Politecnico di Milano

Polo Reginale di Lecco

Faculty of engineering

Master of Science in Architectural Engineering

Sport Center in Garlate, Italy

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It is highly honored for us to give thanks to all those who gave us the possibility to complete this thesis.

Special individual, our supervisor, Ezio Riva should be mentioned, without whom, we would never have completed this work. Furthermore, Professor Danilo Palazzo, Professor Liberato Ferrara and Professor Oscar Pagani helped us a lot.

We spent many hours engrossed in discussion and from these communications we learned a lot about application of building technical process and science. These help, stimulating suggestions and encouragement helped us during all the time of design for and writing of this thesis.

We will not forget our colleagues having studied for 2 years in Politecnico di Milano. We want to thank them for all their help, support, interest and valuable hints. Especially, we would like to give our special thanks to our parents whose patient love enabled us to complete this work.

Let’s make a challenge to the wider world and let’s be person whom others need even if this sentence is general.

Wang Ruqian,

Zhang Yunfei

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Chapter 1

Sport Center in Garlate, Italy

Introduction

1 Introduction

1.1 Statement of Project

Our thesis work is coming from the course 'Conservation and Refurbishment' we had during our master degree study in Politenico di Milano. The context of this course is about a study case award, which is named as 'Paolo Milani'. Its essence is a competition for upgrading the area called Pratogrande, which is located in the Garlate Town. During the course under the supervision of our professor and following the instruction on the brief roughly, we made a preliminary urban plan and architectural design. Later on, we decided to develop and complete the whole project so that it becomes our graduation thesis.

This competition is launched by the Regional Lecco Campus of the Politecnico di Milano, supported by the Facoltà di Ingegneria Edile Architettura, the Community of Garlate and the Pratograndes.r.l, which is the owner of Pratogrande Sport Center. Its aim is to give a new and modern value to the Pratogrande area and the Garlate community. There are two main issues that should be considered in the project. First issue is the refurbishment and to give a new functionality of the existing Pratogrande Sport Center buildings; The second is to realize a new modern Center of Municipality and the region dedicated to sport, wellness and health considering the coordination of the open air facilities, the public areas and the Community Sports Center (referred as Comune Gym) nearby as well as the Pratogrande Sport Center.

Moreover, the project is required to show sensibility to the sustainability, to the relationship between the natural and urban

context, and also to the access for disable people to the sport facilities and to all the green and open areas.

According to the announcement of competition, two kinds of requests are mentioned in detail:

a. Functional schedule for the Pratogrande Sport Center refurbishment

b. Functional schedule for the public area and for the Community Sport Center project

According to those two function schedules, we proposed our project with two steps accordingly, one of which is urban design and followed by refurbishment (architectural design).

From the scope of urban design and according to the requests described in competition brief, it is desired to coordinate all the existing and new sport facilities (public or private owned) and unify them in one unique project dedicated to sport and leisure activities. An area highlighted by comune as VS1 (shown in Figure 1.1), should have the function for sport activities. Within this area, some part is already used for this purpose in which the Comune Gym was realized many years ago.

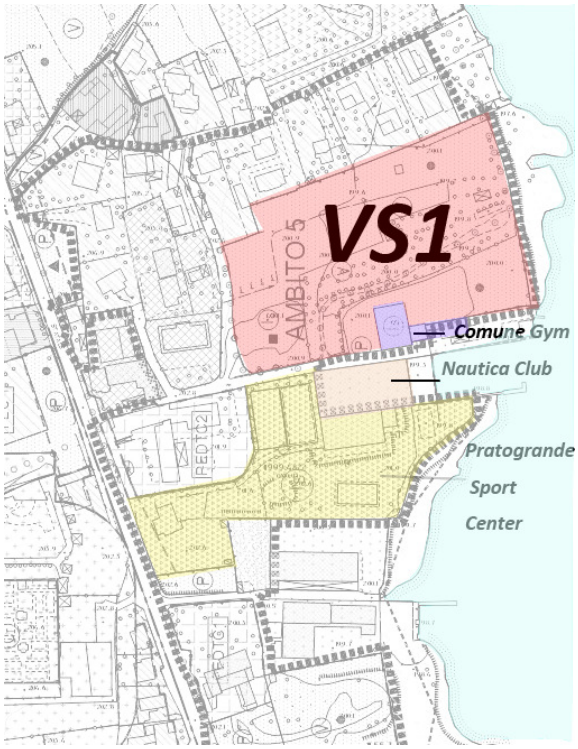


Figure 1-1 Location of VS1

As the Comune Gym was built in 1970s and it is in quite poor condition, several improvement and enlargement is needed. Additionally, some other outdoor activities can be foreseen in this area, which is listed below:

- Lake decks for mooring of canoe related to the canoe competition area of Pescate- Garlate
- BMX bike trail
- Bike and pedestrian trail to be connected with the existing one
- Open air areas for cultural and leisure activities to be used by the Garlate Community

It is required to offer residential facilities around the Pratogrande land

and some attention should be paid:

- Road connections, different trails and path, different levels to make to accessibility of the area easy, safe and comfortable.

- Controlling and preservation of the existing natural and vegetal richness and characteristic shall be included within the new green area project.

A master plan is developed aiming to fulfill the requests from Garlate Community as mentioned above. Detailed description and design will be provided in the Chapter 2 Urban Design.

Contrast to the scope of urban design, a small scale which is focusing on architecture is analyzed. In the area of Pratogrande sport area, what exists is: a doorkeeper home and a concrete building with indoor swimming pool. According to the brief, it is considerable to demolish the doorkeeper home. A refurbishment and enlargement work is needed for the concrete building due to its limited capacity to provide services. The concept is to give the chance to make the sport facilities upgraded with more space dedicated to the wellness center, to kids play and leisure activities. The upgrading activities are due to the reason that:

- The existing building cannot meet the needs any more regarding to the function and capability.

- It is built in 1970s, so that it is relatively old and refurbishment and improvement should be done.

In order to design the project with respect to the requirements, it is necessary to have some analysis on the basic information of this area.

1.2 Location

As it may be found in the Figure 1.2 below, Garlate Town is located in the Italian region Lombardy (highlighted with red in the upper right atlas), in which three distinct natural zones can be fairly easily distinguished: mountains, hills and plains. Besides, a large number of rivers, all direct or indirect tributaries of the Po River, cross the plains of Lombardy. One of the major outlets of Po River is Adda River, which feeds Lago di Como. It has been a popular retreat for aristocrats and wealthy people since Roman times, and a very popular tourist attraction with many artistic and cultural gems.

Figure 1-2 Location of Garlate Town

Located on the west coast of Lake of Como and as it always happens, for example Lake of Lecco (which does not exist but is only a part of Lake of Como), the water domain of Lake of Como within the scope of Garlate, is named as Lake of Garlate. It is located only six kilometers south of Lecco while about forty kilometers northeast away from

Milan, escaping from the modern and fashion, but keeps the features of peace and nature.

1.3 Demographics

According to the statistical data from ISTAT (Italian Statistical Institute), as shown in the Table 1.1, recorded from 1861, in which Kingdom of Italy is established, until 2001, the population of Garlate is increasing steadily. This phenomenon is matched with the general condition in Lombardy in the same period, as you can also find in Table 1.2. A notable population booming during 1951-1981 can be noticed in both of tables. This may be due to the prolonged economic boom which caused a major rural exodus and strong immigration flows to Lombardy area where the development was remarkable comparing to the other parts of Italy.

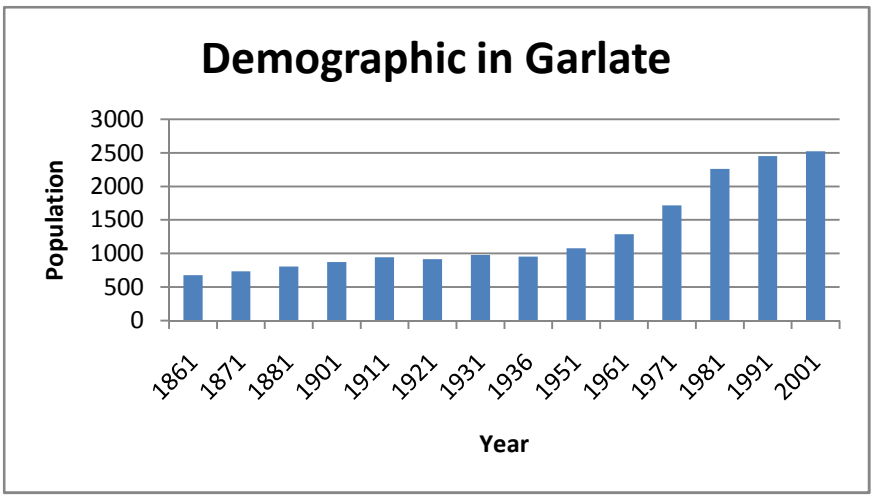


Table 1-1 Demographic in Garlate

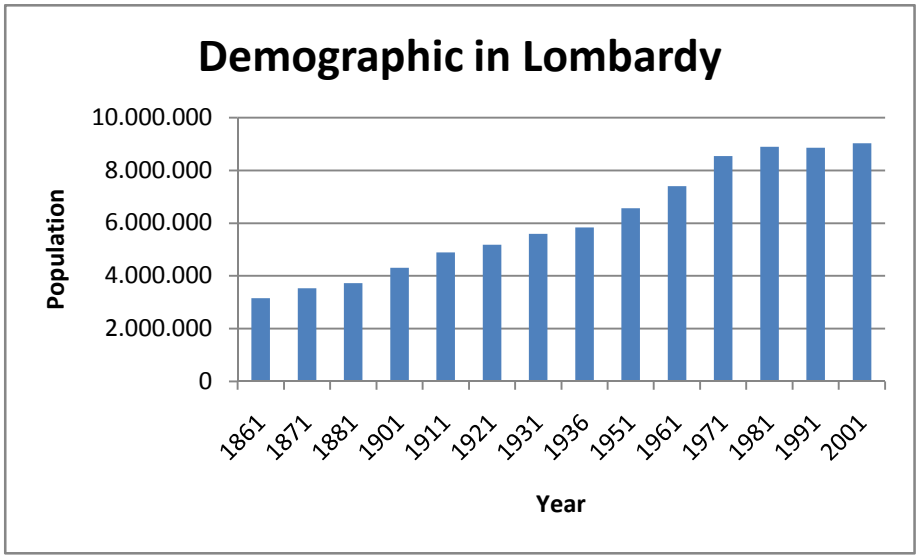


Table 1-2 Demographic in Lombardy

A study about Distribution per age is preceded as shown in the Figure 1.3. It is noticed that the main part of the total population is consisted by the people aged from 15-64. But having the same phenomenon as in the other parts of Italy, the new-born rate is quite low and portion of aged people is relatively high.

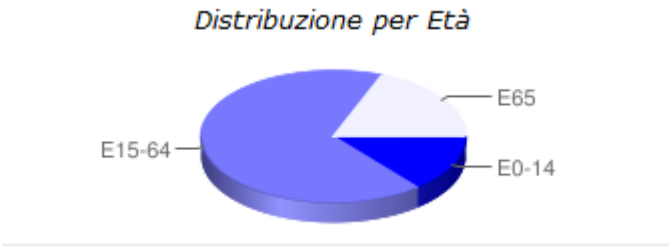


Figure 1-3 Distribution per Age in Garlate

The population booming phenomenon in Garlate can be also apparent if urban evolution of Garlate is studied. As shown in the Figure 1.4, main part of habitants closely lived in the yellow area before 1721 and in the next 130 years, very little residence highlighted in red is extended in the way to surround the main parts. However after 1938

until the data is published, around 2003, the resident distribution is widely spread as shown in purple.

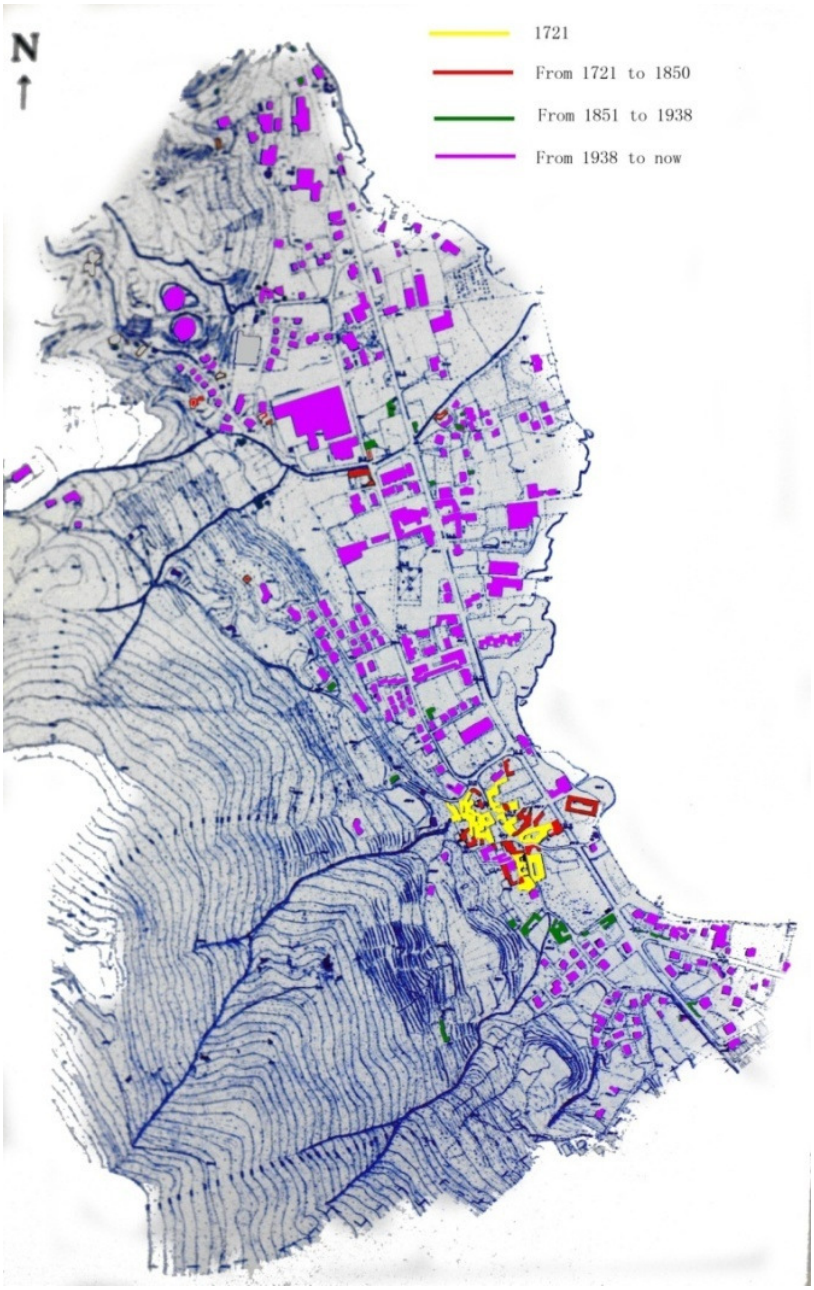


Figure 1-4 Urban Evolution in Garlate

According to the area division of Comune di Garlate, without surprise, the oldest residence area is defined as the center of Garlate, referring to the Figure 1.5. In the Figure, it can be seen that the whole area of Garlate is divided into 23 divisions and the largest one is the 'Centro' area and followed by the 'Pratogrande' area. These two areas are deemed to be the most important places for local culture and normal lives. Interesting thing is that our project area is within the latter one.

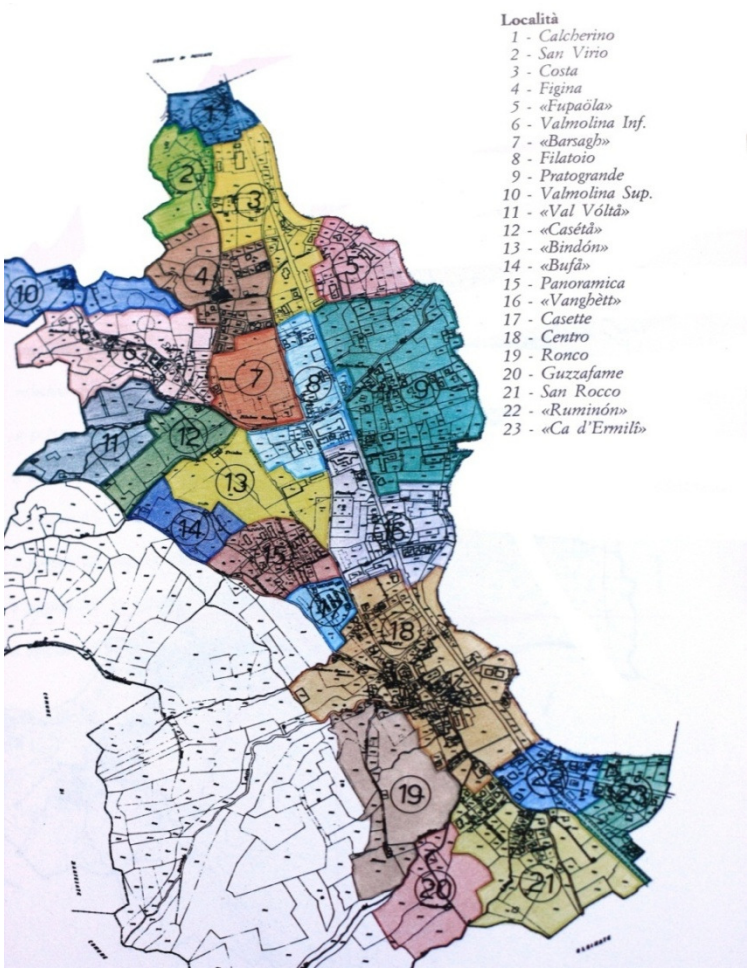


Figure 1-5 Area Division of Garlate

From the previous analysis of urban evolution, it is noticed that, due to geometrical limitation which means that Garlate is sandwiched by mountains and lake, the urban development has a clear axis shown in

Figure 1.6. It is about 30 degrees respecting to the north-south axis and in parallel, there is a provincial road which is the main road SP72 crossing vertically the whole area of Garlate. This road connects with Lecco from the north while extends to South, until Calco, which is a city near the regional park of Monte vechia della Valle di Cur.

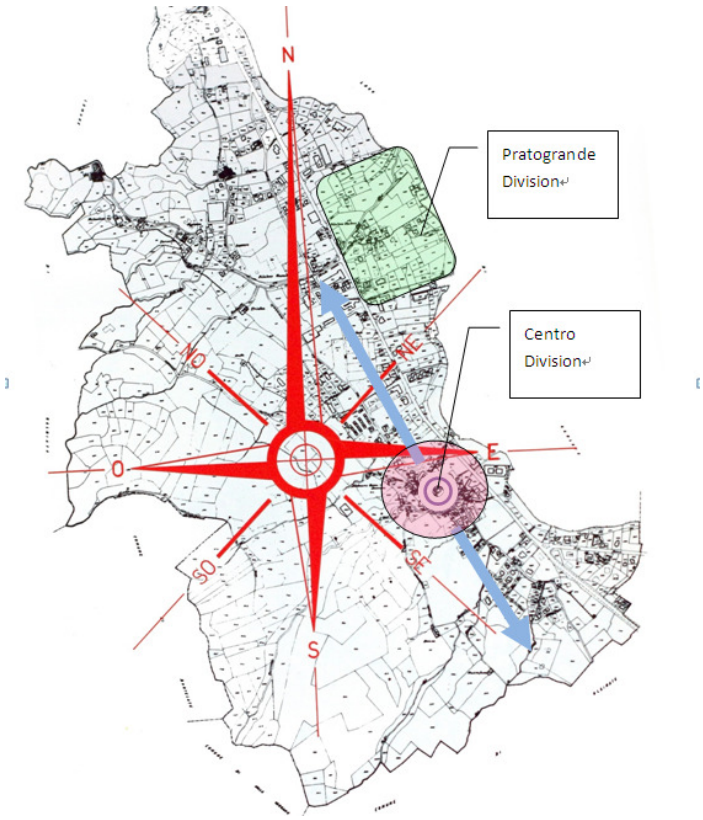


Figure 1-6 Urban Development Axis

1.4 Climate

According to the Köppen climate classification, Garlate has a humid subtropical climate (Cfa) feature. This climate is that, for the coldest months, mean temperature to be between −3 °C and 18°C the warmest month to be above 22 °C. For example in last year 2010, as indicated in the Table 1.3, the coldest month within the whole year is

December and the lowest temperature is -1.4°C. While during the summer time, in which period it is quite hot, the maximum temperature can climb up to 30.1°C. Another feature of humid subtropical climate is along the whole year, there is no any dry season.

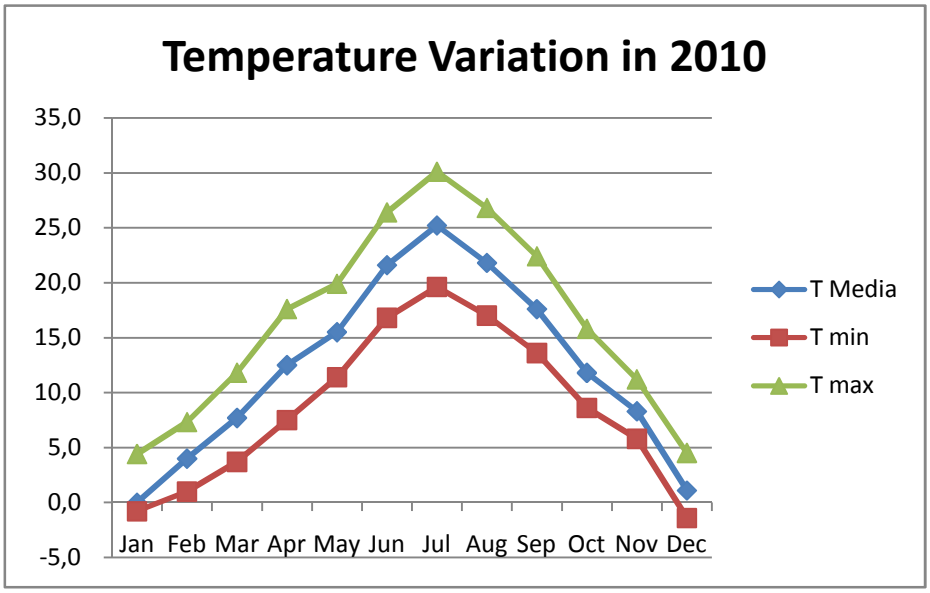


Table 1-3 Temperature Variation in 2010 of Garlate

If it is referred to the Table 1.4 in the next page, we can notice that the humidity is relevantly high especially in the winter time. Thus winters are not long, only around in December and January, but foggy, damp and chilly with occasional periods of frost from the siberian anticyclone; spring and autumn are well marked and pleasant, while summer can be quite oppressive, hot and humid, with sudden violent hailstorms.

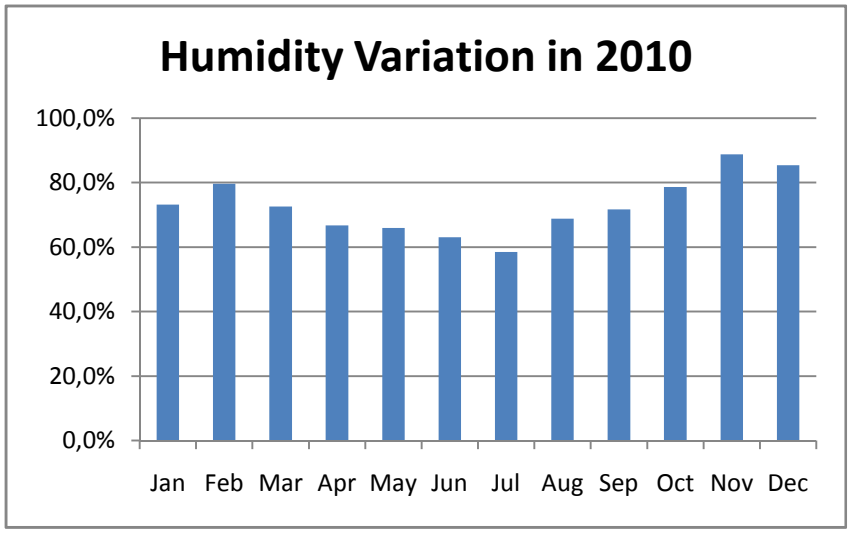


Table 1-4 Humidity Variation in 2010 of Garlate

Another remarkable phenomenon is that, for example as shown in the Table 1.5 according the data in 2010, the daytime duration can be quite long during summer time. This kind of climate gives the maximum possibility for people to enjoy the sunshine and outdoor activities.

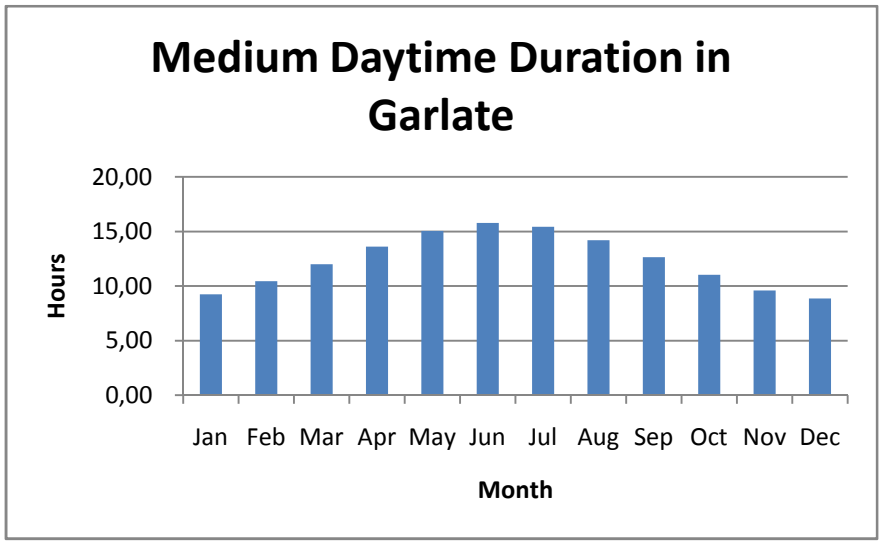


Table 1-5 Medium Daytime Duration in Garlat

Chapter 2

Sport Center in Garlate, Italy

Urban Design

2 Urban Design

As mentioned in the Chapter 1 Introduction part and according to the general analysis, we consider those requirements related to the public interest as part of the requests from the City Administration. What we should repeat and emphasize again is that, from the studying on the brief, it is noticed that the Garlate Community is interested in the project which can coordinate all the existing and new sport facilities (public or private owned) and unify them in one unique project dedicated to sport and leisure activities.

Due to this purpose, it is desired to provide some other activities that are needed to be included or provided in this area:

- Lake decks for mooring of canoe related to the canoe competition area of Pescate- Garlate
- BMX bike trail
- Bike and pedestrian trail to be connected with the existing one
- Open air areas for cultural and leisure activities to be used by the Garlate Community

It is also required to offer residential facilities around the Pratogrande land; with the purpose of developing the full area with a unique aim and concept.

Besides several requests mentioned above, more things are requested to pay attention:

- Road connections, different trails and path, different levels to

make to accessibility of the area easy, safe and comfortable.

- Controlling and preservation of the existing natural and vegetal richness and characteristic shall be included with the new green area project.

2.1 Urban analysis

This part is aiming to proceed an analysis on land use, mobility, green area distribution in order to have a general idea about the project area that we are focusing on. Moreover the study of existing social facilities and public spaces are accomplished based on the information collection and site survey.

2.1.1 Site analysis

1) Land use

As it can be read from the graphic document shown in the Figure 2.1, which describes the land use of Garlate, the historical town center is surrounded by a relative high density residential system while and the north part of Garlate is characterized by industry infrastructure surrounded by lower density residential buildings.

In the following Figure 2-1, a detailed land use in the vicinity of our project area is indicated with different colors.

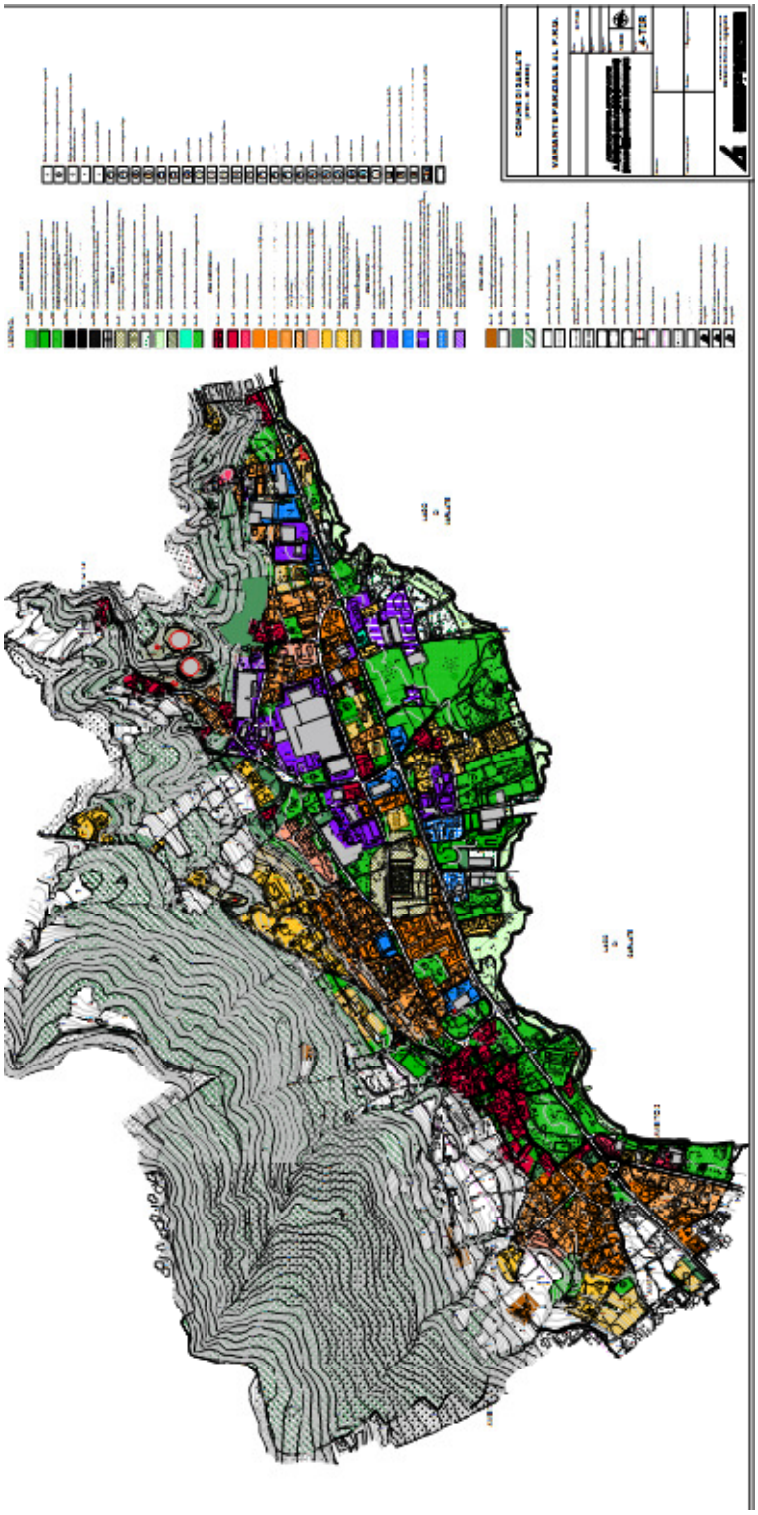


Figure 2-1 Land Use of Garlate

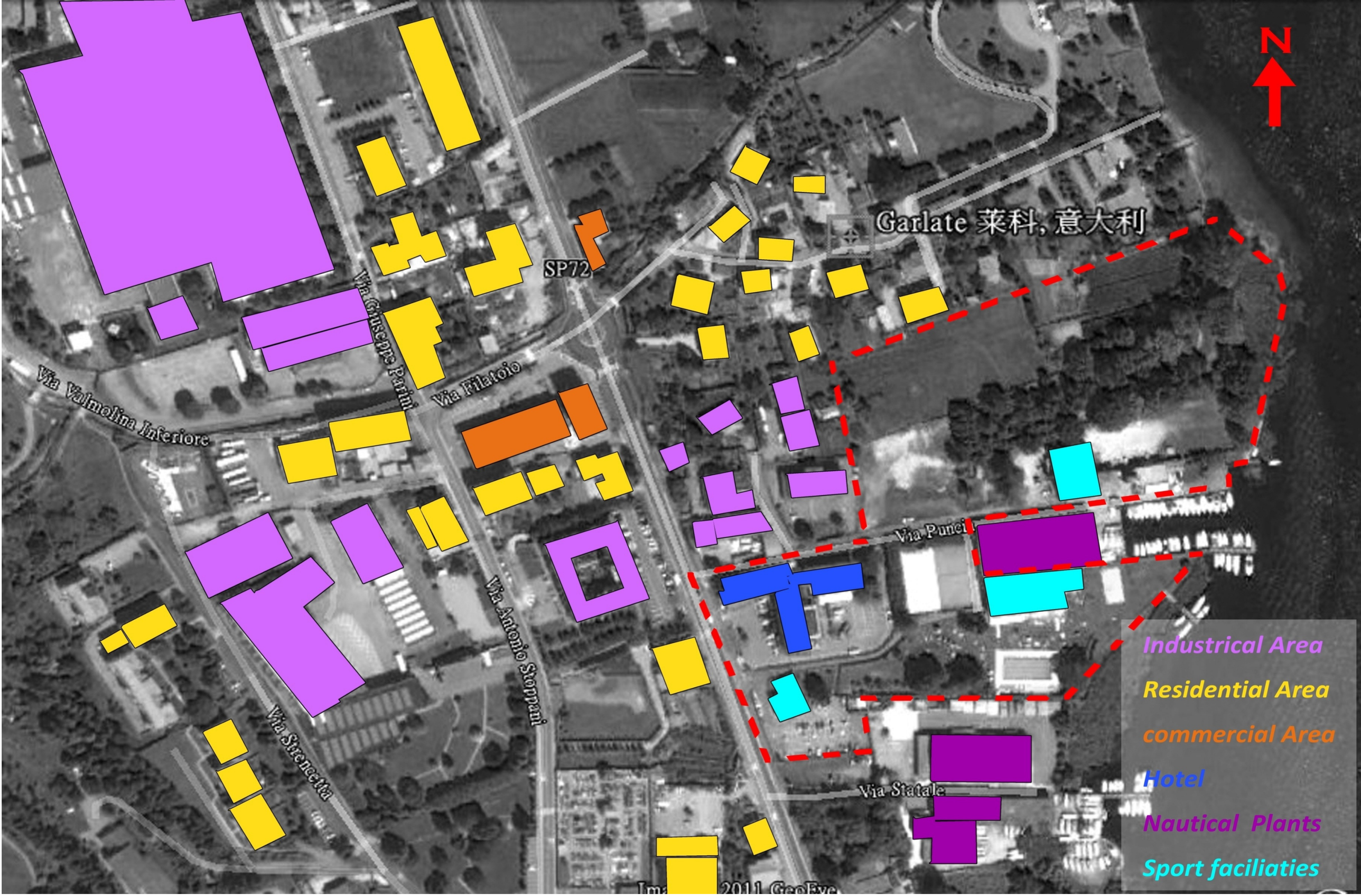


Figure 2-2 Land Use in the Vicinity of Project Area

2) Transportation systems

According to the picture below in Figure 2.3 , it is immediately perceived that the presence of major road links not only constitute a meaningful part of a local road network but are key elements of the comprehensive road network. The most important connection is the provincial road to Lecco (SP n. 72), road to Olginate (SP n. 59) and the road to Garbiate. As in the previous analysis, a detailed exposure in the vicinity of our project is presented in Figure 2.4. ,

These links are added with secondary arteries, leading to local interest, but which, by their design, are often used as a simple way of preferential crossing by those who, in transit, trying to avoid traffic on major arteries, especially when the latter are overloaded. Below are the brief introduction and analysis of these links.

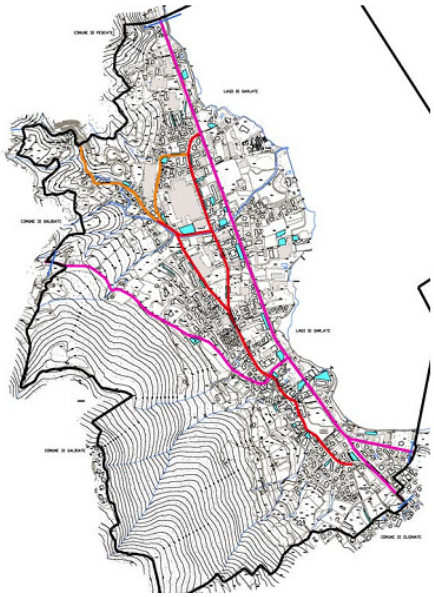


Figure 2-3 Transportation System in Garlate

Figure 2-4 Transportation System in the Vicinity of Project Area

• **Provincial Road No. 72**

Connecting Lecco with the Milan area - This artery runs through the territory of the town from north to south, dividing the municipality in two parts, one of which is the flat area on the lake, another one is at the base of the hill.

In the south of municipality there is the way for Olginate Road to Garbiate - This road branch goes off from the SP No. 72 and after a stretch in which the first through the center of Garlate develops with a typical mountain path, up the hill behind the town and reaches the border of town of Garbiate.

• **Provincial Road No. 59 to Olginate.** This artery follows the lakeshore intersection with the SP 72 in the direction of Olginate.

• **The multiple intersections with urban roads**

They have, over time and with the increase of traffic flows caused inconvenience to both urban activities carried out in centers crossing both the smooth flow of vehicles traveling along and going along still the main road.

The path of interest is through the landscape of the whole city from north to south through the historic center. Some significant views to the lake are present just south and north of the city center, as well as at the municipal boundaries

3) Bicycle Trail Systems

For several years and now existing throughout Italy, a heartfelt request to improve the use of alternative means to the car is increased. This does not mean to replace the cars, but how to

create other means, such as cycling. The bicycle, excellent means of transport for environmental, could play a role in commuting a short distance, enjoying leisure and sporting activity recreation. Several studies have shown that there are countless opportunities to travel daily within two or three kilometers for business, education, leisure etc. Within this margin the use of a bicycle if supported by a secure location, is undoubtedly beneficial. Moreover, even if marginally, it would reduce the factors of traffic congestion and consequently, the volume of pollution from exhaust gases.

Due to the reason mentioned above and the motivation for enhancing the development of bicycle route, the Province of Lecco has already started an analysis on its feasibility. This kind of study and politics encouraged the individual behavior for less impact on environment and also to increase the tourism.

As it is shown in the Figure 2.5 below, the existing bike trail system in the Province of Lecco is highlighted in red. The bike trail that passes in the town is linked to the main bike trail system, which connects the whole complex of Lecco Lake. This bike trail system connects all the towns on Lecco Lake complex by other trails, going from Calolziocorte in the South, to Colico at the top North of the lake. As it may be noticed, this trail system does not pass Garlate, but is only connected with the city bike trails of Garlate via a bridge.

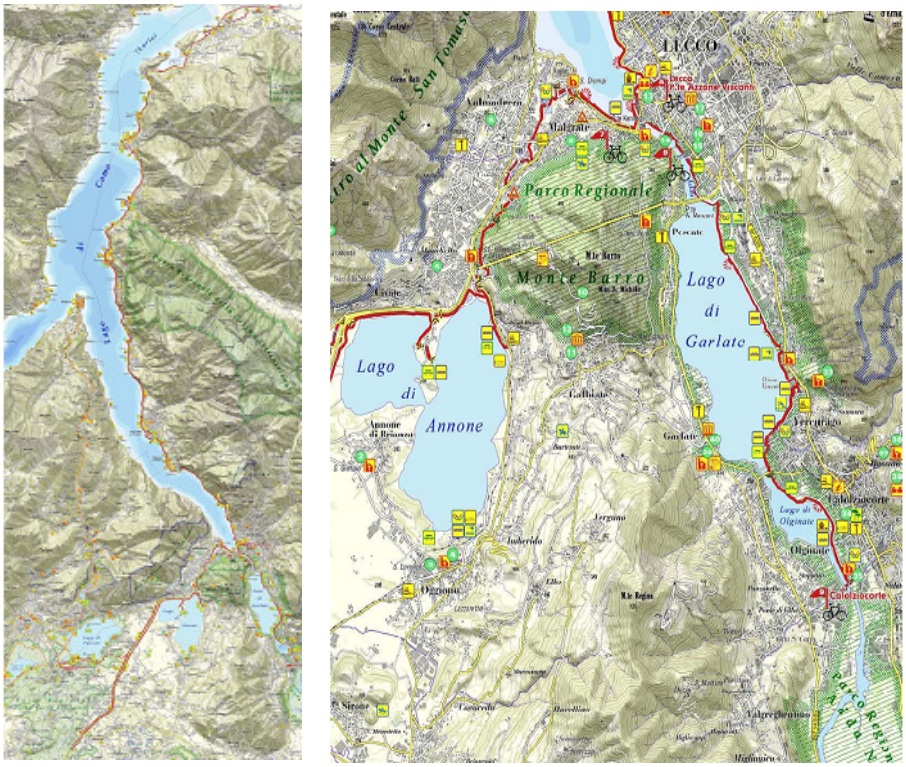


Figure 2-5Existing Bicycle Route in Province of Lecco

However in March 2007, the Provinces of Bergamo, Brescia, Lecco and Milan have reached an agreement on the establishment of a cycle routeshown in the Figure 2.6 and 2.7 connecting the cities of Milan, Lecco, Bergamo, Brescia through the parks of Adda Nord, Brembo, Serio and the Oglio Nord to the pre-alpine lakes of the Lake Sebino and Benaco. A schematic view is presented in the figure below.

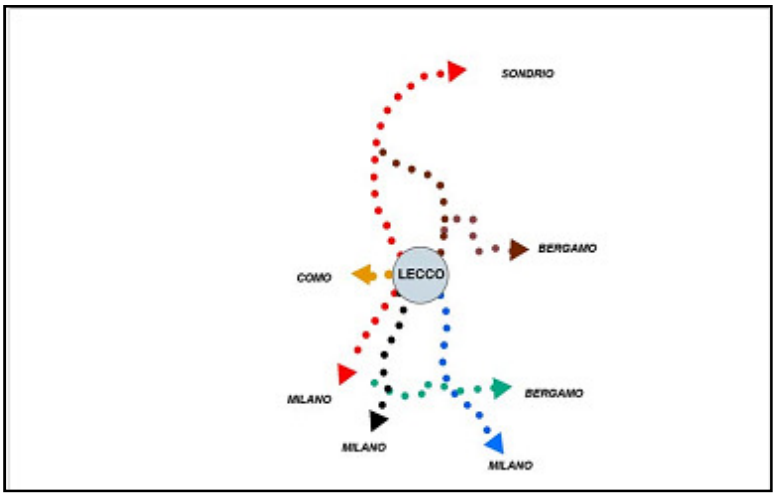


Figure 2-6 Schematic Route in Plan

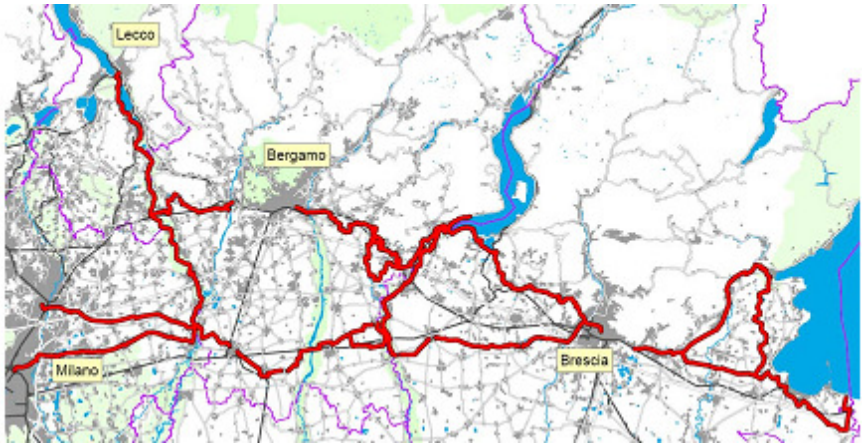


Figure 2-7 Scheduled Route

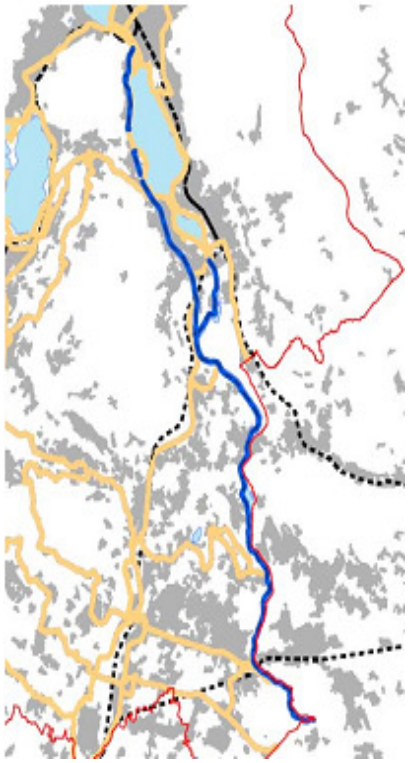
One of the two types of route in the agreement is to connect the North Lake of Garda in Brescia, Lake of Iseo in Brescia and Bergamo Adda. The system will give access to both Milan and Lecco.

There are 18 itineraries in the plan, and Garlate is related to 3 of them as shown in the Table:

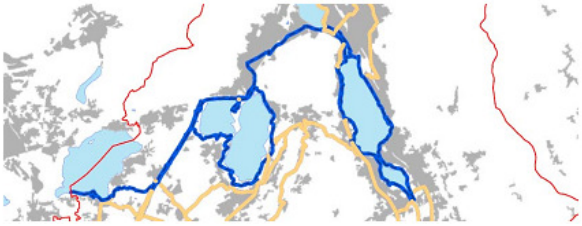
- Valle dell' Adda. Total length is 25.9km; the length of route in Garlate is 1.6km.

- Circuitazione dei Laghi Briantei. Total length is 48.2km; the length of route in Garlate is 3.0km.

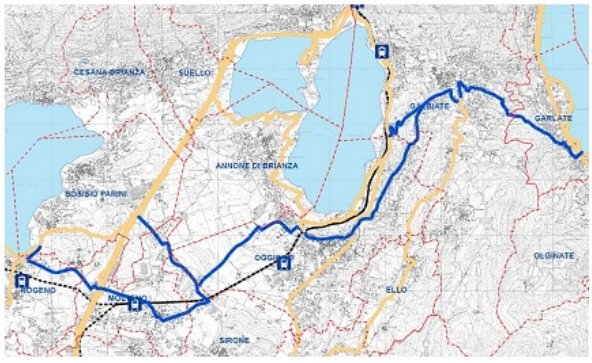
- Collegamento Laghi Briantei. Total length is 18.3km; the length of route in Garlate is 1.7km.



Route of Valle dell' Adda



Route of Circuitazione dei Laghi Briantei



Route of Collegamento Laghi Briantei

Table 2-1 Routes through Garlate

Consequently, as it can be noticed in the plan mentioned, the urban design of bike trail is quite an important aspect for Garlate and consideration should be taken during our project.

4) Green space

In Garlate there are three kinds of Green space as listed below, which are also shown in Figure 2.8:

- Landscape of pasture grass, as these within the wooded areas, or existing in the urban fringe areas of the town and the forest itself. (Indicated as dark blue in the picture below)

- Woods and hardwood forests characterized by the mountain slopes. (Light green)

The wooded areas and the areas covered predominantly by vegetation and trees bring natural, environmental, landscape and ecology features. These areas are ecosystems that having function of key element for balancing ecology. The wooded areas are of most importance in the west of municipality, hilly and mountain-side. However isolated areas are irregular in the north, the boundary of municipal, along the lake and the area bounded by the North Adda Park. These areas represent the traces of an ancient habitat consists of trees and vegetation of the swamp. Overall, the wooded areas cover 40% of the municipal area.

-In the third landscape, (in yellow color),described as "fringe fields and agricultural areas", it is possible to develop urbanization within the suture of vacant spaces that are already developed with internal contexts, or with the modest expansion of the existing building, in the case of outdoor areas, bordering with the built-up areas.

