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IZMIR OPERA HOUSE

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ABSTRACT

Not only for their existence in other cities of Turkey but also for their existence in well-developed worldwide cities is opera house has an important necessity for a city liked Izmir. The cultural locomotive city of Turkey with its enlightened and intellectual population would be a perfect location for the new opera house. For this reason the municipality of Izmir launched a competition. Although there were some major constraints for the project as huge socio-economic gap between the neighborhoods of the peripheral area or the unplanned settlement, the competition caught enough attention and took participation from different social classes and age groups. In this study we aimed to discuss our point of view about the competition.

This study has been done not only to design the opera house but also to suggest solutions to the existing urban problems. Another aim of the project could be stated as to create an example to the constructing new building or preserving the nature conflict by providing services and a more active social life especially for elderly people, disabled people, children and mothers but generally to everybody enabling them to integrate to the society and offering them a more colorful life.

CHAPTER 1

PROPOSAL

1.THE PROPOSAL

1.1.Statement of the Proposal

In an intense collaboration, architects and engineers, not only build building blocks but also build the future of the communities. Establishing the standards, shaping the society for the future is a great responsibility, yet, the relieving idea of adding value to the society and enhancing the community life makes it possible for the architects and engineers to go one step further at each different design case. From this point of view, an opera house project would generate the greatest excitement for architects and engineers since an opera house is one of the major determinants of the common cultural life.

Choosing an opera house project for the topic of thesis was a brave decision but the strong social and cultural aspects of the project made it so attractive that intensive workload became quite acceptable. This is mainly due to the fact that such projects contribute to the vision of the performers of the project, since they require a deep analysis of the society, culture, social life, urban development, environment, and economy, as well as a thorough understanding of the architectural aspects, such as functionality, spatial quality and aesthetics.

1.2.Project Objectives

The Competition held for the İzmir Opera House, was the most appropriate project in regard to the fulfillment of the criteria mentioned. The competition involved the preliminary design of an opera house with a gross floor area of 30.000 m^2 containing cultural center, sports area, open parking area, closed parking area, waterfront.

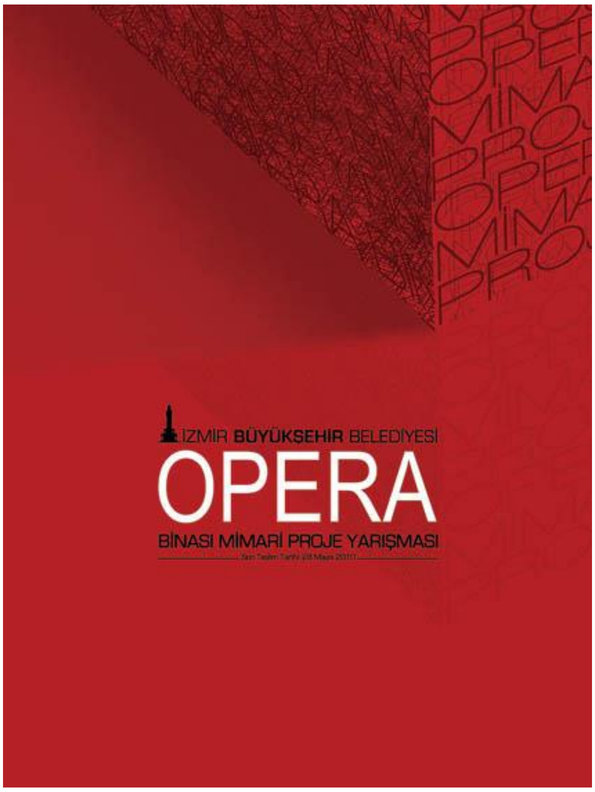


Figure 1 Izmır Opera House Competition

1.3.Site Selection

Figure 2Location Of Site in Karsiyaka/Izmir

Site is in the MaviSehir/Karsiyaka District Of Izmir which is mostly a residential, growing district.

Figure 3 Mavisehir District

In the selection of the project for the performance of the thesis, the location of the project site was seen as one of the most important criteria. This is mainly because traveling to site for couple of times would be possible. What is more, we believe that to be able to create accurate solutions it is important to know well the socio-cultural aspects of the area. In addition, the habitants of the existing development would be more familiar and the sources would be more easily accessible.

1.4.Project Scope of the Work

It is the contribution of an opera house to Izmir but the scope also includes a variety of aspects regarding the analyzing the urban context of the area, the designing of the area surrounding the building, finding technological solution for construction and making the analysis of visual and thermal aspects.

For the purpose of establishing a clear organization for the thesis, the work has been divided into four parts: Urban Design, Architectural Design, Structural Design and Technological Design, which are, in fact, in correlation with each other. In general, the organization of the thesis has been done from larger scale to smaller scale. However, it should be reminded that this organization of the topics does not always imply a chronological order of performance of the work, due to synchronous nature of some parts of each section's process.

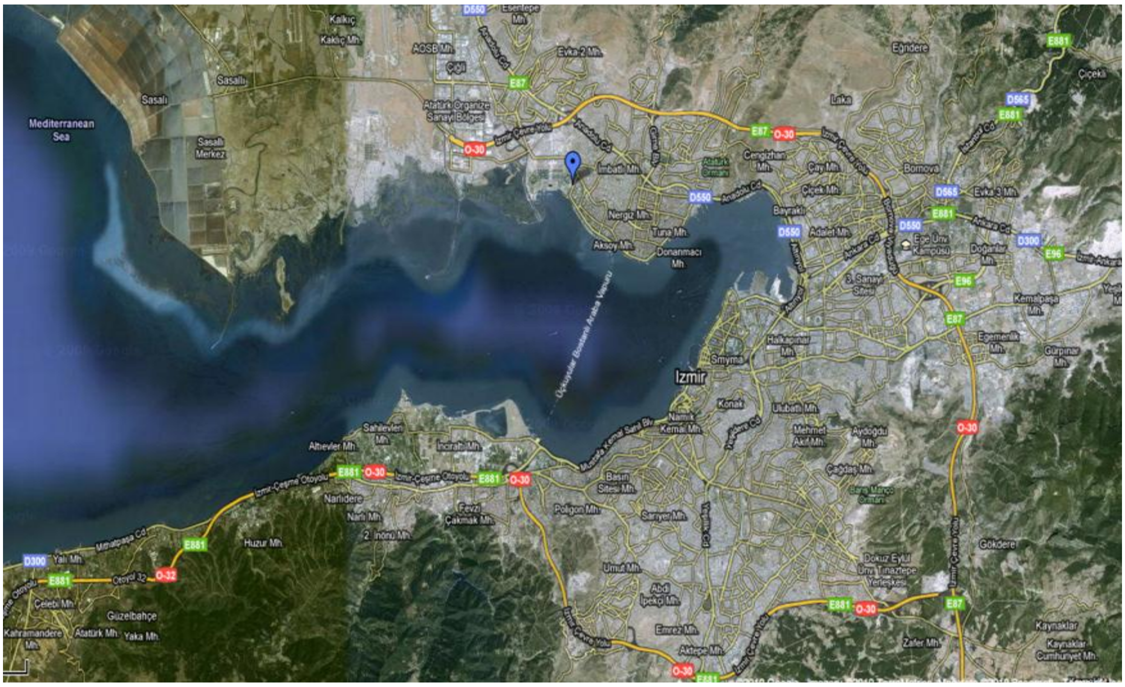


Figure 4 Project site / Izmir

CHAPTER 2

URBAN CONTEXT

2. URBAN CONTEXT

Karşıyaka is a significant district located in city of İzmir, which is the capital of Egean Region, and which is the third highly populated city in Turkey. At this part of the report, the area of the project will be explained from the larger scale to the main location.

2.1. Turkey

Turkey known officially as the Republic of Turkey is a Eurasian country that stretches across the Anatolian peninsula in western Asia and Thrace in the Balkan region of southeastern Europe. Turkey is bordered by eight countries: Bulgaria to the northwest; Greece to the west; Georgia to the northeast; Armenia, Azerbaijan and Iran to the east; and Iraq and Syria to the southeast. The Mediterranean Sea and Cyprus are to the south; the Aegean Sea to the west; and the Black Sea is to the north. The Sea of Marmara, the Bosphorus and the Dardanelles (which together form the Turkish Straits) demarcate the boundary between Eastern Thrace and Anatolia; they also separate Europe and Asia. Turkey's location at the crossroads of Europe and Asia makes it a country of significant geostrategic importance. Turkey is one of the six independent Turkic states. The predominant religion by number of people is Islam

Turkey is a democratic, secular, unitary, constitutional republic with an ancient cultural heritage. Turkey has become increasingly integrated with the West through membership in organizations such as the Council of Europe, NATO, OECD, OSCE and the G-20 major economies. Turkey began full membership negotiations with the European Union in 2005, having been an associate member of the European Economic Community since 1963 and having reached a customs union agreement in 1995. Turkey has also fostered close cultural, political, economic and industrial relations with the Middle East, the Turkic states of Central Asia and the African countries through membership in organizations such as the Turkic Council, Joint Administration of Turkic Arts and Culture, Organization of Islamic Cooperation and the Economic Cooperation Organization. [1]

Turkey's location at the crossroads of Europe and Asia makes it a country of significant geostrategic importance. Given its strategic location, large economy and military strength, Turkey is a major regional power.

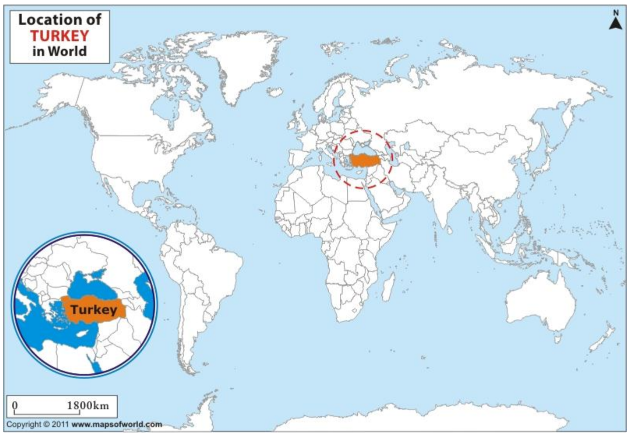


Figure 5 Location Of Turkey[2]

[1] Ministry of Culture and Tourism ; *Turkey : from* www.kultur.gov.tr*; 2011*

[2] Maps of World; Turkey; *19 april 2011; from www.mapsofworld.com*

2.1.1.History of Turkey

Turks began migrating into Anatolia, the area now called Turkey, (Türkiye means land of Turks) in the 11th century. The process was greatly accelerated by the Seljuk victory over the Byzantine Empire at the Battle of Malazgirt. Several small countries (beylik) and the Sultan of Seljuk ruled Anatolia until the Mongol Empire's invasion. Starting from the 13th century, the Ottoman beylik united Anatolia and created an empire encompassing much of Southeastern Europe, Western Asia and North Africa. After the Ottoman Empire collapsed following its defeat in World War I, parts of it were occupied by the victorious Allies. A cadre of young military officers, led by Mustafa Kemal Ataturk, organized a successful resistance to the Allies; in 1923, they would establish the modern Republic of Turkey.

Turkey was formally proclaimed a republic in Oct., 1923, with Atatürk as its first president; he was reelected in 1927, 1931, and 1935. The caliphate was abolished in 1924, and in the same year a constitution was promulgated that provided for a parliament elected by universal manhood suffrage (extended to women in 1934), and for a cabinet responsible to parliament. However, Atatürk governed as a virtual leader, and his Republican People's party was the only legal party, except for brief periods. During the 14 years of Atatürk's rule, Turkey underwent a great transformation, which changed the religious, social, and cultural bases of Turkish society as well as its political and economic structure.

At the death (1938) of Atatürk, Turkey was well on its way to becoming a state on the Western model. In the economic field, Atatürk aimed at obtaining self-sufficiency for Turkey without the aid of foreign capital. Foreign investors had virtually taken over the finances of the Ottoman Empire, and one of the major problems of the Turkish republic was to pay off the old Ottoman debt; the refusal of foreign loans thus was a basic point in Atatürk's nationalist program. The difficulties of establishing basic heavy industries without foreign investment and in the absence of much domestic capital required the government to assume a large role, and state ownership became the rule in the new industries.

In foreign policy, Turkey sought friendly relations with all its neighbors. It entered the League of Nations in 1932, guaranteed its European borders by joining (1934) with Greece, Romania, and Yugoslavia in the Balkan Entente, and signed (1937) a treaty (the Sadabad Pact) with Afghanistan, Iran, and Iraq. Although Communism was severely suppressed at home, relations with the USSR were cordial until World War II. Turkey was able to obtain a revision of the Straits Convention by the Montreux Convention of 1936 and gained a satisfactory solution of the Alexandretta dispute through an agreement with France in 1939[3]

2.1.2.Opera in Turkey

At early history, the first opera staged during the Ottoman period is usually attributed to the reign of Selim III (1761–1808), when Selim, himself a composer and a poet, invited a foreign company to stage an opera at the Topkapı Palace in 1797. In 1840, Gaetano Donizetti's Belisario became the first opera to be translated into Turkish, and was performed at the newly built theatre by Italian architect Bosco. An important public opera performance was Giuseppe Verdi's Ernani, staged by an Italian company in Beyoğlu in 1846. During the period of 1846 - 1877,

[3] Ministry of Culture and Tourism ; *Republic of Turkey*

operas of Verdi, performed mostly by Italian companies, reached a wide audience. That theatre by Bosco later on named Naum Theatre has turned into one of the major halls worldwide. In Garnier's World Theatre Guide of 1871, manages to find a place. Flaubert and Garnier were frequent visitors of Naum theatre till it turns into ashes after a fire.

At republican period, under Atatürk's personal guidance, many talented young people were sent to Europe for professional training. Management of the theatre and the opera were separated in 1958, creating the directorates of Turkish State Theatres and State Opera and Ballet in 1959. This was followed by the establishment of İzmir State Opera and Ballet in 1983, Mersin State Opera and Ballet in 1992, and Antalya State Opera and Ballet in 1999.[4]

Today, opera is not well-followed and doesn't have much audience. Opera houses are mostly located in well-populated cities. Ankara, the capital city, leads in number of houses by 3. Others are in Izmir, Istanbul (2), Antalya, Mersin and Samsun.

Figure 6 Ankara Opera House

Figure 7 Istanbul Sureyya House

[4] Directorate General of State Opera and Ballet; Opera and Ballet in Turkey

Figure 8 Samsun Opera House

Figure 9 Mersin Opera House

Figure 10 Aspendos Opera

La Diva Turca, Leyla Gencer, was a world-renowned Turkish operatic soprano. She was known as "the Turkish Diva" or "The Queen" in the opera world.[5] Gencer was a notable bell canto soprano. She spent most of her career in Italy, from the early 1950's through the mid-1980's, and had a repertoire encompassing more than seventy roles. In particular, Gencer was associated with the heroines of Donizetti.


Figure 11 La diva Turca/Leyla Gencer

2.2 Aegean Region

Turkey's Aegean shores are among the loveliest landscapes in the country. The magnificent coastline, lapped by the clear water of the Aegean Sea, abounds in vast and pristine beaches surrounded by olive groves, rocky crags and pine woods. Dotted with idyllic fishing harbors, popular holiday villages and the remains of ancient civilizations attesting to the inheritance of more than 5,000 years of history, culture and mythology, this region offers a holiday with something for everyone - nature lovers, sun worshippers, photographers, sports enthusiasts, sailors and archaeologists.

The Aegean coastal plain enjoys an exceptionally mild climate, with soft, verdant springs, hot summers, sunny autumns and warm winters marked by occasional showers. Aegean region has perpendicular mountains to its shores and many valleys between them, thus permitting the sea climate reach inner parts of the region, although some of the provinces inland show also characteristics of continental climate..

[5] Franca Cella, *Leyla Gencer, 50 anni alla Scala*, Teatro alla Scala, 2008

The region occupies 11% of the total area of Turkey with its 79.000 square kilometers of land. Most of the population and cities are concentrated on the coast line because of its convenience for sea transportation and tourism. The Aegean region is also both industrialized and agriculturalized. Main products are; textile, leather, carpet weaving, food, machinery and spare parts, marble, tobacco, sugar, olive and olive oil. About half of the total olive trees of Turkey are in this region. There are many important rivers feeding the Aegean Sea.

Izmir, the gateway to the Aegean region, is connected to Istanbul by frequent air, sea, bus and train connections. The plane flight is about 50 minutes, while comfortable overnight buses reach Izmir in about seven hours. Convenient train connection can be made from the Istanbul - Bandirma fast ferry, a two-hour ride across the Marmara Sea. A private maritime company operates over-night car ferries from Istanbul to Izmir a couple of times a week. There are also sea connections between Ancona (Italy) to Cesme in the summer and autumn months. By private car, Izmir can be reached via Bursa road or via Canakkale coastal road. For travelers wishing to begin their journey further to the south, the Dalaman airport near Marmaris is served by regularly scheduled and charter airlines. Self-drive car rentals can be arranged for pick-up at the airport. Provinces in this region: İzmir, Aydin, Manisa, Kutahya, Usak, Mugla, Denizli, Afyon.

2.3. İzmir

İzmir is a large metropolis in western Anatolia and the capital of the İzmir Province in Turkey. It is Turkey's third most populous city and the country's second-largest port city after Istanbul. It is located along the outlying waters of the Gulf of İzmir on the eastern shoreline of the Aegean Sea. The city was formerly known as Smyrna.

Figure 12 Izmır / Western Turkey

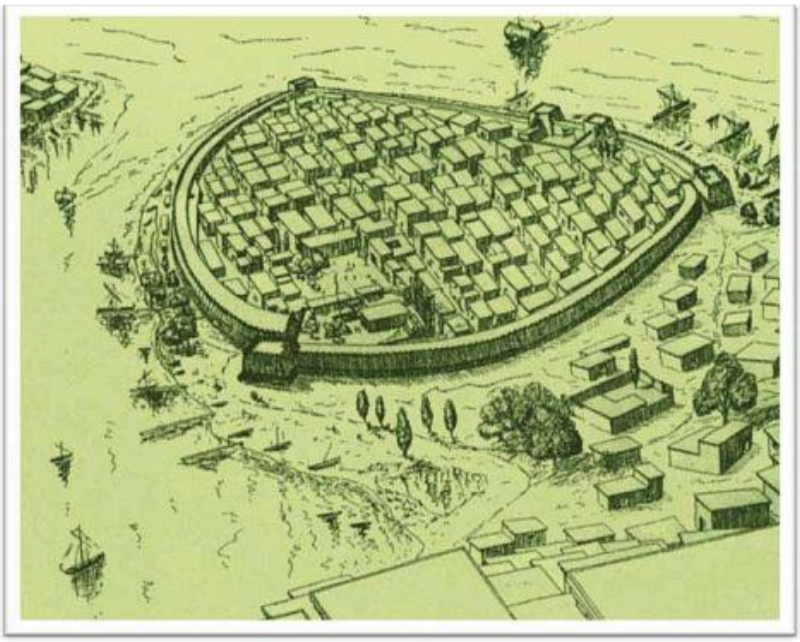
Many legends are known about the derivation of the name of Izmir. According to the knowledge acquired from scientific studies the word "IZMIR" came from Smyrna in the ancient Ionian dialect and it was written as Smyrna in the Attican (around Athens) dialect. The word Smyrna was not Greek, it came from Anatolian root like many other names in the Aegean Region from the texts belonging to 2000 B.C. in the Kültepe settlement in Kayseri, a place called Tismyrna was come across and the (Ti) at the beginning was omitted and the city was pronounced as Smyrna. So the city was called Smyrna the early years of 3000 B.C. or late 1800 B.C. In the Turkish era the city was called Izmir.

The city of İzmir is composed of several districts. Of these, Konak district corresponds to historical İzmir, this district's area having constituted "İzmir Municipality" area until 1984, Konak until then having been a name for a central neighborhood around Konak Square, still the core of the city. With the constitution of "Greater İzmir Metropolitan Municipality", the city of İzmir became a compound bringing together initially nine, and since recently eleven metropolitan districts, namely Balçova, Bayraklı, Bornova, Buca, Çiğli, Gaziemir, Güzelbahçe, Karabağlar, Karşıyaka, Konak and Narlıdere. Almost each of these settlements is former district centers or neighborhoods which stood on their own and with their own distinct features and temperament.

2.3.1. History of İzmir[6]

Ancient Age

The city is one of the oldest settlements of the Mediterranean basin. The 2004 discovery of Yeşilova Höyük and the neighboring Yassıtepe, situated in the small delta of Meles River, now the plain of Bornova, reset the starting date of the city's past further back than was previously thought. The findings of the two seasons of excavations carried out in the Yeşilova Höyük by a team of archaeologists from İzmir's Ege University indicate three levels, two of which are prehistoric. Level 2 bears trace of early to mid-Chalcolithic, and Level 3 of Neolithic settlements. These two levels would have been inhabited by the indigenous peoples of İzmir, very roughly, between 7th millennium BC to 4th millennium BC. With the seashore drawing away in time, the site was later used as a cemetery. Several graves containing artifacts dating, roughly, from 3000 BC, contemporary with the first city of Troy, were found. Karabel rock-carving of the Luwian local leader "Tarkasnawa, King of Myra" is near Kemalpaşa, a few kilometers to the east of İzmir.



Smyrna Ancient City

Figure 13 Symrna Ancient

By 1500 BC, the region fell under the influence of the Central Anatolian Hittite Empire who mentioned several localities near İzmir in their records. The first settlement to have commanded the Gulf of İzmir as a whole is recorded, in a semi-legendary manner, to have been founded on top of Mount Yamanlar, to the northeast of the inner gulf.

In connection with the silt brought by the streams which join the sea along the coastline, the settlement to form later the core of "Old Smyrna" was founded on the slopes of the same mountain, on a hill (then a small peninsula connected to the mainland by a small isthmus) in the present-day quarter of Bayraklı. The Bayraklı settlement is thought to have stretched back in time as far as the 3rd millennium BC.

It rose up to become one of the most advanced cultures in early Anatolian history and was on a par with Troy. The presence of a vineyard of İzmir's Wine and Beer Factory on this hill, also called Tepekule, prevented the urbanization of the site and facilitated the excavations that started in the 1960s by Ekrem Akurgal. However, in the 13th century BC, invasions from the Balkans (the so-called sea people) destroyed Troy VII and Central and Western Anatolia as a whole fell into what is generally called the period of "Anatolian" and "Greek" Dark Ages of the Bronze Age collapse.

[6] Izmır Municipality ; *History of Izmır* ; Izmır Annual Report 2011

ANCIENT TIMES

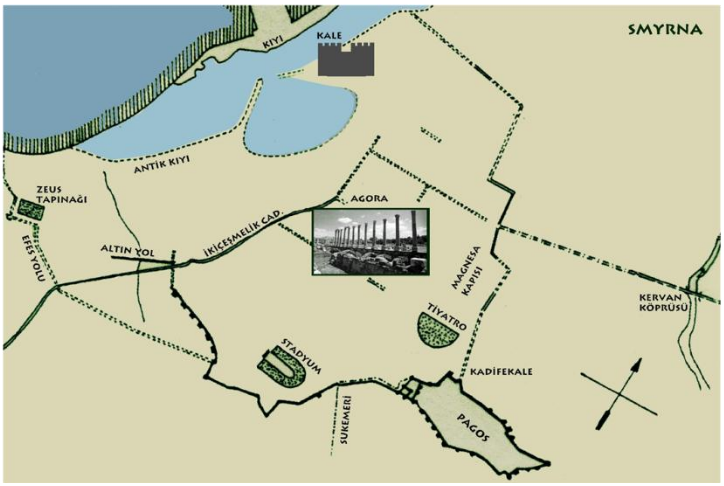


Figure 14 Izmir / Ancient Times

Homer

Homer referred to as Melesigenes which means "Child of the Meles Brook" is said to have been born in Smyrna. Combined with written evidence, it is generally admitted that Smyrna and Chios put forth the strongest arguments in claiming Homer and the main belief is that he was born in Ionia. A River Meles, still carrying the same name, is located within the city of İzmir, although association with the Homeric river is subject to controversy.

Old Smyrna

Nearby ancient site of Klazomenai in Urla, slightly outside İzmir urban zone is associated with some of the oldest known records of trade in olive oil. At the dawn of İzmir's recorded historical era, Pausanias describes "evident tokens" such as "a port called after the name of Tantalus and a sepulcher of him by no means obscure", corresponding to İzmir Gulf area and which have been tentatively located to date. The term "Old Smyrna" is used to describe the Archaic Period city located at Tepekule, Bayraklı, to make a distinction with Smyrna re-built later on the slopes of Pagos (present-day Kadifekale). The Greek settlement in Old Smyrna is attested by the presence of pottery dating from about 1000 BC onwards and the most ancient ruins preserved to our day date back to 725–700 BC. Herodotus says that the city was founded by Aeolians and later seized by Ionians. The oldest house discovered in Bayraklı is dated to 925 and 900 BC. The walls of this well-preserved house (2.45 by 4 meters/8.0 by 13 feet), consisting of one small room typical of the Iron Age, were made of sun-dried bricks and the roof of the house was made of reeds. The oldest model of a multiple-roomed type house of this period was found in Old Smyrna. Known to be the oldest house having so many rooms under its roof, it was built in the second half of the 7th century BC. The house has two floors and five rooms with a courtyard. Around that time, people started to protect the city with thick ramparts made of sun-dried bricks. Smyrna was built on the Hippodamian system in which streets run north-south and east-west and intersect at right angles, in a pattern familiar in the Near East but the earliest example in a western city. The houses all faced to the south. The most ancient paved streets of the Ionian civilization have also been discovered in ancient Smyrna. From then on, Smyrna achieved an identity of city-state. About 1,000 lived inside the city walls, with others living in near-by villages, where fields, olive trees, vineyards, and the workshops of potters and stonecutters were located. People generally made their living through agriculture and fishing.

Ottoman Empire

The upper city of İzmir was captured from its Aydinid rulers by the Ottomans for the first time in 1389 during the reign of Bayezid I, who led his armies toward the five Western Anatolian Beyliks in the winter of the same year he had ascended to the throne. The Ottoman take-over took place virtually without conflict. However, in 1402, Timur (Tamerlane) won the Battle of Ankara against the Ottomans, putting a serious check on the Ottoman state for the two following decades and handing back the territories of most of the Beyliks to their former ruling dynasties. He came in person to İzmir and definitely took back the port castle from the Genoese, giving it to Aydinids briefly reinstated. In 1415, Mehmet I re-captured İzmir for the Ottomans for the second time and with the death of the last bey of Aydın, İzmiroğlu Cüneyd Bey, in 1426 the city definitely passed under Ottoman control. İzmir's first Ottoman governor was a converted son of the Bulgarian Shishman dynasty. Two notable events for the city during the rest of the 15th century were a Venetian surprise raid in 1475 and the arrival of the Sephardic Jews from Spain after 1492, who later made İzmir one of their principal urban centers in Ottoman lands. İzmir could have been a rather deserted place in the 15th and 16th centuries, as indicated by the first extant Ottoman records describing the town and dating from 1528. In 1530, 304 adult males, both tax-paying and tax-exempt were on record, 42 of them Christians. There were five urban wards, one of these situated in the immediate vicinity of the port, rather active despite the town's small size and where the non-Muslim population was concentrated. By 1576, İzmir had grown to house 492 taxpayers in eight urban wards and had a number of depending villages. This corresponded to a total population estimated between 3500–5000.[7]

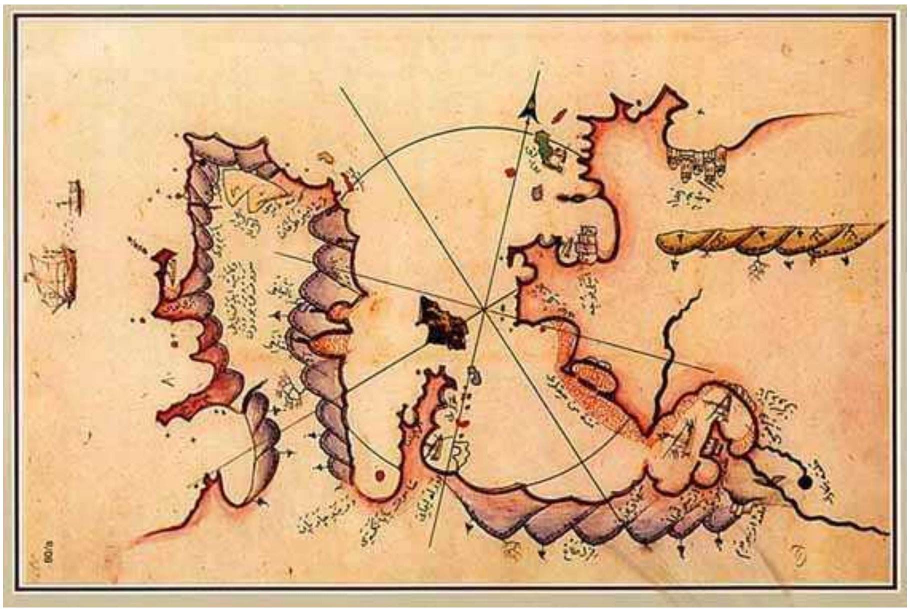


Figure 15 Izmır In Middle ages

[7] Ibid

International port city

İzmir's remarkable growth began starting late 16th century when cotton and other products of the region attracted French, English, Dutch and Venetian traders here. With the privileged trading conditions accorded to foreigners in 1620 (the infamous capitulations that were later to cause a serious threat and setback for the Ottoman state in its decline), İzmir set out on its way to become one of the foremost trade centers of the Empire. Foreign consulates moved in from Sakız (Chios) and were present in the city by the early 17th century (1619 for the French Consulate, 1621 for the British), serving as trade centers for their nations. Each consulate had its own quay and the ships under their flag would anchor there. The long campaign for the conquest of Crete (22 years 1648–1669) also considerably enhanced İzmir's position within the Ottoman realm since the city served as a port of dispatch and supply for the troops.

In the late 19th century, the port was threatened by a build-up of silt in the gulf and an initiative, unique in the history of the Ottoman Empire, was undertaken in 1886 to move Gediz River's bed to its present-day northern course, instead of letting it flow into the gulf, in order to redirect the silt. The beginning of the 20th century saw the city under the genuine and cosmopolitan looks of a metropolitan center with a global fame and reach.
Following the defeat of the Ottoman Empire in World War I, the victors had, for a time, intended to carve up large parts of Anatolia under respective zones of influence and offered the western regions of Turkey to Greece with the Treaty of Sèvres. On 15 May 1919 the Greek Army occupied İzmir, but the Greek expedition towards central Anatolia turned into a disaster for both that country and for the local Greeks of Anatolia.

The Turkish Army retook possession of İzmir on 9 September 1922, effectively ending the Greco-Turkish War (1919-1922) in the field. Part of the Greek population of the city was forced to seek refuge in the nearby Greek islands together with the departing Greek troops, while the rest left in the frame of the ensuing 1923 agreement for the exchange of populations between Greece and Turkey, which was a part of the Lausanne Treaty.

The war, and especially its events specific to İzmir, like the fire that broke out on 13 September 1922, one of the greatest disasters İzmir has ever experienced, continues to influence the psyches of the two nations to this day. The Turks have claimed that the occupation was marked from its very first day by the "first bullet" fired on Greek detachments by the journalist Hasan Tahsin and the killing by bayonet coups of Colonel Fethi Bey and his unarmed soldiers in the historic casern of the city (Sarı Kışla — the Yellow Casern), for refusing to shout "Zito o Venizelos" (Long Live Venizelos). The Greeks, on the other hand, have accused the Turks of committing many atrocities against the Greek and Armenian communities in İzmir, including the lynching of the Orthodox Metropolitan Chrysostomos following their recapture of the city on 9 September 1922 and the slaughter of Armenian and Greek Christians. A Turkish source on İzmir's oral history concedes that in 1922, "hat-wearers were thrown into the sea, just like, back in 1919, fez-wearers were thrown."

The lack of comprehensive and reliable sources from the period, combined with nationalist feelings running high on both sides, and mutual distrust between the conflicting parties, has led to each side accusing each other for decades of committing atrocities during the period. The city was, once again, gradually rebuilt after the proclamation of the Turkish Republic in 1923.

Figure 17 Izmir (1942)

Figure 16 Izmir (1952)

Figure 18 Izmır (1955)

2.3.2.Analysis about the city of İzmir

The municipality of İzmir has carried out some context analyses about the geographical, economic, social and environmental aspects of the city. For the following part of the thesis, the information obtained from the said analyses results were used as the source.
This context analysis is conducted by analyzing the environmental, socio-economic and territorial resulting priority in the territory of İzmir. This broad spectrum analysis seeks to build a coherent and concise portrait of the current state of the environment in İzmir.

2.3.2.1.Geomorphology

Stated in the center of Aegean coast in the west of Anatolian peninsula; zmir covers 1.4 percent of the whole acreage of Turkey with 12.012 kilometers square area. zmir was founded in a bay surrounded with mounts in the west coast of Aegean Region, surrounded by Bal kesir in the North, Manisa in the East and Ayd n in the South. The land of the city is located within 37° 45' and 39° 15’ Northern latitudes, 26° 15' and 28° 20' Eastern longitudes. The border length of the city from the North to the South is approximately 200km and the width from East to West is 180km.

The geographical structure is an important element concerning the development of the city. The position of the mountains laying vertically to the coast and the existence of the zmir Port has a critical role in making the city a logistic center. The situation of the mountains provides the transport to the internal regions to be easy and helps the warming effects of the climate to reach to inner parts. Thanks to both its geographical situation and deep rooted history, zmir is the leading city of the Aegean Region and the sparkling star of Turkey.

2.3.2.1.1 Mountains

At Izmir's low coasts, there are many large and small nesses and recesses such as bays, forelands and oves together with peninsulas, small islands near the coast. The very fertile plains and valleys lying from lands hrough sea, steep mountains vertical to the sea and plateaus filling the sea are all characteristic features of Izmir coasts. These features has occurred during the forth time period when the land plates bented and broken with ectonic movements and in general as a result of land collapses.

Boz Mountains, the altitude of which reaches to 2.159 meters starts from the south of Sarıgöl in the East and lays through Karabel Strait in the southeast of Kemalpasa

2.3.2.1.2 Rivers and Lakes

The rivers around Izmir, surrounded with mountains and hills from the three sides enriches the topographic structure of the city. The drainage basin (canal, runnel, watercourse, the grove of underground water) of Izmir Bay and Bornova Plain is very narrow. For this reason, the rivers of the surrounding are not exactly organized. The rivers and streams flowing between the mountains or slopes flow in short distances and directly reach to Izmir Bay in different places without coming together. Küçük Menderes and Bak rçay flow in the lowest parts of Gediz in Izmir. The others are small rivers with flood characters

2.3.2.1.3 Climate

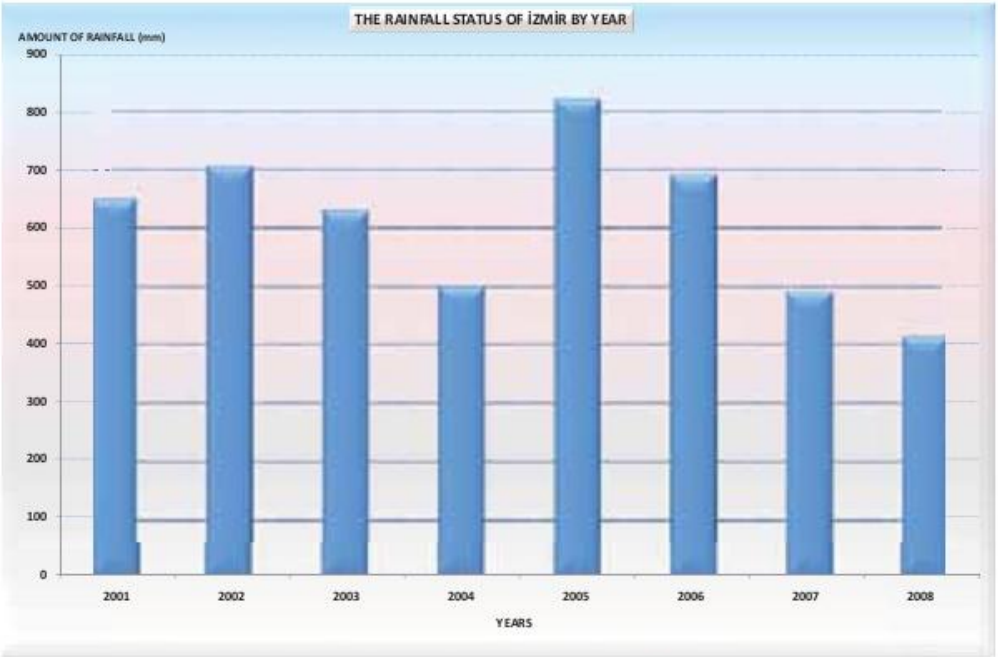
Located in the Mediterranean climate zone, zmir has hot and dry summer seasons and mild and rainy winters. The position of the mountains laying perpendicular to the coast and the plains reaching inner Western Anatolia allow the milding effects of the sea to enter into the internal sections. The annual average temperature in Izmir changes between 16 and 17°C. Regarding the highest and lowest temperatures in Izmir, it is seen that the temperature changes between a maximum of 45,1 °C and a minimum of 13 °C.[8]

İZMİR	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
Average Values in Log Periods												
Average Temperature (°C)	8.9	9.1	11.7	15.9	20.8	25.7	28.1	27.4	23.6	18.9	13.7	10.3
Average Highest Temperature (°C)	12.6	13.2	16.4	20.9	26.0	31.0	33.3	32.7	29.2	24.2	18.2	13.8
Average Lowest Temperature (°C)	5.9	5.8	7.7	11.4	15.6	20.1	22.7	22.4	18.7	14.7	10.4	7.5
Average Sunshine Duration(hours)	4.3	5.0	6.6	7.5	9.5	11.8	12.2	11.6	10.0	7.5	5.3	3.8
Average Rainy Days Number	11.4	10.3	8.3	8.4	5.0	2.2	1.7	1.3	3.7	5.4	8.9	12.3
The Highest and Lowest Values in Long Periods(1975-2007)												
Highest Temperature (°C)	20,4	23,5	30,5	31,8	37,5	41,3	42,6	43	40,1	36	28,6	25,2
Lowest Temperature (°C)	-4	-5	-3,1	0,6	7	10	16,1	15,6	12,6	5,7	0	-2,7

Source: General Directorate of Meteorology

Table 1 Temperature Distribution

[8] General Directorate of Meteorology; *Climate of Izmir*



Source: Ministry of Agriculture and Rural Affairs, İzmir Directorate

Figure 19 rainfall Status Of Izmir[9]

2.3.2.2 Demography

According to TÜIK ADNKS 2008 data, the total population of Izmir together with its districts is 3.795.978. The population of Izmir has increased 15.3 per thousand between 2007–2008 years and this increase is quite high compared to the increase rate in the same period in Turkey (13,1 per thousand). [10]

Table 2 Population Distribution of Izmir

DISTRICT NAME	POPULATION	DISTRICT NAME	POPULATION
Karabağlar	443.159	Menderes	68.029
Konak	411.112	Aliağa	62.258
Buca	407.526	Narlıdere	59.161
Bornova	399.023	Urla	49.774
Bayraklı	303.816	Kiraz	44.830
Karşıyaka	296.031	Bayındır	41.965
Çiğli	153.508	Selçuk	34.459
Ödemiş	128.797	Çeşme	31.968
Menemen	125.478	Dikili	30.863
Torbalı	121.963	Foça	29.018
Gaziemir	112.149	Kınık	28.337
Bergama	100.671	Seferihisar	26.945
Kemalpaşa	87.147	Güzelbahçe	22.138
Tire	77.015	Beydağ	13.395
Balçova	76.219	Karaburun	9.224
TOTAL			3.795.978

As of 2008 Census Population of İzmir's Districts (TÜİK)

[9] Ministry of Agriculture and Rural Affairs,Izmir Dictorate ; *Rainfall Status of Izmir*
[10] Turkish Statistical Institute; *Population of Izmir; 2008*

Table 3 Population According to Gender

AGE INTERVAL	TURKEY Total	TURKEY Man	TURKEY Woman	İZMİR Total	İZMİR Man	İZMİR Woman
0-4	5.998.258	3.082.338	2.915.920	245.594	126.250	119.344
5-9	6.318.132	3.242.581	3.075.551	252.892	130.240	122.652
10-14	6.472.197	3.322.041	3.150.156	279.795	144.209	135.586
15-19	6.185.104	3.171.917	3.013.187	289.508	148.690	140.818
20-24	6.256.558	3.187.625	3.068.933	318.556	163.890	154.666
25-29	6.518.837	3.300.291	3.218.546	350.584	177.242	173.342
30-34	5.810.107	2.939.518	2.870.589	328.825	165.504	163.321
35-39	5.330.484	2.680.941	2.649.543	303.922	151.037	152.885
40-44	4.740.250	2.397.706	2.342.544	280.125	139.916	140.209
45-49	4.284.175	2.153.427	2.130.748	267.858	134.545	133.313
50-54	3.643.173	1.824.582	1.818.591	237.432	119.067	118.365
55-59	2.878.104	1.423.445	1.454.659	190.880	94.980	95.900
60-64	2.188.298	1.035.261	1.153.037	144.376	70.560	73.816
65-69	1.701.384	783.680	917.704	105.135	49.637	55.498
70-74	1.274.681	575.433	699.248	81.171	36.008	45.163
75-79	1.110.782	492.226	618.556	65.172	27.242	37.930
80-84	571.179	213.336	357.843	38.039	13.666	24.373
85-89	175.221	59.076	116.145	12.326	4.195	8.131
90+	60.176	15.730	44.446	3.788	914	2.874
TOTAL	71.517.100	35.901.154	35.615.946	3.795.978	1.897.792	1.898.186

The Population in Turkey and in İzmir According to Age and Gender, 2008

According to TÜIK data in 2008, 6.47% of people living in zmir is between 0-4 ages, 14,03% is 5-14 ages, 0,63% is 15-19 ages 8,39% is 20-24 ages, 46,6% is 25-54, 8,83% is 55-64, and 8,05% is 65 or over. In addition, in Turkey the young population dependency rate is 39%, while it is 28,7% in Izmir. [11]

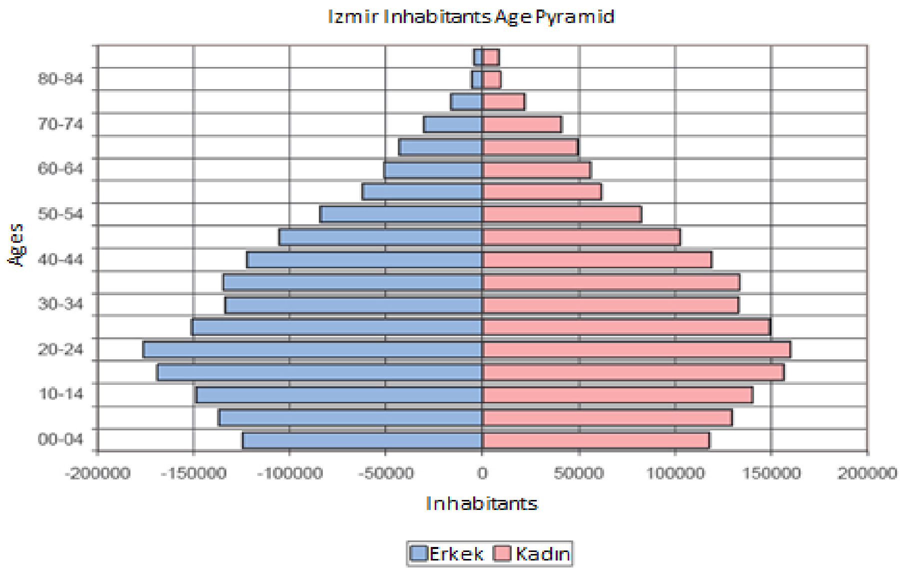


Figure 20 Population Men/Women

[11] Ibid

2.3.3 Income Structure

Izmir is one of most developed cities in terms of Per Capita, industrialization degree, contribution of import and export, the high industrial employment, variety and richness of economic activities. Among 81 cities, Izmir is the third in terms of socio-economic development order performed by State Planning Organization in 2003.

One of the most important scales showing the wealth of the people in a country, region or city is the rate of per capita income. Per Capita income in zmir is above the average both in Turkey and in the Region. It is the sixth among the cities.

As can be seen in the chart above, the economic share of the industrial and service sectors in the total income, which is an important indicator of the economic development, is at positive level for Izmir.

SECTORS AND ACTIVITY BRANCHES	RATE IN GDPPC(%)
The Total of Agricultural Sector	7,50
Farming and Animal Farming	7,00
Forestry	0,10
Fishery	0,40
Industry	31,10
Mining and quarrying	0,40
Manufacturing	27,50
Electric, Gas, Water	3,20
Construction Industry	3,40
Trade	17,90
Wholesale and retail trade	14,50
Hotel, Restaurant Services	3,40
Transport and Communication	14,00
Financial Institutions	2,50
Residence Owners	6,20
Professional Services	4,40
Relative Bank Services (Minus)	-2,90
SECTORS TOTAL	84,10
Public Service	8,10
Non-Profit Servicing Institutions	
SUBTOTAL	92,20
Import Taxes	7,80
GDPPC WITH BUYERS PRICES	100,00

Table 4 Economic Share

In parallel with financial development, the share of agriculture is decreasing, while as the industrial sector can not develop enough, the share of services is increasi ng. In developed countries, a similar increase tendency in the share of services sector has been observed.

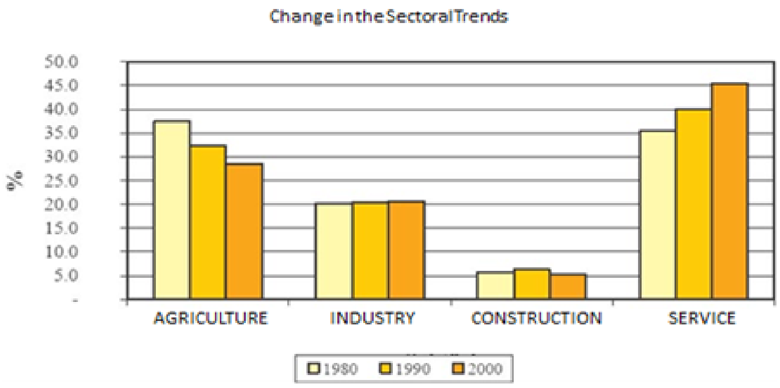


Figure 21 Change in Sectoral Trends

2.3.4 Education

When the quality, results and quantity indicators of education in Turkey are observed, it is seen that Izmir is a developed city.

Table 5 Educational Status/Gender

Population According to Educational Status and Gender (6+ Ages), 2008

Education Level	Total	%	Man	%	Woman	%
Illeterate	166.484	4,8	32.309	1,8	134.175	7,7
Literate but not attended to a school	574.853	16,4	278.287	16	296.566	16,9
Primary School Graduate	1.077.920	30,8	517.324	29,7	560.596	32
Elementary School Graduate	330.330	9,4	174.532	10	155.798	8,9
Secondary School Graduate	190.770	5,5	110.816	6,4	79.954	4,6
High School Graduate	640.821	18,3	338.736	19,4	302.085	17,2
High School or University Graduate	279.028	8	156.031	8,9	122.997	7
Post Graduate	16.897	0,5	9.468	0,5	7.429	0,4
Doctor's Degree Graduate	6.057	0,2	3.585	0,2	2.472	0,1
Unknown	213.990	6,1	123.369	7,1	90.621	5,2
TOTAL	3.497.150	100	1.744.457	100	1.752.693	100

Source: The Statistics Institution of Turkey (TÜİK)

The Number of Higher Education Institutions in Izmir 2009/2010 Educational Year

The of the Institution	Total	Faculty	Institute	Higher	Vocational
Dokuz Eylül University	30	10	10	5	5
Ege University	32	11	8	6	7
İzmir High Technical Institute	4	3	1	-	-
İzmir Economy University	10	5	2	2	1
Yaşar University	10	6	2	1	1
Gediz University	6	3	2	-	1
İzmir University	11	6	-	-	5

Source: The Web sites of the universities

Table 6 Number of Education Instituions

There are totally 7 universities 4 of which are Foundation Universities and 3 of which are the state universities. The number of the units of these universities is shown on the chart above. According to the received data, it can be said that the education is in a growth trend both in the basis of population and in the basis of educational sector.

2.3.5 Culture-Art

Izmir is the centre of the surrounding region in terms of the cultural and art activities. The socio-economic activities are organized by zmir Metropolitan Municipality with the supports of all the public institutions including NGOs and universities and in all the districts.

The activities performed by Izmir Metropolitan Municipality and the associations in Izmir are the indispensable parts of urban life. (Izmir Urban Health Profile, 2009) 80 festivals, 28 contests and 27 special days (except for the independence days and official festivals) were
celebrated in 2007 within the borders of zmir Metropolitan Municipality.

According to 2008 TÜIK data, the cinema seat number per 10000 people is 34, by which zmir is 9th in Turkey. On the other hand, according to 2008 TÜ K data, of 1000 people, 80 people uses the public libraries in zmir, while it is 108 people in Ankara and 24 people in Istanbul.

According to 2007 TÜIK data, the number of theatre halls in Izmir is 11, the cinemas 86, by which Izmir is the third rank in Turkey.

2.3.6 Health

As it can be understood from the data below, according to 2007 TÜIK data, the population per heath officer is better than Turkey in general in all the areas (specialist, dentist, nurse, practicing physician, chemist).

The Population per Health Care Staff in Turkey and İzmir, 2007

Health Officier	Turkey	İzmir
Specialist	1.254	797
Practising Physician	1.290	827
Dentist	3.634	2.486
Nurse	705	548
Chemist	2.890	1.902

Table 7 Population / per health care staff[12]

2.3.7 Infrastructure

2.3.7.1 Electric Consumption

In Izmir, the electric consumption in 2007 is 15.478.086 mwh and the electric consumption per person is 139 kwh.

[12] Ministry of Health of Turkey ; *Health in Turkey* ; 2007

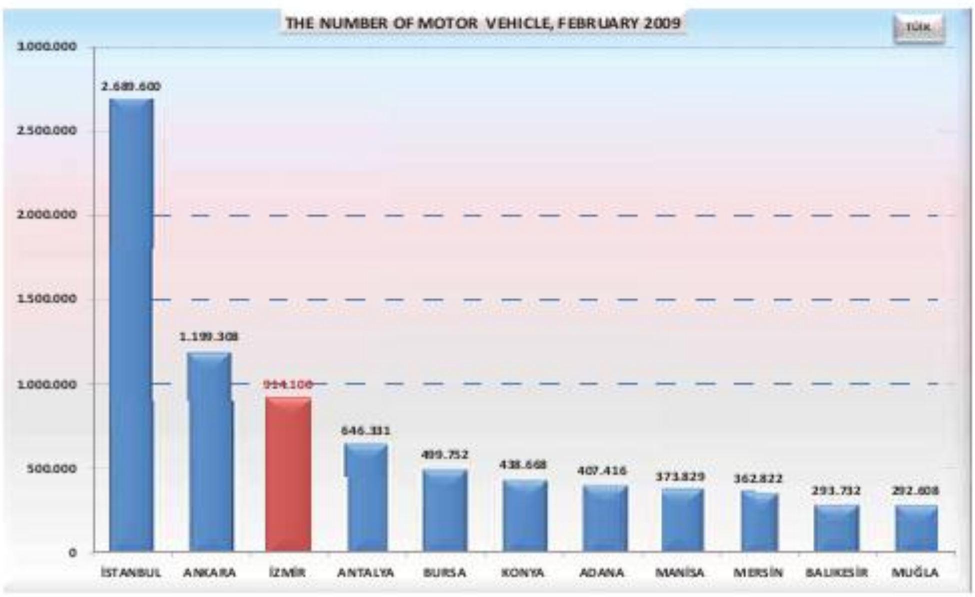
Izmir is in the 7th city in Turkey in terms of the electric consumption per person. Regarding sectoral tribution rate of the electric consumption, 19% of the consumption is used in hous es, 9,8% is for trade, 2,54% r official institutions, 61,1% in industry, 5,3% agricultural watering and others and the rest 2,3% is for umination.

The share of Izmir in Turkey in electric consumption is 9.9%.
I zmir is the 4th city where illegal use of ectricity is very little with 7% rate.

2.3.7.2 Transportation

According to 2007 TÜIK data, the transport in Izmir is provided with 174 km highway, 545 km state highway and 769 km city road. [13]

Izmir is the 9th city in Turkey in terms of having asphalt road in rural areas.



Source: The Statistics Institute of Turkey, Directorate of İzmir Region

Figure 22 number of Motor Vehicles

The share of railway and seaway in public transportation has increased with "Transformation Project in Transport" has been applied since 2000 by Izmir Metropolitan Municipality.

In Izmir 3 airports namely Adnan Menderes, Çigli Kakliç and Selçuk are in operation. Among them, Çigli Kakliç Airport is used for military purposes. Adnan Menderes Airport which is 16 km away from the city centre, has been providing domestic and international connections of Izmir.

According to the field research results performed in surrounding districts, in the order of transport vehicles, pedestrians are the first with 40%, private cars are the second with

[13] Turkey Statistical Institute ; Dictorate of Izmir Region ; 2009

16.7% and free service cars are the third with 15.5%. (Izmir Main Plan of Transport, the Surrounding Districts Residence Questionnaire, 2009) [14]

DTO İzmir Branch İzmir Port Statistics of The Year 2008 and The First Half of 2009

PERIOD	VESSEL WITH TR		VESSEL WITH FROEIN		TOTAL VESSELS		IMPORTED GOODS TOTAL	EXPORTED GOODS TOTAL	GENERAL TOTAL	LORRY NUMBER	LORRY TONNAGE
	ITEM	GRT	ITEM	GRT	ITEM	GRT					
2008	582	4.353.940	1.893	37.857.079	2.475	42.211.019	7.135.766	4.168.090	11.303.856	184	1.020
2009/6	287	2.432.342	1.012	18.701.784	1.299	21.134.126	3.231.057	1.455.602	4.686.659	61	500

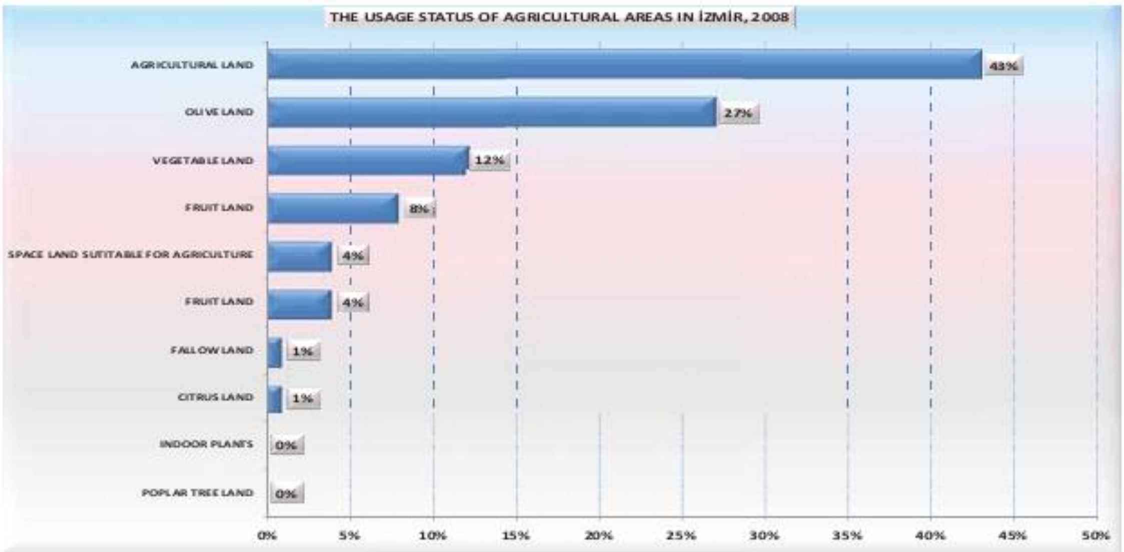
Source: Chamber of Sea Commerce (www.dto.org.tr)

Table 8 Trade Potential by Izmır Port

2.3.8 Sectoral Analysis

2.3.8.1 Agriculture-Farming

According to 2008 TÜIK data, the population dealing with agriculture in the total population is 7.5% in Izmir which is the third crowded city of Turkey.



Source: The Ministry of Agriculture and Rural Affairs, İzmir Directorate

Figure 23 Usage of Agricultural lands[15]

By 2008, 3.3% of the cattle, 1.7% of the sheep and 2.8% of the goats and 5.6% of the chickens in Turkey are in Izmir.

When 2008 data in the web site of The Ministry of Agriculture and Rural Affairs, Izmir Directorate is checked, it can be seen that in zmir in 2008, 36.562 tones of sea products were obtained and totally 330.171.651.713 TL production value was created. Izmir is the second after Mugla in culture fishing in the sea.

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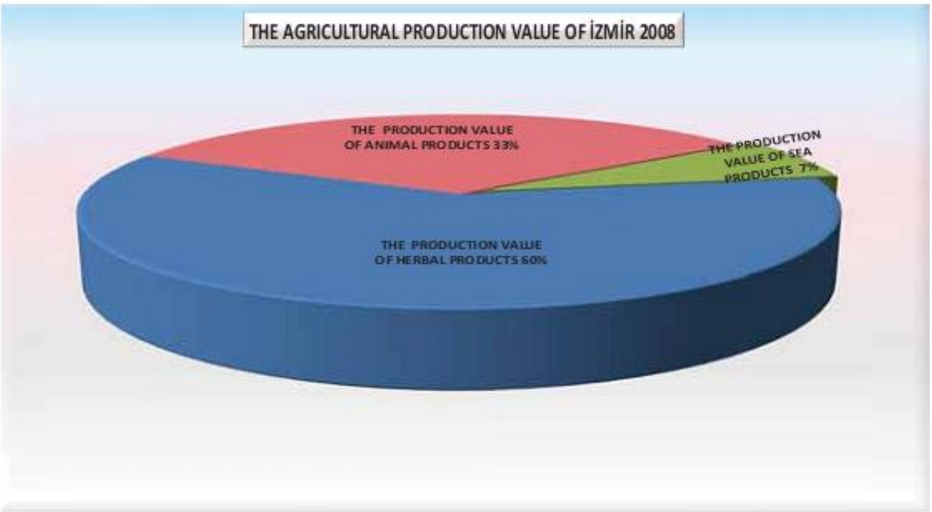
[14] Chamber of Sea Commerce ; *Izmır Port Statistics*; from www.dto.org.tr ; 2009

[15] Ministry of Agriculture and Rural Affairs,Izmir Dictorate ; *Usage of Agricultural Lands in Izmir;2008*



Source: The Ministry of Agriculture and Rural Affairs, İzmir Directorate

Figure 24 Animal products(red),Herbal Products(blue),Sea Products(green)

2.3.8.2 Industry-Trade

According to data of 2008, 6.5% of the total population in Izmir has been employed in industrial sector.

The industry has been based on especially metal goods, the tools of machines and vehicles, food, tobacco, clothing, textile, fur, shoe, leather, chemistry, wood products, furniture and paper.

The importance of organized industrial zones and free zones in local scale has increased and Izmir manufacturing industry has varied the necessary substructure facilities in this perspective to keep the industrial activities within a plan in scope of sustainable development frame.

18 organized industrial zones, 2 free zones, small scale industrial sites, markets and technology development zones are active in Izmir [16]. (One of the most important factors supporting the trade life of I zmir is the expositions identified with the personality of the city. In 2008, totally 36 expositions about mining, technologic developments, furniture ecoration and wedding dresses were performed 30 of which are special fairs, 5 of which are international peciality fair and 1 of which is international general fair. Rapidly growing demands of sectoral speciality expositions are required new modern areas to meet the needs. (Izmir City Health Profile, 2009).[17]

[16] TC Web site Izmir Guidance ; June 2006).

[17] Izmır Municipality,Annual report 2009; *Izmir City Health Profile* ; 2009

2.3.8.3 Tourism

Tourism is one the most rapidly developing sectors of the world which becomes "A small village" by the effects of globalization.

The visitor share of Izmir in the general potential of Turkey is 4%. Izmir has a lively tourism potential with historical, cultural, geographical features and natural sources.

The most suitable sector for the growth of services sector is tourism. Benefiting the natural, urban and historical values in the tourism sector is an important factor deciding the future of the city.

The Number of Tourists according to their Nationalities, 2008			
Country	Turkey	İzmir	İzmir (%)
Germany	4.415.525	251.427	5,7
Russia	2.879.278	13.704	0,5
England	2.169.924	91.234	4,2
Bulgaria	1.255.343	4.253	0,3
Holland	1.141.580	71.348	6,2
Other Countries	14.475.027	602.098	4,1
Total	26.336.677	1.034.064	3,9

Table 9 Number of tourists

2.3.8.3.1 Sea Tourism

Izmir has 629 km coast length by the Aegean Sea. 101 km of this coast is natural beach. As from 2007, here are 9 blue-flagged and 1 marinas within the borders of Izmir Metropolitan Municipality. 4 of them are in Gümüldür, 2 of them are in Karaburun and 2 of them are in Foça[18]

2.3.8.3.2 Culture and Belief Tourism

Within the scope of belief tourism, Seljuk District of Izmir has a special place. As Ephesus Antique city in the district lived many different periods, it has a great importance for Christians. Even though Jesus Christ was born in Palestine, Christianity spread from Ephesus and people of Ephesus was invited to accept Christianity in a meeting held in Ephesus Antique city under the presidency of Saint Jean. Bülbül Mount, 7km. away from Ephesus is accepted as the place where Mother Mary lived her last days. This house is also holy for the Muslims and it is announced as "Pilgrimage Place" for Christians and visited by Papas sometimes.

[18] Ibid

2.3.8.3.3 Other Types of Tourisms

Beside the urban services, the varieties in touristic activities cause congress tourism to be developed. Swissotel Grand Efes, Hilton Hotel, Termal Princess Hotel, Çeşme Altinyunus, Richmo nd Ephesus Hotel and MMO Tepekule Congress and Exhibition Center are built for congress tourism.

Winter Tourism

Natural ski runs located on the North slopes of Bozda altitude situated between Gediz and Küçük Menderes Rivers in Aegean Region enable winter tourism.

Today, 3 open ski runs, 10 natural ski runs are available and the skier capacity of them is 4.000 persons.

Thermal Tourism

There are lots of thermal tourism centres such as Ilıcagol Hot Spring Centers

Wind Surfing

Alaçati area in Çeşme is the most important surfing centre of Europe with various wind conditions and ideasurfing areas.

Mountain Tourism

Balçova Hill and Yamanlar Mountain are the places where mountain sports have been done unprofessionally. Further, among the mountain chains running perpendicular to Izmir Bay, Madra Mountain presents indeed very useful opportunities for mountain tourism with its altitude over 2.000.

2.4 Karsiyaka Dıstrıct

2.4.1 Introduction

Karşıyaka is the second biggest city -in surface area- of the city İzmir. The district consists forty-three neighborhoods and two villages and its population is 13% of the all city. Karşıyaka generally is a residential area.

Figure 25 Karsıyaka

Although before it was a district of agriculture and some small industries, by the time it started to loose this property. Nowadays, the main income is the construction of new buildings and trade. As in the last years new huge shopping malls were started to be settled, by that the economy earned an important acceleration. What is more, although the city couldn't use its tourism potential in maximum, there are some important touristic features.

The first things to recognise would be the bazaar, memorials, sculptures, the football team which has supporters troughout Turkey and the historical

residential pattern. The city has some very improtant historical remainings which are Tantalos Mausoleum and Smyrna-Tepekule area on which İzmir firstly settled. Also, there is a palace dedicated to the Zübeyde Hanım who is the mother of the founder of the modern Turkish Republic, Mustafa Kemal Atatürk.
The district is getting huge waves of national immigration.

The district has 12 km of seashore and for decades it leads the sea transportation of İzmir. It is know that there is more than a century that from Karşıyaka boat transportation is being done.

KARŞIYAKA DISTRICT TAG			
FACTOR	YEAR	UNIT	DATA
AREA	2010	km^2	102,40
POPULATION	2010	person	296.031
URBANIZATION RATIO	2006	%	99,90
ALTITUDE	2006	m	1-700
AVERAGE DISTANCE FROM THE CENTER	2006	km	20
PER CAPITA INCOME	2006	USD	3543
LITERACY RATIO	2006	%	92
STUDENT PER TEACHER RATIO	2006	person	24
PATIENT PER DOCTOR RATIO	2006	person	1127

Table 10 Karsiyaka District Tag

Figure 26 Karsıyaka Overview

2.4.2 History

After the last excavations it has been found that the first settlers of Izmir have come to –today's name- Bayrakli at the year 5000 B.C. The oldest houses that have been built in the entire world, the temple of Athena, the oldest multi-roomed houses and the longest main street of the archaic period are also among the foundlings of those excavations. It's known that the worldwide famous Illiad of Homer is written at 700 B.C. in Bayrakli. The oldest knowledge about Karşıyaka is getting by those archeological excavations which have been done in 1824.

The queen of women warriors of Hittites –which are called the Amazons–, was called Smyrna. When the first urbanization started in Phrygian and Ion, the name Smyrna was given to the area. After that the area is captured by Lydians, Persians, Romans, Byzantines, Seljuks and Ottomans.

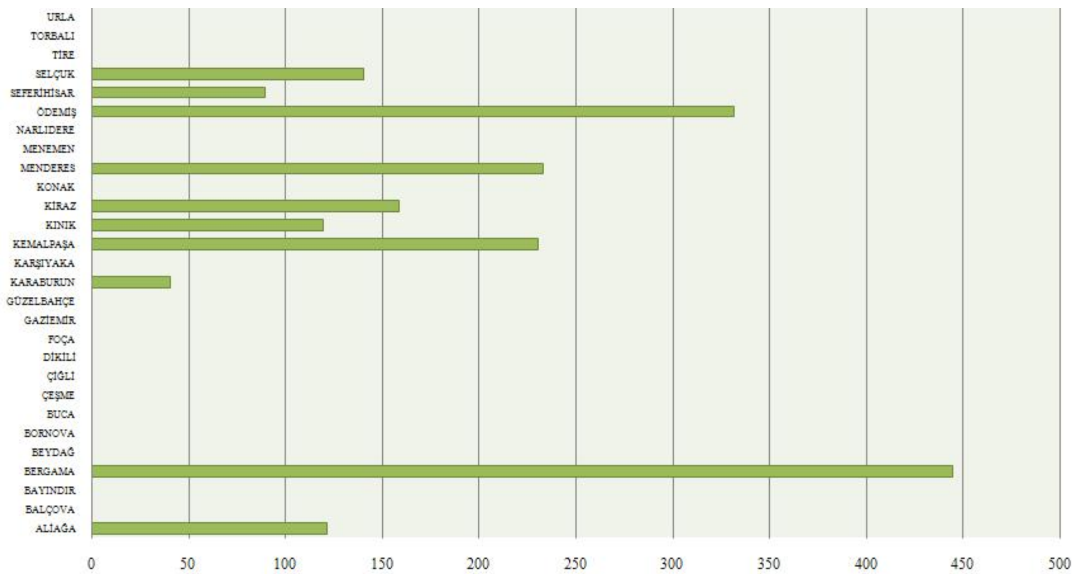
According to an opinion, Karşıyaka was first named after lion-hearted Richard whose moniker in French is "Coeur de Lion". By the time the letter "n" at the end of the name has disappeared and the name became "Cordelio". According to another opinion the district took his name from the word "Kordelino" which in Italian means the seaside.

Till the end of19th century the district was covered by the forests but then by the passing of railway and the starting of sea transportation in 1884 the city started to develop. Although it was a promenade area for the citizens of Izmir it became the second biggest district in Izmir.

2.4.3 Structure

a.Geographical Structure

Climate is a typical feature of Mediterranean climate. Summers are hot and dry, warm and rainy winters. Character of vegetation in the district are Scrub. The average annual rainfall, average wind speed, sea surface temperature and mean absence of a measure on the county meteorological station temperature data was found due. However, almost all meteorological values show proximity to İzmir[19]



\- Figure 27 Agricultural Lands

[19] Izmır Municipality ,City Planning and Development; *Annual Report*; 2011

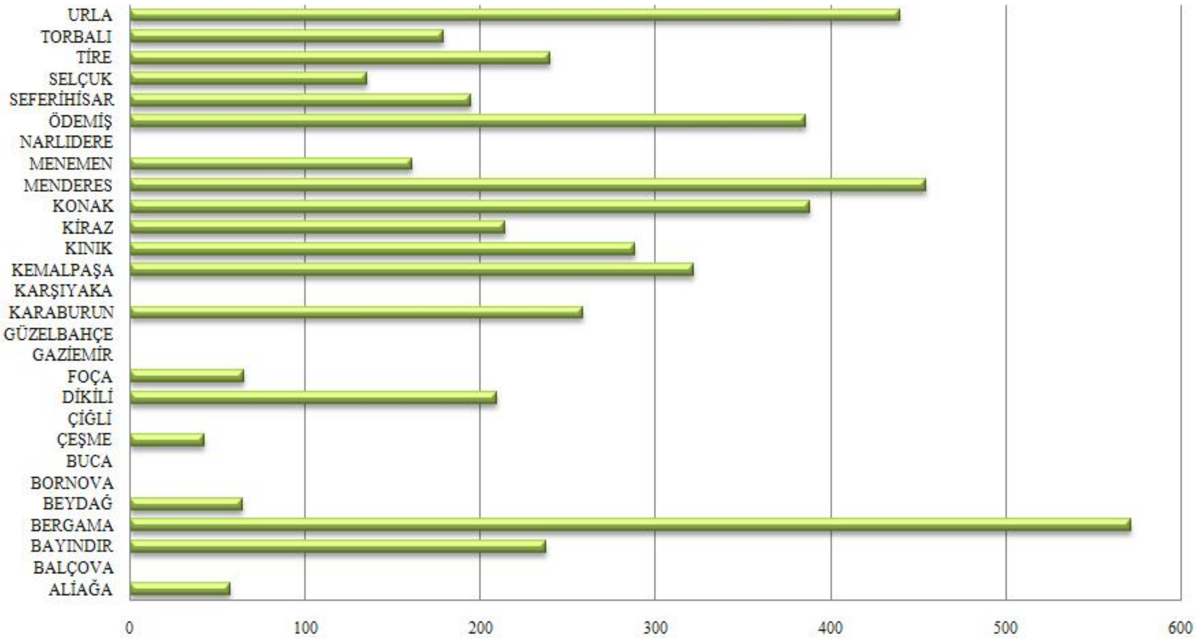


Figure 28 Area of Forests and Scrubs Ratio

b.Demographical Structure

As the district is highly residential the national immigration trend to the area is quite high especially from the eastern parts of Turkey. A great majority of the immigrants are coming from low-income families and that problem is causing illegal conduction.

In the district there are two main groups of inhabitants. At the seashore the high-income group and the retireds are living, in the inner parts low-income group which consist workers and the national immigrants are living.

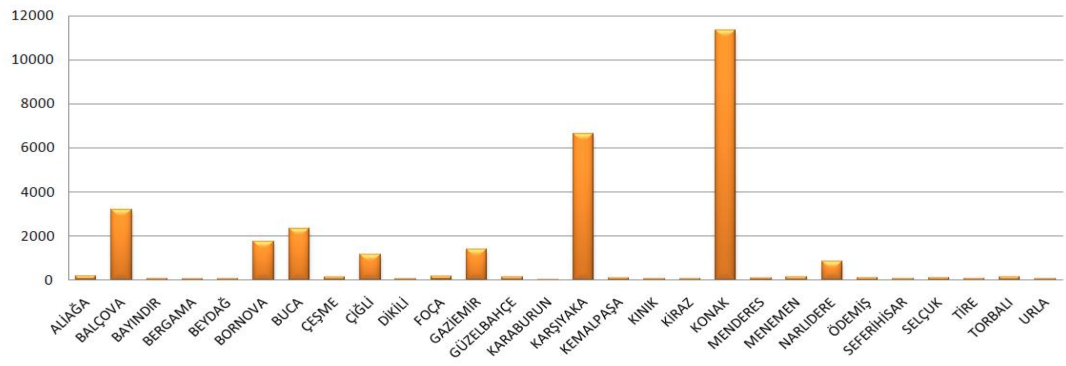


Figure 29 Density of Karsiyaka/Other Districts

2.4.5.Economy

The major problem of the district, as it is for all Turkey, is unemployment. Having inhabitants from very different income groups are causing socio-economical and socio-cultural problems.

Although the acceptance of Karşıyaka as a brand in the public opinion is an advantage, on the other hand is causing national immigration problems.

For shopping the bazaar of Karşıyaka is quite attractive. Most of the significant shops are located there. The bazaar is also attracting customers from different districts and that is giving an important acceleration to the trade.

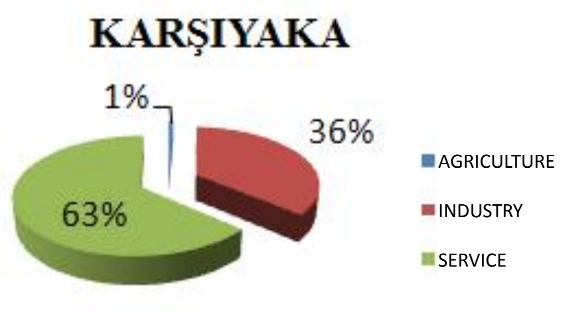


Figure 30 Sectoral Distribution

Figure 31 Agricultural Sector has pretty lost its majority lately

2.4.6 Tourism

In Karşıyaka history and nature tourism are available.

District, although it has historical places like Tepekule, , Tantalus, Smyrna sector is not enough to make use of the potential.

Recently, historical monuments and buildings of interest is increasing in Karşıyaka and is seen to accelerate studies on this issue.

Figure 32 Ancient Ruins / Tomb of Tantalos

3000 years-old Tepekule Bayraklı (Smyrna), the ruins of the tomb of Tantalus
Karsiyaka ancient ruins and bazaar, Tashkent Coast Line, Yamanlar picnic and picnic area

(Karagöl) highlights the town's best touristic attractions.

Separation of accommodation in the district for the development of tourism, historical and cultural support is necessary to expose and heritage.

Funds for the restoration of historical buildings, especially in Bayraklı , are needed
Karsiyaka coastline, includes natural beauty and recreational areas. Particularly

Recreation and sports fields, in Bostanlı and Mavisehir meets everyone s needs .
Marina project is planned.besides sea-taxi/ambulances are considered.
erraces around the zone will be increased.

2.4.7 Social structure

2.4.7.1 Education

Literacy rate is %92 while for men it s %96 and for women %87.
District is in need of new schools and classes.
There is not any college or university in the city.

Also there are good amount of social centers that people can learn hand-works and some skills.


Figure 33 District in need of schools

2.4.7.2 Health Services

Karsiyaka Hospital is very crucial for neighbourhood.

Figure 34 Karsiyaka Central Hospital

But District is in need of a new hospital which there is a on-goin project.
Also there are private health clinics and centers more than 20.

2.4.7.3 Cultural and Social Life

Karsiyaka has one of the oldest sports club in Turkey.
From wrestling to bowling different variety of sports are hold.
Football and Basketball are two main sports.

