# PUNTI F.I.S.S.I.

OF LIFE AND CULTURE "promote urban and environmental quality and social and operational mix"

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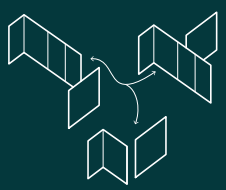

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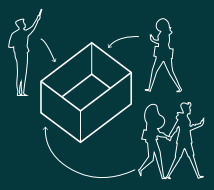

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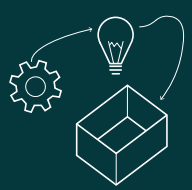

POLITECNICO MILANO 1863

SCHOOL OF ARCHITECTURE URBAN PLANNING CONSTRUCTION ENGINEERING

Master of science in Building and Architectural Engineering

# PUNTI **FISSI** of life and culture

"promote urban and environmental quality and social and operational mix"

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Francieri Roberto

Polo Territoriale di Lecco - Academic year 2021/2022

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*I would like to firstly, deeply, thank my supervisor Francieri Roberto, for his patience and kindness, for his teachings and advice.*

*Every situation is a good chance to learn something new or to correct your mistakes and like once, Ali Güney Özcebe told me, at the end of a course, the exam is the last chance to do it. I would like to thank him, for his helpful, "last-minute" suggestions and assistance, and his and the professor passion during the seismic design course.*

*A special thank goes to a friend, who helped me during my entire university career, Ing. Francesco, who I can finally stop bother for clarifications concerning the structural courses.*

*I finally want to thank all the passionate professors I met during my entire career, both in the Architectural design course, in Milan and in Building Engineer master, in Lecco.*

*Marta*

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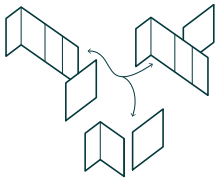

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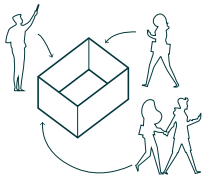

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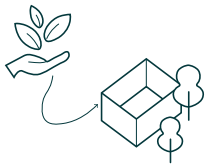

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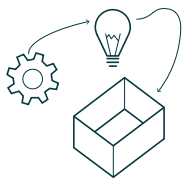


## GOALS AND METHODOLOGY

I live in a town called Busto Arsizio, not very far from Milan. In the last few years, I have noticed with pleasure how the municipality has committed itself to rescue long time abandoned and dismissed areas. These places have always been seen sites of decay and impediment, concerning accessibility and permeability. The, small or big, interventions promoted have been able to give the city a new face and making it a more pleasant place to live in.

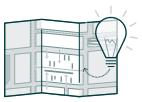
Another aspect I have considered in the last years of my university studies is climate change and consequently how to design sustainable buildings. I referred to the "Reinventing cities" competition to choose the intervention area. The announcement is intended to urban transformation proposals for underused sites, that can be innovative, resilient and zero emission, combining these characteristics with greater healthiness and liveability. This gave me the possibility to develop a project both from an aesthetic, functional point of view and from a technological one by exploiting my entire university career (architecture and engineering).

The thesis is developed in different step, each of them represents a usual design development phase:

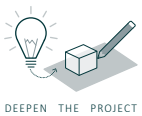


The first phase is divided in two chapters, which deal with the site location and site analysis: it can be called "cognitive phase"! The area, its threats and opportunities are studied, analysed and synthesized. Good analysis and comprehension of the data are important since they embody the baselines for the project design.


The third chapter shows and explains the idea, "the concept" of the project. In this phase it is necessary to find a general idea that, in the best way possible, represents the most important key points able to give life to the entire project area, along all its design phases, from the masterplan up to the details.




The general masterplan embodies the initial step of the design phase. The concept idea is transferred firslty in the project area, and modelled answering to the functions needs. So creating spcific shapes and spaces.




From chapter five, only one significative portion of the design area is developed. Deepen one portion means to include multiple buildings and functions that work together with the environment. This phase bigins with the definition of the architectural frame.

## "REINVENTING CITIES" COMPETITION

In the past years, the climate change phenomenon and its causes have been studied deeply. Therefore, a lot of associations were born by trying to act against climate change on several fronts. In 2005, the C40 cities network was created to deal with the built environment carbon emissions. In fact it represents 50% of the cities' urban total emissions and the construction materials are responsible for more than 30% of the global resources consumption. That involves the world's megacities committed to addressing climate change. The cities collaborate sharing knowledge to lead the way towards a healthier and more sustainable future. 14 years after from its creation in 2019, 96 cities were members of the C40 Cities Climate Leadership Group and they together achieved good results by applying restrictions on high-polluting vehicles, single-use vehicles, non-recyclable plastic and by implementing the use of electric buses and cycle hire schemes (from 21 in 2010 to 82). In addition to these buffer methods, the C40 Group noticed the necessity to prevent the building $CO_2$ emissions by reinventing the cities and protracting benefits in the future. This way "Reinventing cities, a global competition for innovative carbon-free resilient urban project" began.

*F.1 - C40 cities logo*

The competition tries to transform underutilized sites through sustainable and community-focused projects which could lead to a decarbonised and resilient urban regeneration. The participating cities continue to join new sites by giving them dynamicity and by catalysing a systemic change being them examples for the future. The supporter cities' mayors hope that the new development models for buildings, services and business can be integrated and adopted by society as they offer the possibility to a more ecological lifestyle.

*F.2 - reinventing cities logo*

The global competition encourages sustainable development and it celebrates innovative solutions which can be effective in projects through a wide range of architectural practices, typologies and uses, by designing today the city of tomorrow. The projects submitted to the competition must demonstrate it is possible to obtain good environmental performances still having high-quality architecture and good benefits to the inhabitants.

It is possible to imagine that to satisfy the request (i.e. to achive a zero-carbon project) it is necessary to combine solutions that should be taken by considering the site, its configuration and


*F.3 - 10 key challengies categories for the participating teams*

surroundings. According to the competition, the key challenges to carry out a carbon-free project are 10 and 2 of them are mandatory. The goals are subdivided in 3 categories.


The first category concerns the carbon impact:

1. Energy efficiency and low carbon energy (mandatory task) means that the energy standards should be beyond the usual threshold and that the clean energy usage should produce a net zero energy or 'positive energy' status. Following the passivhause standards and so minimizing the energy consumption, paying attention to the design: shape optimization, in agreement with solar exposition and shadow, passive ventilation, reduction of thermal bridge and infiltration phenomena. Also, to the project is asked to reduce energy purchase from the outside, thanks to the use of renewable energy produced on site and stored in dedicated systems (such as batteries instead of generators powered by fossil fuels). That in case of surpluses will be sold to the network with benefits for the occupants who will be able to control, monitor and evaluate the energy consumption and production.
2. Life cycle assessment (LCA) and sustainable materials management (mandatory task), which means to reduce the embodied carbon of the project referred to the lifecycle greenhouse gas emission that occur during the whole life of the material. For this reason the project should prioritize building retrofits over demolishing old buildings and choose construction materials with lower emission from the extraction, manufacture, transportation and end of life phase. Reusing and recycling construction materials is also of great importance, as well as the modularity and flexibility in future uses and alterations.
3. Low carbon mobility, fostering sustainable mobility options, by facilitating and encouraging walking, cycling, public transport, shared vehicles and electric and other low-emission vehicles.


Projects need to address other key strategies beyond decarbonization in order to assist in the rapid transition towards a climate safe, prosperous and sustainable city.

4. Climate resilience and adaption. The project will include an evaluation on climate change and the site climate risks. The resilience concerns two aspects: building occupants resilience (such as tree planting or shaded area to protect residences from the heat island effect); building resilience (such as reinforced structure able to deal with climate risks, e.i. high wind).
5. Ecological services for the neighbourhood and 'green jobs', or rather, include new ecological services for the neighbourhood, helping to promote sustainable lifestyle and habits' consumption, to reduce the cities' environmental impact and to create 'green jobs' (like co-working, work spaces sharing and flexible and economical).
6. Sustainable water management, mostly to face the water shortage or droughts.
7. Sustainable waste management, regarding the operative phase of the project. Developing services, actions and tools that help decrease solid waste generation on the site, by fostering goods reparabil-

ity and recyclability and considering to implement source separated collection.

8. Biodiversity, urban re-vegetation and agriculture are systems that, if applied, can mitigate the climate risks and promote the environmental sustainability. The project should balance the planted areas and the permeable surfaces without and should include Green and Blue infrastructures[1] for the conservation of the urban biodiversity.

The bidding teams must propose projects that combine environmental performance and high-quality architecture, urban design and community benefits, demonstrating that compact and sustainable urban development come together with liveable, enjoyable and inclusive cities.

9. Inclusive actions, social benefits and community engagement.
10. Innovative architecture and urban design. As already mentioned, the project has to balance good environmental performances with high quality architecture and urban design, taking into account the space, the building shape design, the material choices, the use of natural lights and artistic elements.

This year, in the second edition of the competition, 9 cities are involved with 25 new sites: Cape Town, Chicago, Dubai, Madrid, Milano, Montreal, Reykjavik, Roma and Singapore.


*F.4 - ReinventingCities 2020 map*

1 The U.S. E.P.A. (US Environmental Protection Agency) provides the following definition: «The concept of green infrastructure describes a category of artifacts, technologies and practices that use natural systems- or artificial ones that simulate natural processes - with the aim of improving the general environmental quality and provide public utility services. In general, green infrastructures use soil and vegetation for the infiltration, evapotranspiration and / or recycling of rainwater. When used as components of rainwater management systems Green infrastructure, such as green roofs, permeable pavements, rain gardens, and green trenches can provide a variety of environmental benefits. In addition to allowing rainwater sedimentation and infiltration, these technologies can simultaneously help to break down pollutants atmospheric conditions, reduce energy demand, mitigate the island effect of urban heat and retaining carbon monoxide, while offering communities aesthetic benefits and green spaces». By blue infrastructure, on the other hand, we generally mean road infrastructures based on waterways and canals suitable for navigation or to connect in some way anthropogenic activities that depend on water. (From *URBANISTICA INFORMAZIONI special issue*)

Milano is participating with 7 sites: the “Ex Macello” site, situated in the south-east district of the city, between Porta Vittoria station and Milan wholesale market. Connected to it, on one side, there is the built site of Palazzine Liberty. “Scalo Lambrate” site, in the eastern area of the city, near the university campus and between the historical districts of Lambrate and Ortica. Crescenzago, a free parking area for the homonymous underground line 2 station, located in the north-east side. “Monti Sabini” site is an unbuilt-up site in the Vigentino district. “Nodo Bovisa” site which includes the Milano Nord Bovisa Politecnico station. Piazzale Loreto is near the Central station, in one of the most accessible areas of the city.

I found the Ex Macello site very interesting in different aspects: the location and some of the existing architectures, like the distinctive “Galleria”. In the following chapter the site is presented, with its historical evolution and context.


*F.5 - Ex Macello setting area*

## “REINVENTING CITIES” 2016 STUDY CASES

The following pages are going to present two of the winning projects for previous editions in Milan. Having the same climate, it is possible to evaluate the technologies applied for both, in relation to the use and the context.

The competition started in 2017, involving 4 sites spread in the city: Scalo di Greco, the historical building of Scuderie de Montel, a site on Viale Doria and a last one in Via Serio. In May 2019 the projects proclaimed winners foresee «a new sustainable and inclusive neighbourhood with greenery and houses for rent at the Greco airport, a spa theatre that recovers and re-functionalised the historic building of the Scuderie de Montel, a green building dedicated to cancer research in via Serio, an innovative hostel that houses also public functions in Viale Doria» (Comune di Milano | 29/05/2019).

The two projects I analyse in detail are the of Vitae, for the via Serio site, and l'Innesto at the Scalo di Greco.

## 1. VITAE, MILANO | SERIO

*F.6 - VITAE project 3D view*

Developed by COVIVIO Development, Carlo Ratti Associati, Habitech, Vitae is located in the south of Milan, just outside the external ring road, near Viale Isonzo. And so few minutes from the Scalo di Porta Romana, Fondazione Prada, the Park of Industrial Memories and, along Roggia Vettabbia.

The site is similar to the Ex Macello one due to its strategical location and role, between two areas with specific cultural, economical and residential identities.

To understand what Vitae is and where it comes from, the designers words are surely the most explanatory: «The embrace of DNA is the symbol chosen by the Vitae project because the concept of sharing and participation is intrinsic to it. The two founding principles of the project that embrace each other are Biophilia and Research». (Vitae | Relazione tecnico descrittiva)

The complex is composed at the ground floor by a piazza, communicating with "Horto" (an innovative sustainable restaurant), at the first floors are positioned the offices under constant comfort control which makes the environment always welcoming. At the fourth and fifth floor there are the laboratories for cancer research. At the top floors are positioned the guesthouses for researchers. The entire roof is a green pedestrian path which become a point of interest for all the neighbourhood. The creation of this green infrastructure links together the natural implants located in that part of the city.

## 1.1 HOW IT WORKS

### *"BIOFILIA"*

The natural elements are constantly merged with the functional spaces and nothing is left to chance. A lot of attention is given to the wellness and the community, creating health paths and sport or heathy food facilities. Also the offices are linked with the natural paths giving an emotional as well as physical well-being. To create this, the biodiversity is studied and designed deeply.

### *RESEARCH AND TECHNOLOGY*

Particularly interesting are the systems used for the façade and the structure, supporting the complex design. The façade is covered by a casing able to adapt itself to the different daily and annual solar expositions. Specifically it has been created a fixed modular system able to combine different transparent/opaque elements together depending from the needs.

Concerning the structure, the designers studied a hybrid system which combines the benefits of two material: reinforced concrete and wood. The first floors are in concrete, the others are all in wood, able to reduce the energy consumption during its production process.

## 1.2 KEY CHALLENGES RESPONSE

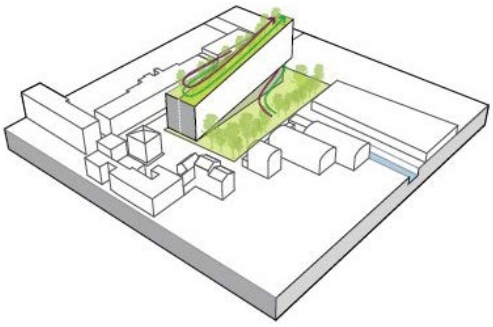
The project satisfies all the 10 competition challenges. The aspects immediately visible are the ones regarding the biodiversity and the architecture and social impact. The vegetation is luxuriant in the project, creating a good mix between the species, ecological corridors and a sensibilization campaign able to teach the community and the next generations.

The resilient design is evident from the creation of green infrastructures: green roofs, vegetable gardens

## 1.*figure* VITAE SITE AND PROJECT IDEA

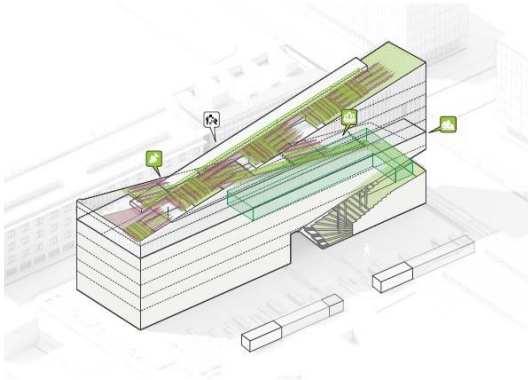

*F.7 - Vitae site context*


*F.8 - Vitae concept*

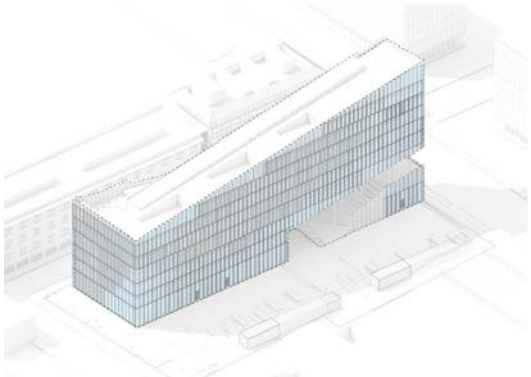


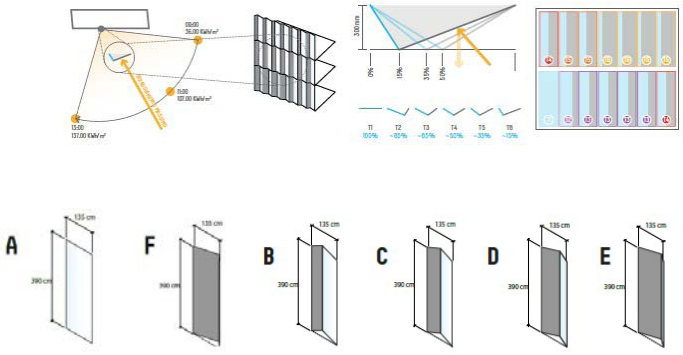
*F.9 - Vitae shape*

## 1.1 *figure* HOW VITAE WORKS




*F.10 - Vitae biodiversity*



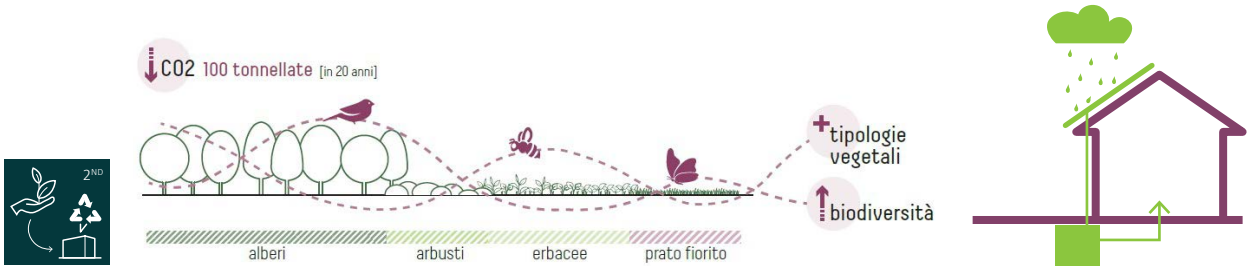



*F.11 - Vitae facade*

*F.12 - Vitae structure*

## *1.2 figure* VITAE KEY CHALLENGES RESPONSE


*F.13 - Carbon impact - Site energy production and LC analysis and thinking*



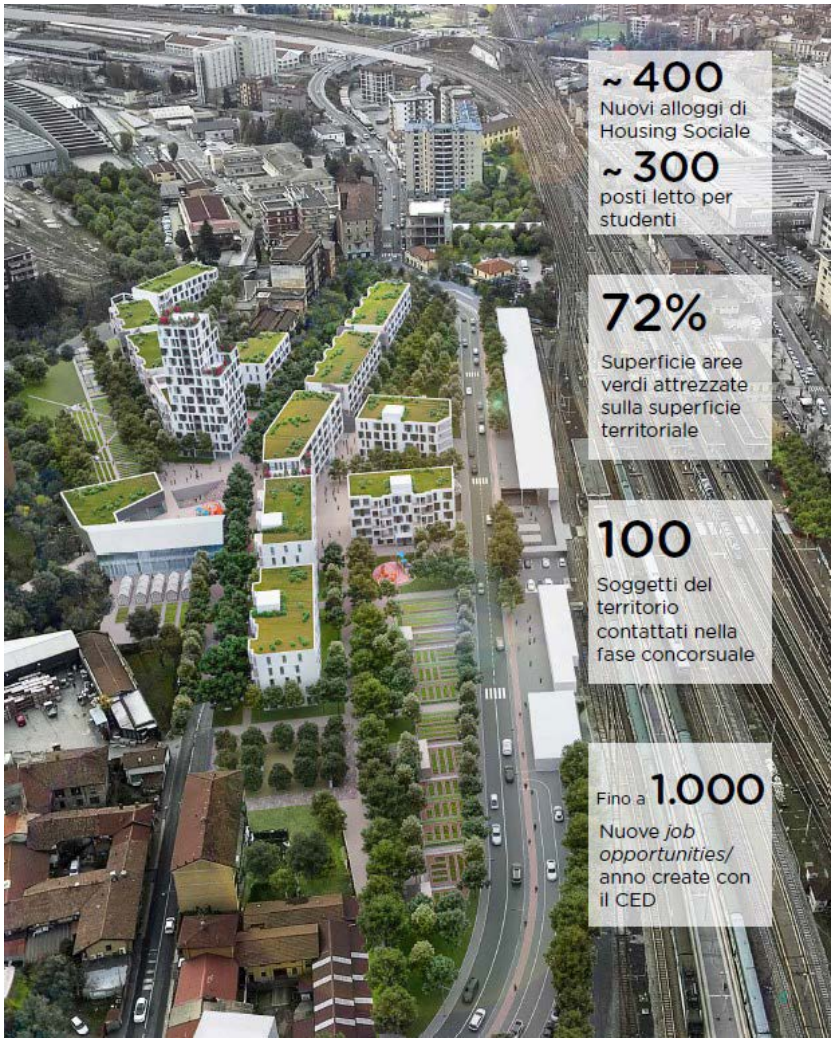

*F.14 - Resilience and sustainability - Biodiversity and water management schemes*


*F.15 - Architecture and Social impact - schematic 3D site views*

and parks, even if they are not the only contributing elements. Water is a precious commodity and therefore must be preserved, which is why the project includes a rainwater use system and reuse of grey water with proper filtering, for a sustainable use of the resources.

The limitation of the $CO_2$ emissions and the use of sustainable materials are probably the less visible but maybe the most important goals. Considering that all the design choices contribute reaching the challenges acquittal, here the adopted strategies are the use of renewable energy produced on and off site and of sustainable materials. Together with a deep Life Cycle Analysis, the strategy adopted is the one to use local and certified products. Right from the design phase is established the waste management plan for the building end of life.

## 2. L'INNESTO, MILANO | SCALO GRECO BREDA




*F.16 - L'INNESTO 3D project view*

Investitori SGR S.p.a. present a complex project for "Scalo Greco Breda", in the Segnanino district. The designers' team is composed of Baracca & La Varra, Arup Italia S.r.l., Wolf visualizing architecture and others, but to ensure the success of the project, many public and private actors have been involved too: Politecnico of Milan, Cariplo factory, Delta ecopolis, and not only.

Not an easy junction is the railway station of Greco-Breda. A tricky task is to try to sew up something constantly divided by the rails, as it was for the Ex Macello site. In these cases, the connection between great entities seems to take the first place at the expense of urban well-being and the functionality of the area. Greco-Breda is

located in the north-east side of Milan, between important social and cultural centres: Bicocca, Precotto and the University, few steps from the station. Therefore the Innesto firstly aims to connect these entities both creating pedestrian paths and corridors connecting the existing green spaces.

The site is thus similar to the Ex Macello one due to its railway component and for the plot area, as well as for the type of uses settled as from the project.

Also here I want to use the words of the designers, to describe the project idea: «L'INNESTO of a design idea based on a new way of conceiving the place and living. (...) a project that focuses on the people who live there and live it.» Innesto, from the Latin, has a twofold meaning: « the insertion of a new element in an existing and heterogeneous environment, generally to create a link, a connection; in the world of botany it indicates the procedure by which a graft of another plant is inserted on an existing plant to increase the plant's ability to produce fruit, improving its quality». (L'Innesto | Relazione tecnico descrittiva)

The desire to integrate and enhance the surrounding is translated into the first social housing zero carbon in Italy: collaborative complex, with an important agricultural component and the involvement and empowerment of the community in a sustainable use of the sources.

### 2.1 HOW IT WORKS

The project aims to solve 3 main goals: zero $CO_2$ emissions; the integrated management of the entire development, from design to implementation and management over its life cycle over a period of 30 years; community involvement in the life of the complex.

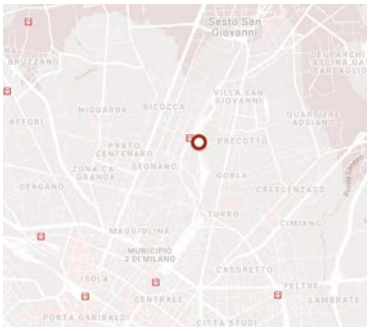
The implant is composed by residential buildings and green and agricultural spaces for the community. They are supported by management functions like the energy centre or the zero waste food store. But also some facilities supporting the surrounding, as the residences for the university.

### 2.2 KEY CHALLENGES RESPONSE

The project satisfies all the 10 competition challenges. In first category, regarding the energy consumption and the carbon impact, the strategies are to reduce the energy consumption, optimize the sources and neutralize the carbon emissions. To do that, the designers planned to exploit all the sources available, from the solar radiation to the heat recovery.

Similarly to the previous project the Innesto uses natural, local, recycled and certified material, after an appropriate study of their Life Cycle Assessment. The low material impact is important as well as an industrialized, dry construction system. The designers introduced in addition a separate waste collection system monitoring the inhabitants' waste production during the buildings life.

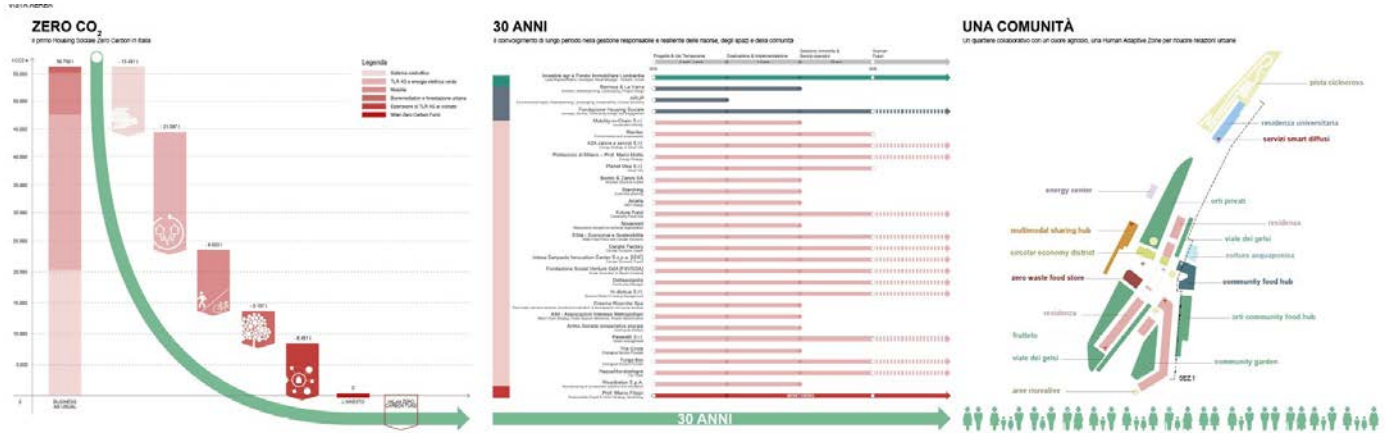
## 2. figure L'INNESTO SITE AND PROJECT IDEA




F.17 - L'Innesto locatio

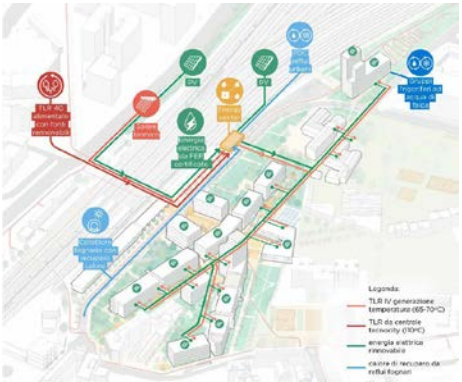
F.18 - L'Innesto, project idea and masterplan generation

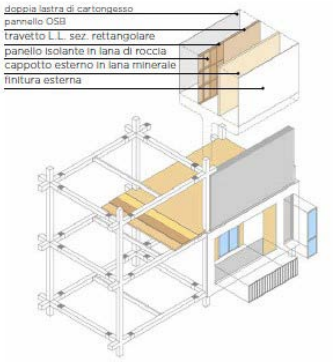
## 2.1 figure HOW THE INNESTO WORKS




F.19 - The Innesto goals and urban implant

## 2.2 figure INNESTO KEY CHALLENGES RESPONSE





F.20 - Carbon impact - Site energy and construction management and materials

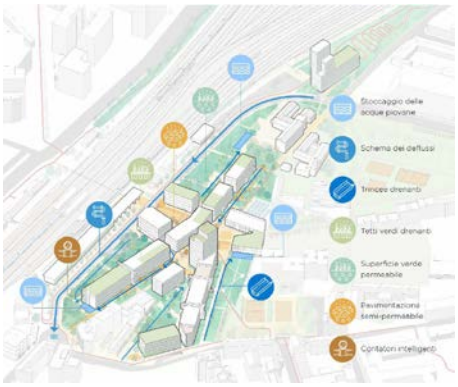
The resilience and adaptation issue is solved by the acquittal of the flooding phenomenon and a 50% increment of the shaded green public areas to reduce the heat island effect and to increase the greenery ratio per capita.