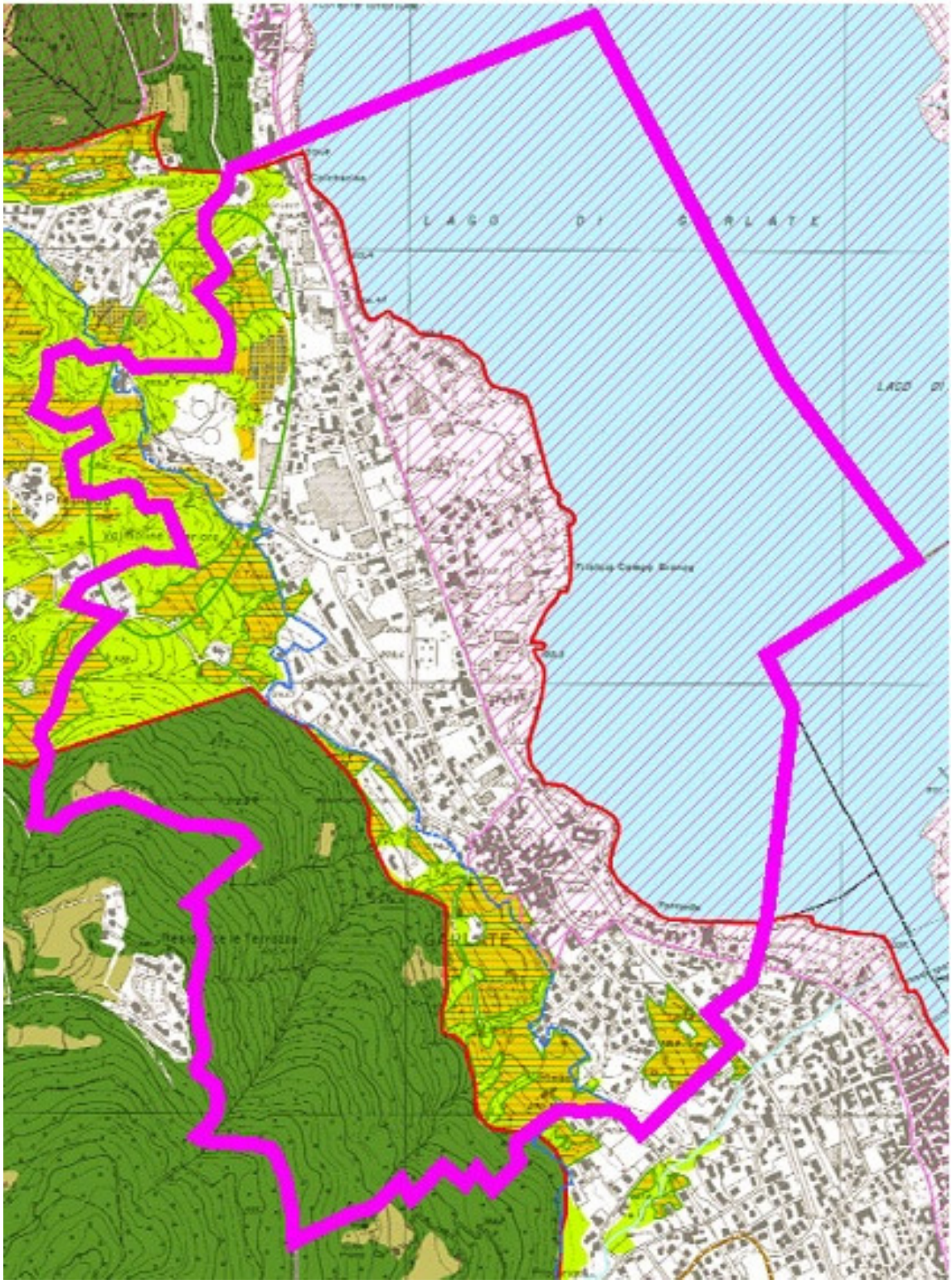


Figure 2-8 Green Area Distribution and Boundary of Garlate

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5) The Elements of Historical Architecture

The elements of historical architecture in Garlate:

- The old towns and the rural villages. In addition to the original accent center of Garlate, dating from the fifth and VI century D.C., there are 4 other centers of some significance: Figina, Upper part of Valmolin, Lower part of Valmolin and Calcherino.

- The civil and religious architectural buildings which are the most significant from the historical and artistic point of view

a) Chiesa Parrocchiale di St. Stefano (built up during early Christian and late Roman). The current structure dates back to 1896 and includes the transept and apse added to the old nave. The main facade, facing east and built in 1800, replaced the apse of the structure in 1600. Close the church it is an octagonal baptistery.

b) Oratorio S.S. Cosmas and Damian. There are not certain dates about construction or renovation. In early 1900 there was a porch on the left. The Interest is the colonnade of the portico.

c) Palazzo Gnecchi (former rectory): building dating back to 1500, faces to the lake and havs windows constructed in eighteenth-century. The balconies with decorative can date back to about 1600.

d) Villa Gada già Testori-De Capitani(XVII century). It 'a body of system consisting of the seventeenth-century villa and outbuildings with large park sloping to the lake. The villa is a long two-floored building with rectangular windows, with a balcony above the entrance and wrought iron railings. The concierge is

built in nineteenth century.

e) Palazzo Abegg, Town Hall (XVIII). The building dates back to 1860 and was built by a Gnecchi with a late-neoclassical style. The courtyard and the portico are of 1800s. From the grand staircase, the access to the private is given.

f) Civico Museo della Seta Abegg (XIX century). It was part of the mill and was used partly as offices and partly for the work. Interest is the meridian painted on the main front in 1841.

g) Giazzera Via Marconi. Century. XVIII, until 1930 was used to preserve meat.

h) Curt Checu of the House of Lords and merchant 1400.The portal of 1500 places Via Manzoni from the courtyard.

i) Palazzo Brini of the eighteenth century.

j) Palazzo Mantegazza, sec. XV - XIX.

2.2 Site Survey

As indicated in the Figure 2.9 below, our project area is shown and the boundary of this area is highlighted with color of purple. The figure also shows the main facilities within this area as listed below.

Figure 2-9Site analysis

1) Protogrande Sport Center was built in 1970s immersed in a park and it is surrounded by green and vegetation through all the lake side, creating a large natural park.

Figure 2-10 Pratogrande Sport Center

2) Hotel Nuovo which was recently refurbished, consisting with about one hundred rooms, a restaurant and a conference room.

Figure 2-11 Hotel Nuovo

3) Nautical Club Garlate built in the early seventies with a restaurant affiliated serving especially for the Club.

Figure 2-12Nautica Club

4) Comune Gym

It was constructed some decades ago and it does not attend the needs of the community. The building is already outdated and too small for the large number of users of the gym. Besides, there is a parking lot in the front of the entrance served for gym but it is without pavement and ground is uneven. Without ordered urban plan, its capacity is poor.

Figure 2-13Comune Gym

5) The vacant green area

To the north of the restaurant, there is a large area which is preserved with green vegetations and woods. The vacant area was kept as its nature and hasn't been used as any function.

Figure 2-14 Vacant Green Area

2.3 Summary- S.W.O.T Analysis

Summarized with the information collected and examined, an S.W.O.T Analysis is going to be presented. S.W.O.T analysis is a strategic planning tool used to evaluate the strengths, weakness, opportunities and threats involved in a project or in a business venture.

- **Strength**

- Competitive location, the project area is near the lake and surrounded by mountains with nice view and pleasant environment

- Vacant area is very large and well preserved

- The presence of the main road Via Statale nearby makes the whole area accessible and visible.

- **Weakness**

- Deficiency of parking areas

- Lack of barrier free design which means less consideration for disable is taken.

- The facilities within the area distribute in a form without compacting and a unique design is desired.

- **Opportunities**

- The vacant area in the north of Pratogrande, creating an opportunity to make a universal place serving for sport facilities.

- Pratogrande center is used by children of school for sport activities, according to the schemes of the City Administration.

- The lot in the south of Pratogrande Sport Center is on sale and the possibility to add more sport facilities in future exists.

- **Threats**

- The main road Via Statale has a heavy traffic with difficulty to connect the lake and the inner side of the city.

- Difficult connection with all the buildings dedicated to sport facilities

2.4 Design Concept

Based on the analysis above and the main task of the project which is to coordinate all the existing and new sport facilities (public and private owned) and unify them in one unique project dedicated to sport and leisure activities, generally we provide two points of view in our project concept:

1) To create a sport square with the aim to provide versatile sport facilities to make the whole project area more active and passionate. This kind of design can unify the whole area to have only one function, which serves for sport, leisure and so on.

2) As discussed about strength in the S.W.O.T Analysis, Garlate has a natural merit of lake surrounding and pleasant environment. The idea is to utilize these advantages which mean to provide a beautiful lake view and large green area around the whole project space. In order to realize this concept, landscape design and waterfront design are involved.

2.4.1 Concept Plan

According to the design concept, a general concept plan presented below in Figure 2.15 is realized in order to fulfill the task and goals. Detailed explanation will be provided in the following paragraph.

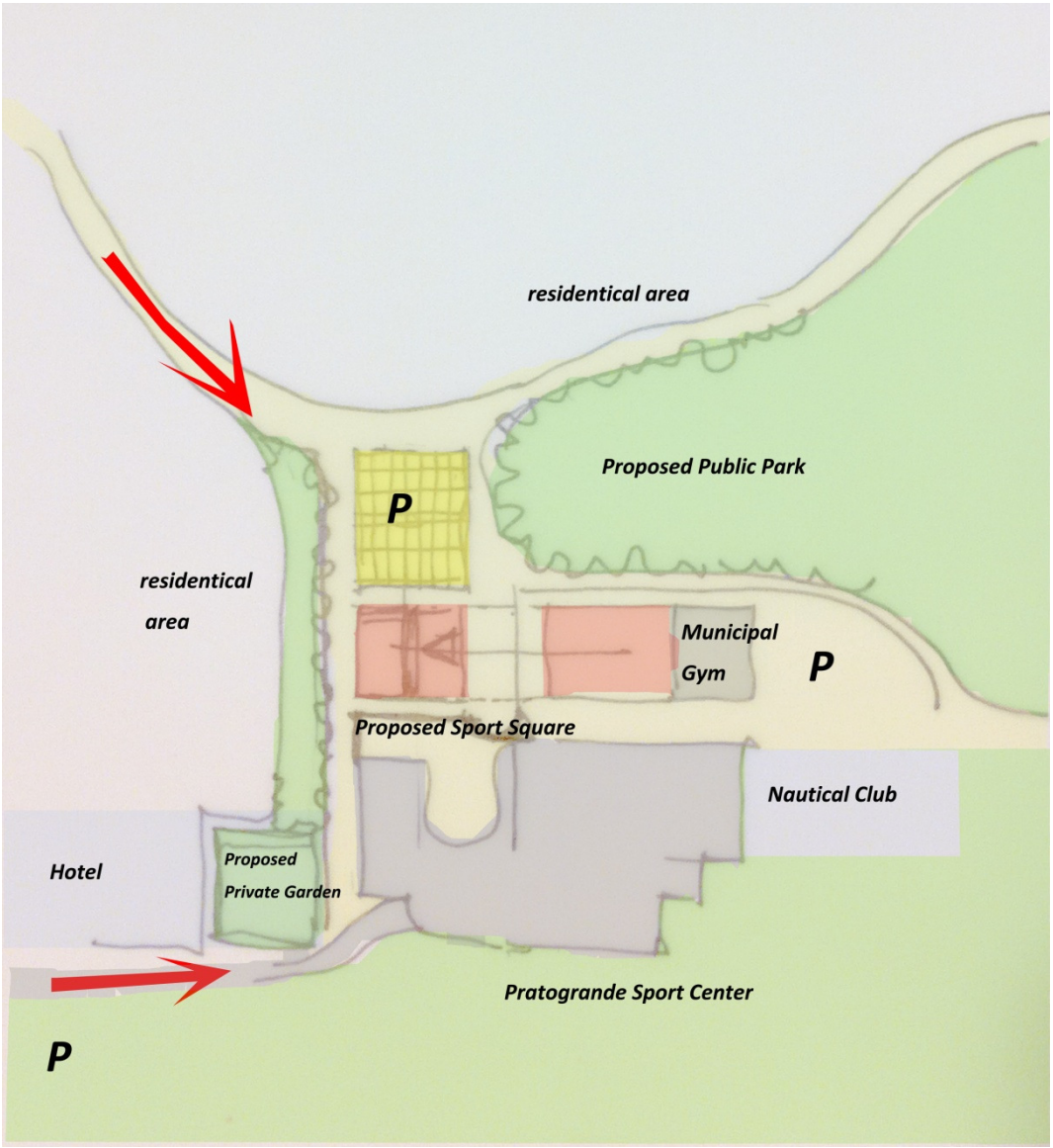
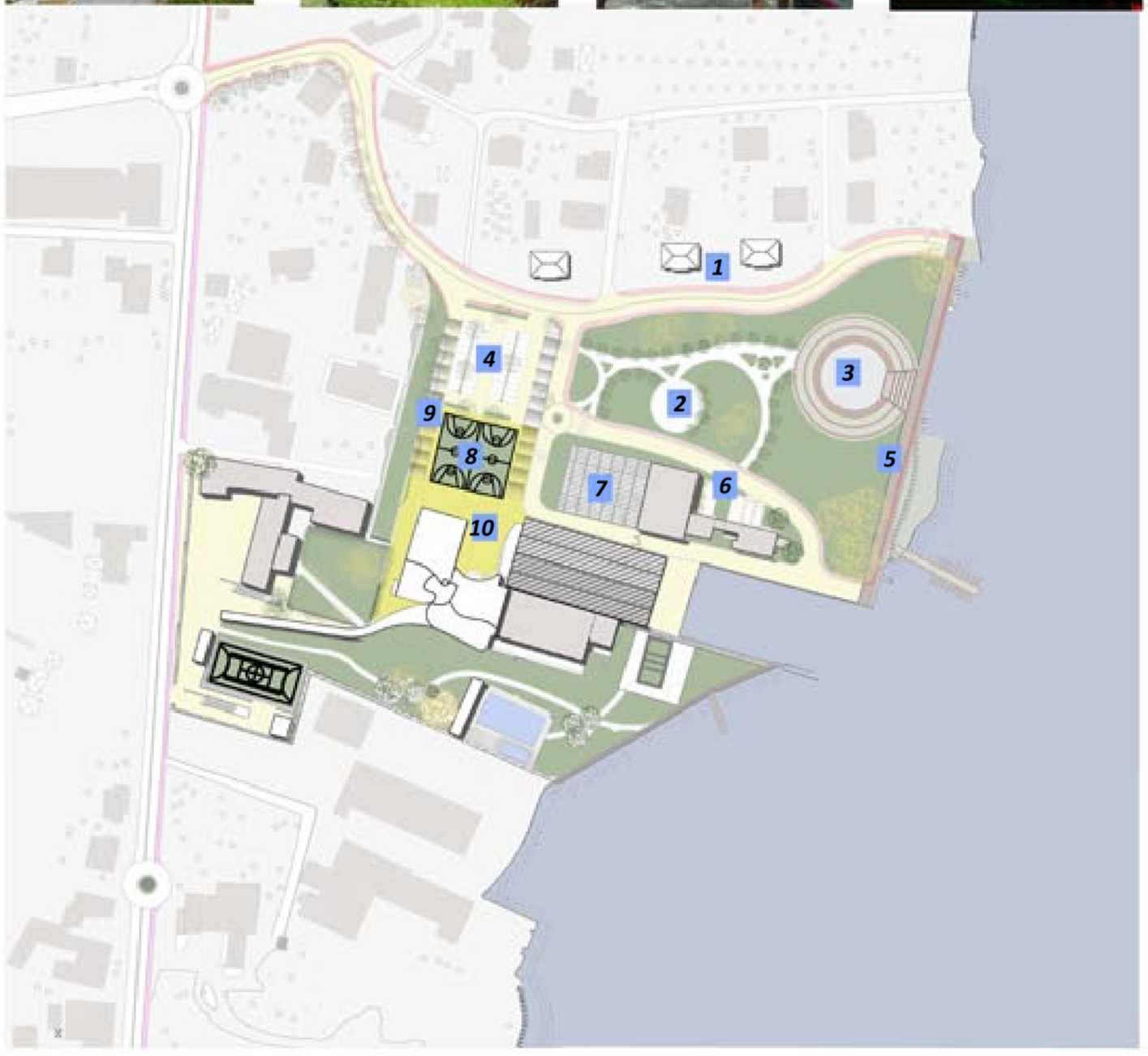


Figure 2-15 Concept Plan

2.5 Master Plan

A master plan is realized based on the above analysis and concept which is shown in the Figure Below..



1 *Residential housing*
2 *Children Playground*
3 *Water fountain- water play area*
4 *Public Parking Area : 78 positions*
5 *Lake deck*
6 *Parking Lot for Nautical Club*
7 *Extention of Municipal Gym*
8 *Basketball play ground*
9 *Tent Roofing*
10 *Sport Square*

Master of Architectural Engeering

Fitness Center in Garlate, Lecco, Italy

Master Plan *Scale 1 :500*

Ruqian Wang & Yunfei Zhang

2.5.1 Master Plan Explanation

- **Accessibility**

Our project area is located in the east side of main road Via Statale with large volume of traffic going through and velocity is quite high. This fact limits the access from Via Statale into our project area.

Another road, Via Puncia which gives the access to Comune Gym and Nautica Club is relatively narrow and not well designed. It is getting difficult to access from this road.

Consequently, in our proposal we raised three suggestions in order to diminish the limits:

1) Adding a circle crossing in the south of Via Statale with the aim to give easy access to our project area from both directions of two roads mentioned above.

2) A new sub-road is created from Via Pratogrande and a public parking is added nearby.

- **Enhancing the connect between all the facilities**

A square between the basket playground and new Pratogrande Sport Center is realized, and followed by several roads with origin in square and destination of the facilities. With this design, it is possible to connect all the facilities, which means to unique them together. The square could be the center of our project area, for people having rest and gathering.

- **Providing friendly pedestrian environment and redesign the cycle route.**

There are two parking areas within our project area, so that it is almost a majority that the walking is the most used way when people presenting. Because of this, friendly pedestrians are quite important. Moreover, the cycle route is introduced into our project area, with the connection to the existing route outside with the aim to unifying all the sport facilities into the project area and also to give a beautiful view of lake as well as the proposed green park.

- **Creating some residential houses at north border of the whole area**

This is due to have the authority to redesign and reorganize the area. In our project area which includes a private garden with natural and romantic characteristic, a large number of vegetation and a vacant green area full of trees and vegetation. So we propose that:

Due to the reason that the vacant area is near to the residential building at the north border and it is not belonged to municipal government, so it is proposed to build several residential buildings in order to get some vacant area in return. A public park can be built in this vacant area serving for both the residence nearby and the whole region with the main function of providing leisure.

- **Extend the Comune gym with a half open space equipped with outdoor sport facilities.**

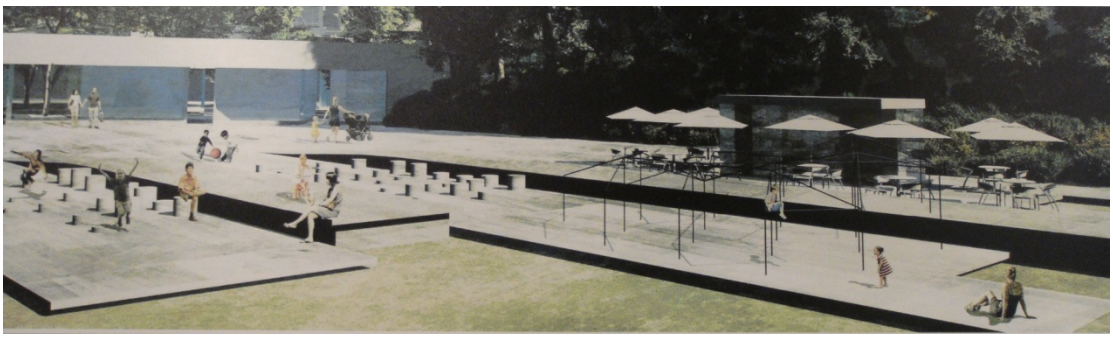


Figure 2-16 Instance for Outdoor Facilities

Some outdoor fitness equipments which serve for the residence are also considerable to be placed.

Figure 2-17 Instance for Outdoor Sport Equipment

Utilizing the vacant area, we design a public park on the lake shore. This park can serve for all the people and giving a wonderful lake view thanks to several waterfront design. This means that we provide a way for people to get close with the lake and have fun in the park.

Natural territory of inside Park of Pratogrande is remained, and it is utilized for the other activities, like holding parties.

A garden is added near the Hotel. The shape of the garden is

conceived as a rectangular which is a classic Italian formation. With this kind of concept, it protects well the privacy of the clients in the hotel and a sight barrier is formed from any observation point from the gym area.

Large scale of green area gives the maximum flexibility for the use of this garden. Any kind of function exploration could be realized, for instance a coffee area can be an extension for the hotel service.

With the target to give a connection from the hotel to the gym area, the garden is designed to have a passageway dividing the garden into two separated parts. The function of hotel is extended due to this passageway which leads to a sport area so that the garden plays a role as a 'bridge' to connect inside with outside.

The private garden is surrounded by bushes to keep its privacy while having one path leading to the opening of Pratogrande area. Inside the garden, different kinds of trees and flowers are planted to keep the garden lively all through the year.

Chapter 3

Sport Center in Garlate, Italy

Conservation

3 Conservation

Before refurbishing of the buildings in Pratogrande Sport Center, it is necessary to analyze the defects or dangers in existing buildings which need to be solved firstly. In the architecture concept plan it is already stated that the original swimming pool will be remained as it was, while the gym will be rebuilt besides the swimming pool from the original place. From the point view of remaining the original building of swimming pool, it is compulsory to analyze the presented problems.

3.1 The defect of indoor swimming pool

3.1.1 Introduction

The swimming pool was built in 1970 which was an important component in the Pratogrande Sport Center, the building was in the combination form of concrete structure andframe system, it was divided into 3 levels which are equipment floor (underground floor), pool area floor (ground floor) and small canteen floor (first floor).

1) Wall

All the envelope walls are of white color, made of light weight material and finished on the outer most layers. Since the building is supported by frame structure, the walls are filled without bearing load. It could be either bricks or concrete blocks.

2) Slab

The floor slabs of the building was made by reinforced concrete with steel bars, which can be seen from some degradation parts whose concrete cover has already fallen off.

3) Column

The column's section is rectangular shape, with surface painted.

3.2 Pathology Anomalies

3.2.1 The water flowing

The water flowing continuously on the floor is near the water compensation tanks which located in the underground floor.

Figure 3-1 Water Flowing on the Floor

Figure 3.1 shows that the water leaked out from the compensation tanks which supply water to swimming pool, and the wall root near the floor has become black because the water leaked continuously out of the tank.

Potential reason of water leakage

The potential reason should be water condensation from compensation tanks to the outside floor; the water could penetrate though the wall of compensation tanks. Usually, the condensation

occurs when air can hold so much moisture in the form of an invisible vapor, no matter what temperature it is. When the air contains more moisture than it can hold, it reaches ‘saturation point’ and when this is reached; the moisture turns back into water.

In this case, the water flows down from tank wall where the condensation occurred from humid air and accumulated on the floor, on the other hand, the water penetrated though the concrete wall to the other side floor when it reached saturation since the porous property of the material itself.

The possible treatment and solution

Controlling the relative humidity is one way to reduce water flowing; however, it is still difficult to reduce relative humidity in swimming pool area. The most acetable way is to use insulation on the existing external wall. In this way, water condenses under the dew point on the cold side but will not penetrate the wall.

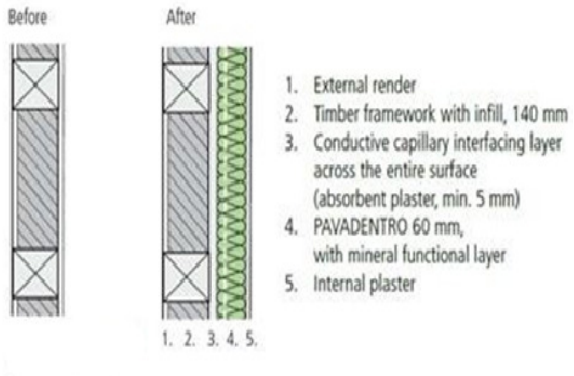


Figure 3-2The Wall after Insulation

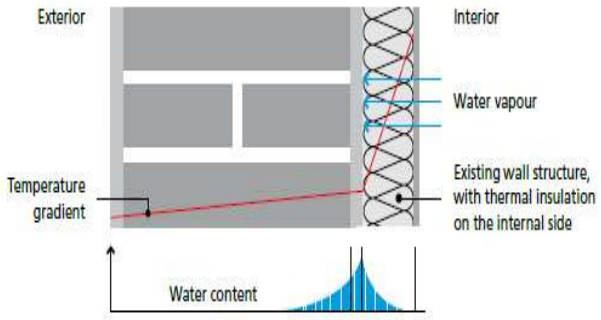


Figure 3-3Insulation of Wall

By insulating an existing external wall with wood fiber insulation, internal condensation occurs only on the insulation layer, as intended. Through the boards' excellent hygroscopic and capillary active properties, the moisture is released back into the room as water vapor and no elements are damaged.

Figure 3-4 Metal Coping for the Protection of the Lapel

The water is easily to gather in the corner of floor, the metal coping which can protect the skirting and corner of floor to resist erosion.

3.2.2 The Sprawled Column

The column shown at below is sprawled through at top, because of the corrosion of reinforce steel bars. (The location of this column is at lower ground floor and close to the hamam bath).

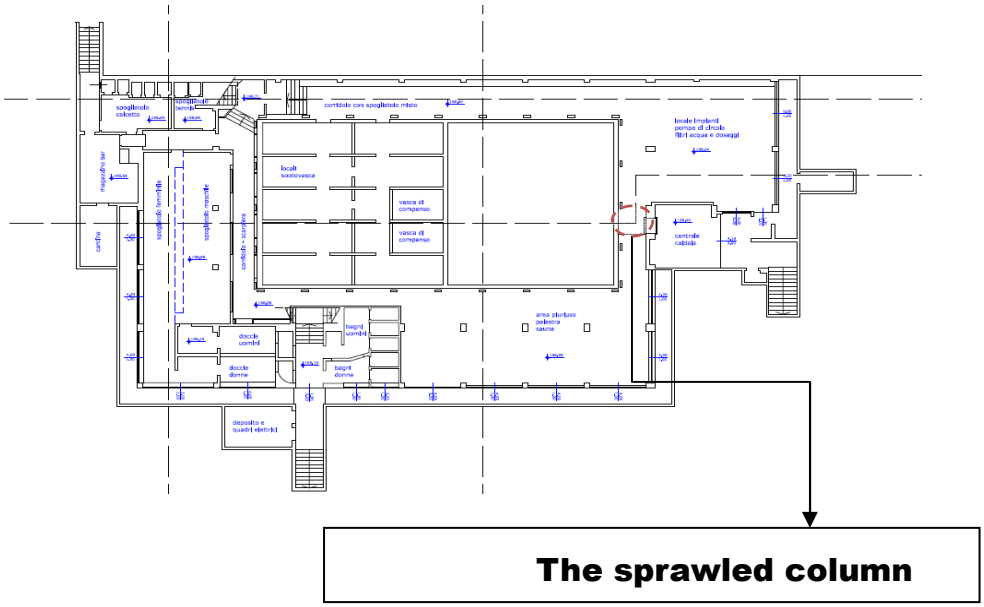


Figure 3-5 Indication of the Sprawled Column

The reason of sprawled column

The column/wall between kids pool and the swimming pool is cracked. The crack is wider at top and less wide at the bottom. It could be due to partial settlement of the soil under the foundation at different degree. Issue of kids pool about its time of construction and type of structure/structural elements is not defined yet.

Figure 3-6The position of cracks

3.2.3 The problem of changing room

The existing changing rooms are at lower ground floor and no matter the shower, locker or the bath rooms couldn't satisfy the requirement of clients in convenience and comfort.

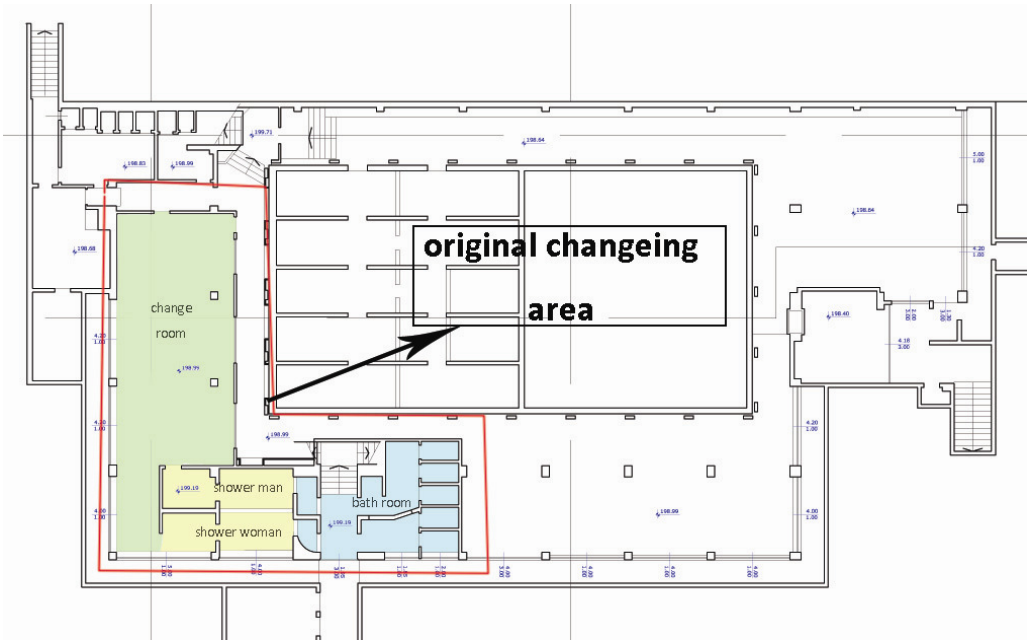


Figure 3-7 Change Room of Swimming Pool

The original changing area as the service swimming pool includes three parts: changing rooms, shower rooms and bath rooms these three parts, and the total area is 150m2.

Expansion the area of changing room

The redesigned changing room which will be shown in next chapter increase area from 150m2 to 300 m2 which means more than twice expanding, this serves not only the swimming pool but the gym and spa at the same time. The original changing room will be replaced by storage place.

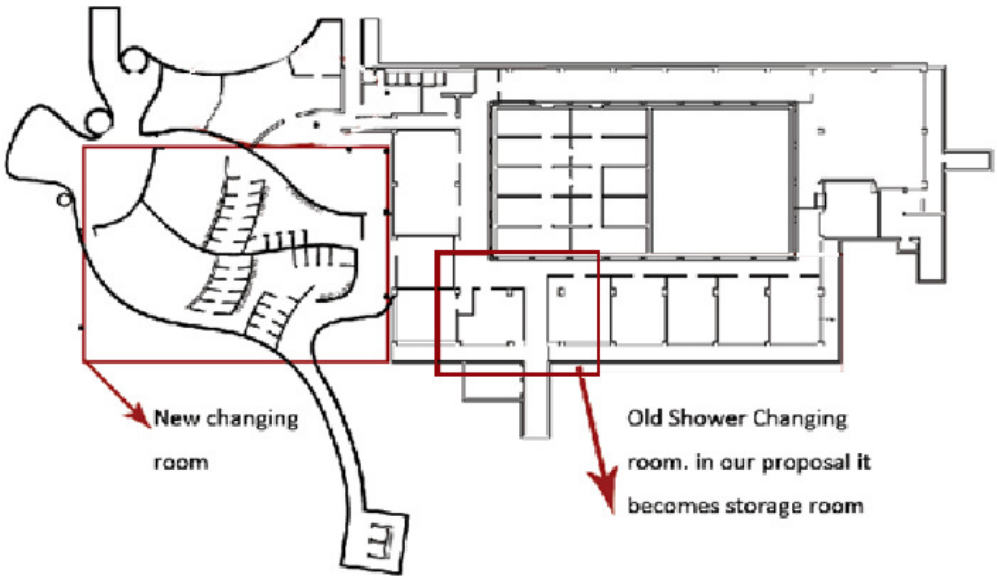


Figure 3-8Solution of Shower Room

3.2.4 Windows

Figure 3-9 The South Façade

The windows glass covered on the south facade of building should be replaced regarding to the new Italian law. The building has built for over 40 years and the windows of existing building couldn't satisfy energy saving requirements.

Possible treatment and solution

The double glazing windows which reduce heat loss in the winter and cooling loss in the summer that can substitute the original glass windows. At the same time this kind of windows also prevent the rate of condensation occur at the same time and make the spaces more efficient the sources of energy transfer should be controlled.

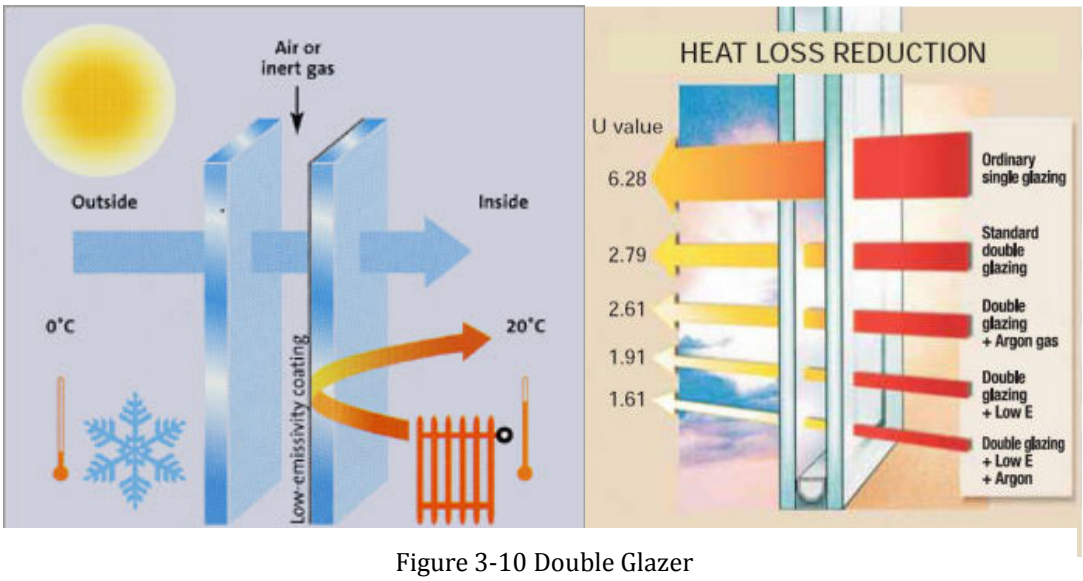


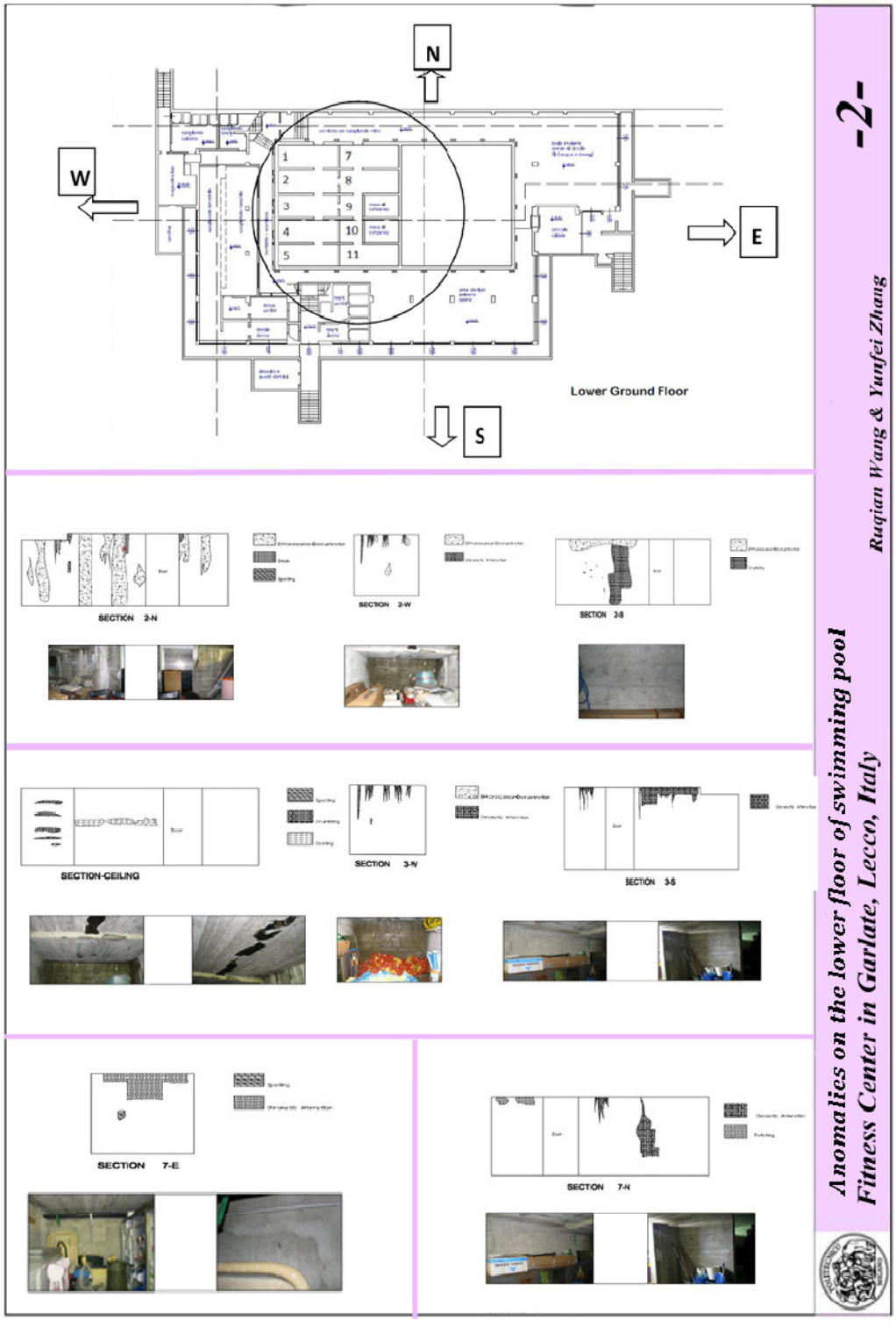
Figure 3-10 Double Glazer

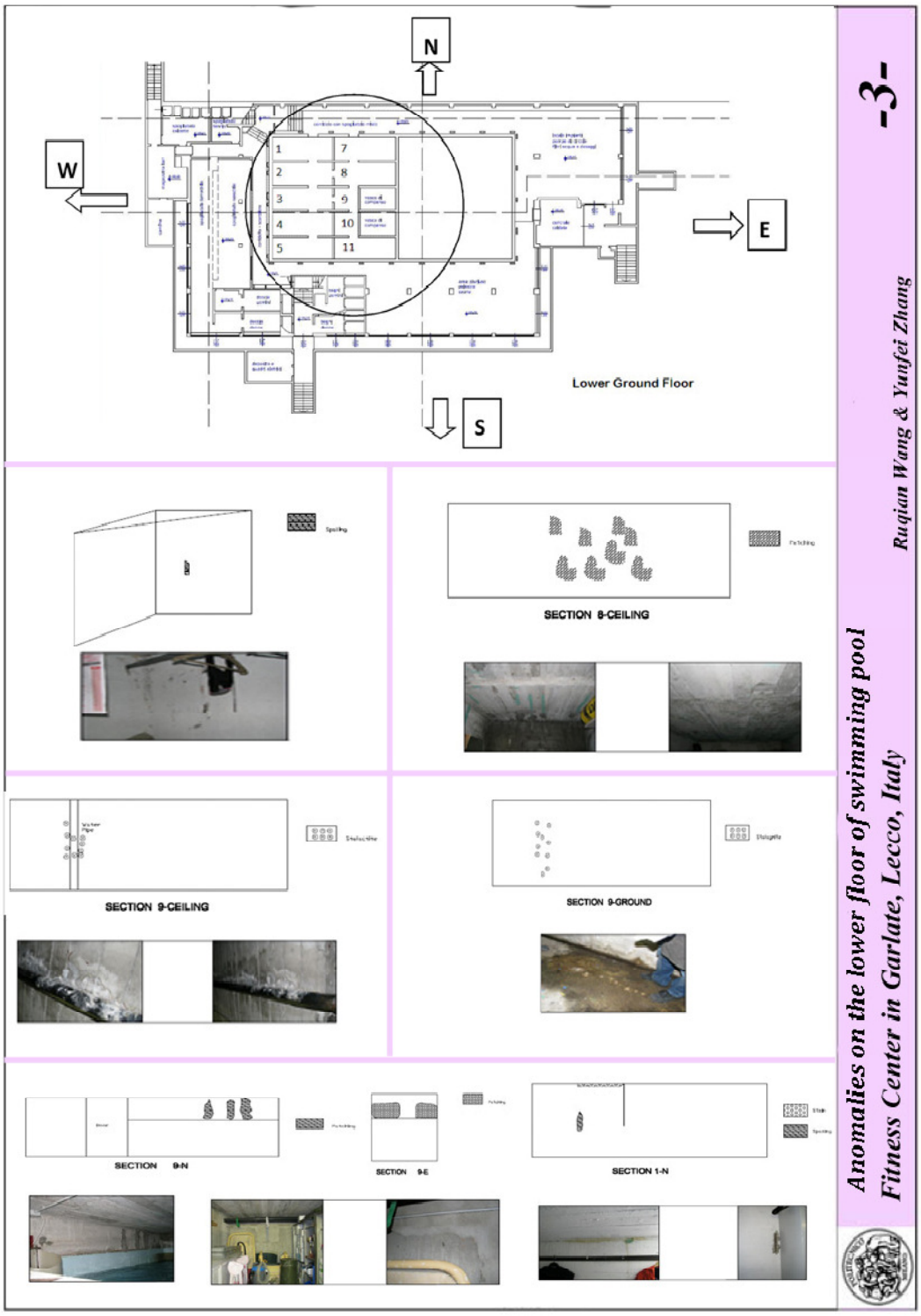
In the Figure 3.10, a double glazing + low e+ Argon window is applied to get the minimum energy losing comparing to other types of glasses. Low-e glazing window the short-wavelength heat energy from the sun enter the building but act as a barrier to the escape of the Long-wavelength energy from internal heat sources. About 60% of the heat energy lost between the panes of glass in a double-glazed window is long-wave radiation.

Figure 3-11 The detail of the double glazer aluminum frame glass wall

Considering the location of our project which is near to the lakeside it is much more humidity in the winter than other locations. Double glazer frame glass wall effectively prevent the condensation in the humidity environments. so Double-glazing is designed to reduce the amount of heat lost through the glass, According to the function of this building that needs to save heat energy in the winter.

3.2.5 The anomalies on the lower ground floor




N
W
E
S
Lower Ground Floor
SECTION 8-CEILING
SECTION 9-CEILING
SECTION 9-GROUND
SECTION 9-N
SECTION 9-E
SECTION 1-N
-3-
Anomalies on the lower floor of swimming pool
Fitness Center in Garlate, Lecco, Italy
Ruqian Wang & Yunfei Zhang

The possible treatment and solution

After surveying the problems of the basement floor, it appears that most of the problems are superficial and the main reason is moisture. Many moisture problems can't be remedied or lessened with ventilation, or by fixing internal sources of moisture. Solving the moisture problem demands drainage, waterproofing and insulation of the external faces of the foundation walls. in our project waterproof material and insulation will be set up to solve the problems mentioned in the poster 2 and 3 above, Due to upstairs of this area is the swimming pool which easily permeate water and salts. because the concrete pool tank as a material porosity separate out of water into downstairs ceiling and walls when its absorb water saturation.

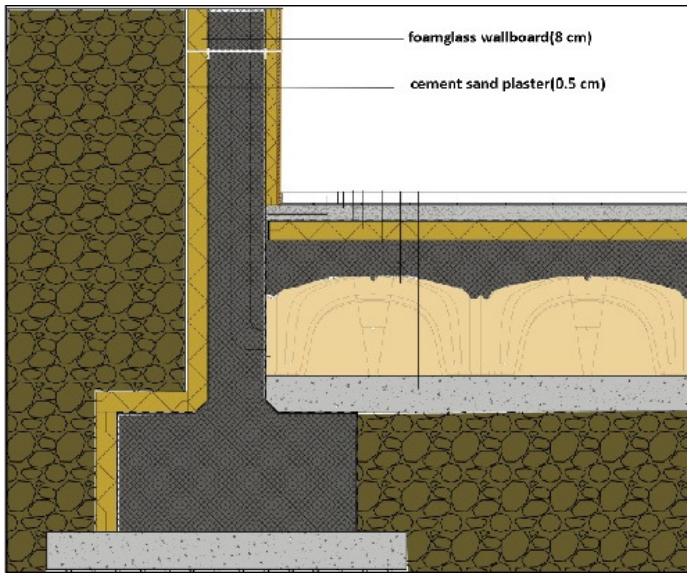


Figure 3-12Detail of underground wall

Due to this reason Macro porous plasters will be a better solution to avoid salts and efflorescence. Because inside their gap pores, we can have freeze or crystal without problems, the big volume of the pores

gives also a low elastic module with and high compression resistance. For this reason the compatibility with old supports is high. Thanks to an easier diffusion of the vapors, the evaporation can be inside and so with this kind of plaster we can also avoid efflorescence.

Chapter 4

Sport Center in Garlate, Italy

Architecture Design

4 Architecture Design

4.1 Introduction

Architecture plays an important role in our human's daily life. Its essence is to fulfill the function for serving the human or changing the life with the maximum possibility of esthetics. The combination of 'service' and 'sensory satisfaction' will be the main topics when a building is judged.

With the target that is mentioned above and according to the analysis in the first Chapter Introduction which stated that ' the formal building was built in 1970s and it cannot meet the requirement any longer', a project about building refurbishment was undergone. With maximum consideration for the habitants and the possible clients, the enlargement and refurbishment is supposed to be done for the buildings. After the possible work with our design concept, a center which is consisted of entertainment, fitness and pleasure is formed with versatile functions. This kind of center not only aims to the young and semi-age people for their fitness exercise requirements but also provides a place for the whole family with children and ages to share their pleasures and spend time. Moreover it is specially designed to have 'no barrier' concept in the project for disable people exploring the function of the center which represents fair, self-value existing and social acknowledgement.

Protogrande existing buildings and facilities

- **Environment**

The Pratogrande Sport Center area is 12.000 sqm and is located aside the coast of the Lake of Garlate in a preserved natural contest surrounded by the Alps with the spectacular view of the Resegone at north, and of the Monte Barro at south which is indicated in Figure 4.1 and Figure 4.2.

Figure 4-1View of Resegone from Pratogrande Area

Figure 4-2View of Monte Barro and Lago di Garlate from Protogrand Area

Furthermore, as shown in Figure 4.3 and 4.4, this Center is built aside the recently refurbished Hotel Nuovo (100 rooms, restaurant and convention center).The Nautico Clubis also nearby, which is built as well during the early seventies.

Figure 4-3Hotel Nuovo View from Street

Figure 4-4 Hotel Nuovo View from Pratogrande Area

- **Existing buildings and facilities**

The Sport Center was built in 1970s with a private natural park inside. It provides the following sport facilities:

- One three level concrete building concluding the sub facilities shown in the Table 4.1.

25mt. Swimming Pool	
Kid's Swimming Pool	
Changing Room	
Reception Area	
Bar & Cold Restaurant	

Table 4-1 Concrete building and facilities

- One two floor concrete building built along the SS36 (originally doorkeeper home) which includes: a beauty center and a weight gym

- Open air sports facilities which include: A 25mt. swimming pool, A separated kids swimming pool with Jacuzzi area, Two tennis or five-a-side courts ,One volley court and one kid play ground

4.2 Design goals

According to the brief, the Pratogrande refurbishment schedule requires the re-use of the three level swimming pool concrete building with the chance to make the sports facilities upgraded with the construction of a second covered 25mt. swimming pool, adding to this structure more space dedicated to the wellness center and to kids sport and leisure activities. The new additional building should be designed in order to be able to warranty the functionality of the existing facilities during the refurbishment and construction process.

The whole refurbishment project shall consider the Hotel and the Club Nautico facilities which shall be part of the new functional organization saving their own identity and private, independent accessibility.

Moreover, it is suggested that the refurbishment project can consider the chance of demolishing the existing 'doorkeeper home' and real connection with the other above mentioned facilities (Hotel and Club Nautico). The project shall consider the possibility of different kind (free entrance or registered/pay entrance) and time schedule of use of the whole new Sport Center.

The new redesigned Sport Center building shall provide:

- Reception area: information, selling area (tickets and registration), control of the accessibility to the different facilities.

- Bar & restaurant: a 200 sqm. Space (kitchen included) with internal services and possible external summer extension. It shall be used from external clients too.

- Two 25mt. swimming pool. One dedicated to leisure activities.

- Two kids swimming pool for leisure activities, one of them shall have space dedicated to rehabilitation purpose.

- One 500 sqm. Complete gym area including two 50 sqm. fitness rooms. The gym shall be connected to a smaller rehabilitation gym.

- One 100 sqm. Rehabilitation gym, including 4 rooms for medical visit (sqm. 9.00 each).

- One tennis or five-a-side court to be closed winter time.

- Male and female changing rooms (250 sqm.) to be used both for gym and swimming pool users. One independent changing area dedicated to the tennis/five-a-side court.

- A beauty center (100/150 sqm.) including 4/6 private rooms for beauty treatments and massage (sqm. 9 each), one sauna, one Turkish bath, one Jacuzzi area.

- Kids play area for 100/150 sqm. with internal toilets.

The open air area shall provide:

- One existing 25mt swimming pool
- One existing kids swimming pool
- Kids play ground
- One volley court

4.3 SWOT analysis

As already explained in Chapter 2, a SWOT Analysis is a summary technique – a strategic planning tool used to evaluate the Strengths, Weaknesses, Opportunities, and Threats involved in a project or in a business venture.

According to our project, summarized all the information collected based upon site visits, comments from the clients and interviews with the owner of Pratogrande during workshops, the SWOT analysis is listed as follows:

- **Strength**

1) The area is in a location which is near to the lake side and full of greenery.

2) The external swimming pool is an attractive place during summer.

3) The green place attracts lots of people from May to September.

- **Weakness**

1) Buildings are not connected very well with each other.

2) The passage from entrance to main swimming pool building is not convenient.

3) The open hours are in the daytime, but maybe some people would like to use it after 22,00 every day.

- **Opportunities**

1) The vicinity of Nautico Club, Community sport center (Gym) and Hotel Nuovo gives the site as a hot spot and makes it important.

2) Swimming activities can be enhanced by covering outside swimming pool with retractable enclosure by which it can be used both in winter and summer time.

3) Some water sport can attract more people, especially in the summer.

- **Threats**

1) Existing deck-level environment.