Figure 35 Karsiyaka Basketball

Figure 36 Karsıyaka Football Team

Karsiyaka holds lots of museums, nursing home, theatres.
Theatres and cinemas provide enough facilities for people.

There are 13 libraries in the district and more than 10 theatres.
There are 45 sports club and 7280 pro,semi pro and amateur players.

Figure 37 Tepekule Convention center

Karsiyaka is known for its museums, festival and exhibition areas
Tepekule conventional center holds 2000 people with 14 saloons.

2.4.8 Infrastructure

Intercity roads do not face any traffic problems while inner streets face
Lack of parking sites is a big problem
Expressway that connects Izmir to Marmara region goes through karsiyaka

City is in need of two lanes road four times what they have right now.
Also there is a tram-way project by the coast
There are three seaports which are Bayrakli, bostanli and karsiyaka

Figure 38 Transportation Systems

Bostanli port can be considered as busy from the fact that 20 trips including 3 ferries are hold.

Karsiyaka has 10 km of railroads.

North tangenziale and Girne roundabout will help traffic solutions.
Undergoing metro projects must be completed (aliaga-menderes)

Domestic Gaziemir airport do not provide the need of northern districts that s why Kalkic airport must be opened.

Sewage system can be considered as efficient and problems are got rid of with basic solutions.

Figure 39 A ferry port in Karsiyaka

2.5 Mavisehir Zone

Figure 40 Some parts of Mavisehir Zone


Figure 41 Another view of Mavisehir Zone


Figure 42 High-Rise Massive Housing

a.Structure

As It can be seen from the pictures above, zone is defined by its high-residentials.
Mavisehir is a very dense residential zone.
Buildings with 12, 16, 20 stories exists.

b.Social Life

Zone consists of 3 Shopping malls and a very big sports center.
A small beach with green zone connected to the coast line of Izmır, provides space to the residents.
But the fact is pretty disogranized, dirty and uneffective.
Apart from this, zone is far away from the city's noise.

Figure 43 Next to coast with a great view offers its residents a high-quality standards.

c.Demography

Mostly well-educated people live in the zone.
Living cost is pretty expensive.
Zone is almost neighbour to ghetto zones.
On the contrary, ıt is pretty secured due to the fact that massive blocks are security-provided.

d.Climate

Summers are hot , winters are warm.
Very Windy zone.

e.Transportation

Very close to northern highway.Train& metro stations near the zone provides public transportation.

Figure 44 Overview of Mavisehir

CHAPTER 3

URBAN DESIGN

3.URBAN DESIGN

3.1 Location Of the Site

Site is located in Mavisehir zone of Karsiyaka/ Izmir

Figure 45 Satellite view of the site and Mavisehir Zone

Total 30000m^2

Figure 46 Next to Coast and high residentials surrounded by roads and green areas

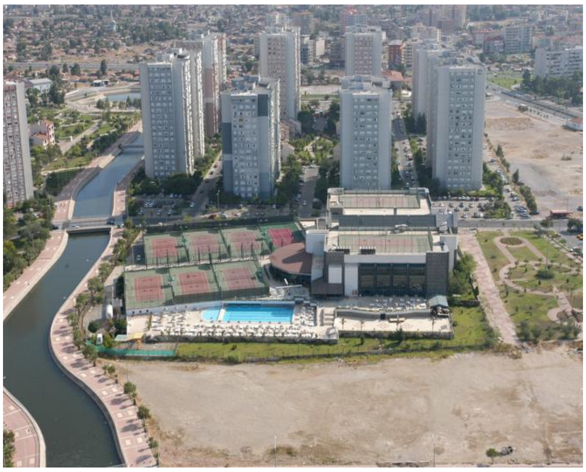
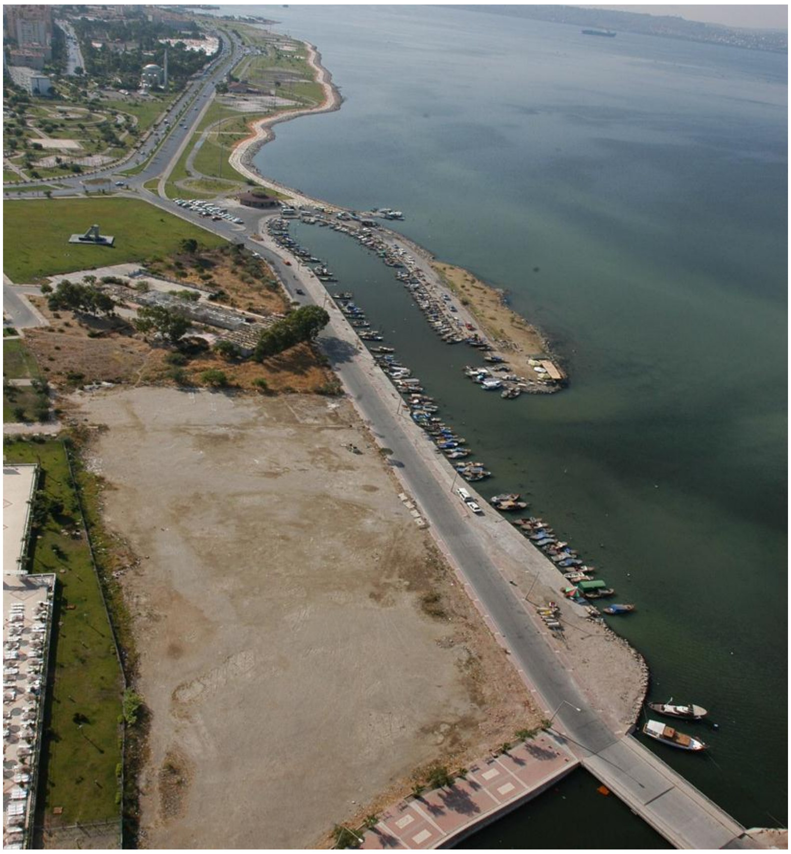
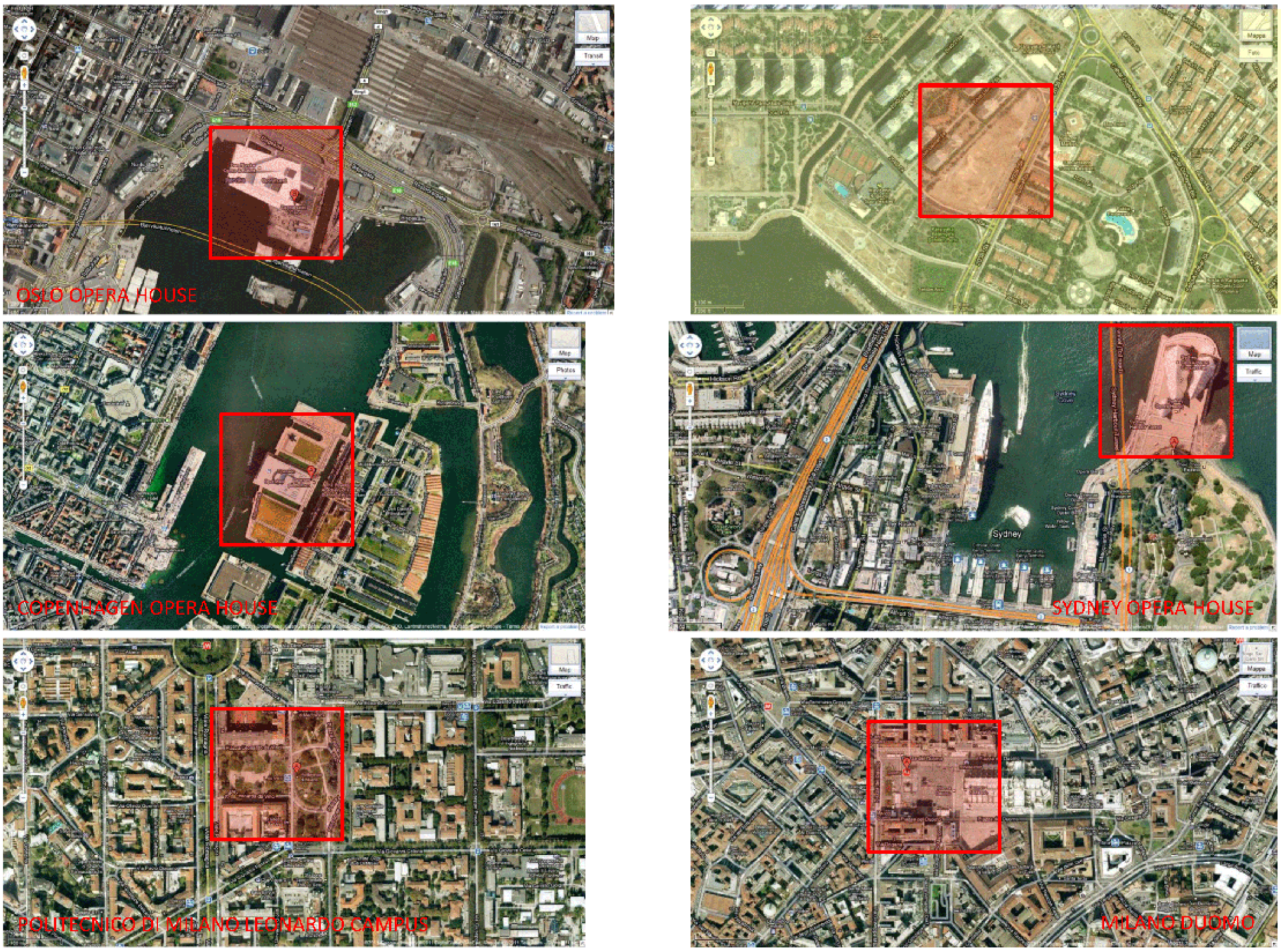


Figure 47 3 different view of Surrounding Area



3.2 Scale Approximation

Figure 48 Comparison of the site area to some references



If we take a deep look at the areas what we see is;

It is bigger than Oslo Opera House and and almost equal to the Sydney Opera building itself.

3.3 Site Analysis

3.3.1 Transportation

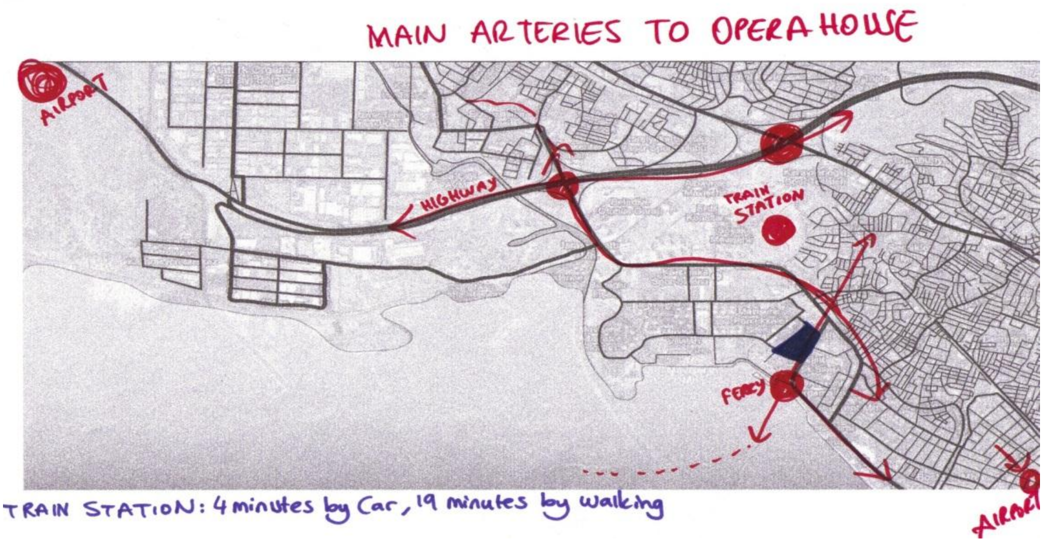


Figure 49 Main Arteries

Area is very rich in transportation.
4 main types,which are ferry,train,airway and vehicles are all working together to make it to the area.

Area provides all demands of tranportation with different styles.

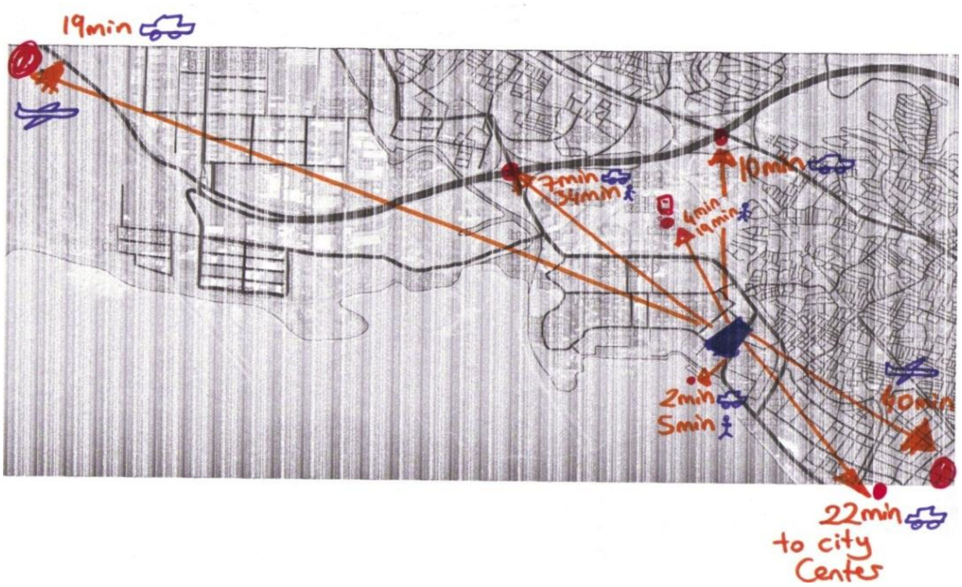


Figure 50 Needed time to go to critical stations

Project site is as reference ;

-20 minutes to <u>Kalkic airport</u> by car
-7 minutes to <u>highway</u> by car
-22 minutes to <u>city center</u> by car

-10 minutes to <u>train station</u> by car
- 2 minutes to <u>Ferry</u> by car
-40 minutes to <u>Adnan Menderes Airport</u> by car

3.3.1.1 Bus Routes

Figure 51 There are two buses passes through the site.

No.121 is directly goes to the city center and No.200 also passes through the city center but its last stop is Adnan Menderes Airport. They are not working very late.[20]

But during the days of events , schedules can be extended.

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[20] Izmır Municipality , Bus and Ports Directorate ; *Bus Schedules* ; 2011

3.3.1.2 Railway Connections

Figure 52 railway system

Green Line passes through the most dense parts of the city which goes till the Kalkic Airport.
The intersections provide a wider network hub which goes to Buca and Bornova.
From City Center to karsiyaka ,distance is almost 10km.

The closest train station is 20 minutes by walking and 4 minutes by car from the project site.

3.3.1.3 Water Connections

Figure 53 Ferry/Boats

As it can be seen from the figure above, Izmır is very active in terms of Sea Transportation.
With the addition of a port next to project , flow of people will obtain a different perspective.It will ease reaching to the opera house and decrease the time of arrival from other side of the bay.

And also special tours to opera house during the day of events can be provided.

Izmır is in the middle of tourist attractions due to the fact that as a city it is very close to the Aegean Beaches and Ancient ruins such as Ephesus. That s why for Cruis-ships , city is a very hot spot.In the figure the density of Cruise ships and their routes can be observed.

Figure 54 Cruise Routes [21]

Spain,Egypt,Croatia,Italy,Greek Islands,Cyprus,Rhodes can be counted as important stops as well as Turkey.

This connection will provide tourists to come and visit Opera House.

And for international events , opera house will increase its chance to become an attraction point because of its easy-accessibility.

[21] Turkey Marıtıme Organızatıon Inc, Port Tariff ; *Cruise Itıneraries* ; 2011

3.3.1.4 Airways

After Istanbul, Izmir is the second biggest spot for airways.

Adnan Menderes Airport, below, operates 7/24 hours welcoming tourists and all kind of passengers which is 40 minutes away from project area. By being an international airport, it welcomes all passengers from all across the Europe.

As a reference Izmır is 2.5 hours away from Milano by plane.

Figure 55 Adnan Menderes Airport

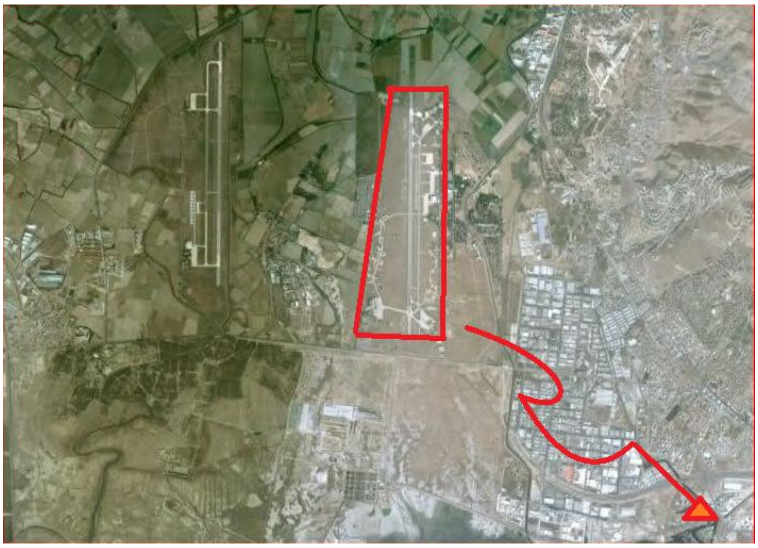


Figure 56 Kalkic airport

With the improvements which are going to be made in this airport, not very functional nowadays, this port will provide long-distance passengers welcoming.

Not to mention it is 20 minutes by car to the project area connected by highway and also connected by Green Railway line arrives to the station 5 minutes away of the area by car.

Project area is between two airports and very accessible through airway.

3.3.1.5 Walkway/ Bikes

Figure 57 Walkway Route.

Izmır , as a city, is very famous with its coastline and amazing view. Through history, in stories and legends, its been mentioned with its beauty and inspiration to authors and poets.

Green lines show the coast available for walking where in red lines not available for walking. As it can be seen that almost 90 per cent is walkable, also for bikes

Coastline is a very hot attraction point ,which is alive 7/24 hours full of kiosks, cafes ,pubs and nightclubs.




Figure 58 Alsancak

Opera house will be the end of coastline and as the last stop people will have the chance to see this beautiful architectural piece and by ferry/buses , access will be provided after long-day passed by walking,biking.

3.4.2 Morphological & Typological Analysis

3.4.2.1 Solid-Void

Figure 59 Solid Void Relationship

It can be considered that, zone is not very dense like the area which can be seen as it s seperated by the red line. Zone on the right is more organized but not in a perfect grid.

There is a reason behind this which is that zone is new and consists of mass blocks .On the contrary zone on the left is older.

3.4.2.2 Street Hierarchy / Road Typology

Figure 60 Street Hierarchy

As line gets thicker, the capacity of the road increases. Near the project area, clearer and more organized roads can be observed while in the older parts of the streets things get complicated. The thickest line is highway which connects to the city center in 20 minutes.

3.4.2.3 Building Typology

Figure 61 Building typology

Darkest zone are older part of Karsıyaka District which consists of old buildings and random grids. Also buildings are around 2-3 stories. On the contrary, as the color goes brighter , grids start to occur and building heights increase. As it is seen building heights rises to the left with new buildings mostly massive blocks.

3.4.2.4 Green Spaces

Figure 62 WaterFront/ Public Spaces / Forest / Other green

Figure 63 Closer Look to Opera Area

The lightest green is defined as decorative green zone comes out of massive blocks and their gardening.

Darker green stands for parks&public spaces. As it can be seen from Fig.63 , number of parks are not very high. Especially in the older zone of Karsiyaka , green is hardly found.

Green which stands for waterfront is very crucial for social life of Izmir. Provided waterfront occupies a great portion of occupants' life in Izmır.

But still stretching the green zone is a priority

3.4.2.5 Water Constraints

Figure 64 Karsiyaka With Water vs Land

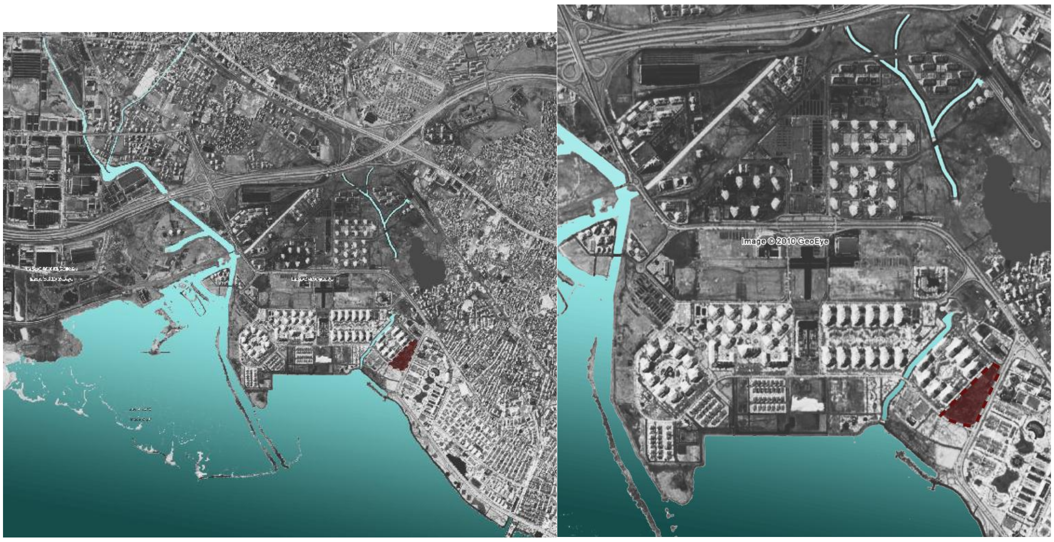


Figure 65 Water vs Land closer

City tries to use water's every aspect in high-efficiency by transportation, trading and sightseeing.
"International port city" is the new motto of Izmir.
Coastline has always been an attraction point of occupants.

Near opera area ,there is a small canal piercing inside the land.
Also on the left side of the opera area, there is a swamp area which needs to be cured.

3.4.2.6 Connections & Uses

Figure 66 Shopping Malls

Area is very rich in malls . Also in approximately 20 minutes there are 2 hospitals.
Basketball arena is the Center Of Karsıyaka Basketball Club.
Following the waterfront there is an amphi-theatre which very active in summers season.
In addition to 2 ferry ports, one will be added to Opera House.
Obvious from the figure below, Mavisehir/Karsiyaka zone is very attractive for Izmır residents.

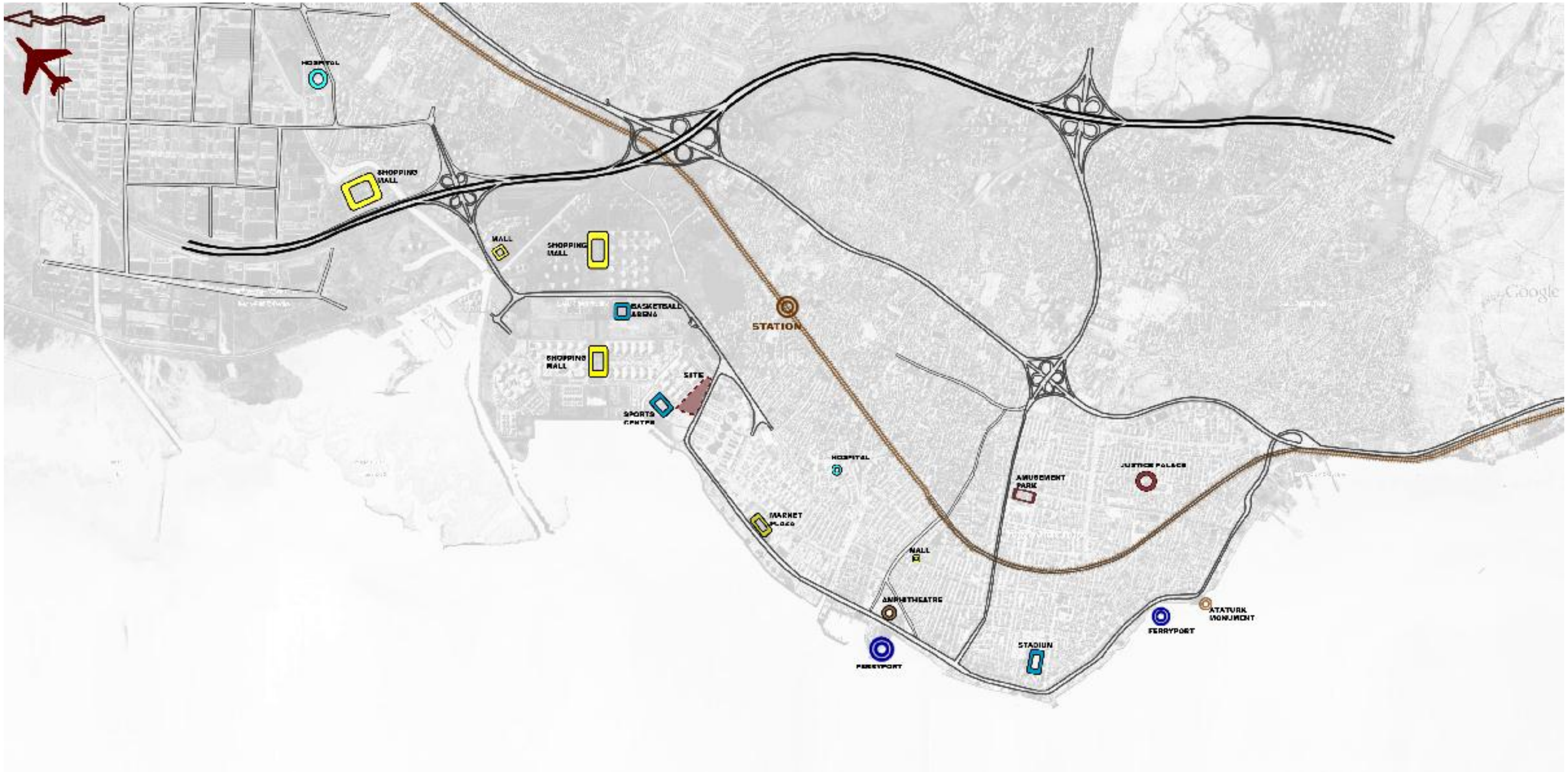


Figure 67 Uses in Karsıyaka Zone

3.4.3 Swot Analysis

3.4.3.1 Izmır SWOT

	STRENGTH	WEAKNESS	OPPORTUNITY	THREAT
MANAGEMENT	Harmony of the local management and the inhabitants in developing and preserving the city	Disagreements between the local management and the government	Strong local management	The possibility of governmental obstacles on local management
EDUCATION & HEALTH	Existing of schools in all neighborhoods Existing of health units in all neighborhoods	tient per doctor ration 1/112	High rate of education of the inhabitants Having public and private universities	
IMMIGRATION	The acceptance of the city as a brand throughout the country	National immigration	Attracting investments	Unplanned settlement of low-income national immigrants
ECONOMY	Good economical situation of the local management by the various income sources	Not having advanced tech	Having major investment and employment opportunities	The national immigration
	Being an industrial city Existing of rich mineral resources Benefiting from renewable energy sources as geothermal energy and wind energy	Unemployment	Having developed industrial areas Existing mining activities and geothermal energy sources Being a port city	More land, sea and air pollution risk

	STRENGTH	WEAKNESS	OPPORTUNITY	THREAT
AGRICULTURE & FORESTS	Agricultural aspects such as existing of rich areas with a variety of different products The encouragement of the local management The existing of research	Lacking of an agricultural program	Convenience of the land to agriculture and livestock	Forest fires
TRANSPORTATION	Developped transportation network between all the districts and villages Reached by land, train, air and sea	The non-finishing maintenance works	Acceleration of restoration and renovation of cultural structures	Unsufficient protection and restoration processes for the historical buildings an areas
TOURISM & CULTURE	Owning of 7000 years old historical and cultural background Highly touristic aspects by its natural beauties, virgin bays, beautiful beaches, ski resorts, surfing areas at international standarts and national parks Worldwide famous historical citys and Having inhabitants from Hosting of international	Not being able to use its tourism potential in the optimum level	Worldwide interest in the city's historical and cultural background Touristic features in the center and all around the city.	The bad effect of external factors like econmical crisis and terror on tourism which is the locomotive sector f the area

3.4.3.2 Karsıyaka SWOT

Strength	Weakness	Opportunity	Threat
Consists generally residential areas	The city is lacking a five star hotel	Investment opportunities for tourism,education,	High rate of immigration to the district
Atakent/mavisehir zone have big shopping malls.	There is not any urban regeneration project against obvious problems	The existing historical and natural beauties	Unsufficient protection and restoration processes
Developed sea transportation	Unfinished crossroads		

3.4.3.3 Mavisehir SWOT

Strength	Weakness	Opportunity	Threat
Easy accessibility	Parking problem		
Well-developed transportation network	Maintenance needed		
Active social life		Attractive for investments	Very close to suburbs
Secure&quite zone		High-rate of education among inhabitants	Very expensive
Port zone			
Host of international conventions		Strong local management	

3.5 Vision

-Changing the use of District

Figure 68 Mix Use

Even though zone has shopping malls , Opera house will change the character of the zone.It will not be known as high-residential zone but a colourful zone. By this way, It will lose its neutral context to a more dynamic context.

-Attract Touristic Interest

Tourism not only creates jobs in the tertiary sector, it also encourages growth in the primary and secondary sectors of industry. This is known as the multiplier effect which in its simplest form is how many times money spent by a tourist circulates through a country's economy.

Money spent in a hotel helps to create jobs directly in the hotel, but it also creates jobs indirectly elsewhere in the economy. The hotel, for example, has to buy food from local farmers, who may spend some of this money on fertiliser or clothes. The demand for local products increases as tourists often buy souvenirs, which increases secondary employment.

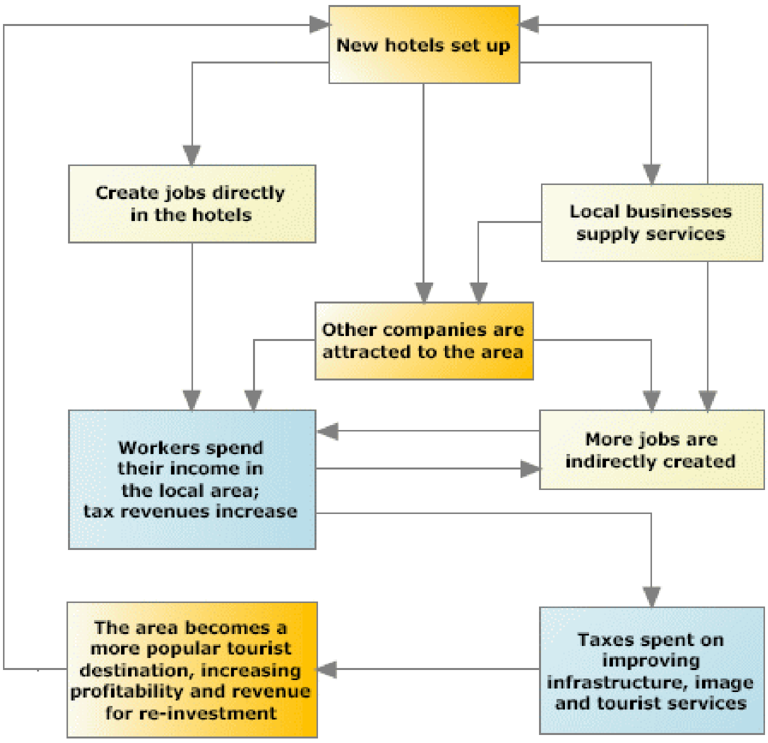


Figure 69 Hotel Cycle

URBAN DESIGN

"Culture" is one of the chief consumables of tourism, and experiencing unusual cultures can be educational for the visitor and highly profitable for the community. But tourism is a necessarily invasive process that thrusts traditional communities into the modern world.

-Activate the Economy

Figure 70 Activitation of Economy

The neighborhood has a great opportunity integrate these different uses and cultivate a growing and dynamic economy. The goal of the urban plan to realize the potential synergies that can come from efficiently managing an intensely mixed-u environment.

Tourism stimulates jobs, particularly in the service sector. People can find new jobs as servers, hotel staff, retail outlets or tour guides. Nearly all these jobs are new to the economy. Tourism also creates infrastructure to build hotels and other facilities, which also creates jobs.

Governments benefit from increased foreign exchange and tax revenues, and local people benefit from job opportunities and increased wealth coming into their community. Socially, there is evidence to show that jobs in the tourism industry are of relatively high status, and that there is an increased propensity for education amongst communities which aspire to work in the industry.

-Revitalize the seashore

There is high appeal for the developments along the seashore.A water front development would open up the seashore in a better way and create more opportunities to enhance the value of land along the coastline. It will also reintroduce the citizens the natural value of the sea and would encourage people to help out in its preservation.By the addition of tourism centers and support facilities , potential to develop to attract tourists.

Figure 71 SeaBuses

It can be seen that parks are developing randomly. Green area in front of the Opera House can serve primary pedestrian and bicycle areas.It can be a part of network of open areas and urban areas for the citizens of Mavisehir.

This green zone can also act as a buffer zone from the seashore. Proper design of these buffer zone would be necessary to help in any case of flooding.

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

Ferries form a part of the public transport systems of many waterside cities and islands, allowing direct transit between points at a capital cost much lower than bridges or tunnels. The contributions of ferry travel to climate change have received less scrutiny than land and air transport, and vary considerably according to factors like speed and the number of passengers carried. A ferry may be used for several routes according to need, whereas a bridge is fixed in a single route. Addition of a passenger ferry port, will come up with these advantages and ease the transportayion from other cities even from other countries.

	PRIMARY GOAL		THE MEAN	
1	Change the use of the district		Opera house	
2	Attract touristic interest		Opera house	
3	Revitalize the seashore		Improving and transforming the existing port and building a new port to western part of the area	
			Improving the green area at the seashore and connecting it with the existing green pattern of the district	
4	Give a new development direction		Opera house	
5	Activate the economy		Opera house	

Figure 72 Goals

3.6 Concept Plan

Many inhabitants live within the boundaries of Mavisehir, few if any of them focus on the area as a unique place because there is no "there" there.

A significant portion of the evolution of Mavisehir needs establishing it as a place with distinctive qualities — and recognizable character that resonates in a powerful and positive way.

Steps aimed at creating more open space, iconic and defining architecture and art, and engaging programming can help make Mavisehir more charismatic and welcoming to the people in the local area as well as those from across the cİty and around the globe.

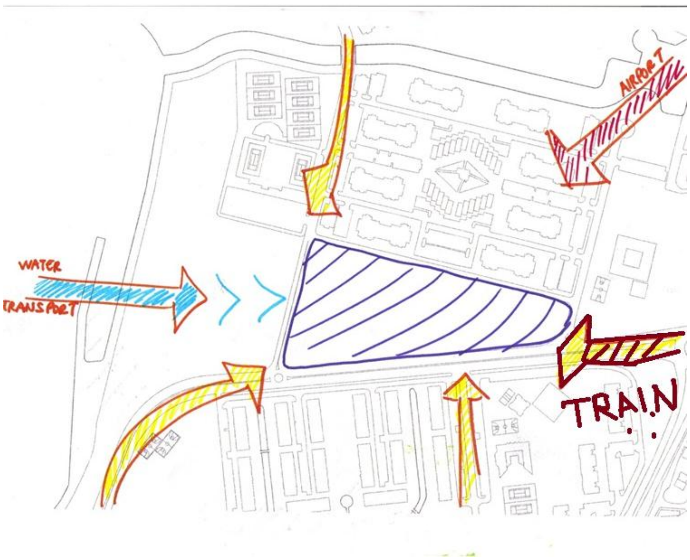


Figure 73 Six Axes

With accomplished 6 axes and iconic opera house consisting public space and and open spaces , It will interact and gel with the city.

The construction of ferries in the region served is a worthwhile goal and is feasible, even in a high wage area by using both established and innovative techniques for modern shipbuilding. It s been said that "God intended people to travel by ship"

Ferries require much less infrastructure investment, have flexible routing topology as demand patterns change over time and near infinite scalability.So leaning on this fact, anothern route will be added to Izmır bay directly connecting Opera House and Mavisehir to other ports.

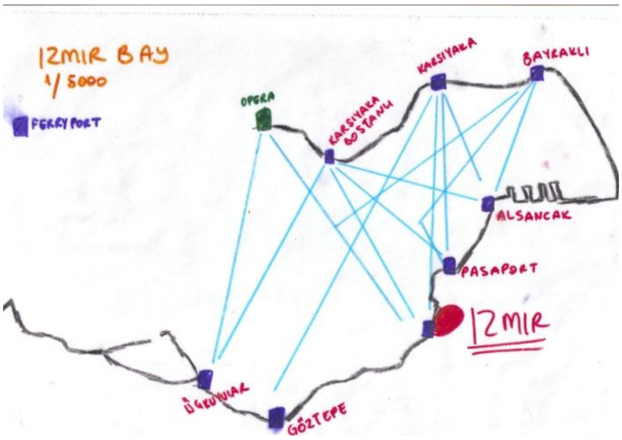


Figure 74 Ferry Port routes including the new one

Figure 75 Green Corridor Accomplished

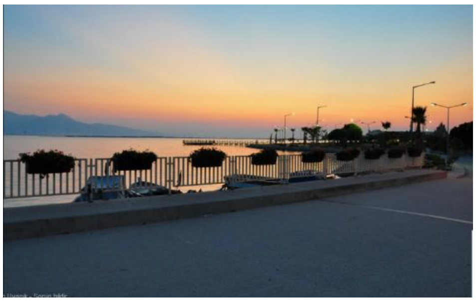
Introduction of these darker green zone in the opera house area and connecting it with coastline and green corridor through the settlements became very important to the development of a network of pedestrian friendly and urban zones for residents of the area.

Green areas area for the health of the people.Water is absorbed by the soil rather than straight through a run off. Urban parks can act as a flood defense,improve air quality,shelter and shade,recreations ,natural habitats and increase the value of the area

Trees planted along the pedestrian corridor will act as carbon sinks. Soil will be used to create redefine microclimate. A completely walkable city would reduce and decrease the need for large pavements, reduce air pollution and reduce the overall environmental impact of the development.

Figure 76 Coastline in Karsıyaka

Figure 77 Red arrows refer to the roads in the pictures



Amount of inhabitants who visit, live and work in the district will continue to grow, placing greater demands on the performance of each square foot of space. Infrastructure that is insensitive to the area's connectivity or is inhospitable to intense pedestrian activity is simply incompatible with the needs of a vibrant and dynamic zone. The roads which are seen in the pictures, are shown by red arrows in the drawing.

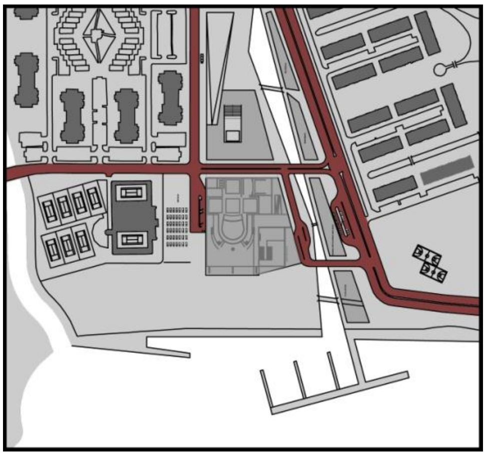


Figure 78 Modified Roads

If we look deeper we see any opportunities to recapture some of the space taken up by infrastructure — such as creating a green zone by removing the roads— to better gel with a rapidly growing residential community.

Open spaces help to balance a densely-built environment with the growing population.

What is proposed here, getting rid of roads next to waterfront and completing coastline with a perfect end like green open space.

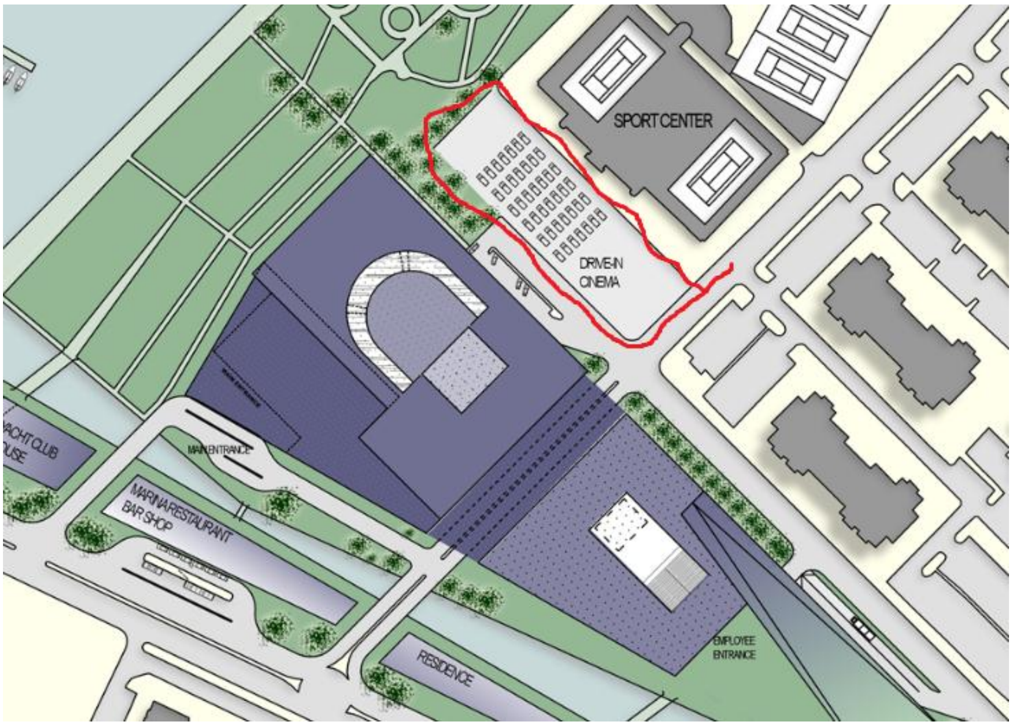
3.6.1.Drıve – In

Izmır is a city with Drive-In culture for years. But lately, with the declination of drive-in cinemas all over the world, people lost interest in these cinemas. We hope to contribute & revive this culture with this cinema.

Hoping to install a 15x25m screen with a steel truss structure with a complex finish
Capacity of the cinema would be around 100 cars.

The concession stand, also called a snack bar, is where a drive-in earns most of its profits. As a result, much of a drive-in's promotion is oriented toward the concession stand. Snack bar offers any food that can be served quickly, such as hot dogs, pizza, cheeseburgers, popcorn, soft drinks, coffee, hot chocolate, ice cream, candy and french fries.

We added children's playgrounds between the screen and the first row of cars.



Drawing 1 Drive-In

Figure 79 Drive-In in Izmir

3.6.2.Marına

Some examples of Marinas

Figure 80 Marina San Giusto in Trieste

The renovated Marina San Giusto is presented in 2009 equipped with new modern facilities, with an increasing number of moorings for pleasure craft and recreational vessels equipped to accommodate up to 70 m. The Marina San Giusto is the only tourist dock at the port of Trieste, located at the center of the port town, just a stroll from the Piazza and the unification of Italy in the city center commercial and institutional, as well as by living good citizen, that is to his shoulders, with its shops and businesses of every kind and type with 250 yacht capacity[22]

Dock in the heart of Trieste: just a few metres away from theatres, museums, top quality restaurants and all the most beautiful attractions of the city.

Figure 81 Marina di Loano

Marina Loano, not only a port but a tourist center of excellence. Unrivaled facilities make it perfectly safe over 1000 berths from 8 to 40 meters[23], for any type of boat and yacht. Art facilities allow all maintenance and repair directly in the Navy, and all around a world of high comfort level that transform your stay into an unforgettable experience on the ground. For a high level of nautical tourism in one of the most beautiful spots of Liguria.

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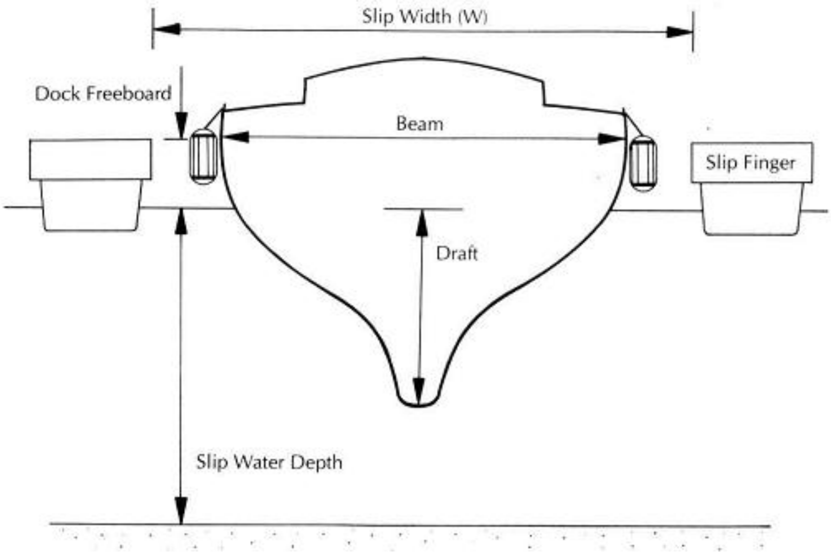
[22] Marina San Giusto Information from http://www.marinasangiusto.it/ ; 2011
[23] Marina di Loano Information from http://www.marinadiloano.it/ ; 2011

3.6.3. Marina Design[24]

[25]**Figure 82 Fig boat&slip characteristics**



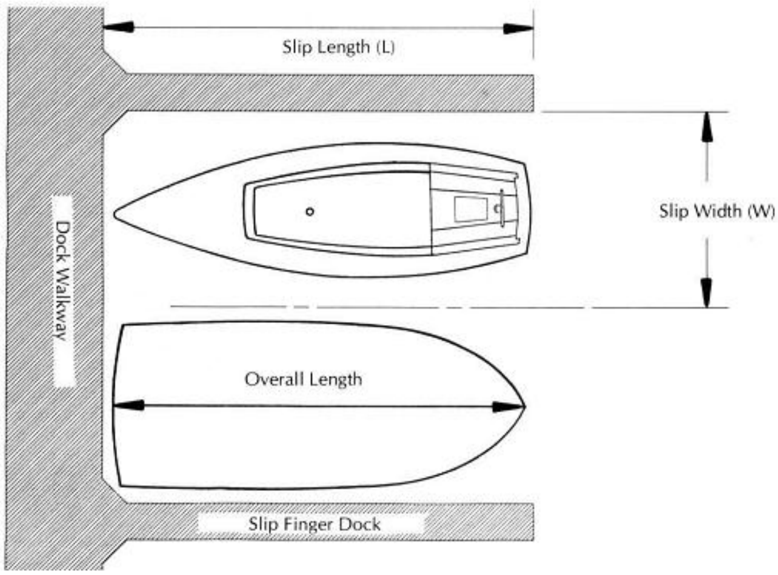


Figure 83 Typical double slip plans

Recommended Minimum Slip Width
for L = 6.0 m to 9.15 m W = L/2
for L = 9.15 m to 25.0 m W = (L/3.74) + 2.13 m

Average Beam = 0.64 (L) 0.715 (meters)

Maximum Draft = (L/10) + 0.3 m

Recommended Minimum Slip Water Depth = (L/10) + 0.8 m

[24] USA Department of Defense, *UFC design :* From 3.6.3.1 to 3.6.3.12 ; *small craft berthing facilities*; 2009
[25] Duncan C. Mellor ; *Modern Marina & Layout Design*; Civil Enginering Practice ;1992

3.6.3.1 Basin

In the design of a marina basin, the following should be considered:

Minimise vertically faced structures.	Vertically faced structures lead to reflection of wave energy, causing confused seas and high wave energy within the berthing area.
Provide two openings, or partial walls on one side.	Two openings at opposite ends of the marina to establish flow-through currents.
Minimise 'dead' water by creating curved surfaces.	Basins with few vertical walls and gently rounded corners or circular or oval shaped basins. Even bottom contours, gently sloping toward the entrance with no pockets or depressions.

3.6.3.2 Entrance Channel

Entrance channel width	For marina basins of say 200 to 300 berth the entrance channel should have a minimum navigable width of 30 to 50 m in unexposed conditions.
Entrance channels should be straight; aligned into prevailing winds; and not in an area of shoaling.	The entrance channel should be as straight as possible and follow an existing natural channel if available. The entrance channel should also be aligned in the

3.6.3.3 Fairway

Preferred fairway width is 1.75L.	To minimise manoeuvring accidents, it has been found that minimum fairway widths between rows of berths in well protected waters should be the greater of 20 m or L + 2 m (where L is length of longest boat in marina). The preferred width is 1.75L.

3.6.3.4 Berthing

Water area for turning = 2.25L.	Turning areas should be provided, particularly adjacent to fuelling berths and dead-end channels. Water area for turning, entering and leaving berths should be 2.25 times the length of the longest boat (minimising chance of collision).
Berths at right angles to walkway.	Berths should be orientated at right-angles to the walkway (maximises numbers, reduces manoeuvring difficulties).
Fingers symmetrically opposite.	Berths should be arranged so that, wherever possible, fingers are symmetrically located on opposite sides of the walkway (reduces manoeuvring difficulties).
Smaller berths closer to shore.	Smaller berths should generally be located closer to the shore (more easily manoeuvred into and out of).

Floating berths are:

Single Berth width (Wb) = B + 0.6 m

Double Berth width (Wdb) = Wbl + Wb2

Berth Length (Lb) = L + 1.0 m

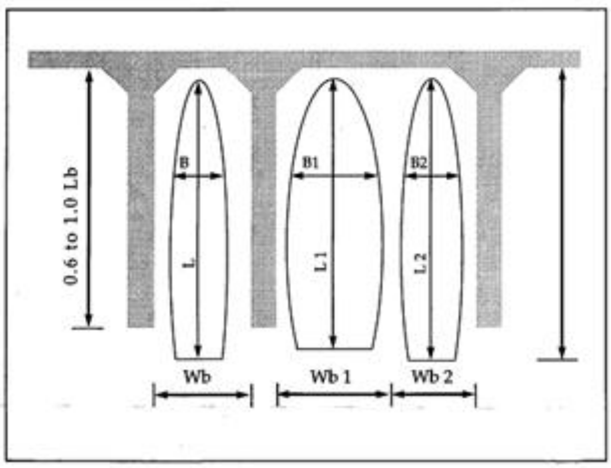


Figure 84 Floating Berth Dimensions

3.6.3.5 Walkway

Optimum finger length is 0.8 Lb.

The length of the fingers should fall between 0.6 times the berth length and 1.0 times the berth length, however the optimum appears to be 0.8 Lb.

3.6.3.6 Administration Office

Administration centre should have a good view over entire marina.

The extent and sizing of administration areas depends on the size of the marina, extent of shore-based activities and whether offices for government authorities are to be provided. The administration centre should command a good view over the entire marina for safety considerations and client management.

3.6.3.7 Maintenance Area

Maintenance area should allow for one boat per 25 craft.
should have a good view over entire marina.

As a guide, allow enough area for maintenance of one average sized boat per 25 craft at the marina. This will vary depending on craft types and the rate of fouling. For initial planning, provision of 5% of total land area for maintenance is reasonable. Maintenance areas should be located above high tide mark to avoid contamination of incoming tidal water.

3.6.3.8 Fueling

Locate fuelling facilities leeward of marina with respect to prevailing winds and leeward of exits.

It should be located to be eas accessible by visiting and passing boats, without access through the main berthing area. The facility should be located to leeward of the marina with respect to the prevailing wind in theboating season and to leeward of exits to permit safe evacuation of boats in the event of fire.

3.6.3.9 Breakwaters

For fixed breakwaters use design features to enhance flushing rates.	Fixed breakwaters can interfere with currents and reduce the flushing rate within the marina, resulting in reduced water quality and increased shoaling. Solid breakwater design should therefore include consideration of natural current and sediment flow, wave patterns and overall flushing characteristics. Circulation can often be maintained by providing openings in solid breakwaters, at both ends of fixed breakwaters or between the fixed breakwater and shore.

3.6.3.10 Parking

Minimum parking requirements detailed opposite.	0.6 parking spaces per wet berth 0.2 parking spaces per dry storage berth 0.5 parking spaces per marina employee 0.2 parking spaces per swing mooring licensed to the marina
Provide separate areas for car parking only.	Provide separate areas for 'car only' parking, and provide sufficient car and trailer parking to meet projected demands for normal usage.
Allow emergency vehicle access.	Provide easy access for emergency vehicles to 'high risk' areas such as workshops.
Avoid large asphalted areas through use of green areas.	Avoid large asphalted expanses through the use of green areas. Green areas in the form of strips or islands may be used as a means of controlling traffic and trailer parking areas
Ensure a high standard of architectural treatment.	Undertake a high standard of architectural treatment (both structural and landscape) in order that the car parking area does not detract from the visual appeal of a marina.

3.6.3.11 Walkway

Table
Minimum Marginal Walkway Widths

Marginal Walkways		
Minimum Width	**Length Range**	**Qualifying Criteria**
6.0 ft	up to 300 ft	when connected to main walkways that **do** have dedicated gangways
8.0 ft	over 300 ft	when connected to main walkways that **do not** have dedicated gangways
10.0 ft	over 600 ft	
12.0 ft	over 800 ft	

Table 11 Walkway Table

3.6.3.12 Interior Channels & Turning Basin

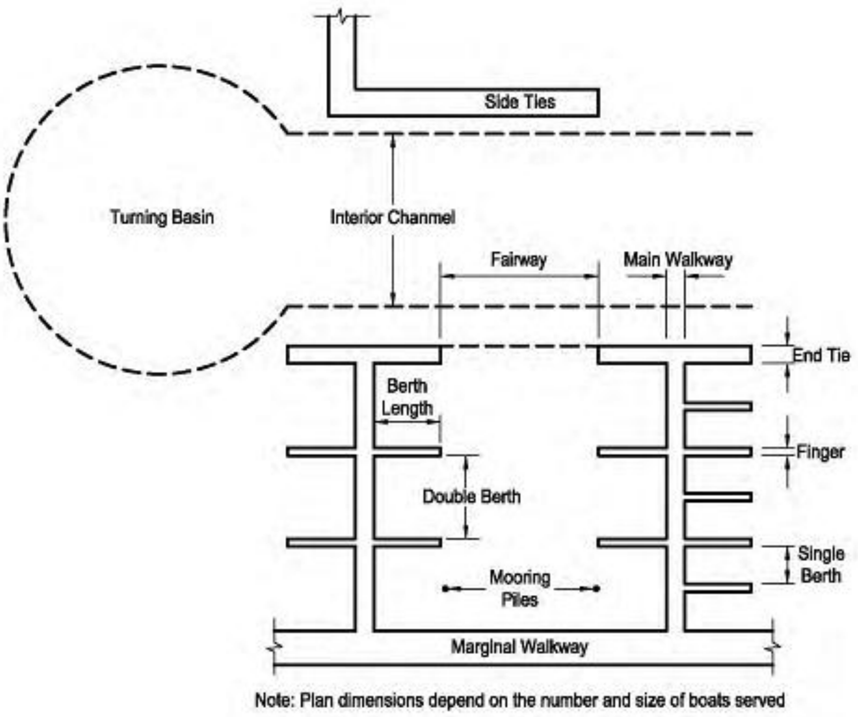


Figure 85 A simple turning basin

The minimum clear width of interior channels should be the greater of:

- 1.5 L , where L is the overall length of the longest boat using the channel or
- 23 m

The preferred width of interior channels should be the greater of:

- 1.75 L, or
- 30 m

If a situation arises in which a substandard channel width exists, a turning basin should be provided at an appropriate point in the channel; the basin should provide a clear turning circle whose minimum diameter is 1.5 L, where L is as defined above. Where channel currents or winds make
turning difficult, this minimum should be increased to 2.0 L.

3.6.3.13 Currents & Wind[26]

Currents:

Currents in rivers and tidal areas can produce high loads on piers and docks and the berthed vessels through their underwater profile areas. This condition is at its worst when vessels are berthed perpendicular to the current direction, and least when the vessels are aligned with the current direction. Generally, when the current exceeds (1 m/s), it could be a significant factor

Winds:

Wind load is based on a wind velocity pressure for steady conditions (neglecting gusts) acting on the above water profile of the berthed vessels and dock system

1 For wind velocities at various geographical locations consult ECOTECT

2 Convert the design wind velocity (in miles per hour) to velocity pressure using the figure below.

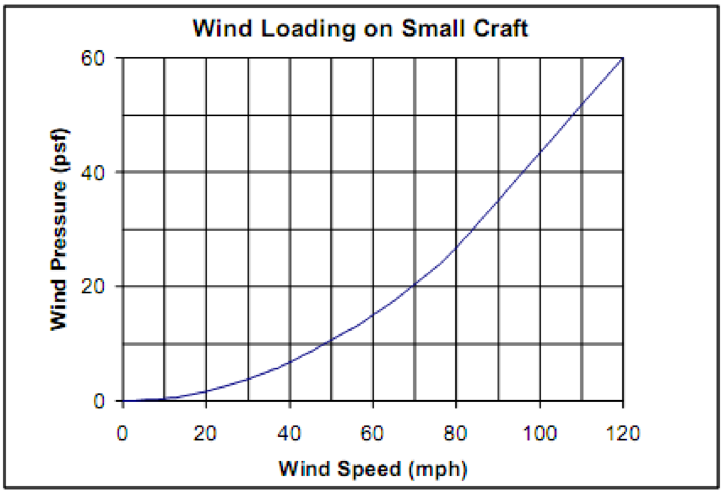


Figure 86 Wind Load GraphIn Izmır , most frequent wind is on North Direction with 10km/h

[26] John Gaythwaite; *Design of marine facilities for the berthing, mooring,*;2004

3. Determine the average profile height for the berthed vessels, generally taken as 15% of the berth length, but other rational method based on the berthed vessel dimensions may be used

4. Compute the wind load, checking both parallel and perpendicular directions to the main axis of the pier or dock.. Assume 100% berth occupancy. For vessels berthed in close proximity to each other, say on either side of a walkway or finger dock, the total force on the structure for each direction should be based on the full wind load applied to the windward (unshielded) vessels, and 20% of the full wind load applied to all leeward (shielded) vessels.

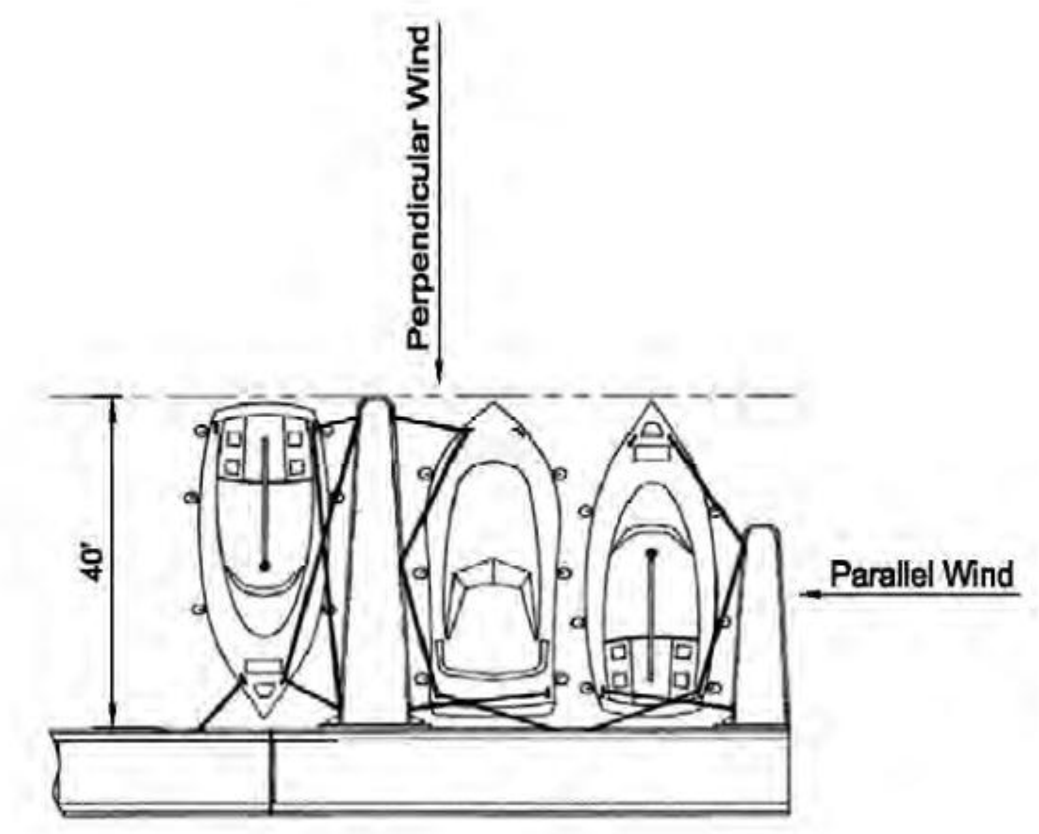


Figure 87 Wind Orientation

PERPENDICULAR WIND

For the sake of calculations, perpendicular wind can be ignored since in that direction wind is very rare.

PARALLEL WIND

DESIGN LOAD IS 8 PSF

40 ‘ UNSHIELDED 1*40*8* 8 = 2560 LBS
40’ SHIELDED 1*40*8*3 = 960 LBS
HEADWALK = 72 LBS
TOTAL 3632 LBS = 1647 KG

3.6.3.14 Breakwater Calculation[27]

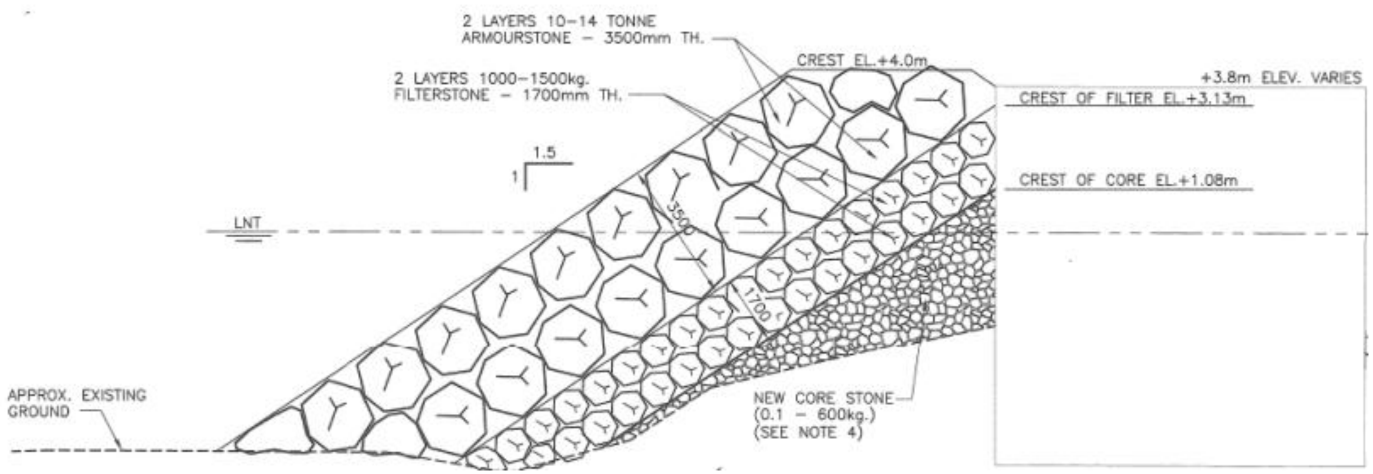


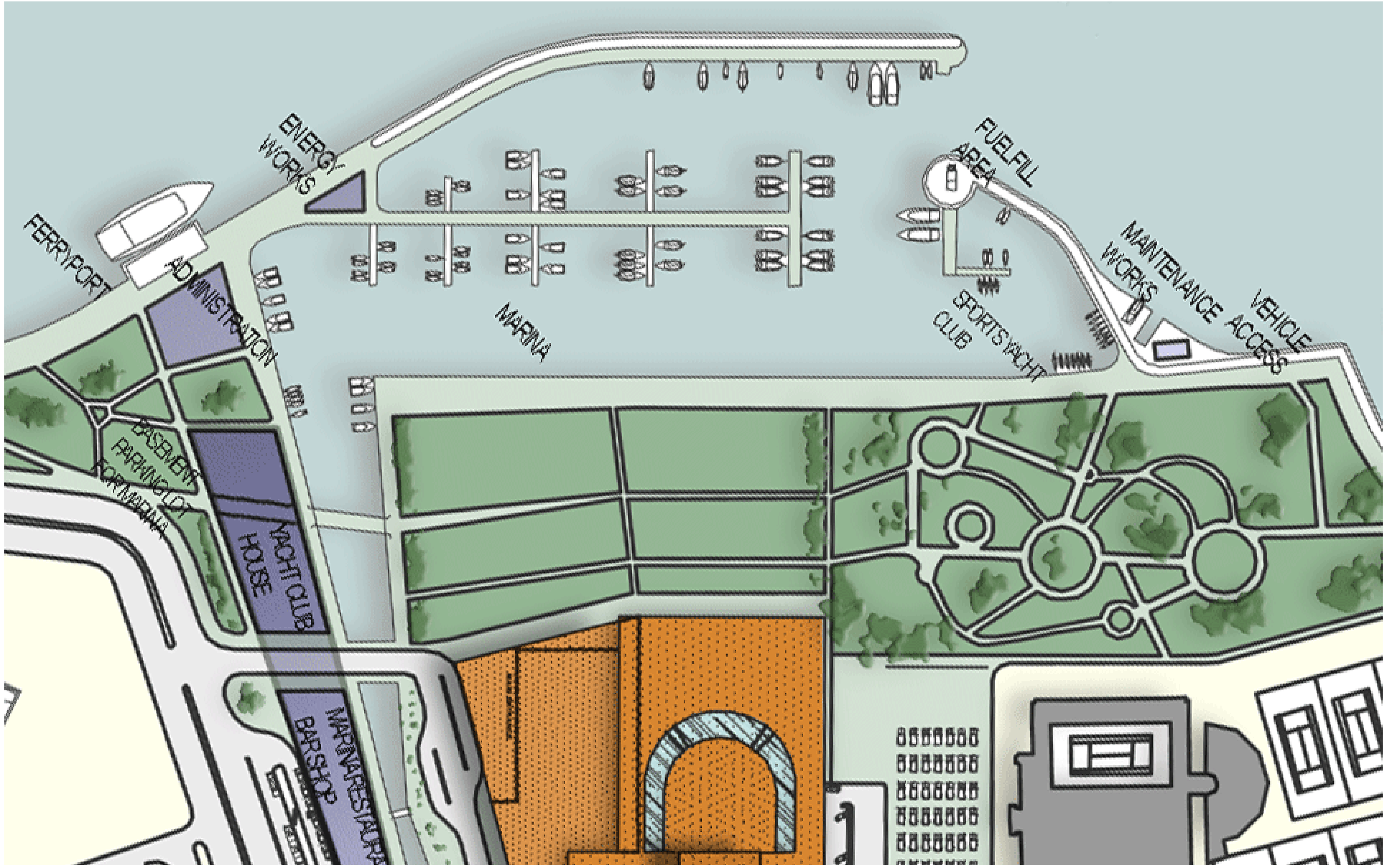
Figure 88 Design Breakwater

$S\alpha$.granite = 2.7
W = 14000kg = 137.240 N
Cot α = 1 / tan *α = 1.5/1 = 1.5*
Assuming rough angular quarry stone, 2 layers and breaking waves K_d = 1.9

Therefore $W = \frac{\Upsilon\alpha.H3}{Kd(S\alpha-1)3.cot\alpha}$

$137240 = \frac{2{,}7\ x\ 1000\ x\ 9{,}81 x H3}{1{,}9(2{,}7-1)3\ x\ 1{,}5}$; H = 4.15 m IS THE DESIGN WAVE LENGTH

[27] EM 1110-2-2904, *Design of Breakwaters and Jetties*, USACE, 1986



Drawing 2 Designed MARINA

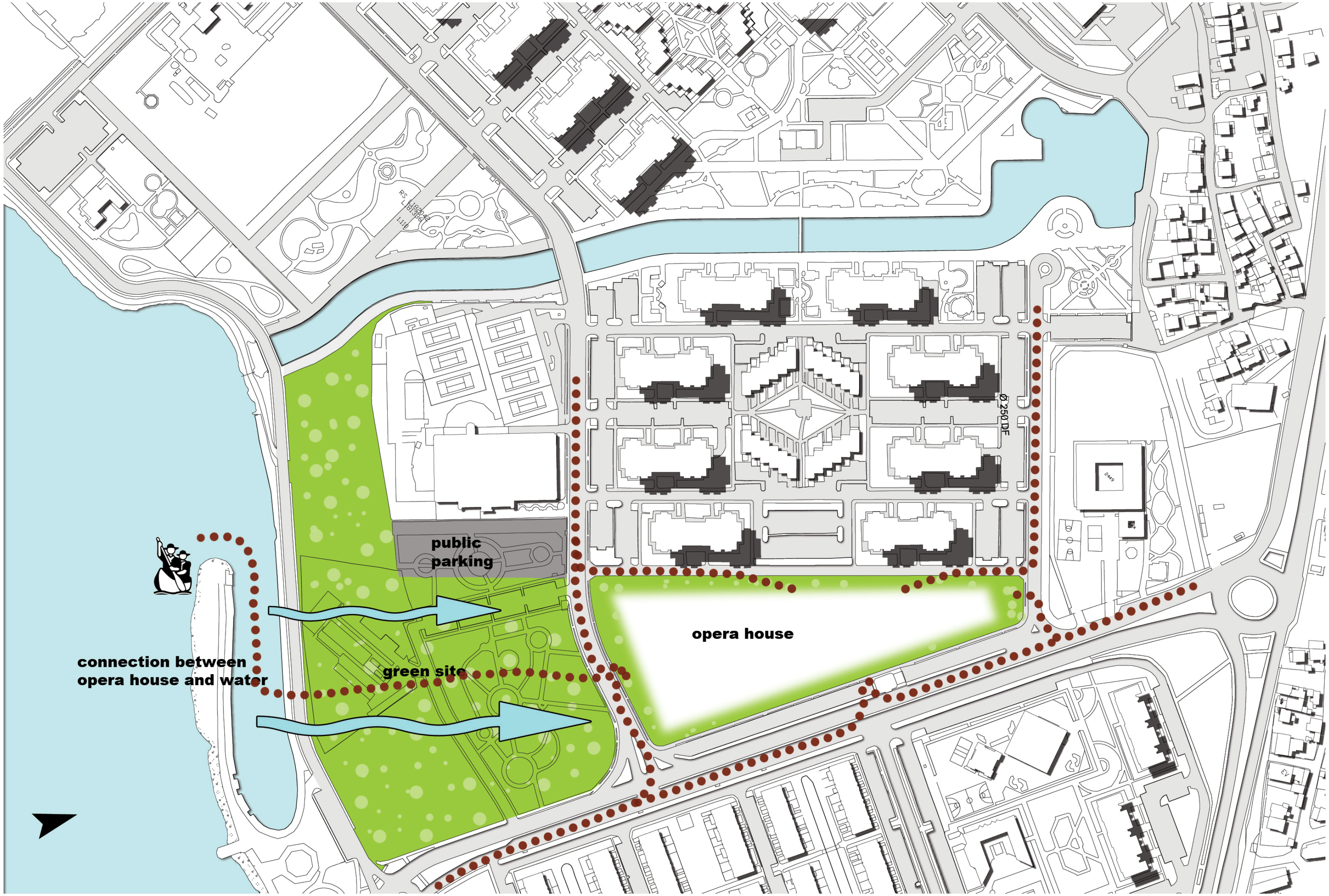
3.6.4 Older Concept Plans

Drawing 3 One of the older concept plans

The picture above is one of the older concept plans. At the beginning, continuing the green space had been thought. Area would be stretched through the coastline.Furthermore, It did not work out well with the zone.

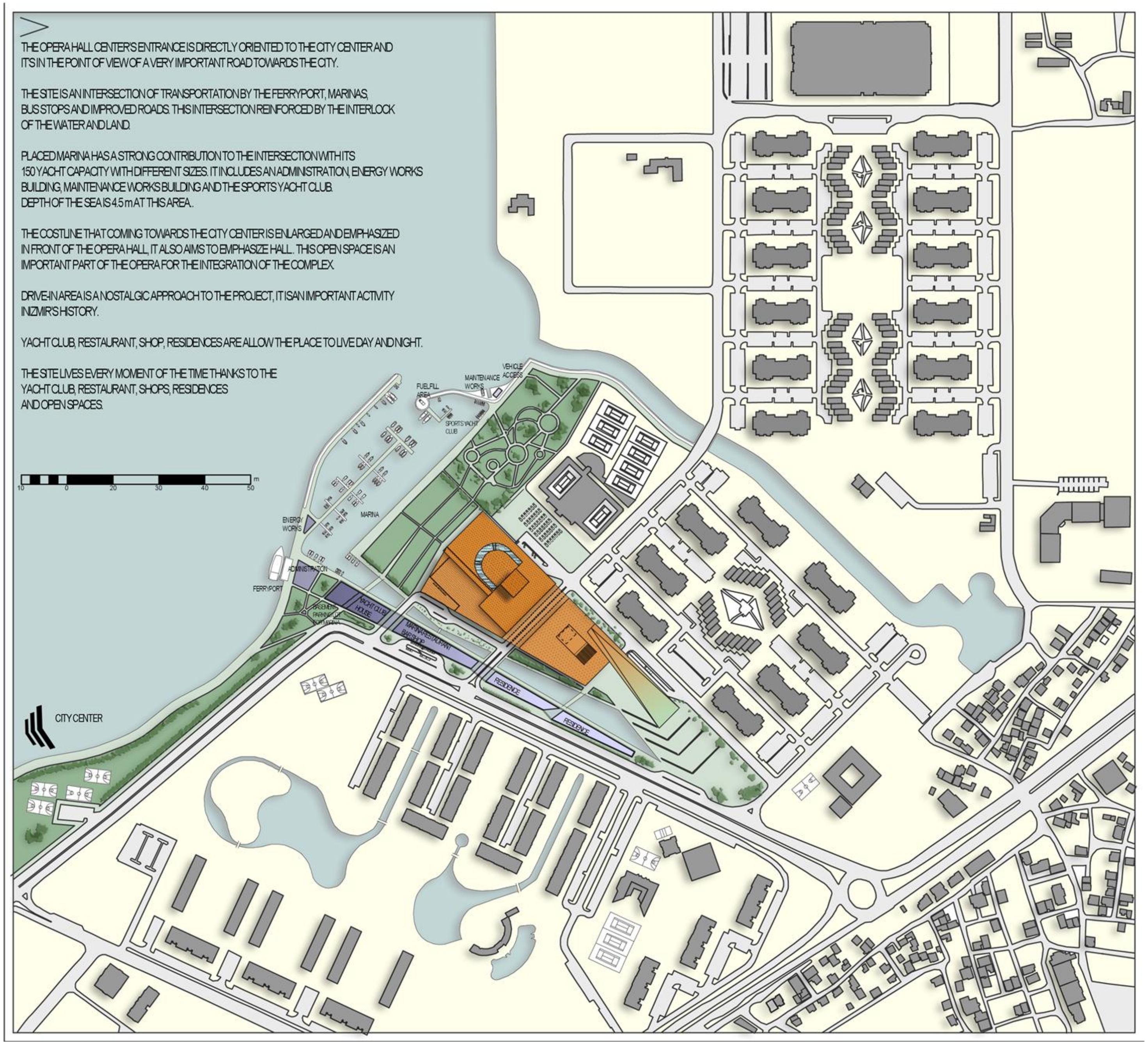
Also an additional ferry port was an another idea. However, later on, combining marina and passenger ferry port seemed more proper. Since ferry is supposed to carry passengers whose wish is to come and participate and be a part of the events in Opera House.