Other sustainable strategies concern the introduction of ecological services, the smart green growth, the sustainable water management, by the implementation of the draining surfaces, rainwater collection systems and other technological instruments.

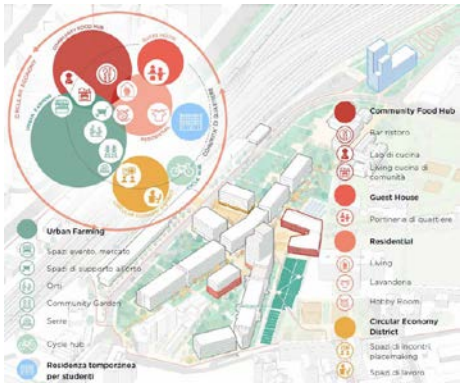
In my opinion, a health and pleasant place is rich of different green spaces and vegetation as it is this project. Besides a good appearance the functional aspects regards mostly the mitigation of the CO2 emissions and presence of pollutant in the city.

A place designed to receive people, like it is, creates benefit not only for the inhabitants but also for the surrounding community, which feels included and attracted by this innovative project.






*F.21 - Resilience and sustainability - Resilience, adaptation and water management schemes*

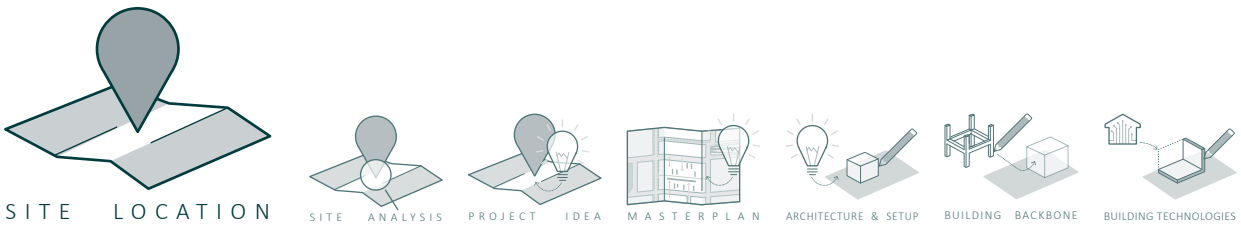




*F.22 - Architecture and Social impact - schematic implant and 3D site views*

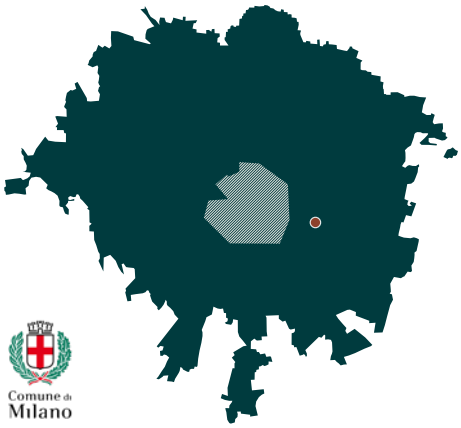
CHAPTER 1

# Ex Macello site

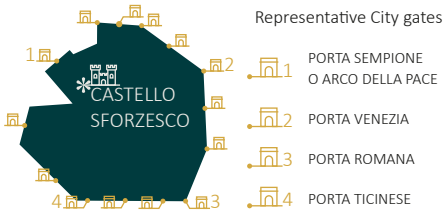
## project area presentation



## 1. THE SITE LOCATION




*F.1.1 - Ex Macello site location in Milan*

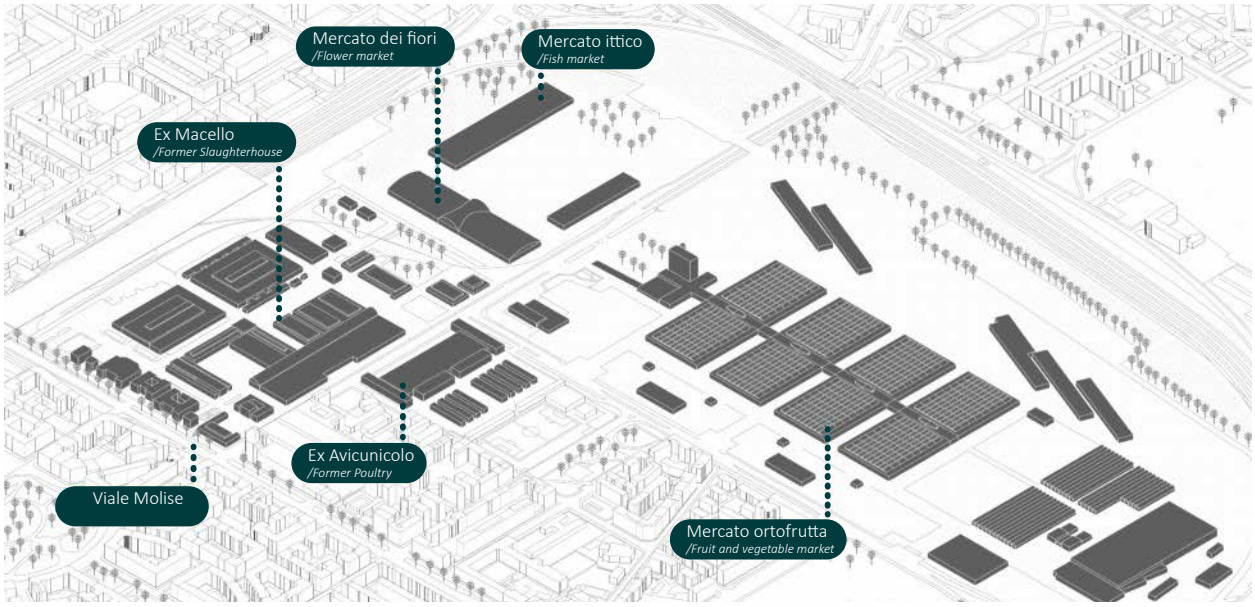



*F.1.2 - "La Grande città di Milano" area with city gates*

The 150thousand m$^2$ disused area of the "ex Macello" is in the 4$^{th}$ Milano district. Historically, it is the site of the town slaughterhouse and the poultry and rabbit market in the real estate compendium of the Milan wholesale market. The 4$^{th}$ district of Calvairate is situated in the south-east side of the city, and the ex Macello is located near Porta Vittoria station. It allows fast access to Porta Nuova and Repubblica business centres, as well as Rogoredo station, served by the high-speed trains, and to Viale Forlanini, linked to Linate International Airport.

The presence of the "Magazzini Generali" (store houses) estate, next to the project area is an important matter. Firstly, for its dimensions, since the built volume scale, composing the whole estate, is utterly different from the surroundings. Therefore, the accessibility and permeability of the area are dissimilar too.

In the second chapter, we see in detail all the functions characterising the surroundings of the site, since now it is possible to distinguish 4 macro zones around it. If on the right side we have a commercial complex, on the opposite one, along Viale Molise,



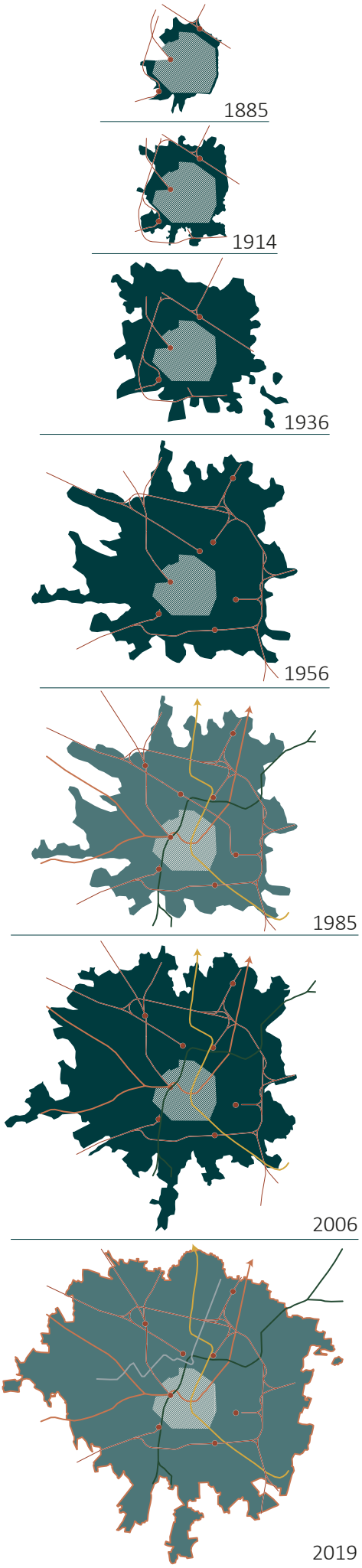

*F.1.3 - Ex Macelli site with pricipal sorrounding references scheme*

the area is dense of residences. The south side is characterized by the presence of multiple functions, including some facilities for the community. Looking at the north side, finally, the Ex Macello borders on a vast green area which is abandoned and non-accessible and which could be reorganized in a green public space equipped with sports facilities.

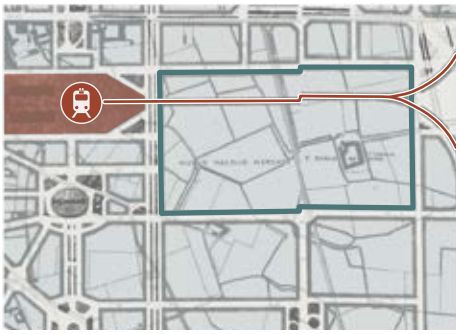
## 2. THE HISTORICAL DEVELOPMENT

Like already mentioned the Ex Macello is located near Porta Vittoria station but at the beginning it was part of it. In the history of Milan, the stations and railway networks had a crucial importance in its development. As we can see from the pictures, Milano started to grow up fast around 1885 with the first railway lines. The city's expansion took place especially towards the north, following a plan that considered the existing historical development. The designer wanted to preserve the hybrid reality of Milan where coexists industries and residences and allow the movement between the sides of the city centre without a burden on it. So, these ring roads gave life to the spider web arrangement that could expand outwards as needed.

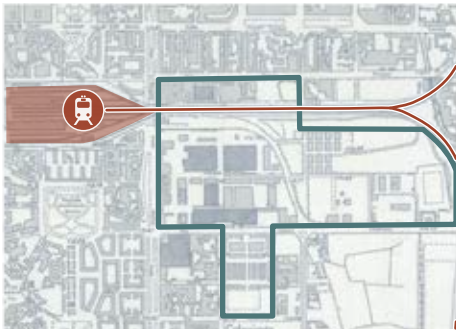
Besides the railway stations, another important link with the city has been Linate Airport to the right side of Milan, as we can see in the figure referred to the year 1936. In 1956 we can see the presence of Porta Vittoria station, later connected with Garibaldi station and in the same period, around 1985 the existence of the first 3 underground lines supporting the urban circulation. At the beginning of the 2000, Porta Vittoria station had already lost its importance, remaining more isolated in respect to the northern stations.



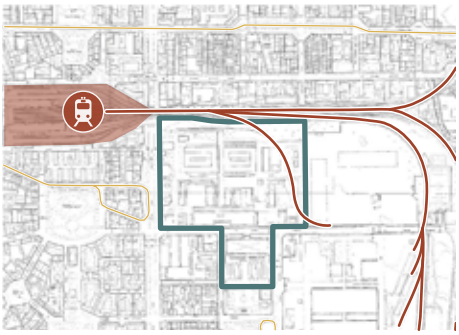

*F.1.4 - Urban historical analysis*



1910 First urbanization plan for Calvairate zone

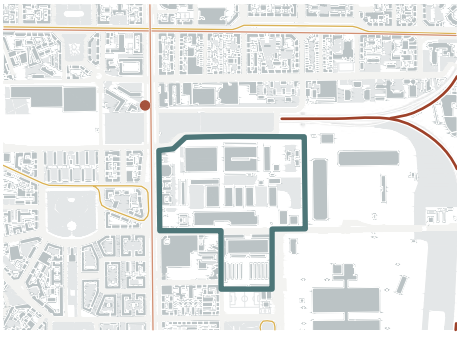


1956 Major expansion of the “Macello”



1990 General markets next to the “Macello”

2006 Slaughterhouse dismission



2019 Requalification of the ex Porta Vittoria railways area

Between 1912 and 1914, the Municipality of Milan studied an expansion project for the city, which included the town slaughterhouse. An area of 300thousands $m^2$ was chosen, located near Porta Vittoria station and the fruit and vegetable market. The freight high-speed railway station was inaugurated in 1911, exactly behind the market. The idea of the designers was to create a real ‘food city’ in the heart of Milan, composed by the fruit and vegetable market, the fish and poultry market, the slaughterhouse and “frigoriferi milanesi” were established in the surrounding area in the following time.

In the specific case of the “Macello”, between 1912 and 1924, zones dedicated to each phase of the slaughter, together with the canteens and spaces for the workers, were built.

Around the mid-1900s all the complex had reached its maximum size as well as Porta Vittoria railways. In the 1990s the plan for the disposal of the slaughterhouse area and Porta Vittoria station were approved, up to the total disposal in 2005. After that, the General Markets were implemented as far as the dimensions thay have nowadays and the area of the railways has been covered. So, the new 2004’s urban Porta Vittoria station became subterranean.

From the covering of the railways, a considerable new empty area divides Calvairate district into two parts. Now in a part of it there are new buildings, residences and facilities for the community. But a vast area is still desolate, abandoned and non-accessible to people.

*F.1.5 - Local historical analysis*

LEGEND

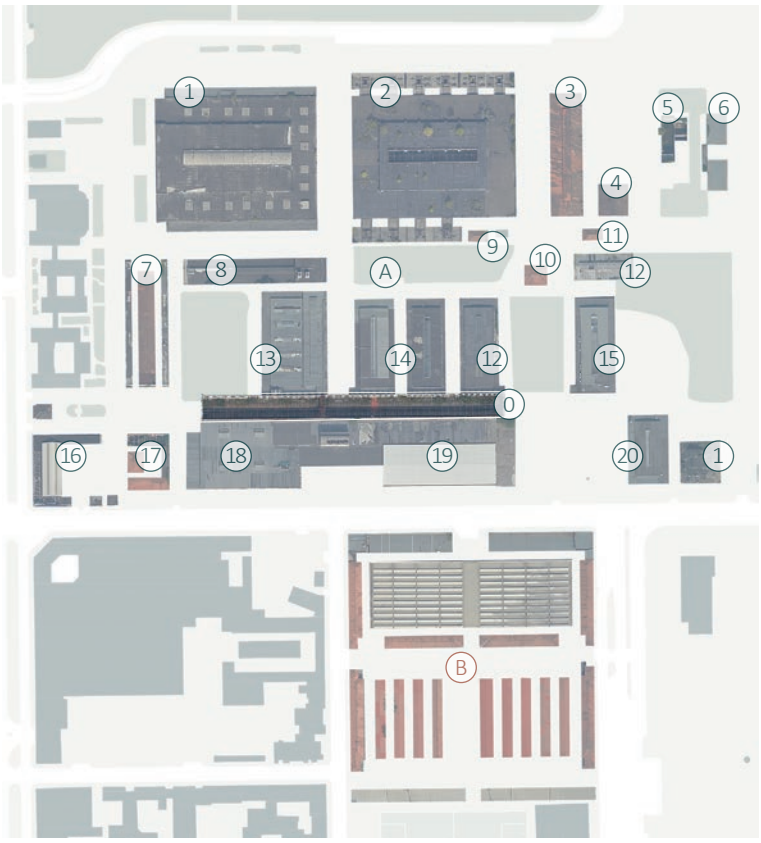
- Macello area
- Station area
- Railway station
- Underground station
- Railway
- Tram line
- Bus line

## 3. THE “EX MACELLO”

We saw the context and the historical developments which interested the birth and the growth of the Macello, now let’s consider how it looks like nowadays and which buildings are part of it. Currently, the Macello is identified as two big areas, one for the poultry and rabbit market (Mercato Avicunicolo) and one for the meat market and public slaughterhouse. They both face Via Cesare Lombroso (which is a large street not very busy) and they are lined with the fruit and vegetable markets and the flower one.

The “Mercato Avicunicolo”, the smaller one, is mostly constituted by warehouses and houses probably for workers, and a large exposition pavilion. On the other side of the street, there is the “Macello”, with an urban plan composition less rigorous and linear than the previous one but also much bigger. Along the streets are the meat market, the refrigerator rooms and some offices; towards the inland, there are instead the slaughtering and tripe departments. These functions are distributed along the “Galleria” building, which connects them. On Via Azzurri d’Italia side are faced the storerooms, the parking area and the stables.

There is no detailed information about the state of decay of the structures but most of the buildings are now unusable and dangerous, as they have been abandoned for almost 30 years. Wild vegetation has




A. MEATS MARKET BUILDINGS
0. “Galleria”
1. Car storage
2. Storage
3. Pre-slaughter stalls
4. Fodder
5. Waste water treatment plant
6. Vehicle washing
7. Maintenance workshop
8. Former cold rooms- former fish slaughterhouse
9. Offices and toilet
10. Booking building
11. Offices
12. Observations departments
13. Former tripperia department
14. Former slaughterhouses
15. Fish products warehouse
16. Former foreseen market
17. Former offices and storage
18. Meat market- cold rooms, section laboratories
19. Cold rooms
20. Commercial offices

B. POULTRY AND RABBIT MARKET BUILDINGS

*F.1.6 - Ex Macello buildings map*

grown and has covered most of the spaces, as it was to be expected.

*F.1.7 - Building 1 - Car storage*

*F.1.8 - Building 2 - Storage*

*F.1.9 - Building 3 - Pre-slaughter stalls*

*F.1.10 - Raised connection walkways*

*F.1.11 - Building 16 - former foreseen market*

*F.1.12 - Building 17 - Offices and storage*

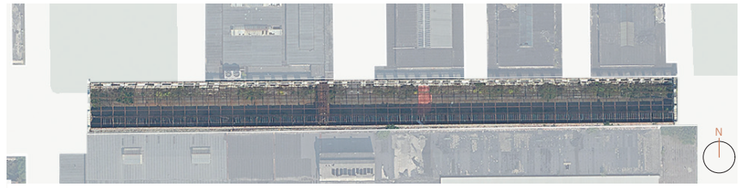
*F.1.13 - Building 19 - Cold rooms*

*F.1.14 - Building 0 - Galleria*

*F.1.15 - Building 0 - Galleria, internal space*

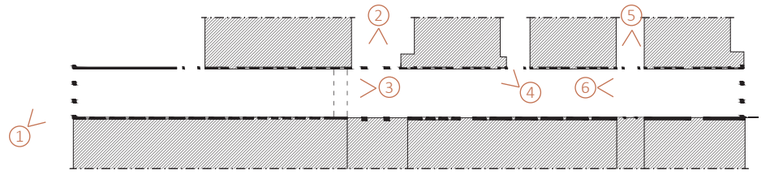
## 3.1 THE "GALLERIA"

The Galleria is a 200 m long corridor, built between functional buildings, linkikng them all together. The entrance portals on the east and west sides area are very visible and emblematic. These two elements are imponent and completely opened, they had probably an aesthetical function only and were not frequently used as entrances. In fact, the building is permeable, with numerous accesses and openings in the longways. To date, there is no roof covering, even if a metal beam structure sets a precise rhythm for the entire nave.