2) If new solutions are not availed, the number of clients will decrease year by year.

3) Rainy season always continue 1or 2 months every year.

4.4 Design concept

Based on the above analysis, the main task of the project is to prolong the season of usage of functional buildings. With the prerequisite of not sacrificing the green area, our concept of refurbishment project mainly includes the following two points listed below:

1) **Make the group of buildings more compact with the purpose of easy managing and people-gathering.**

2) **Remain large green area and give the lake view to the area as shown in the Figure 4.5.**

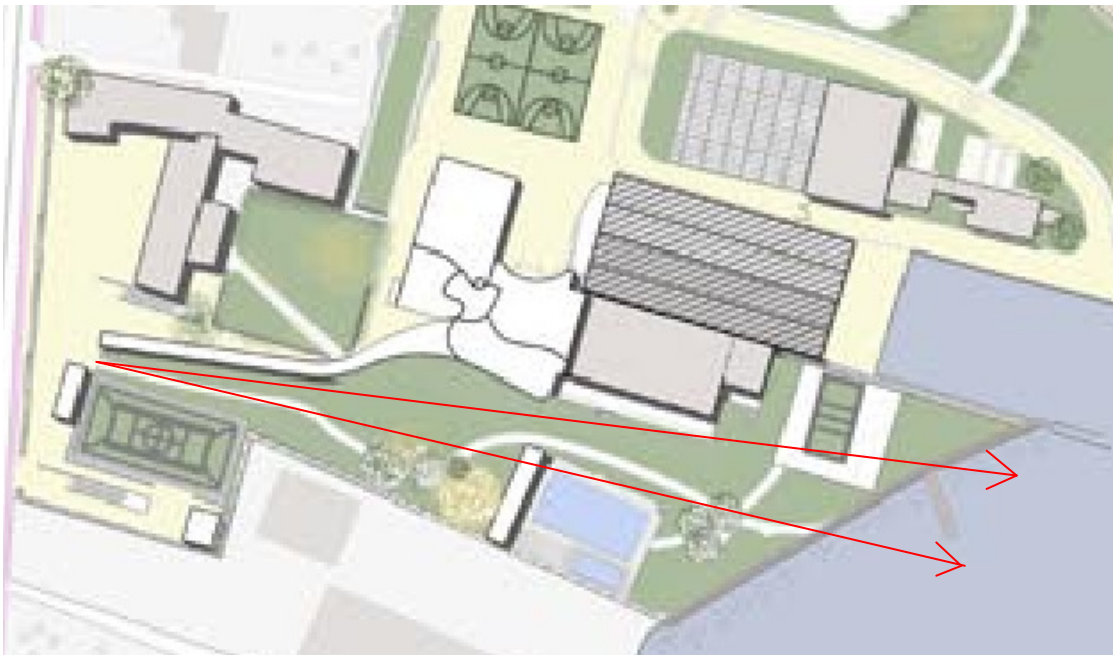


Figure 4-5 Design Concept to remain the green area and give the lake view

Detailed speaking, our idea for the project can be described as:

- To construct a new building block as ‘Center’ with the old building block nearby which will be the center for people gathering and distribution.

- To demolish the doorkeeper house and around the Center, a new building is schedule to build consisting with gym, beauty center. This building and the old building block mentioned above are located on each side of Center respectively.

- These three buildings have different functions but they are connected to each other: From the functional point of view, the two buildings surrounding the center mainly provide sport activities, while Center can supply the service that is needed for both ‘sport’ buildings, such as bar, restaurant, changing rooms and so on. Regarding to the form, ‘sport’ buildings are both rigid blocks but the Center is relatively soft which can be the buffer and middle transform.

- Visual connect with Green & Lake is planned to realize. As mentioned in the SWOT analysis, one of the strengths which also is deemed as the strongest, is the natural environment with green area and lake. It is strongly desired to utilize this merit.

4.5 Design details

- **Accessibilities**

The new design for accessibility is indicated in the Figure 4.6. There will be two entrances instead of one.

The new entrance (1) is designed to be the main one at the exit of new sport square with the public gym beside, which is shown in Figure xx which is a part of Master Plan. The existing entrance (2) from the main road SP72 is remained as a secondary entrance in our new proposal. A glass corridor is scheduled to be realized with the function as 'guide', leading the flow of people to centre building.

Figure 4-6 Entrance Design

As shown in the Figure 4-7 below, the design of main entrance is presented. This entrance is facing to the Square and its façade is made of glass in order to guarantee the lightness of lobby in the ground floor and restaurant in the first floor.

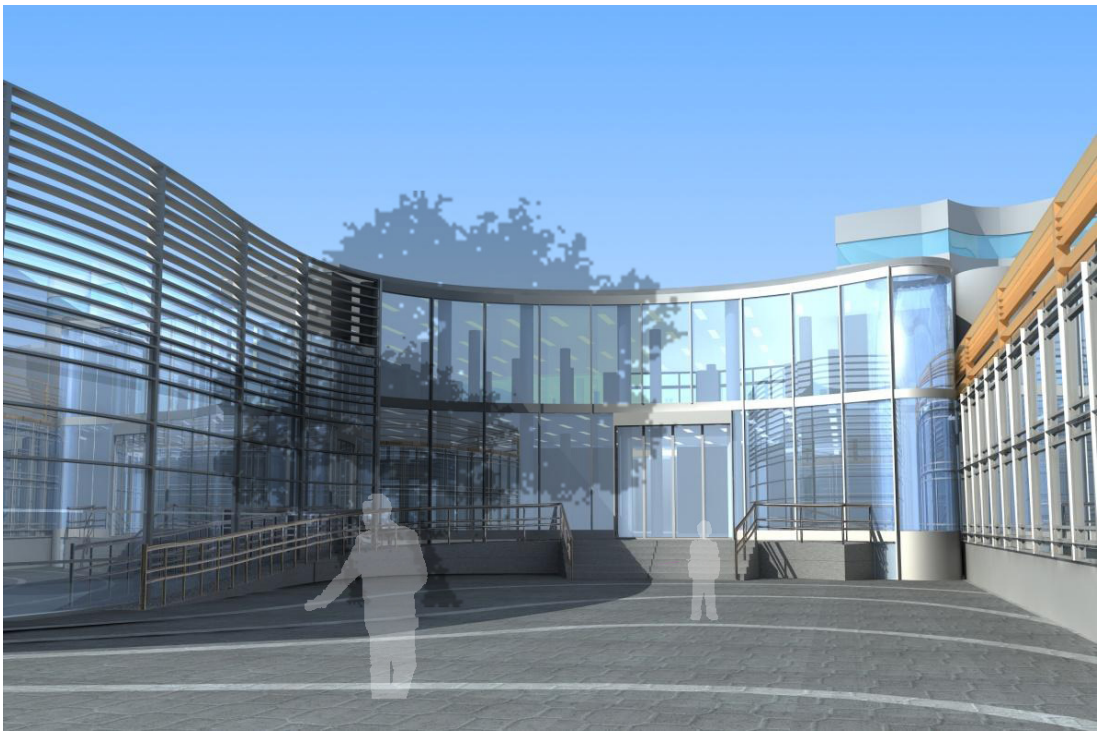


Figure 4-7 Design of Main Entrance

The main parking lot which is presented in the master plan serves for both the public and the Pratogrande Sport Center. This parking lot is availed from the main entrance with a capacity of 78 parking spaces.

Figure 4-8 Parking Lot Design Instances

A secondary underground parking for Pratogrande Sport Center is managed to be near to the secondary entrance from main road SP72 in a two-level basement structure with a capacity of seventy two cars.

This parking design has three merits: first the parking capacity is enlarged comparing to the former lots due to the added underground parking; the parking area is becoming ordered; more space is saved to be used for sport activities.

- **The building volumes**

As indicated in the Figure 4.9, the shape adopted for new proposal is with the concept of flow of fluid (people) coming from main streams (entrances) which adheres between these two solid building blocks. The central volume of the building gives the visual sensation of the fluid adhesion and organic lines. For this new shape it has been focused on the nature (the more prominent) and urban context of the Pratogrande. The entrance corridor and central volume is kept transparent to make a strong relationship between indoor environment to outdoor i.e. to natural green area, open air activities and the lake view.

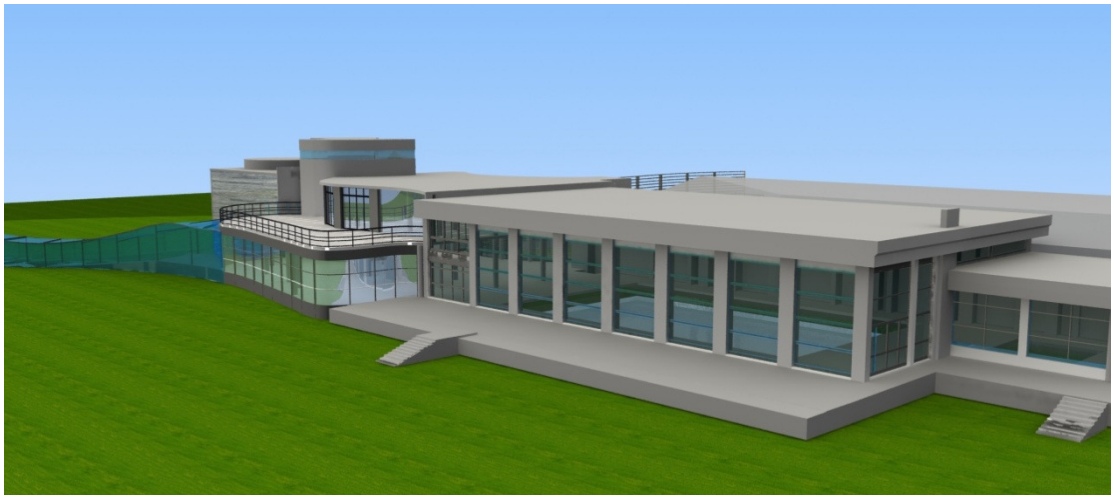


Figure 4-9 Rendering of the New Pratogrande Building

- **Building Envelope**

The elevations of the building in different directions are shown in the Figures below

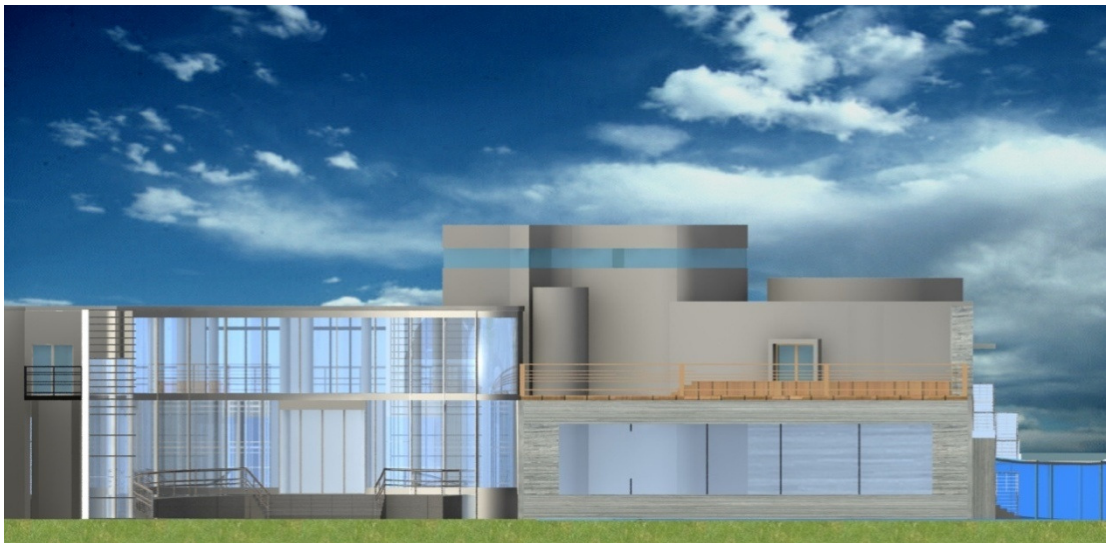


Figure 4-10 The North Elevation of Building

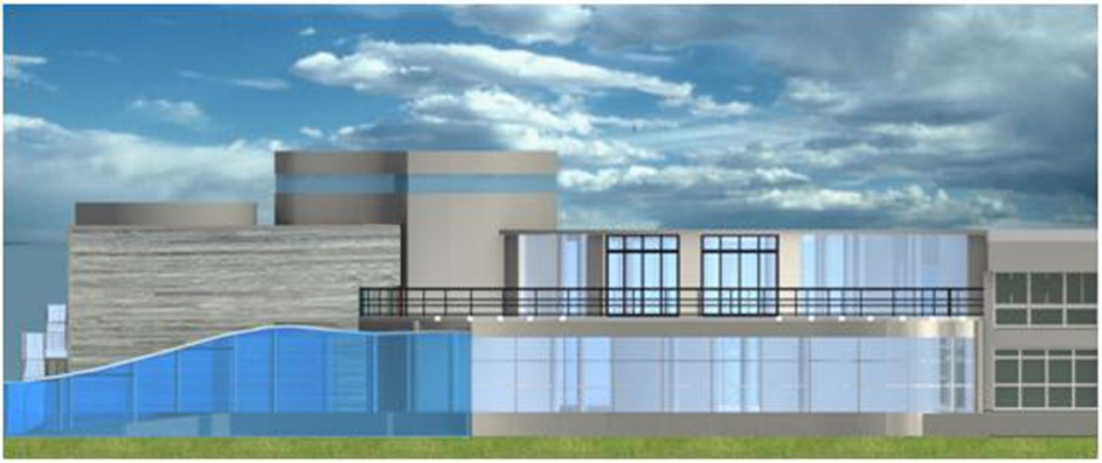


Figure 4-12 The South Elevation of Building

Figure 4-13 The East Elevation of Building

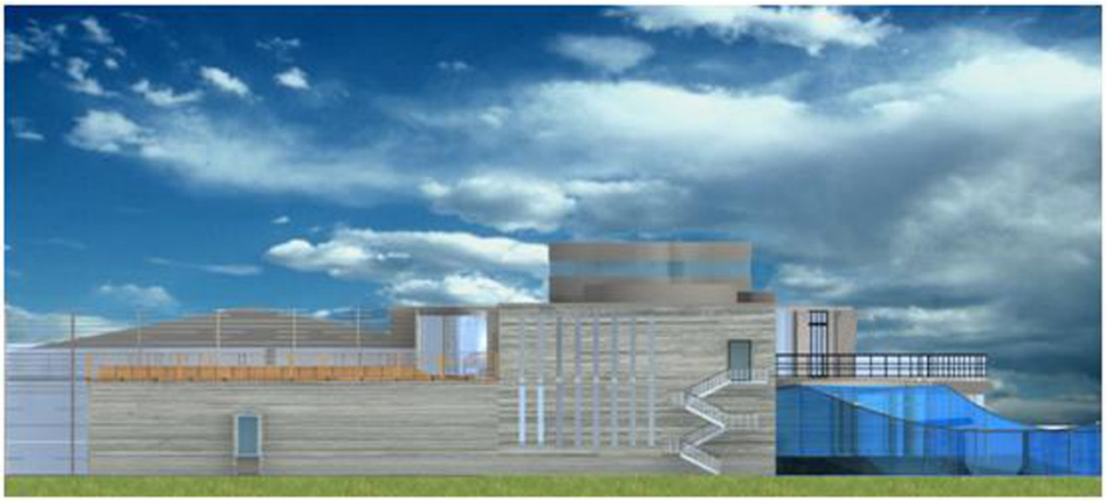


Figure 4-13 The west elevation of Building

- **Facade**

1) Curtain wall

In order to keep the building most transparent and take advantage of the view given by the green area and lake, the north and south facade of the central volume and the east facade of the solid volume are totally enveloped with curtain wall which makes the building flooded with natural daylight. Meanwhile, some liana plants are added to the curtain wall of the buildings with the purpose to minimize the overheating effect of sunshine in summer time.

Curtain wall is broadly used in contemporary architecture in recent years. It is defined as the non-load-bearing building envelope that typically hangs like a curtain from a structural frame. Buildings can appear different effects due to the change of sunshine, moonlight and artificial lights, which bring us a kind of dynamic esthetics. Glass curtain wall is very useful as it controls the weather inside the building, allows light to enter without any structural barrier, easy to maintain and construct, cost effective, save construction time and etc. So, its use is increasing day by day. A lot of well-known architectures are

enveloped by curtain wall as illustrated in Figure xx and Figure xx.

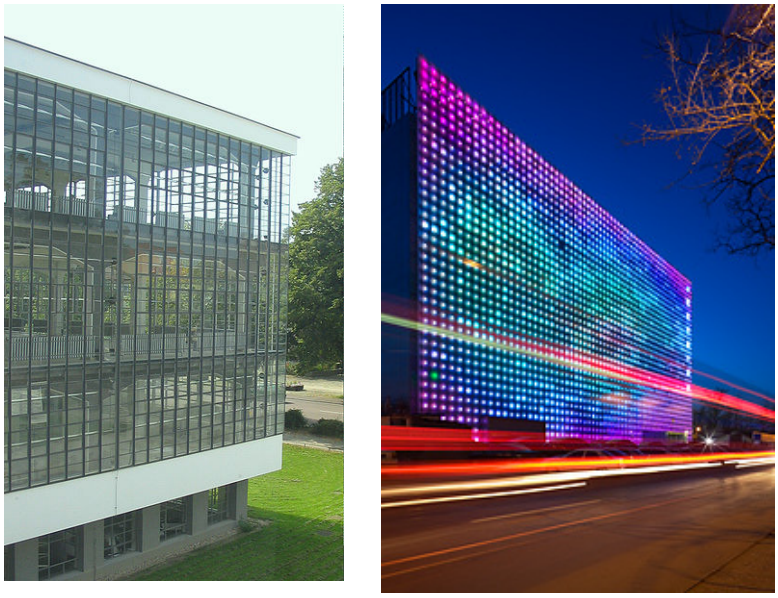


Figure 4-15 Instances of Curtail Wall

Concept and construct of curtain wall

The frame structure was characterized as a universal term of mid-twentieth-century architecture and proposes to be the 'essence of modern architecture.' The widely use of columns and beams of concrete, iron, and steel as a substitute for traditional solid-masonry load bearing walls, marked a major milestone in architectural design and construction. It was significant not only for its technical achievements and widespread dissemination but also as a catalyst for new conceptions of architectural form. One of the most influential ideas derived from the frame structure is the modern curtain wall.

The invention of skeleton-frame construction is the most radical

transformation in the structural art since the development of the Gothic system of construction in the twelfth century. The importance of this new technology extended beyond the physical frame; it allowed reconsidering the essential character of the exterior wall. Traditionally responsible for a wide range of aesthetic and technical tasks, the outer walls of a building were directly implicated by innovative structural methods. However the new frame presented an architectural dilemma. Freed of its load-bearing responsibilities, the exterior became a blank canvas. The character of the new wall and the type of skin which should enclose the skeleton structure are becoming the main topics and question that is needed for discussed. After years of development, curtain wall, which became the most advisable answer, and frame structure continue to dominate construction today.

Transparent visions of curtain wall

The possibility of increasing fascination with the potential dematerialization of the building envelope is reached by the new structural frame and the curtain wall.

The concept of transparency and the increased use of glass is centered, which quickly become the first component of the building envelope with the theories of glass architecture and technologies of glass production involved.

Curtain wall system design

The curtain wall is typically recognized as a system, which is as a coordinated component to perform in a specified way. The relative success or failure of a curtain wall may be judged by the selection and handling of its components in terms of both aesthetics and technical performance. The increasing sophistication and variety in curtain wall

system which characterizes the current field requires

- extensive knowledge of materials and appropriate detail research;
- an accurate check of the building's environmental conditions;
- a comprehensive understanding of the required performance;
- a clear strategy for the relationship of the curtain wall to the building structure.

Given the complexity of most contemporary systems, the design process with a strategy of collaboration is approached.

2) Nero di varenna

Stone

From the ancient time up to nowadays, stone plays a significant role in the architectural world in terms of art expression and engineering point of view. The main reasons that drive the architect to be fascinated by the stone are not only due to its reliability and long durability, but also the variety for architect to adapt, the strong exposure of architectural esthetics. The easy-finding characteristics make the stone according to the social and cultural view.

Figure 4-16 Stonehenge

Stonehenge on Salisbury Plain which has a history of 3,500 years is a representative of ancient stone construction.(figure 4-17)

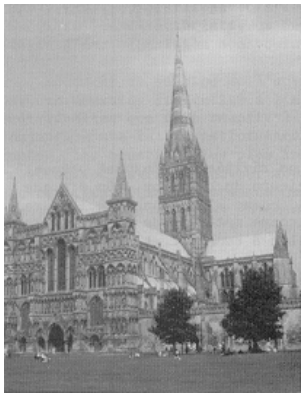


Figure 4-17 castles

The middle Ages saw the building of massive defensive structures in the form of castles, and of lofty church spires, reaching to a maximum of about 160 m above grade. (figure 4-18)

Figure 4-18 Modern building

The modern building with stone facade is also very popular and gives a beauty of power to the building. New elements such as curtain wall are usually used to connect with stone façade to have a bright indoor environment.(figure 4-19)

Nero di varenna in our building

Nowadays there are numerous of enormous buildings constructed

with facade made of stone and their architectural characteristics are expresses with stone's function, which is given by the nature.

In our design, in order to express the 'solid' and 'power' of our gym, the material of stone is chosen. Meanwhile the Nero di Varenna is found as a local material which takes an advantage of easy to purchase.

It is one kind of local produced stone which was widely used for local buildings and also for churches, for example, the church of Duomo in Milan.

Enclosure of outdoor swimming pool

The outdoor swimming pool has a retractable covering, the purposes of this covering are:

- To extend the realistic period of use for what is, otherwise, a seasonal swimming pool, likely to be usable for only about 5 months each year,

- To offer a year round opportunities for users and thereby capitalize on the potential attendance created by the demand which has been established for an outdoor swimming pool,

- To obtain an indoor pool of a relatively low capital expenditure, by exploring the opportunities for retaining any of the existing facilities.

  Considering the reasons above with the idea to save the green area space and remain the originally ecological formation, the system mentioned above is adopted.

Figure 4-18 Rendering of the outside swimming pool

4.6 Functional layout

1) The ground floor

- **Entrance lobby and reception**

The main entrance is the first encounter that the public has with the building and therefore it should be clearly visible. The secondary entrance is guided with a glass corridor leading the way.

The reception desk is the central focus to the space. It is located almost in the core of the reception hall and is designed as to be round so that the staff will be able to have a clear view of people entering and leaving the building from both the two entrances. Furthermore, all people have to pass the reception desk to reach different parts of the building.

Seating for casual use is provided. Plantings are used to soften and

divide seating areas.

- **Bar**

The existing bar which is now on the east side of the reception is kept and enlarged. It is located at the ground floor level and the glazed screen allows for view of the pool hall.

- **Gym**

There are rehabilitation gym and gym which are adjusted in the solid block.

- The gym area is equipped with variety of exercise machines used for strength training, stretching, and Pilates training. Two independent rooms of glass wall are presented for the use of Yoga and fitness courses.


Figure 4-19 Gym and Yoga

- Rehabilitation gym sits just beside the gym area. Four independent therapy rooms are provided for the privacy purpose and allow therapists to progress individualized treatment programs with state-of-art modalities and exercise equipment.

Figure 4-19 Rehabilitation gym

- **Kids playing area**

The kids playing area is in front of the secondary entrance, behind the reception and is visually well connected to open area of the sport center. Kids playing area is totally transparent from approximately all sides for the purpose to give an innocent feeling in central lobby area and for mothers to keep eye on their children.

2) The basement floor

- **Changing, showering and toilet areas**

As the profile of pool users shifts more and more towards a majority of adults, customers are expecting higher and higher standards in changing and related areas.

A separate sex changing area is kept and it is refurbished into a much larger space, with a more obvious changing sequential arrangement. This area combined by changing, showing and toilet functions, serves for all functional spaces where changing of clothes or taking shower is prerequisite for example indoor swimming pool, outdoor swimming pool with retractable covering, gym and spa area.

Items/number	lady	man
lockers	154	134
toilets	4	4
basins	14	7
showers	18	12

Table 4-2 Numbers of lockers, toilets, basins and showers in the changing room

- **SPA area (Jacuzzi, Turkish and sauna)**

SPA area (sauna, Jacuzzi, and Turkish bath etc) is located in the new basement as this functional area required less visual connection with outside.

3) The first floor

- **Restaurant**

The existing cold restaurant is also kept and enlarged at the first floor connected with ground floor's central lobby by stairs and elevators. As it is located at first floor giving the view of indoor swimming pool and providing the service at terraces on which an outdoor overview can be enjoyed while having the meal.

- **Beauty center**

A beauty center on the first floor of the solid block is provided as a new function in this area for the purpose of satisfying the varying

requirements of clients. Six rooms for beauty treatment and massage are provided as required.

A spiral stair leads the way to an upper relaxing and leisure platform. The mansard flat offers a space for clients who can relax and enjoy the sunshine after having massage. This is also a social meeting point for someone who wants to know each other.

An open-door beauty center is extended from the indoor one and is just located on the terrace of the solid volume. This open-door beauty center is equipped with SPA, which provides different experience during summer to winter and having an interesting view of the public gym area and the parks nearby.

Figure 4-20 Outside beauty treatment

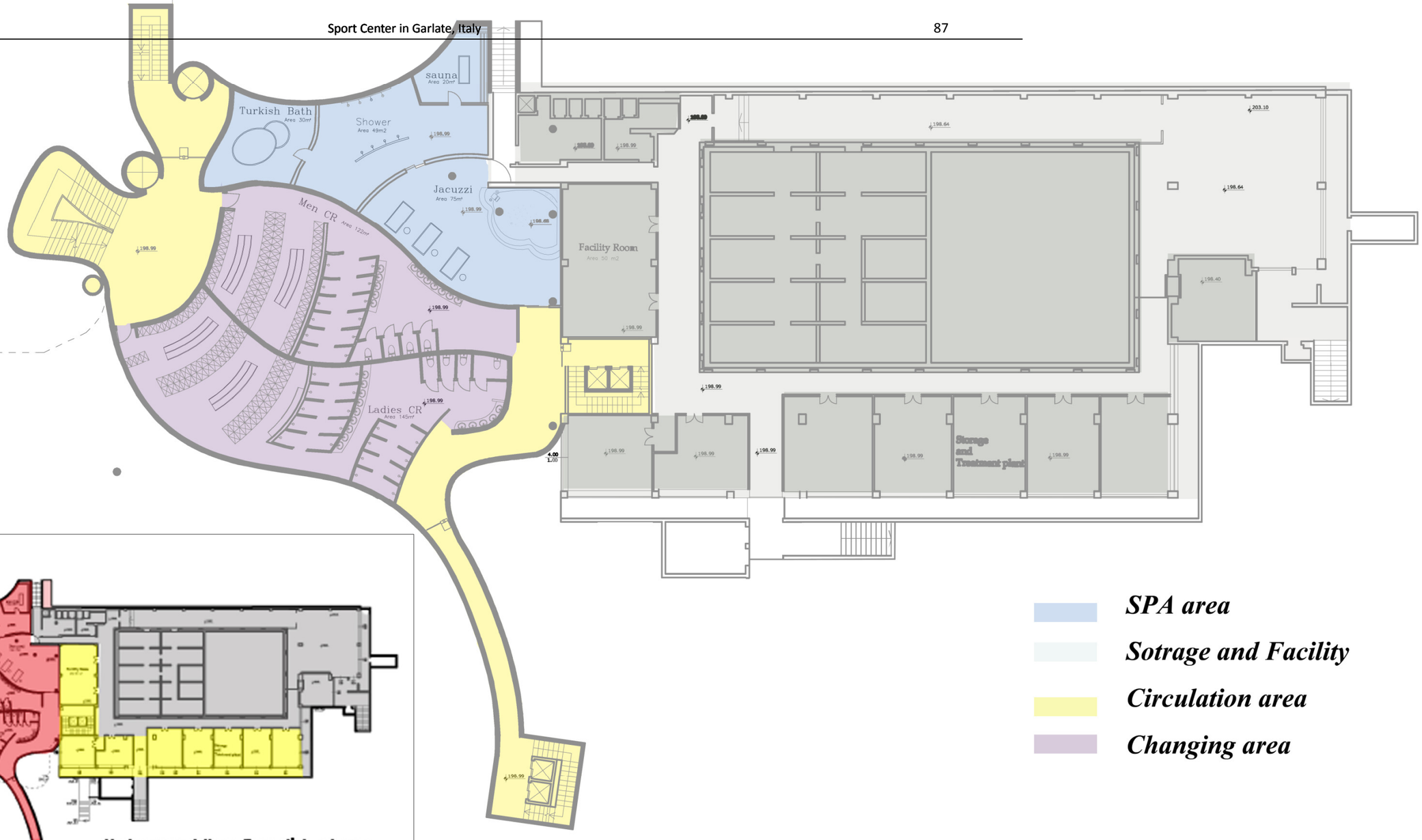
4) Outdoor facilities

- **Five-a-side football court and outdoor kids play area**

Five-a-side football court is designed beside the main entrance on the west, directly having look from the main road SP72 to it, presenting the Pratogrande Sport Center.

There is an outdoor children playing area which is on the green land next to the glass curtain wall of indoor playground. A door is opened for connecting these two spaces for easy in and out. A bath room is

shared for saving the space. The concept for this outdoor playing area is based on the idea that nature is the best playing ground for children. They can find more fun outside and it is good for their health. The goal of indoor training and outdoor relax is reached with combination of indoor and outdoor playground.



SPA area

Sotrage and Facility

Circulation area

Changing area

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Basement Plan *Scale 1 :250*

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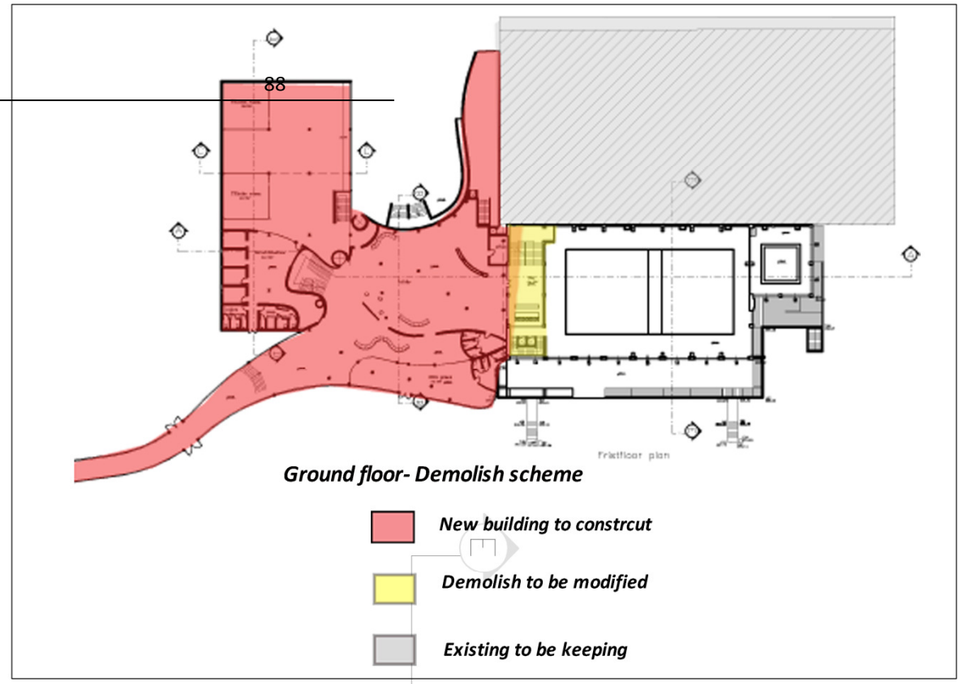

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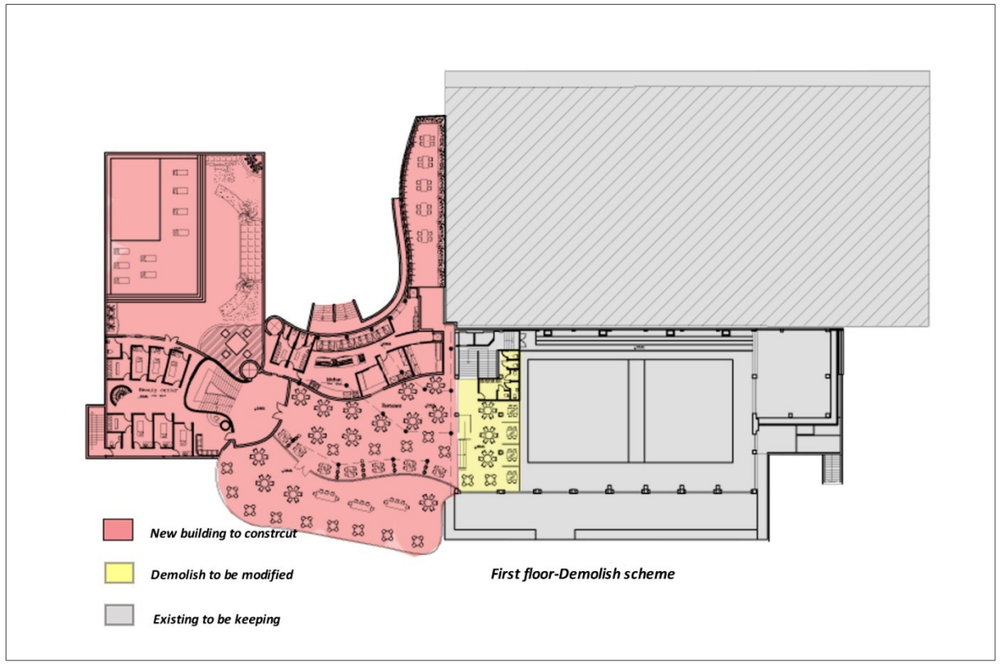
WangRuqian Zhang Yunfei



First floor-Demolish scheme

Beauty Center

Restaurant

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First Floor Plan ***Scale 1 :250***

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4.7 Barrier free design

4.7.1 Introduction

For the 'normal' people, the daily life in this more and more developed world has become easier and more convenient. It may become a fascinating place for working and living, offering a great variety of opportunities and experiences. However, for the disabled people, such built environments are full of uncertainties, anxieties and dangers.

Disabled people encounter many obstacles that prevent them from moving about freely and safely. They have to find a way to go to work, to go shopping, to live a reasonable normal life. The user-unfriendly facilities for the disabled people make their uneasy life even much more difficult.

Fortunately, awareness is growing and many countries have taken steps to integrate the disabled into society. A 'barrier free' concept is adapted during design of buildings and public facilities.

The barrier free design, also known as universal design, refers to broad-spectrum architectural planning ideas meant to produce buildings, products and environments that are inherently accessible to both the able-bodied and the physically disabled.

Figure 4-21 Public facility for the handicapped people

4.7.2 Design Details

1) Ramps

Ramps should be provided wherever stairs obstruct the free passage of pedestrians, mainly for wheelchair users and people with mobility problems. The effective width of passageways should be 1350mm; 900mm is acceptable if wheelchair users have the priority to pass. The maximum recommended slope of ramps is 1:20. Steeper slopes may be allowed in special cases depending on the length to be covered.

In our design, both the two entrances are facilitated with ramps heading to the lobby hall, which are indicated in poster 6. Moreover, ramp runs wherever there is a height difference no matter it is inside or outside building.

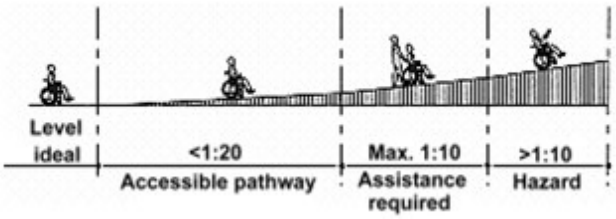


Figure 4-22 slope of ramp

2) Elevators

The accessible elevator is designed to serve all floors normally reached by the public.

The minimum internal elevator dimensions, allowing for one wheelchair passenger alone, are 1.00 m x 1.30 m. The door opening should not be less than 0.80 m. The inside of the elevator should have a handrail on three sides mounted 0.80 to 0.85 m from the floor. The panel should be lower so that the handicapped person can easily control the elevator.

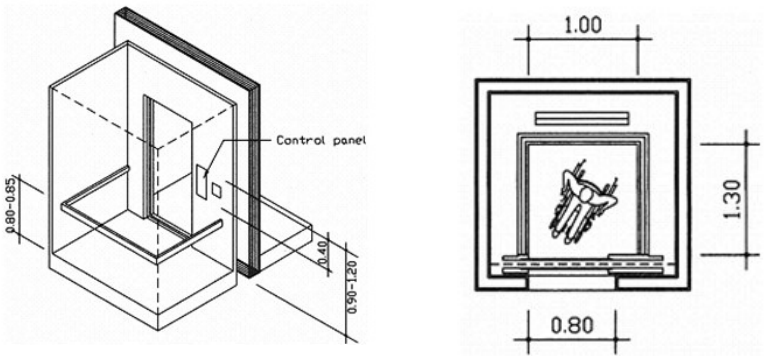


Figure 4-23 size of elevator

3) Entrance and doors

Entrance doors are operated automatically where possible. The main entrance is the most busy access point and it is designed to choose automatic sliding doors since they allow disabled people enter the building without any assistance.

4) Toilets

The toilets for the handicapped are served by a barrier-free path of travel. The door way should have an 850mm- clear- opening. The toilet should not be lower than 430mm when measured from floor to the surface of the toilet seat. A 900mm length grab bar should be located at the back of the toilet and installed no less than 300mm measured from toilet seat to the midpoint of the grab bar.

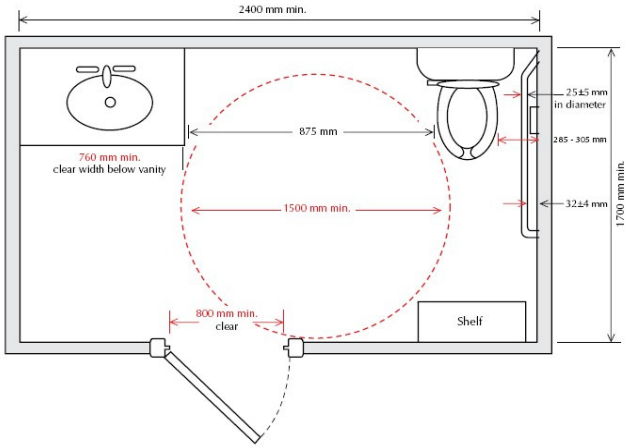


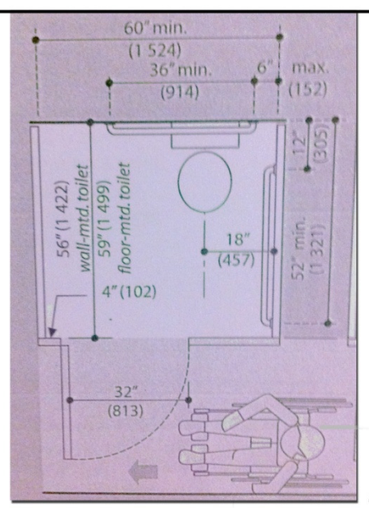
Figure 4-24 size of toilet

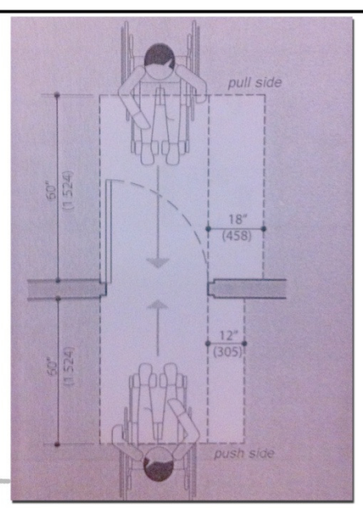
4.7.3 Barrier free path

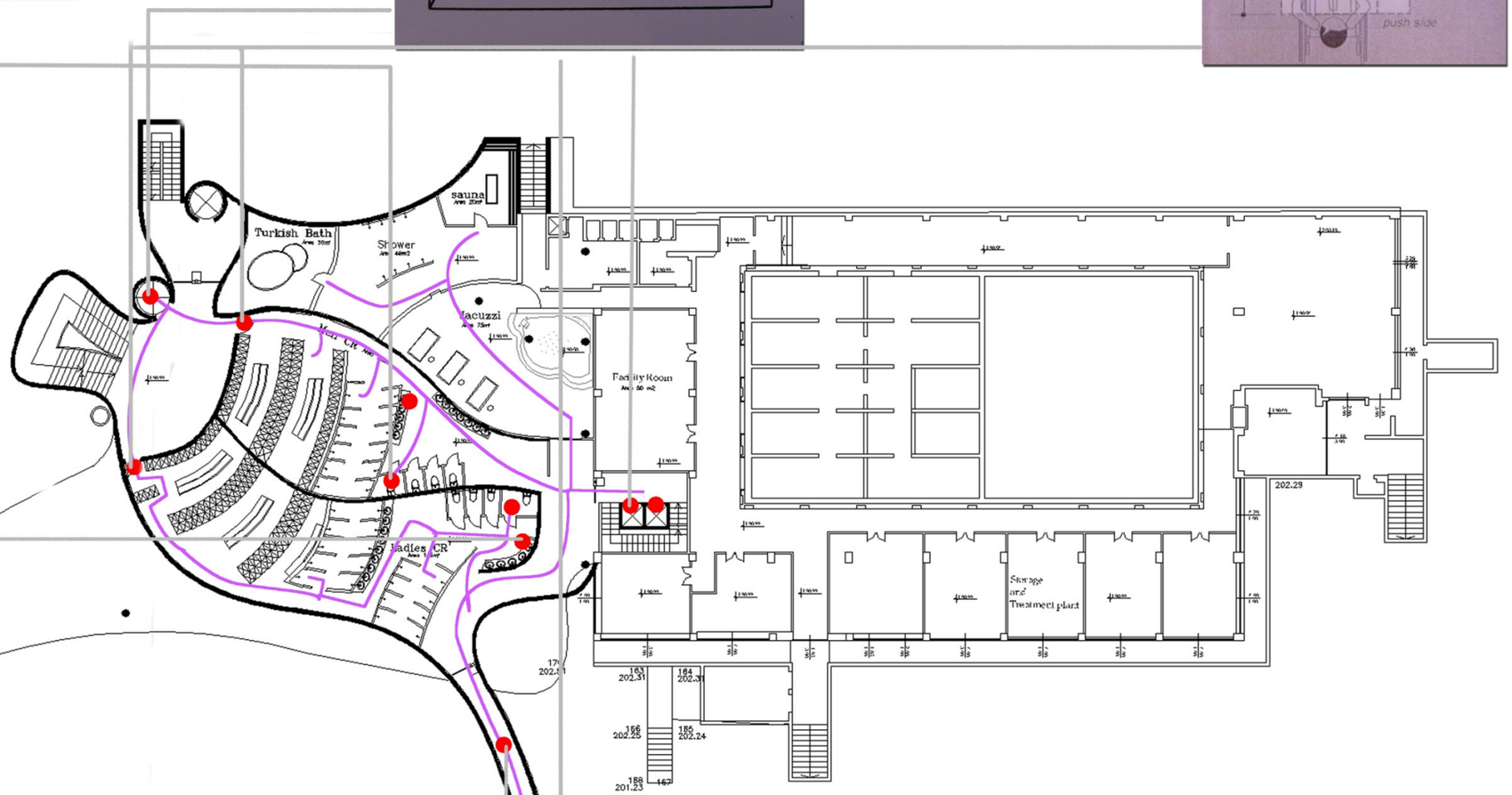
The detaileddrawing of barrier free path for disabledpersonisshown in Poster 7 to Poster 9

4.8 Escape routes

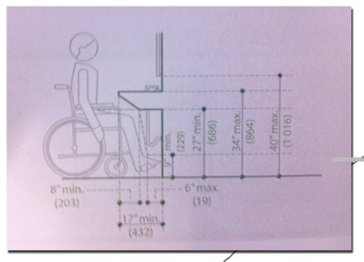
Safe escaping route design is aiming to provide a safety, suitable and convenient escaping route. As shown inPoster 10-12 what we are considering is the case in the most extremely negative situation and the target to save time. As it is a well conscious, that the time is the most crucial issue in emergency, including the time that everybody in the building needs to escape out and the time the building can provide. We give an equation for these two kinds of times or the relation of 'needed' is shorter than ‘provided'. The position of emergency exit, stairs and corridors is also considered.

