the study is the green hub. Its selection among the three, merits from its satisfying all of the requirements of the site selection criteria.

The main Consideration for its selection was first, on the probability of development in the future. The green hub being already classified as an urban renewal area validates this choice. Second, its central location, makes it an important hub in the city. And finally, the size of the project was deemed acceptable for a m.sc. Thesis, as compared to the others, which are too large.

VII. Project Scope of work

The project will focus on the development of a residential building. A concept plan will be proposed for the entire site area of the green hub, while master plan will be proposed only for the selected building zones.

Studies will be made pertaining to the development of the urban plan and the process of the study will be outlined in the succeeding chapters.

A detailed master plan proposal about the building typology will be made and a succeeding architecture design study will be done.

This architecture design study will cover all aspects of design which convenes to an urban renewal project and to the extent of what the urban study dictates to be developed. Detailed plans and elevations will be produced to show the solution of the architecture design study.

Further studies for the implementation of the structure and technological design of the building will be made.

Chapter 2 Urban Design

I. Site history and Characteristics

1- History of Punta Santa Ana

A lot is not known about this small peninsula. The Island across the river, known as Punta Santa Ana, which was called "May Dila" for its shape is like a tongue before the period of the Spanish colonization. This place has also been coined “Little Tondo” for violent riot ravage this area during the 70's till late 80's its grim reputation still haunts the area today.

. From the urbanization during the American period, to the industrialization after the Second World War as part of the rebuilding of Metro Manila, this little place had undergone rapid changes in the past 50 years. Countless numbers of industries built up its factories along the once pristine River Pasig, taking advantage of its location at the heart of the metro, using it as a primary transportation connection to the port area along the bay. And progress continued forth while they neglect the environmental impact of they leave behind.

The rapid growth of the metro also brought with it an increase of informal settlers along the river banks. Punta Sta. Ana was one of the areas that were profoundly affected by these events.

Although a lot have changed since that time, the informal settlers have been relocated and the old industrial zones are slowly converted into residential areas. The improvised houses that once lined the river have been demolished to make way for linear parks for recreation and leisure. With the efforts of the citizens of the area the environment around the area has changed. The once polluted Pasig River, which wraps around the peninsula, through local and international efforts is now slowly springing up back to life.

In fact this area is also riddled with a long history. Little do the inhabitants of the area know, this place is Manila actually gets its name. This area was the route the early Spanish explorers took towards the capital. As the story goes, this area was once abundant in grass called "maynilad". The locals where so confused, when Spaniards asked the name of the place, and thought that they could be asking about the grass so they answered “maynilad”. And so the name stuck.

The original name of the region of Santa Ana, before the arrival of the Spanish conquistadors was Namayan. It was part of a Muslim kingdom’s domain that stretched from what are now Mandaluyong, Makati, Pasay, and the Manila districts of Pandacan and Paco.[1] Historical records suggest that this was where the original Royal Malayan Tribe resided.

The Spaniards established one of the first settlements in Santa Ana. The settlement started after the conquest over the Malayan tribes in what is now called “Intramuros” or the city within the wall, the first city established by the Spaniards as the capital of the Philippine islands. Santa Ana served as the seat of Namayan region. The area was awarded to the Franciscan missionaries.

When the Catholic missionaries asked the natives the name of the area, they pointed to the banks of the Pasig River. The locals responded with "sapa" or the Tagalog word for marshes, thinking they were referring to the terrain instead of the place name.[2]

[1] Punta Santa Ana, http://ph.pagenation.com/mnl/Punta.htm

[2] Manila, http://it.wikipedia.org/wiki/Manila

The Franciscan missionaries henceforth dedicated the district to Saint Anne, the mother of the Blessed Virgin Mary, and called it, Santa Ana de Sapa, or "Saint Anne of the Marshes".

As part of the Spanish empire the country had gradually developed and only in the 1900's, did the Chicago-fame architect Daniel H. Burnham came to the Philippines on an invitation from the government United States Government to plan a modern Manila. Development in the Philippines during the Spanish time was more decentralized as different capitals were established in the different regions and island. For manila, the city then had a population of only a hundred thousand, but Burnham envisioned, as political and social change was in the air for a more centralized government, a metropolis inhabited by millions with multi-lane avenues radiating from its central districts, similar to the design of Washington D.C., the United States capital.[3] The area of Punta Santa Ana was originally designated as the green center of the metro *Fig. 1.* A large garden was proposed on its site connected to the city center by one of the main arteries leading out of the Roxas Boulevard.

[3] The Aborted Plan of Daniel Burnham, http://wordpress.com

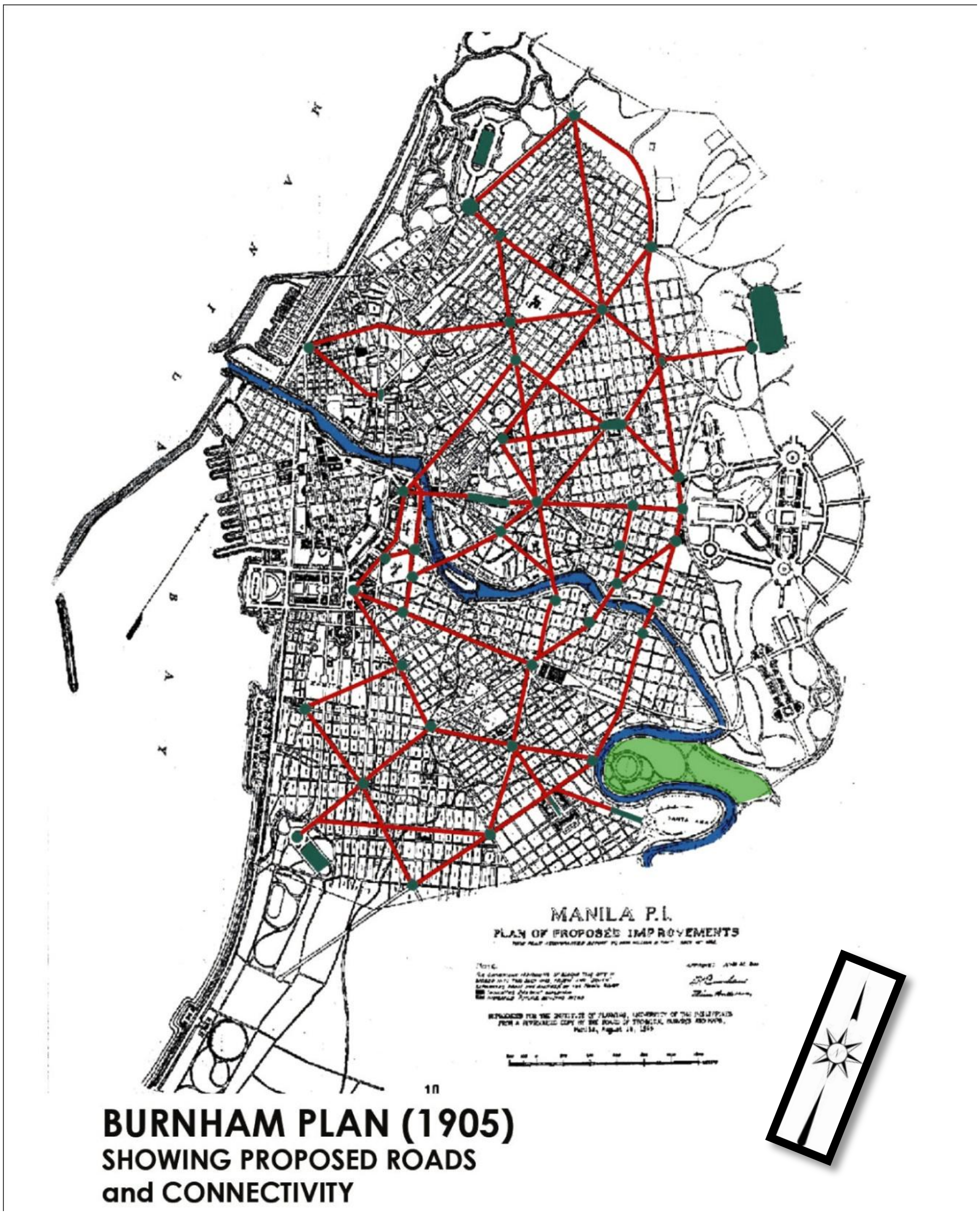


Fig. 1 Punta Santa Ana shown in green, the main arterial roads radiating from the coast line and the Government buildings, shown in red

2- Geographical location and physical features:

Santa Ana is a district of the City of Manila in the Philippines, located at the southeast banks of the Pasig River, bounded on the northeast by Mandaluyong City, Makati City to the east, southwest is the Manila district of Paco, and to the west, Pandacan. (***Fig. 2***)

Punta Santa Ana belongs to Santa Ana district, the 6th congressional district of Manila and is part of the thirty-two barangays from Zone 96 to 100, barangays 874 to 905, with barangay 890-905 located within its borders. Based on the 2000 national census, the National Statistics Office reports that Santa Ana has about 34,694 households, and an approximate 83,306 registered voters based on the national elections of 2004. [4]

3- Topography and geology

The topography is relatively flat with some portions actually below sea level so during high tide, the sea water goes about two kilometers inland along the Pasig River towards its source, the Laguna de Bay, a fresh water lake.

Almost all of Manila's soil sits on top of centuries-old prehistoric alluvial deposits built by the waters of the Pasig River. Most part of the Punta Santa Ana sits on a fill of sand gravel, and clay as a result of elevation of the site for flood protection from the river

[4] MCLUPZO 2005-2020

Pasig.[5] The soil in the area is composed mainly of medium dense sand and firm clay. 4- Hydrology

A good part of Manila is situated in swamps and marshes which include the Punta Santa Ana on its northern banks of Pasig River which directly bisect Manila. Its proximity to the sea and major waterways makes it a strategic location for trade and commerce. (*Fig. 3*)

The Pasig River surrounds Punta Santa Ana on three sides. The San Juan River borders on the north of the site.

Due to the high risk of flooding caused by the blockage of these water ways, the City Engineer's Office of Manila has started to undertake in cleaning of these water areas, also imposing development setbacks to prevent construction of new structures along the river. However, the problem of limited funding has temporarily stalled the completion of the project.

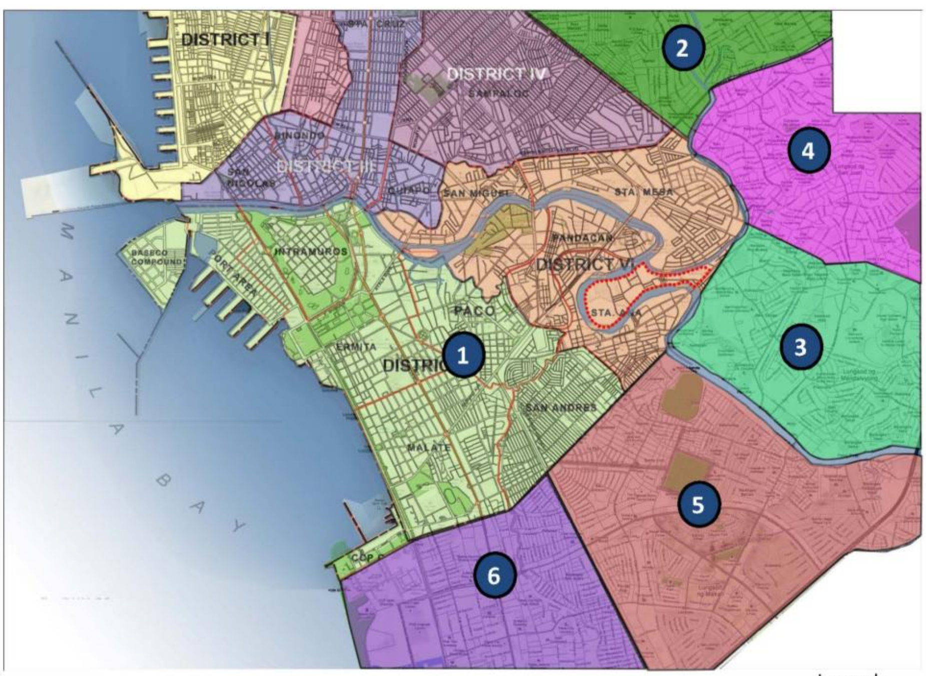


Fig. 2 Map showing municipal site boundaries

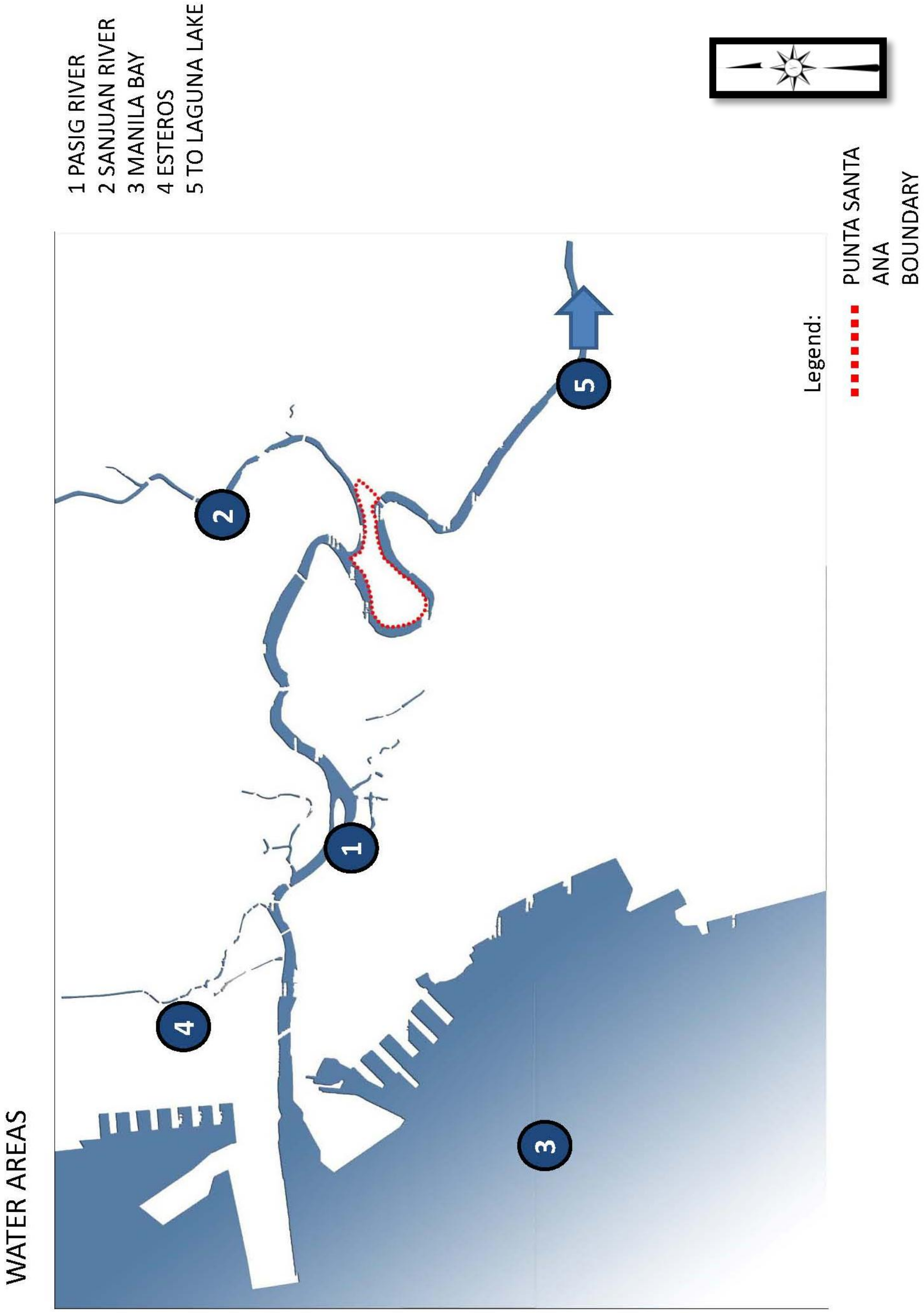


Fig. 3 Hydrology Map

5- Climate

According to the Coronas Classification, Manila's climate belongs to the 1st Type, which has two pronounced seasons - dry from November to April and wet during the rest of the year.[6] A climate station by the Philippine Atmospheric, Geophysical and Astronomic Services (PAGASA) is located in the Port Area providing daily monitoring of climate variables as rainfall depths, air temperature, wind speed and directions, dry and wet bulb temperature, relative humidity, cloudiness and barometric pressure.

According to the results, Manila's annual mean temperature is 28.2 0C ranging from 25.2 - 31.2 0C. Heavy rains usually occur during the months of July and August, with monthly rainfall reaching 486 mm. The highest number of rainy days is 22 per month occurring during the wet season.

Table 1 Climatological Normals

STATION : 425 PORT AREA (MCO), MANILA
LATITUDE : 140 35' N
LONGITUDE : 1200 59'
ELEVATION : 16.0 M.
PERIOD : 1971 2000

MONTH	RAINFALL MM	NO OF RD	TEMPERATURE DEG. C						VP MBS	RH %	MSLP MBS	DIR	SPD MPS	CLD OKT	DAYS TSTM	WITH LTNG
			MAX	MIN	MEAN	DRY BULB	WRT BULB	DEW PT								
JAN	19	5	29.5	23.5	26.5	26.5	22.6	21	24.7	71	1012.8	E	3	6	0	0
FEB	7.9	2	30.5	23.8	27.1	27.1	22.6	20.8	24.3	68	1012.8	SE	3	6	0	0
MAR	11.1	2	32.1	24.9	28.5	28.4	23.3	21.3	25.1	65	1012.1	SE	3	6	0	1
APR	21.4	3	33.5	26.2	29.9	29.8	24.5	22.6	27.1	65	1010.5	SE	3	6	2	3
MAY	165.2	10	33.2	26.7	30	29.9	25.5	24	29.6	70	1009	W	3	6	10	13
JUNE	265	17	32.2	26.2	29.2	29.2	25.7	24.5	30.6	76	1008.4	W	3	7	12	13
JULY	419.6	21	31.1	25.8	28.5	28.4	25.5	24.5	30.6	79	1007.9	SW	4	7	14	13
AUG	486.1	22	30.6	25.5	28.1	28	25.4	24.5	30.6	81	1007.6	SW	4	7	11	9
SEPT	330.3	20	30.9	25.5	28.2	28.1	25.4	24.5	30.6	80	1008.5	SW	3	7	14	12
OCT	270.9	17	30.9	25.5	28.2	28.1	25	23.9	29.5	78	1008.9	W	3	7	8	9
NOV	129.3	12	30.7	24.9	27.8	27.8	24.3	23	28	75	1010.4	NE	3	7	3	2
DEC	75.4	9	29.7	23.9	26.8	26.8	23.2	21.8	25.9	74	1012.1	NE	3	7	1	1
ANNUAL	2201.1	140	31.2	25.2	28.2	28.2	24.4	23	28.1	74	1010.1	SE	3	7	75	76

source: PAGASA

[6] City of Manila: Social Economic Profile city Planning office 2005

Very Low Risk Zones	Low Risk Zones
Caloocan City	Pasay City
East	Sampaloc
Malabon	Pandacan
Valenzuela	East Marikina
Novaliches	
Quezon City	
San Juan	
Mandaluyong	
Makati	
Parañaque	
High Risk Zones	**Very High Risk Zones**
Southeast Marikina	Downtown Manila
Ermita	
Malate	Sta. Cruz, Binondo and Port Area
Navotas South Marikina	Roxas Boulevard
	Pasig Pateros East Taguig Coastal town of the Marikina Valley plain

Table 2 Building Vulnerability

6- SEISMICITY

The City of Manila is physically and socially vulnerable to earthquake related hazards such as liquefaction and ground shaking. The July 1968 earthquake proved devastating to the business community and to the public in general. [7]Earthquakes greatly affect both economic and social interaction. While the implementation of building and structural codes should be emphasized, retroactivity in applying earthquake resistant technologies or sophisticated structural measures (retrofitting/ re-engineering) cannot be immediately applied to older, substandard and hazardous buildings. In this respect, the city's efforts should lean towards the coping mechanisms to earthquake related disasters,

[7] City of Manila: Social Economic Profile city Planning office 2005

focusing on response during earthquake events and recovery. A general vulnerability analysis of various areas in Manila is shown in ***Table 2***. Geological Risks of various areas in Metro Manila. Those areas under very high risks include downtown Manila (covering Quiapo, Intramuros, Sta. Cruz, Binondo, and Port Area) and the Reclamation Area (along Roxas Boulevard). Punta Santa Ana is located at a high to very high seismic zone. Punta Santa located in very high risk zone. The soil composition of medium dense sand and firm clay makes the project area vulnerable to earthquakes.

1- Historical analysis

Pre-Spanish Period

Earliest records of pre Hispanic settlements in manila came from the documents of the Spanish explorers. In the area where they settled there were several known settlements that were once part of Malayan kingdoms, which ruled the area. [8]

The earliest inhabitants of Manila area are maritime-oriented people, where they traded with other Asian countries during the subsequent period bringing influences from Hinduism, Buddhism, and Islam. There was no unifying political state encompassing the entire Philippine Archipelago. Instead, the islands were divided among competing aristocracies ruled by various datus, rajahs, or sultans. Among these were the kingdoms of Maynila, Namayan, and Tondo.[9] ***Fig. 5*** Some of these societies were part of the Malayan empires of Srivijaya, Majapahit, and Brunei [10]

Fig. 4 The ancient Tondo kingdom established before the arrival of the Spanish (above) exhibits a strong Chinese influence up to the present (below)

e

once located in the

[8] Ibid

[9] History of Philippines, http://en.wikipedia.org/wiki/Philippines

[10] City of Manila: Social Economic Profile city Planning office 2005

Spanish Period

In 1521, Portuguese explorer Ferdinand Magellan arrived in the Philippines and claimed the islands for Spain.[30] Colonization began when Spanish explorer Miguel López de Legazpi arrived from Mexico in 1565 and formed the first European settlements in Cebu. In 1571, after dealing with the localroyal families in the wake of the Tondo Conspiracy and defeating the Chinese pirate warlord Limahong, the Spanish established Manila as the capital of the Spanish East Indies.[11]

Upon the arrival of Spanish colonizers settled in Intramuros ***Fig***. *7* located along the banks of manila bay, and gave Santa Ana, the former capital of the Namayan kingdom, to the Franciscan order where they established the church.

Intramuros, located along the southern bank of the Pasig River, was built by the Spaniards in the 16th century and is the oldest district of the city of Manila, the capital of the Philippines. Its name, in Latin, intramuros, literally "within the walls", meaning within the wall enclosure of the city/fortress, also describes its structure as it is surrounded by thick, high walls and moats. During the Spanish colonial period, Intramuros was considered Manila itself.

It was completed in 1606 and it served as the center of political, military and religious power of the Spaniards during the

[11] City of Manila: Social Economic Profile city Planning office 2005

time that the Philippines was a colony of Spain. Inside Intramuros; there are several Roman Catholic churches, like the Manila Cathedral and the San Agustin Church, convents and church-run schools, such as the Universidad de Santo Tomás, the Colegio de San Juan de Letrán and the Ateneo Municipal de Manila, which were usually being run by religious orders such as the Dominicans, Augustinians, Franciscans and Jesuits.

As for Punta Santa Ana, it is not known to have been inhabited but more likely it remained as a marshland during the period.

Shown in ***Fig. 8*** Spanish towns developed along River Pasig. Pandacan became an important trading point located east of Punta Santa Ana.

Officially Pandacan was established as a community in 1574 when Franciscan priests of the Roman Catholic Church established the first mission in the district. Pandacan was originally part of the parish of Sampaloc but was later established as a separate parish in 1712.[12]

Pandacan was a farming community, producing small quantities of rice and sugar that were sold to the Spanish enclave in Intramuros. Aside from a few vegetable plots, the old Pandacan produced bricks & tiles, cotton laces in various colors but in

[12] History of Pandacan Manila, http://en.wikipedia.org/wiki/Pandacan

limited quantities. The district also produced shoes and small boats.

The town of San Juan located in the north was also established during the same period, it located on top of a small hill overlooking the river. During the pre-Hispanic period, the village of what is now San Juan was a part of the Kingdom of Namayan.[13] ***Fig. 8***

Spanish rule contributed significantly to bringing political unity to the archipelago. From 1565 to 1821, the Philippines were governed as a territory of the Viceroyalty of New Spain. Roman Catholic missionaries converted most of the lowland inhabitants to Christianity and founded schools, a university, and hospitals. While a Spanish decree introduced free public schooling in 1863, efforts in mass public education mainly came to fruition during the American period.[14]

American Period

In 1898, the Spanish-American War began in Cuba and reached the Philippines. The Philippines declared independence from Spain in Kawit, Cavite on June 12, 1898 and the First Philippine Republic was established the following year. Meanwhile, the islands were ceded by Spain to the United States in the 1898 Treaty of Paris. As it became increasingly clear the

[13] History of San Juan, http://en.wikipedia.org/wiki/San_Juan,_Metro_Manila
[14] Ibid

United States would not recognize the First Philippine Republic, the Philippine-American War broke out. It ended with American control over the islands which were then administered as an insular area.

As the country's premier city, Manila's business and commercial activities intensified. Expansion in the Binondo, Port Area, Southern Manila Bay and other districts became rapid. ***Fig. 9***. These areas were also underwent industrial transformations. Social and cultural institutions proliferated during this era.

1904, Daniel H. Burnham and his assistant Pierce Anderson arrived in Manila to study existing conditions of its environs. Their report, along with detailed plans and descriptions were submitted in January 1906 and adopted by the Board in June 1906.[15]

Late in the Spanish era and into the American regime, Pandacan was developed into becoming the first industrial estate in the Philippines. The first modern manufacturing company was built in Pandacan and was called the Compania General de Tabacos de Filipinas in 1882, a modern cigar making plant.

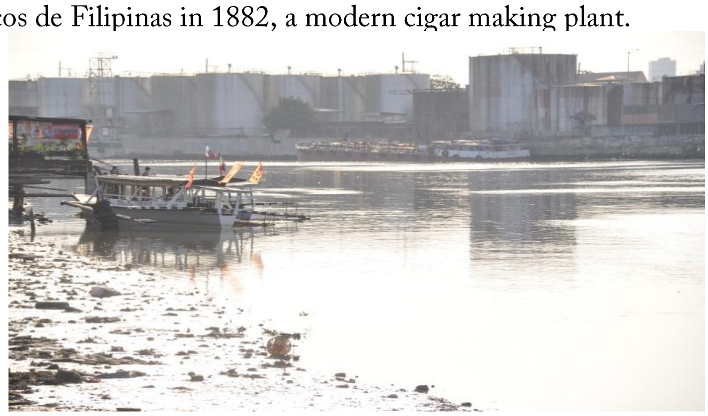


Fig. 5 Pandacan Oil Depot (View from Punta Santa Ana)

[15] City of Manila: Social Economic Profile city Planning office 2005

By the turn of the 19th century, the American colonial government decreed the surrounding area along the river Pasig as the center for industrial activity and had oil companies build their storage and distribution facilities in the districts. ***Fig. 6***

The advent of the Second World War in 1941-44 left the city in ruins. In the Pacific region, Manila was the most devastated capital with many of its historical landmarks destroyed.[16]

Post war Period

The New Philippine Republic wasted no time in rehabilitating the city. It set up the National Urban Planning Commission especially to address the needs of the war-torn land. Post war brought with it rapid industrialization of the area. Sites along the river became highly valued by industry because of transportation of materials.

New districts established, beyond the old boundaries of the city before the war, such as Makati City, Mandaluyong City, Ortigas City, and Global City, more migrants are coming in from all over the country towards the already stressed Manila infrastructure.

[16] City of Manila: Social Economic Profile city Planning office 2005

For Punta Santa Ana, this rapid industrialization brought with it large industrial plants, to maximize the river transportability. Heavy industries developed along the river and the need for manpower also grew. The larger manpower demand also resulted caused an increase of informal settlers around the river. The informal settlers made use of some of the free and unused land. Some of the lands were private and some of the lands that were occupied were the government required setback on the river.

Pre spanish period

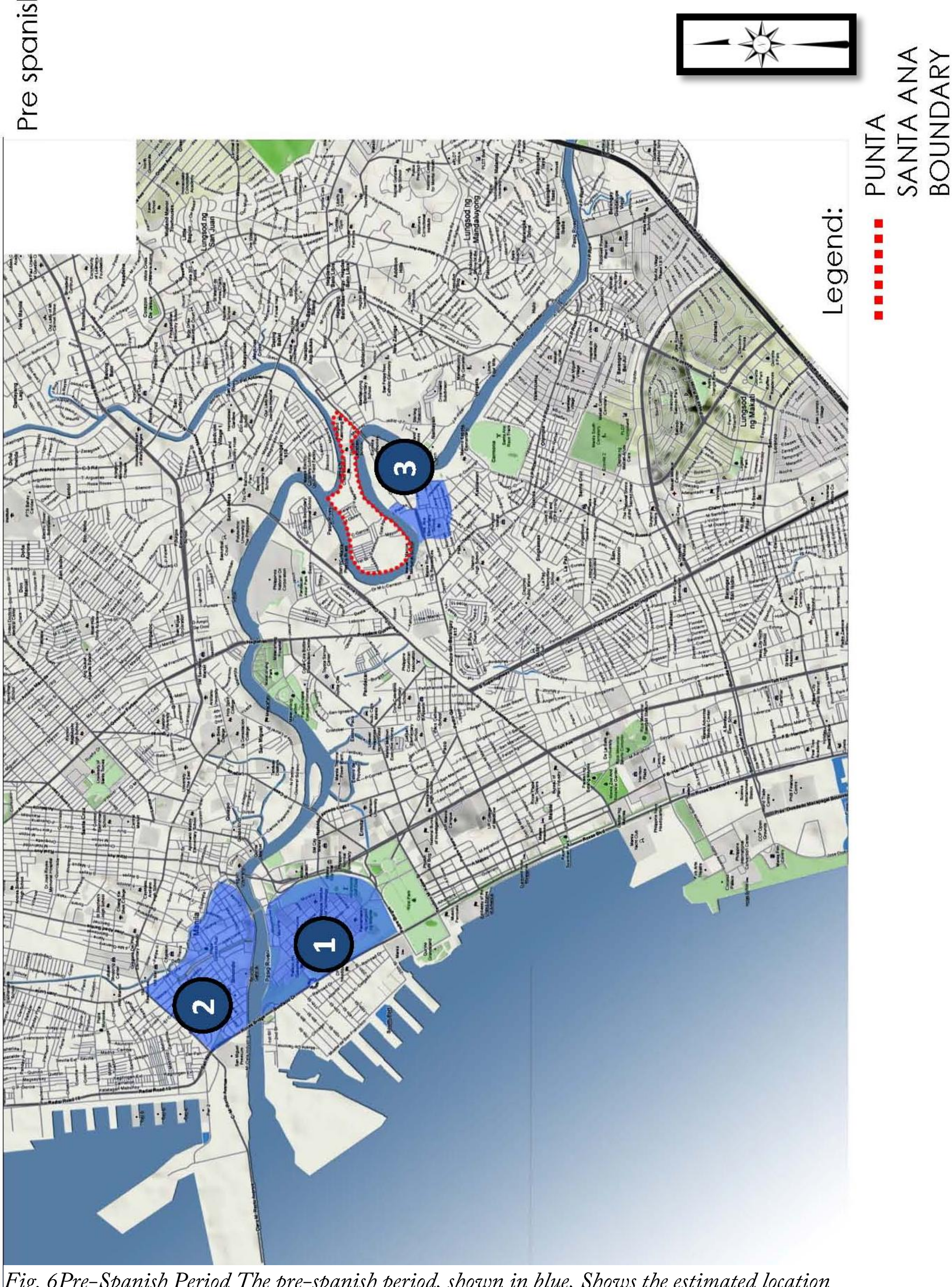


Fig. 6Pre-Spanish Period The pre-spanish period, shown in blue, Shows the estimated location of the early kingdoms in Manila. the kingdoms of Tondo and Manila, which are located near the manila bay, were once located in where the historic districts of Intramuros and Binondo are currently located. The Kingdom of Namayan, is located just across the Punta site.

1- Intramuros; 2-Binondo; 3-Santa Ana

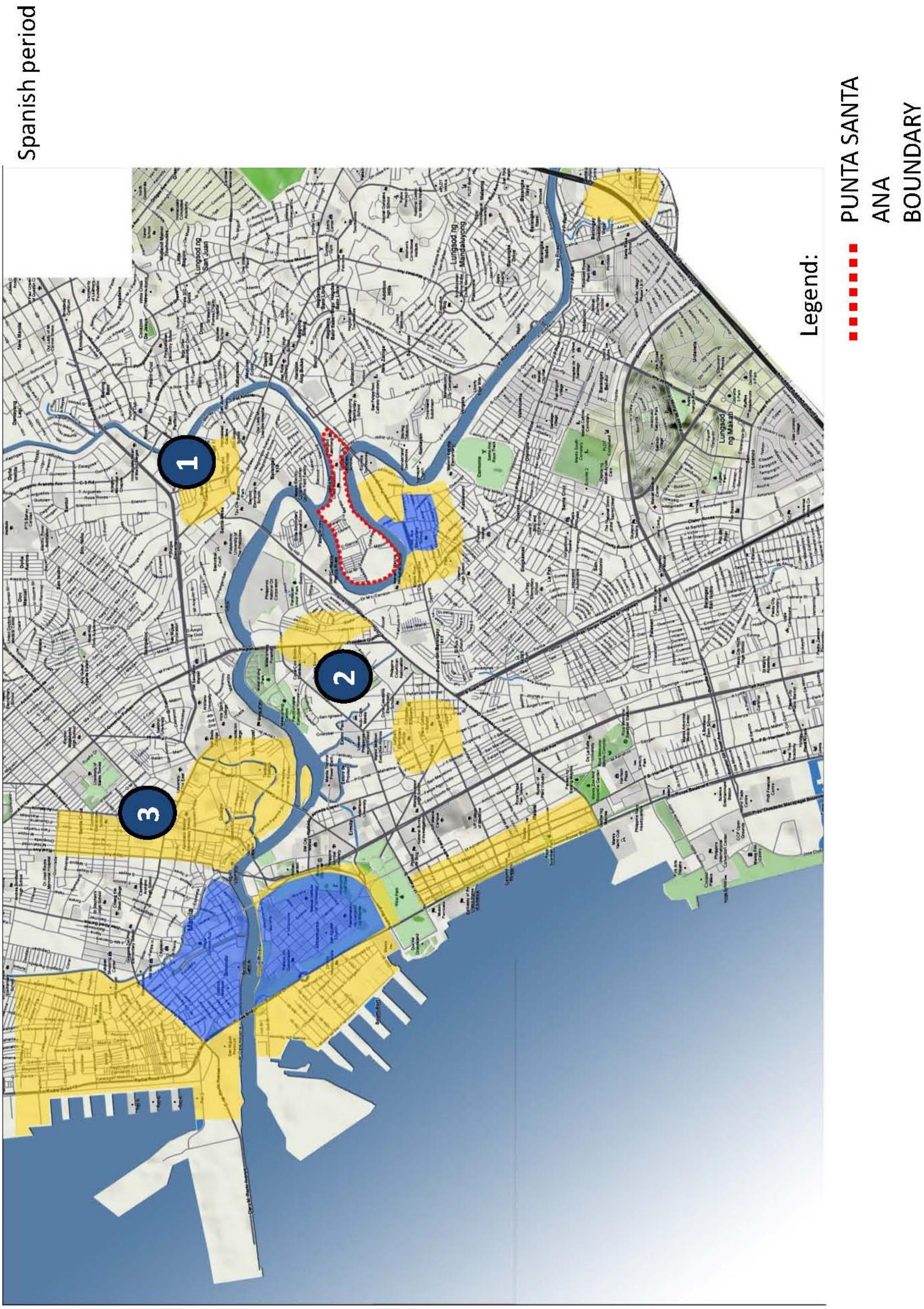


Fig. 7Spanish Period Shown in Yellow

1 San Juan 2 Pandacan 3 Sampaloc

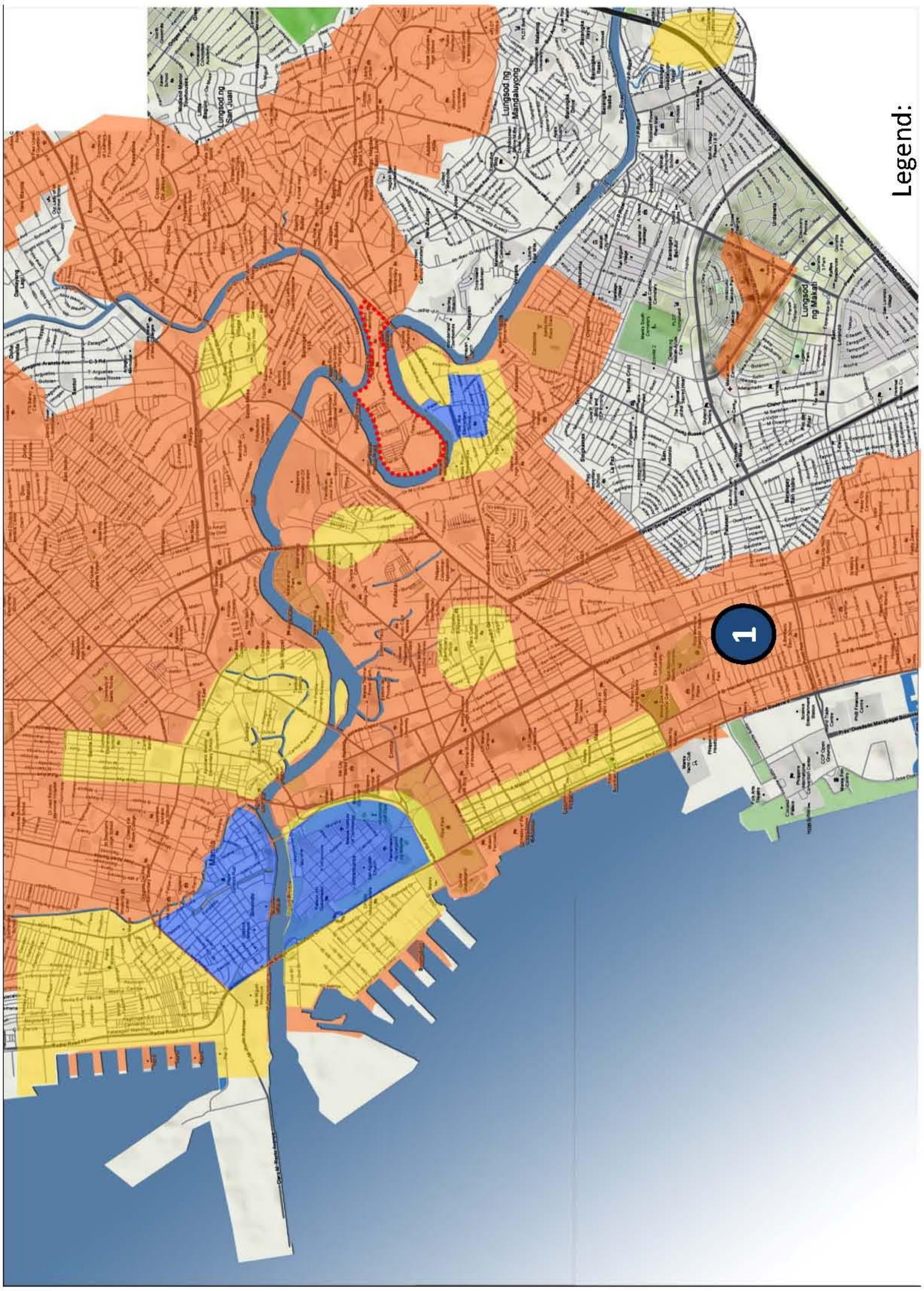


Fig. 8 American Period Shown in Orange, (1- Pasay City)

Post war Period

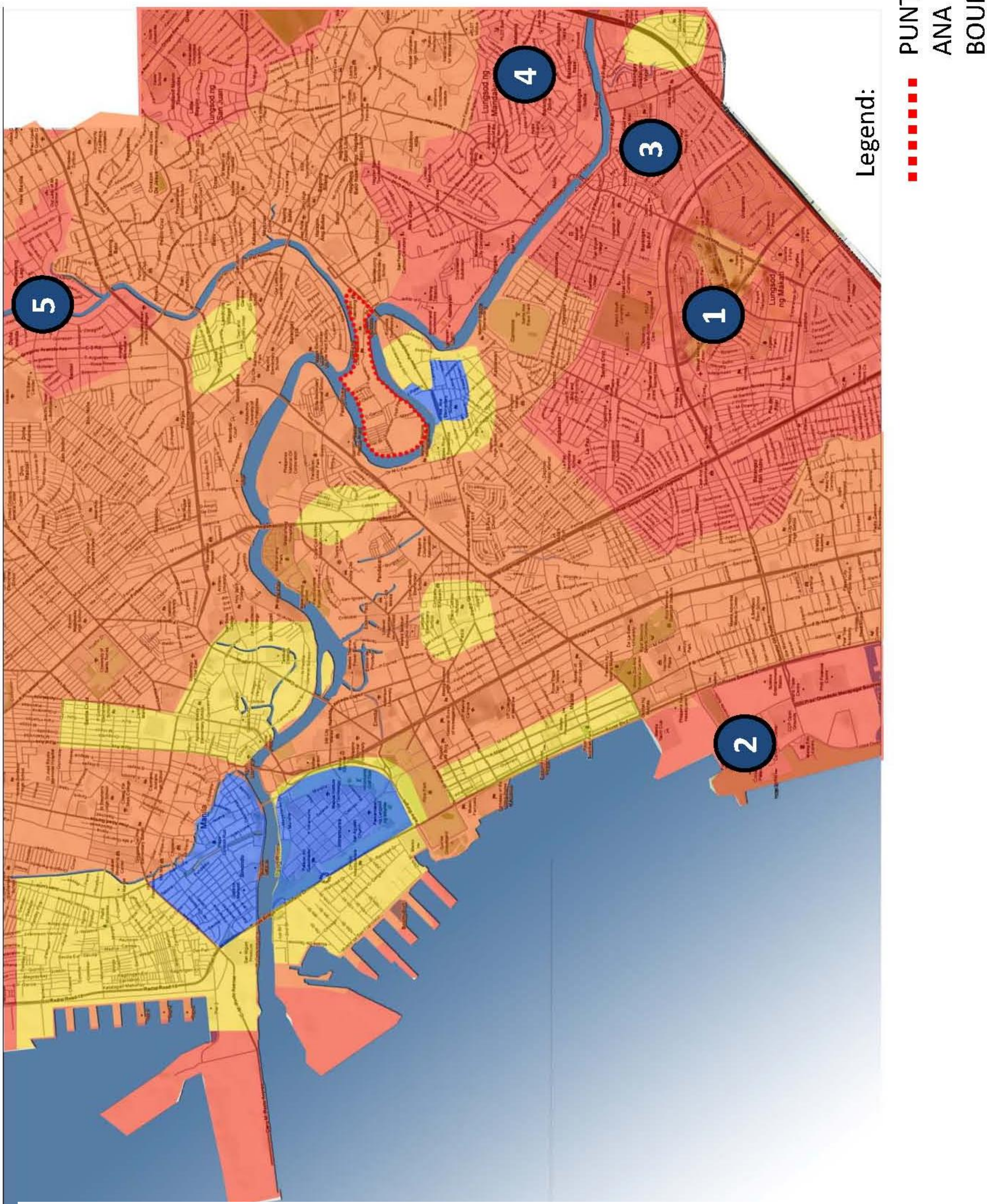


Fig. 9 Post War Period Shown in red

Makati city, 2- Cultural Center of the Philippines,3- Rockwell Center, 4 Mandaluyong City, 5- New Manila

Site Boundaries

The Punta Santa site is oriented on an east to west axis. It is bounded by water on three sides. The Pasig River surrounds the area to form a peninsula on the south, West, and northwestern part. And on the Northeastern part by the San Juan River. (***Fig. 11***)

On the eastern side it is closed in by land bounded by the New Panderos road.

Urban renewal areas

The PRRC has listed the peninsula for urban renewal from this a selection criteria was given based on the proposed rezoning of the peninsula from industrial uses to residential uses. Matchbox factory and oil plant, both are expected to be relocated in the next 10 years as part of the proposed master plan for manila. (***Fig. 12***)

Current Urban renewal areas that are under development by the PRRC (Pasig River Rehabilitation Commission) involves a couple of smaller initiatives to help improve the river quality. Environmental Preservation areas are being identified along the river as well as introduce linear parks along to river and establish a network of green parks from 3 to 10 to 500 meter radius from the river. The river park along the shores of Punta Santa Ana is part of the URA project.

The most prominent project underway is the relocation of the informal settlers along the sites to relocation sites outside the city.

The most successful urban renewal project so far is the establishment of a new river transportation program. New ferry terminals are being made along the river to reuse the river as a potential for river transportation.

URA 3: the Steel Plant

For the development of a master plan, the site selected for the project is a former steel plant. The site is currently abandoned and is under the PRRC jurisdiction and is listed as one of the urban renewal sites along the Pasig River. The site is approximately 13.64 hectares. It is located on the western part of the peninsula. The selected site is composed of three different areas. On the north side, this area is inhabited by informal settlers. The largest part of the area is from the former steel plant located on the western edge. On the eastern side of the steel plant another area for informal settlers. (Fig. *13*)

On the steel Mill site, there are a couple of existing structures still being used by the steel corporation. The Steel mill office located near the river and the storage warehouse are still used by the corporation until the relocation has been finalized. In the northern part of the site another warehouse could be found. This warehouse however doesn't belong to the steel factory. The current warehouse is used as a parking garage for the "jeepney" around the area. (Fig. *13*)

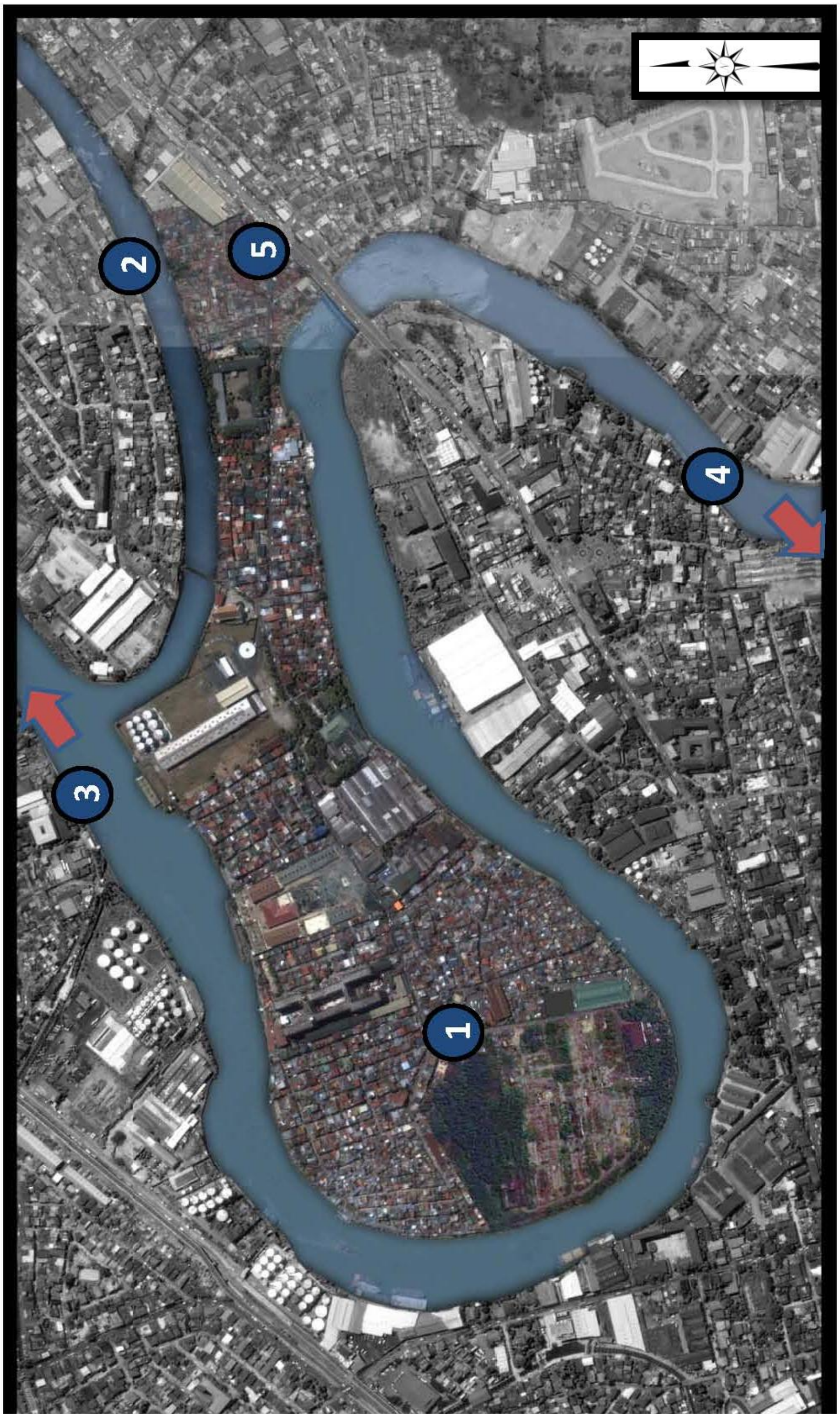


Fig. 10 Site Boundaries of Punta Santa Ana.

1- Punta Santa Ana; 2- San Juan River; 3- Pasig River to Manila Bay; 4- Pasig River to Laguna Lake; 5-New Panderos Road

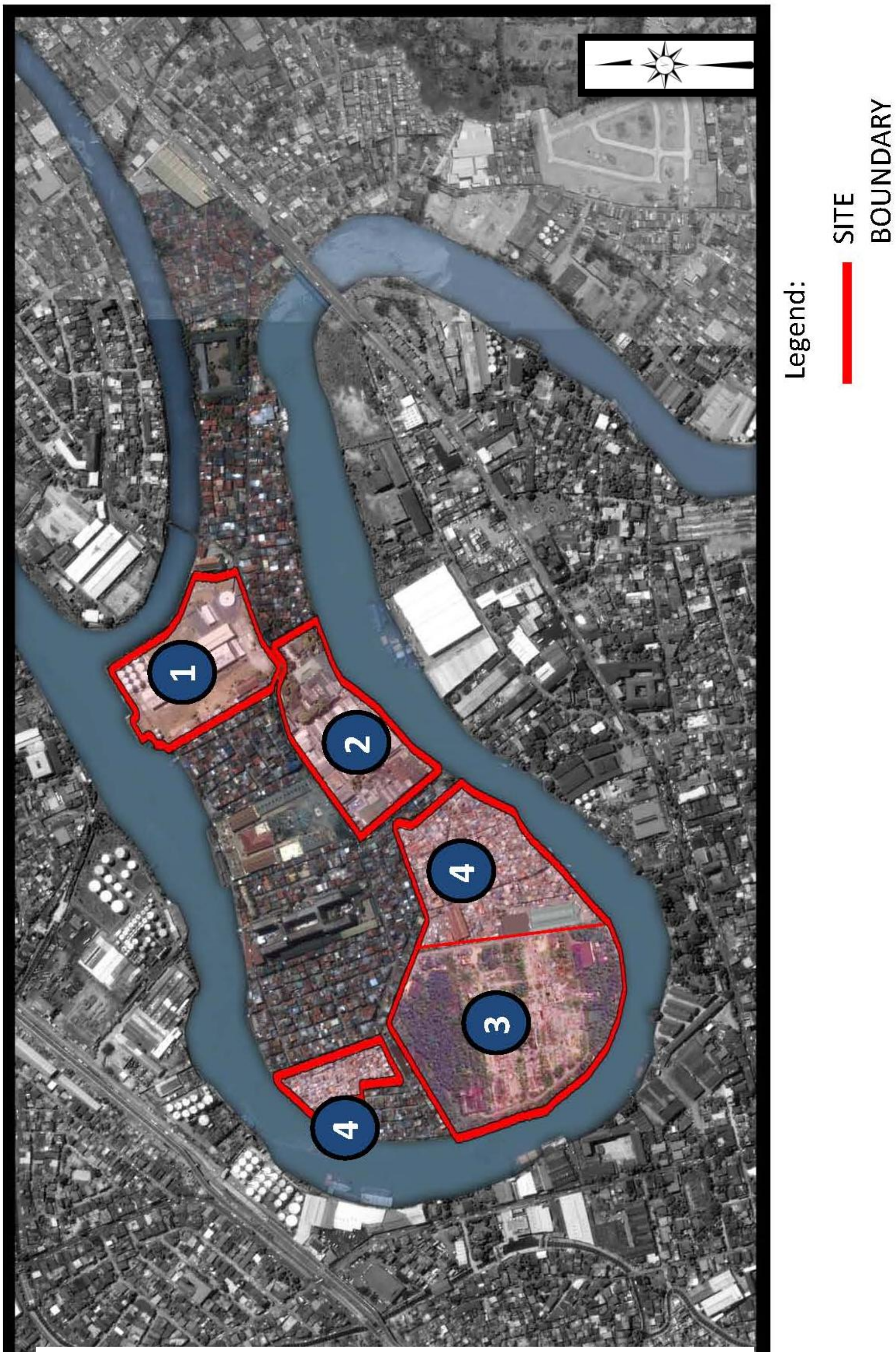


Fig. 11Urban Renewal Areas

1 Food Oil Factory; 2 Matchbox Factory; 3 Steel Plant; 4 Informal Settlers

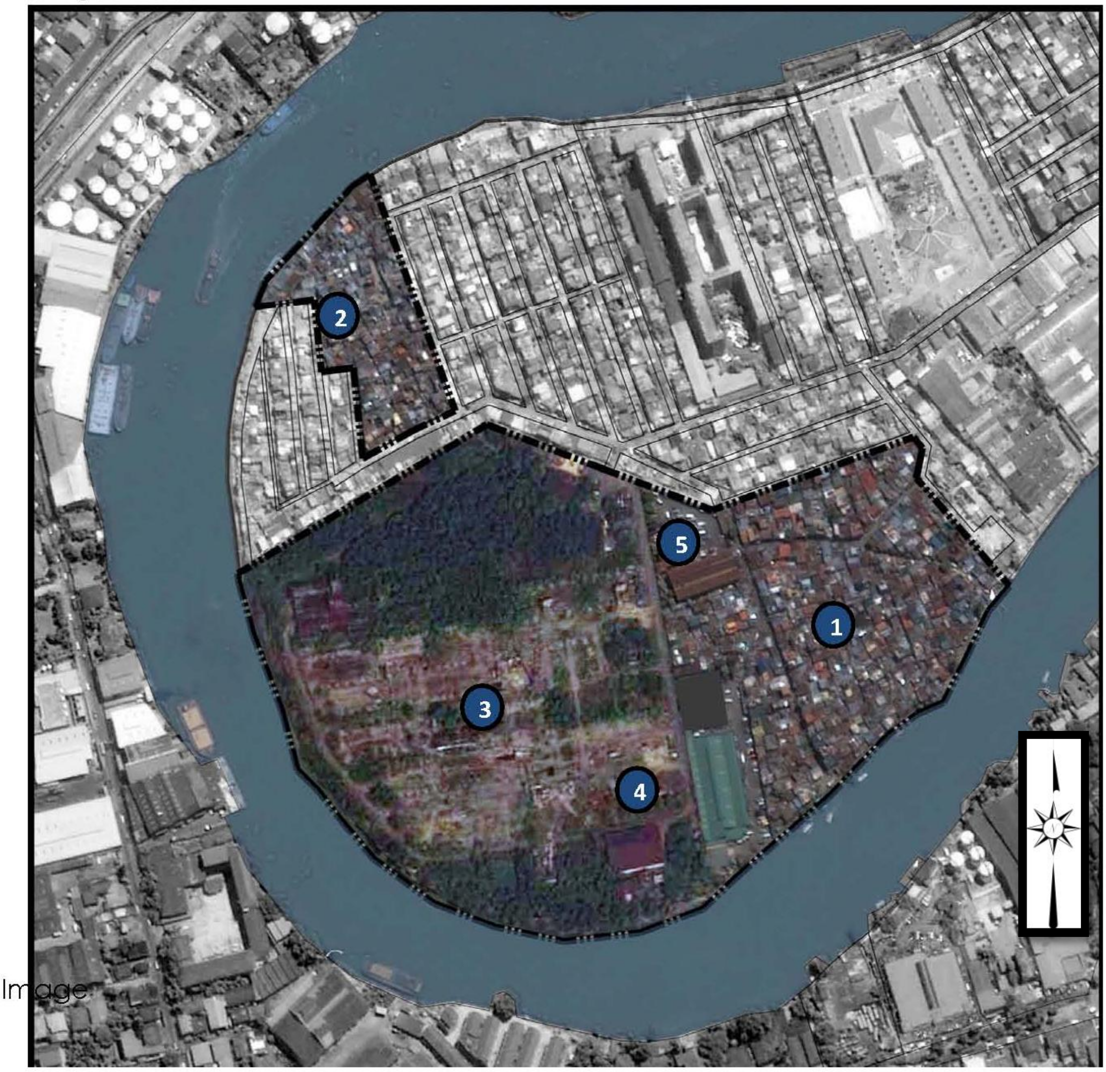


Fig. 12 Steel Mill Site

1-Informal Settlers Area

2-Informal Settlers Area

3-Former Steel Mill

4-Steel Mill warehouse and Offices

5-Warehouse

Site Scale

The two sites have an area of 14.92 hectares. The larger site (3b) has a half arc shape closed to both ends with the road on the site. the approximate overall length of site 3 b is about 540 meters. The clear dimensions of site shown in 3 b are shown in (***Fig. 14***)

Site 3 a, the informal settler slums, has the longest side at 181 meters. That length is from the main road to the edge of the river.(***Fig. 14***)

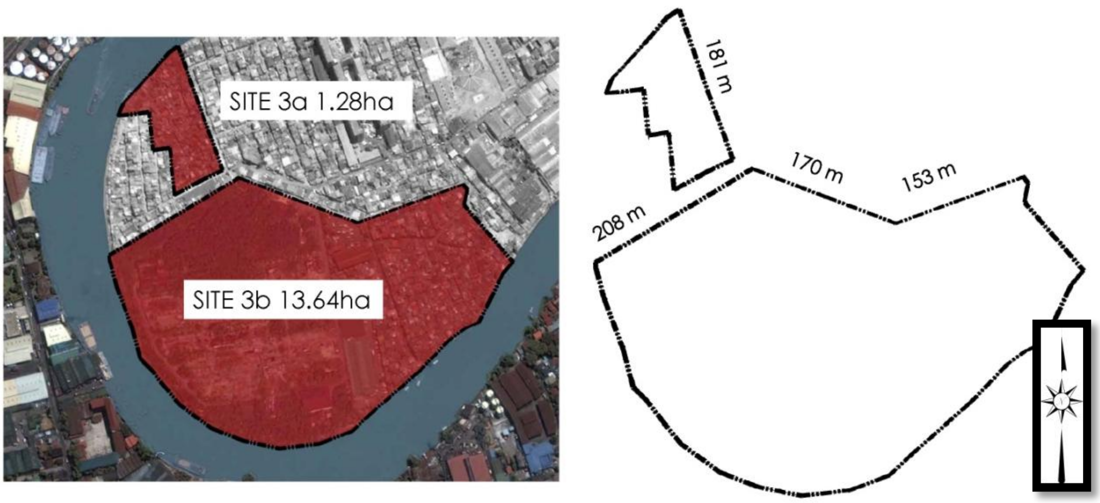


Fig. 13 Site Dimensions, Site areas (left), Site Dimensions (right)

Scale Comparison

Three scale comparison the site with the most recognizable places in Lombardy Italy. First is the Castello Sforzesco in Milan. From the image shown in ***Fig. 15*** on the left side, it can be observed that the whole of the Sforzesco castle from the fountain to the front until Viale Gerolamo Gliado at the back can fit in the whole of site 3b. On site 3a we can see the Milan Palazzo dell Arte. The short walking distance from the Palazzo dell arte to the fountain in front of the Castello can be used as an ideal comparison to the overall distance from the edge of site 3 a on the north to the southern tip of site 3b.

The second comparison is the Piazza Duomo of Milan, it can be seen in (***Fig. 15***) that the whole of the piazza can be accommodated in site 3b as well as the entire Galleria Vittorio Emanuele. On site 3a the Piazza della la Scala could be seen as the same scale as the site. The walking distance between the two piazzas is a good scale comparison between the distances of the center of each site.

The third comparison is made in the city center of Lecco. In this comparison the density of a compact city development such as Lecco can be observed to give a scale to the site. The straight distance from the train station to Piazza Garibaldi can also be observed. That distance of about 600 meters can be compared to the length across the two sites.

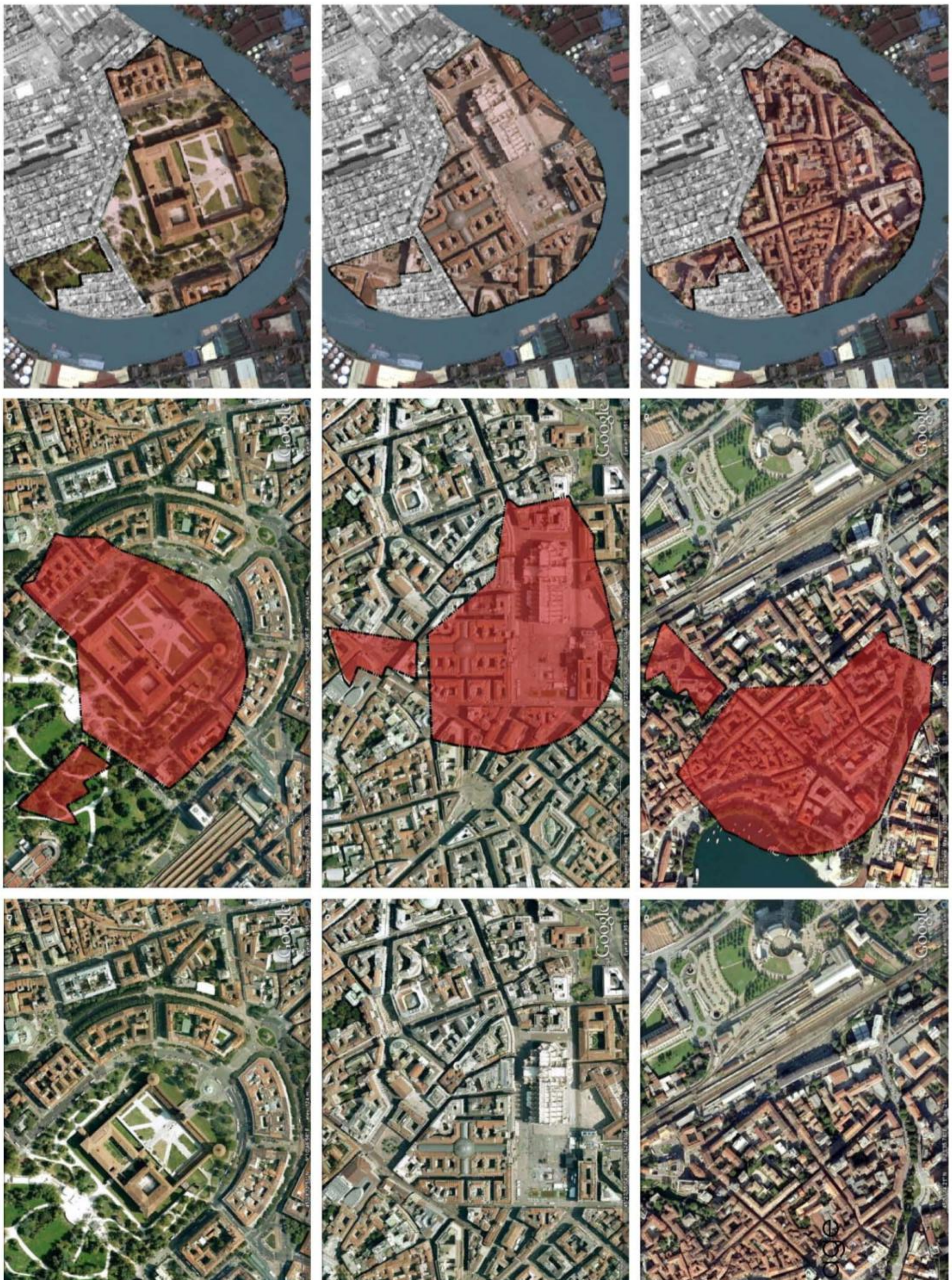


Fig. 14 Site Scale Comparisons, Castello Sforzesco (Milan) on the left, Piazza Duomo (Milan) on the middle, Lecco city center on the right

3- Social and Economic Analysis

Barangay

The peninsula is composed of several barangays headed by a Zone Coordinator who the punong barangay is nominated by his/her colleagues in the zone. The barangay is the smallest political unit headed by the punong barangay who exercises the role of executive, legislative and judiciary branch of government in his/her jurisdiction, elected by the electorate from the respective barangays. A barangay is identified and presented in Hindu Arabic numbers.