Additional parking zones are thought in both concept plans. However, the example below will turn out to be an Drive-In later on in the masterplan.

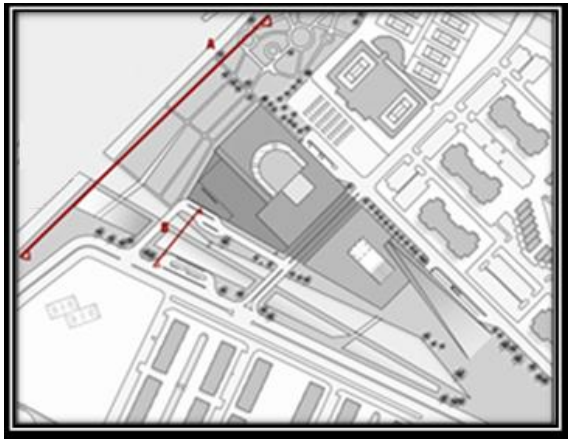


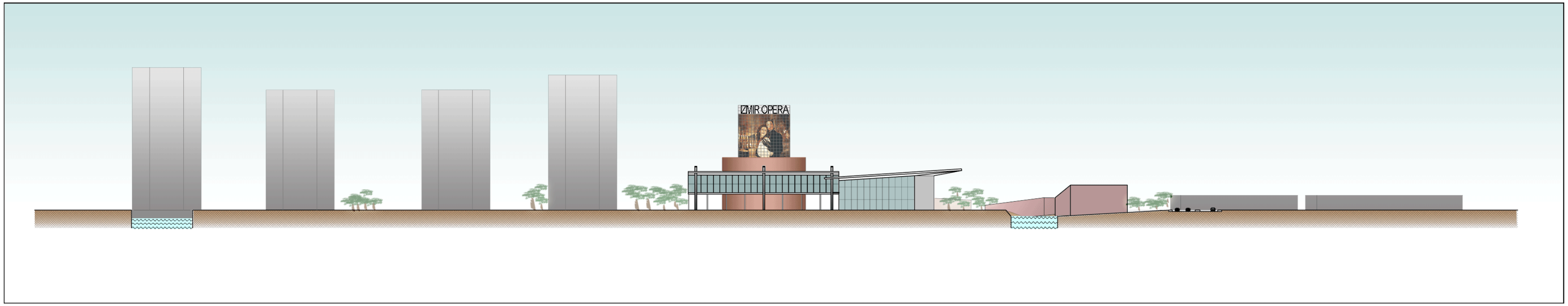
Drawing 4 Another older concept plan

3.7 MASTER PLAN

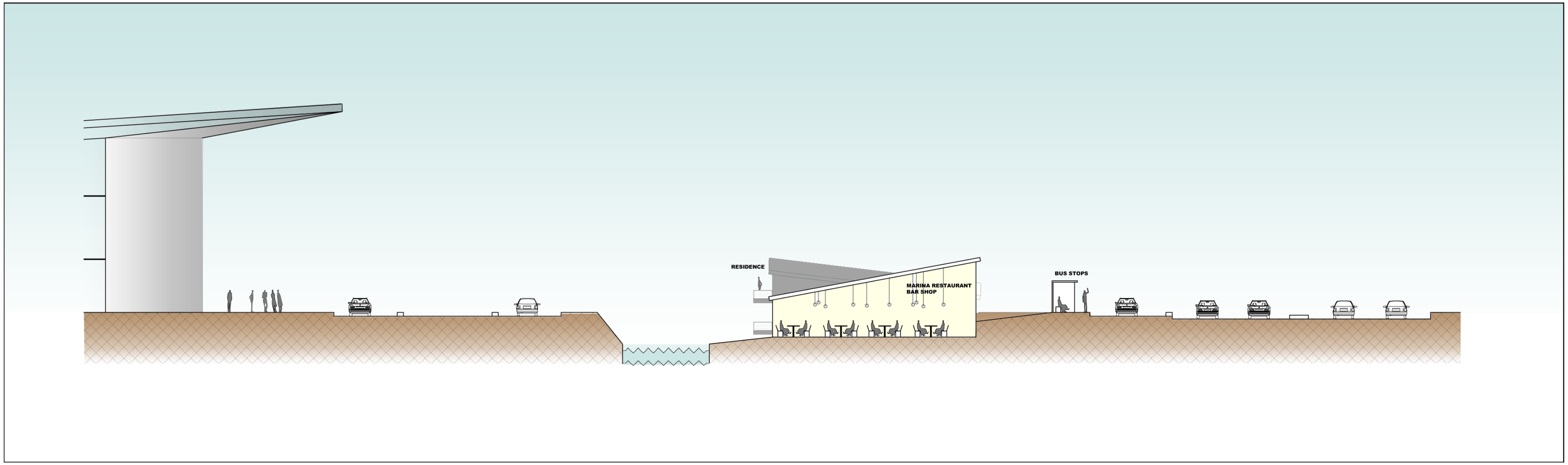


Drawing 5 M.Plan





Drawing 6 Section A-A



Drawing 7 Section B-B

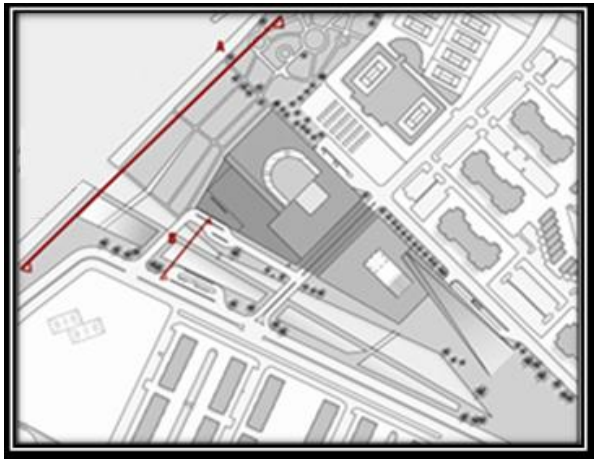


Figure 89 Main Road Connection

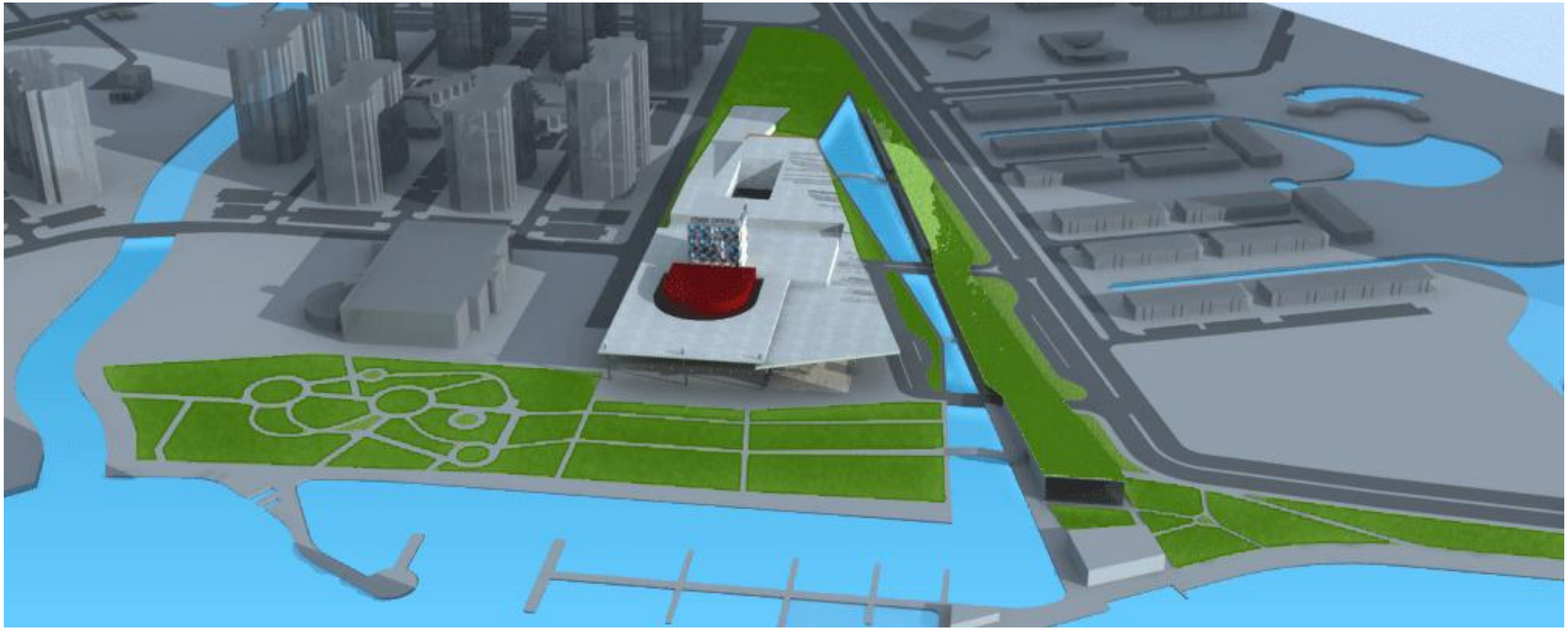
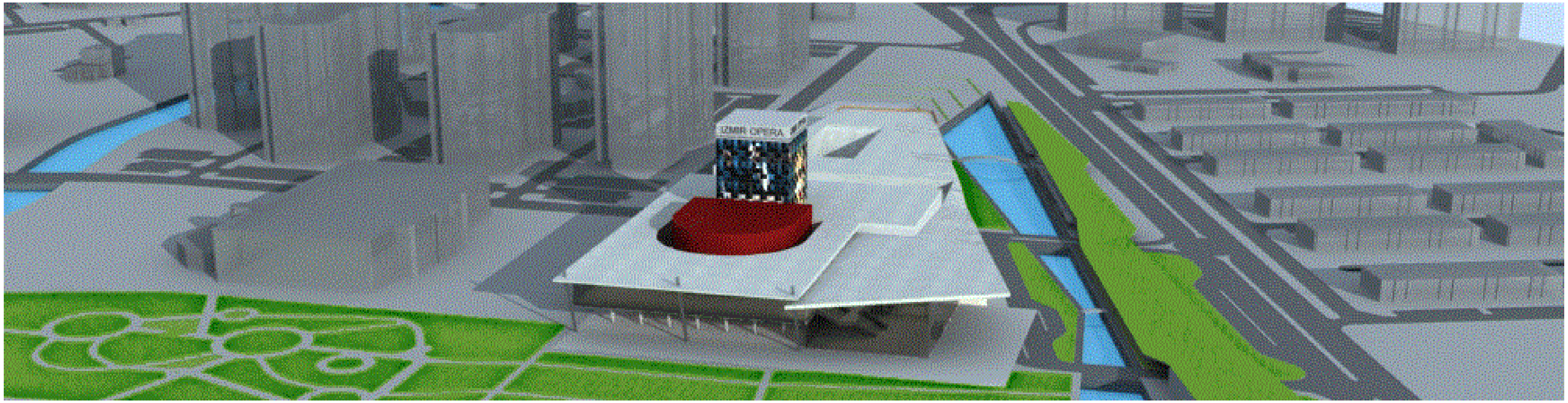


Figure 90 Overall Green Spaces

Figure 91 Main Entrance



CHAPTER 4

ARCHITECTURAL DESIGN

4.ARCHITECTURAL DESIGN

4.1 Opera House

An opera house is a proscenium theatre in form. Seat count ranges from 1200 to 2000 with an upper limit of about 2400 seats. The auditorium is almost always multilevel with side tiers or boxes to enhance visual and aural intimacy. The stage is usually large, with extensive machinery. It sometimes has separate auxiliary stages in a cruciform, six square, or other arrangement to enable the opera company to perform in repertory. European opera houses generally have smaller auditoriums and more elaborate stages, as compared to opera houses in the United States. [1]

The first public opera house was the Teatro San Cassiano in Venice, Italy, which opened in 1637. Italy, where opera has been popular through the centuries among ordinary people as well as wealthy patrons, still has a large number of opera houses. When Henry Purcell was composing, there was no opera house in London. The first opera house in Germany was built in Hamburg in 1678. Early U.S. opera houses served a variety of functions in towns and cities, hosting community dances, fairs, plays, and vaudeville shows as well as operas and other musical events.[2]

Figure 92 Phantom of the opera

In the 17th and 18th centuries, opera houses were often financed by rulers, nobles, and wealthy people who used patronage of the arts to endorse their political ambitions and social positions or prestige. With the rise of bourgeois and capitalist social forms in the 19th century, European culture moved away from its patronage system to a publicly supported system.

In the 2000s, most opera and theaters raise funds from a combination of government and institutional grants, ticket sales and, to a smaller extent, private donations.

Figure 93 Puccini 's Tosca & Lady Macbeth

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[1] HistoryWorld ; History of Opera ; from www.historyworld.com; 2012
[2] Deanna R. Hoying ; A Brief History of Opera ; 2011

4.2 Location

Figure 94 Satellite View

Figure 95 Site is located in Mavisehir zone of Karsiyaka/ Izmir

4.3 Design Philosophy

-To combine and incorporate landmark designation with functionality and design, while keeping in mind the needs and requirements of today's changing Izmır

-A place that has a good relationship with Water-Green-Sky with its users meaning that it is open to a wide range of users: the residents, the workers, the hotel guests, the visitors, the tourists, the students etc..

-A brand new stop of the community, able to attract people to gather on it, able to vibrate the whole neighborhood during daytime.

Figure 96 Diversified Intensified Use

- By not being devoted to a single use, these buildings bring more varied and interesting life.

-Increase intensity of land uses, increase diversity of land uses, integrate segregated uses

- A reference place that is open for innovation and change, providing its users opportunities to meet and socialize, stimulate interest and curiosity in cultural activities, opera and Izmır.

-Tranquility: a varied landscape that would provoke sensations of relaxation

We believe that our building will add to the architectural richness of the city by contributing, with new shapes and dimensions.

4.4 Key Words Of Planning

4.4.1 Character

The character of a building depends upon its capacity to express a particular function and status. In the historical styles of architecture, the function and status of a building were successfully expressed in a variety of styles. No building can have a neutral character

All aesthetic components, such as unity, composition, contrast and scale together make up the character of a building. Character also brings out the utility and purpose of a building. Whether it is a bank or a church or a library, it should possess an appropriate character and not something weird

4.4.2 Aesthetics

Aesthetics is a branch of philosophy devoted to beauty. It dissects the visual compositional elements like proportion and line, as well as other formal qualities—auditory, tactile, olfactory, thermal, and even kinesthetic—that achieve beauty

In the case of architecture, underlying concepts may also include imageable form, a sense of place, and interpretation of available technology. Not surprisingly, then, theories of beauty vary to reflect currents of thought in societies. It is free of specific values.

Figure 97 Aesthetics in the eye of beholder

4.4.3 Ambience

Sensual Quality of the building such as sound, smell, taste& touch for better experiences of the users these qualities must be considered.

Figure 98 Perception of ambience by five senses

4.4.4 Circulation

In the field of architecture, circulation refers to the way people move through and interact with a building Structures such as elevators, escalators, and staircases are often referred to as circulation elements, as they are positioned and designed to optimize the flow of people through a building.

A careful study should be made on the circulation between the spaces must be done to avoid inconveniences of bad interspatial relationship design. The circulation around the site must be accurate in order to avoid wasted spaces and inconveniences for the users

4.4.5 Technology / Sustainability

Strive to use materials with low environmental impact, those that are readily available, and easy to maintain, that are most durable, and are proven reliable. Sustainability is not just about being green its also about a better, healthier, more rewarding and more efficient built environment for the people living and working there.
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.

4.4.6 Accessibility

Accessibility: Our building should be easily accessible to all. Along with the ease of understanding the functioning of services, for identifying pathways, entrances, exits, internal distribution and various parts of complex. (Special care in design for people with disability)

Figure 99 Easy-Accessibility is crucial

4.4.7 Visibility

Easily recognizable in the urban context, as easily should be identifiable individual shares and
their paths internal and external connections.

4.5 Research on Opera Houses

4.5.1 Kopenhagen Opera House

The Opera House, used by the Royal Theater, will host large-scale opera and ballet productions.
New 17 meter wide canals have been dug on both sides of the building accentuating the placement of the Opera House on an island.


Figure 100 Kopenhagen Opera House

The front of the house is visually integrated in the harbor space, whereas the back of the building, designed as a lower building block, relates to the buildings in the area and to the new apartment blocks planned on the north and south side of the building.

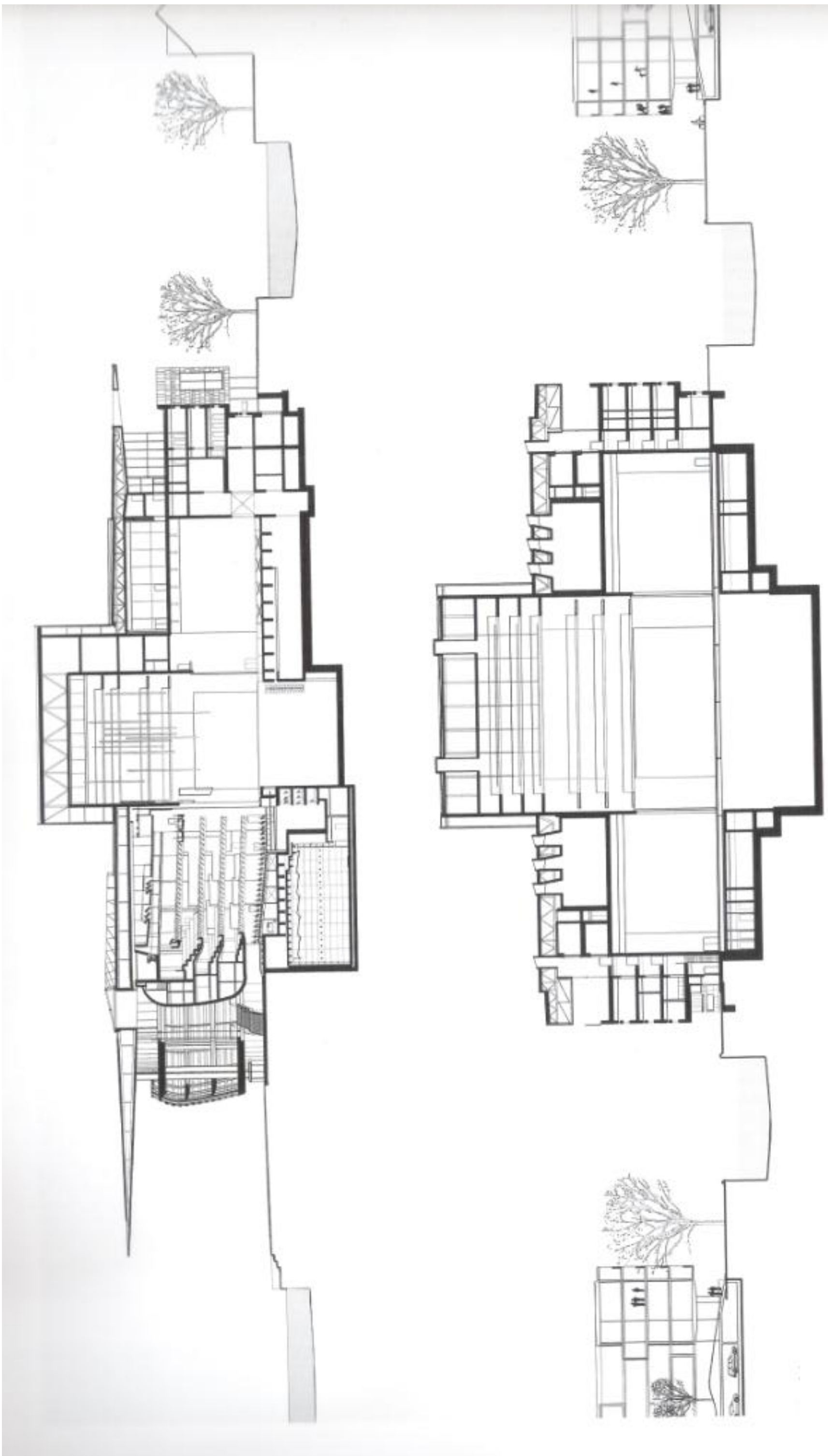


Figure 101 Sections of Kopenhagen Opera House

Grand arrival Plaza, covered by the 32 meter long cantilevered roof, welcomes the audience approaching by boat or from the wide harbor promenade. The building is clad in a golden limestone, the curved 4-stories Foyer in glass, with horizontal steel bands.

From the arrival Plaza three revolving doors lead to the four-story high light filled Foyer paved with Sicilian marble. Balconies and walkways, with magnificent views of the harbor and the city, lead to the main auditorium; the heart of the building.[3]

The main auditorium, with seating in the traditional horseshoe form, seats approximately 1,500
From the restaurant and terrace on the top floor there is a 180 degree view of the harbor and the city.

Below , sections of Kopenhagen Opera House can be seen, which is familiar to our case(A good example for entrance and city orientation

4.5.2 Oslo Opera House

The dividing line between the ground 'here' and the water 'there'[4] is both a real and a symbolic threshold. This threshold is realised as a large wall on the line of the meeting between land and sea, Norway and the world, art and everyday life. This is the threshold where the public meet the art.

Figure 102 Oslo Opera House

To achieve a monumentality, based on the concept of togetherness, joint ownership, easy and open access for all it was wished to make the opera accessible in the widest possible sense, by laying out a 'carpet' of horizontal and sloping surfaces on top of the building.

This carpet has been given an articulated form, related to the cityscape. Monumentality is achieved through horizontal extension and not verticality

Due to its size and aesthetic expression, the operahouse will stand apart from other buildings in the area

The building connects city and fjord, urbanity and landscape

The building is split in two by a corridor running north-south, the 'opera street'. To the west of this line are located all the public areas and stage areas. The eastern part of the building houses the production areas which are simpler in form and finish

[3] Yem Books & Publishing ; Projeler & Yapılar 4 ; *Kopenhagen Opera House* ; July 2011
[4] Statysbygg ; *New Opera House* ; *Oslo opera House* ; 2003

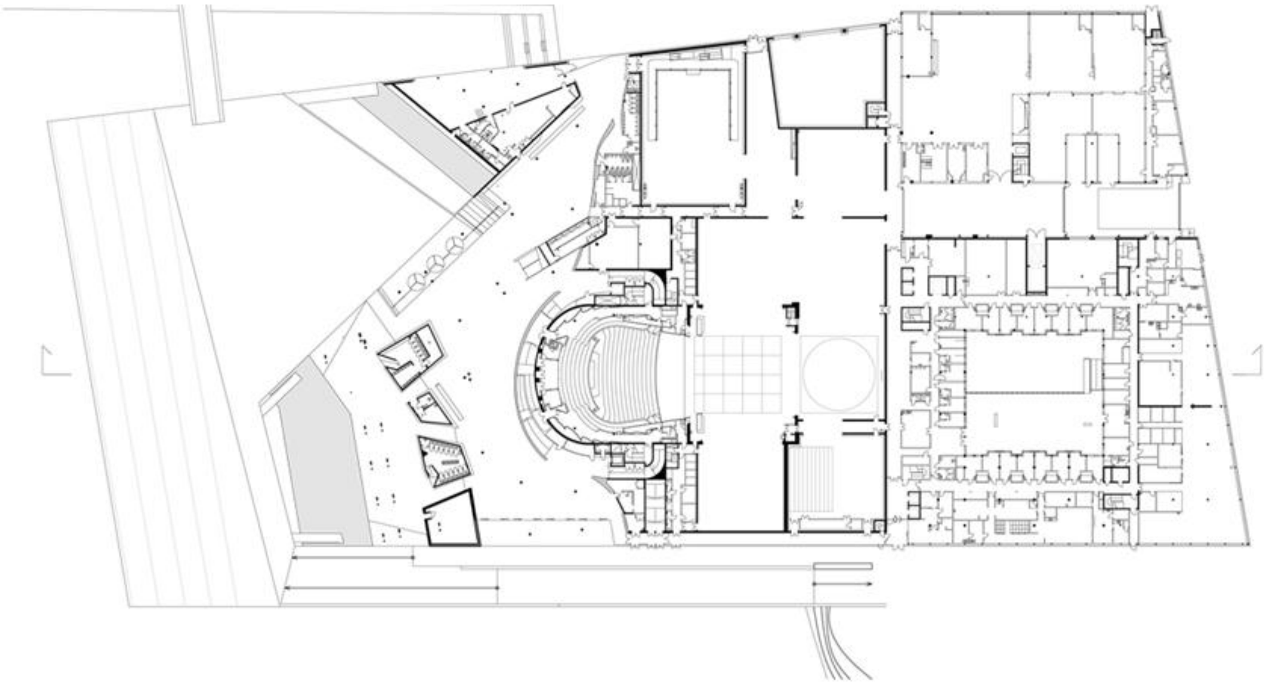


Figure 103 Plan of Oslo Opera House

4.5.3 Sydney Opera House

More remarkable is that the scheme makes no reference to history or to classical architectural forms

As a public building, it conceals its usage in its lack of historical associations, and restores the concept of the 'monument' as being acceptable in social terms

Figure 104 Sydney Opera House

The Sydney Opera House also embodies timeless popular metaphors. The building's organic shape and lack of surface decoration have made it both timeless and ageless. Moreover, it demonstrates how buildings can add to environmental experience rather than detract from it - something of spiritual value independent of function.

Visibility from any point is a very strong suit for the location.
Like the Ancient Greek theatres, auditorium is at the end of platform.
Sydney Opera House lies adjacent to the Sydney Royal Botanic Gardens

The walls and ceilings of the Sydney Opera House are made out of laminated glass that is especially made in France. Two sheets of glass and one sheet of plastic was placed between the two sheets of glass unit which are stuck together. The buildings roofs are made out of fungus ceramic tiles. Pre-cast concrete was used to build the ribs of the shells of the Sydney Opera House. Steel and tendon were not the only thing that was used to hold the pre-cast concrete, the other thing that held the roof was epoxy [5]resin.

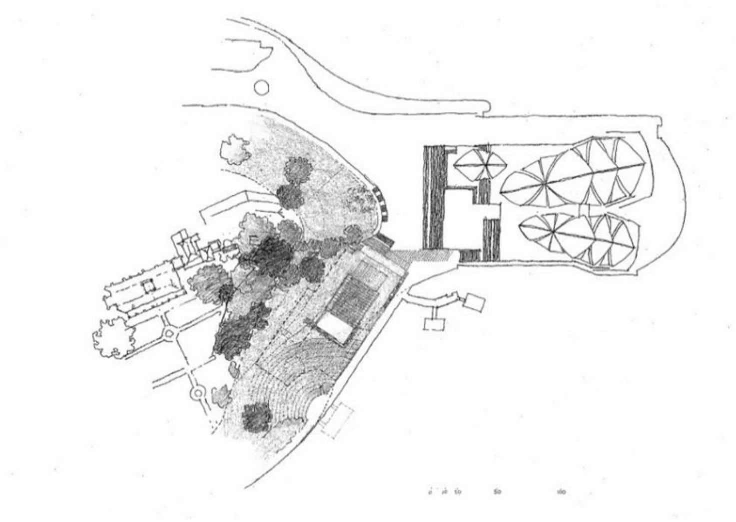


Figure 105 Overview sketch of Syney Opera House

Back of the opera house is a huge botanic garden. And main entrance is at the back of the platform due to the fact that city is also behind the walls.

It's a great example to state that entrance doesn't always have to be from the main façade.

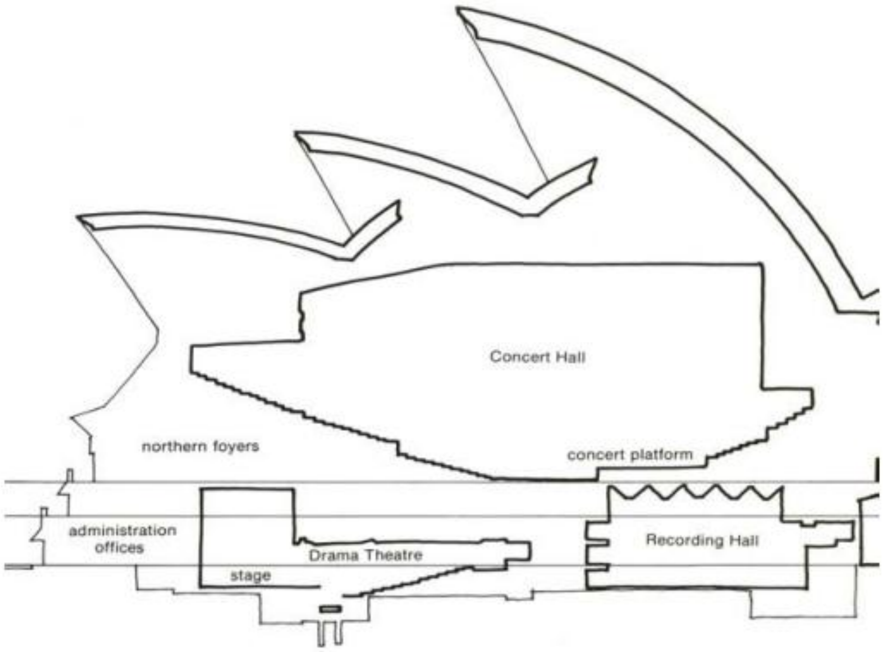


Figure 106 Shells & Section

[5] Sydney Opera House ; *The Utzon Design Principles* ; May 2002

4.5.4 Guangzhou Opera House

Looking at the plan, this is actually just one project but seems like two.
Separated by a passage and two buildings are popping out in the landscape.

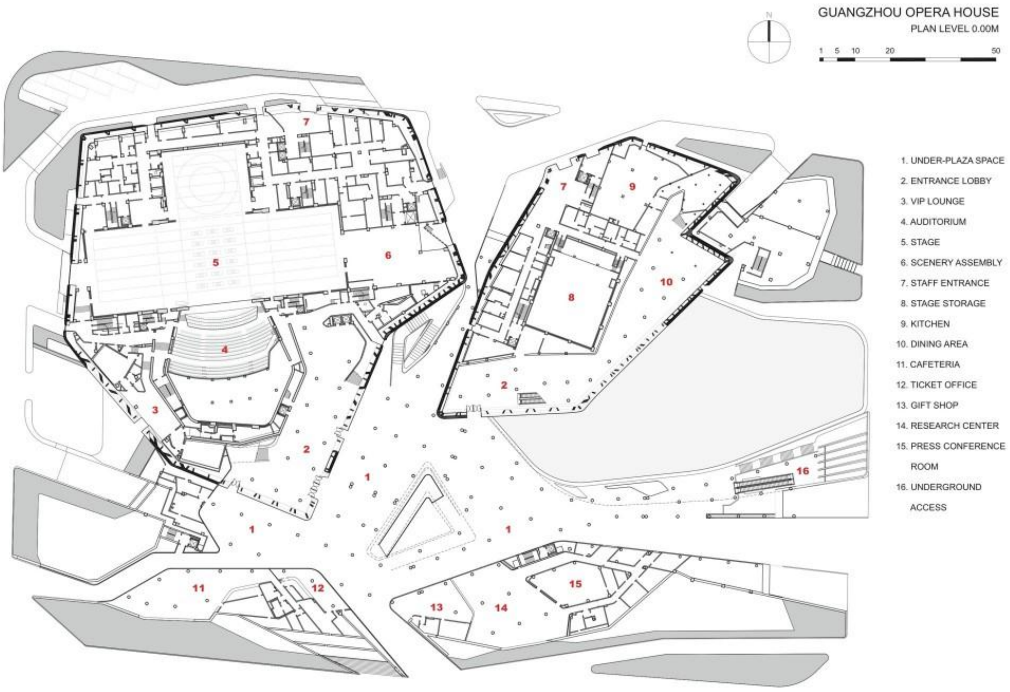


Figure 107 Plan of Guangzhou Opera House

The building is conceived as two rocks shaped by the Pearl River rushing past. The larger, grey granite-clad volume contains the opera house; the smaller, black granite-enveloped volume houses, appropriately, a black box theatre. [6]

Between the two buildings, the ground rises, drawing you in from the grid of the city into disrupted, fluid geometry that seems to acknowledge the flow of the river and the giddiness of the construction, the centre of a churning, changing landscape.

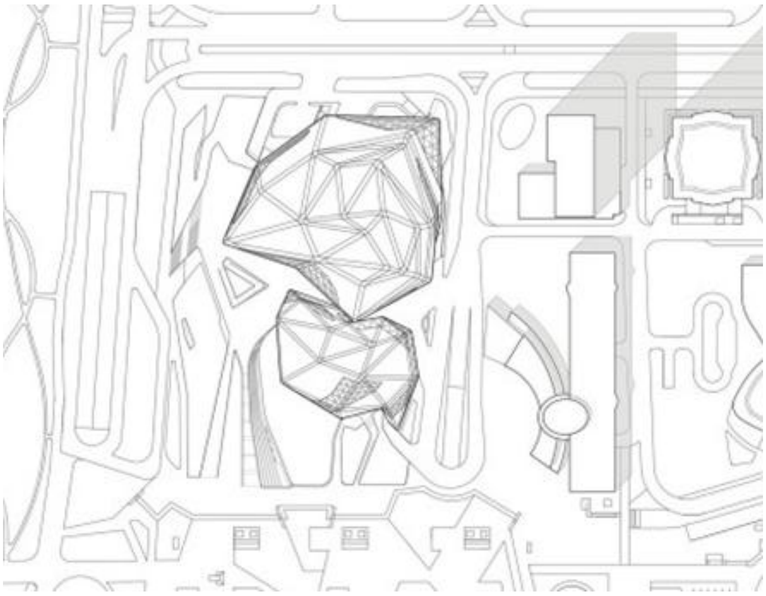


Figure 108 -- 2 in 1 ----

[6] Yem Books & Publishing ; Projeler & Yapılar 4 ; Guangzhou *Opera House* ; July 2011

"The two buildings are embedded in an artificial landscape impregnated with program and spaces," explained by Patrick Schumacher.(he mentioned that to Joseph Giovannini on May 2011 for www.architectmagazine.com)

Visitors approach the site and buildings from several directions and on several levels by vehicular and pedestrian roads ramping through long pools of water. The rising and lowering ground planes contain restaurants, offices, stores, and meeting rooms.

4.6 Brief & Requirements & Specifications

MAIN HALL & STAGES 4810 m²

- MAIN HALL 1200 m²
- MAIN HALL STAGE 400 m² (20X20, h:9m)
  - -MOVEABLE
- MAIN HALL SIDE STAGESX2 400 m ²
- MAIN HALL BACK STAGE 400 m ²
- MAIN HALL BOTTOM STAGE 400 m ²
- ORCHESTRA PIT 250 m²
  - -TOP SHOULD BE TURNED OFF IF NECESSARY
- UNDERGROUND ORCHESTRA PIT 250 m ²

ENTRANCE 4280 m2

- FRONT FOYER 1200 m²
  - -TICKET OFFICE
  - -SECURITY
  - -CAFE
  - -SALES
- VIP ENTRANCE & ROOM 80 m²
  - -KITCHEN
  - -WC
- FOYER 3000 m²
  - -FOR ONLY AUDIENCES WITH TICKET
  - -CAFE
  - -CONNECTED WITH ALL FLOORS OF THE HALL

PARKING 5000 m²

SMALL HALL & STAGE 1113 m²

- SMALL HALL 400 m²
- SMALL HALL STAGE 200 m² (20x10)
- ORCHESTRA PIT 100 m²
- METAL WORKSHOP 200 m² (CHANGING,WC,SHOWER,CHIEF ROOM,STORAGE,BENCHS)
- SHOE WORKSHOP 40 m²
- WOMEN DRESS TAILOR WORKSHOP 120 m ²

OPERA-BALLET RELATED UNITS 1722 m²

- SOLOISTS CHANGING ROOMS 16x20m²
- SOLOISTS MAKE UP ROOM 80 m ²
- SOLOIST WORK&TUNE UP ROOMS 15x10 m ²
- CHORO CHANGING ROOMS 4x60 m ²
- CHORO&FIGURANT MAKE UP ROOMS 2x80 m ²
- FIGURANT CHANGING ROOMS 2x80 m²
- ORCHESTRA MEMBERS CHANGING AND MAKEUP ROOMS 2x80 m²
- SHOWER, WC 2x 30 m²

- UNDERGROUND ORCH PIT 100 m²
- PROJECTOR ROOM 12 m²
- SOUND&LIGHT CONTROL ROOM 20 m²
- DIMMER ROOM 12 m²
- AMPLIFICATOR ROOM 12 m²

GENERAL FACILITIES 450 m²

- DINING HALL 200 m²
- KITCHEN 100 m²

WORKSHOPS & STORAGES 4228 m²

- ASSEMBLY WORKSHOP 100 m² h:9 m (AIR CONDITIONED)
- CARPENTERS WORKSHOP 200 m² h:9m (CHANGING,WC,SHOWER,CHIEF ROOM, AIR CONDITIONED)
- PAINTWORKS 200m² h:9m (CHANGING,WC,SHOWER,CHIEF ROOM,AIR CONDITIONED,BRUSHTUB,STORAGE

- MEN DRESS TAILOR WORKSHOP 120 m²
- DRESS PAINTING 40 m²
- STAGE PAINTERS ROOM 60 m²
- DECORATION WORKSHOP 40 m²
- PLASTIC WORKSHOP 60 m²
- BACKSTAGE SEWING W.SHOP 40m²

- PIANO REPAIRING WORKSHOP 60 m^2
- STRINGED MUSICAL INSTRUMENTS REPAIR WORKSHOP 40 m^2
- DRY CLEANING WORKSHOP 60 m^2
- WIG WORKSHOP 40 m^2
- HAT-FLOWER WORKSHOP 40 m^2
- NOTATOR &SKIN WORKSHOP 20 m^2
- PHOTOGRAPHY WORKSHOP 20 m 2
- PHOTOCOPY ROOM 20 m^2
- MECHANIC WORKSHOP 30 m^2
- ELECTRIC WORKSHOP 30 m^2
- LIGHT WORKSHOP 30 m^2
- ACCESSORIES WORKSHOP 40 m^2
- DECORATION STORAGE 800 m^2
- COSTUMES WORKSHOP 2x200 m^2
- ACCESSORIES STORAGE 100 m^2
- FABRIC STORAGE 50 m^2
- STORAGE CHIEF ROOM 20 m^2

OPERA PART 1302 m^2

- SOLOISTS COLLECTIVE WORKING ROOM 2x60 m^2
- SINGING MASTERS ROOM 4x15 m^2

TECHNICAL PARTS FOR MAIN STAGE 283 m^2

STAGE AROUND 518 m

- BACKSTAGE 100 m^2
- ELECTRIC ROOM 10 m^2
- ACCESSORIES ROOM 20 m^2
- MECHANIC ROOM 10 m^2
- SOLOIST CHORIST CHANGING 2x3
- PROMPTER ROOM 10 m^2
- COSTUME DRESSER ROOM 2x30 m
- DECOR CHANGER ROOM 60 m^2
- FIRST AID ROOM 10 m^2
- FIRE OFFICERS ROOM 30 m^2

REHEARSAL HALLS 1750 m^2

- OPERA REHEARSAL HALL 400 m^2
- BALLET REHEARSAL HALL 400 m^2
- BALLET REHEARSAL HALL 4x100 m^2
- LOUNGE 50 m^2

MAIN SERVICE UNITS 945m^2

- ENTRANCE-INFO-SECURITY 50 m^2
- ARTIST SECRETARIATS 40m^2
- OPERA MANAGER-SECRETARY 80 m^2
- STAGE MANAGER ROOM 20 m^2
- ART TECHNIC MANAGER-SECRETARY 20 m^2
- ART CONSULTANT ROOM 20 m^2
- HEAD STAGE MANAGER ROOM 20m^2
- CHOIR WORKING HALL 150 m^2
- KORREPETITOR ROOM 20 m^2
- CHOIR TUNE UP-CHILDREN CHOIR/BALLET 100 m^2
- WORKING ROOM 100 m^2
- ORCHESTRA WORKING ROOM 250 m^2
- NOTE STORAGE 50 m^2
- WORKING ROOMS 10x10 m^2
- MUSICAL INSTRUMENT ROOM 80 m^2

BALLET PART 480 m^2

- BALLET CHIEF CHOREOGRAPHER 30 m^2
- BALLET HEADMASTER 30 m^2
- BALLET MASTER 30 m^2
- BALLET STAGE DIRECTORATE 30 m^2
- BALLET CHIEFTAINCY 20 m^2
- REPETITOR 20 m^2
- MASSAGE ROOM 30 m^2
- BALLET SHOES&TUTU ROOM 30 m^2
- BALLET ARTISTS CHANGING ROOMS 2x50 m^2

- TECHNICAL MANAGER ROOM 20 m^2
- HEAD DECORATOR ROOM 20 m^2
- DECORATOR&COSTUME CREATORS 100 m^2
- GENERAL MUSIC DIRECTOR-SECRETARY 2x30
- ORCHESTRA DIRECTOR 20 m^2
- HEAD CHOREOGRAPHER 20 m^2
- PRESS-SECRETARY 30 m^2
- INTERNATIONAL RELATIONS-SPONSOR 20 m^2
- CHOIR CHIEF ROOM 20 m^2
- HEAD SCRIPT EDITOR 20 m^2
- SCRIPT EDITORS 30 m^2
- BALLET DIRECTOR-SECRETARY 30 m^2
- HEAD REPETITOR 20 m^2

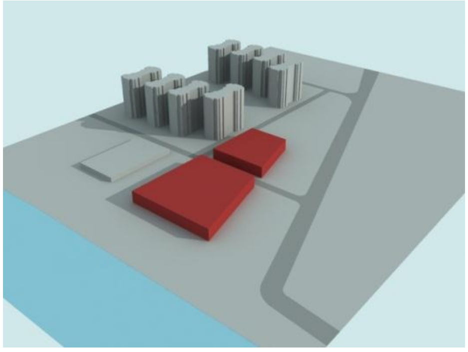
MANAGEMENT PART 795 m^2

TECHNICAL CENTER 1053 m^2

- HEAT CENTER 200 m^2
- AIR CONDITION CENTER 200 m^2
- WATER TANK 250 m^2
- ELECTRICAL WIRING-GENERATOR 100 m
- AUTOMATION ROOM 60 m^2

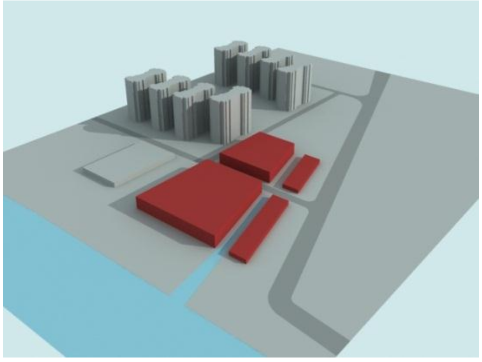
SHELTER 1200 m^2

4.7 Volume



a. This is the site that s been provided for the competition (TRIANGLE). We tried to insert a volume fits that space so that space can be managed efficiently (triangular).Besides, it broadens towards the sea providing a better integration. But, placing the volume into that area gave the sense of belonging to surrounding volumes like the volume is a part of surrounding buildings (sense of being squeezed)

b. In order to get free of surrounding buildings and to create an intersection, we placed this volume over the road and integrated with it. While this caused dividing the volume into two, it helped achieving a volume with more character since now it's not just a vast volume. Besides, it got easier to separate& connect employee& visitors. Underpass for the road is not feasible due to physical conditions. Road in the middle strengthen the sense of two volume.



c. We place small volumes next to two main ones. These would be restaurants, hotels, etc. So that ,there would be a street between the volumes. Thus, Instead of walking down a meaningless vast area, people will have the chance to walk on a qualitative road of which it size is changing from time to time. An artificial canal pierced inside since we wanted to improve the relation between land& sea.We couldn't ignore the existence of the water.We needed to take it as an advantage and intensify it. Beside the transportation, it is good to manage anything to intersect in here. (Land-Sea-Transportation and a street)

d. We decided to place opera hall into the bigger volume facing the sea. In the smaller volume, there is employee offices and other. It can be stated that Volume has two cores, one is opera hall, latter is amphitheatre. Other functions are wrapped around these two.

e. At the beginning, we tried two passages over the road. Due to the fact that it is 20 meters, It was pointless since it is a long way to walk. Also roofs of the smaller buildings have been played like a wave so that they won't affect the sight & visibility of the opera house and they ll be functional.

f. Quitting the idea of bridges, we decided to combine them at 5m height. So that an additional floor emerged which will be used for back-stages and dressing rooms. In addition, distance problem got fixed and apparently It worked out well with the opera hall. To the roof of the smaller volume, we added a ramp to climb up top which people will use to watch and see the open air shows, street arts. Also the rood of the bigger volume has been divided into two in order to provide dynamism. Furthermore, main entrance would be presented better, while emphasizing where the opera hall is. Interconnecting the roofs of the small buildings created a sense of passage.

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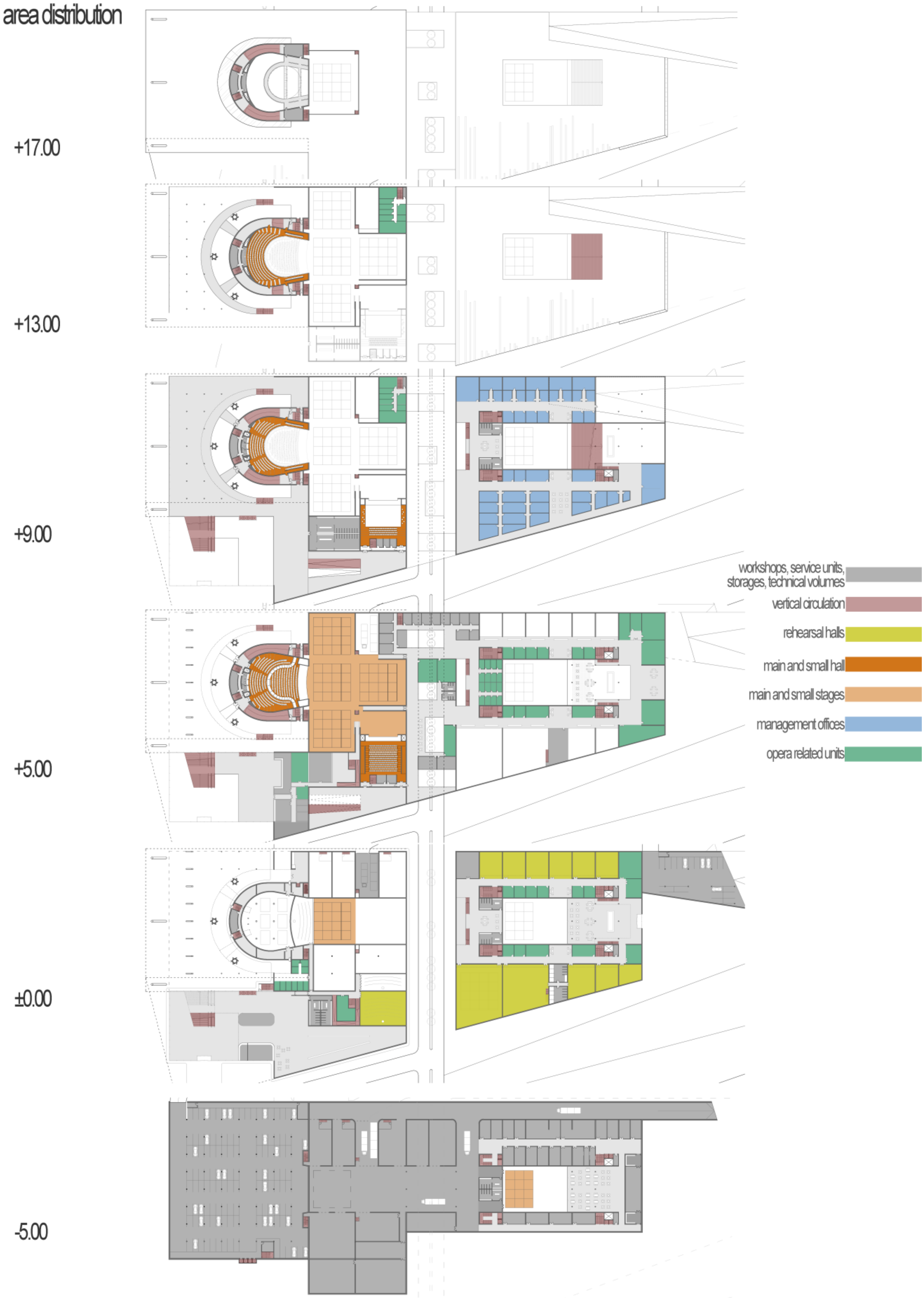
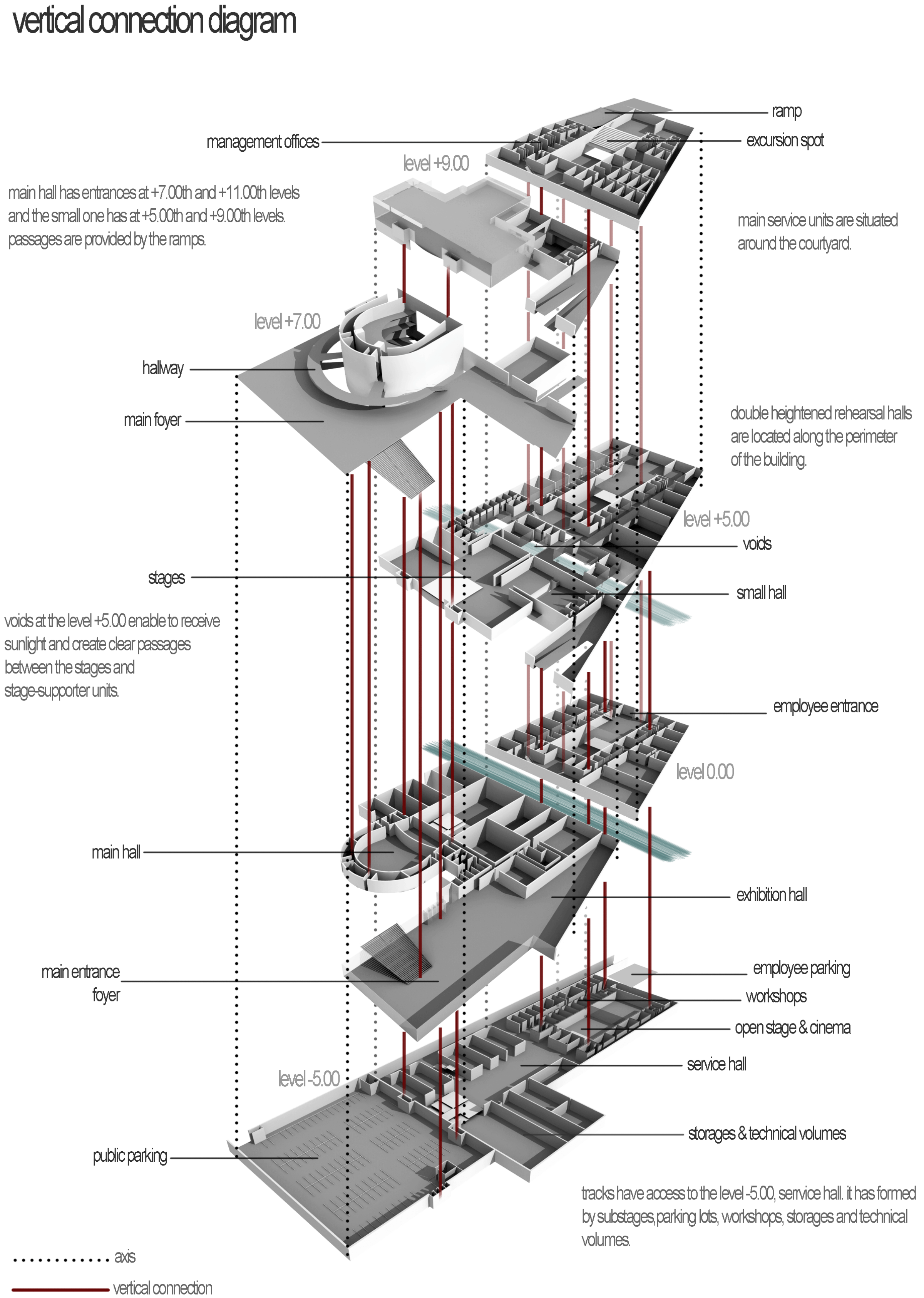
4.8 Distribution Of Functions



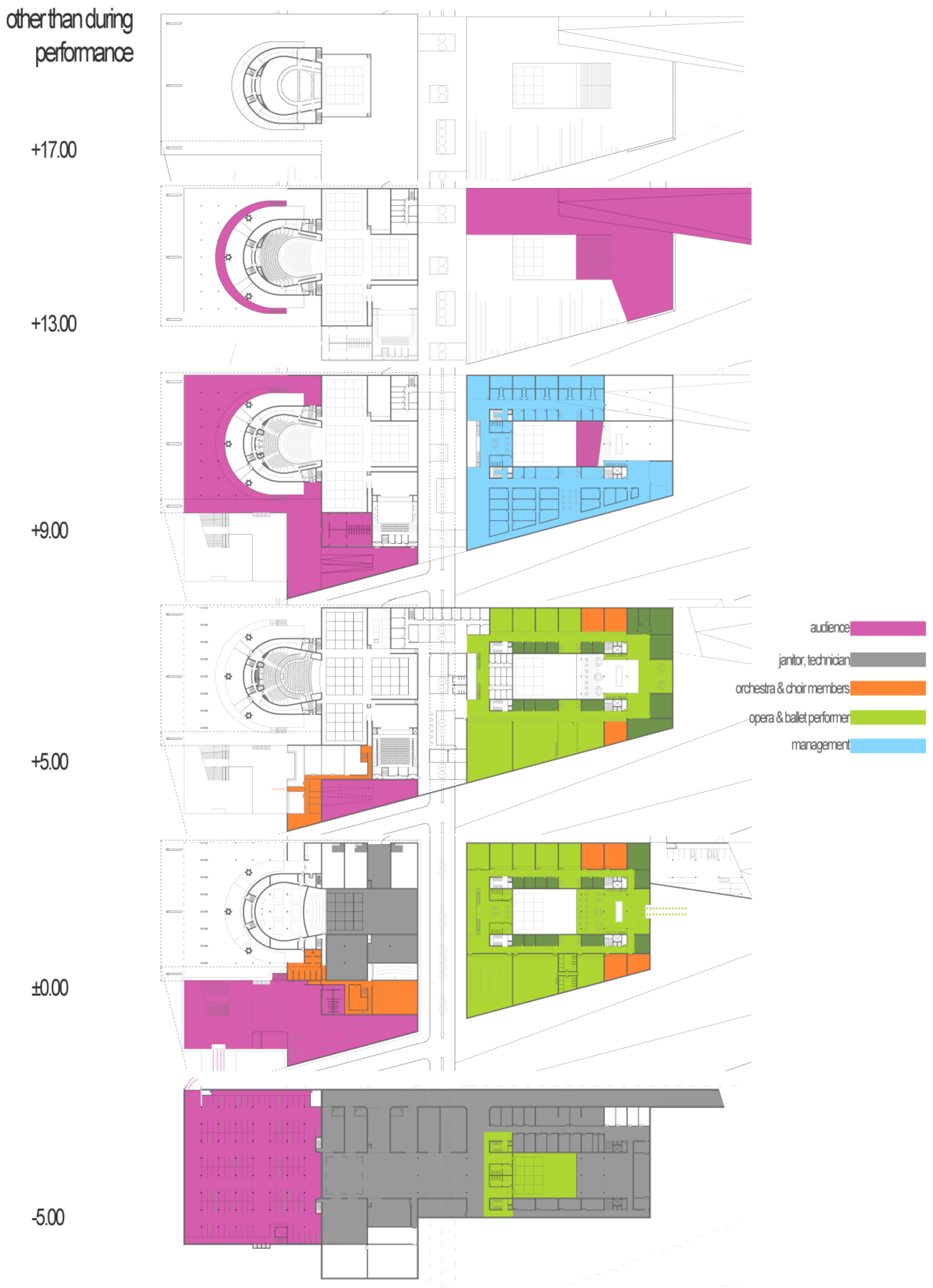
Drawing 8 Distributions of Functions

4.9 Accessibility



Drawing 9 Vertical access

Drawing 10 Circulation during performance



Drawing 11 Circulation other than during performance

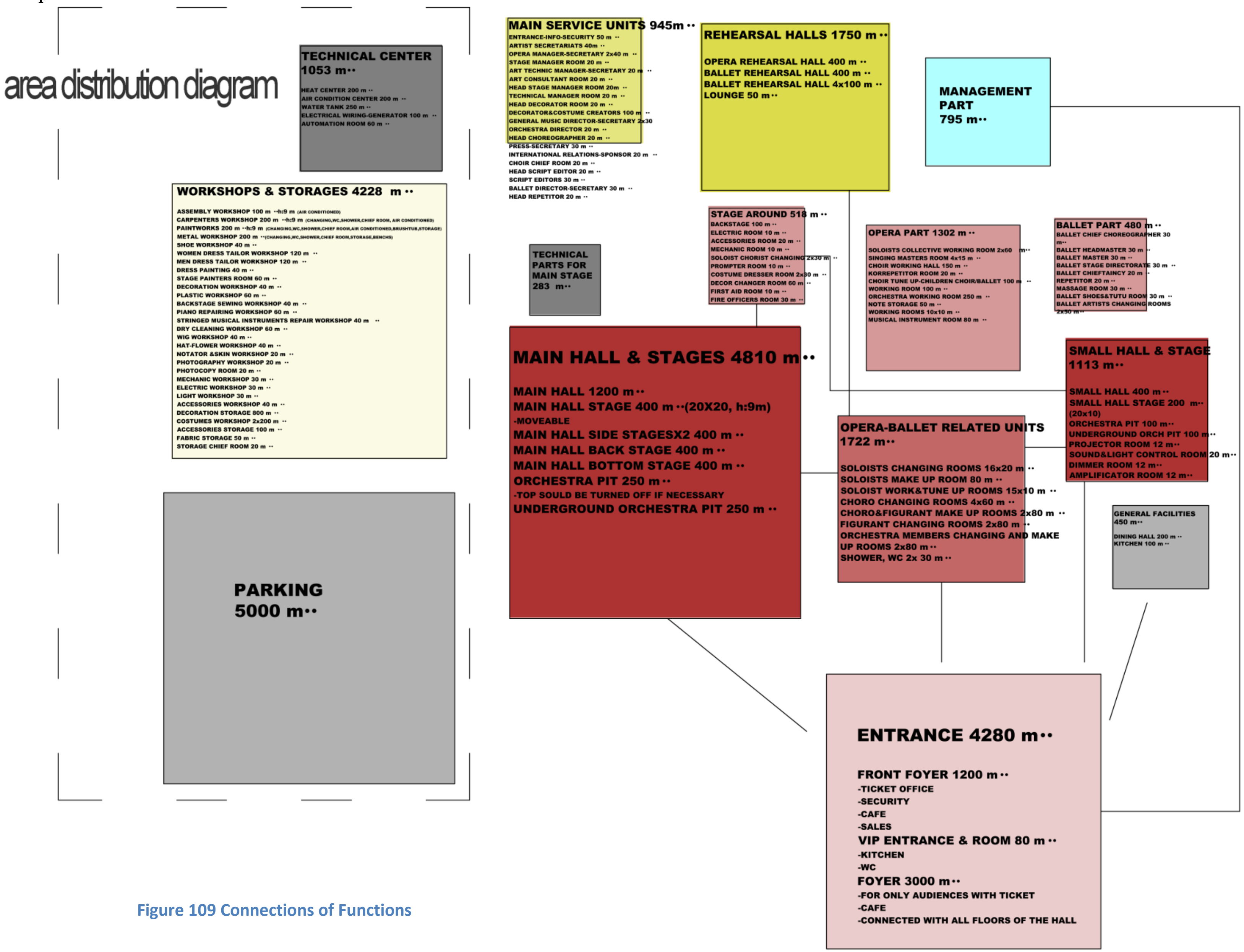


Figure 109 Connections of Functions

Flow During Performance Days;

Ticket-holders move to the zone at 3.5 m and from there, they either move to main foyer at 7m or to the 11m level balcony foyer in order to get in to the opera hall.

Balcony foyer is allowed only for ticket-holders. People who just want to stick around the Opera House, may very well enjoy the main foyer.

Open Theatre; Sub-Foyer Cafe and Exhibition Hall welcomes everybody without ticket holding.

The Audience make use of the parking lot that is provided under the main hall.On the contrary ; Performers and employees make us of the one under the ramp.

At these days, opera and ballet performers ,travel back and forth between dressing rooms,make-up rooms and stages , at the storey above the road connecting two volumes.

During performance days; orchestra players make their final preparations at Level 0.00m and 3.50m where dressing rooms etc ara available.Orchestra players and their spaces are directly connected to Orchestra Pit. They don t come face to face with other performers.

Technical Staff stand ready and work in the rooms under the main hall,stages and the main hall.These spaces are connectd to each other by stairs and elevators vertically, and by bridges and passes horizontally.

Flow other than during performance days ;

Other than performance days; Opera House welcomes citizens with its shop, cafe and exhibition hall.It is open for services to citizens of Izmır.

At these days; citizens can make use of the parking lot under the main hall.For employees; they still make use of th on under the ramp.

The storey over the road connecting two volumes is quite during these days.

Voids opened in this storey, provides the sense of roominess and luminous.

Double heightened rehearsal halls and supporting units are provided for performers during these days.Just through a gallery, they can reach to the area where they can rest and sightsee courtyard.Furthermore, going down to the basement; dining-hall with the view of courtyard is available connected to the courtyard stage.

Courtyard is favourable for citizens every single day ,welcomes them for their experimental experiences regarding the shows and experimental street arts.

Ateliers are wrapped around the courtyard at Level -5.00 m.

Service entrances, installation areas, depots and sub-stage are very well connected

*****THE FLOORS***

- -5.00m LeveL

With two ramps by vehicles , It can be managed to reach to this level. One of them is for citizens and the audience, the other one is for services provided for trucks etc. In order for trucks to take the corner with ease, walls & corners are rounded.

There is a sub-stage and behind it there exists a installation area. Depots open up to this area.

At the basement level; two volumes are one which means that they act like one zone and network is better.

At the basement of the volume where there is courtyard , ateliers exist and light gets in through the voids on the wall of courtyard which also enables to watch the courtyard.

Entrance to Courtyard Stage and dining hall are at this level.

- 0.00m LeveL

Facade that faces South-West direction hosts the main entrance which directed towards the sea and the city. Cafe, shop and exhibition hall is placed in the sub-foyer .

Through a hidden corridor next to the elevators, it can be reached to the zone where orchestra performers have their rehearsals.Besides this zone is directly linked to orchestra pit and the halls.

At this level, building is composd of two volumes. On the other side of the road, there is opera-ballet rehearsal rooms.

Rehearsal rooms are lined up at the perimeter of the building with double height. Nonetheless, courtyard is wrapped with supoorting units such as choreograph, massage, repetitor, ballet instructor rooms.

Employees have thir entrance to th building from th facade facing north. A wide hall enabling to watch courtyard stage exists next to the entrance.

- 3.50m LeveL

This level seems like a mezzanine which links entrance foyer to main foyer. Citizens obtain their here and leaves their belongings to cloakroom and head towards the main foyer. For orchestra members, there is a pass between ticket zone and cloakroom.They can get to the backstage and dressing rooms by this way.In addition to that; this part is linked to the 0.00 level orchestra rehearsal rooms and orchestra pit by a ramp and stairs.

- 5.00m LeveL

This is the level where all the stages are except the sub-stage. It lies from the stages to the employee entrance.Furthermore, It is the level where two volumes bonds. Backstages, make-up rooms , dressing rooms are all in this interconnection zone.

As the other levels, courtyard is wrapped up with supporting units.Since the rehearsal rooms have glass facades, it is welcomed to watch these

Small hall‘s main entrance is through this level where the foyer at the 7.00m connects to it with a ramp.

The two halls are fully connected functionwise such as all service units are common.

- 7.00m LeveL

This is the level where main foyer welcomes citizens. Foyer and the main hall are connected by bridges.Ones that will move to the small hall take th ramp down to 5.00m Level.Furthermore,another ramp takes ticket-holders to 9.00m Level.

- 9.00m LeveL

Here at the courtyard side is where management offices stand. Surrounding the courtyard, management offices are positioned in a way letting a daylight corridor to emerge in between the facade and th offices.

Also this level is the upper floor of the small hall.A ramp from the foyer is the access to this floor.

- 11.00 m LeveL

From this level to the main hall, bridges are the access keys like the ones in 7.00m Level.

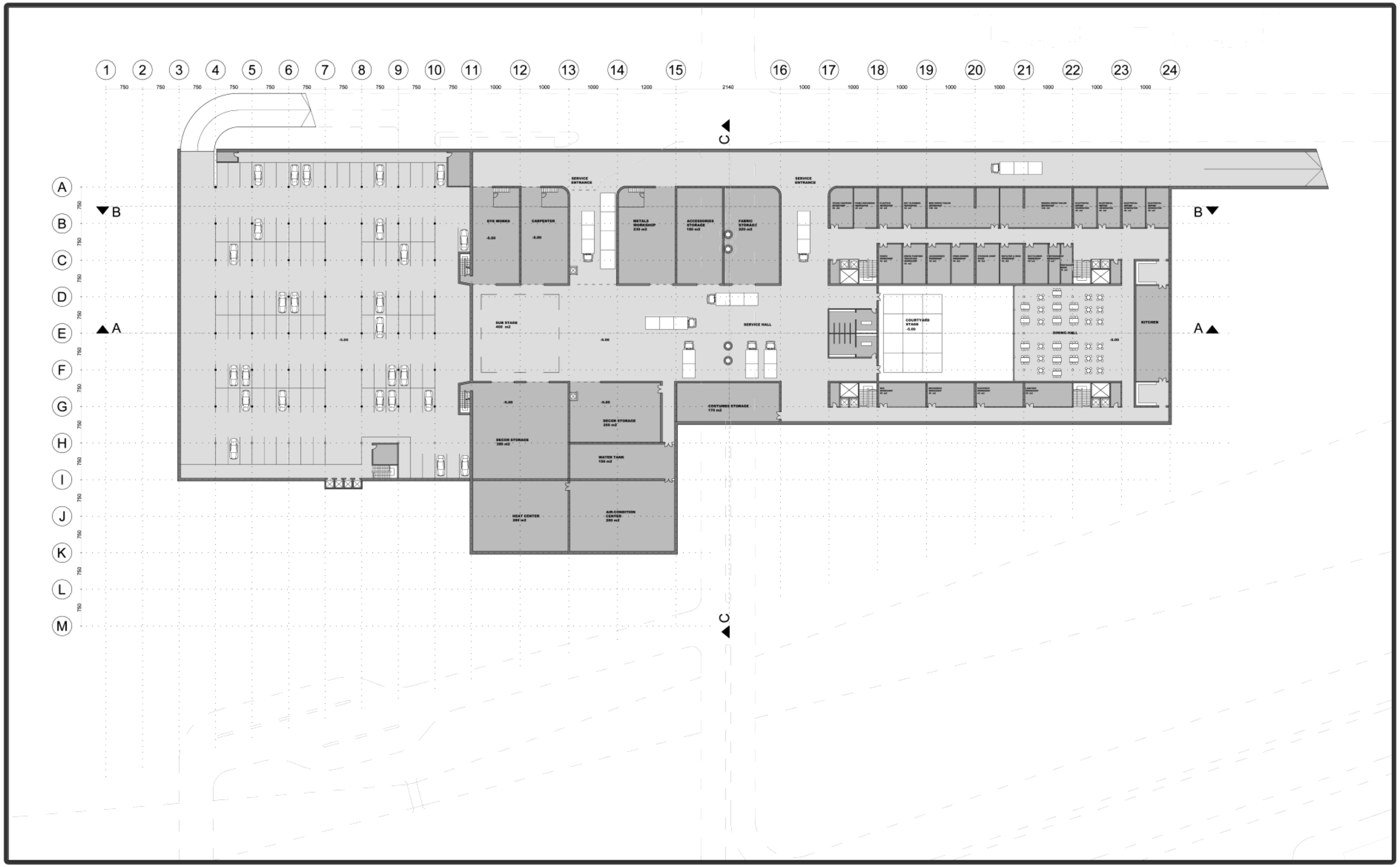
A” balcony” seems like a the proper word to describe this level.

- 17.00m LeveL

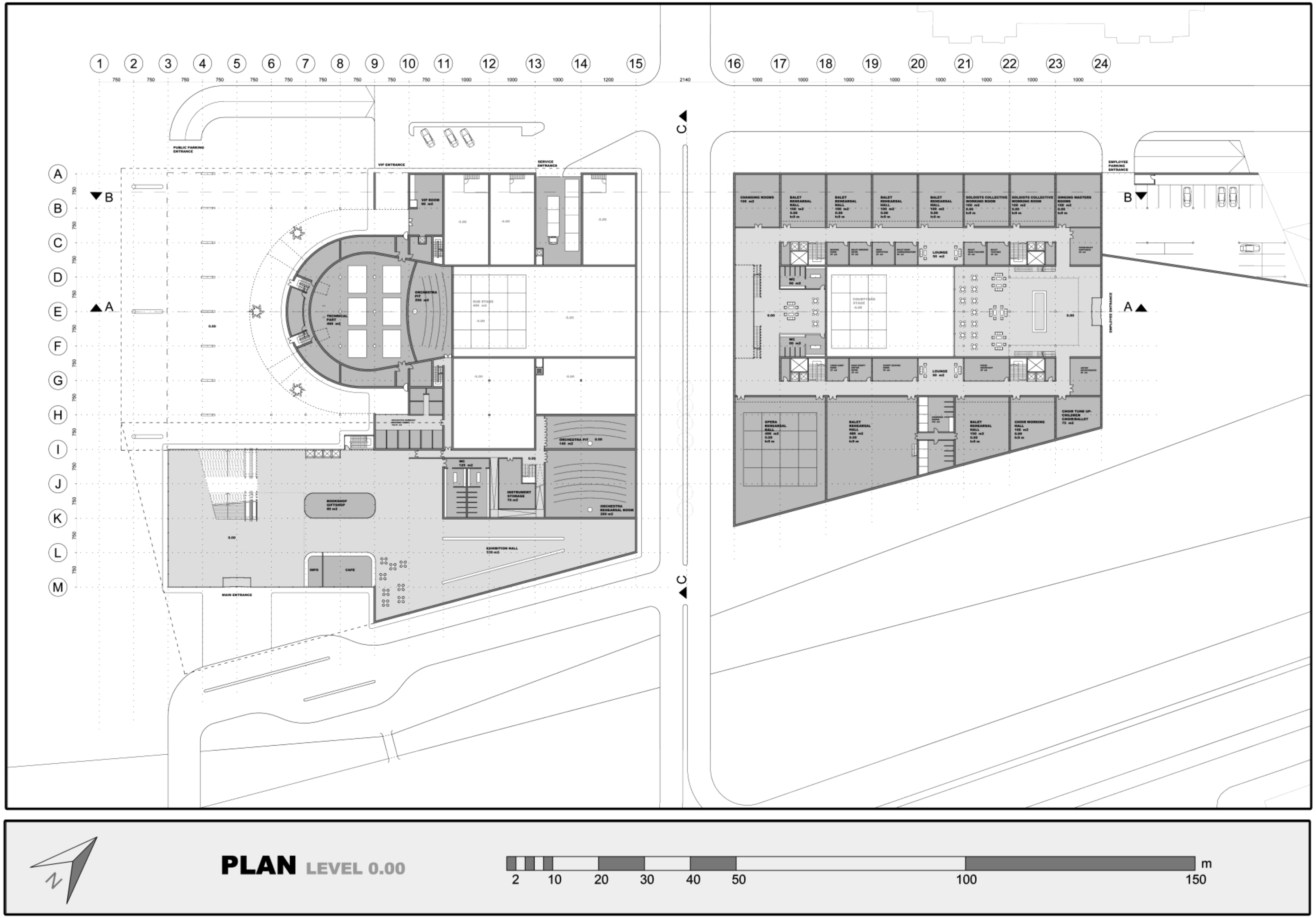
Level covers the tecnical bridges and artificial lighting bridges over the main hall.On the other side, once in every 3m.s after 13.00,these artificial lighting bridges occurs.