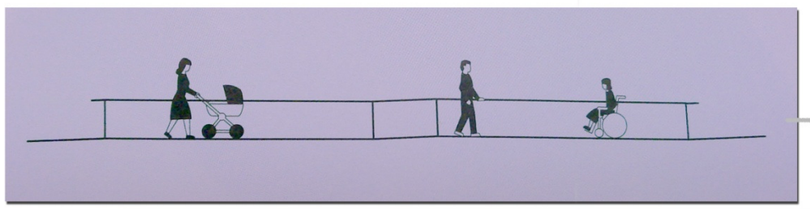






Basement plan





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Barrier Free basement

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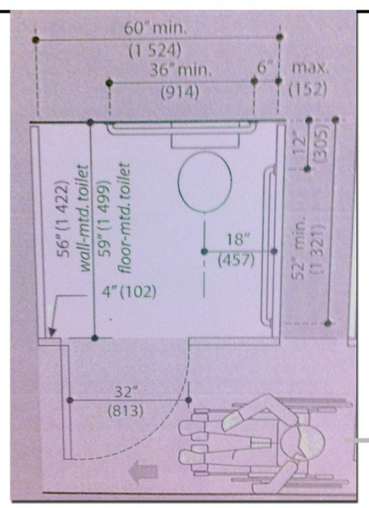
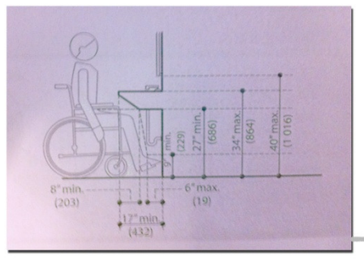
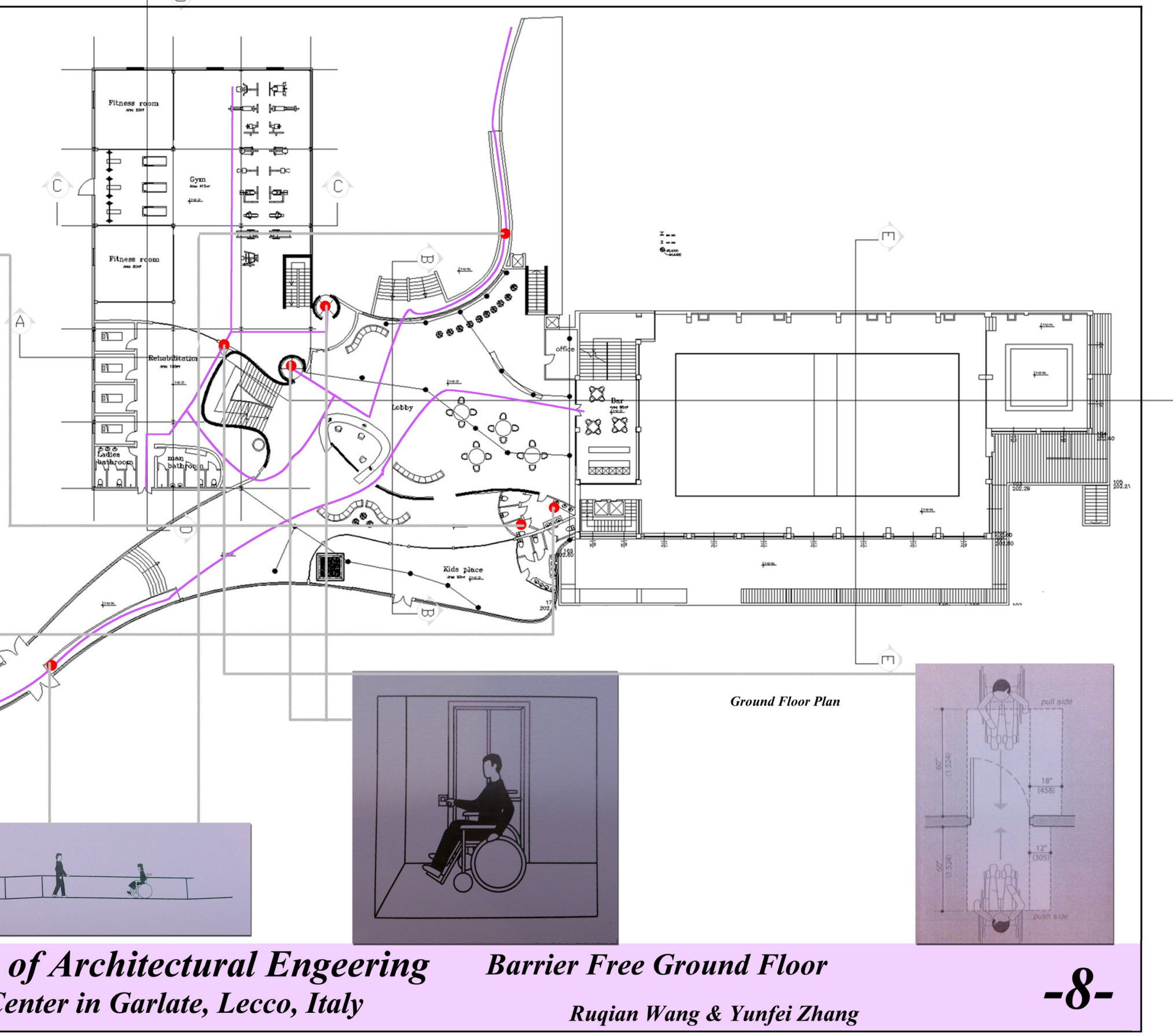
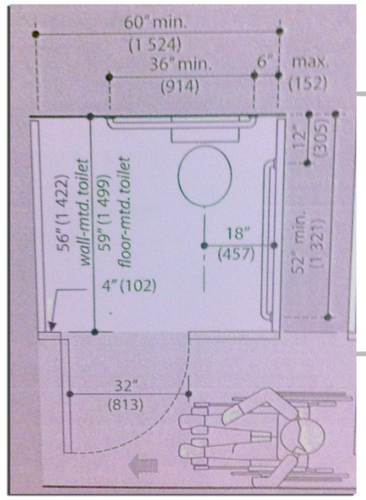
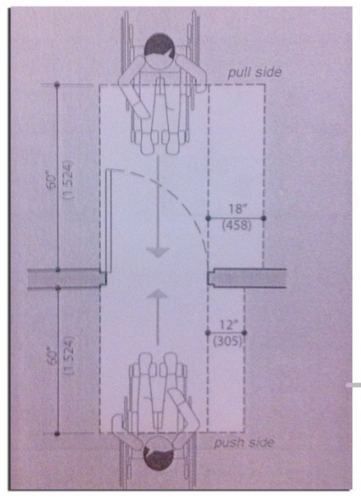


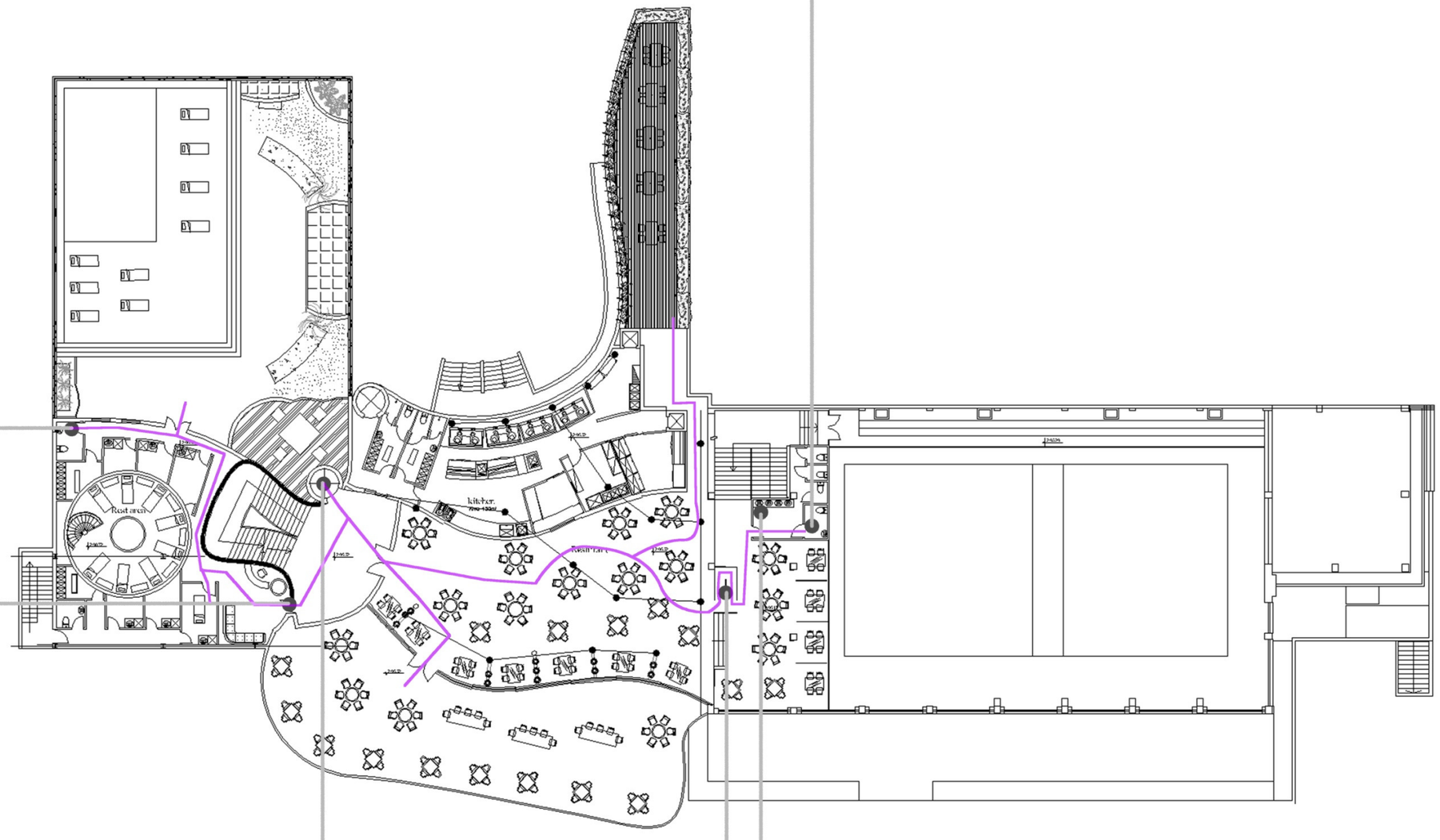




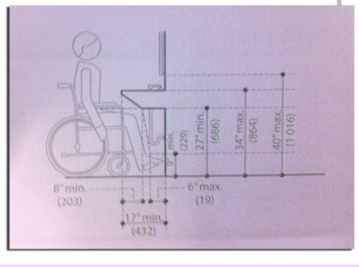
Ground Floor Plan

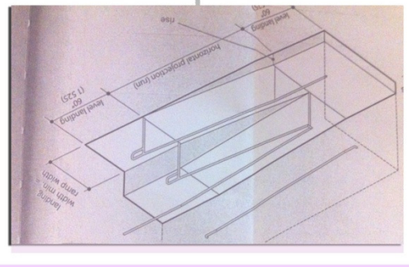






First Floor Plan





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Barrier Free First Floor

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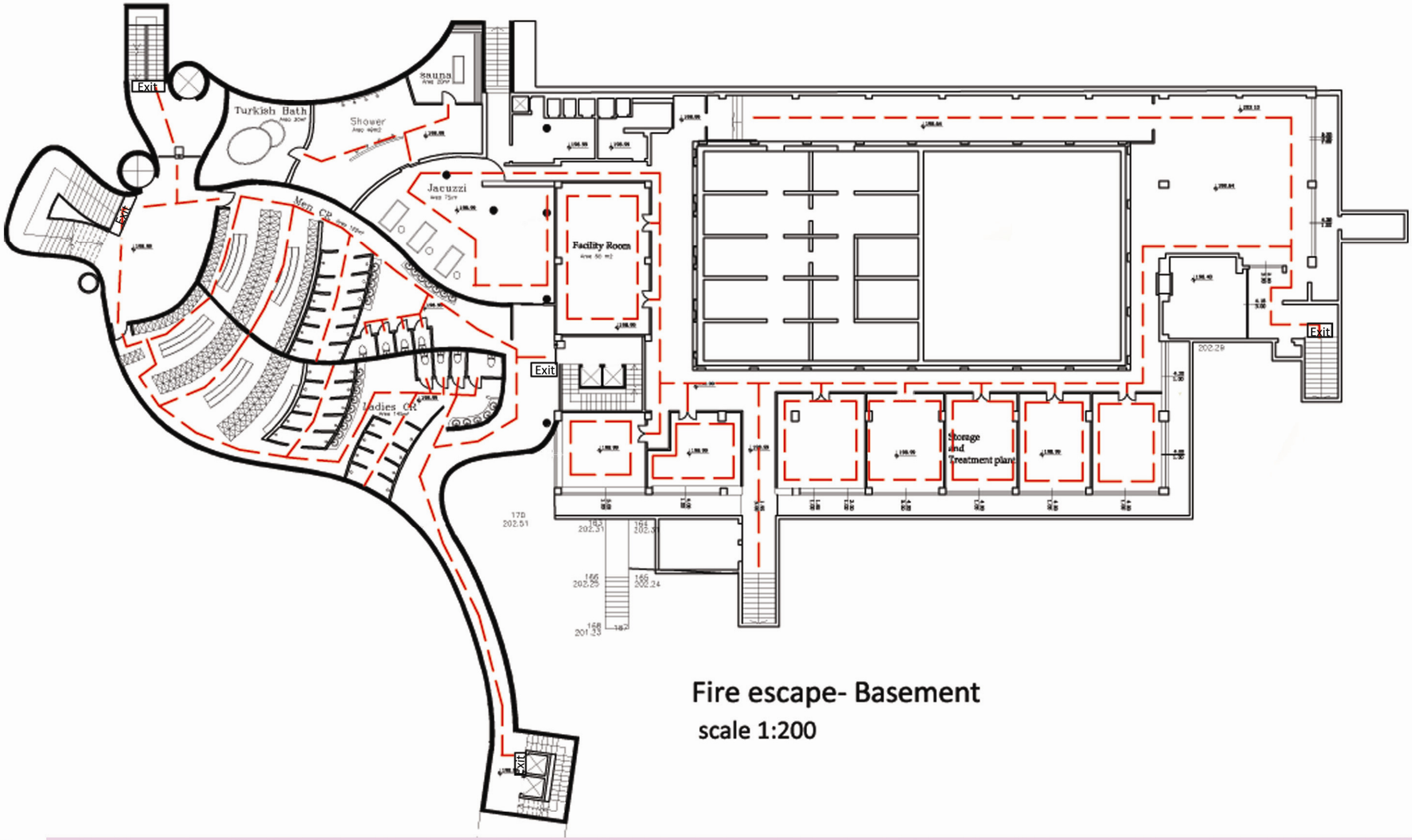
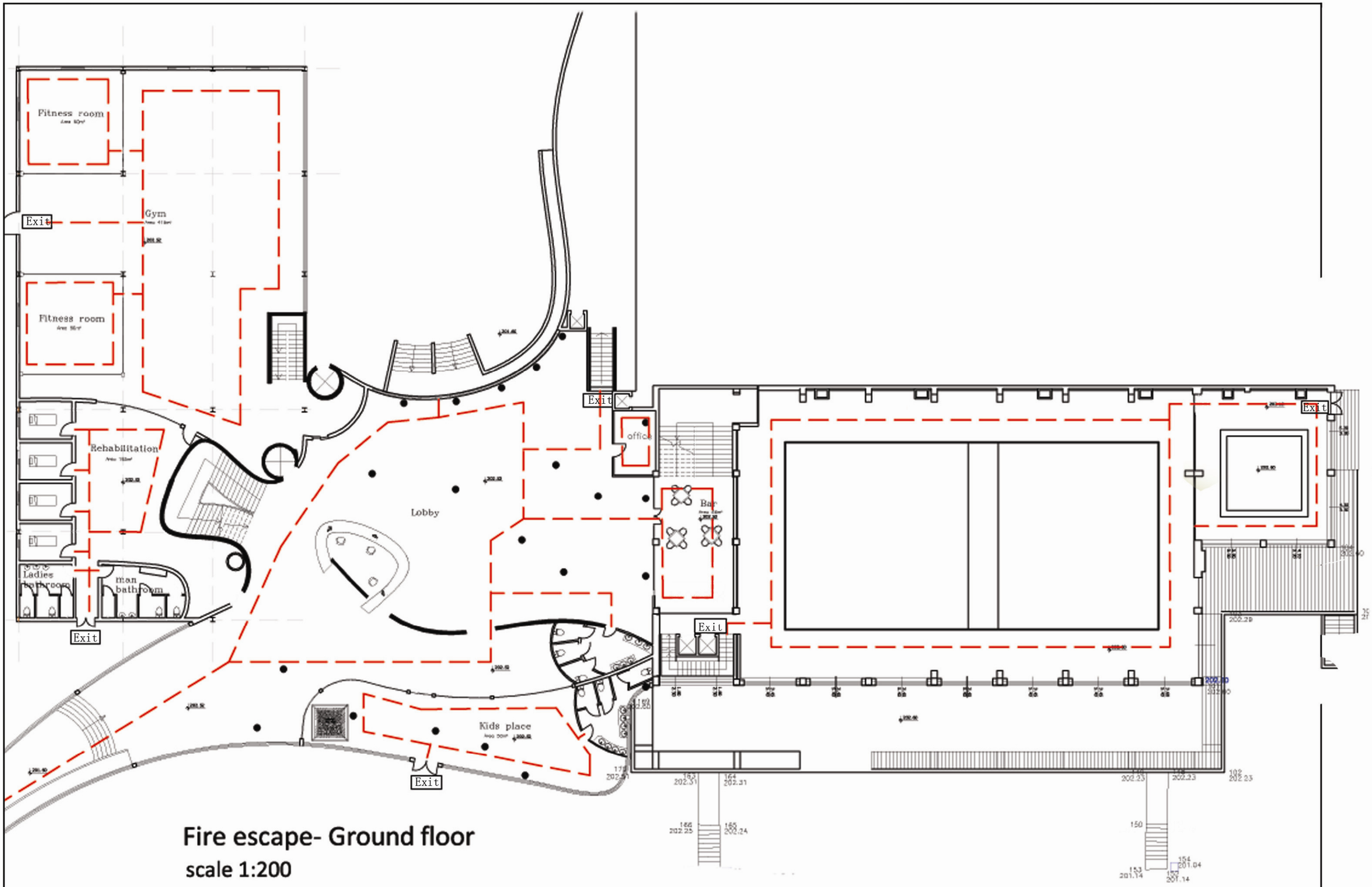


Fire escape- Basement

scale 1:200



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Fire escape-ground floor *Scale 1:200*

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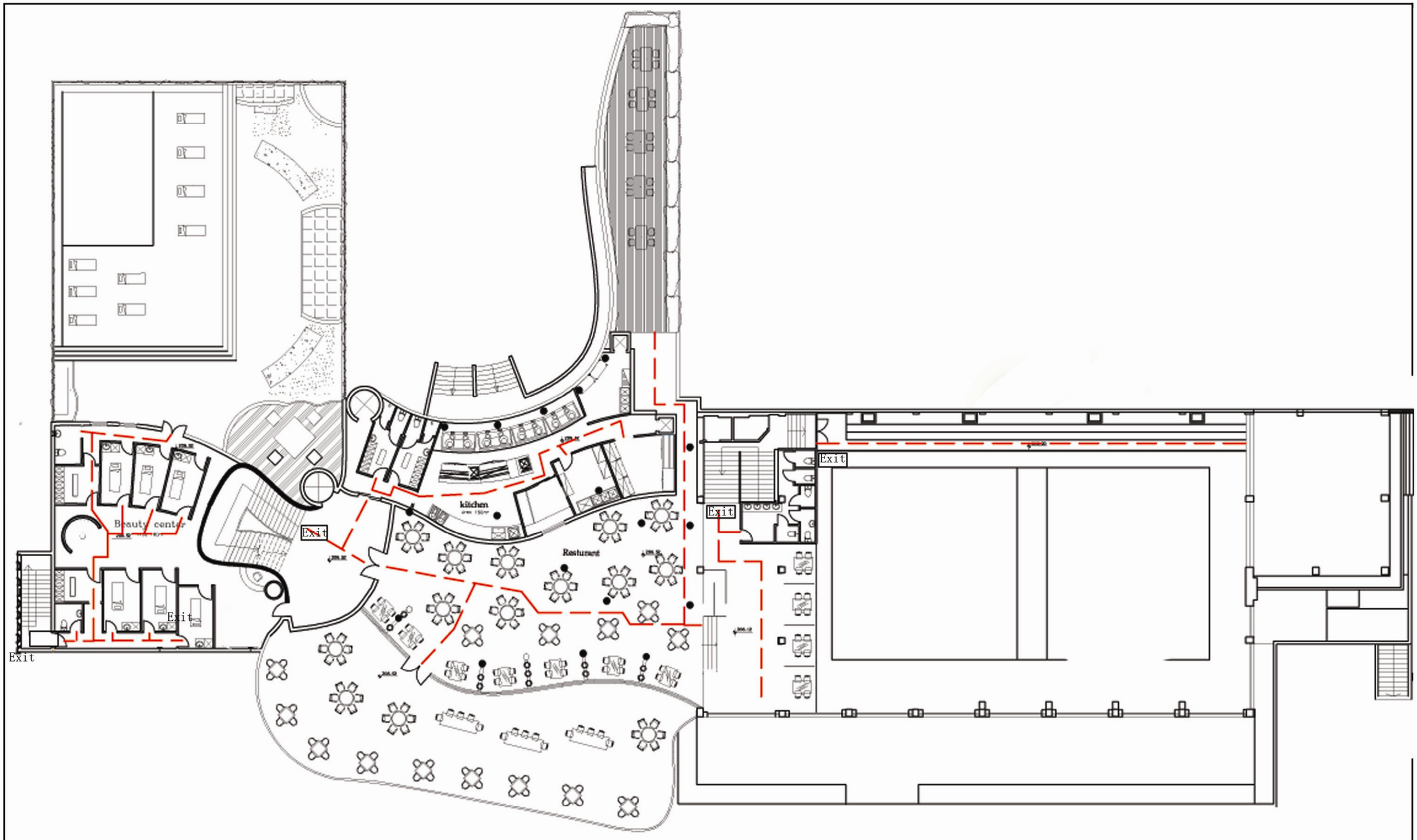


Fire escape- Frist floor

Chapter 5

Fitness Center in Garlate,Italy

Structure Design Concept

5 Structure Design Concept

5.1 Introduction

Structure can be used to define space, create units, articulate circulation, suggest movement, or develop composition and modulations. In this way, it becomes inextricably linked to the very elements which create architecture, its quality and excitement.

With the target that mentioned above and according to the architecture design chapter, the volume of building is divided into three parts concluding: a central Lobby block that is irregular volume, a 3-storey building with a basement in regular shape, and the gym block, shape of which is also regular. For simplicity reason, to consider the structure between buildings with regular and irregular shape requires an analysis of two of three buildings. In this chapter, an idea is given to explain briefly the structures that are adopted and reason for this kind of adoption.

5.2 The structure options

There are 2 different structure options that we can choose to design the structure of the project, which are reinforced concrete structure and steel structure. They are analyzed below respectively considering the advantages and disadvantages.

5.2.1 Reinforced concrete structure

It is the most prolific and versatile structural material in use today. It is composed of two distinct materials，concrete and reinforcement, each of which can be varied in quality, disposition and quantity to fulfill almost any requirements. The concrete structure has superior

resistance to compression, exceptional resistance to fire, and the absence of toxic fumes in case of fire, very competitive overall cost (investment and used) easy for maintenance work and easy to shape.

On the other hand, the concrete structure still has some disadvantage such as construction process takes a long time and it will be dangerous if there is earthquake.

5.2.2 Steel frame Structure:

Steel structure is the technology which is developed rapidly, especially being used for skyscraper in modernity. But the prerequisite is that the risk considering the earthquake and fire is dealt quite well. Time cost of construction process is relatively short and recyclable material could be used together with the feature of light-weighted structure. The risk in case of earthquake is quite low if joints are designed with full attention. With this kind of structure, Satisfying both of the architectural esthetics and high technique demand becomes possible.

However, it has lower resistance to the fire. Due to this reason, the beam, column, bracing and the trapezoidal metal sheeting should be covered by fire resisting dope. Moreover, the cost of steel is higher than other materials due to its poor characteristic for recycling but with large quantity of needs. Meanwhile, maintenance job is quite difficult.

5.2.3 Structure type selection in our project

According to the analysis above and considering about our design concept in which the shape of building contains some features of curvature and irregularity, we choose reinforced concrete structure for the lobby and restaurant part, while the steel structure is chosen for

the gym area for our design.

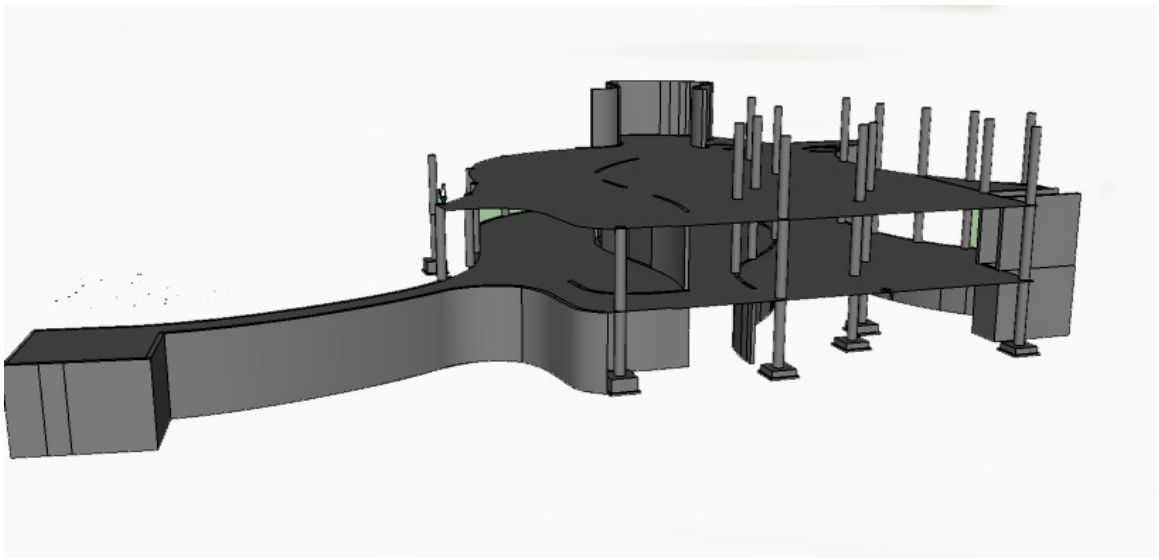


Figure 5-1the concrete structure of lobby area

The concrete slabs, columns and load-bearing walls are designed for the lobby block which is 3 story high building as the main function of changing room (underground floor) and lobby (ground floor) as well as the restaurant (first floor).

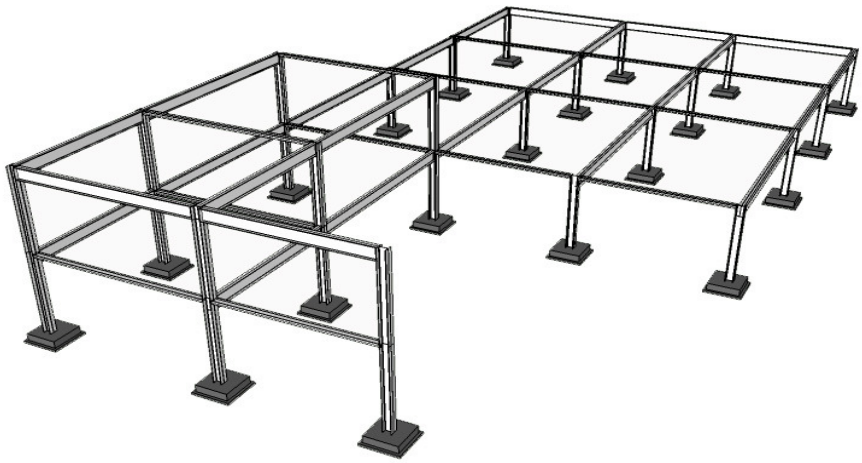


Figure 5-2 the steel structure of gym area

The steel structure is adopted into gym block whose main function is to be used gym and beauty center.

5.3 Seismic gap designed in our case

A seismic gap is also required when one building is separate into two independent structures. They allow the two drift values to be combined in such way that recognizes the low probability of both maximum drifts occurring at precisely the same time. In this project, the new building as an addition to an existing one, although they will be connected inside, they should be separated and considered as three different bodies for earthquake resisting purposes.

The *Eurocode8*, at point 4.2.3.2 gives us the criteria for regularity in plan for earthquake resistance, which our building being an irregular, hence it will also be separated in three bodies.

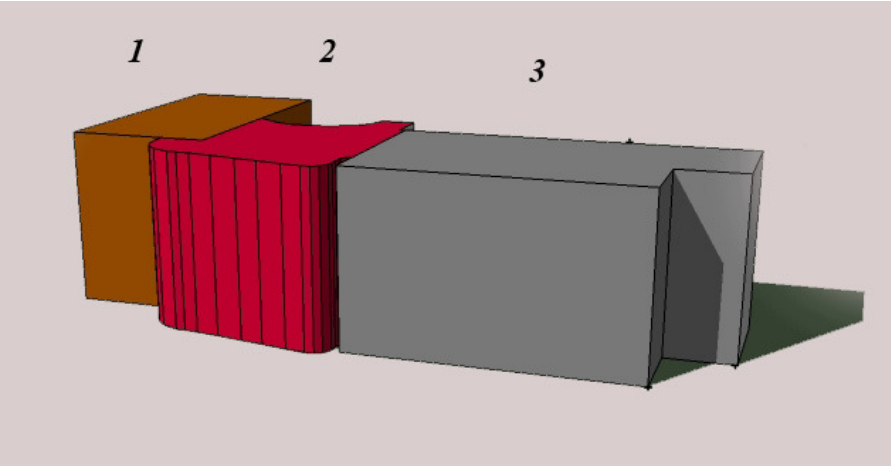


Figure 5-3Three blocks of building

According to the 4.4.3.2 Limitation of interstory drift

a) For buildings having non-structural elements of brittle materials attached to the structure:

$$d_r \leq \frac{0.005(h)}{v}$$

where

*d*r is the design inter story drift

h is the story height;

v is the reduction factor which takes into account the lower return period of the seismic action associated with the damage limitation requirement. For class III and IV structures v= 0.4

$$dr \leq 0.005 \bullet 7.2 / 0.4 \leq 0.09m$$

Since it will happen for all the buildings which are swimming pool, lobby and gym, the inter story drifting is 22 cm. We separate both buildings from each other by 30cm.

Satisfactory architectural treatment of seismic gaps is also required for junctions between floors, walls and ceilings.

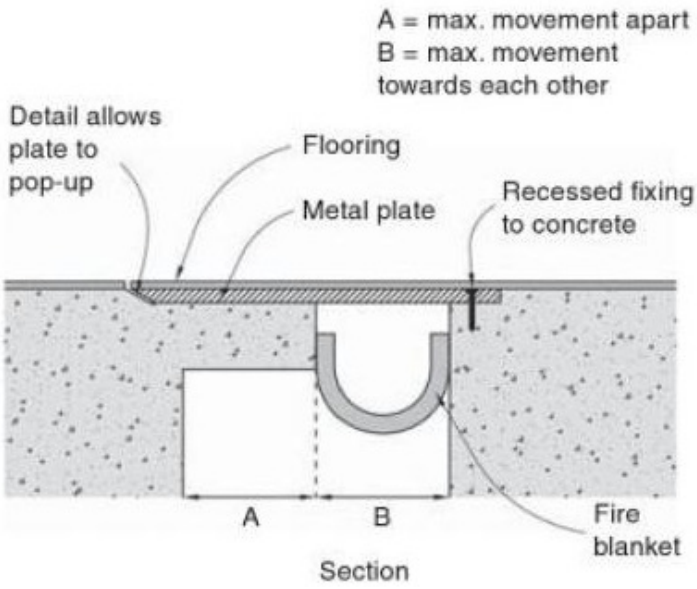


Figure 5-4 Detail of seismic gap

A section through a genetic floor level seismic gap is shown in Figure 5-4. Dimension A can be reduced if damage caused by the plate sliding off its left hand seating is acceptable during smaller relative drifts.

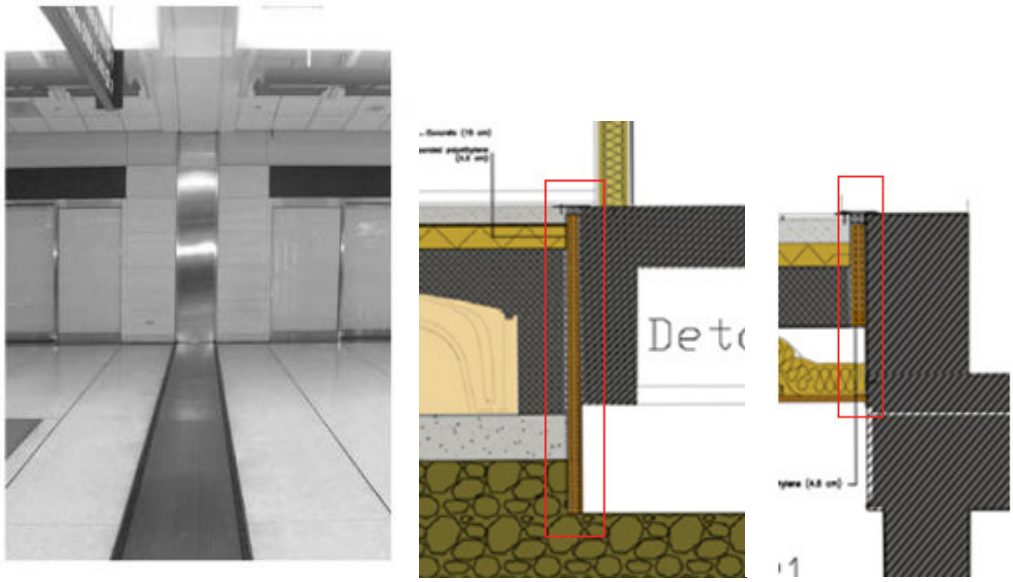


Figure 5-5 The seismic joint

Here is the example of a seismic joint between floors walls and ceilings of two separated structures in Figure 5-5.

5.4 Load Transfer in Structure

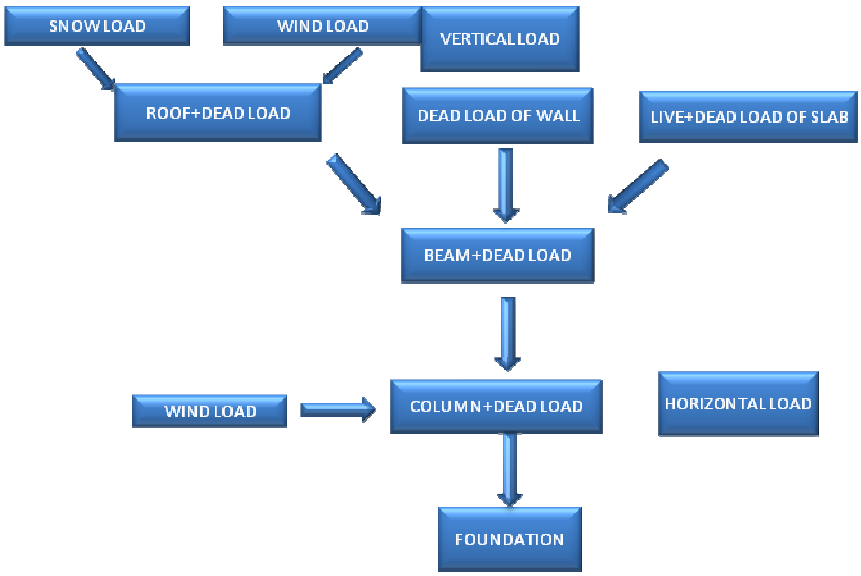


Figure 5-6 load transfer in structure

5.5 The option project

5.5.1 The slab

Due to the large distant from west to east and south to north, and in order to avoid using too many columns in lobby space according to architecture requirements, the Biaxial hollow flat plate slab will be suitable for this purpose as well as for the construction convenience.

The biaxial hollow flat plate slab is a kind of slab that has a significant advantage of saving the dead load of the structure in contrast to solid slabs. Moreover very high load carrying capacity and flexibility is

provided. Compared with the conventional hollow slabs with load transfer in only one direction, the biaxial hollow slabs load transfer is possible in any direction. Therefore, the biaxial hollow slab can be used in long distance structure.

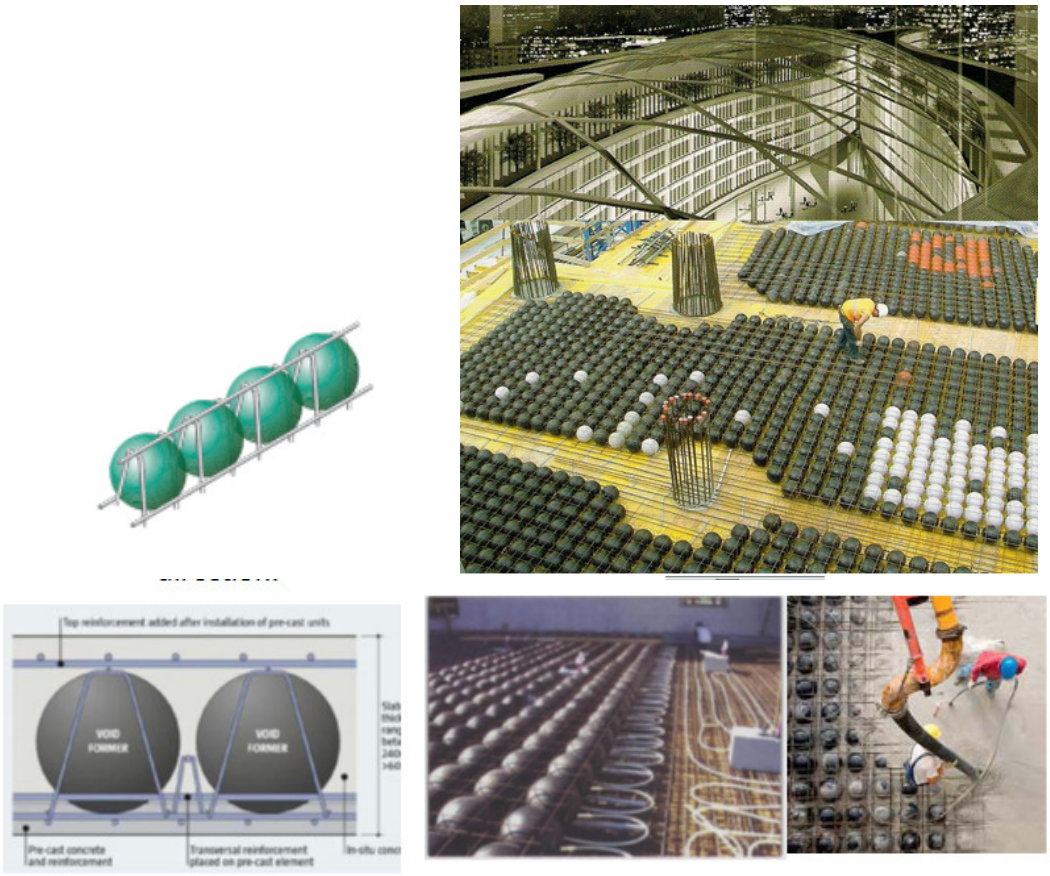


Figure 5-7 Biaxial hollow flat plate slab

As the Biaxial hollow flat plate slab was transfer load in any direction, allows longer spans and less weight, which can be adopted in the curve and irregular shape building structure slab constantly.

According to architecture requirement in this project, the columns number is designed as10 which are homogenously distributed during this long distant (40m)from west to east and can support the irregular

structure of the lobby building. As we can see from this truth, the biaxial hollow flat plate slab is the best choice in this project.

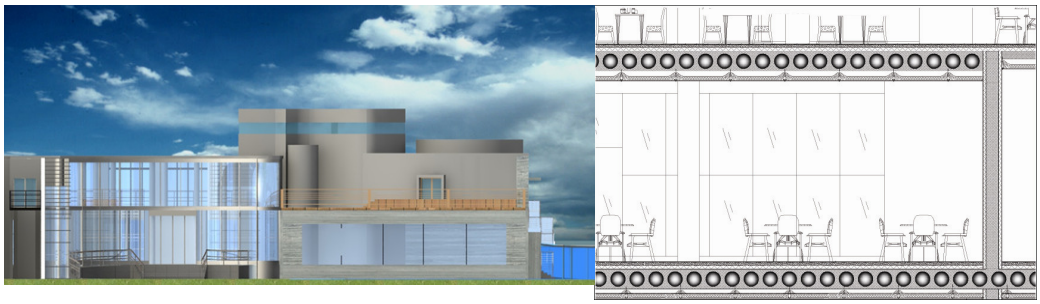


Figure 5-8the selection of slab

5.5.2 The column selection

Column takes load from beams and slabs. Due to the curved and irregular shape of this building in lobby and restaurant part, round column are not symmetrically located around center of the section which can transfer loads from any direction easily(the structure is shown in figure 6-8) Another reason for the choice of round column is to keep the same tone of the whole building.

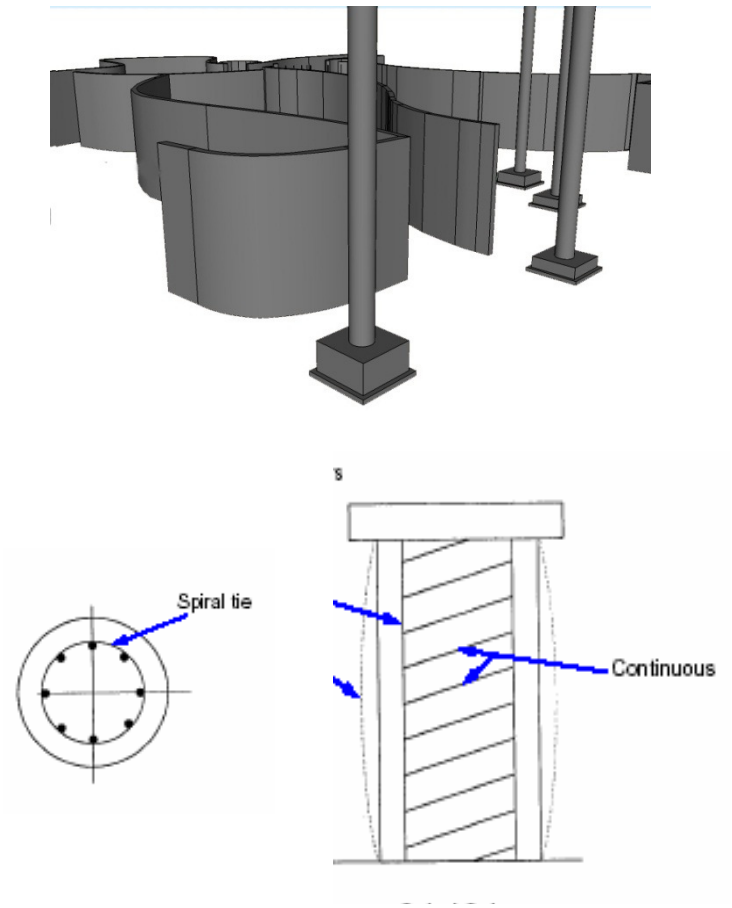


Figure 5-9the column of lobby block

Considering the architecture requirement that the spiral concrete columns are designed in the lobby block, the diameter of column was selected as 400mm.

Steel columns are used in gym part due to the regular shape, which gives more useable space and less visual obstructions because of the smaller size than concrete columns.

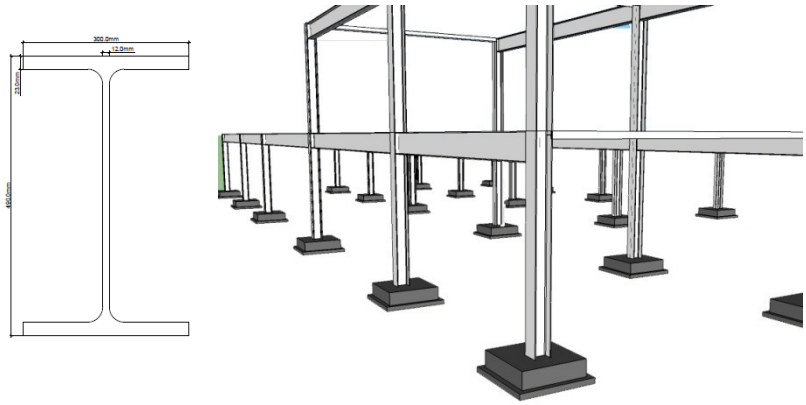
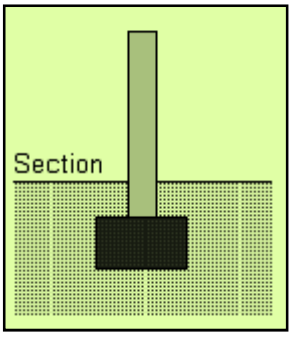


Figure 5-10the columns of gym block

The steel columns and beams are adopted for gym area because of the regular shape according to architecture design.

5.5.3 The Foundation selection



Foundation is a structural member used to support columns and walls and to transmit and distribute their loads to the soil in such a way that the load bearing capacity of the soil is not exceeded, excessive settlement, differential settlement, or rotation are prevented and adequate safety against overturning or sliding is maintained.

In this project, the underground floor is below the ground at least 4 meters, Therefore, the sport center foundation was considered as a combination of strip foundation and a load-bearing wall foundation which would be better than single form of foundations of the lobby section (shown in figure5-11).Strip foundations are used to support a linear loads, which can be suitable for the gym structure (shown in figure5-12).

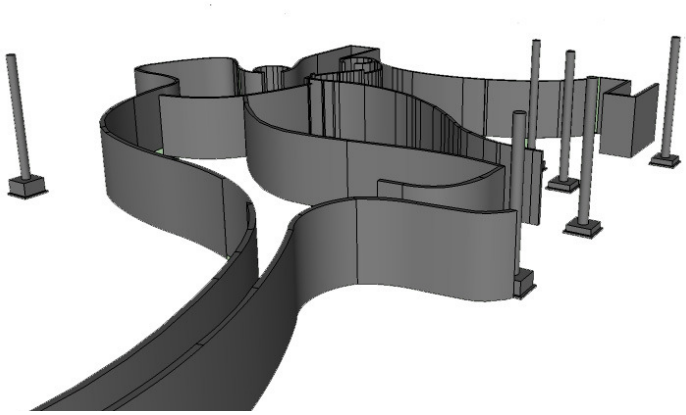


Figure 5-11 the foundation of lobby and changing room area

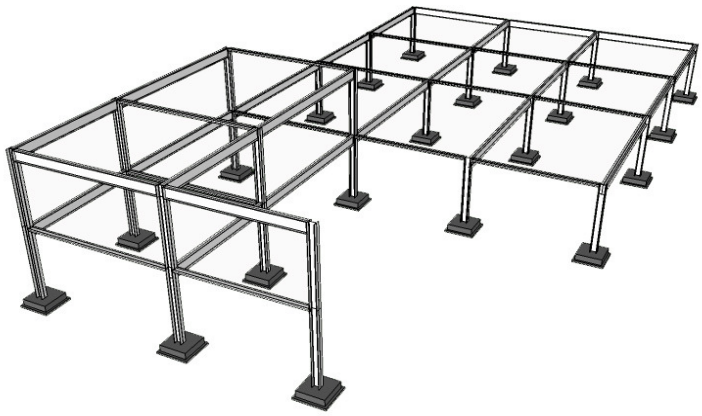


Figure 5-12 Foundation of gym part

5.6 Environment loads

5.6.1 Wind load

Wind is flowing air. As a fluid, it impacts and is redirected by the structures that it encounters, resulting in complex flow paths and variable pressures across the surfaces that it interfaces with. The interaction of fluids and structures is studied using principles of fluid mechanics and experimental testing on models in wind tunnels as well

as full scale buildings in the open environment.

The magnitude of the wind load is defined from factors such as the shape of the building, the area that will withstand it, and the weather characteristics of the site. In our case the building is separated into 2 blocks.

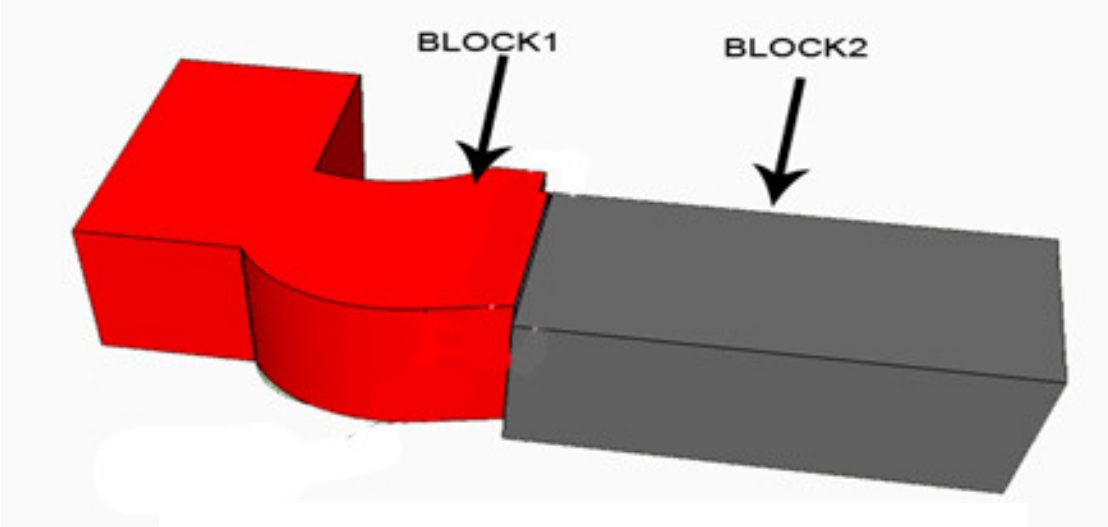


Figure 5-13Two blocks of building

Wind load calculation

According to code EN1991 part4, the table 4-1(*Terrain categories and terrain parameters)*, the location of this project is at the shoreline of LAGO DI LECCO. So the category is I.

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 buildings 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 15 m	1,0	10
NOTE: The terrain categories are illustrated in A.1.			

Table 5-1 Terrain categories and terrain parameters

We use the equation to calculate

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

*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

Here *C* dir, C season recommends as 1.0.

Fundamental value of the basic wind velocity (see European wind map):

$V_{b,0}$ = 24m/s

Therefore Vb=1.0* 1.0*24= 24m/s

Basic velocity pressure

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

Where Pair= 1.25kg/m3(air density)

$qb = \frac{1}{2} * 1.25 * 24^2 = 360 N/m^2$

Peak pressure at height **z** with the equation

$$qp(z) = [1 + 7 * Iv(z)] \frac{1}{2} \rho * v2m(z) = ce(z) * qb$$

Where:

. ρ = Air density

ce(z) = Exposure factor

qb = Basic velocity pressure =360pa

The exposure factor for a flat terrain, where the orography factor co(z) and the turbulence factor kl are equal to 1, is obtained from the *Figure 5-14*:

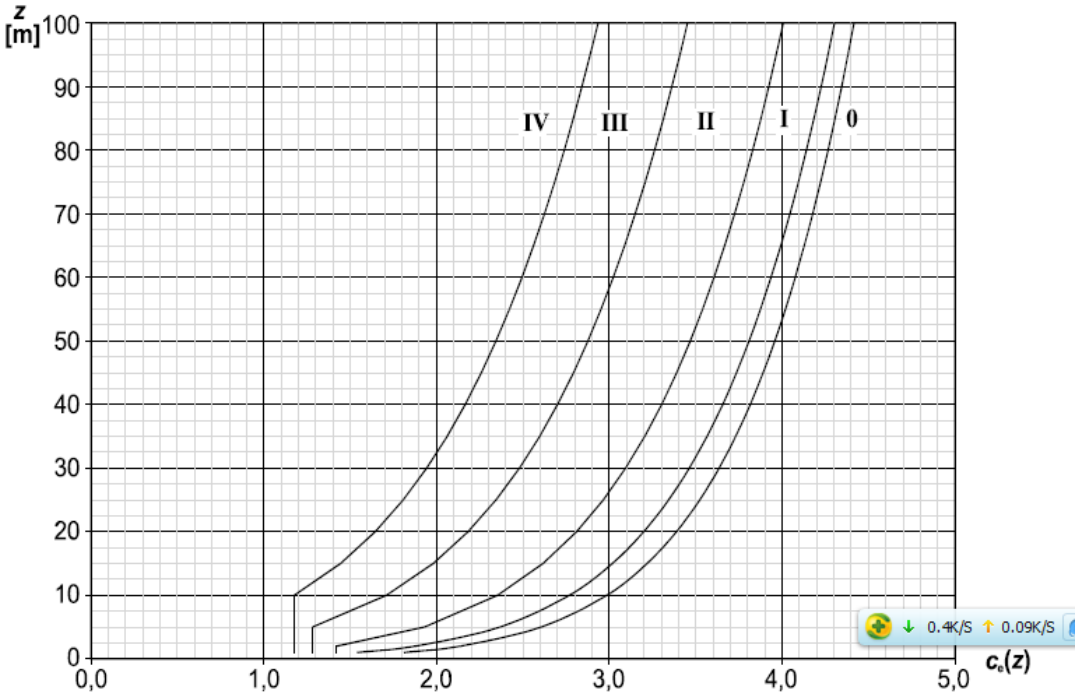


Figure 5-14Graph for the calculation of the orography factor

As has been demonstrated above the Project is located in the category I, Hence the Z is supposed to be7.2m. The value of Ce(z) can be concluded from figure5-14 which is around 2.1

Consequently:

$$qp(z) = Ce(z) * qb = 2.1*360=756 \text{ Pa}$$

Roughness length (z_0) = 0.01 m

Minimum height (z_{min}) = 1 m

Maximum height (z_{max}) = 200 m

While the height of our building is z = 7.20 m,so the relationship z_{min}< z <z_{max}

And we calculate the roughness factor $c_r(z)$. $z_{min} < z < z_{max}$, therefore we use the equation:

$Cr(z)=kr*\ln(z/z_0)$

Where Kr is the terrain factor depending on the roughness length, calculated by:

Kr= 0.17

Cr(z)=1.12

Finally to obtain the wind force acting on the area is used the equation:

$Fw = CsCd * Cf * qp(ze) * Aref$

Where:

cscd (structural factor) =1

For buildings with a height less than 15 m the value of $c_s c_d$ may be taken as 1.

Cf = force coefficient for the element, defined as 1.0 according to section 7.

$qp(ze)$ characteristic peak velocity pressure at height ze, here we have calculated before. $qp(ze)$= 756pa

Aref = reference area of the structural element.