In Punta Santa Ana the area is divided in 12 barangays. Barangays 894-905 of the city of Manila is located in the peninsula. Shown in ***Fig. 23***

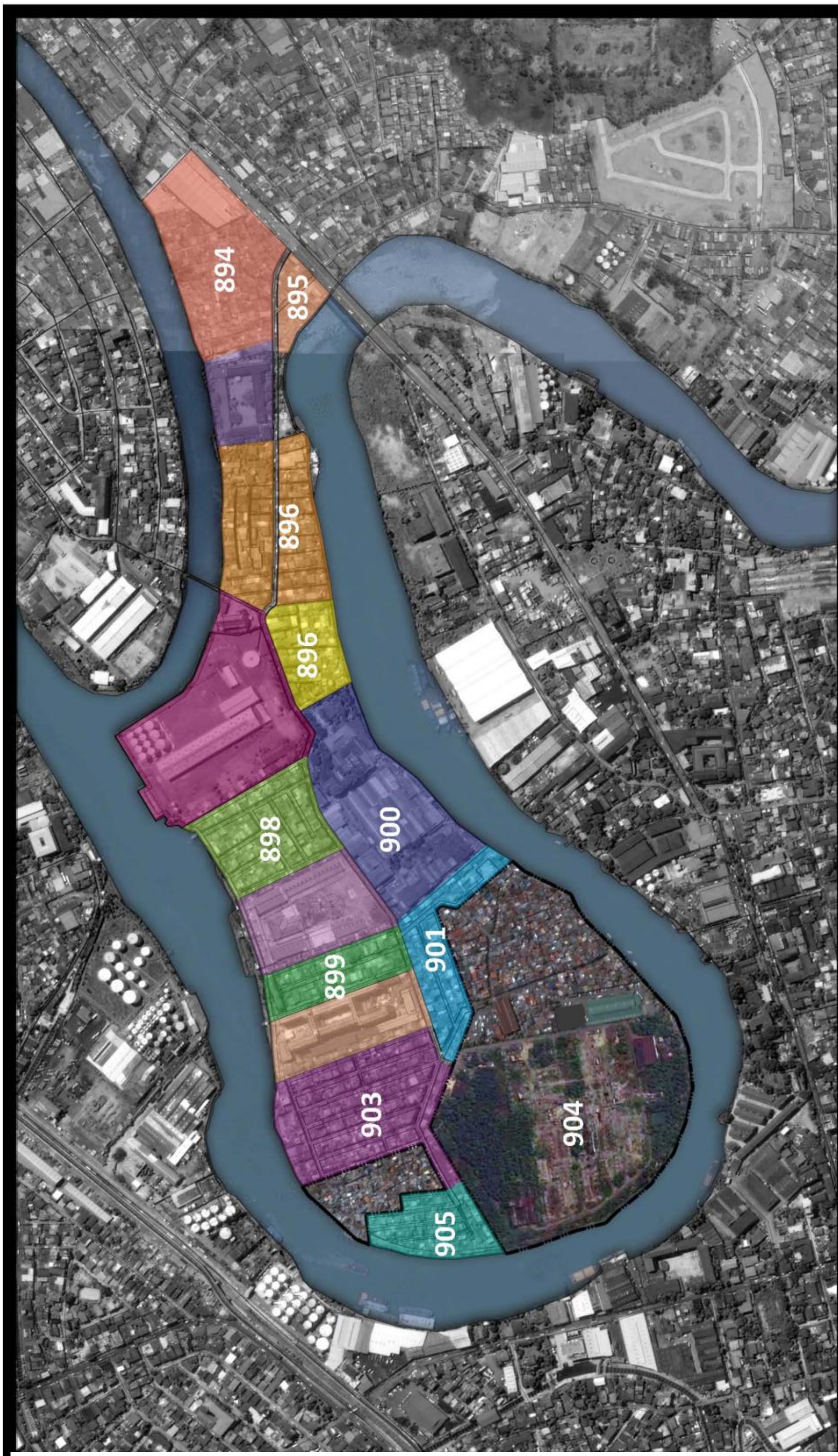


Fig. 15 Punta Santa Ana Barangay districts

Existing land use analysis on Punta Santa Ana

The existing land use plan of the 6th district of manila is shown in *Fig. 17EXISTING LAND USE PLANFig. 17*. Punta Santa Ana is classified as mix residential and industrial use. Although in the past the area is considered as pure industrial. Recent district developments have changed some of the industrial sites to residential sites. And while majority of Punta is now residential, there are sill large industrial plants in the area. The proposed 2020 master plan shown in ***Fig. 18***. The Punta Santa Ana is to be transformed into a pure residential district. The other industrial sites surrounding it are to be proposed as a mixed commercial zone.

There is a mixture of industrial areas and residential areas without any public spaces or buffer spaces between them. These can cause health and environment issues to the residents close to these areas. ***Fig. 23***

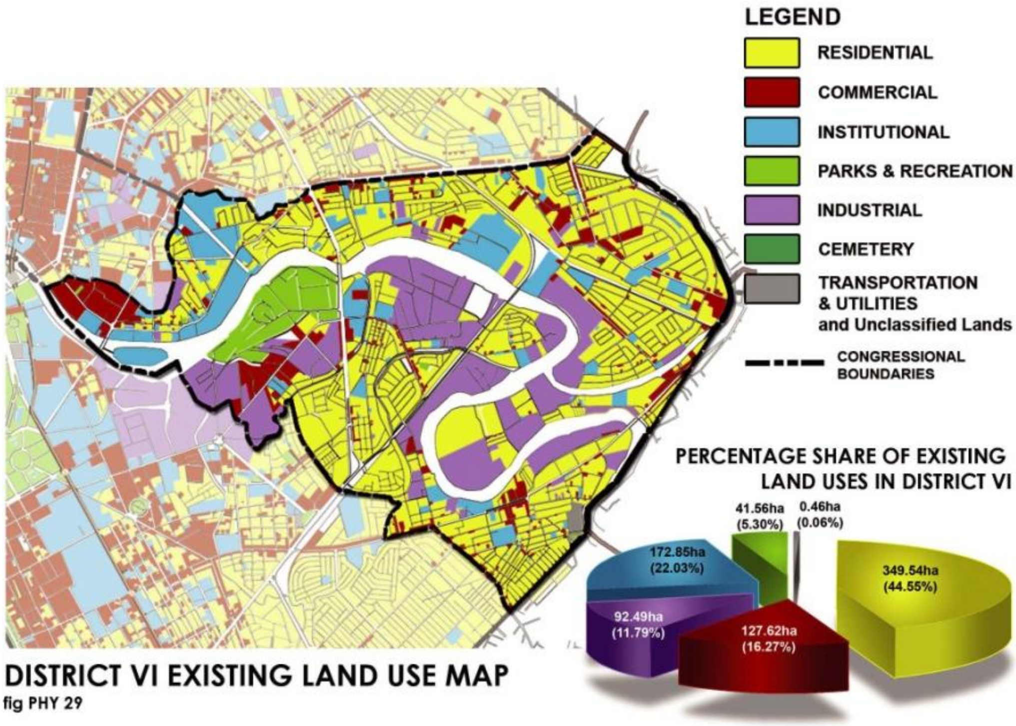


Fig. 16EXISTING LAND USE PLAN

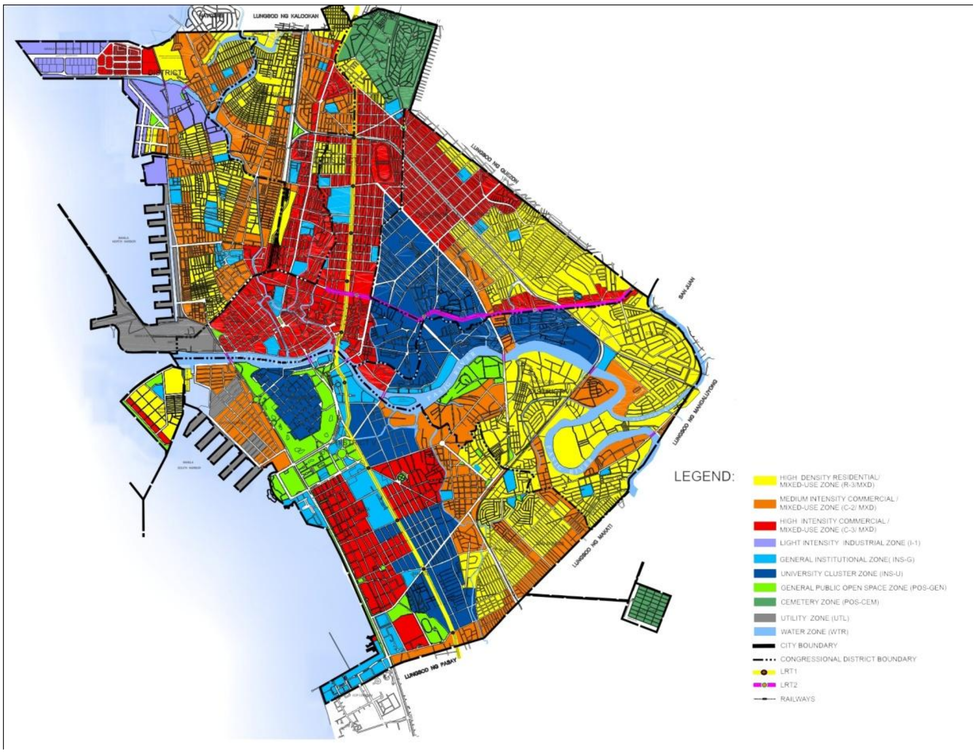


Fig. 17 2020 Land use plan

The micro site analysis of Punta Santa Ana the land use is a bit more diverse than the main land use map. There are a couple of unforeseen developments in the barangays such as commercial nodes, public nodes, and other nodes that have developed naturally. ***Fig. 21***

As mentioned there are the informal settlers located on the site. Both areas are under residential. There are a small concentration of local commercial and business areas on along the main road. These commercial areas are mainly small shops/ cafes/ bakeries.

Recent transformation of the site can be observed in transformation of one of the old industrial areas into an institutional area. This area was developed by the government to provide housing and education to the informal settlers along the river.

On site there still remain a couple industrial areas being used.

Green open areas are very small; the new developments of the green areas are primarily located along the river. These developments are part of the linear park developments by the PRRC.

Fig. 18 Informal Settlers

Fig. 19 Linear park

Fig. 20 Existing land use of Punta Santa Ana

Surrounding Land use map

Around the site, in the other districts of metro manila, such as Makati city and Mandaluying city, the land use are composed of mixed residential and commercial. The industrial areas along the river on these districts have been removed from beginning of the new century. ***Fig. 23***

Some notable industrial area regeneration can be found in Makati city. Shown as number 2 ***Fig. 23***, this former power plant area, has been transformed into one of the chic new districts in the metro called Rockwell center.

In Mandalyong city shown as number 3, notable land uses are the schools and hospitals located in the district.

Fig. 21 Rockwell Center Makati

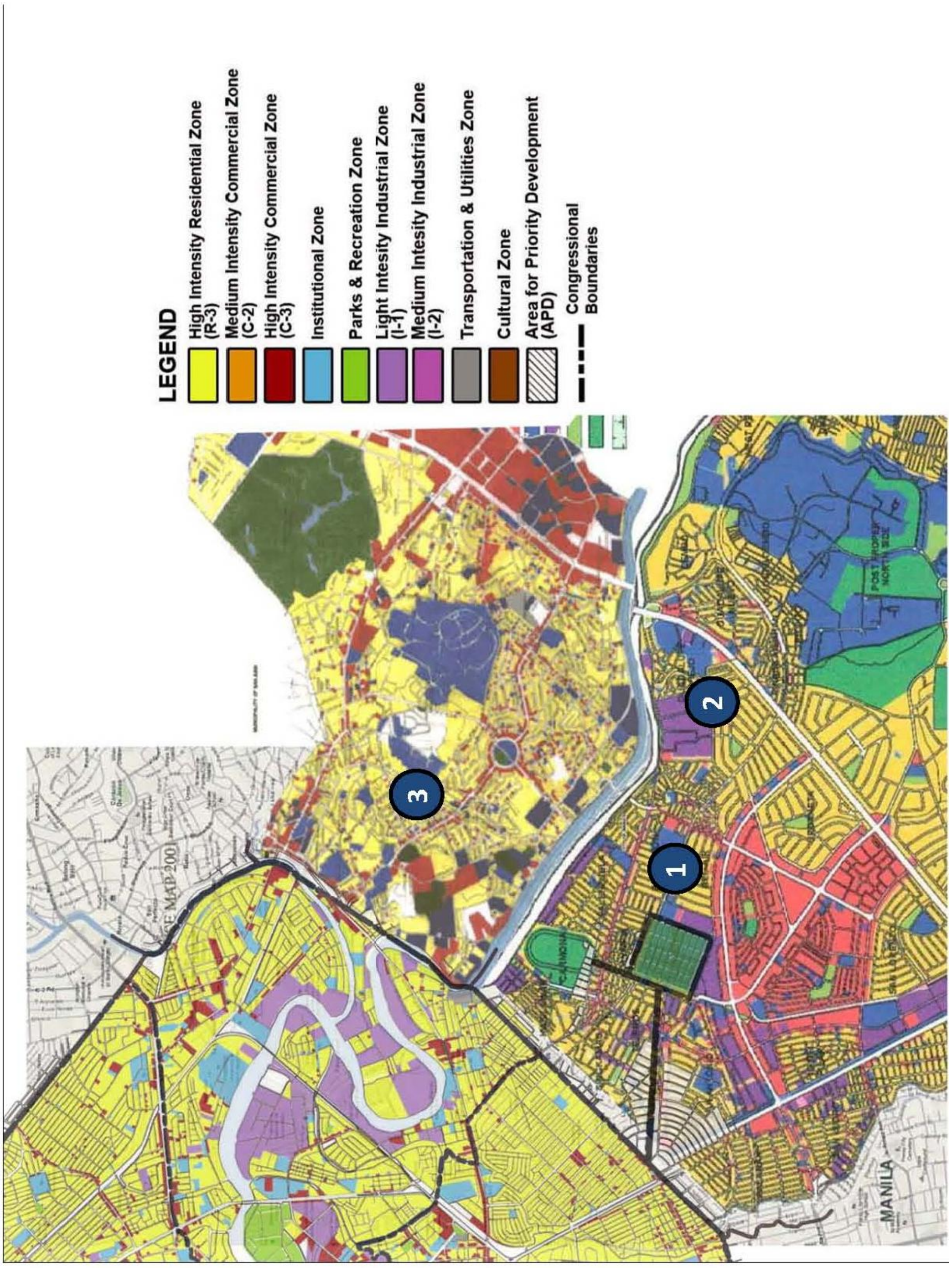


Fig. 22 Surrounding Land Use

1Makati City; 2 Rockwell Center; 3 Mandaluyong city

4- Existing Networks

Road Network

An initial look at the Punta it can be said that the little peninsula is completely isolated from the whole metropolitan. There is only one point of connection for the site to the entire metro. The Punta is served by Pedro Gil extension road known as new Panderos street. Pedro Gil is one of the main avenues of the Burnham plan of manila directly connects the peninsula to the historic district of manila as it can be seen in (***Fig. 1.***) From Pedro Gil, the Pedro Gil extension connects to New Pandersos Street. And from Pedro Gil, there are secondary connections to Osmena highway, Roxas Blvd. and and Taft avenue.(***Fig. 24***)These main roads bisect the entire metropolitan from north to south. These roads also connect to the major highways that links the capital to the whole of Luzon Island.

New Panderos street also connects to San Juan road. and a secondary connection to Aurora blvd. These main roads that bisects the metropolitan from east to west giving the site Punta an indirect connection to any point of the metro from these secondary connections to main arterial roads. Connection to aurora blvd gives access to parts of metro such as the Eastwood city center, and Quezon City. San Juan road directly connects to Mandaluyong city, and the Ortigas city center.

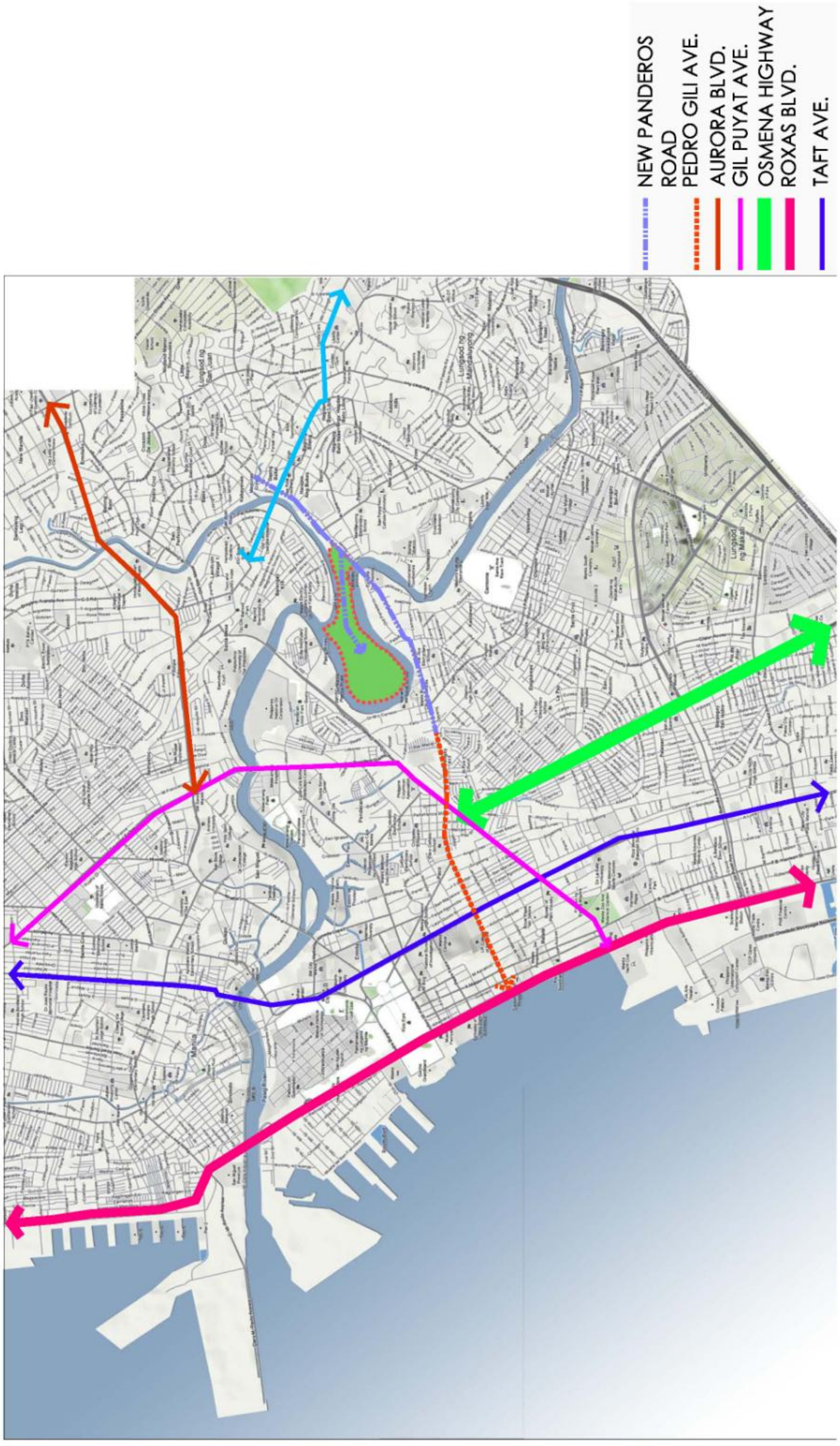


Fig. 23 Major road networks connecting the site

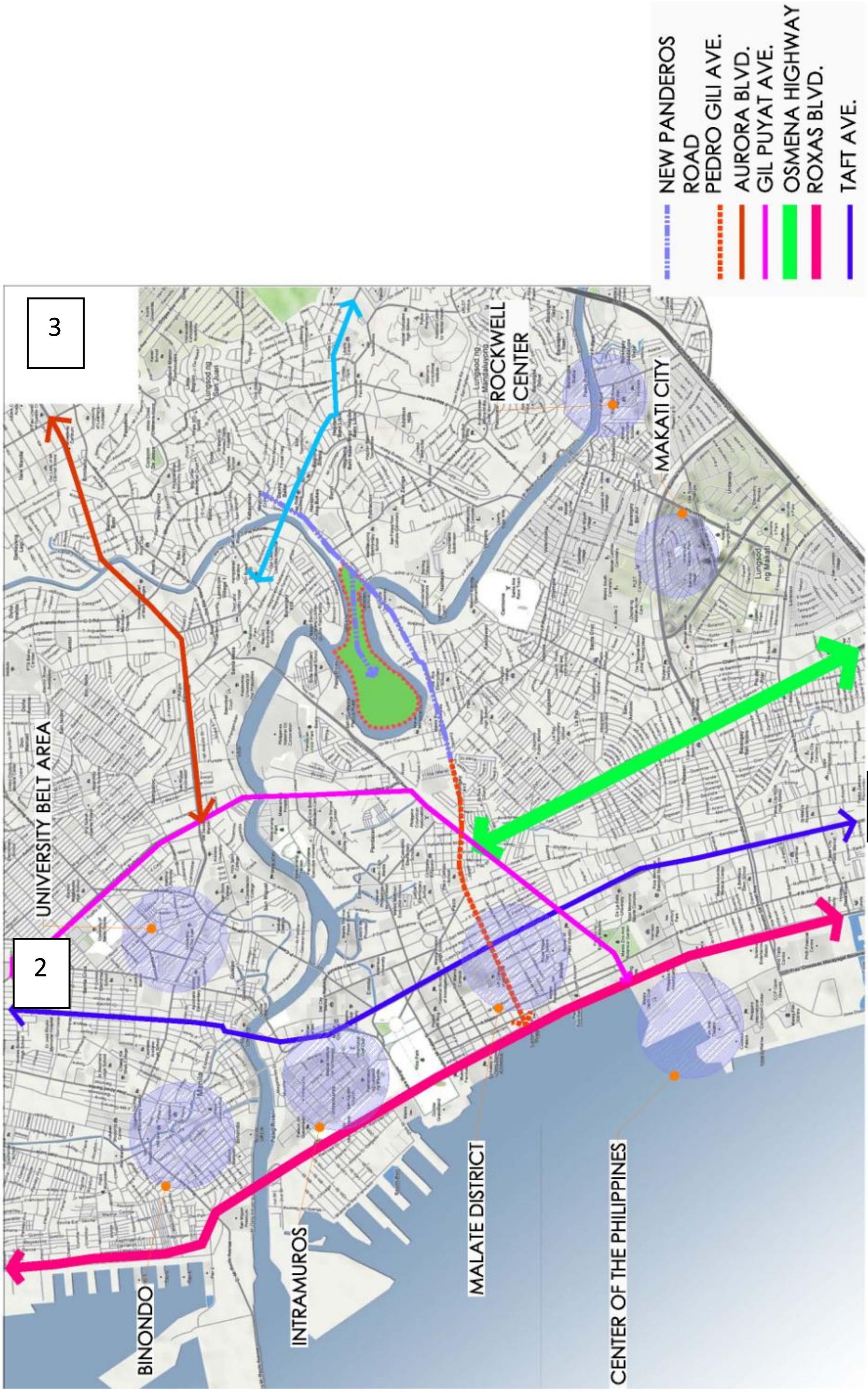
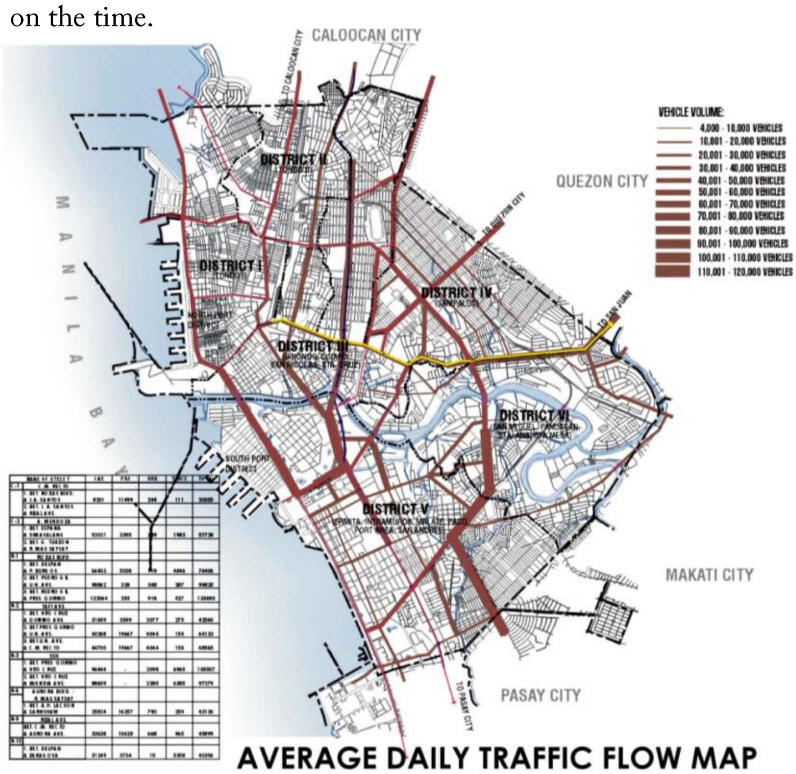


Fig. 24Map Showing major connections

1 To south Super Highway; 2 To north Expressway; 3 To Quezon City

One of the major problems of Metro Manila is the traffic from north to south. Travel time for 10 km distance can take up to an hour to and up to two hours during rush hours. Traveling from east to west is a bit easier in terms of traffic with less cars coming from inside the metro center. The traffic congestion can see on (*Fig. 26*). From this it can be seen that the traffic choke point is in Osmena highway, as this is where majority of the traffic from the south ends.

This traffic congestion makes travelling from Punta to the old Manila center and to the University belt a bit of a problem. The average time it would take to go to Intramuros or Binondo would be around 30 mins to 1 hour depending on the traffic. It would take more time to go the university belt as you have to pass Gil Puyat Ave. it would take about 1 hour to 2 hours depending on the time.



AVERAGE DAILY TRAFFIC FLOW MAP

Fig. 25 Average Traffic Flow Map

Punta Santa Ana is then served by one main arterial road. this road, F.Y. Manalo, Bisects the peninsula into two and ends abruptly in the middle of the peninsula, in the perimeter of site 3b. This road connects to the New Panderos street, an extension of Pedro Gil Avenue. And from here secondary roads serves the different barangays. Fig. 29

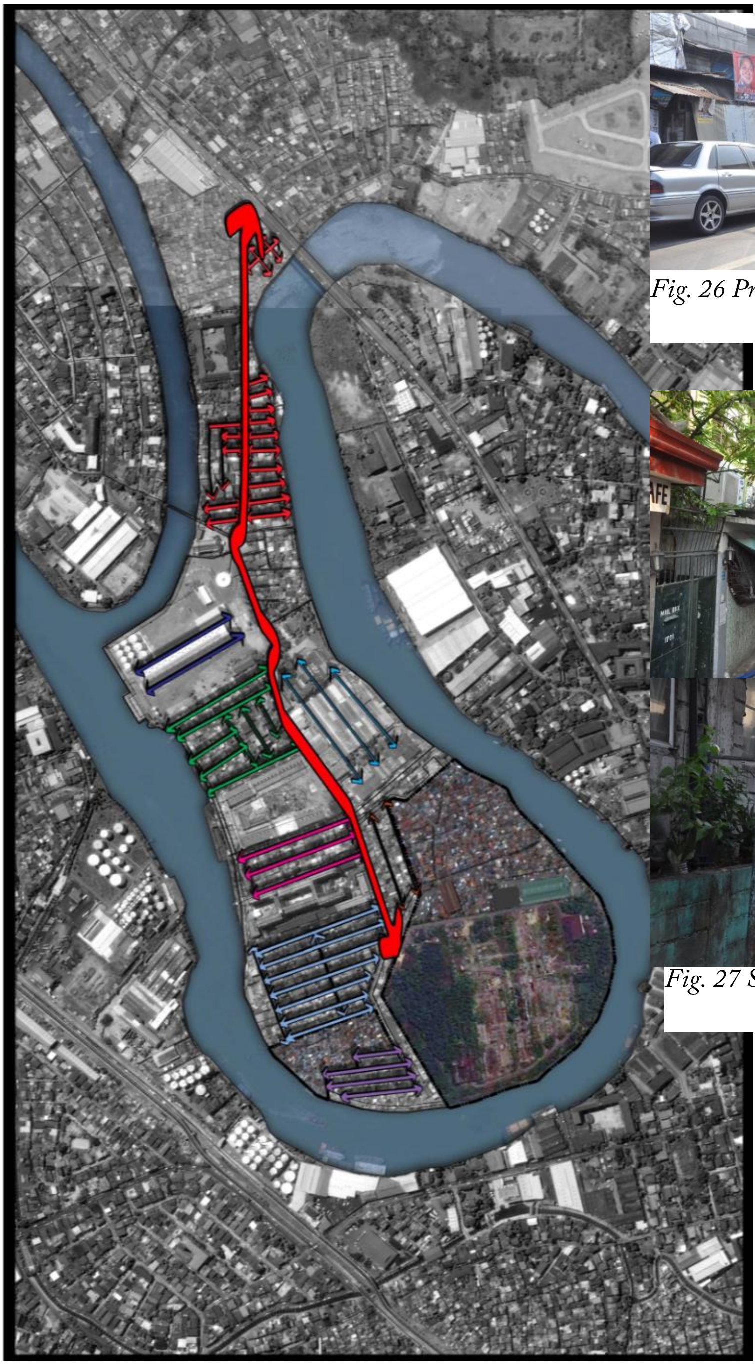


Fig. 26 Primary Road

Fig. 27 Secondary Road

Fig. 28 Punta Santa Ana Road Network

Water network

The Pasig River is currently serviced by a waterbus network. The Pasig River Ferry Service, is the only water-based transportation that cruises the Pasig River. The system is owned and operated by a private company, SCC Nautical Transport Services Incorporated. Although commonly referred to as a ferry, it is more akin to a water bus.

The travel speed of water buses at 12 knots or 22kph. The travel time from the existing water bus stop to in Punta the last stop in the old manila district of Binondo and Intramuros, including the U-belt is about 30 mins +/- 10 mins for the loading and unloading of passengers. The travel time by water is still significantly much faster than travelling by car or any public land transportation. [17]

Other sites that have direct access by water is the high end commercial residential center, Rockwell district in Makati. The Robinsons place Guadalupe is another rising commercial/business district along the banks of the river. Both of these places are less than 20 minutes from the site by boat. By car it would take more than half an hour.

17

A little bit further along the Marikina River a junction of the Pasig river is the Eastwood city district, another high-end commercial/business/residential district. It would take approximately 1 hour of travel time by the current average speed of the boats. Traveling to the same location by land base transportation, public or private it would take about the same time.

Fig. 29 Santa Ana Ferry Station

Fig. 30 Pasig River Ferry

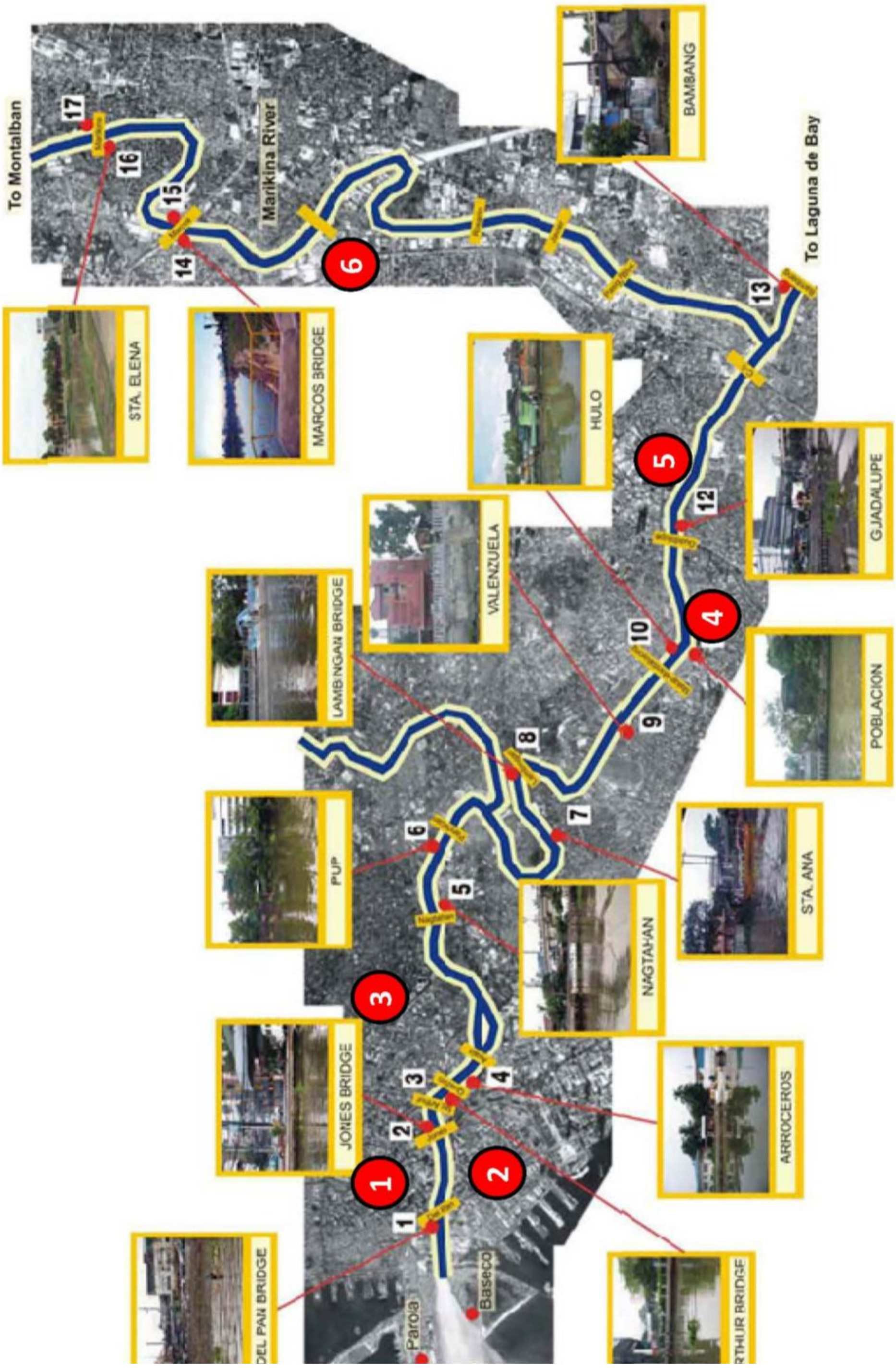


Fig. 31 Ferry stops

1 Binondo; 2 Intramuros; 3 University Belt; 4 Rockwell Center; 5 Guadalupe Center ; 6 Eastwood Center

PNR or Philippine National Railways. (Filipino: Pambansang Daangbakal ng Pilipinas). It is a state-owned railway operator in the Philippines, operating an extensive railway line on the island of Luzon.[18] PNR began operations on June 26, 1875 as theFerrocaril de Manila-Dagupan, during the Spanish colonial period

PNR used to operate over 479 km (298 mi) of route from La Union up to Bicol. However, continued neglect in past decades reduced PNR's efficiency and railroad coverage. Persistent problems with informal settlers in the 1990s contributed further to PNR's decline.

In 2007 the Philippine government initiated a rehabilitation project aiming to remove informal settlers from the PNR right-of-way, revitalize commuter services in Metro Manila, and restores the Manila-Bicol route as well as lost services in Northern Luzon.[19]

PNR being the regional train network, it would indirectly connect the site to Makati City, the Central Business District, and connections to the other parts of the metro. Fig. 35

[18] http://en.wikipedia.org/wiki/Philippine_National_Railways
[19]

Fig. 32 Image of Pnr Station *Fig. 33 Image of Pnr train*

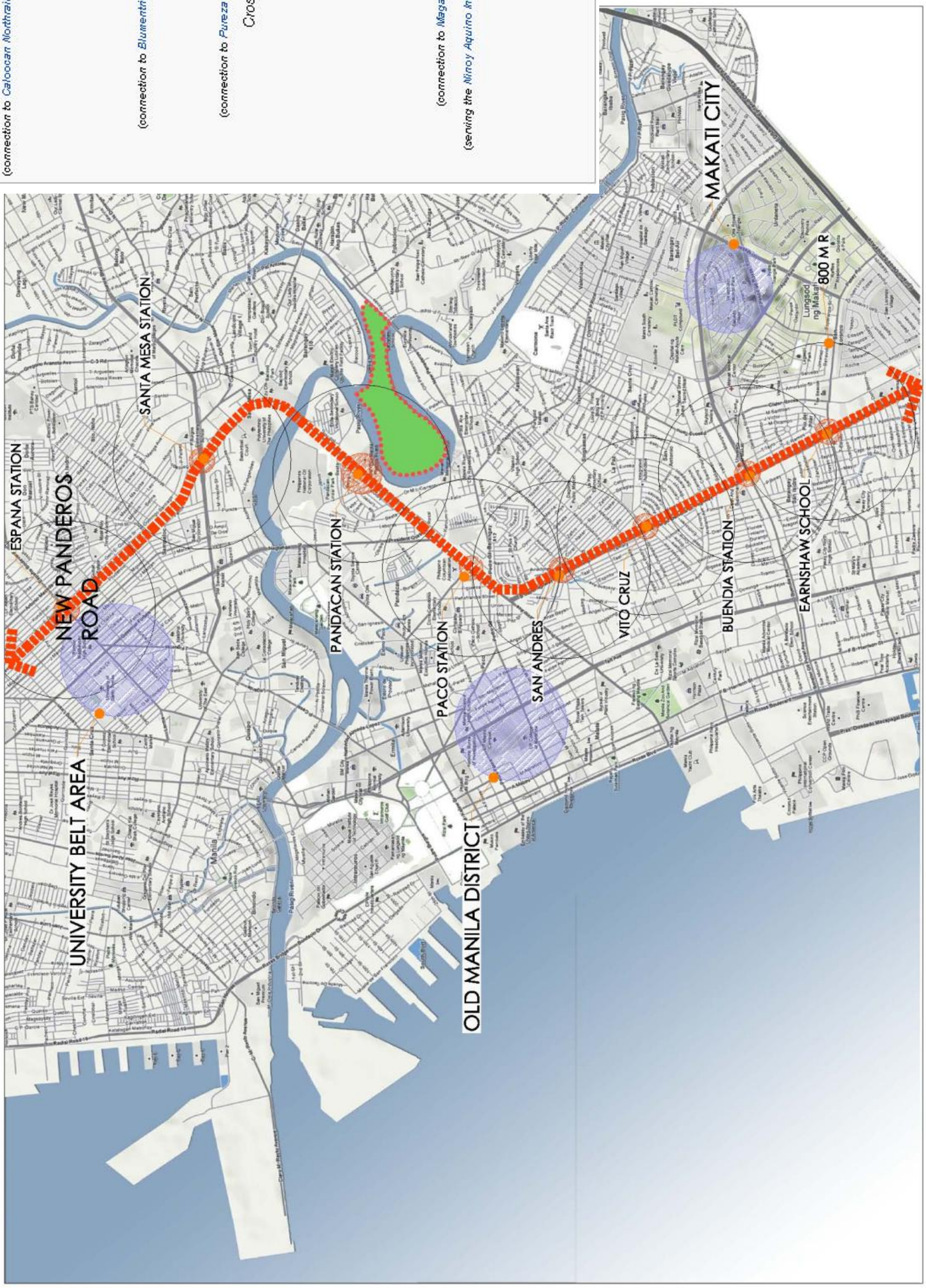


Fig. 34 Pnr Train stop

LRT Metro

The Manila LRT Purple Line is the second line of the Manila Light Rail Transit System. The line contains eleven stations and runs over 13.8 kilometers of mostly elevated track.

The line runs in a general east-west direction, linking the cities of Manila, San Juan, Quezon City, Marikina and Pasig. Passengers can transfer to the Yellow Line at Recto station, while passengers can transfer to the Blue Line at Araneta Center-Cubao station.20

The Manila LRT Yellow Line is the first metro line of the Manila Light Rail Transit System. Presently, the line contains twenty-two stations and runs over twenty point seven kilometers of fully elevated track. As the name implies, the line is colored yellow on all LRT maps.21

There is a very important secondary connection to the metro line 2, which bisects the metro east to west. In terms of transportation this would be the fastest point of connection from east to west. This secondary connection is established by the intersection of t

Fig. 35 Image of Mrt purple line

[20] http://en.wikipedia.org/wiki/Manila_LRT
[21] http://en.wikipedia.org/wiki/Manila_LRT_Yellow_Line

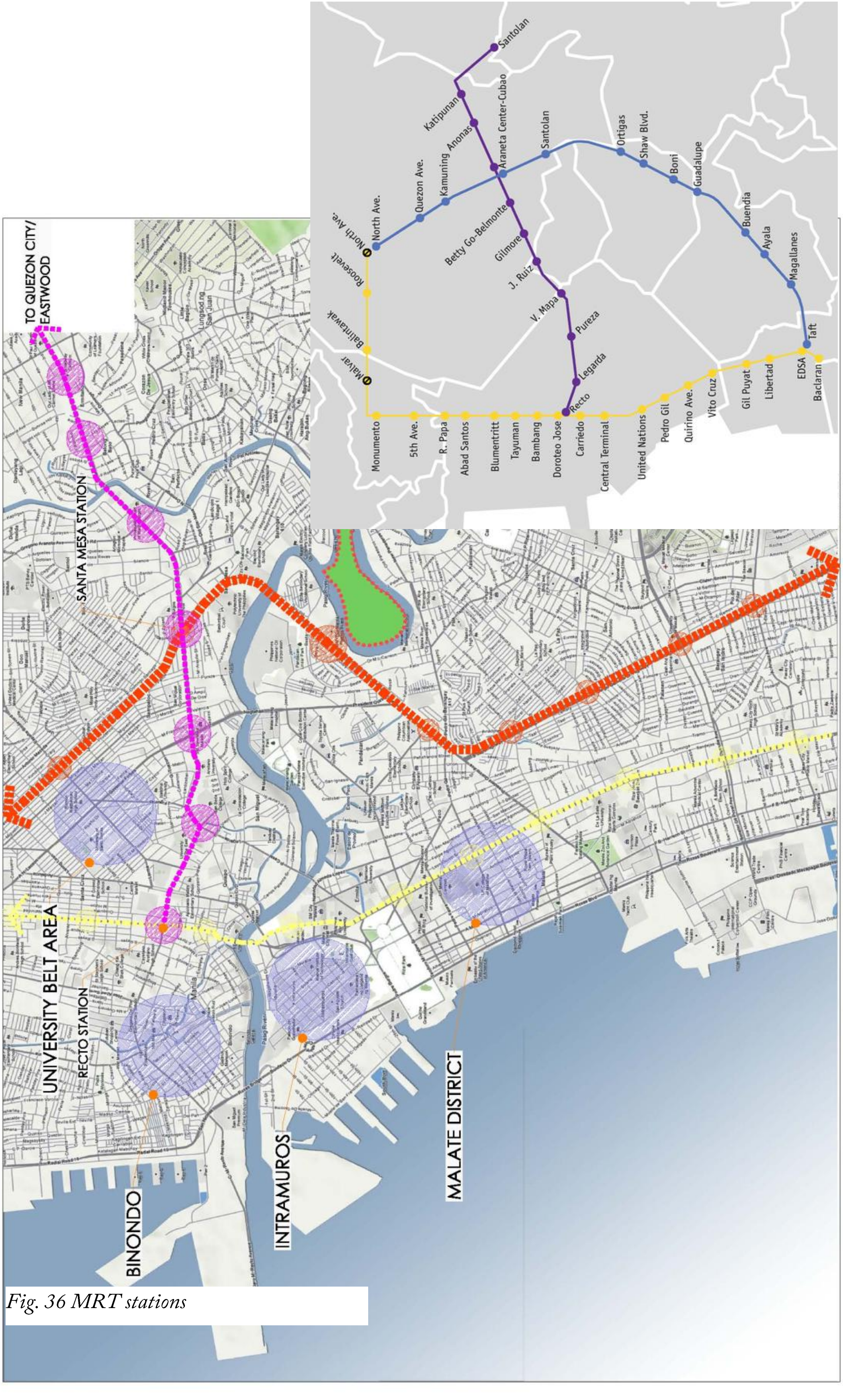


Fig. 36 MRT stations

Jeepney network

Jeepneys are the most popular means of public transportation in the Philippines. They were originally made from US military jeeps left over from World War II and are known for their flamboyant decoration and crowded seating. They have become a symbol of Philippine culture.

The word jeepney is a portmanteau of "jeep" and "Jitney".[22]

Jeepneys provide the most direct form of public transportation to and from Punta Santa Ana. there are 2 recognizable routes from the jeepneys that originate from the peninsula itself. From these routes there are several outer routes, or secondary routes that connect Punta to the rest of the Metro. Show in fig 2, image of the jeepneys of Punta Santa Ana shown in

Because of the demand of transportation, there are numerous jeepney routes in the metro. Almost every point of the city can be reached by a combination of 2 or three jeepney rides. This makes public transportation in the Philippines very effective, and also, because of the big number of routes and the large demand for the jeepney, the traffic congestion in the metro is often caused by too many jeepneys.

[22] http:

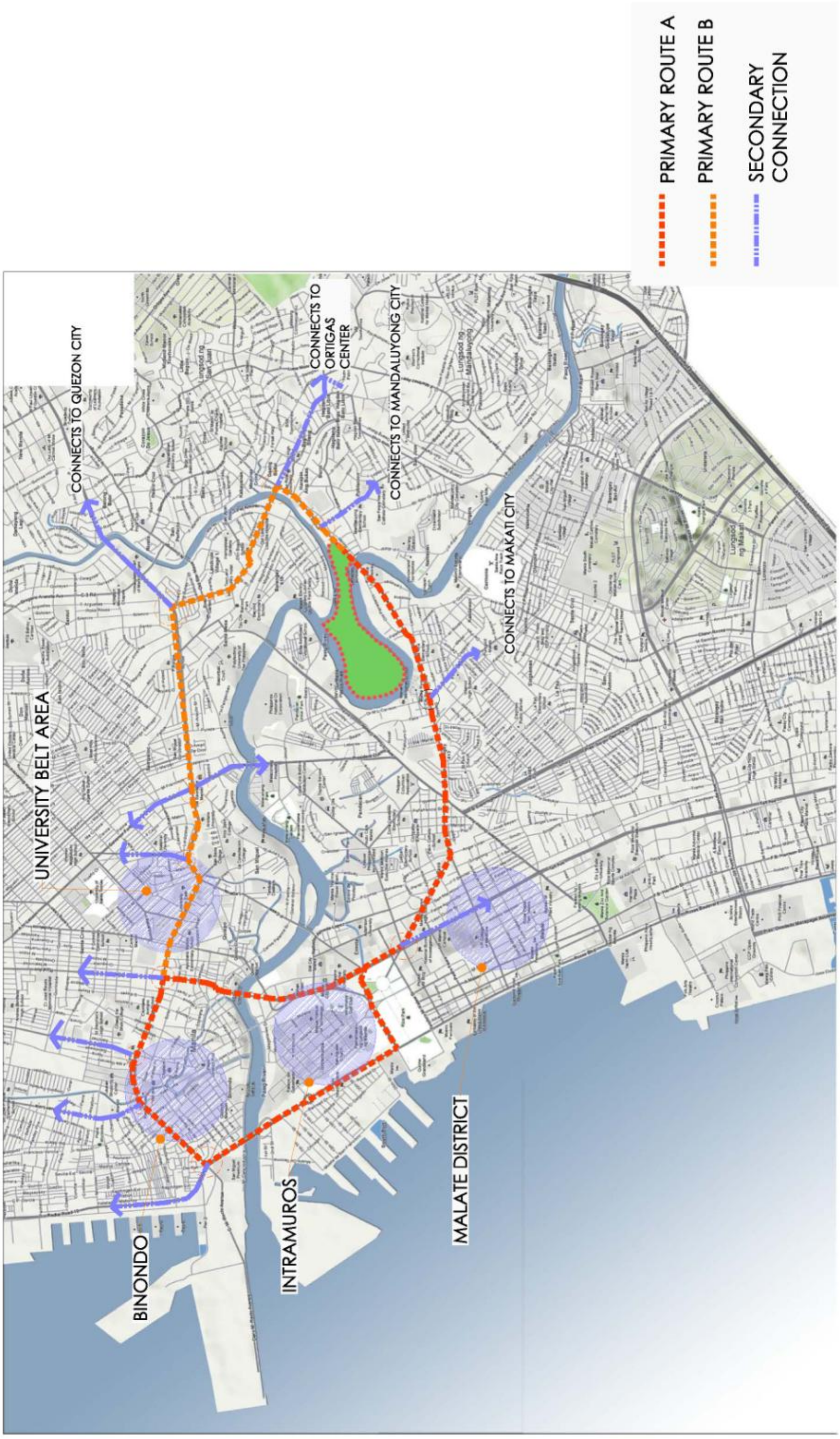


Fig. 37 Jeepney Routes, Primary and Secondary routes

Pedestrian Network

The walking distance measure denotes the distance that can be travelled by walking in a fixed amount of time. In Japan, the standard measure for walking distance is 80 meters = one minute walking time.[23] This is the standard used in real estate listings, for example, if a building is 10 minute walk from a particular train station it is 800 meters away. The walking distance zones and their respective travel time is shown in *Fig. 39 Walking Distance and Travel Time**Fig. 39***

For biking distance, an average speed of 10 kph is considered. This is the average riding speed in an urban setting. The corresponding distances and their travel time is shown in ***Fig. 40***

[23] http://en.wikipedia.org/wiki/Walking_distance_measure

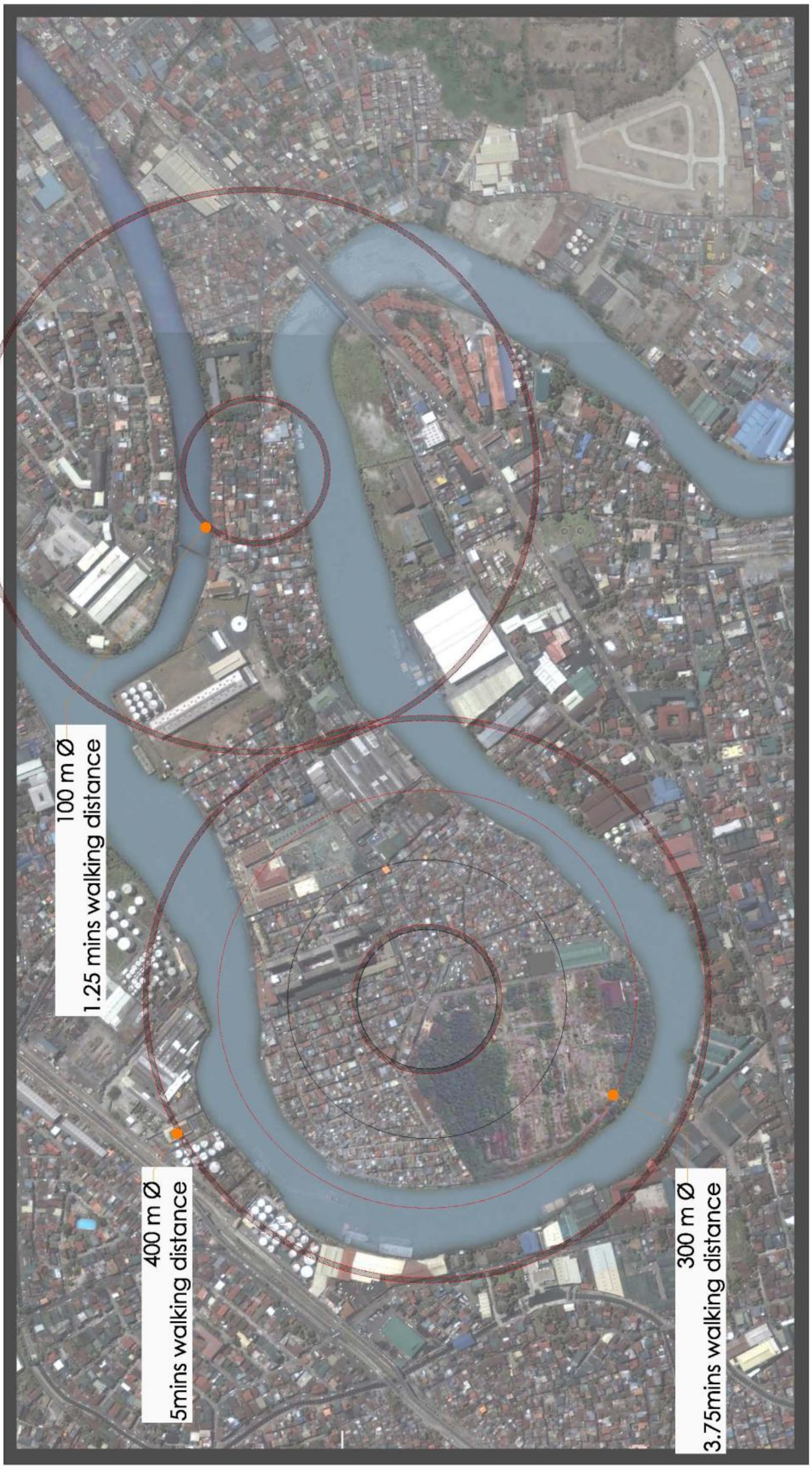


Fig. 38 Walking Distance and Travel Time

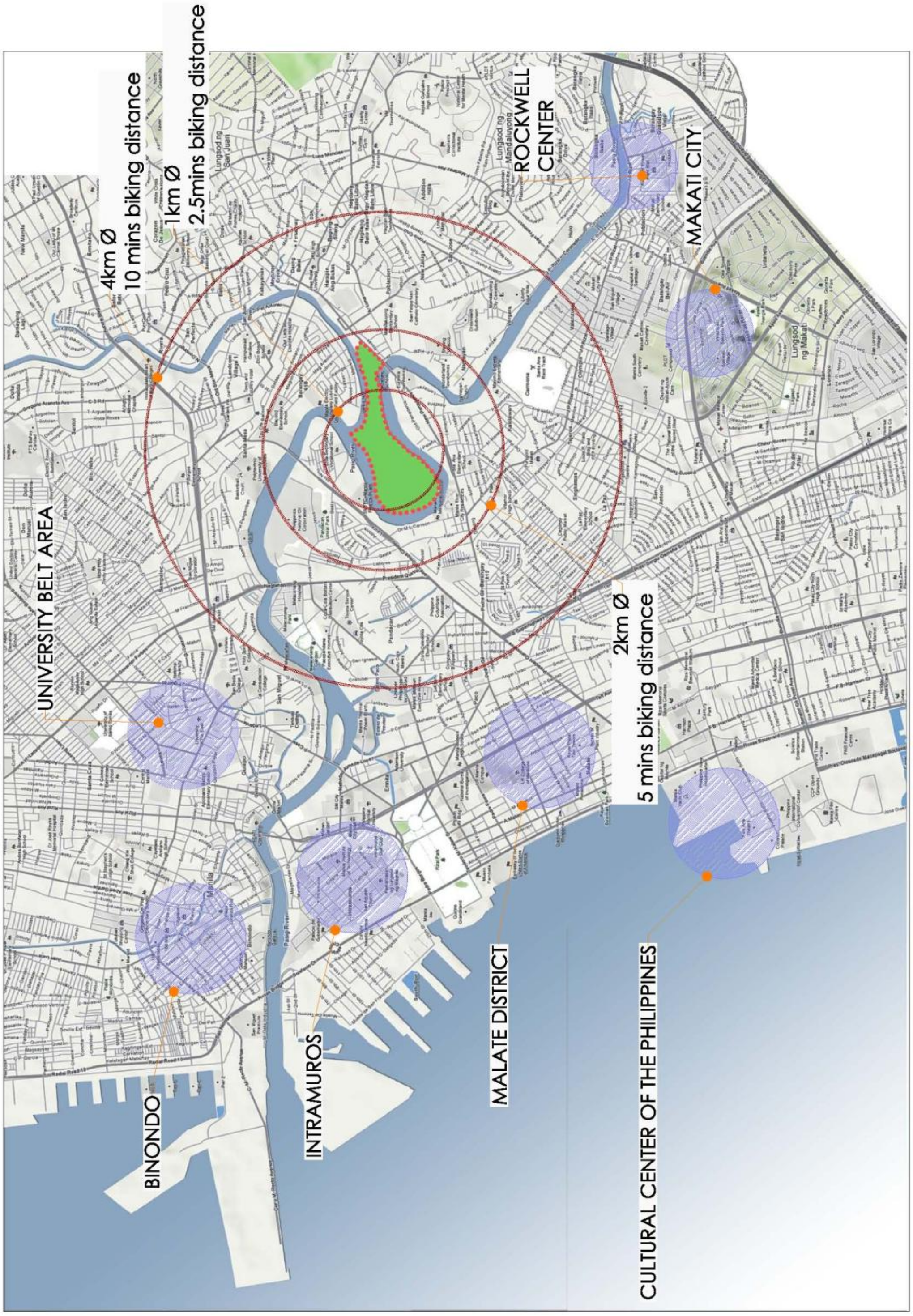


Fig. 39 Biking Distance and Travel Time

Environment

Part PNR is being transformed into a linear park that runs along the entire track line from north to south. ***Fig. 41***

In the past, the setback from the rail road tracks have been encroached by informal settlers. This situation has been resolved as most of the informal settlers along the tracks have been relocated and a green buffer zone is being established along the rail tracks. The tracks are also being transformed from regional train system into a metro line system, giving advantage to the development of a pedestrian friendly linear park that would run throughout the city.

Linear parks along the river banks of Pasig River are being developed. In the Punta Santa Ana area, part of the informal settlers that live along the banks have been relocated to make way for a 10meter wide public park. These parks are the public areas around the river seen in ***Fig. 21***. Part of the PRRC is to reinforce the setback rules to build along the river banks. The linear park development can be seen in***Fig. 42***

The introduction of these parks along the river became important to the development of a network of pedestrian friendly and urban zones for the residents of the area. On the peninsula, the existing green area can be seen on Site 3b shown in dark green ***Fig. 42***. This green area is the largest open green space in the peninsula. Other green and open areas belong to the other two industrial sites as shown in the same image.

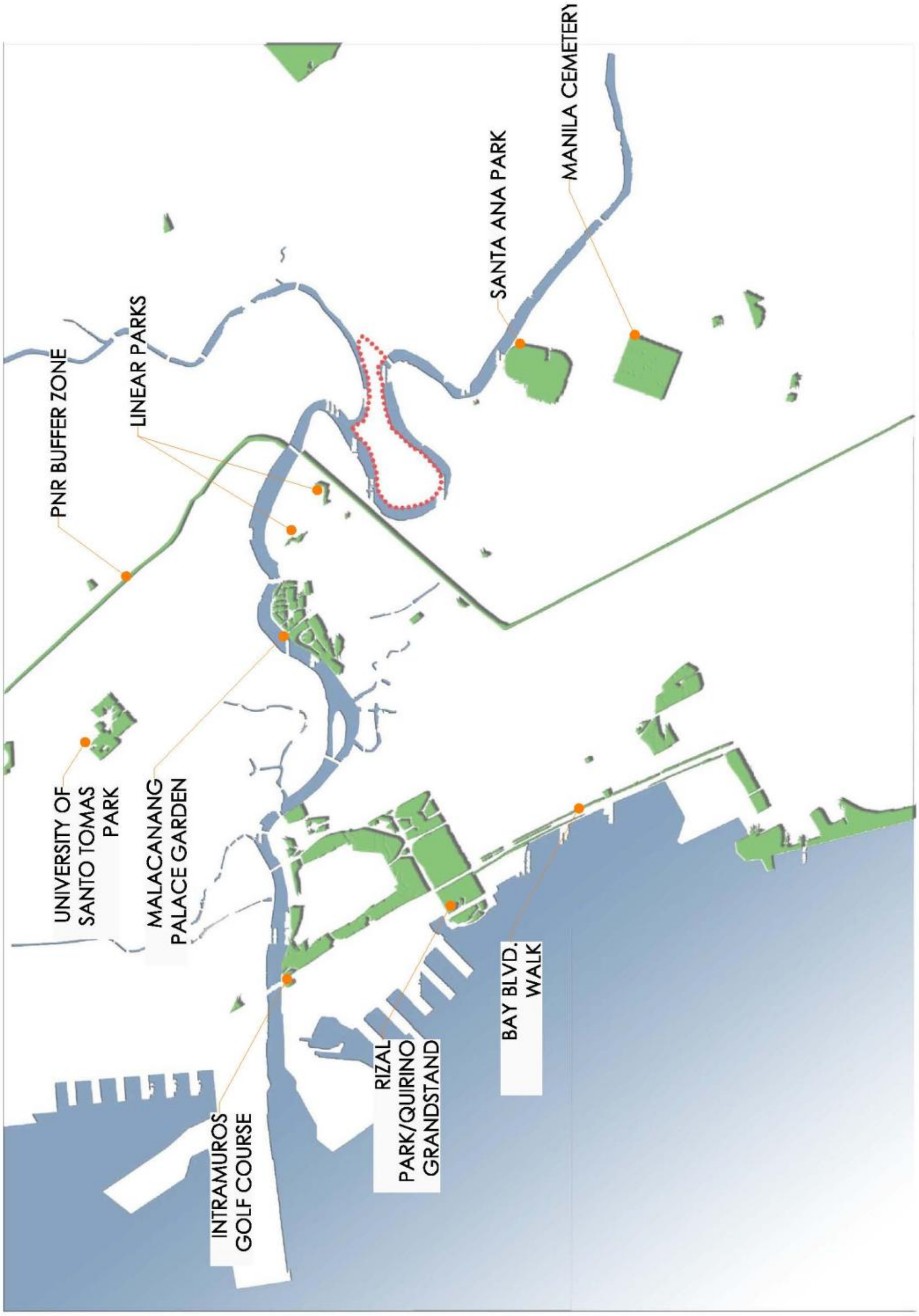


Fig. 40 Regional Green Network

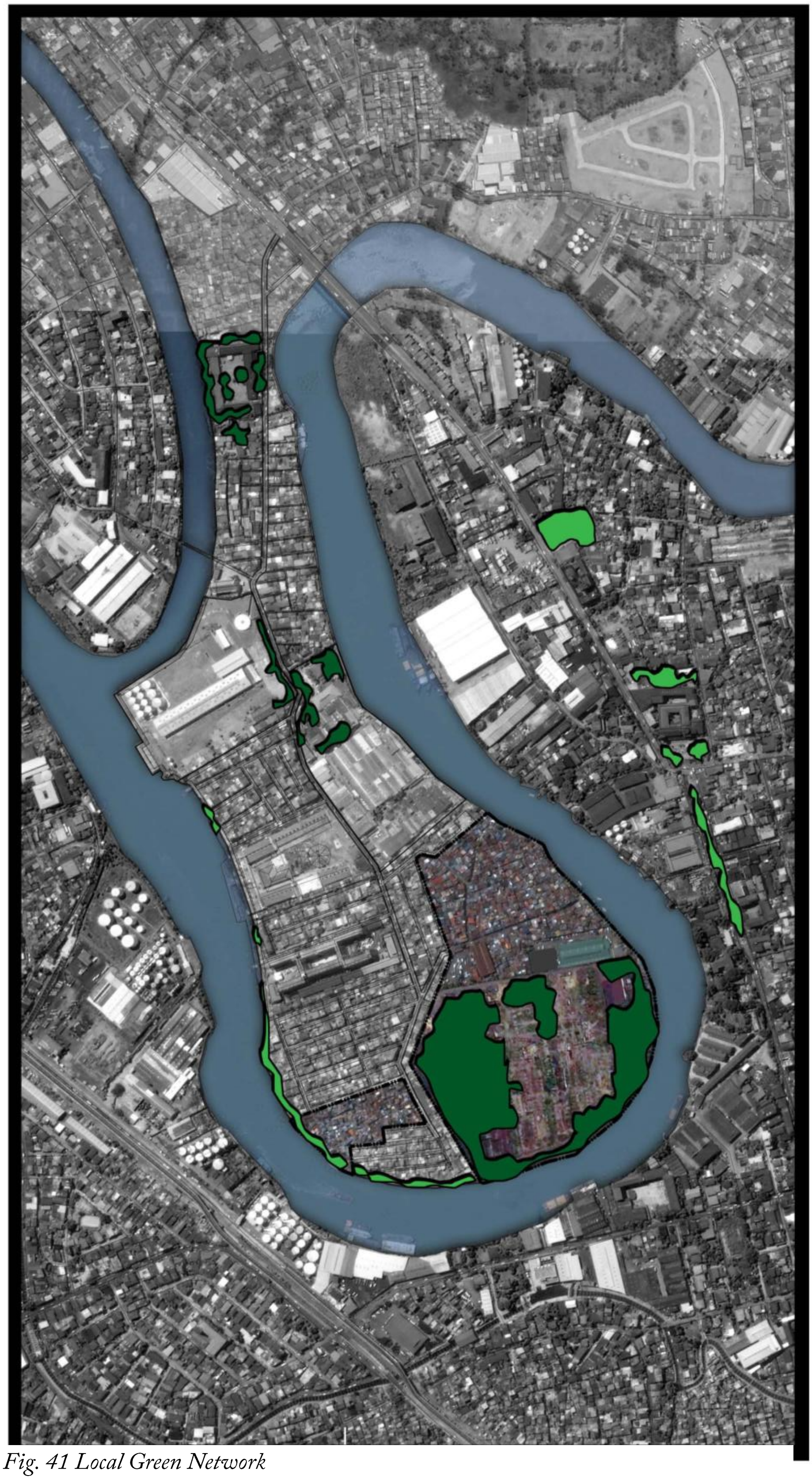


Fig. 41 Local Green Network

Flooding

Metro Manila is composed of 7 highly urbanized river sub-basins that drain directly to Manila Bay. Through Pasig River serves as the main outlet of the major tributary basin, the Marikina river basin in the north east. It is also the main outlet of one extensive lake region, Laguna bay basin.[24] Fig. 43

Flooding in manila is usually caused by an unsual amount of rain fall, coupled with the blockage of the esteros and the main creek and rivers. The thyphoon Ondoy which struck on Sep. 2009 is one such example. The effect of this storm system in the metro was devastating to say the least.