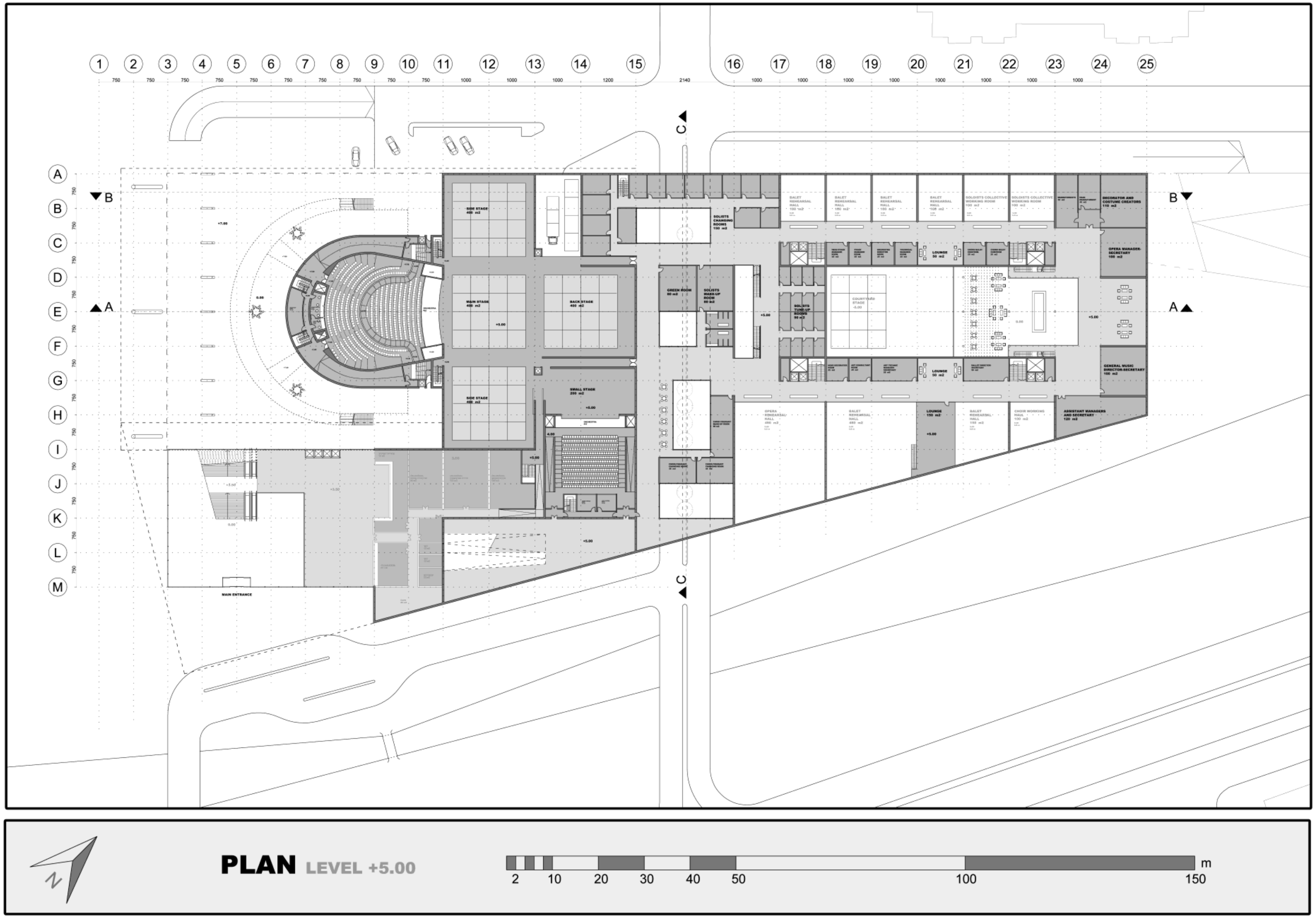
4.10 Plans

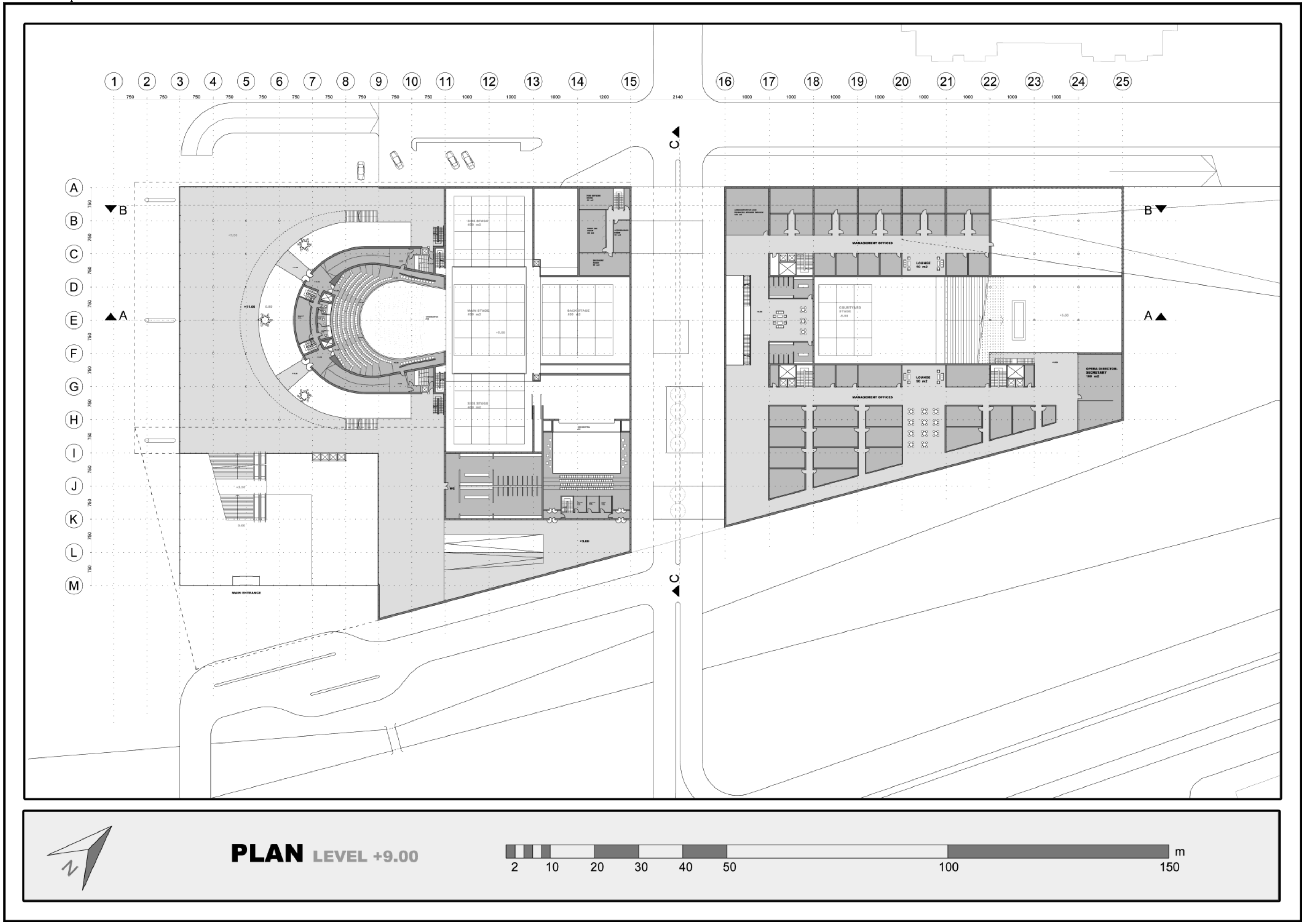
- Level -5.00
- Level 0.00
- Level +5.00
- Level +9.00
- Level +13.00
- Level +17.00



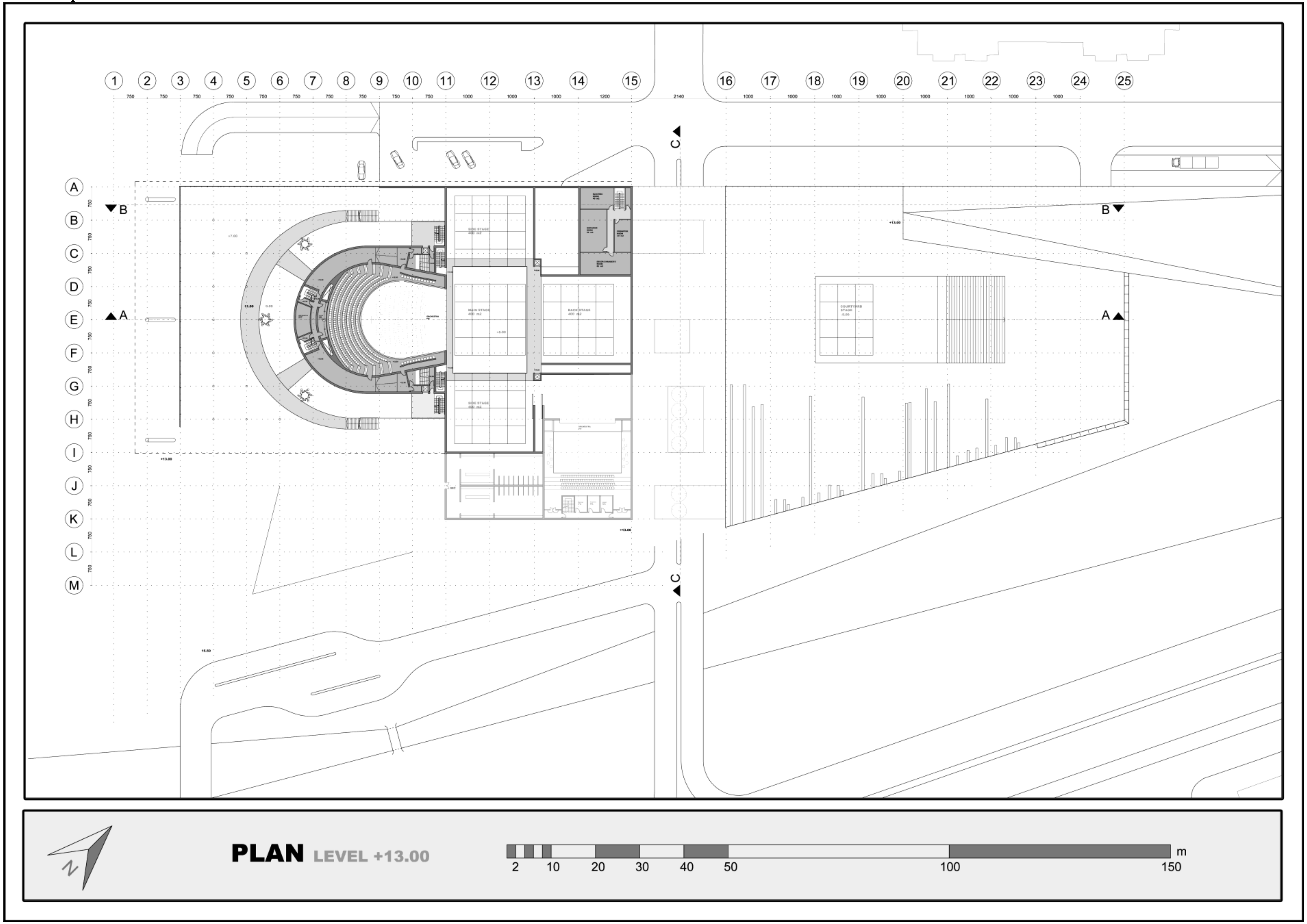
PLAN LEVEL -5.00


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
A B C D E F G H I J K L M
PLAN LEVEL 0.00
2 10 20 30 40 50 100 150 m


PLAN
LEVEL +5.00
2 10 20 30 40 50 100 150 m
A
B
C



ARCHITECTURAL DESIGN


PLAN LEVEL +13.00
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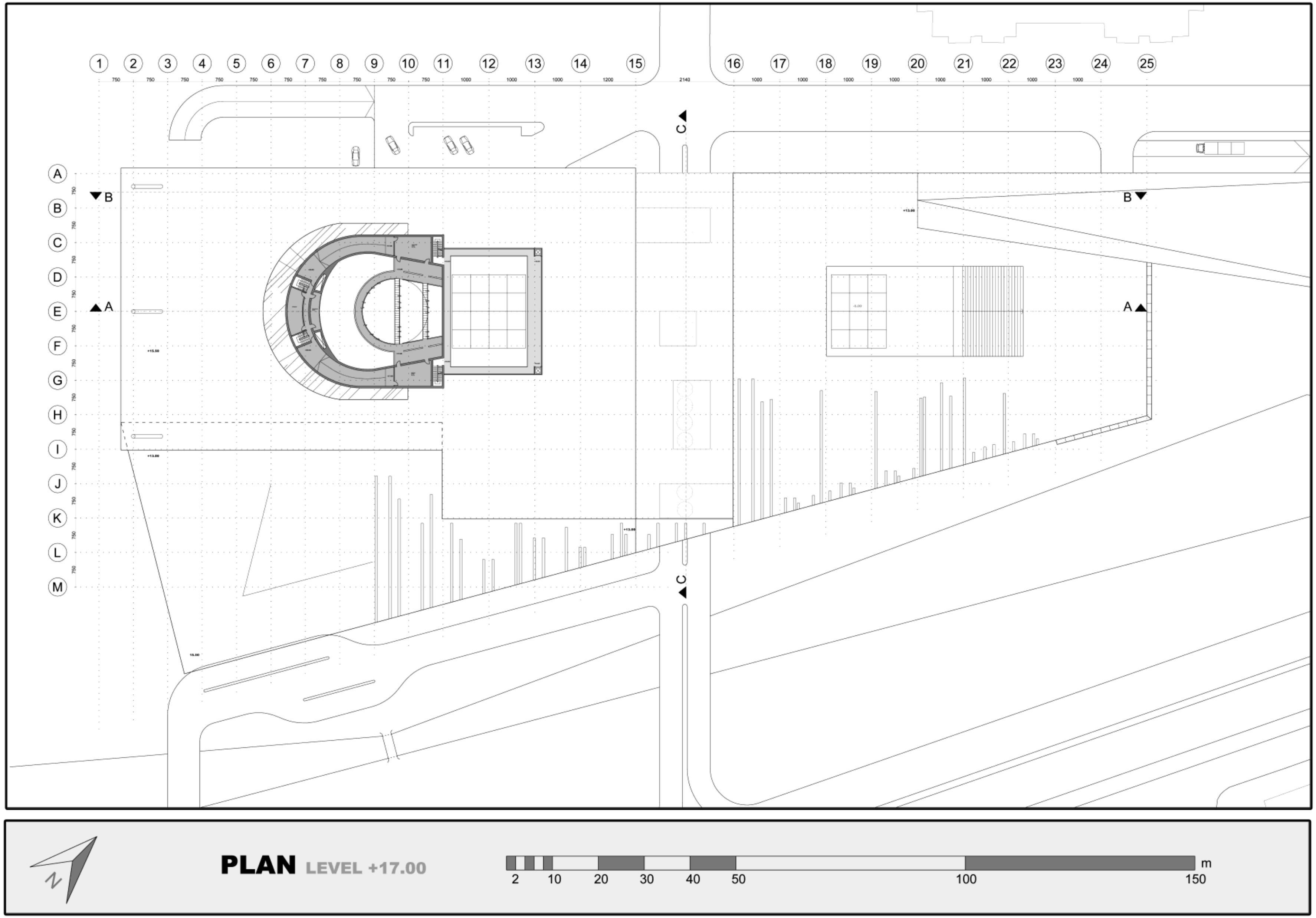
PLAN LEVEL +17.00
2 10 20 30 40 50 100 150
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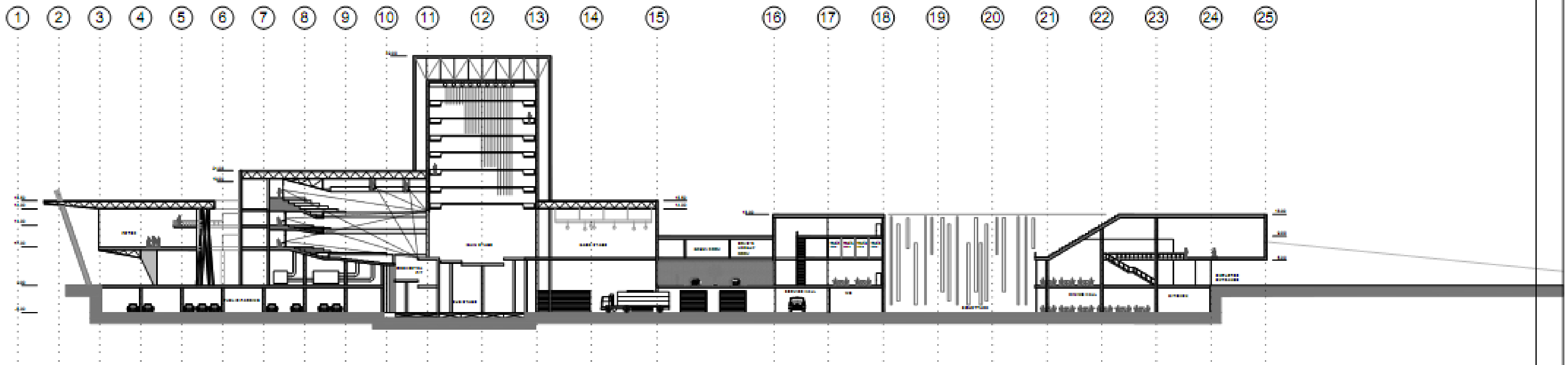
4.11 Sections

- AA
- BB,CC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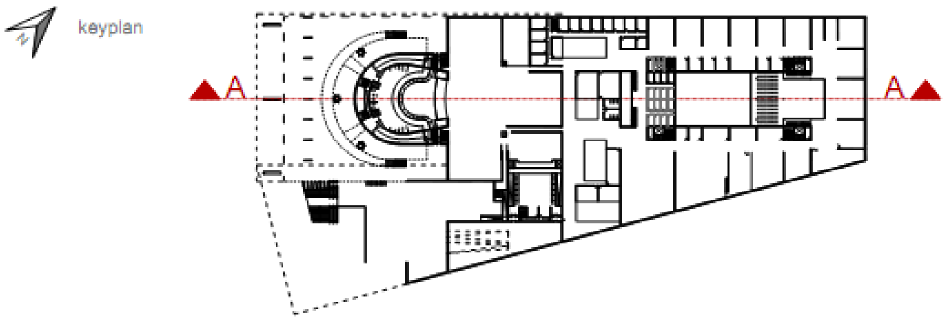
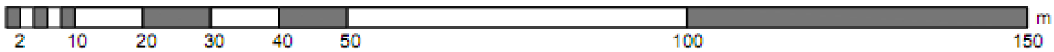

keyplan
A
A

SECTION AA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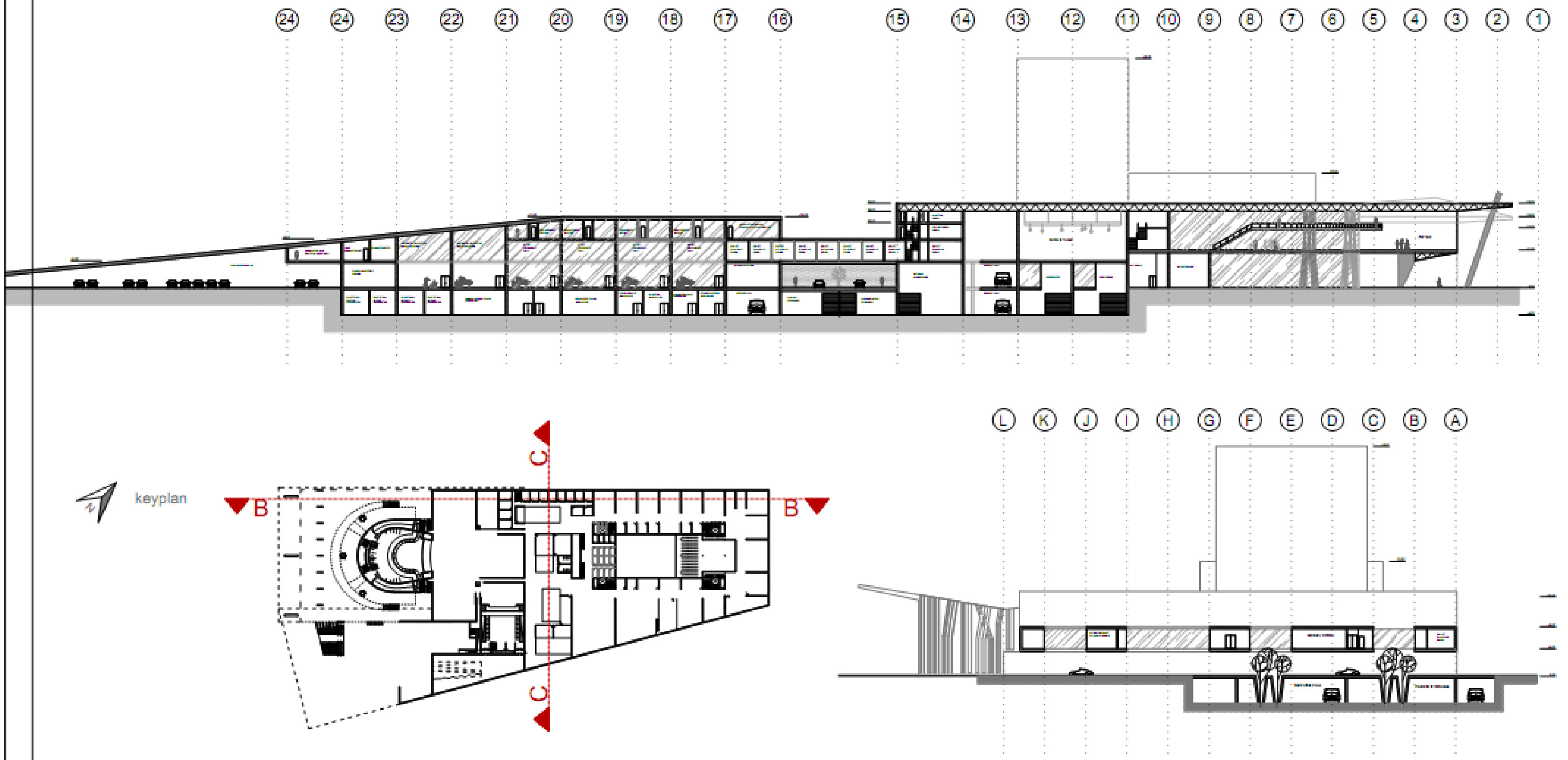
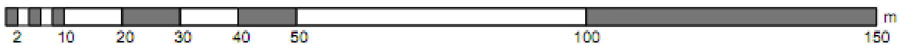


SECTION BB, CC



4.12 Renders

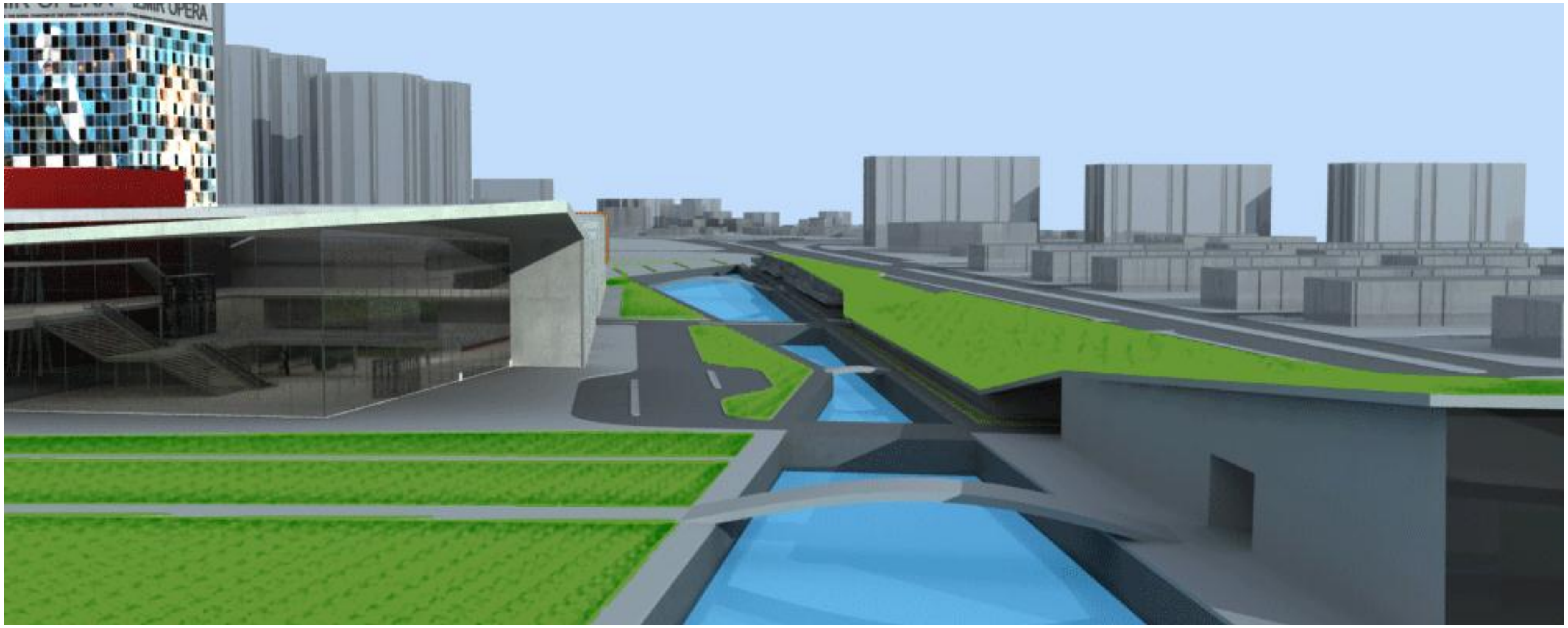


Figure 110 Street-Canal - Entrance

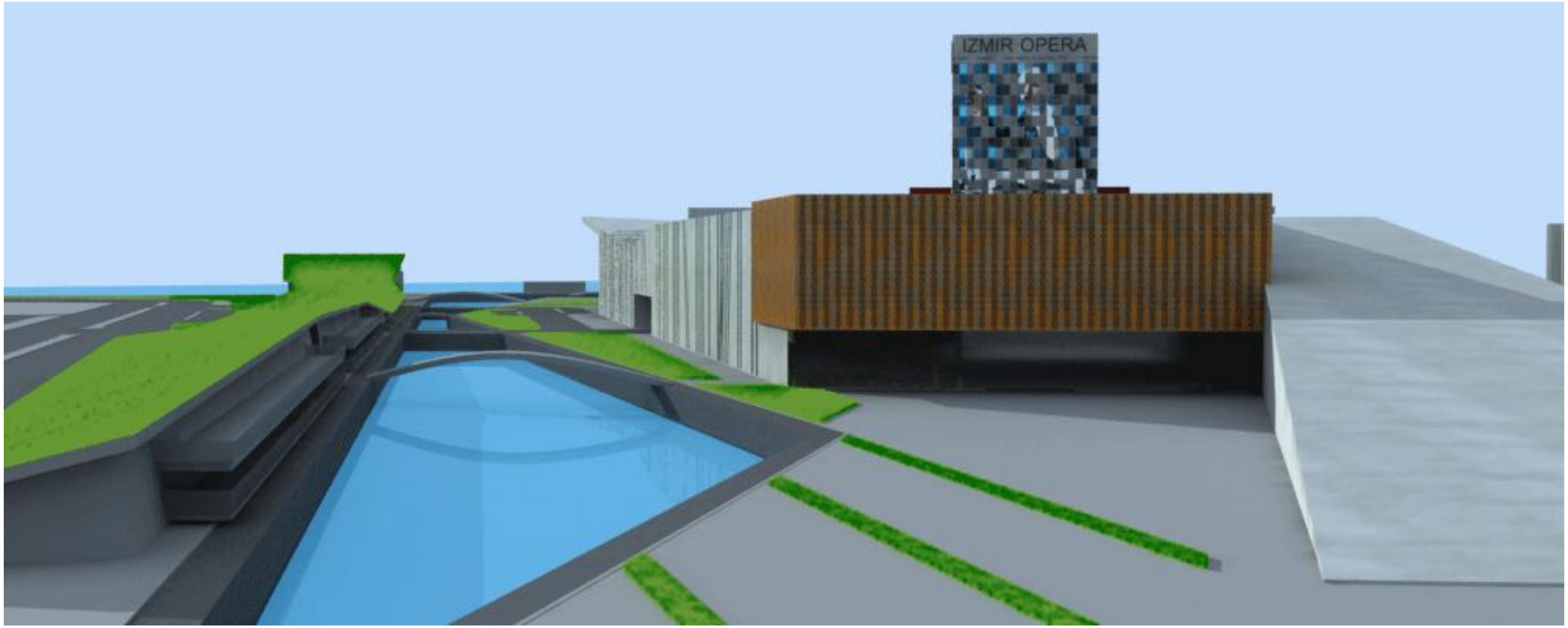


Figure 111 Rusty Metal Covering

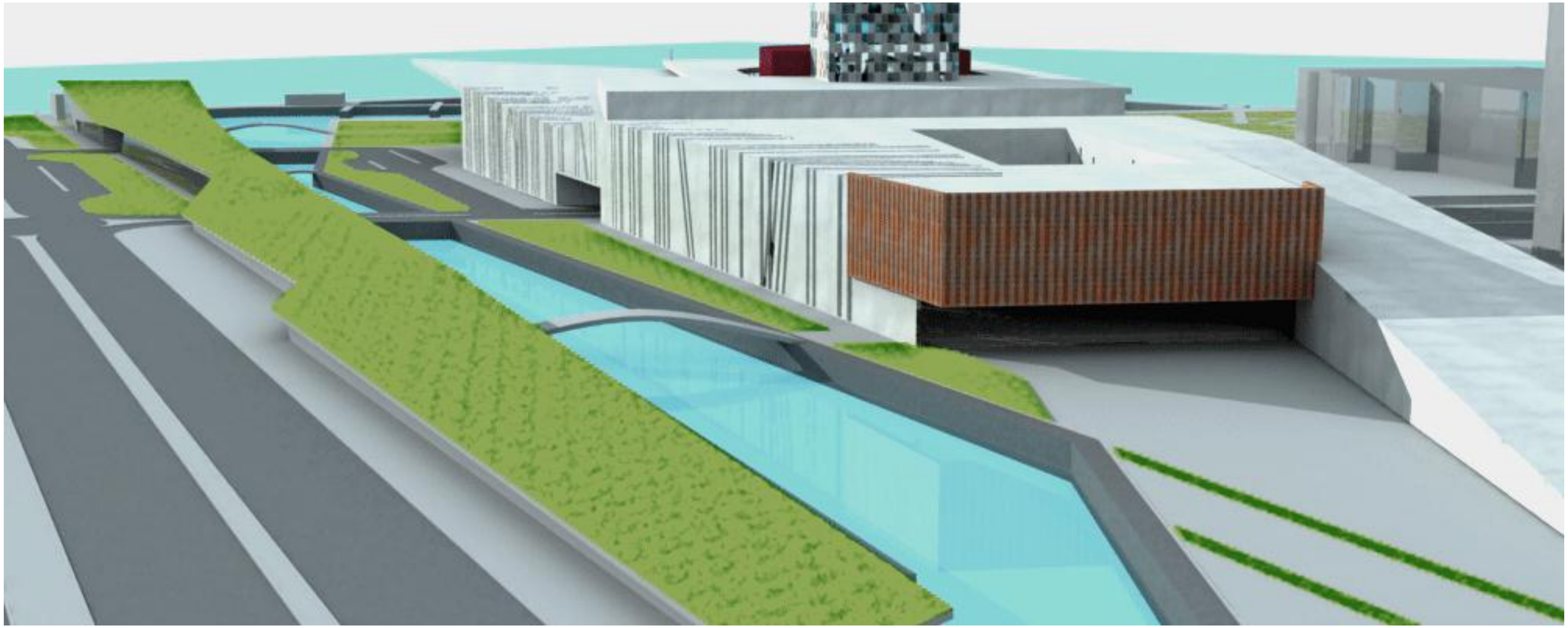


Figure 112 Main Road- Entrance view

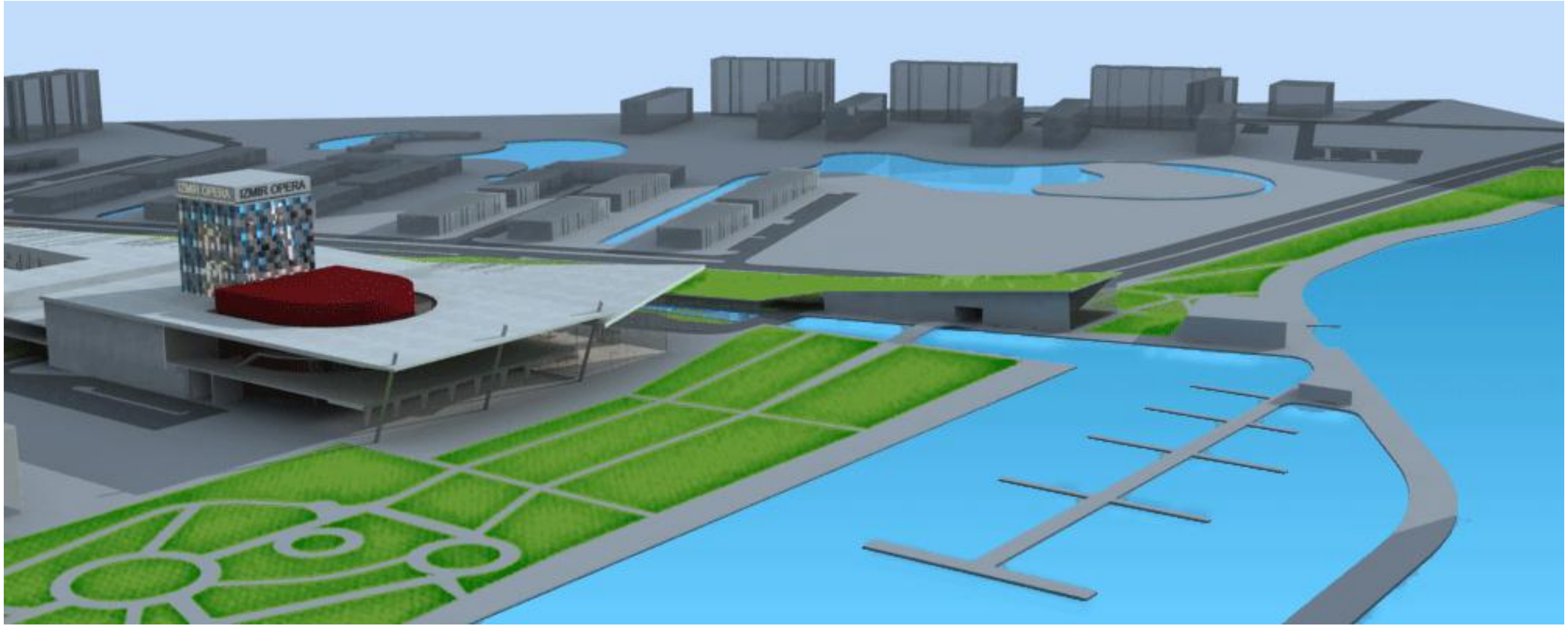


Figure 113 Overview of Green Coastline

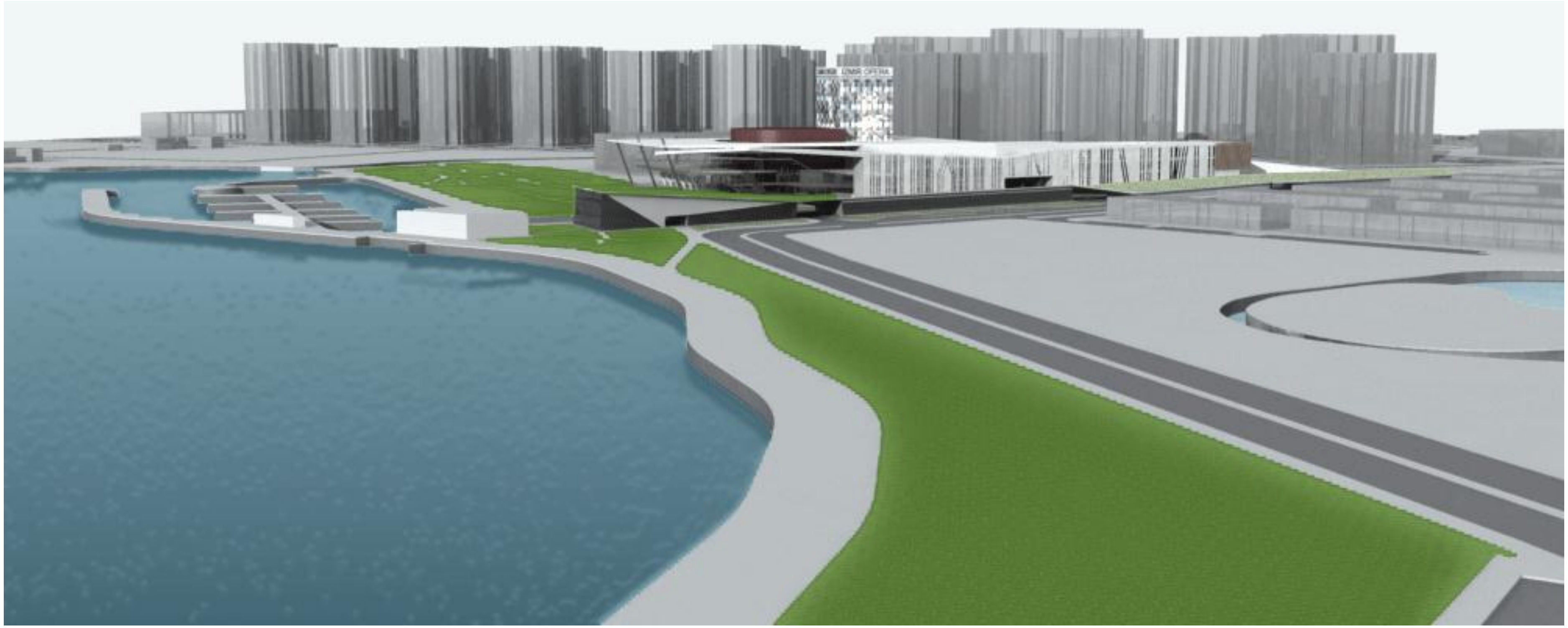


Figure 114 Opera House - Further view

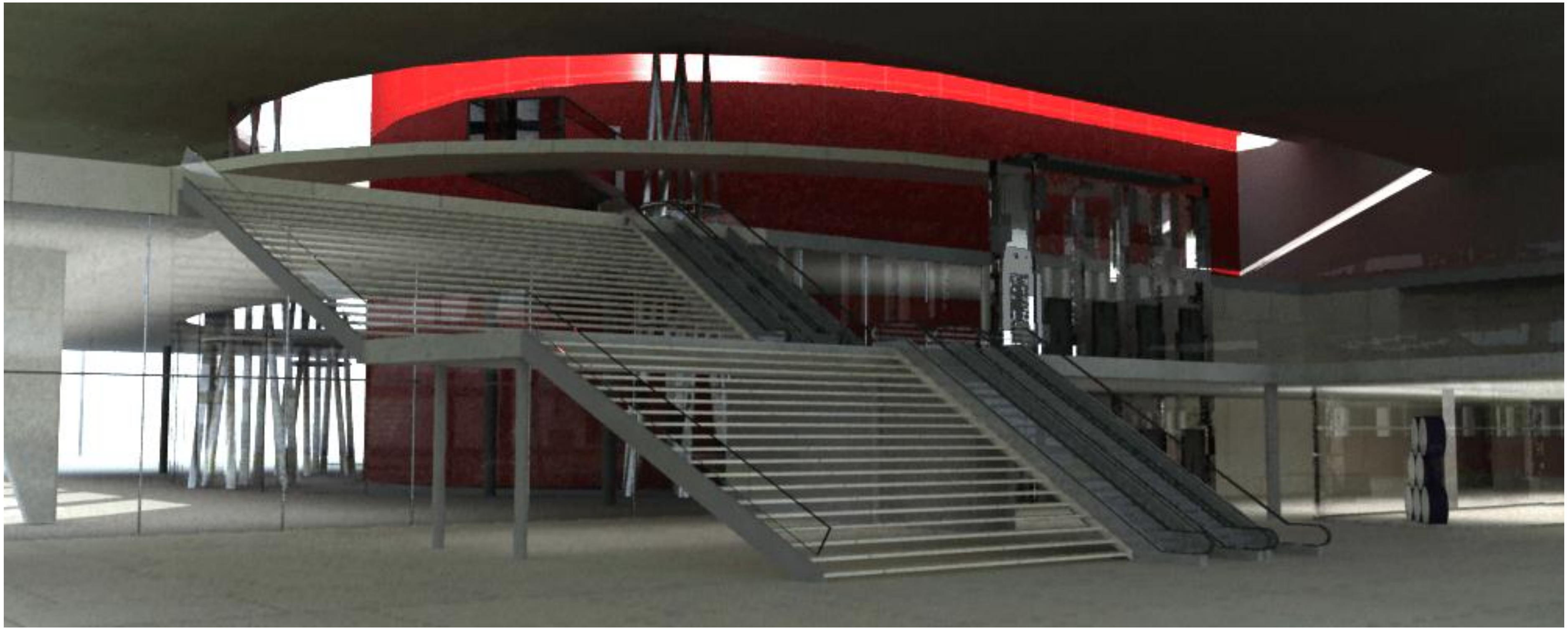


Figure 115 Main Entrance-SubFoyer

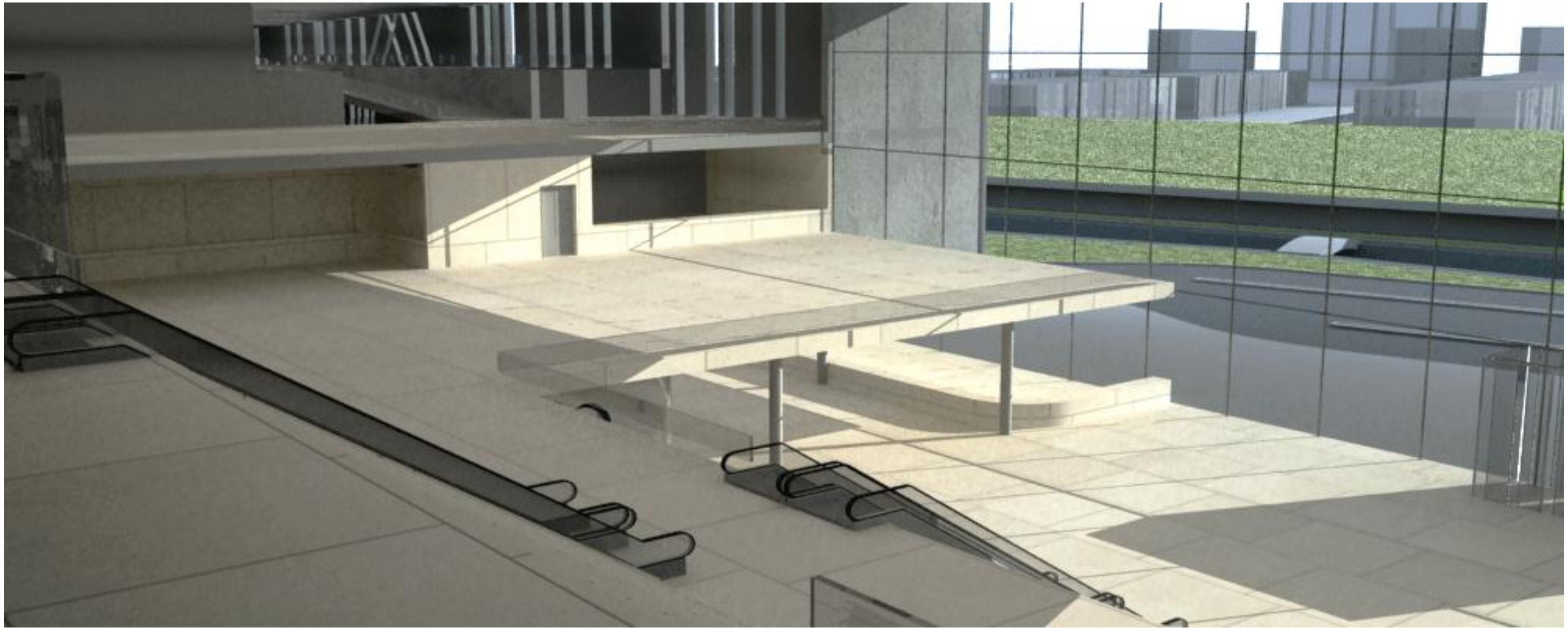


Figure 116 3.50 m level

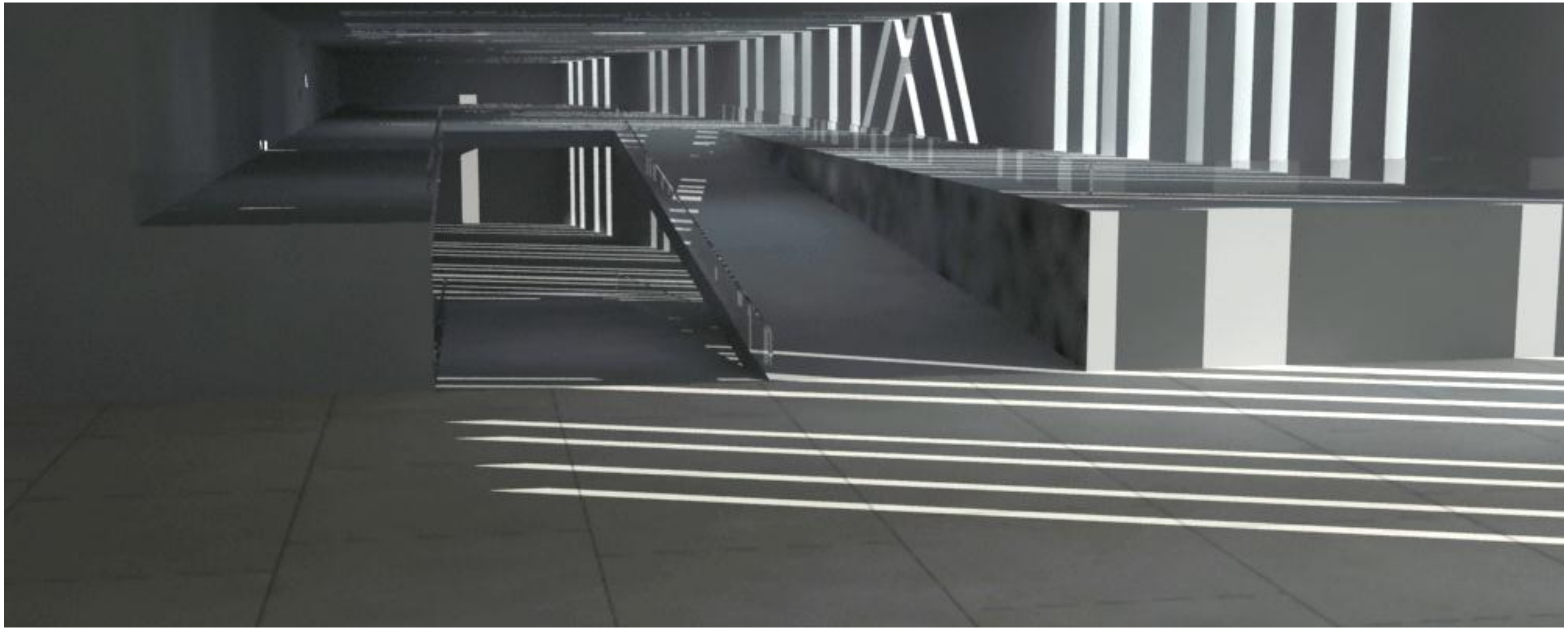


Figure 117 Ramps towards the small hall

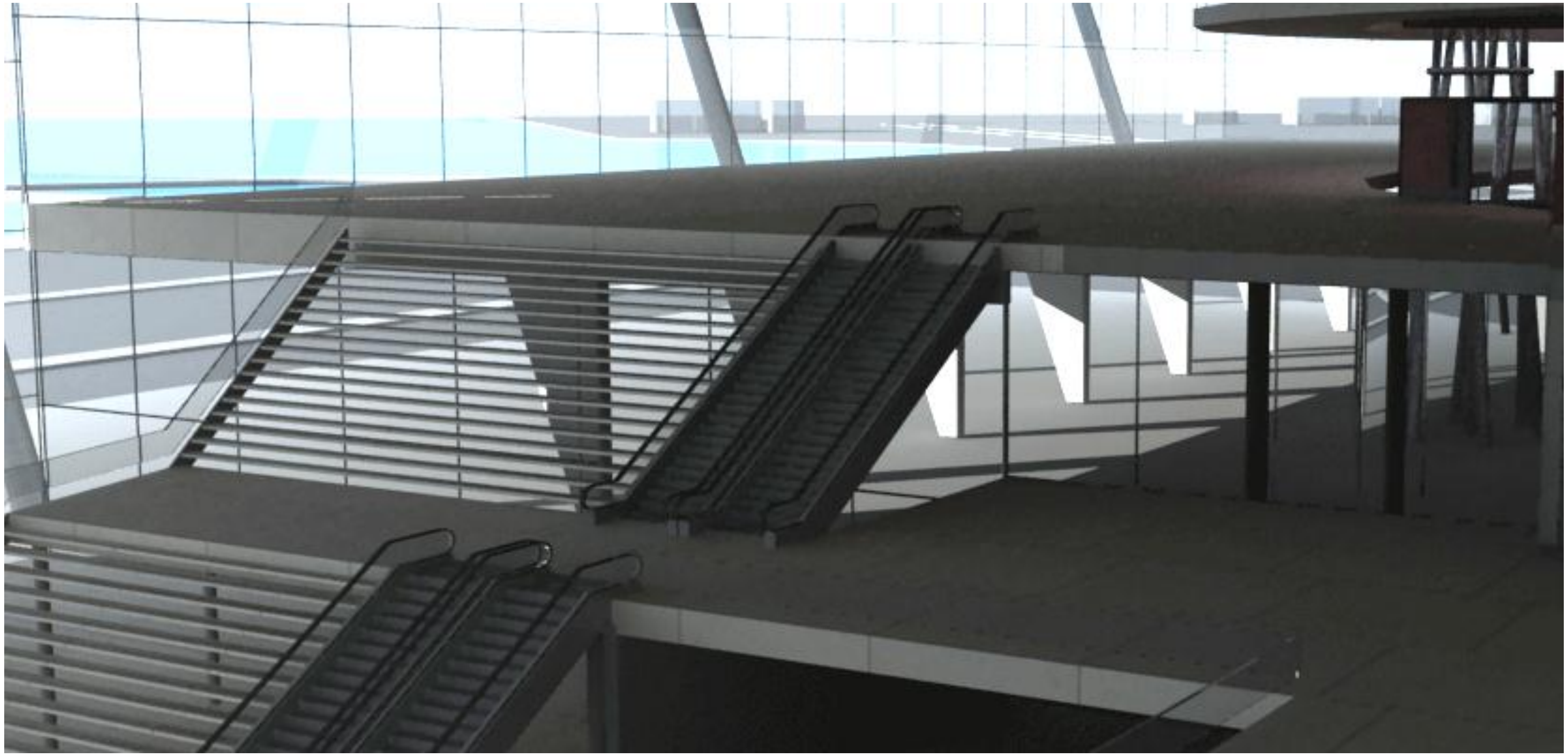


Figure 118 Foyer

CHAPTER 5

TECHNOLOGICAL DESIGN

5.TECHNOLOGICAL DESIGN

5. 1 Environment & Physics

Located in the Mediterranean climate zone, Izmir has hot and dry summer seasons and mild and rainy Winters. The position of the mountains laying perpendicular to the coast and the plains reaching inner Western Anatolia allows the milding effects of the sea to enter into the internal sections.

Izmir, Turkey

Latitude & longitude; 38°26'N 27°10'E.

Altitude; 25 m (82 ft).

The average temperature in Izmir, Turkey is 17.5 °C (64 °F).[1]

The range of average monthly temperatures is 18.5 °C.

The warmest average max/ high temperature is 33 °C (91 °F) in July & August.

The coolest average min/ low temperature is 5 °C (41 °F) in January & February.

Figure 119 Izmır's Location

Izmir receives on average 695 mm (27.4 in) of precipitation annually or 58 mm (2.3 in) each month.

On balance there are 69 days annually on which greater than 0.1 mm (0.004 in) of precipitation (rain, sleet, snow or hail) occurs or 5.8 days on an average month.

The month with the driest weather is July & August when on balance 3 mm (0.1 in) of rainfall (precipitation) occurs.

The month with the wettest weather is January & December when on balance 141 mm (5.6 in) of rainfall (precipitation) occurs.

There is an average range of hours of sunshine in Izmir of between 4.0 hours per day in January and 12.5 hours per day in July.

On balance there are 3008 sunshine hours annually and approximately 8.2 sunlight hours for each day.

On balance there are 8 days annually registering frost in Izmir and in January there are on average 3 days with frost.

[1] Turkish State Meteorological Service; *Climate of Izmır* ; from www.mgm.gov.tr ; 2012

5.1.1 Temperature

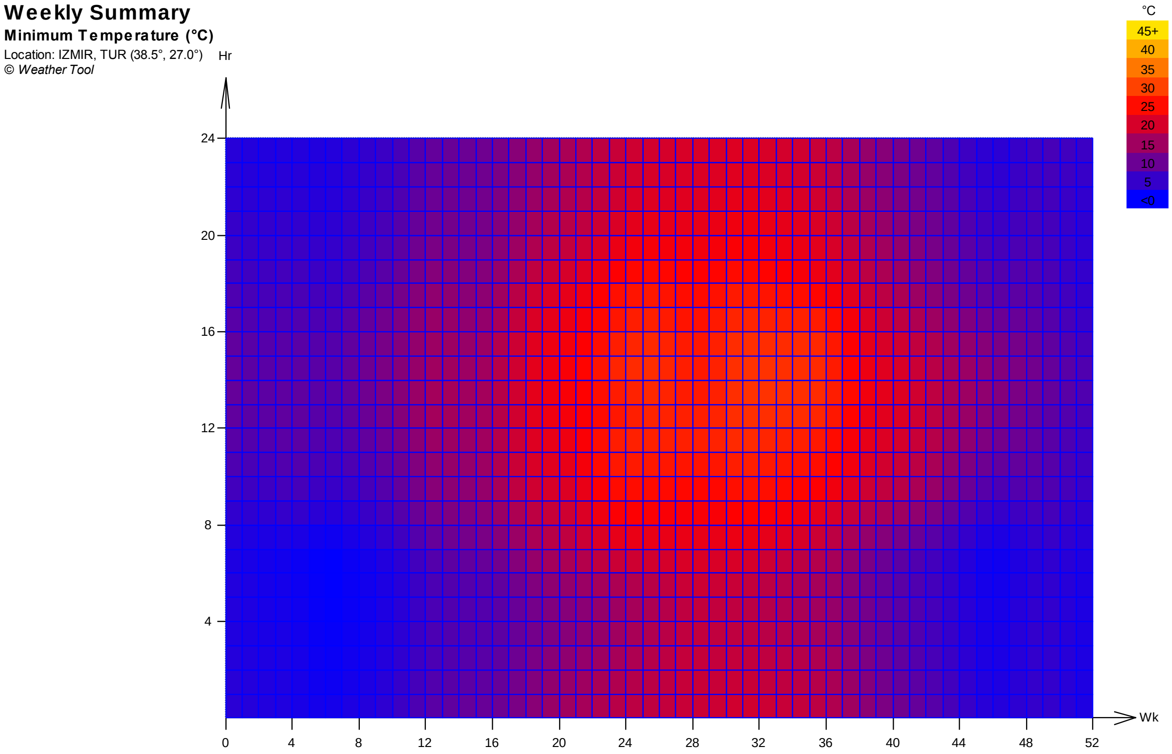


Figure 120 Minimum temperature- Ecotect

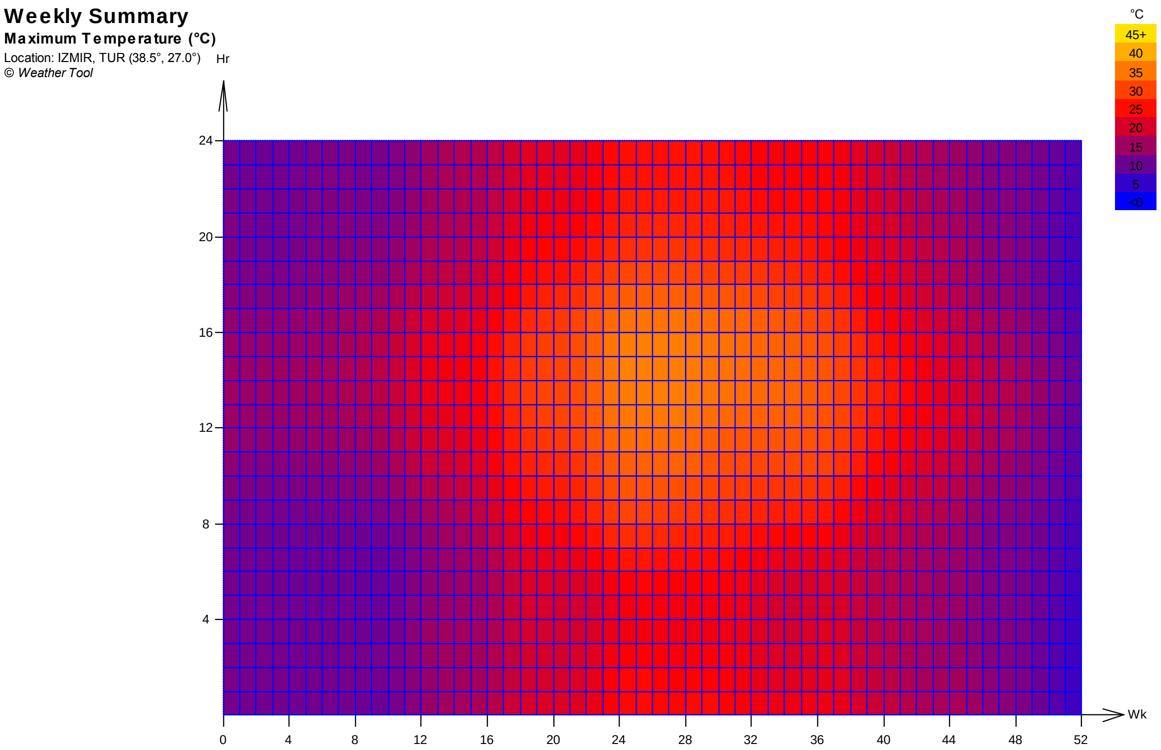


Figure 121 maxiumum Temperature - Ecotect

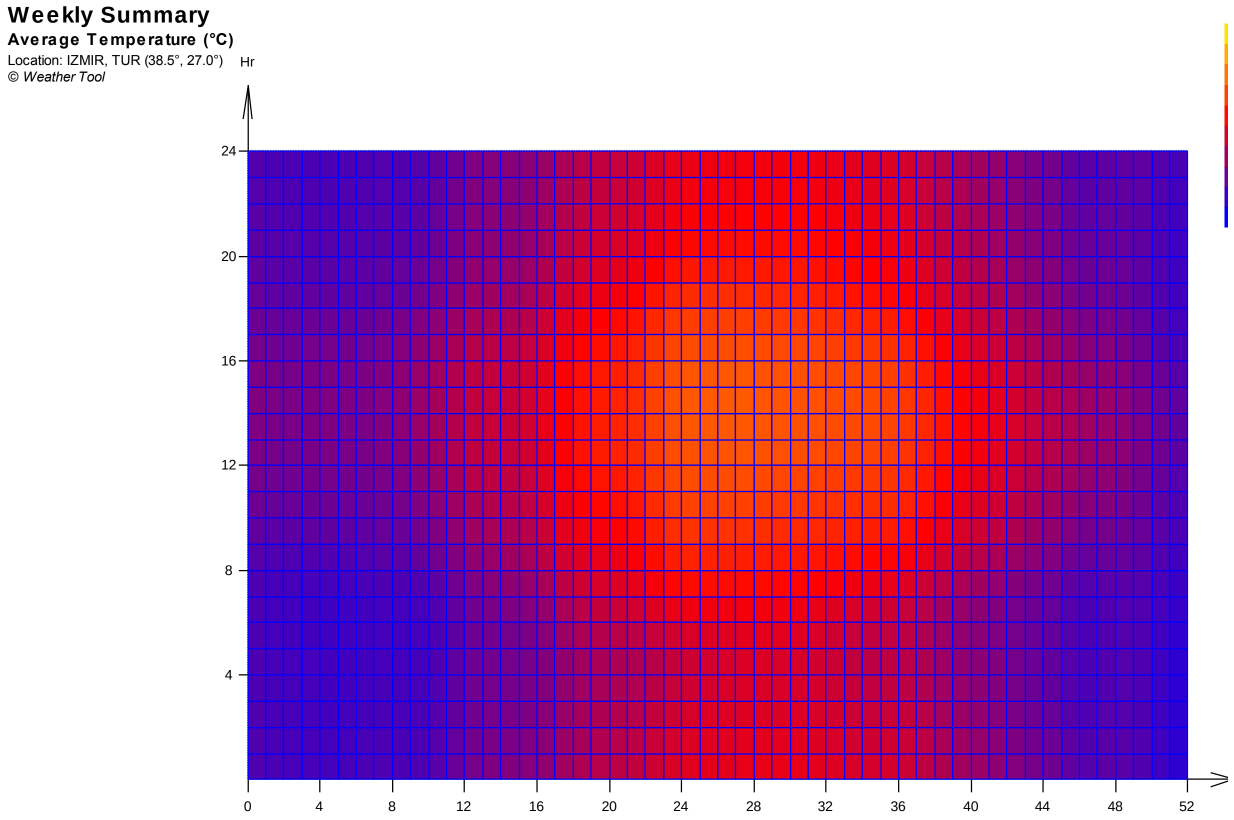


Figure 122 Average Temperature -Ecotect

Figure shows a color coded graph of the average temperature of Izmır on a weekly basis. The blue color indicates temperatures below 0° C as the color becomes purple the temperature increases up to 15° C. Reddish and orange colors indicate temperature values above 25° C. In the Y axis the hours of the day are given.

The temperature increases toward the afternoons and decreases in the night.

Average temperatures in Izmır, does not exceed 30° C and the highest average values are recorded between 24th and 28th week.

Obviously, the buildings should be cooled during these weeks and it is necessary to provide heating for the buildings throughout the first 12 weeks and during week 44, 48 and 52.

5.1.2 Wind

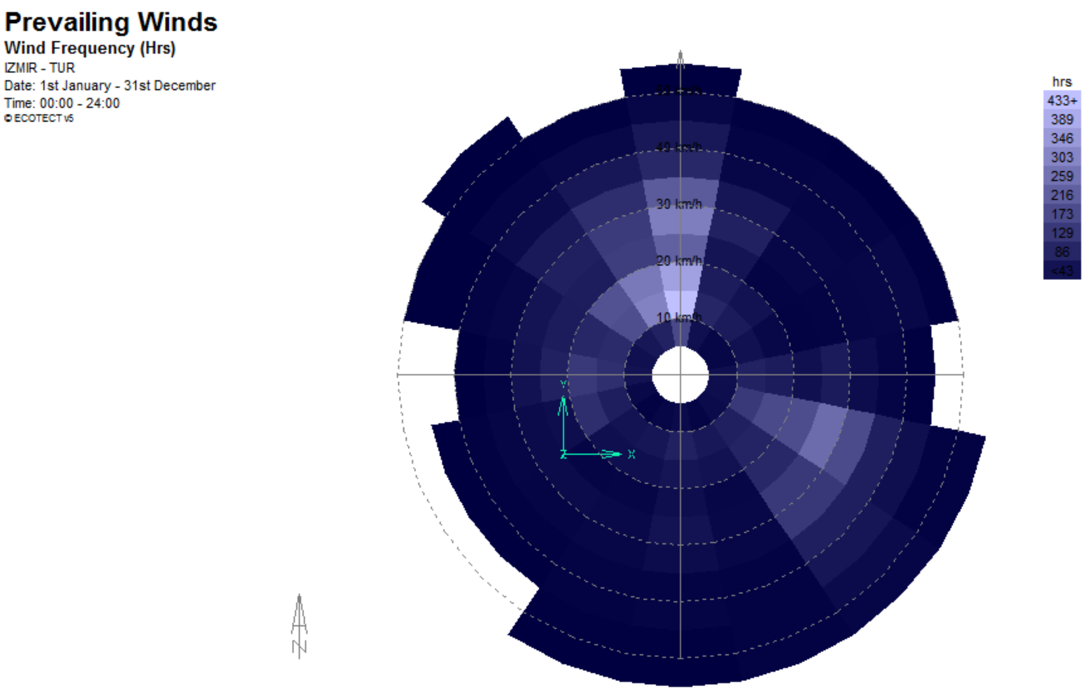


Figure 123 Wind Direction in Izmir

The coloured segments plot the frequency of wind speed and direction for the selected period, with the brighter colours representing the greatest number of hours
10km/h on the NORTH are the most frequent ones.

5.1.3 Precipitation

Precipitation is defined as "any product of the condensation of atmospheric water vapor" that falls down on Earth. Moisture form the Earth's surface evaporates and forms the clouds. Then, it condenses and returns to the Earth's surface in the form of droplets. This cycle is repeated continuously. [1]

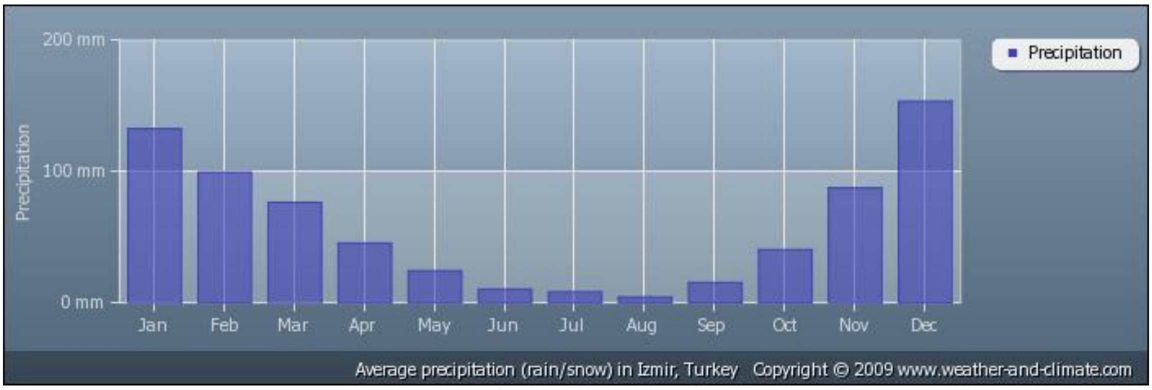


Figure 124 Average Precipitation of Izmır; from Weather-and-Climate.com

5.1.4 Relative Humidity

[1] "Precipitation". Glossary of Meteorology. American Meteorological Society. 2009. Retrieved 2012

Relative humidity [1] is a measure of the amount of moisture in the air relative to the total amount of moisture the air can hold

Compared to summer when the moisture content of the air (relative humidity) is an important factor of body discomfort, air moisture has a lesser effect on the human body during outdoor winter activities. But it is a big factor for winter indoor comfort because it has a direct bearing on health and energy consumption.

The colder the outdoor temperature, the more heat must be added indoors for body comfort. However, the heat that is added will cause a drying effect and lower the indoor relative humidity, unless an indoor moisture source is present.

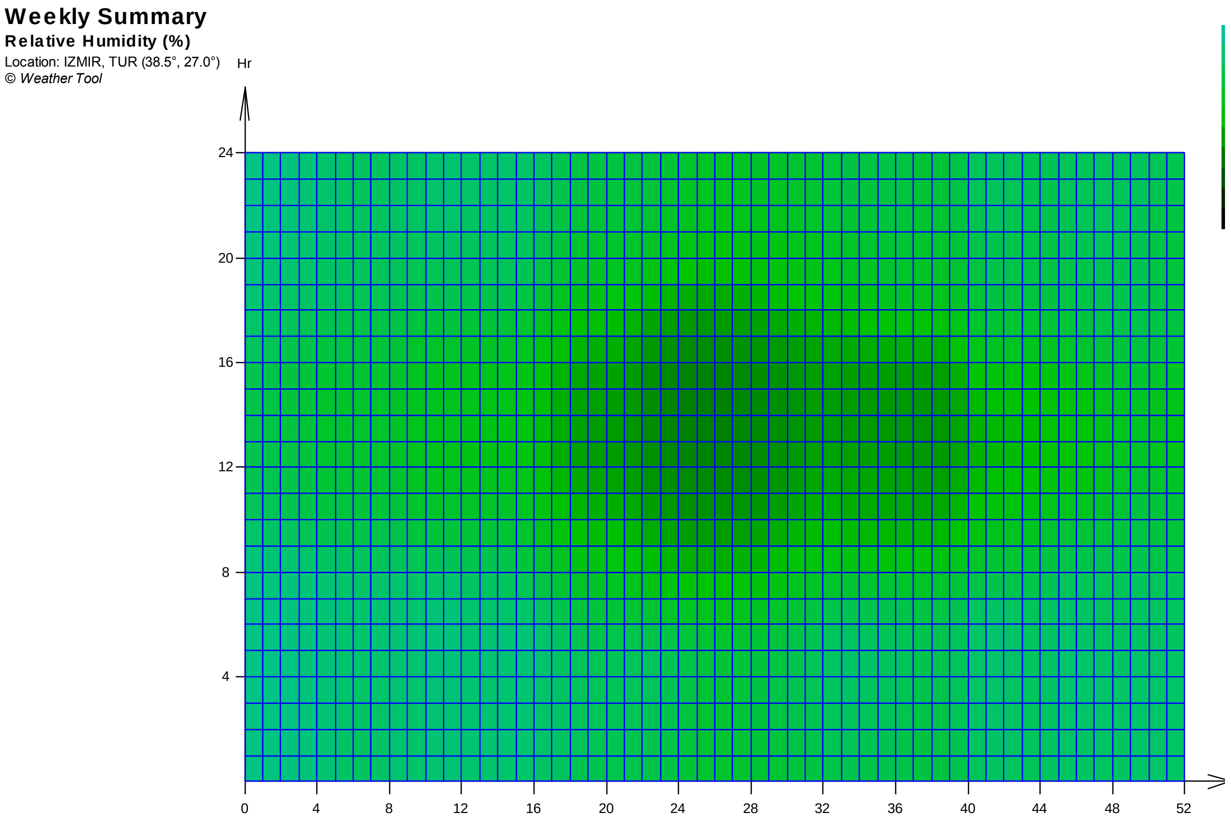


Figure 125 Relative Humidity Analysis of Izmır -Ecotect

Mean relative humidity for an average year is recorded as 61.7% and on a monthly basis it ranges from 49% in July & August to 72% in January & December.

Highest humidity is mostly between 10pm-9 am in the morning reaches 80-90%
Between 10pm-3 pm ; Relative humidity drops to 50% which is a more comfortable level.
Between 24-32 the weeks; Relative humidity drops to 40% which gives us to opportunity to employ a evaporative cooling into our design.

[1] "Relative Humidity". Glossary of Meteorology. American Meteorological Society. 2009. Retrieved 2012

5.1.5 Direct Solar Radiation

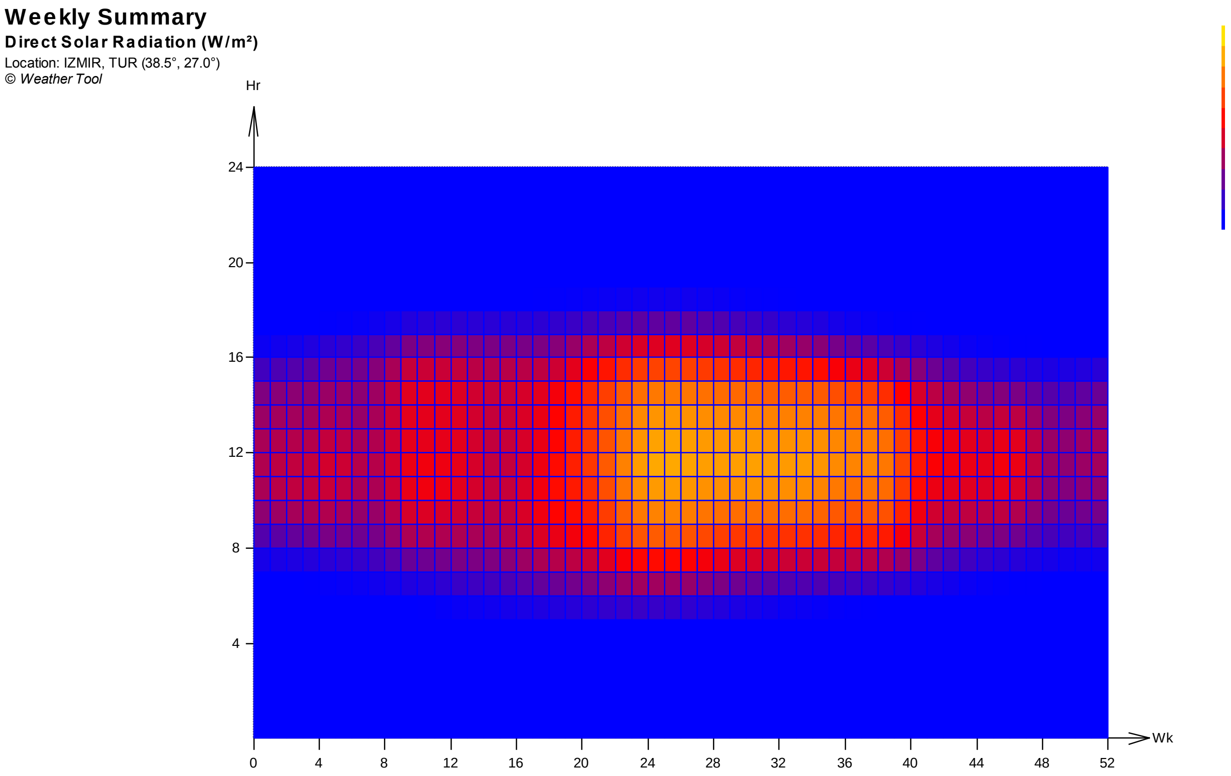


Figure 126 Direct Solar Radiation -Izmır

The Figure shows the direct solar radiation Izmir receives on a weekly basis.

The highest directs solar radiation in Izmir is between week 24 and 32 where it receives around 700- 900W/m² direct solar radiation from 7am to 4pm.

This data gives the valid information for the designing of the shading system and the energy required to be generated by PV panels.

In the following pages, the weather data is summarized based on the summer and winter peaks that occur on the 28th of June and 23th of February respectively.

In the next page, basically show the maximum, minimum and average monthly temperatures in Izmir. In addition to that the dotted green line shows the relative humidity while the solid green area shows the comfort zones for the particular months.

The graphs on the bottom right hand corner show the daily details for the summer peak, 28th of June and for the winter peak, 23th of February. The figures also tell us that the months of January, February, and Deccember require some sort of heating. While, the months June, July, August, September and parts of October require us to provide cooling if we are to attain comfort conditions.