Ax=266.4m2

Wind force on the X axis is Fw= 201 KN

Ay=326m2

And the wind force on the Y axis is Fw=229KN

5.6.2 Snow load

The design snow load represents the peak snow accumulation on a roof over winter season. In colder regions the design snow load represents snow deposited by multiple snow events. This may also be true in some more moderate climates as well.

For its calculation there should be taken considerations such as the pitch of the roof, or snow sliding from higher to lower level roofs. In our project, that the roof is not pitched so the load will be calculated as uniform according to Euro code EN1991.

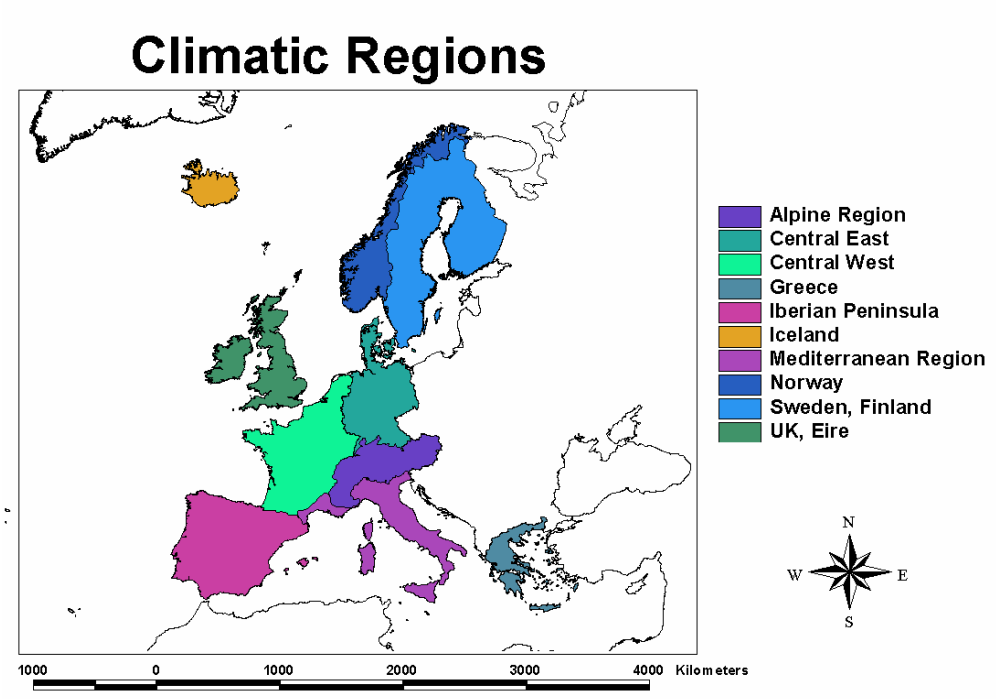


Figure 5-15 Climate region

The project was located in the province of Lecco which is northwest of Italy. From the fig5-16 below, our project is in the zone Mediterranean Region.

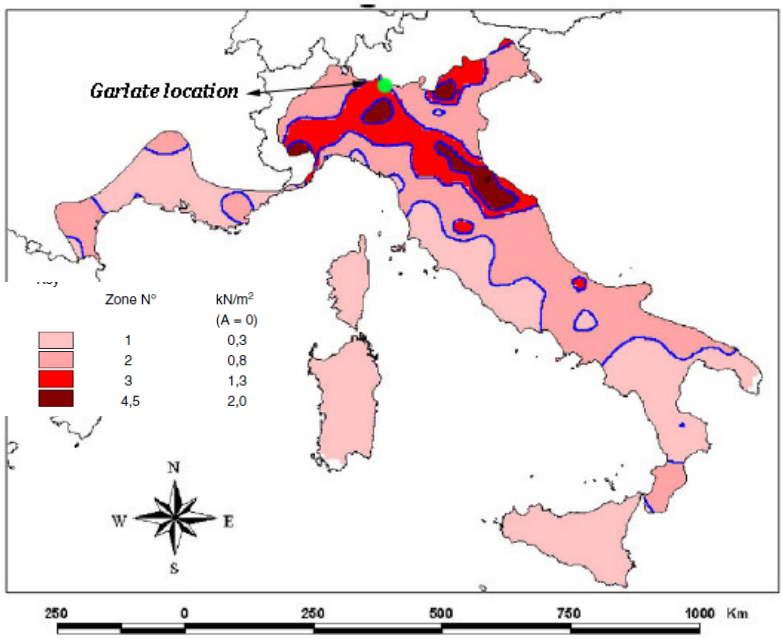


Figure 5-16 Seismic Zone

Climatic Region	Expression
Alpine Region	$s_k = (0{,}642Z + 0{,}009)\left[1 + \left(\frac{A}{728}\right)^2\right]$
Central East	$s_k = (0{,}264Z + 0{,}002)\left[1 + \left(\frac{A}{256}\right)^2\right]$
Greece	$s_k = (0{,}420Z + 0{,}030)\left[1 + \left(\frac{A}{917}\right)^2\right]$
Iberian Peninsula	$s_k = (0{,}190Z + 0{,}095)\left[1 + \left(\frac{A}{524}\right)^2\right]$
Mediterranean Region	$s_k = (0{,}498Z + 0{,}209)\left[1 + \left(\frac{A}{452}\right)^2\right]$
Central West	$s_k = 0{,}164Z + 0{,}082 + \frac{A}{966}$
Sweden, Finland	$s_k = 0{,}790Z + 0{,}375 + \frac{A}{336}$
UK, Republic of Ireland	$s_k = 0{,}140Z - 0{,}1 + \frac{A}{501}$
s_k is the characteristic snow load on the ground [kN/m²]. A is the site altitude above Sea Level [m]. Z is the zone number given on the map.	

Table 5-2 climate region- expression

So we use the equation from table C.1 that shows load relationships depending on the climatic Mediterranean region.

$$s_k = (0{,}498Z + 0{,}209)\left[1 + \left(\frac{A}{452}\right)^2\right]$$

Where:

S_k= characteristic snow load on the ground [kN/m²]

A = altitude above sea level [m]

Z = zone number given on the map

We get:

$$Sk = (0.498*3+0.209)\left[1+(375/452)2\right] \cong 1.035 KN/m2$$

5.6.3 Earthquake load

According to the seismic map of Italy, the town of Garlate is in the 4 Zone which is considered a low seismicity area from Figure 5-16.

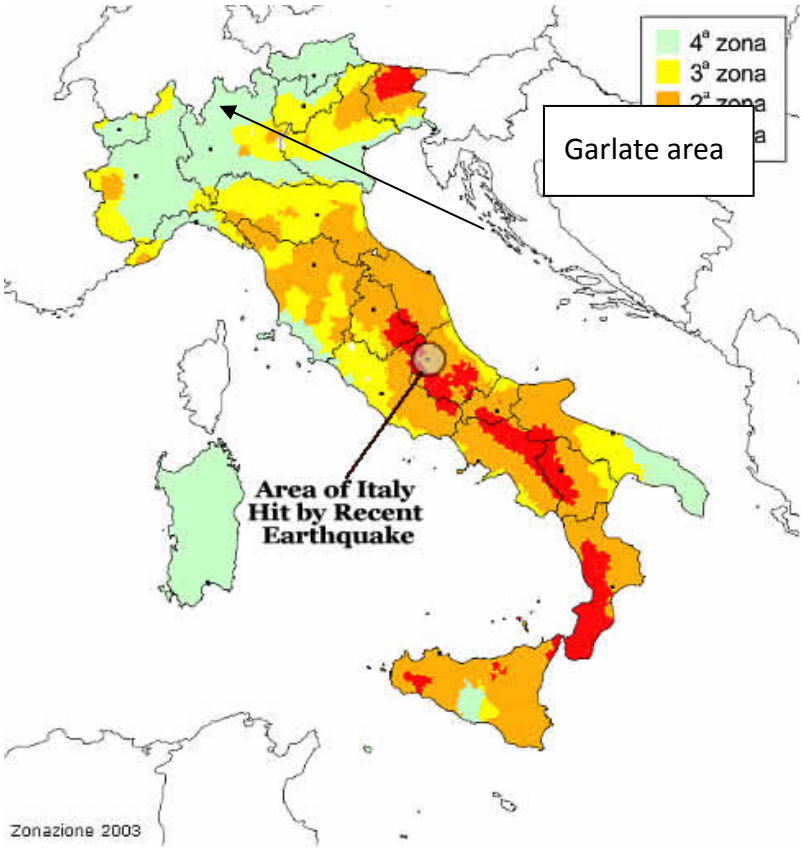


Figure 5-17 seismic zones

According to the Eurocode 8 identification of ground types, our project is located in Garlate which is on the lakeside and mountainous configuration. From table 5-3 it is considered as ground type B to do calculate the seismic action.

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

Table 5-3 Ground type

Due to large quantity people will be in the sport center at same time. The sport center is considered the importance as the class III(For important structures (γI>1,0). In this case it is possibility of being used as a temporary shelter, so the γI factor will be 1.1

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

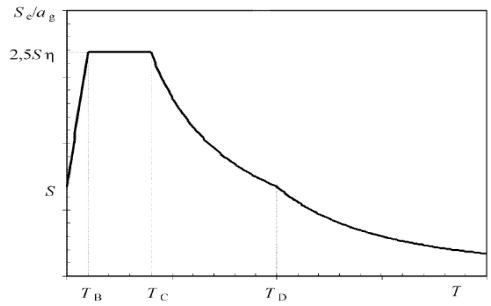
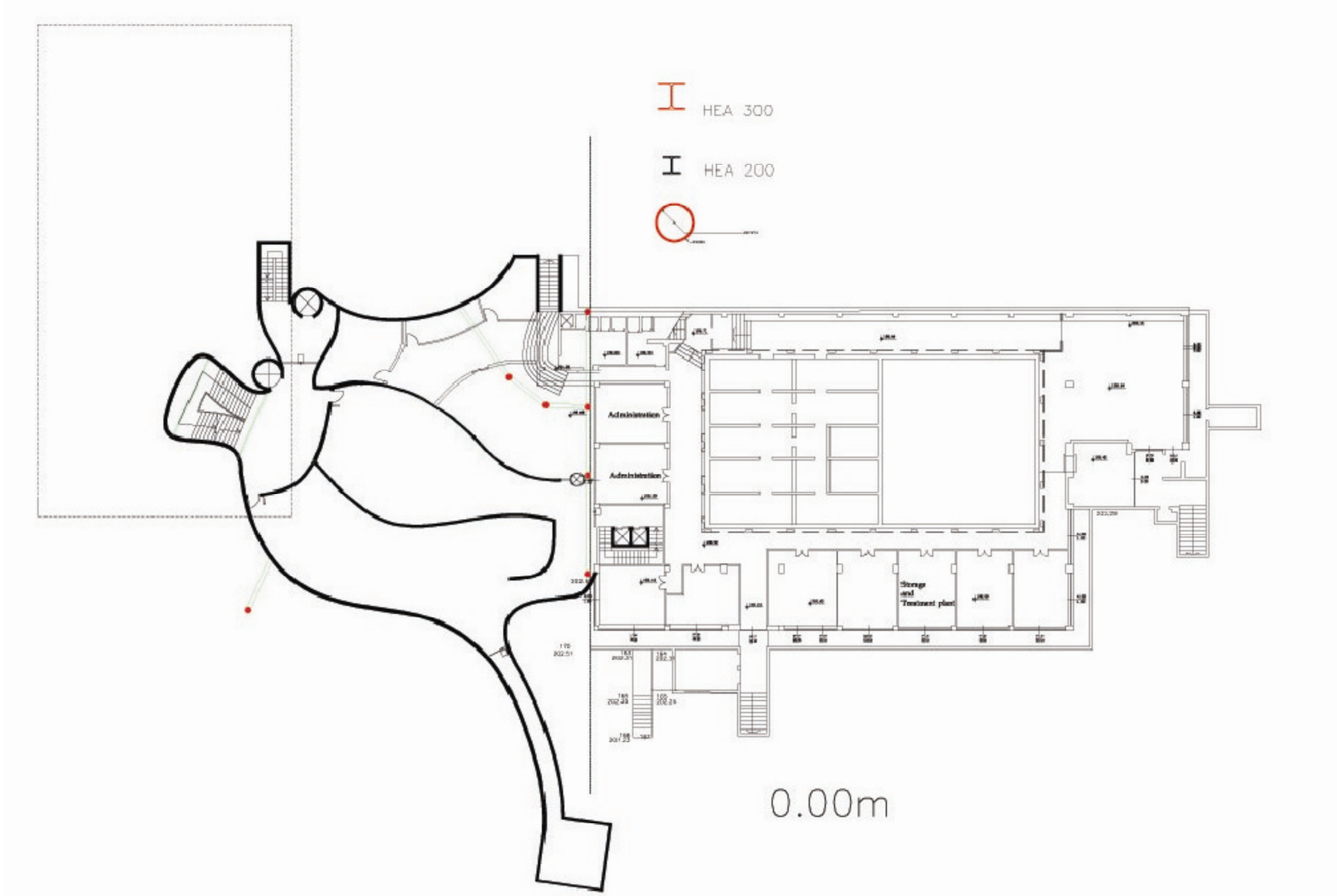
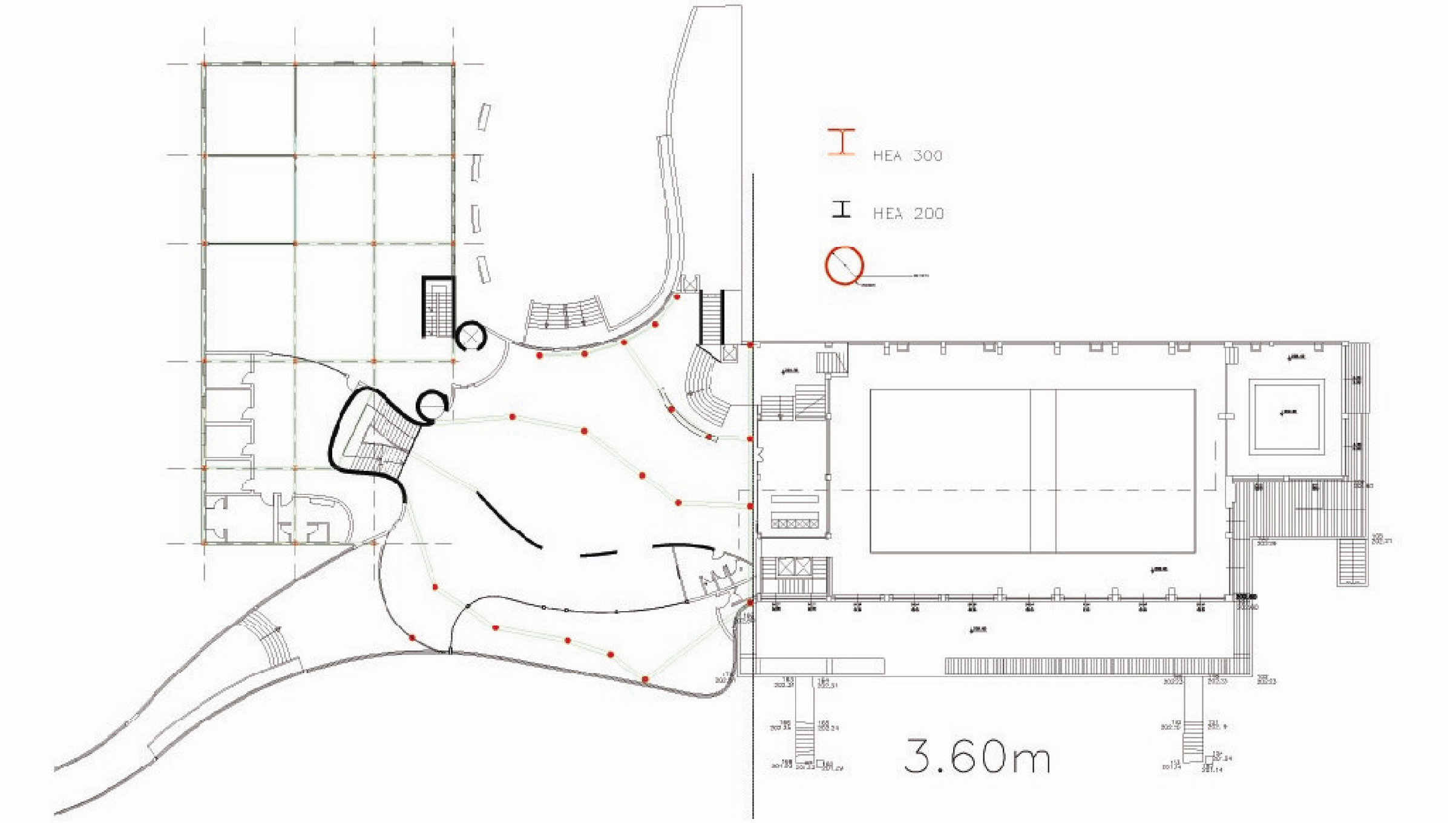
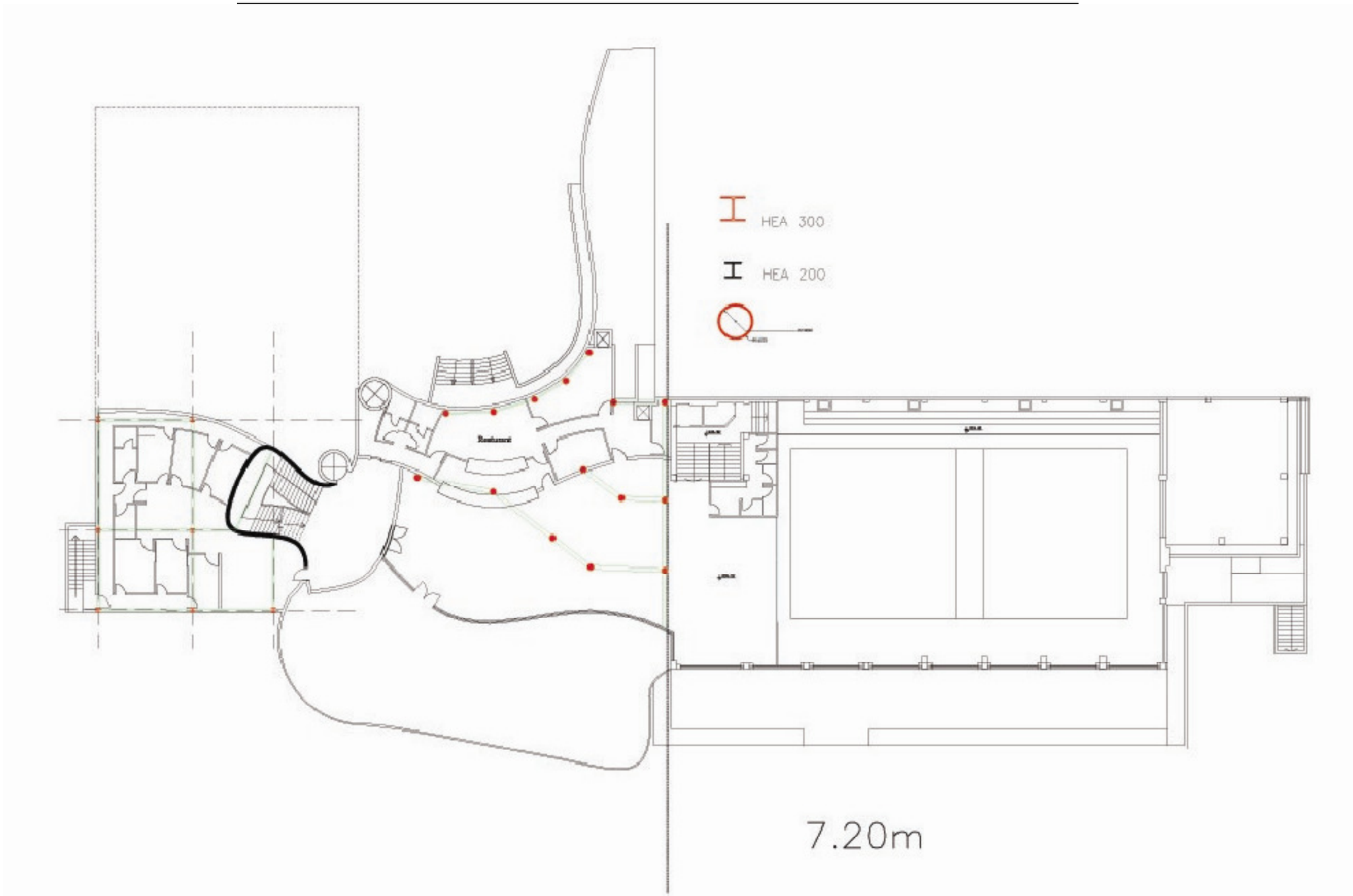


Figure 5-18 Values of the parameters Type 1 elastic response spectra

5.7 The layout of structure


HEA 300
HEA 200
Administration
Administration
Storage
and
Treatment plant
0.00m


HEA 300
HEA 200
3.60m


HEA 300
HEA 200
7.20m

Chapter 6

Sport Center in Garlate, Italy

Technological Design

6 Technological Design

This chapter is dealing with technology details in the project, the climate information of Lecco was used in the analysis of energy losing in program CASA NOVA, because Garlate is a town that belongs to Lecco province, the temperature distribution and wind velocity of Lecco can be adopted in this project. The technological designs were done by followed the architecture design.

6.1 Background of project

The meaning of the term low-energy house in general use is changing over time, and it is still in the evolution in following days. Nowadays, it is generally considered by architecture engineers and is also referred in German & Swiss low-energy standards that the value of space heating in the range from 30kWh/m²a to 20kWh/m²a. Below this the term ultra-low energy building is often used.

Low-energy buildings typically use high level of insulation, energy efficient windows, low levels of air infiltration and heat recovery ventilation to lower heating and cooling energy. They may also use passive solar building design techniques or active solar technologies. These buildings may use hot water heat recycling technologies to recover heat from showers and dishwashers. The building itself makes direct use of solar energy by virtue of its placement, geometry, building materials and components. Weatherization provides more information on increasing building energy efficiency.

6.2 Climate in Lecco province

Garlate is an Italian town of 2525 inhabitants in Lombardy, 50km north away from Milan, it is one of the towns in province of Lecco. The town lies at the end of the south-east branch of Como Lake which named Lake of Lecco.

Temperature distribution

The average temperature in Lecco is listed in the following table:

LECCO	TEMPERATURE(C)	VAPOR PRESSURE(Pa)
JANUARY	3.9	676
FEBRUARY	5.7	735
MARCH	9.6	875
APRIL	13.3	1106
MAY	16	1314
JUNE	20.1	1666
JULY	22.6	1844
AUGUST	22.1	1855
SEMPTERBER	19.2	1671
OCTOBER	14.3	1285
NOVEMBER	9.2	988
DECEMBER	5.3	754

Table 6-1 Temperature distribution

In this table it indicates that the average monthly temperature as well as the partial vapor pressure distribution in Lecco throughout the year. The highest temperature usually appears in July as shown in figure 6-1

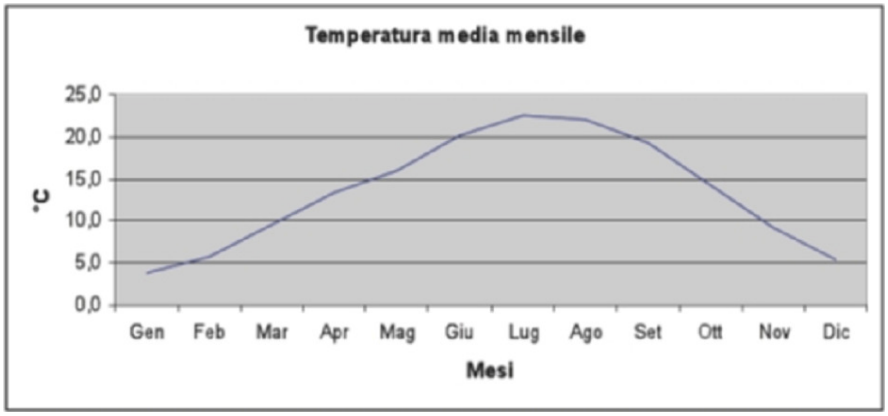


Figure 6-1 Temperature distribution of Lecco

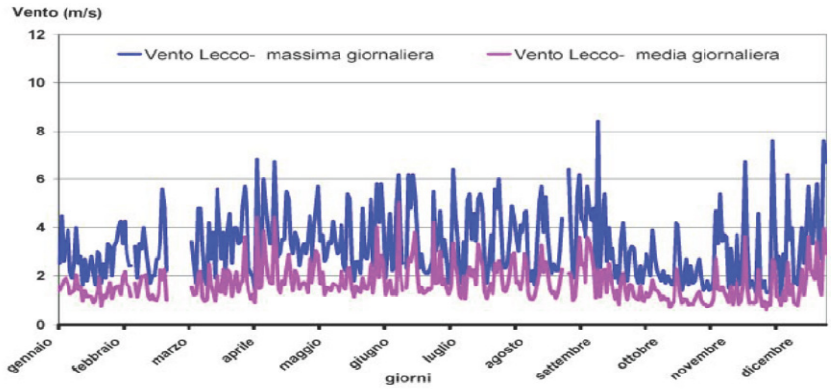


Figure 6-2 Wind Velocity in Lecco

Wind is in the form of air circulation, therefore the velocity of air can be chosen as the parameter to describe wind in different months, which is shown in the figure6-2

6.3 THERMAL COMFORT Concept

This stage of the concept provides a comfortable thermal environment that supports the productivity and wellbeing of building occupants. The external shading is designed to control solar gains and minimize summer overheating.

6.3.1 Heat Transfer calculations

There are three basic modes of heat transfer: ***conduction, radiation*** and ***convection***

Conduction is the transmission of energy between two bodies which are indirect contact.

Convection is the transmission of energy through a fluid. An object thetas the particles that make up the fluid such as air or water.

Radiation is the transmission of energy by electromagnetic rays. These rays are felt when standing in the sun's path.

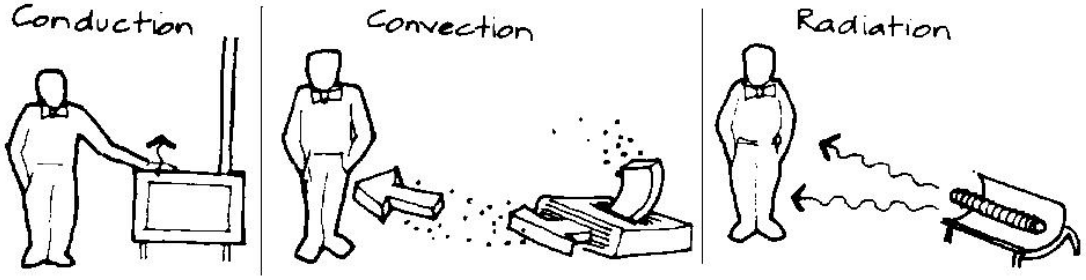


Figure 6-3 Heat transfer

According to the 2nd law of thermodynamics, Heat (energy) will always flow from a hotter body towards a cooler body. The rate at which that heat will flow is proportional to the temperature difference and inversely proportional to the resistance of the heat path. In a building, the heat will be transferred first through convection from the air when it reaches one surface, then through conduction from one layer to the other of the wall, and then finally through convection again when it goes out from the other surface of the wall. The overall heat transfer coefficient for a wall can be calculated as:

$$\frac{1}{U \cdot A} = \frac{1}{h_1 \cdot A_1} + \frac{dx_w}{k \cdot A} + \frac{1}{h_2 \cdot A_2}$$

Where

U = the overall heat transfer coefficient (W/m^2K)

A = the contact area for each fluid side (m^2)

k = the thermal conductivity of the material (W/mK)

h = the individual convection heat transfer coefficient for each fluid (W/m^2K)

d_{xw}= the wall thickness (m)

The convection heat transfer coefficient - h - depends on the type of fluid - gas or liquid the flow properties such as velocity, other flow and temperature dependent prosperities.

The flow properties such as velocity

Other flow and temperature dependent properties

Fourier's Law expresses conductive heat transfer as:

$$q = \frac{k \cdot A \cdot dT}{s}$$

Where

A = heat transfer area (m2, ft2)

k = thermal conductivity of the material (W/m.K or W/m ^{o}C, Btu/(hr^{o}F

ft2/ft)); obtained each material from the ISO 10456 standard.

dT = temperature difference across the material (K or ^{o}C, ^{o}F)

s = material thickness (m, ft)

6.3.2 Condensation

Based on the U values, keeping the indoor temperature in the range of comfort is very important. We calculate the risk of condensation between different material layers in order to avoid water condensation, which can decrease the utilization of the layers and temperature comfort. The calculation is demonstrated below.

Theory of calculation

Calculation of the temperature distribution is based on the thermal insulation calculation. The quantity of heat flowing through a wall by conduction (from higher to lower temperature) is proportional to the thermal conductivity U of the component:

$$\Phi = U \cdot S \cdot \Delta T$$

With U depending on the physical characteristics of the layers making up the wall. Thermal resistance of the wall depends on the properties of its layers.

$$\frac{1}{R} = \frac{1}{\sum \frac{s}{\lambda} + \sum \frac{1}{h}}$$

This equation means that the lower the conductivity λ of components, the higher the overall R value.

$$U = \frac{1}{1/h_i + \Sigma s/\lambda + 1/C + 1/h_e} \qquad t_i = t_{i-1} - \frac{\Delta T}{k_i} \cdot U$$

ki is the transmittance of i-th layer

Estimate the condensation risk

If a wall separates two environments with different concentrations of water vapor, a vapor flow will start (from higher to lower concentration).The highest partial vapor pressure p_v is generally to be found where temperature is higher. With vapor flowing through the wall at different temperatures, p_v moves from the indoor to the outdoor value. The decrease in p_v value is proportional to the resistance of every homogeneous layer to the passage of vapor. If, at some point of the wall, p_v reaches the saturation value p_s, condensation occurs.

As a rule, condensation does not occur in single-layer, homogeneous walls, while it is very likely if the inner layers are insulating and with small resistance to the passage of vapor.

Condensation should be avoided because:

(1) It decreases the durability of materials;

(2) If it happens in insulating materials, it makes them ineffective (condensed water fills the air gaps).

Two ways to avoid condensation:

(1) Raising the saturation value p_s: this happens if the inner surface temperatures are higher, which means, working on the insulation

level;

(2) Lowering the partial pressure p_v

The risk of condensation can be assessed tracing the Glaser diagram: in every point, p-v curve should remain below ps curve. If the distribution of temperatures through the wall is known, saturation pressure can be determined by specific charts, while partial vapor pressure can be calculated from

6.3.3 Wall Layers

1) External Wall

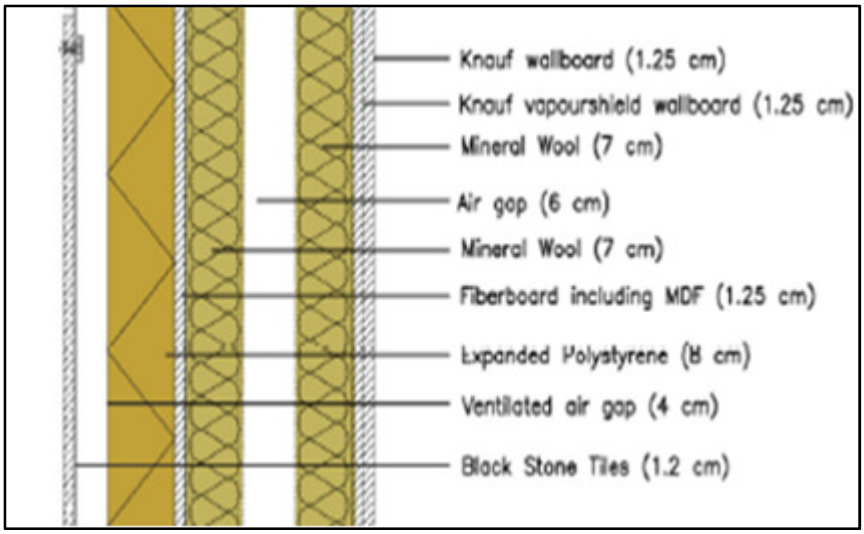


Figure 6-4Detail of external wall

Material	Thickness (S)	Thermal conductivity(λ)	Resistance (R)
Rse			0.04
Knauf wallboard	0.025	0.020	0.756
Mineral Wollbatt	0.070	056	2.105
Air garp	0.060	0.278	0.072
Mineral Wool Batt	0.070	0.038	2.105
Fiberboard includingMDF	0.0125	0.278	0.216
Expanded Polystyrene	0.080	0.038	0.054
Ventilated air gap	0.040	0.160	0.081
Black stone tiles	0.012	0.160	0.081
Rsi			0.013
∑ External Wall	0.365	1.224	5.523

Table 6-2U value calculation

According to the thermal concept that mentioned above, the U value should be calculated within the allowable range. From table 6-2 the value Resistance of the external wall is 5.523, so the U value of external wall is ∑U=1/∑R=1/5.523=0.18W/㎡.K, and the ∑U (allowable) =0.34 W/㎡.2

he(w/m²k)		25
hi(w/m²k)		7
outside temperature℃		-5
inside temperature ℃		20
temperature difference		25
outside relative humidity (%)		80
inside relative humidity (%)		50

Material	Thickness (S)	Thermal conductivity(λ)	k=λ/s(W/m2.k)	T(℃)
Rse				−5
Knauf wallboard	0.025	0.020	0.500	2.500
Mineral Wollbatt	0.070	056	13.846	2.771
Air garp	0.060	0.278	0.475	10.666
Mineral Wool Batt.	0.070	0.038	4.633	11.475
Fiberboard includingMDF	0.0125	0.278	0.45	17.55
Expanded Polystyrene	0.080	0.038	0.475	19.370
Ventilated air gap	0.040	0.160	12.308	19.674
Black stone tiles	0.012	0.160	12.308	19.979

Table 6-3 Temperature calculation

The condensation is usually generated in winter; in this case, it is considered that the temperature of outdoor environment is -5 cent degree and indoor 20 cent degree. These two figures are used to calculate the pressure. Table 6-3 shows temperature differences between two sides of the wall due to cold air penetration.

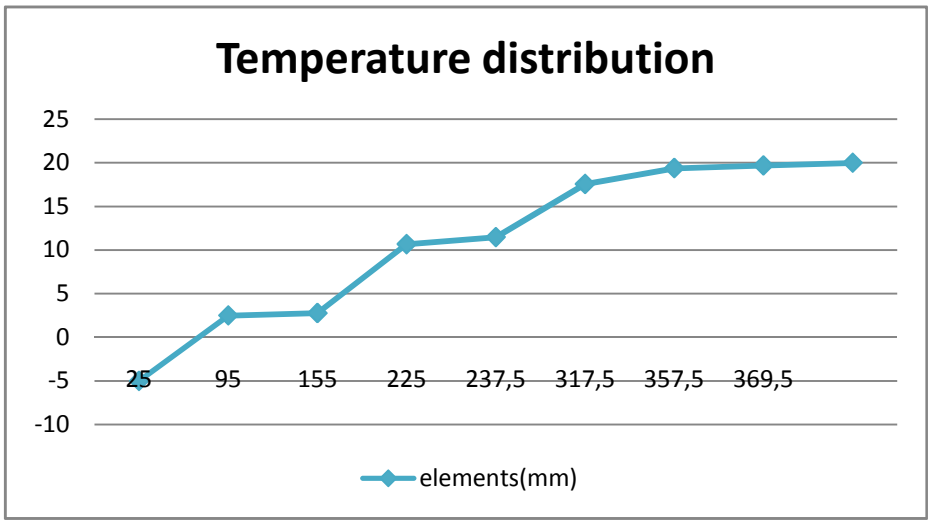


Table 6-4 Temperature distribution

Layer	S (m)	δ*10-12 (Kg/mspa)	ρ = s/δ(*10-12m2spa/kg)	T (℃)	Ps (Pa)	Pv (Pa)
	0			-5	406	321
Knauf wallboard	0.025	66.7	0.0006	2.500	434	357
Mineral Wollbatt	0.070	2	0.02	2.771	447	358
Air garp	0.060	700	0.0001	10.666	793	529
Mineral Wool Batt	0.070	1.5	0.04	11.475	1186	530
Fiberboard includingMDF	0.0125	52	0.00133	17.87	1267	531
Expanded Polystyrene	0.080	7	0.0018	19.370	1286	603
Ventilated air gap	0.040	7	0．0018	19.674	1320	876
Black stone tiles	0.012	52	0.0166	19.979	1342	1284
		ρtot	0.065		2235	1824

Table 6-5 Condensation calculation

A Glaser Diagram Pv and Ps can be traced to assess the risk of condensation. Table 6-5 shows the Pv and Ps values of external wall that the condensation will not occur among the layers.

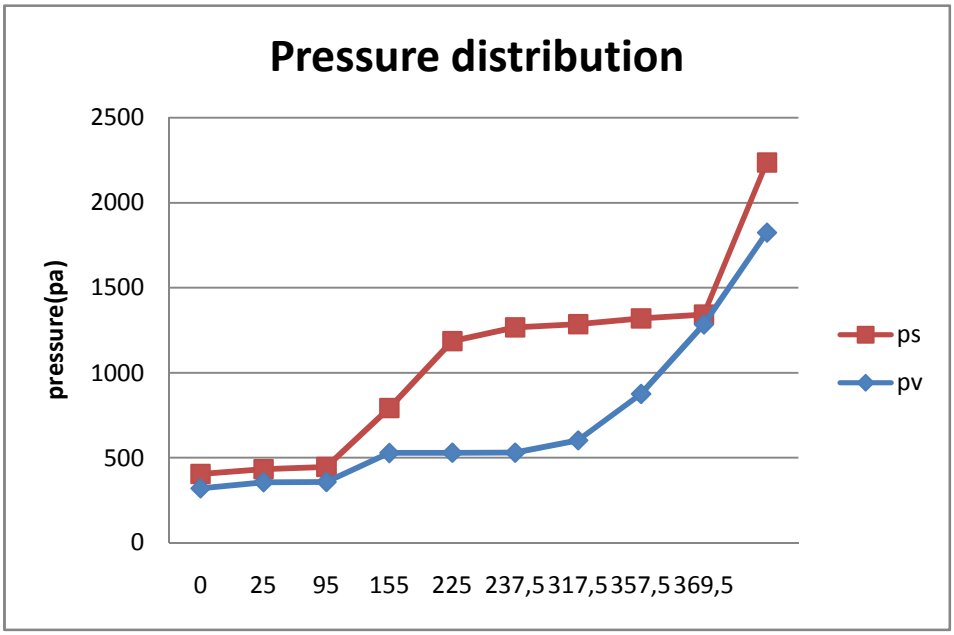


Figure 6-5 Pressure distribution

2) Basement Wall

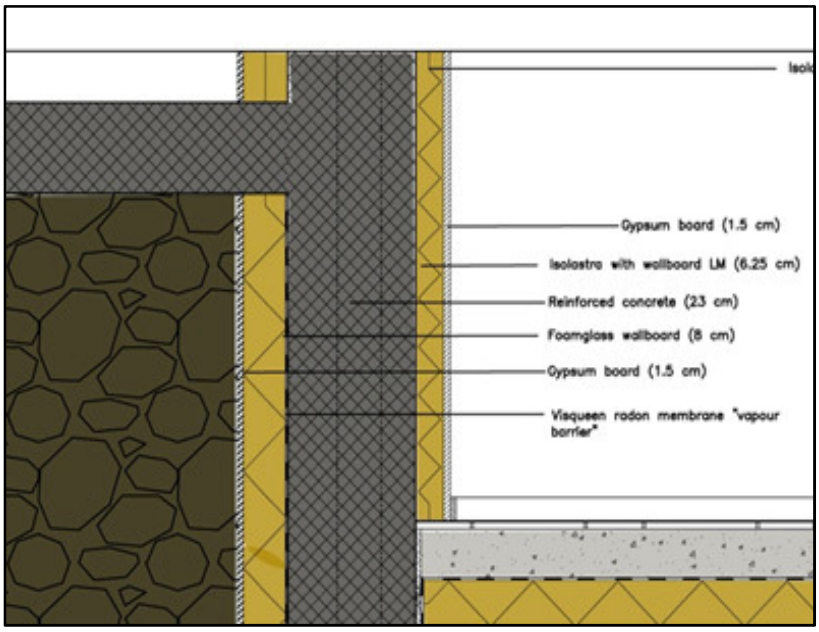


Figure 6-6 Detail of Basement Wall

U value calculation of the basement wall

Material	Thickness (S)	Thermal conductivity(λ	Resistance (R)
Rse			0.000
polyroplyene(25% glass fibre)	0.050	0.250	0.200
Bituminous paper	0.004	0.200	0.020
Reinf. Concrete(2% steel)	0.250	2.500	0.100
Visqueen Vapor Barrier	0.000	0.330	0.000
Foam Glass	0.080	0.032	2.500
Knauf Wall Board	0.013	0.160	0.081
Rsi			0.130
∑basement Wall	0.397	3.472	3.031

Figure 6-7 U value calculation

According to the concept of thermal comfort mentioned above, the U

value should be within the allowable limitation. A value of 3.031 is adopted to be the value of Resistance of external wall. Hence the U value of external wall is calculated as ∑U=1/∑R=1/3.031=0.33W/㎡.K, and the ∑U (allowable) =0.34 W/㎡.K

Glazer diagram of the basement wall

Material	Thickness (S)	Thermal conductivity(λ)	k=λ/s(W/m2.k)	T(℃)
				−5
polyroplyene(25% glass fibre)	0.050	0.250	5.00	-4.6
Bituminous paper	0.004	0.200	50.0	-4
Reinf. Concrete(2% steel)	0.250	2.500	10.00	15.4
Foam Glass	0.080	0.032	0.40	16
Knauf Wall Board	0.013	0.160	12.307	17.7

Figure 6-8 Temperature calculation

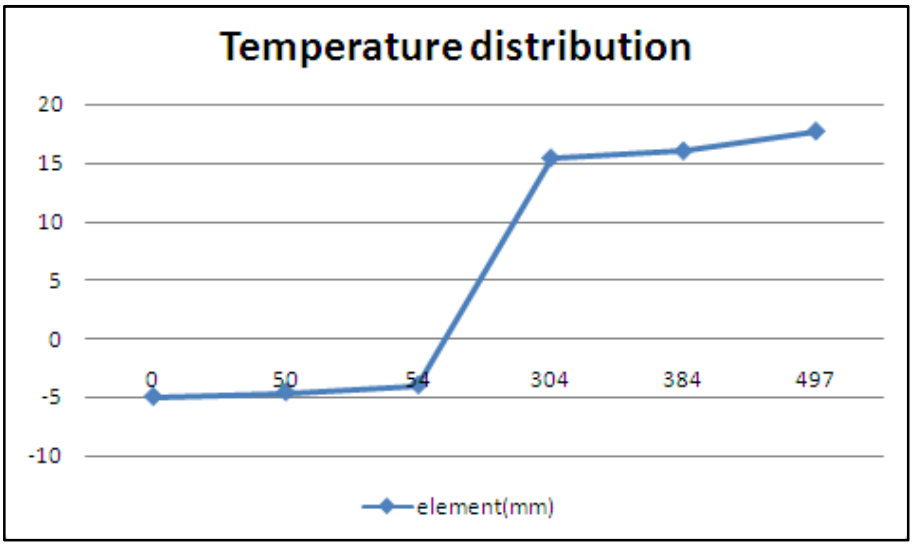


Figure 6-9 Temperature distribution

Layer	S (m)	δ*10-12 (Kg/mspa)	ρ = s/δ(*10-12m2spa/kg)	T (℃)	Ps (Pa)	Pv (Pa)
	0			-5	402	321
polyroplyene(25% glass fibre)	0.050	2.5	0.02	-4.6	414	327
Bituminous paper	0.004	40	0.0001	-4	437	352
Reinf. Concrete(2% steel)	0.250	12.5	0.02	15.4	1744	353
Foam Glass	0.080	500	0.00016	16	1745	1136
Knauf Wall Board	0.013	0.65	0.02	17.7	1818	1167
		ρtot	0.060		2025	1168

Table 6-6Condensation calculation

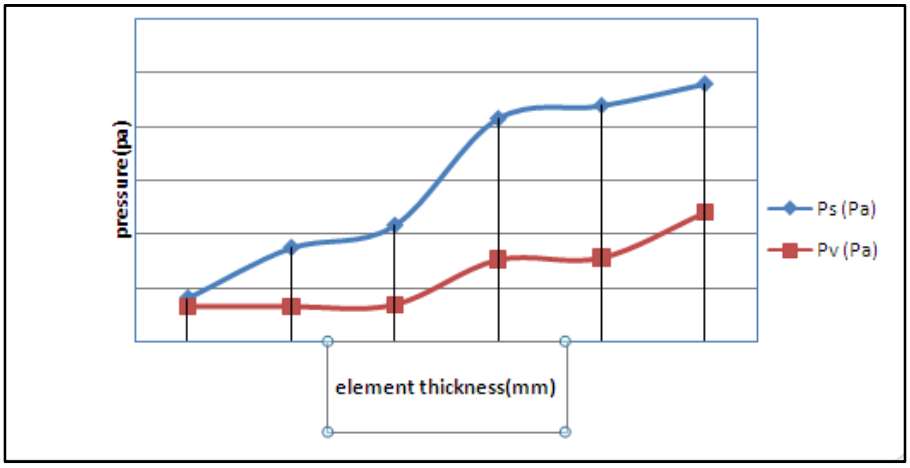


Figure 6-10 Pressure distribution

6.3.4 Roof Layer

Solar integrated flat roof

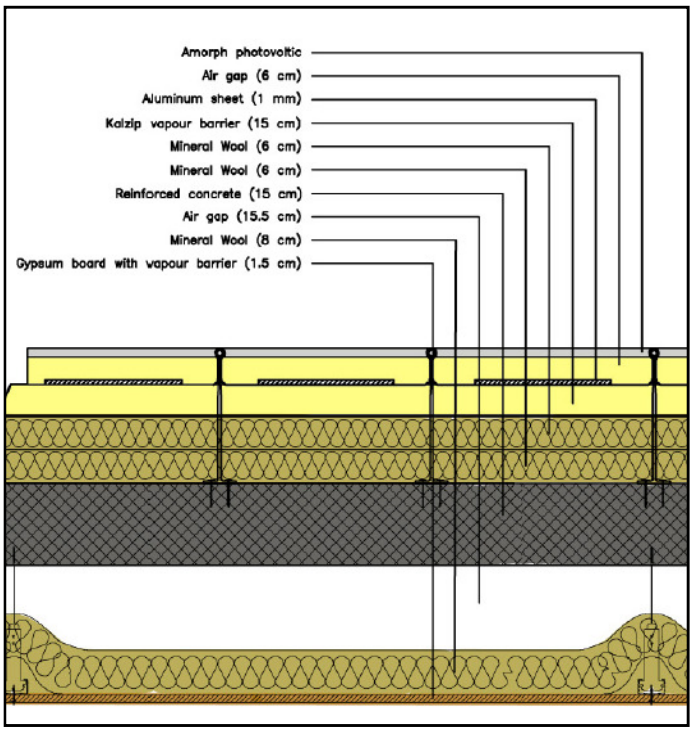


Figure 6-11 Detail of roof

U value calculation of the roof

Material	Thickness (m)	Thermal conductivity(λ)	Resistance (R)
Rse			0.010
Amorphphotovolito	0.02	0.351	0.057
Aluminum sheets	0.001	45.000	0.0004
Ventilated air gap	0.06	5.560	0.011
Mineral wool Batt	0.06	0.038	1.579
Mineral wool Batt	0.06	0.038	1.579
plywood	0.02	0.150	0.133
Mineral wool Batt	0.08	0.038	2.105
plywood	0.02	0.150	0.133
Rsi			0.040
∑Roof	0.321	51.325	5.648

Table 6-7 U value calculation

Using the same concept and according to the table above, the

∑U=1/∑R=1/5.648=0.18W/㎡.K, **and the** ∑U (allowable) =0.30 W/㎡.K

Area del grafico	s(m)	λ(W/mK)	K = λ/s(W/m2K)	T (℃)
				-5
Amorphphotovolito	0.02	0.351	17.55	-4.75
Aluminum sheets	0.001	45.000	45000.00	-4.74
Ventilated air gap	0.06	5.560	92.67	-4.69
Mineral wool Batt	0.06	0.038	0.63	2.30
Mineral wool Batt	0.06	0.038	0.63	9.29
plywood	0.02	0.150	7.50	9.88
Mineral wool Batt	0.08	0.038	0.48	19.20
plywood	0.02	0.150	7.50	19.79

Table 6-8 Temperature calculation

Glazer diagram of the roof

Layer	S (m)	δ*10-12 (Kg/mspa)	ρ = s/δ(*10-12m 2spa/kg)	T (℃)	Ps (Pa)	Pv (Pa)
				-5	402	321
Amorphphotovolito	0.02	60	0.000333	-4.75	434	357
Aluminum sheets	0.001	50	0.00002	-4.74	447	358
Ventilated air gap	0.06	2	0.03	-4.69	793	529
Mineral wool Batt	0.06	2	0.03	2.30	1267	531
Mineral wool Batt	0.06	2	0.03	9.29	1286	603
plywood	0.02	60	0.000333	9.88	1342	890
Mineral wool Batt	0.08	2	0.04	19.20	2226	1600
plywood	0.02	60	0.000333	19.79	2235	1863
		ρtot	0.13102	20	2235	1870