The effect of the high rain fall with the blockage of the river outlets caused the water to spill over its banks and flood the low lying areas of Manila.

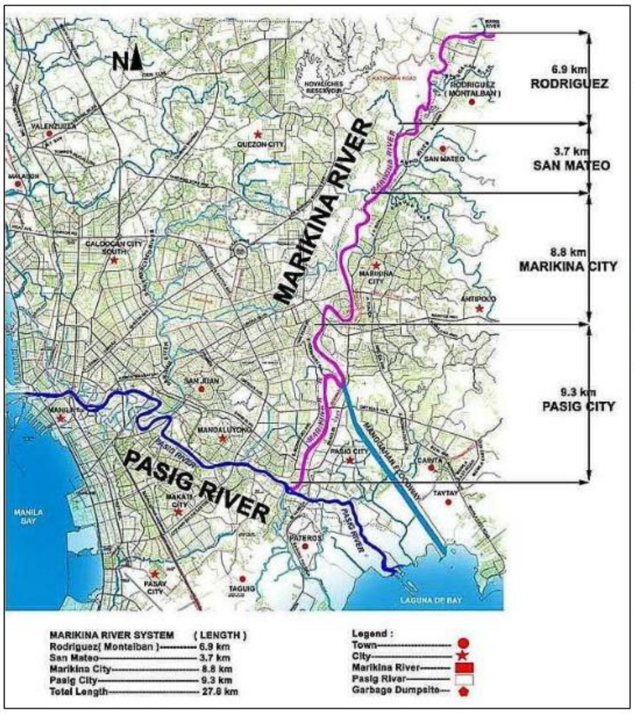


Fig. 42 RIver Map Manila

[24] Typhoon Ondoy (ketsana), Upcoe-Ice-Nhcr Public Presentation, October 26 2009

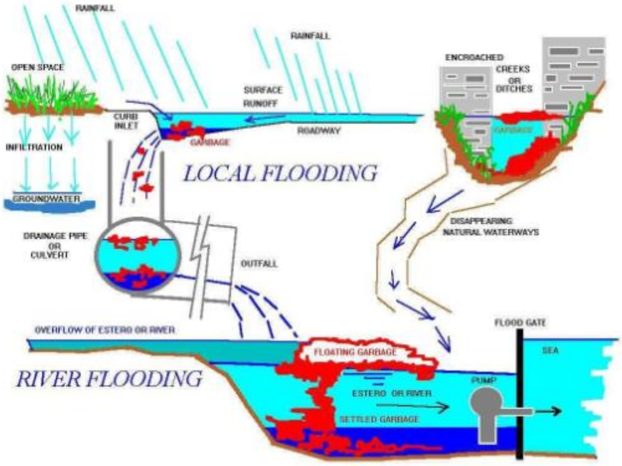


Fig. 43 Flooding diagram

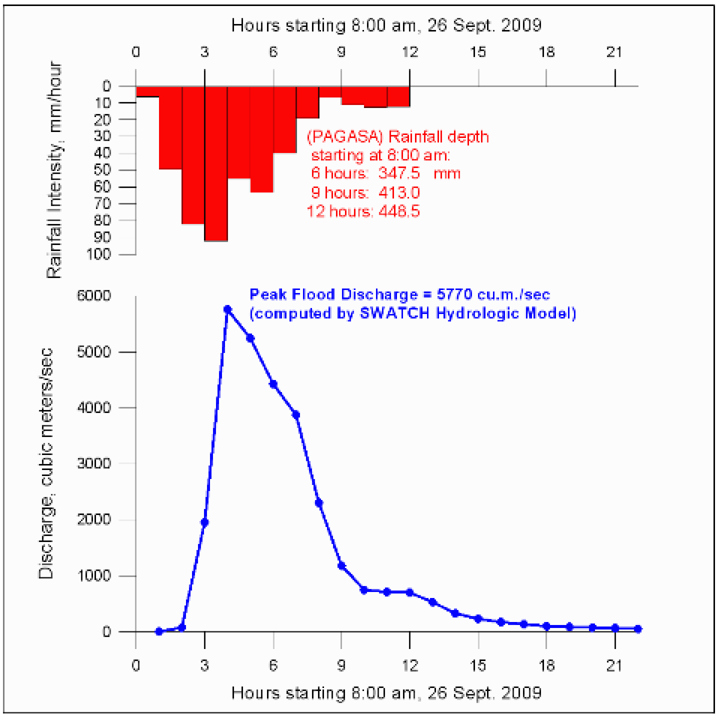


Table 3 Rain fall and River discharge rate during typhoon ketsana

The unusual rain pattern that the typhoon brought was the monthly average of rain in a matter of 6 hours.

The resulting flood and its affect to the metro gave way to re analyzing the flood control systems in place around the metro. Such flood control systems includes river dikes, dams, flood gates, and monitoring systems.

The conclusion of the study done by a panel of experts is that the effect of the 2009 peak flood flow which reached 5770 cum/s has exceeded the previous 100 year flood return period and therefore, necessitates a review and possible revision of the flood frequency distribution.

It is nonetheless noted that the effect of typhoon ketsana storm has produced the 100-150 maximum return period. As compared to the previous 100 year flood of 3310 cum/s; 50 year flood 2980 cum/s, and 30 year flood 2740 cum/sec. The 30 year period is the design flood capacity adopted by the Flood control systems design. Also noted in the report is that the 30 year flood limit has not been exceeded before the September 26 2009 flood.

A reevaluation of the hydrologic design parameter was then proposed by the Department of public works and highways of the Philippines. The primary topics considered were the design of flood run off areas along Marikina and Pasig River. in[25] ***Fig. 46***

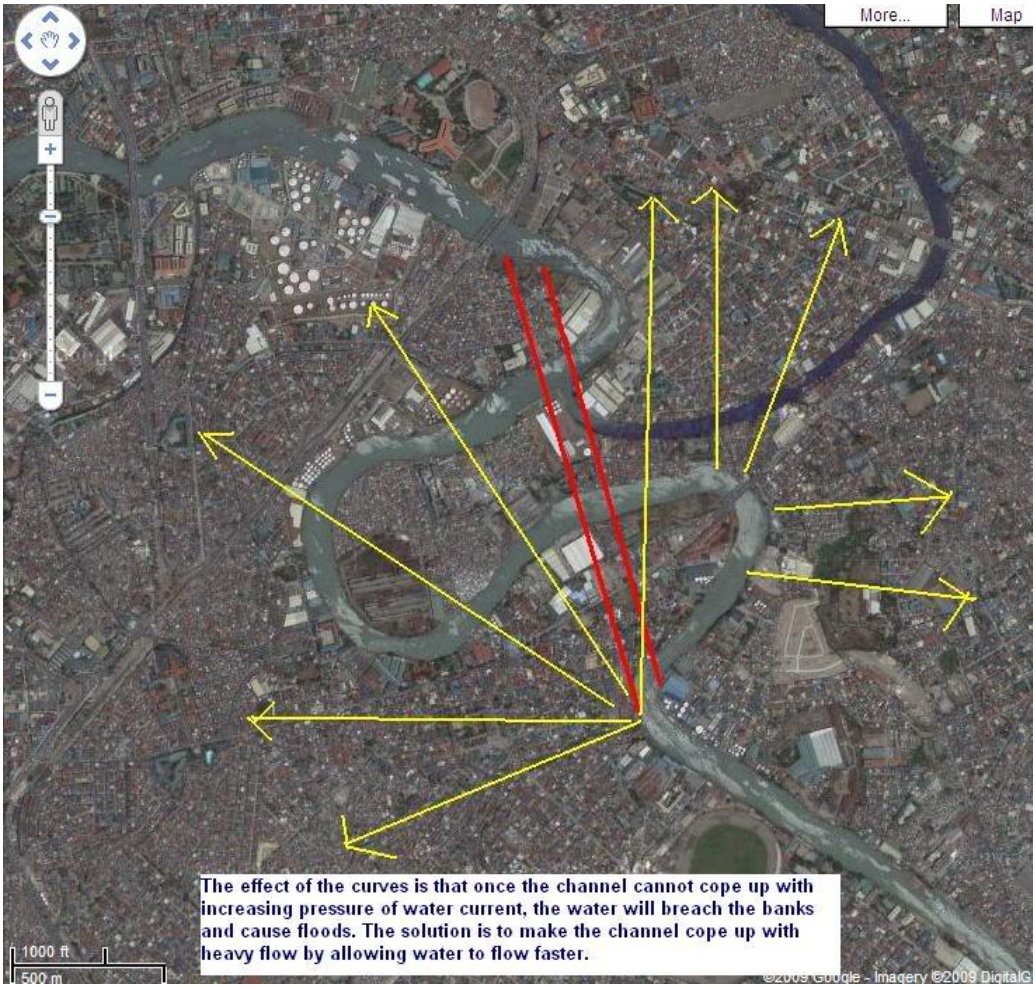


Fig. 45 Punta santa ana water Choke point

[25] Manila Flood Control

Morphology

The peninsula is divided by one main access road the J.Posadas. The main access to site 3a and site 3b is from this road. As mentioned before, minor roads extend from this main road to serve each barangay. ***Fig. 29***. A very distinct road network morphology can be observed in the image, each road network is different from each other. Each barangay dictated the pattern of the road. The road axis also pays no attention to the natural curves of the site, a very rigid grid can be observed in all of the street patters. The north to south orientation of the road network however, are oriented for the best light and ventilation pattern, as explained in the other chapters. These specific patterns for each barangay can be seen on ***Fig. 47***

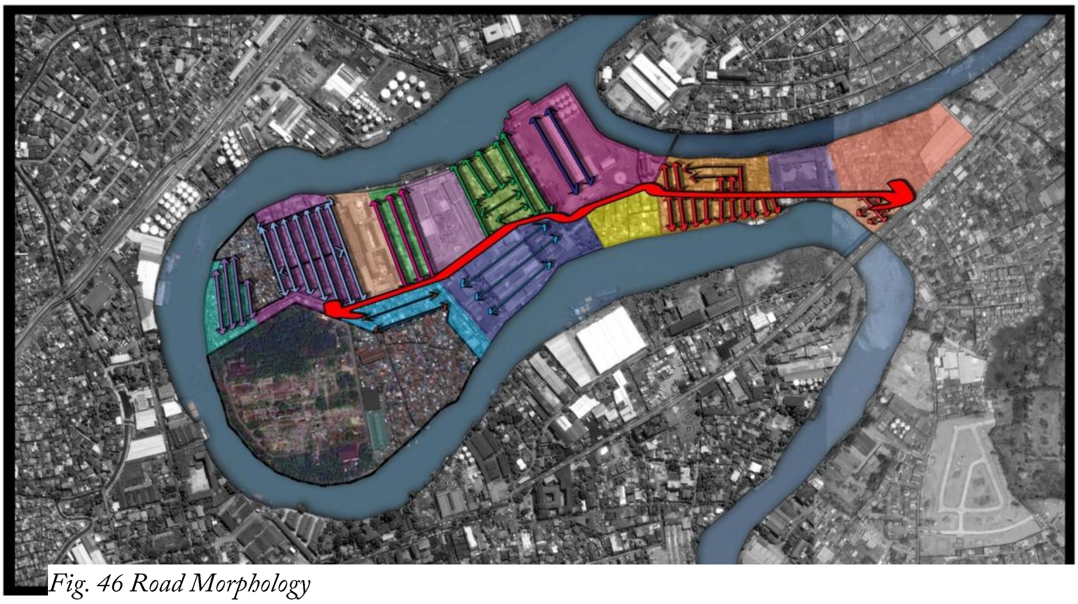


Fig. 46 Road Morphology

Built and Un-built spaces

Creating a postive and negative image of the open and closed spaces in the peninsula, it can be observed that the site selected, 3b, has the largest open space avaliable for development. Part of this large open space as seen in ***Fig. 42*** is of natural vegetation. The very compact and very dense typology for the buildings can be observed. There are hardly any open space for each resident for various activities.

In the use of the vehicle road for recreation is notable with the lack of open space to host such activities. An overcrowding of the streets is then the result of this uncommon way of using the streets and an increase in traffic and pollution in the whole area as a secondary effect.

Among the built and unbuilt spaces, the open spaces are also clasified as public or private.***Fig. 48*** The public domain is limited to the public roads and the linear park being developed. Most of the open sites belong to private oweners. Site 3b also belongs to a private corporation. There are a few public spaces inserted into the barangay units. These spaces are mainly the churches and chapels of each barangay. Each barangay also plays host to its onw barangay hall, which is the office building of the barangay chairman and its cabinet members.

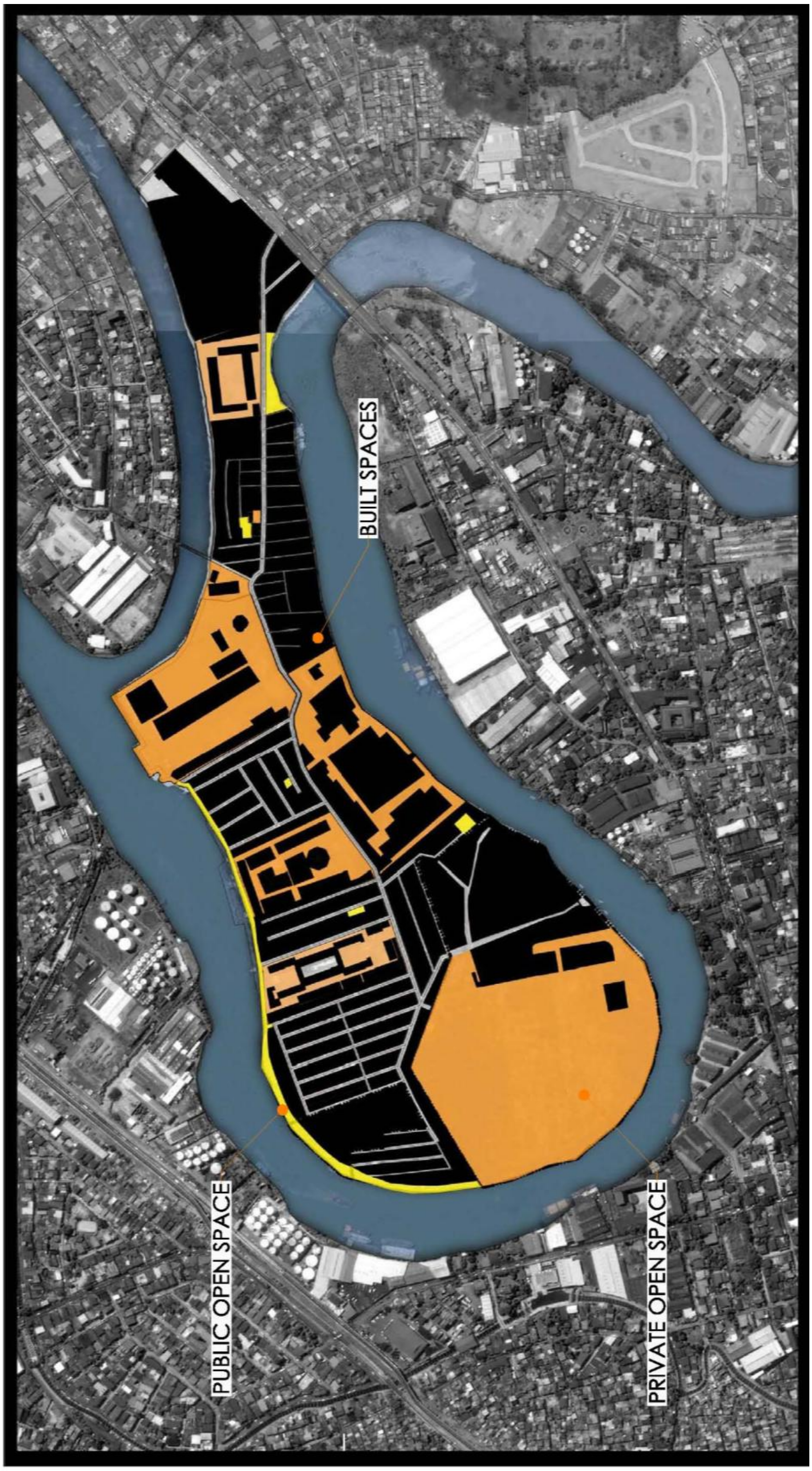


Fig. 47 Built and Unbuilt space

There are several socially important landmarks in the peninsula or Punta Santa Ana. ***Fig. 49*** Here in Punta Santa Ana is where the first Inglesia ni Cristo church was founded july 28, 1914. The Inglesia ni cristo is a major and the largest, entirely indigenous, Christian religious organization that originated from the Philippines and the largest independent church in Asia. The first church still stands in the very site it was founded, and is now the museum for the religious organization. FIGIGIG

The Tenement Bldng, is another one of the important landmark of the area. It is considered to be the most fortified Bldng. Project of the late President Diosdado Macapagal. Built during the housing reforms of the 1960's it is one of the most recognizable buildings in the area. Its eight storey concrete façade imposes itself on the relatively flat landscape around it. This tenement housing project was built for the informal settlers that once scattered all over the metro during that time. FIGIGIG

Thomas Earnshaw Elementary School, owned by Tomas Earnshaw one of the known Professor a local from Tondo.

A local supermarket is located in the entrance of the peninsula. it is located along the new Posadas road

Aside from the Inglesia ni Cristo Museum. There is also a new Inglesia ni Cristo Church built on site. This community church not only serves the peninsula but also the surrounding district of Santa Ana. The very gothic style of the building creates an interesting addition to the skyline of the area. FIIIG

Each Barangay has its own barangay hall. Barangay halls differ from each other from the size of the barangay. Some of the barangays halls in Punta, consists of a group of buildings and an open court, usually used as a basketball playing court. Other barangay halls are just small office buildings. Most barangays are also served by one church or chapel. Most of the time they are located within close vicinity to the barangay hall and open court.

Landmarks outside Punta Santa Ana

There are a number of sites around the area that are historic landmarks. Some are known. And some have become inaccessible to the general public. ***Fig. 49***

Across the river in the town proper of Santa Ana, there are a row of vintage homes. These homes are being considered as a culture heritage in the area. Most of these houses are well preserved and are perfect examples of Spanish colonial architecture in the Philippines, although the houses were built no more than a hundred years ago. FIIIG

The Pandacan oil depot is another landmark in the region. The large groups of oil storage containers had defined the landscape of the area for nearly a century. Although current government developments see these depots to be removed, the historical significance of the large industrial area should be considered in the future developments.

There's one imposing and one important landmark in the district of Santa Ana, Manila it is the Church of the Our Lady of the Abandoned, but more popularly known as Santa Ana Church. Its origins actually date back in 1578, when the Franciscan missionaries established themselves at the old community of Namayan. The present Santa Ana Church was actually built in 1720 through the efforts of Fr. Vicente Ingles, who was a parish priest there at the time. It was also Fr. Ingles who brought to the church the image of Our Lady of the Abandoned, to whom the church was eventually dedicated to. Carved in 1713, it is said that it was through the grace of Our Lady of the Abandoned that Santa Ana was spared from much destruction brought about by World War II in the city. It is also one of the few churches in the city that has largely remained intact.

The Santa Ana public market has been part of the community since the establishment of the town by the Franciscan order. Although the current market on site is relatively new, the importance of its ever endearing presence in the same area promotes itself to one of the most recognizable landmarks in the area. FIIIG

The lady of Lourdes Hospital is a newly built general hospital for the residents of Santa Ana.

The Colegio de la Inmaculada Concepcion de la Concordia, simply Concordia College is a school Roman Catholic institution of learning located in Pedro Gil, Paco, Manila, in the Philippines. The college was founded in 1868. It is one of the oldest schools in the country and is a landmark of the whole metro manila.

José Rizal University (JRU) (Formerly José Rizal College / JRC) is a non-sectarian, non-stock private educational institution. It is located at Shaw Boulevard, Mandaluyong City, Philippines. It was founded in 1919 and named after the national hero of the Philippines.

Don Bosco Technical College (DBTC or simply Don Bosco Mandaluyong) is a private Catholic educational institution owned and operated by the Salesians of Don Bosco.

The Tanduay factory along the river pasig is another important landmark. Tanduay Rhum is an alcohol beverage from the Philippines. It is produced by Tanduay Distillers Inc, and with origins dating from 1854, has over 155 years of history.

Large numbers of institutions are located in the old district of Binondo and the University belt. These institutions ranging from kindergartens to major universities are the target of the project.

Some of the notable schools are ***Fig. 50***

- University of Santo Tomas

- Far eastern university
- Philippine Normal University
- Polytechnic University of the Philippines
- University of the Philippines
- de LaSalle Zobel
- San Beda College
- National University
- Mapua Institute of Technology
- Adamson University
- FEITI University
- Saint Jude Catholic School
- Arellano University
- Saint Benilede College
- University of the East

Other important landmarks around the site includes the site and along the Pasig River are ***Fig. 50***

- Malacanang Palace
- Malacanang Palace Garden
- Paco Cemetery
- Apolinario Mabini Shrine
- Santa Ana Park/race track
- Central Post Office
- Manila General Hospital
- Intramuros

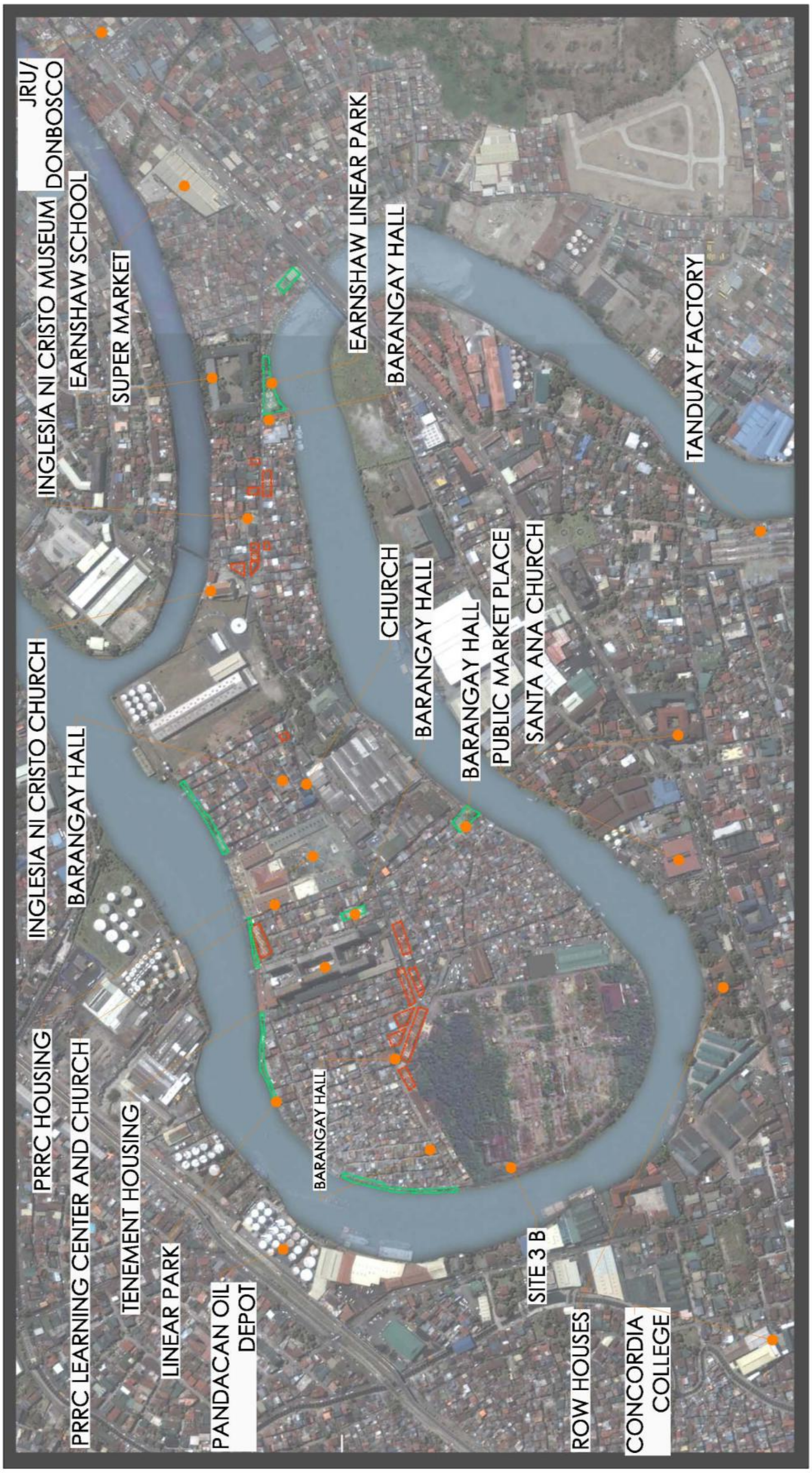


Fig. 48 Landmarks in Around Punta Santa Ana

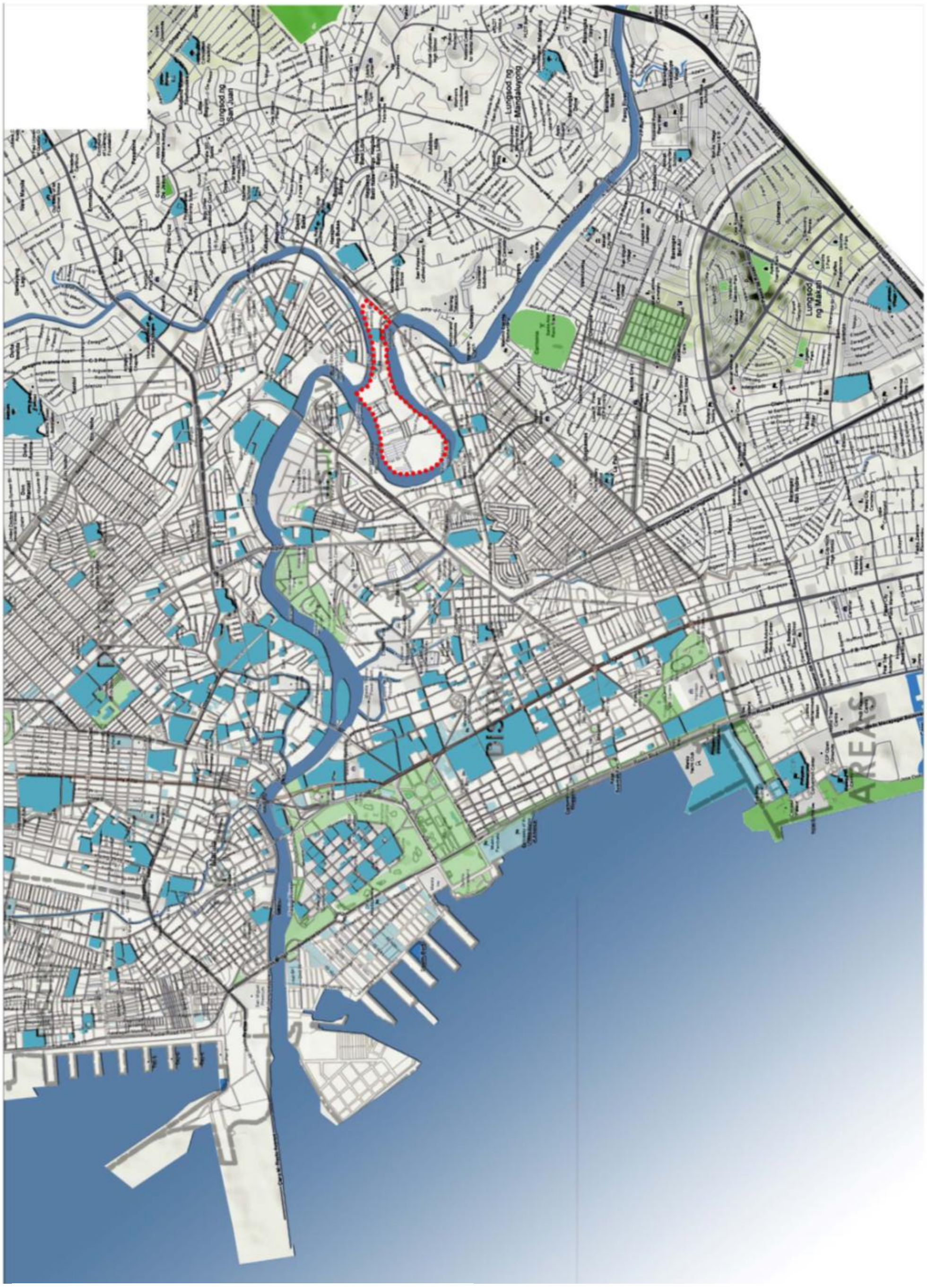


Fig. 49 Map Showing all Landmarks in Manila

III. SWOT Analysis

1- SWOT

Strengths

Large open area for development

Bounded by Mandaluyogn city and Makati City

Has access to San Juan, Makati, Mandaluyong, and Ortigas

Has access to Philippine National Railroad

Surrounded by Pasig River

Accessible by Pasig River

Has a number of historical places

Has parks

Least number of barangays with squatters.

Indirect connection to other rail networks

Large green area on site

Local businesses in area

Weaknesses

Congested housing/residential areas

Clogged rivers

Overhead electric wires are an eyesore

Poor environmental condition

Poor environmental strategy

Lack of commercial establishments

High risk to earthquake

Presence of large oil depots

Polluted river

Traffic congestion

Lack of open public spaces

Air pollution from vehicles

Presence of informal settlers

Presence of industrial areas

Brownfield site

Opportunities

Close to Malacanang Palace

Close to the University belt

Has indirect connections to entire metro

Construction of commercial facilities area

Construction of infrastructures around the area

Achievement as a core of the city

Vicinity to network of green spaces

Vicinity to historical districts and landmarks

Threats

Increasing informal settler population

Flood prone increase

Earthquake risk

Further contamination of river Pasig

Presence of oil depot

Shortage of water supply

Solid waste management problem

IV. Strategies/Options

The following are the Strategies and options taken into consideration for the urban design phase:

Workshops

There are a high number of local student populations. A consideration could be taken with the creation of workshop spaces for school activities/cultural activities such as workshops for theater, dance, and music. These spaces will provide a venue for the students to learn and practice. Workshop spaces for different arts and sciences would not only be beneficial for the large student population, but it will also be beneficial to the large unemployed population in the area.

Training centers

The creation of more specific training centers or technological institutes will help the unemployed population and to tap the vast human resource available on the area.

School facilities (Classrooms, Libraries)

There is a large shortage of school facilities in the entire metro. For Punta Santa Ana it is more evident because of the large concentration of residential areas. The lack of school facilities, such as libraries and classrooms, can be offset by location such said facilities on this site because of its connection to the rest of the metro is ideal.

Business centers

The area can be developed into a business center. It can be a satellite node between the other Central business nodes. Surrounded by residential areas it would be an ideal location to develop a business commercial center to provide jobs for the local population without having them commute much farther than necessary. Increasing habitation density will increase the need for public spaces while increase use of cars.[26]

Town planning and legislature measures: road traffic to pedestrian oriented community, use of public mass transportation as an alternative to individual vehicles, central car parking to avoid the unnecessary travel of cars around the small area, new building typologies, proper land uses to avoid increased travel times. Closer relationships between the business areas and residential areas for example will decrease the need for travelling. Using the river as an alternative form of transportation is the best solution. [27]

River front developments.

There is high appeal for developments along the river. The significance of the river Pasig in manila has long been forgotten by its citizens. But until recently all to the effort of PRRC, people from manila are slowly finding the connection back to the river. A river front development would open up the river to the citizens of manila and create more opportunities to

[26] Maistroli, Helen; Interventions of urban Regenerations of Historic City
[27] Ibid

enhance the value of land along its banks. It will also reintroduce the citizens to the natural ecological value of this river and would encourage people to help out in its preservation.

Urban renewal areas

Around the site other areas are being renewed to become business centers and other high density residential areas. Developing the area as a high dense residential zone as proposed would be against the benefit as there is no more space in the area, adding more population to the area would choke the area. Addition of more people would also bring in more traffic. More traffic will bring more pollution. However there is a possibility to develop a less dense residential area. And try to create more green areas and open areas for the population of Punta.

Housing Programs

Housing programs for the informal settlers on site is not economically viable because of the land use classification of the whole district. Also the location of informal settlers would produce a vast difference in projected economic profile of the area. The location of informal settlers on site would also decrease the value of the land rather than enhance it.

There are some debates about relocation, where to relocate them. The current government programs relocate them outside the city. A problem with this approach is that some of the settlers' livelihood is tied with the city. And moving them away from the city just forces them to go back and resettle somewhere else. Currently there are two informal settlers housing in the area.

Removal of informal settlers

Relocation programs for the informal settlers can be enforced in slum areas. This clears the way for proper development of the area. The density of the informal settler population put stress on the local infrastructure, ie: water waste management, which in turn affects the overall environment. Unplanned settlements such as this also decrease the social and commercial value of the area. Historically the area is known for its high crime rate. Only through the relocation of a majority of the informal settlers have improvements been seen.

Tourism centers and support facilities

Being located in between known city centers, Intramuros and the old district of Santa Ana, and the newer districts of Rockwell, Makati and Guadalupe, and with the presence of other historical sites along the river, the site has a good potential to be developed as a support places to attract the tourists along the river. Support facilities such as theaters or other cultural facilities can be developed as a support for the sites and as an attraction itself.

Proper zoning

The mixed and unplanned zoning in the peninsula causes unnecessary traffic and confusion on the morphology of the area. Developing specific zones for commercial and business would be ideal.

Urban spaces as a pedestrian network. This way the urban spaces are used as part of the urban infrastructure.

Urban agriculture as part of sustainability aspect of the urban design.

In the past century, food production has become industrialized and globalized and in effect unsustainable. They say is symbolized by the fact that fresh produce troubles on average 1500 miles from field table in America. That's a lot of fuel consumption. The feeding needs of our expanding community's family farms have been taken over by the businesses sprawls an agricultural mono culture. Sadly, the farm as corporation economic model has become the paradigm for modern for production with the bottom line of volume and efficiency. This low cost food is of questionable quality and taste and safety. Fruits and vegetables from the conventional system harbor resin use of multiple pesticides are toxic to the environment and the body. It is no mystery that health problems can be traced back to diet and the current food.

Sustainable solutions are within reach new economic models for food productions are emerging that can feed the world more nutritiously.

Sustainable food production and increased food access are being integrated into neighborhoods. All they can achieve this by integrating food systems in two basic ways from food production and through food access by proper zoning regulations to allow for communities and individuals to produce their own food. In communities, minimal food access can be created with minimal economic investment in infrastructure.

Good quality food is vital to the public health of a population. The economic benefits of community based food systems including creating jobs and self sustaining markets. Environmental benefits and less energy use, cleaner air and water, and remediated soil. Community benefits include food security, better healthy, neighborhood beautification and greater connections between people and earth.

Local food production also offers the potential for recycling for waste removing organic materials from the waste stream and using it to make soil.

Sustainability in economy can be produced. Labor for the population can be tapped.

The market place of Santa Ana, which is the historic market for the area, can be used for the distribution of the food produced in the area.

The center of the Punta can also be used as a secondary zone to distribute the food. It lays on the primary green corridor which can be accessed by pedestrians.

The new city identity brings back the original context of the area as a grassland/irrigation land.

Waste Water Management

The landscape now brings into it a new role, rather than just to beautify the city, the landscape is part of an infrastructure that is vital to the sustainability of the area. [28]

Urban Park: Parks are for the health of the people,
Water is absorbed by the soil rather than straight through a run off. Urban parks can act as flood defense; improve air quality, shelter and shade, recreations, natural habitats. And overall increase the value of the area.[29]

Easements on the river

The current building codes enforce a 10 meter setback from the river Pasig. These setbacks are then suggested to be developed into public linear parks that will be part of the "re-greening" of the river. In Punta Ana, this rule has been enforced. And informal settlers and illegal structures built along the setback have been removed and a public park has been built. But because of land ownership issues, such as the topic site being private, the

[28] Landscape Urbanism Reader
[29] Ibid

linear park development is not complete. It can be seen that the parks are developing randomly. A starting point for greening of the river for this project is to complete the linear park that surrounds the peninsula. This park can serve as not only the primary pedestrian and bicycle areas. But it can be part of a network of open areas or urban areas for the citizens of Punta.

Buffer Zones

These parks can also act as a buffer zone from the river. Proper design of these buffer zones would be necessary to help against flooding.

Transportation brings with it noise and air pollution. The best option is to reduce the transportation density by integrating public mass transportation systems with pedestrian networks. This will negate the need for constant use of vehicles.[30]

Trees planted along the pedestrian corridor will act as carbon sinks. Soils will be used to create redefine the micro climate.

Car Free Zone

There are advantages and disadvantages in developing an area. One advantage is the increase in the land value. This increase will bring an increase in population, depending on how the area is developed. Increases in population will without doubt increase the number of vehicles within the site. The Punta Santa Ana infrastructure, more specifically the road networks, cannot

[30] Cuchi, Albert, Traditional Technology for sustainable approach

accommodate an increase of vehicles in any sort of magnitude. The one main access road is already overstressed and adding further developments would be unreasonable. An increase in vehicular traffic will also increase the amount of air pollution in the area.

There are a couple of solutions to follow. The building of other ingress and egress from the area would help to alleviate the traffic problems. This solution however, is still less ideal from the point of view of the environment of the site. Creating more roads in the area will allow for more vehicles to pass through it and elevate noise and air pollution problems. Building these bridges would have to imply further expansion of some roads and the creation of more buffer areas to lessen the environmental impact of the increased number of vehicles.

A completely walk able city would reduce the need for vehicles and decrease the need for large pavements, reduce air pollution and reduce the overall environmental impact of the development.[31]

A car free approach would be more ideal. Removing all of the cars in the area would allow developing the existing roads into green areas or proper urban spaces. An analysis of how these existing roads are used by the community shows the openness of the community values of the Filipino people. Most community

[31] Ibid

events and activities are done on these streets. The problem of vehicle traffic makes it dangerous for the population to use the roads. But a lack of open areas or urban areas for public use exceeds the problem and the spaces are used otherwise.

Developing these roads into urban spaces can be beneficial to both the social and environmental health of the area. Proper urban spaces to socialize without the dangers of vehicular traffic would benefit the community. These areas can also be developed into linear parks. Reducing the concrete around the peninsula would also reduce the heat island effect and create a better atmosphere for living. These green areas could also be used as part of the urban agriculture concept providing the residents with planting space for them to grow their own food.

Naturalization Zone

There are areas that could be proposed to be naturalized. These areas being already inhabited by thick vegetation is home to a large number of flora and fauna. The main site, 3b, which has not been used in the last 10 years has already a good potential to be allowed to be re-naturalized.

These naturalized zones will be home to nature and will help increase the environmental quality of the area. The re-naturalization of these areas will also increase the biodiversity of the flora and fauna, as well as increase the amount of carbon sink in the area.

The naturalization zones to be proposed would be green areas that are allowed develop into a natural habitat for local species. Rather than designing open green spaces for the inhabitants, these natural zones will be a haven for the plants and animals of the area.

Reduce heat island effect

An urban heat island (UHI) is a metropolitan area which is significantly warmer than its surrounding rural areas. As population centers grow they tend to modify a greater and greater area of land and have a corresponding increase in average temperature. Monthly rainfall is greater downwind of cities, partially due to the UHI. Increases in heat within urban centers increases the length of growing seasons. Another consequence of urban heat islands is the increased energy required for air conditioning and refrigeration.[32]

Mitigation of the urban heat island effect can be accomplished through the use of green roofs and the use of lighter-colored surfaces in urban areas, which reflect more sunlight and absorb less heat.

The temperature difference between urban areas and the surrounding suburban or rural areas can be as much as 10 degrees. Nearly 40 percent of that increase is due to the prevalence of dark roofs, with the balance coming from dark pavement and the

[32] http://en.wikipedia.org/wiki/Urban_heat_island

declining presence of vegetation. The heat island effect can be counteracted slightly by using white or reflective materials to build houses, roofs, pavements, and roads.

Using light-colored concrete has proven effective in reflecting up to 50% more light than asphalt and reducing ambient temperature. A low albedo value, characteristic of black asphalt, absorbs a large percentage of solar heat and contributes to the warming of cities. By paving with light colored concrete, in addition to replacing asphalt with light-colored concrete, communities can lower their average temperature. This is a long established practice in many countries.

A second option is to increase the amount of well-watered vegetation. These two options can be combined with the implementation of green roofs. Green roofs are excellent insulators during the warm weather months and the plants cool the surrounding environment. Air quality is improved as the plants absorb and convert carbon dioxide to oxygen.[33]

Harder pavements will give way to softer more friendly surfaces in an architecture and urban design scale. These slight interventions have significant environmental impacts to the region. And very distinct micro climate effects such as reduced heat island effect and control of humidity in the area. [34]

[33] Mough, Cliff, Urban Design Green DImensions
[34] Energy Efficient Site Design

Connect to other Green Networks

The importance of creating a bioregion of environment. Connect the large green areas. Connect the naturalized zone to the linear park to the Malacanang palace. Sta ana race track to the south

Urban structure as a part of a whole bioregion and considering the countryside food production and penetrating it into the city

Bioregion:

The city is part of a bioregion. The development is part of the city. Considerations should be made in analysis of this connection between the site the city and the bioregions. Rather than have a separate system for city, town and country, it is considered to overlap such elements to bring balance into the environment. The design of the area is not about going back to the past.

Building on Stilts

In order to increase the resilience of the place it was elected to put the buildings on stilts. The flood defenses in the area are based on the 50 year return period. Flooding is well prepared with actually very few events of the river breaking its banks and flooding the area. The problem was during the Ondoy storm system. Which was a very rare event based on a 150 year return period. The resilience aspect of the urban strategy takes into account the probably effects of rising sea water in the future and the eventual exacerbation of the global warming effect through the change in weather.

What was surprising is that even though the flood systems in place for the site are based on 50 years. And in since the construction of the river dikes the river has not surpassed this 50 year return period. On the other hand the 150 year return period arrived in less than the estimated time.

Further studies must be made about the flooding systems for the urban plan. The Ondoy storm system has forced the local engineering officials to reconsider the risk analysis of floods in the area. Points to be considered as are as mentioned above. And the officials are considering in redefining the limits with Ondoy being classified as a 100 year return period.[35]

The suggested height of 4 meters for the building level is based on actual survey during on site visit. As reported by the local inhabitants of the flood level of Ondoy reached the 1st floor level of the local houses, which is about 4 meters above ground. Major consideration of this observed data is given and it is applied in the urban design proposal. The 4 meters height should be sufficient to substantially offer an increased the resilience against flooding in the proposed communities.

Commercial centers.

[35] Typhoon Ondoy (ketsana), Upcoe-Ice-Nhcr Public Presentation, October 26 2009

Commercial centers now are the primary urban spaces in the metro. These large, completely enclosed and air-conditioned structures are the escape of the residents of manila from the year round heat of the sun.

Sports centers such as basketball courts

Parks are used primarily for leisure. With the few parks located within the metropolitan area, parks are a green haven for the citizens of manila. These spaces are used for relaxation and often time used for games or sports events for the community. Larger park spaces are also used to accommodate cultural activities such as musical concerts and dance performances or other variety shows.

Sports centers, basketball courts.

Basketball courts are found all over the metro, almost every barangay has a central basketball court, the court is used as a multipurpose area for any type of community events. In some areas where a court is not within reasonable distance from the residences make, makeshift courts are made onto the streets.

Streets play a major role in the residential areas of the metro with very little public spaces around. Most interaction or activity is taken place along the street. The streets are used for sports, cultural, community events. Around Punta Santa Ana, the streets are the main urban spaces for the residents. This is where people interact with each other and relax. Getting away from the heat of indoor environments, most residents spend their time outside where there is a cool breeze passing through.

1- Schemes

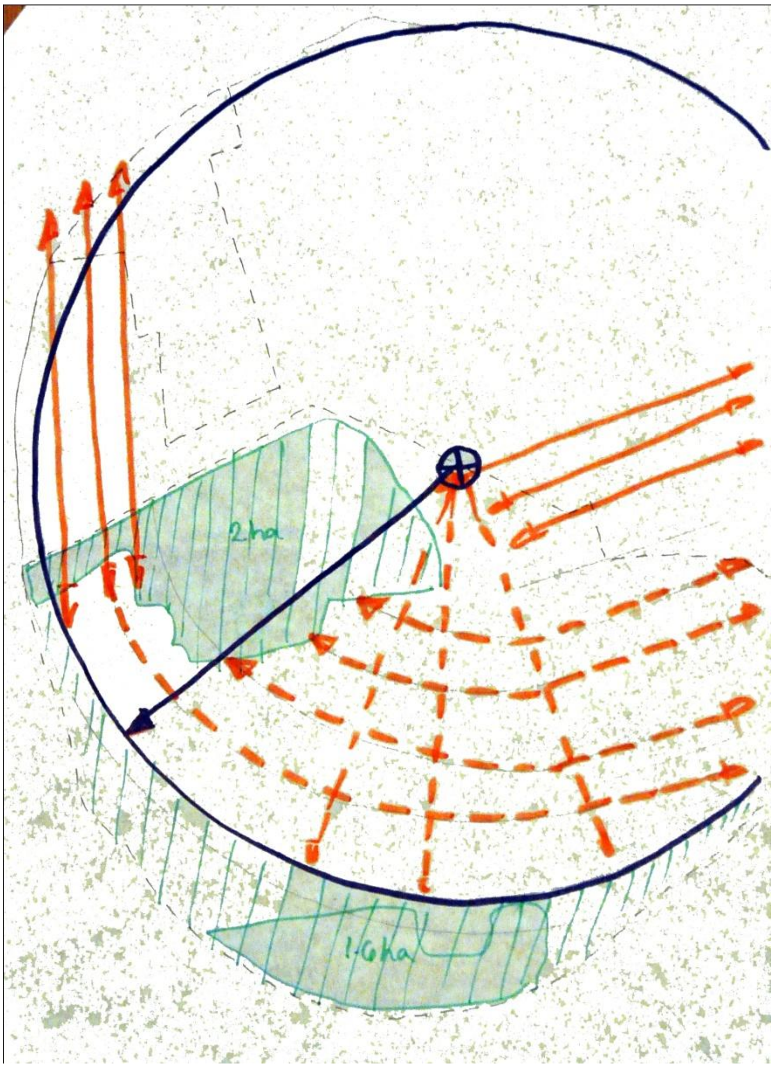


Fig. 50 Scheme A Proposed morphology

Starting from the entry point of the site through J. Posadas Road, it can be seen that the entry point is the geographical center of the peninsula.

The entrance point is then extended, south westerly, towards the river. This establishes one of the major axis of the site. (Shown as black line)

Two natural zones have also been identified. These areas are the places that have already developed a heavy amount of vegetation.

By creating a circle from this center the limits of the site is now established, keeping the 1.6 ha outside of the zone. This part is then left as part of the green network.

The initial proposed networks are also shown in scheme A. The road network established here is based on the extension of the existing networks. The idea behind this pattern is to try and create a more unifying road network to the site as opposed to the scattered morphology that exists at the moment.

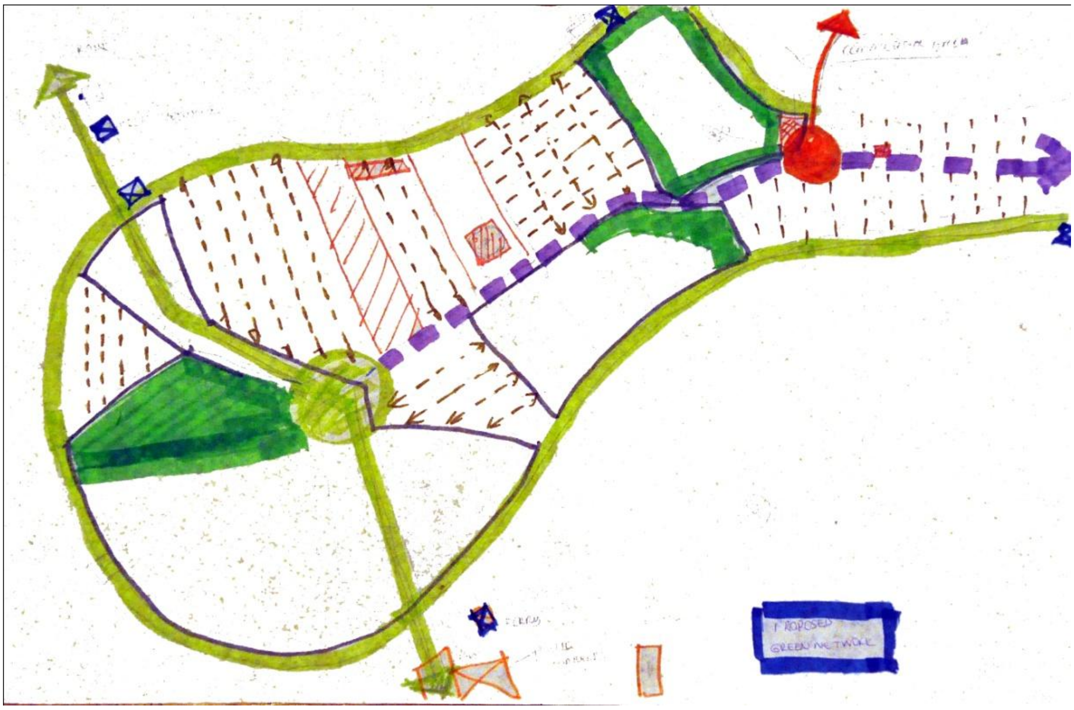


Fig. 51 Scheme B Proposed Green and pedestrian networks

The proposed green and pedestrian networks shown in Fig. **52** Scheme B Proposed Green and pedestrian networks. The main green corridor is set, bisecting the peninsula north to south.

On the north side, a pedestrian bridge is proposed to connect Punta Santa Ana to the PNR rail network. This green Connection to the PNR buffer zone would connect the entire peninsula to the entire bio region of the Metro. This network is shown in **Fig. 53**. This network connects the site to the Malacanang Palace garden to the linear parks in the districts of Pandacan. This network will also connect the site to the Santa Ana Park to the south.

Fig. 52 Proposed Green Network

The linear park is also established in Scheme B. The park is already part of the PRRC program but is largely incomplete. The proposed linear park around of Punta santa Ana will encompass the entirety of the peninsula.

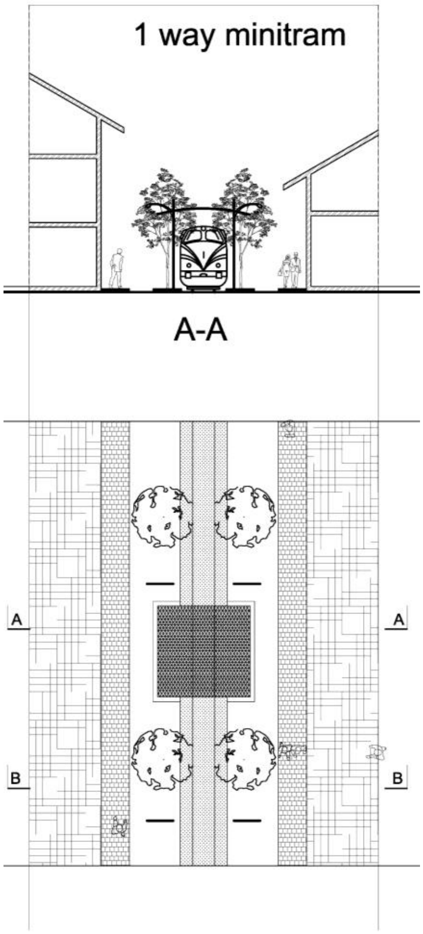


Fig. 53 Proposed Tram Line

Also shown in Fig. 52 scheme b is the initial proposal of the tram line in the middle of the peninsula. The proposed tram will run along the main road. As part of the concept of a car free zone, the tramline aims to be the primary form of transportation along the peninsula.

This solution aims to solve the problem of traffic inside the site caused by the unreasonable amount of jeepneys. The jeepney would then be relocated outside of the peninsula.

As for the secondary roads, with this proposal the secondary roads are reassigned as pedestrian corridors. There are already existing pedestrian corridors on site, shown in image below.

These pedestrian corridors will then be the primary connection of the residents served by the tram line and the Primary green corridor.

This proposal benefits the residents of the area greatly in terms of safety for the use of the roads for other activities. It is as a matter of fact, already being used for various activities shown in the image.

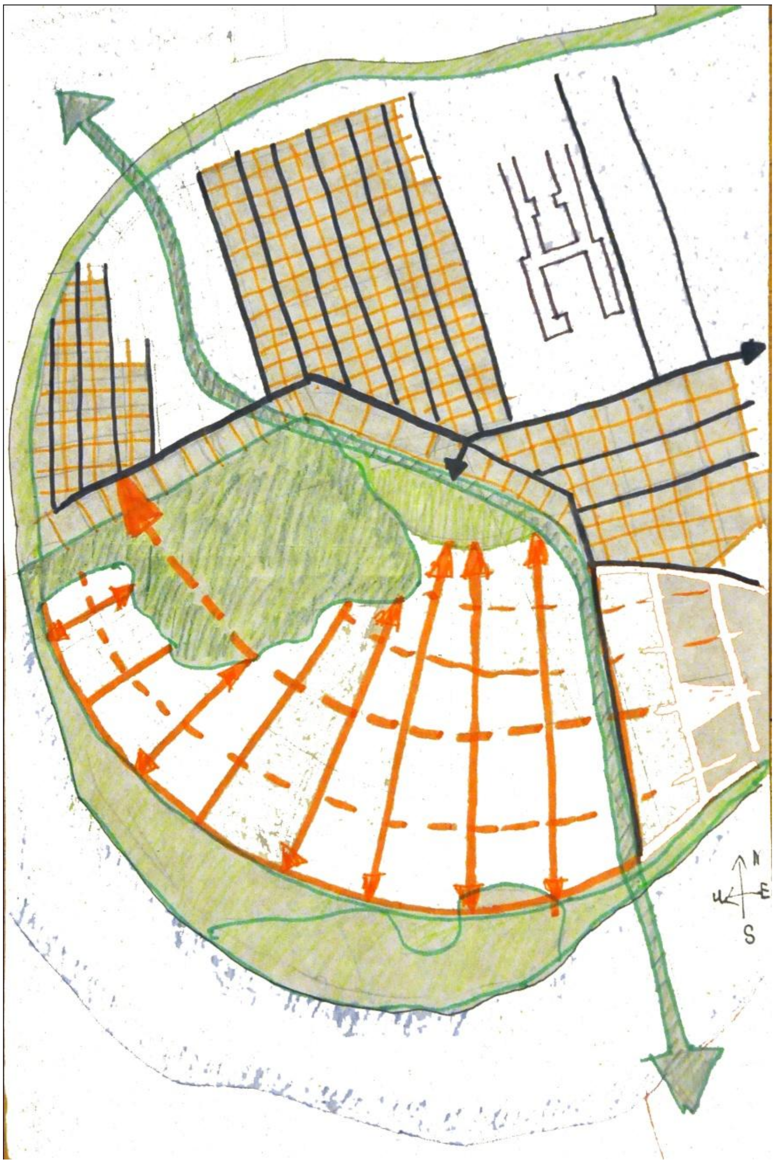
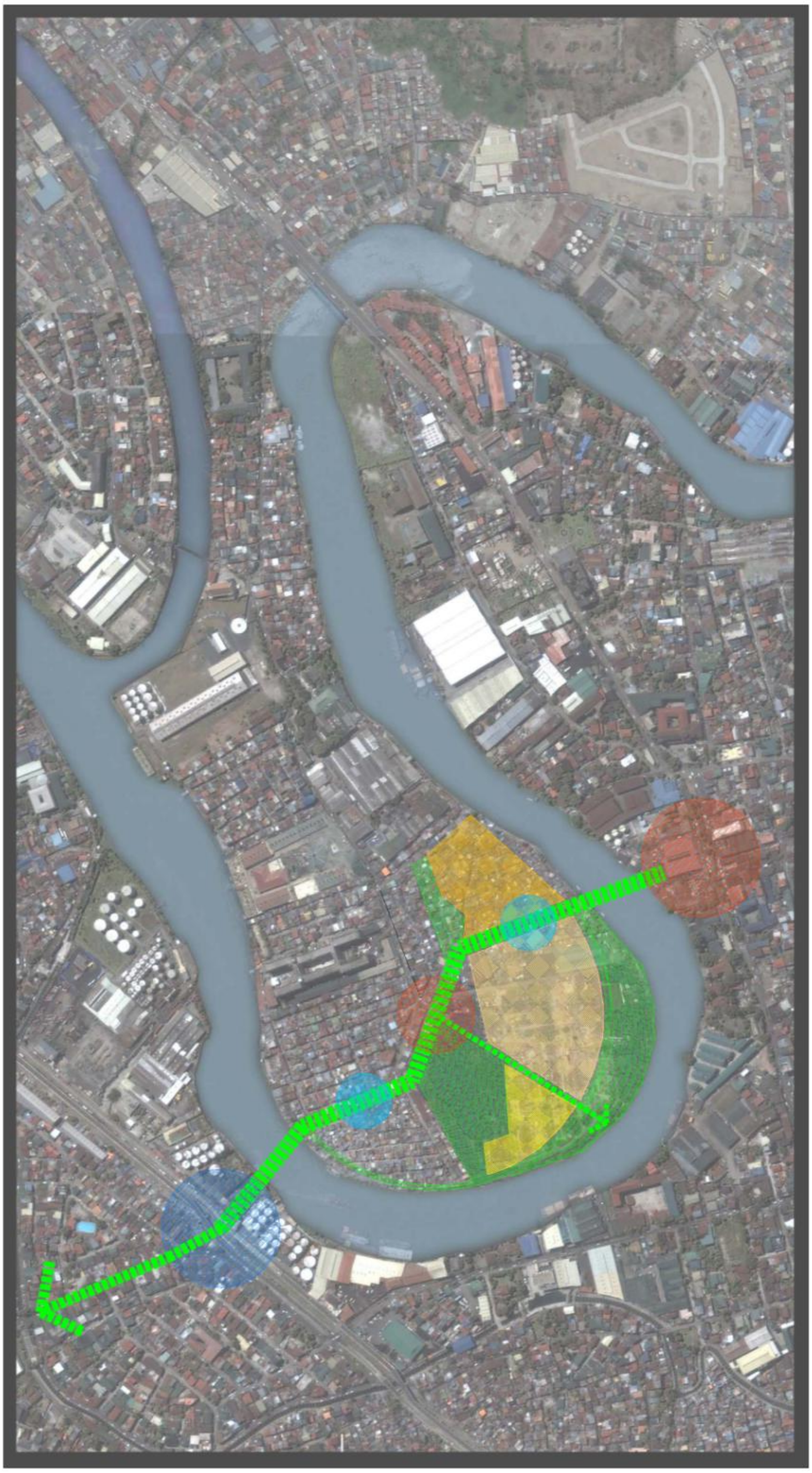


Fig. 54 Scheme C

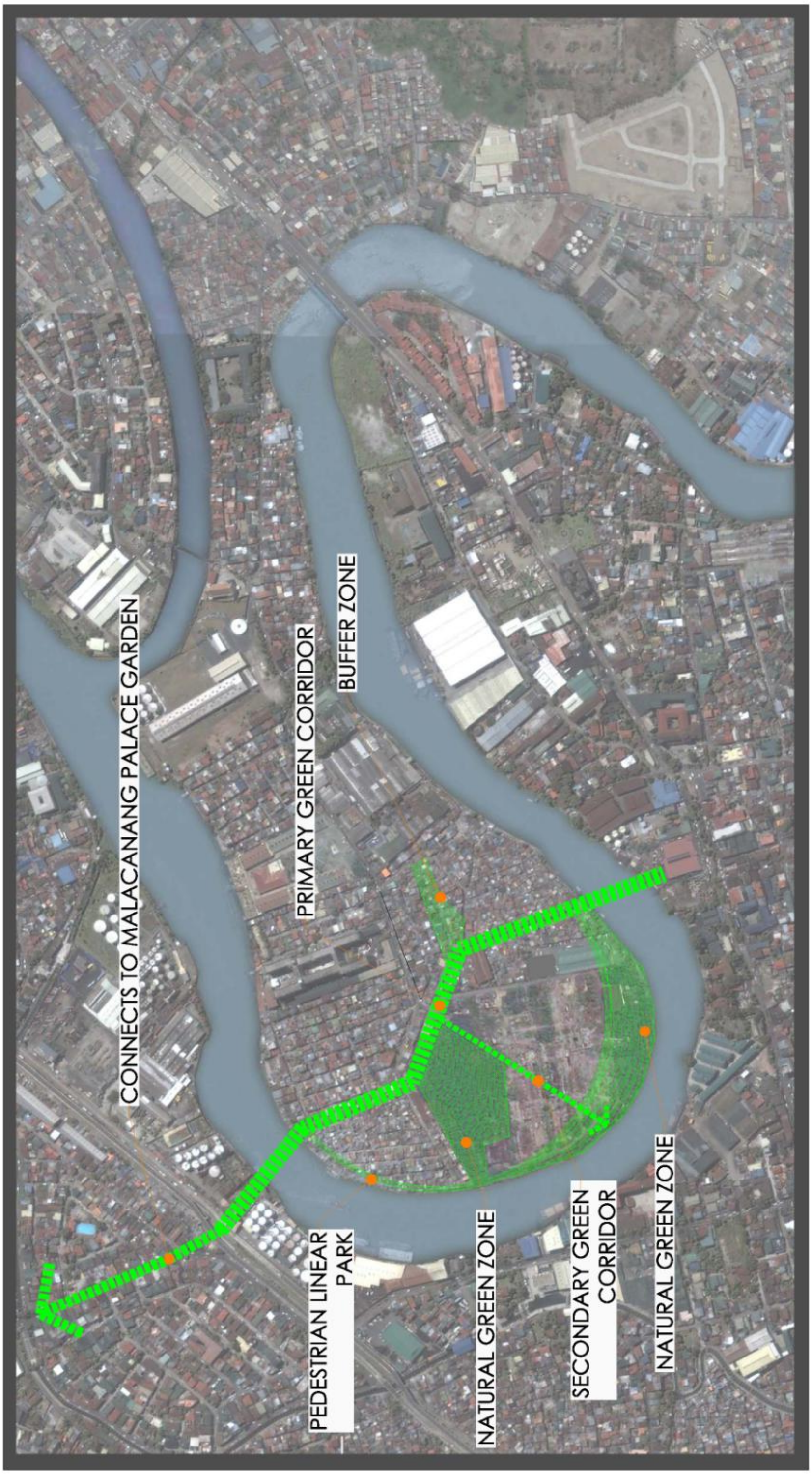
Scheme C, Fig. **55**, formally establishes the road networks as defined previously. The final green areas and green corridors are also identified here.

The networks produces a grid of spaces with dimensions of 50m x 50 meters as an ideal spacing for the area.