Figure 127 Monthly Diurnal Averages - Summer Peak

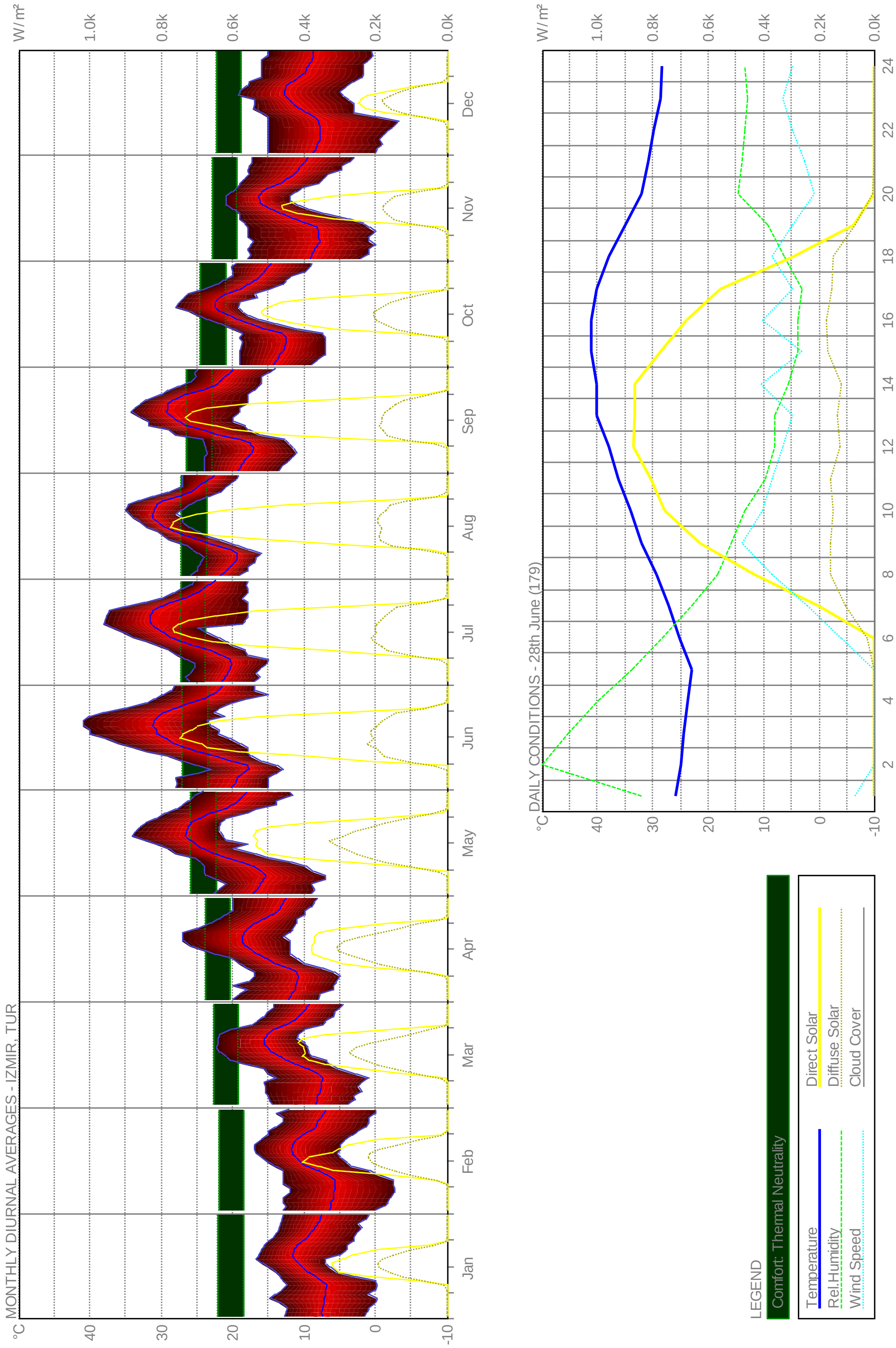
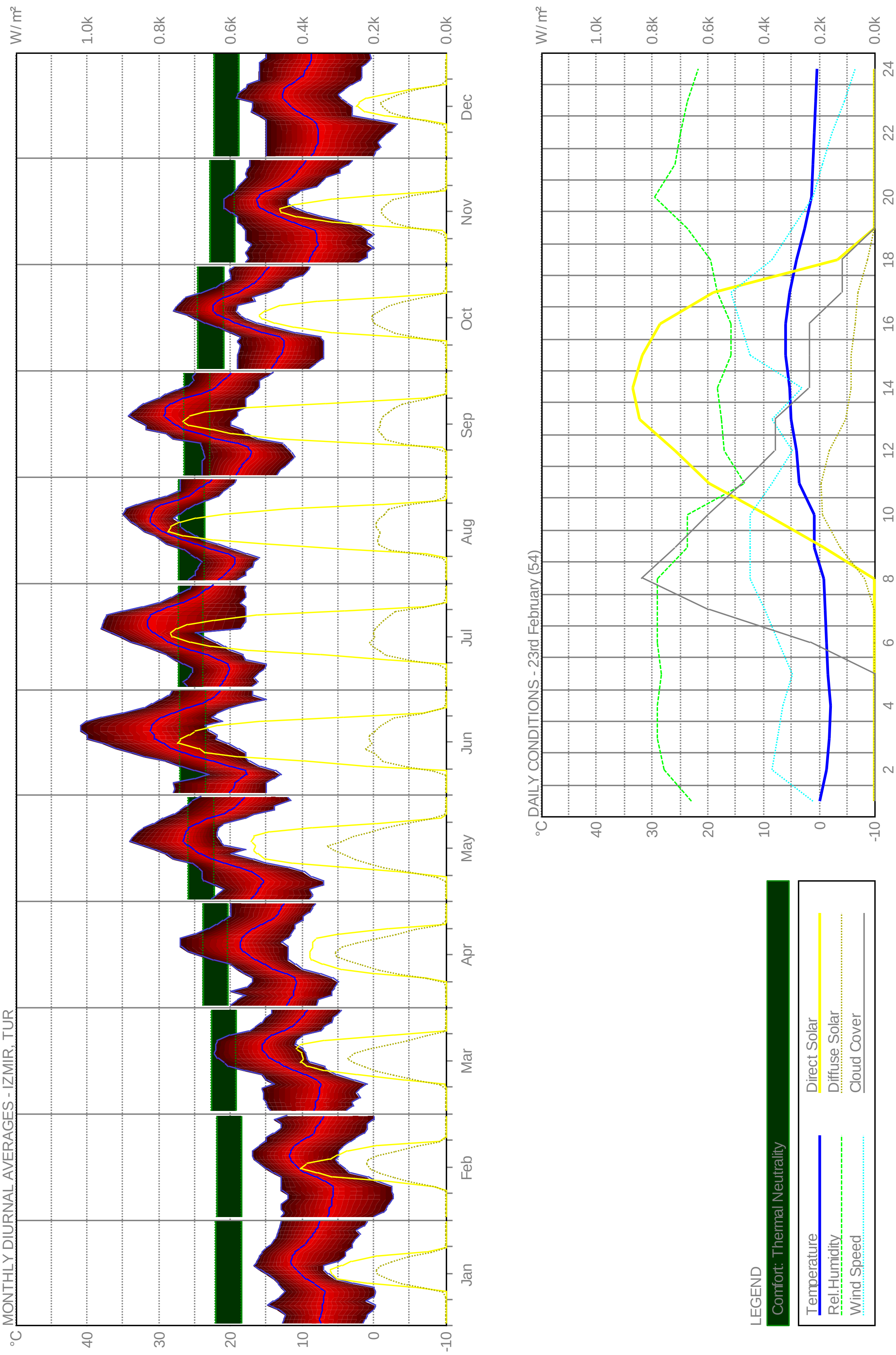


Figure 128 Monthly Diurnal Averages - Winter Peak



5.1.6 Physcometric Chart

Based on the aforementioned weather conditions we then shift our focus to the Psycho-metric charts that show us a comfort band that we shall strive to attain through our designs.

- Date: SUMMER

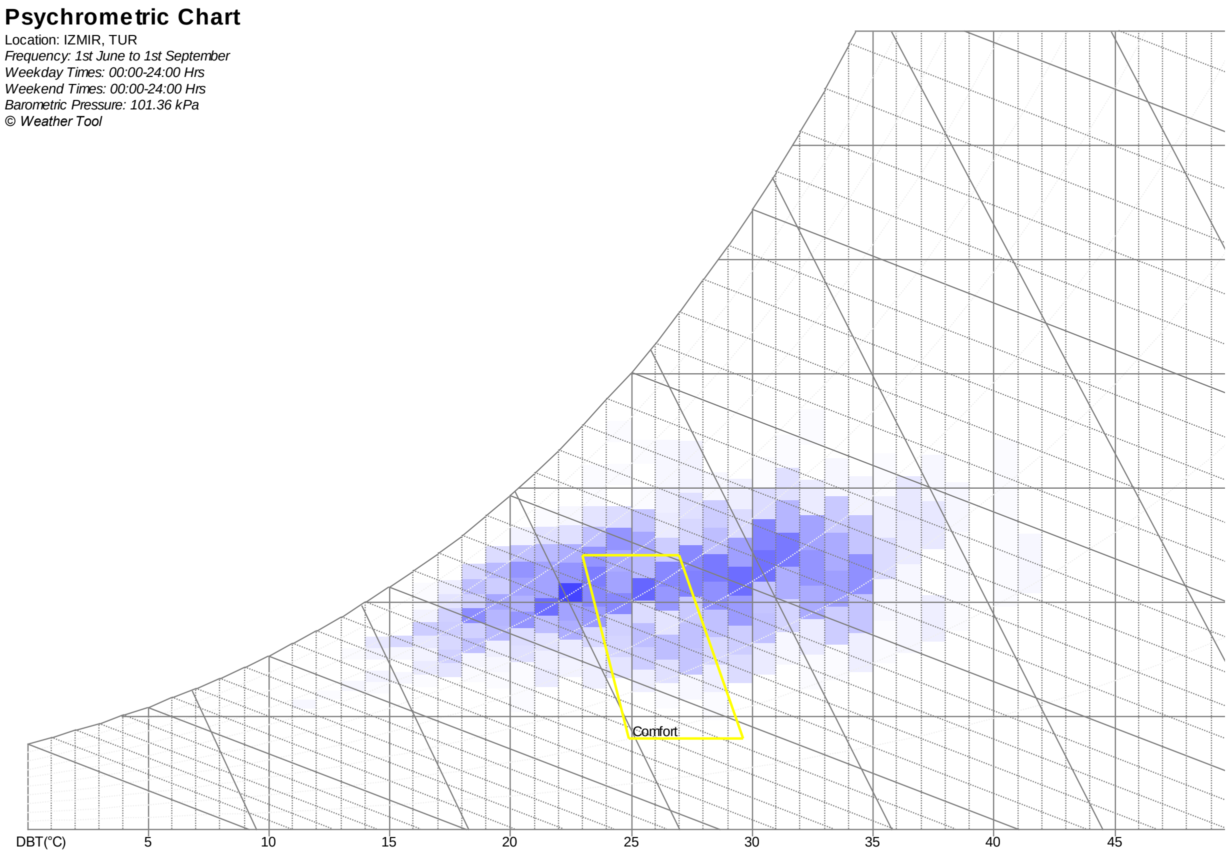


Figure 129 Psychometric Chart from ECOTECT- Izmır / SUMMER

From the summer comfort zone it is clear that the cumulative frequency of the temperatu re is not very outside the comfort band.

The relative humidity is also near 50% remaining in the comfort zone with occasionally going higher 70-80% remaining in the comfort zone.

This means it should be put into consideration that cooling with little dehumidification when necessary should be provided.

- Date : WINTER

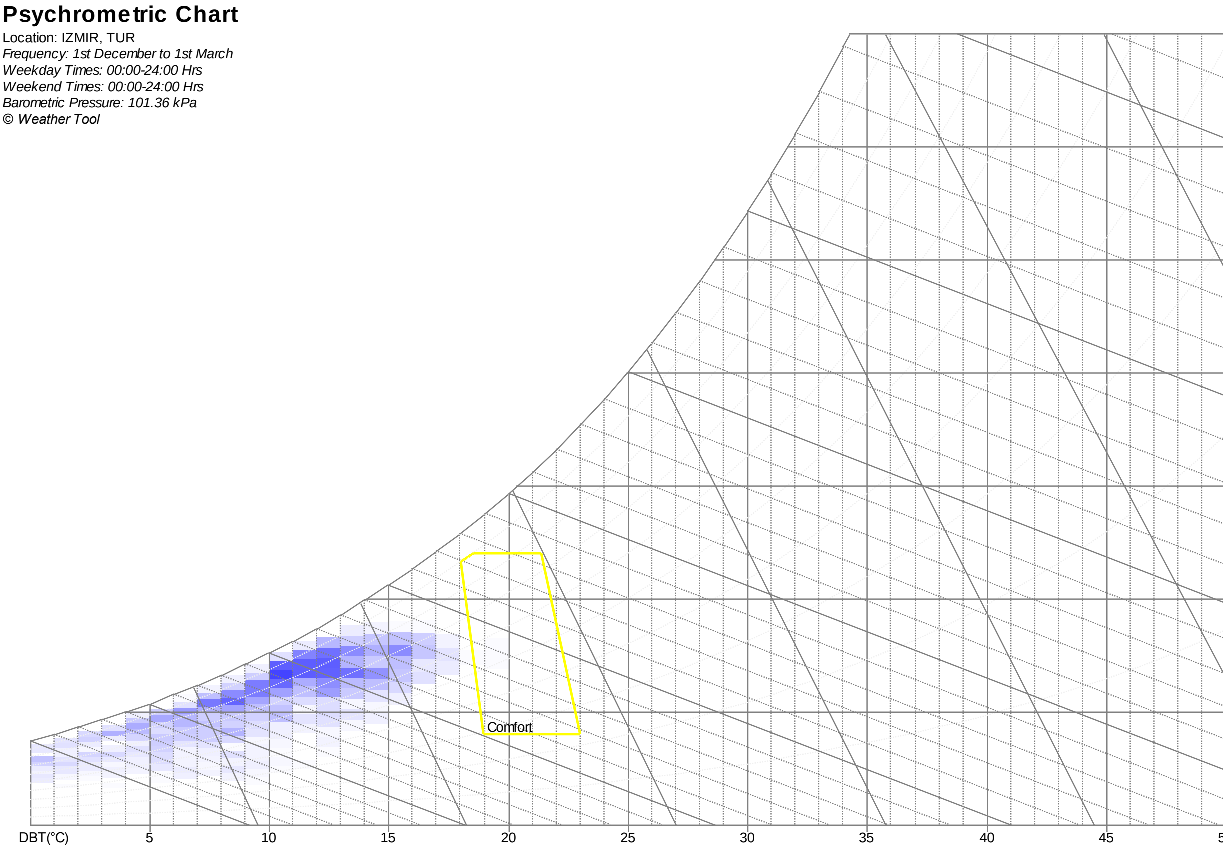


Figure 130 Psychometric Chart from ECOTECT – Izmır / WINTER

Again, from the winter comfort zone it is easily understood that the cumulative frequency for temperature falls short of the comfort zone.

The relative humidity on the other hand stays at a comfortable level of 50% to 60%.

Therefore, in the winter, we conclude, that we are required to heat the incoming air while probably also humidifying it since when air is heated without humidification the relative humidity decreases.

If the relative humidity of the heated air drops be low comfort levels we shall humidify it in hopes of attaining comfort.

However, if we choose to heat the morning air, with considerably high relative humidity and low in temperature, we lower the relative humidity while increasing the temperature of incoming air.

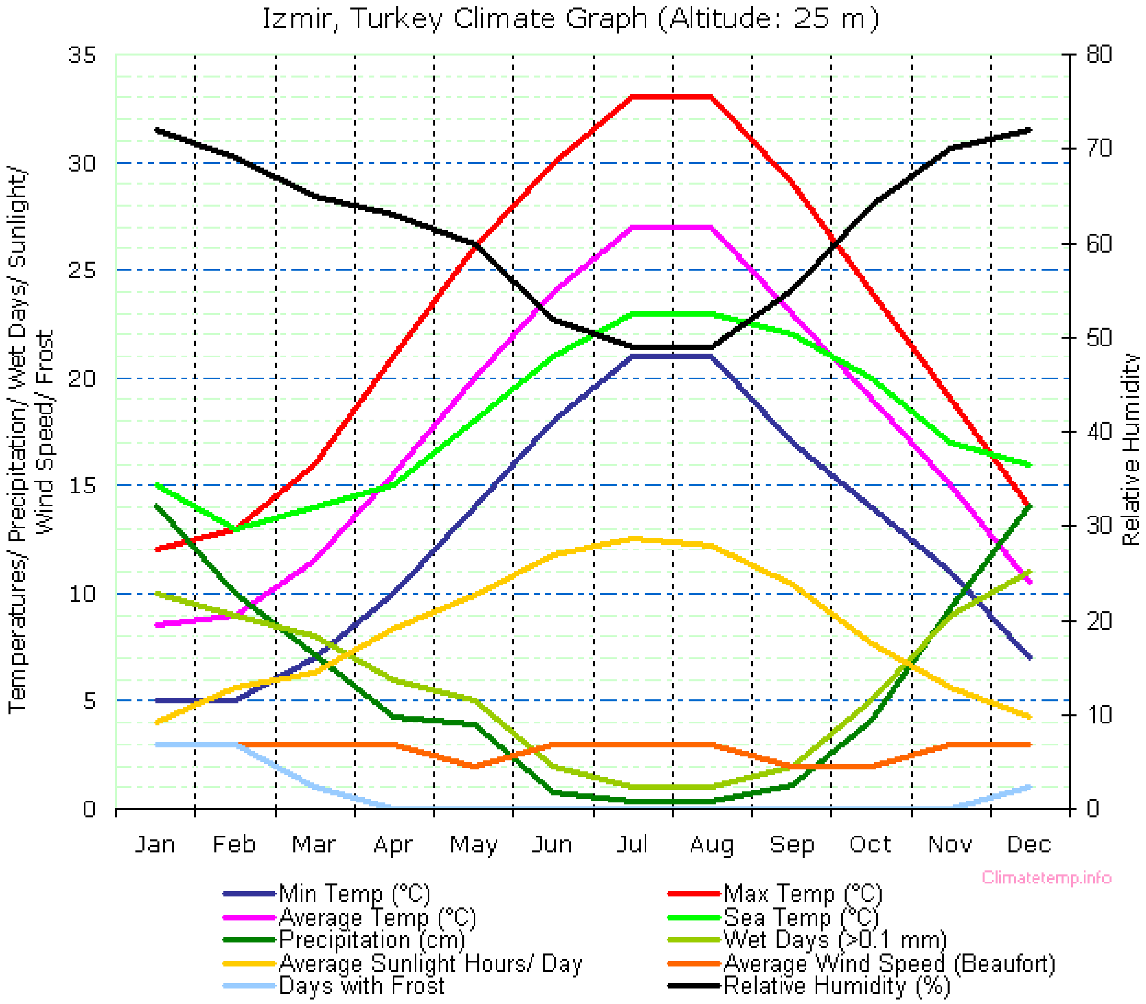


Figure 131 Important datas in one[1]

5.1.7 Sun Path Diagram

Sun path; refers to the apparent significant seasonal, hourly position of the sun changes (and length of daylight) as the Earth rotates, and orbits around the sun. The relative position of the sun is a major factor in the heat gain of buildings and in the performance of solar energy systems.

Accurate location, specific knowledge sun path and climatic conditions is essential for economic decisions about solar collector area,orientation, landscaping, summer shading and the cost-effective use of solar trackers

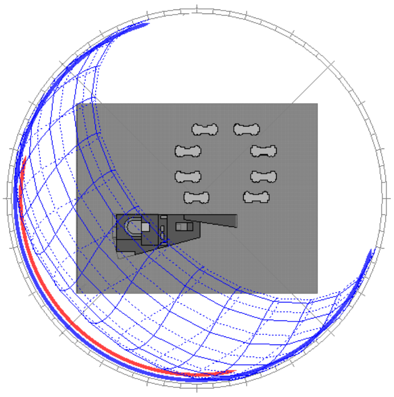


Figure 132 Sun Path Diagram

[1] ClimateInfo ;*Climate of Izmir* ; from www.climatetempo.info ; 2012

5.1.8 Shadow Pattern

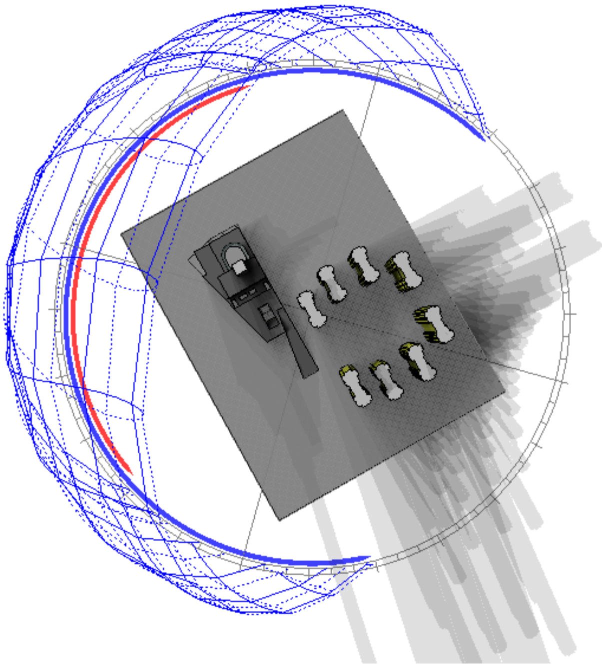
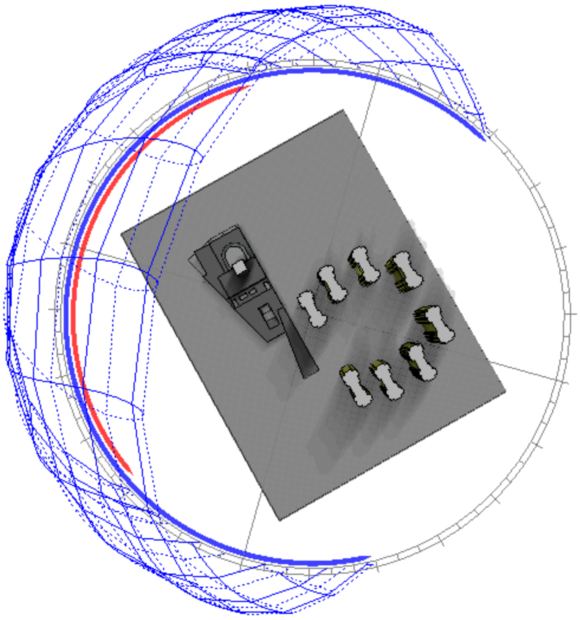


Figure 133 21st of December Shadow Overlay

Figure 134 21st of June Shadow Overlay



21st of June

It can be stated that there is no overlay of shadows

5.2 Materials

5.2.1 Precast Concrete

AS A SHELL FOR THE FACADES, IT S BEEN DECIDED TO CHOOSE PRECAST CONCRETE.

There are many factories manufacturing precast elements near Izmir.

Energy conservation is a key tenet of sustainability and a major benefit of using precast concrete components. Precast concrete's inherent capabilities to provide energy efficiency rely on the high thermal mass of the material, which benefits exterior wall applications. Precast concrete's high thermal mass can delay or reduce peak loads, reduce total loads in many climates and work well regardless of the placement of mass.

AS A SHELL FOR THE FACADES, IT S BEEN DECIDED TO CHOOSE PRECAST CONCRETE

Precast's high thermal mass can help shift the peak hour of electric demand for air conditioning to a later hour and help reduce time-of-use charges. Nighttime ventilation can be used to cool thermal mass that has been warmed during the day. Local outdoor humidity levels influence the effectiveness of nighttime ventilation strategies. These strategies can help to reduce the overall load in many climates.

Its high mass provides benefits to the inside surfaces as well by absorbing heat generated by people and equipment. Interior mass from interior walls, floors and ceilings will help moderate room temperatures and reduce peak energy use.

Light-colored precast concrete will reduce energy costs associated with indoor and outdoor lighting. The more reflective surfaces will reduce the amount of fixtures and lighting required.

Figure 135 An example of precast concrete

Precast& Leed[1]

Precast concrete can help meet minimum energy requirements, optimize energy performance, and increase the life of a building. The constituents of concrete can be made from recycled materials, and concrete itself can also be recycled. The materials are usually available locally. (IZMIR)

The general attributes and capabilities of precast concrete that help meet LEED certification center on these key areas:

[1] Barber Architecture ;*Precast Concrete Achieves Sustainability Goals* ; spring 2007

a. Durability[1]

Precast concrete panels provide a long service life due to their durable and low-maintenance concrete surfaces. A precast concrete shell can be left in place when the building interior is renovated. Yearly maintenance should include inspection and, if necessary, repair of joint material.

b. Urban Heat-Island Mitigation

Precast concrete provides reflective surfaces that minimize the urban heat-island effect, which result from solar radiation being absorbed by horizontal surfaces such as roofs, pavements and parking lots

Figure 136 Sustainability

c. Abundant Constituent Materials

Concrete contributes to a sustainable environment because it does not use scarce resources. It consists of only a few ingredients, primarily cement, water, large and small aggregates and admixtures, all of which are abundant locally.

d. Minimized Production Needs

The production of precast concrete has many environmental benefits, including:

- Less material is required because precise mixture proportions and tighter tolerances are achieved.
- Optimal insulation levels can be incorporated into precast concrete sandwich wall panels.

e. Energy Savings

Precast concrete walls provide benefits because they delay or reduce peak loads, reduce total loads in many climates and work well regardless of the placement of mass.

Figure 137 Energy Saving

f. Improved Indoor Air Quality:

Precast concrete components also aid indoor air quality standards because they are delivered to the site in modules that do not require fabrication, processing or cutting at the construction site, thereby reducing dust and airborne contaminants on site. Concrete is not damaged by moisture and does not provide nutrients for mold growth.

[1] Barber Architecture ;*Precast Concrete Achieves Sustainability Goals* ; spring 2007

Precast Concrete& Sustainability[1]

Figure 138 Sustainability

Precast concrete contributes to green building practices in significant ways. The low water-cement ratios possible with precast concrete -0.36 to 0.38- mean it can be extremely durable. The thermal mass of concrete allows shifting of heating and cooling loads in a structure to help reduce mechanical-system requirements. Because precast concrete is factory-made, there is little waste created in the plant and also It is very energy efficient(HVAC)

5.2.2 Beige Marble Stone

For the platforms which are walkable, beige marble stone has been chosen.

Marble stone is a kind of precious building materials because of its environmental nature and unparalleled texture and the Beige marble stone is the most classical and beautiful one among marble stone.

Izmir is very rich in natural stone and in 100km

perimeter, there are couple of quarries

Figure 139 Beige Marble Stone

Figure 140 Beige Marble Stone Quarry in Izmir

.HIGH HARDNESS

·LOW RADIATION

·LONG SERVICE LIFE

·ALL NATURAL INGREDIENTS

·UNDUPLICATED

[1] Martha VanGeem ; *Achieving Sustainability withPrecast Concrete* ; January 2006

5.2.3 Rosso Laguna Marble

For the outer part of the opera hall that crimson- colored marble has been chosen

This marble has been discovered in Turkey by a Turkish-Italian Company.It has a very unique color & structure that makes it special for us to use it.

Figure 141 Examples of Rosso Laguna

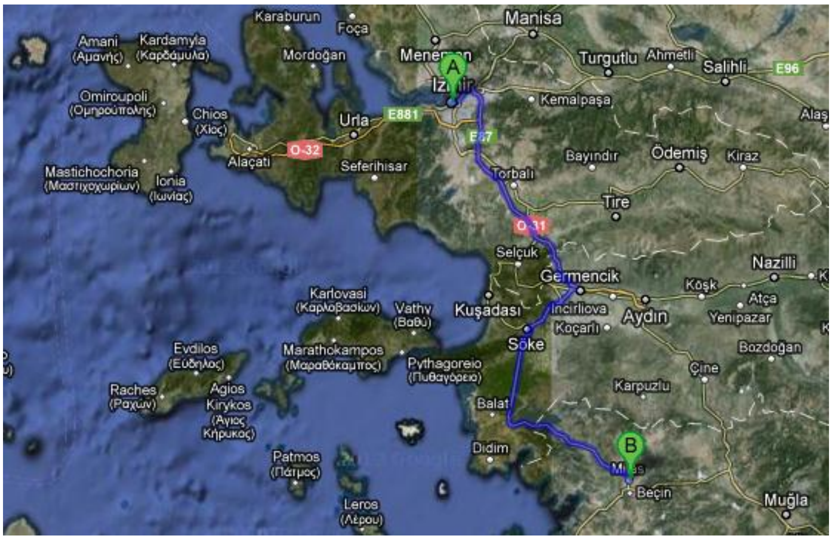


Figure 142 Just 200km s there is a quarry of rosso laguna marble.

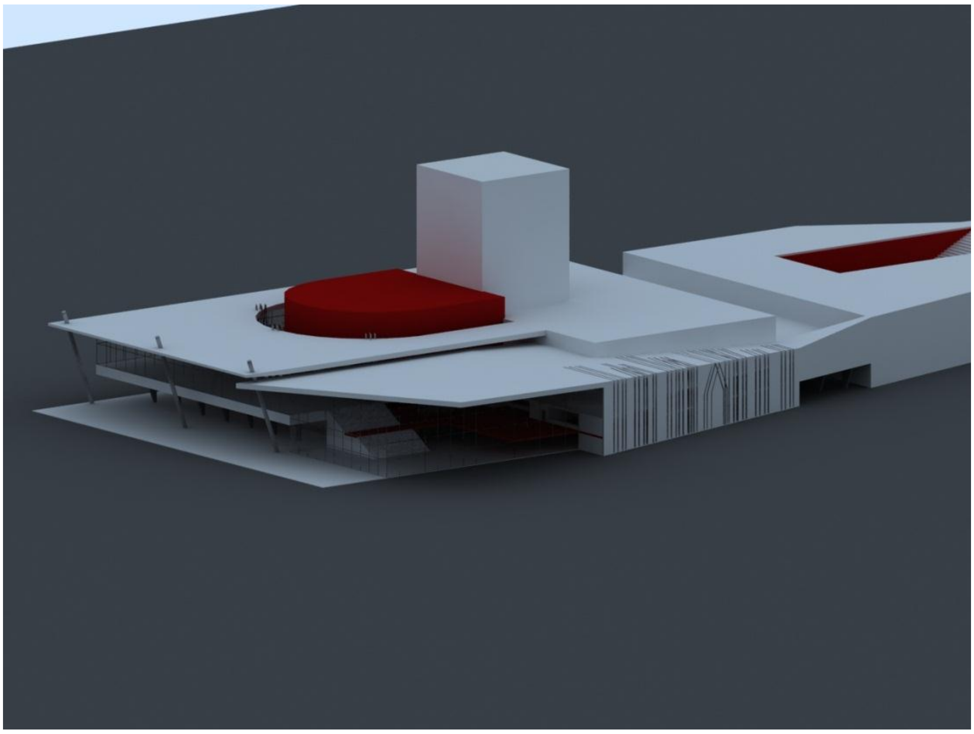


Figure 143 3-D view of designed opera house and red marble zone

5.2.4 Glass

5.2.4.1 Schüco E² Façade

Saving Energy - Generating Energy

The Schüco E2 façade ensures maximum efficiency and maximum profitability. It offers clear investment benefits and guarantees profitable management of real estate with maximum user comfort[1]

The Schüco E2 façade is an energy-efficient, complete system with a revolutionary combination of façade and system technology, which both saves and generates energy. Investment costs can be reduced as early as the planning stage and the operating costs can be actively managed and optimized over the entire life cycle of a building. The result is max-conomic success of the property with the highest possible energy efficiency, conservation of resources and environmental protection.

Figure 144 A schüco E2 facade

The function modules in the Schüco E2 façade:

opening units, solar shading, solar modules

[1] E² Schüco Technical Guide & Specifications ; from schueco.com ; 2012

OPENING UNITS[1]

The concealed, flush-fitted integration of all opening units, including their system drives, ensures maximum creative freedom when designing façades and perfect integration with the building management system.

Flush-fitted façade integration; fixed lights and opening units appear identical Concealed system drives; optional intelligent control via building management system Energy saving in combination with night-time cooling; Storey-height window solutions possible; Large ventilation cross sections

Figure 145 E2 facade with shading

Solar shading: Transparent and highly resilient

The transparent blind consists of micro louvre blades that ensure solar shading and anti-glare protection with complete shading from when the sun is at an angle of 20° .The transparent blind consists of micro louvre blades that ensure solar shading and anti-glare protection with complete shading from when the sun is at an angle of 20°

Weather-resistant, aluminium micro louvre blades

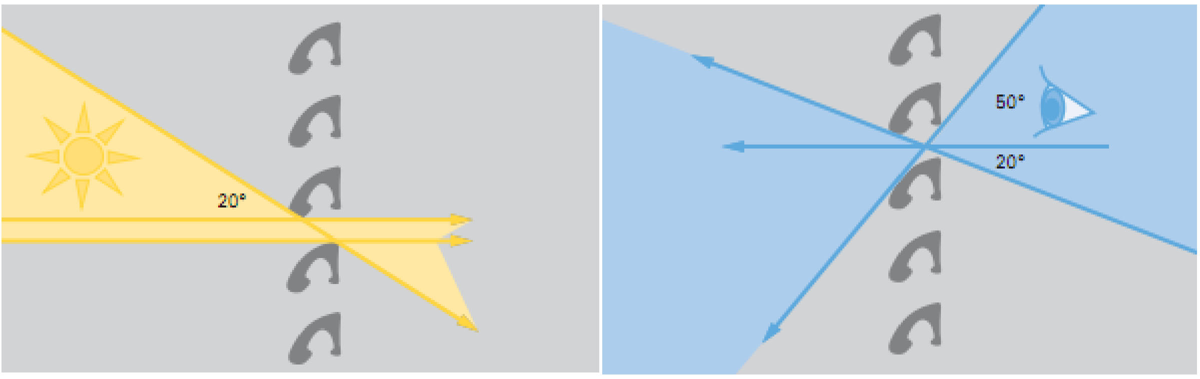


Figure 146 Figures showing how shading & transparency work

During the warmer months, it is possible to reduce the cooling load for the building approximately 50% thanks to external system. The solar shading function module thereby makes a considerable contribution to reducing the operating costs.

[1] E² Schüco Technical Guide & Specifications ; from schueco.com ; 2012

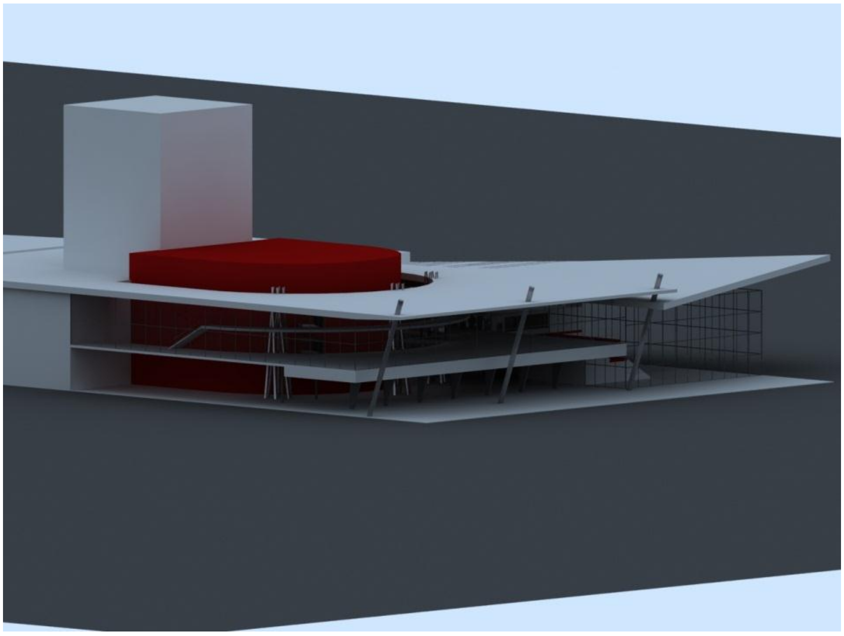

Figure 147 E2 Schüco Photo voltaic modules applications

Solar modules: Façade-integrated photovoltaics

With Schüco façade-integrated photovoltaic modules, the Schüco E2 façade features a highly effi cient component for solar energy generation. The solar modules meet all the requirements of a conventional infi ll unit in terms of thermal insulation, weather resistance and sound reduction

Especially for the foyer , SCHUCO E2 is a perfect choice to provide the needs.

Figure 148 For the Foyer Schüco E2 is a good option.



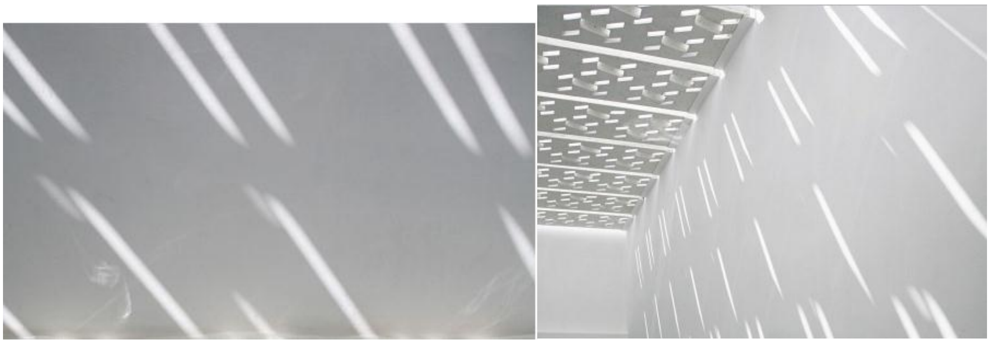
[1] Figure 149 Examples of SCHÜCO E2 façade applications

Figure 150 Another Schüco E2 application

[1] E² Schüco Technical Guide & Specifications ; from schueco.com ; 2012

5.2.4.2 Perforated Glass

Figure 151 Examples of Perforated Glass Applications



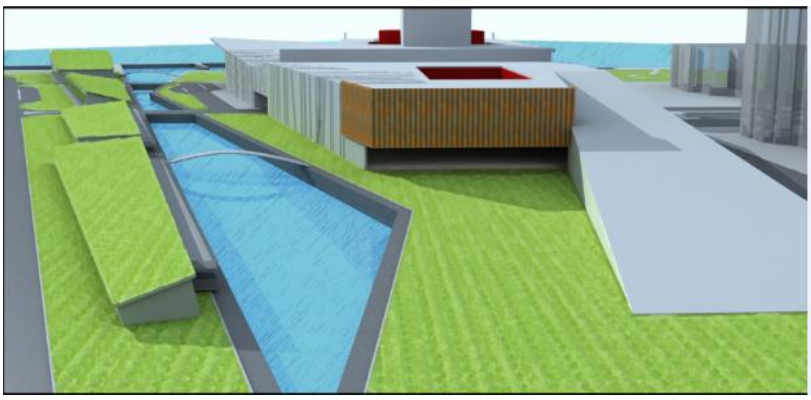
Enabling us to use & play shadows efficiently

For the exhibition hall , perforated glass seems like the best choice.

5.2.5.2 Metal

Rusty metal for architectural design

Figure 152 Rusty Metals Examples throughout the world, and the zone where we apply it



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5.3 Daylight Analysis

Daylight also enables opportunities to boost energy savings by 35-60% using automatic daylighting controls.

The daylight factor (DF)[1] is a very common and easy to understand measure for expressing the daylight availability in a room. It describes the ratio of outside illuminance over inside illuminance, expressed in per cent. The higher the DF the more natural light is available in the room .The daylight factor is defined as :

DF= (SC + ERC+ IRC)

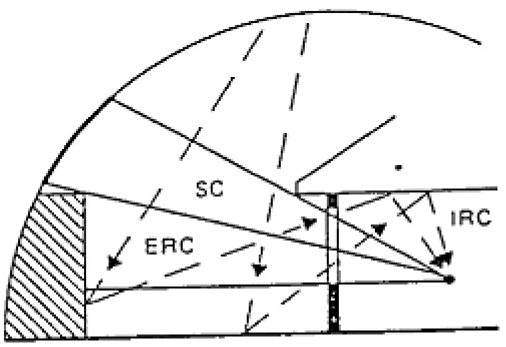
DF (%)	
≤2%	Room look gloomy. Electric lighting needed most of the day
2% to 6%	Room appears predominatly daylit. Artificial lighting may be require. This value strikes a good balance between daylight & artificial light
≥6%	Room appears strongly daylit. Daytime electrical lighting is likely not needed, but there exists a potential for thermal problems due to overheating

Table 12 Daylight Factor - Light in the rooms

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.

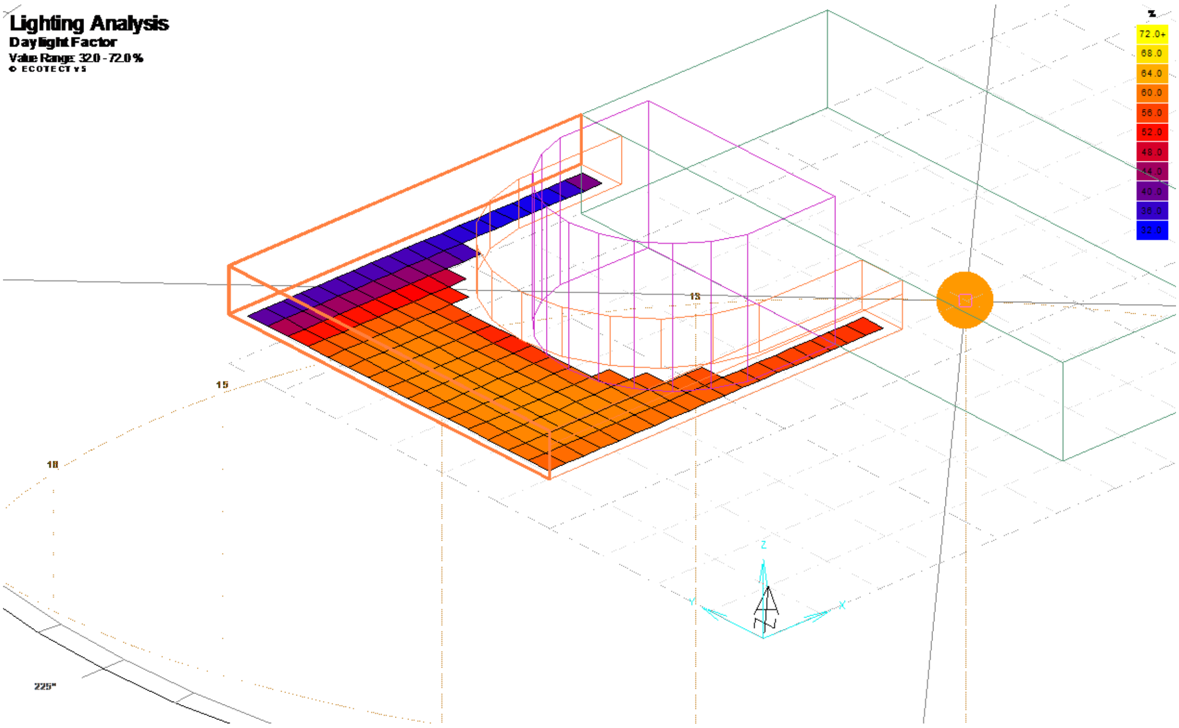
Internally Reflected Component (IRC) - The inter-reflection of 1 and 2 off surfaces within the room.



This intrinsic value of daylight is increasingly recognized. If appropriately designed and integrated, it can improve amenity value, significantly offset the cost and reduce the environmental impact associated with artificial lighting.

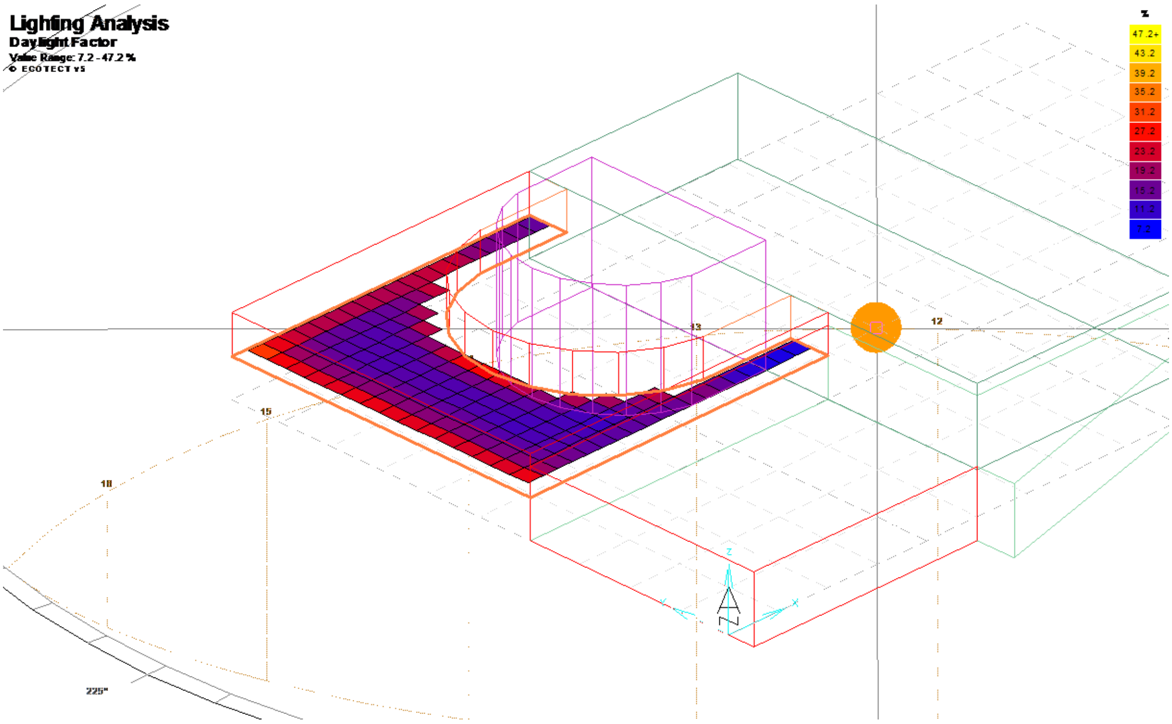
Figure 153 The reflections of components

[1] Martin A. Wilkonson, University of Bath, ; *Daylight Factor* ; 2012



without shading and single glazed window

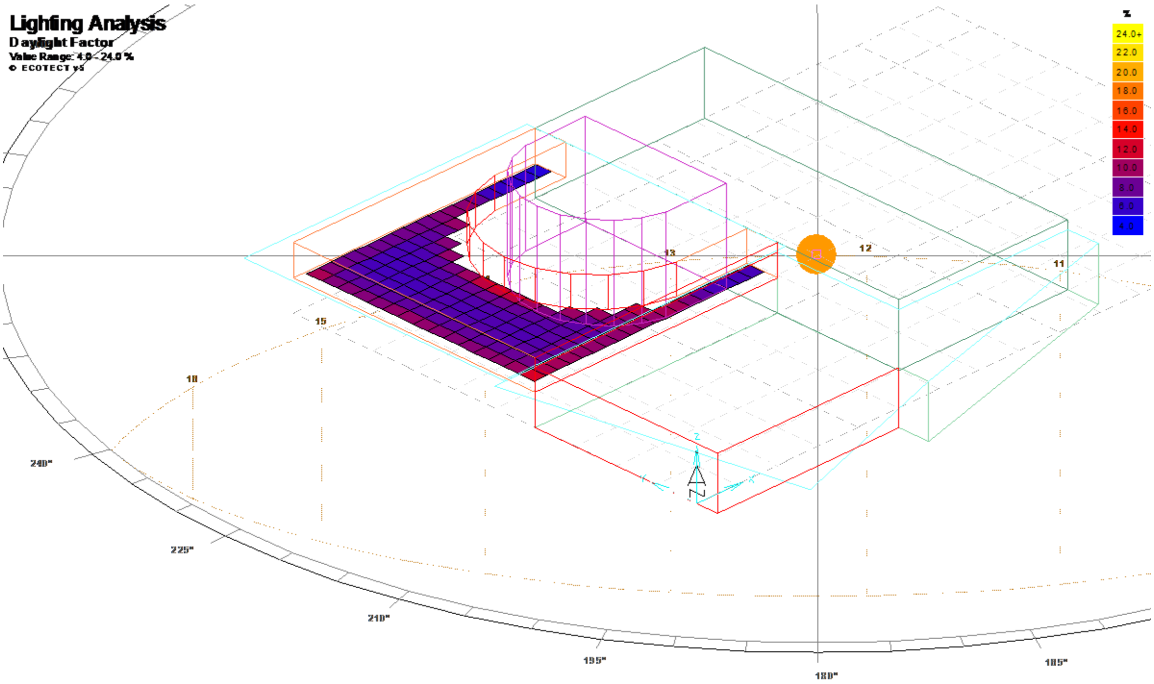
smallest : 32 % highest :72 %



With shading and double glazed

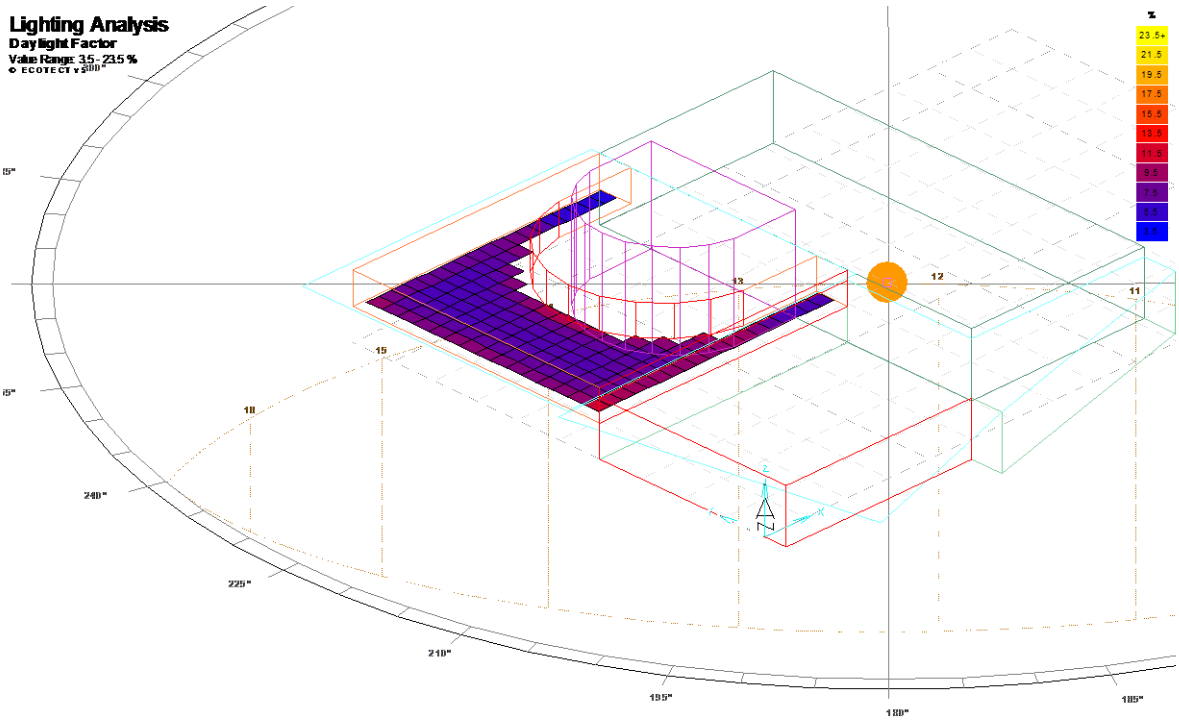
smallest :7% highest 40%

Figure 154 In the figures above different daylight factors for different cases



With shading and double glazed windows (lower reflectance and emissivity)

Smallest : 4% highest 15%



With shading and double glazed SCHUCO E2 advantage windows

Smallest : 3,5 %   Highest 9%

Figure 155 Different cases ; Final case with Schüco E2

The average daylight factor from step 1 to step 4, was reduced in a 80%, also showing a good light distribution, thanks to the chosen shading and glass systems characteristics.

5.4 Insolation Analysis

In this phase, we use the insulation analysis since the incident solar radiation is one of the biggest sources of heat gain for the building.

Insolation analysis have been run to calculate the cumulative solar radiation during the hottest three months which are June, July and August.

Analysis have been run through ECOTECT since the building is already designed.

Below you ll see analysis of shaded but with different glasses

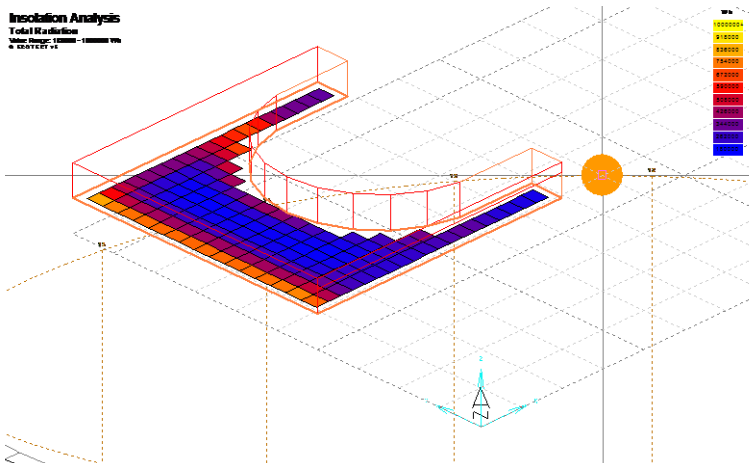


Figure 156 Without shading single glazed windows

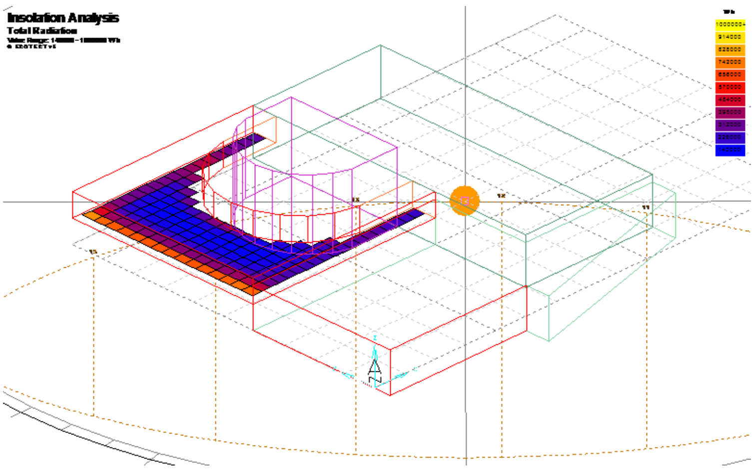


Figure 157 With shading double glazed windows

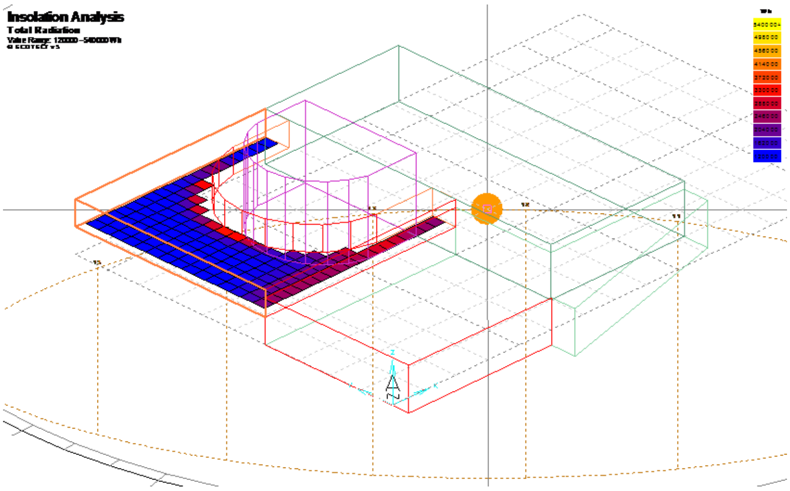


Figure 158 With shading single glazed windows Schüco E2 advantage

From the dedication of the floor, we can easily conclude the change we have made in the façade significantly effective in term of energy for the building.

5.5 Heating& Cooling Loads

5.5.1 Without shading single glazed and thermal insulation layer, dry wall having U = 0,24W/m2K

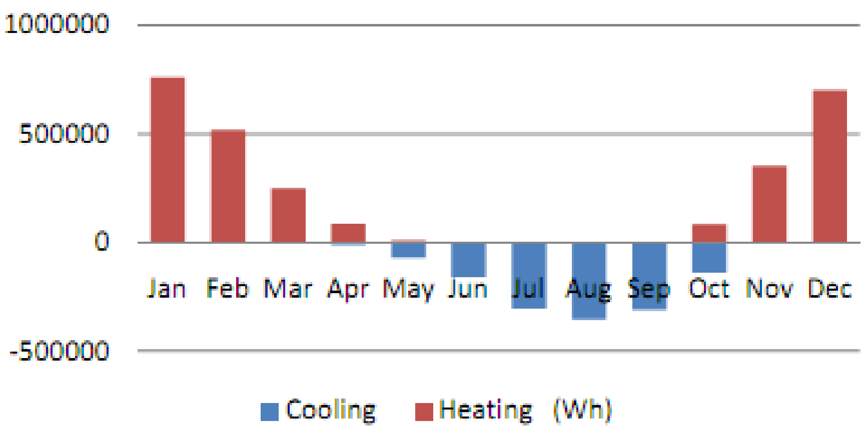


Figure 159 Heating-Cooling Load for Case 1

The y-axis of the charts denote heating and cooling loads in Wh.

The average heat load of the box 1 is around 56kWh/m2

Max heating 920 W ; Max cooling 590 W

Total loss : 62.4 kWh

Total gain : 31.8 kWh

The Next case is examined by improving the quality of insulation layers and glass.

5.5.2 Without shading –double glazed and thermal insulation layer, dry wall having U = 0,17W/m2 K

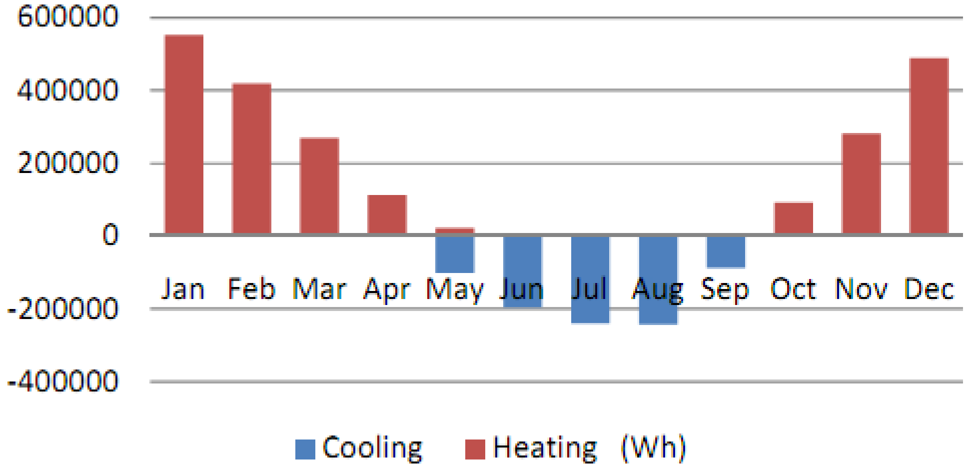


Figure 160 Heating-Cooling Load for Case 2

Above, due to the better quality of thermal insulation and glass, the heat loads decreased dramatically. The average heat load is around 33,9 kWh/m2

5.5.3 With shading and double glazed (Schuco E2) and thermal insulation layer

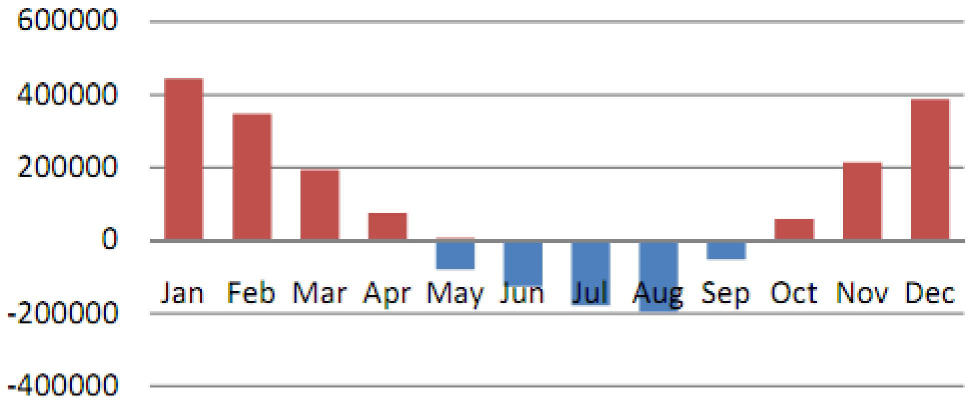


Figure 161 Heating-Cooling Load for Case 3

As can be seen, the shading system noticeably contributed to the decrease of the cooling loa d of it resulted in the decrease of yearly average heat load from 56 to 32,1 kWh/m2

Max heating : 625 W

Max cooling : 329 W

Total loss : 36 kWh

Total gain : 22.4 kWh

According to the ECOTECT there is a need to use a shading system to protect from the sun.

5.6 Lighting Technologies

The minimisation of the visibility of light sources – a feature should be made of the structure rather than of the lighting installation itself The maintenance of the iconic presence of the building in its environment.

The lighting level should relate to the general illumination of the city backdrop and dominate night vistas from any vantage point. Lighting in a manner that expresses and reinforces their sculptural form, geometry and construction.. The light intensity and direction should enable the structural , the tile panels and the different tile finishes

Opera lighting[1] must light the singers for clarity, the dancers and chorus for interest and the scenery for atmosphere.

Operas may be simplistic and straight forward, or highly complex and stylized. It is not unusual for 'visions' to appear from out of 'nowhere'. Nor is it unusual to have the 'devil' frequently appear or disappear throughout the course of the production. The opera lighting designer must be ready for this and for much more.

The 'scale' of opera lighting can often exceed that of theatre, dance or musical theatre lighting. Typically, opera will use a great deal performance space.

1- Led lighting

Light Emitting Diodes (LED) present many advantages over traditional light sources

Including lower energy consumption, longer life-time, improved robustness, smaller size and faster switching. Typical indicator LED's are de-signed to operate with no more than 3060 milli- watts [mW] of electrical power. This is one of the key advantages of LED-based lighting,its high efficiency, as measured by its light output per unit power input.The various advantages[2] of LED lights are listed below

Figure 162 An example of LED Lighting

- LED's produce more light per watt than incandescent light bulbs. LED's can emit light of an intended color with-out the use of color alters that traditional lighting methods require. This is more efficient and can lower initial costs. LED's can be very small, therefore can be in-stalled anywhere in the building. They light up quickly, they achieve full bright ness in microseconds.

[1] Bill Williams; ; *Stage Lighting Design* Edition 2.d ;1997-1999
[2] Led Depot ; Advantages of Led ; from http://www.led-depot.com.au/led-advantage ; 2012

- These lights can be very easily dimmed, and can be customized to the users visual comfort needs.

- Cool light. In contrast to most light sources, LED's radiate very less heat. - Compared to Fluorescent lights lifetime of 10 thousand hours, LED's last 40 thousand hours. Making it a very good initial investment.

- LED's are not toxic like other lights, since they do not contain Mercury. With the barrage of advantages of LED lights there remains no choice but to use them. We recommend the use of Philips Lumileds in the building.

2- *Hybrid lighting*[1]

In case of energy efficiency , hybrid lighting provides great improvement .These light bulbs does nothing but providing no-less light quality than any other energy efficient technologies.

As it is a fact than more than 75% of the energy consumed by lamps is a waste for IR energy or heat. In addition to that, HL converts most of the heat to renewable energy.

What makes it possible is that thin-film coating applied to the outside of the capsule that redirects wasted infrared radiation or heat, back to filament for more energy.

This kind of lamps are capable of inducing the energy consumption to one-third.

Figure 163 An example of hybrid Lighting

[1] U.S. Department of Energy; *Hybrid Solar Lighting Illuminates Energy Savings for Government Facilities*;2012

5.7 Solar Energy Potential

Even though we are not going to use Photovoltaic Panels and Solar Energy , it would be good to see Capacity of The Opera house concerning solar energy.

In the following pages , further estimated and approximate calculations for Opera's houses capacity to function with Solar Energy can be found.

In order to have a reference , It s been stated that annual electrical energy consumption of Sydney Opera House on lighting is in the order of 700 MWhr.

REGIONAL SOLAR ENERGY POTENTIAL OF TURKEY

REGION	TOTAL SOLAR ENERGY (KWh/m²-year)	SUNSHINE HOUR (hour/year)
Southeastern Anatolia	1648	2845
Mediterranean	1548	2737
Aegean	1528	2615
East Anatolia	1523	2519
Inland Anatolia	1481	2563
Marmara	1329	2250
Black Sea	1305	1929

Table 13 Izmir Solar Radiation

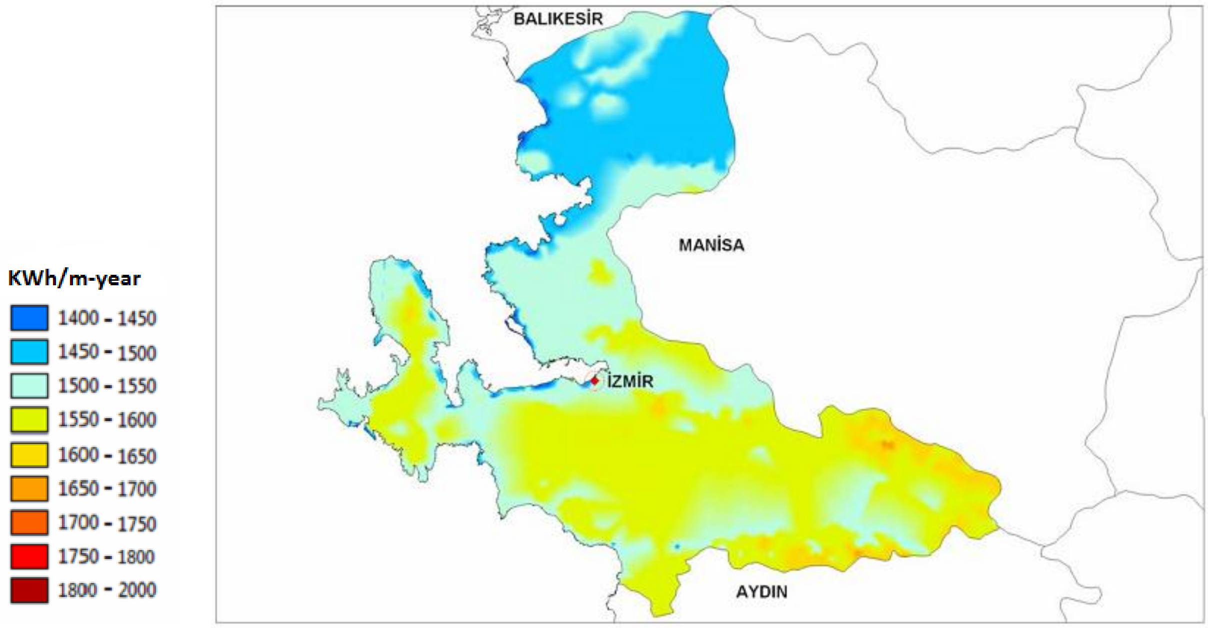


Figure 164 Izmir Solar Radiation

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	KWh/m²-year observed	KWh/m²-day observed	KWh/m²-year Model	PV Equivalent	City area (km²)	Sunshine hour (h/day)	Sunshine hour (h/year)
ADANA	62	75	113	134	167	172	181	164	130	102	68	54	1421	3.9	1525	228.8	14256	7.4	2704
ADIYAMAN	54	68	104	126	156	167	168	152	124	92	62	47	1320	3.6	1681	252.2	7572	8.1	2950
AFYON	63	82	130	153	183	199	209	192	154	107	69	53	1594	4.4	1456	218.4	14532	6.7	2461
AGRI	58	74	115	127	161	178	183	167	136	93	58	43	1392	3.8	1383	207.4	11315	6.3	2306
AKSARAY	67	84	124	141	174	186	194	179	146	106	74	59	1534	4.2	1557	233.5	8051	7.5	2728
AMASYA	47	66	109	136	170	184	192	174	134	89	52	38	1393	3.8	1469	220.3	5731	5.6	2059
ANKARA	50	67	108	128	164	178	189	172	137	96	58	41	1389	3.8	1440	216.1	25615	6.9	2506
ANTAKYA	49	66	105	132	163	178	182	164	130	95	60	45	1369	3.8	1510	226.5	5678	7.4	2689
ANTALYA	75	91	138	160	197	208	215	196	163	123	82	66	1715	4.7	1562	234.2	20599	8.4	3054
Ardahan	56	75	114	133	164	179	184	166	132	94	60	47	1404	3.8	1405	210.8	5495	5.9	2136
ARTVIN	50	69	114	138	168	177	169	156	126	89	55	42	1352	3.7	1310	196.5	7493	4.9	1789
HAKKARI	76	95	135	147	175	191	198	181	147	110	74	67	1596	4.4	1657	248.5	7729	7.9	2877
IGDIR	52	71	110	126	153	167	169	154	123	90	58	44	1318	3.6	1525	228.7	3584	6.3	2315
ISPARTA	59	73	107	123	149	161	168	154	126	94	64	50	1328	3.6	1535	230.3	8733	7.5	2741
ISTANBUL	41	56	95	129	166	180	184	161	127	83	50	36	1306	3.6	1303	195.5	5170	5.9	2163
IZMIR	64	79	123	151	186	203	207	186	154	111	71	55	1589	4.4	1562	234.3	11811	7.9	2893
KAHRAMANMARAS	60	78	124	153	193	214	224	199	161	112	69	51	1638	4.5	1628	244.2	14213	7.2	2619
Karabük	48	64	101	123	156	170	179	160	124	83	52	39	1299	3.6	1307	196.1	2864	5.9	2170

Table 14 Izmir Solar Radiation compared to other cities

----- IZMIR -------

1589 KWH/m2 per year is observed

4.4 KWH/m2 per day is observed

City Area 11811 km2

7.9 hours is Sunshine hour per day

2893 sunshine hours per year is observed

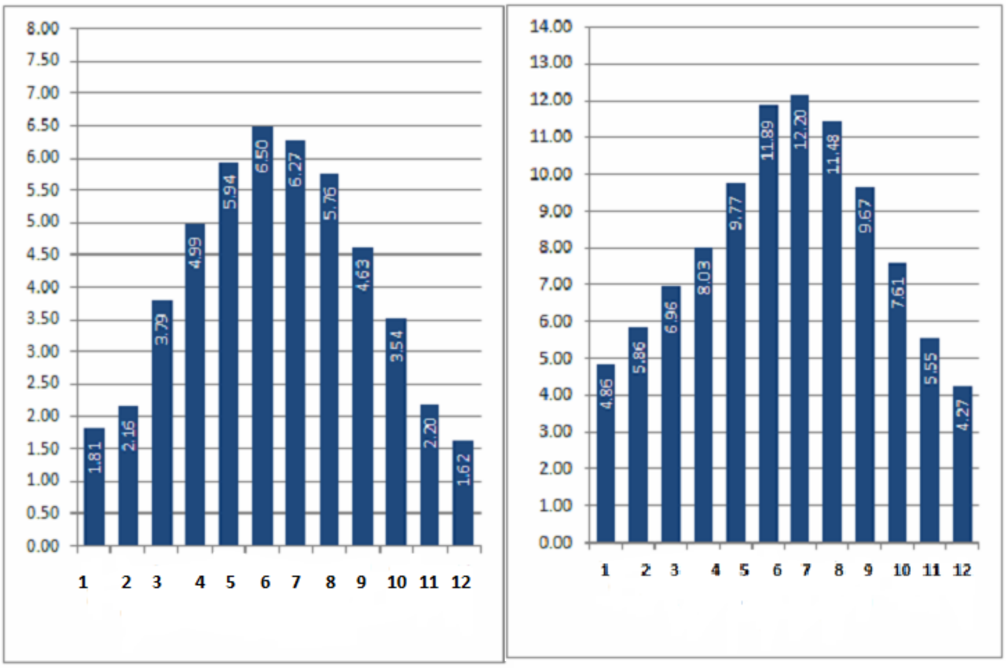


Figure 165 a.GLOBAL RADIATION KWH/M2-DAY /month & b.SUNSHINE HOURS /months

Yerleşim Yeri	Ocak	Şubat	Mart	Nisan	Mayıs	Haz.	Tem.	Ağus.	Eylül	Ekim	Kas.	Aral.
İzmir İli genel ortalama	1,81	2,16	3,79	4,99	5,94	6,50	6,27	5,76	4,63	3,54	2,20	1,62
Bornova	1,83	2,19	3,79	5,00	5,93	6,49	6,30	5,77	4,63	3,56	2,20	1,61
Urla	1,72	2,14	3,81	5,08	5,98	6,62	6,33	5,82	4,66	3,59	2,20	1,63
Ödemiş	1,90	2,27	3,90	5,06	6,01	6,53	6,38	5,84	4,75	3,63	2,29	1,70
Bergama	1,74	2,13	3,65	4,88	5,89	6,40	6,10	5,62	4,48	3,33	2,05	1,49
Çeşme	2,03	2,12	3,71	4,50	5,94	6,42	6,40	5,73	4,47	3,17	1,97	1,47
Dikili	1,70	2,09	3,65	4,87	5,87	6,41	6,08	5,62	4,46	3,35	2,09	1,49
Karaburun	1,56	2,18	3,81	4,94	6,00	6,59	6,35	5,72	4,61	3,44	2,12	1,56
Selçuk	1,92	2,21	3,90	5,09	5,95	6,55	6,28	5,86	4,75	3,70	2,30	1,72
Kemalpaşa	1,82	2,17	3,82	5,02	5,97	6,52	6,35	5,77	4,66	3,59	2,21	1,63
Seferihisar	1,82	2,15	3,81	5,07	5,94	6,58	6,30	5,84	4,69	3,60	2,26	1,67
Torbalı	1,90	2,13	3,83	5,03	5,92	6,51	6,28	5,83	4,69	3,65	2,28	1,70
Kınık	1,73	2,05	3,65	4,87	5,88	6,39	6,10	5,63	4,48	3,38	2,09	1,50
Foça	1,74	2,11	3,71	4,96	5,90	6,48	6,23	5,67	4,56	3,49	2,18	1,57
Aliağa	1,78	2,10	3,70	4,90	5,88	6,42	6,24	5,67	4,52	3,44	2,11	1,54
Menemen	1,80	2,13	3,73	4,97	5,91	6,47	6,26	5,71	4,58	3,50	2,20	1,59
Çiğli	1,80	2,13	3,79	4,99	5,90	6,49	6,24	5,71	4,60	3,50	2,20	1,60
Karşıyaka	1,87	2,30	3,81	5,02	5,96	6,51	6,29	5,78	4,66	3,50	2,20	1,61
Konak	1,83	2,09	3,79	5,01	5,96	6,54	6,33	5,80	4,62	3,60	2,20	1,62
Güzelbahçe	1,62	2,07	3,78	5,02	5,94	6,54	6,31	5,80	4,63	3,60	2,20	1,61
Narlıdere	1,79	1,94	3,74	5,00	5,88	6,51	6,24	5,74	4,56	3,60	2,20	1,60
Kiraz	1,92	2,38	3,93	5,10	6,06	6,55	6,46	5,87	4,80	3,60	2,29	1,70
Tire	1,91	2,14	3,89	5,06	5,97	6,54	6,31	5,83	4,72	3,69	2,30	1,71
Beydağ	1,89	2,08	3,89	5,07	6,00	6,54	6,39	5,83	4,72	3,67	2,30	1,69
Bayındır	1,89	2,25	3,86	5,04	5,96	6,51	6,30	5,82	4,72	3,61	2,27	1,70
Buca	1,90	2,22	3,82	5,02	5,95	6,52	6,32	5,83	4,67	3,60	2,21	1,66
Balçova	1,80	1,99	3,76	5,00	5,90	6,50	6,24	5,76	4,58	3,60	2,20	1,60
Gaziemir	1,90	2,15	3,80	5,00	5,91	6,50	6,30	5,82	4,64	3,60	2,20	1,67

Table 15 DISTRICTS OF IZMIR / RADIATION KWH/M2 PER DAY / MONTHS

Yerleşim Yeri	Ocak	Şubat	Mart	Nisan	May.	Haz.	Tem.	Ağus.	Eylül	Ek.	Kas.	Ar.
İzmir İli genel ortalama	4,86	5,86	6,96	8,03	9,77	11,89	12,20	11,48	9,67	7,61	5,55	4,21
Bornova	4,84	5,89	7,03	8,06	9,77	11,97	12,26	11,57	9,65	7,70	5,59	4,26
Urla	4,97	6,13	7,32	8,36	10,09	12,11	12,31	11,58	10,07	7,84	5,75	4,53
Ödemiş	4,96	5,78	6,85	7,89	9,60	11,68	12,06	11,41	9,63	7,51	5,52	4,20
Bergama	4,59	5,62	6,58	7,78	9,63	11,73	12,01	11,27	9,31	7,34	5,27	4,07
Çeşme	4,92	6,21	7,39	8,50	10,26	12,22	12,34	11,60	10,25	8,04	5,74	4,61
Dikili	4,80	5,75	6,89	8,04	9,74	11,89	12,15	11,40	9,47	7,45	5,38	4,19
Karaburun	4,86	6,04	7,27	8,29	10,05	12,06	12,21	11,50	10,01	7,76	5,60	4,47
Selçuk	5,03	6,08	7,17	8,21	9,85	12,01	12,31	11,64	9,90	7,88	5,83	4,46
Kemalpaşa	4,74	5,77	6,92	7,95	9,71	11,86	12,10	11,41	9,61	7,56	5,52	4,15
Seferihisar	5,07	6,11	7,29	8,31	10,06	12,08	12,37	11,63	9,98	7,85	5,82	4,55
Torbalı	4,97	6,01	7,12	8,15	9,79	12,03	12,35	11,65	9,82	7,77	5,71	4,36
Kınık	4,48	5,59	6,51	7,70	9,57	11,73	12,09	11,33	9,26	7,31	5,27	3,98
Foça	4,90	5,95	7,16	8,20	9,87	12,06	12,32	11,59	9,75	7,67	5,59	4,36
Aliağa	4,84	5,84	7,00	8,07	9,76	11,99	12,29	11,55	9,57	7,59	5,50	4,22
Menemen	4,87	5,91	7,08	8,11	9,80	12,02	12,34	11,58	9,67	7,67	5,59	4,28
Çiğli	4,98	5,99	7,17	8,19	9,88	12,07	12,38	11,60	9,80	7,78	5,69	4,39
Karşıyaka	4,89	5,91	7,05	8,06	9,75	11,94	12,26	11,56	9,65	7,70	5,61	4,29
Konak	4,99	5,97	7,16	8,19	10,04	12,06	12,42	11,66	9,83	7,76	5,69	4,40
Güzelbahçe	5,01	6,03	7,25	8,27	10,05	12,08	12,37	11,62	9,91	7,78	5,72	4,44
Narlıdere	4,94	5,92	7,15	8,17	10,00	12,04	12,38	11,63	9,79	7,71	5,63	4,33
Kiraz	4,98	5,69	6,82	7,82	9,54	11,46	11,89	11,27	9,58	7,39	5,45	4,18
Tire	4,98	5,92	6,98	8,04	9,74	11,92	12,27	11,57	9,75	7,67	5,63	4,28
Beydağ	4,99	5,71	6,84	7,90	9,64	11,66	12,07	11,39	9,65	7,45	5,47	4,13
Bayındır	4,86	5,88	6,94	7,96	9,65	11,83	12,19	11,53	9,68	7,60	5,61	4,25
Buca	4,94	5,96	7,07	8,09	9,83	11,99	12,32	11,61	9,71	7,76	5,68	4,36
Balçova	4,99	5,97	7,15	8,19	10,01	12,09	12,44	11,68	9,79	7,77	5,68	4,38
Gaziemir	5,01	6,03	7,17	8,20	10,00	12,02	12,40	11,69	9,81	7,81	5,75	4,44

Table 16 SUNSHINE HOURS PER DAY / MONTHS

KARSIYAKA s values are almost identical to Izmır ;

1580 KWH/m2 per year is observed 8 hours is Sunshine hour per day

SUGGESTED ANGLE CALCULATIONS

VERY ROUGHLY FOR IZMIR :

a- OPTIMUM PER ANNUM : β = 0.9 x latitude

b- 7 months of Winter : β = latitude + 15°

c- 3 coldest month of Winter : β = latitude + 25°

d- optimum for Summer : β = latitude – 25o

Efficiency of Modules are generally between 12%-14%

For PV panels , optimum angle is 30° for summers, 45° for springs.