Table 6-9 Condensation calculation

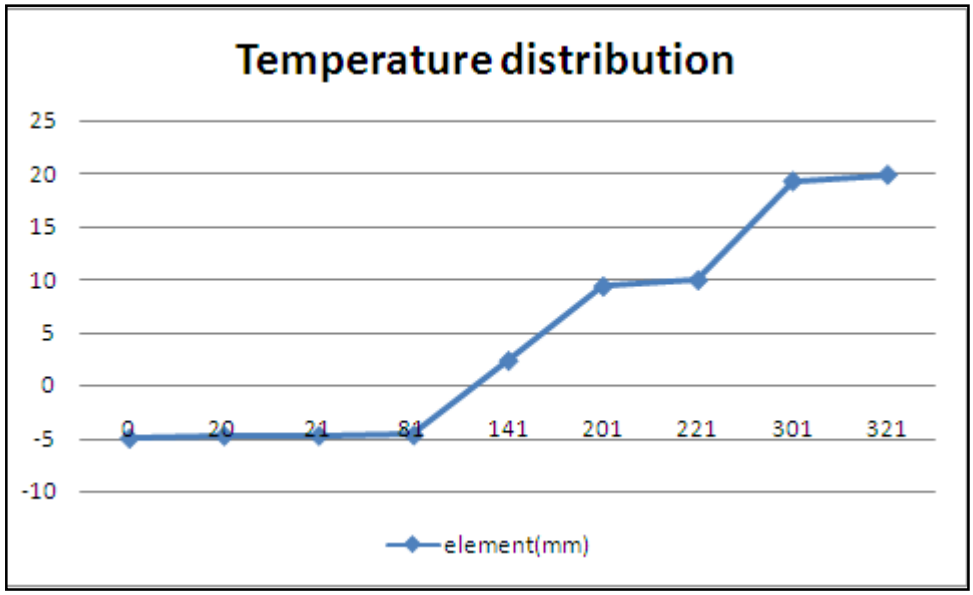


Figure 6-12 Temperature distribution

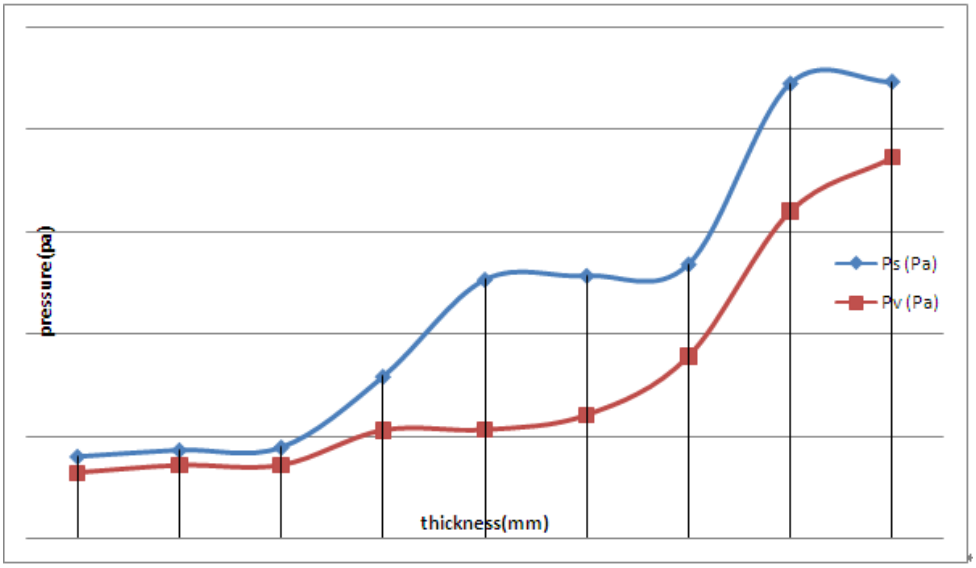


Figure 6-13Pressure distribution

6.3.5 Floor Layers

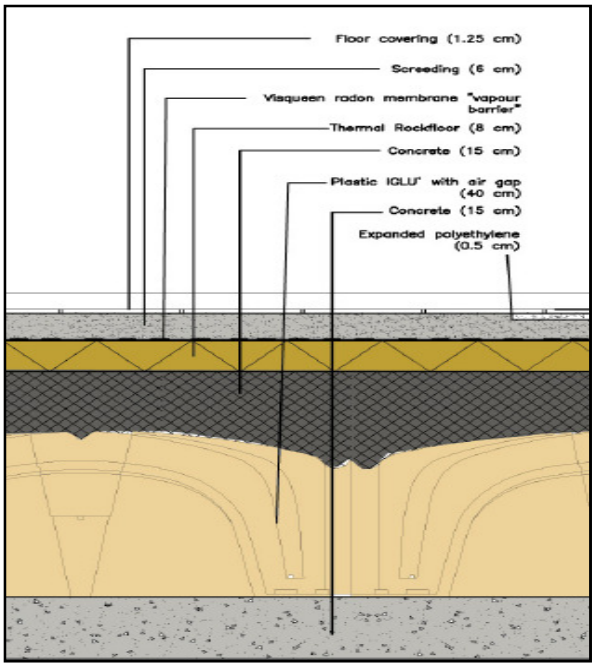


Figure 6-14 Detail of basement floor

1) Basement floor

U value calculation of the basement floor

Material	Thickness (m)	Thermal conductivity(λ	Resistance (R)
Rse			0.04
Ceramic tile	0.014	1.2	0.012
Concrete md	0.06	0.335	0.179
Tr26fm	0.060	1.00	2.609
Steel floor deck with concrete	0.11	0.757	0.145
Air gap	0.014	5.56	0.003
Mineral wool	0.08	0.038	2.105
Gypesm board	0.015	0.65	0.023
Rsi			0.1
∑ basement Floor	0.353	8.56	5.216

Figure 6-15 U value calculation

Based on the concept mentioned above and according to the Figure 6-15, the ∑U=1/∑R=1/6.497=0.19W/㎡.K, **and the** ∑U (allowable) =0.30 W/㎡.K

Glazer diagram of the basement floor

Material	Thickness (S)	Thermal conductivity(λ)	k=λ/s(W/m2.k)	T(℃)
				-5
Ceramic tile	0.014	1.2	10.67	-4.8
Concrete md	0.06	0.335	0.50	-4.5
Tr26fm	0.060	1.00	0.63	3
Steel floor deck with concrete	0.11	0.757	3.48	9
Air gap	0.014	5.56	15.75	10
Mineral wool	0.08	0.038	0.43	10.3
Gypesm board	0.015	0.65	57.50	19

Table 6-10 Calculation of Temperature distribution

Layer	S (m)	δ*10-12 (Kg/mspa)	ρ = s/δ(*10-12m2spa/kg)	T (℃)	Ps (Pa)	Pv (Pa)
	0			-5	414	321
Ceramic tile	0.015	50	0.0003	-4.8	437	352
Concrete md	0.080	200	0.0004	-4.5	458	360
Tr26fm	0.060	5	0.012	3	982	594
Steel floor deck with concrete	0.080	200	0.0004	9	1500	860
Air gap	0.073	3	0.024333	10	2079	1107
Mineral wool	0.060	2	0.03	10.3	2153	1119
Gypesm board	0.020	20	0.001	19	2239	1194
		ptot	0.068433	20	2399	1199

Table 6-11 Pressure distribution

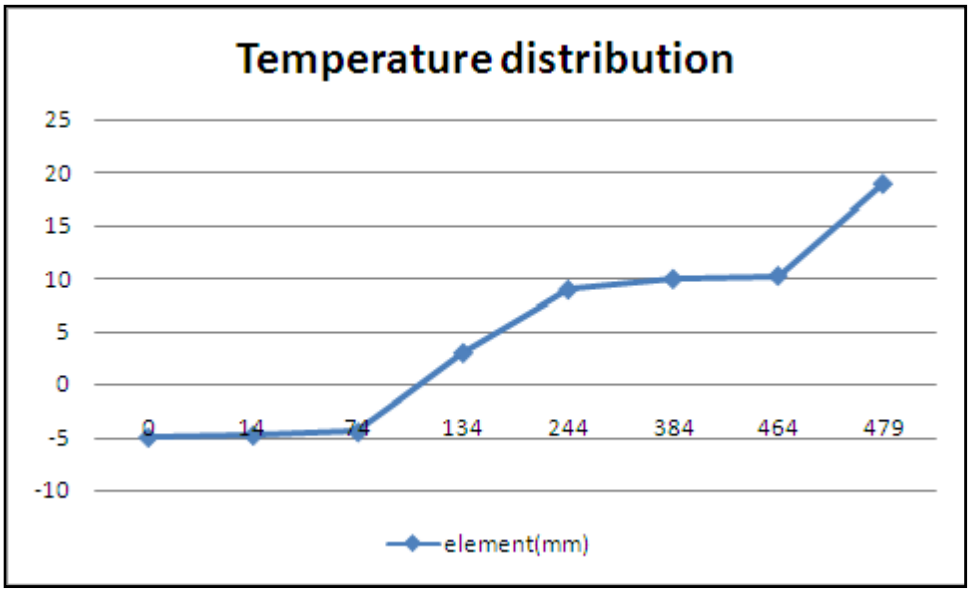


Figure 6-16 Temperature distribution

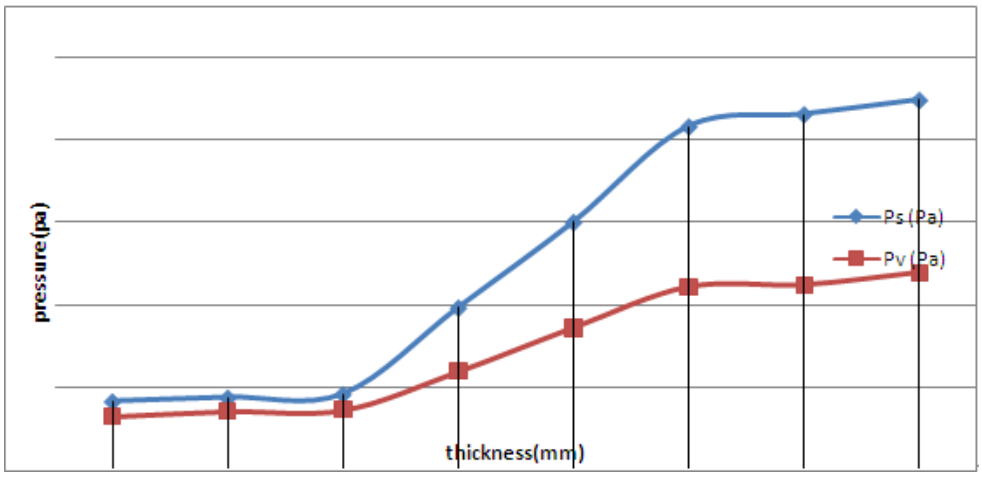


Figure 6-17 Pressure distribution

2) Internal floor layers

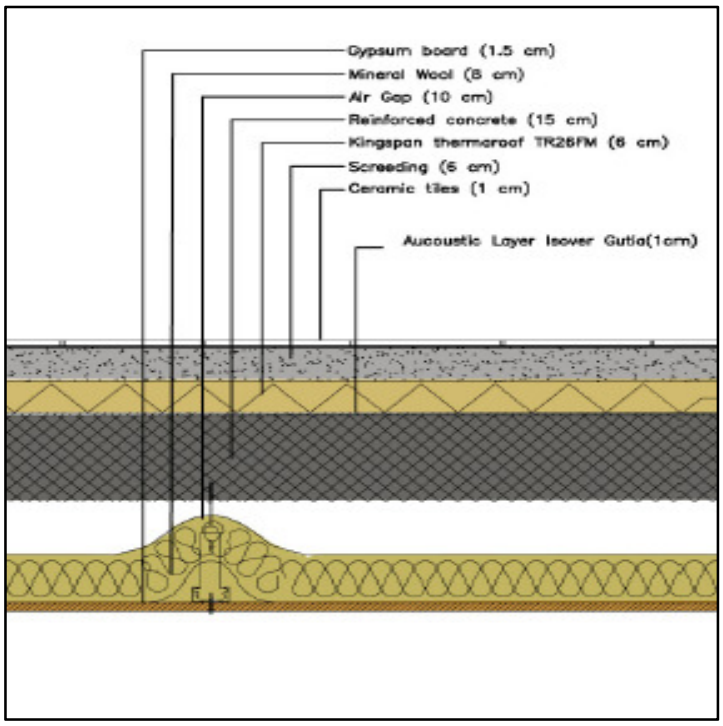


Figure 6-18 Detail of internal floor

U value calculation of the intermediate floor

Material	Thickness (S)	Thermal conductivity(λ	Resistance (R)
Rse			0.040
Gyproc Wallboard DUPLEX	0.015	0.160	0.094
Expanded polystyrene (EPS)	0.080	0.040	2.000
Mineral Wool Batt	0.060	0.038	1.579
Unventilated Air	0.080	0.278	0.288
Concrete Medium Density	0.073	1.150	0.063
KingspanThermaroof TR26	0.060	0.026	2.308
Concrete Medium Density	0.020	1.150	0.017
Ceramic/porcelairi Tiles	0.010	1.300	0.008
Rsi			0.100
∑ Intermediate Floor	0.398	4.472	6.497

Area del grafico

Figure 6-19 U value calculation

According to the same theory and based on the Figure 6-19, the ∑U=1/∑R=1/6.497=0.15W/㎡.K, **and the** ∑U (allowable) =0.30 W/㎡.K

Glazer diagram of the intermediate floor

Material	Thickness (S)	Thermal conductivity(λ)	k=λ/s(W/m2.k)	T(℃)
				-5
Gyproc Wallboard DUPLEX	0.015	0.160	10.67	-4.8
Expanded polystyrene (EPS)	0.080	0.040	0.50	-4.5
Mineral Wool Batt	0.060	0.038	0.63	3
Unventilated Air	0.080	0.278	3.48	9
Concrete Medium Density	0.073	1.150	15.75	10
KingspanThermaroof TR26	0.060	0.026	0.43	10.3
Concrete Medium Density	0.020	1.150	57.50	19
Ceramic/porcelairi Tiles	0.010	1.300	130.00	19.1

Table 6-12 Temperature calculation

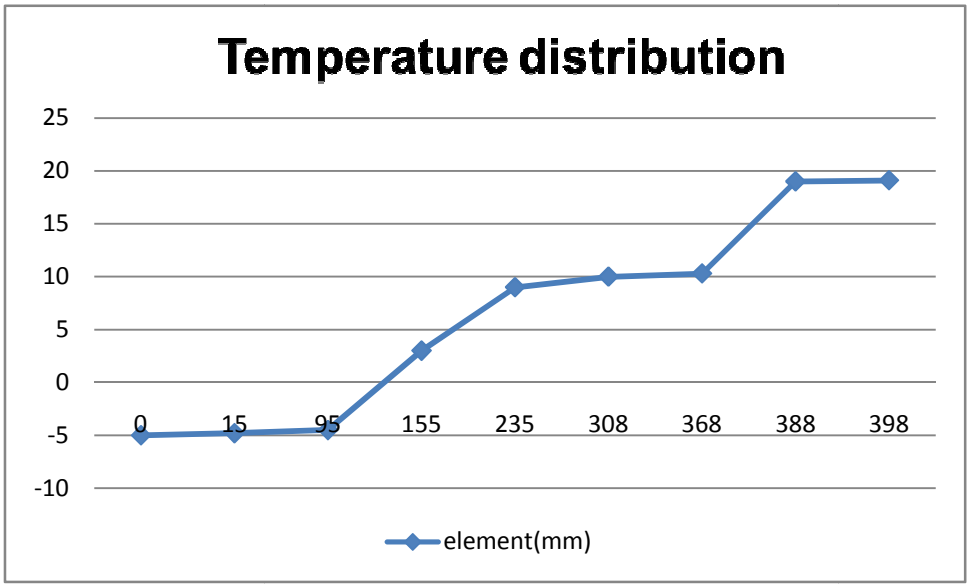


Figure 6-20 Temperature distribution

Layer	S (m)	δ*10-12 (Kg/mspa)	ρ = s/δ(*10-12m2spa/kg)	T (℃)	Ps (Pa)	Pv (Pa)
	0			-5	406	321
Gyproc Wallboard DUPLEX	0.015	150	0.0001	-4.8	434	357
Expanded polystyrene (EPS)	0.080	16	0.005	-4.5	447	358
Mineral Wool Batt	0.060	3.8	0.016	3	793	529
Unventilated Air	0.080	1600	0.00005	9	1186	530
Concrete Medium Density	0.073	3.68	0.02	10	1267	531
KingspanThermaroof TR26	0.060	500	0.00012	10.3	1342	1264
Concrete Medium Density	0.020	0.5	0.04	19	2226	1824
Ceramic/porcelairi Tiles	0.010	7.7	0.0013	19	2435	1863
		ρtot	0.102	20	2235	1870

Table 6-13Condensation calculation

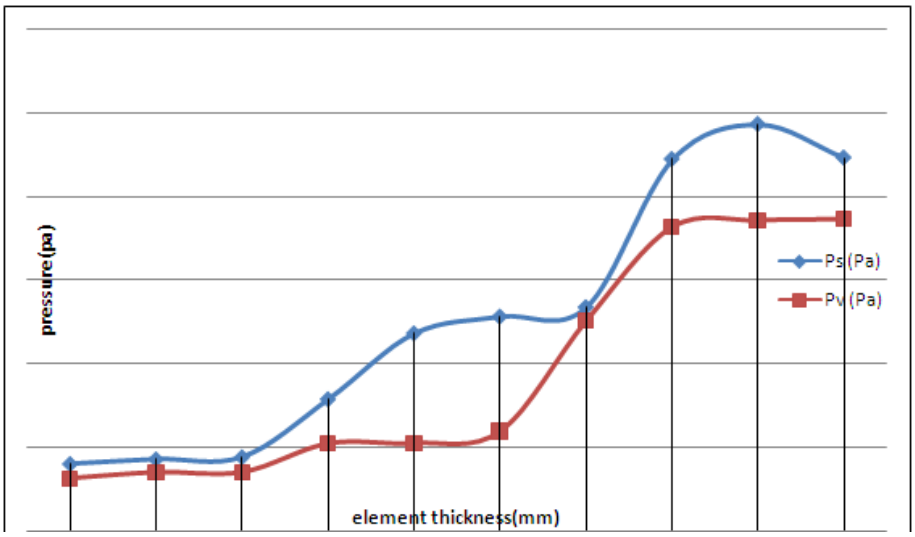


Figure 6-21 Pressure distribution

6.4 Shading analysis

Effect of the shading on the heating and cooling energetic demand

The use of sun control and shading devices is an important aspect of many energy-efficient building design strategies. In particularly, the buildings with the function of passive solar heating or day lighting often depend on well-designed sun control and shading devices.

During hot seasons, external window shading is an excellent way to prevent unwanted solar heat entering a conditioned space. Shading can be provided by natural landscaping or by building elements such as awnings, overhangs, and trellises.

The design of effective shading devices are depending on the solar orientation of a particular building facade. For example, simple fixed overhangs are an effective way in the summer with high solar angle

for south-facing windows shading.

The program CASA nova – An educational software for heating and cooling energy demand as well as the temperature behavior in buildings can be used intuitively to understand the relations between building geometry, orientation, thermal insulation, glazing, solar heat gains, heating demand, heating and primary energy as well as overheating in summer.

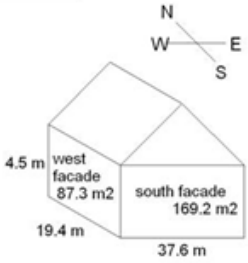
Since such software does not allow defining exactly the geometry of a building, the models used we recreated as similar as possible to the original configuration, but this first analysis was done merely for comparison purposes, and the results were not used for actual energy load demand calculations, we mainly analysis two area in this project: Gym area and Swimming pool area.

1) Gym area:

Geomerty:

Length (North-South):	37.6 m
Width (West-East):	19.4 m
Height (without roof):	4.5 m
Number of floors:	1
Deviation from South direction (west positive):	0 °
Useful area:	583.6 m2
Air volume	2626.0 m3
A/V - value	0.60 1/m
Facade North/South:	169.2 m2
Facade West/East	87.3 m2

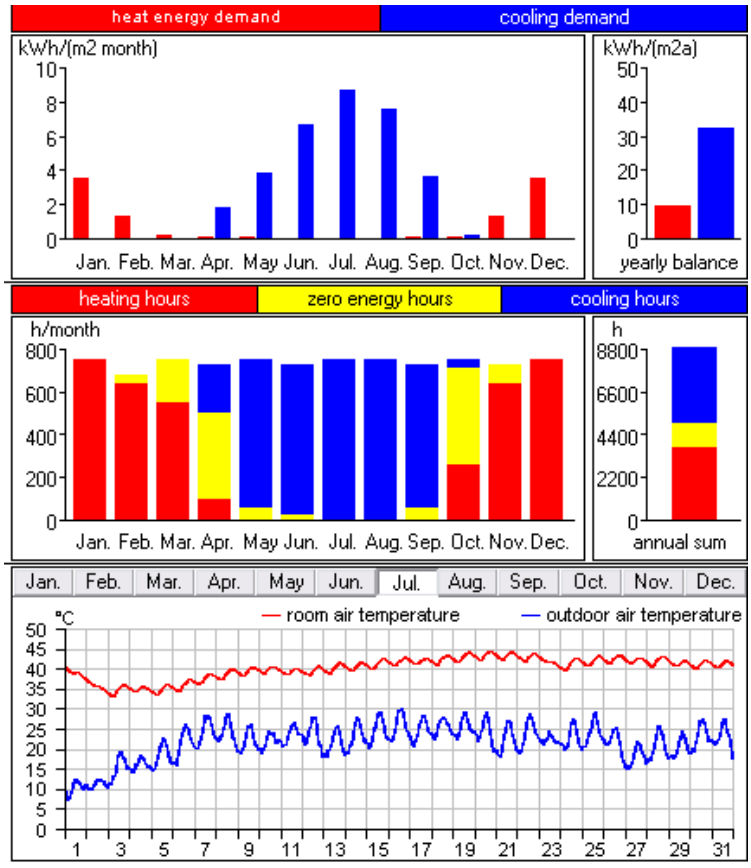
Sketch:



Area shaded by the perforated panel: 70%

Indoor set temperature: 20°C

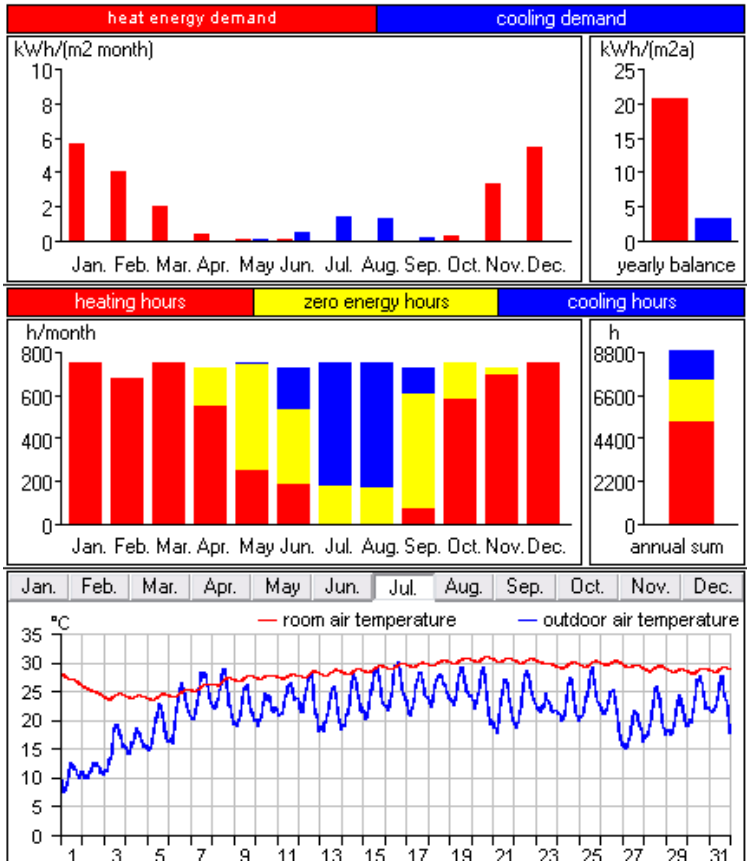
Gym without shading panel:



Heating and Cooling demand

	Heat energy demand in kWh/m2	Cooling demand in kWh/m2
January	3.4	0.0
February	1.2	0.0
March	0.1	0.0
April	0.0	1.7
May	0.0	3.8
June	0.0	6.6
July	0.0	8.6
August	0.0	7.5
September	0.0	3.5
October	0.0	0.1
November	1.2	0.0
December	3.4	0.0
Yearly sum	9.3	31.8

Gym with shading panel:



Heating and cooling demand

	Heat energy demand in kWh/m2	Cooling demand in kWh/m2
January	5.5	0.0
February	3.9	0.0
March	1.9	0.0
April	0.3	0.0
May	0.0	0.0
June	0.0	0.4
July	0.0	1.3
August	0.0	1.2
September	0.0	0.1
October	0.2	0.0
November	3.3	0.0
December	5.4	0.0
Yearly sum	20.4	3.1

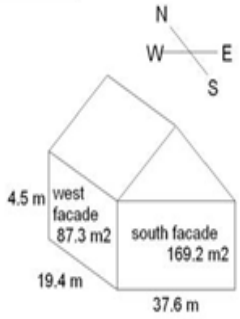
Even though the heating load increases when the shadow device is presented, the cooling load radically decreases. The yearly energy consumption, including heating and cooling loads, would be 3 times higher without placing the panels.

2) Swimming pool area:

Geomerty:

Length (North-South):	37.6 m
Width (West-East):	19.4 m
Height (without roof):	4.5 m
Number of floors:	1
Deviation from South direction (west positive):	0 °
Useful area:	583.6 m2
Air volume	2626.0 m3
A/V - value	0.60 1/m
Facade North/South:	169.2 m2
Facade West/East	87.3 m2

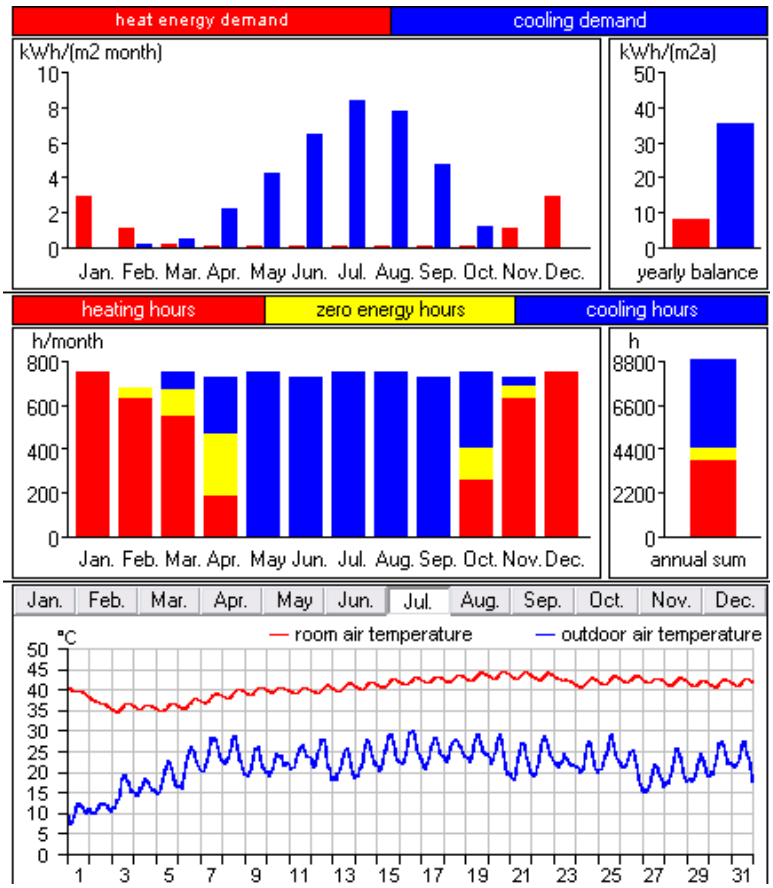
Sketch:



Area shaded by the perforated panel: 70%

Indoor set temperature: 24°C

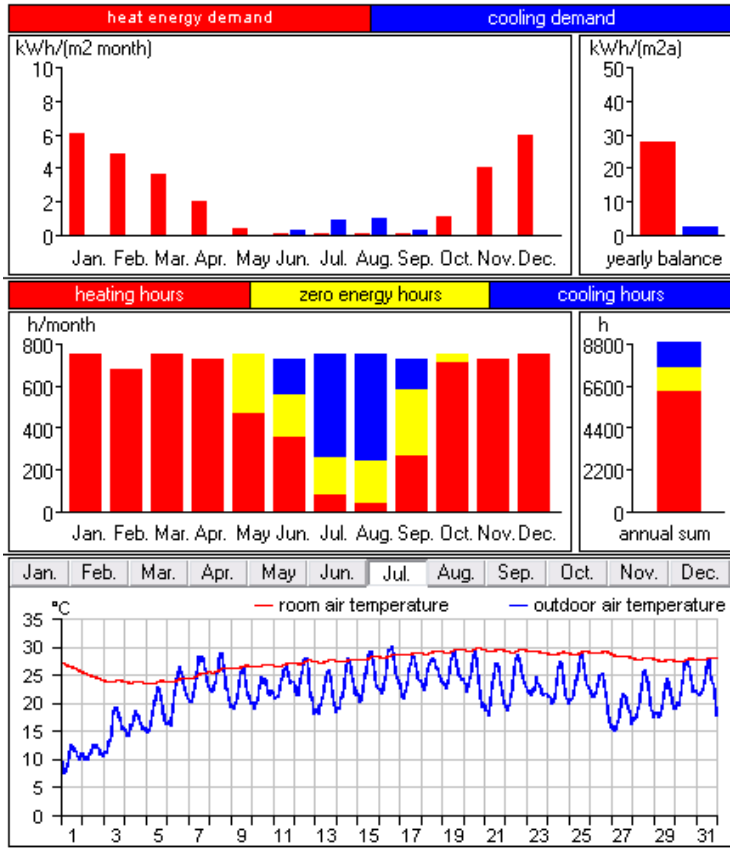
Swimming pool panel without shading:



Heat energy and cooling demand:

	Heat energy demand in kWh/m2	Cooling demand in kWh/m2
January	2.8	0.0
February	1.0	0.1
March	0.1	0.4
April	0.0	2.1
May	0.0	4.1
June	0.0	6.4
July	0.0	8.3
August	0.0	7.6
September	0.0	4.6
October	0.0	1.1
November	1.0	0.0
December	2.9	0.0
Yearly sum	7.8	34.7

Swimming pool panel with shading:



Heating energy and cooling demand:

	Heat energy demand in kWh/m2	Cooling demand in kWh/m2
January	6.0	0.0
February	4.7	0.0
March	3.5	0.0
April	1.9	0.0
May	0.3	0.0
June	0.0	0.2
July	0.0	0.8
August	0.0	0.9
September	0.0	0.2
October	1.0	0.0
November	3.9	0.0
December	5.8	0.0
Yearly sum	27.1	2.1

In the building of swimming pool, the reduction of the cooling load without shading is 34.2 kwh/m2 per year, while the heating load is 7.8 kwh/m2 per year. The values of cooling and heating load with shading panel are 2.1 kwh/m2 and 27.1kwh/m2 per year respectively. The heating load increases a little bit when the shadow device is applied. Therefore it can be concluded that the use of shading devices can benefit the energy saving purposes of the building.

6.5 Heating and cooling energy demand

The calculation of heating demand is based on the European norm EN 832. CASA nova uses building shapes of rectangular form, from which the heating and cooling energy are calculated.

Heating demand is defined as the difference between energy losing and energy gains of the building. By a general study of the geometry of the building and with the shading devices placed, the required heating and cooling loads can be obtained for achieving thermal comfort.

A temperature of 24°C for the swimming pool area during winter and 27°C for summer are considered, while a temperature of20°C for the gym area was considered in general and which can increase to 25°C during summers. Meanwhile, the summer season is considered as the months from June to September while winter (colder season)is treated as the rest months during the year.

1) Gym area

20°C was considered as comfortable temperature during winter

	Heating demand (kWh/m2)	Cooling demand (kWh/m2)
January	5.5	0
February	3.9	0
March	1.9	0
April	0.3	0
May	0	0
June	0	0.4
July	0	1.3
August	0	1.2
September	0	0.1
October	0.2	0
November	3.3	0
December	5.4	0
Year sum	20.5	3

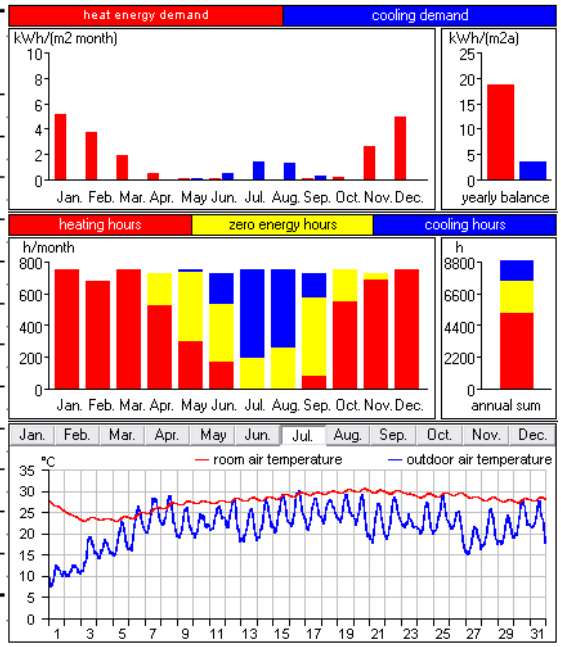


Table 6-14Heating and cooling demand

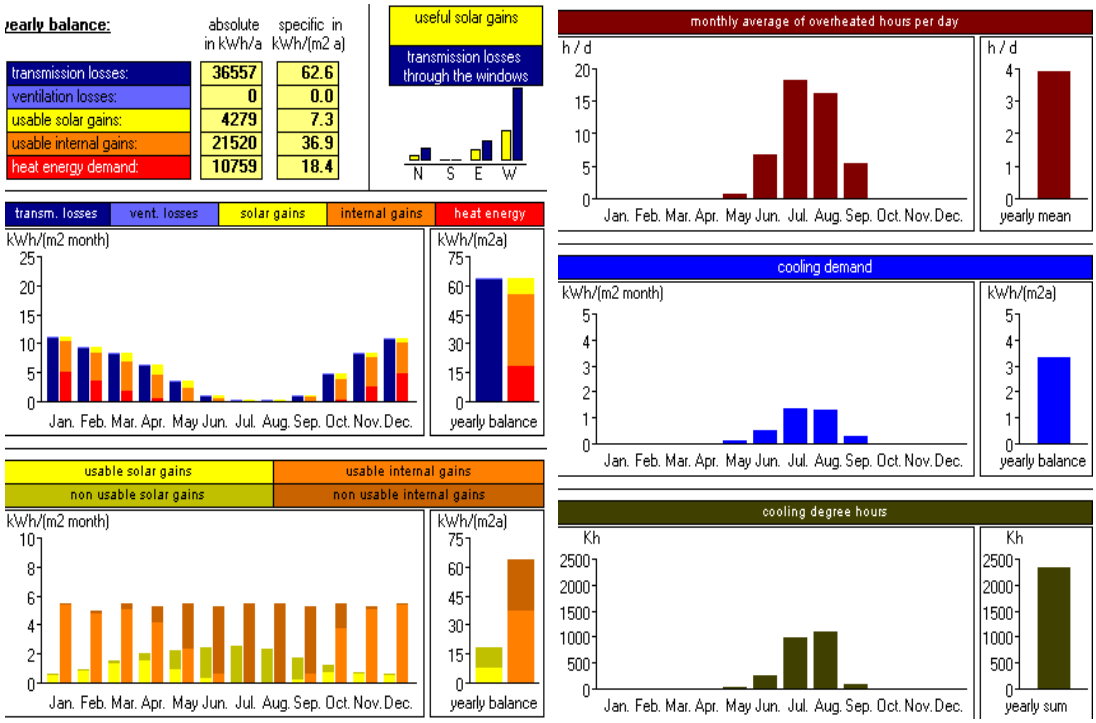


Figure 6-22 Heating and cooling load demand detail

25°C was considered as comfort temperature in the summer

	Heating demand (kWh/m2)	Cooling demand (kWh/m2)
January	8. 2	0
February	6. 4	0
March	4. 7	0
April	2. 4	0
May	0. 5	0
June	0	0. 5
July	0	1. 4
August	0	1. 3
September	0	0. 3
October	1. 7	0
November	5. 5	0
December	7. 9	0
Year sum	37. 3	3. 5

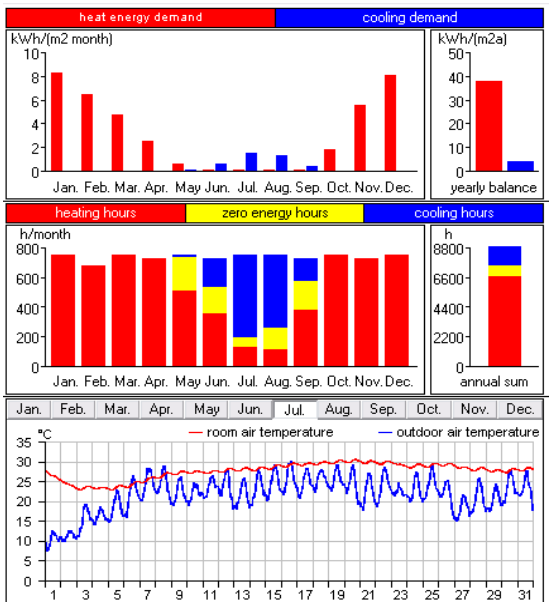


Figure 6-23 Heating and cooling demand

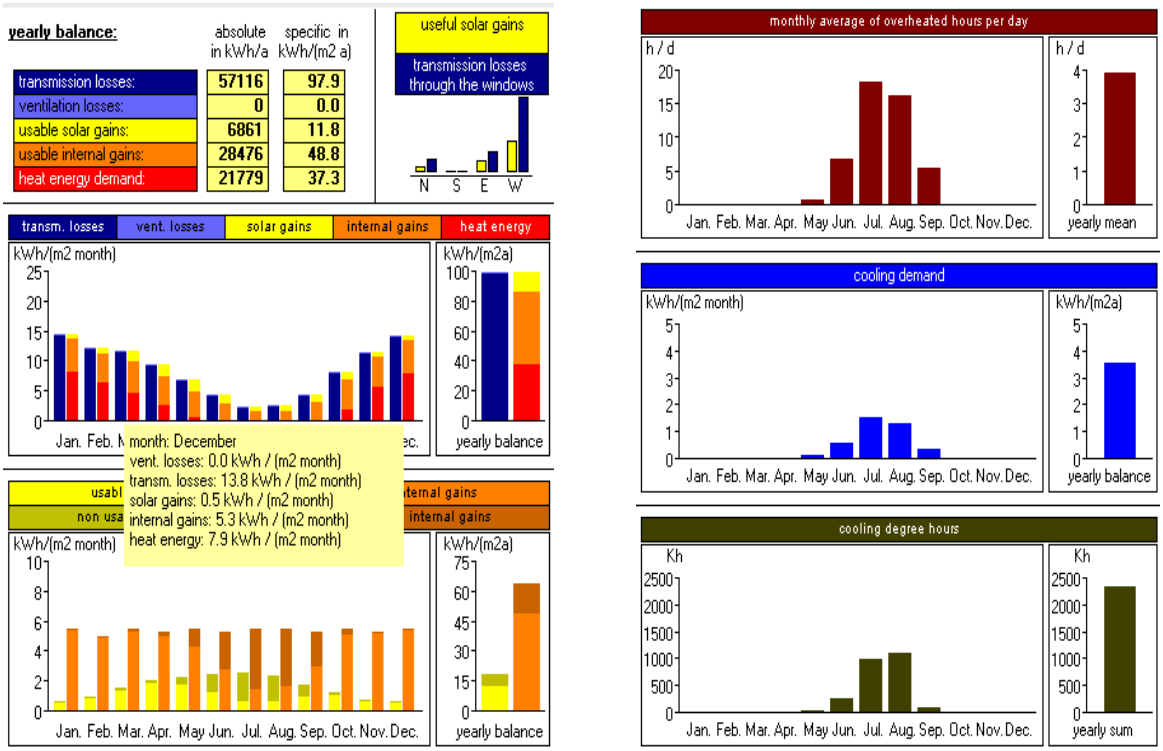


Figure 6-24 Heating and cooling demand detail

2) Swimming Pool Area

24°C is considered as the comfortable temperature in winter

	Heating demand (kWh/m2)	Cooling demand (kWh/m2)
January	6	0
February	4. 7	0
March	3. 5	0
April	1. 9	0
May	0. 3	0
June	0	0. 2
July	0	0. 8
August	0	0. 9
September	0	0. 2
October	1	0
November	3. 9	0
December	5. 8	0
Year sum	27. 1	2. 1

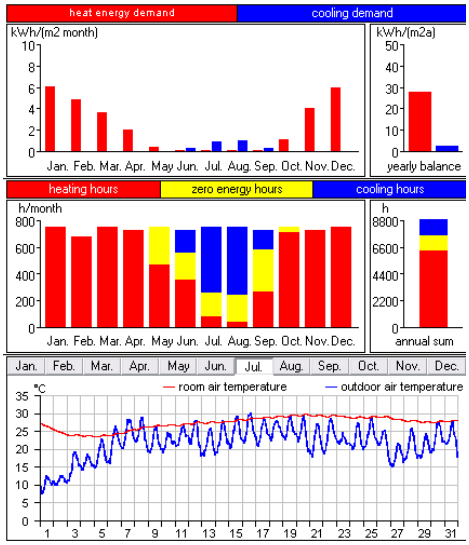


Figure 6-25 Heating and cooling demand

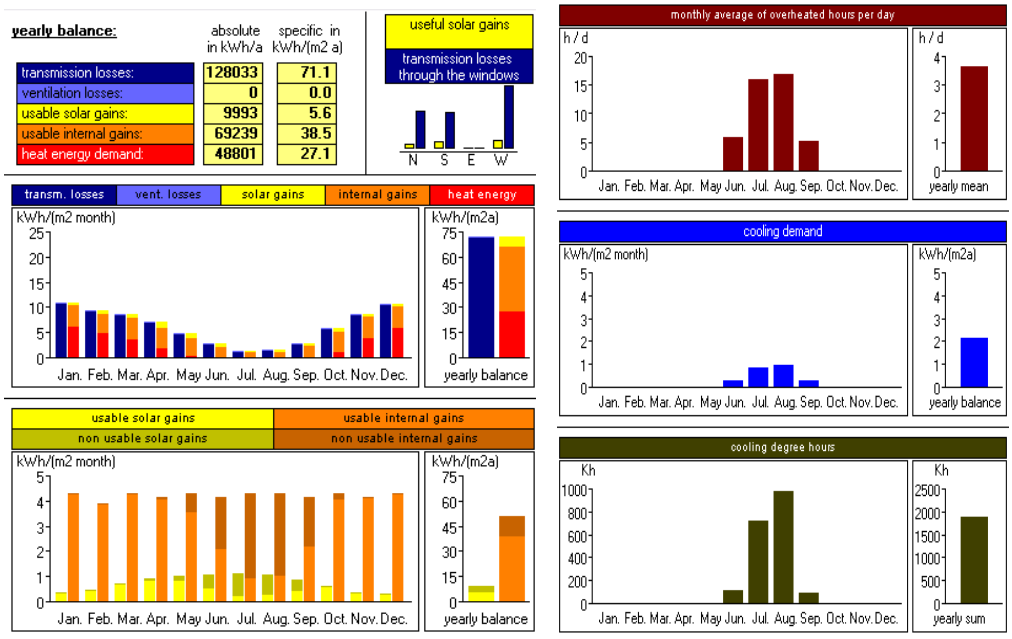


Figure 6-26 Heating and cooling load demand

27°C is considered as comfortable temperature during summer

	Heating demand (kWh/m2)	Cooling demand (kWh/m2)
January	7.4	0
February	6	0
March	4.9	0
April	3.2	0.1
May	1.1	0.4
June	0.1	0.7
July	0	1.4
August	0	1.2
September	0.1	0.6
October	2.3	0.1
November	5.3	0
December	7.3	0
Year sum	37.8	4.5

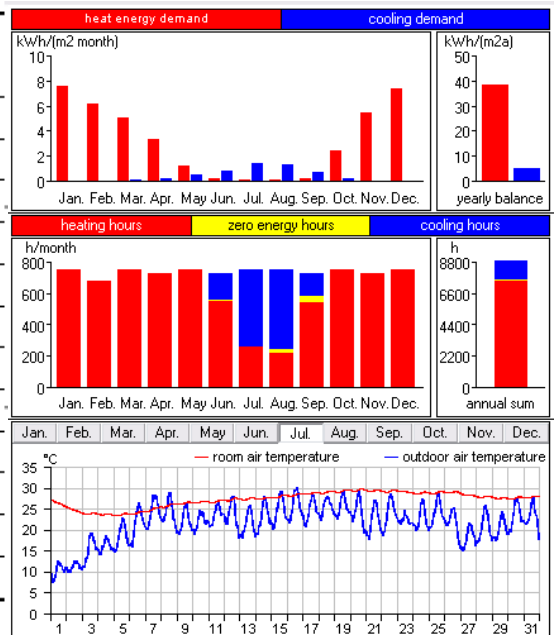


Figure 6-27 Heating and cooling demand

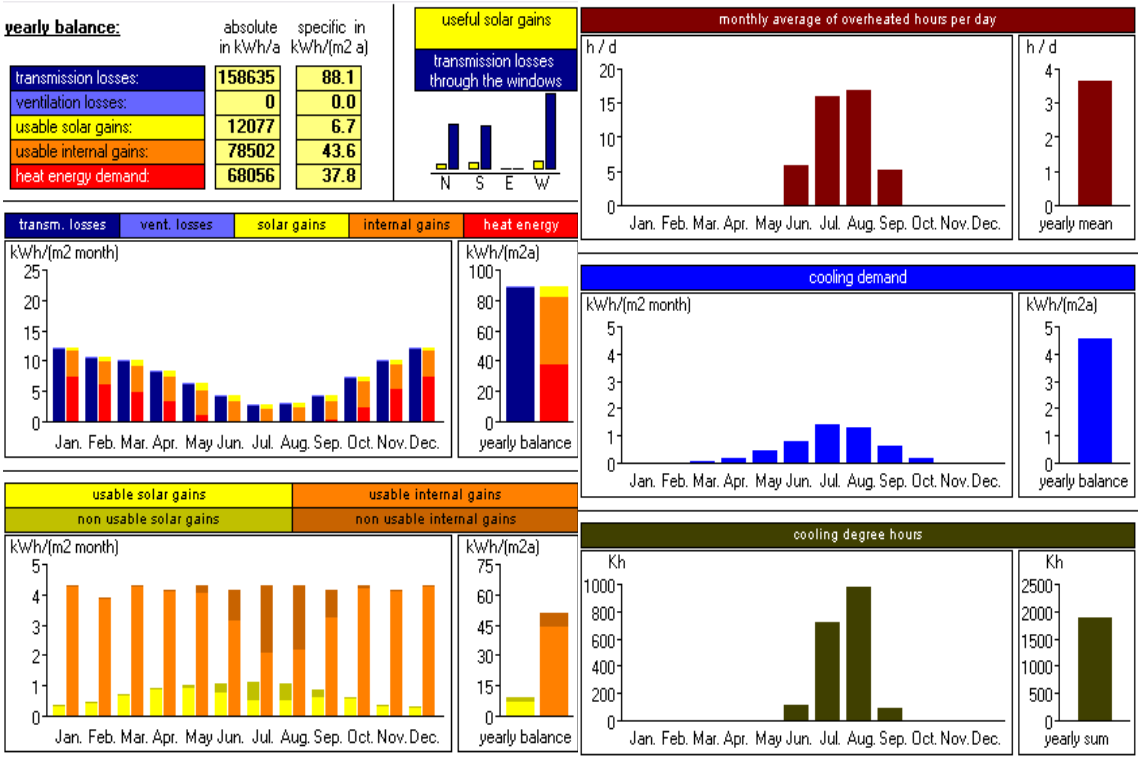


Figure 6-28 Heating and cooling demand details

The following thermal loads can be summarized from the analysis results which were obtained from different temperatures for both areas during the year:

a) Gym areas

Comfort temperature	Months	Heating demand (kWh/m2)	Cooling demand (kWh/m2)
20	January	5.5	0
	February	3.9	0
	March	1.9	0
	April	0.3	0
	May	0	0
25	June	0	0.5
	July	0	1.4
	August	0	1.3
	September	0	0.3
20	October	0.2	0
	November	3.3	0
	December	5.4	0
	Year sum	20.5	3.5