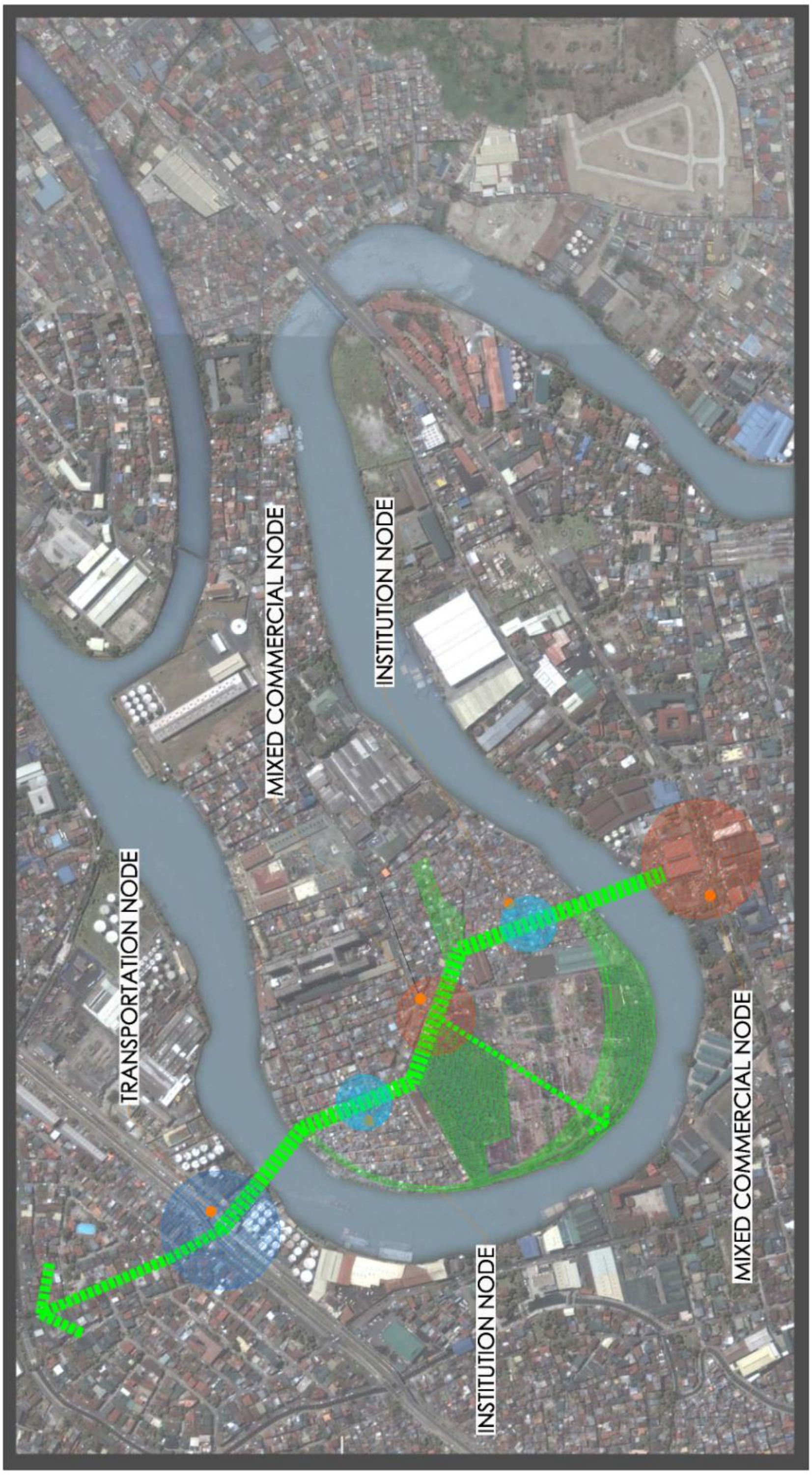
2- Final Concept Plan



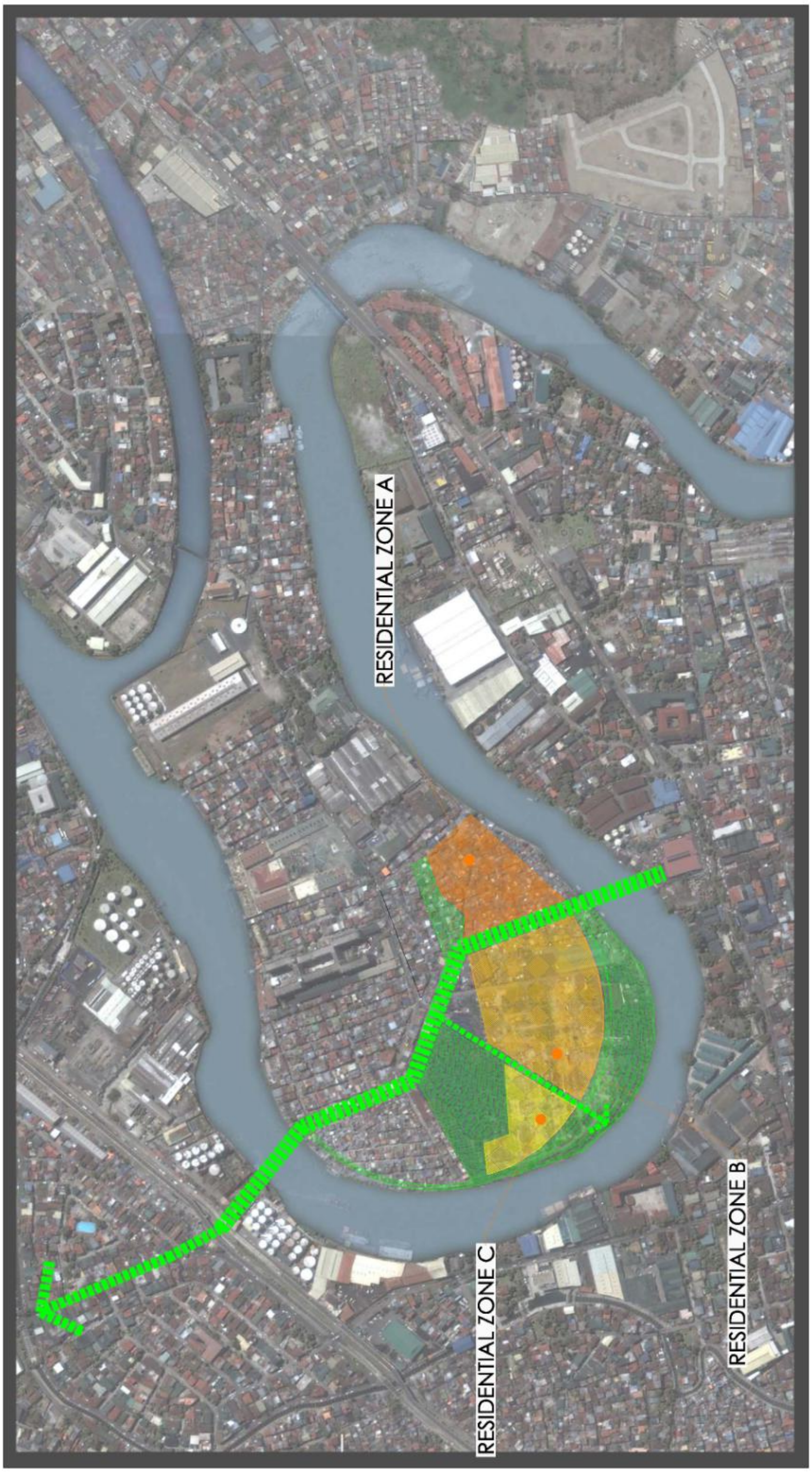
CONCEPT PLAN



GREEN NETWORKS


MIXED COMMERCIAL NODE
INSTITUTION NODE
TRANSPORTATION NODE
INSTITUTION NODE
MIXED COMMERCIAL NODE

NODES



RESDENTIAL ZONE

1- Site Design Profile

Student Housing

The final project proposal is a student residential complex to service the vast amount of student population in the area. As every year more people migrate to the capital, a steady increase in student population can be observed. A rise in residential demand is also attributed to this increase. Student housing developments in Manila however, have always been substandard to proper building codes. Most student houses along the university belt are makeshift dormitories. A majority of them are just mainly single family residences whose bedrooms are rented out to 1 or sometimes even 4 people at a time. This low quality of living is not desirable for the student

The demand for school facilities is also a problem in Manila. There is a great need of classrooms and other educational facilities such as classrooms, theaters, and workshops.

The final design proposal considers the development of these structures adjacent to that of the student houses.

The proposed support facilities are also considered to directly serve the local population and so they are located accordingly.

2- Design Consideration for Site Design

Being located in a hot and humid region, the maximum solar radiation is at the south with 4x more than east and west during the winter or cold season. During the summer periods east and western facades hold more radiation than the south façade about two times as much. Shading requirement is at 75% of the year.

There is a high humidity due to precipitation, effects of low land evaporation and the effects of the ocean.

3- Site Design

- Reduction of heat production and solar gain in the site area is reduced by increasing the green area and reducing the harder paved surface.

  In the urban farming concept can be used in this criteria. The urban farms can provide the sufficient reduction in the UHI index while increasing the sustainability of the area.

Fig. 55 Patterns of farmland

The patterns for farmland were used as the primary visual reference to the design of the masterplan.

- In choosing which type of green area should be designed it was taken into account the different effects of different typologies of green vegetation.
- In land sites with thick vegetation are very damp
- High elevations and slopes can capture breeze
- High canopy trees promote shade and cooling by ventilation but high canopy trees may also block the ventilation in buildings if not properly placed

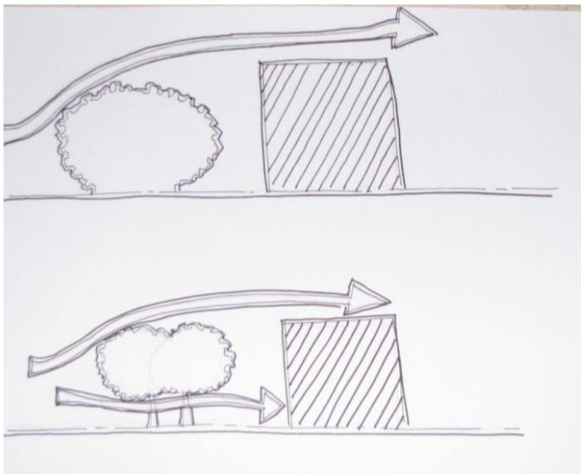


Fig. 56 Effect of Vegetation

- The sites avoid the concentration of dense and low canopy trees as it may trap humidity and create dead air pockets. There are only a few areas where thick vegetation is allowed to grow.

- Considerations to site must be made for wind patterns and orientation. The orientation of the buildings follows several criteria. The most important one is to ensure that the wind is not dampened by developments like tall buildings that can block breezes.

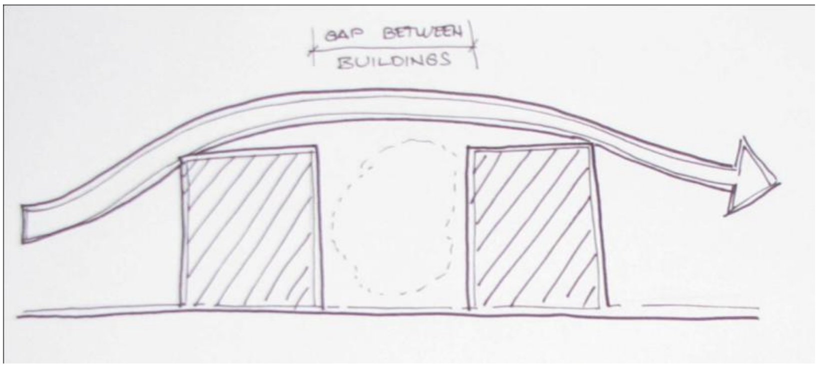


Fig. 57 Building damping wind

Flat sites require greater spacing for buildings to allow air the circulate.

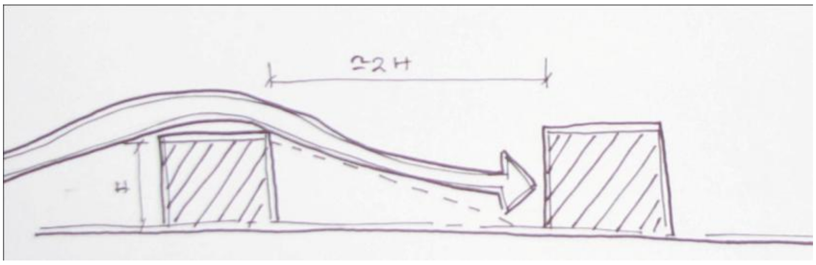


Fig. 58 Proper Distance between two buildings for proper air circulation

- The three residential zones are arranged with different orientation in order to maximize the ventilation throughout the site following the wind patterns.

- East to west patterns of the wind are channeled maximize surface exposure to the wind.
- The Open spaces are therefore used to channel the wind.

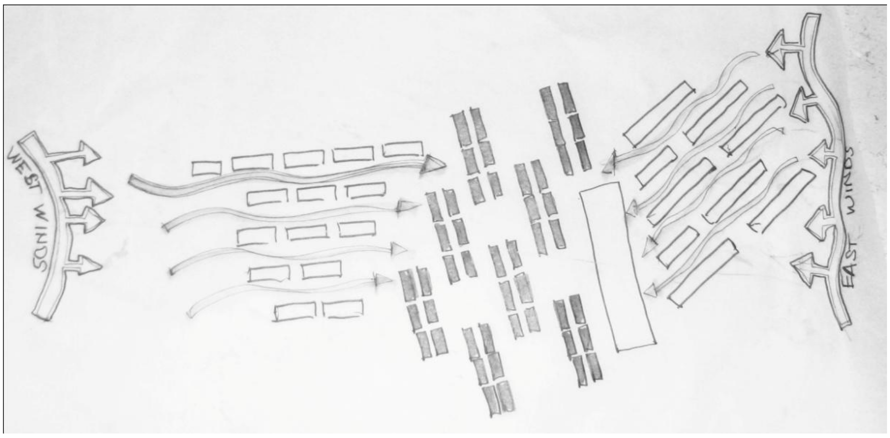


Fig. 59 Builiding oriented to recieve maximum ventilation as well as chanel the wind direction

- In order to promote evaporation loss through ventilation. The buildings must be opened for maximum breezes for ventilation and cooling.

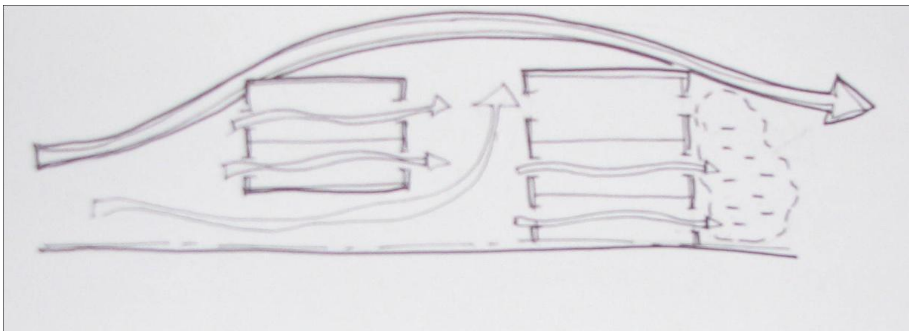


Fig. 60 Scheme of Open building to recieve maximum ventilation

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- Loose and scattered plans for air flow
- Structure should be shaded in early morning and late afternoon
- Increased asphalt surface can increase temp by 10 percent

- Pedestrian circulation areas must be shaded by vegetation or canopies

Transport Scheme

The master plan calls for a cycle friendly road network with streets and networks are friendly for walking.

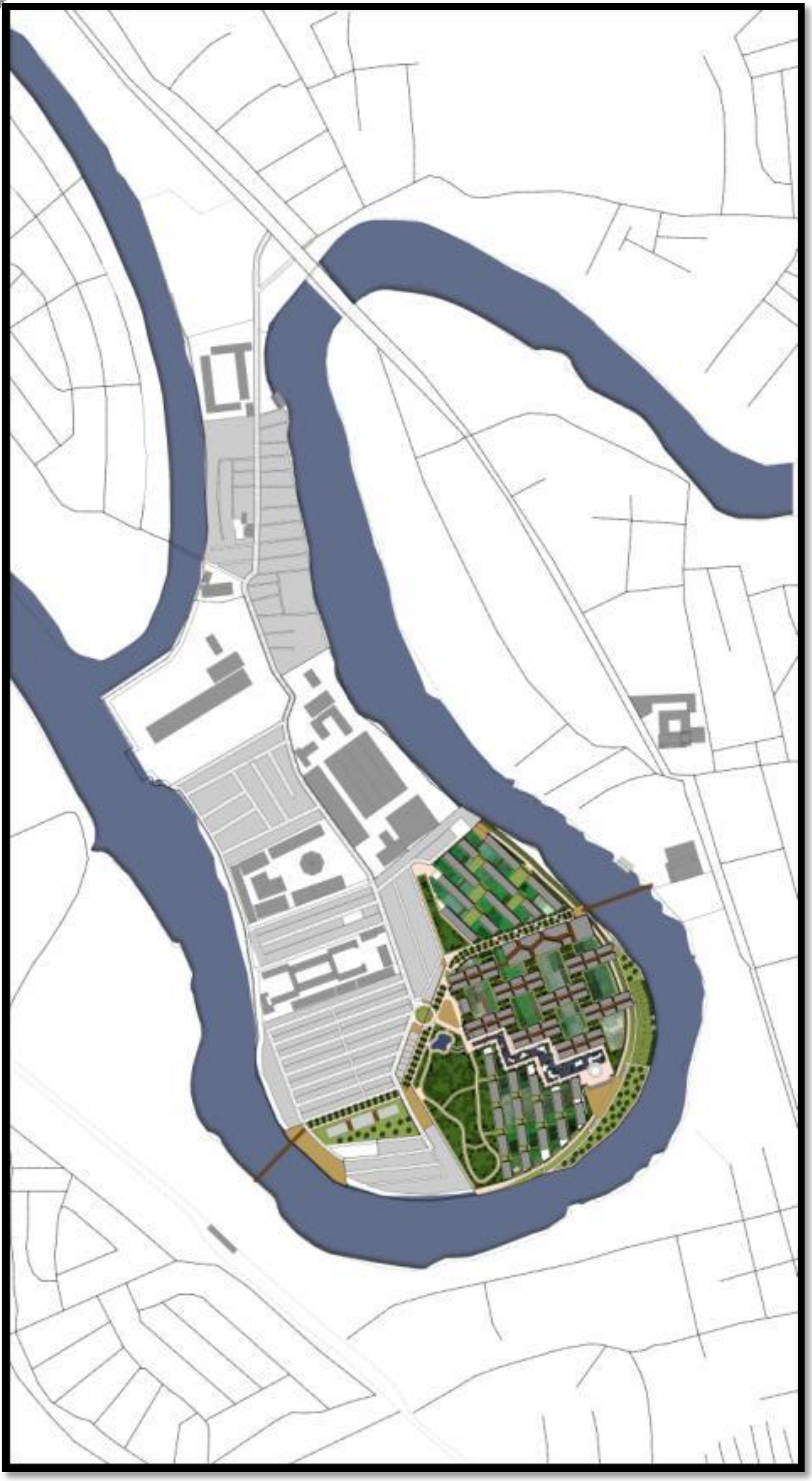
Services and facilities brought closer together by adding pedestrian bridges. With these networks there is a reduction with the need for using transportation and it will also assist to getting to the destination faster

Increased public transport with the use of the river and other means of mass transportation will be the primary connection to the entire metro rather than using the road. Use of these networks will reduce the need for car transportation.

The Project developed can be considered as a compact high density/low density and decentralized concentration in the city.

The aim of this project is a Sustainable city region: a sustainable city region with be ped, centered orientation. 3 to 4 stories,using regional materials for the design.

MASTER PLAN (GROUND FLOOR PLAN)



MASTER PLAN (ROOF PLAN)

Chapter 3 Architecture

I. Introduction

The selected architecture project to be developed for this study will be a student housing residence. On the master plan there are three proposed typologies of residence units. The first type is the shared apartments for groups of students or families to rent during their stay. The second is the single room/studio apartment types. This type of typology is expressed to be used by older students, who would prefer their privacy, i.e.: students on their master's of PhD studies, or students doing their final thesis. The third, is the building selected to be developed and studied. The initial proposals and concepts for the two other typologies are presented here briefly.

Among the three the third typology is the largest in terms scale and use. The proposal is a mixed apartment building for use of the general population of the students. The urban design concept has already established the basic concepts for connections and the relationship of each building with each other.

As defined by the urban master plan the mixed apartment residences for 1000 students are divided into 9 blocks. Each building block is connected together on the 1st floor by a network of pedestrian bridges that connects the community of buildings to the main student center. The proposed student center is to accommodate a library, commercial center and, the classrooms and workshops for use of the students.

The master plan had already considered the initial concepts of the buildings in terms of passive design features such as orientation, shape, sections and, volumes

Fig. **6**. For the reason of the initial design phase of the architecture had already been defined in the urban planning stage; the starting point of the architecture design study is about the relationship of these building volumes to the project site, the context around it and, the environment conditions.

Fig. 1 Master Plan Aerial Perspective

1- Design Philosophy

Reinvention

As they say, architecture is an endless act of invention and reinvention. The design concept of the architecture project comes from the review of the traditional form of architecture in the Philippines. The idea of reinvention involves the look into the past as perfect examples of green and sustainable structures with zero carbon footprints. Thus giving the designers the chance to, and a responsibility, expresses these concepts in the project.

In view of the expanse of globalization and rapid development of third world countries, individualism is lost, and unique cultures die out to accommodate what is universally accepted. This is evident most evident in the architecture found in the Philippines. Architects and designers opt in adopting universal standards that have often not been formulated to take into consideration local conditions, leaving out traditional forms as they sought out to create forms that are based on standards suited for other countries.

The term reinvention keyed here is a way to revitalize losses caused by the globalized world. It is the way to reintroduce individualism to an otherwise global world. Through architecture, this concept is applied in creating structures that are well adapted to the conditions, hence, the importance of the study of the past. These concepts not only provide site specific solutions for green design, but they also embody the socio-culture of the Filipino. Reinvention then prevents the disappearance of this culture through the reintroduction of those concepts. By combining them with new ideas the recreation of a new form of Filipino architecture can be the result.

2- Objectives

In starting the design of the building in an architecture and technology design point of view, and in this case, the designs for hot humid regions, two basic considerations are taken into account. First, the condition of the climate is uncomfortable throughout the whole year and building using the passive design concepts does little to improve the indoor conditions, although, passive design concepts enables the creation of buildings that require less power. The second, most countries in these tropical regions are developing countries. The latter fact has a direct impact upon the practicality of some modern concepts of urban and building design from a climatic and energy viewpoint. Vast majority of the inhabitants cannot afford air-conditioning systems. Therefore, the primary goals of a sustainable architecture design in a tropical, hot and humid, climate is to reduce thermal stresses to a minimum primarily by low cost approaches.

The objective of the architecture project is to study and introduce some low cost solutions and concepts for the proposed building typology. The primary aim is to develop a climate responsible and, cost-effective design in hot humid climates.

The Design aims entail the need to reduce internal temperatures, plus to maximize ventilation rates to increase the effectiveness of sweat evaporation, and, provide protection from sun, rain and insects.

. The issues associated with hot, humid tropical climates and the appropriate architectural responses to the climate are discussed in this chapter. The final solution sets that are proposed for this project are based on the pre design analysis done during the design development stage of the project. The calculation data and the report on analysis are presented in the next chapter.

3- Design Considerations

Character

The character of the building is important. The role of these structures in the area is to be the reinvented green hub of the Punta. The character therefore should exhibit this. The character consideration sees architecture as a form of public art and the relationship of the building to the area should be thus.

Aesthetics

Aesthetics refers to the different visual qualities of the structure. It refers to the visual qualities such as size, shape, colors, and scale. A great deal of consideration must be taken into account in designing the exterior and interior landscape of the building. These aspects should reflect the ideals of the structures use. A personal scale must be established for the comfort of the students who would use the area.

Ambience

Ambience refers to the different sensual quality of the structures such as sound, smell, sight, touch, taste. These qualities must be considered in the design of the spaces for the better experience of the end-user of the structures. In this case a good learning environment must be exhibited within the structures.

Circulation

A general consideration was taken for the circulation within and outside of the structure, since its location is central, and because of the number of different users and activities, a careful study on the circulation between spaces must be done to avoid the inconveniences of bad interspatial relationship design.
The circulation around the site must be accurate in order to avoid wasted spaces and inconveniences for the end users.

Technology

Given a constricted site the main problem is how to develop the site to accommodate such activities. Using different types of new and high-tech technologies this problem can be solved.

By using new construction techniques the structural design of the building can be altered to suit the different site conditions. Materials and finishes can also help achieve the desired experience within the site.

By applying different design concepts and techniques, a more sustainable and eco-friendly design could be achieved.

Accessibility

There are two types of accessibility considered here. The first is the accessibility for the disabled and second is the accessibility for the general public.

The accessibility for the disabled is considered in this project as required by the national building code. Spaces for the disabled will be provided. And the design of the structure would be so for the easy circulation for the disabled.

The accessibility for the general public includes providing spaces for them to better gain access to the area. These would include proper drop-off points and, proper design of spaces, with safe and direct access, to public transportation.

4- Site Considerations

Climate Considerations

The area is located along the tropical belt, which are generally hot and humid regions where warm all year round, with daytime maximum temperature of 30–35ºC. The range of average monthly temperature is about 1–3ºC; the average diurnal temperature variation is about 8ºC; the annual mean temperature is about 27ºC. Humidity and rainfall is high throughout the year; annual precipitation is greater than 1500mm.Coastal areas enjoy trade winds, while inland areas such as our site offer more variety type of winds. Solar radiation intensity varies widely with cloud conditions.

There are three climate conditions considered in the Philippines. During the months of June to November this season experiences a heavy amount of rain. This season is called "tag-ulan" which translates to rainy season. This season is primarily characterized by heavy rain fall at an average of 400-600mm a month. Showers will occur almost daily and down pours during the rainy season is a lot worse than the rest of the year. This season is also the typhoon season of the region, tropical storm systems that can reach maximum sustained winds of 200kph.

From December to February this period in the year is characterized by the cold winds blowing from the China Sea in the north. This season has a reduced average temperature than the yearly average to about 28 degrees Celsius, with colder temperature during the night time. This season is usually “tag-lamig”, translated to English it means cold season.

For the rest of the year it is known as “tag-init”. From march to May, this season is the hottest and driest period in the country. Temperatures may reach maximum 35 to even 40 during the latter parts of the season.

Throughout the year the relative humidity stays on average making the most of the year uncomfortable.

From November to February the country is affected by a north east prevailing wind.

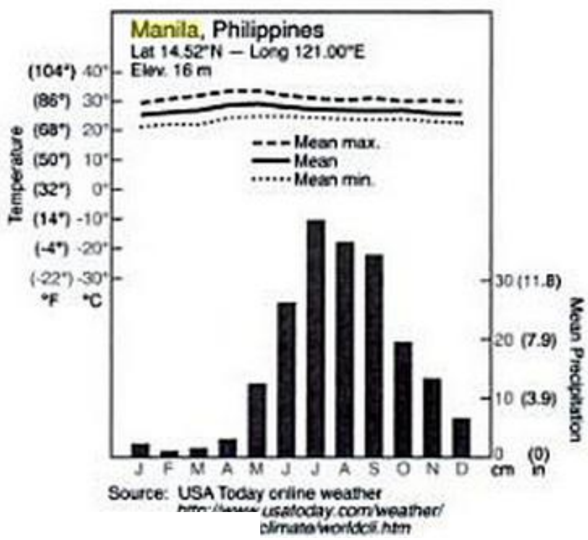


Fig. 2 Manila Climograph

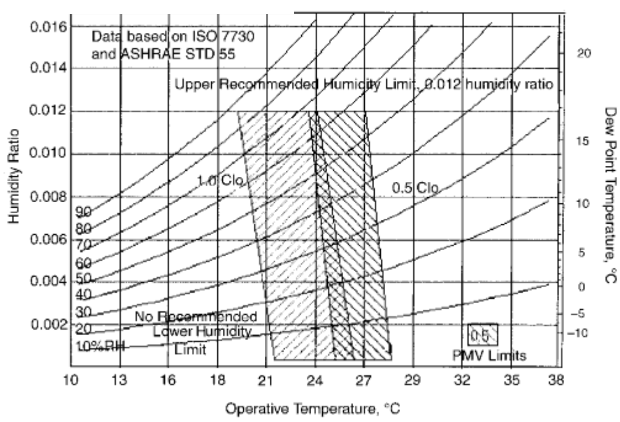


Fig. 3 ASHREA Standard 55

The climograph Fig. 2 of manila[1] shows that all temperatures fell outside the recommended American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 55 summer comfort zone Fig. 3. The required cooling period is throughout the year.

[1] Rohli, Robert v., Climatology, Climate in Manila

II. Philippine Architecture

Philippine architecture is the sum total of the domestic and public buildings that have been built by natives of the Philippines on Philippines soil and, over the centuries, in response to various climatic, geographical, and cultural conditions prevailing in a given place and time. Philippine architecture has been subject of discussion and debate. One extreme view denies that there is such a thing. Buildings of the ethnic or pre- colonial tradition are not considered architecture because, according to this view, they lacked magnitude, durability, and aesthetic value. The architecture of the Spanish colonial period is regarded entirety in the case of forts and churches, or, in the case of provincial churches and houses, poor invitations of Spanish architecture.

The architecture of the American colonial and contemporary periods is viewed as unabashed copies of western buildings. While colonial temporary buildings are accepted as architecture they are not acknowledged as authentically Filipino.
The extreme opposite view contents that any architecture produced in the Philippines is Filipino, not because of its geographical setting, but also because it is, for better or for worse, a part and expression of the culture. [3]

Philippine Architecture is the product of evolution. And over time the architecture has changed from simple lightweight structures of bamboo to all steel and glass cladding facades. The history behind Filipino architecture shows it is culturally diverse. It varies from region to region. Its foreign ancestry involves Spanish architecture, the neo-classical style, the gothic, and the baroque. Yet it is essentially a tropical style. With its steep hip roofs, post and lintel construction, the seemingly light and quite airy structure, and the elevated living quarters, the sense of grandeur and solidity, the dramatic arrangement of spaces, the use of masonry, and the system of ornament are its heritage from European architecture. In its synthesis of the indigenous and the imported it is both a practical response to the environment.

The concept of space and structure, the concept of living with nature, the concern for ventilation and for adequate protection from the sun and rain, the integration of structure and ornamentation and honesty in the use of materials and in the economic aspect of the design makes Philippine architecture a truly unique subject in design. With its different concepts and principles, particular forms and features, it tells us about the personality and the psyche of the Filipino.

Philippine architecture also sees space as not enclosed or contained. It seems to flow from one room to another through doors and arcades and from indoors to outdoors through vast windows that stretch from wall to wall. In the "bahay na bato" (house of stone) Fig. 4 Example of Bahay na Bato The space is surround by space. The play of space is enhanced by the apparent lightness or transparency of the structure. Fig. 5

Fig. 4 Example of Bahay na Bato

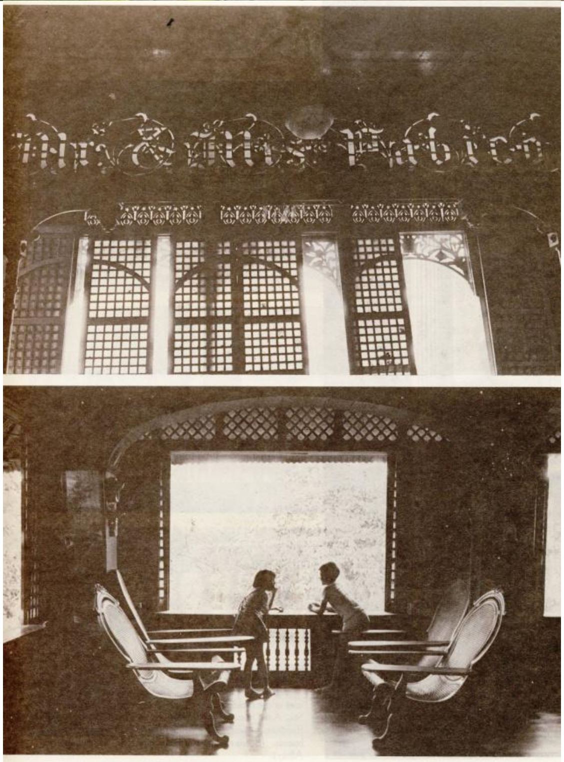


Fig. 5 Interior Bahay na Bato

Before the industrial age buildings were bioclimatic in nature and confronted climates without the need for services.[2] Technology brought the possibility to create artificial environments that are highly sought after by the end-users of the building. And in the course of time the logical sense of bioclimatic design was forgotten in place of artificial indoor environments. This was because during that time energy was thought to be abundant and the effects of the pollution were not realized yet. But in the 21st century with an energy and environment conscious society, there are valuable lessons to be learned by looking backwards.

1- Design Features

Ancestral houses in the Philippines use key features for bioclimatic design in the area.

Reduce direct heat gain

By using large overhangs to protect internal spaces from solar radiation; In the *bahay kubo* These overhangs are provided with the large eaves of the roofs covering the porch areas and part of the windows. In the *bahay na bato* some exhibit large eaves but the primary form of protection from increased solar radiation is in form of a semi transparent windows that allow light in but block most of the solar radiation. In old houses some uses a small window covering that opens 90 degrees up from the vertical. This

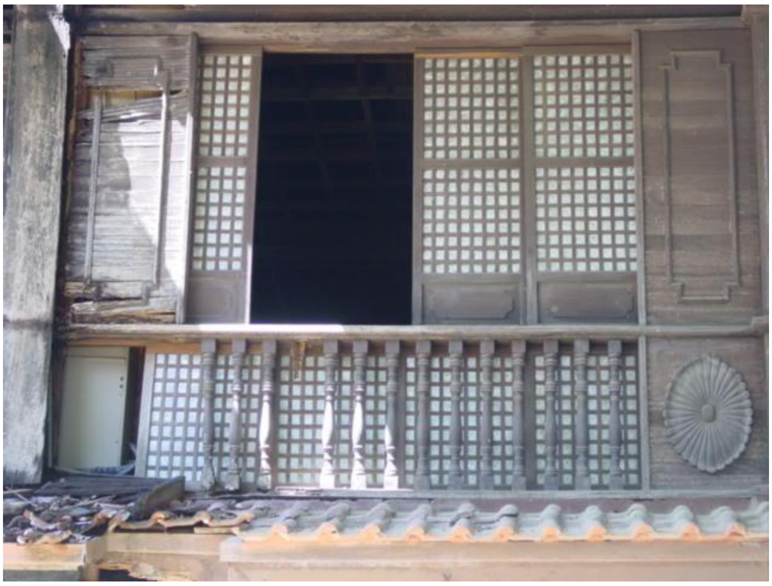
[2] Cuchi, Albert, Traditional Technologies for Sustainable Approach for Urban Renewal

type of window is very effective in keeping solar radiation from getting inside. This type of shutters usually made out of thatched grass is light weight, transparent and has a very low thermal mass.

Using shading devices to minimize solar gain is popularly used during the Spanish and pre Spanish eras.

Other examples of shadings, the *Ifugao* houses and the other pre Spanish homes are raised on stilts. The spaces below these houses are then primarily used as the main living areas, with the sleeping areas on the building floor. The floor on the ground, being that is covered by the building offers better conditions than living inside the huts as it is 100% ventilated and solar gains from the roof is buffered by the building.

The old Filipino houses are usually oriented to a north west to south east. This ensures maximum ventilation in the buildings. The longer façade of the building is slightly exposed the eastern and western facades but these are solved by using the capiz windows. These lightweight windows, usually made out of *capiz* shells, a type of transparent sea shell allow the light to enter the building while blocking or reflecting the direct sunlight.



In pre Spanish homes consideration is taken to minimize window openings ensuring that east and west elevations have few or no windows admitting low sun. Spanish urban planning also properly spaced the buildings from the road to ensure that the low sun will be shaded by the nearby building. Walls used by the old house are not insulated. It was preferred to use light weight materials to avoid absorption of too much heat by the thermal mass. The Spanish houses make use of thick masonry walls in the ground floor. In some studies the effect of cooling from these thermal masses are significant as it can be seen that in some of these houses the ground floor is significantly cooler.

Also the heavy stone built churches have significantly cooler temperatures all to the effects of a large thermal mass. Some versions of the *bahay na bato* incorporates a stone wall façade with lime plaster finish, such as the houses found in the historic city of Vigan.

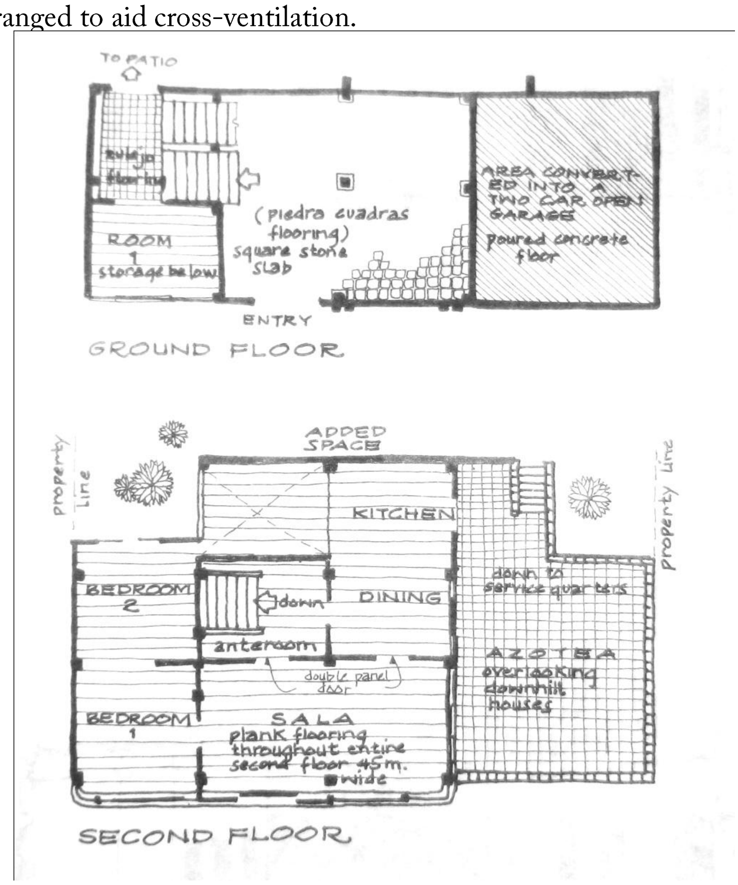
The walls used in Spanish houses uses lime plaster usually painted white or wooden panels in white. This ensures that the and that walls on these elevations are reflective. While on the other hand pre Spanish buildings uses thatched walls or bamboo walls. These systems do have a low thermal mass and is ventilated, significantly reducing the gains from the absorption of heat. Using low thermal mass materials will minimize heat storage;

Further studies should be made about the designing of buildings with this system. Complications arise because of the need to ventilate the walls during the night and to prevent the walls from releasing the heat during a much cooler evening period.

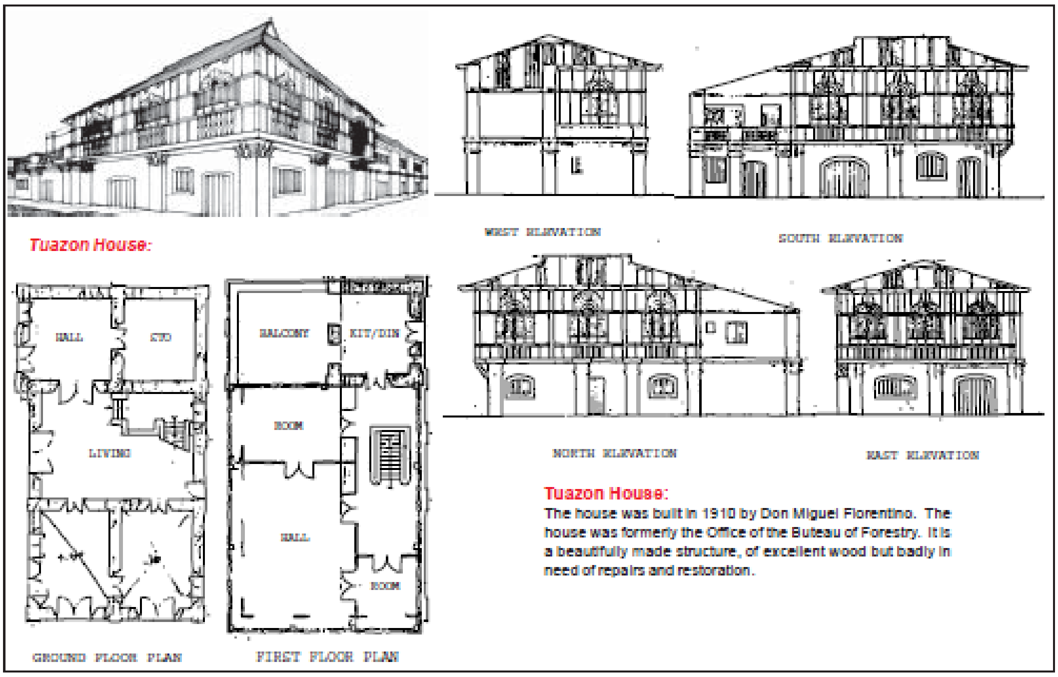
Maximize natural ventilation

Buildings are oriented to receive the maximum ventilation from the prevailing winds of the seasons. The prevailing winds coming from the north east and south west orients the long facades perpendicular to this axis for ventilation.

The double-banking of rooms is avoided. The rooms are arranged to aid cross-ventilation.

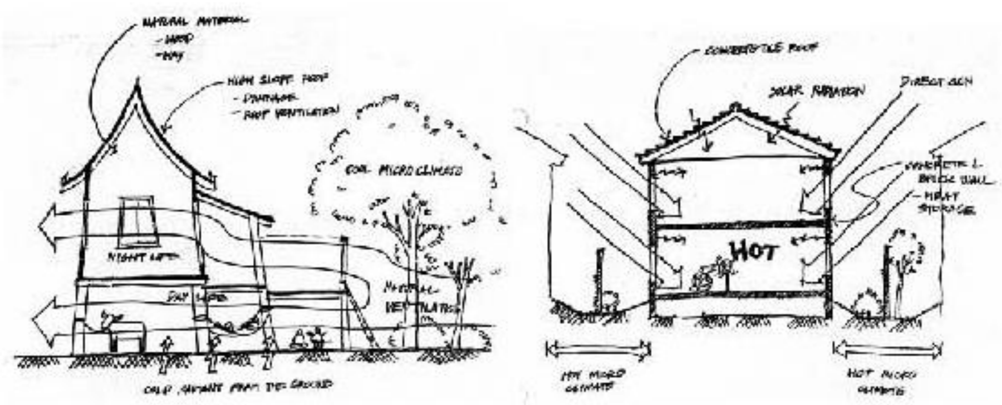


Plans are open Floor plans in ancestral houses are arranged very openly allowing air to pass through it. Rooms are not divided by small doors rather they are divided by large sliding partitions which can be opened most of the day and closed only for privacy. In any case if doors are needed, on top of doors bresoleils are placed to allow wind to pass through.



Free spaces between buildings are wide. Heavy concentration of vegetation is avoided as thick vegetation can create humidity pockets which are not desirable. Large trees with high canopies are often preferred for pathways as it allows air to pass underneath it and provide shade from the sun. large spaces between the trees are considered to avoid the trees acting as wind bufferes from the building, redirecting the wind away from the house. Trees are placed on the north and south of the houses to avoid them blocking the prevailing wind.

Large volumetric ventilation is provided to remove internal heat. Rooms in ancestral houses have very high ceilings and a ventilated roof. In pres-spanish homes large interior spaces are also used with ventilation from the roof to allow the heat to go out.



(a) (b)

III. Design of Student Housing

General Principles

According to the general Principles for designing Student Houses[3], the project to be should be near the institution of higher education or with favorable traffic links to the institution of higher education and should be assigned to a residential area.

Building Programs for student resident types

Depending on the housing types it is indicated in the Planning of Student [4]dormitories several planning guidelines should be followed

For a housing type with single rooms, there is a minimum of 12 square meters of living space. Providing a common kitchen should be for a maximum of 8 people. Bathrooms and sanitary areas should be at a ratio of 1 water closet for 4 people, and 1 shower for 6 people. One lavatory must be provided for each room.

Designing an apartment for a group of maximum 8 people, rooms must also be at a minimum of 12 square meters. Kitchen and dining area, as well as sanitary rooms must follow the same ratio.

A Partial apartment (suite) is a bit larger than the common apartment. For this type a maximum of 10 people are allowed for these types. A larger single room of 15 square meters

[3] Student Housing: The German Experience
[4] Ibid

must be provided. The kitchen and dining should not be shared by more than 10 people.

Full apartment types with self contained units will provide the students with single rooms with their own cooking niche and sanitary room. A minimum of 16.3 square meters must be observed.

Apartments for married couples should also be considered. These types are usually double room types. There are two single rooms with a minimum of 12 square meters a piece with a shared cooking niche that includes a stove. A sanitary room may be provided.

Another type of apartment for married couple may consider rooms for up to a maximum of two children. Three rooms must be provided in this case with no more than 12 square meters each. A common cooking niche and sanitary room must be provided. The minimum apartment type is at 46 square meters.

All of the examples given above can be combined within a hall of residences.[5]

Communal areas

Common rooms in case of more than 20 dormitory places must be provided. These multi-use spaces must be designed usually for a tea kitchen, with a small kitchenette. These spaces

[5] Ibid

can also be used as game rooms for table tennis, or other indoor table games. The rooms may also be used as a common television or audio visual room. The multi use rooms should also be capable to be used for various student activities. In example it could be used a photo laboratory area. It may also be used as a music room that is why careful consideration must be taken in the location of these rooms. An estimated of 1.5 square meters per dormitory space is the minimum area required as a common area.

Other required Spaces

Rooms for student hall supervisors should be provided. Consideration with designing this room must be taken as the student hall supervisor has different requirements to that of a student. A larger room with other spaces may be needed, spaces such as storage spaces for maintenance equipments. An office for the hall or residence supervisor should be provided

Staff apartments should be designed as required corresponding to residential construction guidelines in the valid version for families with at least two children. Each apartment should have at least two bedrooms each with a minimum of 14 square meters or atleast with three bedrooms with one 14 square meter bedroom and two 10 square meters for the children.

Auxiliary spaces for storage of maintenance materials should be provided at convenient locations. An estimate of 1 square meter for each dormitory space should be provided.

Functional rooms such as laundry, electrical systems room, are designed as required by the building.

A covered bicycle room must also be provided for the students. A ratio of 1 bicycle space for 2 students must be provided.

Student Housing Principles

Student housing should be considered as living groups large apartments used by several students with communal areas that can be used by everyone. These areas such as bars, cafeterias reading rooms, play rooms, provide the primary interaction and relaxation area for students.

The primary function of the student housing serves an academic function. The rooms are for residential but considerations should be given in other programs, such as tutoring programs.

Introduction and the design of the communal areas highlight the importance communal co habitation with the people. There is a need to create a community spirit within the students. Providing open spaces for interaction is a good way to achieve this.

One of the primary considerations taken is for the quality of the design of the student housing. As student housing are designed for temporary housing, so it is understandable that the quality and comfort are significantly lower than that of a regular housing. The design approach however shouldn't negate the user comfort and quality of space, rather the maximum consideration should be given to the comfort and quality without the need to increase cost in construction.

A solution sometimes adopted in the design of student houses includes the use of communal areas such as kitchens and toilets rather than individual units per each room. This is to avoid misuse and to discourage the residents from staying longer than needed. Most residents will prefer to have separate kitchens and toilets for comfort.

It is also very important for the design to have a very low and light density design give and give a very personal scale to the buildings. This approach gives the students a sense of belonging to the place. The relaxing nature of home atmosphere helps with the psychological effect of the space to the students.

Study spaces, reading rooms and, libraries are usually located in the basement. This is made possible by the need to provide service spaces for building. This consideration cannot be taken into account in a hot and humid climate as the service requirements of buildings are very minimal. This location for the study spaces most often offers very bad conditions. There is hardly any natural light and ventilation. The dark basement is the least appropriate space. These communal spaces should be considered at other locations to allow for better conditions.

Locating them on the ground floor as an example would allow a sufficient amount of natural light in the room, and not give out a very dark and damp environment. Often these rooms are connected to an outdoor private environment for a more relaxing atmosphere. Another option is on the roof, with rooms very well lit and very well ventilated. Considerations on the latter case should be given to designing for the disabled. Nonetheless, as a general rule common rooms should be located in the entrance area and clearly separated from living areas in order to avoid or at least minimize noise.

The guidelines that stipulate the share of area taken by the hallways may not exceed 5 square meters as indicated in the standards. However, this figure does not include the hallways inside the apartment unit types. This orientation value is also very difficult to maintain, in the case of hallways that receive natural light only from one side. In contrast, bright, naturally lit hallways are attractive and thus desirable. In such cases economically efficient designs are having narrow rooms and placing larger apartments at the end of the hallways. The demands of noise protection can also make it advisable to select access from only one side. Only common rooms, kitchens, and dining areas are placed along the loud side.

If the dormitory uses a double loaded corridor with rooms along both sides, this might result in a dark hallway. Although this approach is the most economical, it isn't efficient in a tropical climate design. If this type of corridor is opened through skylights or ports, and made larger, an adequate spatial quality may be acquired.

Accessibility for Wheelchair users

The ground floors of many dormitories contain rooms and apartments for wheelchair users. Without a proper elevator for the handicapped, wheelchair users remain confined to the immediate vicinity of their living area and largely isolated from visits to classmates and from community events. Further plans should take this into more strong considerations. New dormitories should be designed with as few barriers as possible. This actually entails very little in the way of special construction measures.

IV. Space Program

The Size and dimensions of the individual student rooms should be atleast 12 square meters. It should be 13 square meters with the introduction of a computer unit. The spaces are determined by the number and size of the furnishings. Here are the list of room furnishings used to determine the size of the rooms

Furniture

- One clothes and laundry cabinet, measuring 120x150cm; walk-in if necessary, floor to ceiling with corresponding compartments
- One bed, 200x90 cm with frame and interior sprung mattress and synthetic cloth covering, with mattress cover and bedclothes box.
- One wall hung shelf, running approximately 6-8 meters or along the wall length. It is 30 cm deep.
- One desk with 75x150cm dimensions with substructure and two drawers.
- One small couch table or coffee table measuring 60x60
- One desk chair
- One additional chair or seat
- One curtain rail, wall to wall, with curtain 1.5 times the width of the room

- One desk lamp with a 60 watt bulb

Fittings:

- One crystal porcelain washing table, ,50x60 cm, with mixer tap, work surface, towel hooks.
- One mirrored medicine cabinet 65x45 cm
- One shower area 80x80cm with mixer tap, shower head, shower compartment or curtain
- One toilet
- One stove/sink combination unit, 100cm wide, one sink and mechanical ventilation system
- One 145-liter refrigerator

V. Architecture Concepts

Bioclimatic design and urban regeneration

Traditional buildings are optimal in terms of energy use. The traditional architecture is the perfect example of a completely sustainable structure with zero carbon footprints. Local architecture makes use of locally available materials, theses materials are natural, biodegradable and completely recyclable.

Marrying old into new systems to find solutions that will not fail us. Finding a balance between old forms and new technology will help alleviate the need for large cooling systems to regulate the building climate. The basic ideas of passive design help the structure find its optimum configuration requiring less need for such artificial systems.

Bioclimatic through nature

The initial concept is to attain a climate responsive building. –"buildings are structures that are out of sync with nature. Human beings are organisms that must be synced with nature. [6]" . Henceforth, building must be able interact with the environment. Buildings were in tune with the natural rhythms of nature rather than against it. The building must enjoy the relationship between the elements but controls neither.

[6] Marteli, Luigi, Biolimatic through Nature: The Four Elements

Inside, the housing will take in the spatial rhythm of repetition of built and void spaces. Inserting courtyards appropriately provides ventilation and lighting, and will be an important tool for passive climate control to reduce energy consumption.

Void spaces are connected vertically by "wind corridors". Horizontally pocket gardens allow the wind to pass through the building. The interior layout is based on conventionally connecting dwelling units through inner passageways, and each unit is distributed along these open corridors.

The concept of preserving the traditional silhouette. This shows the architecture of the place how and why it was built in that way. All around the site or in the Manila in general, random developments have sprung up in recent times. The skyline created large clumps of buildings grouped together in different parts of the metro. These buildings usually characterized by the unnatural materials that make it seem detached from a general point of view to the traditional silhouette of the city. These buildings are more related to the international style of which they came from rather than the Filipino culture that it exists upon.

The typology of the architecture brings back the beauty of the informal settler's deconstructed structures that once lined the river. The solid masses and use of different materials brought a unique identity to the river and this identity for the architecture is reviewed.

The building consists of a double loaded corridor. This building typology is not ideal in a hot and humid climate as natural ventilation is hard to achieve with a double loaded corridor, and one of the main requirement to achieve a bioclimatic design is to ensure a passive design solution. This situation is alleviated by introducing atrium spaces to allow natural circulation of air within the whole volume of the building. The building is then oriented to receive the maximum amount of ventilation and through the optimized angle to not receive unnecessary amounts of solar gains.

Ventilation

Air is the primary element that defined the architecture. The building orientation is optimized against the solar radiation gain and the annual wind patterns of Manila.

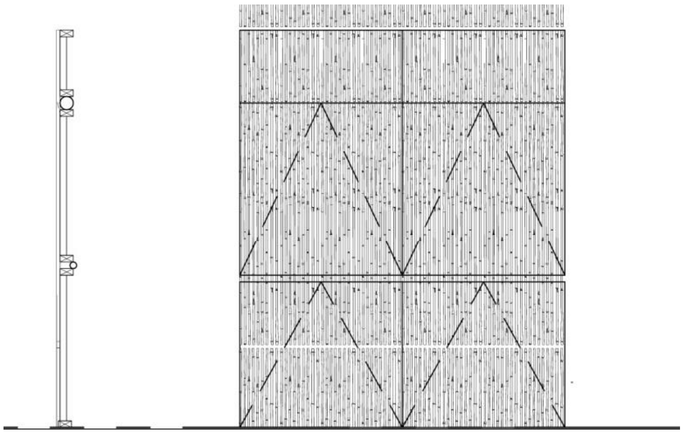
Each room is open has a glass door that slides completely open to the outside. This in effect extends the boundaries of the room to an outdoor balcony. The large openings and the proposed orientation allows for better natural ventilation benefits.

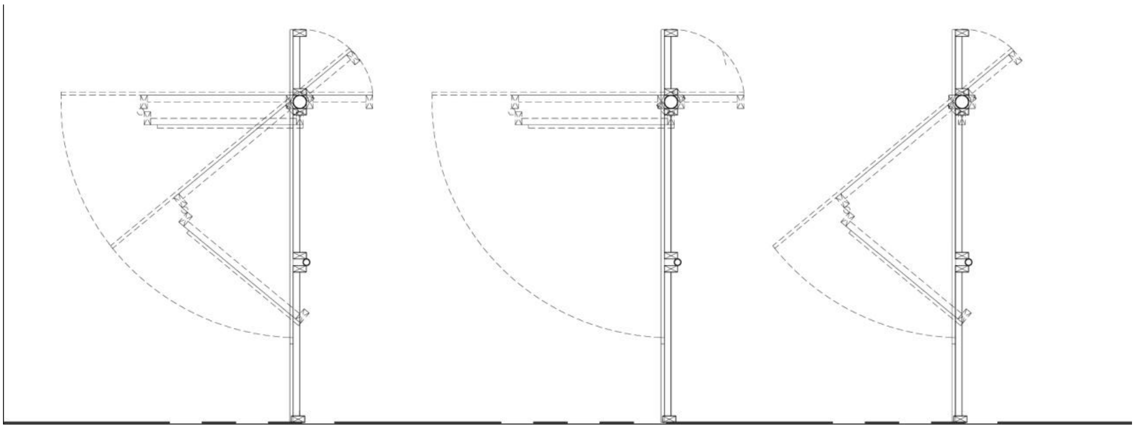
As the longer side of the building to be exposed to be on a very strong windward side, the wind pattern creates a negative pressure on the other leeward side of the building and as a result sucks in the air to the rooms on the other side. This design features creates a very effective passive design approach for securing natural ventilation.

Light

Maximum natural light is allowed in with large windows into the room. Light shelves are also used provide better lighting into the individual rooms. The buildings are arranged to maximize the building ventilation as explained in the urban plan. The orientation of the building also means that the longer side of the building is slightly exposed to the western and eastern façade, resulting in an undesired solar heat gain. This problem is solved easily by introducing a shading device concept that opens and closes vertically. The vertical orientation of the shading device extends a shading system over the glass windows and actively shades the primary façade from direct sunlight for the majority of the day.

Light in the central corridor is allowed through an opening forming an atrium to prevent dark areas in the middle of the building.





Water

The constant rain and the amount of it define the shape and the design of the building. To ensure the protection of the building from the rain, a large trellised roof is located over the atrium. This allows the protection of this large area from constant rain while allowing air to pass through it and facilitate ventilation. On the roof deck a partially covered roof garden is placed. The open areas are roofed by smaller trellises from the rain. Water from this shading systems are then collected for storage and reuse as grey water. Large gutter areas are provided on the roof deck to provide sufficient drainage of the large amount of rainfall accumulated on the roof deck.

Negative effects on the building by the water element by flooding of the river are reduced by raising the buildings on stilts. On the ground floor basic building elements are located, such as the laundry room, a small lobby and reception area for guests, and a small living area and kitchen area to provide communal living spaces for the residents of the buildings. The increased building height from the public road grade line of 4 meters is found to be sufficient to consider a 150 year return period of flooding (see urban).

The use of Materials

Architecture should be expressed in feeling, sight, sound, light, smell and, taste. The materials considered in the project are based on this concept. The materials on a project can have a profound effect on the idea of the building. In example, traditional houses in the Philippines exhibit a visual lightness expressed by the wooden structure above the solid stone ground floor walls.

The design of the Buildings here aims to be of the site rather than buildings on the site.[7] The connection of the building with nature is expressed by the use of natural materials, local to the site. The use of these materials humanizes the otherwise concrete,

[7] Ibid

steel and glass cladding buildings of the same typology. It decreases the scale of the building and makes it more personal for the users of the building.

The bamboo façade and shading systems seems to mimic the outlines of the rusted galvanized iron shapes of the informal settler houses along the river. This patched up small shacks, usually composed of three or four different materials, roughly put together with nails and whatever can be used to hold it all together is expressed by a painting of one of the national artist of the Philippines, Vicente Manansala . This view of the river Pasig exemplifies the condition of the river during his time. The artist expressed both his admiration and dislike of the slum area. The painting visually captures the essence of it and he was able to express its significant role in the history of the place.

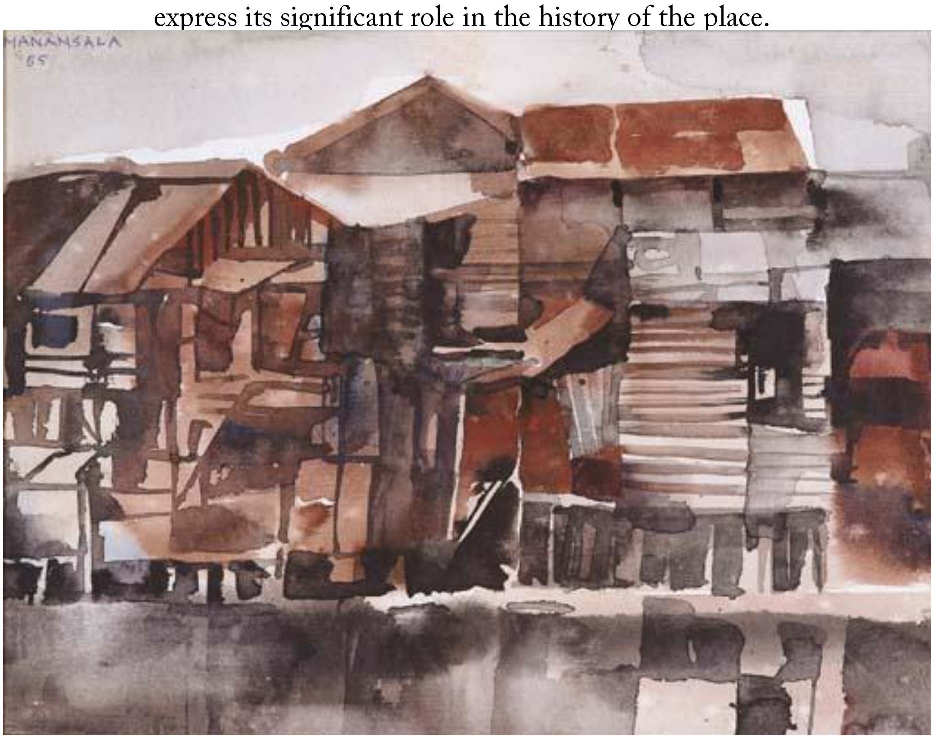


Fig. 6Pasig River by Vicente Manasala

This visual concept is the special features that can be seen in the area and is expressed accordingly to the architecture design. From the material used, to the rough and rugged edges produced by the extruding angles, brings forth this organized chaos that would extend this image of the past in a better form of future. “Art is a form of expression therefore architecture must express something define something It must tell storey”

Building Shape

“Architecture must have form balance and interpretation.” the rigid boxes established by the planting area, juxtaposed with the smooth curves of the river, and the chaotic image of the informal slum settlements that lined the area before are certain design features and special characteristics that define the area. The massive building volumes established by the urban planning principles adopt a rhythmic balance between these different elements.

Building Construction

The building’s design and light weight construction allows for a very flexible building. This allows it to extend its life cycle. The building consists of four storey to reduce the need for lifts and reduce energy demands of the building.

The construction system extends the tradition of building on stilts. This is both for the river flooding aspect and the bioclimatic design aspect. The building on stilts also resembles the local fishing villages out in the sea. These community of buildings are grouped together to form a network for harvesting of fishes.

These groups of houses linked together by bridges to form a community become the background of linking the group of residential houses together. The bridge located at a +1 level allows the residents of the buildings to freely move an use the group of buildings without any compromise. This aspect of the design improves the building function over all resistance to the avid floods in the area.

As the fishing villages are arranged surrounding a fishing pen, this concept is also reflected in the arrangement of the group of buildings. The blocks of Buildings are arranged around a green area as a form of mimicking these

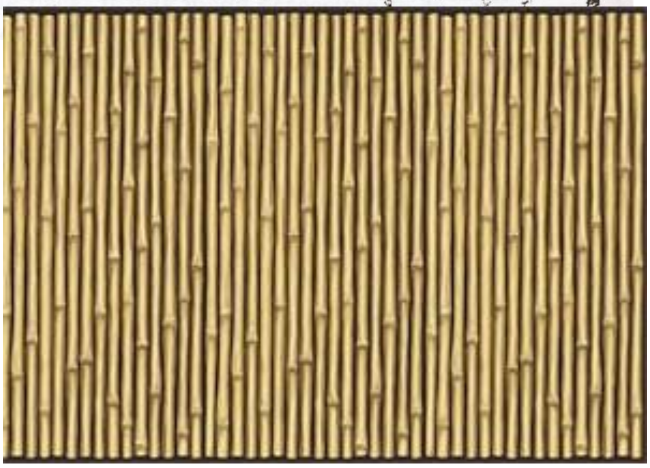
Visual Lightness

The massive building volumes established by the master plan guidelines are broken up further to express the visual lightness of Filipino architecture.

The visual lightness is expressed by the selected bamboo covering surrounding the building volumes. The lightness of the material reduces the heaviness of the blocks. Stilts on the buildings also extend the image of lightness to the structure.

The bamboo elements are also slightly curved outwards expressing another aspect of this visual image. The idea of stilt houses comes into mind as masses being supported by bamboo stilts are a common architecture features.

The slightly curved façade expresses visually the heaviness of the slabs on top of it. This approach creates a visual illusion. This contradiction between heavy and light visual approaches playfully displays a balance of contradictions.



Roof Gardens and Pavilions

The apparent openness of Philippine architecture to nature is expressed in the creation of the roof garden and pavilion. The creation of a livable green space on the roof provides another living space for the students and also benefits the structures thermal performance.

The building extends the existing green area in the ground floor to the roof. An effect of the horizontal slabs being extruded out from the ground and supported by the bamboo facades completes the idea of building with the site.

Energy in buildings

An integrated design approach is used to ensure that the building has a minimal cost in terms of operating and construction. The design process entails an optimization of a passive design system for cooling; this in the end entailed a reduced energy demand from the building for cooling.

Consideration has also been taken to the energy of the building by using materials with low embodied energy such as bamboo and local concrete and use of other natural materials. Materials that can be used in the building are local resistant re used recycled substituted for a reduced environmental impact over the course of the whole building cycle. Most of the materials used can be reused and recycled or biodegradable at the end of the building life cycle.

Building energy producing systems such as using renewable energy solar water heater heat pump wind power photovoltaic biomass are considered.