Setting


Context




Existing site views

View 1

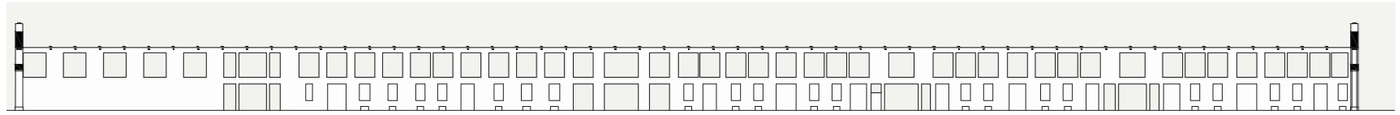
View 2

View 3

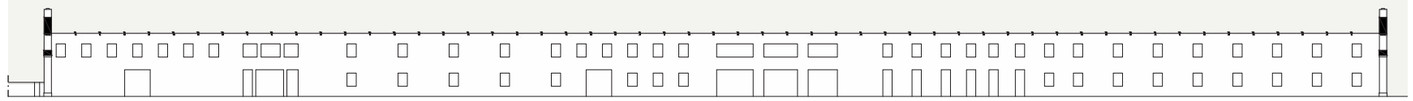
View 4

View 5

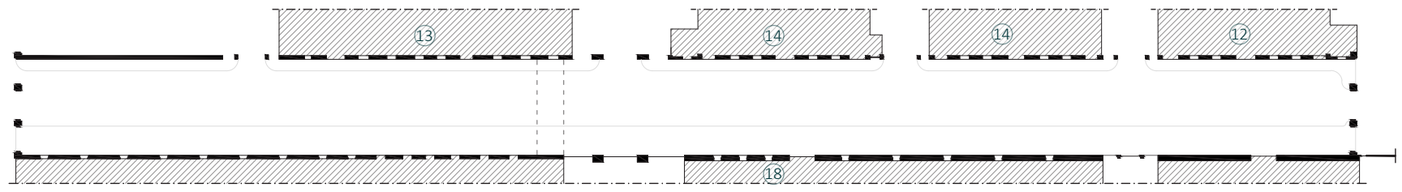
View 6



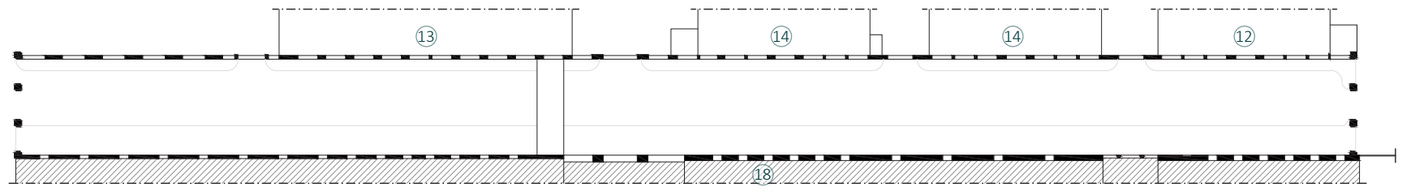
North facade, internal side - 1:1000



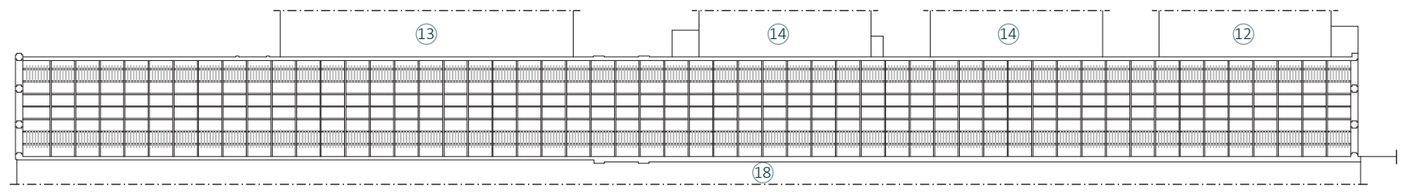
South facade, internal side - 1:1000



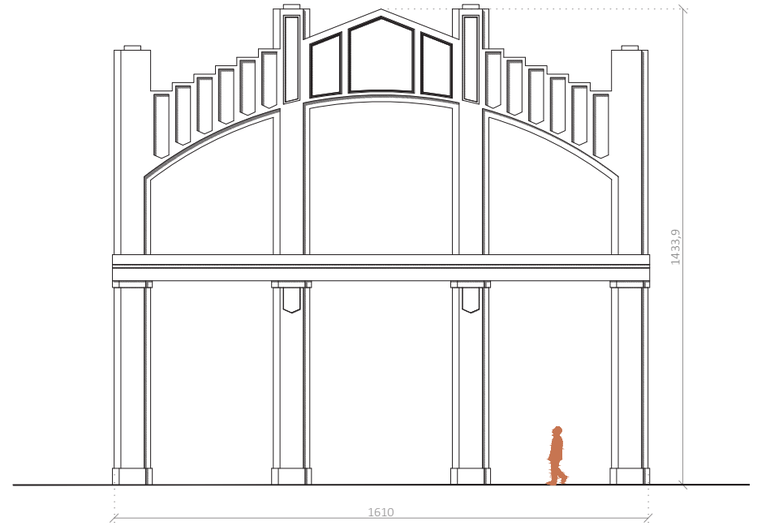

Ground level plan - 1:1000



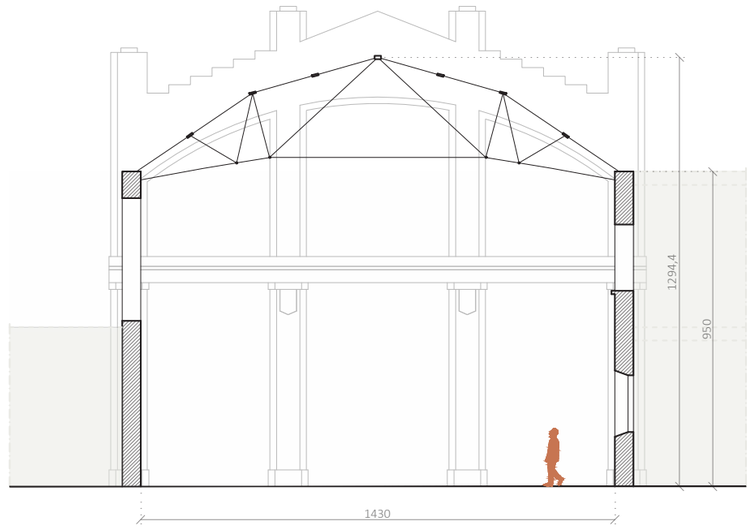

First floor plan - 1:1000




Roof - 1:1000




East and west facade - 1:200

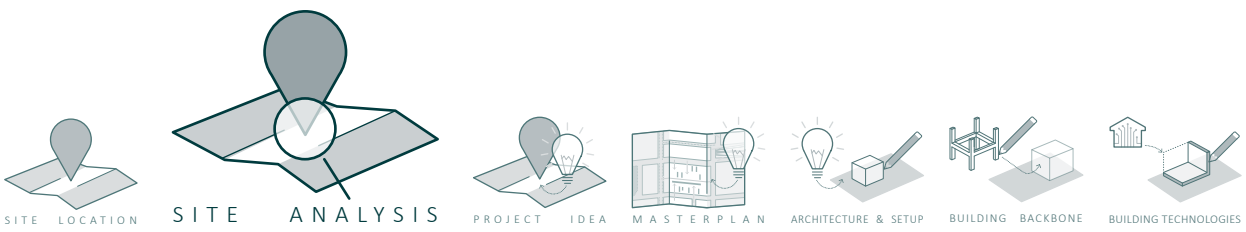



Transversal secion - 1:200

CHAPTER 2

# Site Analysis

## context study and comprehension

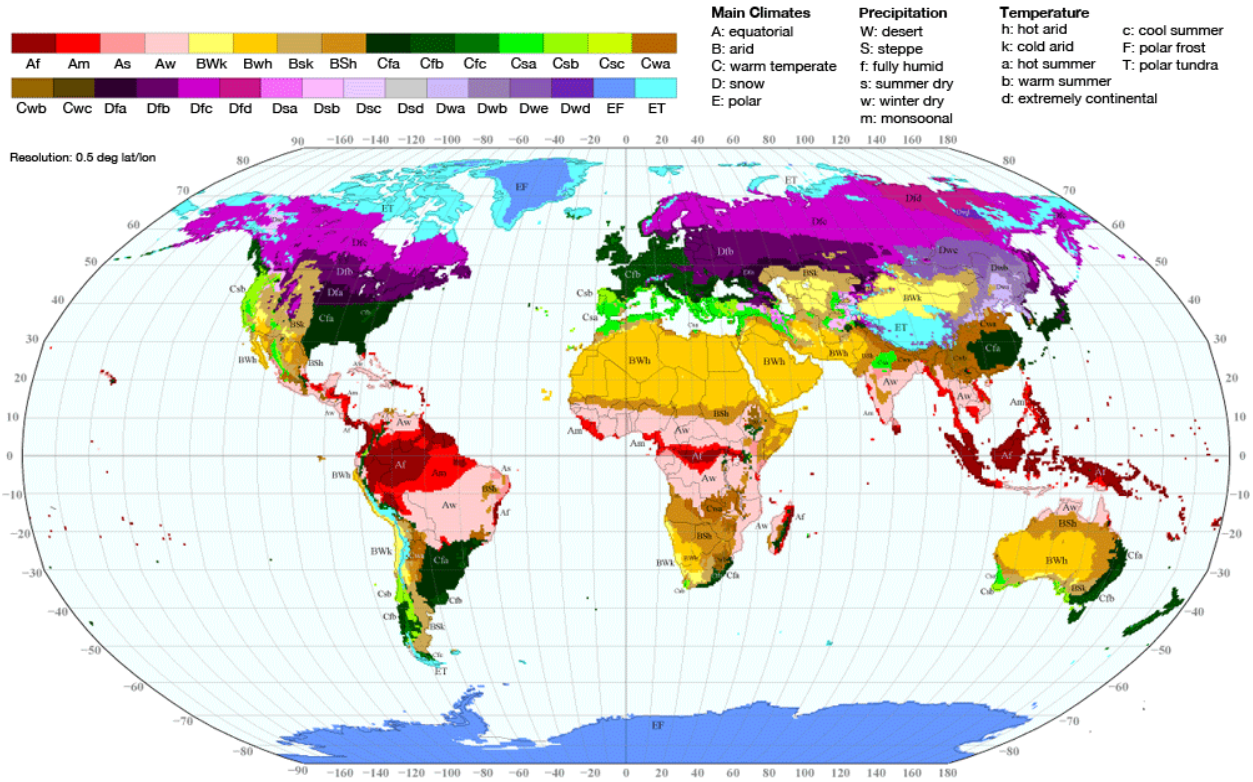


Every design proposal should be supported by an important initial phase of knowledge. The analysis represent this fundamental step because they allow the designer to select and synthetise the information, in the way to integrate correctly the project in the context.

The analysis reported in this chapter are done on different aspects: the climatic one (identifying the typo of climate and the specific characteristics of it, counting the different periods during the year) and the urban ones (evaluating the transportation, the green spaces and the distribution of them in the area, as well as for the building functions and services) and, maybe more significant, the relation between all of them.

## 1. MILANO'S CLIMATE ANALYSIS

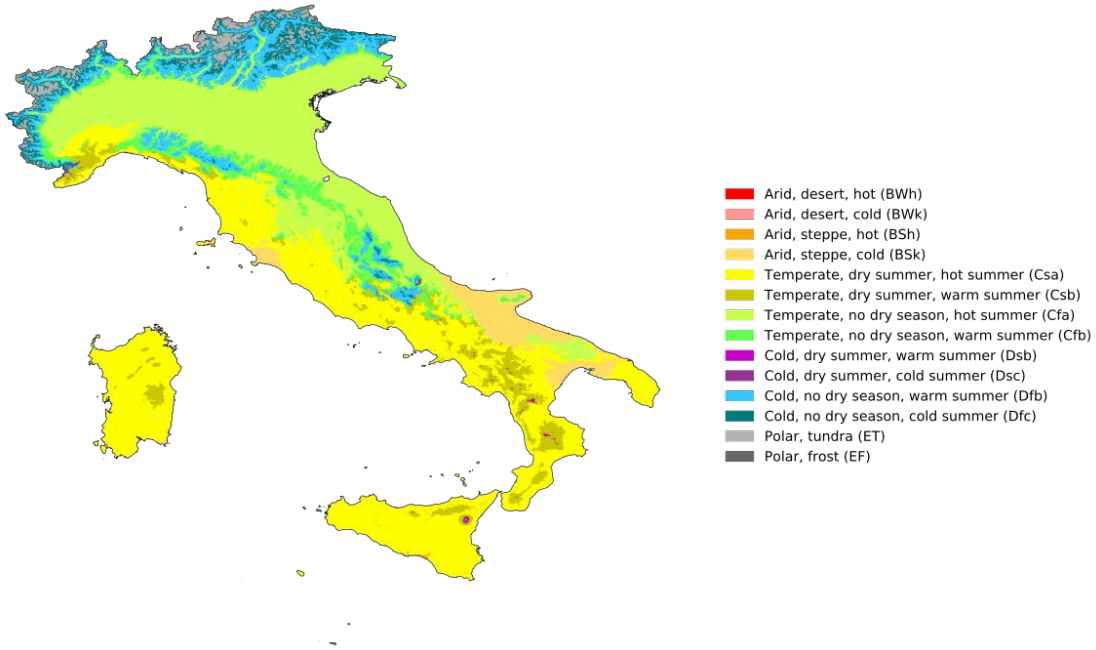
Milano lies 133 m above sea level and it is denoted by a humid and temperate climate, as generally defined.




*F.2.1 - World's Koppen climate classification map*

2 «The Köppen climate classification system categorizes climate zones throughout the world based on local vegetation. Wladimir Köppen, a German botanist and climatologist, first developed this system at the end of the 19th century, basing it on the earlier biome research conducted by scientists. These scientists learned that vegetation and climate are intricately linked. The vegetation that grows in a region is dependent on the temperature and precipitation there, which are two key factors of climate. Areas with more rainfall and higher temperatures contain more forests while regions with less rainfall tend to be deserts. The Köppen climate classification system has been enhanced and modified several times since it was first published. The system divides the world into

This climate type is classified with the Cfa code of the Köppen-Geiger Climate classification system[2], which is used to denote different climate regions on the Earth based on local vegetation.



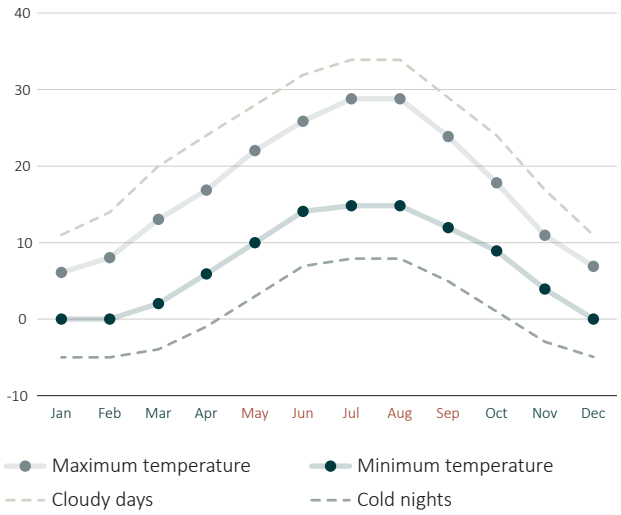

*F.2.2 - Italy's Koppen climate classification map*

The code is composed by three letters, the first one describes the main climate (among five categories), the second one describes precipitations and the third one temperatures. For the Cfa code:

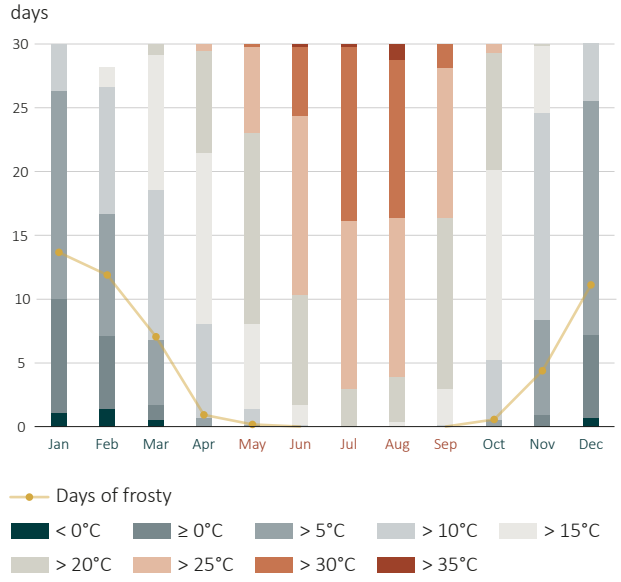
C: the temperature of the warmest month is greater than or equal to 10°C, and the temperature of the coldest month less than 18°C but greater than -3°C.
f: precipitations are more evenly distributed throughout the year; criteria for neither "s" (precipitations in the driest month of summer half of the year are less than 30 mm and less than one-third of the wettest month of the winter half) nor "w" (precipitations in the driest month of the winter half of the year less than one-tenth of the amount in the wettest month of the summer half) criteria are satisfied.
a: the temperature of the warmest month reaches 22 °C or above.

five climate zones based on criteria, usually temperature, which allows for different vegetation growth. [...] Each zone is further subdivided based on temperature or dryness. [...] Köppen's classification maps are still used by scientists and climatologists to this day. Although he published his first map in the early 1900s, Köppen continued to update it until his death in 1940. Subsequent climatologists, including Rudolf Geiger, updated versions of this map, which often include Geiger's name as well. At the time of writing, a recent revision to this map was published in 2018.» (From *National Geographic Encyclopedia*)

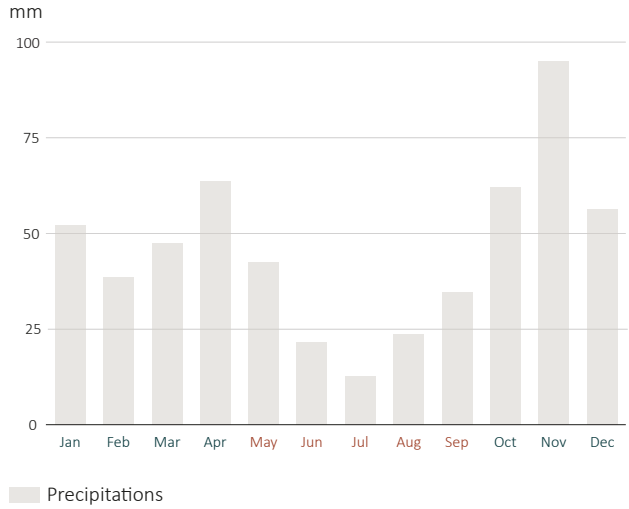
TEMPERATURE ANALYSIS




MAXIMUM TEMPERATURE ANALYSIS




PRECIPITATIONS ANALYSIS



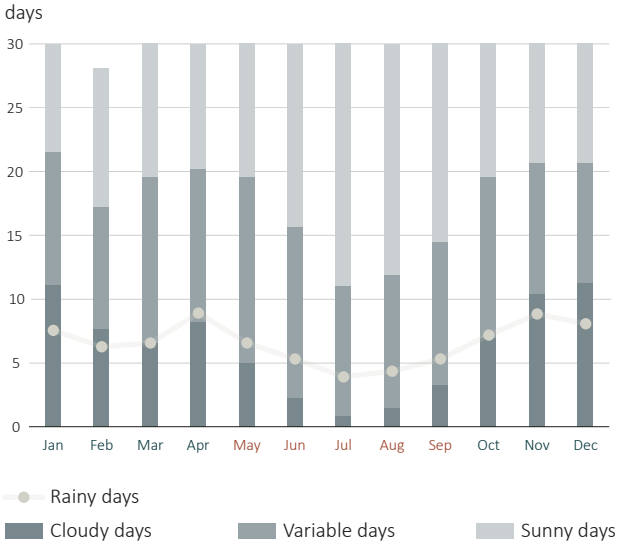

## 1.1 METEOROLOGICAL ANALYSIS

As mentioned the temperatures, let's speak now about them more in detail. The thermal excursion between the daylight minimum and maximum temperatures in the year is around 30°C. In fact, in the winter season the minimum peak temperature is around 0°C and the maximum one, in summer, is approximately 29°C. Since these temperatures are monthly averages, it is important to specify that it is not unusual to find higher values than 30°C but even than 35°C, during May, June, July, August and September. In fact, in the graphs, they are coloured in red as the warm months of the year. On the other hand, it is not unusual to have temperatures under 0°C, even if rare. What is less rare is to experience of frosty days.

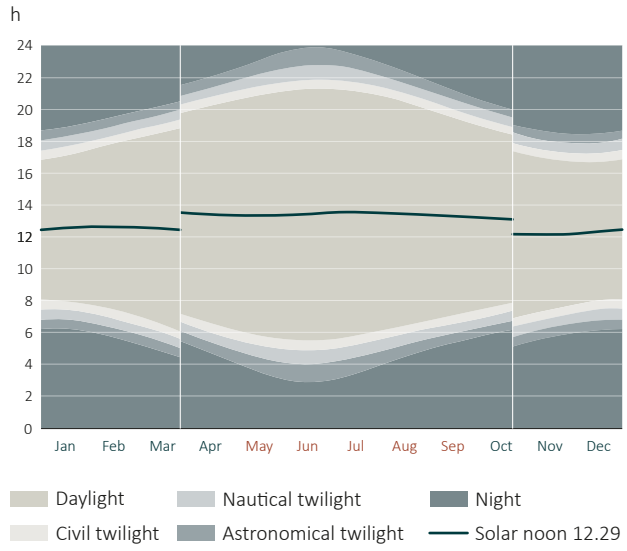
Another interesting aspect is the difference between the maximum and the minimum temperatures in a month: during winter the difference is of 6 or 7°C while approaching the hot months the difference is even doubled, passing from 30°C, as maximum, to 15°C.

As far as precipitations, they are well distributed all over the year, with a peak in November, and a drier period in summer, especially in July. The graph anyway doesn't show the number of rainy days but the amount of rain fallen. Comparing this graph with the one of the monthly meteorological analysis, in fact, even November has almost the same rainfall level as the other months because, except in July and August, the number of rainy days is less than 10 days per month.

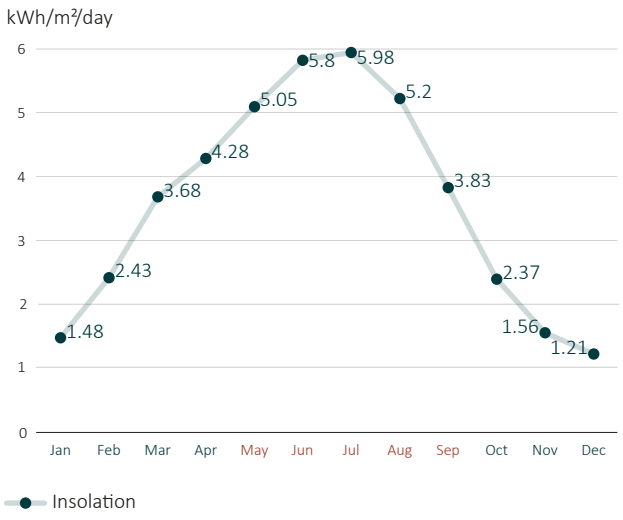
MONTHLY METEOROLOGICAL ANALYSIS




HOURLY DAYLIGHT MEASURE




SOLAR ENERGY ANALYSIS




In addition to temperature and precipitation considerations, the meteorological analysis shows cloudy and variable days all over the year. This fact is particularly interesting, together with the sun analysis for the design of collecting energy systems, since the use of PV panels is often considered.

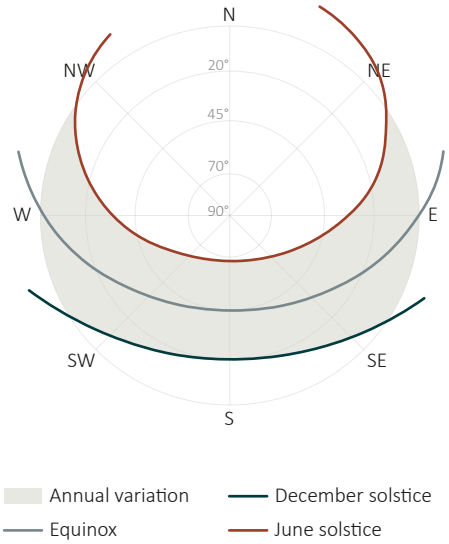
## 1.2 SUN ANALYSIS

Aside from this fact, the sun irradiation and daylight contribute actively on the life of a building: they heat it positively on some occasions but with negative results in some others. In addition to that, it is to be considered that the daylight furnishes natural light to the internal spaces if well designed, permitting to use less artificial light, decreasing the energy consumption, besides a possible well-being increment.

All over the year, Milan presents hourly daylight measure longer than 10 hours, which is the lowest value, verified in the winter months. In June daylight is instead about 16 hours in a day. It is also interesting that the daylight peak doesn't correspond to the highest temperature in the year. But in general, all the daylight analysis shows that there is no precise correspondence in the seasonal subdivision of the year, as expected, as instead is clear in the case of the temperature analysis. In fact, the period during which the hours of daylight are fewer goes from November to January and the period when they are more is from May to July.

Related to the daylight analysis, is the solar energy analysis which expresses the number of kWh per $m^2$ emitted in a day. It expresses the

SUN PATH ANALYSIS



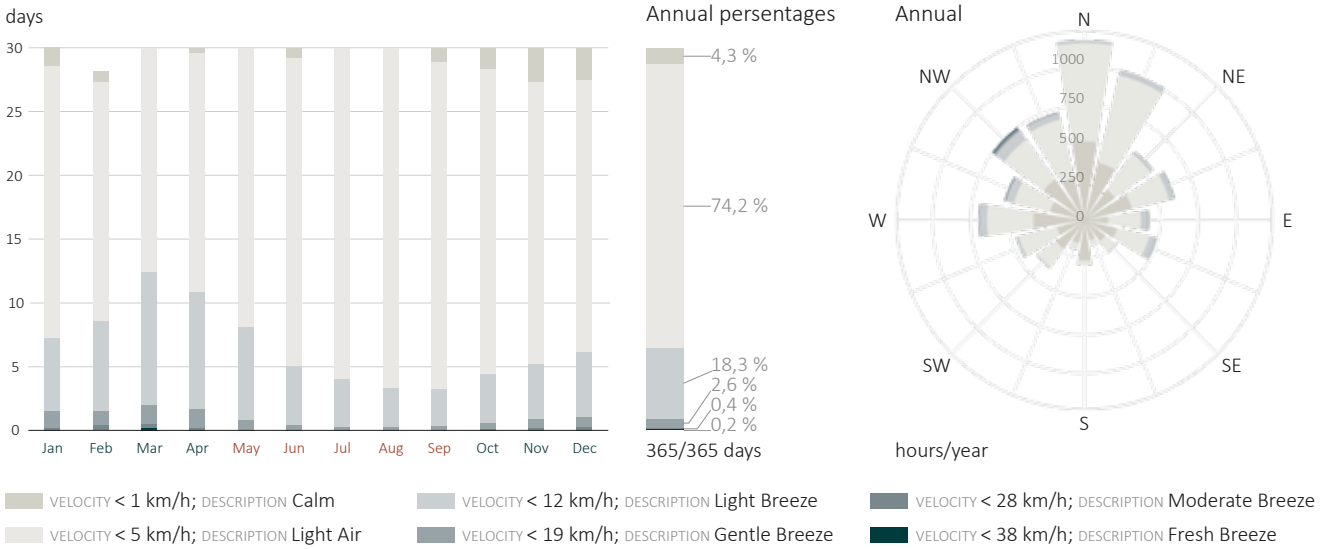

insolation and it is very low in November, December and January, while in the rest of the year these low values (around 1,5 kWh/m$^2$/day) double and quadruple. From December to July a gradual rise in values occurs, while from August to November instead, there is a rapid decrease.

Then the sun path analysis shows the sun inclination and orientation during the year. It covers a wide range in summer when there is a solar irradiation angle between 45°C (which correspond to the Equinox) and 68°C, on June solstice day. On the other hand, in winter the sun creates a amller angle with the Earth's crust: between 45°C and 22°C in the day of the December solstice.

## 1.3 WIND ANALYSIS

The wind analysis shows that in Milan most of the time there is 'light air' and a 'light breeze' that frequently comes from the North, the North-East and the North-West, from the mountain range of the Alps, as can be expected. Consider that the classification in the wind speed scale is characterized by 17 levels and that the 'calm air', with a speed < 1 km/h, corresponds to 0 Beaufort[3] number and Milano worst wind, the 'fresh breeze', corresponds to the level 7, which occurs in very few days in March.

WIND ANALYSIS



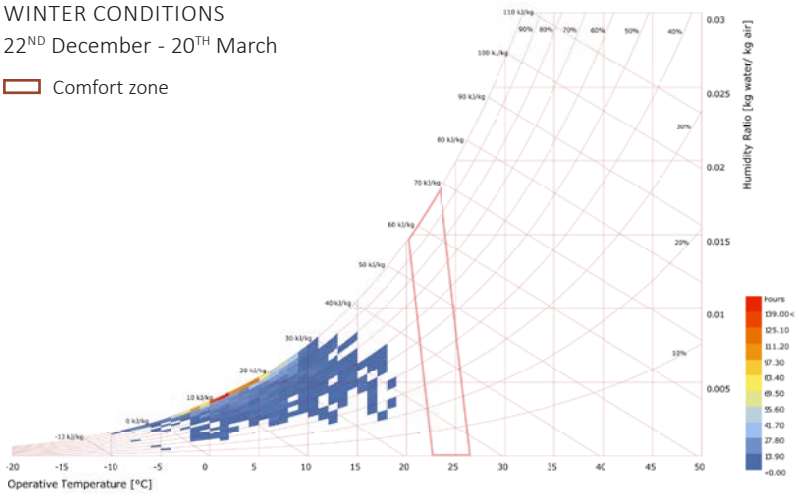

3 The Beaufort scale is an empirical measure that relates wind speed to observed conditions at sea or on land. Its full name is the Beaufort wind force scale and measures 17 grades of wind.

## 1.4 COMFORT ANALYSIS

The following analysis considers the thermodynamic conditions in the specific Milan environment. The psychrometric chart[4] relates the conditions all together and in this case it specifies how many hours certain climate states occur in fixed periods of the year. In addition, the typical comfort zone is shown in a red rectangle, in a range between 20 and 27°C and 0 to 100% relative humidity, compatibly with the people thermal insulation parameter. This allows the designer to understand if in the external environment people can find comfort conditions and how long. This analysis helps to design internal and external spaces, as shown in the next paragraph.

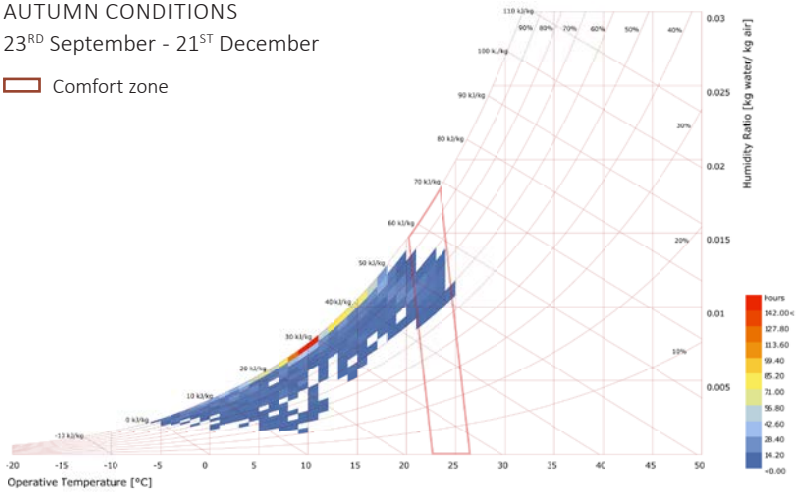
WINTER CONDITIONS
22ND December - 20TH March

Comfort zone




AUTUMN CONDITIONS
23RD September - 21ST December

Comfort zone




The analysis is provided for the four seasons: Winter (22nd December - 20th March); Spring (21st March - 21st June); Summer (22nd June - 22nd September); Autumn (23rd September - 21st December).