Table 6-15 Energy demand in Gym area

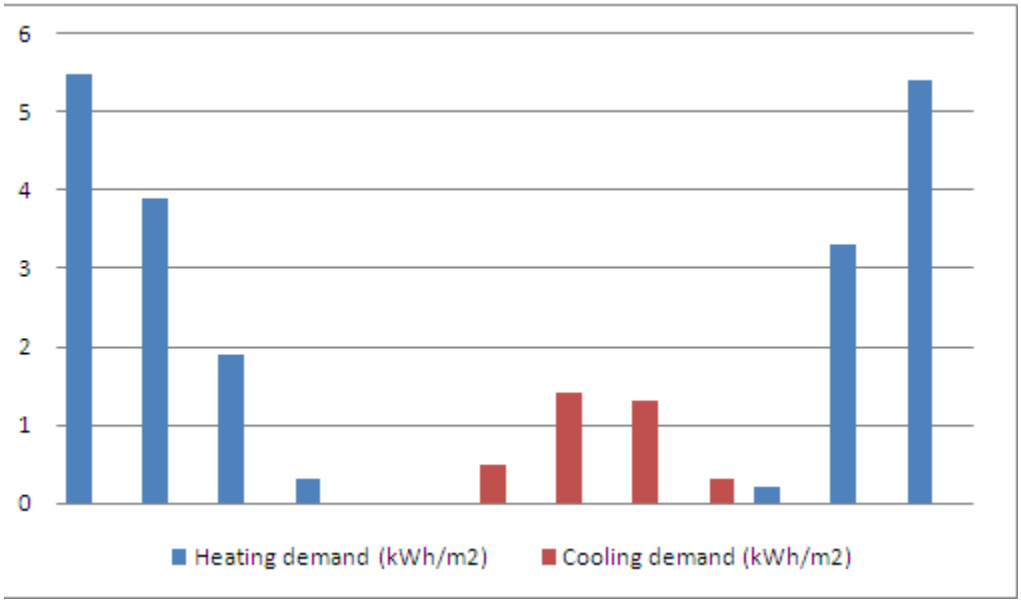


Figure 6-29 Energy demand in Gym area

b) Swimming pool area

Comfort temperature	Month	Heating demand (kWh/m2)	Cooling demand (kWh/m2)
24	January	6	0
	February	4.7	0
	March	3.5	0
	April	1.9	0
	May	0.3	0
27	June	0.1	0.7
	July	0	1.4
	August	0	1.2
	September	0.1	0.6
24	October	1	0
	November	3.9	0
	December	5.8	0
	Year sum	21.5	3.9

Table 6-16Energy demand in Swimming pool area

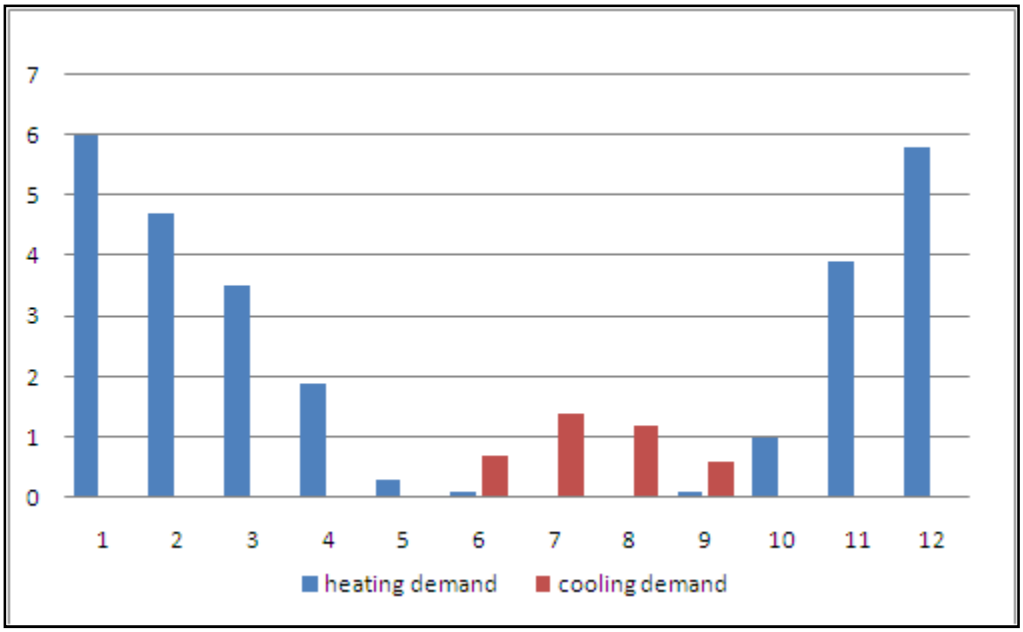
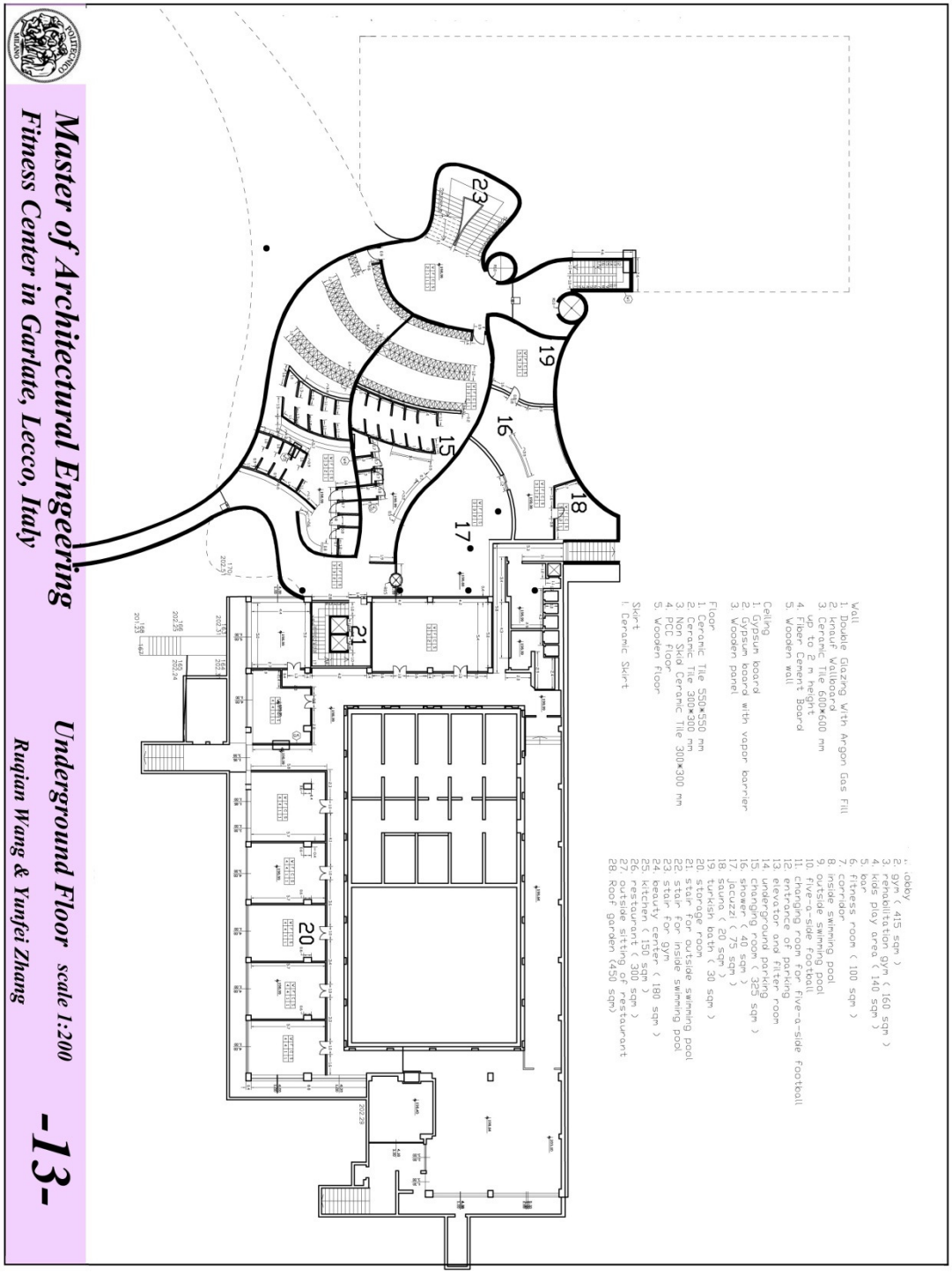
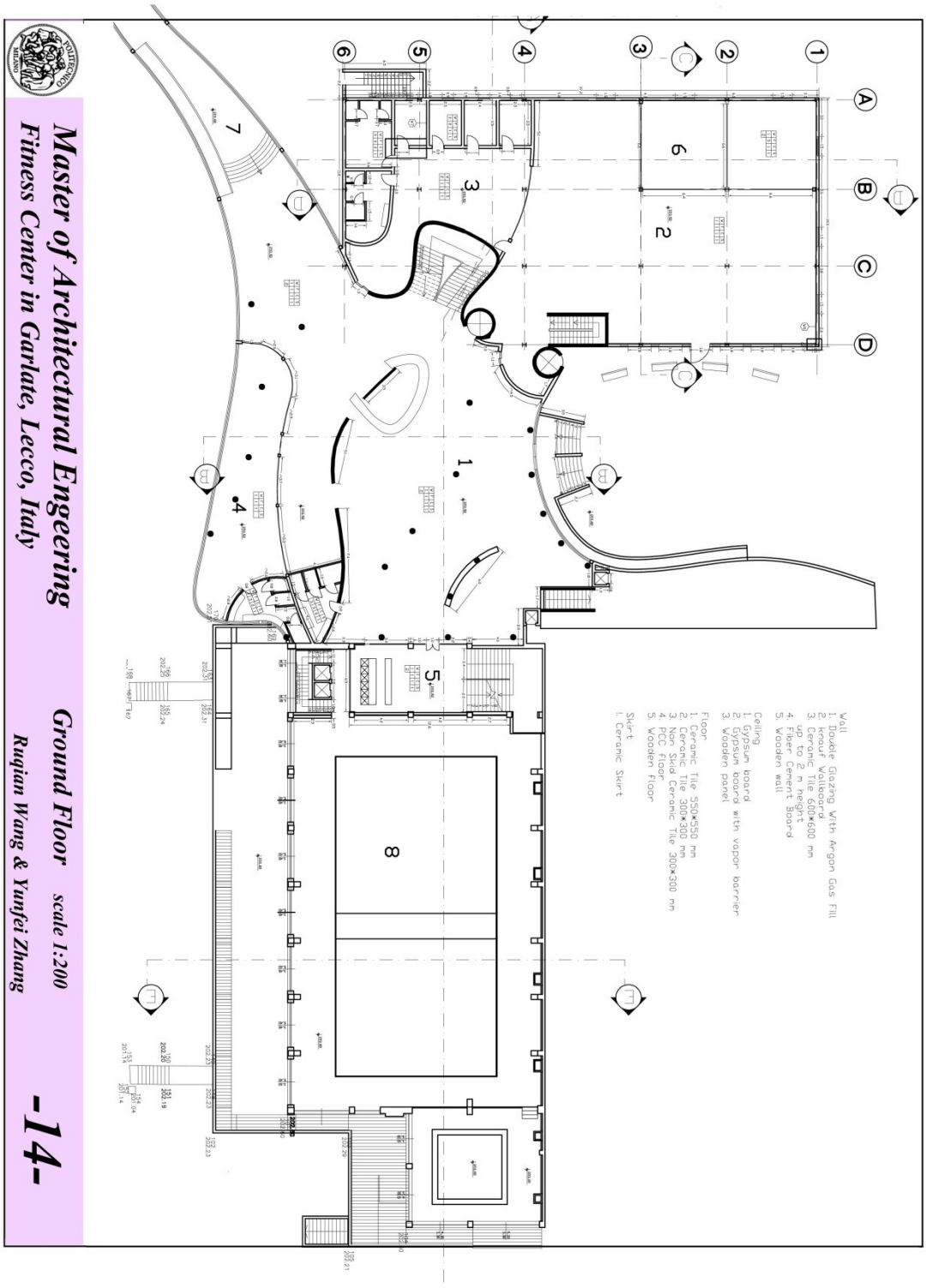


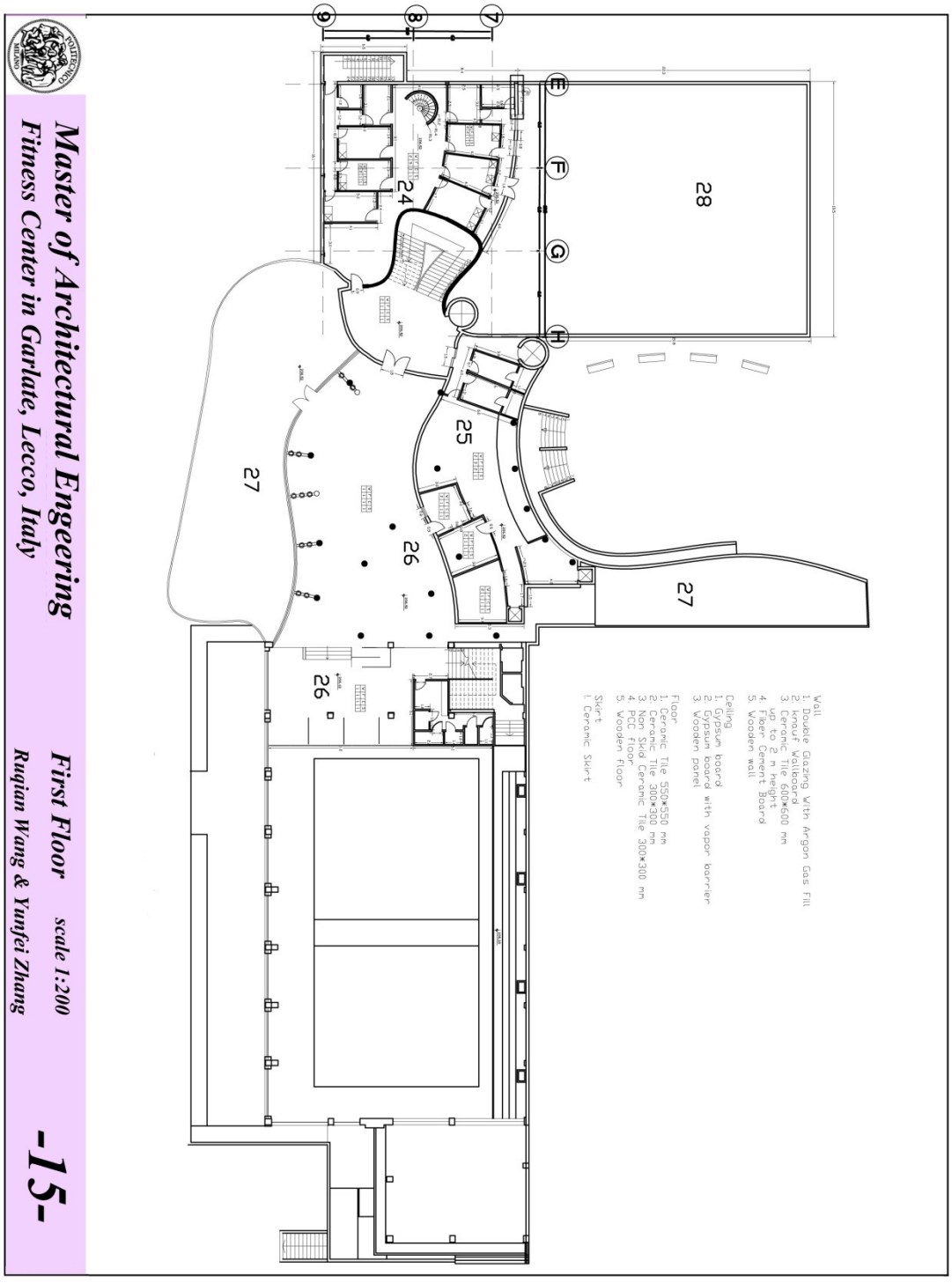
Figure 6-30 Energy demand in Swimming pool area

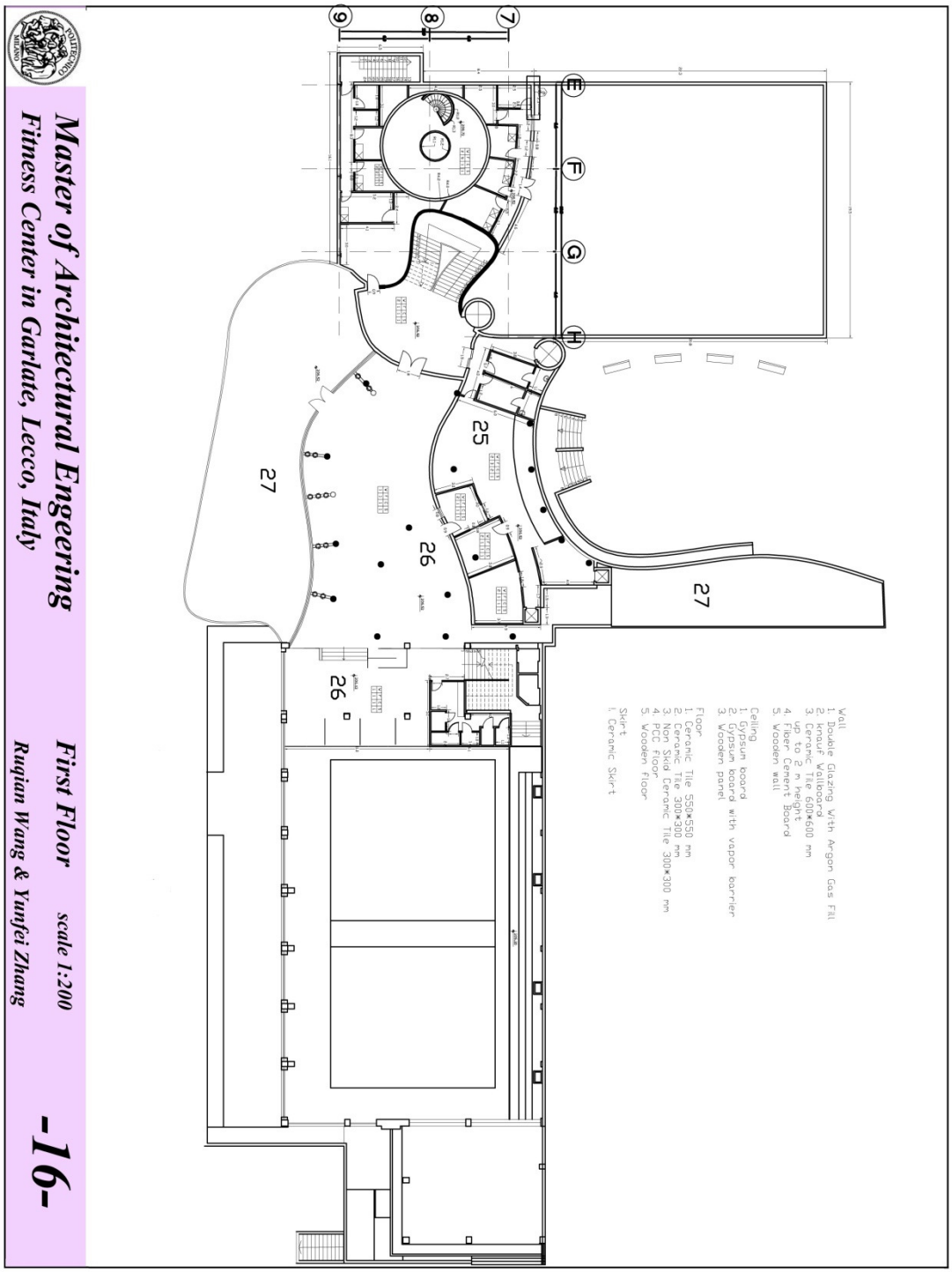
6.6 Details

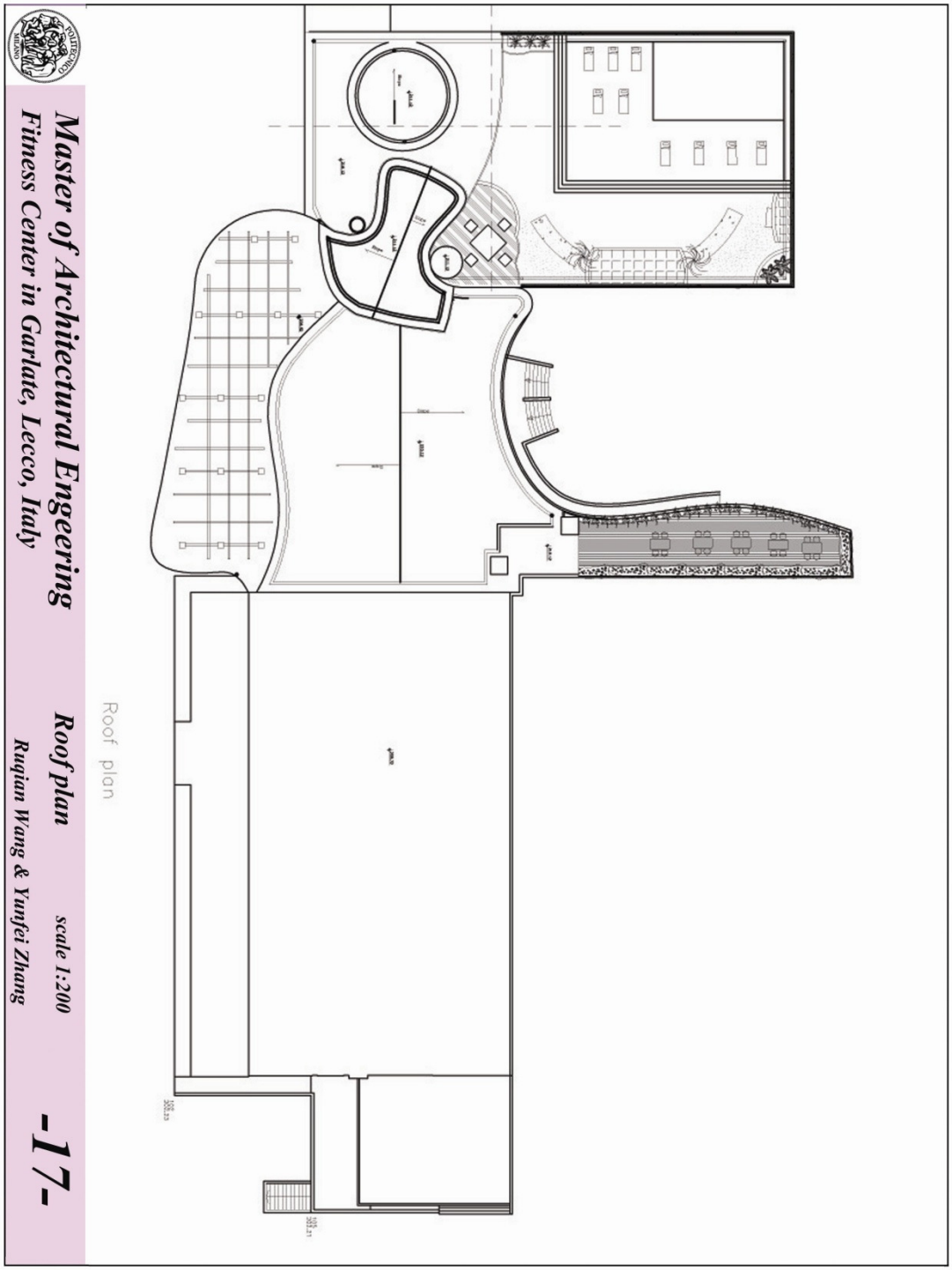
The details are shown in the following graphs which are not in scale. The 1:10 scaled drawings are presented in the book of drawings.

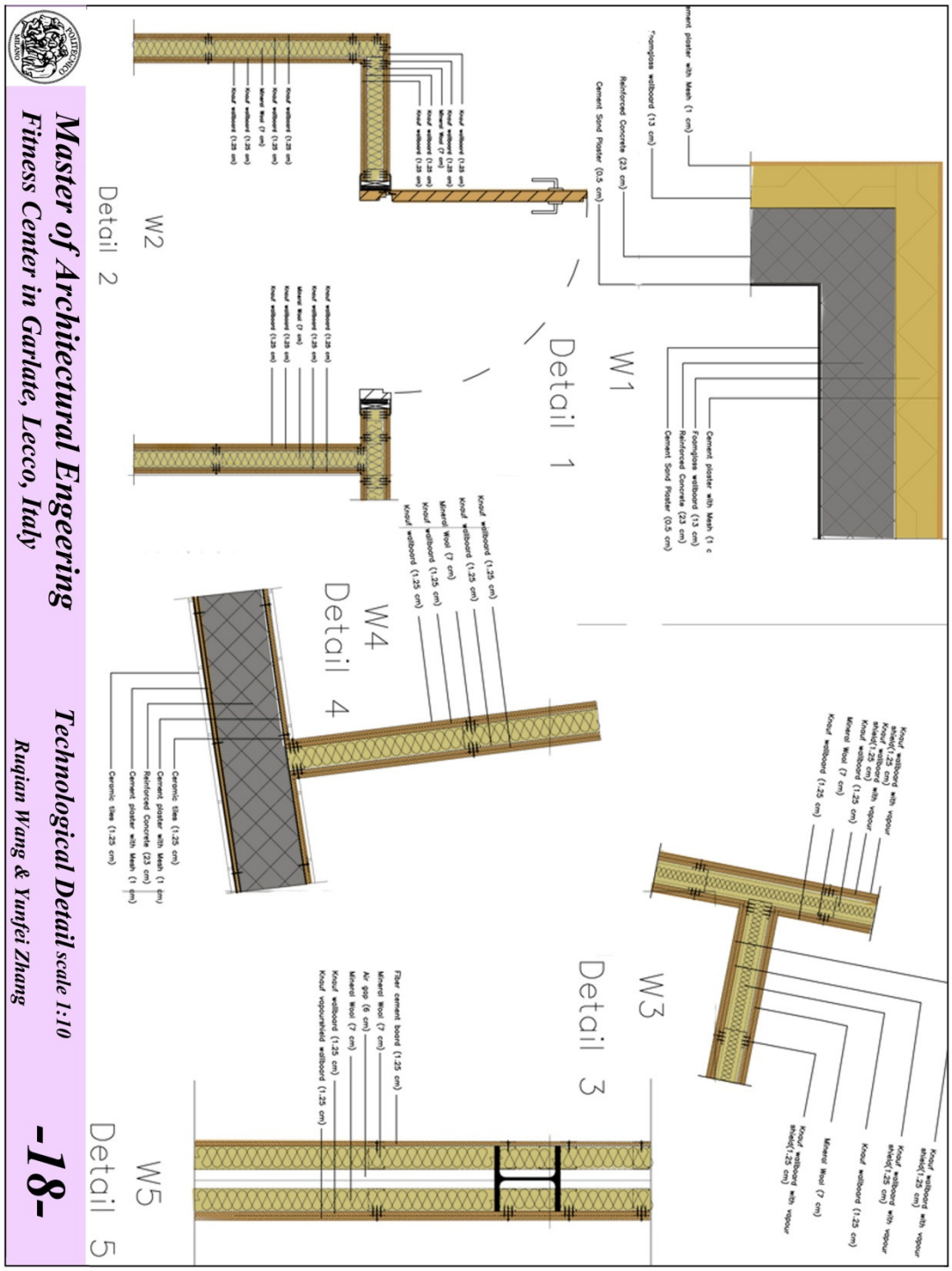

Master of Architectural Engeering
Fitness Center in Garlate, Lecco, Italy
Underground Floor scale 1:200
Ruqian Wang & Yunfei Zhang
-13-
1. Lobby
2. Gym (415 sqm)
3. Rehabilitation gym (160 sqm)
4. kids play area (140 sqm)
5. bar
6. fitness room (100 sqm)
7. corridor
8. inside swimming pool
9. outside swimming pool
10. five-a-side football
11. changing room
12. entrance for parking
13. elevator and filter room
14. underground parking
15. changing room (325 sqm)
16. shower (40 sqm)
17. Jacuzzi (75 sqm)
18. sauna (20 sqm)
19. turkish bath (30 sqm)
20. storage room
21. stair for outside swimming pool
22. stair for inside swimming pool
23. stair for gym
24. beauty center (180 sqm)
25. kitchen (150 sqm)
26. restaurant (300 sqm)
27. outside sitting of restaurant
28. Roof garden (450 sqm)
Wall
1. Double Glazing With Argon Gas Fill
2. Knauf Wallboard
3. Ceramic Tile 600×600 mm
4. Floor Cement Board
5. Wooden wall
Ceiling
1. Gypsum board
2. Gypsum board with vapor barrier
3. Wooden panel
Floor
1. Ceramic Tile 550×550 mm
2. Ceramic Tile 300×300 mm
3. Non Skid Ceramic Tile 300×300 mm
4. PCC Floor
5. Wooden Floor
Skirt
1. Ceramic Skirt


Master of Architectural Engeering
Fitness Center in Garlate, Lecco, Italy
Ground Floor scale 1:200
Ruqian Wang & Yunfei Zhang
-14-
Wall
1. Double Glazing With Argon Gas Fill
2. Knauf Wallboard
3. Ceramic Tile 600*600 mm
up to 2 m height
4. Fiber Cement Board
5. Wooden wall
Ceiling
1. Gypsum board
2. Gypsum board with vapor barrier
3. Wooden panel
Floor
1. Ceramic Tile 550*550 mm
2. Ceramic Tile 300*300 mm
3. Non-Skid Ceramic Tile 300*300 mm
4. PCC floor
5. Wooden floor
Skirt
1. Ceramic Skirt


Master of Architectural Engeering
Fitness Center in Garlate, Lecco, Italy
First Floor
scale 1:200
Ruqian Wang & Yunfei Zhang
-15-
Wall
1. Double Glazing With Argon Gas Fill
2. Knauf Wallboard
3. Ceramic Tile 600*600 mm
4. Gypsum Cement Board
5. Wooden Wall
Ceiling
1. Gypsum board
2. Gypsum board with vapor barrier
3. Wooden panel
Floor
1. Ceramic Tile 550*550 mm
2. Ceramic Tile 300*300 mm
3. Non Skid Ceramic Tile 300*300 mm
4. PCC Floor
5. Wooden Floor
Skirt
1. Ceramic Skirt
24
25
26
27
28


Master of Architectural Engeering
Fitness Center in Garlate, Lecco, Italy
First Floor
scale 1:200
Ruqian Wang & Yunfei Zhang
-16-
25
26
27
Wall
1. Double Glazing With Argon Gas Fill
2. Knauf Wallboard
3. Ceramic Tile 600*600 mm
4. Hebel Cement Board
5. Wooden wall
Ceiling
1. Gypsum board
2. Gypsum board with vapor barrier
3. Wooden panel
Floor
1. Ceramic Tile 550*550 mm
2. Ceramic Tile 300*300 mm
3. Non Skid Ceramic Tile 300*300 mm
4. PCC Floor
5. Wooden floor
Skirt
1. Ceramic Skirt


Master of Architectural Engeering
Fitness Center in Garlate, Lecco, Italy
Roof plan
scale 1:200
Ruqian Wang & Yunfei Zhang
-17-
Roof plan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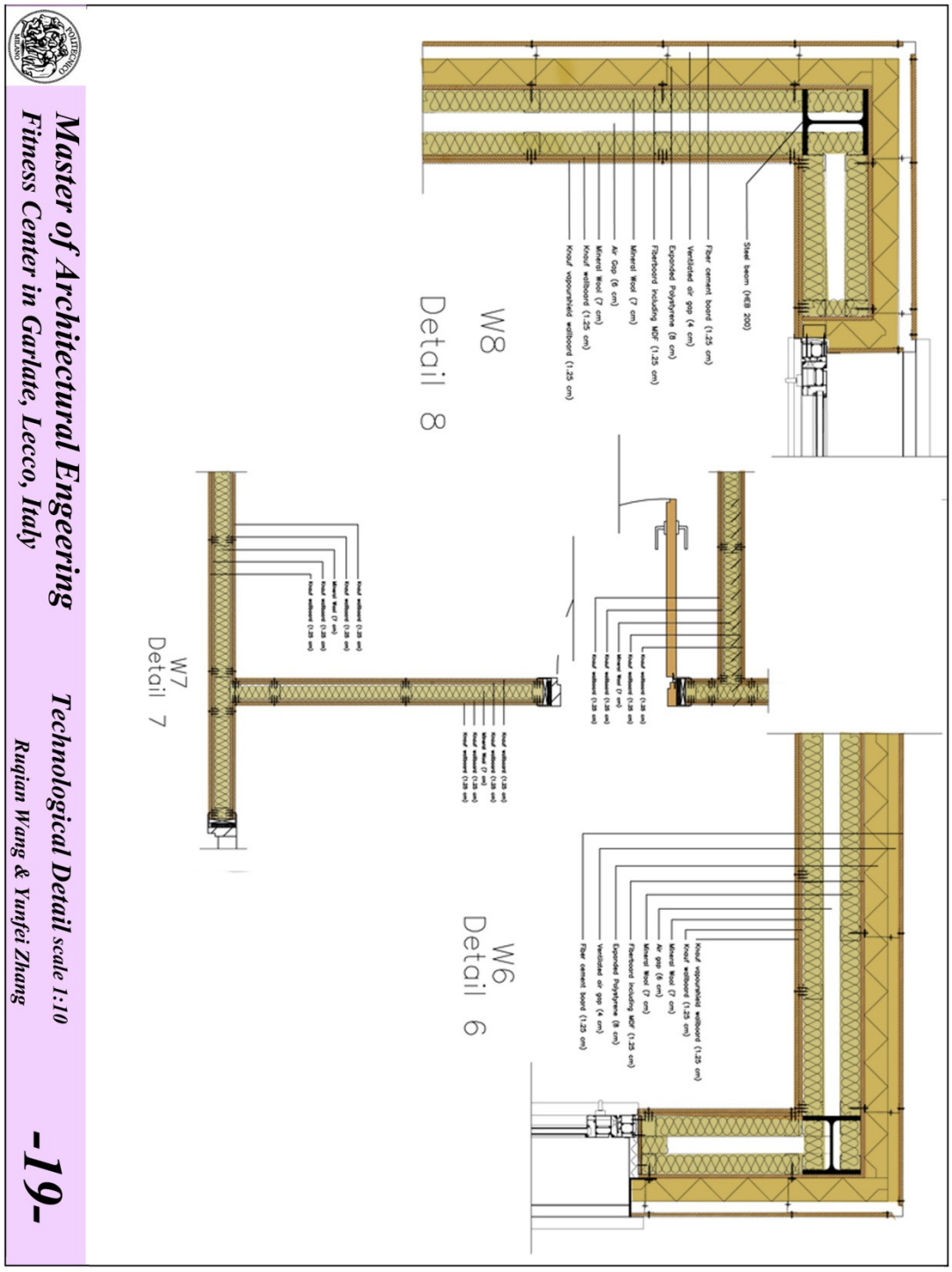
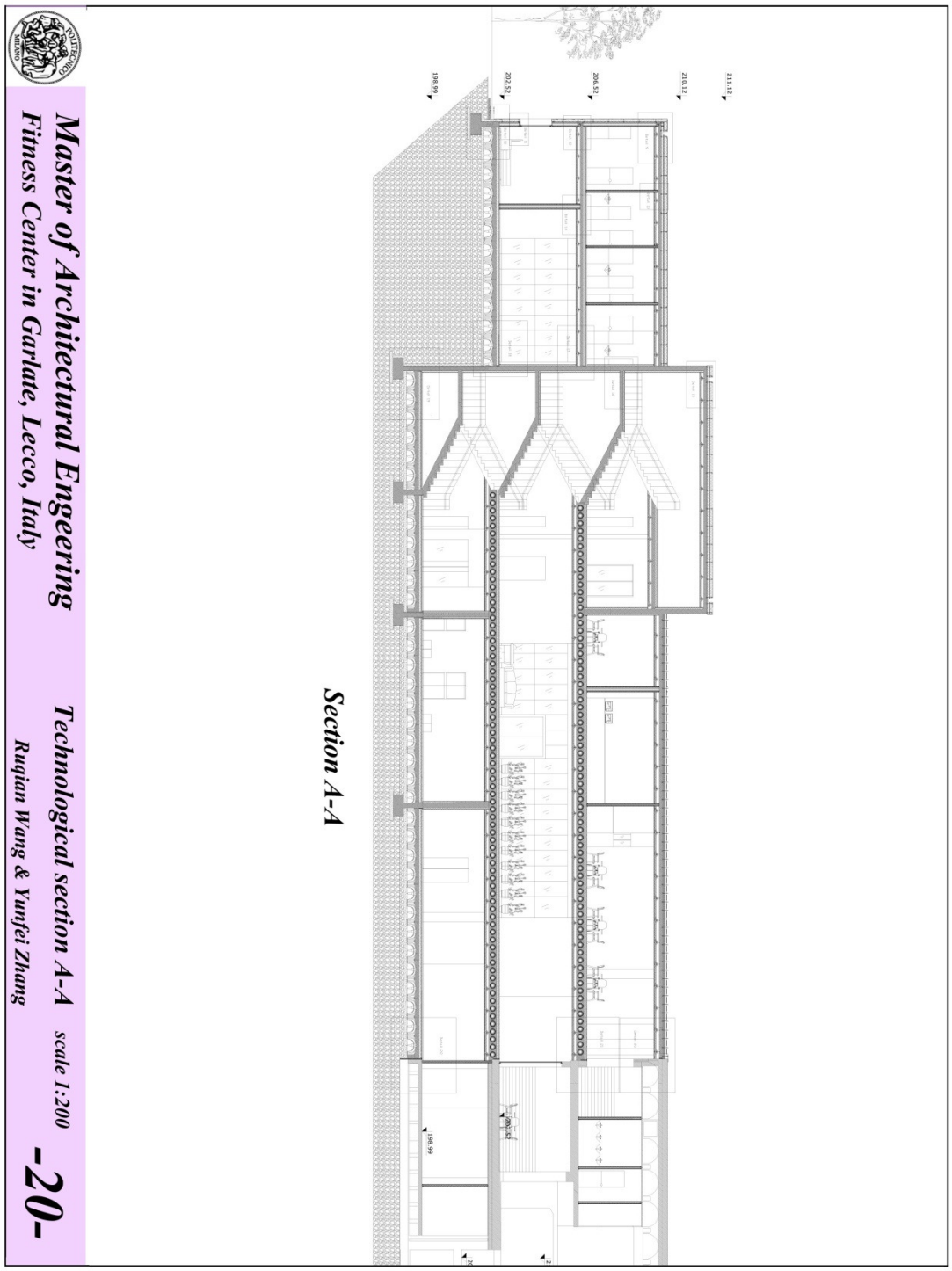
Fitness Center in Garlate, Lecco, Italy
Technological Detail scale 1:10
Ruqian Wang & Yunfei Zhang
-18-
W1
Detail 1
W2
Detail 2
W3
Detail 3
W4
Detail 4
W5
Detail 5
Cement plaster with Mesh (1 cm)
Reinforced Concrete (23 cm)
Cement Sand Plaster (0.5 cm)
Knauf wallboard with vapour shield(1.25 cm)
Knauf wallboard (1.25 cm)
Mineral Wool (7 cm)
Ceramic tiles (1.25 cm)
Fiber cement board (1.25 cm)
Air gap (6 cm)
Knauf vapourshield wallboard (1.25 cm)


Master of Architectural Engeering
Fitness Center in Garlate, Lecco, Italy
Technological Detail scale 1:10
Ruqian Wang & Yunfei Zhang
-19-
W8
Detail 8
W7
Detail 7
W6
Detail 6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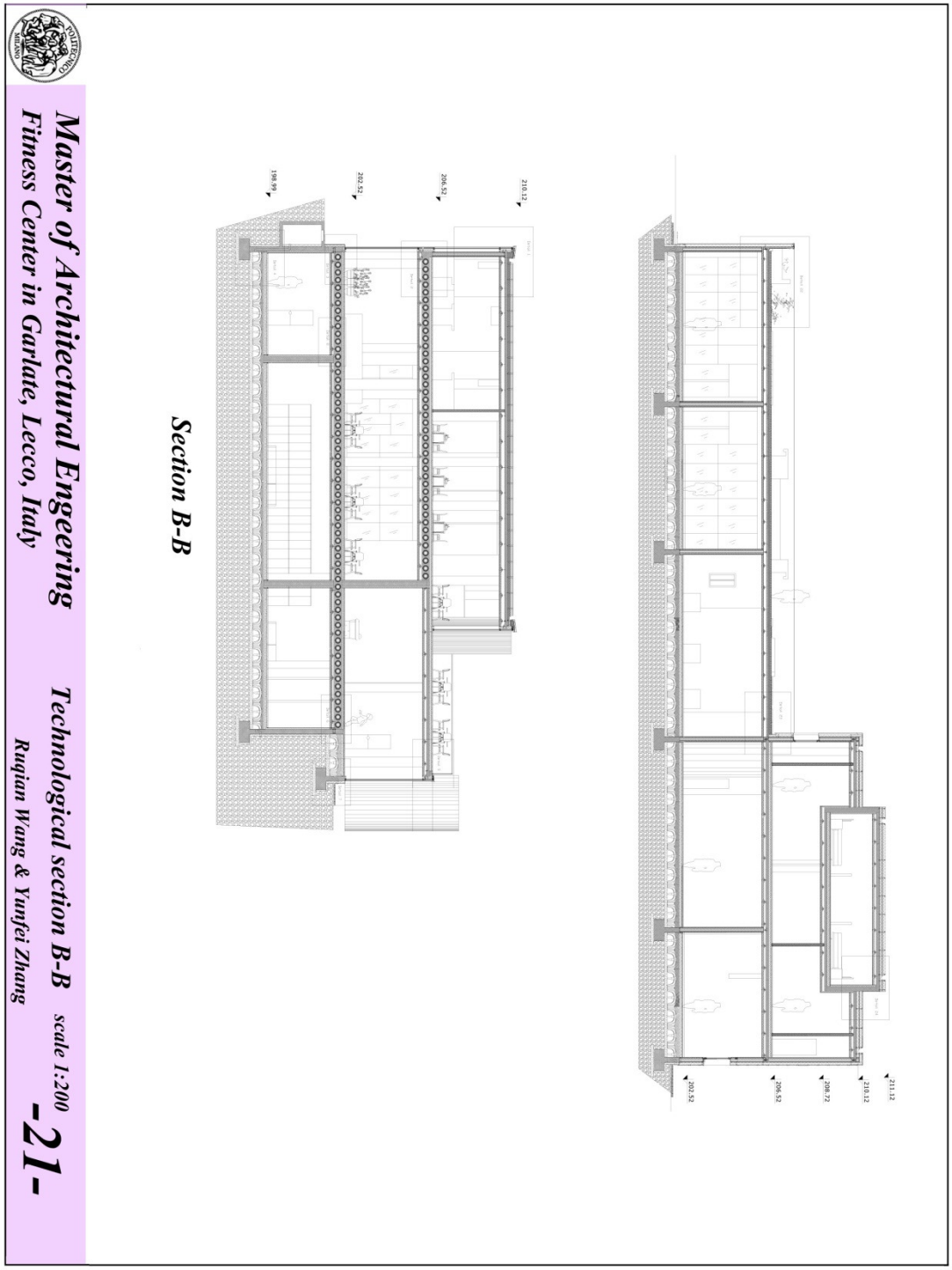
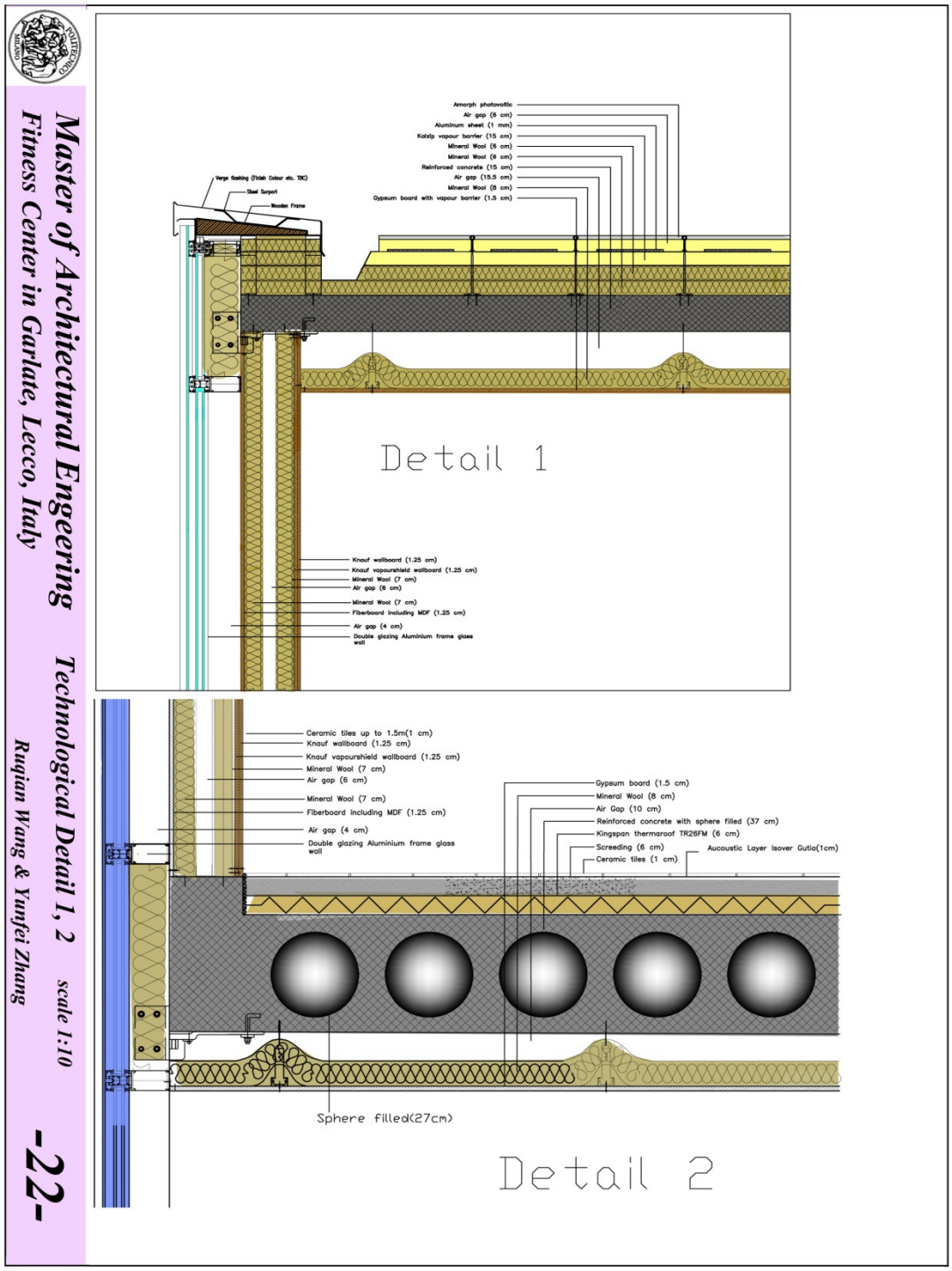
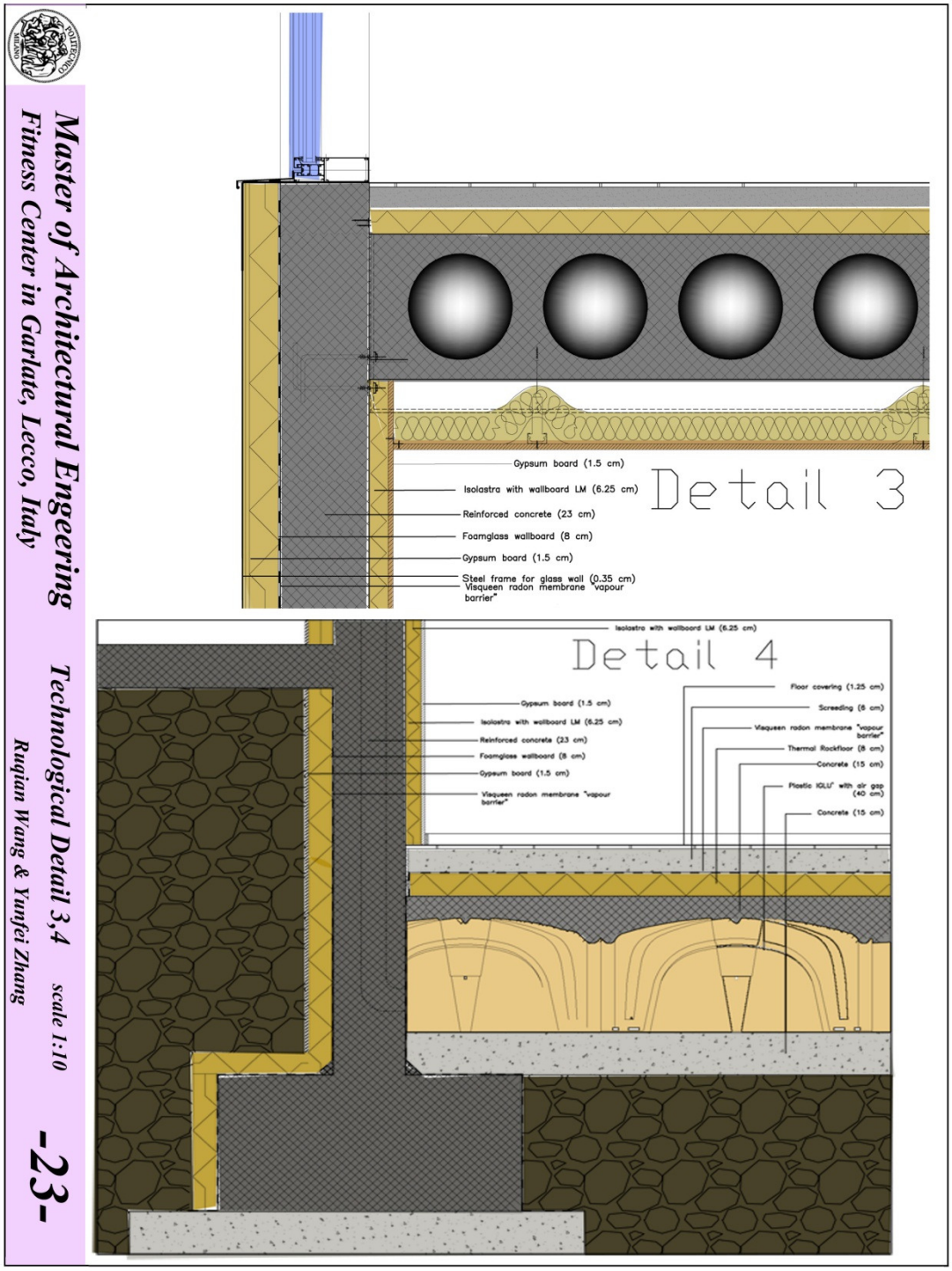
Fitness Center in Garlate, Lecco, Italy
Technological section A-A
scale 1:200
Ruqian Wang & Yunfei Zhang
-20-
Section A-A
198.99
202.52
206.52
210.12
211.12