VI. Architecture Drawings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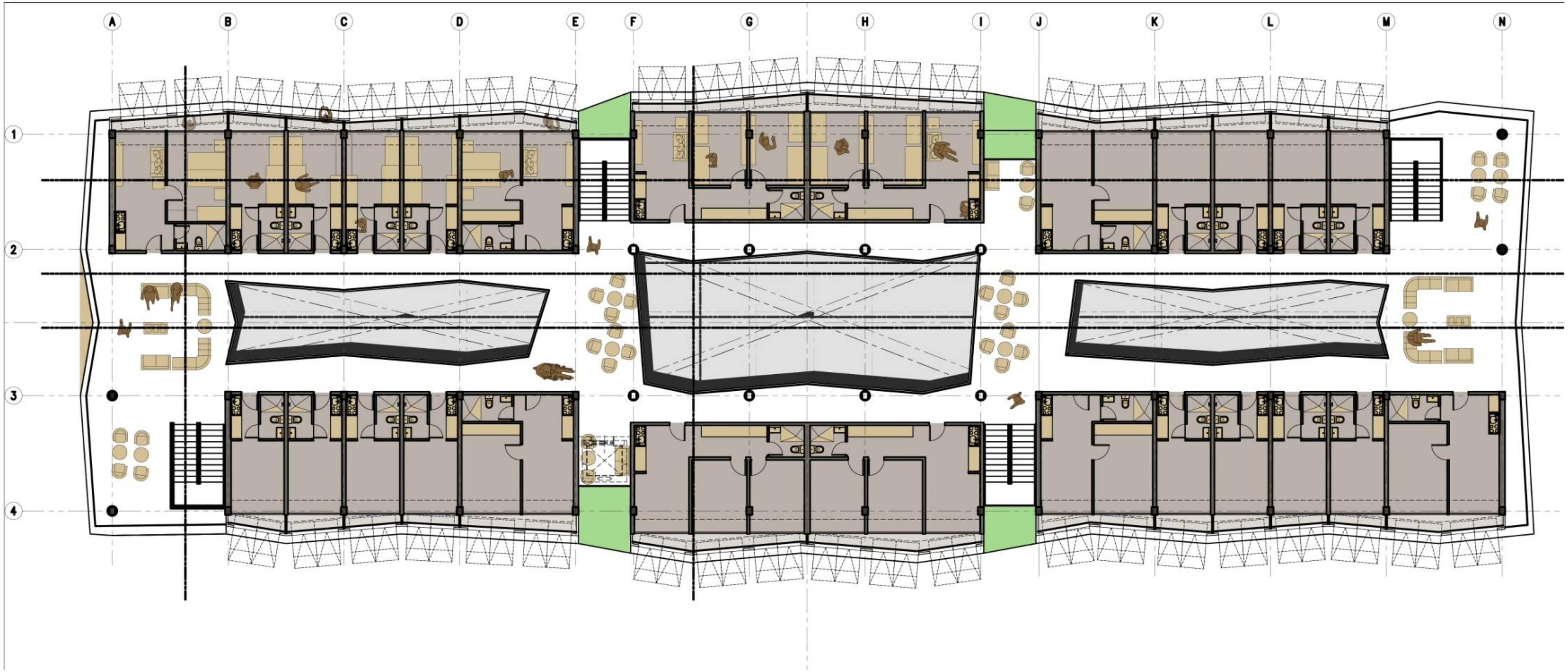
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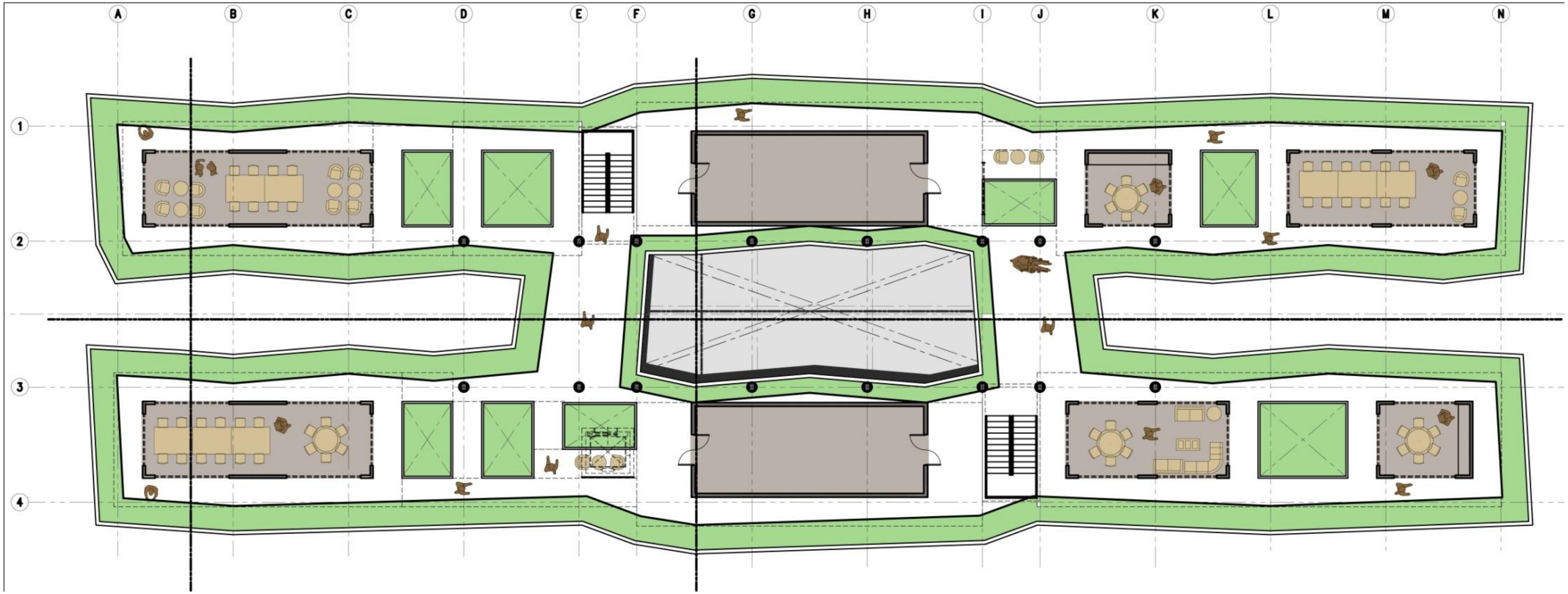
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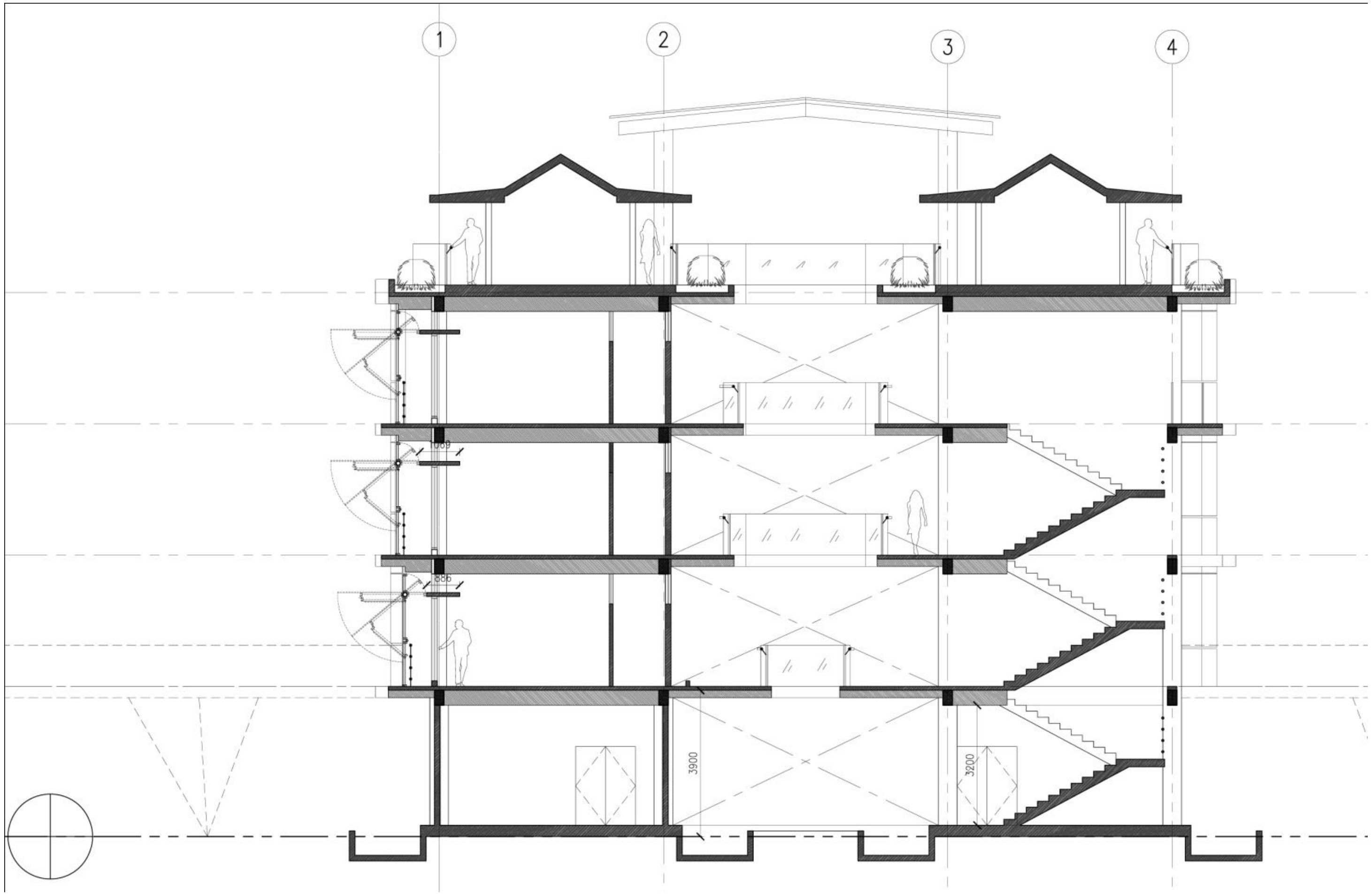
1
2
3
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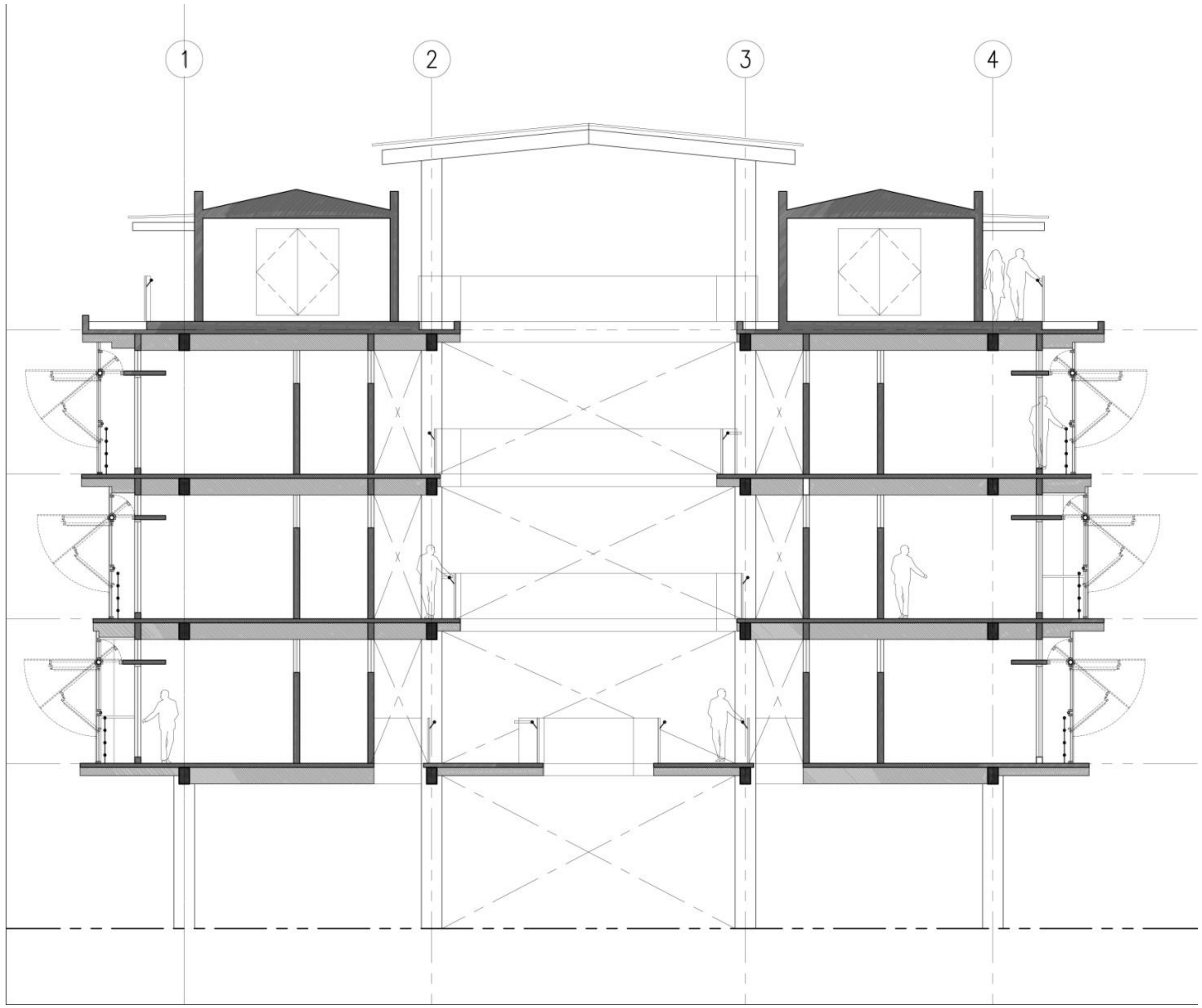
3900
3200


1
2
3
4

Chapter 2: STRUCTURAL DESIGN

1. OVERVIEW

The building was designed to meet both strength and serviceability requirements when subjects both to gravity load and lateral loads. The plan of the building is 72x19.6m.

The lateral force resisting systems in the 19.6m direction is the steel moment braced frame V bracing is used at all stories along grid A,E,J,N. The 4 stories use 2 story X-braces. On other direction , the vertical V bracing system also locates on grid 2&3 between span EF, GH,HI.

The lateral force resisting systems in the 72 m direction is the steel moment with rigid connection for all joints in the two outer frames .The strong members were required on the lowest story to combat the seismic forces for the building.

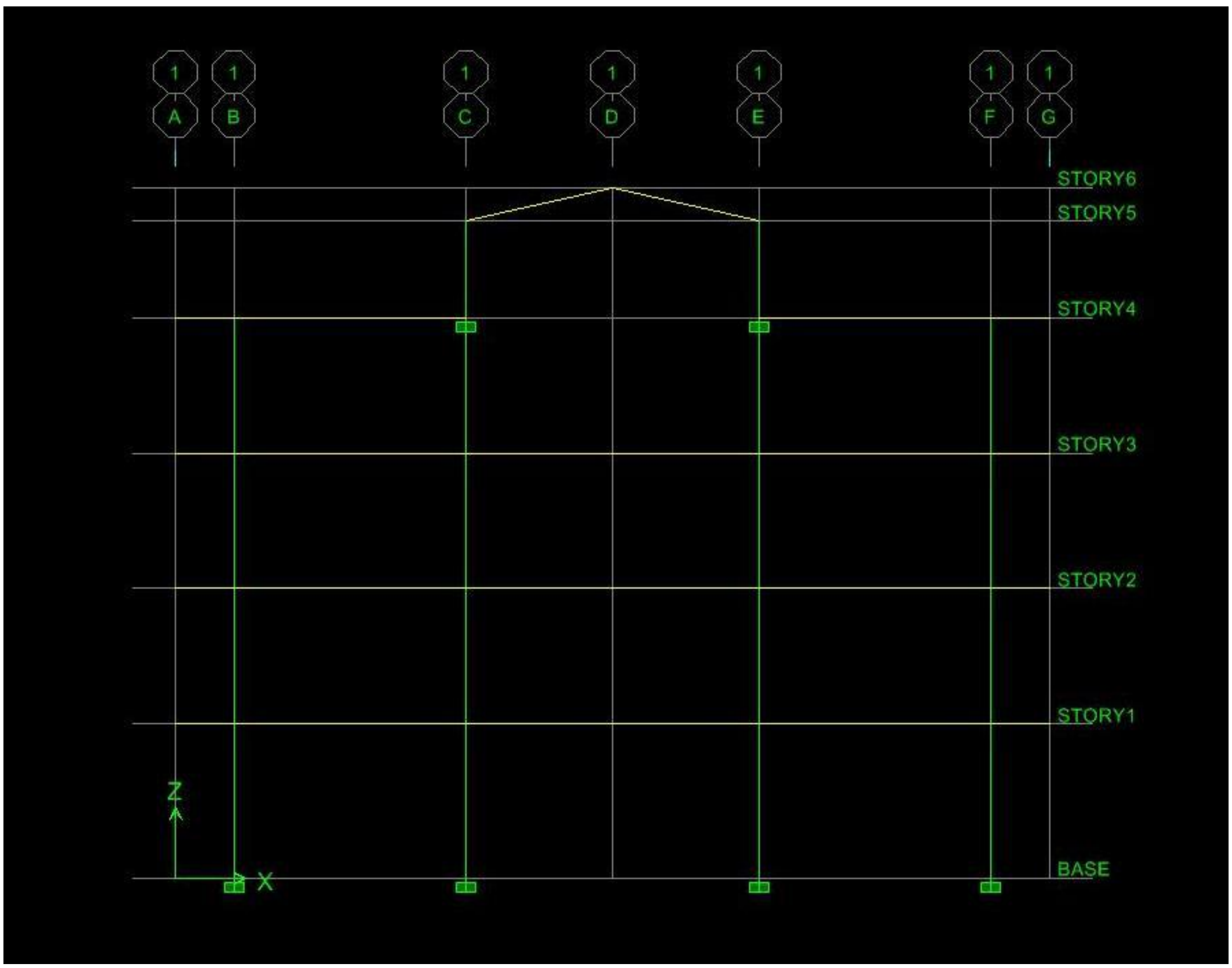
For strength design, all standard load combinations were considered and members were designed to resist the ultimate, factored loads. Because of the extreme seismic load, plastic yielding behavior of the structure is expected and accounted for, with the plastic deflections limited to story drifts .To prevent brittle failure at the beam-columns connections, reduced beam section were used in the moment frame beams to ensure ductile failure by forcing plastic hinges to form at those locations.

For serviceability, beam deflections were limited to L/240 under service live loads and story drifts are limited to L/400 under50 year wind conditions.

All load combinations were entered into the model and the combined load effects were indicated by EUROCODE. The structure was designed for serviceability.

The model was constructed in ETABS to conduct 2D frame analysis of structure.

The model included only the main beams and the columns, while the floor beams and decking were designed by hand. Lateral loads were applied to diaphragms at each floor, diaphragms were assumed rigid as justified by a diaphragm flexibility study.



2. PRELIMINARY DESIGN

The material chosen, steel is sensitive with thermal .The need for expansion joint should be considered in the first step of structural design. Dimensional changes in a structure and its elements due to the variation in temperature, relative humidity, or other effects of connection

$L_{max} = L_{allow} + (R_1 - R_2 - R_3 - R_4) L_{allow}$ (1)

Where:

L_{max} : maximum length of the building with no expansion joints or between expansion joints.

R_1 =0.15 ,if the building is heated and air-conditioned

R_2 =0.33,if the building is unheated

R_3 =0.25,if the columns are fixed base

R_4 =0.15,if the building has substantially greater stiffness at one end

L_{allow} : allowable length from Fig. 1

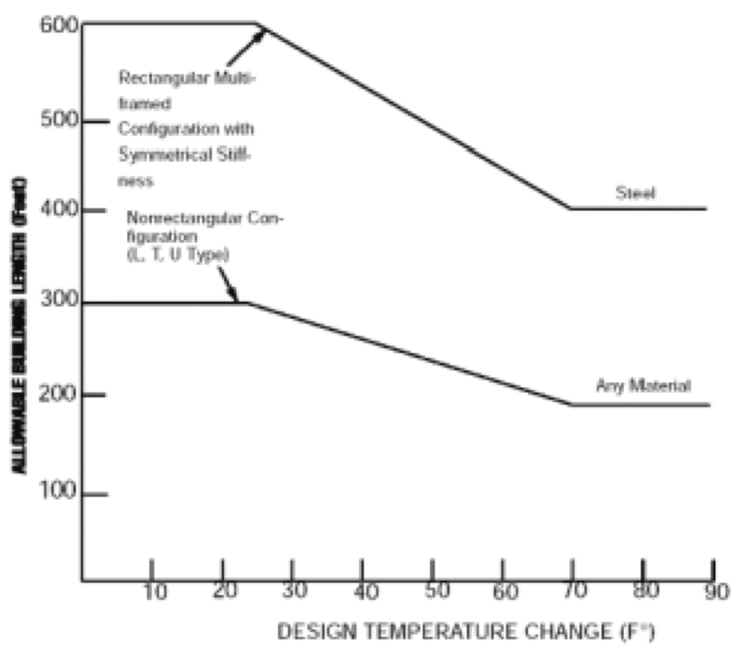


Figure1. Expansion Joint Spacing Graph [taken from F.C.C Tech. Report N° 65, Expansion Joints in Building].

From the equation (1) and Fig 1, we have the length of building without expansion joint in our case:

L_{max}= 450 + (0.15 -0.33- 0.25- 0) x450 = 256 ft = 78 (m)

So since whole building length is 72 m, it could be designed as 1 single block without any expansion joint.

3. LOADING

3.1 Gravity Loads

Dead, live, roof live loads were calculated in accordance with EUROCODE 2.Calculations of gravity loads are included in Appendix A

3.1.1 Dead load

Dead load were calculated including the weight of all structural components (columns, main beam, floor beams and floor system, wall system), superimposed dead load of 1.2 kN/m^2 (due to the equipment)

- Floors and balcony

COMPONENTS	Density (kg/m3)	Thickness (cm)	Weight (kN/m2)
Bamboo flooring spieces	60	3	0.018
Concrete	2400	16	3.84
Corrugated Steel Sheet 1mm	1300	0.1	0.013
Acoustic Insulation Layer	380	6	0.228
Suspended Ceiling	200	10	0.2
		Σ	4.281

- Exterior wall

COMPONENTS	Density (kg/m3)	Wall high (m)	Thickness (cm)	Weight (kN/m)
Bamboo covering layer	400	3.2	3	0.384
Strawboard Panel	400	3.2	20	2.56
Finishing Plasterboard	1250	3.2	3	1.2
			Σ	4.144

- Partition wall

COMPONENTS	Density (kg/m3)	Wall high (m)	Thickness (cm)	Weight (kN/m)

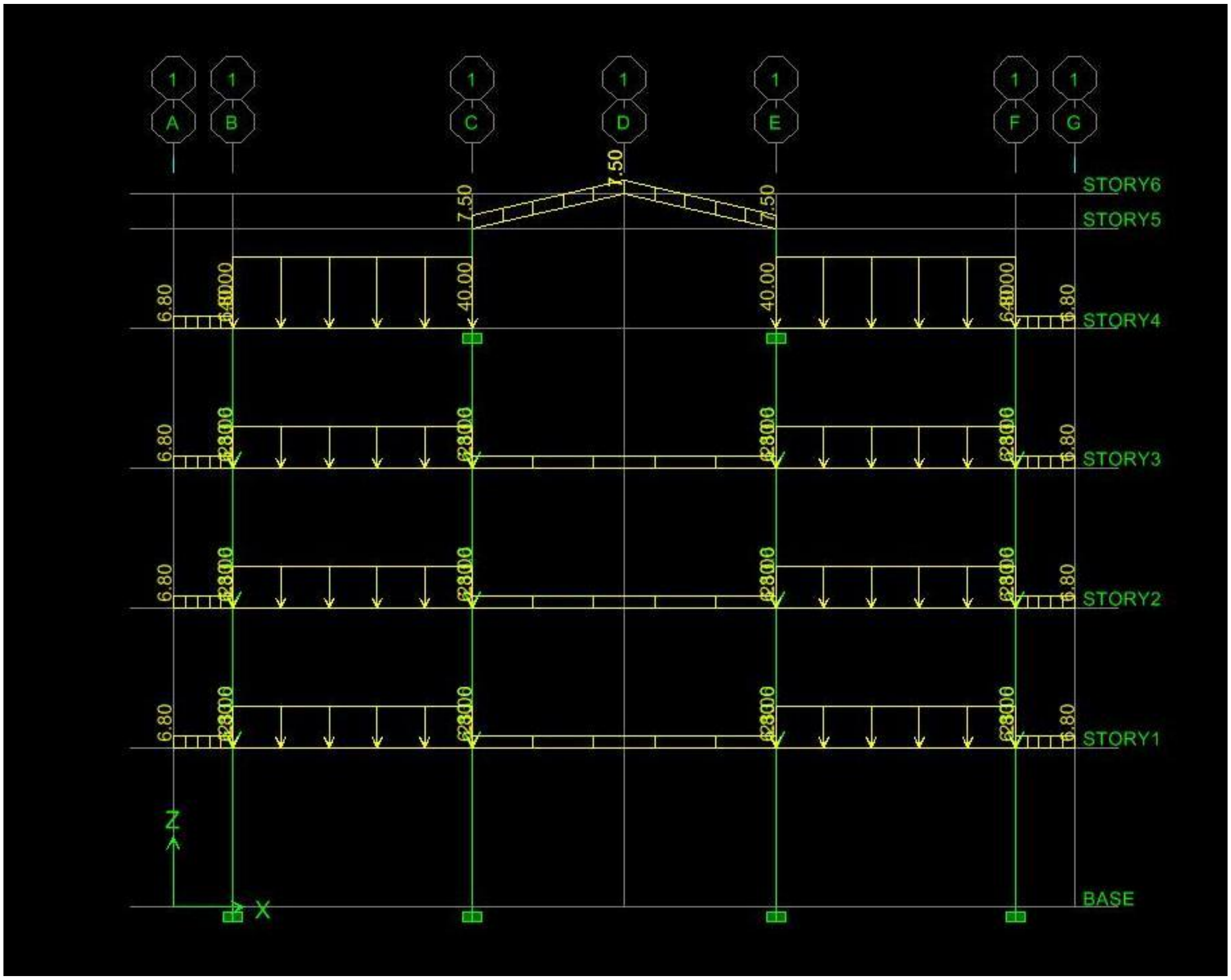
Strawboard Panel	400	3.2	10	1.28
Finishing Plasterboard	1250	3.2	3	1.2
			Σ	2.48

- Glass façade

COMPONENTS	Density (kg/m3)	Wall high (m)	Thickness (cm)	Weight (kN/m)
Glass	-	-	-	1.31
Aluminum Frame	-	-	-	0.06
Bamboo Louvre System	400	2.8	8	0.896
			Σ	2.266

- Roof

COMPONENTS	Density (kg/m3)	Thickness (cm)	Weight (kN/m2)
Solar Panel	-	-	0.16
PTFE Membrane	24	5	1.2
Green Roof	-	-	4

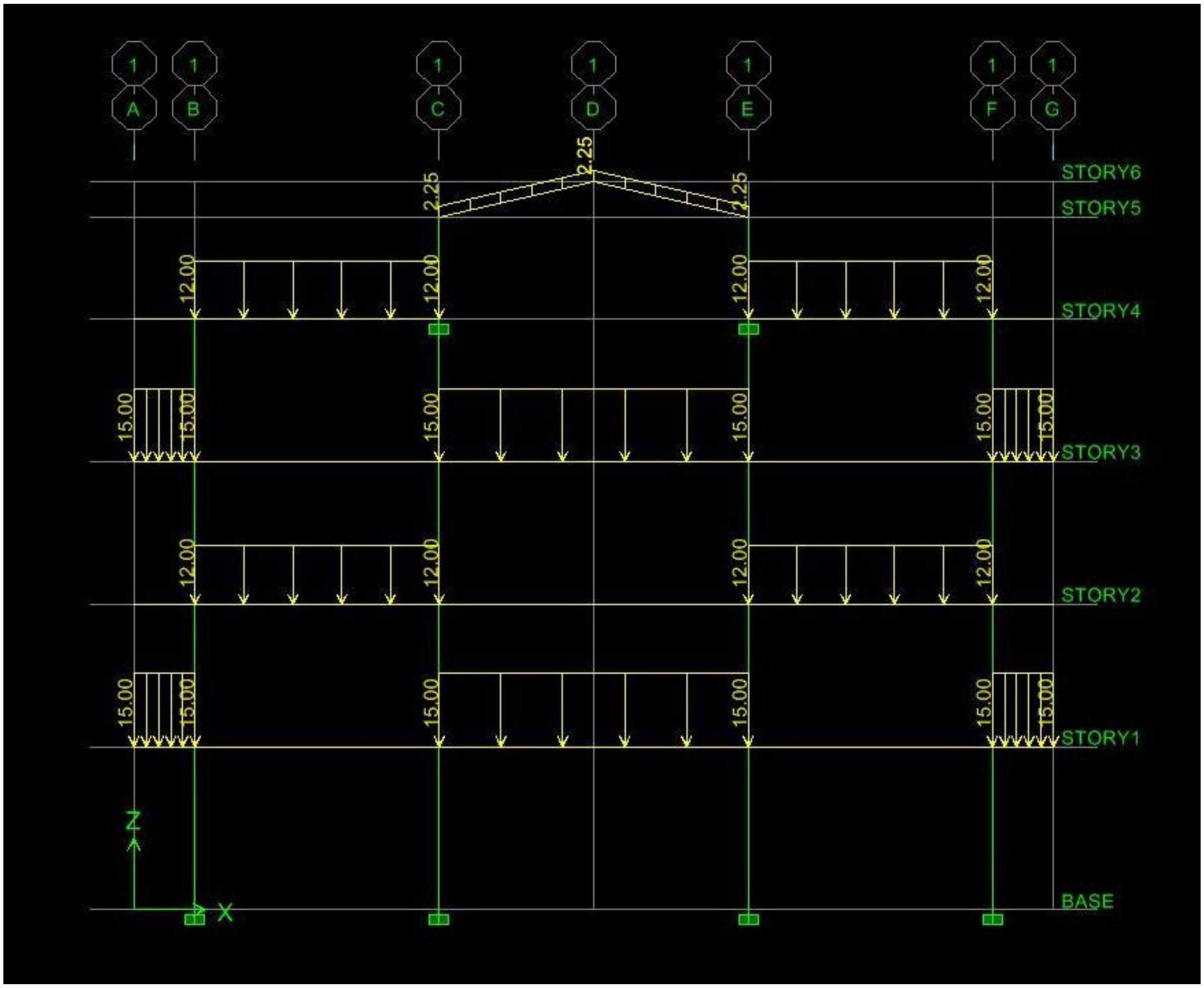


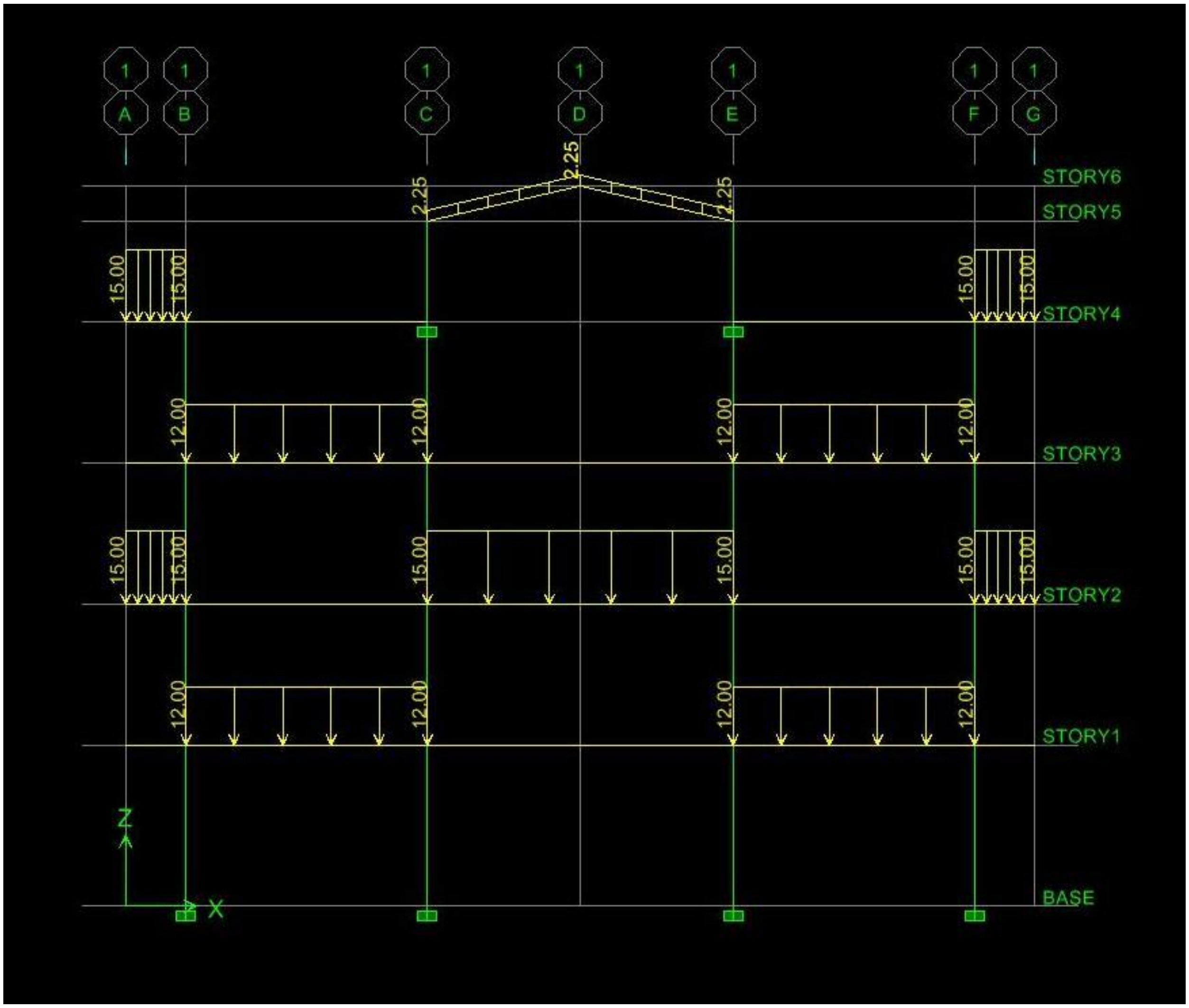
3.1.2 Live load

All area:

FUNCTION	Load (kN/m²)
Residential area	2
Balcony area	2.5
Roof with activities	2

Roof no activities	0.75




A
B
C
D
E
F
G
STORY6
STORY5
STORY4
STORY3
STORY2
STORY1
BASE
2.25
15.00
12.00
Z
X

3.2 Lateral loads

3.2.1 Wind load

Wind loading was calculated using EUROCODE 1, since it's not classified as a high-rise building

Because of the urban design of the area, as well as the neighborhood, it was assumed this student residence would be located in the urban environment of low vegetation and isolated obstacles; exposure category II was used. No special topographic considerations were taken into account, and the building was also classified as an enclosed structure.

Once all wind pressured been computed and applied to the proper building faces, they were summed up within the vertical tributary area of each diaphragm and the resultants were applied as intersection of beams and columns.

a. Basic values

Determination of basic wind velocity

$$v_b = c_{dir} \cdot c_{season} \cdot v_{b,0}$$

Where :

v_b is the basic wind velocity, defined as a function of wind direction terrain category II

$v_{b,0}$ is the fundamental value of the basic wind velocity, see (1)P

c_{dir} is the directional factor, see Note 2.

c_{season} is the season factor, see Note 3.

Fundamental value of the basic wind velocity (refer the Phillipines design guidelines)

$v_{b,0}$ = 26 m/s

Terrain category II $z_0 = 0.05m$

$z > z_{min}$

$v_b = 26$ m/s

For simplification, the directional factor c_{dir} , c_{season} are general equal to 1.0.

b. Basic velocity pressure

$$q_b = \frac{1}{2} \times \rho_{air} \times v_b^{\ 2}$$

Where $\rho_{air} = 1{,}25$ kg/m³

$q_b = 1/2 \times 1.25 \times 26^2 = 422{,}5$ N/m²

c. Peak pressure

$$q_p(z) = [1 + 7 I_v(z)] \times \frac{1}{2} \times \rho \times v_m(z)^2$$

Calculation of mean wind velocity: $v_m(z)$

$$v_m(z) = c_r(z) \times c_o(z) \times v_b$$

$c_o(z)$ is the orography factor

$c_r(z)$ is the roughness factor

$$c_r(z) = k_r \cdot \ln\left(\frac{z}{z_0}\right) \quad \text{for} \quad z_{min} \le z \le z_{max}$$

$$c_r(z) = c_r(z_{min}) \quad \text{for} \quad z \le z_{min}$$

Where : z_0 is roughness length

k_T is the terrain factor, depending on the roughness length z_0 calculated using

$$k_T = 0{,}19 \times \left(\frac{z_0}{z_{0,II}} \right)^{0{,}07}$$

Where $z_{0,II}$=0.05(terrain category II)

Zmin is the minimum height

Zmax is to be taken as 200m

Calculation of l_v (z)

l_v (z) turbulence intensity

$$l_v = \frac{k_1}{c_o(z) \times \ln(z/z_0)} \quad \text{for } z_{min} \le z \le z_{max}$$

$$l_v = l_v(z_{min}) \quad \text{for } z < z_{min}$$

Where : k_I is the turbulenxe factor recommended value for k_I is 1,0

z = 19.4m

so $z_{min} < z < z_{max}$

$$q_p(z) = \underbrace{\left[1 + \frac{7k_1}{c_o(z) \times \ln(z/z_0)} \right]}_{\text{squared gust factor}} \times \underbrace{\frac{1}{2} \times \rho \times v_b^{\,2}}_{\text{basic pressure}} \times \underbrace{\left(k_T \times \ln(z/z_0)\right)}_{\text{wind profile}}$$

q_p(19.4)= 1.178 (m/s)

d. Wind pressure on the surface (pressure coefficients for internal frame)

A positive wind load stands for pressure whereas a negative wind load indicates suction on the surface. This definition applies for the external wind action as well as for the internal wind action.

e. **External pressure coefficient**

The wind pressure acting on the external surfaces, w_e should be obtained from the following expression :

$$w_e = q_p(z_e) \times c_{pe}$$

Where z_e is the reference heights for the external pressure

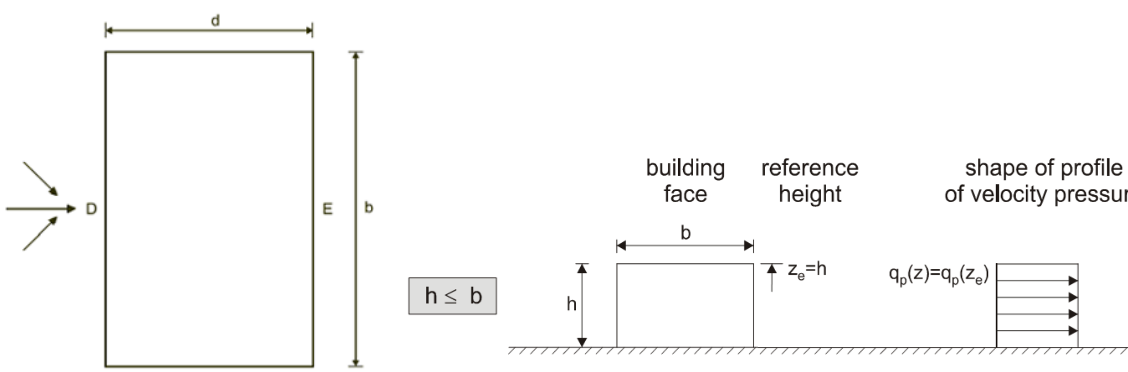
c_{pe} is the pressure coefficient for the external pressure depending on the size of loaded area A = $c_{pe,10}$ because the loaded area A for the structure is larger than 10 m^2

- Vertical wall

Cause h/d= 19/19.6 = 0.97 <1

D : C_{pe}= 0.8

E : C_{pe}=- 0.5

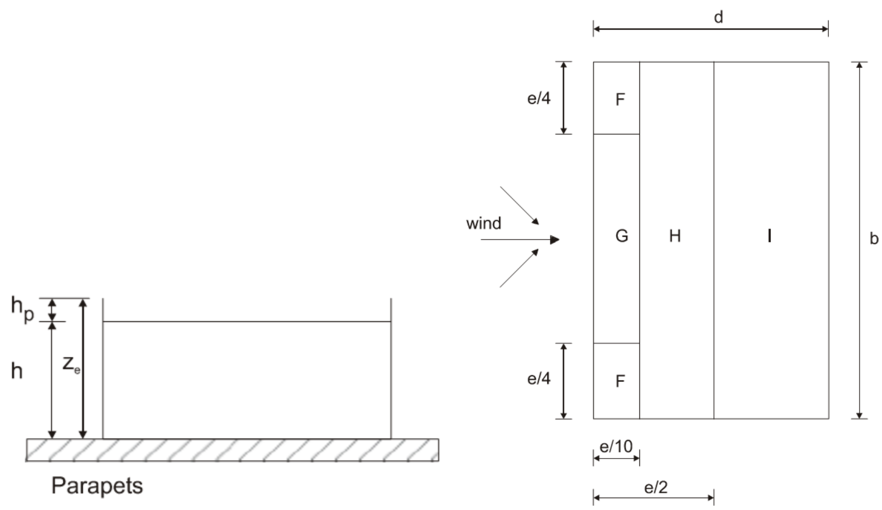


- Roof

In the middle span, the slab was opened to create the stack-effect for the building, and this affect was also leads the wind effect on the roof of this span. This frame connected with the frame under by hinge.

Look at the frame under, we catalogued it into the flat Roof with Parapet, to calculate its coefficient.

h = 14m, hp = 1.1m



e = min (b,2h) = min(72,28)= 28

$$\frac{hp}{h} = \frac{1.1}{14} = 0.078$$

G : C_{pe}= -0.8

H : C_{pe}=- 0.7 I : C_{pe}= ±0.2

The unfavorable case C_{pe} when it's C_{pe}= 0.2.

f. **Internal pressure coefficient**

The wind pressure acting on the internal surfaces of the structure, w_i should be obtained from the following expression

$$w_i = q_p(z_i) \times c_{pi}$$

Where z_i is the reference height for the internal pressure

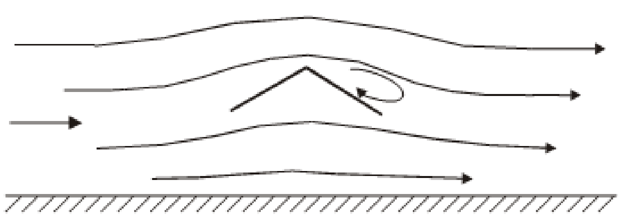
c_{pi} is the pressure coefficient for the internal pressure

The internal pressure coefficient depends on the size and distribution of the openings in the building envelope.

- Middle span

In the middle span, the slab was opened to create the stack-effect for the building, and this affect was also leads the wind effect on the roof of this span.

Roof in the span was considered as a canopy roofs due to the architectural design of the roof with no permanent wall.

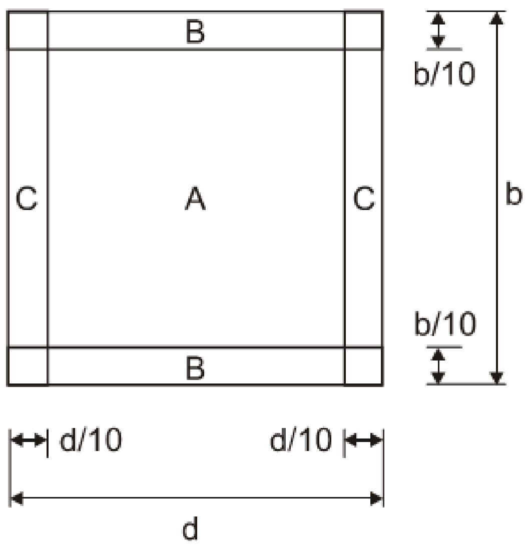


Empty, free-standing canopy (φ=0)

The coefficient C_{pe} distributed like the following plan :

Net Pressure coefficients $c_{p,net}$

Key plan



$\alpha = 6^{\circ}$

ρ= 0 (blockage) ; d/10 = 7.6/10 = 0.76

A : C_{pi}= 1.2 ; B : C_{pi}= 2.4 ; C : C_{pi}= 1.6

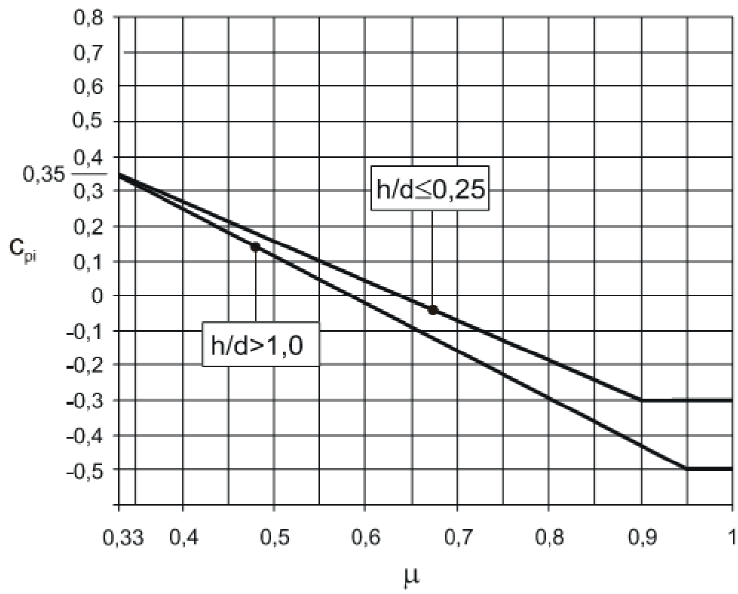
- Flat roof

  This function of the ratio of the heights and the depth of the building,h/d and the opening ratio

$$\mu = \frac{\sum \text{area of openings where } c_{pe} \text{ is negative or - 0,0}}{\sum \text{area of all openings}}$$

M= $^{1}/_{4}$; h/d = 14/6> 1

From the chart



$C_{pi} = 0.35$.

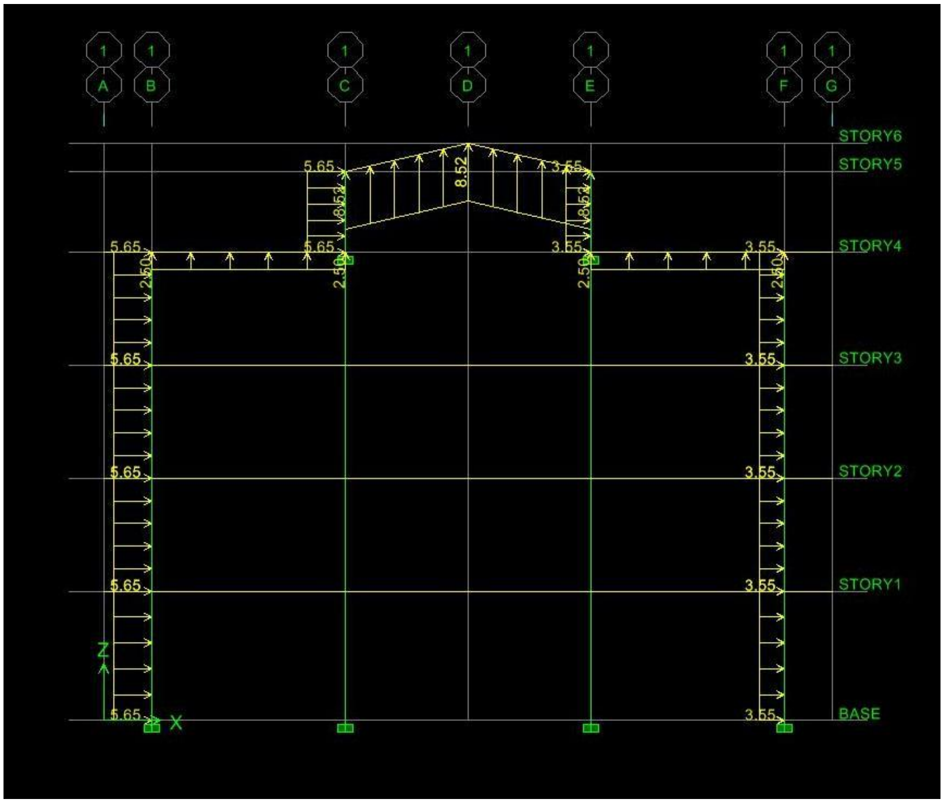
Wind loads

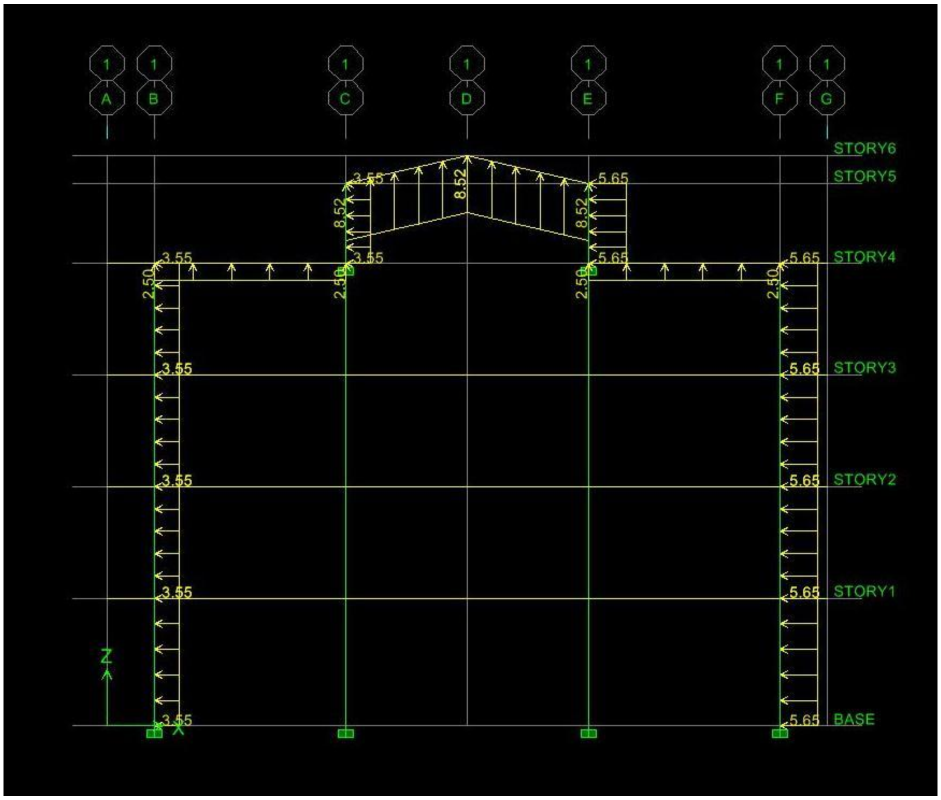
The wind loadings per unit length w (kN/m) for an internal frame are calculated using the influence width (spacing) *s* = 6m

$$w = (C_{pe} + C_{pi}) \times q_p \times s$$

Internal and external pressures are considered to act at the same time. The worst combination of external and internal pressures are to be considered for every combination of possible openings.

These forces are shown in the figures below


A
B
C
D
E
F
G
STORY6
STORY5
STORY4
STORY3
STORY2
STORY1
BASE
5.65
8.52
3.55
2.50
Z
X



3.2.2 Seismic load

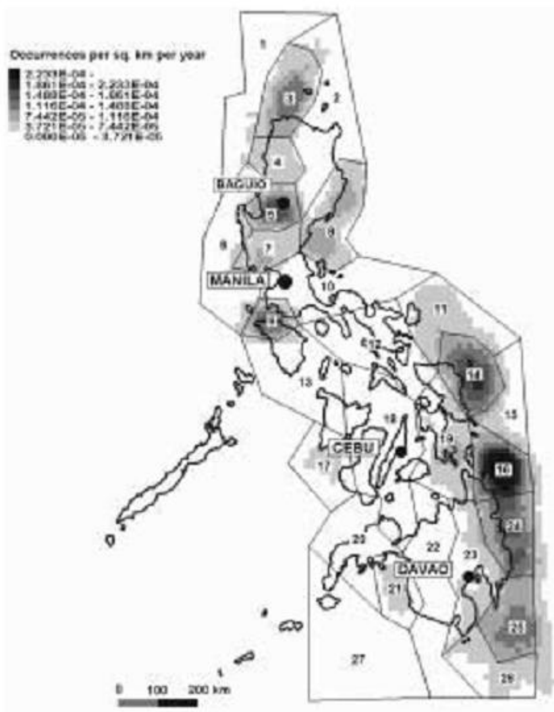
Manila lies on the seismic zone. Although earthquakes do not frequently occur in the area, the quakes load should be considered in the design. Following EUROCODE 8, the building was determined to be designed using ground site C with the peak ground acceleration $0.08 m/s^2$, the importance type as I with the important factor $\gamma 1 = 1.25$.

Lateral forces were found using base shear due to the quake and the building's weight, adjusted by the response modification coefficient. The load on the frame is shown in the Figure, and detail calculation in the Appendix C. These forces were applied on the rigid diaphragm of each story.

Story drifts were printed, adjusted using the deflection amplification and importance factors and used as the basic of the design check.

The importance of the building II as ordinary buildings is not minor not vital importance.

The geologic situation of the site: deep deposits of dense or medium- dense sand, gravel or stiff clay with thickness from several tens to many hundreds of meters – Class C
Method of analysis: Modal response spectrum analysis.



Firgure 1. Seismics source zone – The Philippines

Table1. Values of the parameters describing the recommended Type 1 Elastic response spectra

Ground type	S	T_B (s)	T_C (s)	T_D (s)
A	1,0	0,15	0,4	2,0
B	1,2	0,15	0,5	2,0
C	1,15	0,20	0,6	2,0
D	1,35	0,20	0,8	2,0
E	1,4	0,15	0,5	2,0

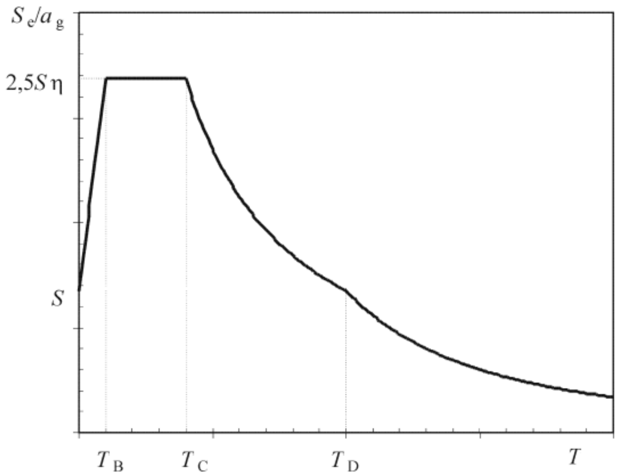


Figure 1.Shape of elastic response spectrum

4. DESIGN PROCESS

4.1 Flooring design

Slab and floor beams play the main roles to transfer horizontal loads.

In addition, the portion of material as well labor for these components is pretty weighty, so the solution for safety and economical is the optimum target. The composite floor deems to be the best answer in this case .Composite floors offer significant advantages related to speed of construction and reduced overall construction depth.

The principal advantage of composite floors compared with other systems is that of speed and ease of construction. Once the units have been placed, a working platform is provided which facilitates the remaining stages of construction and also allows work to continue on lower floors in relative safety. There is therefore a considerable improvement in speed of construction compared with traditional slab forms. A further implicit advantage of this system is that overall construction depth is reduced because of the relatively short spans used.

The metal decking slab acts as floor beams to support the slab. Consequently, the thickness of the slab and the floor beams are reduced leads to size of vertical components also are smaller. This result means that the mass or dead load on the building decrease.

ComFlor® 80 Composite Slab - volume & weight

Slab Depth (mm)	Concrete volume (m^3/m^2)	Weight of Concrete (kN/m^2)			
		Normal weight Concrete		Lightweight Concrete	
		Wet	Dry	Wet	Dry
130	0.086	2.03	1.99	1.61	1.53
140	0.096	2.27	2.22	1.80	1.70
150	0.106	2.51	2.45	1.98	1.88
160	0.116	2.74	2.68	2.17	2.06
170	0.126	2.98	2.91	2.36	2.23
180	0.136	3.21	3.14	2.54	2.41
190	0.146	3.45	3.38	2.73	2.59
200	0.156	3.68	3.61	2.92	2.76
250	0.206	4.86	4.76	3.85	3.64

4.2 Member design

Frame Section Property Data - General

Frame Section Name	Material Name	Section Shape Name or Name in Properties File
B2	STEEL	460UB82.1
B1	STEEL	310UB40.4
C1	STEEL	250UC89.5
B4	STEEL	410UB59.7

Frame Section Property Data – Dimensions

Frame Section Property Data - Dimensions

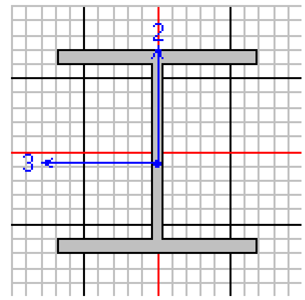
Frame Section Name	Section Depth	Top Flange Width	Top Flange Thickness	Web Thickness	Bot Flange Width	Bot Flange Thickness
460UB82.1	0.4600	0.1910	0.0160	0.0099	0.1910	0.0160
310UB40.4	0.3040	0.1650	0.0102	0.0061	0.1650	0.0102
250UC89.5	0.2600	0.2560	0.0173	0.0105	0.2560	0.0173

Frame Section Property Data - Dimensions

Frame Section Name	Section Depth	Top Flange Width	Top Flange Thickness	Web Thickness	Bot Flange Width	Bot Flange Thickness
410UB59.7	0.4060	0.1780	0.0128	0.0078	0.1780	0.0128

COLUMN C1

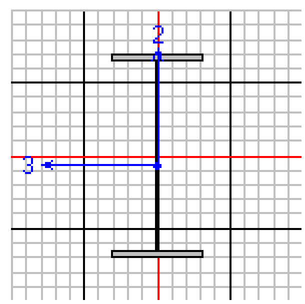
```
Element: C2
Section Name: 250UC89.5
Frame Type:  Moment Resisting Frame
Station: 2.500
Combo: DSTLS4
Classification: Class 2
```




```
A=0.011  I22=4.840E-05  I33=1.430E-04  Wpl22=5.750E-04  Wpl33=0.001
Wel22=3.781E-04  Wel33=0.001  i22=0.065  i33=0.112
E=199947978.80  fy=344737.894
RLLF=1.000
```

BEAM B1

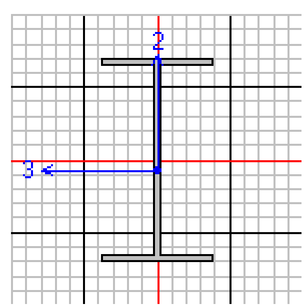
```
Element: B1
Section Name: 410UB59.7
Frame Type:  Moment Resisting Frame
Station: 5.870
Combo: DSTLS6
Classification: Class 2
```




```
A=0.008  I22=1.210E-05  I33=2.160E-04  Wpl22=2.090E-04  Wpl33=0.001
Wel22=1.360E-04  Wel33=0.001  i22=0.040  i33=0.168
E=199947978.80  fy=344737.894
RLLF=1.000
```

BEAM B3

```
Element: B3
Section Name: 310UB40.4
Frame Type:  Moment Resisting Frame
Station: 1.370
Combo: DSTLS2
Classification: Class 2
```

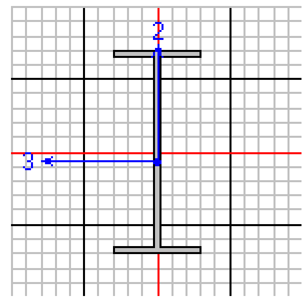



```
A=0.005  I22=7.650E-06  I33=8.640E-05  Wpl22=1.420E-04  Wpl33=6.330E-04
```

```
Wel22=9.273E-05  Wel33=5.684E-04  i22=0.038  i33=0.129
E=199947978.80  fy=344737.894
RLLF=1.000
```

BEAM B4

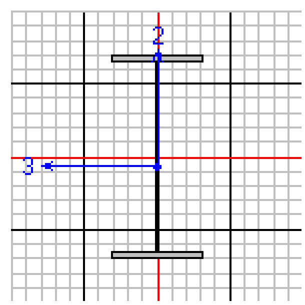
```
Element: B4
Section Name: 460UB82.1
Frame Type:  Moment Resisting Frame
Station: 7.470
Combo: DSTLS2
Classification: Class 2
```




```
A=0.011  I22=1.860E-05  I33=3.720E-04  Wpl22=3.030E-04  Wpl33=0.002
Wel22=1.948E-04  Wel33=0.002  i22=0.042  i33=0.188
E=199947978.80  fy=344737.894
RLLF=1.000
```

BEAM B2

```
Element: B1
Section Name: 410UB59.7
Frame Type:  Moment Resisting Frame
Station: 0.000
Combo: DSTLS4
Classification: Class 2
```




```
A=0.008  I22=1.210E-05  I33=2.160E-04  Wpl22=2.090E-04  Wpl33=0.001
Wel22=1.360E-04  Wel33=0.001  i22=0.040  i33=0.168
E=199947978.80  fy=344737.894
RLLF=1.000
```

Story drift requirements due to seismic loading controlled the design of all members in the moment frames and the braces in the braced frames. For all interior columns, compressive strength controlled proportioning. For all simply supported beams, serviceability (live-load deflection) controlled member proportioning.

Seismic Story Drift

Lateral forces due to seismic effects were found using base shear due to the earthquake and the buildings weight (due from dead loading).These forces were applied on the rigid diaphragm of each story.

From 4.28 EUROCODE 8, the largest story drift for the structure in the ULS should be 1% of the story height. Story drift was calculated to allow for safety during plastic yielding of the building member due to a seismic event. Reduced beam sections are used on beams in the moment resisting frames to force plastic hinge failure at a point near the end of the beam (a ductile failure) instead of along brittle failure if the connection. The standard dimensions for the reduced beam sections in ETABS were used and shown in the Figure.