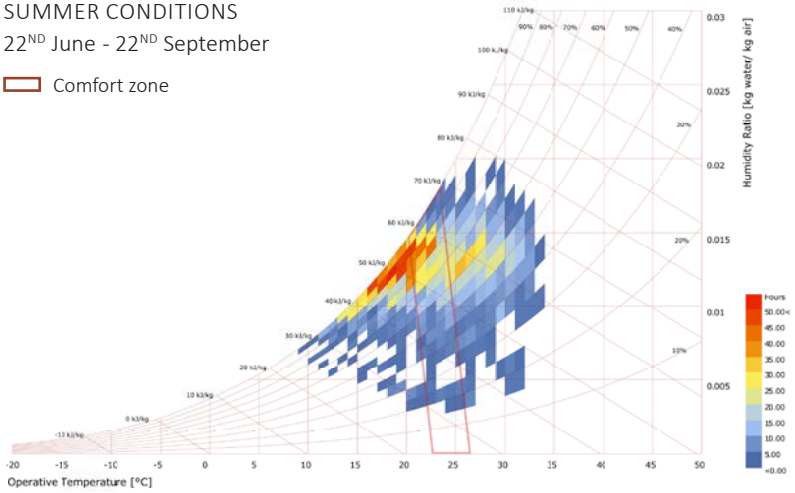
As expected, in Winter time the comfort zone is never reached, even if there is a large variation in temperatures. Most of the time the environmental conditions present a temperature between 0 and 5°C and a relative humidity between 90% and 100%.

Autumn is similar to Winter, the major difference is in terms of temperature range, higher than 5° C (between -5 and 25°C). Despite that, some comfort occasions occur but only for 5-20 hours in the whole season. There is instead a decisive concentration of time in the 10°C.

4 A psychrometric chart is a graph of the thermodynamic parameters of moist air at constant pressure (1 atm = 101325 Pa). The air properties on the chart are: $t_{dp}$ [°C] dry-bulb temperature; $t_{wb}$ [°C] wet-bulb temperature; $t_{dp}$ [°C] dew point temperature; *RH* [%] relative humidity; *x* [$kg_v/kg_{da}$] humidity ratio; *h* [$kJ/kg_{da}$] enthalpy; *v* [$m^2/kg$] specifiv volume.

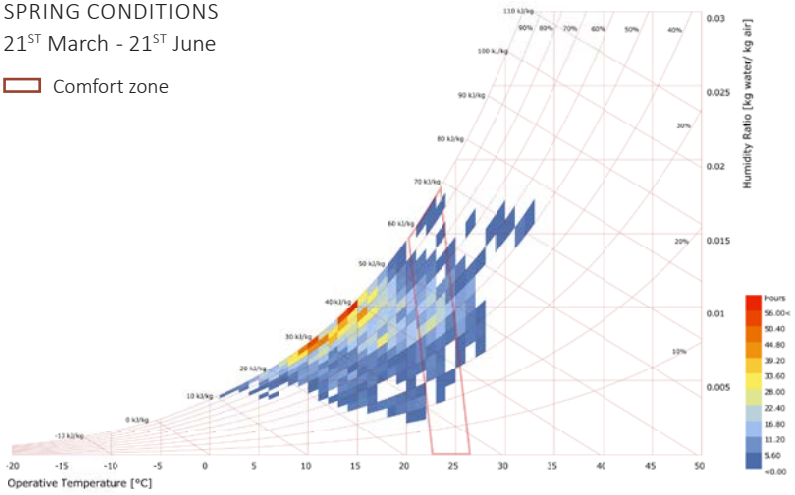
SUMMER CONDITIONS
22ND June - 22ND September

Comfort zone




SPRING CONDITIONS
21ST March - 21ST June

Comfort zone




The summer season is the one with most of situations of comfort. It presents a smaller range in terms of temperatures, but a higher concentration of time for some conditions. Even if there are a lot of moments in which discomfort states occur, more than in the red zone, most of the times the properties are below this range. We can see anyway a good balance during the three months.

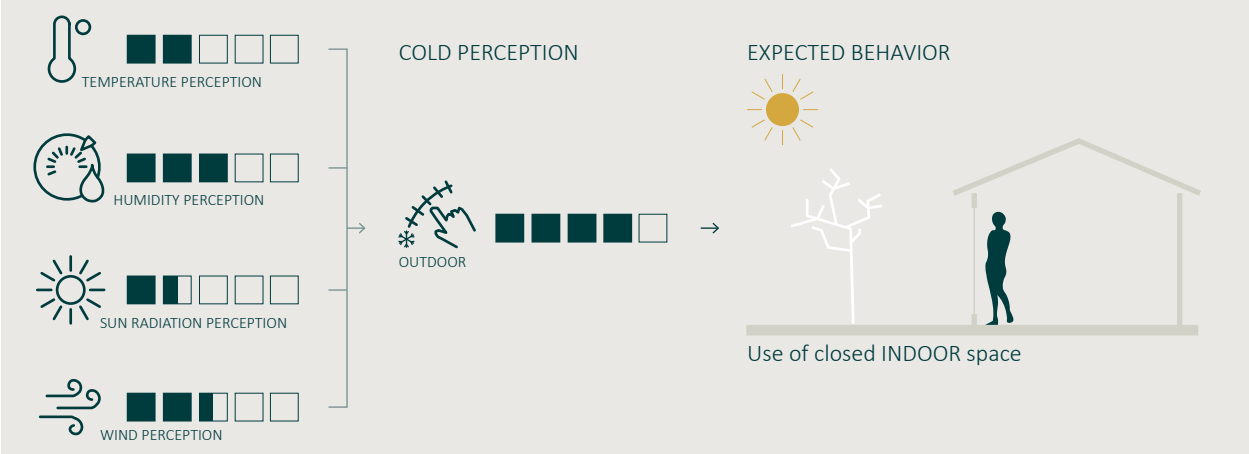
In Spring the red zone is reached on some occasions, but for short periods of time, mostly between 5 and 20 hours (maximum 28 hours), that is less than a day. Here as during summer, the relative humidity occupies a larger range than in winter and autumn. Spring looks also like the season with the larger extension in terms of temperature.

## 1.5 CONCLUSIONS

It is fundamental to understand how the climatic states can affect buildings construction and so, how they need to be designed from a technological point of view. The other aspect takes into consideration people behaviour, that is, how they will probably use the space, outdoor conditions permitting. People want well designed built volumes and voids, according to their needs.

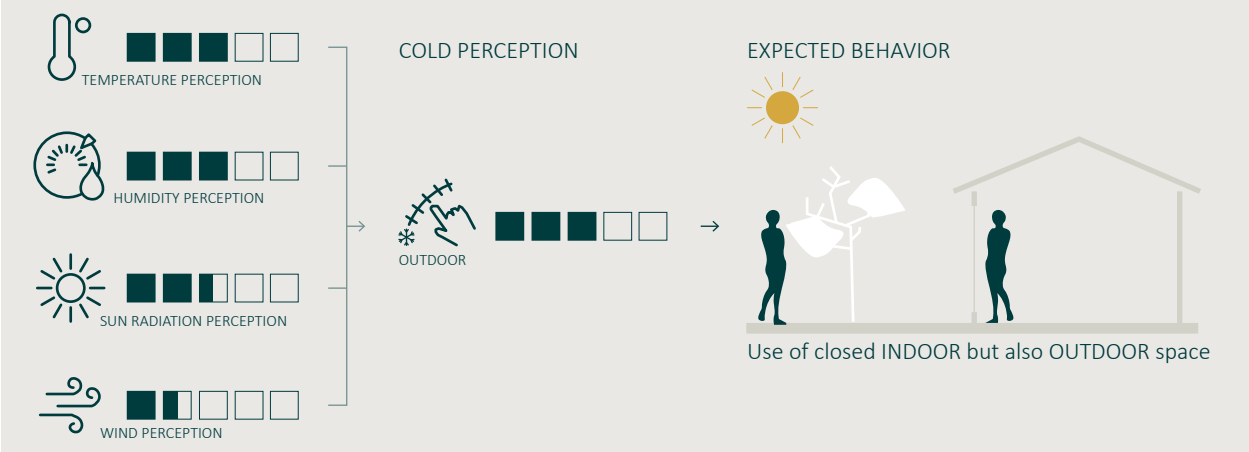
Starting from the people sensations investigation, four fundamental parameters are considered, temperature, humidity, solar radiation and wind speed perception, which all contribute to the heat or cold perception. The cold perception parameter is used in ‘cold seasons’, Autumn and Winter, while the heat perception in ‘hot seasons’, Spring and Summer. Every season is then described separately, in order to discover an expected people behaviour in every period of the year.

In winter temperatures aren't so low but the humidity and the wind perception make people fell cold and consequently in this period of the year there is a grater use of closed and heated spaces. In sunny days the places more appreciated are the ones which can gain sun radiation, like the windows. A non considered parameter is daylight, but as already said, there will be only 8 hours of light during the days.




*F.2.3 - Winter climate analysis conclusive considerations*

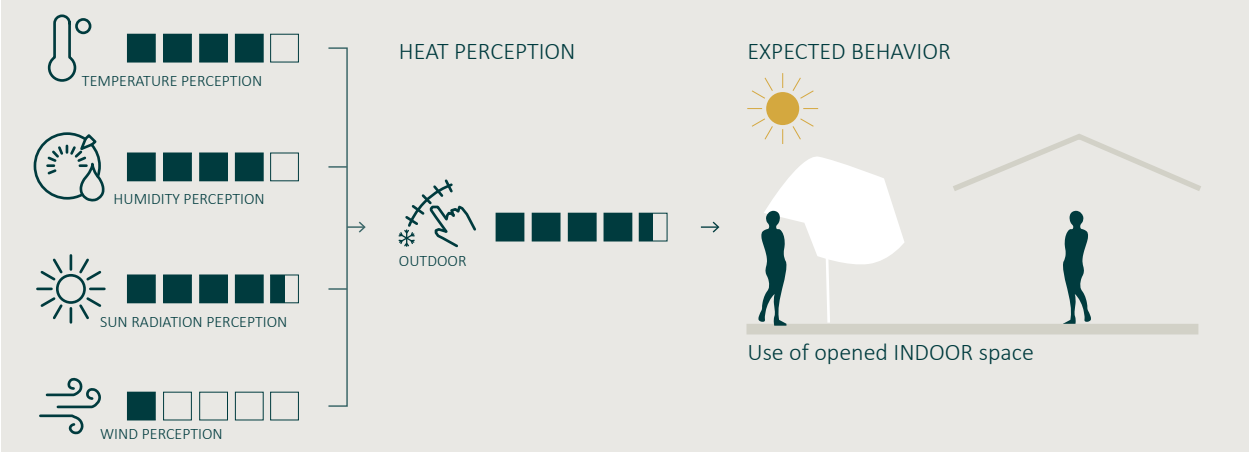
In autumn it is possible to make almost the same considerations as before, besides the fact that temperatures are higher and outdoor spaces are possibly still frequently used. Nevertheless the amount of daily light starts to decrease.




*F.2.4 - Autumn climate analysis conclusive considerations*

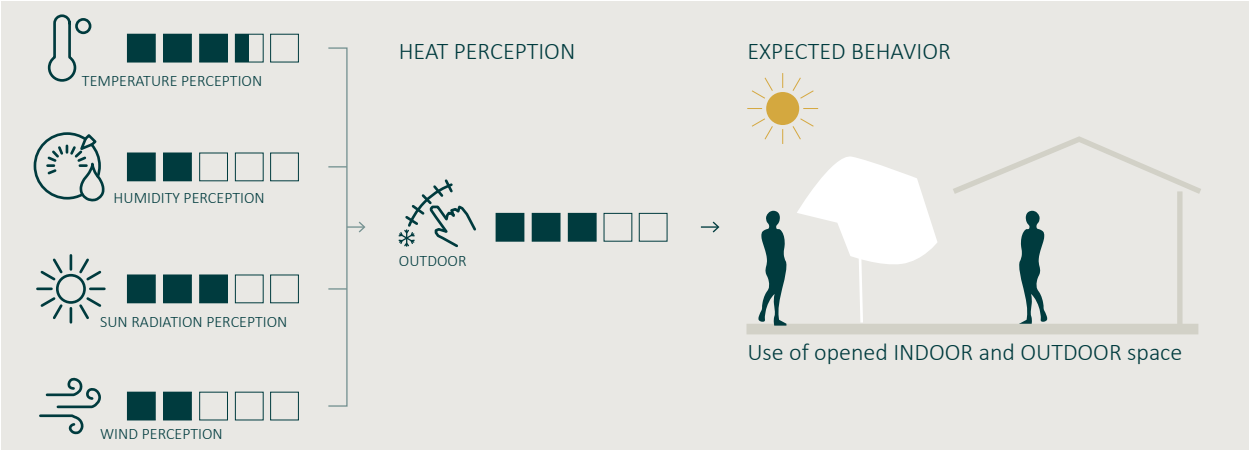
In Summer, the heat perception is high and reasonably most people are in a situation of discomfort, differently from what reported in the comfort analysis. This is because in paragraph 1.4 was not considered solar

radiation, which instead, is relevant. Solar radiation increases heat perception, heating the skin and the environment, it is not only a matter of climate temperature and/or humidity but also of heat transmission. Consequently, outdoor ventilated and shaded spaces are used most of the period. People choose to stay in contact with nature if possible, and/or to live in closed but ventilated areas (or even air-conditioned ones during particularly hot days).




*F.2.5 - Summer climate analysis conclusive considerations*

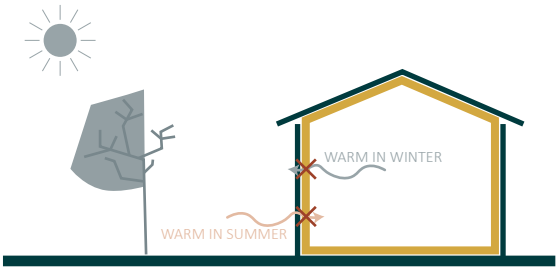
Like autumn, spring is a 'transitional' season, during which you pass from cold climate to warm climate or vice versa. During this period of the year people stay gladly outside because temperature starts to increase, as well as solar gain. Internal spaces are still frequently used because temperatures are not high enough. Also the amount of light in a day starts to increase, thanks to the switching to daylight saving time too.



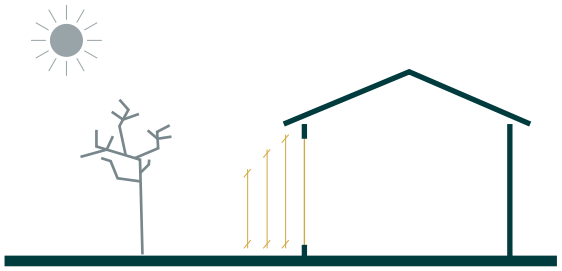

*F.2.6 - Spring climate analysis conclusive considerations*

From a technological point of view, considering climatic parameters, some conceptual strategies for the built volumes are now fixed before starting the project development. First of all a building should be well insulated, to contrast the heat movement both in cold periods and in hot ones. Concerning the solar radiation, we saw that in some cases it embodies a good gain for the building, for that reason, the windows sizes and positions should be well designed, as well as the shading devices. To contrast high temperature but also the stagnation of humidity or bad air in indoor environments, ventilation is important and appreciated. Also energy production systems have of course to be designed in agreement with the type of renewable sources available.

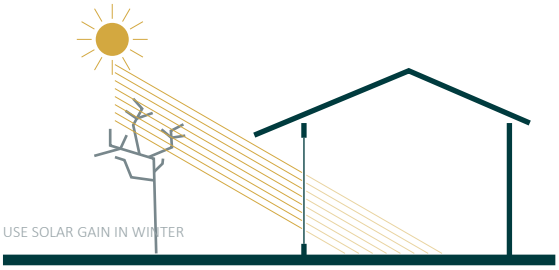
BUILDING CONCEPT STRATEGIES:

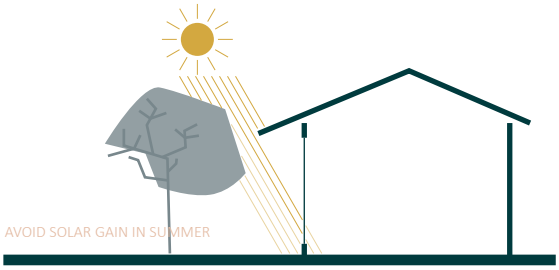



*F.2.7 - Sufficient insulation*

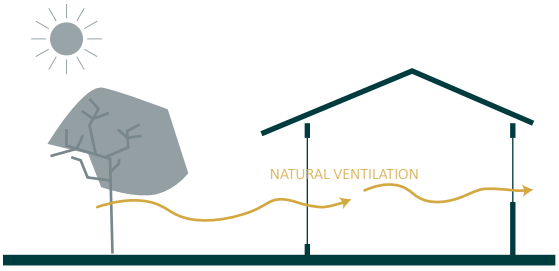


*F.2.8 - Windows sizing and positioning*

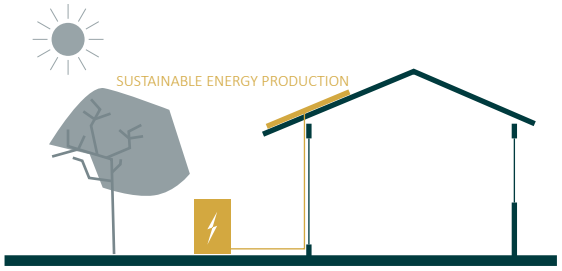



*F.2.9 - Shading devices sizing and positioning*




*F.2.10 - Natural ventilation*




*F.2.11 - Sustainable energy production*

## 2. EX MACELLO URBAN AREA ANALYSIS

The urban analysis is concentrated on the area around the ex Macello, in order to consider the context and its characteristics.

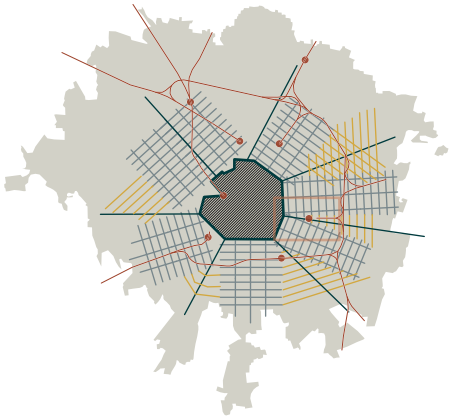
### 2.1 TEXTURE ANALYSIS

First of all, we can start with some brief considerations about the urban texture: the city main axis come from a radial development which started from “La Grande Città” borders (1629 city limits) (see a representative diagram on page 26).

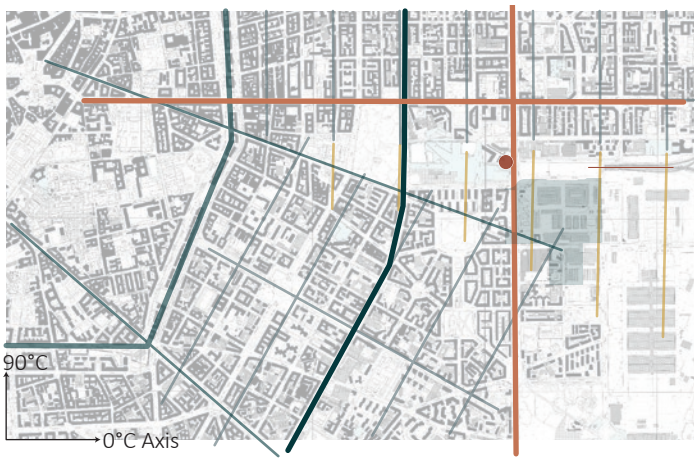
“La Grande Città”, in the centre of the city (dark blue lines), creates a sort of irregular hexagon, from which, from each its side, comes a parallel and perpendicular grid (light blue in the picture), with some connective grid-grid additional axis (marked in yellow).

As can be imagined, the texture is very regular in the hexagon side grid and messier in the proximity of the intersection of different angles grids. The area of intervention is located exactly in of these intersections, as can be seen from the map, but with the prevalence of a 0-90°C axis.

At the local scale, the two fundamental axis are also two of the main area’s roads (marked in red). The 90°C Viale Molise, which starts from “Città Studi” as Viale Romagna and reaches Corso Lodi as Viale Lucania. The 0°C Viale Corsica, starting from Piazza Cinque Giornate as Corso XXII Marzo, it reaches Milano Linate airport and the Idroscalo, becoming Viale Enrico Forlanini, which also passes from the east ring road.



*F.2.12 - Texture analysis, urban scale*




*F.2.13 - Urban texture, local scale*

LEGEND

1629 Urbanized area
Urbanized area
Zoomed at local scale area

Railway station
Railway

Axis urban scale
1629 CITY LIMIT
MAIN SUNBURST AXIS
REGULAR GRID
JUNCTION BETWEEN THE GRIDS

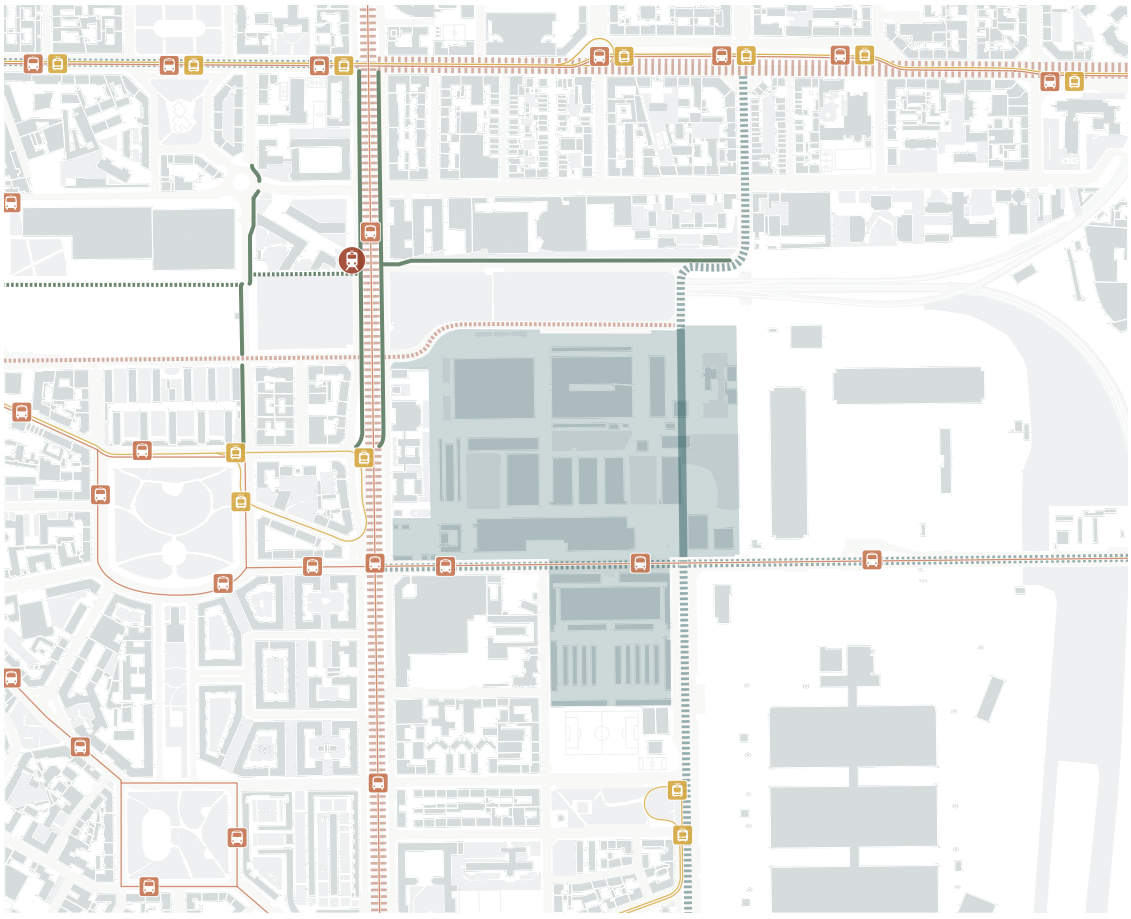
Axis local scale
1629 CITY LIMIT
MAIN SUNBURST AXIS
REGULAR GRID
GRIDS JUNCTION

CIRCULAR AXIS
PRINCIPAL LOCAL AXIS

## 2.2 MOBILITY NETWORK ANALYSIS

Public transport in Milan is quite efficient, not very expensive and offers a wide timetable. It is well distributed in the city, in particular in the city centre, where are the main touristic attractions, there is a higher concentration of underground stations.

In Calvairate district, transportations are focused on the two main roads, mentioned earlier, where buses runs. The internal district areas are served by tram lines, of which one stop is located in the other street front of the project site. This is also fastly accessible from the train station and the East ring road, even if it is not visible in the analysis map. There are no car or bike-sharing spots, even near the train station, but the municipality is trying to develop a cycle path around it and along the busiest streets.



*F.2.14 - Mobility network analysis, scale 1:10000*

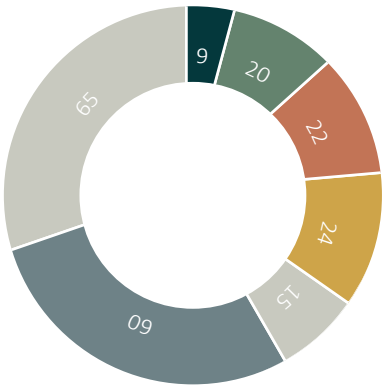
LEGEND

- Train stop
- Bus stop
- Tram stop
- Bus line
- Tram line
- Cyclepath
- Planned cyclepath
- Urban flowing road
- Street connecting neighborhoods
- Planned street connecting neighborhoods
- Neighborhoods street

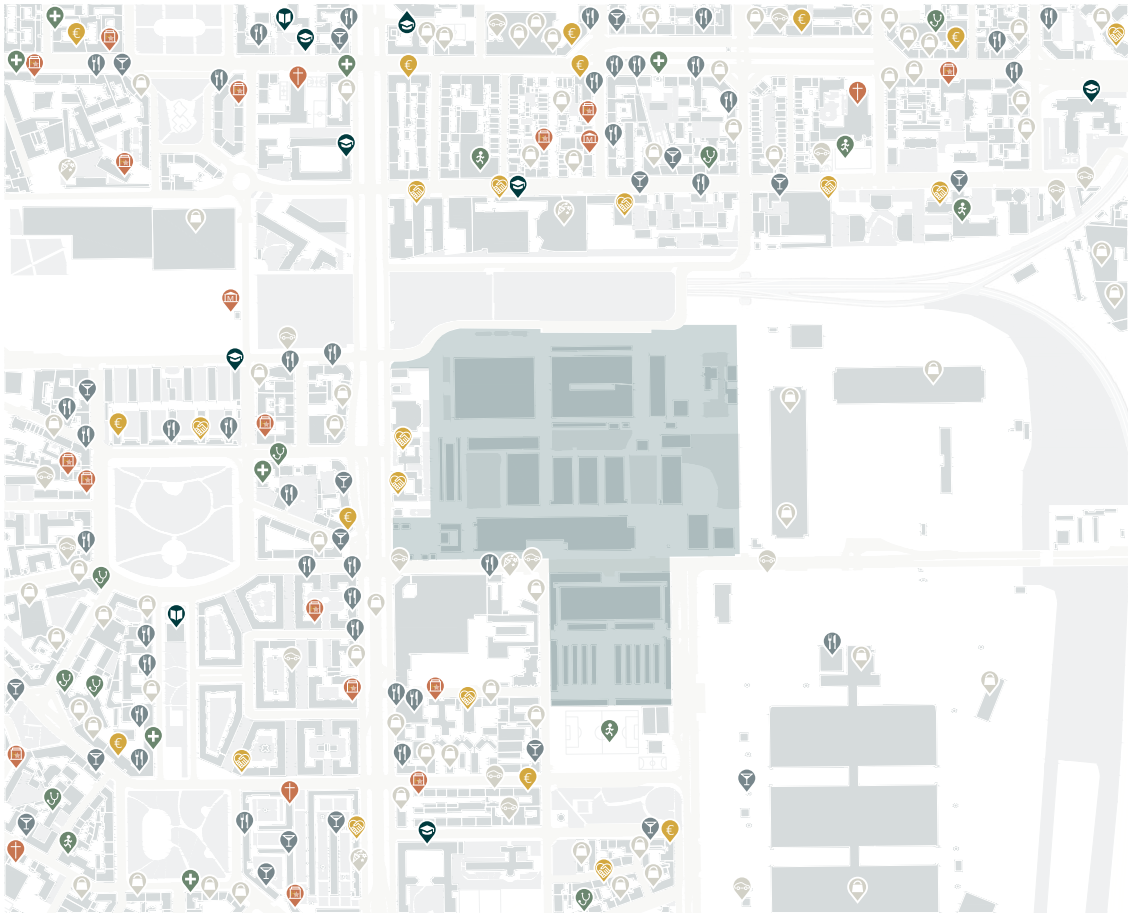
## 2.3 FACILITY ANALYSIS

The area is peripherical and mostly residential. Activities support this primary type of use, furnishing services for the community and creating job occasions.