To mention, wrong-oriented panels cost a %2 loss in energy production.

Electric energy that can be produced by 1 m2 panel per year is calculated by using the following relation:

Average Annual Insolation x Efficiency of the Module x Efficiency of other components of the PV system = Average electricity that can be produced per year

Width of the panel : 1m

Heigh of the panel : 1.6 m

Area of the panel : 1.6m

Panel efficiency : 14%

Annual Insolatıon: 1580 KWH/m2

Number of panels: considering the roof of the opera house – 100 panels.

Energy produced by 1 : 1580 x 16 x 85 = 214,88 kwh/m2/year

Energy produced : total area*energy produced = 1,6 x 100 x 214,88 = 34380 kwh /year

In oslo opera house , Solar Panels provide almost 20000kwh/year[1] scattered to a 300m2 area

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[1] Jackie Craven; *Oslo Opera House Guide* ; from architcture.about.com ; 2012

5.7 Geo-Thermal Energy

Izmir is very rich in natural energy sources especially geothermal and wind energy. Most of the districts are using geothermal energy as energy source. Luckily, 3 km away from project site there are couple of geothermal spots.

As Izmir Municipality declared in their annual plan, there will be a district network of Geothermal Energy in a year.

The hot water supplied form the district network which is at about 130 C° is pumped to the building after its temperature is reduced via a heat exchanger.

Figure 166 Kalkic Geothermal Energy Source

A renewable energy has some advantages.

• An energy resource nearly infinite, delivering heat and power 24 hours a day throughout the year, and available all over the world.

• Friendly for the environment : large reduction in $CO2$ emissions

• Very low visual impact, and most of the infrastructure can be hidden beneath the ground.

• Not noisy and pollution-free

A safe and controlled technology:

• Independent of climatic conditions

• Reliable and proven technically: drillings, heat pumps

• High-Efficient feedback from leading countries

To manage this source efficiently, there are some boundaries to be achieved :[1]

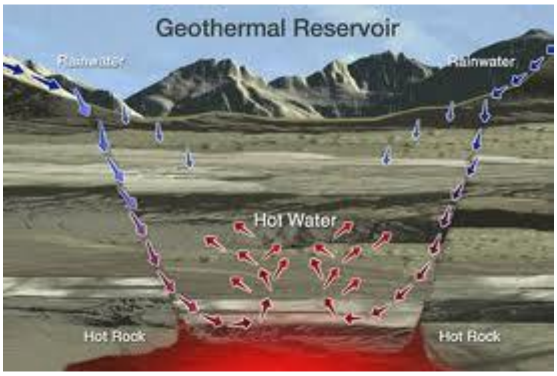


Figure 167 Geothermal Reservoir

• Minimization of energy requirements as much as possible

•Flow temperatures of 16 to 35°C for heating and cooling.

• Proportion of overall property size to building volume must be balanced in order to ascertain efficient use of both solar power and earth geothermal heat.

An energy adaptable with high performance:

• Is a solution to many type of needs.

• Can be modulated to according to size and needs

•Can be adopted anywhere

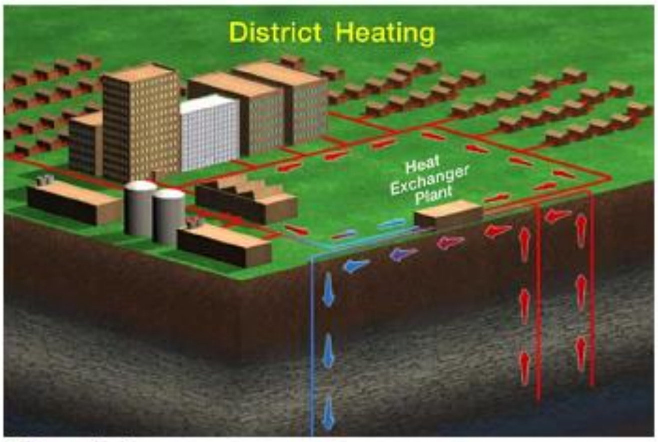


Figure 168 Distribution of Energy

An energy economically sustainable:

• induction of energy demand from 40 to 80%

• Independent of energy prices.

Geothermal energy is a very clean and environmentally responsible type of energy.

Figure 169 Heat Exchanger Mechanism

[1] Max Rutherford ; *How geothermal energy works* ;10th november 2009 ; from biofuelswatch.com

5.7.1 Heating

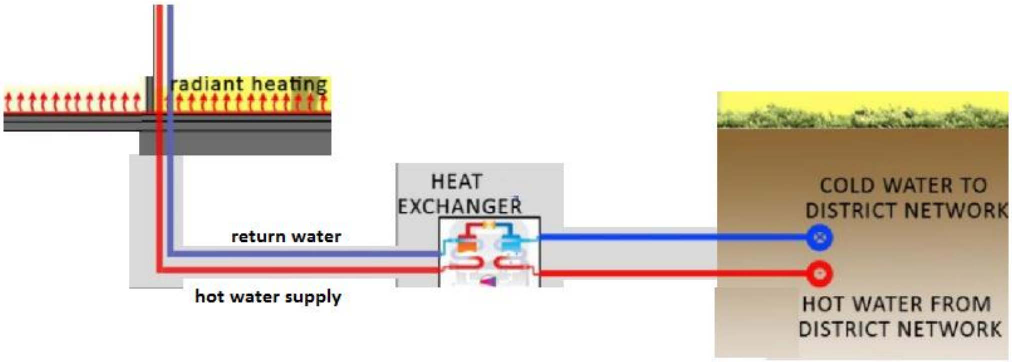


Figure 170 Winter Scheme

- Geothermal energy[1] is used for the heating of the building. In the neighborhood there is a district heating network will be available. The hot water supplied form the district network which is at about 130 C° is pumped to the building after its temperature is reduced to 40° via a heat exchanger.

- Spaces are heated by radiant floor heating system which circulates hot water coming from the heat exchanger.

-To reduce heat emission to the outside, an elevated insulation level also leads to increased thermal comfort.

-A great contribution to the environment is that heat supply is best adjusted to users demand. Individual building boilers are replaced by a heat exchanger three-way valve piping outfit, fuel supplies and operation/maintenance are optimized, all factors resulting in significant cost savings. Last but not least, it reduces greenhouse gas emissions and excess heat losses, thus securing upgraded environmental control.

5.7.2 Cooling

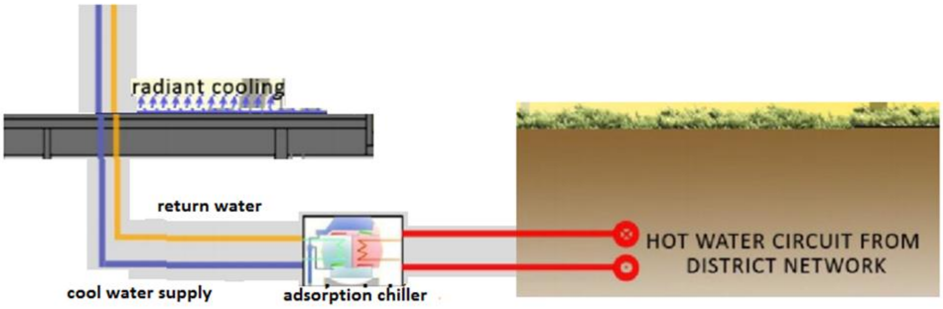


Figure 171 Cooling Scheme

[1] US Energy Information Administration ;from www.eia.gov ; 2012

Geothermal energy is used for cooling the building in summer. Hot water supplied from the district network provides energy for cooling.

- Rooms are cooled by radiant floor cooling system which circulates cool water coming from the adsorption chiller

5.7.3 Radiant Heating

Radiant heating systems involve supplying heat directly to the floor or to panels in the wall or ceiling of a house.

The systems depend largely on radiant heat transfer: the delivery of heat directly from the hot surface to the people and objects in the room via the radiation of heat, which is also called infrared radiation. Radiant heating is the effect you feel when you can feel the warmth of a hot stovetop element from across the room. When radiant heating is located in the floor, it is often called radiant floor heating or simply floor heating.

Hydronic Radiant Floors

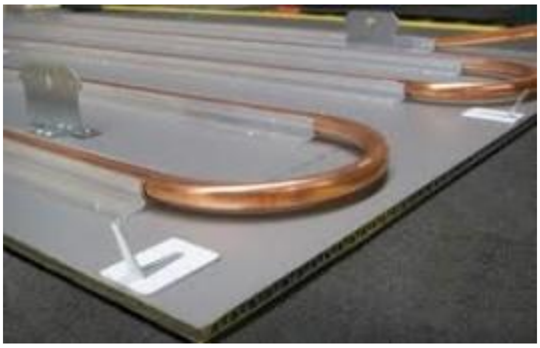


Figure 172 Radiant hydronic tubes

Hydronic (liquid) systems are the most popular and cost-effective radiant heating systems for heating-dominated climates. Hydronic radiant floor systems pump heated water from a boiler through tubing laid in a pattern underneath the floor.

In some systems, the temperature in each room is controlled by regulating the flow of hot water through each tubing loop. This is done by a system of zoning valves or pumps and thermostats. The cost of installing a hydronic radiant floor varies by location and also depends on the size of the home, the type of installation, the floor covering, remoteness of the site, and the cost of labor.

ADVANTAGES OF RADIANT HEATING SYSTEMS[1]

Radiant heating has a number of advantages:

-Ducts: it is more efficient than baseboard heating and usually more efficient than forced-air heating because no energy is lost through ducts.

-Allergy : The lack of moving air can also be advantageous to people with severe allergies.

-Electricity : Hydronic (liquid-based) systems use little electricity, a benefit for homes off the power grid or in areas with high electricity prices.

-Variety of heating :The hydronic systems can also be heated with a wide variety of energy sources, including standard gas- or oil-fired boilers, wood-fired boilers, solar water heaters, or some combination of these heat sources.

- Comfort: Radiant floor heating provides even, comfortable, warmth as there is less air movement with this type of system. There are no drafts with this type of heating, unless it is through the building envelope. The thermal mass (concrete floor) evens out the temperature fluctuations. The floor is warm to the touch.

- Energy-Efficiency: the warmest air is at the floor where it is desired (and not at the ceiling) and there is reduced heat loss through the ceiling and walls. Zoning a variety of rooms with the options for different temperatures has the potential to reduce energy consumption.

- Energy Source Compatibility: Since radiant floor heating has a low operating temperature, a wide range of sources can be used to heat the water–a ground-source heat pump, a condensing or non-condensing boiler, solar or even district heating.

- Quietness: The system is quiet because a properly-sized circulator pump, used to slowly move the water, is almost inaudible.

- Cleanliness: Unlike conventional forced-air furnaces, radiant floor heating has no ducts or radiators to contribute to dust collection or movement. For residents with allergies, the reduction in dust movement may be beneficial

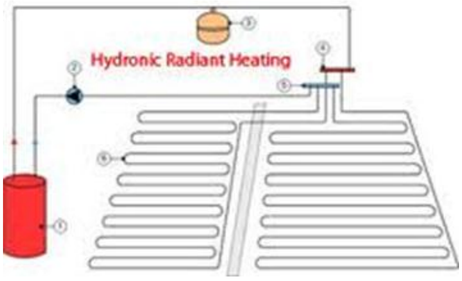
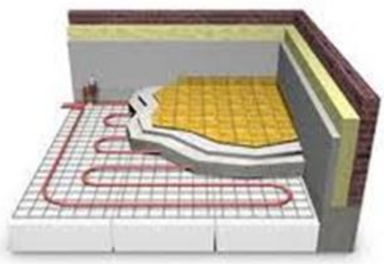


Figure 173 Examples of Radiant Floor Heating Systems



[1] Richard D. Watson ;Advantages of radiant heat; Fine Homebuilding June-July 1992

5.7.4 Infloor Radiant Design : Heat Loss To Average Fluid Temperature[1]

Heat loss influences everything in the design process

Step 1 - Heat Loss

Total loss : 36 kWh

Step 2 – Flux

36 KWh / 2 000 m2 = 18 W/m2 in an hour

Step 3 - Surface Temperature

One of the critical but simplest calculations to perform is the floor surface temperature. The floor can't be too hot (max 28o, ANSI/ASHRAE Standard 55-2004) or it will be uncomfortable and if it isn't warm enough it may not be able to transfer the Btu's. To calculate the surface temperature simply divide the flux by 2 and add the result to the desired operative temperature. The value of 2 is a 'heat transfer coefficient' or HTC and before continuing let's be very clear the value of 2 is for radiant heated floors and is a nominal number which means it's not exactly 2. It's a different number for walls and ceilings and it also changes for cooling.

18 /2 = 9

9+21 = 30

At 30 ˚C we will be able to transfer 18 W/m2 in an hour to keep the room at 21 ˚C.

Step 4 - Floor Coverings

Contrary to popular misunderstanding, the heat flux is not affected by floor coverings as long as the floor is not a highly polished mirror like surface. Carpet or concrete have for practical purpose identical abilities to emit radiant energy the only difference floor coverings have on the design is in the tube spacing and fluid temperature. The greater the sum of R values of the floor assembly above the tubes, the closer the tubes and or the hotter the fluid temperature must be. The hotter the fluid temperature the greater the back loss and thus the higher the insulation required below the tubes.

Step 5 – Spacing

The greater the tube density (closer the spacing), the lower the average fluid temperature - the higher the efficiency from a boiler, heat pump or solar system.

The less tube density the hotter the fluid temperature and the lower the heating plant efficiency

So if you want a poor performing heating plant and poor quality surface temperatures use the least amount of tube of the lowest quality in an inefficient place.

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[1] Robert Bean ; R.E.T., P.L.(Eng.),Radiant Panel Report ; 2006

To determine fluid temperature at your selected tube spacing, floor covering and heating flux use the Radiant Design Graph for Spacing & Fluid Temps.

Spacing = 8' *Average fluid temperature calculated more or less , 35 degrees.*

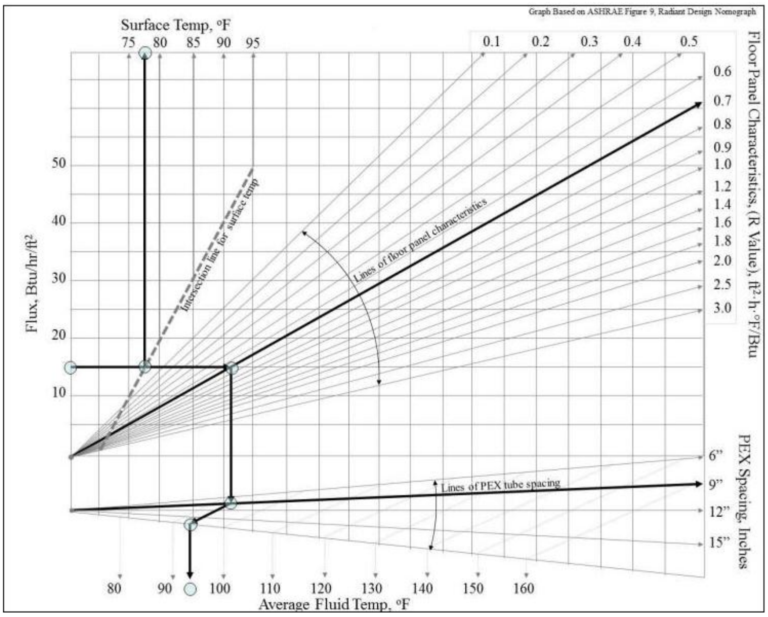

Figure 174 Radiant Design Graph for Spacing & Fluid Temps. SI System

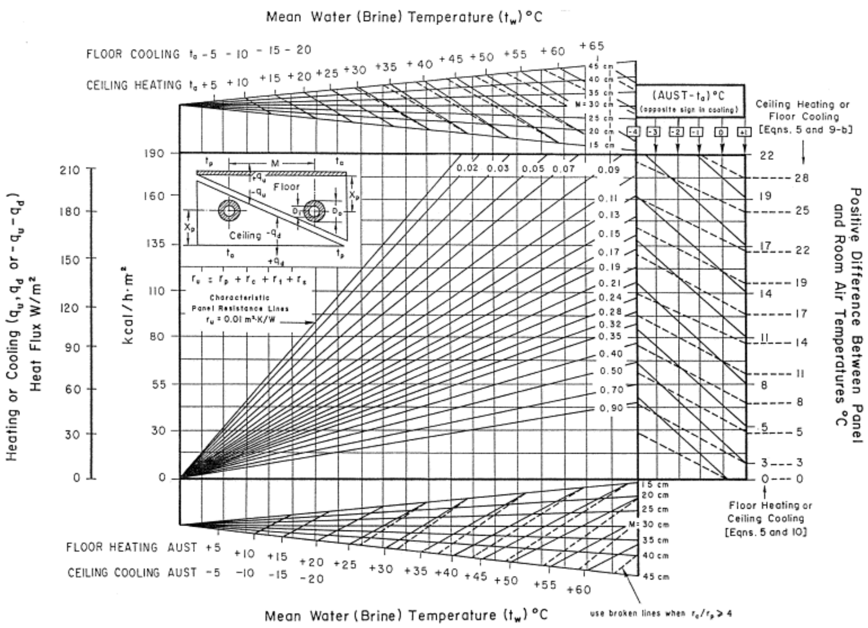

Figure 175 Radiant Design Graph for Spacing & Fluid Temps. Metric System

5.9 Water

• 29% of all the water consumed at homes is flushed out in the form of showers and hot baths.

• 1 quarter of all clean water is flushed in toilets.

• 5,500 litres of water is wasted from dripping taps a year.

• Dishwashers and washing machines use about 15% of the total water used per year.

• 25% of water is used outdoors in car washing, watering plants and other related activities.

• 1000 litres of water is wasted by sprinklers in gardens per hour.

• 19% of water is consumed in food preparation and other related tasks[1].

In order to fulfill the demands of consumption, the water from rainfall is collected in tanks and is purified to make it drinkable. These filtering and detoxifying methods require sufficient funding.

Because of the technological and financial resources needed to make water fit to drink, many economically challenged countries simply go without.

In addition, there has been a great change in the world weather and the rainfall patterns due to global warming. This phenomenon adds to the water scarcity issue in various parts of the world.

Human beings, not to mention animals and agriculture, are facing dire circumstances. Our active participation is needed to find solutions so that we can change these drastic circumstances.

5.9.1 Water Conservation & Solutions

PRODUCTS AVAILABLE THAT WILL HELP THAT CAUSE

Install aerators, flow regulators, flow restrictors, and pressure-limiting valves to your taps. These measures will minimize the flow of water considerably.

Water efficient taps. These taps turn off automatically when not in use.

Low flush toilets can reduce water consumption by 60% compared to less-efficient models. Switching out an old toilet that uses 3.5 gallons per flush to one that uses only 1.28 gallons could save $90 a year for a family of four. That would amount to $2,000 of savings over the toilet's lifetime.

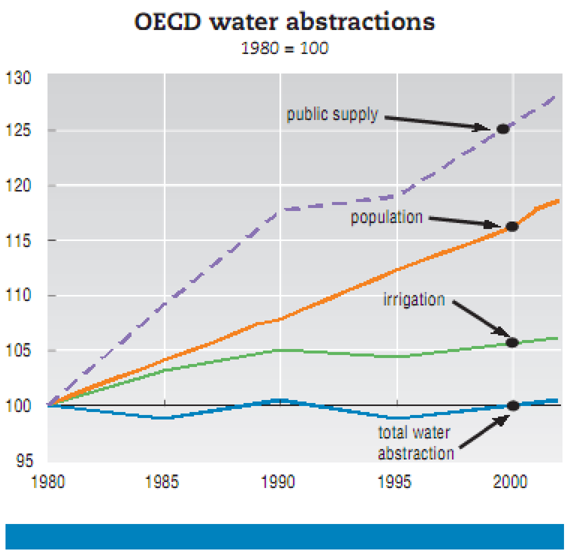

Figure 176 OECD Water Datas

[1] Turkish Water Directorate ; *Annual Report* ; 2011

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Figure 177 Installing a dual flush toilet-,Waterless urinals -Installing sensor-typed water elements

5.9.2 Rainwater Use

Rainwater is usually soft, which makes it a good option for watering your flowers and plants. Actually, the absence of those very chemicals that make tap water safe for drinking makes rainwater a better choice for your outdoor watering needs.

Green roof

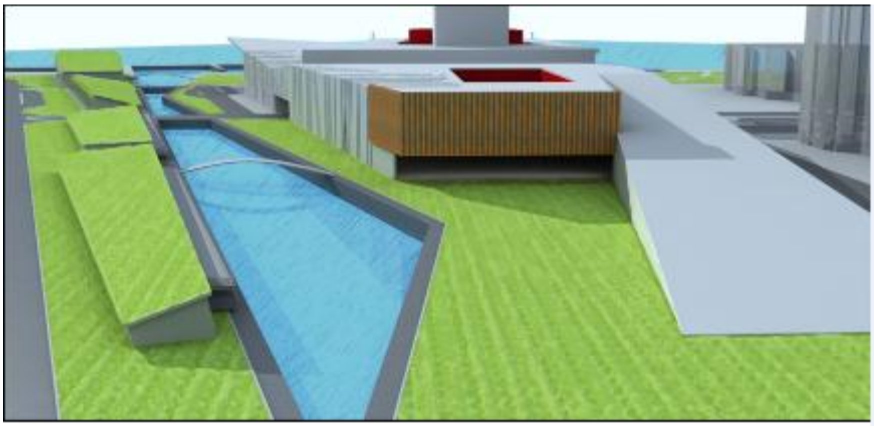

Figure 178 Green Roofs designed by us.

Green roof applications will be available on the roofs of resturant, yacht club,residence and hotel.

Reducing the demand for water helps protect the local ecology, too. Water that isn't being diverted into municipal water systems stays in the lakes and rivers to sustain fish, birds and other wildlife. Besides relaxing some of the demand on existing water resources, harvesting rainwater reduces the amount of polluted rainwater runoff. Dirty rainwater is often released from storm drains directly into lakes and streams, causing big problems for plants and animals. Imagine the chemical stew you see on the roadways, like oil and antifreeze, washing directly into your favorite brook or creek.

Green Roof & Advantages[1]

- It is free; the only cost is for collection and use.
- It lessens demand on the municipal water supply.
- It saves money on utility bills.
- It makes efficient use of a valuable resource.
- It diminishes flooding, erosion, and the flow to storm-water drains.
- It reduces the contamination of surface water with sediments, fertilizers and pesticides from rainwater run-off resulting in cleaner lakes, rivers, oceans and other receivers of storm-water.
- It is convenient in the sense that it provides water at the point of consumption and operating costs are negligible. Water collected from the roof catchment is available for use in non-potable applications such as toilets and urinal flushing, mechanical systems, custodial uses.

Since rainwater is collected using existing structures, i.e., the roof, rainwater harvesting has few negative environmental impacts compared to other water supply project

Figure 179 A very simple water tank application

In Izmir Opera House ,tower this type of water is processed into usable water, which is totally safe from a hygienic point of view but does not have the same quality as drinking water. It is used for toilet flushing, watering the green areas and cleaning purposes. This means, in effect, that drinking water is then being used twice and the total amount of used drinking water is decreased.

[1] Green Roofs for Healthy Cities ;www.greenroofs.org

5.10 Ventilation

There are four types of air-conditioning systems available which are:

1. All-air systems

2. Air-and-water systems

3. All-water systems

4. Unitary, refrigeration-based systems.

All-air systems

The general advantages of central systems (including all-air systems) include:

■ Major equipment is centrally located in dedicated service spaces, which allows maintenance to take place in unoccupied areas.

■ Major noise-generating equipment is centrally located in a space that can be acoustically isolated, allowing for reasonable noise control opportunities.

■ There is no condensate drain piping or HVAC power wiring in occupied areas (as opposed to unitary or fan-coil systems).

Among the specific advantages of all-air systems are:

■ Such systems are well suited to air-side economizer use, heat recovery, winter humidification, and large-volume outdoor air requirements.

■ They are the best choice for close control of zone temperature and humidity.

■ They are generally a good choice for applications where indoor air quality is a key concern.

■ They are amenable to use in smoke control systems.

■ There is simple seasonal changeover.

■ It is difficult to provide comfort in locations with low outdoor temperatures and typical building envelope performance when warm air is used for perimeter heating.

■ Providing ready maintenance accessibility to terminal devices requires close coordination between mechanical, architectural, and structural designers.

■ Such systems generally permit simultaneous heating and cooling in different zones.

Among the disadvantages of all-air systems are:

■ All-air systems use significant amounts of energy to move air (approximately 40% of all-air system energy use is fan energy).

■ Ductwork space requirements may add to building height.

■Air balancing may be difficult

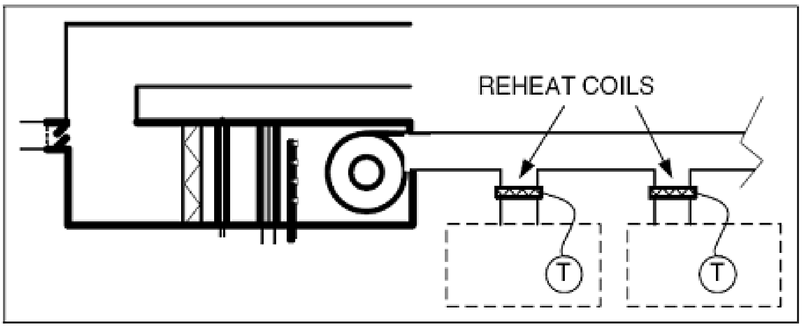

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Figure 180 Reheat system

5.10.1 Reheat System

A zone thermostat can then control the heater to maintain the desired zone setpoint temperature.

The air to each zone passes over a reheat coil before entering the zone.

A thermostat in the zone controls the reheat coil. If the requires full cooling, the thermostat will shut off the reheat coil.Then, as the cooling load drops, the thermostat will turn on the coil to maintain the zone temperature.

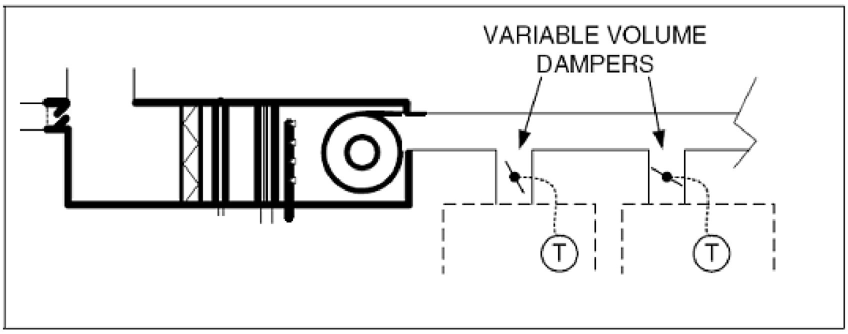

Figure 181 VAV system

5.10.2 Variable Air Volume System

They are more efficient than the reheat systems.

Again assume that the basic system provides air that is cool enough to satisfy all possible cooling loads

In zones that require only cooling, the duct to each zone can be fitted with a control damper that can be throttled to reduce airflow to maintain the desired temperature.

5.10.3 Underfloor Air Distribution[1]

Displacement Ventilation

Displacement ventilation can in principle be any airflow pattern where “old” air is displaced by “new” air. By Displacement Ventilation, as commonly used in ventilation, we understand the technique of letting warm contaminants rise to the ceiling, extract the contaminated air at ceiling level and supply fresh, cool air at floor level.

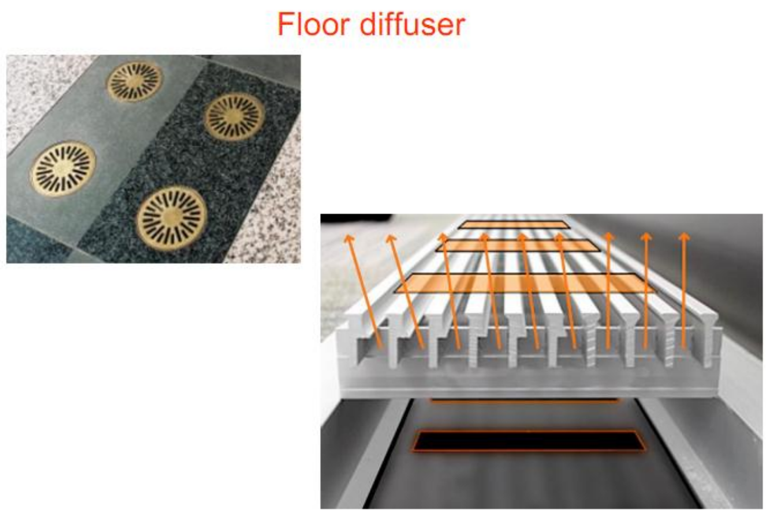

Figure 182 Floor Diffusers

Usually, we find that both mixing and displacement systems require about the same airflow rates, but displacement ventilation usually gives a better air quality for the same amount of ventilating air

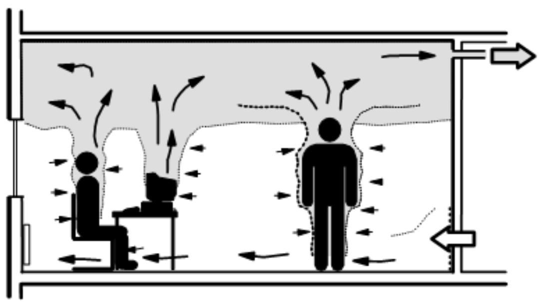

Figure 183 Better air quality with DV

The mechanism behind displacement ventilation is to supply as much air per person as is entrained in the convection flow around the person (or other convective sources).

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[1] Prof.Rapisarda Gıuseppe ; Ventilation ;All datas&graphs and informations are taken from Politecnico Di Milano Buildinf Services Design course notes ; section 3.10-3.11 of this paper; 2010

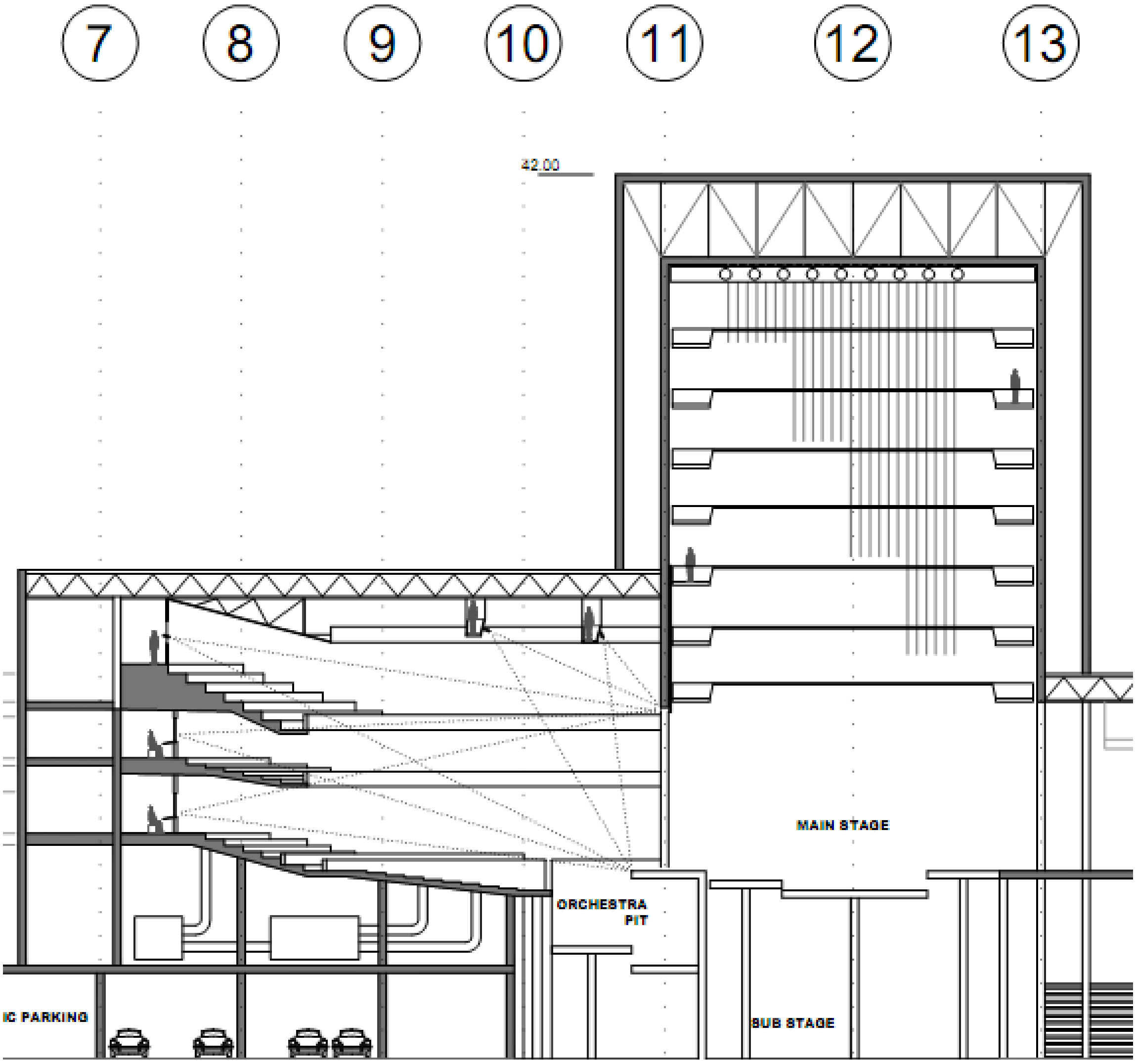
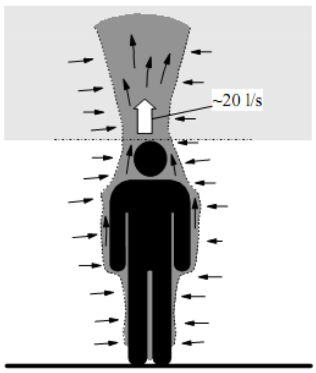


Figure 184 DV application in Izmir Opera House design

In this way the contaminated air is brought up into the layer above people.



The total ventilation rate should equal the sum of the airflow rate s in the plumes above the people and other convective sources in the room.

Then we might get an airflow pattern as shown to the left in the figure below, with contaminated air stratifying above the head of the people in the room.

Figure 185 Contaminated air above the head

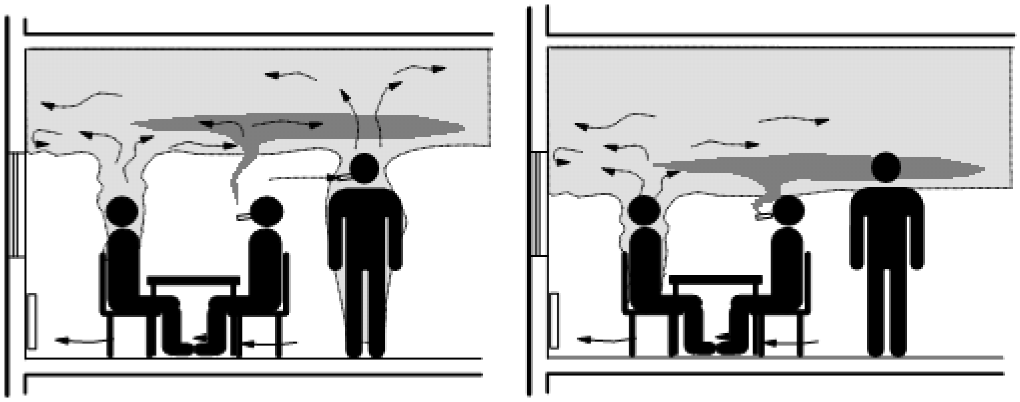


Figure 186 Smokers affect DV

Attention must be paid to the temperature close to the floor. In practice, this means that when the air is supplied with under-temperature, one has to choose a diffuser with the right amount of mixing between the room air and the supply air.

The air velocity near the diffuser may also create problems when induction rates are high.

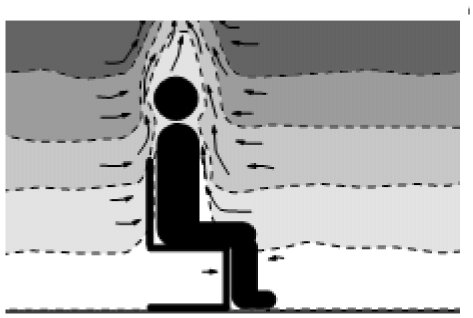


Figure 187 Rising airflow around a person

The rising airflow around a person brings fresh air up to the breathing sone.

The general rule for displacement ventilation is: "Don't heat the room by the ventilation air." So, how should we do it? Generally, there are three different means of room heating that are used together with displacement ventilation:

- Floor heating
- Radiant heating
- Convectors

Heating the room by warm air is generally avoided, but may be used as supplement for heating the room at the start of the working day, or for rapid heating after the room has been opened to the cold outside air. The means that the room may be heated by the ventilation air in cases where air quality or ventilation efficiency is not important.

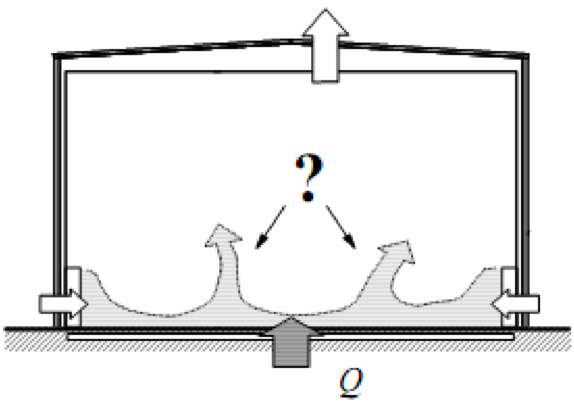


Figure 188 Too much floor heating

Too much floor heating may theoretically heat the supply air so much that the air ascends due to buoyancy, thereby destroying the displacement airflow pattern. In practice this does not occur for normal heat loads.

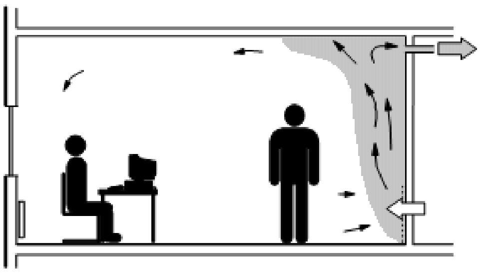


Figure 189 Fresh air-Short Circuit

If warm air is supplied at floor level in a cold room, the warm, fresh air will rise due to buoyancy, and be extracted when it reaches the ceiling. Thus, the fresh air will short circuit into the outlet openings and little of the fresh air will reach the occupied spaces.

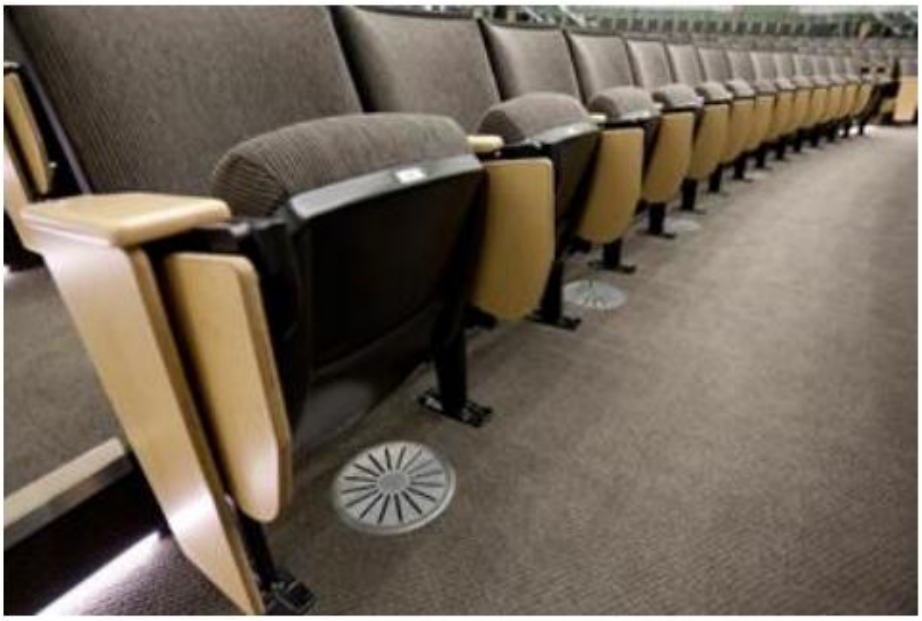


Figure 190 Underground Distribution

Theater or Auditorium

This is another open space that is well suited for DV. With stadium seating, air can be supplied from underneath the seats directly to the occupants. DV helps to meet the demanding acoustic requirements of theaters and performing arts centers.

Cooling Capacity Reduction and Demand Savings

With DV, warmer air is exhausted from the space. The warm return air exhausted to the outdoors is replaced by outside air. DV requires less energy to pre-cool the outside air to the return air temperature. As a result, the cooling load on the system is reduced. Another way to show the reduced cooling requirement is to look at the temperature drop across the cooling coil.

Improved Acoustic Performance

DV systems are quieter due to the low air velocities at the diffusers. Also, fans and cooling equipment are typically located remotely, isolated from the interior space. This makes these systems an excellent choice for noise-sensitive areas such as classrooms. When mechanical equipment is located close to interior space, the use of DV may prevent the need for other costly noise abatement measures.

	Overhead (Mixing)	Underfloor Air Distribution (Mixing/Displacement)	Lower Wall (Displacement)
Description	Diffusers located in the ceiling deliver 55°F air at velocity of 400–700 ft per minute (fpm). Objective is a well mixed airspace.	Diffusers mounted in the floor deliver 65°F air at about 100–200 fpm velocity. Air pattern causes some mixing in the occupied space, but a higher temperature near the ceiling.	Diffusers mounted near the floor level deliver 65°F air at less than 75 fpm velocity. Air flow causes a thermally stratified space and vertical air movement towards the return.
Supply conditions	Nominally 55°F in cooling.	Typically 60°F–64°F in cooling. Some temperature rise will occur in the underfloor plenum.	Typically 63°F–68°F air in cooling.
Architectural requirements	Space above ceiling for ductwork and ceiling diffusers.	Minimum ceiling height of 8–9 ft recommended. A raised access floor is used as an air plenum and for wiring and communications. Possibility to reduce floor-to-floor height slightly.	Minimum ceiling height of 9 ft is recommended. Higher ceilings are preferred. Diffusers may take up some wall space. Floor-to-floor height is not necessarily impacted.
Thermal comfort	Even temperatures throughout the space in cooling with proper design.	Good thermal comfort with proper airflow. Potential for individual temperature control.	Very good thermal comfort in cooling with proper design. Some potential for drafts near the diffusers.
Ventilation effectiveness	FAIR—Supply air mixes with room air to dilute contaminants.	GOOD—Better than overhead distribution, but some mixing occurs in the occupied zone.	VERY GOOD—Supply air is delivered directly to occupants, and contaminants are displaced to the upper unoccupied zone.
Acoustic performance	Diffusers can be a noise source if the air velocity is too high.	Quieter due to low air velocity.	Also quieter due to lower air velocity at the diffusers.
Applications	Any.	Offices or any space with open floor plans.	Schools, restaurants, theaters, atria, and other spaces with high ceilings.

Table 17 Application Datas of DV(SI System)

A displacement system is preferable for the following situations:

- the specific airflow rate per unit of floor area is high (as in lobbies, theatres, and conference rooms)
- high contaminant loads exist, as in industry and smoking areas
- the height of the space is more than 3 metres.

Figure 191 Auditorium under DV

A displacement ventilation system can be designed to fulfil requirements for sustainable and energy-efficient buildings that provide healthy and productive indoor climate conditions.

ROOM CONDITIONS AND SUPPLY UNIT

Room temperature	23..25 °C
Supply air temperature	16..21 °C (14 °C)
Typical pressure drop of units	10 ...40 Pa
Sound pressure level	< 25 ...40 dB(A)

Figure 192 Ranges of Supply vs Room Temperature

Figure 193 A closer look to a diffuser

A displacement system can realise excellent indoor climate conditions in terms of air quality and also thermal and acoustic conditions. The system operates excellently also when airflow rate is controlled according to the demand.

Application	Recommended minimum supply air temperature °C	Room air °C
Auditorium	21 ... 22	24
Lobby	18 ... 22	24
Atrium	18 ... 24	24
Classroom	20 ... 22	24
Industry	14 ... 18	24
Hot and humid conditions	16 ... 18	26

Figure 194 Recommended Supply Temp.

5.11 Ventilation & Acoustics Design

The acoustics and ventilation method allows the designer to explore ventilation and acoustics issues at an early design stage. Few input parameters are necessary, like the number of people the space must accommodate and the volume of air per person appropriate to the acoustic function.

Issue	Design input or output	symbol
1	Number of people to occupy space	n
2	Volume of air per person /m^3	Z
3	Volume of space /m^3	V
4	Floor area, assuming rectangular /m^2	A
5	Length, golden section /m	l
6	Width of space /m	w
7	Height of room /m	h
8	Total surface area in space /m^2	S
9	Additional chimney added to height /m	
10	Reverberation time /s	RT
11	Acoustic absorption due to people (0.56) /m^2	AP
12	Area-weighted absorption coefficient	α
13	Acoustic absorption due to fabric /m^2	a
14	Air change rate per hour	N
15	Stack effect pressure /Nm^{-2}	Δp
16	Air inlet (and outlet) grille area /m^2	G
17	Grille inlet (and outlet) area to floor area %	R

While allowing the comfort temperature to rise during occupation by some 10 to 15%, the natural ventilation and acoustics can be discussed via the volume of the space.

CALCULATIONS WILL BE MADE FOR BALLET REHEARSAL HALL

Approximately Rectangular show box type of rehearsal hall, for the sake of calculations.

5.11.1 Acoustics Design

ROW 1 – INPUT

The number of people to occupy the space, n. When thinking about the design of a space a fundamental parameter must be the number of people that the space must accommodate.

We choose : n = 40 people

ROW 2 – INPUT

The volume of air per person, Z m3 per person. For a space to work acoustically, the volume of air that each person has in the space must be chosen with care. Choral music is more acceptably reproduced in large volumes like cathedrals, while a law court, where speech intelligibility is paramount, requires a smaller volume. Egan[1] and Smith[2] have both reported optimum volumes of air per person for various spaces. Here, it is proposed that the following m^3 per person be used; for rooms for speech 2.5 to 3.5, for cinemas 3 to 4, for Italian style opera houses 4 to 5, for churches where speech is important 5 to 9, for churches where music is important 6 to 10, for concert halls 8 to 12, and for multipurpose spaces 6 to 11 m3 per person.

We choose: Italian opera house $Z = 6m^3$ per person

ROW 3 – OUTPUT

The volume of space, V m3 . This row is simply the product of row 1 with row 2

$V = 40 X 7 = 280 m^3$

ROW 4 – OUTPUT

The floor area, assuming the space, A m^2. The floor area is the product of the number of people and the seat density adjusted for circulation and performing area.

The first assumption is the floor area occupied by each individual in the space.

If a occupation density of 0.65 m^2 per person is assumed, it is a simple matter to increase this figure by a factor of 1.15, or an increase of 15%, to allow for circulation and performing area

$A = 40 \times 0,65 \times 1.15 = 30m^2$

ROW 5 – OUTPUT

However,

for the purposes of this paper a simple geometry for the floor area is chosen, to calculate the room dimensions. Acousticians, like Sugden[3] , suggest that auditoria with a rectangular shoe box shape usually give the warmth and clarity required of a concert hall, while others pursue more exciting forms. Here a ratio of room length to width of 1.6180 has been chosen,

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[1] Egan, M. D. "Architectural Acoustics." McGraw-Hill, USA, 1988.
[2] Smith, B. J. "Environmental Physics : Acoustics.",1976.
[3] Sugden, D. "Back to the 'shoe-box'." Architects' Journal

which leads to a golden plan. A golden plan would be a rectangular floor "the sides of which are in the approximate ratio 3:5, or 8:5 is presumed to have the most pleasing proportions aesthetically speaking." Anon[1] however we choose 4 : 6 which is 1.5 , a close one to golden plan.

L = 15 m

ROW 6 - OUTPUT:

The width of space, w m.

W = 10 m

ROW 7 – OUTPUT

The height of space, h m. Given that the space is a rectangular shoe-box the ceiling height above the floor is the volume divided by the floor area. This height is important since the stack-effect, used to determine the ventilation rate, relies on the temperature difference across this height. To achieve ventilation it will be assumed that the cool air is at floor level, while the warm air is at ceiling height. In some spaces it may be appropriate to add some height to improve the stack-effect. This is achieved by adding a chimney.

H = V / A = 280 /30 = approximately 9 m.

ROW 8 - OUTPUT:

The total fabric surface area in the space, S m2

This row gives the total wall, floor and ceiling area in the rectangular box, and this area will be used later to calculate the acoustic absorption required in the space to achieve the optimum reverberation time.

300m2 = floor +ceiling

180 m2 + 270 m2 = 450 m2 = walls

S =Total = 750 m2.

[1] Anon "The Golden Section." The New Encyclopaedia Britannica, 2012

ROW 9 – OUTPUT

One major advantage in adding a chimney, or duct through which the air must flow to escape the main space, is that the walls of this duct may be lined with acoustically absorbing material. External ambient noise may be attenuated in the chimney, ensuring that suitable background noise
levels may be achieved.

Additional chimney height = 0

ROW10-OUTPUT

The optimum reverberation time in seconds, RT.

The Stephens and Bate [1] empirical expression for the optimum reverberation time in seconds at a frequency of 500 Hz

is,

$RT = r\,[\;0.0118\,(n\,Z)^{1/3} + 0.1070\;]$ sec

where the value of r depends upon the type of sound to be produced in the space. For speech r is taken as 4, for orchestral music 5 and r is 6 for choral and organ music. We will use r as 4 for human speech. Row 10 gives this optimum reverberation time at 500 Hz. Another run. Some form of speech reinforcement system would be required in this large space. This optimum reverberation time RT is quoted at a frequency of 500 Hz. At 125 Hz the RT should be increased by about 30%, while the RT at 4000 Hz should be decreased by about 20%, The magnitude of bass increase is often a matter of taste, while the decrease at high frequency can reflect the air absorption. For the example, the opera house has an optimum reverberation time shown as 1.11 seconds. It follows that the reverberation times at 125 and 4000 Hz should be 1.60 and 0.98 seconds respectively. Reverberation times must be treated with caution. The values were once thought to be the only measure of the acoustics of a space

r = 6 for choral

$RT = 6\,[0.00118\,(40 \times 6)\,)^{1/3} + 1.1070\,]$ sec

<u>RT = 1.15 sec</u>

[1] Stephens, R. W. B. and Bate, A. E. "Acoustics and Vibrational Physics." (Second edition), 1966.

ROW 11 – OUTPUT

The acoustic absorption due to the people present in the space, AP m2.

Before Beranek [1]the average human absorption at 500 Hz was taken as 0.46 m2 per person. However, this value is now regarded as an underestimate and, moreover, we now use the effective audience floor area together with an absorption coefficient of 0.8 in more sophisticated calculations for concert halls. To enable this simple calculation we will follow Beranek and take the average human absorption coefficient as 0.56 m^2 per person at 500 Hz. Row 11 gives the acoustic absorption provided by the people present in the space.

AP = 0.56 m^2

ROW 12 – OUTPUT

The area-weighted absorption coefficient α

.The Eyring [2]expression for reverberation time is used to assess the absorption necessary in the space. The total absorption has two components, (neglecting the air absorption), (i) the absorption by the fabric surfaces, and (ii), that due to the people. Eyring derived his expression for the reverberation time of a space assuming the acoustic energy was lost, or absorbed, when it was incident on a surface. The expression is,

$$RT = 0.16 V / [- S \log_e(1 - \alpha) + AP]$$

where S is the total surface area in the space, and AP is the total absorption provided by the people. This expression can be re-arranged to give a value of a. It would be simpler to use the Sabine expression, except that the Sabine expression is not valid if the value of a is greater than 0.2

$$1.15 = 0.16 \times 280 / [-750 \log_e (1-\alpha) + 0{,}56]$$

$$\alpha = 0.05$$

ROW 13 – OUTPUT

The acoustic absorption provided by the fabric in the space. This is calculated from the area-weighted acoustic absorption coefficient times the total surface area in the space, and suggests how the surfaces finishes in the space might be chosen in order to achieve the optimum reverberation times

A = 750 x 0,05 = 37,5 / m^2

1 Beranek, L. L. “Audience and chair absorption in large halls, II.” J Acoust. Soc. Amer , 1969.

2 Eyring, C. F. “Reverberation times in ‘dead’ rooms.” J Acoust. Soc. Amer., vol1, 1929

Floor materials	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
Carpet	0.01	0.02	0.06	0.15	0.25	0.45
Concrete (unpainted, rough finish)	0.01	0.02	0.04	0.06	0.08	0.1
Concrete (sealed or painted)	0.01	0.01	0.02	0.02	0.02	0.02
Marble or glazed tile	0.01	0.01	0.01	0.01	0.02	0.02
Vinyl tile or linoleum on concrete	0.02	0.03	0.03	0.03	0.03	0.02
Wood parquet on concrete	0.04	0.04	0.07	0.06	0.06	0.07
Wood flooring on joists	0.15	0.11	0.1	0.07	0.06	0.07

Seating materials	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
Benches (wooden, empty)	0.1	0.09	0.08	0.08	0.08	0.08
Benches (wooden, 2/3 occupied)	0.37	0.4	0.47	0.53	0.56	0.53
Benches (wooden, fully occupied)	0.5	0.56	0.66	0.76	0.8	0.76
Benches (cushioned seats and backs, empty)	0.32	0.4	0.42	0.44	0.43	0.48
Benches (cushioned seats and backs, 2/3 occupied)	0.44	0.56	0.65	0.72	0.72	0.67
Benches (cushioned seats and backs, fully occupied)	0.5	0.64	0.76	0.86	0.86	0.76
Theater seats (wood, empty)	0.03	0.04	0.05	0.07	0.08	0.08
Theater seats (wood, 2/3 occupied)	0.34	0.21	0.28	0.53	0.56	0.53
Theater seats (wood, fully occupied)	0.5	0.3	0.4	0.76	0.8	0.76
Seats (fabric-upholsterd, empty)	0.49	0.66	0.8	0.88	0.82	0.7
Seats (fabric-upholsterd, fully occupied)	0.6	0.74	0.88	0.96	0.93	0.85

Reflective wall materials	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
Brick (natural)	0.03	0.03	0.03	0.04	0.05	0.07
Brick (painted)	0.01	0.01	0.02	0.02	0.02	0.03
Concrete block (coarse)	0.36	0.44	0.31	0.29	0.39	0.25
Concrete block (painted)	0.1	0.05	0.06	0.07	0.09	0.08

Concrete (poured, rough finish, unpainted)	0.01	0.02	0.04	0.06	0.08	0.1
Doors (solid wood panels)	0.1	0.07	0.05	0.04	0.04	0.04
Glass (1/4" plate, large pane)	0.18	0.06	0.04	0.03	0.02	0.02
Glass (small pane)	0.04	0.04	0.03	0.03	0.02	0.02
Plasterboard (12mm (1/2") paneling on studs)	0.29	0.1	0.06	0.05	0.04	0.04
Plaster (gypsum or lime, on masonry)	0.01	0.02	0.02	0.03	0.04	0.05
Plaster (gypsum or lime, on wood lath)	0.14	0.1	0.06	0.05	0.04	0.04
Plywood (3mm(1/8") paneling over 31.7mm	0.15	0.25	0.12	0.08	0.08	0.08
Plywood (5mm(3/16") paneling over 50mm	0.38	0.24	0.17	0.1	0.08	0.05
Plywood (6mm(1/4") , airspace, light bracing)	0.3	0.25	0.15	0.1	0.1	0.1
Plywood (10mm(3/8"), airspace, light bracing)	0.28	0.22	0.17	0.09	0.1	0.11
Plywood (19mm(3/4") , airspace, light bracing)	0.2	0.18	0.15	0.12	0.1	0.1

Absorptive wall materials	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
Drapery (10 oz/yd2, 340 g/m2, flat against wall)	0.04	0.05	0.11	0.18	0.3	0.35
Drapery (14 oz/yd2, 476 g/m2, flat against wall)	0.05	0.07	0.13	0.22	0.32	0.35
Drapery (18 oz/yd2, 612 g/m2, flat against wall)	0.05	0.12	0.35	0.48	0.38	0.36
Drapery (14 oz/yd2, 476 g/m2, pleated 50%)	0.07	0.31	0.49	0.75	0.7	0.6
Drapery (18 oz/yd2, 612 g/m2, pleated 50%)	0.14	0.35	0.53	0.75	0.7	0.6
Fiberglass board (25mm(1") thick)	0.06	0.2	0.65	0.9	0.95	0.98
Fiberglass board (50mm(2") thick)	0.18	0.76	0.99	0.99	0.99	0.99
Fiberglass board (75mm(3") thick)	0.53	0.99	0.99	0.99	0.99	0.99
Fiberglass board (100mm(4") thick)	0.99	0.99	0.99	0.99	0.99	0.97
Open brick pattern over 75mm(3") fiberglass	0.4	0.65	0.85	0.75	0.65	0.6
Pageboard over 25mm(1") fiberglass board	0.08	0.32	0.99	0.76	0.34	0.12
Pageboard over 50mm(2") fiberglass board	0.26	0.97	0.99	0.66	0.34	0.14
Pageboard over 75mm(3") fiberglass board	0.49	0.99	0.99	0.69	0.37	0.15
Performated metal (over 50mmfiberglass)	0.25	0.64	0.99	0.97	0.88	0.92

Ceiling material	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
Plasterboard (12mm(in suspended ceiling grid)	0.15	0.11	0.04	0.04	0.07	0.08
Underlay in perforated metal panels (25mmbatts)	0.51	0.78	0.57	0.77	0.9	0.79
Metal deck (perforated channels,25mm(1") batts)	0.19	0.69	0.99	0.88	0.52	0.27
Metal deck (perforated channels, 75mm(3") batts)	0.73	0.99	0.99	0.89	0.52	0.31
Plaster (gypsum or lime, on masonary)	0.01	0.02	0.02	0.03	0.04	0.05
Plaster (gypsum, rough finish or timber lath)	0.14	0.1	0.06	0.05	0.04	0.04
Sprayed cellulose fiber (75mm on solid backing)	0.7	0.95	1	0.85	0.85	0.9
wood tongue-and-groove roof decking	0.24	0.19	0.14	0.08	0.13	0.1

OUR DESIGN RESULTS

150 m2 ceiling plaster board rough finish

150 m2 floor wooden parquet

450 m2 walls fiberglass board

Figure 195 Fiberglass acoustic board above ;Wooden Parquet below,Plaster board on the right

5.11.2 Ventilation Design

ROW 14 – OUTPUT

The air-change rate per hour, N per hour.

The incidental heat gains from the occupants, equipment and lighting causes the air temperature to rise

Each person in the space will be generating heat at a constant rate W Watts, or 3600W Joules per hour, and the heat will be lost by the ventilation.

Suppose the ventilation rate provides N air-changes per hour, then we can write a differential equation for the rate of change of temperature as the heat gain and heat loss rates compete.

It will be assumed that the thermal exchange takes place continuously and that the fabric of the space is, therefore, not heated in the process. In other words, it will be assumed that the heat given to the air is removed via the ventilation

$$1200\, n\, Z\ (d\theta / dt) = n\ W\ 3600 - 1200\, N\, n\, Z\, (\theta - \theta_e).$$

The volumetric heat capacity of air is taken as 1200 J/m3 degC, since this magnitude divides simply by the number of seconds in one hour.

This expression shows that the result is independent of the number of people in the audience, and note that it is per hour

$$d\theta / dt = (3\ W/Z + N\, \theta_e) - N\, \theta$$

A state of equilibrium will be reached after a time.

$$N = 3\ W / Z(\theta_f - \theta_e)$$

the final temperature in the auditorium is the initial temperature plus some rise , or $\theta f = \theta s + \theta r$,;

$$N = 3\ W / Z(\theta_s + \theta_r - \theta_e)$$

N = 3 x 85 / 6 (20 +3 – 16)

N = 6,07 air change rate.

N x V = 6,07 x 280 / 3600 = 0,5 m^3/s air volume flow rate

This recognises the difference between sensible and latent heats, and is a simple way of allowing the effective temperature in the space to rise by 3 C, but allowing only 1.5 C to be the sensible rise in air temperature to drive the stack effect. Once the air-change rate N is obtained, then the volume of air required per second can be determined, and if an assumption about the pressure difference driving this air-change is made then the cross-sectional area of the ventilation inlet and outlets systems can be calculated

ROW 15 –AIR STACK EFFECT

The pressure difference giving the stack-effect, Δp Pa.

The stack effect pressure difference driving the air through a building comes about because of a temperature difference.

For the stack effect, which considers two columns of air, but at different temperatures, say

Ta > Tb K

$$\Delta p = 0.043\ h\ (\theta_b - \theta_a)$$

Δp = 0,35

Row 16. ***OUTPUT***:

The input - output ventilation grille area, G m^2

dQ/dt = 0.83 A (Δp) ^{½} m3 /sec is the quantity of the of air

$$G = 4.75\ 10^{-4}\ N\ n\ Z\ (\ \Delta p\ )^{-0.5}\ m^2$$

G = $4{,}75 \times 10^{-4} \times 1700 \times (0{,}35)^{-0{,}5}$

G = 1,3 m^2

Row 17- OUTPUT

The grille area to floor area ratio, R. A recent design guide by Penz[1] has suggested that the area of fresh air intakes to a naturally ventilated law court should be 1% of the floor area, the outlets having an area 2% the floor area

1) Penz, F. "A design guide for naturally ventilated courtrooms." Cambridge Architectural Research Ltd, Cambridge, 1990

5.12 Other Technologies

5.12.1 Photovoltaic Cells

The photovoltaic cells generate electricity directly from the solar energy, an important type of renewable energy source, without needing any intermediary device. The photovoltaic cells comprises of two layers of oppositely charge silicon slices joined together by wire. When the sunrays fall on silicon the electrons starts moving through the wire in natural manner thus generating the electricity. The amount of electricity generated by two silicon layers in the photovoltaic cells is very small and it can be used only for the small devices like calculator, watches, small light bulbs etc.

Figure 196 An example of Street Light PV

The photovoltaic arrays are used for powering lights and appliances at homes and offices. They are also used to supply electricity to the street lights, pumps, billboards. The solar photovoltaic arrays are an excellent source of supplying electricity to the remote places, places located away from the main power grids, far off villages, various site operations including construction and exploration, and much more.

The solar street lights work on the principle of the photovoltaic cell or solar cell. The solar cell converts solar energy to the electrical energy which is stored in the battery. The solar lamp draws the current from this battery and it requires no other wiring.

Working of Solar Street Lights

The solar street lights use solar energy, a form of the renewable energy. These days it is common to see the solar street lamps along the sides of roads. The solar street lights comprise of the photovoltaic cells, which absorb the solar energy during daytime. The photovoltaic cells convert solar energy into electrical energy, which is stored in the battery. At the nighttime the lamp starts automatically and it consumes the electricity already stored in the battery. During the day time the battery gets recharged and the process keeps on repeating every day.

Figure 197 Street Lights PV applications

5.12.2 Solar Tubes

Solar skylight tubes are an innovative and efficient alternative to traditional skylights. Unlike traditional skylights that are large panels allowing passive sunlight into your rooms, solar tubes capture light entering from any direction and utilize reflective tubes to diffuse the light evenly into a room. Solar light tubes are a superior alternative to traditional skylights.

Solar Skylight tubes are environmentally friendly as well as an efficient way to light an entire room. Tubular lights provide pure natural light while minimizing heat gain and loss because they are contained in a sealed system.

Figure 198 Solar tube applications on top,left and below

For the parts not lightened very well like basements solar tubes can be used.

5.12.3 Acoustics Design Advanced Technologies

Larger surfaces are 'broken up' with recesses to help reduce strong sound reflections on the walls and the ceiling there is a carefully designed array of tuned low frequency sound absorbers, sound scattering devices and broadband sound absorption.

Figure 199 first applied at Kopenhagen Opera House

Changıng formatıon of panels adopts easily to the performance depending on its type whether it's a concert or an opera.

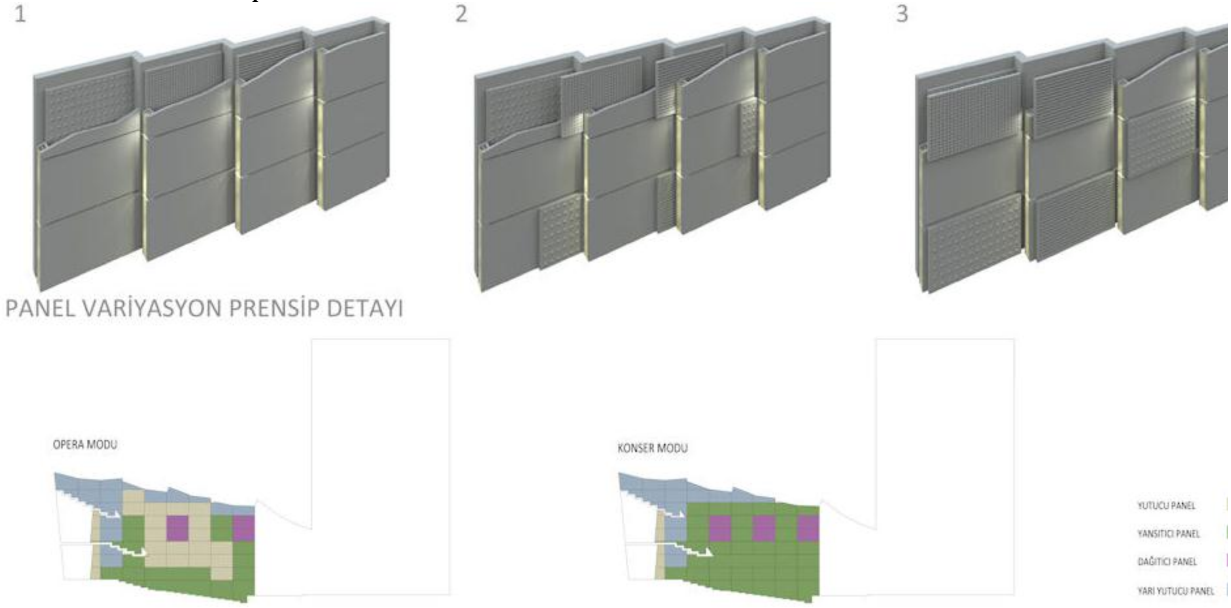

Figure 200 Adoptable Acoustic Panels.