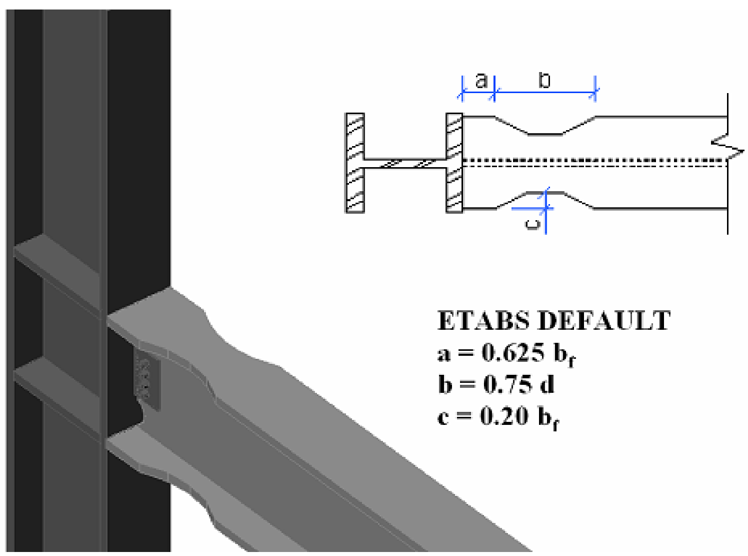
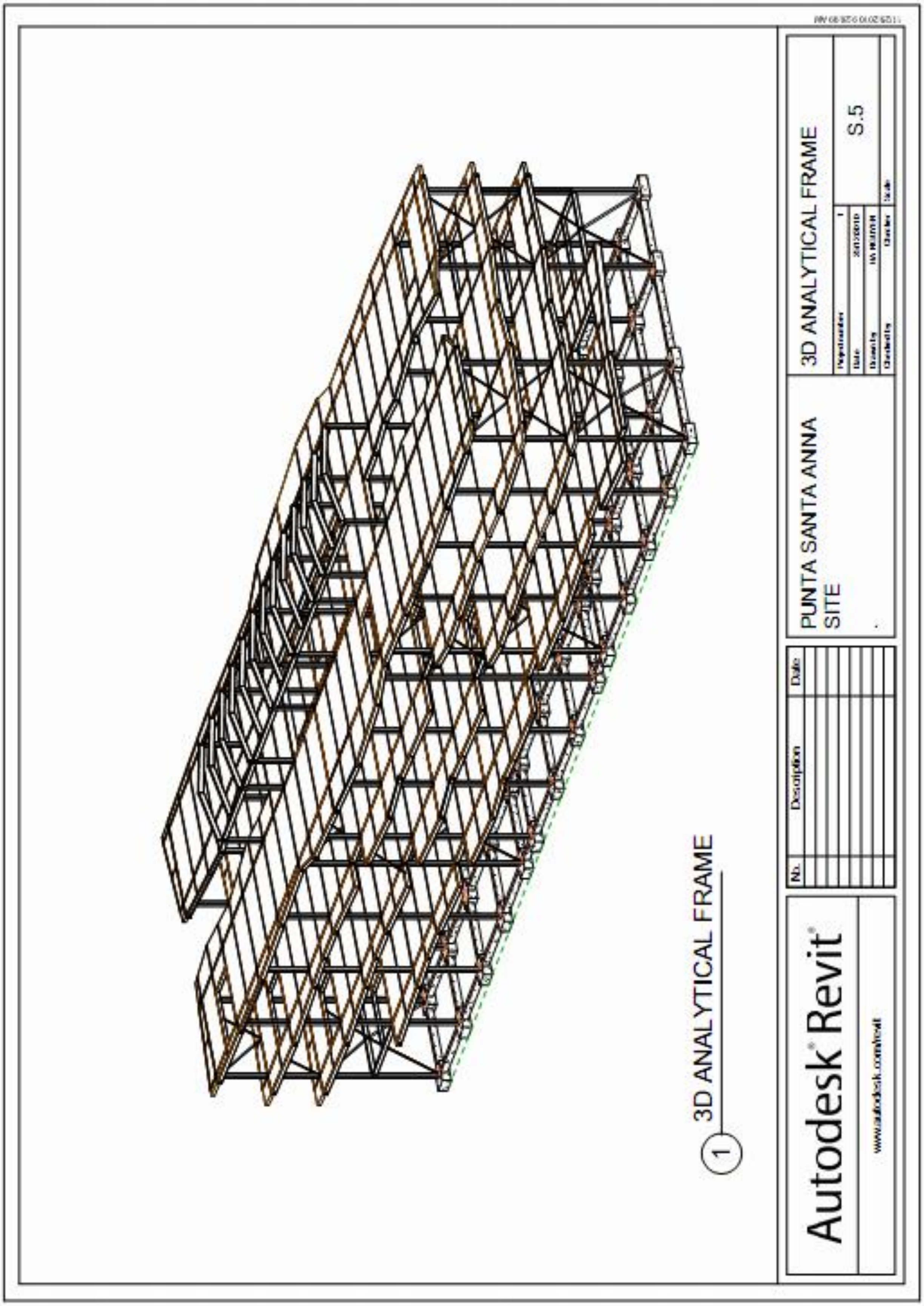


Figure1. The reduction section by ETABS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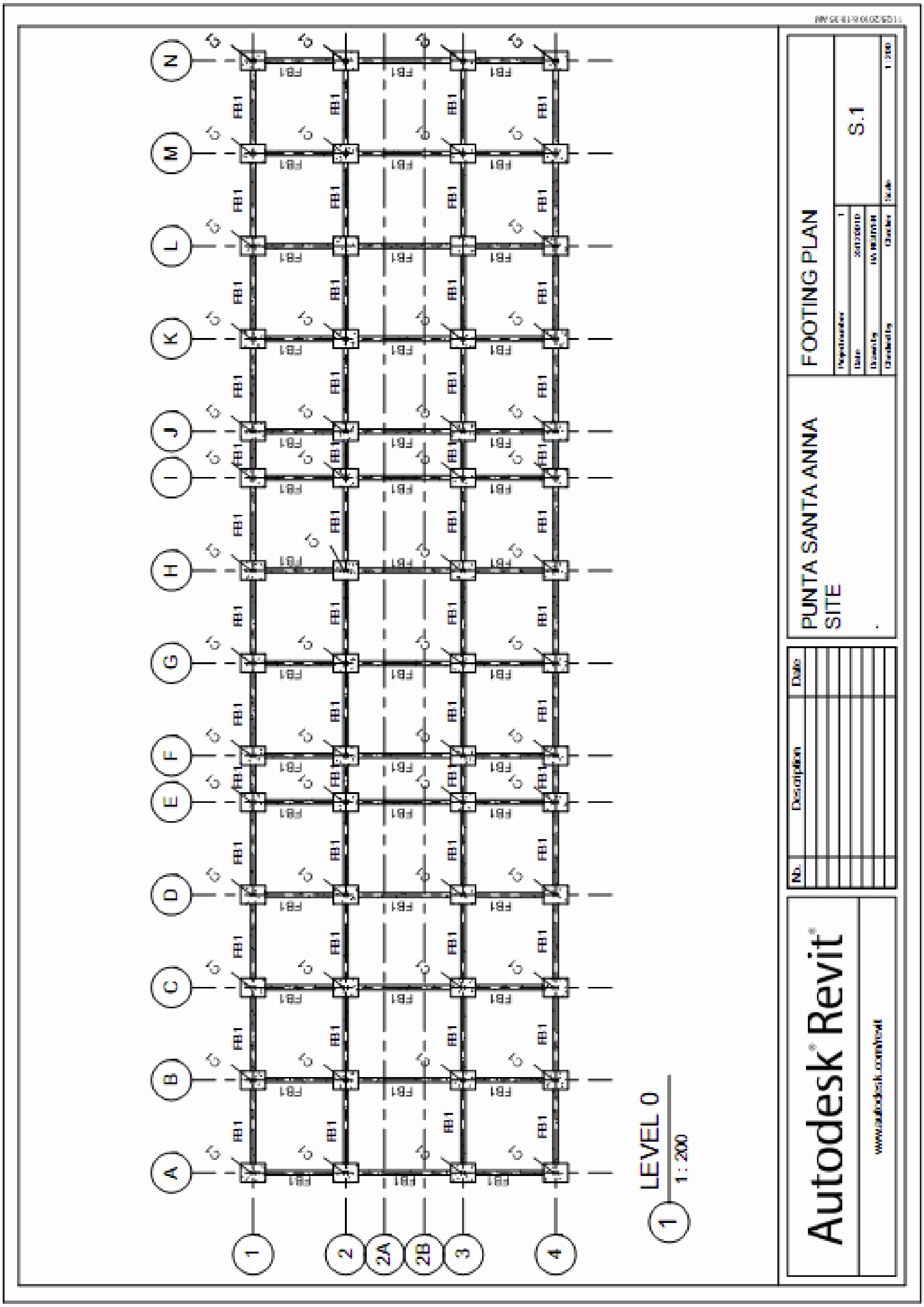
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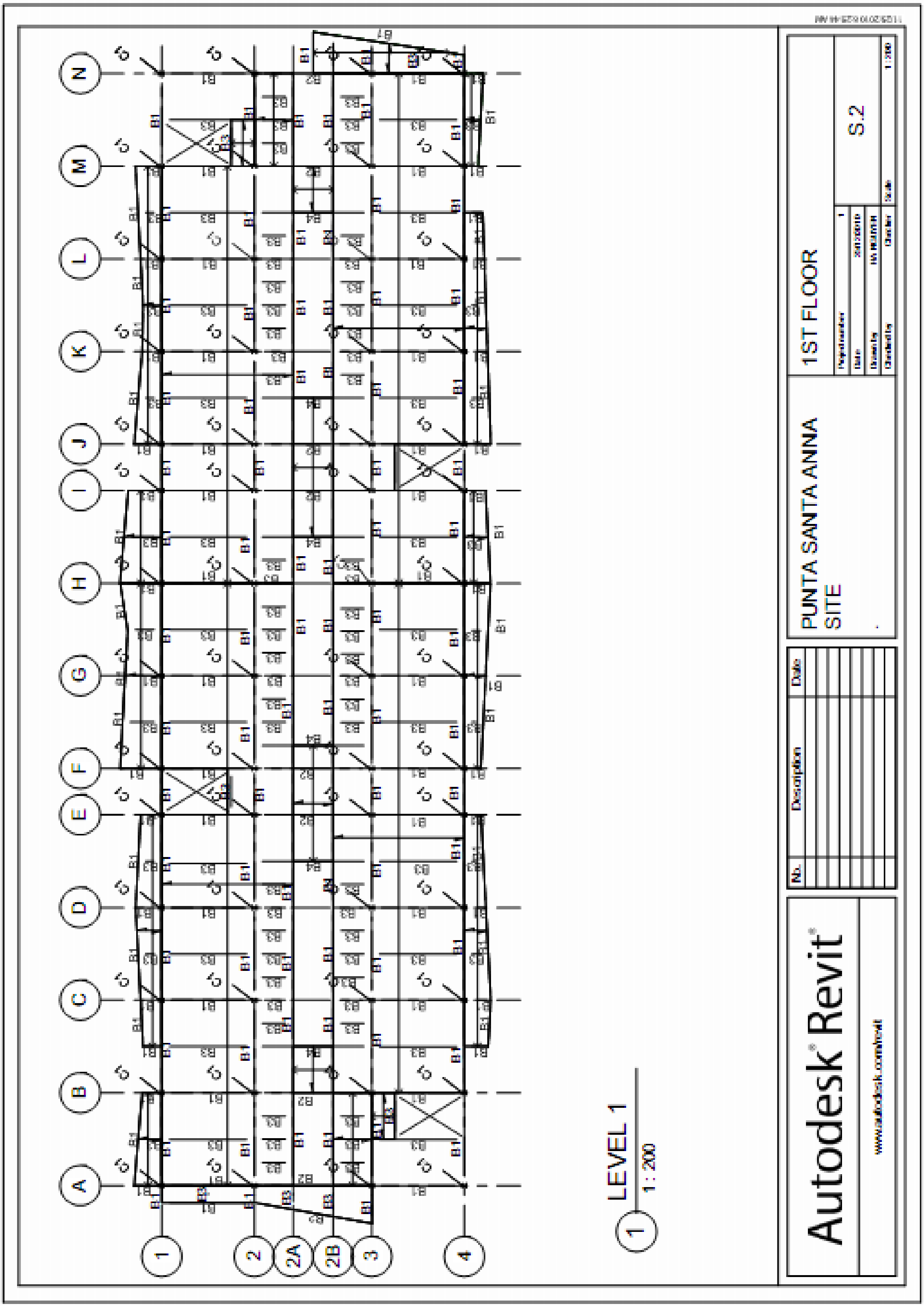
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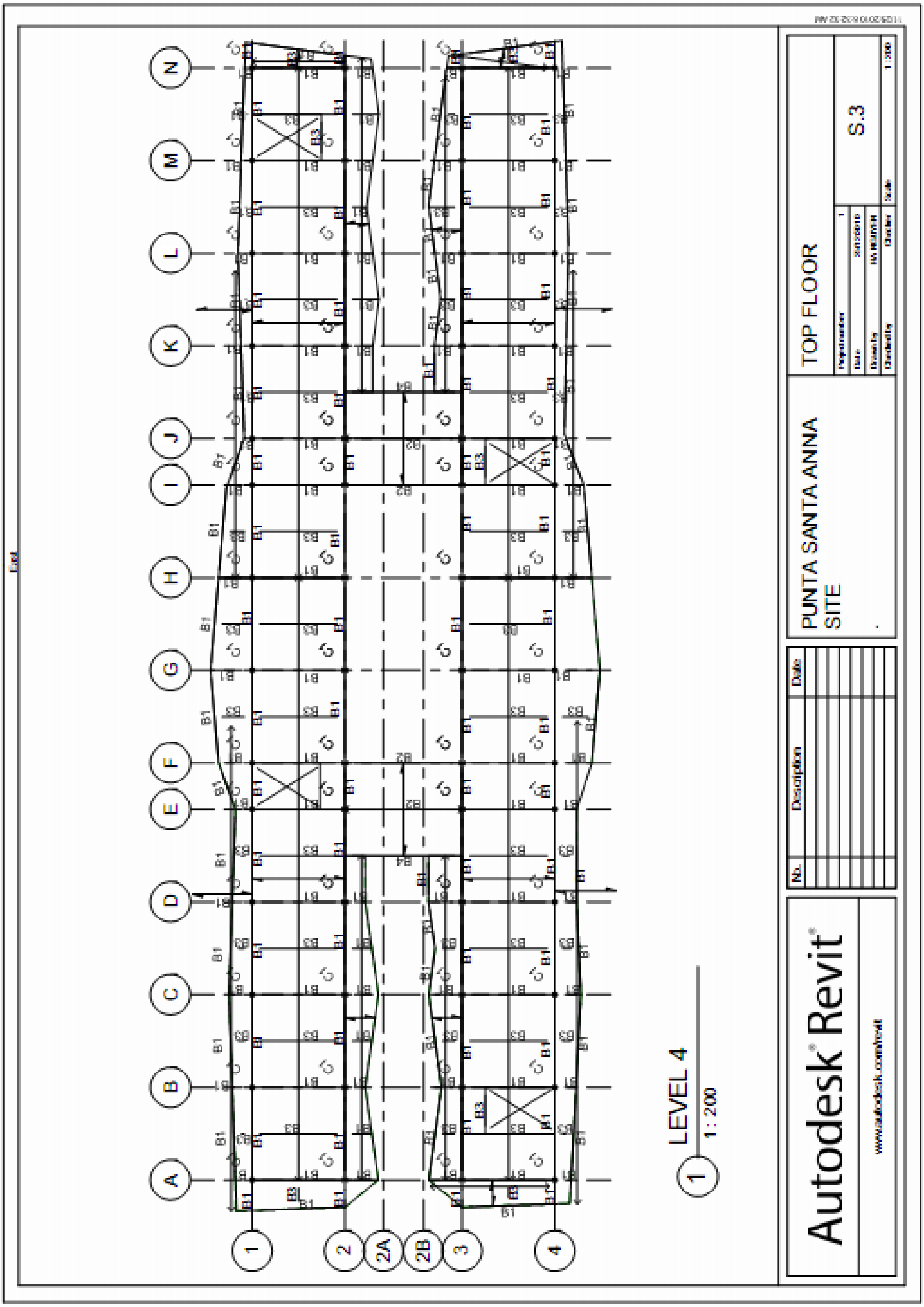
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1 : 200
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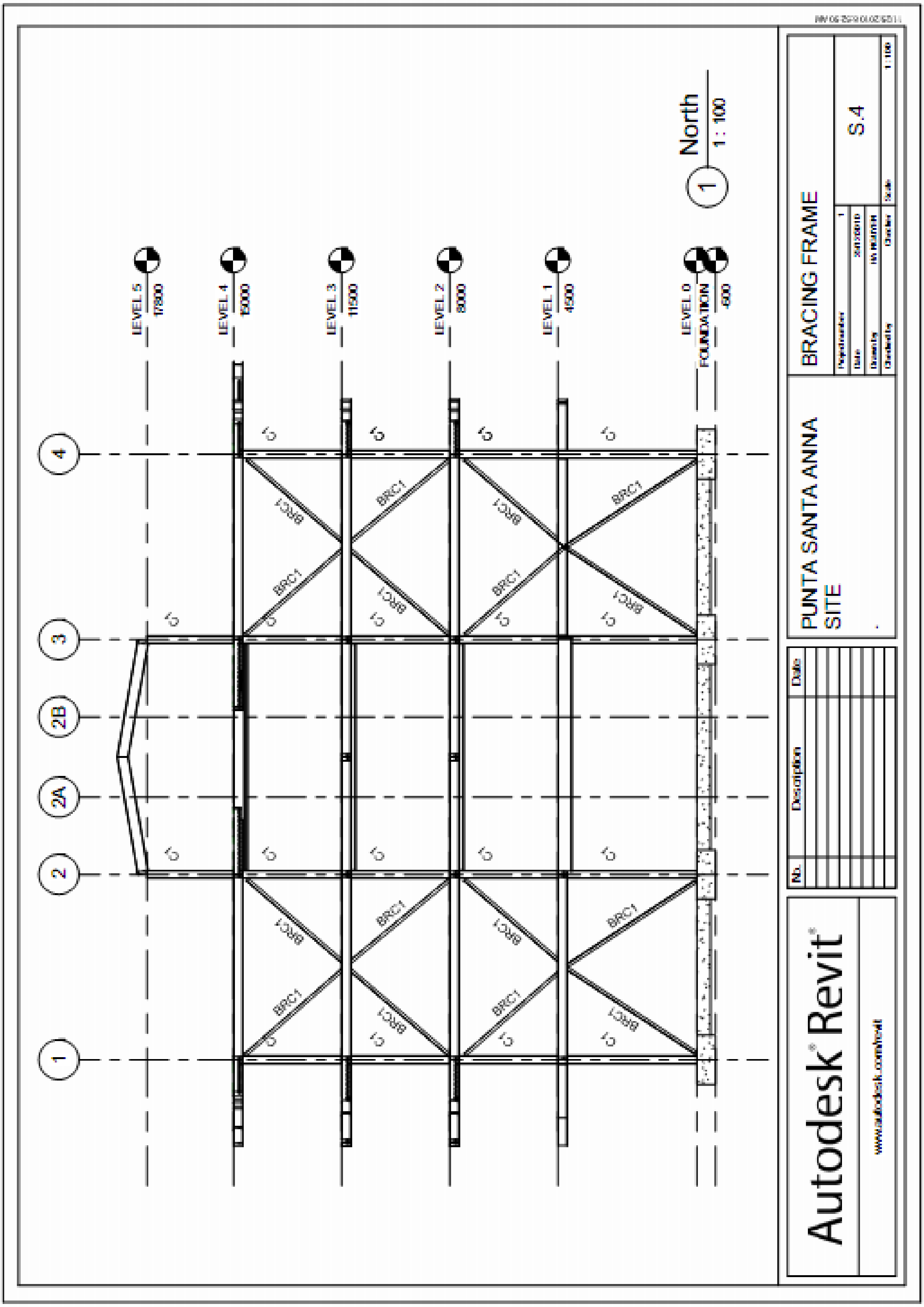
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2B
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LEVEL 5
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LEVEL 4
15000
LEVEL 3
11500
LEVEL 2
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LEVEL 1
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LEVEL 0
FOUNDATION
-600
BRC1
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BRACING FRAME
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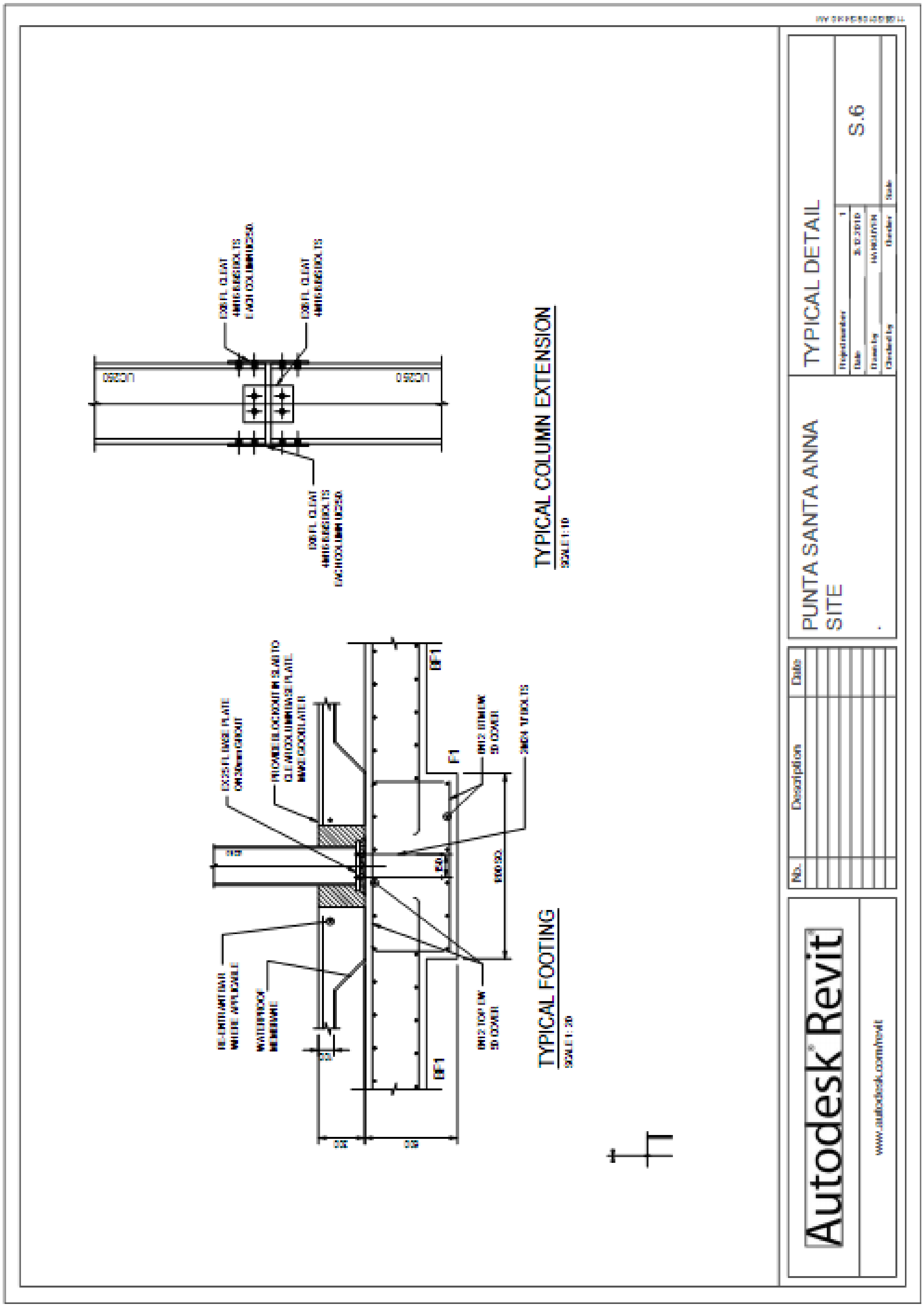
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TYPICAL FOOTING
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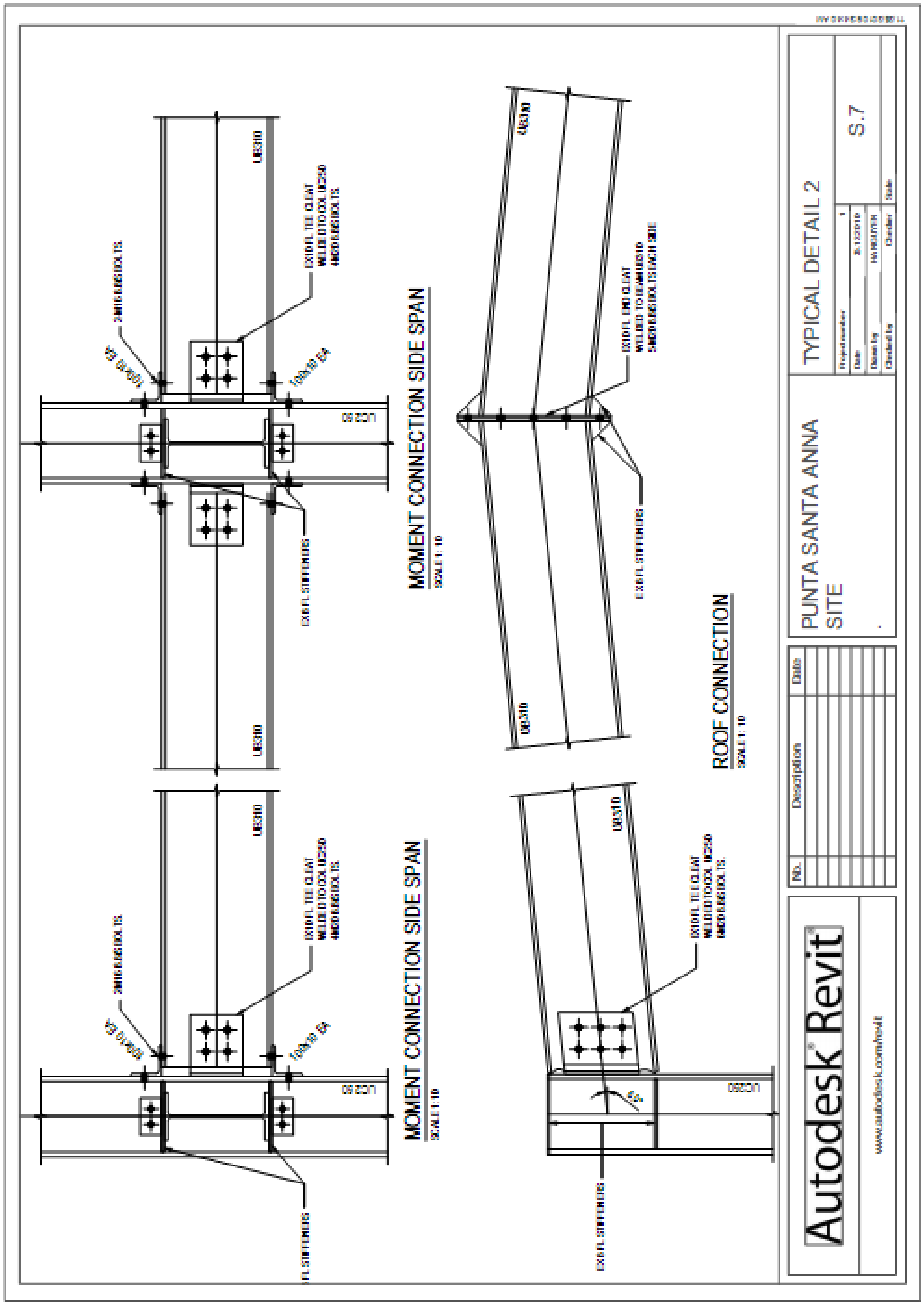
MOMENT CONNECTION SIDE SPAN
MOMENT CONNECTION SIDE SPAN
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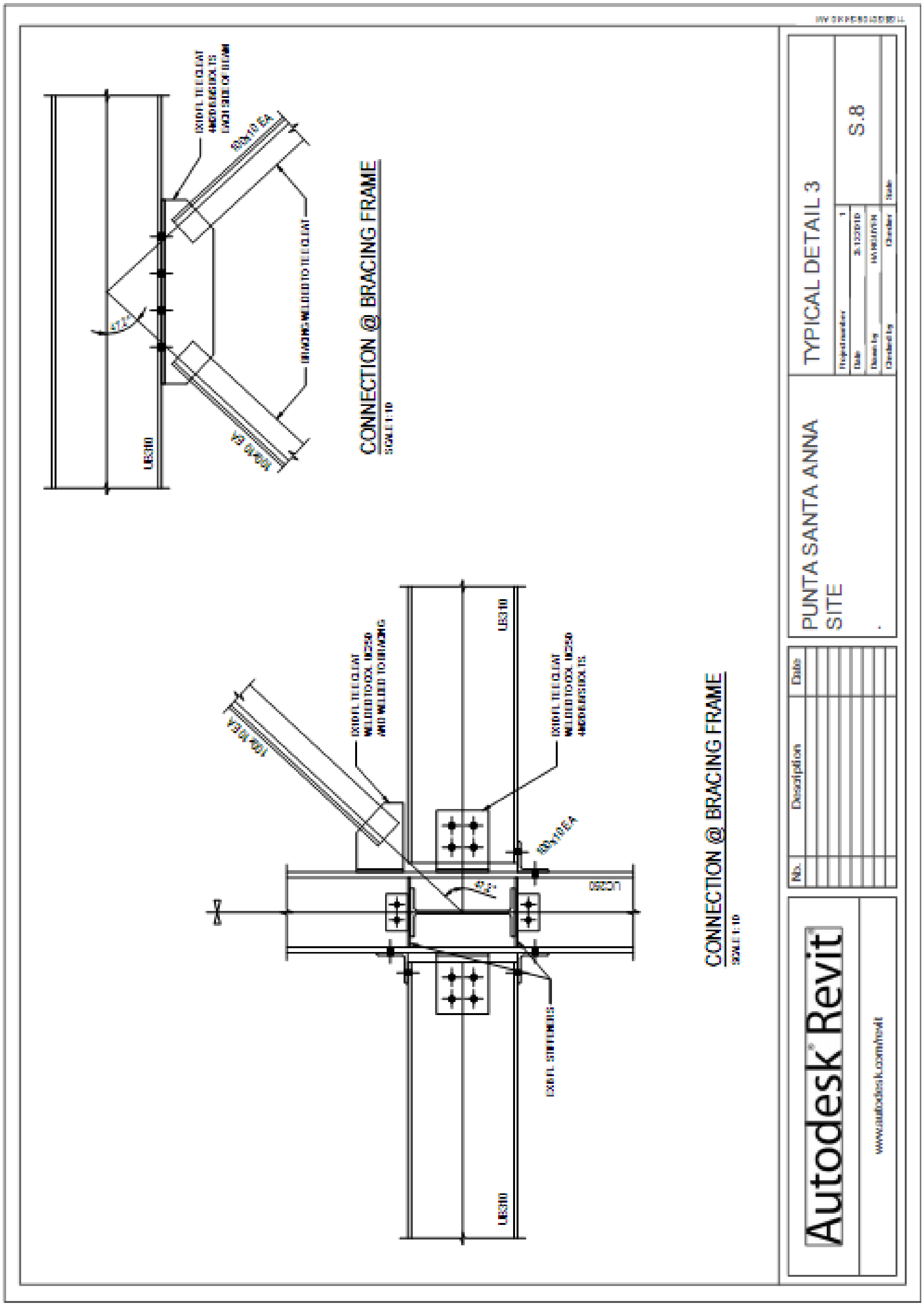
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CONNECTION @ BRACING FRAME
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5. **Fire Protection – Site apply solution**

Passive fire protection materials

Passive fire protection materials insulate steel structures from the effects of the high temperatures that may be generated in fire. They can be divided into two types, non-reactive, of which the most common types are boards and sprays, and reactive, of which intumescent coatings are the best example.

Method	Advantages	Disadvantage
Boards	*Appearance:* offer a clean, boxed appearance which may be pre-finished or suitable for further decoration. The specifier should be aware however that cheaper board systems are available where appearance is not important. *Fixing* - application is dry and may not have significant effects on other trades. *Quality assured* - boards are factory manufactured thus thicknesses can be guaranteed. Surface preparation - boards can be applied on unpainted steelwork.	*Cost* - a non-decorative board system can be relatively cheap however a decorative system can significantly increase costs. *Application* - fitting around complex details may be difficult. *Speed* - board systems may be slower to apply than some other methods.
Sprays	*Cost* - spray protection can usually be applied for less than the cost of the cheapest board. Because the cost of sprayed material is low compared to that of getting labour and equipment on site, costs do not increase in proportion to fire resistance times. *Application* - it is easy to cover complex	*Appearance* - sprays are not visually appealing and so are usually used only where they are not visible. *Overspraying* - masking or shielding of the application area is usually required on-site. *Application* - is a wet trade, this can have significant knock on effects on the

	details. *Durability* - some materials may be used externally. Surface preparation – some materials may be applied on unpainted steelwork.	construction program with the result that the real cost of spray protection may be significantly higher than that assumed using the application costs only.
Thin film intumescent coatings	*Aesthetics* - the thin coating allows the shape of the underlying steel to be expressed. *Finish* - attractive, decorative finishes are possible. *Application* - complex details are easily covered. *Servicing* - post-protection fixing is simplified.	*Cost* - typical application costs are higher than sprays and generally comparable with board systems. *Application* - is a wet trade which requires suitable atmosphere conditions during application and precautions against overspray. *Limited Fire Resistance Periods* - most intumescent coatings can provide 30 and 60 minutes fire resistance,or 90 and 120 minutes, however the cost increases considerably for periods over 60 minutes.
Flexible/Blanket systems	*Low Cost* - blanket systems are comparable with cheap boards. *Fixing* - application is dry and may not have significant effects on other trades.	*Appearance* - unlikely to be used where the steel is visible.
Concrete encasement and other traditional systems	*Durability* - these robust encasement methods tend to be used where resistance to impact damage, abrasion and weather exposure are important e.g. warehouses, underground car parks and external structures	*Cost* - concrete encasement is normally one of the most expensive forms of fire protection. *Speed* - time consuming on-site. *Space Utilization* - large protection thicknesses take up valuable space around columns. Weight - building weight can increase

		considerably.

Chapter 5: Technological Design

In this chapter we would like to present the
technological approaching sustainable outcomes, or
in other words, bio-e climate design.

I. VISION

Attaching to the final target of sustainable architecture, we have specified vision of this section in very detailed criteria such as material, energy consumed and supplied in the scale of local availability.

- For sustainable energy use

The 1st important thing is that maximize the efficiency of natural ventilation and lighting to reduce as much as possible the energy load and still guarantee the thermal and visual comfort for the occupants. Rather than that, we would like to make the best possible use of the natural resources and renewable energy generation such as solar energy, biomass.

- For renewable building material

Not only cost of building material for install and maintain is not the only point that we consider but also the availability, renewability and friendly to environment.

II. PHYSICS AND ENVIRONEMNT

Manila climate is catalogued as tropical hot and humid .The range of temperature is quite small, rarely going lower than 20 °C and going higher than 38 °C. However, humidity levels are usually very high which makes it feel much warmer In general, there are two distinct seasons: dry season from January to April, wet season from May to December. These charts below give us the detail summary of meteorology information of the whole year.

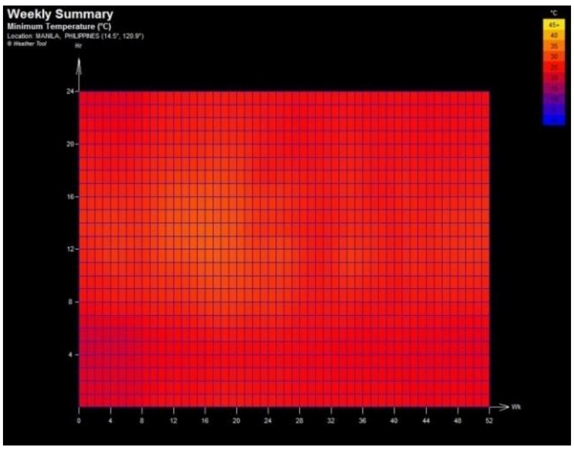


Figure1. Minimum Temperature.

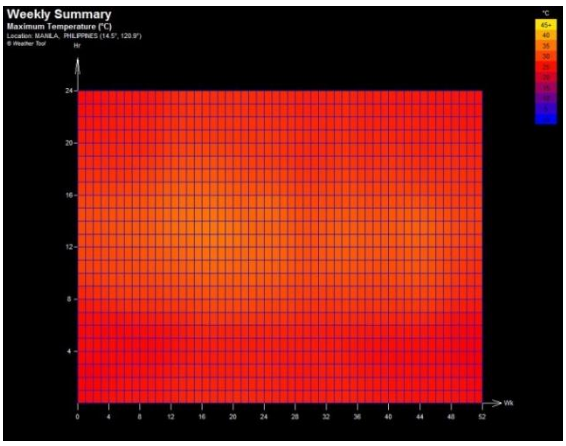


Figure2. Maximum Temperature.

Figure 1, 2, 3 & 4 show the graphs of the minimum, maximum, average temperature and relative humidity of Manila respectively on a weekly basis. The horizontal axis is presenting the time lines with 52 weeks that make up a year. The vertical axis is the hour axis that device into 24 which shows the number of hours each day.

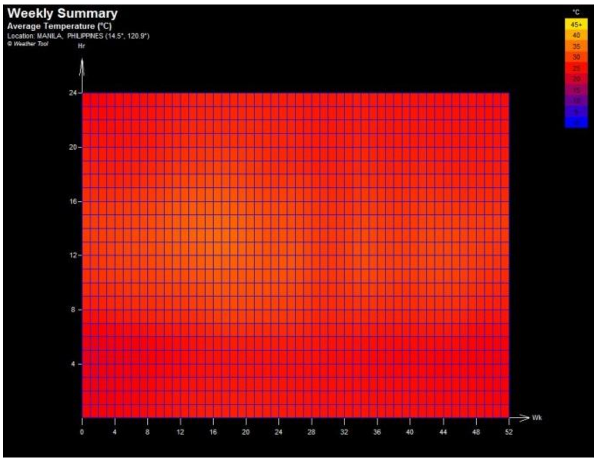


Figure3. Average Temperature

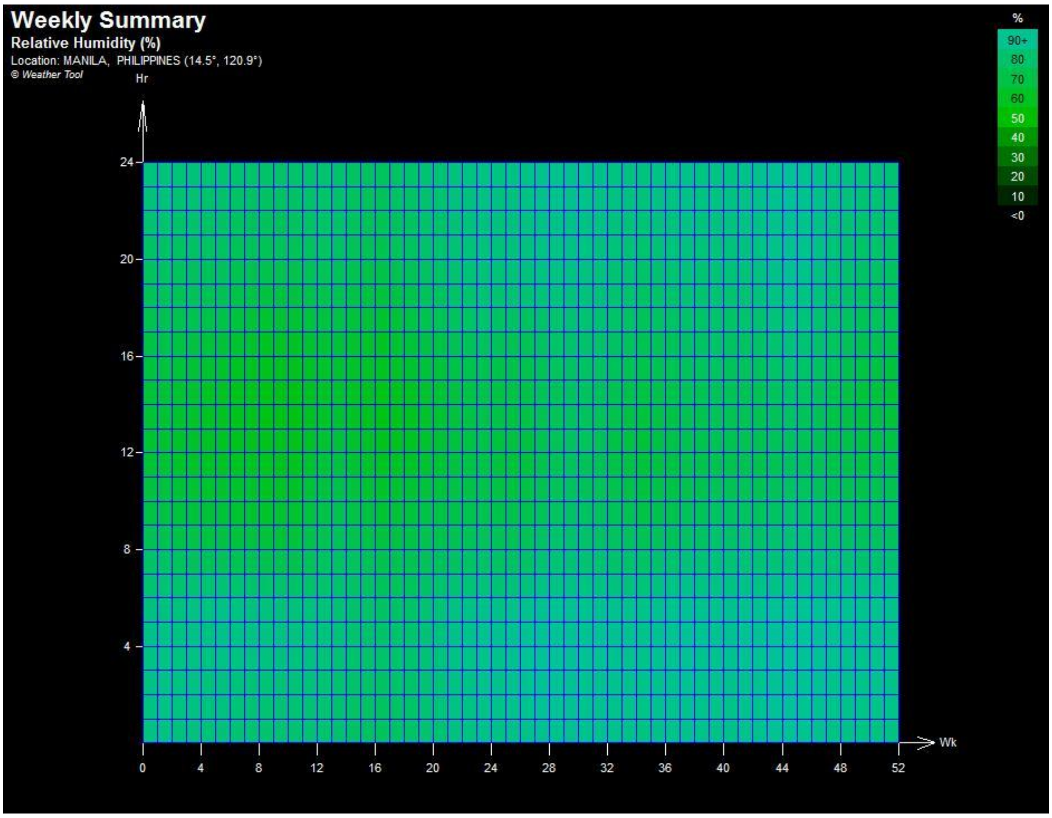
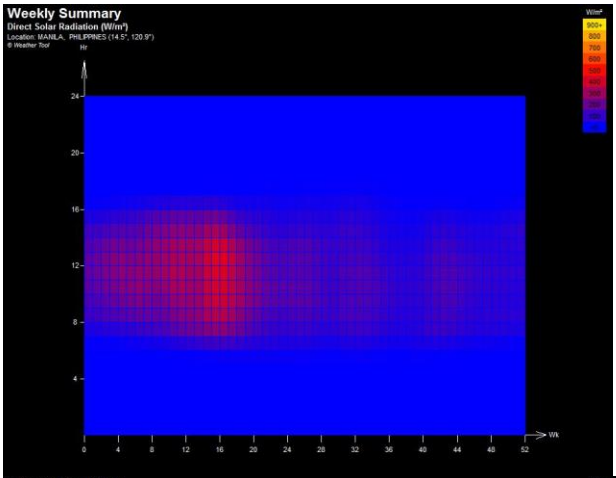


Figure4. Relative Humidity

The temperature is highest between the 12th week and 22nd week; April, May and June, during the hours 10 am to 14 pm. The relative humidity also is always high, range from 60 to 80% but during the day.

The high temperature and relative humidity would bring us a serious challenge in design to satisfy the thermal comfort for the building and control the energy load.



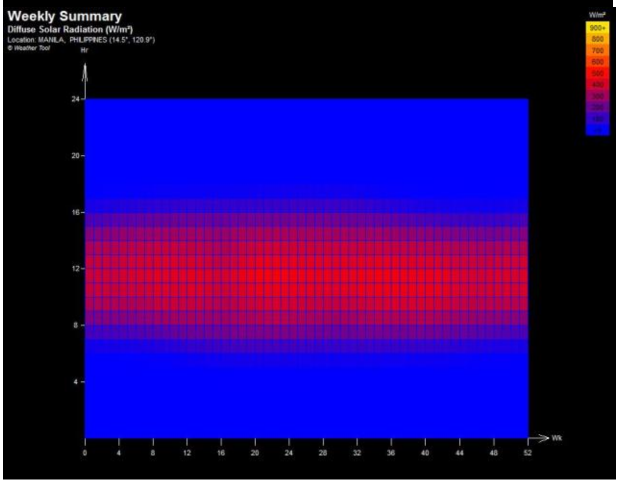
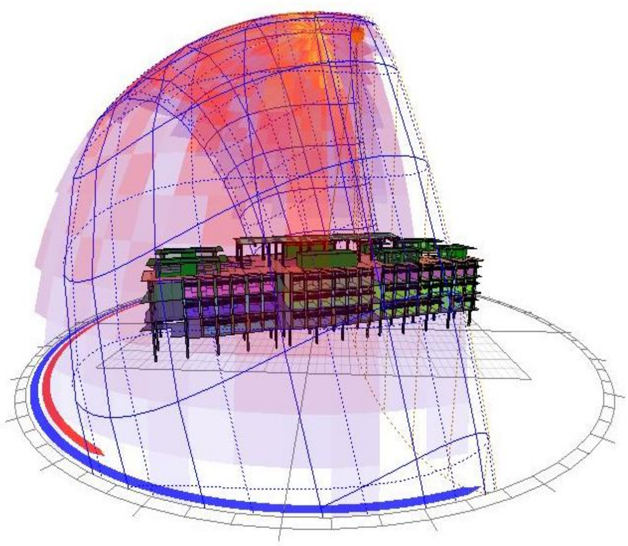


Figure5. Direct Solar Radiation

Figure6. Diffuse Solar Radiation



On another hand, the solar radiation analysis pointed out a huge potential of the sun here. Figure 5 and 6 shows weekly basis of the direct and diffuse solar radiations, respectively. Both direct and diffuse solar radiation amounts are in the range of 400-500 W/m2. Direct solar radiation is observed during the months of April and May. This particular condition of Manila gives us the opportunity to make used of the radiation towards day lighting, and also as the renewable energy to provide for the community.

Figure7. Solar Stress at 21st of June

Figure7 shows the average instantaneous solar radiation, which is the averaged value of direct and diffuse solar radiation, over the sky dome on the 21st of June at noon time with daily and annual Sun path. The yellow areas show the high radiation zones, while blue areas show the low radiation zones.

Figure 8, 9 perform all the data about the temperature, relative humidity, wind speed, direct solar on the hottest (2nd January) and coldest (28th June).

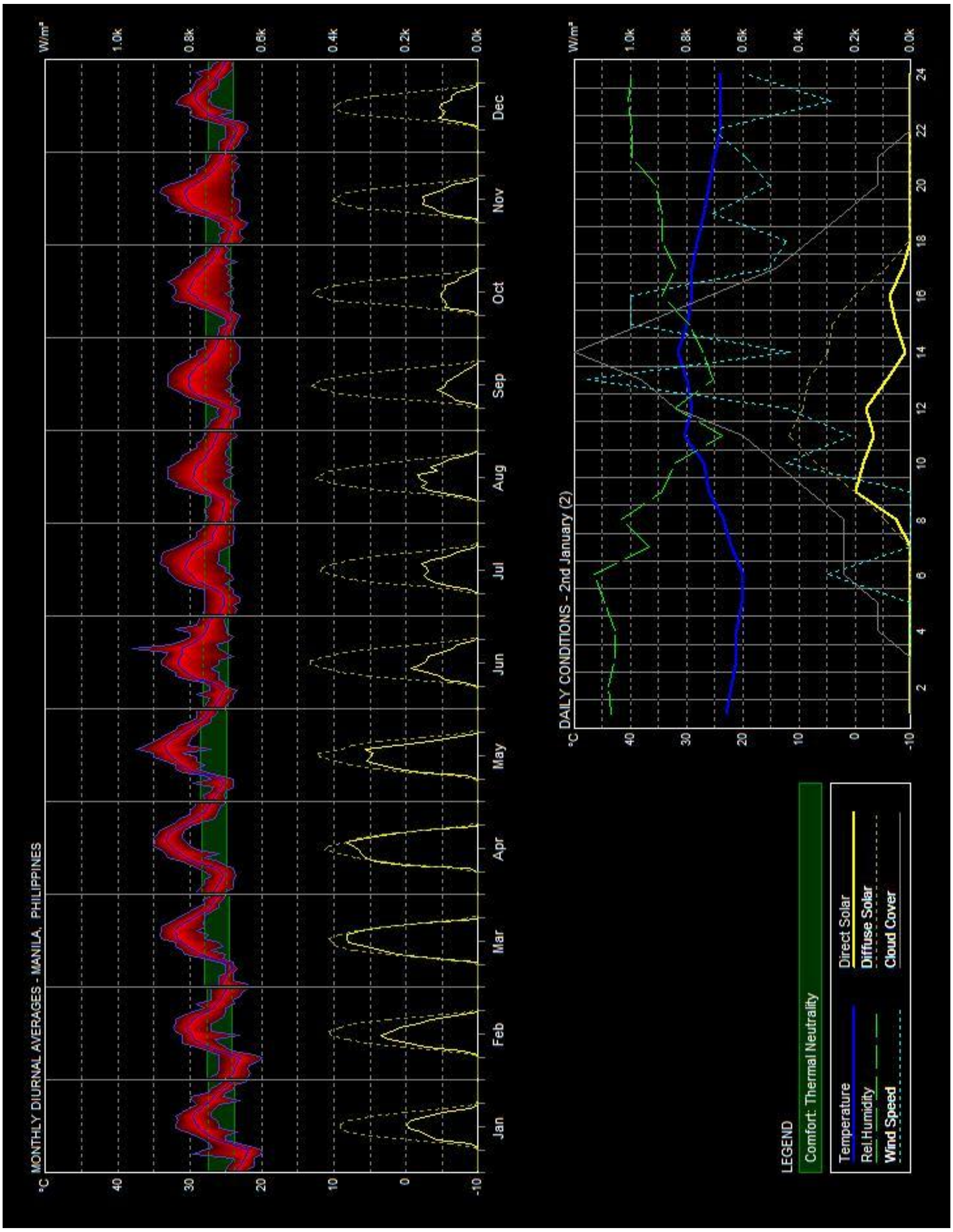


Figure 8: Coldest Day Conditions

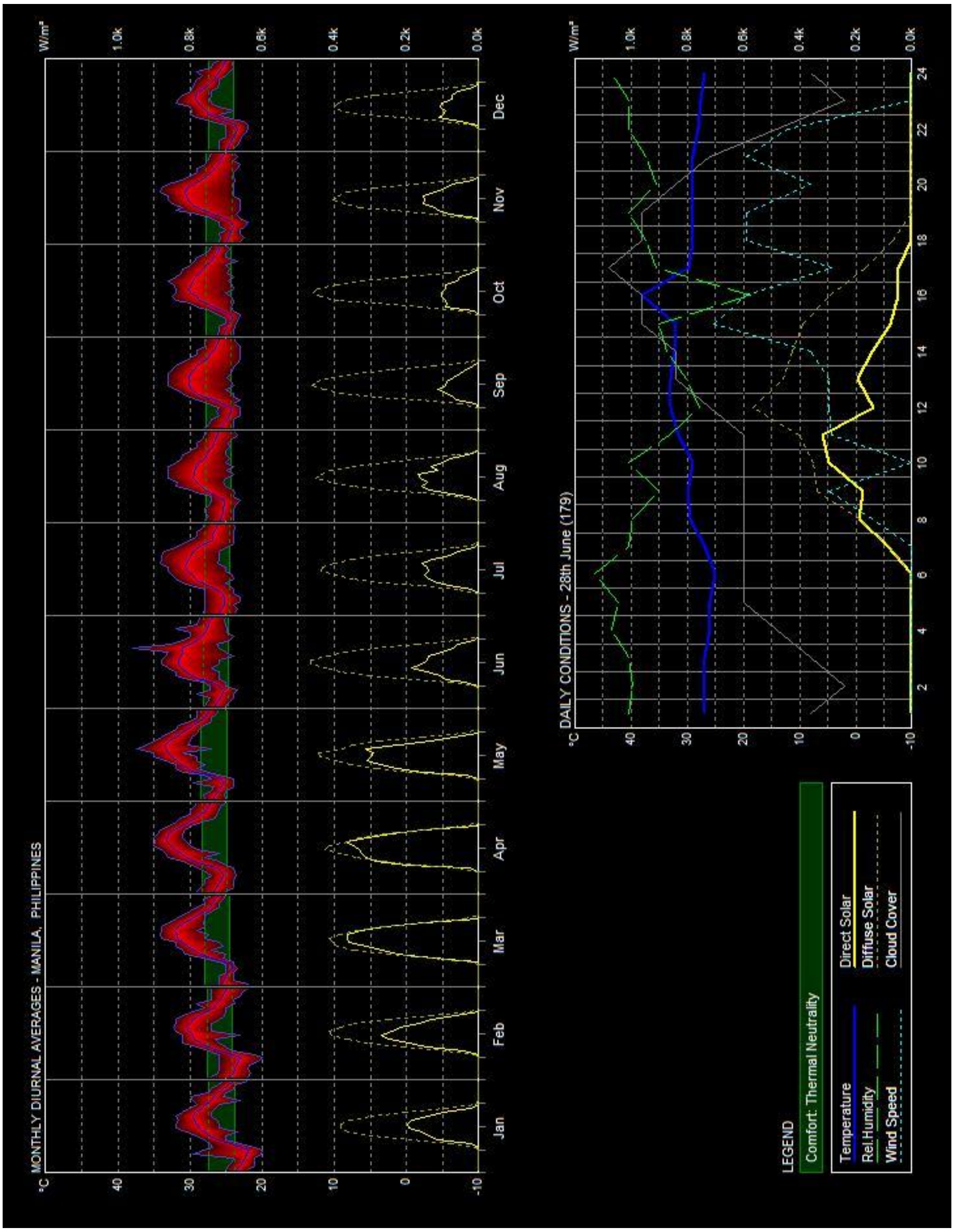


Figure 9: Hottest Day Conditions

The psychometric chart provides full state of the air under any condition. This includes dry-bulb and wet-bulb temperatures, relative and absolute humidity, vapor pressure, air volume.

From the comfort zone, we can recognize that most of the climate data of Manila is out far of that comfort zone.

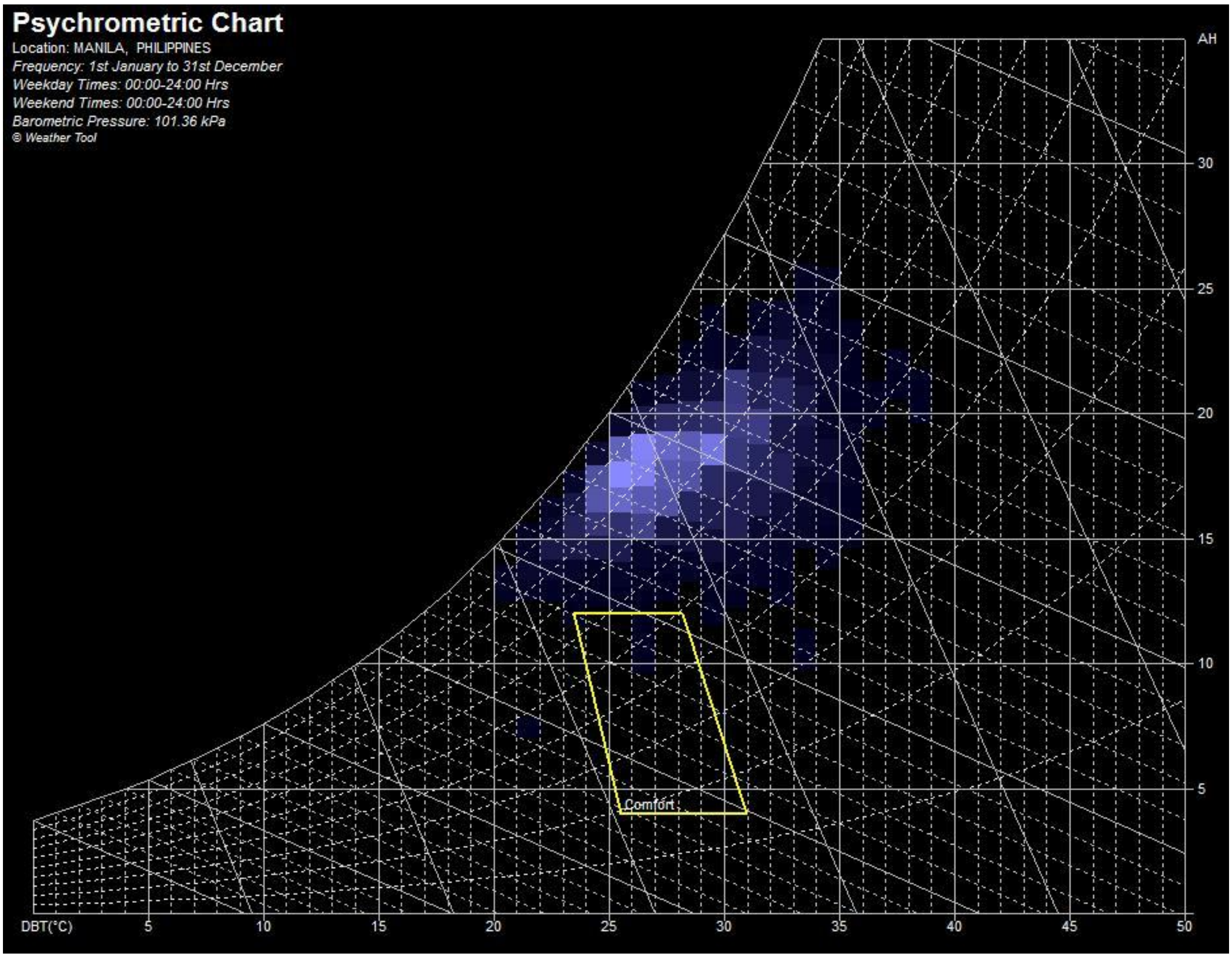


Figure 11: Psychometric Chart

III. PROJECT DESIGN

In this scale of design, we have researched on the energy, building material which can apply on our project.

a. Energy

Fuels such as coal, oil, and natural gas are non-renewable. Once a deposit of these fuels is depleted it cannot be replenished – a replacement deposit must be found instead. In contrast, renewable energy sources are energy sources that are continually replenished. These include energy from water, wind, the sun, geothermal sources, and biomass.

With the aid of advance computerized mapping system (ACMS) conducted by the United States National Renewable Energy Laboratory (NREL), which simultaneously identified the potential areas for wind resource generation as well as those areas with solar energy potential. Since average sunlight hours in Manila range between 4.3 hours per day in July & August and 8.6 hours per day in April, the potential to make use of this source is undeniable, as shown on the map , the energy received from the sun is about 3.6 kWh/m^2.

And to depress the swing of energy demand during the day, solar energy for cooling purposed could make a significant contribution to lowering the energy consumption.

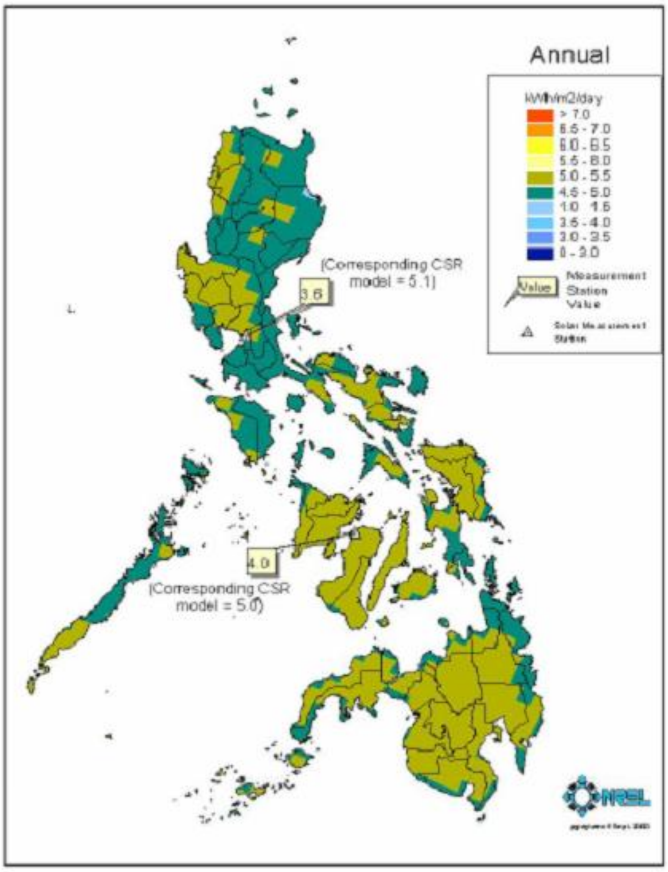


Figure1. Potential solar energy site

b. Building material

a. Straw panels

After researching carefully, we have selected straw panel to be the main material applied for the project because of its local availability, renewable and good performance in thermal and sound insulation.

The straw panels are made of straw, the agriculture incidental product, and it has very impressive performance in building component after a simple process of treatment.

A solid core of compressed wheat or rice straw is made up the panel. High pressure and temperatures forces the straw to release a natural resin that binds the fiber together. The compressed panels are sandwiched by the oriented strand boards and Styrofoam.

Strawboard panels are the structural insulated panels for interior exterior walls as well as flooring solution, which are very well-insulated, low thermal mass and tight. Thermal resistance of this material is R=0.72m2kW and the density is bout 150kg/m^3.

To withstand with the high humidity and biological attack, additional fire resistance, the boron compound polybor can be factory added to the core.

The workability of straw panel is as good as wood, it can be sawn, drilled, routed, nailed, screwed, and glued.

Since, the Philippines is primarily an agriculture country and the country's main agricultural crops are included rice, corn, wheat with high productivity, so straw can be became available annually. This material could be employ into exterior and partition walls.

b. Bamboo

Bamboo is one of the oldest construction materials, it appeared since ancient housing in the regions in which it grows in abundance like Asia, India, special in South East Asia…It has strength, flexibility and versatility and therefore it is a suitable material for practically every part of the house of the house when treated and used properly.

It's very economical it's local product since and it can be used to substitute for timber in many applications and compared to the wood plant, bamboo grows substantially faster, just 3-4 months to reach the full high and girth.

IV. TECHNOLOGICAL DESIGN

4.1 PRELIMINARY INSULATION ANALYSIS

Understand the useful of energy analysis program ECOTECT in passive design; we deploy the application into calculating the insulation behavior of the building from the preliminary phase of design. Since the volume and shape of the architecture established, we insert them in the ECOTECT and look at the behavior of each façade under real climate of the site. In this phase, we use the insulation analysis radiation analysis since incident solar radiation is one of the biggest sources of heat gain for the building.

We have run the insulation analysis to calculate the cumulative incident solar radiation during the hottest three months which are April, May, and June.

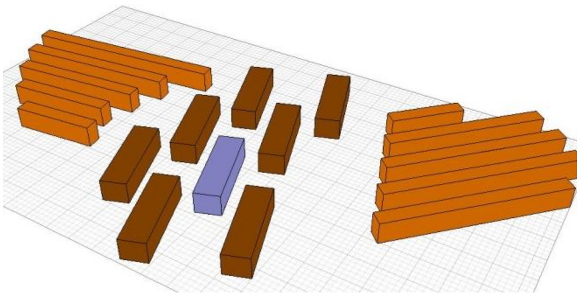


Figure 17: Envelope of proposed building

After the insulation analysis for the model, we have seen that the North and South facades are exposed to high amount of insulation when compared with the East and West facades. So we have decided to not insert any windows at North and South facades.

After changing the openings on the façade, we make the analysis again to compare and evaluate if the solution is really effective. Figure 18 shows the insulation analysis on each façade at Level 1. Yellow areas represent the high amount of insulation while blue areas represent the low amount of insulation.

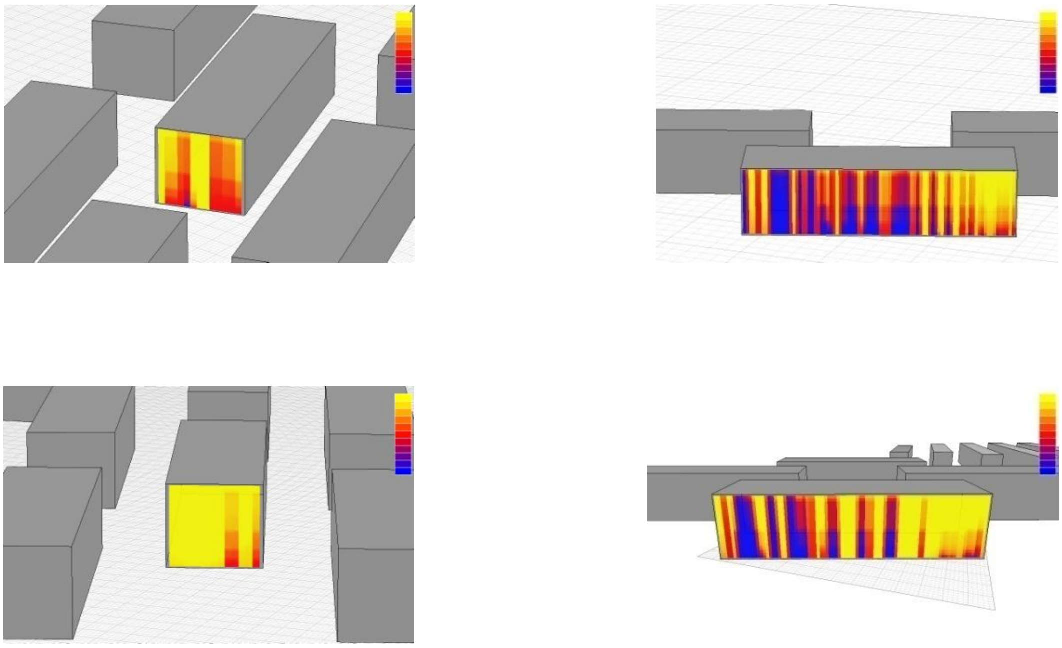


Figure 18: Insulation Analysis on North, West, South and East Facades in 1st case

Figure 21: Proposed Building model for modified case

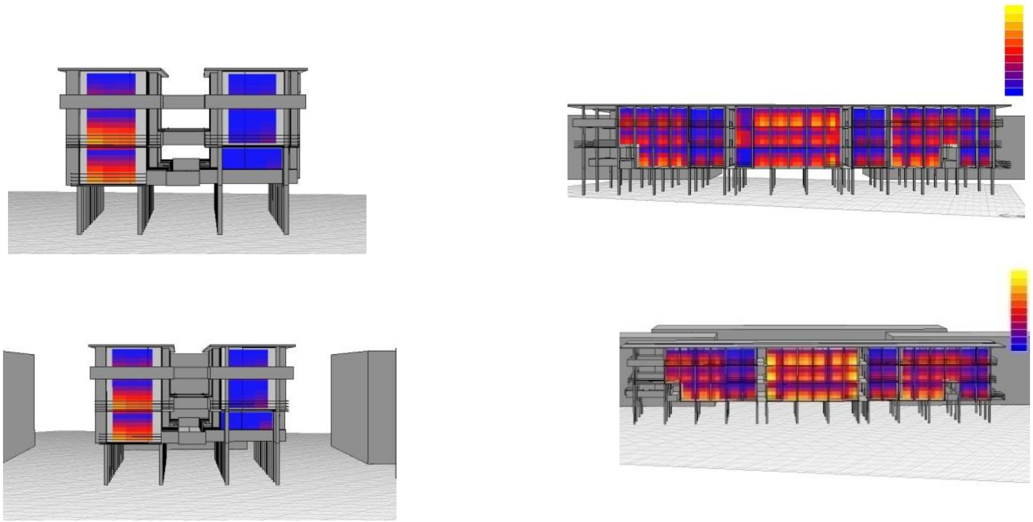


Figure 20: Insulation Analysis on North, West, South and East Facades

From the dedication of color, we can easily conclude the change we have made in the façade significantly effective in term of energy for the building. From this analysis, we've come up with the final floor plans.

4.2 DETAIL DESIGN

Due to the architecture design, the West façade is opened to outside through the glass façade. This solution is perfectly making use of day lighting during the day time but it also cause the problem of heat gain through glass. To balance the advantage and disadvantage the movable shading systems and a light shelves were supplied. The movable screen is made of bamboo which can rotate horizontally 90˚.The effectiveness of this systems will be further discussed in the day lighting section. In this section, we would like to evaluate its thermal insulation characteristic.

4.2.1 Shading devices design based on cooling load

Since the heat gain was reflected through the cooling load, we counted on this measurement to compare the shading façade solutions.

2 case studies were carried out. Case 1 is the glazing façade and case 2 is the glazing façade in tandem with bamboo shading façade was closed.

4.2.1.1 CASE 1: Glazing facade

The cooling load analysis is run for the experimental room between the hours of 8 am to 17 pm for Case 1. Maximum amount of cooling is 6500 W on 22nd of April. The annual cooling load is about 1738 KWH. The details of the cooling load for Case 1 are shown in Table 3.