Facilities like restaurants are numerously present also on the south-west side of the map, where the residences' density is higher. There is, by the way, a shortage of day and night bars and no alternative activities are proposed for free evening-night time, especially for young people.




*F.2.15 - Facilities categories graph*



*F.2.16 - Facilities analysis, scale 1:10000*

LEGEND - FACILITIES

- Educational
  - SCHOOL
  - LIBRARY
- Sport and ealth
  - SPORT
  - MEDICAL CENTRE
  - PHARMACY
- Tourism and culture
  - ACCOMODATION
  - ART
  - CHURCH
- Governamental
  - BANK
  - SERVICE FOR PEOPLE
- Leisure and commercial food
  - BAR & NIGHT BAR
  - RESTAURANT
- Leisure and commercial
  - EVENT
  - PRIVATE MOBILITY SERVICE
  - COMMERCIAL

*F.2.17 - Educational functions zoom*

*F.2.18 - Sport and ealth functions zoom*

A high commercial fabrics concentration is located on the upper and east side of the map, along Corso XXII Martiri, with many shops facing the street. While the east side, below the railways, is occupied by General Markets, a unique activity which fills two immense and not permeable blocks. In all neighbourhood, the presence of public educational spaces and sports centres is decidedly poor, but at least, homogeneously scattered.

As a last observation, the function network indirectly emphasises the division of the district by the zones of the former platforms of the old station.

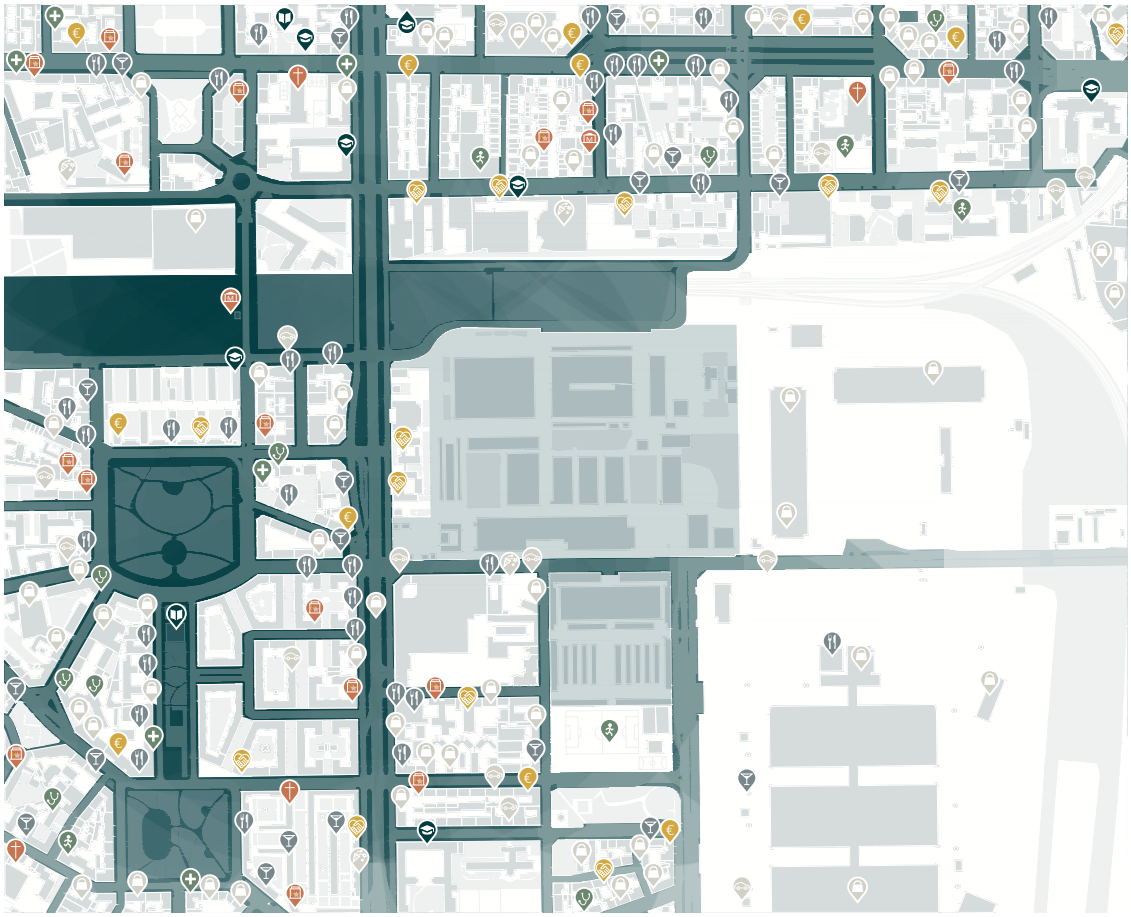
Relate the facilities with the mobility network analysis, give the functions' accessibility. This is necessary to understand if a service is usable and at which level and if an unexploited area can have the potential for the community. The analysis is made creating a 400 m radius circle from each tram and bus stop (the station is not included). 400 m represents a reasonable pedestrian path, walkable in a short time. The accessibility results higher where the overlapped circles give darker pattern colours.

*F.2.19 - Bus stops accessibility*

*F.2.20 - Tram stops accessibility*

In the following map, the bus and tram accessibility maps are joined, avoiding the blocks' areas, that cannot be crossed but that must be turned around. The result shows high accessibility focused along Corso XXII Martiri and Viale Molise and the garden Francesco Rucci. An elevated approachability is focused even in the fenced and unused green areas covering the underground railway station, and the "Ex Macello" site, with consequently a potential.

For this analysis, it is fundamental to consider that the area under survey doesn't consider the transportation stops outside of it, even if surely they influence the accessibility of the site. Another point is a fact that 400 m radius is a straight line, while, walking it is usually not possible to cross the city by a straight path.



*F.2.21 - Accessibility analysis, scale 1:10000*

LEGEND - ACCESSIBILITY

Public transportations
Radius 400 m

Bus stops
Radius 400 m

Tram stops
Radius 400 m

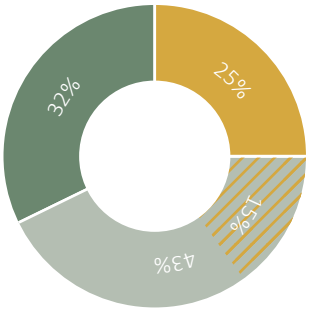
Accessibility degrees

ACCESSIBILITY TRANSPORTATIONS
ACCESSIBILITY BUS STOPS
ACCESSIBILITY TRAM STOPS

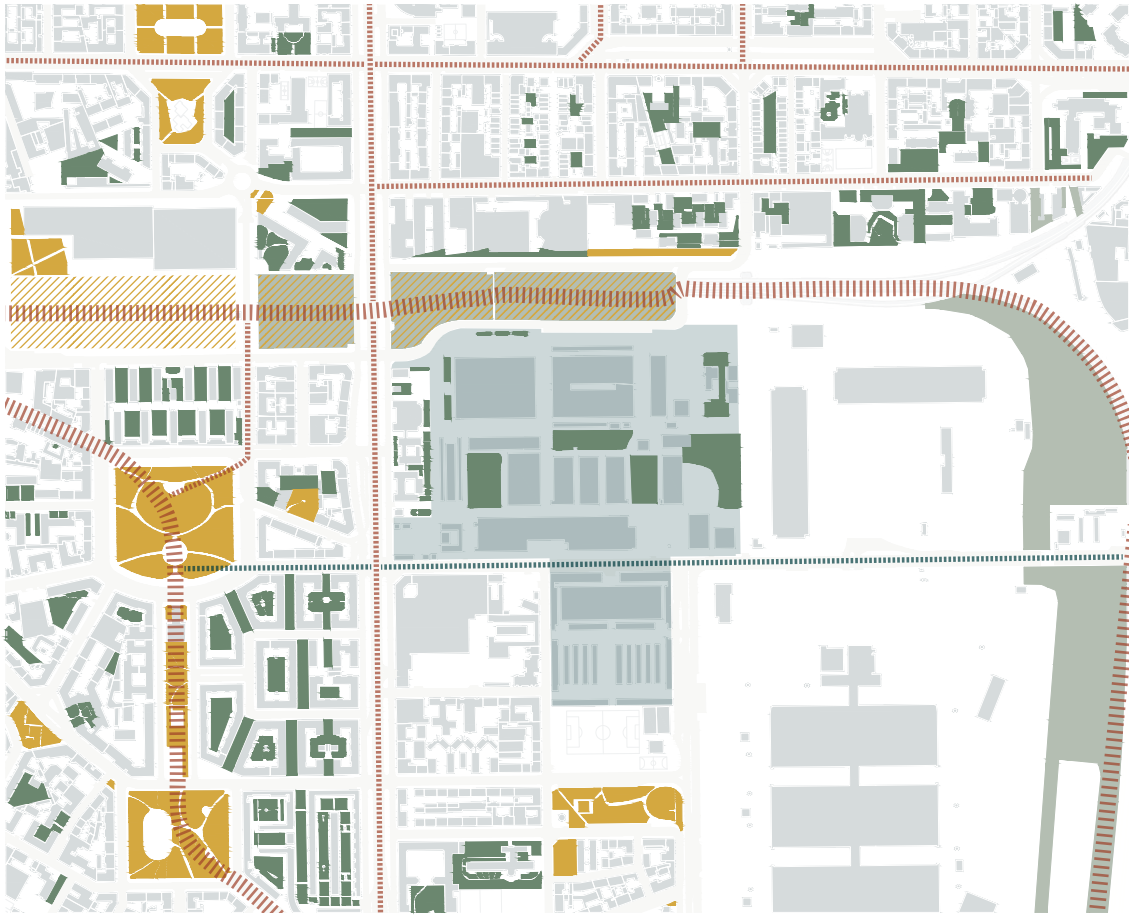
LOW HIGH

## 2.4 GREEN SPACE ANALYSIS

People relationship with green is fundamental in their life, firstly from an aesthetical point of view and for physical and emotional well-being. Wide streets work like green corridors, with great trees which separate the habitations from circulation and pollution. A lot of private green spaces are located in organised residential complexes, as well as those of public housing. Public green isn't effectively distributed, but as well present within a good percentage. In that sense, the difference can be made by the requalification of the abandoned areas.




*F.2.22 - Green categories percentages graph*



*F.2.23 - Green network analysis, scale 1:10000*

LEGEND - GREEN NETWORK

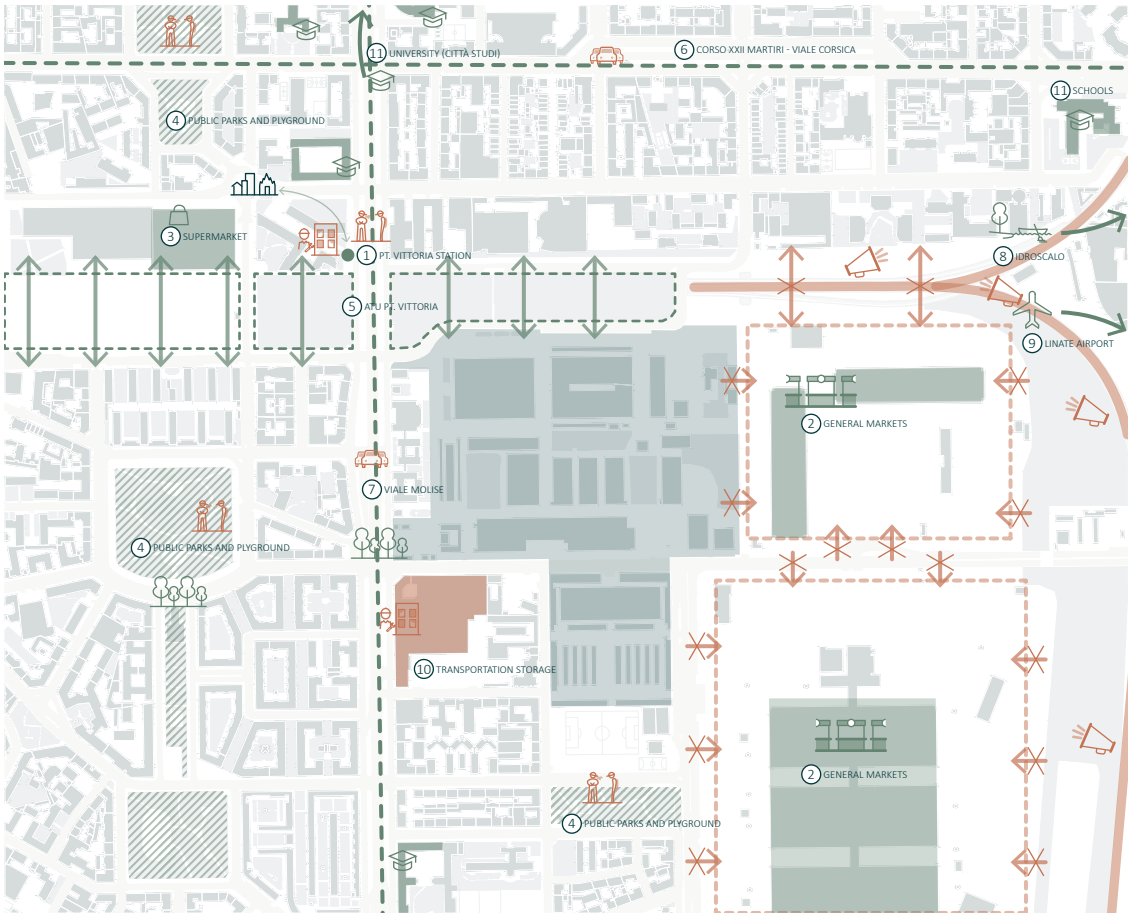
- Planned accessible green
- Accessible green
- Not accessible green/abandoned
- Private green
- Green infrastructure
- Existing green linear connections
- Planned green linear connections

## 2.5 CONCLUSIONS

### *OPPORTUNITIES AND CONSTRAINS*

The information and knowledge gained have been translated into an opportunity and constraint map. That provides a much clearer and a simpler representation of the problem areas, as well as areas of great potential that could be utilized in the future.

In opportunity zones can sometimes exist also some constraints, as for the case of public parks, or stations whose railways can propagate noise pollution. Every important point is however briefly explained in the following list and conceptually illustrated in the map.




*F.2.24 - Opportunities and constrains, scale 1:10000*

LEGEND

- Green corridor
- School and university
- Linate airport
- Idroscalo
- Supermarket
- General markets
- Porosity & connection
- No connection
- Low porosity
- Bad people aggregation
- High traffic level
- Noise pollution
- Low building maintenance
- Milano city

1. PT. VITTORIA STATION AND RAYLWAYS
O: Connection with the city
C: Degradation of the station itself, “bad people” aggregation, raylways split the territory and create noise pollution

2. GENERAL MARKETS
O: Commercial attraction point, important economical activity for the territory
C: Huge area complitely dedicated to this function and low porosoty of the isolate

3. SUPERMARKET
O: Commercial service, parking area

4. PUBLIC PARKS AND PLYGROUND
O: Big green areas with equipment for children, green corridors
C: Bad people aggregation during some daily hours

5. ATU PT. VITTORIA
O: Regeneration of Pt. Vittoria ex station and railways area, creation of an urban connection between the upper and lower side of the railways (this two sides have always been separated)

6. CORSO XXII MARTIRI - VIALE CORSICA
O: Commercial facilities, services, and transportations
C: High traffic level

7. VIALE MOLISE
O: Green corridors and public transportations
C: High traffic level

8. IDROSCALO
O:Natural green and water attraction 15 minutes from the neighborhood
C: No direct public transportation can be taken from Pt. Vittoria area

9. LINATE AIRPORT
O: International connection, tourism
C: Noise and atmospherical pollution

10. TRANSPORTATION STORAGE
C: Huge building with low maintenance

11. SCHOOLS AND UNIVERSITY (CITTÀ STUDI)
O: Attractive points for young people since it is mostly a residential area

*THE S.W.O.T. ANALYSIS*

As the name suggests, the analysis focuses on examining strengths (S), weaknesses (W), opportunities (O) and threats (T), the design may face. It, therefore, allows analysing the exact problems, as well as how best to overcome them. Differently from the previous maps, this analysis focuses on the aspects strictly related


CONTEXT
- Presence of big green spaces and nearby natural green and water attraction (Idroscalo, 15 minutes far)
- Served by public transportation, presence of cyclable path
- Presence of services for the people along the main axis and of educational centres (max 15 minutes far)

EX MACELLO SITE
- Flexible to mix with modern buildings for renovation
- Availability of large spaces for green area
- Characteristic constructions


CONTEXT
- The green abandoned spaces divide the Calvairate area in two
- Bad air quality and noise due to the high traffic level and the presence of the railways
- Lack of leisure and sport facilities and attractions (cinemas, art centres, clubs, etc.)

EX MACELLO SITE
- No clear or welcoming entrances to the site
- Absence of acoustic and visual barriers or for buffer zones related to commercial sites (Mercati Generali)
- There is neither simmetry nor proportion between the different buildings, which also are very degradated


CONTEXT
- Improvement of the pedestrian cyclable-path integrated with green areas
- Availability of areas in which integrate sport facilities
- Increase phisical activities and cyclable mobility

EX MACELLO SITE
- Potential of change functions to create something attractive and useful for the sorroundings
- Potential of crating amateur sport areas and promote a healthier lifestyle

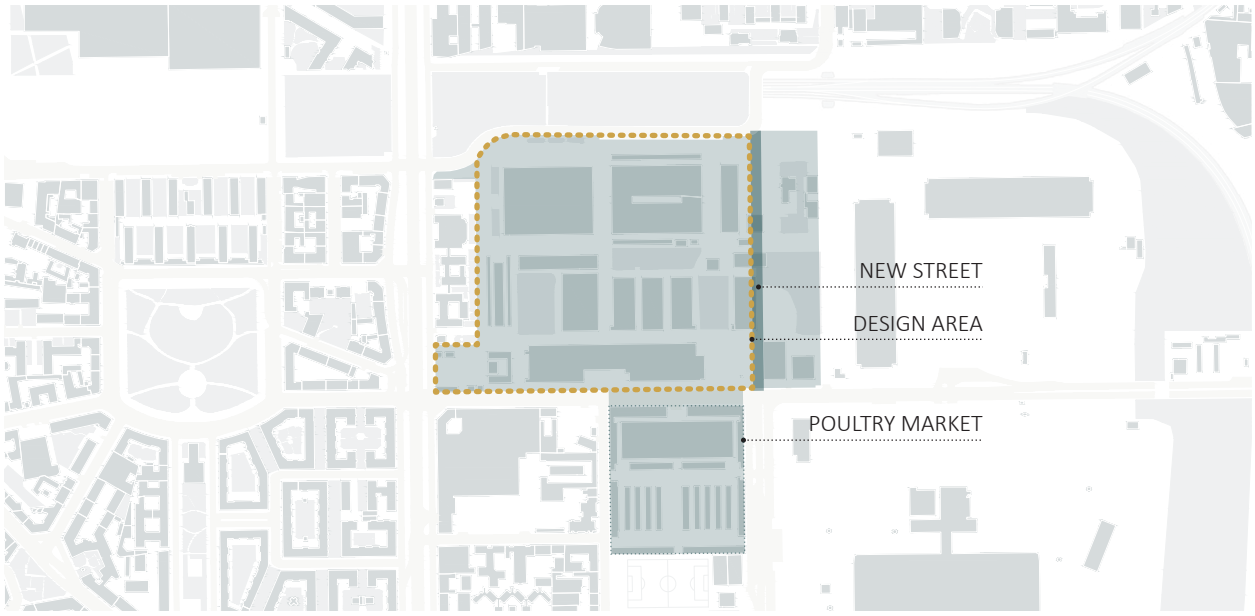

CONTEXT
- The urban texture lead to the isolation of some spaces from the morphological and functional point of view
- Threat of traffic james in the peak hours
- Lands which are not well planned will increase a lack of identity and absence of public spaces

EX MACELLO SITE
- The area is very big and messy
- Part of the Macello is used also today
- A new planned street risks to divide the site

*F.2.25 - SWOT analysis*

to the future project, on wich the design will focus. So the aspects are related to the Ex Macello site and its context.

After all the considerations I have to make a premise concerning the following design phases, the masterplan and the concept. They are focused just on a part of the entire Ex Macello site. The poultry market is in fact excluded, since a part of it is still used today. Anyway a connection between the two areas is provided. In addition to that, as the mobility network analysis announces, the municipality planned the creation of a new connective street between the neighbourhoods, also the portion on the right of this new road is excluded from the plan. The area is mostly dedicated to a park to separate the huge buildings of the General Markets from the new type of use of the site.

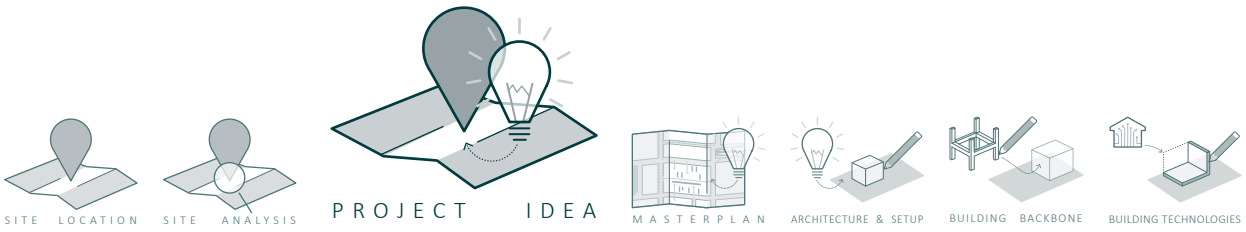


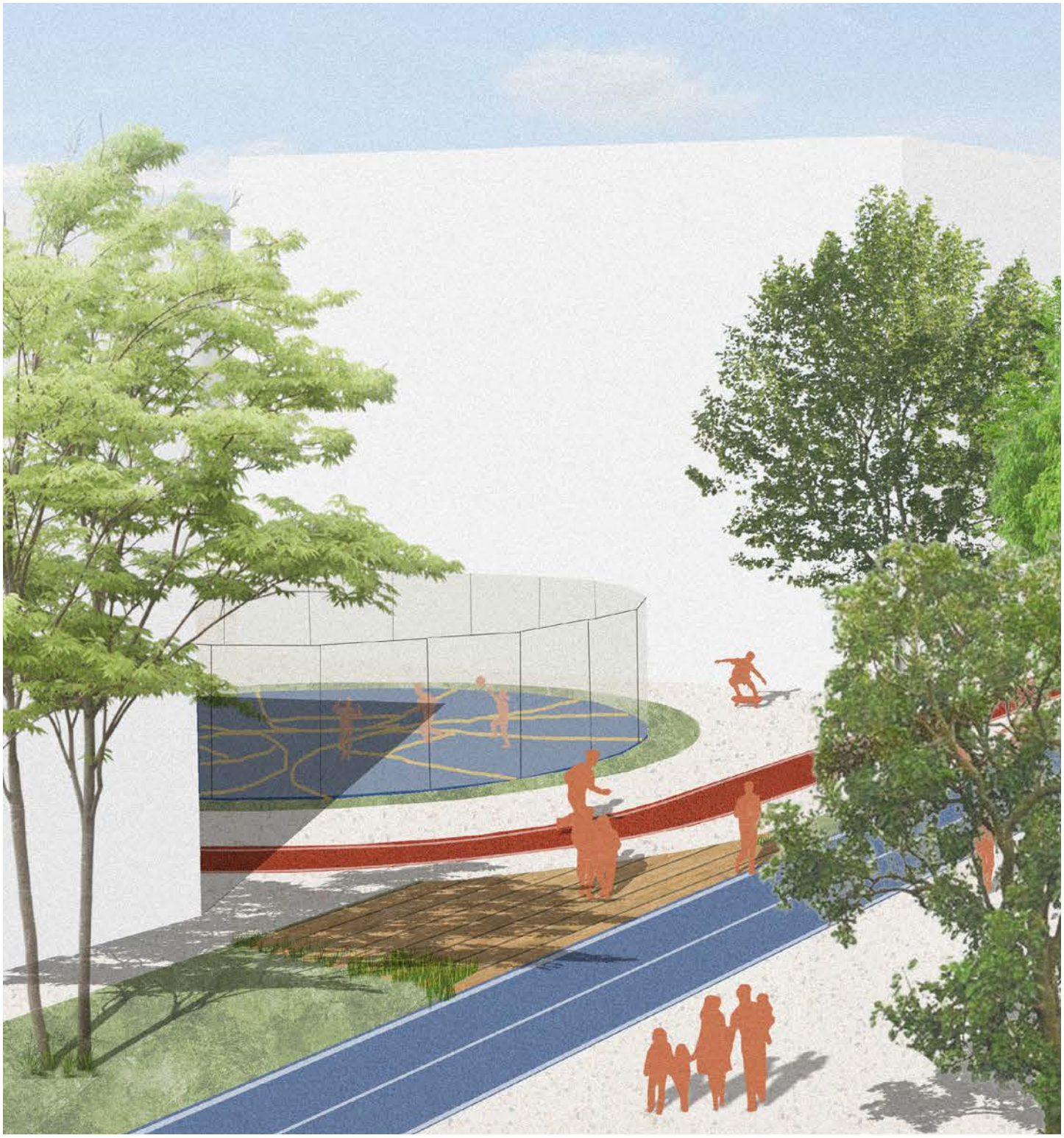

*F.2.26 - Design area*

CHAPTER 3

# Project idea

## concept & masterplan generation





*VIEW 1 - Project idea level of detail, view on the main longitudinal pedesrtian street referring to the complete masterplan. Semi-private,*

*residential block on the left and public functions block on the right*

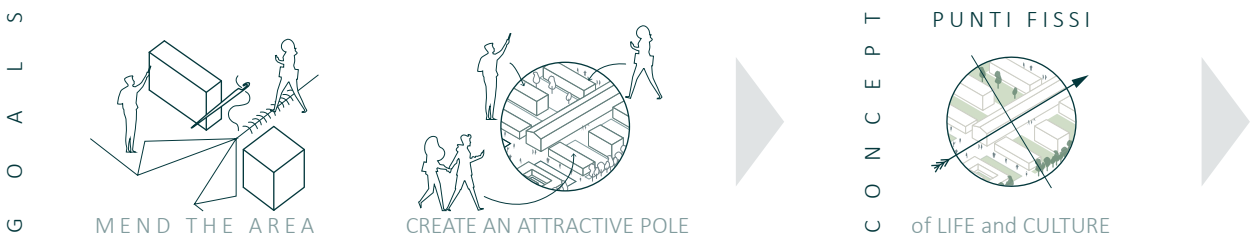
## CONCEPT

The concept phase of the design process focuses on creating the initial project vision. This means not only establish a baseline, but also support and develop it through goals to ultimately achieve. The two primary goals are: mending the urban fabric (the area and its neighbourhoods) and create an attractive pole for the surrounding community. Although the two goals serve their individual purposes, they are both heavily connected to one another and cooperate to achieve a unified and effective project.