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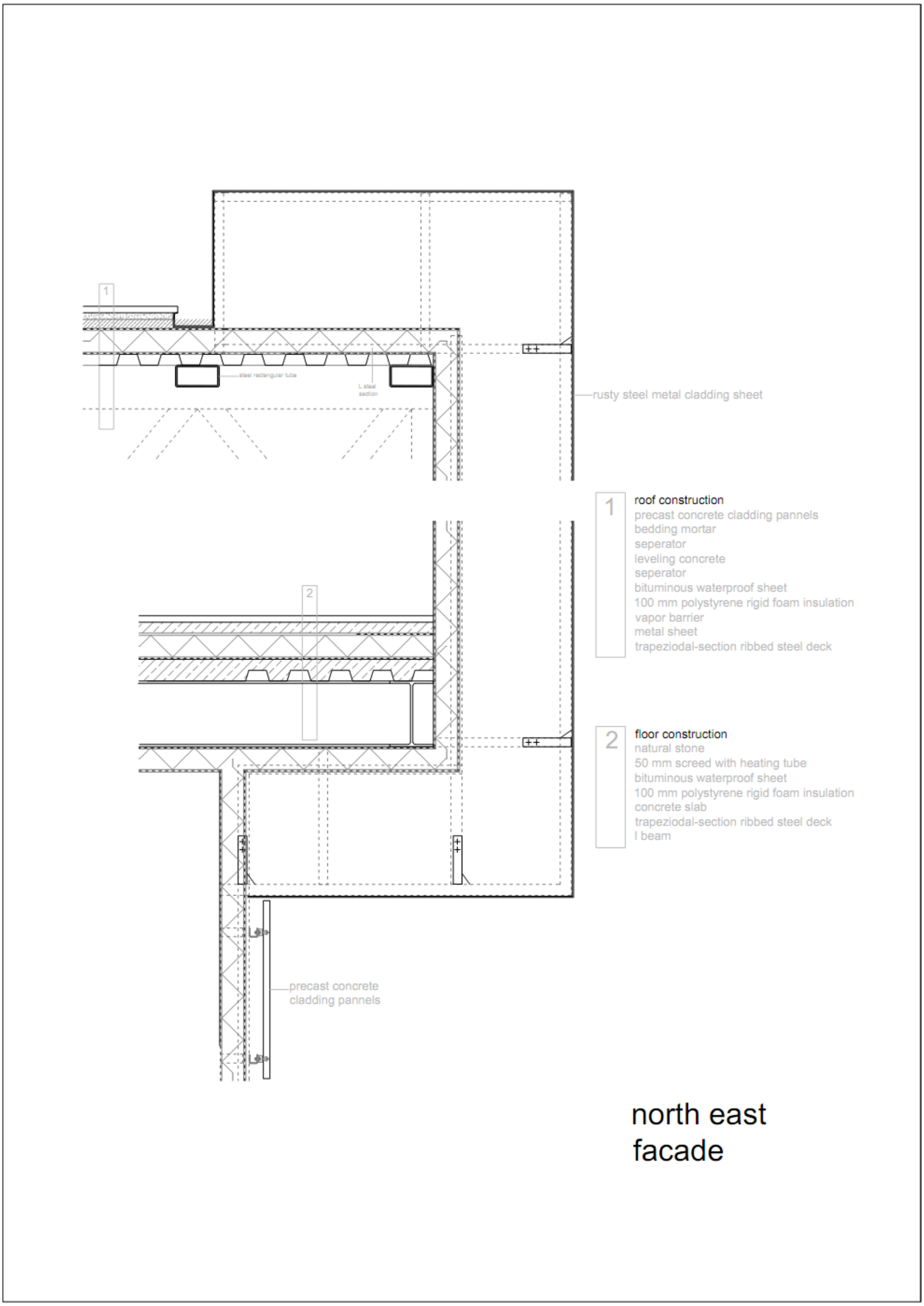
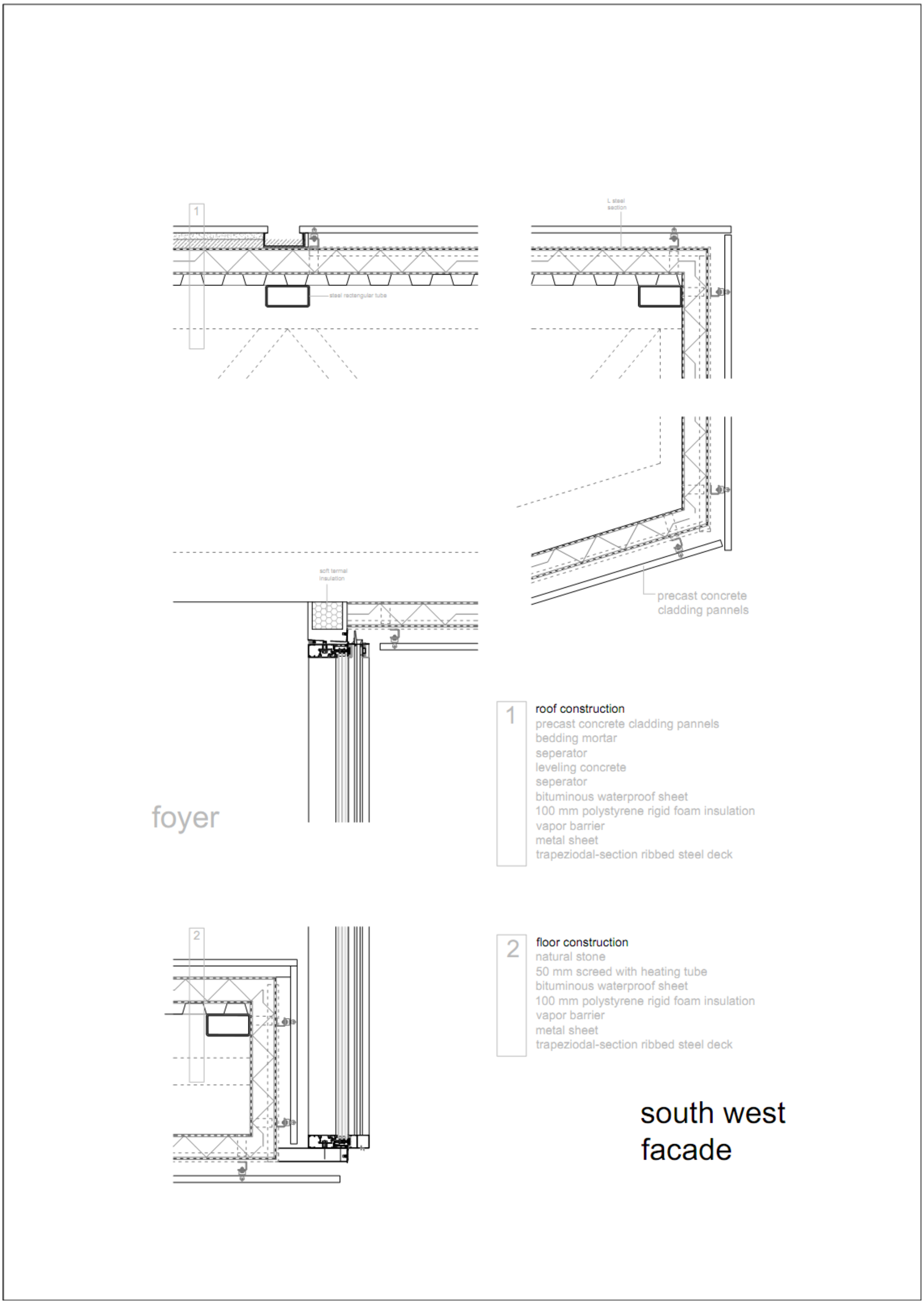
5.13

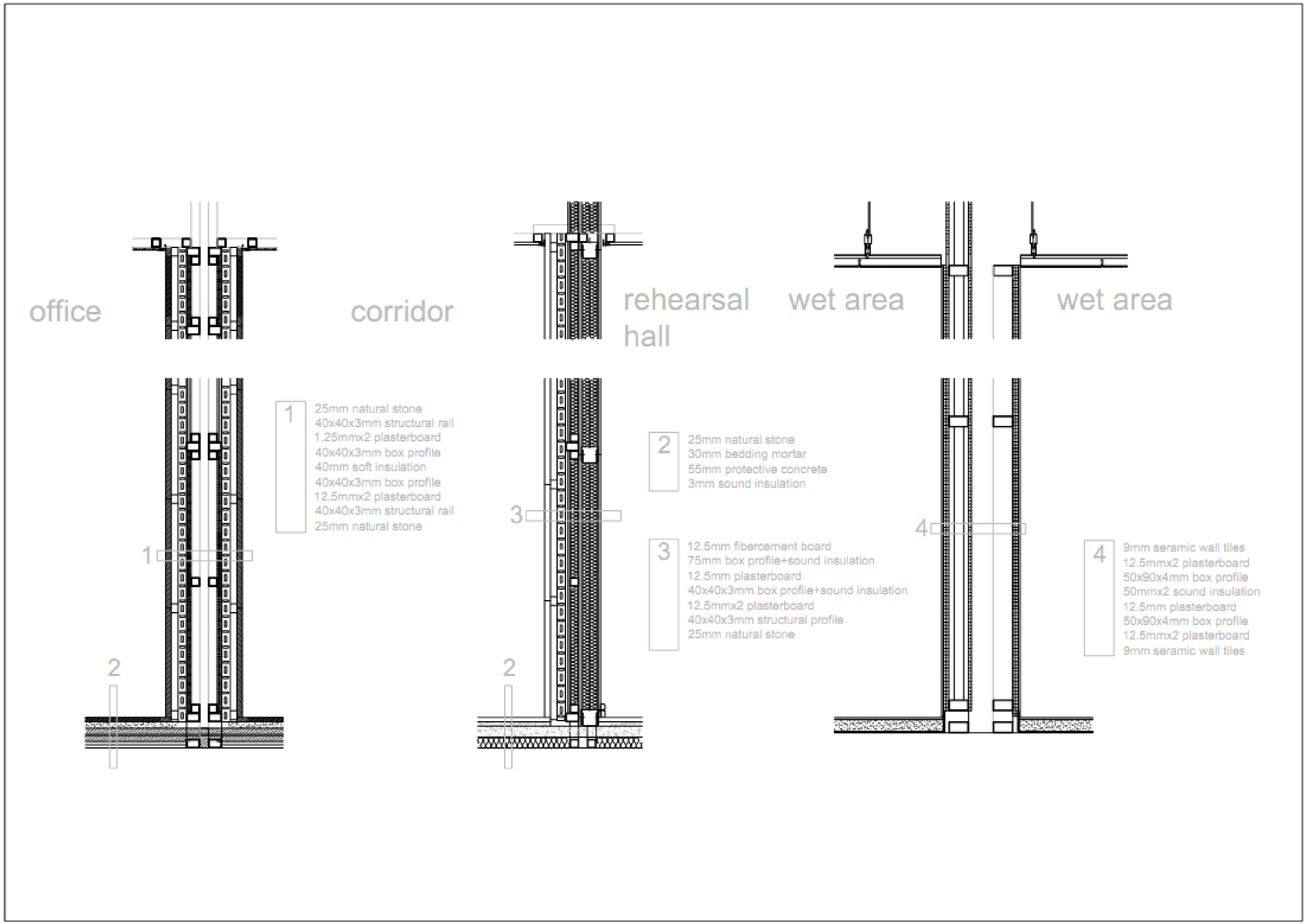
Details



Drawing 20 metal facade detail



Drawing21 facade+roof detail



Drawing 22 Dry Wall Detail

CHAPTER 6

STRUCTURAL DESIGN

6. STRUCTURAL DESIGN

6.1 Overview

The building is designed to meet both strength and serviceability requirements when subjected to lateral and gravity loads. We have divided it into three different volumes. We have also chosen the steel frame structural system as the main support element for our building. Steel was not economically made in the late nineteenth century. However, since then steel has become the predominate material for the construction of bridges, buildings, towers, and other structures. It exhibits desirable physical properties that make it one of the most versatile structural materials in use. Its great strength, uniformity, light weight, ease of use, and many other desirable properties make it the material of choice for numerous structures.

The many merits of steel can be summarized as follows:

- High Strength

This means that the weight of structure that made of steel will be small.

- Uniformity

Properties of steel do not change as oppose to concrete.

- Elasticity

Steel follows Hooke's Law very accurately.

- Ductility

A very desirable of property of steel in which steel can withstand extensive deformation without failure under high tensile stresses, i.e., it gives warning before failure takes place.

- Toughness

Steel has both strength and ductility.

- Additions to Existing Structures

New bays or even entire new wings can be added to existing frame buildings, and steel bridges may easily be widened.

Although steel has all this advantages as structural material, it also has many disadvantages that make reinforced concrete as a replacement for construction purposes. For example, steel columns sometimes cannot provide the necessary strength because of buckling, whereas R/C columns are generally sturdy and massive, i.e., no buckling problems occur.

The many demerits of steel can be summarized as follows:

- Maintenance Cost

Steel structures are susceptible to corrosion when exposed to air, water, and humidity. They must be painted periodically.

- Fireproofing Cost

Steel is incombustible material; however, its strength is reduced tremendously at high temperatures due to common fires

- Susceptibility to Buckling

For most structures, the use of steel columns is very economical because of their high strength-to-weight ratios. However, as the length and slenderness of a compressive column is increased, its danger of buckling increases.

- Fatigue

The strength of structural steel member can be reduced if this member is subjected to cyclic loading.

- Brittle Fracture

Under certain conditions steel may lose its ductility, and brittle fracture may occur at places of stress concentration. Fatigue type loadings and very low temperatures trigger the situation.

We used reinforced concrete for composite floor and footing system. For strength design, all standard load combinations were considered and members were designed to resist the ultimate factored loads. Because of the seismic load in Ankara, 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-column connections reduced beam section were used in the moment frame beams to ensure ductile failure by forcing plastic hinges to form at those locations.

6.2 Loading

All the analysis and estimations are done on the basis of Euro codes:

- Eurocode 0 (EN 1990): Basis of structural design
- Eurocode 1 (EN 1991): General actions on structures
- Eurocode 3 (EN 1993): Design of steel structures
- Eurocode 4 (EN 1994): Design of composite steel and concrete structures

- Dead Load calculations

No.	Layers	Thickness (m)	Specific weight (KN/m3)	Weight (KN/m2)
1	Natural Stone floor	0.020	9.80	0.20
2	Cement screed	0.040	22.00	0.88
3	Rigid insulation	0.045	0.30	0.01
4	Steel deck with concrete	0.100	23.55	2.36
5	Air gap	0.300	0.00	0.00
6	Plaster board	0.013	8.82	0.11
	Total			**3.55**

Table 18 Dead load: Intermediate floor slab

No.	Layers	Thickness (m)	Specific weight (KN/m3)	linear weight (KN/m)
1	Mortar andpaint baumit	0.01	9.80	0.392
2	Cement board	0.0125	8.82	0.441
3	Ventilated air gap	0.05	0.00	0.00
4	Polyfoam agriboard	0.075	0.29	0.087
5	Polyfoam agriboard	0.075	0.29	0.087
6	Soft insulation Knafu	0.1	0.31	0.124
7	Double plasterboard	0.025	8.82	0.882
8	Mortar and paint baumit	0.01	9.80	0.392
	Total			**2.405**

Table 19 Dead load: External wall

No.	Layers	Thickness (m)	Specific weight (KN/m3)	linear weight (KN/m)
1	Low E glass	0.006	25.270	0.531
2	gas cavity	0.014	0.000	0.000
3	Low E glass	0.006	25.270	0.531
	Total			**1.06**

Table 20 Dead load: Glass wall

No.	Layers	Thickness (m)	Specific weight (KN/m3)	linear weight (KN/m)
1	Mortar andpaint baumit	0.01	9.80	0.392
2	Double plasterboard	0.025	8.82	0.882
3	Acoustic Knafu Roll RD 10	0.1	0.09	0.036
4	Double plasterboard	0.025	8.82	0.882
5	Mortar andpaint baumit	0.01	9.80	0.392
	Total			**2.584**

Table 21 Dead load: Internal partition wall

- Live Load

According to EN1991-1-1: section 6, there are imposed loads to be considered for a wide variety of cases. For the opera house we used a variable load of 5 KN/m^2.

- Wind Load calculation

EN 1991-1-4 gives guidance on the determination of natural wind actions for the structural design of building and civil engineering works for each of the loaded areas under consideration.

Determination of the Basic Wind Velocity, Vb:

$$V_b = C_{dir} \cdot C_{season} \cdot V_{b,0}$$

Where;

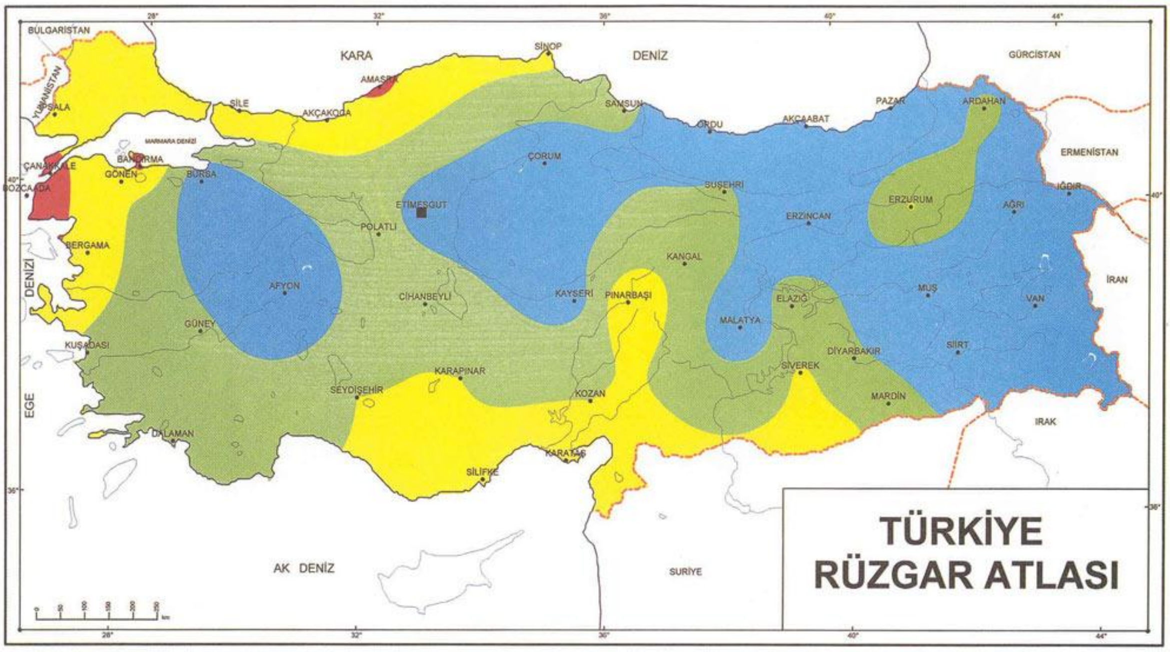
V_b is the basic wind velocity, defined as a function of wind direction and time of year at 10 m above ground of terrain category II

$V_{b,0}$ is the fundamental value of the basic wind velocity

C_{dir} is the directional factor

C_{season} is the season factor

NB: The value for C_{dir} and C_{season} recommended by EN 1991-1-4 is 1.



Beş farklı topoğrafik durum için yer seviyesinden 50 m yükseklikteki rüzgar potansiyelleri[1]										
	Kapalı Araziler[2]		Açık Araziler[3]		Kıyılar[4]		Açık Deniz[5]		Tepe ve Bayırlar[6]	
	ms^{-1}	Wm^{-2}	ms^{-1}	Wm^{-2}	ms^{-1}	Wm^{-2}	ms^{-1}	Wm^{-2}	ms^{-1}	Wm^{-2}
	> 6.0	> 250	> 7.5	> 500	> 8.5	> 700	> 9.0	> 800	> 11.5	> 1800
	5.0–6.0	150–250	6.5–7.5	300–500	7.0–8.5	400–700	8.0–9.0	600–800	10.0-11.5	1200–1800
	4.5–5.0	100–150	5.5–6.5	200–300	6.0–7.0	250–400	7.0–8.0	400–600	8.5-10.0	700–1200
	3.5–4.5	50–100	4.5–5.5	100–200	5.0–6.0	150–250	5.5–7.0	200–400	7.0-8.5	400–700
	< 3.5	< 50	< 4.5	< 100	< 5.0	< 150	< 5.5	< 200	< 7.0	< 400

1. Rüzgar potansiyeli, rüzgarın gücünü temsil etmektedir. Rüzgar türbini halihazırdaki potansiyelin % 20 ile % 30 luk bölümünü kullanabilir. Potansiyel hesaplamaları; deniz seviyesinde 1 Atm lik standart basınç ve 15 °C sıcaklığa karşılık gelen 1.23 kg/m³ hava yoğunluğuna göre yapılmıştır.
2. Yerleşim alanları, ormanlar ve rüzgar kırıcıların yoğun olduğu tarım alanları (pürüzlülük sınıfı 3)
3. Az sayıda rüzgar kırıcının olduğu açık araziler (pürüzlülük sınıfı 1). İç bölgelerde en fazla tercih edilen alanlar genellikle bu sınıfta bulunmaktadır.
4. Düzgün kıyı alanları ve çok az sayıda rüzgar kırıcı içeren kara yüzeyleri (pürüzlülük sınıfı 1). Eğer hakim rüzgar yönü deniz tarafından ve sürekli ise, potansiyel daha fazla olabilir. Tam tersi durumda ise potansiyel daha az olabilir.
5. Kıyılardan en az 10 km uzaklıktaki açık denizler (pürüzlülük sınıfı 0).
6. Bütün sınıflarda % 50 ye varan bir hız artışı görülmektedir ve bu sonuç 400 m yüksekliğinde ve 4 km çapındaki simetrik bir tepede yapılan hesaplamalarda elde edilmiştir. Rüzgar hızındaki artış; tepenin yüksekliğine, uzunluğuna ve yapısına bağlıdır.

Figure 201 Wind zone map of Turkey

Therefore the basic wind velocity is given by:

$V_b = C_{dir} \cdot C_{season} \cdot V_{b,0}$

$V_b = 1 \text{ x } 1 \text{ x } 15.6 \text{ m/s}$

$V_b = 15.6 \text{ m/s}$

Calculation of the Mean Wind Velocity, Vm (z):

$$Vm (z) = Cr (z) \cdot Co (z) \cdot Vb$$

Where;

Cr (z) is the roughness factor,

Co (z) is the orography factor, taken as 1.0 unless otherwise specified.

$$Cr (z) = kr \cdot \ln (Z / Z0) \qquad \text{for } Zmin < Z < Zmax$$

$$Cr (z) = Cr (Zmin) \qquad \text{for } Z < Zmin$$

Where;

Z0 is the roughness length

Kr is the terrain factor depending on the roughness length z0

$$Kr = 0.19 \cdot (Z0 / Z0, II)^{0.07}$$

Where;

Z0, II = 0.05 m (the value for terrain category II given in Table 4.1 of EN 1991-1-4)

Zmin is the minimum height defined in Table 4.1

Zmax is to be taken as 200 m, unless otherwise specified in the National Annex

Z0, Zmin depend on the terrain category, Table 4.1 of EN 1991-1-4 also provides the recommended values for Z0, Zmin depending on five representative terrain categories. Accordingly;

$$Z0 = 0.05m$$

$$Zmin = 2\ m$$

$$kr = 0.19 \cdot (0.05 / 0.05)^{0.07} = 0.036$$

Calculation of Wind Turbulence, Iv (z):

$$Iv(z) = Iv / vm(z) \qquad \text{for } zmin < z < zmax$$

$$Iv(z) = Iv(zmin) \qquad \text{for } z < zmin$$

Terrain category	z_0 (m)	z_{min} (m)
0 Sea or coastal area exposed to the open sea	0.003	1
I Lakes or flat and horizontal area with negligible vegetation and without obstacles	0.01	1
II Area with low vegetation such as grass and isolated obstacles(trees, buildings) with separations of at least 20 obstacle heights	0.05	2
III Area with regular cover of vegetation or building or with isolated obstacles with separations of maximum 20 obstacle heights(such as villages, suburban terrain, permanent forest)	0.3	5
IV Area in which at least 15% of the surface is covered with buildings and their average height exceeds 15m	1	10

Table 22 Peak Velocity Pressure, qp (z)

Where;

kr is the terrain factor calculated above,

v_b is the basic wind velocity calculated above,

k_l is the turbulence factor, which is recommended to be taken as 1,0 by EN 1991-1-4.

Calculation of Peak Velocity Pressure, q_p (z):

$$q_p (z) = [1 + 7 \cdot I_v (z)] \cdot ½ \cdot \rho \cdot v_m^2 (z)$$

Where;

ρ is the air density which depends on the altitude, temperature and barometric pressure to be expected in the region during wind storms. The recommended value is 1.25 kg/m³ in EN 1991-1-4.The building corresponds to the first case h ≤ b, so the peak velocity pressure, q_p (z) will be:

Floor	Height, Z (m)	$c_r(z)$	I_v (z)	v_m (z) , (m/s)	q_p (z) , (N/m²)
3 Floors	13	0.623	0.237	13.488	40.35

Table 23 Peak Velocity Pressure, qp (z)

Determination of Pressure Coefficient, c_{pe}

The external pressure coefficients c_{pe} for buildings and parts of buildings depend on the size of the loaded area A, which is the area of the structure that produces the wind action in the section to be calculated. The external pressure coefficients are given for loaded areas A of 1 m² and 10 m² in the tables for the appropriate building configurations as c_{pe1}, for local coefficients, and c_{pe10}, for overall coefficients, respectively.

Since the pressure coefficients for vertical walls and flat roof vary through the wall and roof surface, the calculation is made considering geometry of the structure, the aspect ratio (h/d) and wind direction.

$$C_{pe} = C_{pe,\,1} \quad , \quad \text{for } A \leq 1m2$$
$$C_{pe} = C_{pe,\,1} - (C_{pe,\,10} - C_{pe,\,1}) \log_{10} A \quad , \quad \text{for } 1<A<10m2$$
$$C_{pe} = C_{pe,\,10} \quad , \quad \text{for } A > 10m2$$

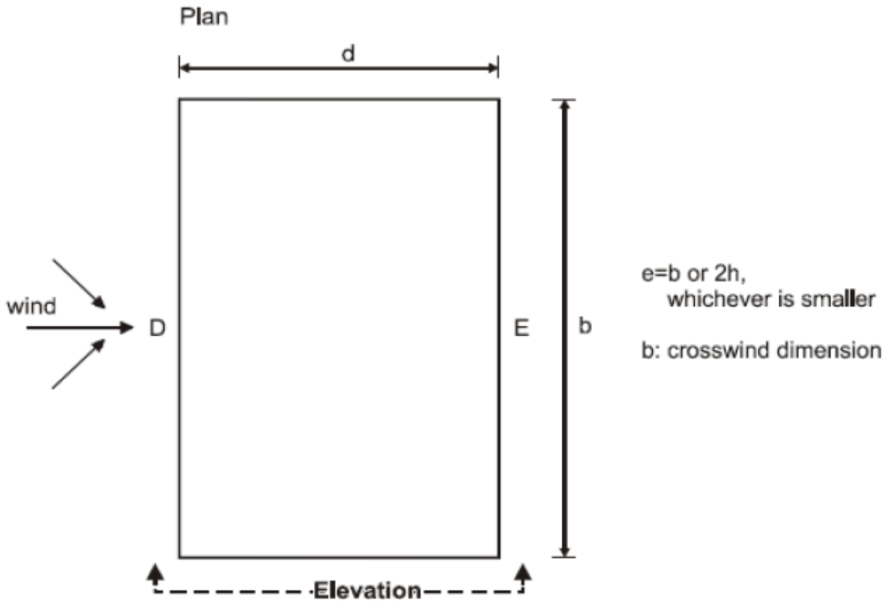


Figure 202 Pressure coefficient for vertical

Wall Source: EN 1991-1-4 Figure 7.5 - Key for Vertical walls

The area is greater A>10 m^2 in all the cases hence the wind pressure on the surfaces is calculated from the peak velocity pressure q_p (z), and external pressure coefficient to be used will be $C_{pe,10}$. Multiplying this coefficient by the characteristic peak velocity pressure (q_p) we obtain the external wind pressure we. Finally to obtain the wind force acting on the area is used the equation:

$$F_w = c_s c_d \cdot c_f \cdot q_p (z_e) \cdot A_{ref}$$

Where:

c_{scd}, structural factor, defined as 1.0 according to section 6.
$c_{f,}$ force coefficient for the element, defined as 1.0 according to section 7.
q_p(ze), characteristic peak velocity pressure at height ze, calculated before.
A_{ref}, reference area of the structural element.
By this we obtain all the forces that will be acting on the building, and are distributed on the elements for their analysis.

Zone	$C_{pe,10}$	q_p (z) , (N/m²)	Area (m²)	W_e (N/m²)	F (KN)
A	-1.20	40.35	24	-48.42	-2.020
B	-0.80	40.35	27	-32.28	-1.195
C	-0.50	40.35	18	-20.17	-1.122
D	0.80	40.35	28	-32.28	1.15
E	-0.50	40.35	20	-20.17	-1.010

Table 24 Wind forces on wall at 0°

Zone	$C_{pe,10}$	q_p (z) , (N/m²)	Area (m²)	W_e (N/m²)	F (KN)
A	-1.20	40.35	36	-48.2	-1.334
B	-0.80	40.35	32	-32.28	-1.101
D	0.80	40.35	32	32.28	1.101
E	-0.50	40.35	14	-20.17	-1.428

Table 25 Wind forces on wall at 90°

- Snow Load calculation

Loads of snow on the roof, according to Eurocode 1, can be determined with the following expression:

$$s = \mu i \; Ce \; Ct \; sk$$

s is the snow load on the cover;

μi is the coefficient of form of coverage;
sk is the characteristic value of snow load to the soil [kN/m2];
Ce is the coefficient of exposure, which generally has the value 1;
Ct is the temperature coefficient, which typically has the value 1.

The load acts vertically and is expressed on a horizontal projection of the roof. It is assumed that the building is located in zone 1. The characteristic value of the cargo snow on the ground from Table:

- Characteristic value of the load of snow on the ground.

Load sk [kN/m2]	Elevation A [m]
1.60	≤ 200
1.60 + 3 × (A - 200) / 1000	200 <A ≤ 750
3.25 + 8.5 × (A - 750) / 1000	A> 750

Table 26 Characteristic value of the load of snow

where the altitude reference A is the proportion of land above sea level at the site of construction of the building, in this case assumed 500 m.
we got, sk = 2.50 kN/m2
The coefficient of form μi roof derived from Table, where α indicates the angle that the cover forms, with the horizontal.
Coefficient of form

	Flap angle		
Coefficient of Form	0 ° <α ≤ 30 °	30 ° <α ≤ 60 °	α> 60 °
Mi	0.8	0.8 × (60 - α) / 30	0.0

Table 27 Coefficient of Form

The snow load on the coverage is equal to:

s = 0.80 × 1 × 1 × 2.50 = 2.0 kN/m2

- Seismic Load calculation

Identification of earthquake zone
The national territory has been divided into seismic zones, each marked by a different value of the parameter g, maximum horizontal acceleration on soil category C [EC8 - 3.1.2 (1)]. It is given that peak horizontal ground acceleration equal to: a_g = 0.10g

Classification of the type of subsoil
for the purposes of the definition of the seismic design, Euro code 8 defines several categories of stratographic profile of the soil foundation. The hearings on the ground, performed with measurement of shear wave velocity V_S30, define belonging to the category of soil type C (average deposits of sands and gravels thickened or clay of medium texture with thickness of several tens of meters), [EC8 -- 3.1.2]. The value of the parameter S is: S = 1.15.

Ground types A, B, C, D, and E, described by the stratigraphic profiles and parameters given in Table 3.1 and described hereafter, may be used to account for the influence of local ground conditions on the seismic action. This may also be done by additionally taking into account the influence of deep geology on the seismic action

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

Table 28 Recommended elastic response spectra

Table 3.1: Ground types

Ground type	Description of stratigraphic profile	Parameters		
		$v_{s,30}$ (m/s)	N_{SPT} (blows/30cm)	c_u (kPa)
A	Rock or other rock-like geological formation, including at most 5 m of weaker material at the surface.	> 800	_	_
B	Deposits of very dense sand, gravel, or very stiff clay, at least several tens of metres in thickness, characterised by a gradual increase of mechanical properties with depth.	360 – 800	> 50	> 250
C	Deep deposits of dense or medium-dense sand, gravel or stiff clay with thickness from several tens to many hundreds of metres.	180 – 360	15 - 50	70 - 250
D	Deposits of loose-to-medium cohesionless soil (with or without some soft cohesive layers), or of predominantly soft-to-firm cohesive soil.	< 180	< 15	< 70
E	A soil profile consisting of a surface alluvium layer with v_s values of type C or D and thickness varying between about 5 m and 20 m, underlain by stiffer material with v_s > 800 m/s.			
S_1	Deposits consisting, or containing a layer at least 10 m thick, of soft clays/silts with a high plasticity index (PI > 40) and high water content	< 100 (indicative)	_	10 - 20
S_2	Deposits of liquefiable soils, of sensitive clays, or any other soil profile not included in types A – E or S_1			

Table 29 Ground types

Elastic response spectra

The motion due to a seismic event at a given point on the surface of the soil can be represented by an elastic response spectra of acceleration of the ground. Action seismic horizontal is described by two orthogonal components considered independent between them, but represented with the same elastic response spectra. The elastic response spectrum consists of a spectral form considered independent the level of seismic activity, multiplied by the maximum value at the ground that characterizes the site $a_g \cdot S$.

If the elastic response spectra (T) is characterized by the following expressions

$$0 \leq T \leq T_B : S_e(T) = a_g \cdot S \cdot \left[1 + \frac{T}{T_B} \cdot (\eta \cdot 2{,}5 - 1) \right]$$

$$T_B \leq T \leq T_C : S_e(T) = a_g \cdot S \cdot \eta \cdot 2{,}5$$

$$T_C \leq T \leq T_D : S_e(T) = a_g \cdot S \cdot \eta \cdot 2{,}5 \left[\frac{T_C}{T} \right]$$

$$T_D \leq T \leq 4\text{s} : S_e(T) = a_g \cdot S \cdot \eta \cdot 2{,}5 \left[\frac{T_C T_D}{T^2} \right]$$

- $Se(T)$ is the elastic response spectrum;
- T is the vibration period of a linear single-degree-of-freedom system;
- ag is the design ground acceleration on type A ground ($ag = \gamma_I . agR$);
- T_B is the lower limit of the period of the constant spectral acceleration branch;
- T_C is the upper limit of the period of the constant spectral acceleration branch;
- T_D is the value defining the beginning of the constant displacement response range of the spectrum;
- S is the soil factor;
- η is the damping correction factor with a reference value of $\eta = 1$ for 5% viscous damping
- For important structures (>1,0) topographic amplification effects should be taken into account

Buildings are classified in 4 importance classes, depending on the consequences of collapse for human life, on their importance for public safety and civil protection in the immediate post-earthquake period, and on the social and economic consequences of collapse. The importance classes are characterised by different importance factors as described in EN-1998 2.1(3).

Table 4.3 Importance classes for buildings

Importance class	Buildings
I	Buildings of minor importance for public safety, e.g. agricultural buildings, etc.
II	Ordinary buildings, not belonging in the other categories.
III	Buildings whose seismic resistance is of importance in view of the consequences associated with a collapse, e.g. schools, assembly halls, cultural institutions etc.
IV	Buildings whose integrity during earthquakes is of vital importance for civil protection, e.g. hospitals, fire stations, power plants, etc.

Table 30 Importance class for buildings

The value of γI for importance class II shall be, by definition, equal to 1,0.

Assume a soil type C, we have S = 1.15, T_B = 0.2 s, T_C = 0.6 s, T_D = 2 s.

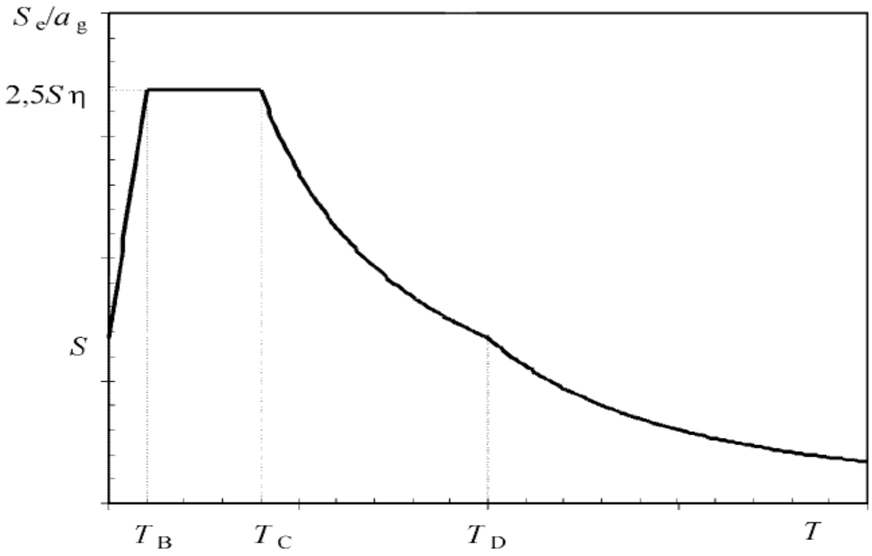


Figure 203 Shape of the elastic response spectrum

Design spectrum for elastic analysis

The capacity of structural systems to resist seismic actions in the non-linear range generally permits their design for resistance to seismic forces smaller than those corresponding to a linear elastic response.
To avoid explicit inelastic structural analysis in design, the capacity of the structure to dissipate energy, through mainly ductile behavior of its elements and/or other mechanisms, is taken into account by performing an elastic analysis based on a response spectrum reduced with respect to the elastic one, henceforth called a ''design spectrum''. This reduction is accomplished by introducing the behavior factor *q*.

The behavior factor *q* is an approximation of the ratio of the seismic forces that the structure would experience if its response was completely elastic with 5% viscous damping, to the seismic forces that may be used in the design, with a conventional elastic analysis model, still ensuring a satisfactory response of the structure.
The values of the behaviour factor *q*, which also account for the influence of the viscous damping being different from 5%, are given for various materials and structural systems according to the relevant ductility classes in the various Parts of EN 1998.

The value of the behaviour factor *q* may be different in different horizontal directions of the structure, although the ductility classification shall be the same in all directions. For the horizontal components of the seismic action the design spectrum, $S\mathrm{d}(T)$, shall be defined by the following expressions:

$$0 \le T \le T_B : S_d(T) = a_g \cdot S \cdot \left[\frac{2}{3} + \frac{T}{T_B} \cdot \left(\frac{2,5}{q} - \frac{2}{3}\right)\right]$$

$$T_B \le T \le T_C : S_d(T) = a_g \cdot S \cdot \frac{2,5}{q}$$

$$T_C \le T \le T_D : S_d(T) \begin{cases} = a_g \cdot S \cdot \frac{2,5}{q} \cdot \left[\frac{T_C}{T}\right] \\ \ge \beta \cdot a_g \end{cases}$$

$$T_D \le T : \quad S_d(T) \begin{cases} = a_g \cdot S \cdot \frac{2,5}{q} \cdot \left[\frac{T_C T_D}{T^2}\right] \\ \ge \beta \cdot a_g \end{cases}$$

where

- a_g, S, T_C and T_D are as defined in elastic response spectra.
- $S_d(T)$ is the design spectrum;
- q is the behaviour factor;
- β is the lower bound factor for the horizontal design spectrum.

NOTE : The value to be ascribed to β for use in a country can be found in its National Annex. The recommended value for β is 0,2.

Class of ductility and coefficient of behavior

The building is designed according to the requirements for the class of medium ductility(DCM). The coefficient of behavior or structure factor q must be evaluated for each direction of the project through the following expression:

$$q = q_0 \, k_w \ge 1.5$$

- q_0 is the base value of the coefficient of behavior is the class of ductility, the structural type and regularity for mixed systems, chassis or frame-wall
- k_w is the factor reflecting the prevailing failure mode in structural systems with walls

STRUCTURAL TYPE	DCM	DCH
Frame system, dual system, coupled wall system	$3,0\alpha_u/\alpha_1$	$4,5\alpha_u/\alpha_1$
Uncoupled wall system	3,0	$4,0\alpha_u/\alpha_1$
Torsionally flexible system	2,0	3,0
Inverted pendulum system	1,5	2,0

Table 31 DCM and DCH

DCM class:

$q_0 = 3.0\alpha_u/\alpha_1$

- α_u is the value of the multiplier of the horizontal seismic force which occurs formation of a number of plastic hinges that make the structure unstable
- α_1 is the value of horizontal seismic force multiplier for which the first element structural reaches its flexural strength: α_u/α_1= 1.1 for single storey, multi-bay frames or frame-equivalent dual structures

q_0 = 3.0 × 1.1 = 3.3 for both directions. The value of q_0 is not reduced by 20% because the building is regular elevation.
The coefficient k_w reflects the prevailing mode of collapse in structural systems with walls. Must be chosen as follows:

$kw=\{1+\alpha0/3 < 1, \mathit{but\ not\ less\ than}\ 0{,}5, \mathit{for\ wall, wall - equivalent\ and\ torsionally}\}$
1,00, for frame and frame equivalent dual systems

kw= 1.00, for frames and mixed systems are equivalent to frame

The coefficient of behavior to be used is therefore: q = 3.3

Lateral force method of analysis

This type of analysis may be applied to buildings whose response is not significantly affected by contributions from modes of vibration higher than the fundamental mode in each principal direction and for buildings which full fill both of the two following conditions.

a) they have fundamental periods of vibration $T1$ in the two main directions which are smaller than the following values:

$$T_1 \leq \begin{cases} 4 \cdot T_C \\ 2{,}0\ \mathrm{s} \end{cases}$$

b) they meet the criteria for regularity in elevation,

NOTE: For the building we are considering ,from the geometry it is regular both in plan and elevation

For buildings with heights of up to 40 m the value of $T1$ (in s) may be approximated by the following expression:

$$T1 = C * H^{\frac{3}{4}} = 0.075 * 4.5^{\frac{3}{4}} = 0.232sec$$

where

- C*:* is 0,085 for moment resistant space steel frames, 0,075 for moment resistant space concrete frames and for eccentrically braced steel frames and 0,050 for all other structures;
- *H* is the height of the building, in m, from the foundation or from the top of a rigid basement.(H=4.5m)

Now calculating

$$S_d(T1) = a_g.S.\frac{2.5}{q} = 0.10 ** 9.81 * 1.15 * \frac{2.5}{3.3} = 0.8546\frac{m}{s2}$$

Base shear force

The seismic base shear force *F*b, for each horizontal direction in which the building is analysed, shall be determined using the following expression:

$$F_b = S_d(T1).m_{tot}.\lambda$$

$$F_b = 0.8546 * 28800.35 * 1 = 246.2\text{KN}$$

- *m* is the total mass of the building, above the foundation or above the top of a rigid basement, computed above.
- λ is the correction factor, the value of which is equal to: λ = 0,85 if *T*1 < 2 *T*C and the building has more than two storeys, or λ= 1,0 otherwise.

Distribution of the horizontal seismic forces.

The fundamental mode shapes in the horizontal directions of analysis of the building may be calculated using methods of structural dynamics or may be approximated by horizontal displacements increasing linearly along the height of the building.

$$F_i = F_b.\frac{z_i.m_i}{\sum z_j.m_j}$$

where
zi, zj are the heights of the masses mi ,mj above the level of application of the seismic action.

The horizontal forces *F*i determined in accordance with this clause shall be distributed to the lateral load resisting system assuming the floors are rigid in their plane.

$$F_{roof} = F_b = 246.2KN$$

Note: These floor loads should be applied at the mass center of each floor. Since the plan is symmetrical, we can simply consider the mass center for both floors at (X=40m and y=45m), where the special joint is to be located.

6.3 Design Of Composite Floor

The function of a slab is to transfer loads to the load bearing frame and to act as a diaphragm in transfer of lateral loads arising from wind actions, etc.. In this project a composite floor system that is composed of corrugated steel sheet and reinforced concrete is adopted. The advantages and disadvantages of composite floor system are explained in Section 4.2. In the design of the composite slab the provisions of Eurocode 4 were followed. The preliminary thickness of the slab is accepted as 120 mm and steel sheeting with 60 mm of height is chosen so that the thickness of the concrete above the main flat surface of the top of the ribs of the steel sheeting remained as 60 mm. The geometry and technical specifications of the selected product for steel sheeting are given below.

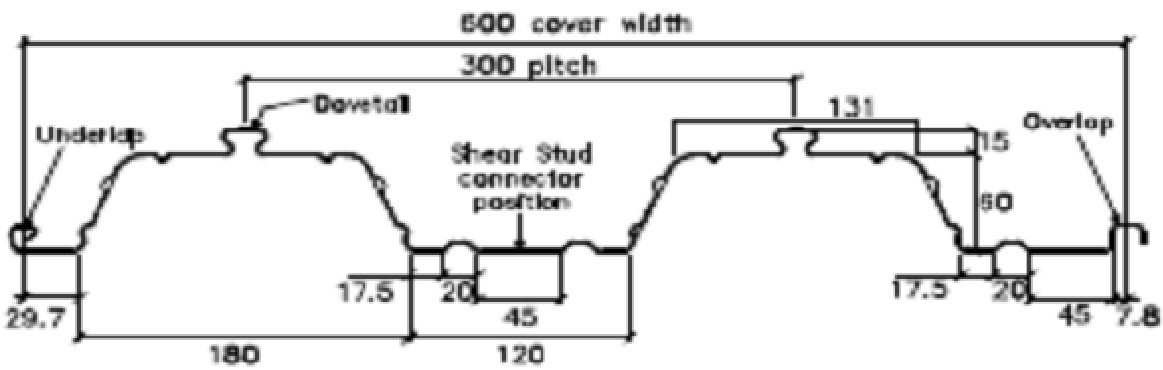


Figure 204 Steel Profile

Composite slab - volume and weight					
		Weight of concrete (kN/m^2)			
		Normal weight concrete		Lightweight concrete	
Slab depth (mm)	Concrete volume (m^3/m^2)	Wet	Dry	Wet	Dry
120	0.087	2.05	2.00	1.62	1.53

Table 32 Composite floor- volume and weight

Section properties (per metre width)							
Nominal thickness (mm)	Design thickness (mm)	Profile weight (kN/m^2)	Area of steel (mm^2/m)	Height to neutral axis (mm)	Moment of inertia (cm^4/m)	Ultimate moment capacity (kNm/m)	
						Sagging	Hogging
1.20	1.16	0.137	1721	31.7	132.91	15.21	13.07

Table 33 Section Properties

Advantages:

- Long span capability,

- Reduced concrete usage

- Excellent acoustic and fire performance

- Minimal maintenance

- Safer manual handling

Verification of the Composite Slab

According to Section 9 of Eurocode 4, the verification of a composite slab is required to be performed in ultimate limit state for two of 3 different critical sections:

- Critical section I.

Flexure: bending resistance Mp.Rd.

- Critical section II.

Longitudinal shear: longitudinal shear resistance Vp,Rd.

- Critical section III.

Vertical and punching shear: vertical shear resistance Vv.Rd.

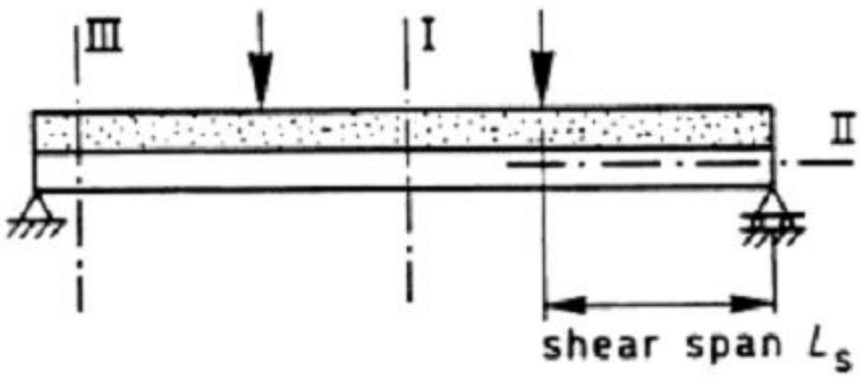


Figure 205 Critical Sections

The slab is analyzed under ultimate limit state assuming that it is a reinforced concrete beam of width 300 mm and steel acts as reinforcing bars in a beam. In the ultimate limit state for both Critical Section I and Critical Section II, the concrete is assumed to be cracked and steel has yielded.

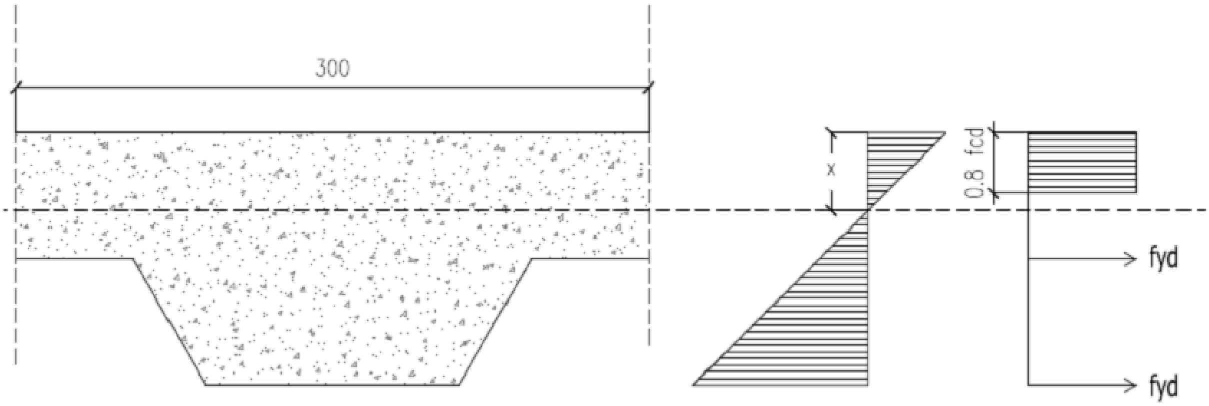


Figure 206 Position of Neutral Axis

0.8 · b · x · fcd – As· fyd= 0

where;

As is the area of the steel and is equal to 5.163 · 10-4 m2

Fyd is the design yield strength of the steel profile which is 350/1.15 MPa

b is the width of the beam which is 0.3 m

x is the depth of the neutral axis to be determined

fcd is the design compressive strength of the concrete which is 0.85 · 30/1,5 for

C30 class concrete.

The position of the neutral axis is determined as x = 0,0385 m. It is observed that the neutral axis does not pass through the steel profile. Thus, the capacity of the slabunder flexure is calculated as follows;

Resistance to Bending Moment:

Mp,rd = Ncf (dp-0,5x c)

Ncf = Ap· fyp/ γ ap

xc= Ncf/b/(0.85fck/ γ c)

where;

Ap is the area of the steel sheet under tension which is 5.163 · 10-4 m2

dp is the distance from the top of the slab to the centroid of the effective area of the steel sheet

x_c is the depth of the stress block for the concrete

b is the width of the cross-section considered.

Ncf= 5.163 · 10-4 m2 x 350/1,10 = 164.277 kN

xc=164.277/0.3/(0.85 x 30 x 10-3 /1,5) = 0.0322 m

Mp,rd = 164.277 x (0,09 – 0.5 x 0.0322) = 12.14 kNm

The design bending moment for a 1.5 m span of slab; MEd =q·l2/8

MEd = 18 x1.52/8 = 5.06 kNm

MEd<Mp,rd

The slab is satisfactory under bending.

Resistance to Vertical Shear:

V_{vRd} = bo· dp· Rd· kv· (1.2 + 40)

Rd = 0.25 fctk / c

kv = 1.6 - dp> 1

ρ= Ap/bo.dp< 0.02

where;

bo is the mean width of the concrete ribs (minimum width for re-entrant sheeting);

R_d is the basic shear strength

F_{ctk} is fctk 0.05, characteristic tensile strength of concrete

A_p is the effective area of the steel sheet in tension within the considered width bo;

R_d = 0.25 x 1.8/1.5 = 0.3

ρ = 5.163 · 10-4 m2 / 0.3 / 0.09 = 0.019 < 0.02

kv = 1.6 – 0.09 = 1.51 > 1

V_{vRd} = 23.9 kN

VEd = q·l / 2 = 13.5

$V_{ed} < V_{vRd}$

The slab is satisfactory under vertical shear.

Design of Reinforcing Mesh:

Eurocode 4 provides that the nominal transverse reinforcement should have a cross-sectional area of not less than 0.2 % of the area of structural concrete above the ribs. In the case under study, the area of the structural concrete above the ribs is calculated as;

A_{ar} = 12 x 6 = 72 cm2

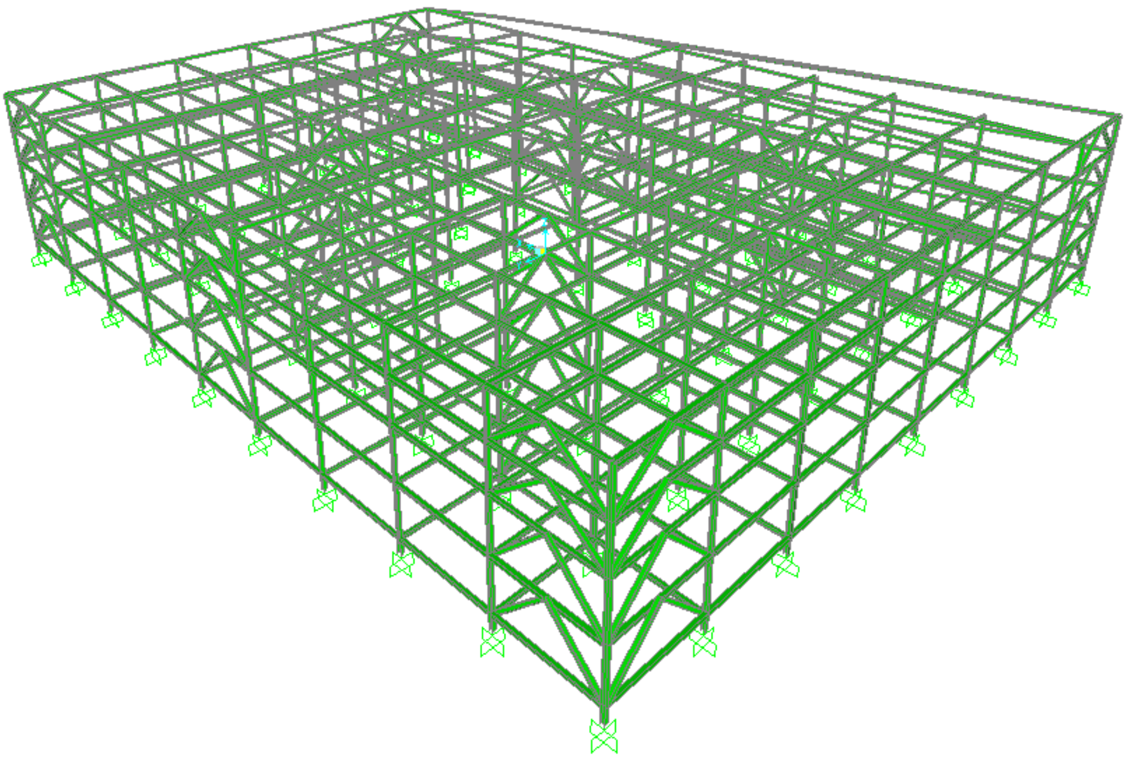
The area of the nominal transverse reinforcement cross section should not be less than;

72 x 0.002 = 0,144 cm2

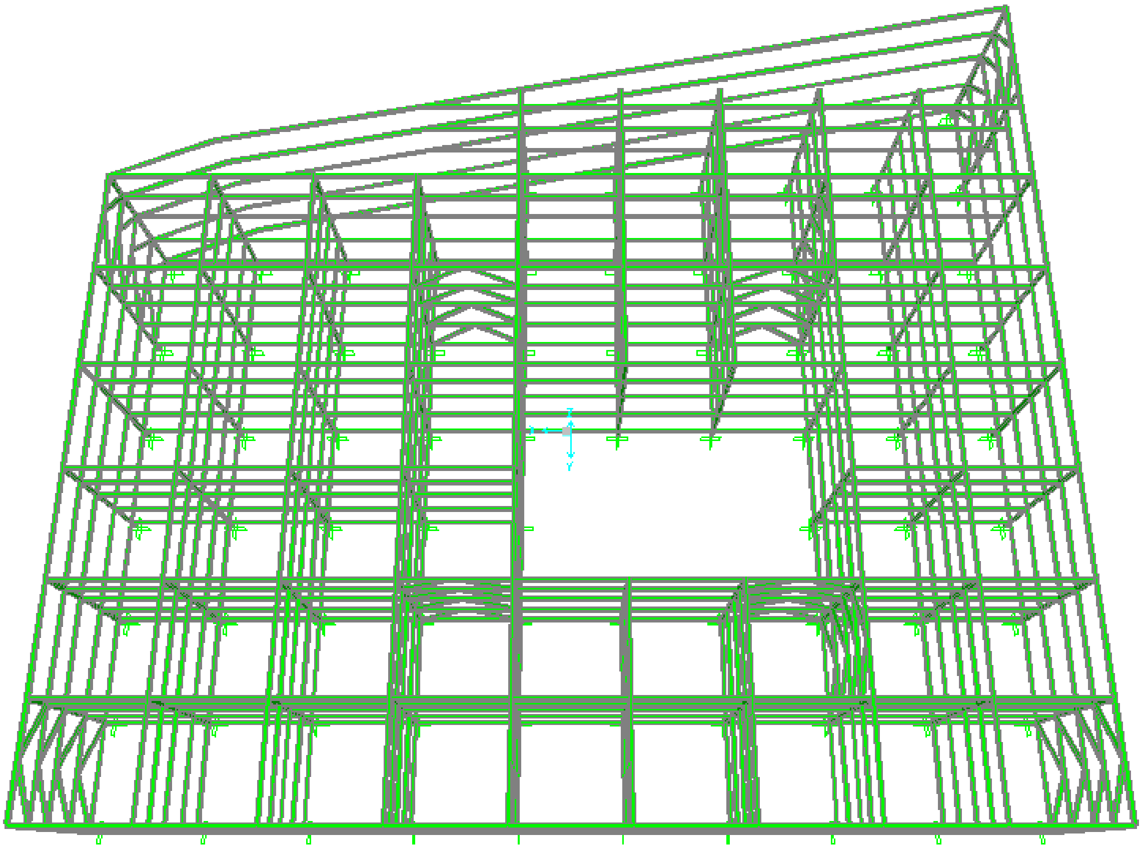
A mesh reinforcement of A142 is selected:

A_{mr} = 0,1728 cm2 >0,144 cm 2

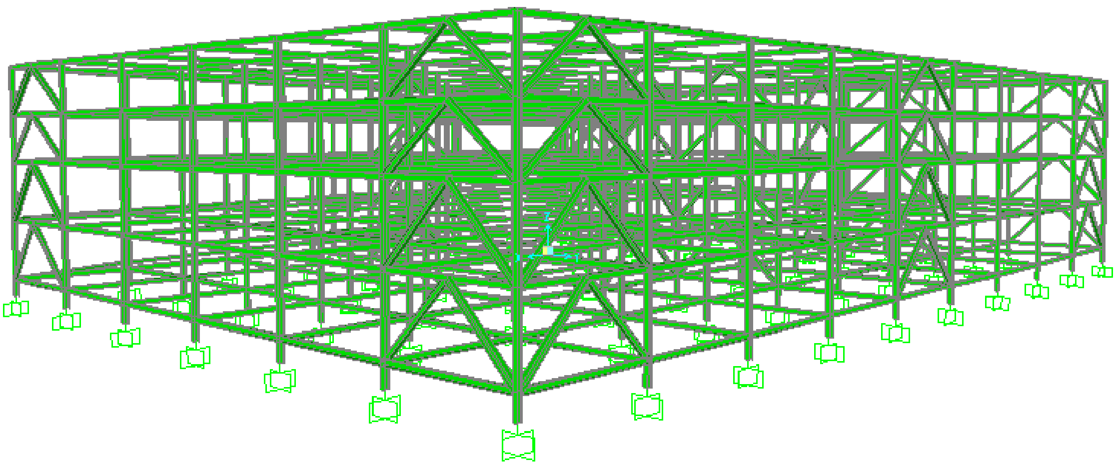
6.4 Structural Frame Modeling



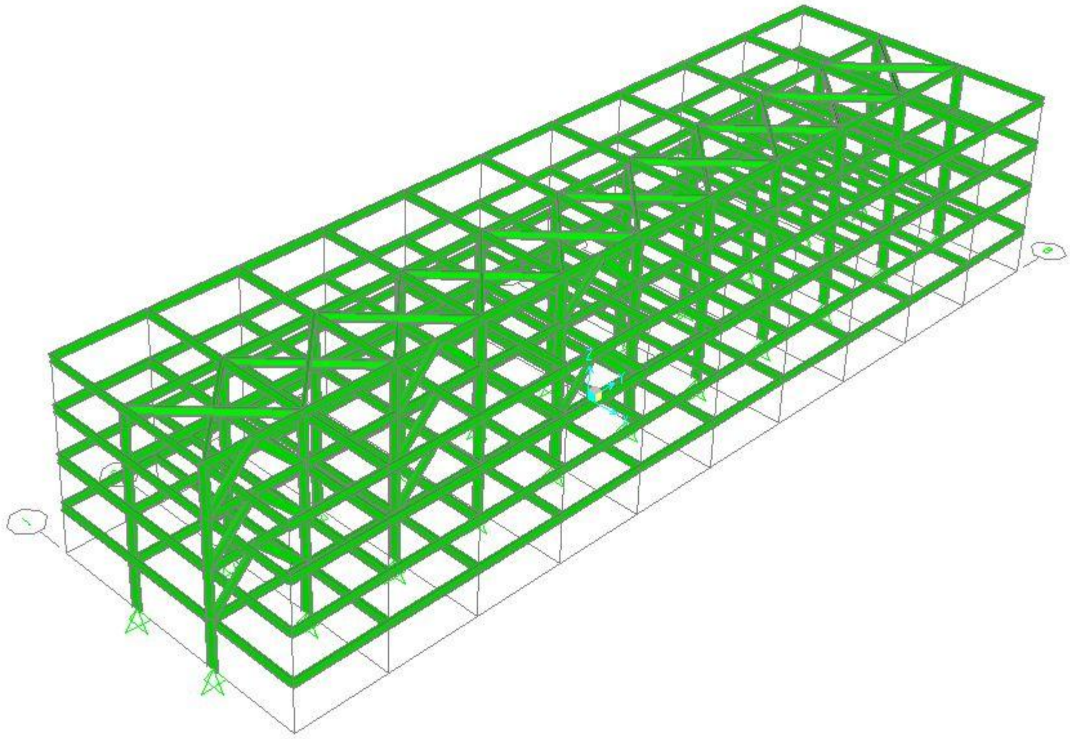
Drawing 23 Structural frame – part 1



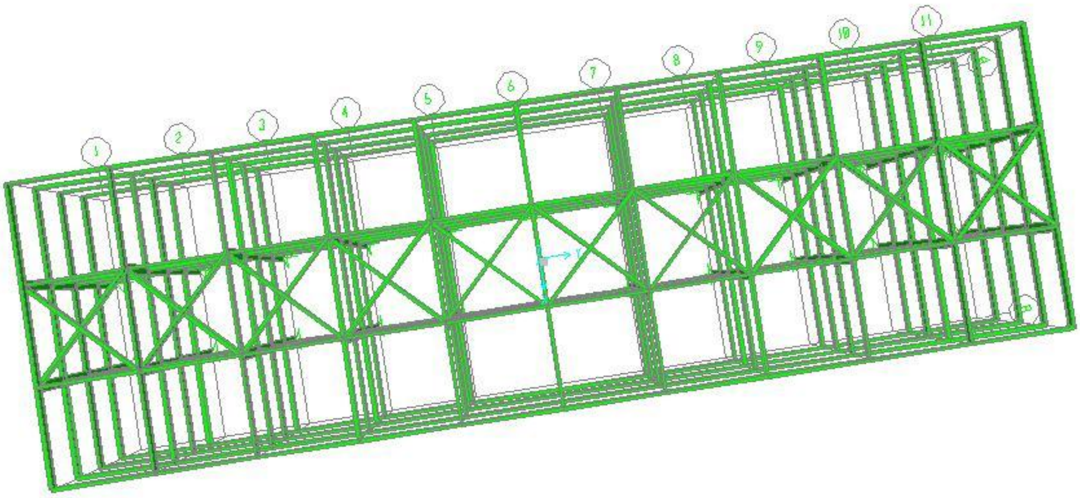
Drawing 24 Structural frame – part 1



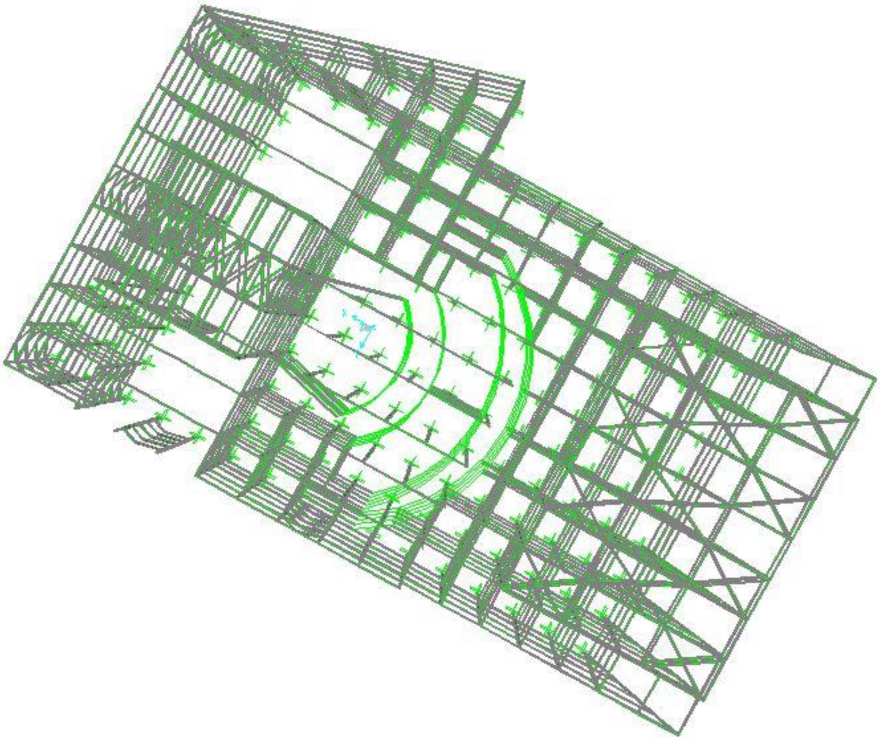
Drawing 25 Structural frame – part 1



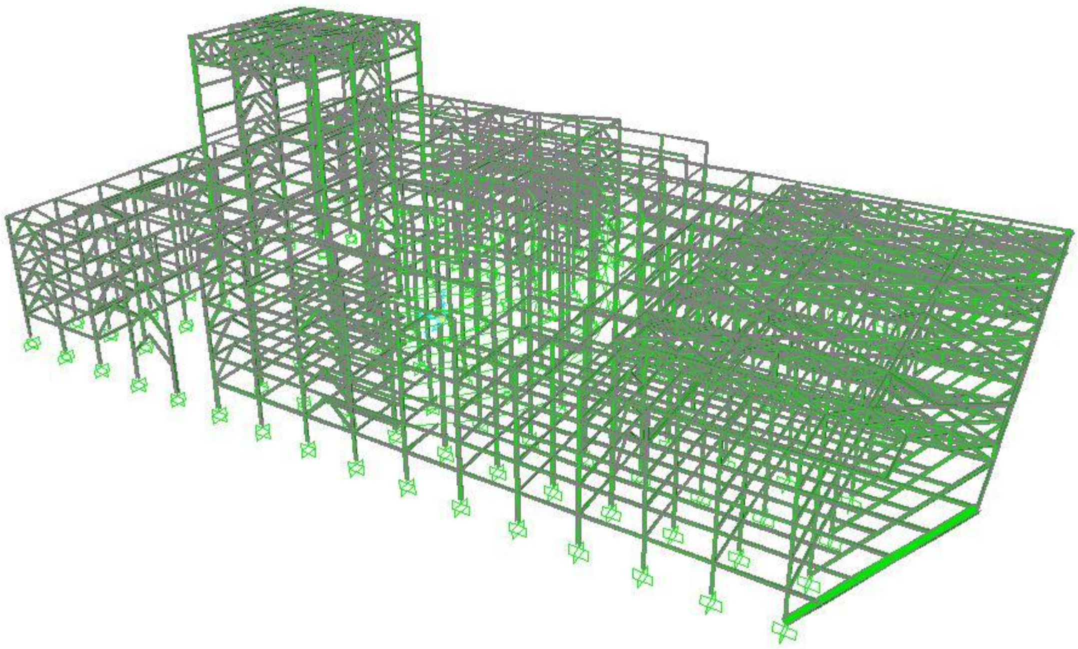
Drawing 26 Structural frame – part 2



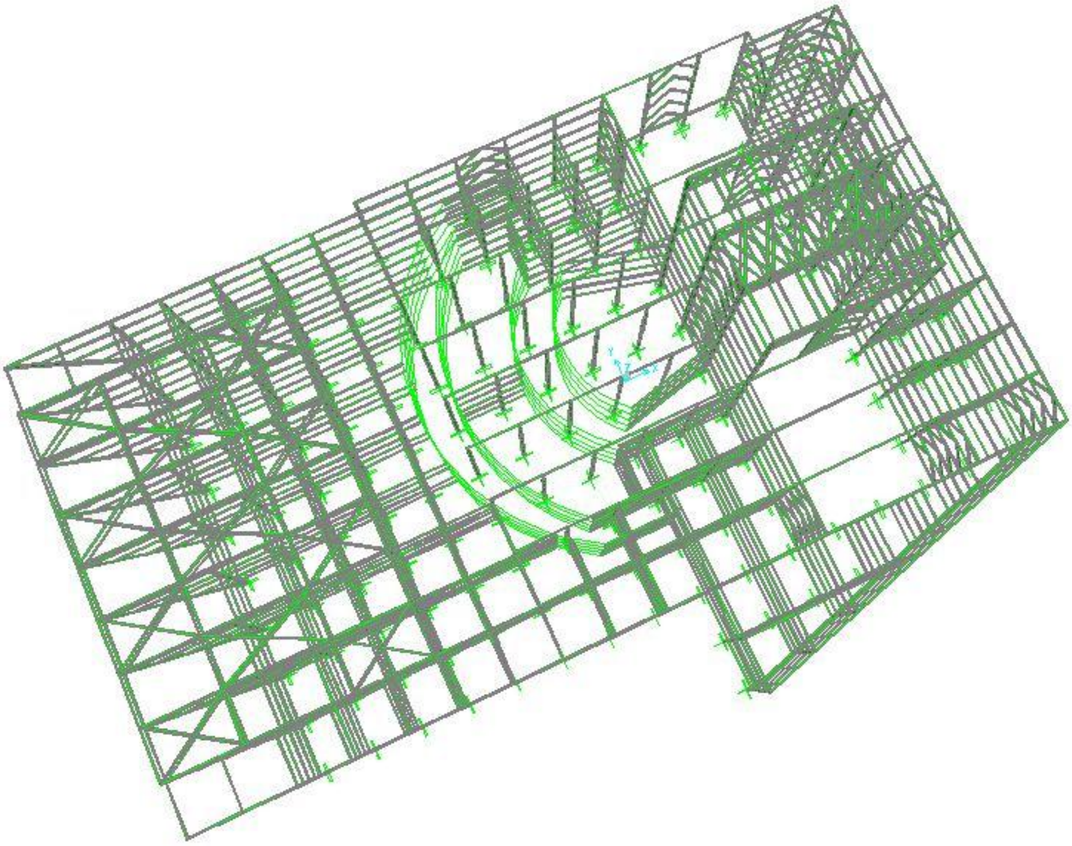
Drawing 27 Structural frame – part 2



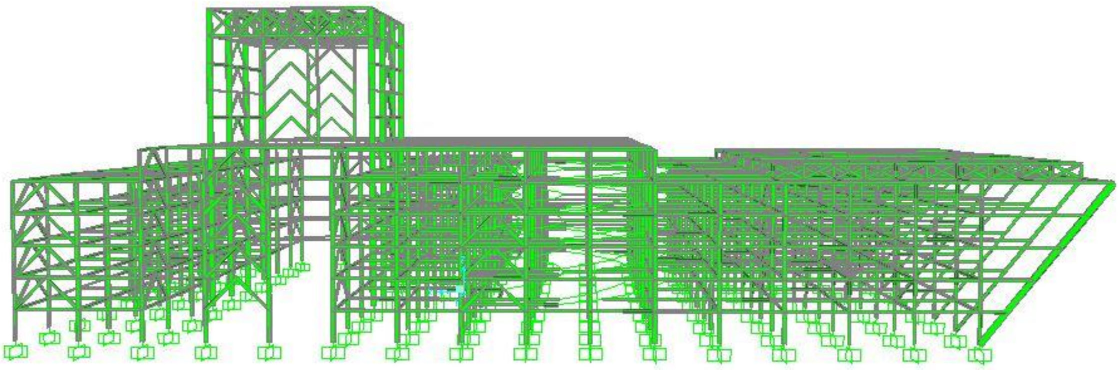
Drawing 28 Structural frame – part 3



Drawing 29 Structural frame – part 3



Drawing 30 Structural frame – part 3



Drawing 31 Structural frame – part 3

6.5 Structural Element Design

6.5.1 Beam Design

After analyzing the structure in SAP for different combination cases, we take one beam from the frame to design. As shown in Figure above.

MEd = 224.21 kNm

VEd = 112.34 KN

Check for Bending:

MEd / Mc, Rd < 1.0

Assuming a Class 1 Section, the required capacity is calculated as follows;

Mc, Rd = Mpl, Rd = Wpl· fy/ γ_{M0}

fy= 350 MPa

γ_{M0}= 1.00

224.21 kNm <Mc, Rd

Wpl> 0.862 x10^{-3} mm^3

HE 400 B wide flange section is selected. The plastic section modulus for this section is:

Wpl = 2.078 x 10^{-3} mm^3 > 0.862 x10^{-3} mm^3 √

Section Properties for HE 400 B

h = 440 mm	A = 30.3 x 10^3 mm^2
b = 310 mm	Iy = 5920 x 10^5 mm^4
tw = 21 mm	Wel,y = 3482 x 10^3 mm^3
tf = 39 mm	Wpl,y = 4078 x10^3 mm^3
r = 27 mm	hw = 262 mm

For the verification of the section class, the selected section is checked according to table provided by Eurocode 3.

For flange

$c = (b - tw - 2r) / 2$

$c = 117.5$ mm

$c / t_f = 3.01$

$\varepsilon = \sqrt{(235/fy)} = 0.814$

$c / t_f < 9\varepsilon$

3.01< 7.326 √

For web

$c = (h - 2 t_f - 2r) / 2$

$c = 104$ mm

$c / tw = 4.95$

$c / tw < 72\varepsilon$

4.95 < 58.6 √

Shear Check:

$VEd / Vc, Rd < 1.0$

$Vpl, Rd = Av \cdot (fy/\sqrt{3}) / \gamma_{M0}$

Av for hot rolled I and H sections is calculated as;

$Av = A - 2 \cdot b \cdot tf + (tw + 2r) \cdot tf$

$Av = 9.045 \times 10^{-3}$ m^2

fy= 350 Mpa , $\gamma_{M0} = 1.00$

Vpl, Rd = 1827.7 KN > 112.34 KN √

VEd< Vpl, Rd/2 Hence; No check required for combined bending and shear

Shear Buckling Resistance:

$hw/tw < 72 / \eta$; $\eta = 1$

hw/tw = 262 /21= 12.47

12.47 < 58.6 √

No check required for shear buckling resistance

Deflection check:

For deflection check, maximum moment developed in the section due to working load is calculated by taking into account only the DL and LL without considering any safety coefficients which corresponds to the first combination in our case.

Mmax = 322.52 kNm

Elastic resistance of the section, Mc, Rd (el) = Wel· fy/ γ_{M0}

fy= 350 Mpa , γ_{M0} = 1.00

Mc, Rd (el) = 483.73 kNm > 322.52 KNm √

Elastic calculation can also be done:

- δmax@mid span = 0.0115 m

Maximum deflection that can be allowed should be smaller than span / 250.

Span / 250 = 0.04 m

- δmax@mid span < span / 250 √

6.5.2 Column Design

After analyzing the structure in SAP for different combination cases, we take one column from the frame to design. As shown in Figure above.

NEd = 2037.35 KN

MEd = 45.18 kNm

VEd = 12.7 KN

HE 650 B wide flange section is selected.

Section Properties for HE 650 B

h = 650 mm	A = 28.6 x 10^3 mm^2
b = 300 mm	Iy = 2106 x 10^5 mm^4
tw = 16 mm	Wel,y = 6480 x 10^3 mm^3
tf = 31 mm	Wpl,y = 7320 x10^3 mm^3
r = 27 mm	hw = 588 mm

For the verification of the section class, the selected section is checked according to table provided by Eurocode 3.

For flange

$c = (b - tw - 2r) / 2$

$c = 117.5$ mm

$c / t_f = 3.01$

$\varepsilon = \sqrt{(235/fy)} = 0.814$

$c / t_f < 9\varepsilon$

$3.01 < 7.326$ √

For web

$c = (h - 2\, t_f - 2r) / 2$

$c = 104$ mm

$c / tw = 4.95$

$c / tw < 72\varepsilon$

$4.95 < 58.6$ √

The section is Class-1 as assumed

Compression resistance of cross section:

$NEd / Nc, Rd < 1.0$

$Ncl, Rd = A \cdot fy/\gamma_{M0} = 10.15 \times 10^3$ KN

$NEd < Nc, Rd$ √

Bending resistance of cross section:

$Mc, Rd\ (pl) = W_{pl} \cdot fy/ \gamma_{M0} = 2598.6$ kNm

$MEd < Mc, Rd(pl)$ √

Shear resistance of cross section:

$VEd / Vc, Rd < 1.0$

$Vpl, Rd = Av \cdot (fy/\sqrt{3}) / \gamma_{M0}$

Av for hot rolled I and H sections is calculated as;

$Av = A - 2 \cdot b \cdot tf + (tw + 2r) \cdot tf$

$Av = 7.831 \times 10^{-3}\ m^2$

$fy = 350$ Mpa , $\gamma_{M0} = 1.00$

$Vpl, Rd = 1604.83$ KN > 12.7 KN √

Combined bending and axial resistance of cross section:

$MEd \leq MN,Rd$

$MN,Rd = Mpl,Rd[\,1 - (NEd / Nc,Rd)] = 2077.15$ kNm

$MEd < MN,Rd$ √

Buckling resistance of cross section:

$N_{Ed} / N_{b,Rd} \leq 1.0$

$N_{b, Rd} = \chi . A . f_y / \gamma_{M0}$

$\lambda_1 = 93\ \varepsilon = 75.70$

$\lambda_y = \lambda_z = L_{cr} / i / \lambda_1$

$\lambda_y = \lambda_z = 2800/80.2/75.7 = 0.46$

Buckling curve: Type a for ⍰⍰= 0.46

$$\chi = \frac{1}{\phi + (\phi^2 - \bar{\lambda}^2)^{0.5}} \leq 1$$

$$\phi = 0.5(1 + \alpha(\bar{\lambda} - 0.2) + \bar{\lambda}^2)$$

$\Phi = 0.633$

$\chi = 0.93 < 1$

Nb,Rd = 9507.95 kN

NEd < Nb,Rd √

6.5.3 Bracing Design

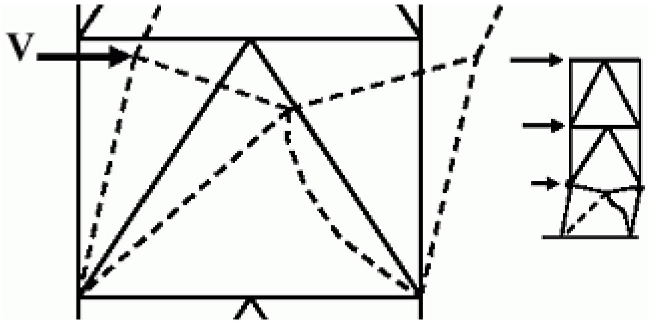


Figure 207 Bracing Movement

VEd = 112.34 KN

we propose other cross-section for this kind of bracing member: SHS 70 x 8H.

$$A_{SHS70x8H} = 1920 mm^2; I_y = I_z = 1200000 mm^4; f_y = 235 N/mm^2\ ; E = 2.1 \cdot 10^5 \frac{N}{mm^2},$$

length of the bracing member: L = 3.91m;

Calculate the resistance of cross-section, considering the compressive design axial force NEd = 112.34kN,

which should satisfy: $\frac{N_{Ed}}{N_{c,Rd}} \leq 1.0$ $\gamma_{M0} = 1.0$

$$Nc, Rd = \frac{Ashs\ 70X8h\ \ x\ fy}{\gamma mo} = 451{,}2\ KN$$

Check the cross-section strength ;

N_{ed} / $N_{c,Rd}$ =112,34 / 451,2 KN = 0,24 <1.0 √

Calculate the buckling resistance of bracing member N_{ed} /$N_{b,Rd}$ < 1

$$N_{b,Rd} = \frac{\chi \cdot A \cdot f_y}{\gamma_{M1}}$$ (class 1 cross-section);

$$\chi = \frac{1}{\Phi + \sqrt{\Phi^2 - \bar{\lambda}^2}} (\leq 1.0)$$

$$\Phi = 0.5 \cdot \left[1 + \alpha \cdot \left(\bar{\lambda} - 0.2\right) + \bar{\lambda}^2\right]$$

$$\bar{\lambda} = \sqrt{\frac{A \cdot f_y}{N_{cr}}}$$

α - imperfection factor α=0.21 (for hot finished hollow sections and steel grade we choose

buckling curve a);

- partial factor, recommended value by EN 1993-1-1: $\gamma_{M1} = 1.0$;

- elastic critical force $N_{cr} = \frac{\pi^2 \cdot E \cdot I}{L_{cr}^2}$

Lcr = buckling length; we modeled the bracing not restrained in rotation, so:

Ncr = 162.68 Kn

$\bar{\lambda}$ = 1,665 ; ϕ =2,04 ; χ = 0,31 <1 √ ;

$N_{b,Rd}$ = 139,9 KN

N_{er} / $N_{b,Rd}$ = 0,80 <1 √

6.5.4 Design Of Base Plate

The design of base plate was according to the maximum load that has been derived from SAP analysis and the building supports are fixed supports, which they can take axial load, shear and moment. The reason for using this kind of support is that the building will be able to withstand more vertical forces.