Figure 23 shows the monthly cooling load distribution for Case 1. As it can be seen from Figure 23, May is the month which requires maximum amount of cooling load. April and June are the months that follow May for the requirement of high cooling loads.

Figure 24 shows the distribution of daylight in the experimental room for Case 1.

MONTHLY HEATING/COOLING LOADS

Zone: 3 MIDDLE EAST
Operation: Weekdays 08-17, Weekends 08-17.
Thermostat Settings: 24.0 - 31.0 C

Max Heating: 0.0 C - No Heating.
Max Cooling: 6500 W at 09:00 on 22nd April

MONTH	HEATING (Wh)	COOLING (Wh)	TOTAL (Wh)
Jan	0	0	0
Feb	0	0	0
Mar	0	108248	108248
Apr	0	445026	445026
May	0	616507	616507
Jun	0	307533	307533
Jul	0	145992	145992
Aug	0	39739	39739
Sep	0	44605	44605
Oct	0	0	0
Nov	0	29896	29896
Dec	0	0	0
TOTAL	0	1737545	1737545--
PER M²	0	16370	16370
Floor Area:	106.140 m2		

Table 3: Monthly Cooling Loads in Case 1

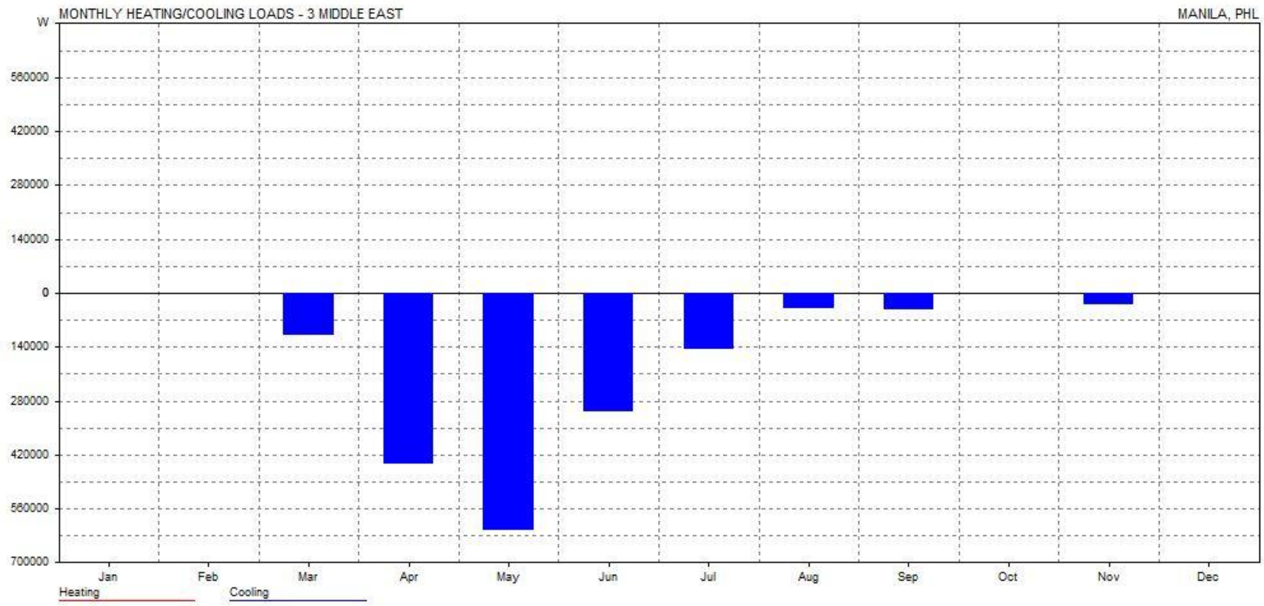


Figure 23: Monthly Cooing Load Distribution for the room in Case 1

4.2.1.2 CASE 2: Glazing facades with shading devices

In Case 2, maximum amount of cooling is 6262 W on 22nd of April. The annual cooling load is about 1404 KWH. The details of the cooling load for case 2 are shown in Table 4.

Figure 25 shows the monthly cooling load distribution for case 2. As it can be seen from Figure 25, May is the month which requires maximum amount of cooling load. April and June are the months that follow May for the requirement of cooling loads.

Figure 26 shows the distribution of daylight in the experimental room for Case 2.

MONTHLY HEATING/COOLING LOADS

Zone: 3 MIDDLE EAST
Operation: Weekdays 08-17, Weekends 08-17.
Thermostat Settings: 24.0 - 31.0 C

Max Heating: 0.0 C - No Heating.
Max Cooling: 6262 W at 09:00 on 22nd April

MONTH	HEATING (Wh)	COOLING (Wh)	TOTAL (Wh)
Jan	0	0	0
Feb	0	0	0
Mar	0	57486	57486
Apr	0	378684	378684
May	0	542532	542532
Jun	0	251528	251528
Jul	0	113056	113056
Aug	0	24148	24148
Sep	0	26005	26005
Oct	0	0	0
Nov	0	10852	10852
Dec	0	0	0
TOTAL	0	1404291	1404291
PER M²	0	13231	13231

Table 4: Monthly Cooling Loads in Case 2

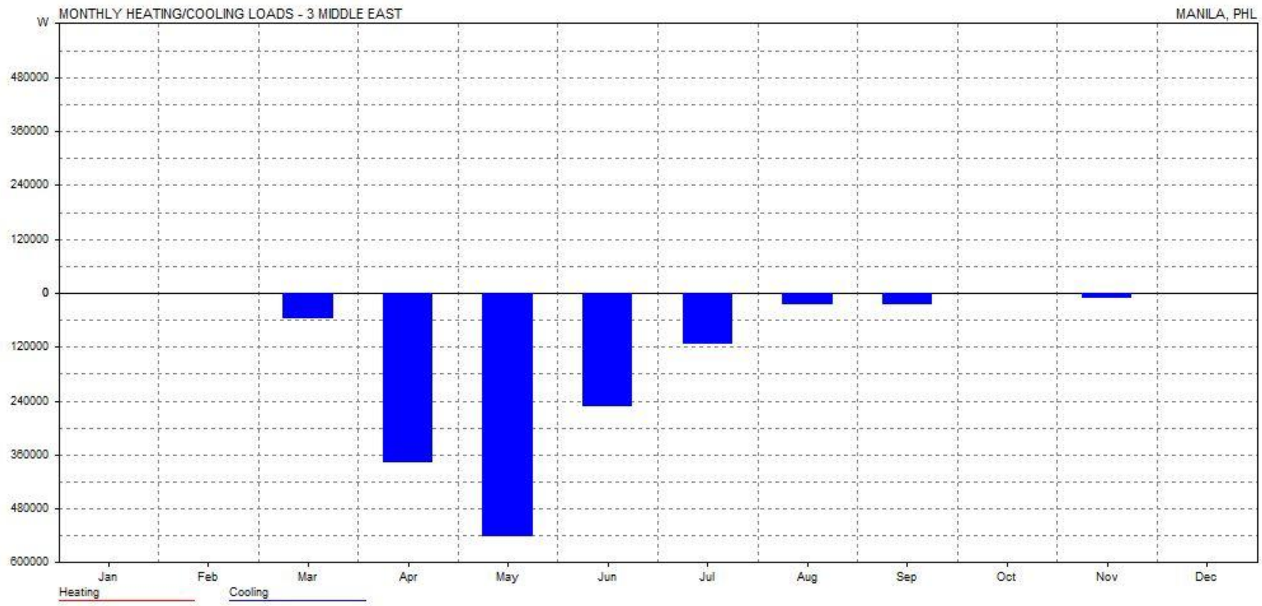
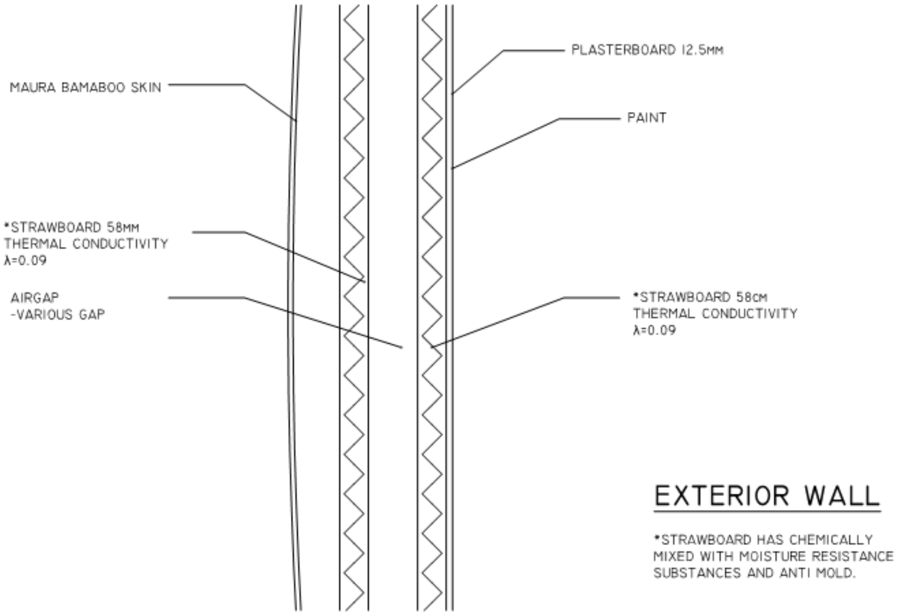


Figure 25: Monthly Cooing Load Distribution for the room in Case 2

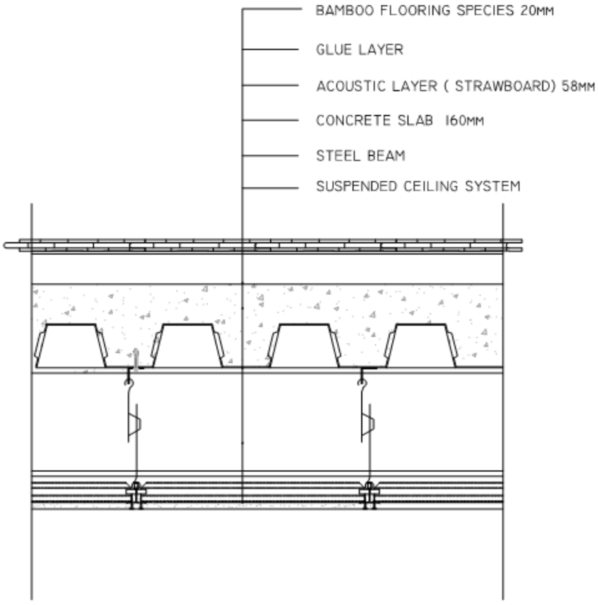
4.2.2 Layer Composition

U-values is the measure of the rate of heat loss through a material, depended on the thermal conductivity and thickness of material layers:. The smaller U value, the better for thermal insulation

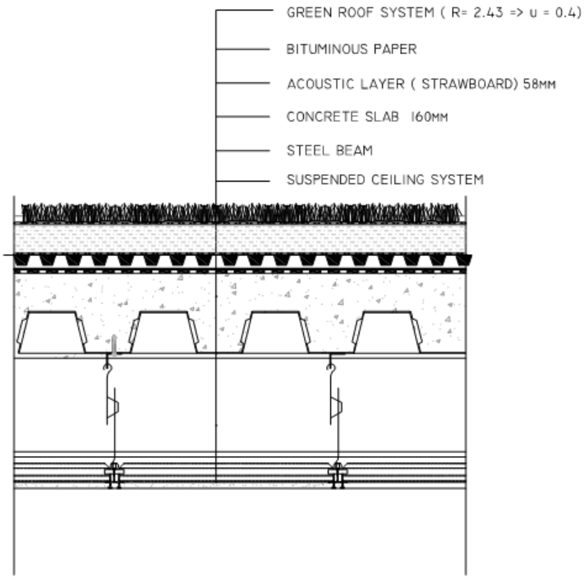
U = 1/ $\sum_{n=1}^{\infty}$ Ri



Exterior wall : U= 0.54 W/m2K



TYPICAL FLOOR



GREEN ROOF

Floor U = 0.77 W/m2K

Green roof U = 0.36 W/m2K

4.2.3 VENTILATION ANALYSIS

As a matter of fact, ventilating cooling may be accomplished by either natural means or mechanical means. However, natural ventilation has the potential to significantly reduce the energy required for mechanical ventilation of the building. In the design, we have applied two fundamental approaches to natural ventilation:

- Wind driven cross ventilation.

Wind-driven cross ventilation occurs via ventilation openings on opposite sides of an enclosed space. A significant difference in wind pressure between the inlet and outlet openings and a minimal internal resistance to flow are required to have the ventilation flow.

- Buoyancy –driven stack ventilation.

Buoyancy –driven stack ventilation replies on density differences to draw cool, outdoor air in at low ventilation openings and exhaust warm, indoor at higher ventilation openings. A atrium roof is used to generate buoyancy forces or wind affect to achieve the flow in this stack ventilation.

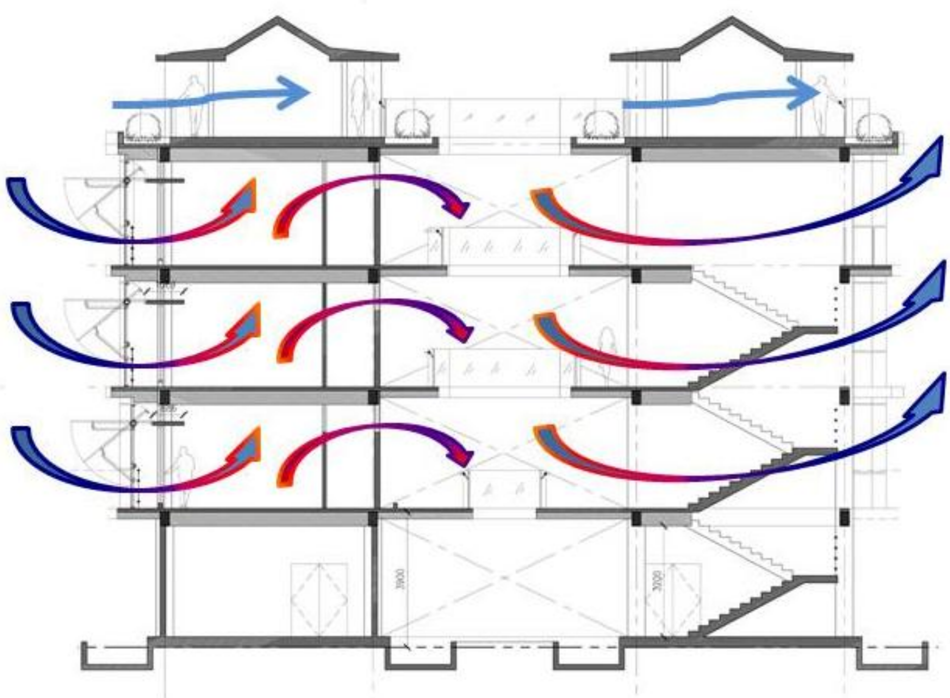


Figure1.Wind driven cross ventilation

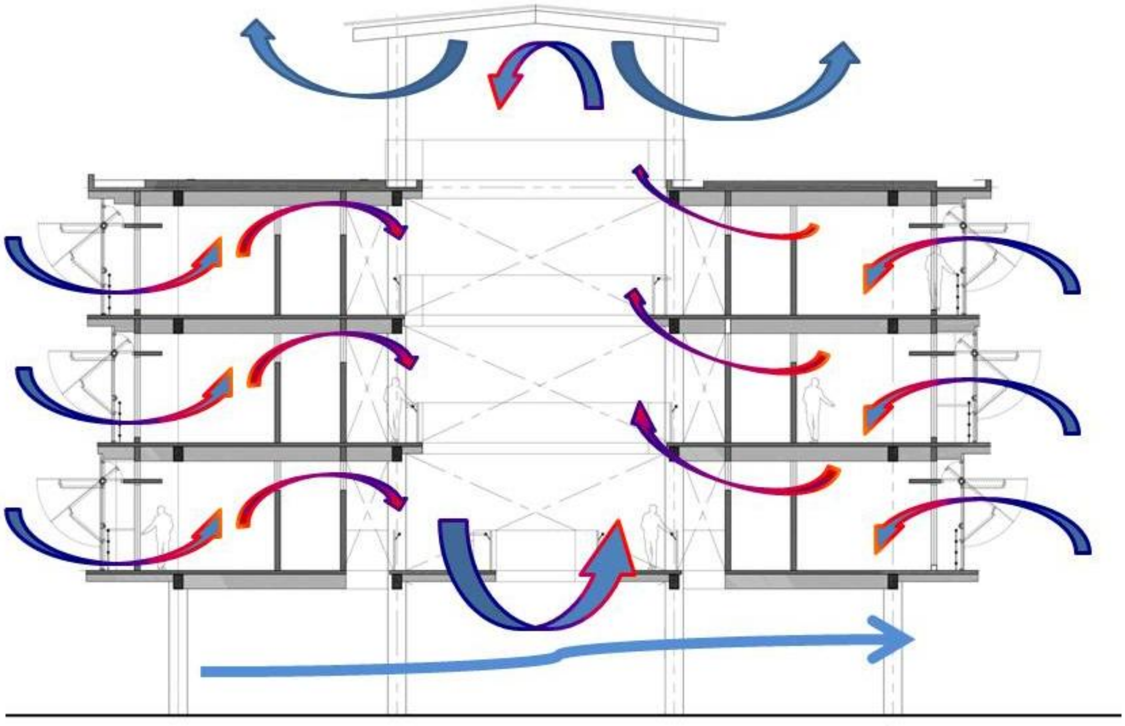


Figure2. Buoyancy –driven stack ventilation

4.2.4 SHADOW ANALYSIS

The shadow analysis are done on 21st of December which is the winter solstice. For the shadow analysis the 21st of December is selected intentionally. Because on the north hemisphere, sun rays are directed in the lowest angle which causes largest shadow range. In Manila, on that day sun rises at about 6.30 am and sets at about 17.30 pm. Hence the time range is selected between the 7 am and 17 pm. Figure 27 shows the shadow range between 7 am and 17 pm on the 21st of December. Figure 28 shows the shadows from 7 am to 17 pm on the proposed building hour by hour. As it can be seen from the figures, there is not an overshadowing situation on the proposed building.

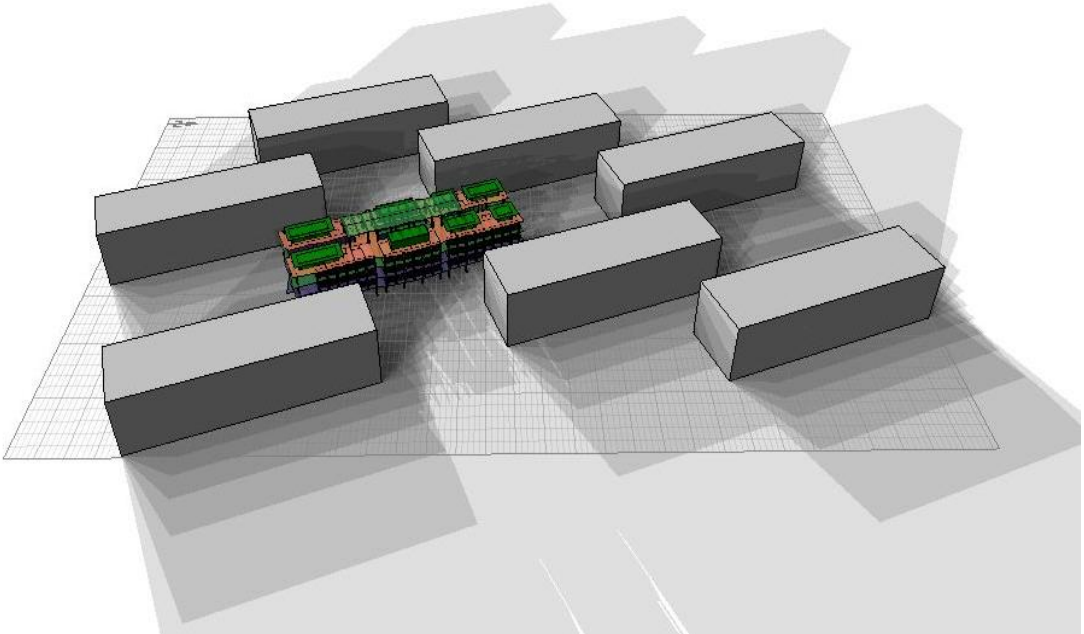


Figure 27: Shadow Range of proposed building on the 21st of December

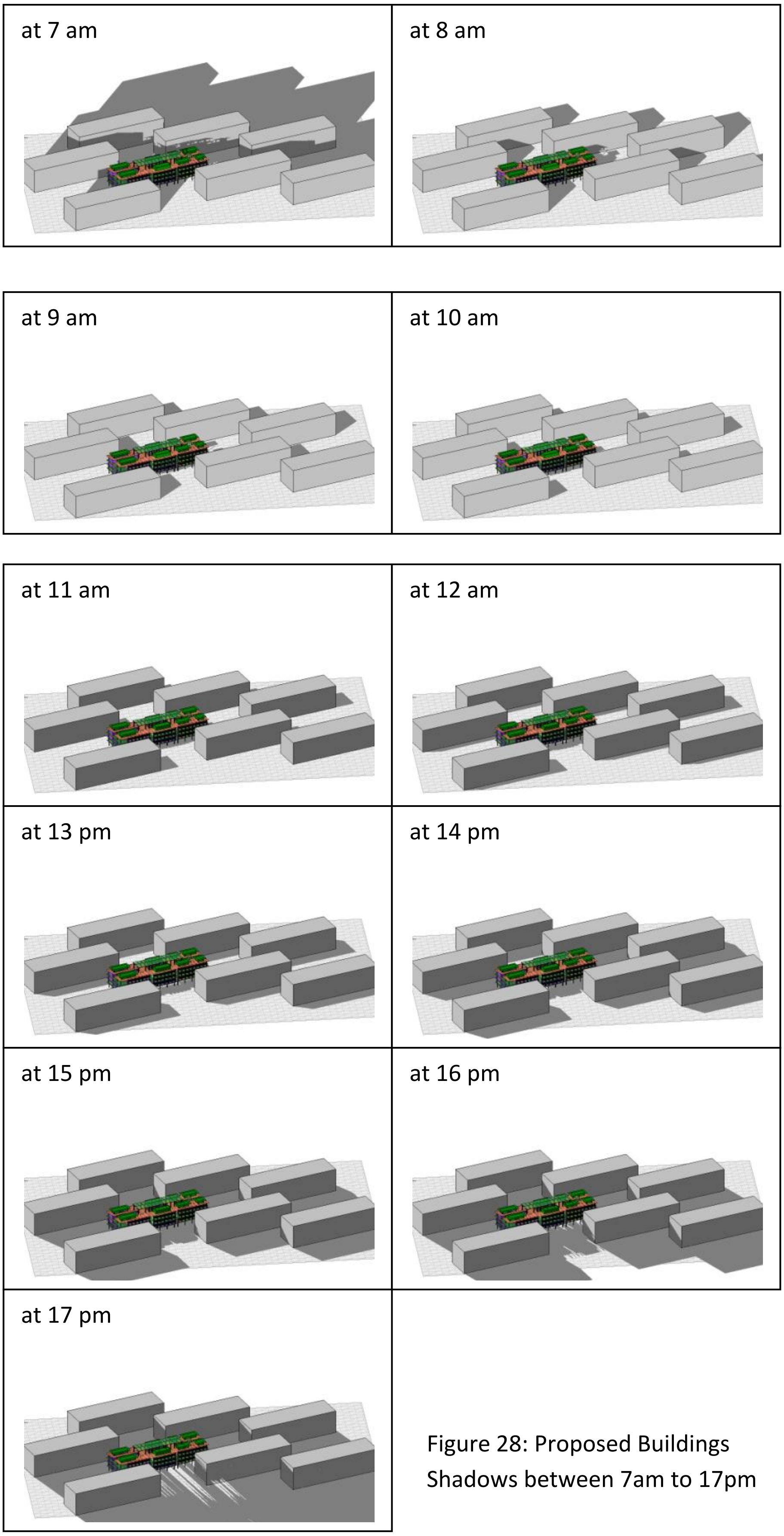


Figure 28: Proposed Buildings Shadows between 7am to 17pm

4.2.5 VISUAL COMFORT

One of our purposes is to provide visual comfort without utilizing the artificial lighting during the day time. To achieve this purpose large-scale windows are designed by maximizing the natural daylight. The proposed building is modeled in Ecotect to calculate the daylight factor.

The Building Research Establishment (BRE) Split- Flux Method is a widely useful technique for calculating daylight factors. In BRE Method, there are 3 components of if natural light which are sky component, externally reflected component and internally reflected component. The definitions of these components are as follows:

Sky Component (SC): Directly from the sky, through an opening such as a window,

Externally Reflected Component (ERC): Reflected off the ground, trees or other buildings,

Internally Reflected Component (IRC): The inter-reflection of sky component and externally reflected component off surfaces within the room

The daylight factor is the sum of sky component, externally reflected component and internally reflected component [3].

$$DF (\%) = SC + ERC + IRC$$

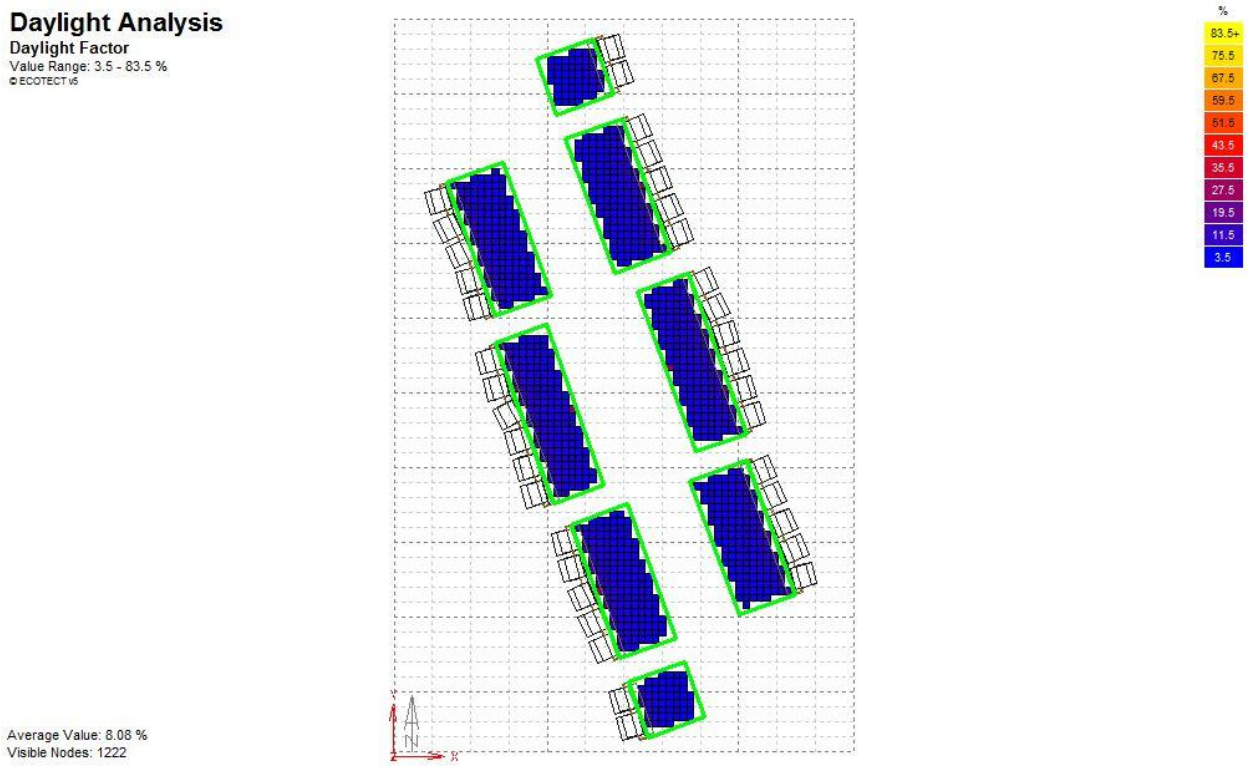
The daylight factor of each floor is calculated separately in the software ECOTECT. The plane of daylight is shifted 700mm above the plane of each floor which is the average height of a work surface. The results of these analyses are shown in Figure 29. The daylight factors of all rooms are higher than 6% which means that rooms have strong daylight. In the colored scale while yellow zones mean high daylight, the blue zones mean need of artificial light. It is easily seen from the Figure 29 that, visual comforts of the rooms are satisfactory and there are no need to utilize artificial lighting during the day time.

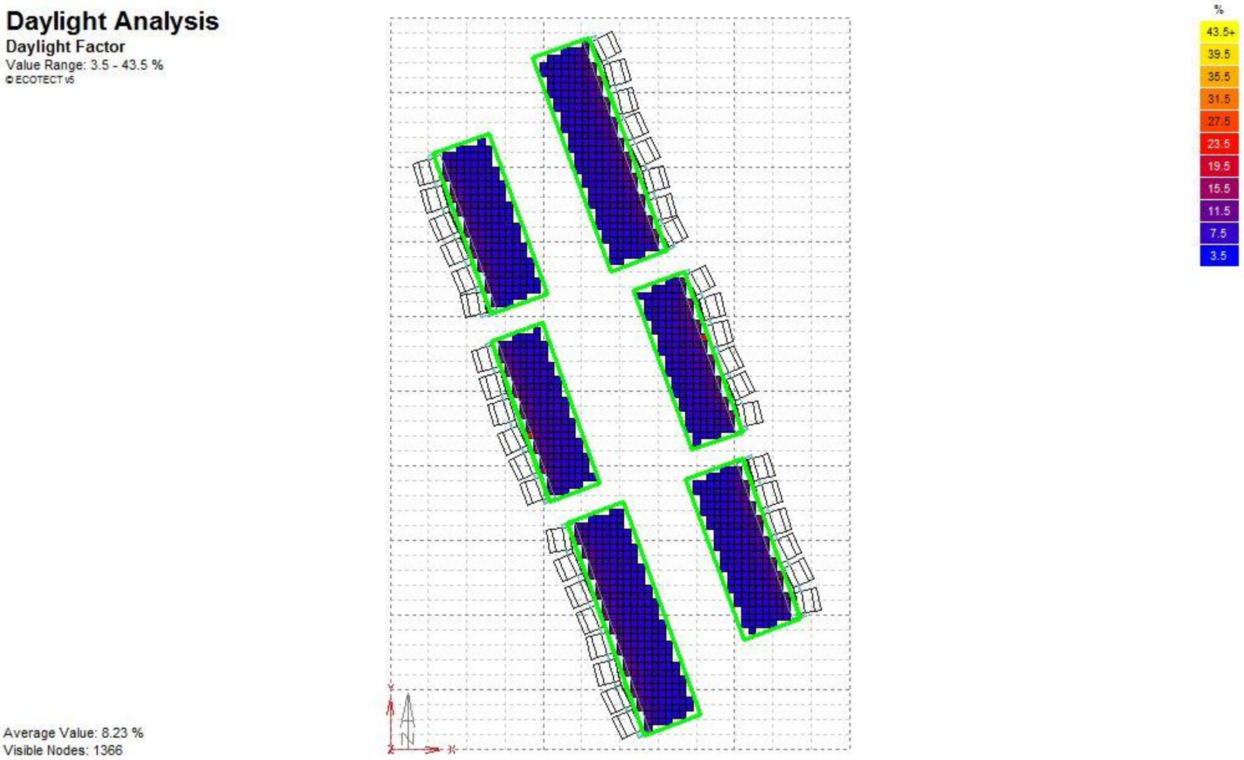
	Daylight Factor (%)
First Floor	8.08

Second Floor	8.23
Third Floor	8.29

Average DF	Appearance	Energy Implications
< 2%	Room looks gloomy	Electric lighting needed most of the day
2% to 6%	Predominantly daylight appearance, but supplementary artificial lighting is needed.	Good balance between lighting and thermal aspects
> 6%	Room appears strongly daylight	Daytime electric lighting rarely needed, but potential for thermal problems due to overheating in summer and heat losses in winter

Visual





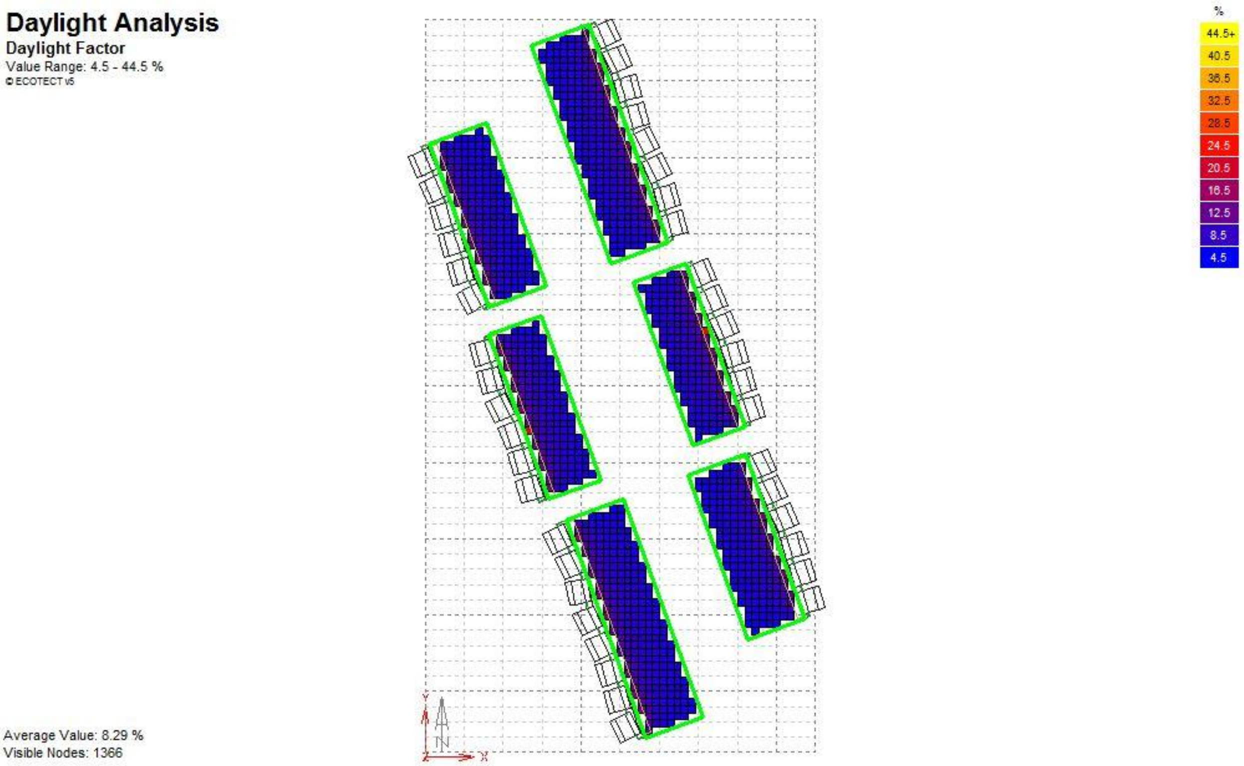


Figure 29: Daylight Analyses of First, Second and Third Floor

5. Building services

5.1 Cooling Load

Since the ECOTECT analysis just gave out cooling load not the energy load, but the average load of the whole building for the hottest period of the year. To design the mechanic system, we decided to estimate the peak cooling load.

The design cooling load (or heat gain) is the amount of heat energy to be removed from a house by the HVAC equipment to maintain the house at indoor design temperature .There are two types of cooling loads:

- Sensible Cooling Load
- Latent Cooling Load

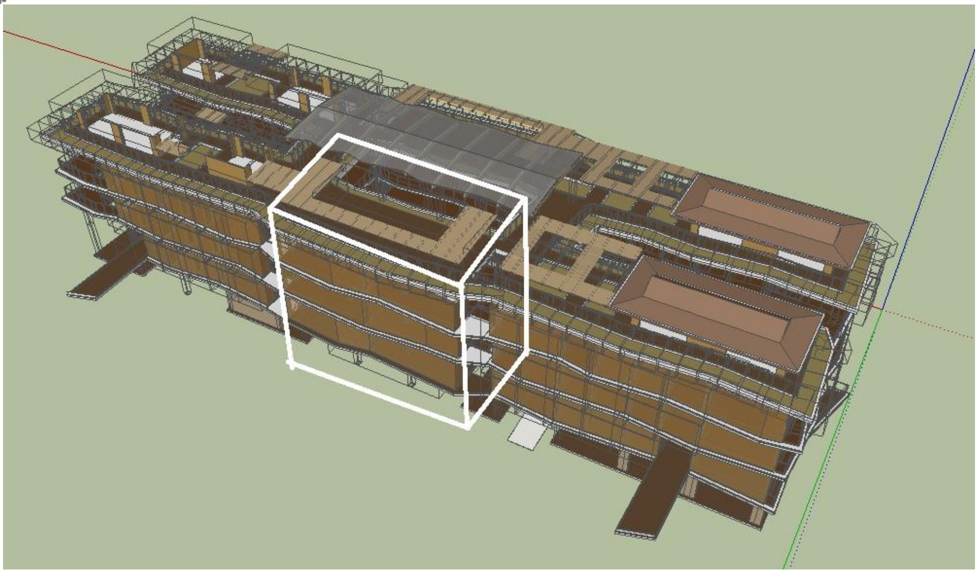
Sensible Cooling Load refers to the dry bulb temperature of the building, while latent cooling load refers to the wet bulb temperature. General saying, sensible load is responsible for temperature and latent load is responsible for humidity.

Two these load are depended on many factors like insulation layers of walls and façades, roof solution, air infiltration through cracks in the building, doors, windows, occupants , equipment and appliances operated cooling period, lights….

In the process of calculating, we have used the program "CASANOVA", which give out the total cooling need for design. CASANOVA counts on a single-zone dynamical thermal model, based on hourly data of the outside temperature and the solar heat gains through windows and walls in condition of comfort setting for the building.

INPUT

It was picked 1/6 the building from the ground floor up to the top and insert data into Casanova. And all the data we inserted are all converted as accurate as we can from data of the building.



The simulate building is supposed as the Fig above.

The block with 4 floors (18x6x14m^3), is orientated 23◦ deviated from the South.

Heat gains through envelope

The Northern, Southern façades are totally surrounded by the exterior wall with U= 0.7W/m^{2}K. The West façade is opened to the main corridor by the main doors with the window above was calculated to be opened 5% area.

The Eastern façade has double skins. The 1st skin is the window systems with approximately 80% area of double glazing (U= 3W/m^{2}K).The 2nd skin is the movable bamboo shading system. Although this skin (when it's completely closed) shelters the whole façade but due to the gap between the bamboo sticks on the screen, the area of shading inserted into the program is just counted as 90% measurement.

Heat gains through the roof

The block is entirely insolated with the roof (U= 0.4W/m^{2}K).Nevertheless, the roof is catalogued as ventilated roof due to its layers.

Indoor temperature and ventilation

The temperature set are 25◦ C, 29◦ C as comfort indoor temperature, overheating temperature respectively.

Air change rate has also been inserted as 0.5 time per hour, suitable for the residence building.

Internal heat gains

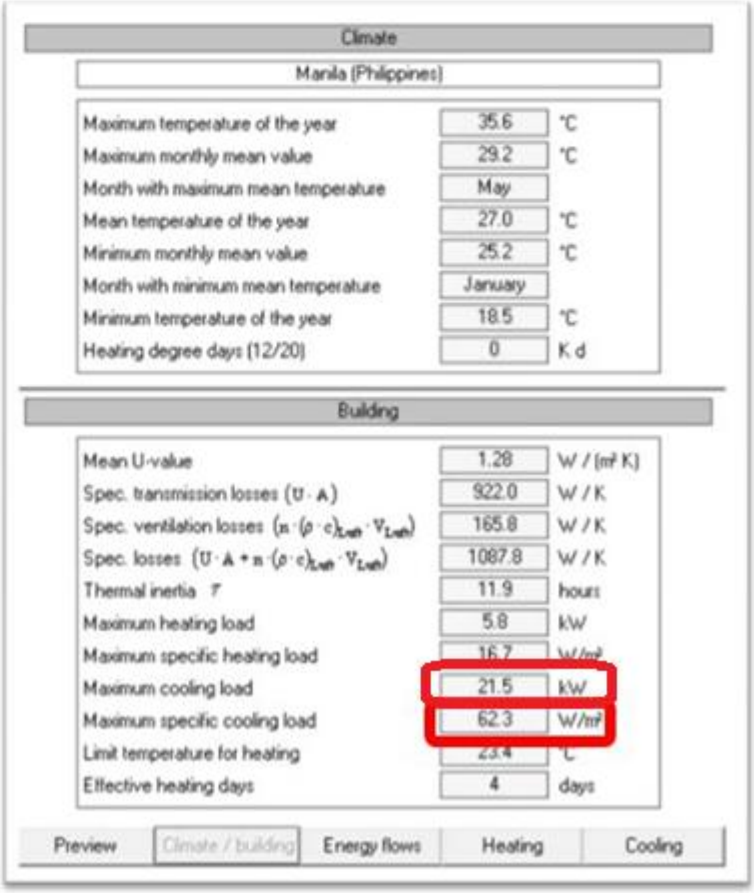
For residential building, the internal heat gains concluded heat from lighting, occupants, equipments, … can be estimated as $5W/m^{2*}$.

** : These data was brought from the psychometric chart of Manila and the book "Bioclimatic housing – Innovative designs for warm climates" with the case of Malaysia. Since Malaysia and the Philippines share the common in climate characteristic, we have referred these comfort data from Malaysia to apply in our research.*

OUTPUT

Design for cooling system would be processed from the Maximum Specific Cooling Load: $62.3W/m^2$

The maximum cooling load for 1 block is 21.5 kW , so 1 unit building is 21.5*6 = 129 kW.



5.2 Principle of cooling system

From researching and comparing traditional air conditioning system and some alternative technology, we have decided to apply the *Solar Desiccant Cooling* to comply the cooling demand of our residence community. There are some outstanding potential of this system which persuade us to choose this system.

Desiccant cooling systems combine absorb dehumidification, heat recovery, evaporation and heating to create a cooling process .Waste heat or solar energy can be used for the required regeneration of the absorber in the dehumidifier, leafing to further energy savings.

The unit comprises a desiccant wheel in tandem with a thermal wheel with evaporative coolers in both supply and return air streams before the thermal wheel. The desiccant cooling system takes air from outside or from the building dehumidifies it with a solid or liquid desiccant, cools it by heat exchange and then evaporatively cools it to the desired state of a maximum 100% relative humidity in the inlet air stream. The desiccant wheel contains a desiccant material (Lithium Chloride) which needs to be regenerated with an external heat source. This heat is taken from a solar installation consisting of a solar storage tank and solar collector. Since the required regeneration temperatures are low (40˚C to 70˚C) liquid flat plate collector are used.

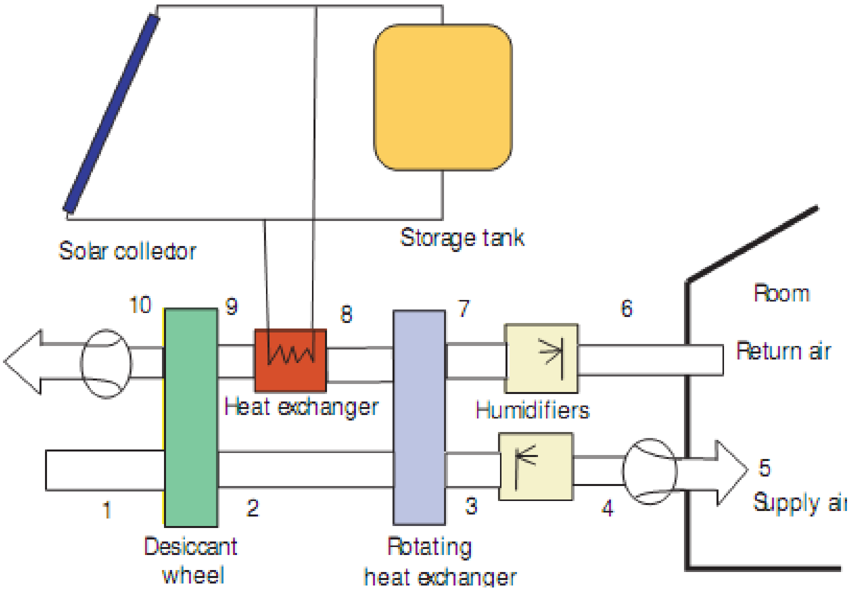


Figure 1. Schematic representation of the desiccant cooling system coupled with the solar installation

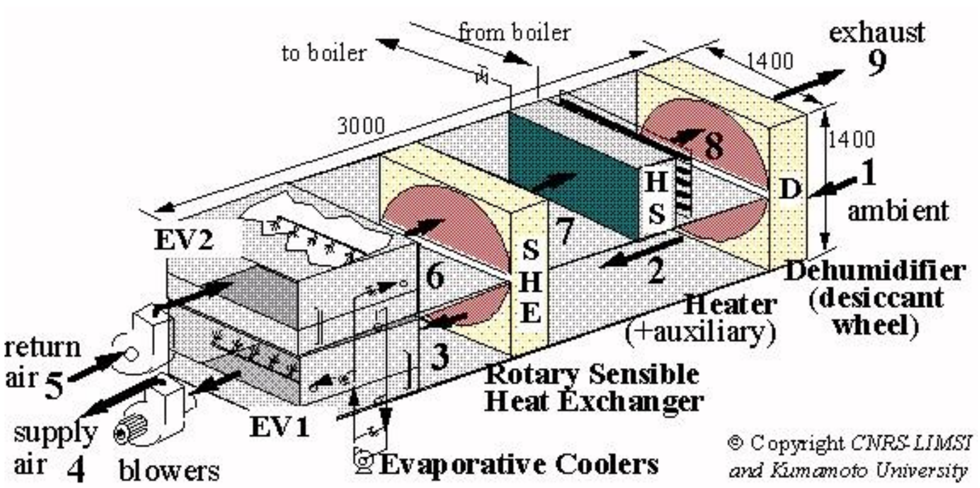
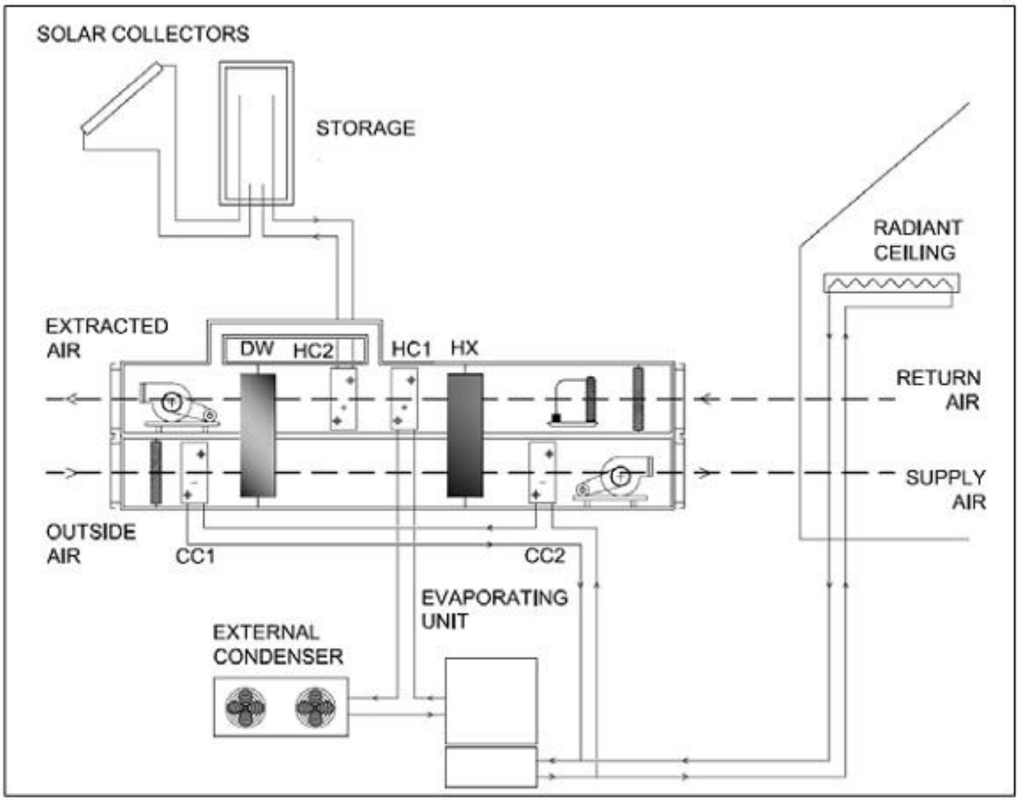


Figure2. Desiccant cooling unit.

5.3 System Configuration



To maximize the specific cooling power of the radiant ceiling different load conditions, we would like to combine the desiccant AHU with radiant ceiling system.

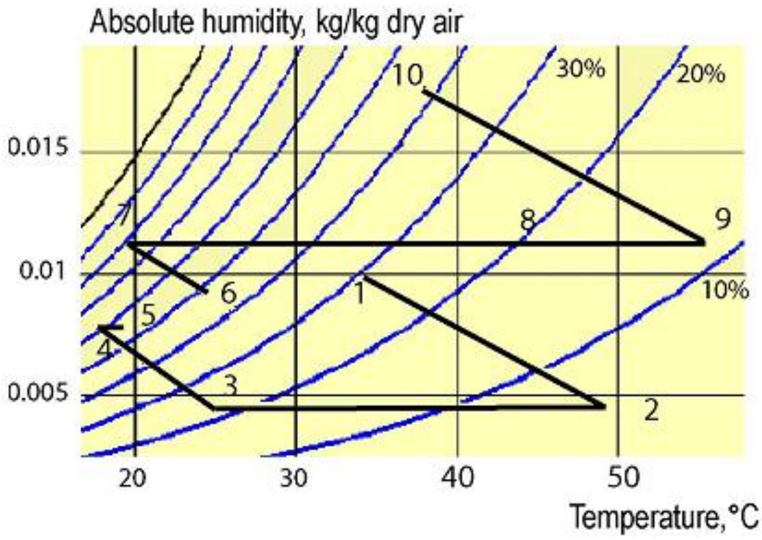


Figure 2. The corresponding air evolution in psychometric chart

If the humidity ratio and /or temperature set point of supply air is not met, further dehumidification and temperature decreasing can be achieved by means of two auxiliary cooling coils.

As mentioned, a thermodynamic heat recovery is achieved by means of the condensation heat of the water chiller feeding the radiant ceiling and the auxiliary cooling coils. The heat rejected by the chiller can be used on the return side process to preheat the regeneration air steam. The condensation coil HC1 allows a preheating of the regeneration air stream increasing its temperature of about 12-15◦ C.An external condenser connected in series to this coil provides for the remaining condensation of the refrigerant of the vapor compression cycle. A further advantage of this configuration is also the good time correlation between the cooling power demand and the heat rejection at the condenser. Further temperature rise up occurs in the solar collectors loop in order to reach regeneration temperature of 65-70◦ C at the inlet of the desiccant rotor. Due to the higher chilled water temperature required both by the chilled ceiling and auxiliary cooling coils (about 12◦ C), an increase of the cooling capacity and COP of the chiller can be achieved. A heat storage with proper volume tank balances the heat preoduced by the solar system and the heat supplied to the coil HC2.

Depending on outside air conditions and on building loads, air installation has four operating modes:

- Ventilation mode in which only the supply fan (4-5).
- Direct humidification mode in which supply air is directly humidified (3-4)
- Indirect humidification mode where supply air is sensibly cooled through a rotating heat exchanger, zreturn air is cooled by humidification (6-7).
- Desiccant mode in which outdoor air is dehumidified through the desiccant wheel. During the absorption of the vapor water in the wheel, air is dehumidified almost adiabactically (1-2).After that, the temperature is lowered in the rotating heat exchanger (2-3), and in the direct humidifier (3-4). The return air is cooled in the evaporative cooler (6-7) and is used to cool down the process air in the heat exchanger

(7-8). Then it is heated from the solar installation (8-9) to regenerate the desiccant wheel (9-10). The states of the process and exhaust air are represented on the psychometric chart.

5.4 Night cooling scheme

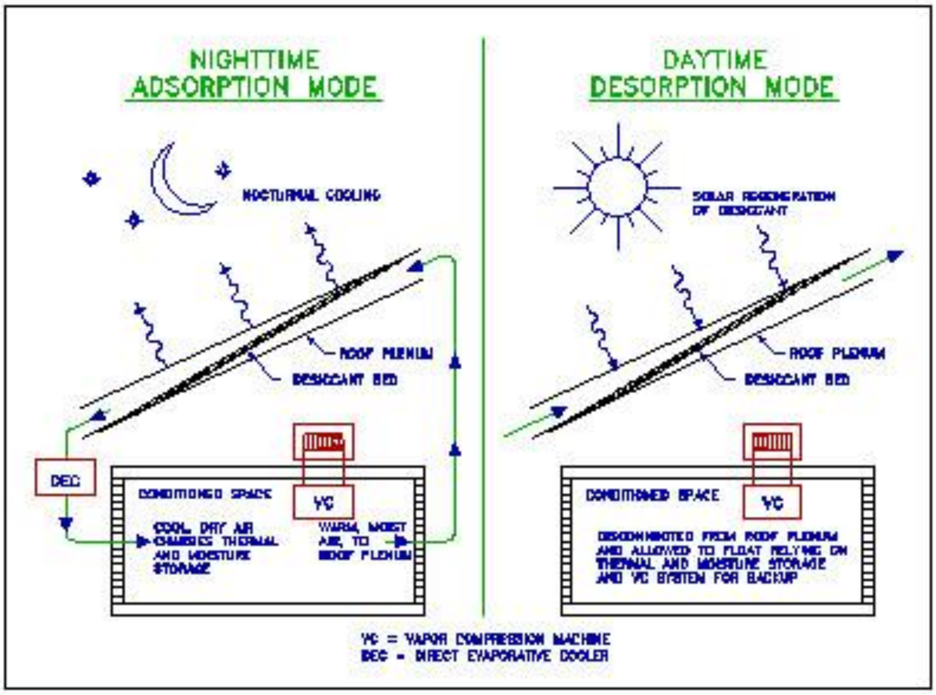


Figure4. Desiccant enhanced Radiant cooling (DESRAD) concept

For the adsorption mode, excess moisture and heat, stored by the house during the day, is rejected at night to a desiccant bed and the cooler night sky. The desorption mode begins the next day when the sun's heat is used to regenerate the desiccant bed. The cycle repeats itself every 24 hours, using electrical energy only for fans and an evaporative cooler pump. The system relies on solar regeneration heat, nocturnal cooling, and thermal and moisture energy storage for its operation.

5.5 Estimated Energy

For thermally driven cooling systems (absorption and adsorption cooling) it can be approximated that for 1 kW cooling capacity approx, 2 m^2 collector area is needed. These values result as an average of all solar cooling systems realized in Europe.

From the solar radiation map, we can see that thank to the geography characteristic, the Sun offers about 1.5 time solar radiation for the country.

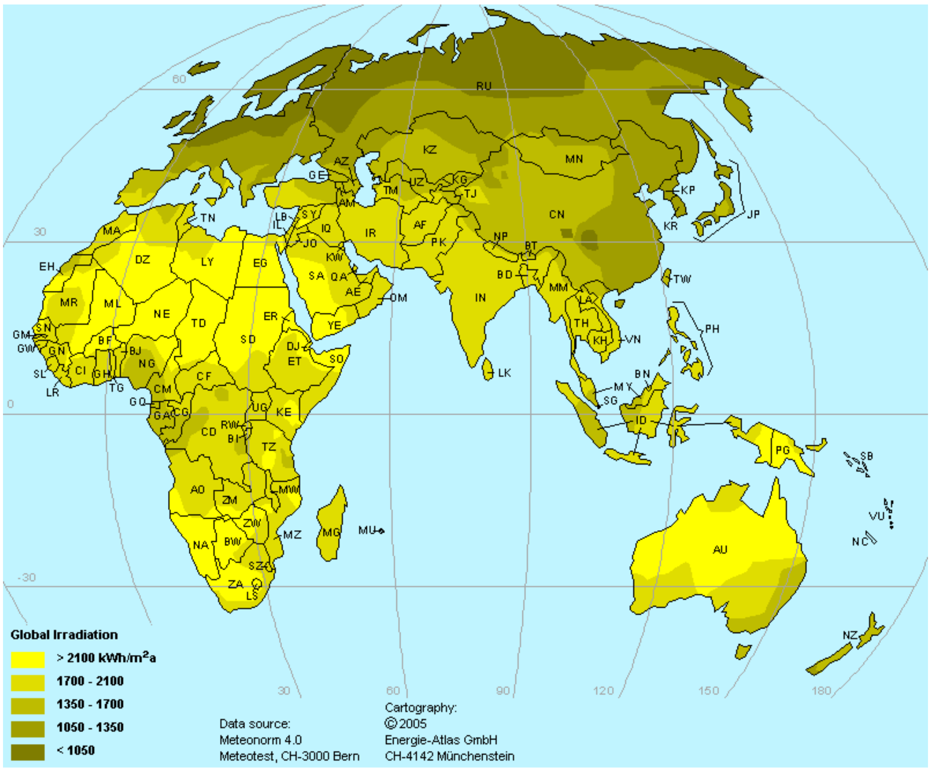


Figure3. Solar irradiation received by Africa, Asia, and Europe every year.

Units of kWh/m2/yr (source: ENERGIE Atlas)

Make a small calculation by the rule of thumbs, we need 86 m^2 to supply for the cooling demands of the building.

6. Technologies

This paragraph would present some of outstanding technologies proposed in the building in particular and the project in general.

6.1 Photovoltaic panel

Generate electricity directly solar energy by the "Photoelectric effect", photovoltaic panel is employed to make use of the availability of plenty of sun hours in the country.

The solar panels are placed on the trellis' top on the roof also played the role as a layer of the ventilated roof. This photovoltaic array also is the main energy source for the cooling system of the building. Beside from that, these panels are spread out all the site on separated street light to collect energy for the street lighting system.

The solar panel itself will be connected to a solar controller – a battery charger which is automatically topped up by the solar panel linked to a timer or photocell which ensures that the solar powered street lights operate in the hours of darkness. Some specific systems employ a further function whereby the light dims at specific times.

6.2 Polycarbonate Roofing

The large main "air well" was required cover to render the stack-effect ventilation of the building as well as to allow the light penetrating from the top to the ground floor .The material of this roofing is expected to meet the requirement of transparent, light in weight ,as well as easy cleaning. The polycarbonate sheet is proposed to utilize because of meeting all above demand.

Polycarbonate sheet is a modern complement to glass, it combines a variety of features: transparency, light weight and flexibility. One more reason this polycarbonate make it suitable is its impact strength and virtually unbreakable, and this would improve the safety, ease during construction and also using period alike.

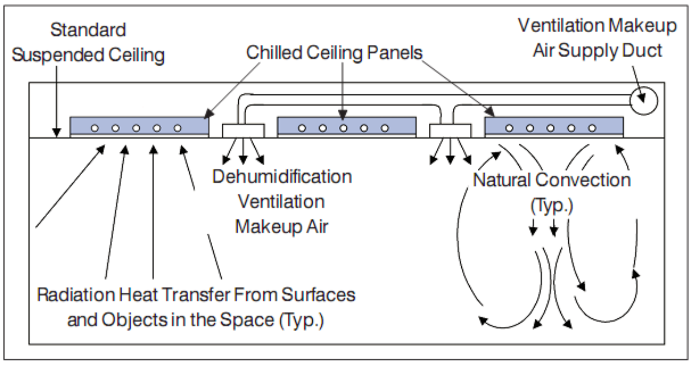
6.3 Hybrid Light

Hybrid lighting is a general lighting technology that dramatically improves the energy efficiency of the incandescent light bulb. Hybrid light bulbs provide the same light quality and comfort attributes as incandescent with no sacrifice in performance inherent in other energy efficient lighting technologies.

Over 80% of the energy consumed by incandescent lamps is wasted as heat, or infra-red (IR) energy. Hybrid lighting technology recycles this large amount of heat, converting it to useable light energy, allowing for lamp designs that require much less energy while delivering the same amount of light as their incandescent equivalent.

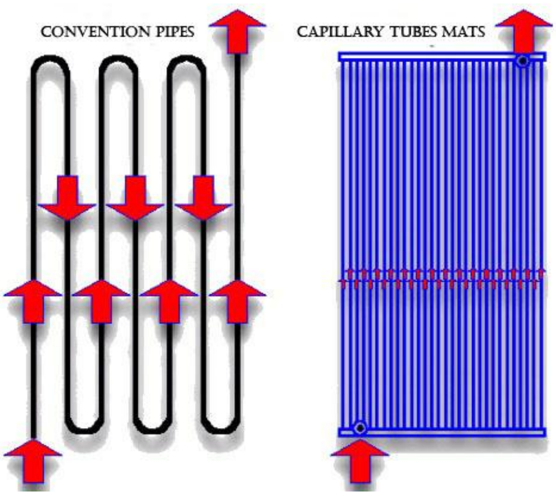
Thank for a specialized thin-film coating is applied to the outside of the capsule that redirects wasted infrared radiation (IR), or heat, back onto the filament to generate more light. Therefore, lamps may be designed that require less energy while maintaining the same amount of light output. Compared to the common incandescent light bulb, this Hybrid light technology is currently capable of decreasing the energy consumption to one-third.

6.4 Radiant Ceiling Cooling - Capillary Tubes System



Building with radiant ceiling cooling system, also known as " chilled beam" system, incorporate pipes in the ceiling through chilled water flow.The piples in the ceiling surfaces or in the panels,and they cool the room via natural convection and radiation heat transfer.

Capillary Tubes Mats



This is a mesh of conduits, contain capillary tubes which are extremely thin , which give them a great thermodynamic advantage over similar systems with thicker and larger tubes.

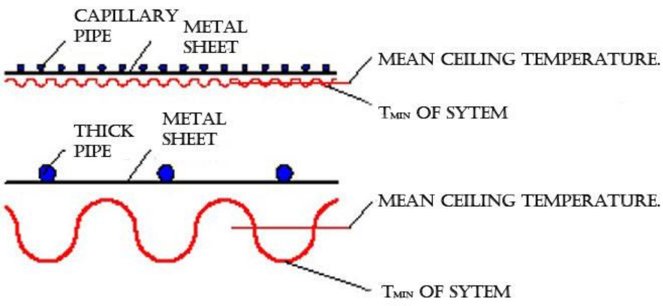


Figure. Difference of Mean Temperature of ceiling from T_{min} of system in Thick Pipe and Capillary Tubes systems

Capillary mats are made completely of polypropylene materials,plus with the small size of the tubes'diameter(2mm) so they are flexible and easy to install.

In the building,the system is tandem with the solar desiccant cooling system to meet all of the coolign need.The various benefits of this system are

- Energy consumpt 23% less in compare with HVAC 's (MUMMA reported) mean while in new construction, the installed costs of radiant ceilign appear to be similar to be conventional system.
- Supply air quantities usually do not exceed those required for ventilation and dehumidification.
- Almost all mechanical equipment may be centrally located, simplifying maintenance and operation.