Following the Reinventing Cities competition prescriptions, the intention is to «promote urban and environmental quality and social and operational mix».

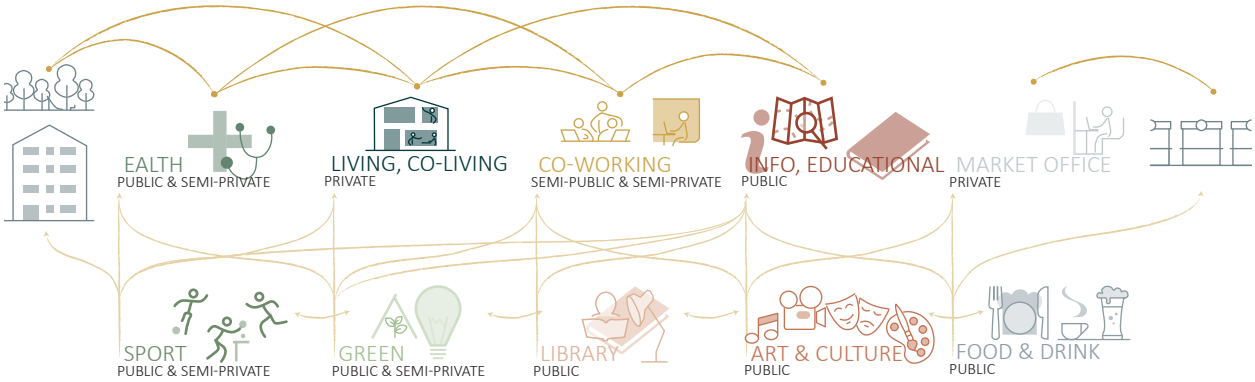
Practical and effective strategies help achieve the goals, finally leading to their implementation through the masterplan. Reminding the site analysis, my choice is to: promote sport and athletic activities in the area, at an amateur level, flanking the high residential concentration; promote a healthier lifestyle; have suitable work, study, and playful places for the neighbourhood residences.

The new facilities should be able to fill the lacks in and around the site and relate them to the existing ones. The main surrounding uses are residences, green areas and general markets. Health, living, co-working, info and educational, market offices are the primary functional goals. They are supported and connected to




*The project includes ordinary life functions serving people who live on the site or the area around it. My purpose is to create a daily life attractive pole for people. Translated not in simple and closed residential complex but in an interactive mix of opened and closed spaces with functions and facilities able to satisfy the need of shareable areas for people of all ages. So, the proposal for the Ex Macello is to fit into the context with the ambition of being one of the "punti FISSI" of people's life and culture.*

*"Punti FISSI" is in English "fixed points", composed by some baseline words, in "F.I.S.S.I." : the letter* **F** *of flexibility, opposed to the same adjective "fixed", evidences the need of reference points able*



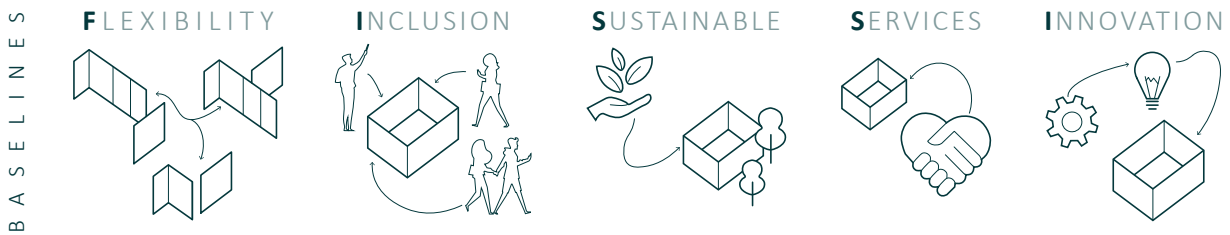

*F.3.1 - Functions and relation between them*

LEGEND

Primary functions connection

Secondary functions connection

some secondary functions: sport and green spaces, coming from the same health category, library and art and culture, from the educational branch, food and drink, finally, are in reality, present to support all the other facilities. My desire is to interconnect all the facilities, opened and closed spaces, in order to avoid net separations, except for the case of the market offices.




*to adapt themselves to the situations and needs of everyday times;* **I** *from inclusion announces the desire to involve the community to live the project, as much as possible, sustainably; from here comes the* **S***: sustainability is an important requirement today and it has a lot of applications (environmental, economical, cultural sustainability); Finally* **S** *from services;* **I** *from innovation, this last concepts are particularly important to support and educate about change.*

*The compass allows you to orient yourself by pointing north. the symbol of the concept schematically recalls the compass. whose pointer has its center in the project area and points towards the "Galleria", the connecting element of the project and the historical reference of the site.*

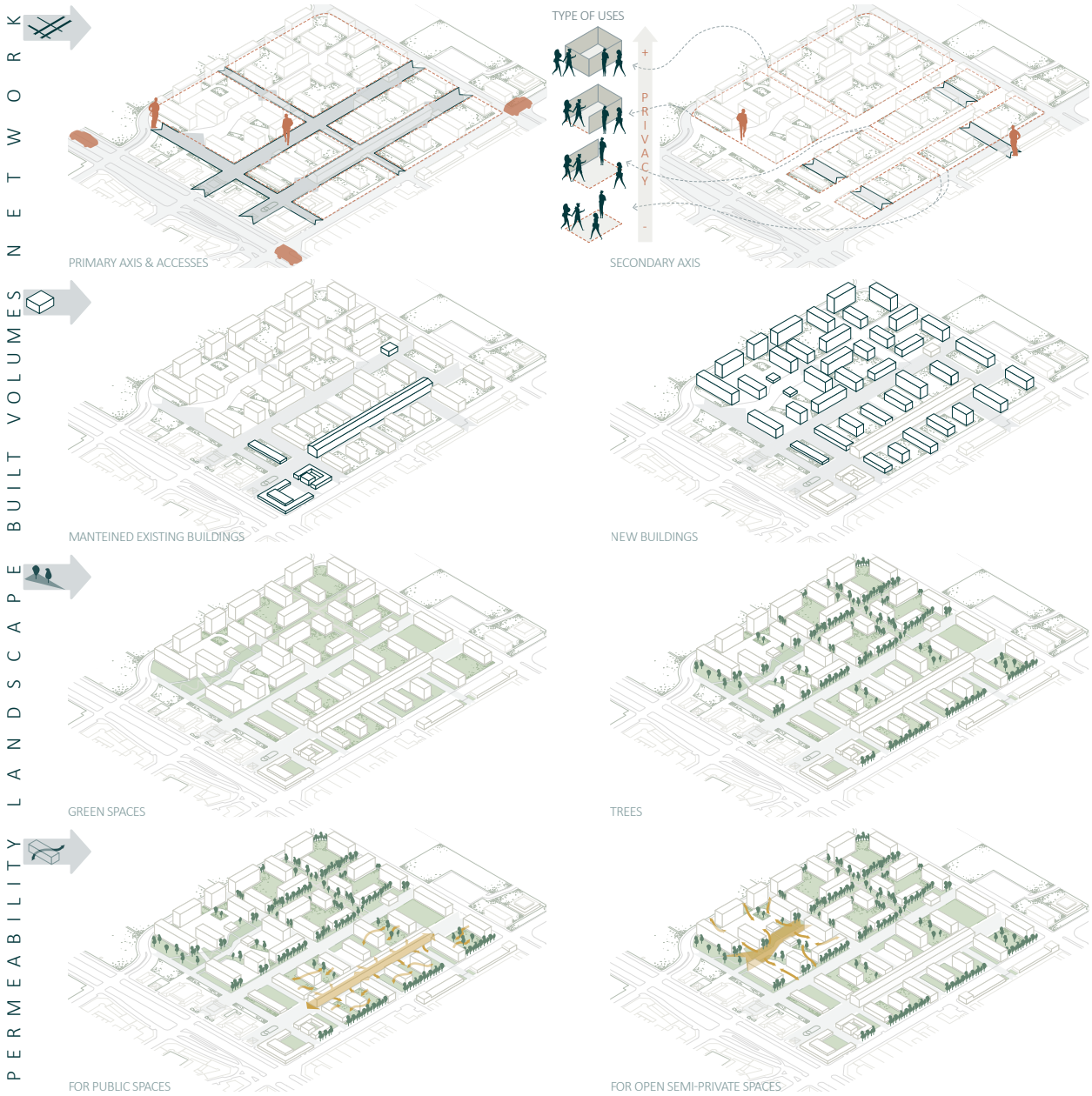
## 1. MASTERPLAN GENERATION

The concept and the strategies are now transferred to the masterplan. This phase focuses on the creation of a new distributive plan of the area, combining all the practical solutions in a unique design. The masterplan is composed by the street network, built volumes, landscape, concerning green spaces and plants positioning, and permeability. The area is mailnly subdivided in two by the central horizontal axis, from the mid building of “Palazzine Liberty” site, along Viale Molise, which I believe can be an emblematic entrance.

*F.3.2 - Three-dimensional schematic Masterplan concept - A. network; B. built volumes; C. landscape; D. permeability*

While the upper block has a residential type of use, private and semi-private with an outdoor space opened to the public. The lower block has a different conformation, developed around the maintained “Galleria” building. This is a public and semi-public block facing Cesare Lombardo street.

As the figure shows, the site is characterized by a lot of green areas all around the buildings. While the streets around the site are vehicular, the paths in the Ex Macello site are all pedestrian, to promote and raise awareness of sustainability and healthy viability.



### *A. NETWORK*

The primary roads separate four blocks with complementary type of uses and provide the basic connections between the vehicular streets. Part of the grid are the two horizontal axis, with the already mentioned large central axis, and two vertical axis, one, smaller, separating Palazzine Liberty and the design site, and another one which passes through the Galleria. Of course, a secondary grid facilitates the mobility. The grid sometimes is more regular, while in the residential blocks is irregular: a sort of sinuous path in green corridors.

The two blocks around the Galleria are public and semi-public. The one facing the Palazzine and the park on the railways is semi-private, with a big ground space dedicated to amatorial sport. The last block, on the upper right angle of the site, which is the more reserved one, is private. So there is an increase of privacy on the streets with the lower traffic level as well as other buildings presence.

### *B. BUILT VOLUMES*

Few of the existing buildings are maintained and renovated. The first reason regards the decay and secondarily the adaptability of themselves to the new functions. Most of the buildings are disproportionately big and their maintenance isn't sustainable. The emblematic Galleria is preserved as an element of connection, as it was its function also in the past. I decided to keep other few buildings of small dimensions, since they can be easily transformed, or they are particularly significant, and they can transfer to the new plan their character.

The new volumes are disposed of differently following each type of use needs. The volume heights rise towards the park to the north without reaching more than 23 m high, which means seven floors above ground. As from the following urban sections, the scope is obviously to reconnect the site with the surrounding buildings.

In the public and semi-public block, the new volumes are arranged in a comb with respect to the central core of the gallery. The semi-private block volumes create a big court, opened at the ground level, while in the private block the courts are smaller and close to the outside.

All the new buildings are constructed following a modulus of 12x12 m. This allows the light to reach the internal spaces, as it was in the buildings of the past.

### *C. LANDSCAPE*

The green spaces are almost everywhere on the site, balancing the natural environment and the built one. It is free and accessible, to make people use and take care of it. The green areas in the private courts are reserved and accessible from the inhabitants. The trees are more present in this area, to give more privacy and a pleasant view. In the public spaces, the plants are used to play with the buildings instead of creating a

barrier. This happens only in the case of the view on Viale Cesare Lombardo, to protect from the noise and the pollution of the street. The scope is also the one to contrast the other side of the street, with a strong natural element.

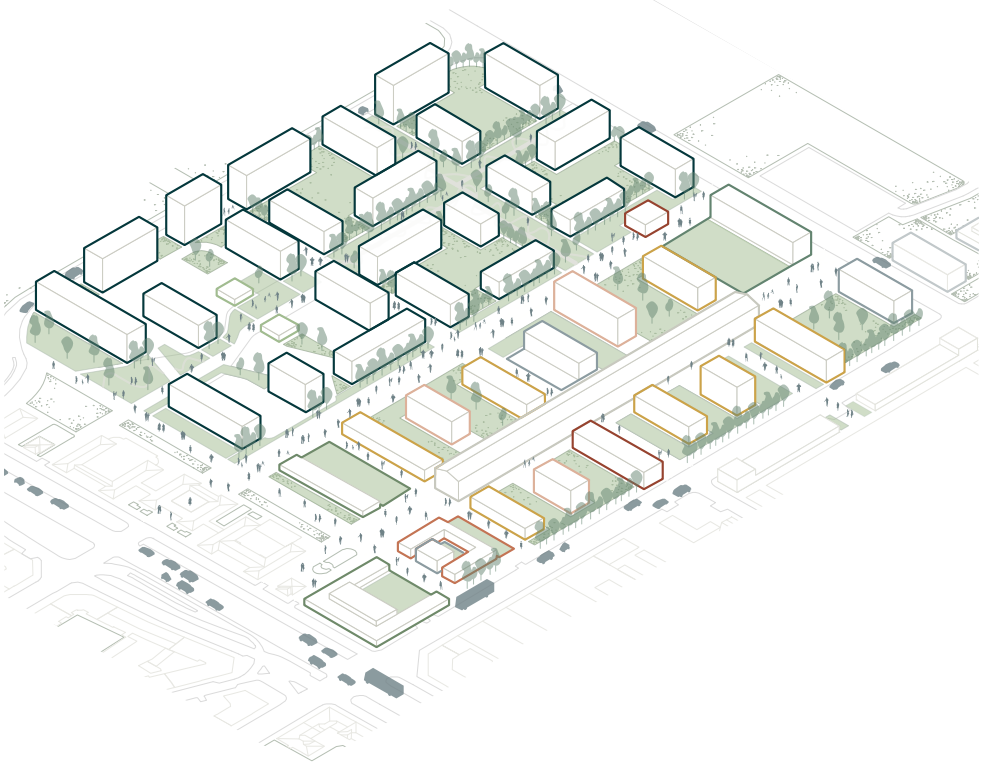
### *D. PERMEABILITY*

In the previous concepts, I already mentioned accessibility. This deals with the permeability of the site. At a very general level, the area is very permeable from each of its sides. In the specific internal blocks cases, the permeability is high also through the buildings, concerning the public area. The semi-private one instead, is opened at the ground level, as already mentioned. In the private block, the permeability is restricted.

## 1.1 MASTERPLAN FUNCTIONS

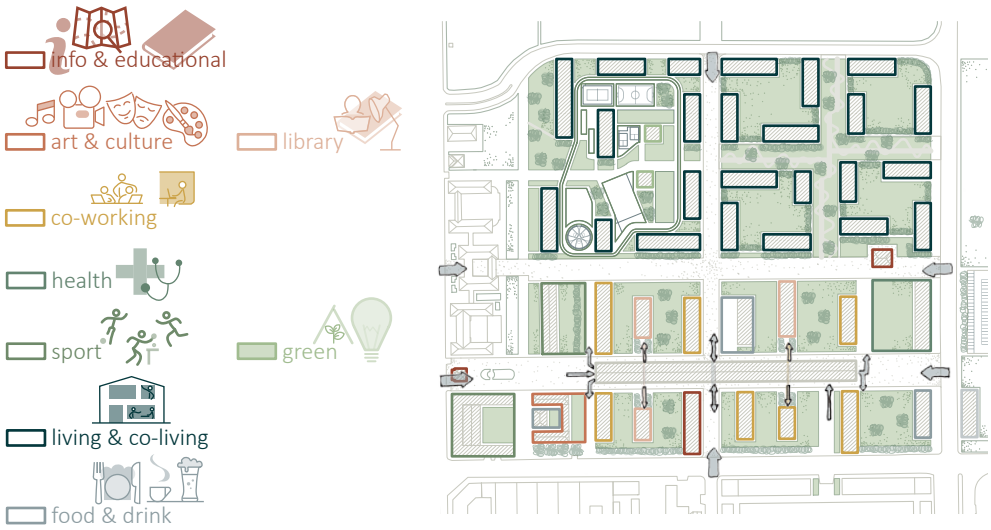
Here each facility is placed in the buildings. The functions, together with the design, permit to create relations and to imagine how the people will use the spaces. In the plan (at the following page) are shown also the principal accesses to the site and to and trough the gallery building, which works as a connection.

Deeping the public area, direct access is given to the info and educational function, which introduces the site being a point of reference too. The most common function is the co-working, represented in yellow.



*F.3.3 - Three-dimensional schematic Masterplan functions concept*

The other facilities are mixed with the co-working buildings as they, together, create a network of functions useful to each other.




*F.3.4 - Schematic Masterplan functions concept and legend*

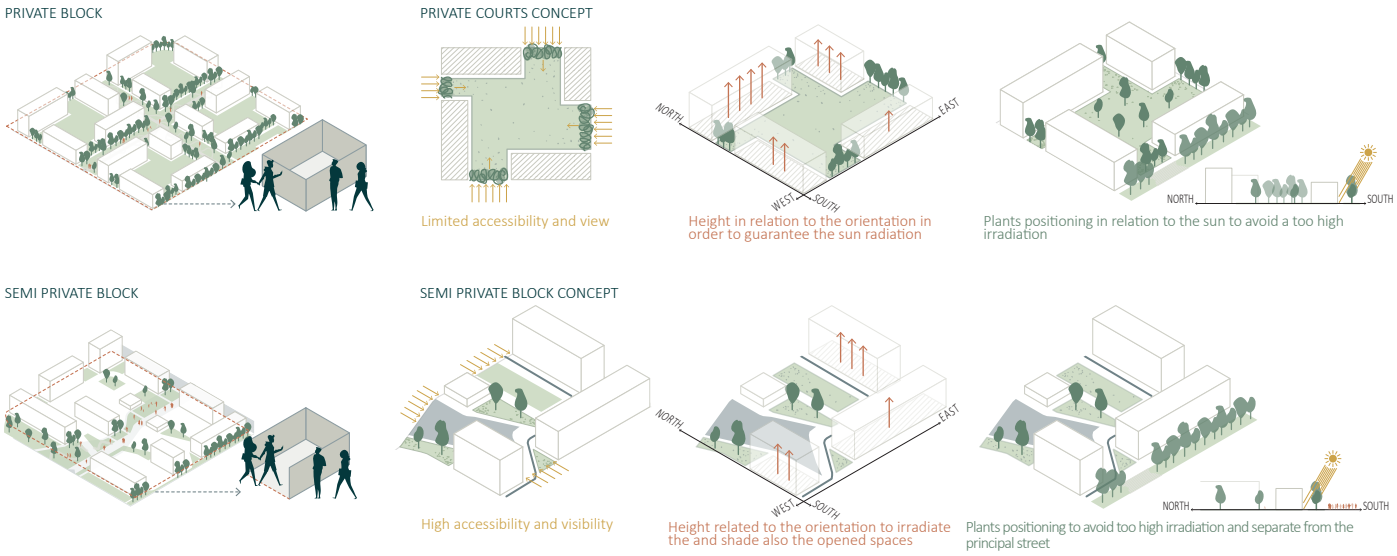
## 1.2 MASTERPLAN BLOCKS

As mentioned, the blocks forming the masterplan are differentiated by different privacy levels and functions. This first two blocks are residential, with different privacy levels:

The most private block is constituted by courts, inserted in a green context, which distances without dividing them and creates an occasion of a connective natural space. To increase privacy it has been decided to avoid to close them completely to the outside, instead, some natural elements are exploited to limit the accessibility and the direct view to the inner space.

The disposition and height of the buildings composing the courts have been studied according to the orientation, going from south to north and from west to east the volumes becomes higher, to let the light reach all of them. At the same time, solar radiation can become a cons, in the hot seasons. A correct trees positioning allows to reduce the direct sun in the hot months and to let it filter in the cold months when the leaves fall and the solar radiation can give some benefit.

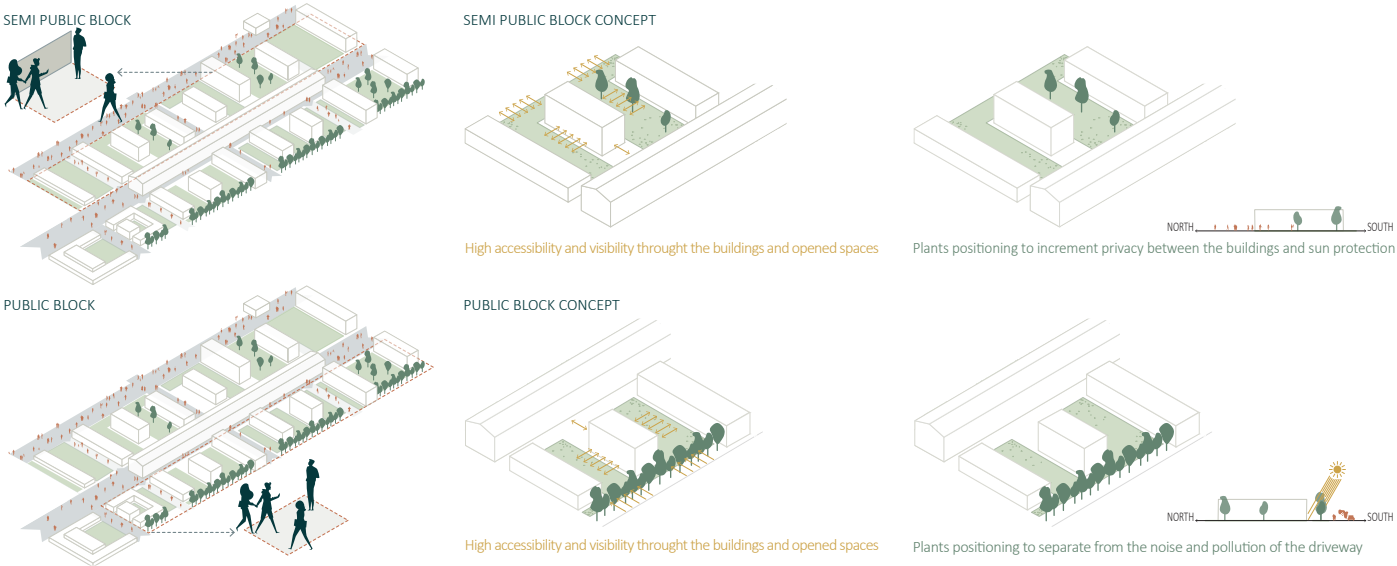
Looking at the scheme, the semi-private block follows the same ‘rules’ from many points of view. The composition is instead completely different: in this case, the intention was to create a unique big court, able to be opened and accessible at the ground level. Here in fact is where are positioned the amateur sports activities.




*F.3.5 - Masterplan residential blocks concept*

The semi-public and public blocks are very similar and works together so they need to be considered as a unique block.

The volumes disposition works in relation to the maintained buildings and especially the Galleria. The volumes are located, with respect to the Galleria as if to form a comb: like if the same buildings become the streets to go through. Differently from the previous blocks, here the buildings are opened to the external space and interact together. At last, the trees along the car street on south, become a sort of barrier not only from the sun but also from the noise and pollution.

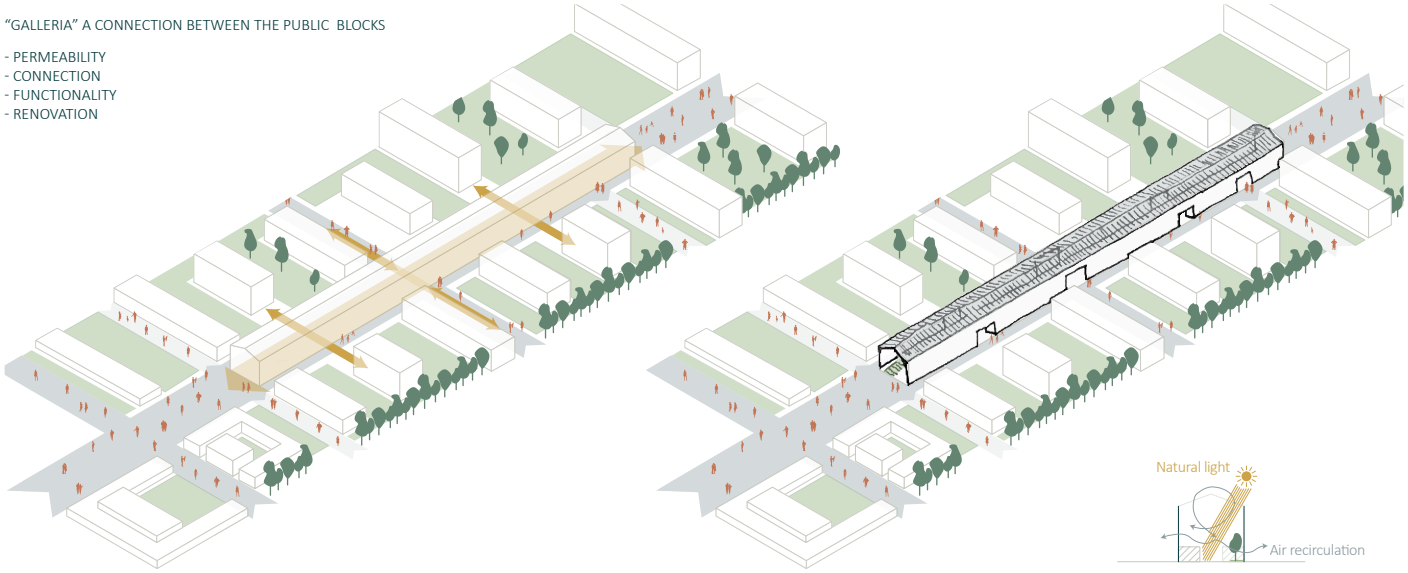



*F.3.6 - Masterplan public blocks concept*

## 1.3 GALLERIA

The Galleria assumes a really important role working with the public functions. It embodies some basic concepts, the first one is the renovation of such an emblematic element. Renovation also in its function: in the past the Galleria were used to connect the buildings together and also now this function is maintained like a reminder of the past and an occasion for the future. We use to think about a building as a closed casing, opened ad permeable only where we want it to be. The concept of permeability completely cover the Galleria, full of openings. It is permeable by the human but also from the light, the air, the nature. The building interacts with everything able to give it life, without loosing its functionality. As said it is an element of connection, but at some point it can also become an occasion to stop and to use it.