Initial design inputs:
Column cross section: 650×300×31mm
Material strength: Steel grade S 355 M: f_y= 355 N/ mm^2
Concrete grade C 30: f_{ck} = 30 N/mm^2
The column is supported concentrically on 1800×2000×600 mm reinforced concrete footing.

Design loads from SAP2000
Design compressive force: N_{sd}= 2339.11 KN
Design Shear force: V_{sd} = 39.64 kN

Axial resistance

The thickness of base plate should not be less than the thickness of the column flange. Therefore use base plate thickness, $t > t_f$, i.e. 40mm (assumption). The maximum potential effective bearing width, c, of the plate is given by:

$$c = t\,(f_y / 3.f_j\,.\gamma_{M0})^{0.5}$$

Where the bearing strength:

$f_j = \beta_j\, k_j\, f_{cd}$

Where:

$f_{cd} = f_{ck} / \gamma_c = 30/1.5 = 20$ N/mm^2

$\beta_j = 0.67$ (from Eurocode)

k_j = concentration factor = $(a_1 \times b_1 / a \times b)^{0.5}$

If we assume that the base plate has 750×400×30mm dimension to provide adequate space for locating the holding down bolts then:

a = 750 mm, b = 400 mm

a_1 = a + h (effective depth of foundation) = 750 + 600 = 1350 mm

b_1 = b + h = 400 + 600 = 1000 mm

$k_j = (1350 \times 1000 / 750 \times 400)^{0.5} = 2.12$

$f_j = 0.67 \times 2.12 \times 20 = 28.41$ N/mm^2

$f_y = 355$ N/mm^2

$\gamma_{M0} = 1.0$

Hence, $c = 40\,(355/3 \times 28.41 \times 1.0)^{0.5} = 81.6$ mm

Effective area of the base plate:

$A_{eff} = (650 + 2 \times 81.6)\,(300 + 2 \times 81.6) = 376.67 \times 10^3$ mm^2

Design bearing pressure:

$N_{sd}/A_{eff} = 2339.11 \times 10^3 / 376.67 \times 10^3 = 6.21$ N/mm^2

Bearing strength:

f_j = 28.41 N/mm² > 6.21 N/mm² √

Shear resistance:

When the applied shear force is less than 20% of the applied vertical load, no special provisions are necessary for the transfer of the shear force from the base plate to the foundation.

N_{sd} = 2339.11 KN

Therefore, $N_{sd}/5$ = 2339.11/5 = 467.82 KN

V_{sd} = 39.64 KN

$V_{sd} < N_{sd}/5$ √

Design of plate dimensions:

Minimum width of plate required = b + 2c

= 300 + 2 × 81.6 = 463.2 mm ≈ 500 mm

Minimum depth of plate required = d + 2c

= 650 + 2 × 81.6 = 813.2 mm ≈ 850 mm

Therefore, 850 × 500 × 40 mm thick grade S 350 M steel base plate has been used.

Design of bolts:

Plate size 850x500x40 with Steel Grade F_e 350, f_u = 235 N/mm² is used.

Bolts M 20 Grade 8.8, f_{yb} = 640 N/mm², f_{ub} = 800 N/mm²; Diameter 30 mm.

Bolt area at the bottom of the thread: A_s = 561 mm².

Diameter of holes d_0 = d + 2 = 30 + 2 = 32 mm.

Minimum edge distance, e_1 = 1.2 d_0 = 1.2 x 32 = 38.4 mm

Minimum hole distance, p_1 = 2.5 d_0 = 2.5 x 32 = 80 mm

Maximum edge distance, e_1 = 12 t = 12 x 40 = 480mm

Maximum hole distance, p_1 = 14 t = 14 x 40 = 560 mm

Shear resistance of bolts:

Assumptions: One shear area per bolt and

Threads area in the shear plane.

Hence the shear capacity of the bolts is given by:

$$F_{v,Rd} = f_{vd} = \frac{0.6 f_{ub} A_s}{\gamma_{Mb}} \leq \frac{0.87 f_{yb} A_s}{\gamma_{Mb}}$$

α_v = 0.6 for classes 4.6, 5.6 and 8.8:

$F_{v,\,Rd}$ = (0.6x800x561x10^{-3})/1.25 = 215.4 KN > NEd / 2t_p = 2339.11/2x40 = 29.23 KN √

And (0.87x640x561x10^{-3})/1.25 = 249.89 KN > 215.4 KN √

Bearing resistance of connection beam and connection plate:

Bearing capacity of bolts:

$$F_{bb,Rd} = d\,t\,f_{bb,d} = \frac{dt\left[0.9\left(f_{ub} + f_{yb}\right)\right]}{\gamma_{Mb}}$$

$F_{bb,\,Rd}$ = 30x40x0.9x(800+640)x10^{-3}/1.25 = 652.68 KN > 29.23 KN √

Bearing capacity of plate:

$$F_{bp,Rd} = \frac{d\,t\left[0.8(f_u + f_t)\right]}{\gamma_M} \leq \frac{1}{2} e_1 t\, f_{bp,d}$$

$F_{bp,\,Rd}$ = 30x40x0.8x(430+235)x10^{-3}/1.25 = 341.44 KN > 29.23 KN √

And; ½ x 38.4x40x0.8x(430+235)x10^{-3}/1.25 = 393.04 KN > 341.44 KN KN √

Bearing capacity of connection column and connection plate:

Since the web thickness of the column is t_w = 16mm is greater than the plate thickness t_p =10 mm, again the plate is the critical member which is the same as above.

Tension resistance:

$$F_{t,Rd} = \frac{k_2 \ f_{ub} \ A_s}{\gamma_{M2}}$$

$F_{bp,\ Rd}$ = (0.9x800x561x10^{-3})/1.25 = 323.14 KN > 29.23 KN √

Punching shear resistance:

$$B_{p,Rd} = 0{,}6\,\pi\, d_m\, t_p\, f_u / \gamma_{M2}$$

$B_{p,\ Rd}$ = (0.6x3.14x30x10x800)/1.25 = 361.72 KN > 29.23 KN √

6.5.5 Design Of Connection

We used bolted connections which are employed mainly in structures subjected under reversed and vibration loads, over all in members with heavy conditions. The black hexagon bolt shown in the Figure below with nut and washer is the most commonly used structural fastener.

Design Bending moment: MEd = 336.96 kNm

Design Shear force: VEd = 2037.35 KN

Geometric check:

Plate size 200x200x10 with Steel Grade F_e 430, f_u = 275 N/mm^2 is used.

Bolts M 20 Grade 8.8, f_{yb} = 640 N/mm^2, f_{ub} = 800 N/mm^2; Diameter 22 mm.

Bolt area at the bottom of the thread: A_s = 303 mm^2.

Diameter of holes d_0 = d + 2 = 22 + 2 = 24 mm.

Minimum edge distance, e_1 = 1.2 d_0 = 1.2 x 24 = 30 mm

Minimum hole distance, $p_1 = 2.5\ d_0 = 2.5 \times 24 = 60$ mm

Maximum edge distance, $e_1 = 12\ t = 12 \times 10 = 120$ mm

Maximum hole distance, $p_1 = 14\ t = 14 \times 10 = 140$ mm

Shear resistance of bolts:

Assumptions: One shear area per bolt and

Threads area in the shear plane.

Hence the shear capacity of the bolts is given by:

$$F_{v,Rd} = f_{vd} = \frac{0.6 f_{ub} A_s}{\gamma_{Mb}} \leq \frac{0.87 f_{yb} A_s}{\gamma_{Mb}}$$

$\alpha_v = 0.6$ for classes 4.6, 5.6 and 8.8:

$F_{v,Rd} = (0.6 \times 800 \times 303 \times 10^{-3})/1.25 = 116.35$ KN > VEd / $2t_p$ = 2037.35/2x20 = 50.9 KN √

And $(0.87 \times 640 \times 303 \times 10^{-3})/1.25 = 134.96$ KN > 116.35 KN √

Bearing resistance of connection beam and connection plate:

Bearing capacity of bolts

Since the web thickness of the beam which is $t_w = 21$ mm is greater than the plate thickness t_p = 10 mm, the plate is the critical member.

$$F_{bb,Rd} = d\,t\,f_{bb,d} = \frac{dt\left[0.9\left(f_{ub} + f_{yb}\right)\right]}{\gamma_{Mb}}$$

$F_{bb,Rd} = 22 \times 10 \times 0.9 \times (800+640) \times 10^{-3}/1.25 = 456.19$KN > 50.9 KN √

Bearing capacity of plate

$$F_{bp,Rd} = \frac{d\,t\left[0.8\left(f_u + f_t\right)\right]}{\gamma_M} \leq \frac{1}{2} e_1 t\, f_{bp,d}$$

$F_{bp, Rd}$ = 22x10x0.8x(430+275)x10^{-3}/1.25 = 128.53KN > 50.9 KN √

And; ½ x 30x10x0.8x(430+275)x10^{-3}/1.25 = 135.36 KN > 128.53 KN √

Bearing capacity of connection column and connection plate:

Since the web thickness of the column is t_w = 16mm is greater than the plate thickness t_p =10 mm, again the plate is the critical member which is the same as above.

Tension resistance:

$$F_{t,Rd} = \frac{k_2 \ f_{ub} \ A_s}{\gamma_{M2}}$$

$F_{bp, Rd}$ = (0.9x800x303x10^{-3})/1.25 = 172.8 KN > 50.9 KN √

Punching shear resistance:

$$B_{p,Rd} = 0,6 \, \pi \, d_m \, t_p \, f_u / \gamma_{M2}$$

$B_{p, Rd}$ = (0.6x3.14x22x10x800)/1.25 = 265.28 KN > 50.9 KN √

6.6 Structural Check List

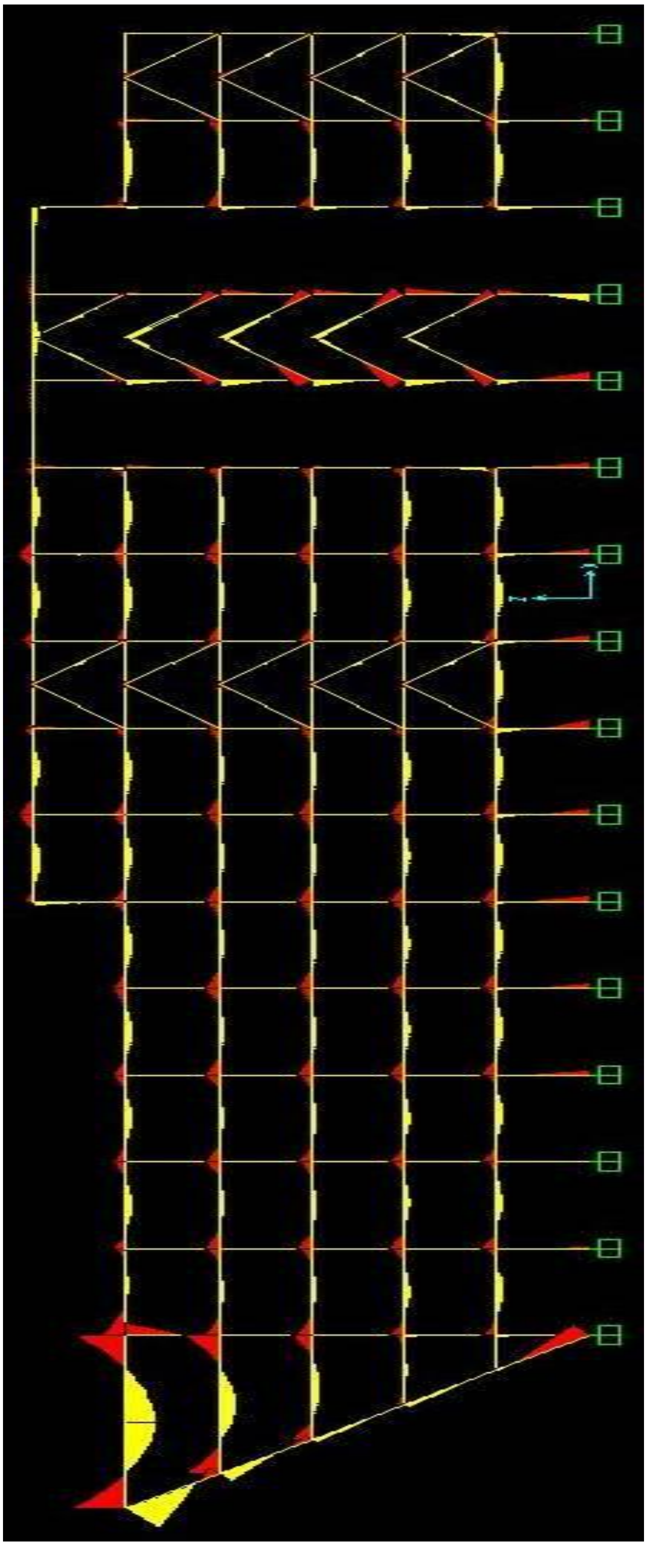


Figure 208 Bending Moment Diagram Comb 3

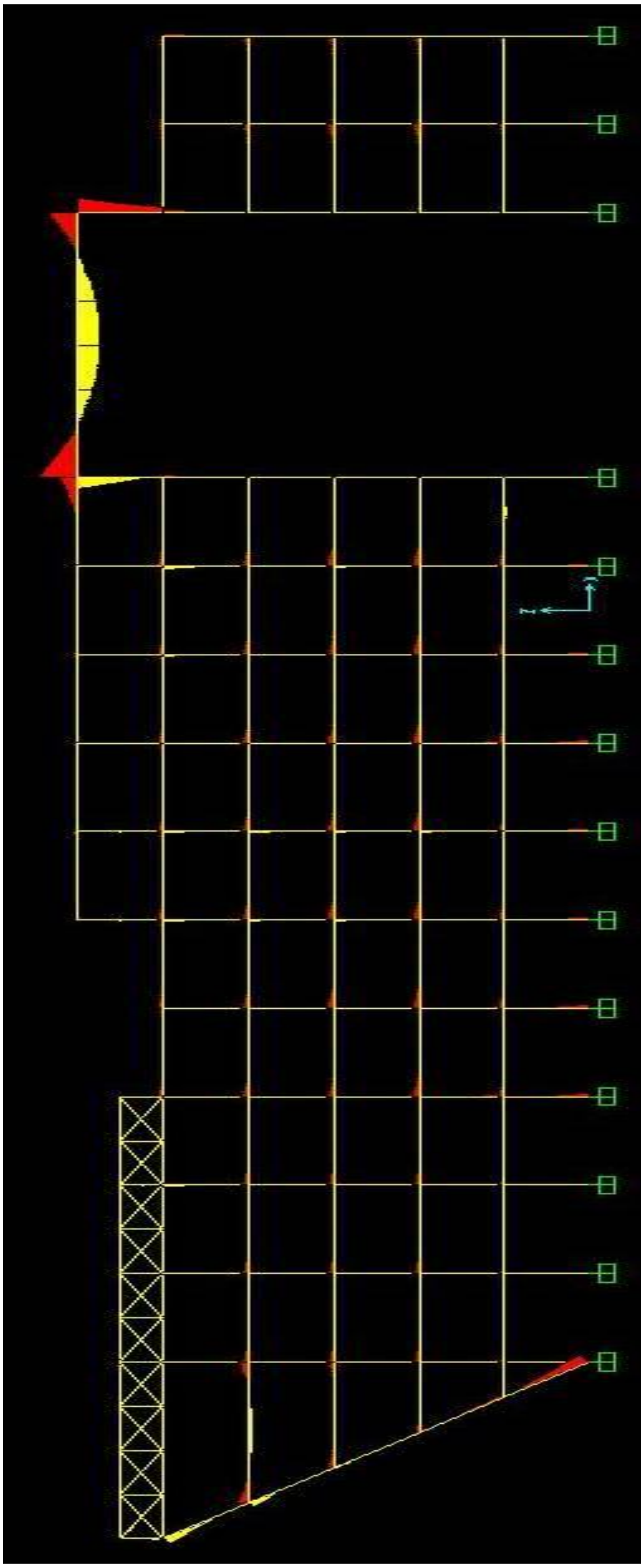


Figure 209 Bending Moment Diagram – Comb-3

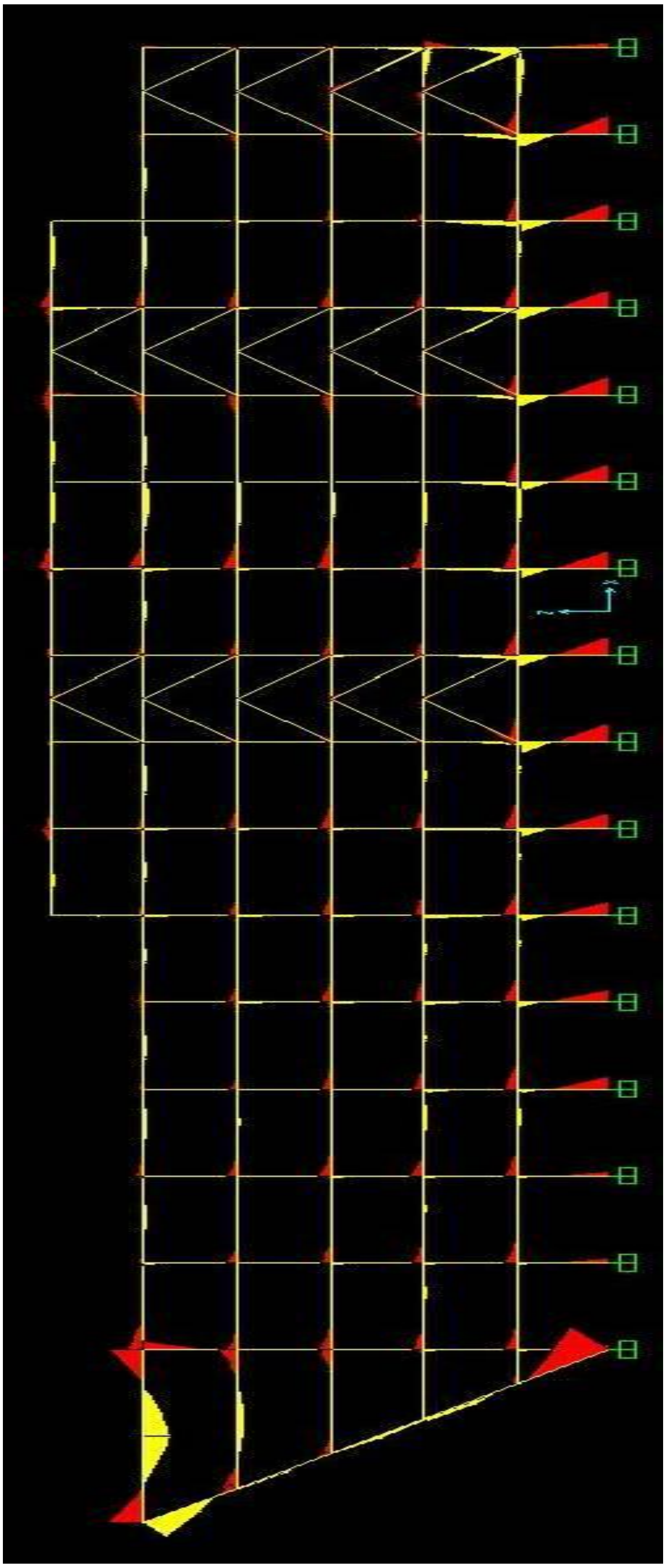


Figure 210 Bending Moment Diagram – Comb-2

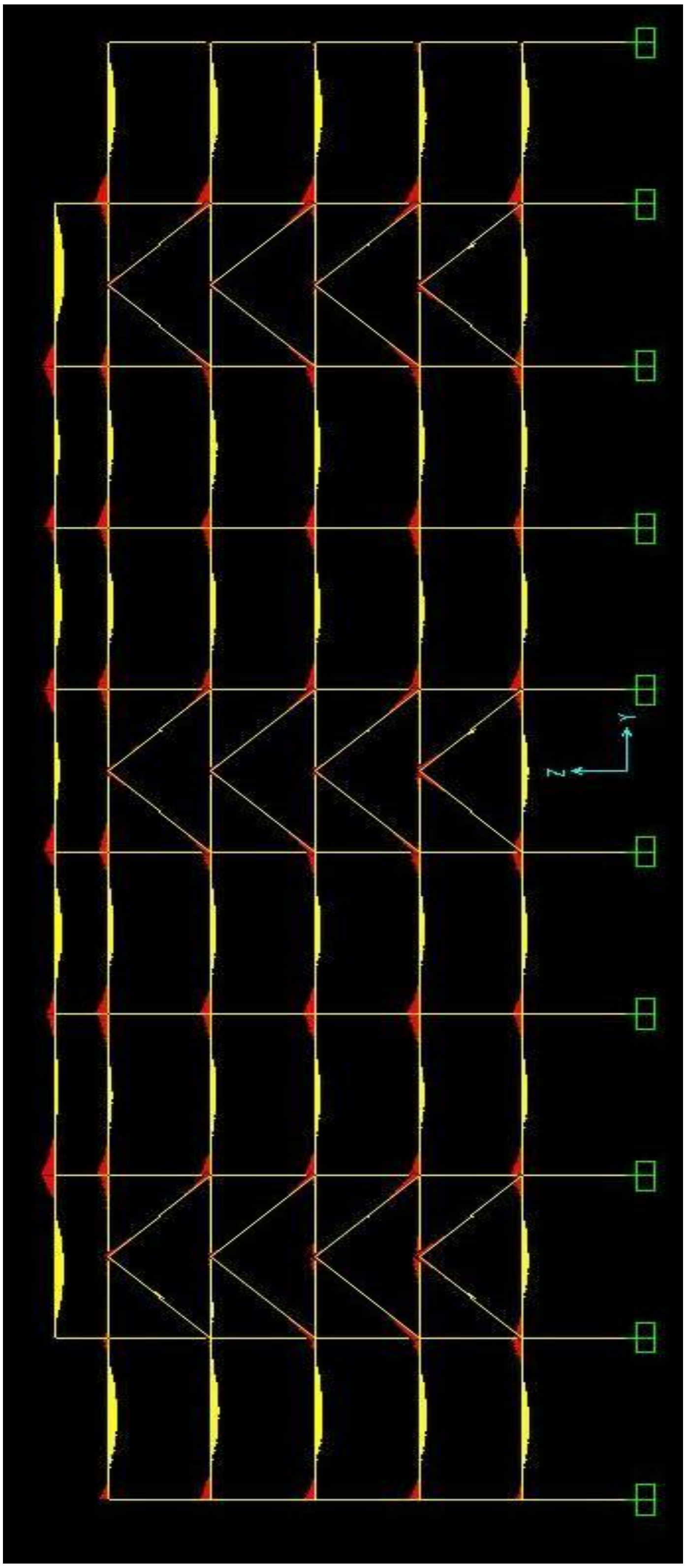


Figure 211 Bending Moment Diagram – Comb-4

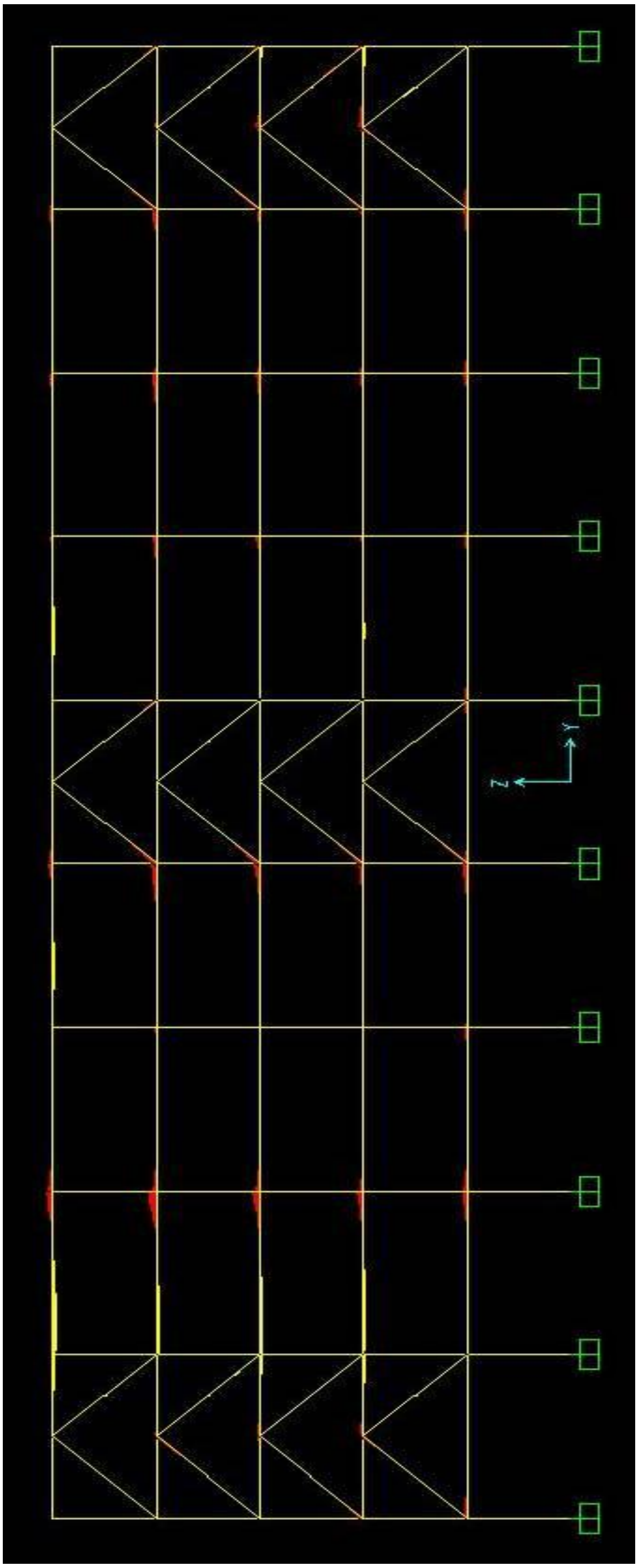


Figure 212 Bending Moment Diagram Comb 1

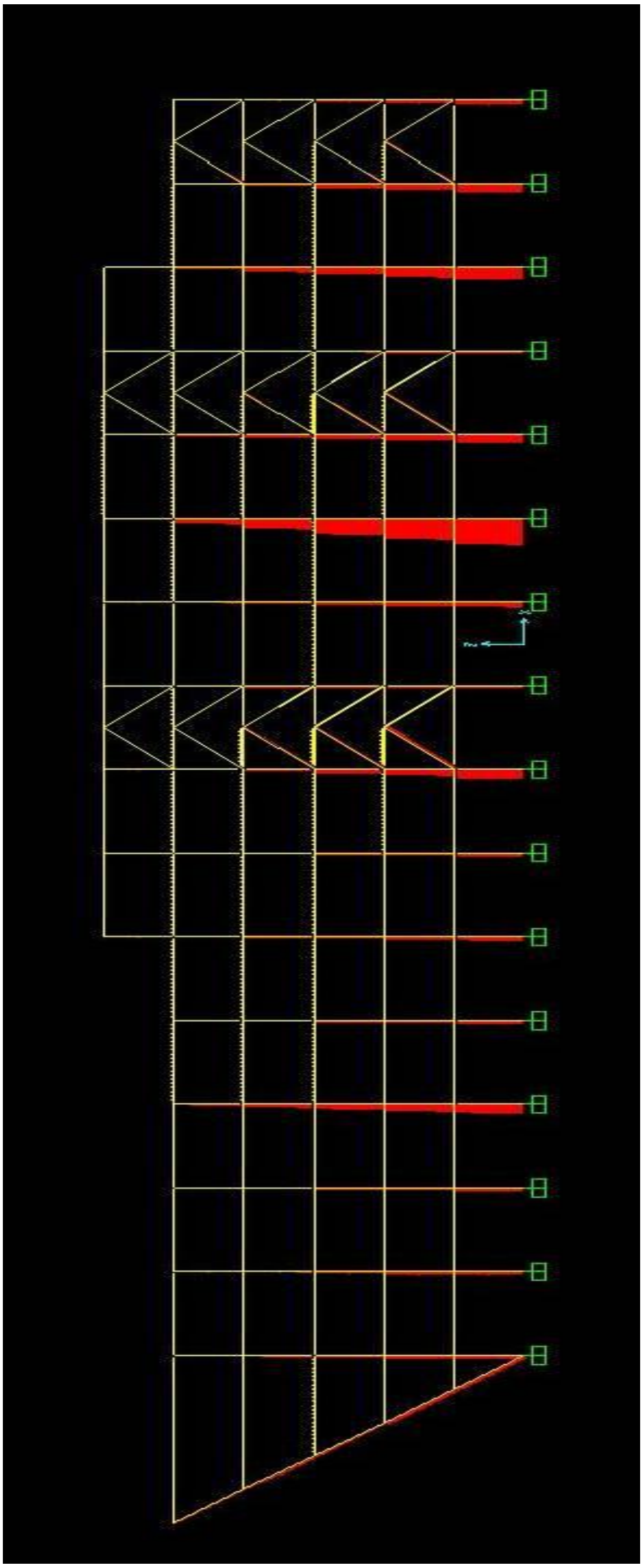


Figure 213 Axial Force Diagram – Comb-5

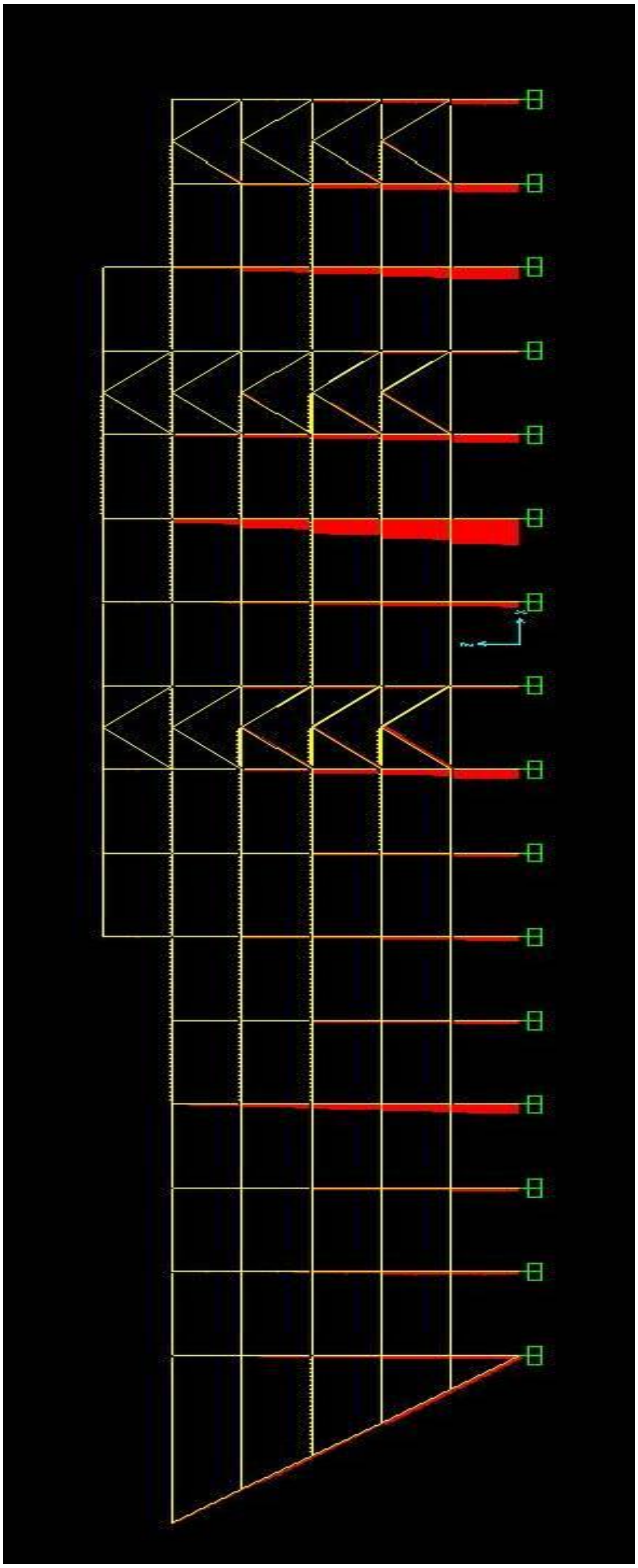


Figure 214 Axial Force Diagram – Comb-2

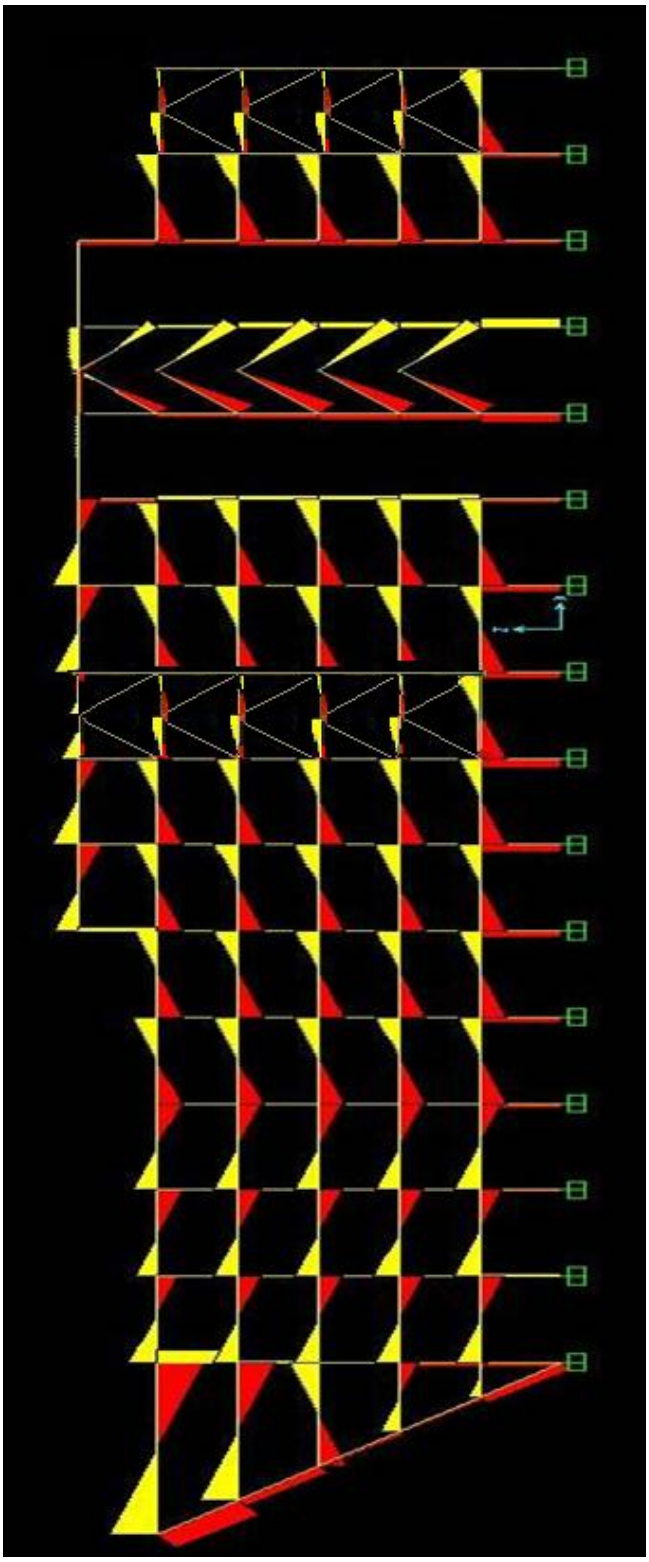


Figure 215 Shear Force Diagram – Comb-2

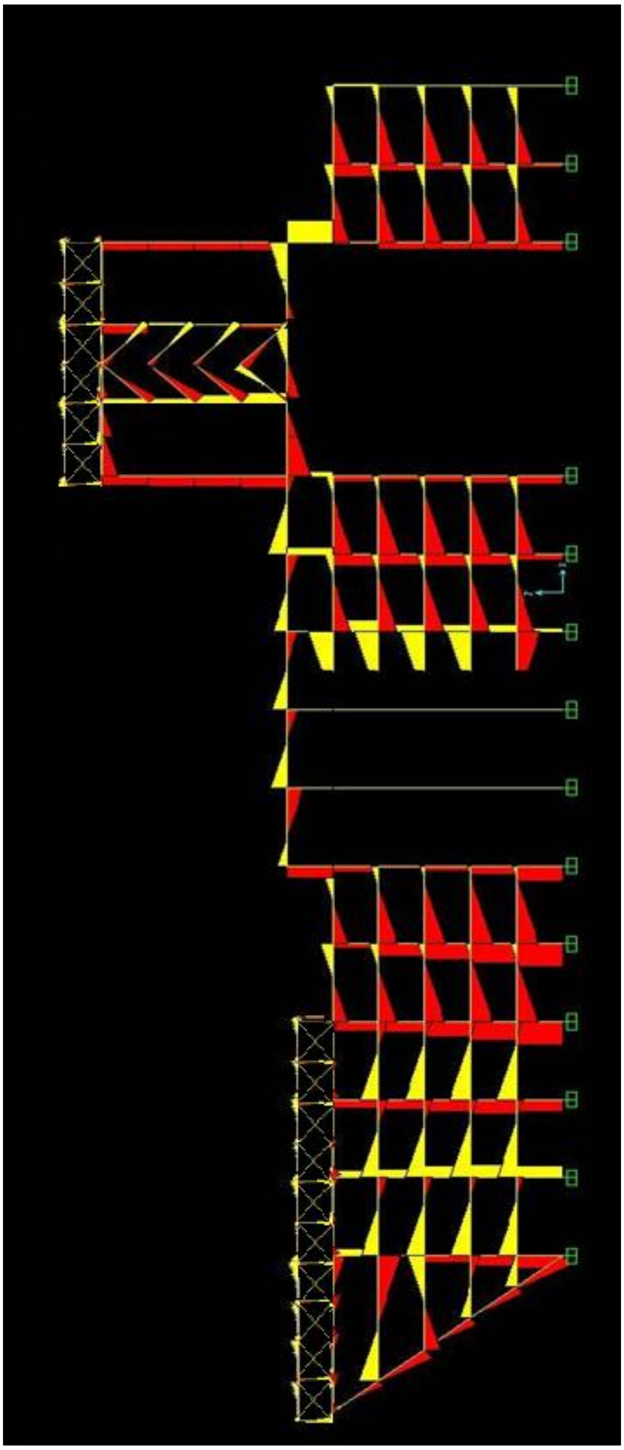


Figure 216 Shear Force Diagram – Comb-3

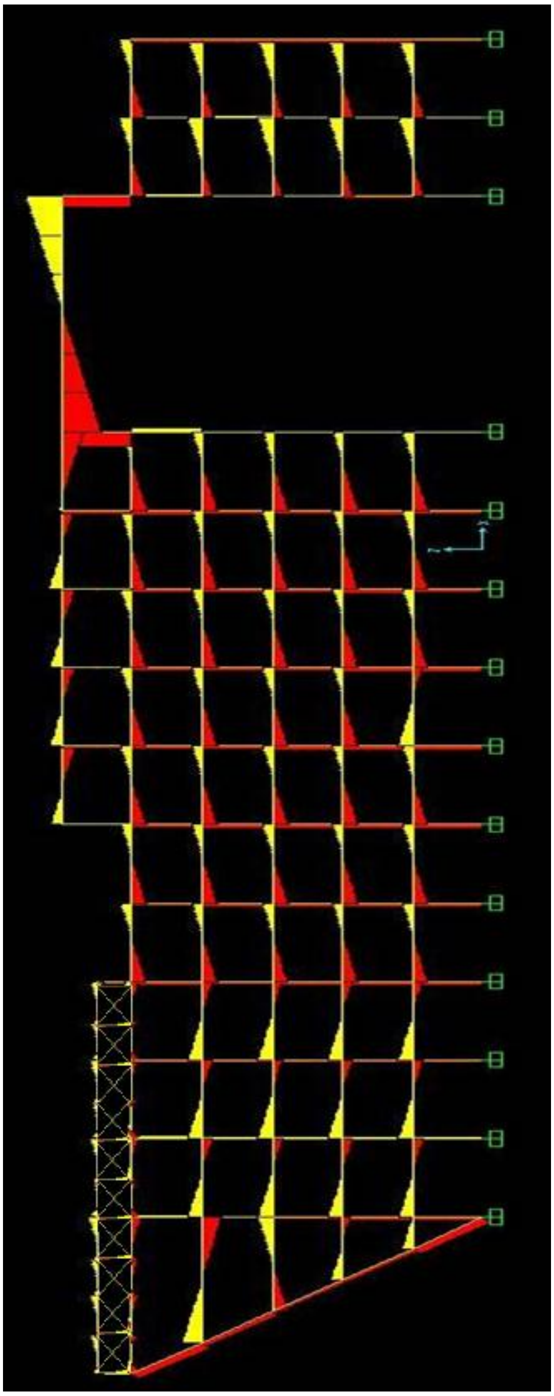


Figure 217 Shear Force Diagram – Comb-4

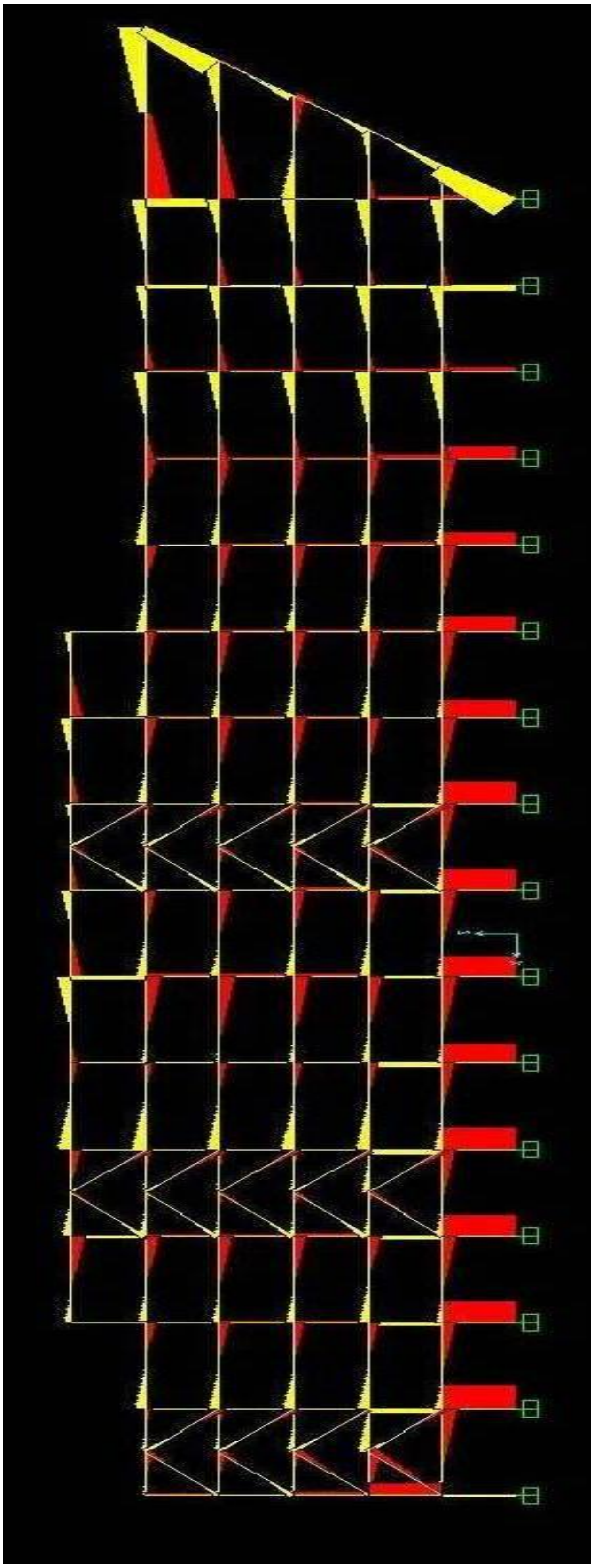


Figure 218 Shear Force Diagram – Comb-2

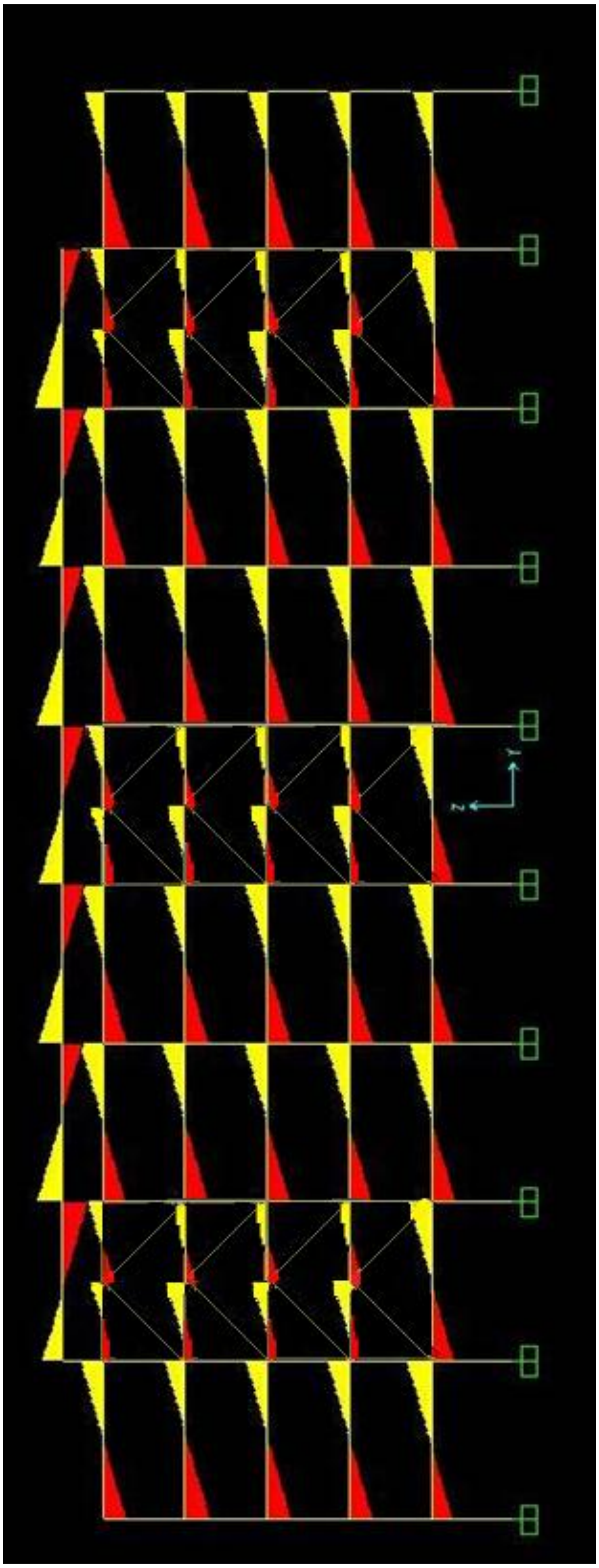


Figure 219 Shear Force Diagram – Comb-4

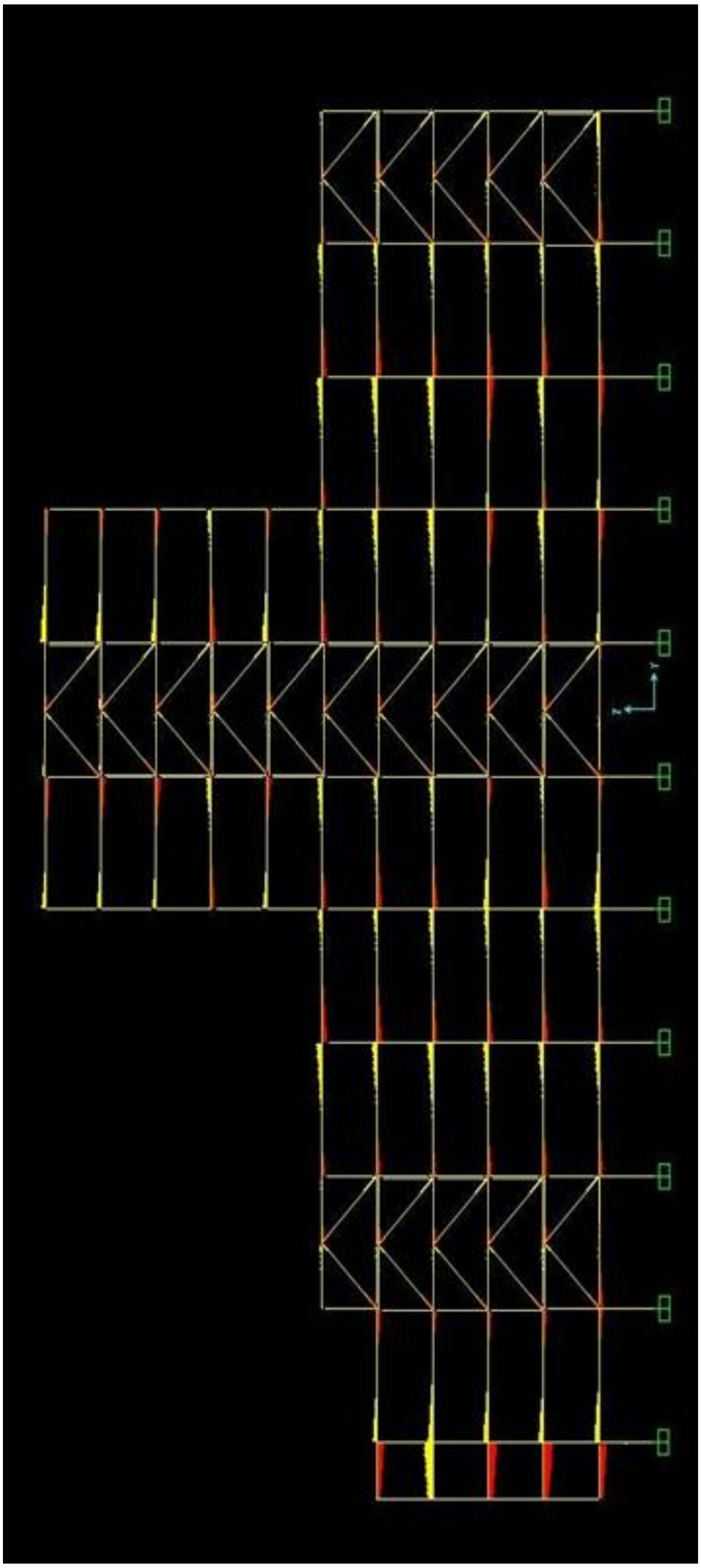


Figure 220 Shear Force Diagram – Comb-1

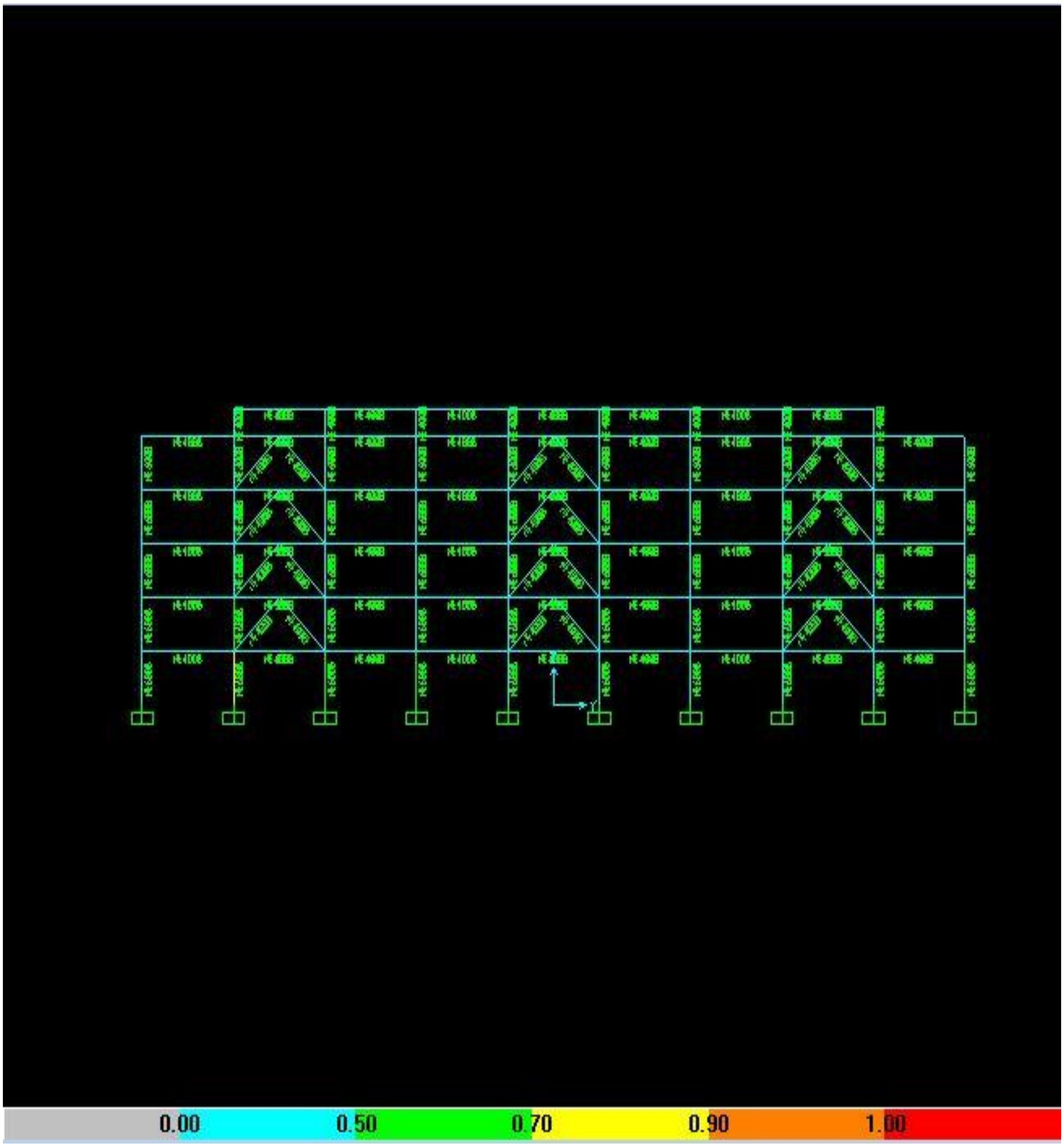


Figure 221 Design Check – Frame 1

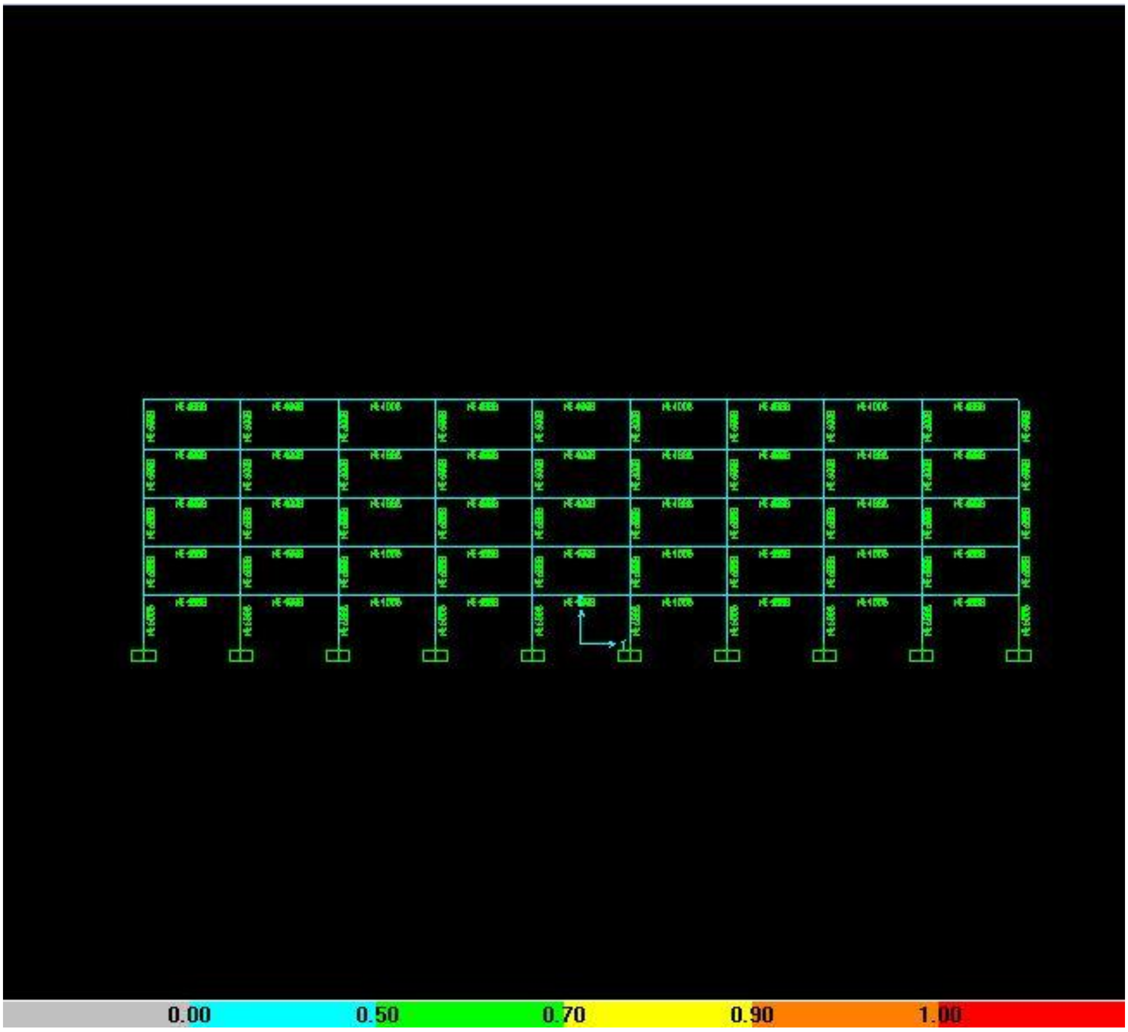


Figure 222 Design Check – Frame 2

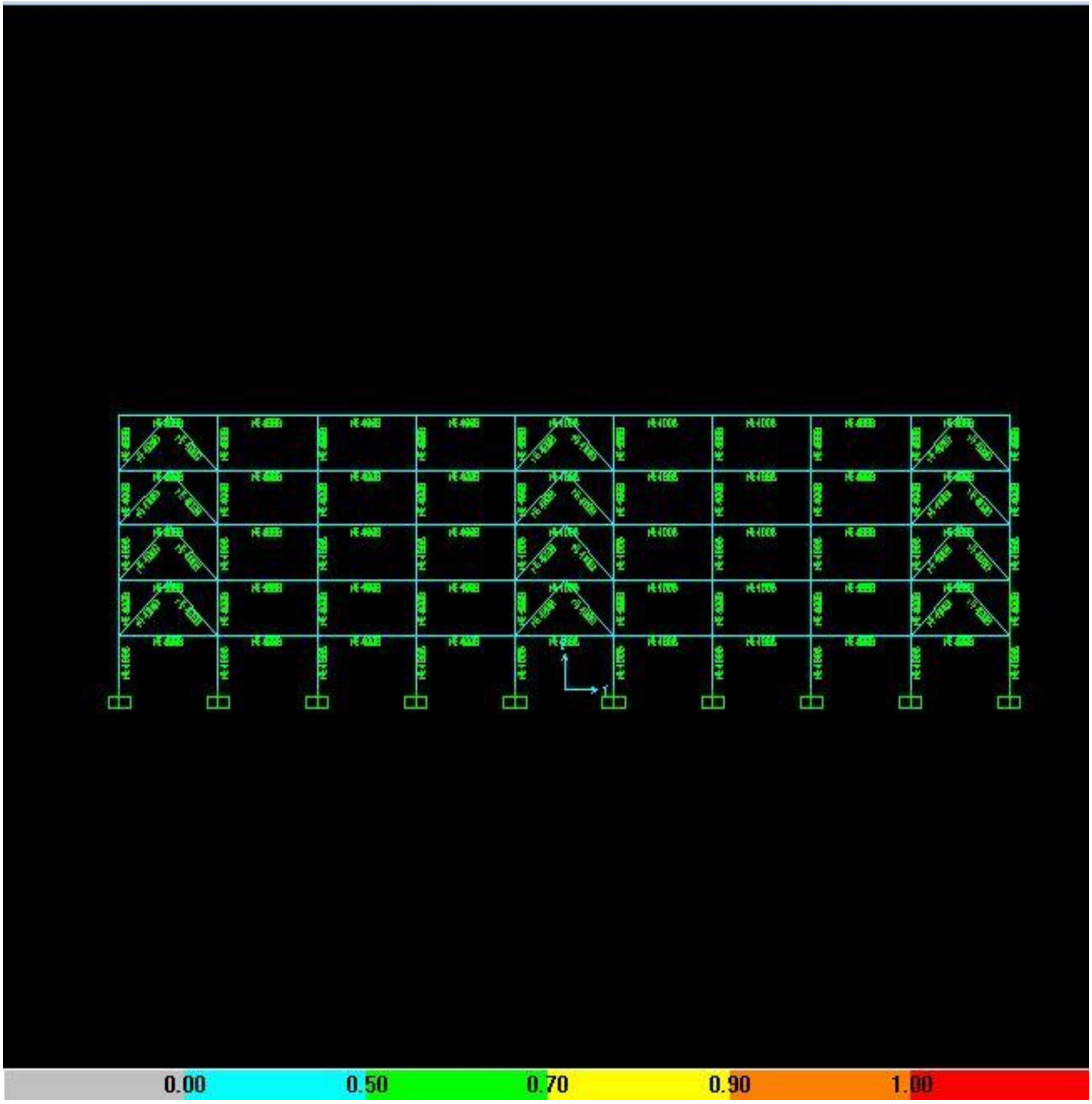


Figure 223 Design Check – Frame 3

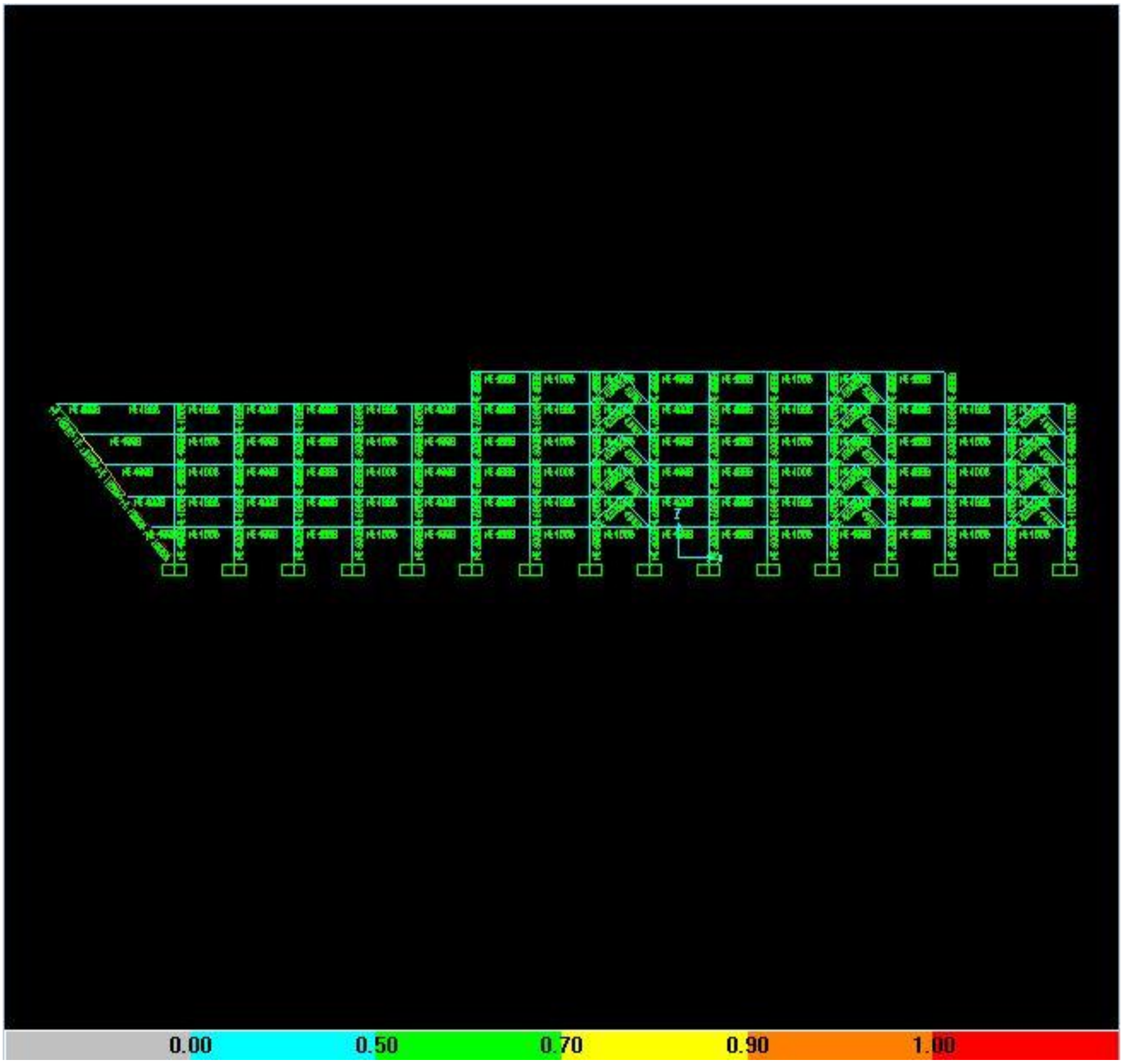


Figure 224 Design Check – Frame 4

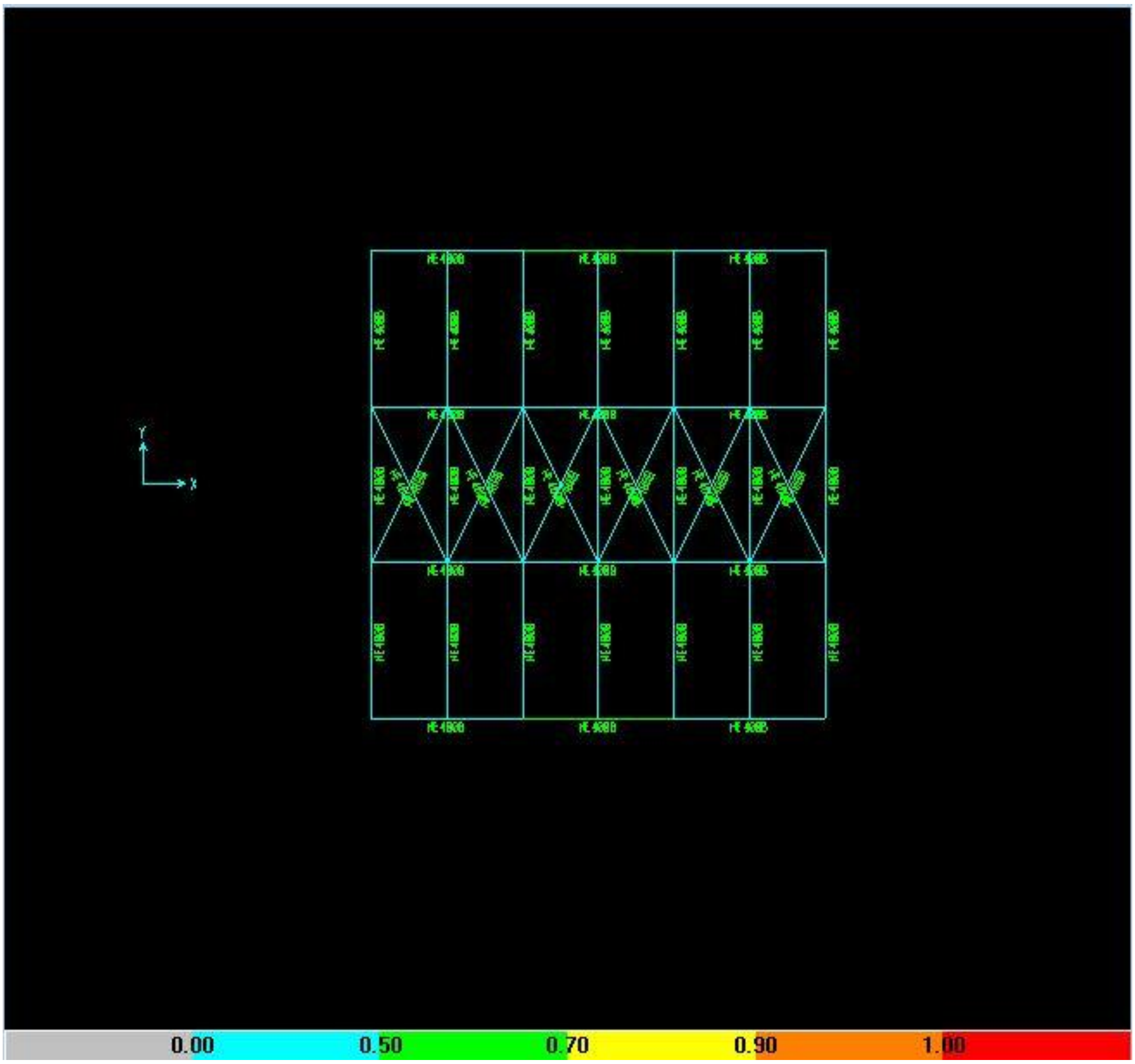


Figure 225 Design Check – Plan view

6.6 STRUCTURAL DETAILS

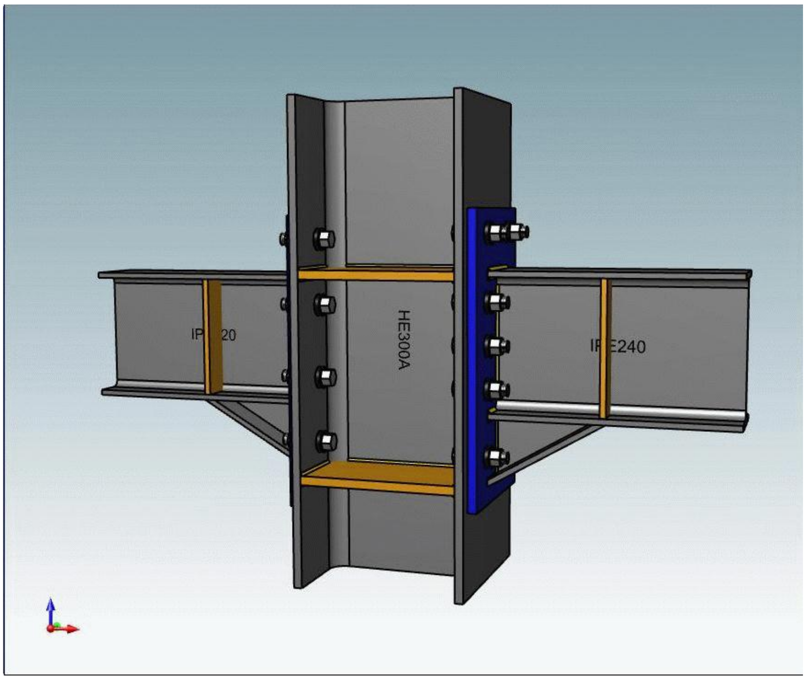


Figure 226 Beam-Column Connection detail

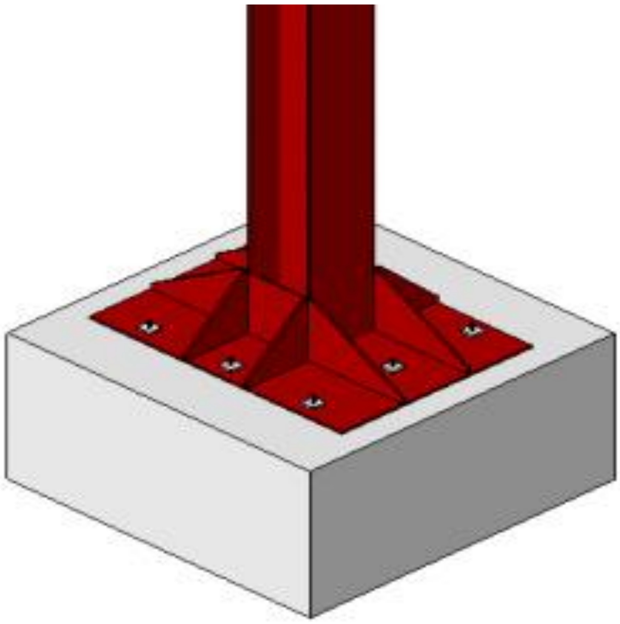


Figure 227 Base plate Connection detail

LIST OF DRAWINGS