APPENDIX

DEAD LOAD

DEAD LOAD OF SIDE SPAN -LOWER FLOOR

	Uniform load	
Member length	6 (m)	
	kN/m^2	KN/m
Deck slab	3.1	18.6
Floor Beam		0.37
Wall (exterior+interior)		2.28
Total		21.25
	Pointed load	
Member length	3.5 (m)	
	KN/m	KN
Glass façade	1.37	8.22
Shading façade	0.9	5.4
Total		13.62
	Superimposed Load	
Member length	6 (m)	
	kN/m^2	KN/m
Superimposed Load	0	0
Total		0

DEAD LOAD OF MIDDLE SPAN -LOWER FLOOR

	Uniform load		
Member length	7.6 (m)		
		kN/m^2	KN/m
Deck slab		3.1	23.56
Floor Beam			0.37
Wall (exterior+interior)			0
	Total		23.93

	Pointed load		
Member length	3.5 (m)		
		KN/m	KN
Glass façade		-	0
Shading façade		-	0
	Total		0

	Superimposed Load		
Member length	6 (m)		
		kN/m^2	KN/m
Superimposed Load		0	0
	Total		0

DEAD LOAD OF SIDE SPAN –ROOF

	Uniform load		
Member length	6 (m)		
		kN/m^2	KN/m
Deck slab		3.1	18.6

Floor Beam		0.37
Wall (exterior+interior)		0
Trellis	1.12	6.72
Green Roof	2	12
Sloar Panel	0.16	0.96
Total		38.65

	Pointed load	
Member length	3.5 (m)	
	KN/m	KN
Glass façade	0	0
Shading façade	0	0
Total		0

	Superimposed Load	
Member length	6 (m)	
	kN/m^2	KN/m
Superimposed Load	1.2	7.2
Total		7.2

DEAD LOAD OF SIDE SPAN –ROOF

	Uniform load	
Member length	7.6 (m)	
	kN/m^2	KN/m
Deck slab	0	0
Floor Beam		0.37
Wall (exterior+interior)	0	0
PTFE Membrane	1.2	7.2
Total		0.37

	Pointed load	
Member length	3.5 (m)	

	KN/m	KN
Glass façade	0	0
Shading façade	0	0
Total		0
	Superimposed Load	
Member length	6 (m)	
	kN/m^2	KN/m
Superimposed Load	1.2	7.2
Total		7.2

DEAD LOAD OF BALCONY

	Uniform load	
Member length	1.5 (m)	
	kN/m^2	KN/m
Deck slab	3.1	4.65
Floor Beam		0.37
Wall (exterior+interior)		0
Total		5.02
	Pointed load	
Member length	3.5 (m)	
	Superimposed Load	
Member length	6 (m)	
	kN/m^2	KN/m
Superimposed Load	0	0
Total		0

LIVE LOAD

BEAM B1 – LOWER FLOOR

Member length	6 (m)

	Span	Grid
Floor boundary	A,B	1,2
	C,D	1,2
	C,D	3.4
	D,E	1,2
	D,E	3.4
	F,G	1,2
	F,G	3.4
	G,H	1,2
	G,H	3.4
	H,I	1,2
	H,I	3.4
	J,K	1,2
	J,K	3.4
	K,L	1,2
	K,L	3.4
	M,N	1,2
Area Use		Residential
Level applied	1,2,3	
	kN/m^2	KN/m
Load value	2	12
Imposed load	0	0
Reduction factor	-	-
Total		12

BEAM B2 – LOWER FLOOR

Member length	7.6 (m)	
	Span	Grid
Floor boundary	A,B	2,3

	C,D	2,3
	D,E	2,3
	F,G	2,3
	F,G	2,3
	G,H	2,3
	H,I	2,3
	J,K	2,3
	K,L	2,3
	M,N	2,3
Area Use		Corridor
Level applied	1,2,3	
	kN/m^2	KN/m
Load value	2.5	15
Imposed load	0	0
Reduction factor	-	-
Total		15

BEAM B1 – ROOF

Member length	6 (m)	
	Span	Grid
Floor boundary	A,B	1,2
	C,D	1,2
	C,D	3.4
	D,E	1,2
	D,E	3.4
	F,G	1,2
	F,G	3.4
	G,H	1,2

	G,H	3.4
	H,I	1,2
	H,I	3.4
	J,K	1,2
	J,K	3.4
	K,L	1,2
	K,L	3.4
	M,N	1,2
Area Use	Roof with activities	
Level applied	1,2,3	
	kN/m2	KN/m
Load value	2	12
Imposed load	0	0
Reduction factor	-	-
Total		12

BEAM B2 – ROOF

Member length	6 (m)	
	Span	Grid
Floor boundary	A,B	2,3
	C,D	2,3
	D,E	2,3
	F,G	2,3
	F,G	2,3
	G,H	2,3
	H,I	2,3
	J,K	2,3
	K,L	2,3
	M,N	2,3

Area Use	Roof with activities	
Level applied	1,2,3	
	kN/m2	KN/m
Load value	2	12
Imposed load	0	0
Reduction factor	-	-
Total		12

BEAM B4 – UPPER ROOF

Member length	6 (m)	
	Span	Grid
Floor boundary	A,B	2,3
	C,D	2,3
	D,E	2,3
	F,G	2,3
	F,G	2,3
	G,H	2,3
	H,I	2,3
	J,K	2,3
	K,L	2,3
	M,N	2,3
Area Use	Roof without activities	
Level applied	1,2,3	
	kN/m2	KN/m
Load value	0.75	2.25
Imposed load	0	0
Reduction factor	-	-
Total		2.25

ETABS®

EUROCODE 3-1993
Steel Frame Design Report

Prepared by
polimi

Model Name: 2d.edb

22 November 2010

Design Preferences

Frame Type =	Moment Frame
GammaM0 =	1.1
GammaM1 =	1.1
Psi_vec =	0.8
K_tau =	5.34
Consider Deflection =	Yes
Deflection Check Type =	Both
DL Limit, L / =	120
Super DL+LL Limit, L / =	120
Live Load Limit, L / =	360
Total Load Limit, L / =	240
Total--Camber Limit, L/ =	240
DL Limit, abs =	0.0254
Super DL+LL Limit, abs =	0.0254
Live Load Limit, abs =	0.0254
Total Load Limit, abs =	0.0254
Total--Camber Limit, abs =	0.0254
Pattern Live Load Factor =	0.75
Stress Ratio Limit =	0.95
Maximum Auto Iteration =	1

Load Combinations

Load Combinations

Combination Name	Combination Definition
COMB1	1.000*COMB1NL
COMB2	1.000*DEAD + 1.000*LIVE2
COMB3	1.000*DEAD + 0.900*LIVE1 + 0.900*WIND1
COMB4	1.000*DEAD + 0.900*LIVE2 + 0.900*WIND1
COMB5	1.000*DEAD + 0.900*LIVE1 + 0.900*WIND2
COMB6	1.000*DEAD + 0.900*LIVE2 + 0.900*WIND2
COMB7	1.000*DEAD + 1.000*WIND1
COMB8	1.000*DEAD + 1.000*WIND2
COMB10	1.000*DEAD + 1.000*EQZ
COMB11	1.000*DEAD + 0.900*LIVE1 + 0.900*EQX
COMB12	1.000*DEAD + 0.900*LIVE1 + 0.900*EQZ
COMB13	1.000*DEAD + 0.900*LIVE2 + 0.900*EQX
COMB14	1.000*DEAD + 0.900*LIVE2 + 0.900*EQZ
UDSTLS1	1.350*DEAD
UDSTLS2	1.350*DEAD + 1.500*LIVE1 + 1.500*LIVE2
UDSTLS3	1.350*DEAD + 1.350*LIVE1 + 1.350*LIVE2 + 1.350*WIND1
UDSTLS4	1.350*DEAD + 1.350*LIVE1 + 1.350*LIVE2 – 1.350*WIND1
UDSTLS5	1.350*DEAD + 1.350*LIVE1 + 1.350*LIVE2 + 1.350*WIND2
UDSTLS6	1.350*DEAD + 1.350*LIVE1 + 1.350*LIVE2 – 1.350*WIND2
UDSTLS7	1.350*DEAD + 1.500*WIND1
UDSTLS8	1.350*DEAD – 1.500*WIND1
UDSTLS9	1.350*DEAD + 1.500*WIND2
UDSTLS10	1.350*DEAD – 1.500*WIND2
UDSTLS11	1.000*DEAD + 1.500*WIND1
UDSTLS12	1.000*DEAD – 1.500*WIND1
UDSTLS13	1.000*DEAD + 1.500*WIND2
UDSTLS14	1.000*DEAD – 1.500*WIND2
UDSTLS15	1.000*DEAD + 0.450*LIVE1 + 0.450*LIVE2 + 1.000*EQX
UDSTLS16	1.000*DEAD + 0.450*LIVE1 + 0.450*LIVE2 + 1.000*EQZ
UDSTLS17	1.000*DEAD + 1.000*EQX
UDSTLS18	1.000*DEAD + 1.000*EQZ
DSTLS1	1.350*DEAD
DSTLS2	1.350*DEAD + 1.500*LIVE1 + 1.500*LIVE2
DSTLS3	1.350*DEAD + 1.350*LIVE1 + 1.350*LIVE2 + 1.350*WIND1
DSTLS4	1.350*DEAD + 1.350*LIVE1 + 1.350*LIVE2 – 1.350*WIND1
DSTLS5	1.350*DEAD + 1.350*LIVE1 + 1.350*LIVE2 + 1.350*WIND2
DSTLS6	1.350*DEAD + 1.350*LIVE1 + 1.350*LIVE2 – 1.350*WIND2
DSTLS7	1.350*DEAD + 1.500*WIND1
DSTLS8	1.350*DEAD – 1.500*WIND1
DSTLS9	1.350*DEAD + 1.500*WIND2
DSTLS10	1.350*DEAD – 1.500*WIND2
DSTLS11	1.000*DEAD + 1.500*WIND1
DSTLS12	1.000*DEAD – 1.500*WIND1
DSTLS13	1.000*DEAD + 1.500*WIND2
DSTLS14	1.000*DEAD – 1.500*WIND2
DSTLS15	1.000*DEAD + 0.450*LIVE1 + 0.450*LIVE2 + 1.000*EQX
DSTLS16	1.000*DEAD + 0.450*LIVE1 + 0.450*LIVE2 + 1.000*EQZ

Load Combinations

Combination Name	Combination Definition
DSTLS17	1.000*DEAD + 1.000*EQX
DSTLS18	1.000*DEAD + 1.000*EQZ
DSTLD1	1.000*DEAD
DSTLD2	1.000*DEAD + 1.000*LIVE1 + 1.000*LIVE2

Material Property Data - General

Material Property Data - General

Name	Type	Dir/Plane	Modulus of Elasticity	Poisson's Ratio	Thermal Coefficient	Shear Modulus
STEEL	Iso	All	199947978.80	0.3000	6.5000E-06	76903068.77

Material Property Data - Mass & Weight

Material Property Data - Mass & Weight

Name	Mass per Unit Volume	Weight per Unit Volume
STEEL	7.8271E+00	7.6820E+01

Material Property Data - Steel Design

Material Property Data - Steel Design

Name	Steel F_y	Steel F_u	Cost per Unit Weight
STEEL	344737.894	448159.263	1.00

Frame Section Property Data - General

Frame Section Property Data - General

Frame Section Name	Material Name	Section Shape Name or Name in Properties File
460UB82.1	STEEL	460UB82.1
310UB40.4	STEEL	310UB40.4
250UC89.5	STEEL	250UC89.5
410UB59.7	STEEL	410UB59.7

Frame Section Property Data - Dimensions

Frame Section Property Data - Dimensions

Frame Section Name	Section Depth	Top Flange Width	Top Flange Thickness	Web Thickness	Bot Flange Width	Bot Flange Thickness
460UB82.1	0.4600	0.1910	0.0160	0.0099	0.1910	0.0160
310UB40.4	0.3040	0.1650	0.0102	0.0061	0.1650	0.0102
250UC89.5	0.2600	0.2560	0.0173	0.0105	0.2560	0.0173
410UB59.7	0.4060	0.1780	0.0128	0.0078	0.1780	0.0128

Frame Section Property Data - Properties Part 1 of 2

Frame Section Property Data - Properties Part 1 of 2

Frame Section Name	Section Area	Torsional Constant	Moment of Inertia I33	Moment of Inertia I22	Shear Area A2	Shear Area A3
460UB82.1	0.0105	0.0000	0.0004	0.0000	0.0046	0.0051
310UB40.4	0.0052	0.0000	0.0001	0.0000	0.0019	0.0028
250UC89.5	0.0114	0.0000	0.0001	0.0000	0.0027	0.0074
410UB59.7	0.0076	0.0000	0.0002	0.0000	0.0032	0.0038

Frame Section Property Data - Properties Part 2 of 2

Frame Section Property Data - Properties Part 2 of 2

Frame Section Name	Section Modulus S33	Section Modulus S22	Plastic Modulus Z33	Plastic Modulus Z22	Radius of Gyration r33	Radius of Gyration r22
460UB82.1	0.0105	0.0000	0.0004	0.0000	0.0046	0.0051
310UB40.4	0.0052	0.0000	0.0001	0.0000	0.0019	0.0028
250UC89.5	0.0114	0.0000	0.0001	0.0000	0.0027	0.0074
410UB59.7	0.0076	0.0000	0.0002	0.0000	0.0032	0.0038

Steel Column Design - Element Information Part 1 of 2

Steel Column Design - Element Information Part 1 of 2

Story Level	Column Line	Section Name	Frame Type	RLLF Factor	L_Ratio Major	L_Ratio Minor
STORY4	C1	250UC89.5	MOMENT	1.000	0.884	0.884
STORY3	C1	250UC89.5	MOMENT	1.000	0.913	0.913
STORY2	C1	250UC89.5	MOMENT	1.000	0.913	0.913
STORY1	C1	250UC89.5	MOMENT	1.000	0.924	0.924
STORY5	C2	250UC89.5	MOMENT	1.000	1.000	1.000
STORY4	C2	250UC89.5	MOMENT	1.000	0.884	0.884
STORY3	C2	250UC89.5	MOMENT	1.000	0.869	0.869
STORY2	C2	250UC89.5	MOMENT	1.000	0.869	0.869
STORY1	C2	250UC89.5	MOMENT	1.000	0.885	0.885
STORY5	C3	250UC89.5	MOMENT	1.000	1.000	1.000
STORY4	C3	250UC89.5	MOMENT	1.000	0.884	0.884
STORY3	C3	250UC89.5	MOMENT	1.000	0.869	0.869
STORY2	C3	250UC89.5	MOMENT	1.000	0.869	0.869
STORY1	C3	250UC89.5	MOMENT	1.000	0.885	0.885
STORY4	C4	250UC89.5	MOMENT	1.000	0.884	0.884
STORY3	C4	250UC89.5	MOMENT	1.000	0.913	0.913
STORY2	C4	250UC89.5	MOMENT	1.000	0.913	0.913
STORY1	C4	250UC89.5	MOMENT	1.000	0.924	0.924

Steel Column Design - Element Information Part 2 of 2

Steel Column Design - Element Information Part 2 of 2

Story Level	Column Line	Section Name	Frame Type	K Major	K Minor
STORY4	C1	250UC89.5	MOMENT	1.763	1.000
STORY3	C1	250UC89.5	MOMENT	2.348	1.000
STORY2	C1	250UC89.5	MOMENT	2.317	1.000

Steel Column Design - Element Information Part 2 of 2

Story Level	Column Line	Section Name	Frame Type	K Major	K Minor
STORY1	C1	250UC89.5	MOMENT	1.719	1.000
STORY5	C2	250UC89.5	MOMENT	1.000	1.000
STORY4	C2	250UC89.5	MOMENT	1.359	1.000
STORY3	C2	250UC89.5	MOMENT	1.401	1.000
STORY2	C2	250UC89.5	MOMENT	1.389	1.000
STORY1	C2	250UC89.5	MOMENT	1.347	1.000
STORY5	C3	250UC89.5	MOMENT	1.000	1.000
STORY4	C3	250UC89.5	MOMENT	1.359	1.000
STORY3	C3	250UC89.5	MOMENT	1.401	1.000
STORY2	C3	250UC89.5	MOMENT	1.389	1.000
STORY1	C3	250UC89.5	MOMENT	1.347	1.000
STORY4	C4	250UC89.5	MOMENT	1.763	1.000
STORY3	C4	250UC89.5	MOMENT	2.348	1.000
STORY2	C4	250UC89.5	MOMENT	2.317	1.000
STORY1	C4	250UC89.5	MOMENT	1.719	1.000

Steel Beam Design - Element Information Part 1 of 2

Steel Beam Design - Element Information Part 1 of 2

Story Level	Beam Bay	Section Name	Frame Type	RLLF Factor	L_Ratio Major	L_Ratio Minor
STORY4	B1	410UB59.7	MOMENT	1.000	0.957	0.957
STORY3	B1	310UB40.4	MOMENT	1.000	0.957	0.957
STORY2	B1	310UB40.4	MOMENT	1.000	0.957	0.957
STORY1	B1	310UB40.4	MOMENT	1.000	0.957	0.957
STORY4	B3	310UB40.4	MOMENT	1.000	0.913	0.913
STORY3	B3	310UB40.4	MOMENT	1.000	0.913	0.913
STORY2	B3	310UB40.4	MOMENT	1.000	0.913	0.913
STORY1	B3	310UB40.4	MOMENT	1.000	0.913	0.913
STORY3	B4	460UB82.1	MOMENT	1.000	0.966	0.966
STORY2	B4	460UB82.1	MOMENT	1.000	0.966	0.966
STORY1	B4	460UB82.1	MOMENT	1.000	0.966	0.966
STORY4	B5	410UB59.7	MOMENT	1.000	0.957	0.957
STORY3	B5	310UB40.4	MOMENT	1.000	0.957	0.957
STORY2	B5	310UB40.4	MOMENT	1.000	0.957	0.957
STORY1	B5	310UB40.4	MOMENT	1.000	0.957	0.957
STORY4	B6	310UB40.4	MOMENT	1.000	0.913	0.913
STORY3	B6	310UB40.4	MOMENT	1.000	0.913	0.913
STORY2	B6	310UB40.4	MOMENT	1.000	0.913	0.913
STORY1	B6	310UB40.4	MOMENT	1.000	0.913	0.913

Steel Beam Design - Element Information Part 2 of 2

Steel Beam Design - Element Information Part 2 of 2

Story Level	Beam Bay	Section Name	Frame Type	K Major	K Minor
STORY4	B1	410UB59.7	MOMENT	1.000	1.000
STORY3	B1	310UB40.4	MOMENT	1.000	1.000

Steel Beam Design - Element Information Part 2 of 2

Story Level	Beam Bay	Section Name	Frame Type	K Major	K Minor
STORY2	B1	310UB40.4	MOMENT	1.000	1.000
STORY1	B1	310UB40.4	MOMENT	1.000	1.000
STORY4	B3	310UB40.4	MOMENT	1.000	1.000
STORY3	B3	310UB40.4	MOMENT	1.000	1.000
STORY2	B3	310UB40.4	MOMENT	1.000	1.000
STORY1	B3	310UB40.4	MOMENT	1.000	1.000
STORY3	B4	460UB82.1	MOMENT	1.000	1.000
STORY2	B4	460UB82.1	MOMENT	1.000	1.000
STORY1	B4	460UB82.1	MOMENT	1.000	1.000
STORY4	B5	410UB59.7	MOMENT	1.000	1.000
STORY3	B5	310UB40.4	MOMENT	1.000	1.000
STORY2	B5	310UB40.4	MOMENT	1.000	1.000
STORY1	B5	310UB40.4	MOMENT	1.000	1.000
STORY4	B6	310UB40.4	MOMENT	1.000	1.000
STORY3	B6	310UB40.4	MOMENT	1.000	1.000
STORY2	B6	310UB40.4	MOMENT	1.000	1.000
STORY1	B6	310UB40.4	MOMENT	1.000	1.000

Steel Brace Design - Element Information Part 1 of 2

Steel Brace Design - Element Information Part 1 of 2

Story Level	Brace Bay	Section Name	Frame Type	RLLF Factor	L_Ratio Major	L_Ratio Minor
STORY6	D1	410UB59.7	MOMENT	1.000	1.000	1.000
STORY6	D2	410UB59.7	MOMENT	1.000	1.000	1.000

Steel Brace Design - Element Information Part 2 of 2

Steel Brace Design - Element Information Part 2 of 2

Story Level	Brace Bay	Section Name	Frame Type	K Major	K Minor
STORY6	D1	410UB59.7	MOMENT	1.000	1.000
STORY6	D2	410UB59.7	MOMENT	1.000	1.000

Steel Column Design - Capacity Check Output

Steel Column Design - Capacity Check Output

Story Level	Column Line	Section Name	Moment Interaction Check Ratio = AXL + B33 + B22	Shear22 Ratio	Shear33 Ratio
STORY4	C1	250UC89.5	0.324 = 0.090 + 0.234 + 0.000	0.116	0.000
STORY3	C1	250UC89.5	0.321 = 0.193 + 0.128 + 0.000	0.079	0.000
STORY2	C1	250UC89.5	0.405 = 0.276 + 0.128 + 0.000	0.091	0.000
STORY1	C1	250UC89.5	0.516 = 0.347 + 0.170 + 0.000	0.089	0.000
STORY5	C2	250UC89.5	0.304 = 0.038 + 0.266 + 0.000	0.163	0.000
STORY4	C2	250UC89.5	0.227 = 0.123 + 0.104 + 0.000	0.068	0.000
STORY3	C2	250UC89.5	0.133 = 0.025 + 0.108 + 0.000	0.043	0.000
STORY2	C2	250UC89.5	0.111 = 0.027 + 0.084 + 0.000	0.041	0.000
STORY1	C2	250UC89.5	0.274 = 0.163 + 0.111 + 0.000	0.053	0.000
STORY5	C3	250UC89.5	0.304 = 0.038 + 0.266 + 0.000	0.163	0.000
STORY4	C3	250UC89.5	0.227 = 0.123 + 0.104 + 0.000	0.068	0.000
STORY3	C3	250UC89.5	0.133 = 0.025 + 0.108 + 0.000	0.043	0.000
STORY2	C3	250UC89.5	0.111 = 0.027 + 0.084 + 0.000	0.041	0.000
STORY1	C3	250UC89.5	0.274 = 0.163 + 0.111 + 0.000	0.053	0.000
STORY4	C4	250UC89.5	0.324 = 0.090 + 0.234 + 0.000	0.116	0.000
STORY3	C4	250UC89.5	0.321 = 0.193 + 0.128 + 0.000	0.079	0.000
STORY2	C4	250UC89.5	0.405 = 0.276 + 0.128 + 0.000	0.091	0.000
STORY1	C4	250UC89.5	0.516 = 0.347 + 0.170 + 0.000	0.089	0.000

Steel Beam Design - Capacity Check Output

Steel Beam Design - Capacity Check Output

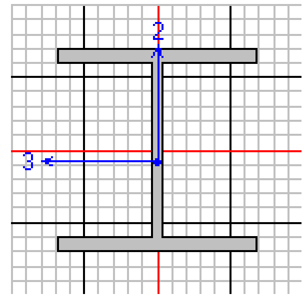
Story Level	Beam Bay	Section Name	Moment Interaction Check Ratio = AXL + B33 + B22	Shear22 Ratio	Shear33 Ratio
STORY4	B1	410UB59.7	1.386 = 0.109 + 1.278 + 0.000	0.430	0.000
STORY3	B1	310UB40.4	1.719 = 0.010 + 1.710 + 0.000	0.438	0.000
STORY2	B1	310UB40.4	1.726 = 0.016 + 1.710 + 0.000	0.438	0.000
STORY1	B1	310UB40.4	1.698 = 0.010 + 1.688 + 0.000	0.438	0.000
STORY4	B3	310UB40.4	0.156 = 0.000 + 0.156 + 0.000	0.132	0.000
STORY3	B3	310UB40.4	0.156 = 0.000 + 0.156 + 0.000	0.132	0.000
STORY2	B3	310UB40.4	0.156 = 0.000 + 0.156 + 0.000	0.132	0.000
STORY1	B3	310UB40.4	0.156 = 0.000 + 0.156 + 0.000	0.132	0.000
STORY3	B4	460UB82.1	0.751 = 0.000 + 0.751 + 0.000	0.147	0.000
STORY2	B4	460UB82.1	0.757 = 0.010 + 0.746 + 0.000	0.146	0.000
STORY1	B4	460UB82.1	0.743 = 0.005 + 0.739 + 0.000	0.146	0.000
STORY4	B5	410UB59.7	1.386 = 0.109 + 1.278 + 0.000	0.430	0.000
STORY3	B5	310UB40.4	1.719 = 0.010 + 1.710 + 0.000	0.438	0.000
STORY2	B5	310UB40.4	1.726 = 0.016 + 1.710 + 0.000	0.438	0.000
STORY1	B5	310UB40.4	1.698 = 0.010 + 1.688 + 0.000	0.438	0.000
STORY4	B6	310UB40.4	0.156 = 0.000 + 0.156 + 0.000	0.132	0.000
STORY3	B6	310UB40.4	0.156 = 0.000 + 0.156 + 0.000	0.132	0.000
STORY2	B6	310UB40.4	0.156 = 0.000 + 0.156 + 0.000	0.132	0.000
STORY1	B6	310UB40.4	0.156 = 0.000 + 0.156 + 0.000	0.132	0.000

Steel Brace Design - Capacity Check Output

Steel Brace Design - Capacity Check Output

Story Level	Brace Bay	Section Name	Moment Interaction Check Ratio = AXL + B33 + B22	Shear22 Ratio	Shear33 Ratio
STORY6	D1	410UB59.7	0.386 = 0.083 + 0.303 + 0.000	0.167	0.000
STORY6	D2	410UB59.7	0.386 = 0.083 + 0.303 + 0.000	0.167	0.000

Story Level: STORY5
Element: C2
Section Name: 250UC89.5
Frame Type: Moment Resisting Frame
Station: 2.500
Combo: DSTLS4
Classification: Class 2



L=2.500
A=0.011 I22=4.840E-05 I33=1.430E-04 Wpl22=5.750E-04 Wpl33=0.001
Wel22=3.781E-04 Wel33=0.001 i22=0.065 i33=0.112
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.304 = 0.038 + 0.266 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS4	-112.417	101.110	0.000	-61.638	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	112.417	2997.544	3572.738	3451.005	2997.544

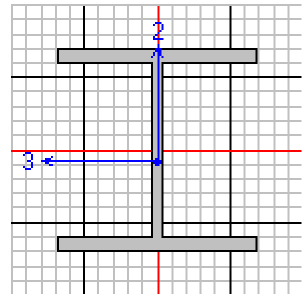
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	101.110	385.480	385.480	379.496
Minor Bending	0.000	180.204	180.204	

	K	L	k	klt	C1
Major Bending	1.000	1.000	0.991	0.999	2.700
Minor Bending	1.000	1.000	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	61.638	493.967	0.125
Minor Shear	0.000	1335.582	0.000

Story Level: STORY5
Element: C3
Section Name: 250UC89.5
Frame Type: Moment Resisting Frame
Station: 2.500
Combo: DSTLS6
Classification: Class 2



L=2.500
A=0.011 I22=4.840E-05 I33=1.430E-04 Wpl22=5.750E-04 Wpl33=0.001
Wel22=3.781E-04 Wel33=0.001 i22=0.065 i33=0.112
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.304 = 0.038 + 0.266 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS6	-112.417	-101.110	0.000	61.638	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	112.417	2997.544	3572.738	3451.005	2997.544

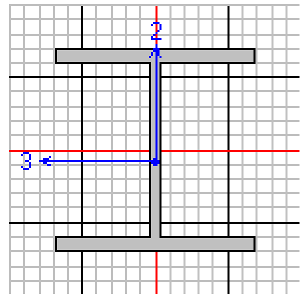
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	101.110	385.480	385.480	379.496
Minor Bending	0.000	180.204	180.204	

	K	L	k	klt	C1
Major Bending	1.000	1.000	0.991	0.999	2.700
Minor Bending	1.000	1.000	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	61.638	493.967	0.125
Minor Shear	0.000	1335.582	0.000

Story Level: STORY4
Element: C1
Section Name: 250UC89.5
Frame Type: Moment Resisting Frame
Station: 3.094
Combo: DSTLS6
Classification: Class 2



L=3.500
A=0.011 I22=4.840E-05 I33=1.430E-04 Wpl22=5.750E-04 Wpl33=0.001
Wel22=3.781E-04 Wel33=0.001 i22=0.065 i33=0.112
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.324 = 0.090 + 0.234 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS6	-247.257	88.018	0.000	-57.439	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	247.257	2747.094	3572.738	2909.717	2747.094

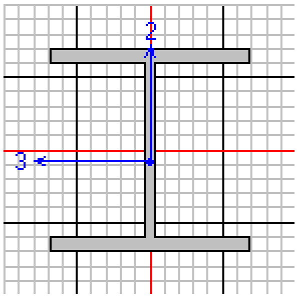
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	88.018	385.480	385.480	374.702
Minor Bending	0.000	180.204	180.204	

	K	L	k	klt	C1
Major Bending	1.763	0.884	0.962	0.995	2.700
Minor Bending	1.000	0.884	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	57.439	493.967	0.116
Minor Shear	0.000	1335.582	0.000

Story Level: STORY4
Element: C2
Section Name: 250UC89.5
Frame Type: Moment Resisting Frame
Station: 0.000
Combo: DSTLS5
Classification: Class 2



L=3.500
A=0.011 I22=4.840E-05 I33=1.430E-04 Wpl22=5.750E-04 Wpl33=0.001
Wel22=3.781E-04 Wel33=0.001 i22=0.065 i33=0.112
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.227 = 0.123 + 0.104 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS5	439.293	39.930	0.000	25.369	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.4.8.1)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	439.293	2747.094	3572.738	3165.302	2747.094

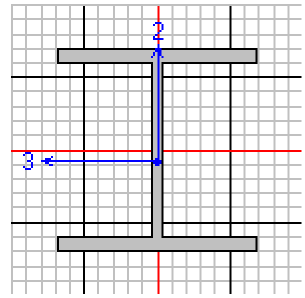
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	39.930	385.480	385.480	374.702
Minor Bending	0.000	180.204	180.204	

	K	L	k	klt	C1
Major Bending	1.359	0.884	1.074	1.000	2.700
Minor Bending	1.000	0.884	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	25.369	493.967	0.051
Minor Shear	0.000	1335.582	0.000

Story Level: STORY4
Element: C3
Section Name: 250UC89.5
Frame Type: Moment Resisting Frame
Station: 0.000
Combo: DSTLS3
Classification: Class 2



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Wel22=3.781E-04 Wel33=0.001 i22=0.065 i33=0.112
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.227 = 0.123 + 0.104 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS3	439.293	-39.930	0.000	-25.369	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.4.8.1)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	439.293	2747.094	3572.738	3165.302	2747.094

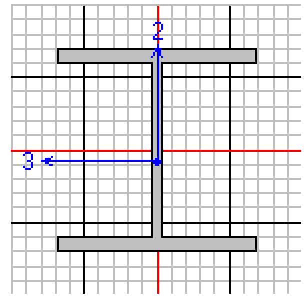
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	39.930	385.480	385.480	374.702
Minor Bending	0.000	180.204	180.204	

	K	L	k	klt	C1
Major Bending	1.359	0.884	1.074	1.000	2.700
Minor Bending	1.000	0.884	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	25.369	493.967	0.051
Minor Shear	0.000	1335.582	0.000

Story Level: STORY4
Element: C4
Section Name: 250UC89.5
Frame Type: Moment Resisting Frame
Station: 3.094
Combo: DSTLS4
Classification: Class 2



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E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.324 = 0.090 + 0.234 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS4	-247.257	-88.018	0.000	57.439	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	247.257	2747.094	3572.738	2909.717	2747.094

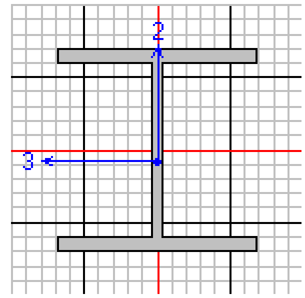
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	88.018	385.480	385.480	374.702
Minor Bending	0.000	180.204	180.204	

	K	L	k	klt	C1
Major Bending	1.763	0.884	0.962	0.995	2.700
Minor Bending	1.000	0.884	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	57.439	493.967	0.116
Minor Shear	0.000	1335.582	0.000

Story Level: STORY3
Element: C1
Section Name: 250UC89.5
Frame Type: Moment Resisting Frame
Station: 0.000
Combo: DSTLS6
Classification: Class 2



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E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.321 = 0.193 + 0.128 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS6	-461.965	-52.942	0.000	-18.803	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	461.965	2394.936	3572.738	2394.936	2702.434

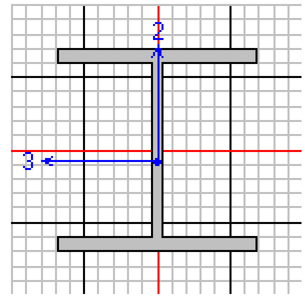
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	52.942	385.480	385.480	373.896
Minor Bending	0.000	180.204	180.204	

	K	L	k	klt	C1
Major Bending	2.348	0.913	0.932	0.991	2.700
Minor Bending	1.000	0.913	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	18.803	493.967	0.038
Minor Shear	0.000	1335.582	0.000

Story Level: STORY3
Element: C2
Section Name: 250UC89.5
Frame Type: Moment Resisting Frame
Station: 0.000
Combo: DSTLS8
Classification: Class 2



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E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.133 = 0.025 + 0.108 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS8	87.929	41.662	0.000	21.134	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.4.8.1)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	87.929	2770.557	3572.738	3155.146	2770.557

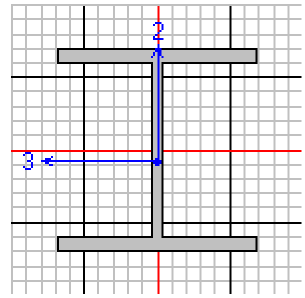
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	41.662	385.480	385.480	375.131
Minor Bending	0.000	180.204	180.204	

	K	L	k	klt	C1
Major Bending	1.401	0.869	1.008	1.000	2.700
Minor Bending	1.000	0.869	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	21.134	493.967	0.043
Minor Shear	0.000	1335.582	0.000

Story Level: STORY3
Element: C3
Section Name: 250UC89.5
Frame Type: Moment Resisting Frame
Station: 0.000
Combo: DSTLS10
Classification: Class 2



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E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.133 = 0.025 + 0.108 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS10	87.929	-41.662	0.000	-21.134	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.4.8.1)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	87.929	2770.557	3572.738	3155.146	2770.557

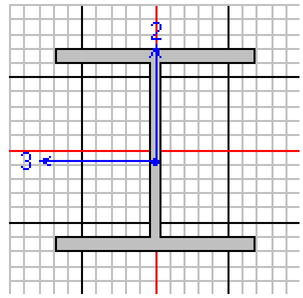
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	41.662	385.480	385.480	375.131
Minor Bending	0.000	180.204	180.204	

	K	L	k	klt	C1
Major Bending	1.401	0.869	1.008	1.000	2.700
Minor Bending	1.000	0.869	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	21.134	493.967	0.043
Minor Shear	0.000	1335.582	0.000

Story Level: STORY3
Element: C4
Section Name: 250UC89.5
Frame Type: Moment Resisting Frame
Station: 0.000
Combo: DSTLS4
Classification: Class 2



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E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.321 = 0.193 + 0.128 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS4	-461.965	52.942	0.000	18.803	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	461.965	2394.936	3572.738	2394.936	2702.434

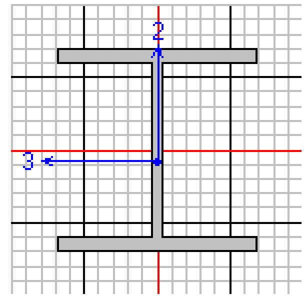
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	52.942	385.480	385.480	373.896
Minor Bending	0.000	180.204	180.204	

	K	L	k	klt	C1
Major Bending	2.348	0.913	0.932	0.991	2.700
Minor Bending	1.000	0.913	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	18.803	493.967	0.038
Minor Shear	0.000	1335.582	0.000

Story Level: STORY2
Element: C1
Section Name: 250UC89.5
Frame Type: Moment Resisting Frame
Station: 0.000
Combo: DSTLS6
Classification: Class 2



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E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.405 = 0.276 + 0.128 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS6	-668.677	-54.236	0.000	-18.887	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	668.677	2422.305	3572.738	2422.305	2702.434

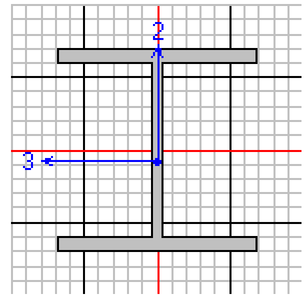
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	54.236	385.480	385.480	373.896
Minor Bending	0.000	180.204	180.204	

	K	L	k	klt	C1
Major Bending	2.317	0.913	0.913	0.987	2.700
Minor Bending	1.000	0.913	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	18.887	493.967	0.038
Minor Shear	0.000	1335.582	0.000

Story Level: STORY2
Element: C2
Section Name: 250UC89.5
Frame Type: Moment Resisting Frame
Station: 0.000
Combo: DSTLS10
Classification: Class 2



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Wel22=3.781E-04 Wel33=0.001 i22=0.065 i33=0.112
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.111 = 0.027 + 0.084 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS10	-75.439	31.504	0.000	20.406	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	75.439	2770.557	3572.738	3161.636	2770.557

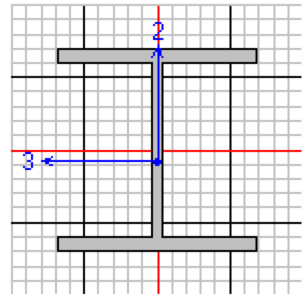
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	31.504	385.480	385.480	375.131
Minor Bending	0.000	180.204	180.204	

	K	L	k	klt	C1
Major Bending	1.389	0.869	0.987	0.998	2.700
Minor Bending	1.000	0.869	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	20.406	493.967	0.041
Minor Shear	0.000	1335.582	0.000

Story Level: STORY2
Element: C3
Section Name: 250UC89.5
Frame Type: Moment Resisting Frame
Station: 0.000
Combo: DSTLS8
Classification: Class 2



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Wel22=3.781E-04 Wel33=0.001 i22=0.065 i33=0.112
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.111 = 0.027 + 0.084 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS8	-75.439	-31.504	0.000	-20.406	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	75.439	2770.557	3572.738	3161.636	2770.557

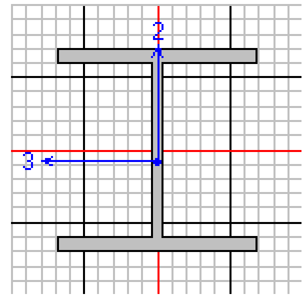
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	31.504	385.480	385.480	375.131
Minor Bending	0.000	180.204	180.204	

	K	L	k	klt	C1
Major Bending	1.389	0.869	0.987	0.998	2.700
Minor Bending	1.000	0.869	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	20.406	493.967	0.041
Minor Shear	0.000	1335.582	0.000

Story Level: STORY2
Element: C4
Section Name: 250UC89.5
Frame Type: Moment Resisting Frame
Station: 0.000
Combo: DSTLS4
Classification: Class 2



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Wel22=3.781E-04 Wel33=0.001 i22=0.065 i33=0.112
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.405 = 0.276 + 0.128 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS4	-668.677	54.236	0.000	18.887	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	668.677	2422.305	3572.738	2422.305	2702.434

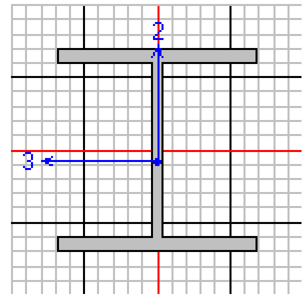
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	54.236	385.480	385.480	373.896
Minor Bending	0.000	180.204	180.204	

	K	L	k	klt	C1
Major Bending	2.317	0.913	0.913	0.987	2.700
Minor Bending	1.000	0.913	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	18.887	493.967	0.038
Minor Shear	0.000	1335.582	0.000

Story Level: STORY1
Element: C1
Section Name: 250UC89.5
Frame Type: Moment Resisting Frame
Station: 0.000
Combo: DSTLS4
Classification: Class 2



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E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.516 = 0.347 + 0.170 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS4	-859.151	-64.755	0.000	-43.868	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	859.151	2478.454	3572.738	2697.302	2478.454

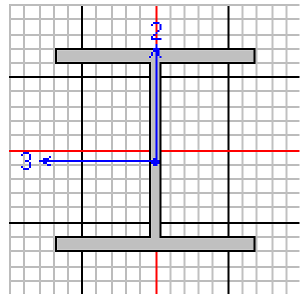
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	64.755	385.480	385.480	370.003
Minor Bending	0.000	180.204	180.204	

	K	L	k	klt	C1
Major Bending	1.719	0.924	0.891	0.970	2.700
Minor Bending	1.000	0.924	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	43.868	493.967	0.089
Minor Shear	0.000	1335.582	0.000

Story Level: STORY1
Element: C2
Section Name: 250UC89.5
Frame Type: Moment Resisting Frame
Station: 0.000
Combo: DSTLS3
Classification: Class 2



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E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.274 = 0.163 + 0.111 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS3	-415.626	41.831	0.000	19.196	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	415.626	2549.044	3572.738	3055.623	2549.044

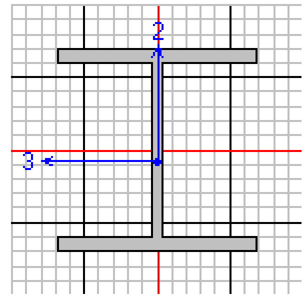
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	41.831	385.480	385.480	371.208
Minor Bending	0.000	180.204	180.204	

	K	L	k	klt	C1
Major Bending	1.347	0.885	0.952	0.987	2.700
Minor Bending	1.000	0.885	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	19.196	493.967	0.039
Minor Shear	0.000	1335.582	0.000

Story Level: STORY1
Element: C3
Section Name: 250UC89.5
Frame Type: Moment Resisting Frame
Station: 0.000
Combo: DSTLS5
Classification: Class 2



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Wel22=3.781E-04 Wel33=0.001 i22=0.065 i33=0.112
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.274 = 0.163 + 0.111 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS5	-415.626	-41.831	0.000	-19.196	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	415.626	2549.044	3572.738	3055.623	2549.044

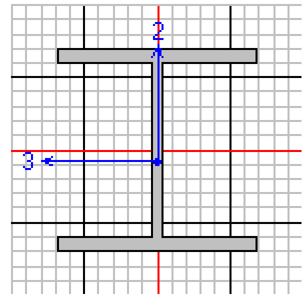
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	41.831	385.480	385.480	371.208
Minor Bending	0.000	180.204	180.204	

	K	L	k	klt	C1
Major Bending	1.347	0.885	0.952	0.987	2.700
Minor Bending	1.000	0.885	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	19.196	493.967	0.039
Minor Shear	0.000	1335.582	0.000

Story Level: STORY1
Element: C4
Section Name: 250UC89.5
Frame Type: Moment Resisting Frame
Station: 0.000
Combo: DSTLS6
Classification: Class 2



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Wel22=3.781E-04 Wel33=0.001 i22=0.065 i33=0.112
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.516 = 0.347 + 0.170 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS6	-859.151	64.755	0.000	43.868	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	859.151	2478.454	3572.738	2697.302	2478.454

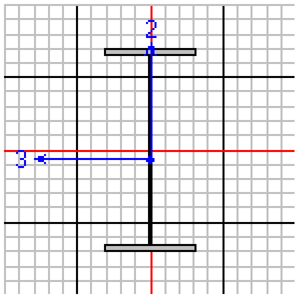
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	64.755	385.480	385.480	370.003
Minor Bending	0.000	180.204	180.204	

	K	L	k	klt	C1
Major Bending	1.719	0.924	0.891	0.970	2.700
Minor Bending	1.000	0.924	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	43.868	493.967	0.089
Minor Shear	0.000	1335.582	0.000

Story Level: STORY4
Element: B1
Section Name: 410UB59.7
Frame Type: Moment Resisting Frame
Station: 5.870
Combo: DSTLS6
Classification: Class 2



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E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 1.386 = 0.109 + 1.278 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS6	-59.385	-241.989	0.000	234.714	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	59.385	545.951	2394.361	2247.772	545.951

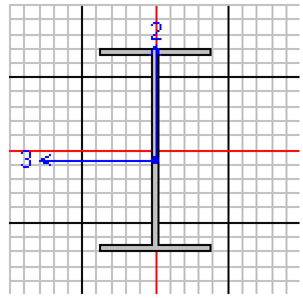
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	241.989	376.078	376.078	185.130
Minor Bending	0.000	65.500	65.500	

	K	L	k	klt	C1
Major Bending	1.000	0.957	1.000	0.977	1.314
Minor Bending	1.000	0.957	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	234.714	573.002	0.410
Minor Shear	0.000	687.091	0.000

Story Level: STORY4
Element: B3
Section Name: 310UB40.4
Frame Type: Moment Resisting Frame
Station: 1.370
Combo: DSTLS2
Classification: Class 2



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Wel22=9.273E-05 Wel33=5.684E-04 i22=0.038 i33=0.129
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.156 = 0.000 + 0.156 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS2	0.000	-30.237	0.000	44.142	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	0.000	1463.284	1632.804	1632.804	1463.284

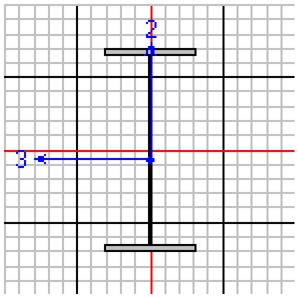
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	30.237	198.381	198.381	193.534
Minor Bending	0.000	44.503	44.503	

	K	L	k	klt	C1
Major Bending	1.000	0.913	1.000	1.000	1.880
Minor Bending	1.000	0.913	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	44.142	335.536	0.132
Minor Shear	0.000	507.538	0.000

Story Level: STORY4
Element: B5
Section Name: 410UB59.7
Frame Type: Moment Resisting Frame
Station: 0.130
Combo: DSTLS4
Classification: Class 2



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Wel22=1.360E-04 Wel33=0.001 i22=0.040 i33=0.168
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 1.386 = 0.109 + 1.278 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS4	-59.385	-241.989	0.000	-234.714	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	59.385	545.951	2394.361	2247.772	545.951

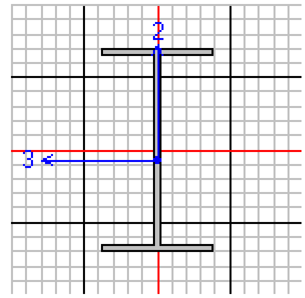
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	241.989	376.078	376.078	185.130
Minor Bending	0.000	65.500	65.500	

	K	L	k	klt	C1
Major Bending	1.000	0.957	1.000	0.977	1.314
Minor Bending	1.000	0.957	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	234.714	573.002	0.410
Minor Shear	0.000	687.091	0.000

Story Level: STORY4
Element: B6
Section Name: 310UB40.4
Frame Type: Moment Resisting Frame
Station: 0.130
Combo: DSTLS2
Classification: Class 2



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Wel22=9.273E-05 Wel33=5.684E-04 i22=0.038 i33=0.129
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.156 = 0.000 + 0.156 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS2	0.000	-30.237	0.000	-44.142	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	0.000	1463.284	1632.804	1632.804	1463.284

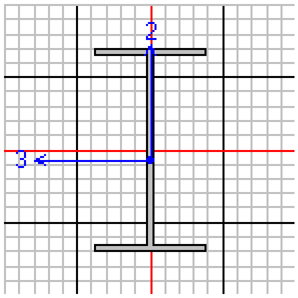
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	30.237	198.381	198.381	193.534
Minor Bending	0.000	44.503	44.503	

	K	L	k	klt	C1
Major Bending	1.000	0.913	1.000	1.000	1.880
Minor Bending	1.000	0.913	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	44.142	335.536	0.132
Minor Shear	0.000	507.538	0.000

Story Level: STORY3
Element: B1
Section Name: 310UB40.4
Frame Type: Moment Resisting Frame
Station: 5.870
Combo: DSTLS2
Classification: Class 2



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Wel22=9.273E-05 Wel33=5.684E-04 i22=0.038 i33=0.129
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 1.719 = 0.010 + 1.710 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS2	15.791	-140.451	0.000	146.855	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	15.791	348.215	1632.804	1459.838	348.215

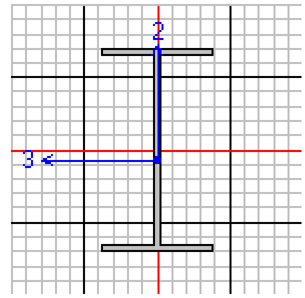
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	140.451	198.381	198.381	81.342
Minor Bending	0.000	44.503	44.503	

	K	L	k	klt	C1
Major Bending	1.000	0.957	1.000	1.000	1.084
Minor Bending	1.000	0.957	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	146.855	335.536	0.438
Minor Shear	0.000	507.538	0.000

Story Level: STORY3
Element: B3
Section Name: 310UB40.4
Frame Type: Moment Resisting Frame
Station: 1.370
Combo: DSTLS2
Classification: Class 2



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Wel22=9.273E-05 Wel33=5.684E-04 i22=0.038 i33=0.129
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.156 = 0.000 + 0.156 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS2	0.000	-30.237	0.000	44.142	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	0.000	1463.284	1632.804	1632.804	1463.284

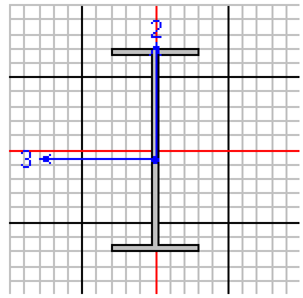
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	30.237	198.381	198.381	193.534
Minor Bending	0.000	44.503	44.503	

	K	L	k	klt	C1
Major Bending	1.000	0.913	1.000	1.000	1.880
Minor Bending	1.000	0.913	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	44.142	335.536	0.132
Minor Shear	0.000	507.538	0.000

Story Level: STORY3
Element: B4
Section Name: 460UB82.1
Frame Type: Moment Resisting Frame
Station: 7.470
Combo: DSTLS2
Classification: Class 2



L=7.600
A=0.011 I22=1.860E-05 I33=3.720E-04 Wpl22=3.030E-04 Wpl33=0.002
Wel22=1.948E-04 Wel33=0.002 i22=0.042 i33=0.188
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.751 = 0.000 + 0.751 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS2	0.000	-142.373	0.000	120.262	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	0.000	533.576	3290.680	3025.515	533.576

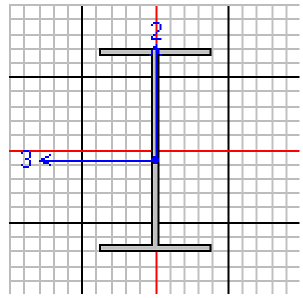
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	142.373	576.652	576.652	189.688
Minor Bending	0.000	94.960	94.960	

	K	L	k	klt	C1
Major Bending	1.000	0.966	1.000	1.000	1.000
Minor Bending	1.000	0.966	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	120.262	824.003	0.146
Minor Shear	0.000	921.590	0.000

Story Level: STORY3
Element: B5
Section Name: 310UB40.4
Frame Type: Moment Resisting Frame
Station: 0.130
Combo: DSTLS2
Classification: Class 2



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Wel22=9.273E-05 Wel33=5.684E-04 i22=0.038 i33=0.129
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 1.719 = 0.010 + 1.710 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS2	15.791	-140.451	0.000	-146.855	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	15.791	348.215	1632.804	1459.838	348.215

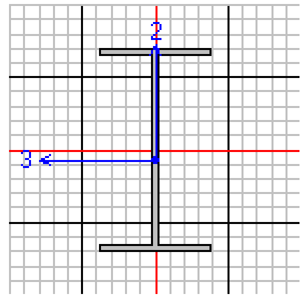
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	140.451	198.381	198.381	81.342
Minor Bending	0.000	44.503	44.503	

	K	L	k	klt	C1
Major Bending	1.000	0.957	1.000	1.000	1.084
Minor Bending	1.000	0.957	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	146.855	335.536	0.438
Minor Shear	0.000	507.538	0.000

Story Level: STORY3
Element: B6
Section Name: 310UB40.4
Frame Type: Moment Resisting Frame
Station: 0.130
Combo: DSTLS2
Classification: Class 2



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Wel22=9.273E-05 Wel33=5.684E-04 i22=0.038 i33=0.129
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.156 = 0.000 + 0.156 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS2	0.000	-30.237	0.000	-44.142	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	0.000	1463.284	1632.804	1632.804	1463.284

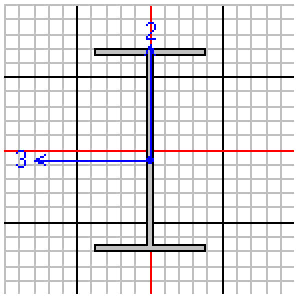
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	30.237	198.381	198.381	193.534
Minor Bending	0.000	44.503	44.503	

	K	L	k	klt	C1
Major Bending	1.000	0.913	1.000	1.000	1.880
Minor Bending	1.000	0.913	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	44.142	335.536	0.132
Minor Shear	0.000	507.538	0.000

Story Level: STORY2
Element: B1
Section Name: 310UB40.4
Frame Type: Moment Resisting Frame
Station: 5.870
Combo: DSTLS2
Classification: Class 2



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Wel22=9.273E-05 Wel33=5.684E-04 i22=0.038 i33=0.129
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 1.726 = 0.016 + 1.710 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS2	-5.577	-139.667	0.000	146.864	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	5.577	348.215	1632.804	1459.838	348.215

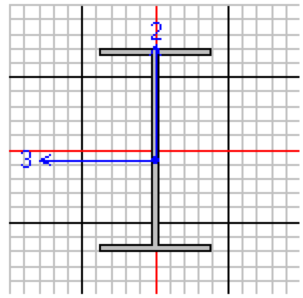
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	139.667	198.381	198.381	81.391
Minor Bending	0.000	44.503	44.503	

	K	L	k	klt	C1
Major Bending	1.000	0.957	1.000	0.997	1.085
Minor Bending	1.000	0.957	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	146.864	335.536	0.438
Minor Shear	0.000	507.538	0.000

Story Level: STORY2
Element: B3
Section Name: 310UB40.4
Frame Type: Moment Resisting Frame
Station: 1.370
Combo: DSTLS2
Classification: Class 2



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Wel22=9.273E-05 Wel33=5.684E-04 i22=0.038 i33=0.129
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.156 = 0.000 + 0.156 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS2	0.000	-30.237	0.000	44.142	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	0.000	1463.284	1632.804	1632.804	1463.284

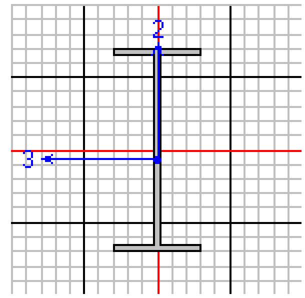
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	30.237	198.381	198.381	193.534
Minor Bending	0.000	44.503	44.503	

	K	L	k	klt	C1
Major Bending	1.000	0.913	1.000	1.000	1.880
Minor Bending	1.000	0.913	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	44.142	335.536	0.132
Minor Shear	0.000	507.538	0.000

Story Level: STORY2
Element: B4
Section Name: 460UB82.1
Frame Type: Moment Resisting Frame
Station: 7.470
Combo: DSTLS2
Classification: Class 2



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Wel22=1.948E-04 Wel33=0.002 i22=0.042 i33=0.188
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.757 = 0.010 + 0.746 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS2	-5.498	-141.971	0.000	120.262	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	5.498	533.576	3290.680	3025.515	533.576

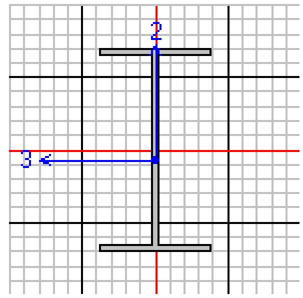
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	141.971	576.652	576.652	189.688
Minor Bending	0.000	94.960	94.960	

	K	L	k	klt	C1
Major Bending	1.000	0.966	1.000	0.997	1.000
Minor Bending	1.000	0.966	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	120.262	824.003	0.146
Minor Shear	0.000	921.590	0.000

Story Level: STORY2
Element: B5
Section Name: 310UB40.4
Frame Type: Moment Resisting Frame
Station: 0.130
Combo: DSTLS2
Classification: Class 2



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A=0.005 I22=7.650E-06 I33=8.640E-05 Wpl22=1.420E-04 Wpl33=6.330E-04
Wel22=9.273E-05 Wel33=5.684E-04 i22=0.038 i33=0.129
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 1.726 = 0.016 + 1.710 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS2	-5.577	-139.667	0.000	-146.864	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	5.577	348.215	1632.804	1459.838	348.215

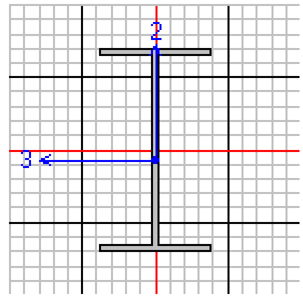
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	139.667	198.381	198.381	81.391
Minor Bending	0.000	44.503	44.503	

	K	L	k	klt	C1
Major Bending	1.000	0.957	1.000	0.997	1.085
Minor Bending	1.000	0.957	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	146.864	335.536	0.438
Minor Shear	0.000	507.538	0.000

Story Level: STORY2
Element: B6
Section Name: 310UB40.4
Frame Type: Moment Resisting Frame
Station: 0.130
Combo: DSTLS2
Classification: Class 2



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A=0.005 I22=7.650E-06 I33=8.640E-05 Wpl22=1.420E-04 Wpl33=6.330E-04
Wel22=9.273E-05 Wel33=5.684E-04 i22=0.038 i33=0.129
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.156 = 0.000 + 0.156 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS2	0.000	-30.237	0.000	-44.142	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	0.000	1463.284	1632.804	1632.804	1463.284

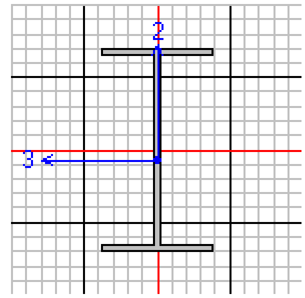
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	30.237	198.381	198.381	193.534
Minor Bending	0.000	44.503	44.503	

	K	L	k	klt	C1
Major Bending	1.000	0.913	1.000	1.000	1.880
Minor Bending	1.000	0.913	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	44.142	335.536	0.132
Minor Shear	0.000	507.538	0.000

Story Level: STORY1
Element: B1
Section Name: 310UB40.4
Frame Type: Moment Resisting Frame
Station: 5.870
Combo: DSTLS2
Classification: Class 2



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Wel22=9.273E-05 Wel33=5.684E-04 i22=0.038 i33=0.129
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 1.698 = 0.010 + 1.688 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS2	15.727	-139.086	0.000	146.979	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	15.727	348.215	1632.804	1459.838	348.215

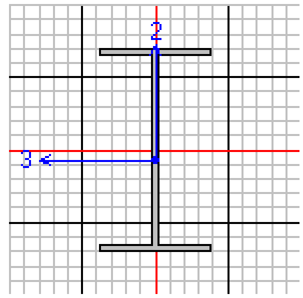
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	139.086	198.381	198.381	81.581
Minor Bending	0.000	44.503	44.503	

	K	L	k	klt	C1
Major Bending	1.000	0.957	1.000	1.000	1.088
Minor Bending	1.000	0.957	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	146.979	335.536	0.438
Minor Shear	0.000	507.538	0.000

Story Level: STORY1
Element: B3
Section Name: 310UB40.4
Frame Type: Moment Resisting Frame
Station: 1.370
Combo: DSTLS2
Classification: Class 2



L=1.500
A=0.005 I22=7.650E-06 I33=8.640E-05 Wpl22=1.420E-04 Wpl33=6.330E-04
Wel22=9.273E-05 Wel33=5.684E-04 i22=0.038 i33=0.129
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is   0.156 = 0.000 + 0.156 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS2	0.000	-30.237	0.000	44.142	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN   (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	0.000	1463.284	1632.804	1632.804	1463.284

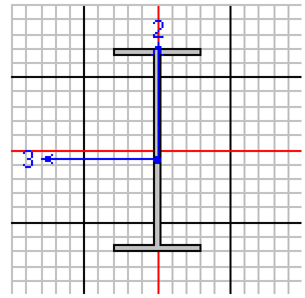
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	30.237	198.381	198.381	193.534
Minor Bending	0.000	44.503	44.503	

	K	L	k	klt	C1
Major Bending	1.000	0.913	1.000	1.000	1.880
Minor Bending	1.000	0.913	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	44.142	335.536	0.132
Minor Shear	0.000	507.538	0.000

Story Level: STORY1
Element: B4
Section Name: 460UB82.1
Frame Type: Moment Resisting Frame
Station: 0.130
Combo: DSTLS2
Classification: Class 2



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A=0.011 I22=1.860E-05 I33=3.720E-04 Wpl22=3.030E-04 Wpl33=0.002
Wel22=1.948E-04 Wel33=0.002 i22=0.042 i33=0.188
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.743 = 0.005 + 0.739 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS2	15.211	-141.967	0.000	-120.262	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	15.211	533.576	3290.680	3025.515	533.576

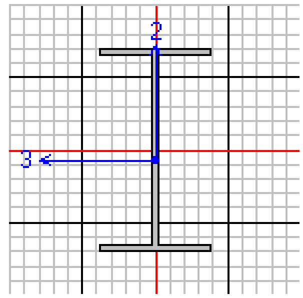
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	141.967	576.652	576.652	189.688
Minor Bending	0.000	94.960	94.960	

	K	L	k	klt	C1
Major Bending	1.000	0.966	1.000	1.000	1.000
Minor Bending	1.000	0.966	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	120.262	824.003	0.146
Minor Shear	0.000	921.590	0.000

Story Level: STORY1
Element: B5
Section Name: 310UB40.4
Frame Type: Moment Resisting Frame
Station: 0.130
Combo: DSTLS2
Classification: Class 2



L=6.000
A=0.005 I22=7.650E-06 I33=8.640E-05 Wpl22=1.420E-04 Wpl33=6.330E-04
Wel22=9.273E-05 Wel33=5.684E-04 i22=0.038 i33=0.129
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 1.698 = 0.010 + 1.688 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS2	15.727	-139.086	0.000	-146.979	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	15.727	348.215	1632.804	1459.838	348.215

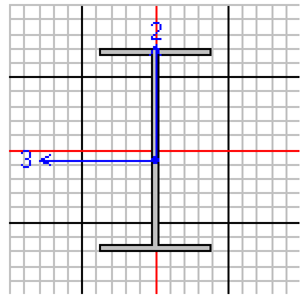
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	139.086	198.381	198.381	81.581
Minor Bending	0.000	44.503	44.503	

	K	L	k	klt	C1
Major Bending	1.000	0.957	1.000	1.000	1.088
Minor Bending	1.000	0.957	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	146.979	335.536	0.438
Minor Shear	0.000	507.538	0.000

Story Level: STORY1
Element: B6
Section Name: 310UB40.4
Frame Type: Moment Resisting Frame
Station: 0.130
Combo: DSTLS2
Classification: Class 2



L=1.500
A=0.005 I22=7.650E-06 I33=8.640E-05 Wpl22=1.420E-04 Wpl33=6.330E-04
Wel22=9.273E-05 Wel33=5.684E-04 i22=0.038 i33=0.129
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.156 = 0.000 + 0.156 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS2	0.000	-30.237	0.000	-44.142	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	0.000	1463.284	1632.804	1632.804	1463.284

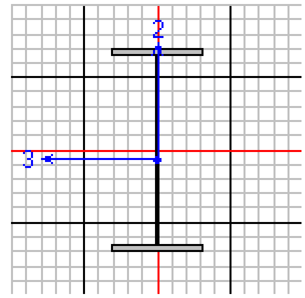
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	30.237	198.381	198.381	193.534
Minor Bending	0.000	44.503	44.503	

	K	L	k	klt	C1
Major Bending	1.000	0.913	1.000	1.000	1.880
Minor Bending	1.000	0.913	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	44.142	335.536	0.132
Minor Shear	0.000	507.538	0.000

Story Level: STORY6
Element: D1
Section Name: 410UB59.7
Frame Type: Moment Resisting Frame
Station: 0.000
Combo: DSTLS4
Classification: Class 2



L=3.901
A=0.008 I22=1.210E-05 I33=2.160E-04 Wpl22=2.090E-04 Wpl33=0.001
Wel22=1.360E-04 Wel33=0.001 i22=0.040 i33=0.168
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.386 = 0.083 + 0.303 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS4	-85.483	-101.110	0.000	-95.549	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	85.483	1027.123	2394.361	2336.732	1027.123

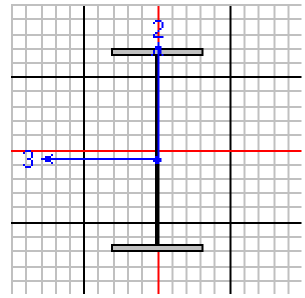
	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	101.110	376.078	376.078	328.007
Minor Bending	0.000	65.500	65.500	

	K	L	k	klt	C1
Major Bending	1.000	1.000	0.997	0.983	2.700
Minor Bending	1.000	1.000	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	95.549	573.002	0.167
Minor Shear	0.000	687.091	0.000

Story Level: STORY6
Element: D2
Section Name: 410UB59.7
Frame Type: Moment Resisting Frame
Station: 0.000
Combo: DSTLS6
Classification: Class 2



L=3.901
A=0.008 I22=1.210E-05 I33=2.160E-04 Wpl22=2.090E-04 Wpl33=0.001
Wel22=1.360E-04 Wel33=0.001 i22=0.040 i33=0.168
E=199947978.80 fy=344737.894
RLLF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.386 = 0.083 + 0.303 + 0.000

STRESS CHECK FORCES & MOMENTS

	P	M33	M22	V2	V3
Combo DSTLS6	-85.483	-101.110	0.000	-95.549	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (5.5.4)

	Nc.Sd or Nt.Sd	Nc.Rd	Nt.Rd	Nb33.Rd	Nb22.Rd
Axial	85.483	1027.123	2394.361	2336.732	1027.123

	M.Sd	Mc.Rd	Mv.Rd	Mb.Rd
Major Bending	101.110	376.078	376.078	328.007
Minor Bending	0.000	65.500	65.500	

	K	L	k	klt	C1
Major Bending	1.000	1.000	0.997	0.983	2.700
Minor Bending	1.000	1.000	1.000		

SHEAR DESIGN

	V.Sd	V.Rd	Ratio
Major Shear	95.549	573.002	0.167
Minor Shear	0.000	687.091	0.000