Master of Architectural Engeering
Fitness Center in Garlate, Lecco, Italy
Technological section B-B
scale 1:200
Ruqian Wang & Yunfei Zhang
-21-
Section B-B
198.99
202.52
206.52
210.12
203.52
206.52
208.72
210.12
211.12


Master of Architectural Engeering
Fitness Center in Garlate, Lecco, Italy
Technological Detail 1, 2
scale 1:10
Ruqian Wang & Yunfei Zhang
-22-
Amorph photovoltic
Air gap (6 cm)
Aluminum sheet (1 mm)
Kalzip vapour barrier (15 cm)
Mineral Wool (6 cm)
Mineral Wool (6 cm)
Reinforced concrete (15 cm)
Air gap (15.5 cm)
Mineral Wool (8 cm)
Gypsum board with vapour barrier (1.5 cm)
Verge flashing (Finish Colour etc. TBC)
Steel Surport
Wooden Frame
Detail 1
Knauf wallboard (1.25 cm)
Knauf vapourshield wallboard (1.25 cm)
Mineral Wool (7 cm)
Air gap (6 cm)
Mineral Wool (7 cm)
Fiberboard including MDF (1.25 cm)
Air gap (4 cm)
Double glazing Aluminium frame glass wall
Ceramic tiles up to 1.5m(1 cm)
Knauf wallboard (1.25 cm)
Knauf vapourshield wallboard (1.25 cm)
Mineral Wool (7 cm)
Air gap (6 cm)
Mineral Wool (7 cm)
Fiberboard including MDF (1.25 cm)
Air gap (4 cm)
Double glazing Aluminium frame glass wall
Gypsum board (1.5 cm)
Mineral Wool (8 cm)
Air Gap (10 cm)
Reinforced concrete with sphere filled (37 cm)
Kingspan thermaroof TR26FM (6 cm)
Screeding (6 cm)
Ceramic tiles (1 cm)
Aucoustic Layer Isover Gutia(1cm)
Sphere filled(27cm)
Detail 2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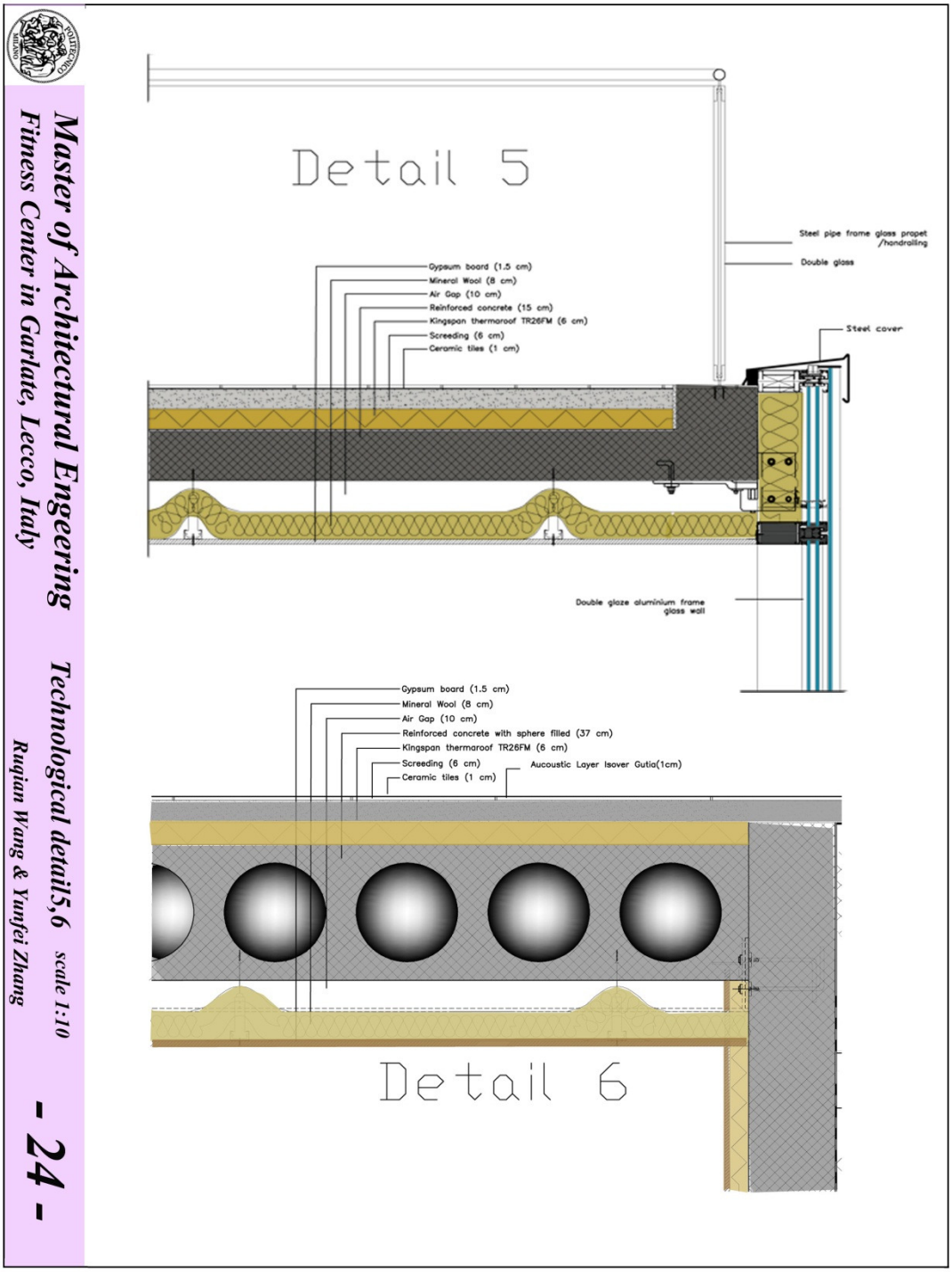
Fitness Center in Garlate, Lecco, Italy
Technological Detail 3,4
scale 1:10
Ruqian Wang & Yunfei Zhang
-23-
Detail 3
Gypsum board (1.5 cm)
Isolastra with wallboard LM (6.25 cm)
Reinforced concrete (23 cm)
Foamglass wallboard (8 cm)
Gypsum board (1.5 cm)
Steel frame for glass wall (0.35 cm)
Visqueen radon membrane "vapour barrier"
Detail 4
Isolastra with wallboard LM (6.25 cm)
Gypsum board (1.5 cm)
Isolastra with wallboard LM (6.25 cm)
Reinforced concrete (23 cm)
Foamglass wallboard (8 cm)
Gypsum board (1.5 cm)
Visqueen radon membrane "vapour barrier"
Floor covering (1.25 cm)
Screeding (6 cm)
Visqueen radon membrane "vapour barrier"
Thermal Rockfloor (8 cm)
Concrete (15 cm)
Plastic IGLU' with air gap (40 cm)
Concrete (15 cm)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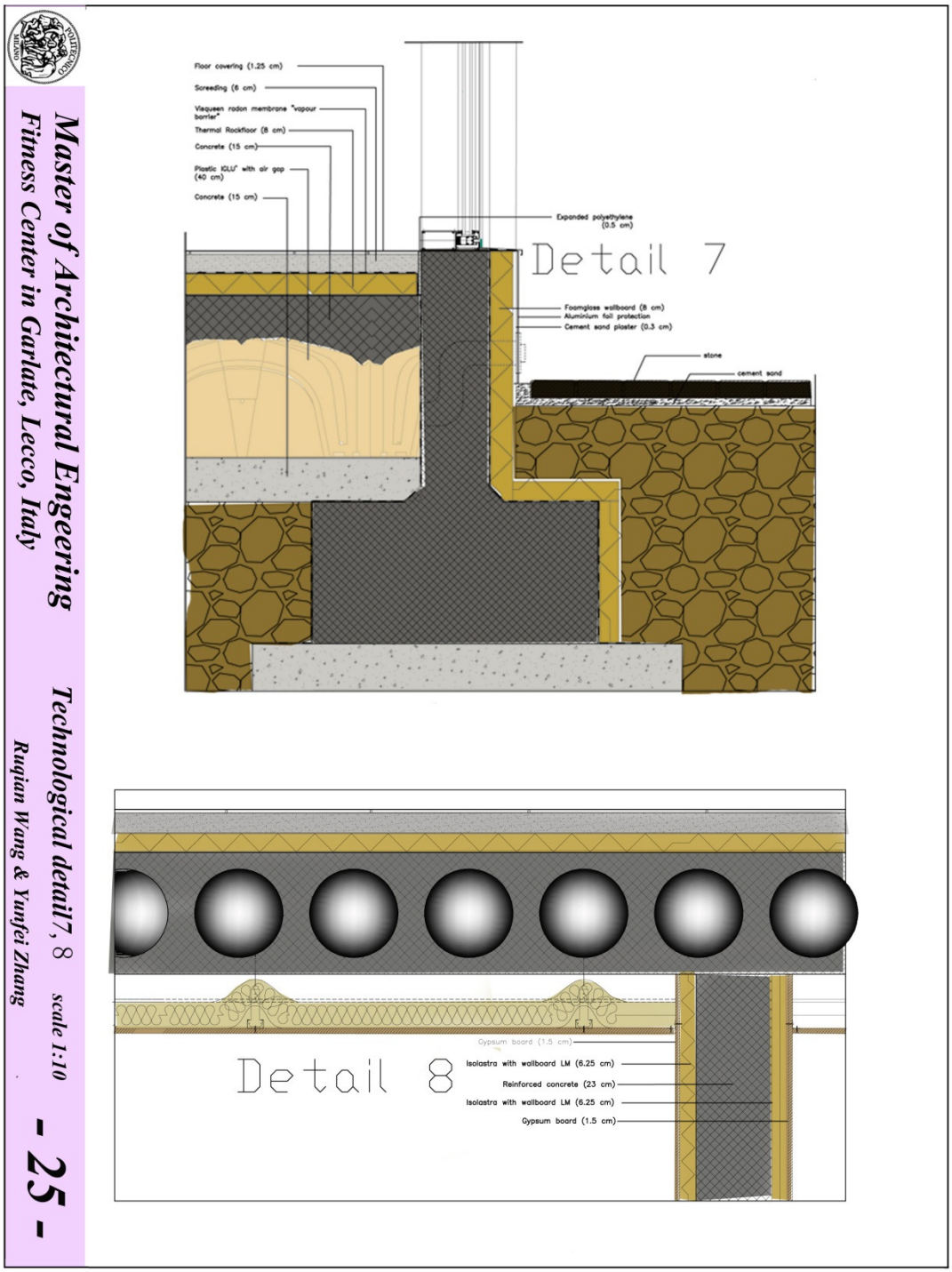
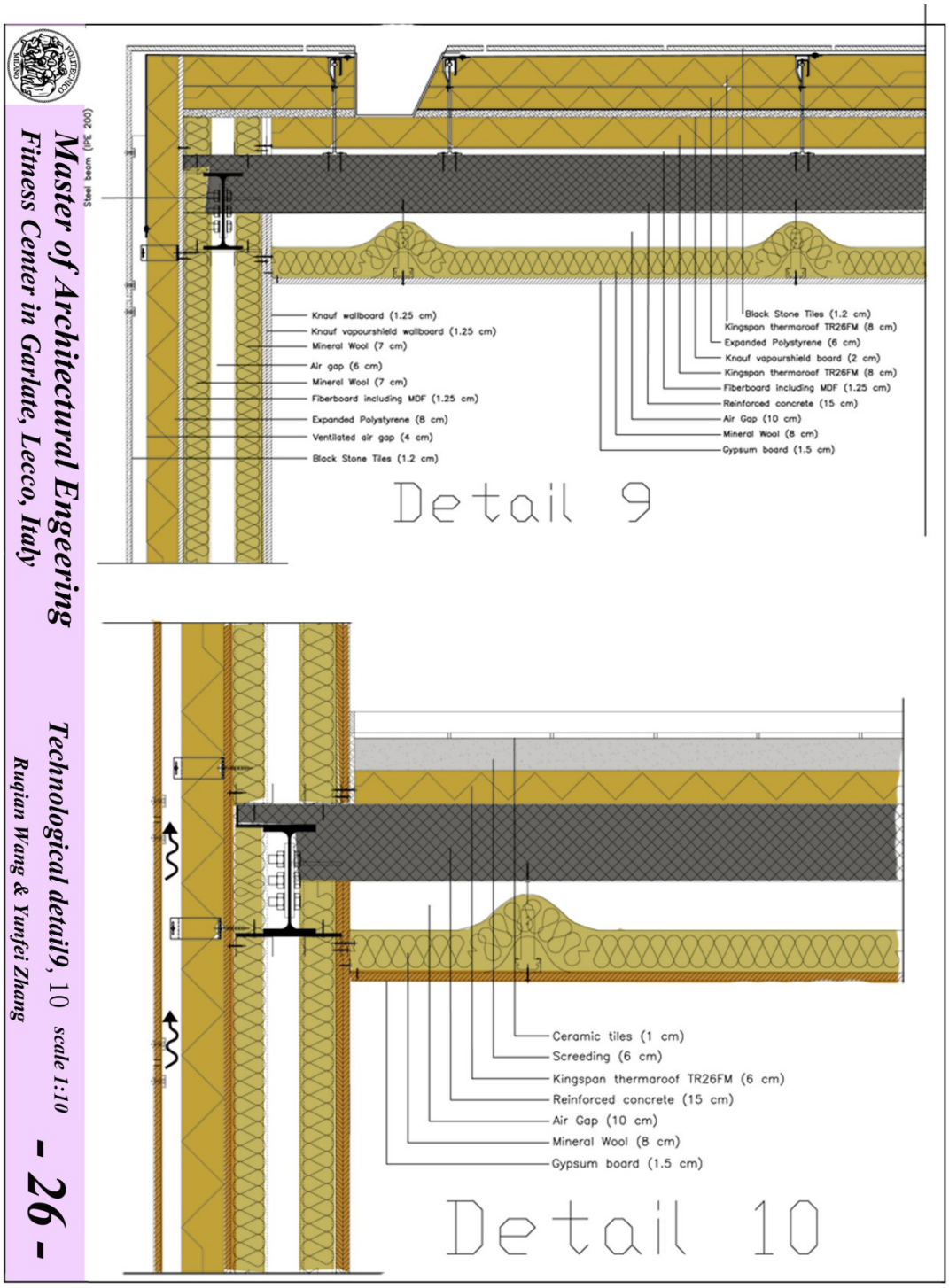
Fitness Center in Garlate, Lecco, Italy
Technological detail5,6
scale 1:10
Ruqian Wang & Yunfei Zhang
- 24 -
Detail 5
Steel pipe frame glass propet /handralling
Double glass
Steel cover
Gypsum board (1.5 cm)
Mineral Wool (8 cm)
Air Gap (10 cm)
Reinforced concrete (15 cm)
Kingspan thermaroof TR26FM (6 cm)
Screeding (6 cm)
Ceramic tiles (1 cm)
Double glaze aluminium frame glass wall
Gypsum board (1.5 cm)
Mineral Wool (8 cm)
Air Gap (10 cm)
Reinforced concrete with sphere filled (37 cm)
Kingspan thermaroof TR26FM (6 cm)
Screeding (6 cm)
Ceramic tiles (1 cm)
Aucoustic Layer Isover Gutia(1cm)
Detail 6


Master of Architectural Engeering
Fitness Center in Garlate, Lecco, Italy
Technological detail7, 8
scale 1:10
Ruqian Wang & Yunfei Zhang
- 25 -
Floor covering (1.25 cm)
Screeding (6 cm)
Vapour barrier"
Thermal Rockfloor (8 cm)
Concrete (15 cm)
Plastic ICLU" with air gap (40 cm)
Concrete (15 cm)
Expanded polyethylene (0.5 cm)
Detail 7
Foamglass wallboard (8 cm)
Aluminium foil protection
Cement sand plaster (0.3 cm)
stone
cement sand
Gypsum board (1.5 cm)
Isolastra with wallboard LM (6.25 cm)
Reinforced concrete (23 cm)
Isolastra with wallboard LM (6.25 cm)
Gypsum board (1.5 cm)
Detail 8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Fitness Center in Garlate, Lecco, Italy
Technological detail9, 10 scale 1:10
Ruqian Wang & Yunfei Zhang
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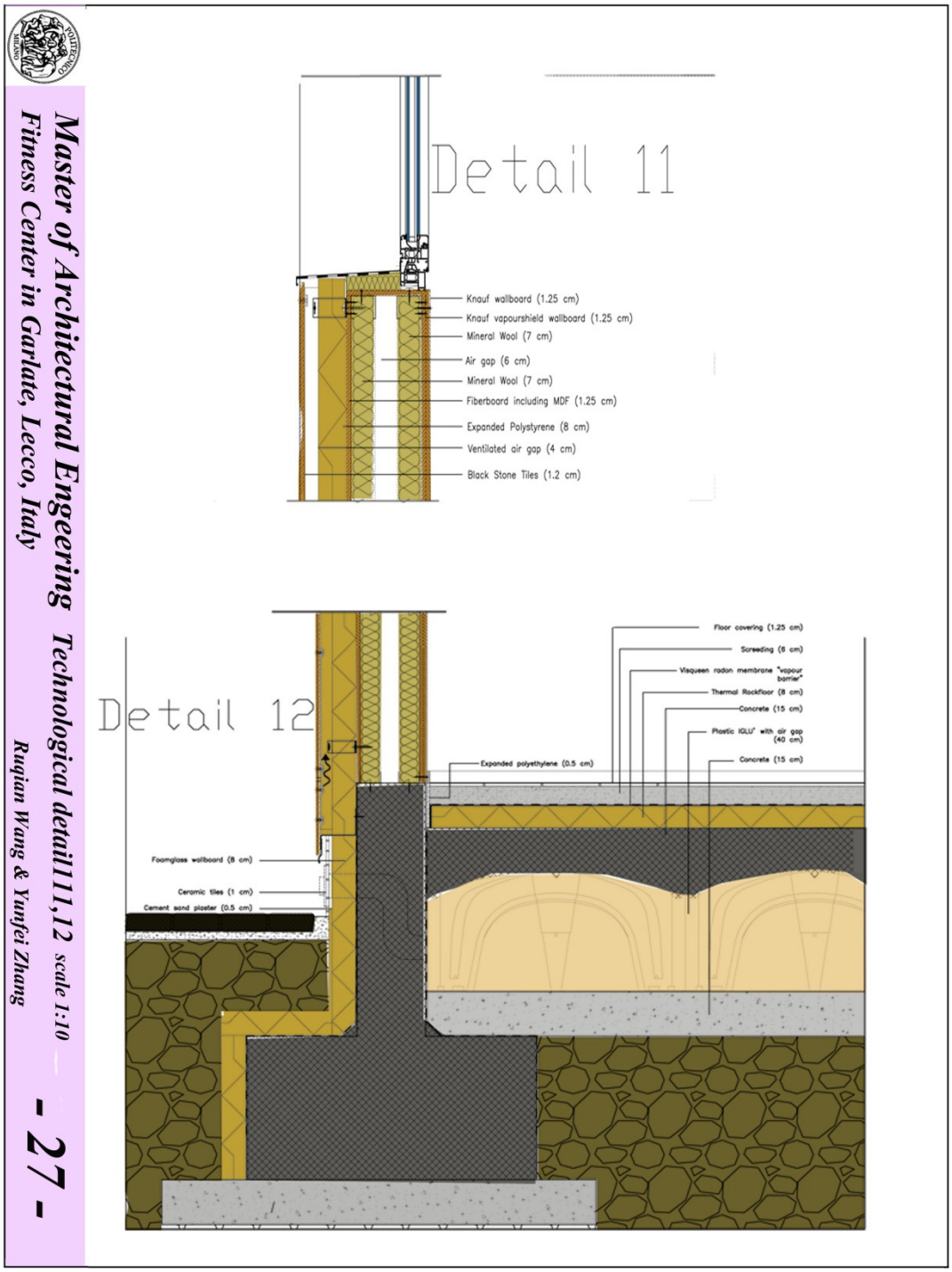
Steel beam (IPE 200)
Knauf wallboard (1.25 cm)
Knauf vapourshield wallboard (1.25 cm)
Mineral Wool (7 cm)
Air gap (6 cm)
Mineral Wool (7 cm)
Fiberboard including MDF (1.25 cm)
Expanded Polystyrene (8 cm)
Ventilated air gap (4 cm)
Black Stone Tiles (1.2 cm)
Black Stone Tiles (1.2 cm)
Kingspan thermaroof TR26FM (8 cm)
Expanded Polystyrene (6 cm)
Knauf vapourshield board (2 cm)
Kingspan thermaroof TR26FM (8 cm)
Fiberboard including MDF (1.25 cm)
Reinforced concrete (15 cm)
Air Gap (10 cm)
Mineral Wool (8 cm)
Gypsum board (1.5 cm)
Detail 9
Ceramic tiles (1 cm)
Screeding (6 cm)
Kingspan thermaroof TR26FM (6 cm)
Reinforced concrete (15 cm)
Air Gap (10 cm)
Mineral Wool (8 cm)
Gypsum board (1.5 cm)
Detail 10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Fitness Center in Garlate, Lecco, Italy
Technological detail11,12 scale 1:10
Ruqian Wang & Yunfei Zhang
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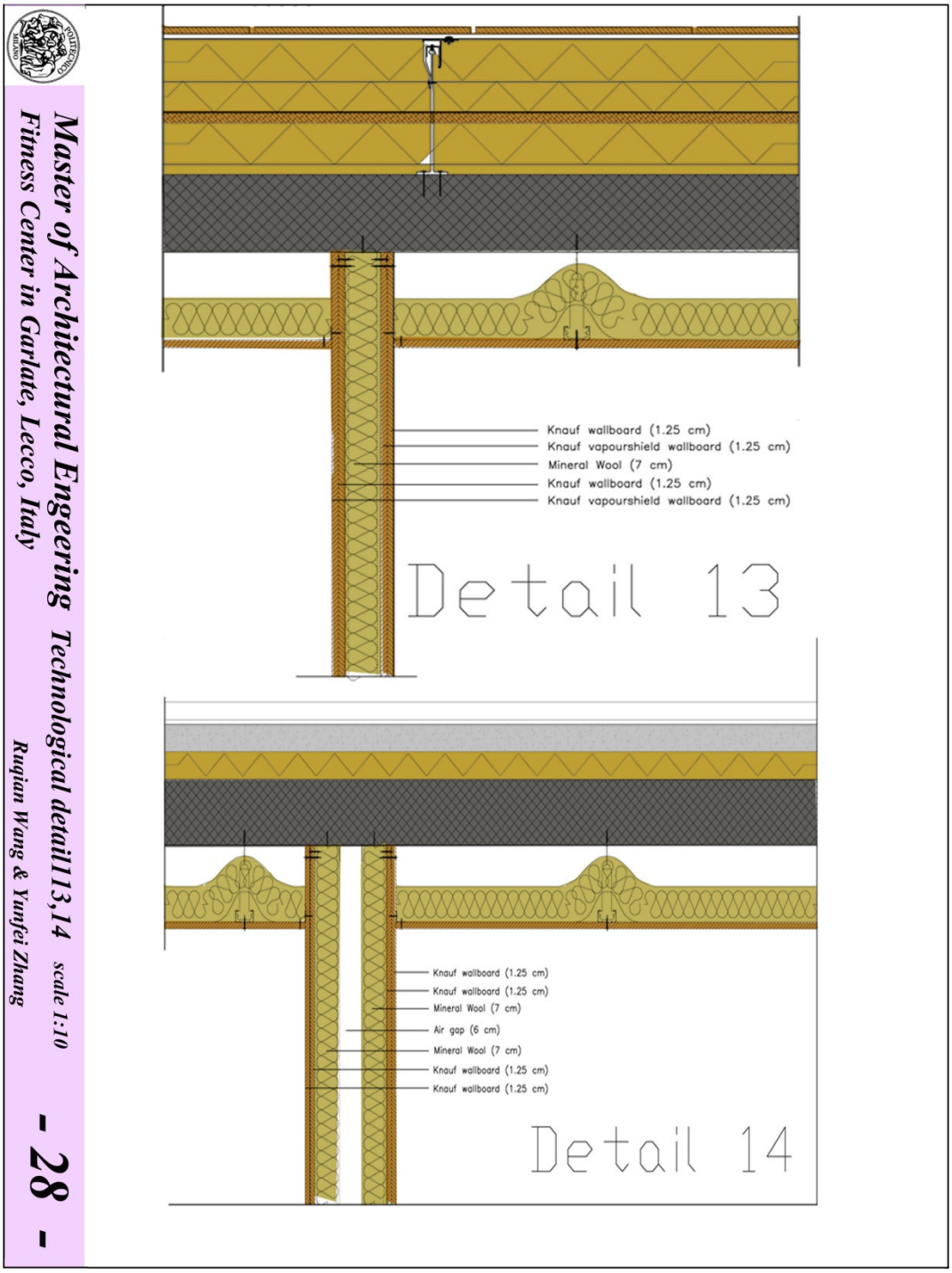
Detail 11
Knauf wallboard (1.25 cm)
Knauf vapourshield wallboard (1.25 cm)
Mineral Wool (7 cm)
Air gap (6 cm)
Mineral Wool (7 cm)
Fiberboard including MDF (1.25 cm)
Expanded Polystyrene (8 cm)
Ventilated air gap (4 cm)
Black Stone Tiles (1.2 cm)
Detail 12
Floor covering (1.25 cm)
Screeding (6 cm)
Visqueen radon membrane "vapour barrier"
Thermal Rockfloor (8 cm)
Concrete (15 cm)
Plastic IGLU' with air gap (40 cm)
Concrete (15 cm)
Expanded polyethylene (0.5 cm)
Foamglass wallboard (8 cm)
Ceramic tiles (1 cm)
Cement sand plaster (0.5 cm)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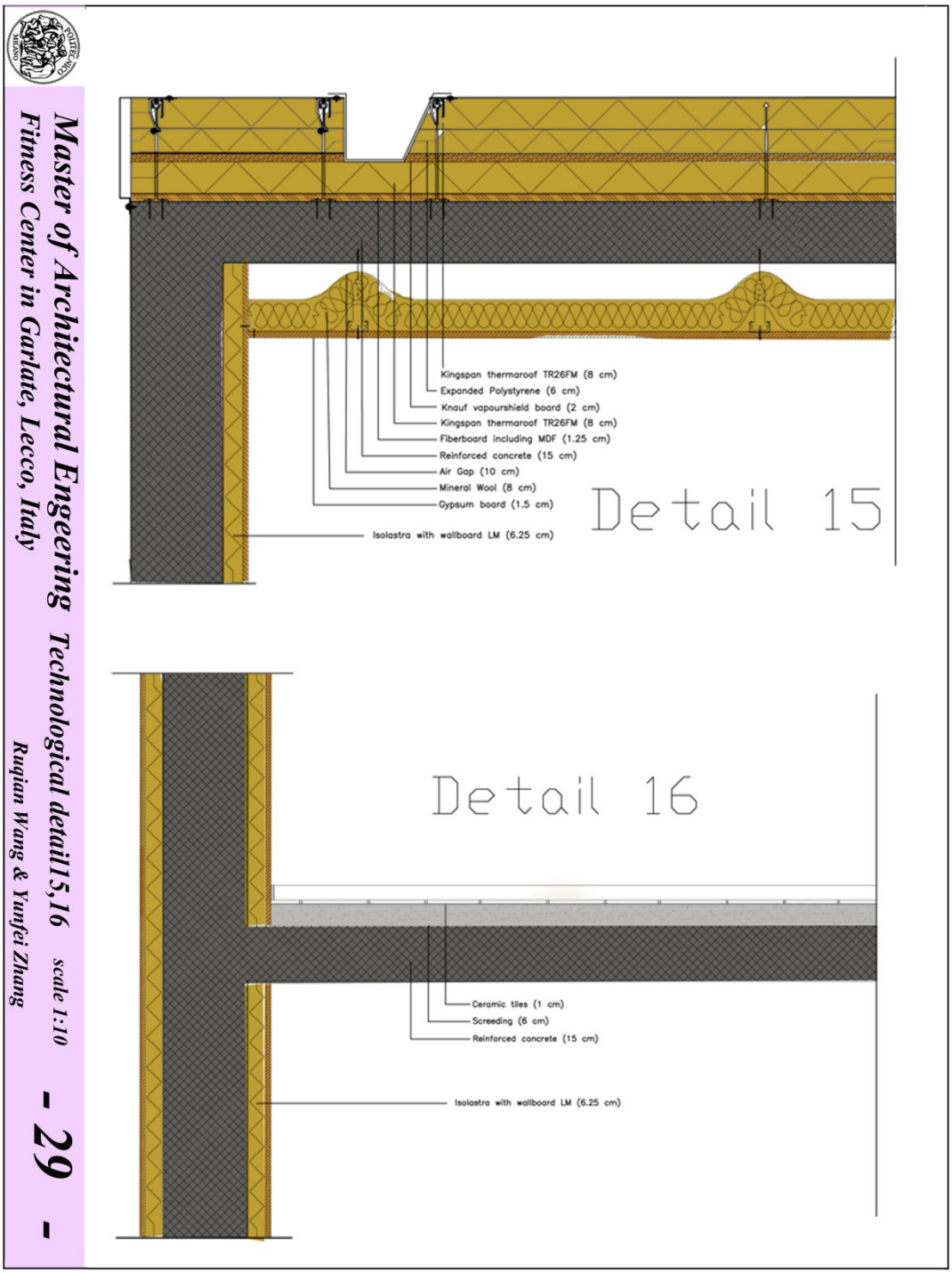
Knauf wallboard (1.25 cm)
Knauf vapourshield wallboard (1.25 cm)
Mineral Wool (7 cm)
Knauf wallboard (1.25 cm)
Knauf vapourshield wallboard (1.25 cm)
Detail 13
Knauf wallboard (1.25 cm)
Knauf wallboard (1.25 cm)
Mineral Wool (7 cm)
Air gap (6 cm)
Mineral Wool (7 cm)
Knauf wallboard (1.25 cm)
Knauf wallboard (1.25 cm)
Detail 14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Technological detail15,16
Fitness Center in Garlate, Lecco, Italy
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Ruqian Wang & Yunfei Zhang
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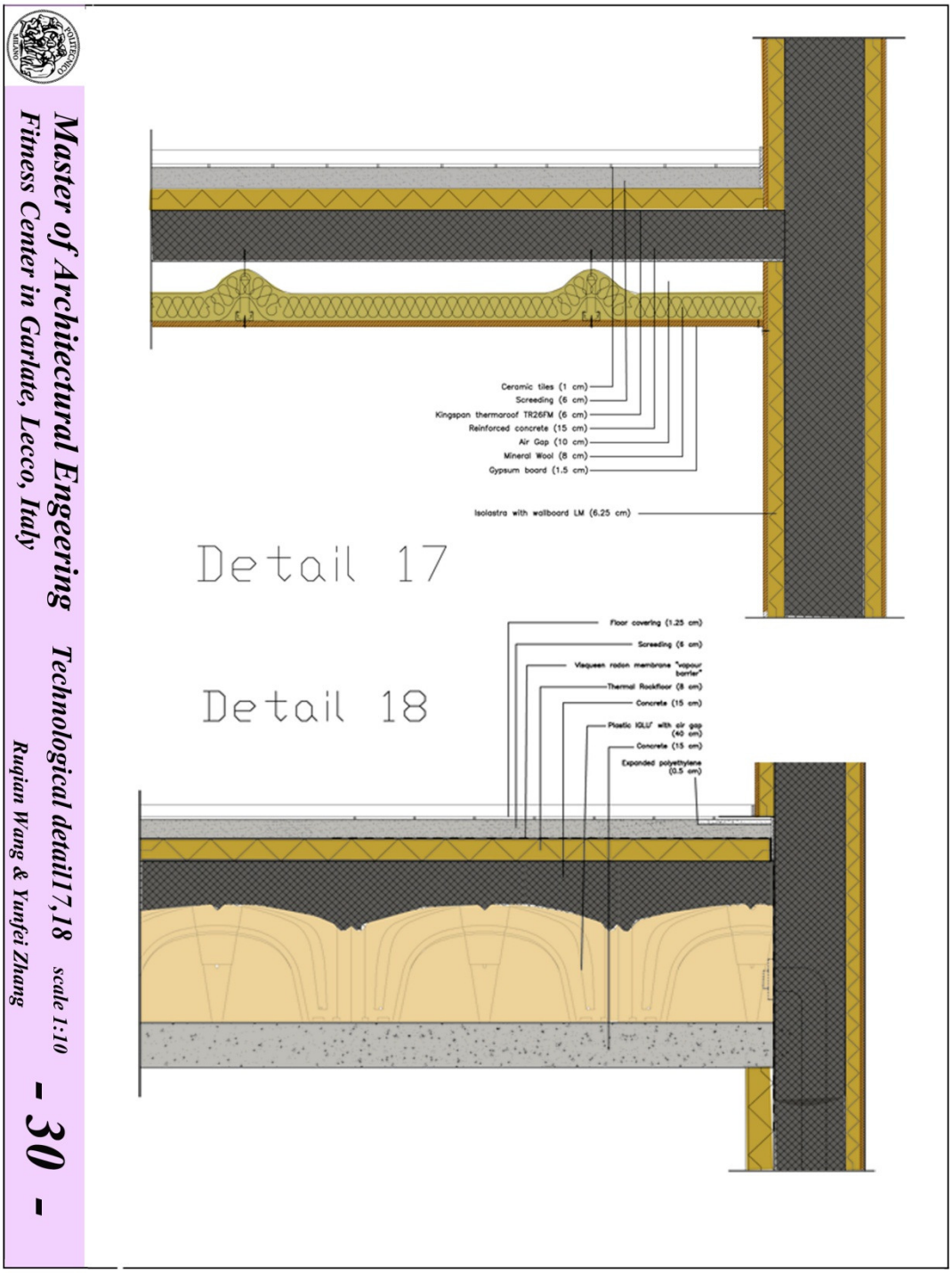
Kingspan thermaroof TR26FM (8 cm)
Expanded Polystyrene (6 cm)
Knauf vapourshield board (2 cm)
Kingspan thermaroof TR26FM (8 cm)
Fiberboard including MDF (1.25 cm)
Reinforced concrete (15 cm)
Air Gap (10 cm)
Mineral Wool (8 cm)
Gypsum board (1.5 cm)
Isolastra with wallboard LM (6.25 cm)
Detail 15
Detail 16
Ceramic tiles (1 cm)
Screeding (6 cm)
Reinforced concrete (15 cm)
Isolastra with wallboard LM (6.25 cm)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Technological detail17,18
scale 1:10
Ruqian Wang & Yunfei Zhang
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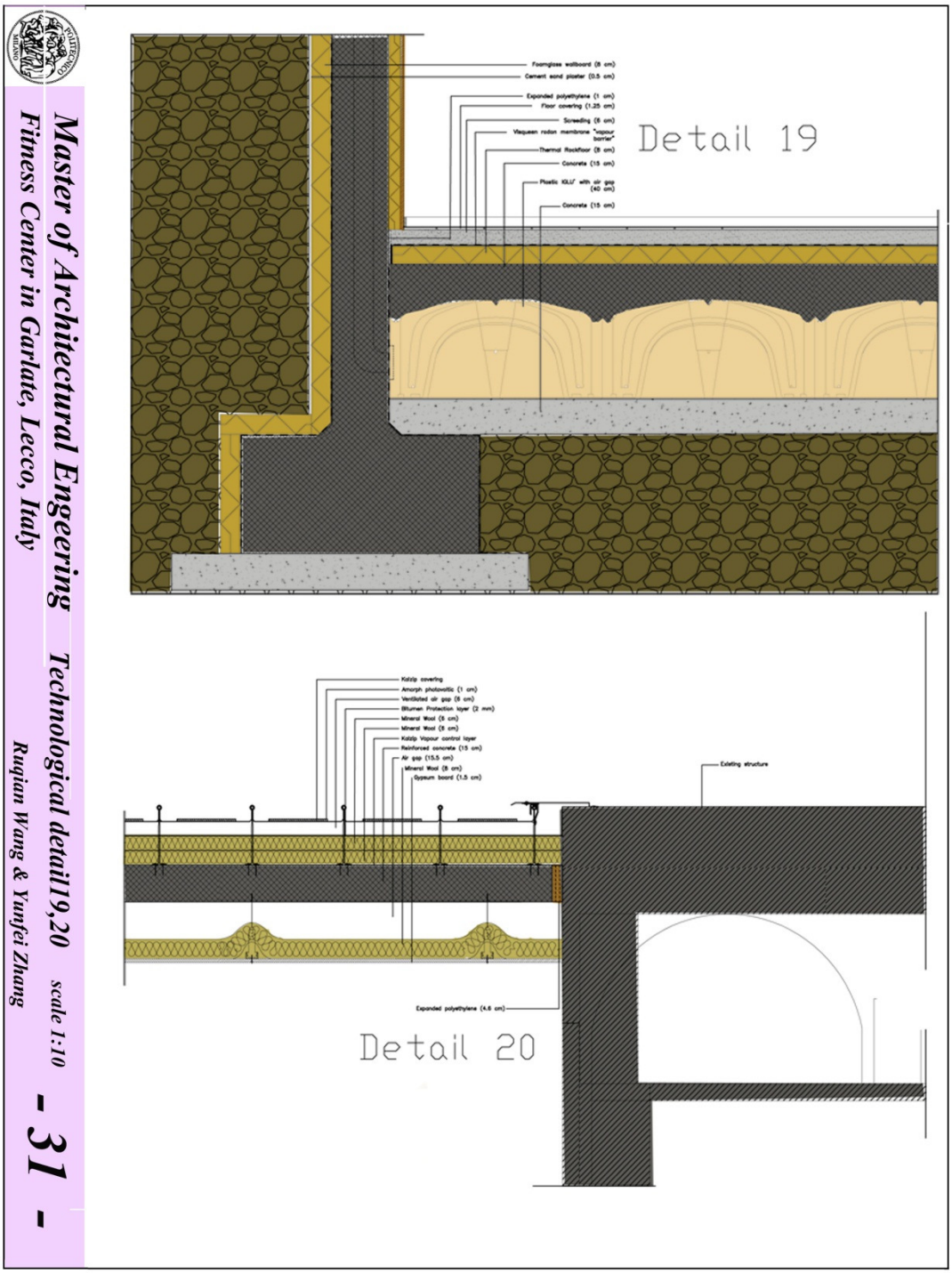
Ceramic tiles (1 cm)
Screeding (6 cm)
Kingspan thermaroof TR26FM (6 cm)
Reinforced concrete (15 cm)
Air Gap (10 cm)
Mineral Wool (8 cm)
Gypsum board (1.5 cm)
Isolastra with wallboard LM (6.25 cm)
Detail 17
Floor covering (1.25 cm)
Screeding (6 cm)
Vlaqueen radon membrane "vapour barrier"
Thermal Rockfloor (8 cm)
Concrete (15 cm)
Plastic IGLU' with air gap (40 cm)
Concrete (15 cm)
Expanded polyethylene (0.5 cm)
Detail 18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Technological detail19,20
Fitness Center in Garlate, Lecco, Italy
scale 1:10
Ruqian Wang & Yunfei Zhang
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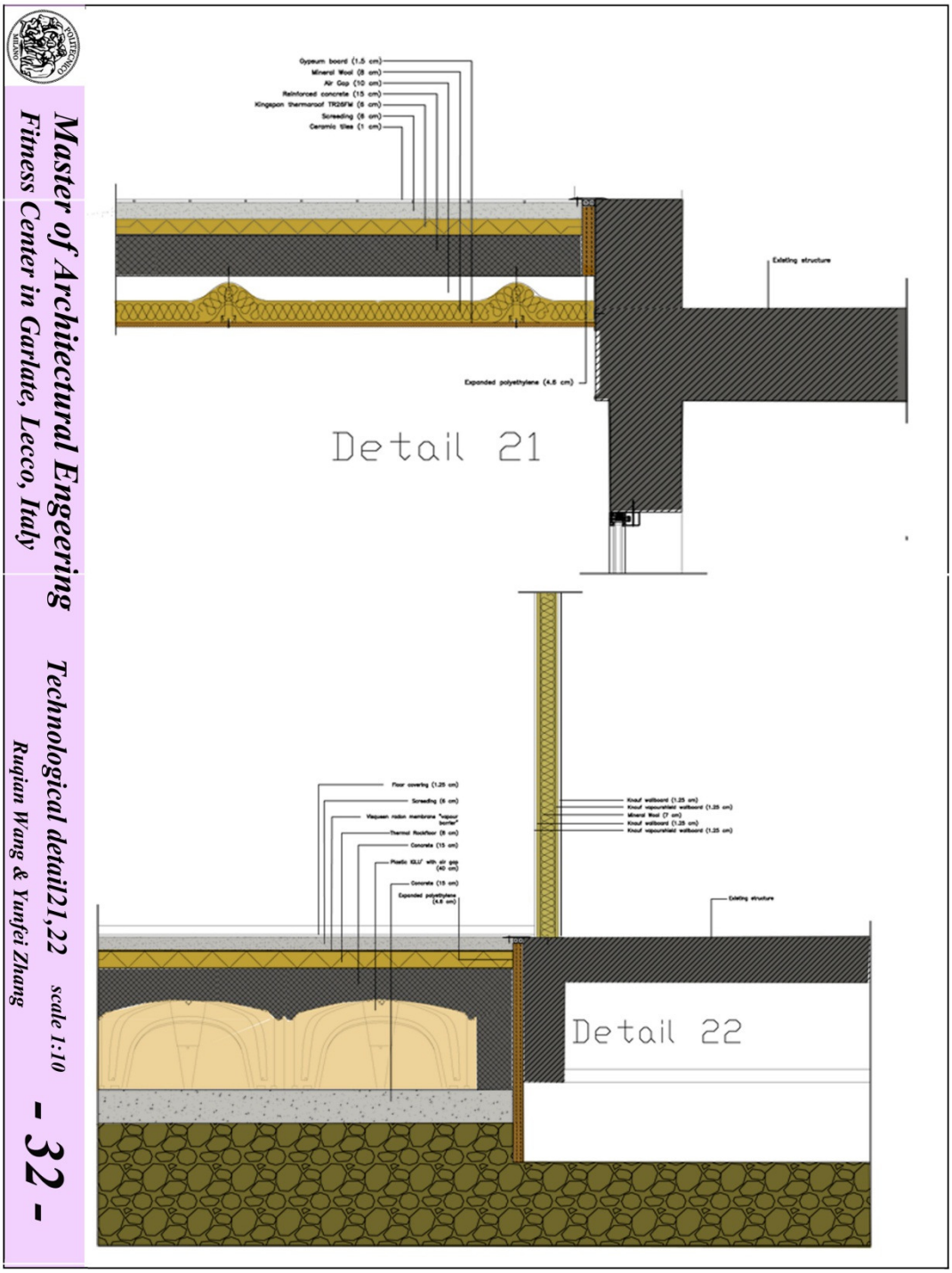
Foamglass wallboard (8 cm)
Cement sand plaster (0.5 cm)
Expanded polyethylene (1 cm)
Floor covering (1.25 cm)
Screeding (8 cm)
Vlaqueen radon membrane "vapour barrier"
Thermal Rockfloor (8 cm)
Concrete (15 cm)
Plastic Klili' with air gap (40 cm)
Concrete (15 cm)
Detail 19
Existing structure
Expanded polyethylene (4.8 cm)
Detail 20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Technological detail21,22
scale 1:10
Ruqian Wang & Yunfei Zhang
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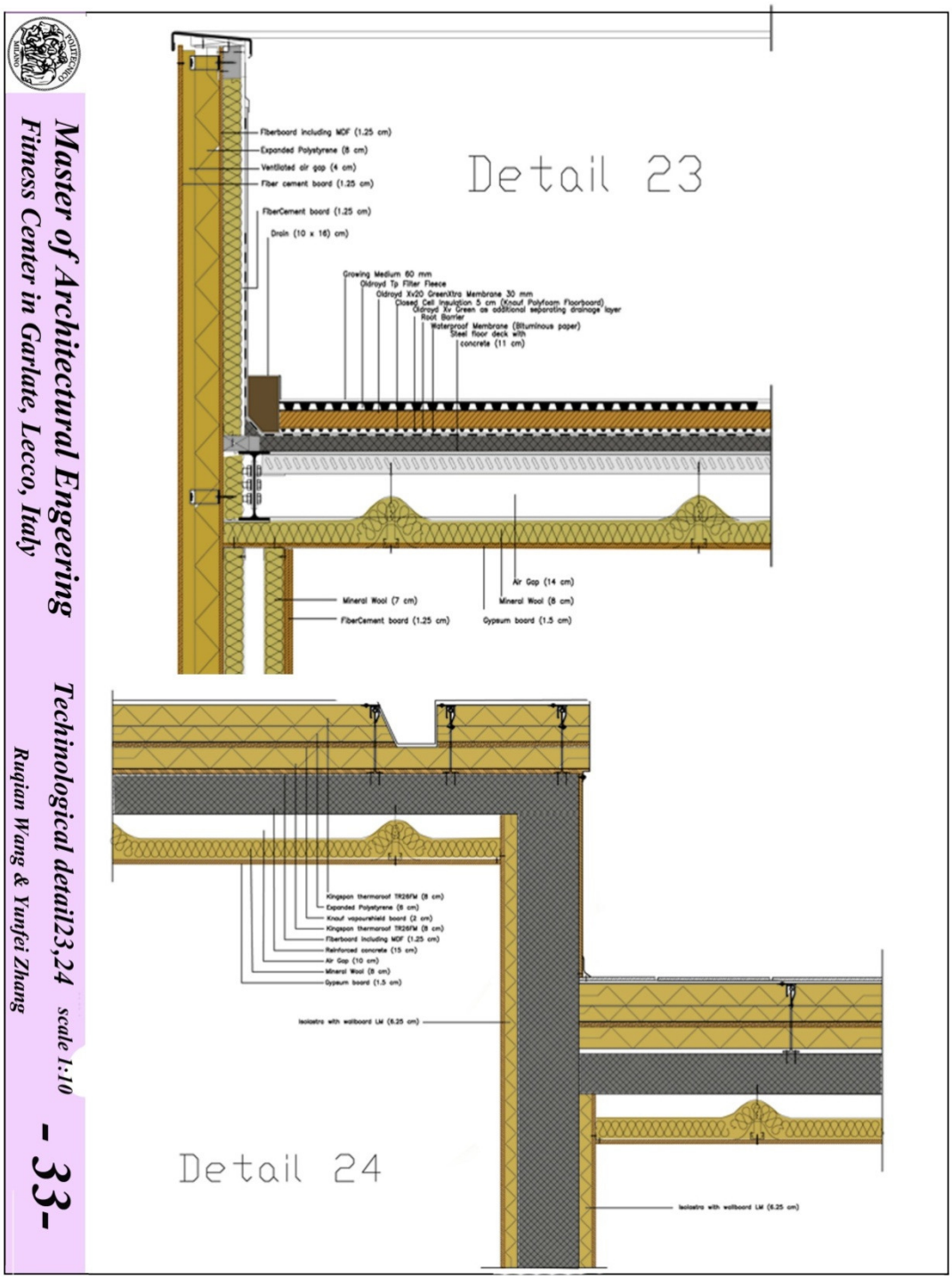
Gypsum board (1.5 cm)
Mineral Wool (8 cm)
Air Gap (10 cm)
Reinforced concrete (15 cm)
Kingspan thermaroof TR26FM (6 cm)
Screeding (6 cm)
Ceramic tiles (1 cm)
Existing structure
Expanded polyethylene (4.6 cm)
Detail 21
Floor covering (1.25 cm)
Screeding (6 cm)
Vapour barrier
Thermal Rockfloor (8 cm)
Concrete (15 cm)
Concrete (15 cm)
Knauf wallboard (1.25 cm)
Knauf vapourisked wallboard (1.25 cm)
Mineral Wool (7 cm)
Knauf wallboard (1.25 cm)
Knauf vapourisked wallboard (1.25 cm)
Existing structure
Detail 22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Fitness Center in Garlate, Lecco, Italy
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scale 1:10
Ruqian Wang & Yunfei Zhang
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Detail 23
Fiberboard including WDF (1.25 cm)
Expanded Polystyrene (8 cm)
Ventilated air gap (4 cm)
Fiber cement board (1.25 cm)
FiberCement board (1.25 cm)
Drain (10 x 16) cm)
Growing Medium 60 mm
Oldroyd Tp Filter Fleece
Oldroyd Xv20 GreenXtra Membrane 30 mm
Closed Cell Insulation 5 cm (Knauf Polyfoam Floorboard)
Oldroyd Xv Green as additional separating drainage layer
Root Barrier
Waterproof Membrane (Bituminous paper)
Steel floor deck with
concrete (11 cm)
Air Gap (14 cm)
Mineral Wool (8 cm)
Gypsum board (1.5 cm)
Mineral Wool (7 cm)
FiberCement board (1.25 cm)
Kingspan thermaroof TR26FM (8 cm)
Expanded Polystyrene (8 cm)
Knauf vapourshield board (2 cm)
Kingspan thermaroof TR26FM (8 cm)
Fiberboard including WDF (1.25 cm)
Reinforced concrete (15 cm)
Air Gap (10 cm)
Mineral Wool (8 cm)
Gypsum board (1.5 cm)
Isolastro with wallboard LM (6.25 cm)
Detail 24
Isolastro with wallboard LM (6.25 cm)

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