The building becomes integrative part of one of the principal axis and it is enriched by additional functional elements to live it. The functions recall the ones already present in the site, as a reference, without substituting them, but becoming a sort of exposition of them.




*F.3.7 - Galleria concept*

### *STUDY CASES FOR THE GALLERIA*

### AUDITORIUM PAGANINI, PARMA

The Auditorium comes from the idea to transform a dismissed industrial zone in a modern 'sound factory'. The space have been reinvented to eliminate the boundaries between the architectonic space and the natural one of the park. The project maintains the two massive walls 80 m long, with a roof resting on

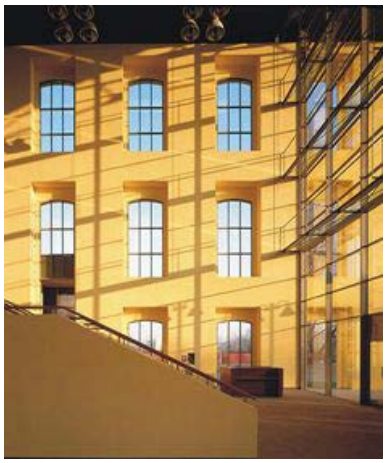
steel trusses. The architecture reinvents the space creating a visual telescope which conservates the two walls and to which it contrasts two entirely glazed transverse walls. These permit the view on the sorrounding park.

The building typology is the same of the Galleria and, even if the intervention reguards a closed building, it is really interesting how the contact with the outside is always preserved and favoured.

*F.3.8 - Internal view, pre renovation*

*F.3.9 - Internal view, after renovation*

*F.3.10 - Auditorium Paganini External view, after renovation*



*F.3.11 - Entrance view, after renovation*

## MALOPOLSKA GARDEN OF ARTS, KRAKOW, POLAND

The building introduces new spatial order: starting from a multifunctional hall, which was entered into the outline of the old, 19th-century horse-riding arena, used in the last years of its history as workshops and storage space for the Juliusz Słowacki Theatre in Kraków.

The architects focused on interaction with the fu-

*F.3.12 - Internal view*

ture recipients. The openwork roofing raised over from the garden level on the side of Rajska Street, doesn't work as an actual roof, it transports the gateway to the stage directly out onto the street. In this way, the building delicately nudges passers-by, giving the onlooker the impression of going beyond the borders of a garden, where culture is grown.

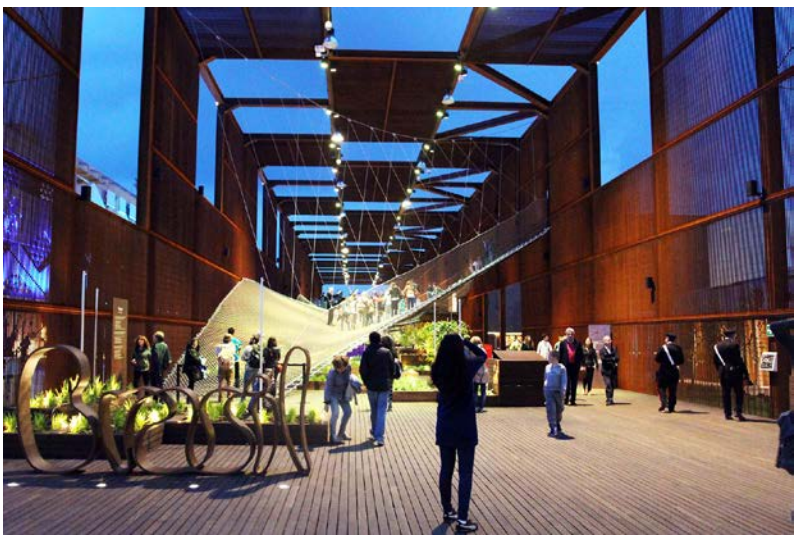
In conclusion, one of the most interesting aspect is how the architects worked on the building envelop and how they tried to attract people with a permeable facade. The final impact is the result of the designers' sensitivity to signals coming from the environment, like the opening in the perforated roof of the garden, for the growing maple tree.

*F.3.13 - Garden detail*

*F.3.14 - External view*

## BRAZILIAN PAVILION FOR EXPO MILAN 2015

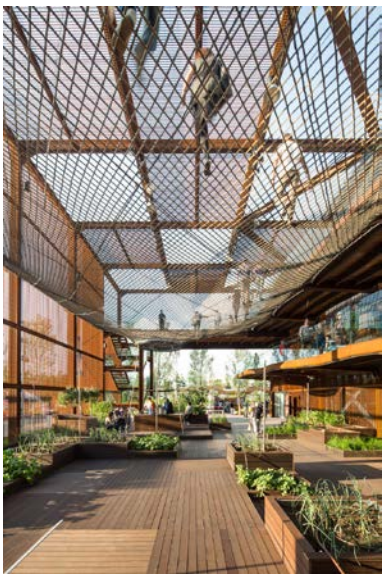
The intention is to create a public square the daws people together and engenders curiosity, a sensorial immersion which includes: leisure, high technology information, interaction, learning. The Cartesian grid in this long rectangular shape building plays with organic landscape, in a game of superposition and dialogue between the hand of man and the forces of nature. The project gives a lot of importance to the environment and biodiversity: as one of the most important source of the Planet, it is the protagonist and the sustainability is everywhere, from the construction/deconstruction system made up with prefabricated modules, to the water reuse mechanisms and



*F.3.15 - Brazilian Pavilion entrance view*

the employment of certified and recyclable materials. At the entrance, the visitor is wrapped by a space dedicated to Brazilian plants, flowers and fruits, mixed to game and information workstations. The addition of the suspended network makes everything more intriguing for the public, interacting with them and the building itself creating a pleasant atmosphere.

*F.3.16 - Pavilion concept*



*F.3.17 - Internal view*

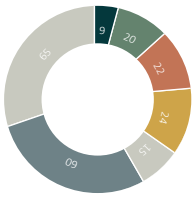
*F.3.18 - External view*

## 1.4 MASTERPLAN

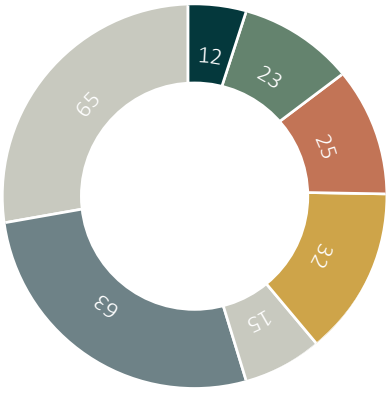
The final aspect of the masterplan is the one showed in the boards 2A and 2B, respectively concerning the plan and the elevation of the project.

As can be seen the project fits in the site with a lot of green areas which I think can be pleasantly appreciated. The project recalls some parts of the surroundings. The residential courts surrounded by greenery, remind the traditional courts present in the south west side of the plan. The semi-private opened court recalls the residential complex in the north-east with some greenery. The semi-public and public block instead, in my opinion can be seen as the streets network, with the Galleria as the principal horizontal axis. We can look at the streets network as the most emblematic representation of the public soil, without limits or enclosures. If we remove the viability and we look only at the grid, we can think at it as the most permeable and accessible space with the only limit of the built volumes. So, looking in negative at this block we could maybe see it as it is this grid of accessible and permeable axis. Here people can pass through or find their destination and stay.

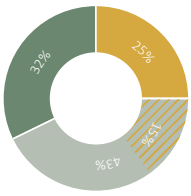
Recalling the urban analysis in chapter 2, here there is a comparison, in terms of facilities for people and green spaces, between the actual ad the project situation.



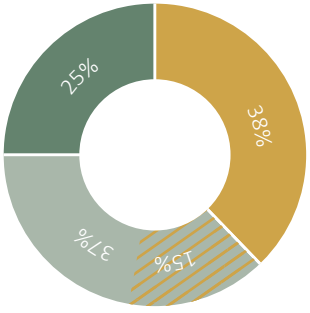

*F.3.19 - Facilities graph BEFORE*




*F.3.20 - Facilities graph AFTER*




*F.3.21 - Green percentages graph BEFORE*



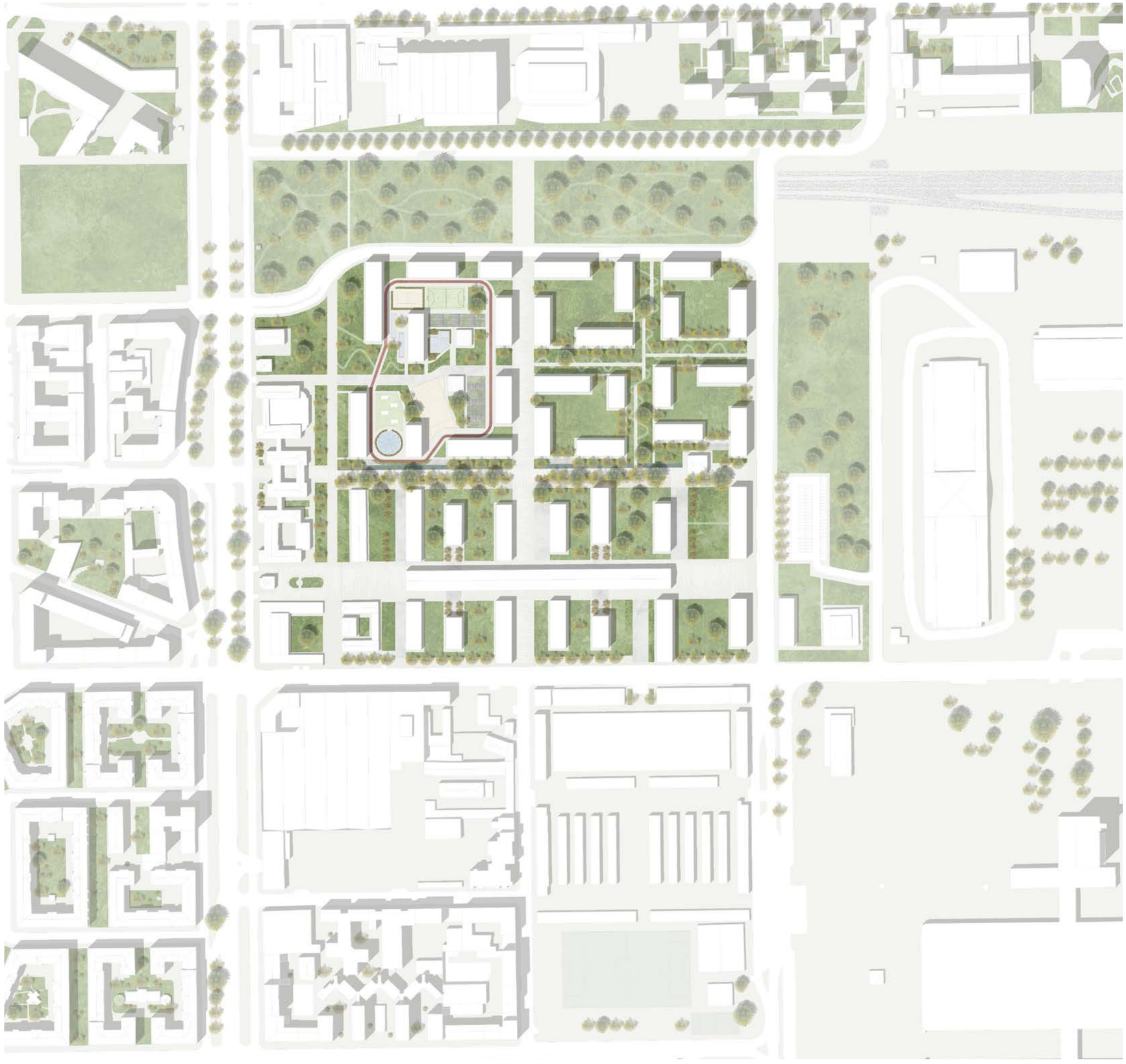

*F.3.22 - Green percentages graph AFTER*

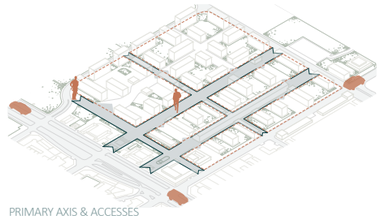
LEGEND - FACILITIES

- Educational
  - SCHOOL
  - LIBRARY
- Sport and ealth
  - SPORT
  - MEDICAL CENTRE
  - PHARMACY
- Tourism and culture
  - ACCOMODATION
  - ART
  - CHURCH
- Governamental
  - BANK
  - SERVICE FOR PEOPLE
- Leisure and commercial food
  - BAR & NIGHT BAR
  - RESTAURANT
- Leisure and commercial
  - EVENT
  - PRIVATE MOBILITY SERVICE
  - COMMERCIAL

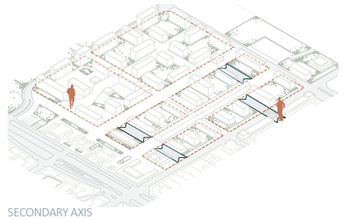
LEGEND - GREEN NETWORK

- Planned accessible green
- Accessible green
- Not accessible green/abandoned
- Private green

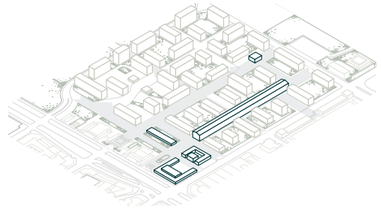




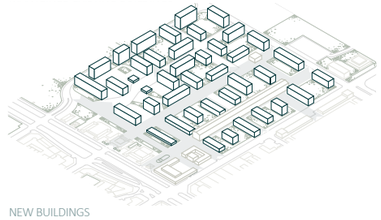
PRIMARY AXIS & ACCESSES



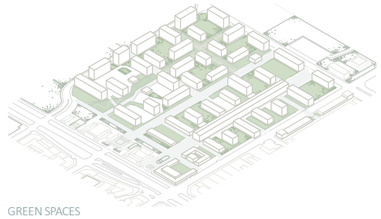
SECONDARY AXIS



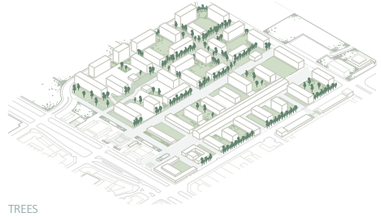
MANTEINED EXISTING BUILDINGS



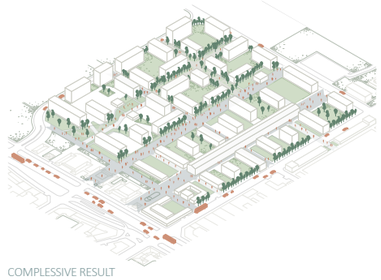
NEW BUILDINGS



GREEN SPACES



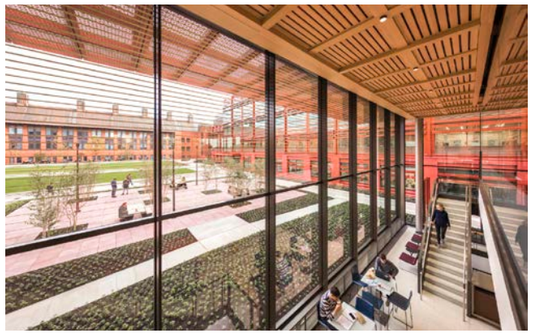
TREES



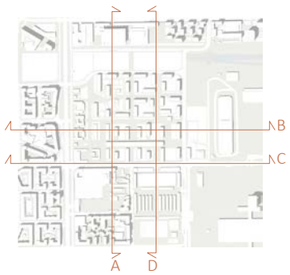
COMPLESSIVE RESULT

Masterplan evolution

1. Yale Science Building | Pelli Clarke Pelli Architects and Stantec - internal and external views



2. Second Stage of Hangzhou Cloud Town Exhi-

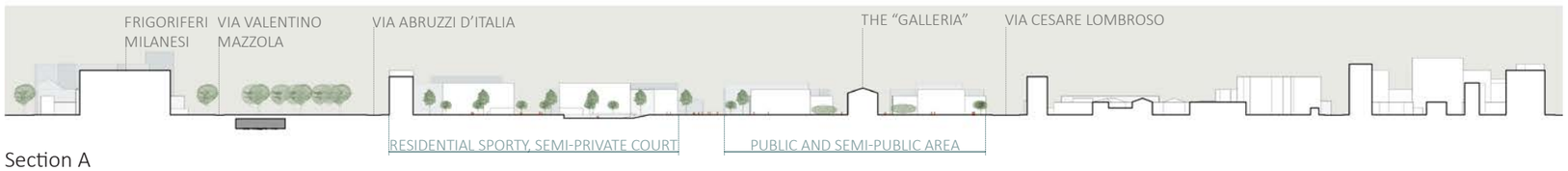



## PROJECT EXAMPLES

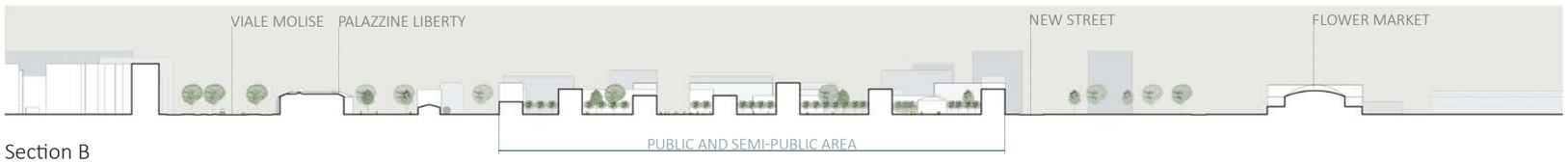
1. Public space example: the Yale Science Building expresses the relation between the internal and external spaces thanks to the transparent building envelope. The indoor ambient is airy and bright.

2. Public sporty space for leisure example: the Second Stage of Hangzhou Cloud Town Exhibition Center exploits the building roof to create an opportunity to promote sport and a healthy life.

3. Private residential courts example: the “CasaNova” Social Housing is a closed space, not accessible from the outside, but large and airy and with a broad view to the outside.

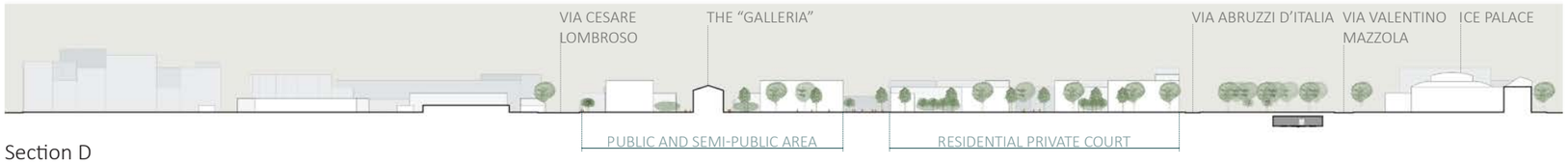



Section A

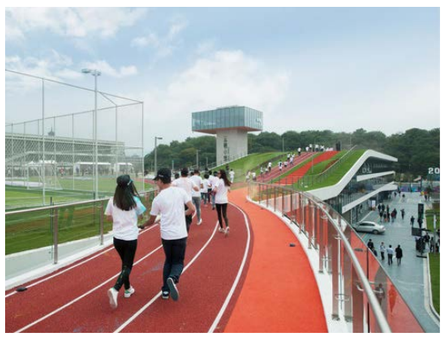



Section B

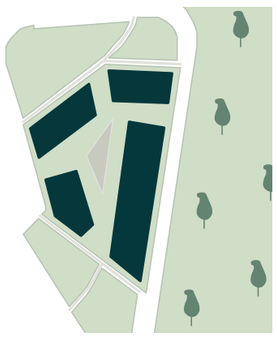

Section C




Section D



bition Center | Approach Design (ZUP) - outdoor space views

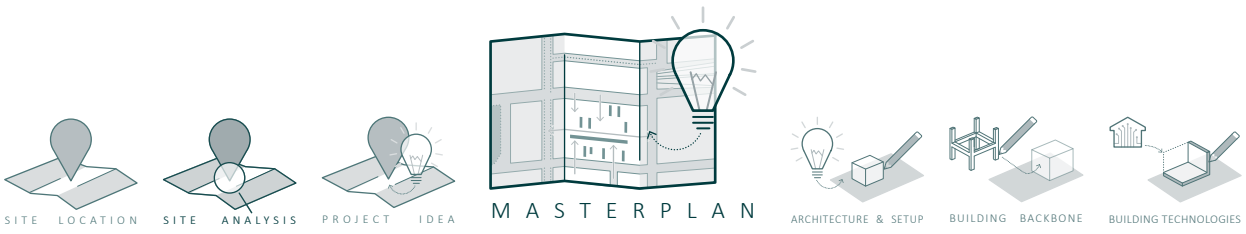


3. “CasaNova” Social Housing | cdm architetti associati - residential courts view

CHAPTER 4

# Masterplan

## functional & technological design



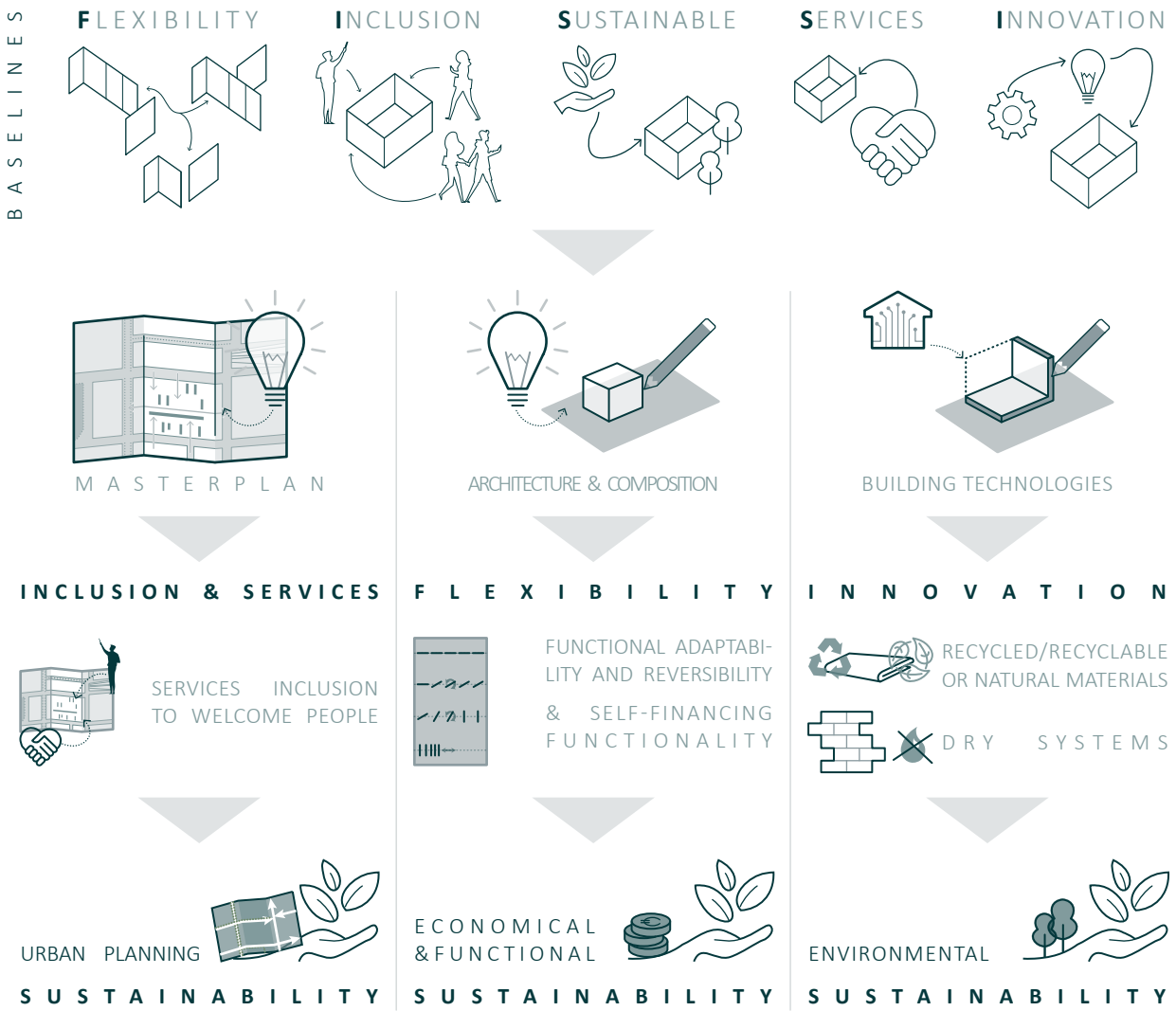
*VIEW 2 - Project idea level of detail, view from the transversal main road, residential block on the back and bar on the right.*

*VIEW 3 - Project idea level of detail, view from the southern vehicular road to the public block.*

## PROJECT PHASES GOALS

Till now the entire location of the ex Macello has been investigated achieving a suitable morphological implant at the urban scale. From now on, the project is approached on a major scale, detaling with a portion of masterplan at 1:500 scale, the building project, at 1:200 scale, and their technological and detailed aspects. At each step of the project are still valid the concept and the baselines. But in which way are they adopted now?

All the project phases are uncharged to be sustainable for the city, the people and the environment, all contributing to a good design. The design phases are one another related as their responsibility for a sustaina-




*F.4.1 - Design phases sustainabilities*

ble design. In the scheme and in the hereafter considerations different type of sustainability are illustrated for each project step.

Through services and functions are promoted inclusion and people welcoming. The goal is intended to achieve urban planning sustainability in the masterplan phase.

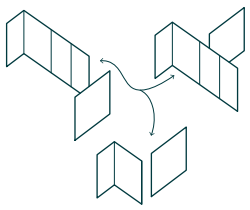
The architecture and setup phase permits flexibility in plan, elevation and of functions, through an appropriate design and configuration. The functional adaptability and reversibility of the spaces is an important issue that facilitates self- financing policy. This step is therefore concentrated on economical and functional sustainability.

Particularly in the building technologies, the innovation plays an important role, permitting an evaluation of the construction materials impact, for example. Through the use of dry systems and recycled/recyclable or natural materials the environmental sustainability is also included in the project.

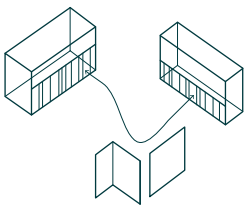
The central baseline, the sustainability, is therefore achieved thanks the others: flexibility, inclusion, services and innovation.

### 1. THE GALLERIA COMB

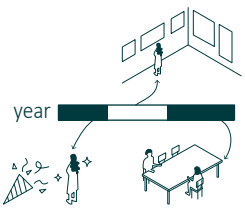
The masterplan development is now concentrated on the area of the public and semi-public functions, around the Galleria building. The Galleria, oriented east-west, together with the surrounding volumes, creates a sort of comb configuration. This setup well relates the building functions among them: the connecting and distributive one of the Galleria to the others, which provide services for people. In this plan various activities and public opened spaces, having different configurations, are linked, and made collaborative, as



FLEXIBILITY OF OPENED AND CLOSED SPACES



INTERACTION BETWEEN BUILDINGS

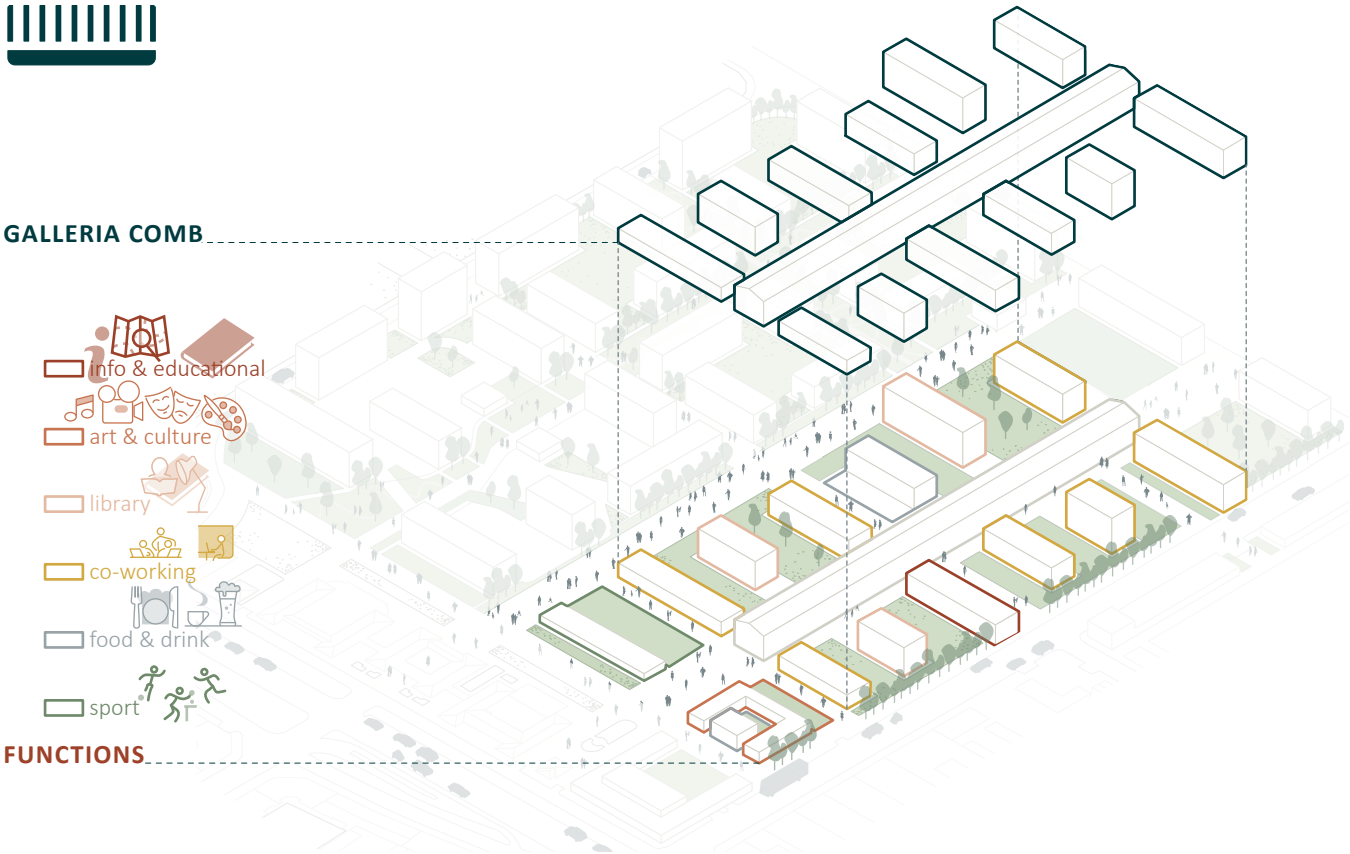



TEMPORARINESS OF USES

*F.4.2 - The COMB uses strategies*

a part of single large system. The spaces (opened or closed) are therefore flexible and adaptable in relation to the necessities.

As from the scheme of the functions (already reported in the concept masterplan chapter), the activities included in the “comb”, are related to info and educational facilities, working spaces and food and drink




*F.4.3 - The COMB configuration and its functions*

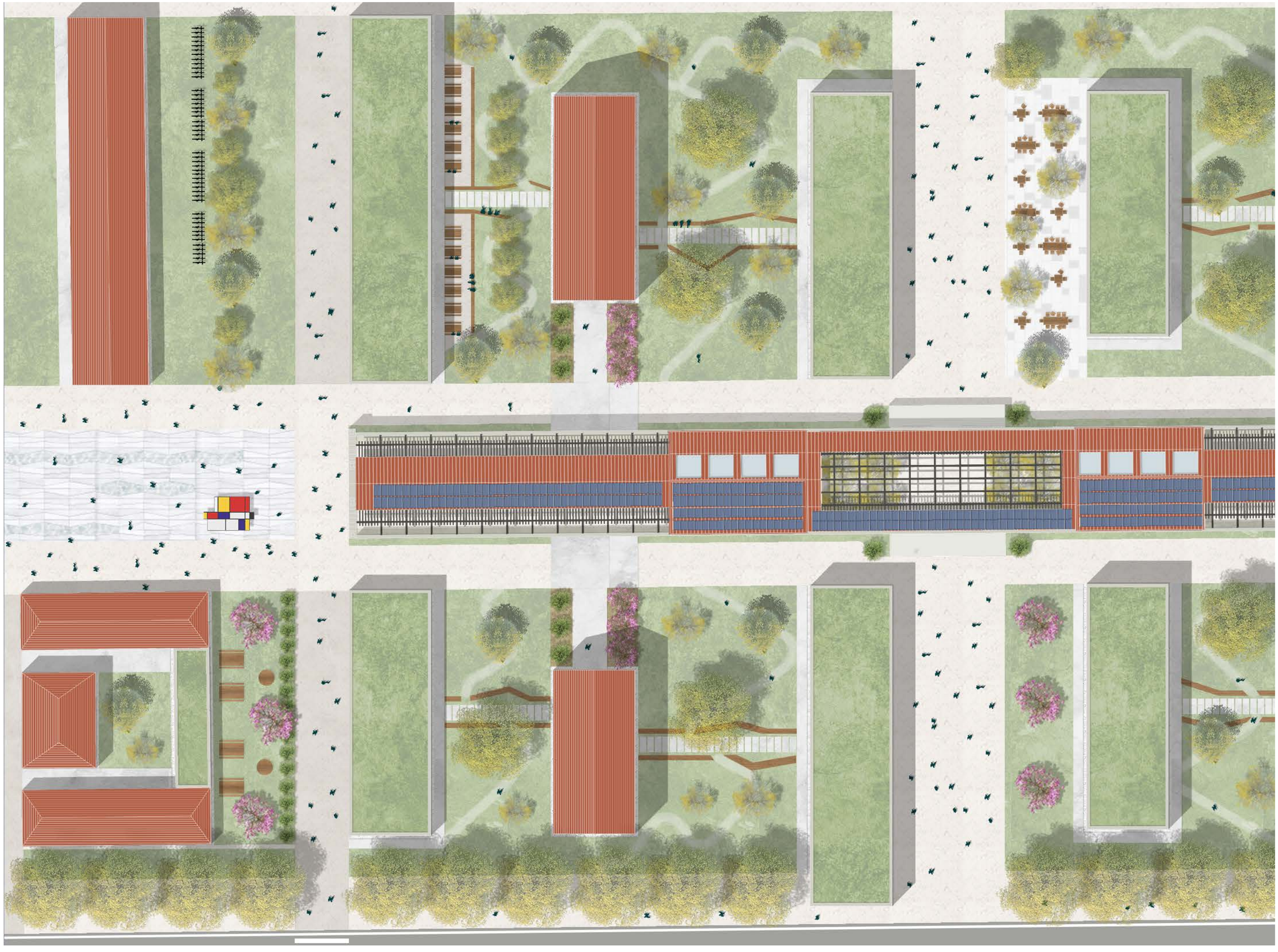
*F.4.4 - Statale di Milano Fuorisalone examples:*

*Fuorisalone 2015*

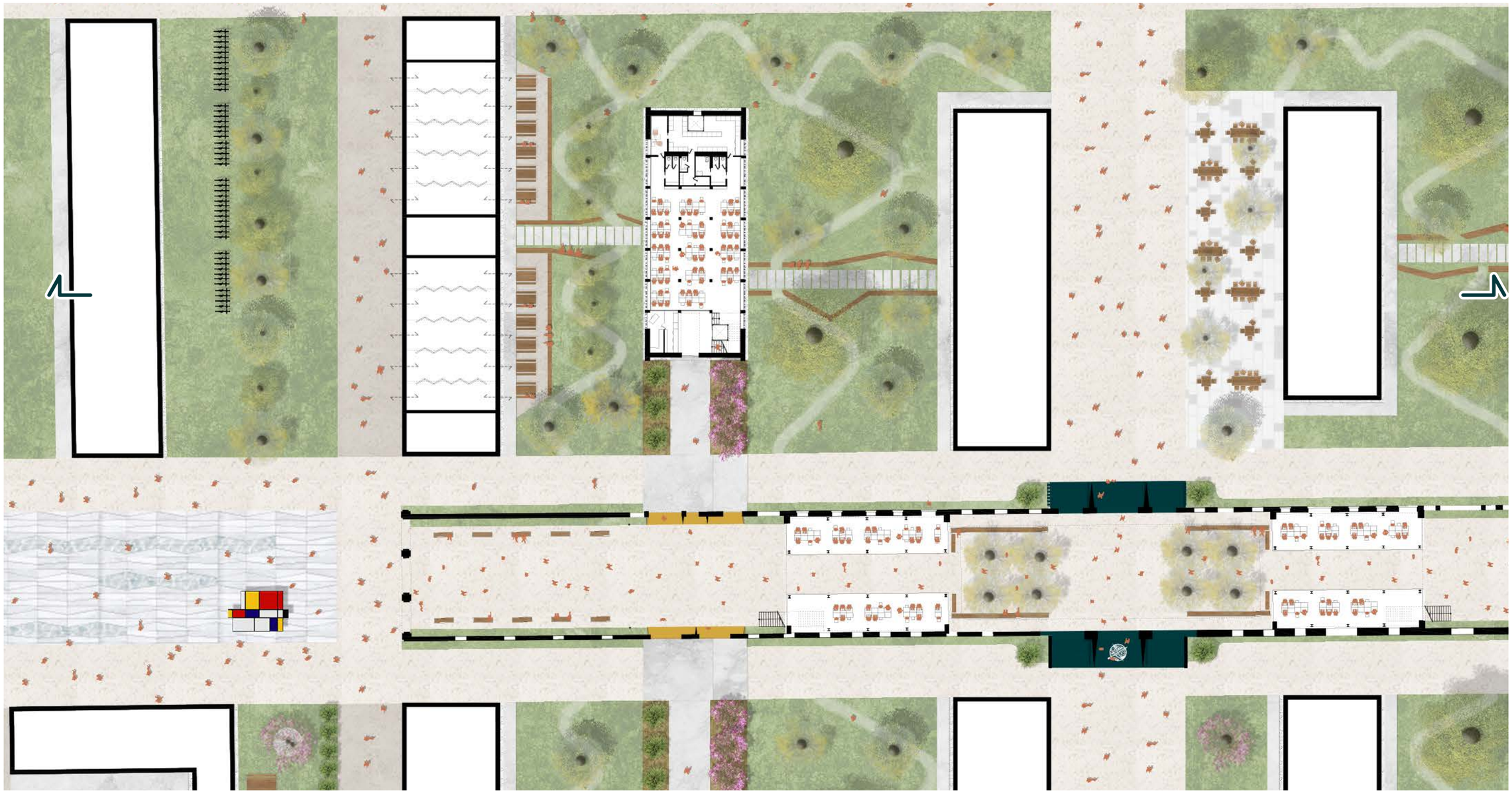
*Fuorisalone 2016*

*Fuorisalone 2017*

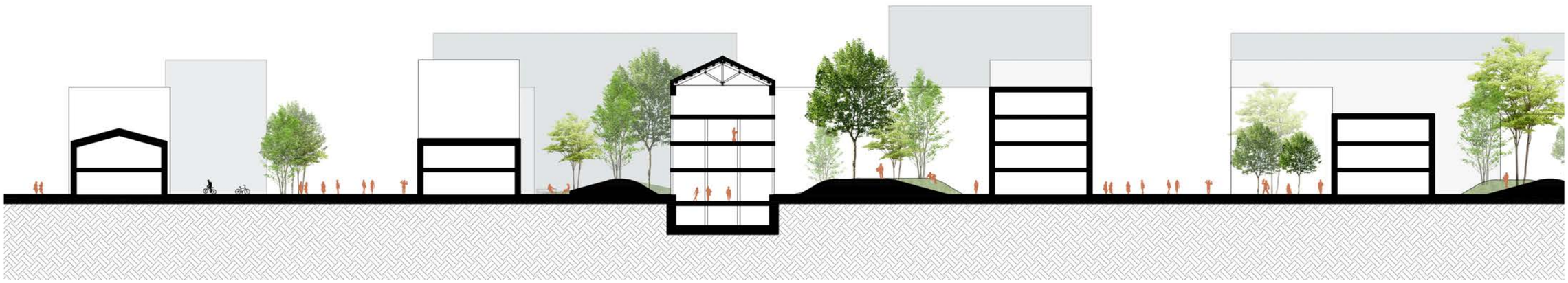
*Fuorisalone 2019*



COMB MASTERPLAN - PORTION OF MASTERPLAN | SCALE 1:500



Plan, “attacco al suolo”



Urban section

# COMB SECTIONS - URBAN PLAN & URBAN SECTION | SCALE 1:500

areas. Also, the opened spaces can be exploited for activities or temporary installations, during the year or the day, improving self-financing. An example of temporary event is the “Fuorisalone”, taking place annually in Milan during the “Milano design week”. Located throughout the city, it is constantly looking for new locations. “Punti F.I.S.S.I.” would provide storage and exhibition spaces, both indoor and outdoor, and managing offices in site. The described solutions are provided by flexibility of opened and closed spaces, interaction between buildings and temporariness of uses.

Looking at the masterplan, the big pedestrian crowded streets, crossing the Galleria, frame the small building blocks, creating calmer, sinuous green areas between volumes. The green spaces are protected by the buildings themselves and are thought as relaxing paths to escape from the messy of the city, where it is possible to take a break from the work just moving at the ground floor.

The numerous trees increase freshness and naturalness in the hot city summers. In some cases, the spaces adjacent to the buildings can become themselves their extensions. It is the case of the co-working building on the left, for example, or the food and drink building. They use external areas as extension of the internal space. For instance, they have equipped tables for working and for taking an Aperitivo, far from the vehicular street, after studying in the library or working.

From the “attacco al suolo” and section board, the relation between the buildings, their heights and the external spaces is much evident. The buildings facing the pedestrian streets are permeable and directly accessible from the long sides. The others, more hidden from the main routes, are accessible only from the short facades facing the Galleria, to which they are symmetrically related, creating a sort of crossing grid. The building of the Galleria, deeply addressed in the next chapter, present a central “Piazza”, created by the grid just mentioned: the two main axes meet in a partially covered and planted square.

## 2. TECHNOLOGICAL DESIGN

### 2.1 SCHEMATIC DESIGN

All the functional, compositional aspects investigated till now are strictly related to technological choices. Some of them have already been mentioned, in a general way, during the preliminary steps. The technological strategies are mostly related to the site climatic situation.

Therefore, recalling the second chapter’s climate analysis, we define the masterplan and the buildings responses. The heat and the mugginess in summer and the cold in winter are the major characters and they are addressed by proper strategies, reported in the hereafter schematic design.

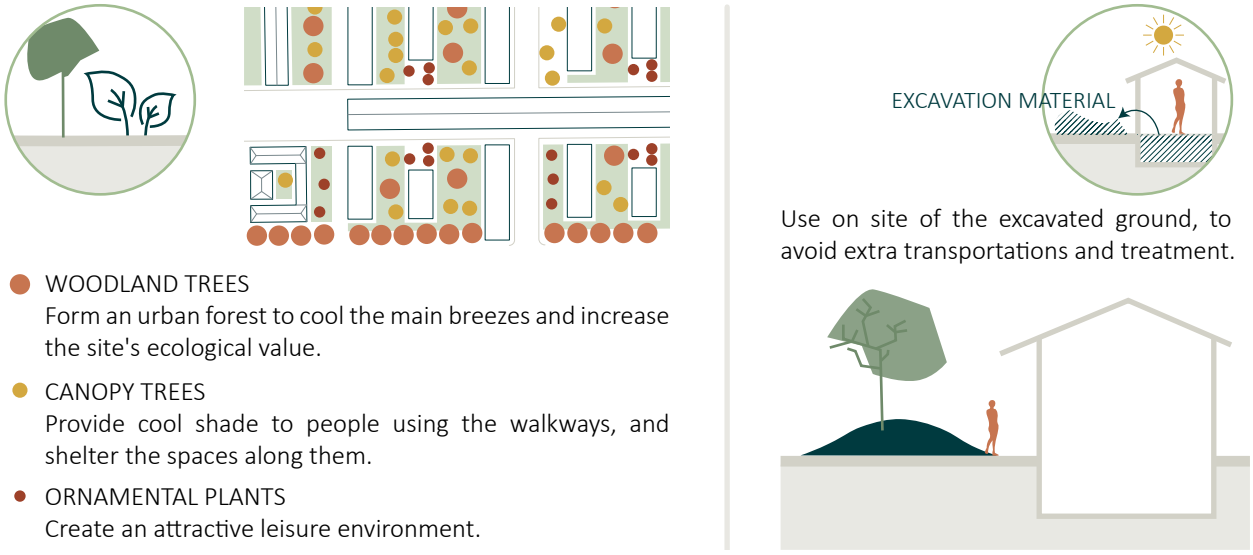
Apart from planning choices, the trees and plants planting bring strategic benefits on several fronts. From the south side, exposed to the vehicular way, the trees are in charge to create a separation from the street

noise and pollution, improving the air quality. Additionally, the trees' foliage creates pleasant shadow, which naturally filters the solar radiations, good for people and the overall environment.

The plant presence adds up to the shade already provided by the buildings. The difference between the two is the height, the intensity, and the saturation. That characteristic plays a fundamental role, especially for seasonal differentiation: solar gain in winter when the leaves fall and solar radiation protection during summer when the sun hurts the most.

The trees help to contrast the heat island effect[5], a frequent phenomenon determining a hotter microclimate in the urban areas than in the surroundings. In the same sense, it is adopted a clear flooring colour, coupled with natural soil. The choice is determined by fact related to the colour's thermal energy absorption: the white colour is the only one that doesn't attract the heat since the white objects reflect all visible light wavelengths.

Most of the time, building construction requires excavation for the underground floors and foundations. The extracted soil is usually moved off sites and worked for a new life or thrown away. The use on-site of the excavation material permits to avoid that passage and the consequent losses in terms of waste of sources already available on site and transportation.



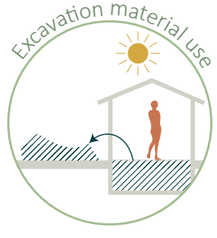

*F.4.5 - Some schematic design insights*

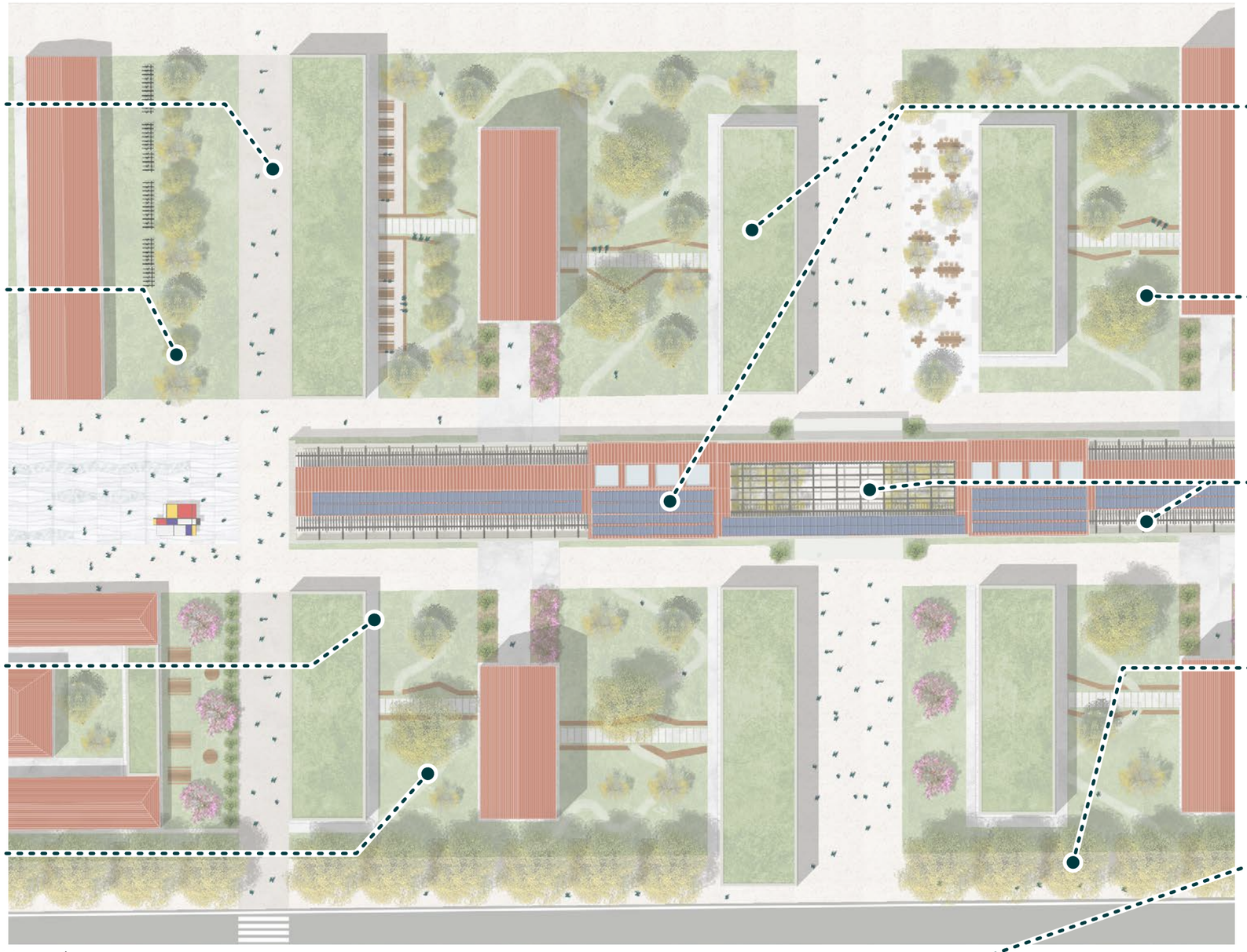
5 We talk about urban heat islands in areas where very high temperatures persist for several days and nights. The cause is the urban conformation, the quality of unnatural soil, the intense anthropic activity, the production of atmospheric pollutants. This condition can cause some harmful effects to people when, for consecutive days, daytime temperatures exceed 35°C and night temperatures do not drop below 25°C.



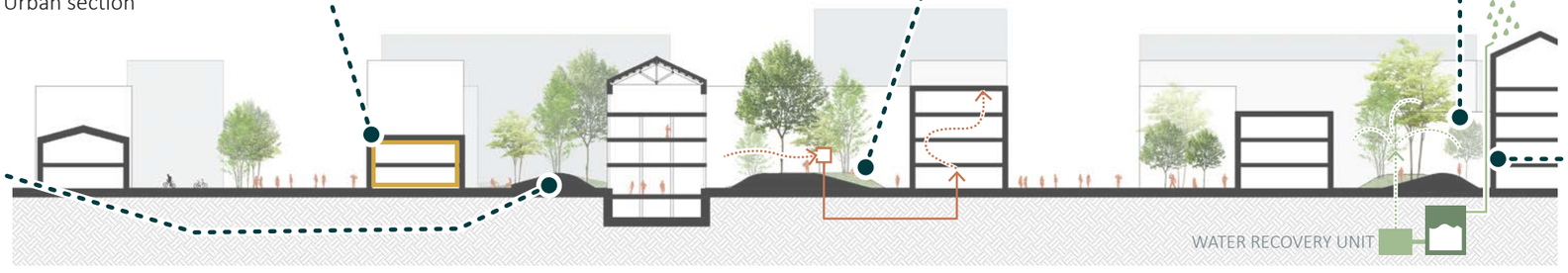
STUDY OF A PARTICULAR DISPOSITION AND CHOICE OF PLANTS, IN ORDER TO COOL THE AIR THROUGHT THE RELEASE OF MOISTURE AND THE CREATION OF SHADOW.



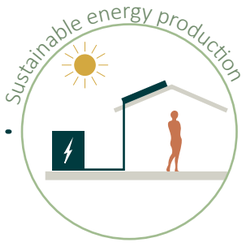



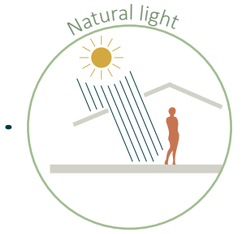
Masterplan




Urban section











Another important resource available on site is the water. The strategy is to collect it through appropriate rainwater accumulating systems on the buildings' roofs.

Other technical choices related to the building, are the exploitation of natural ventilation and a good level of insulation, avoiding additional energy consumption and losses. In the same way, also the use of natural light, favour energy saving. It also allows solar heat gain, favourable during winter or when the temperatures are low. In contrast, instead of the solar gain during hot periods, it is employed a proper shading system, which still permitting the view through itself and the glass walls.

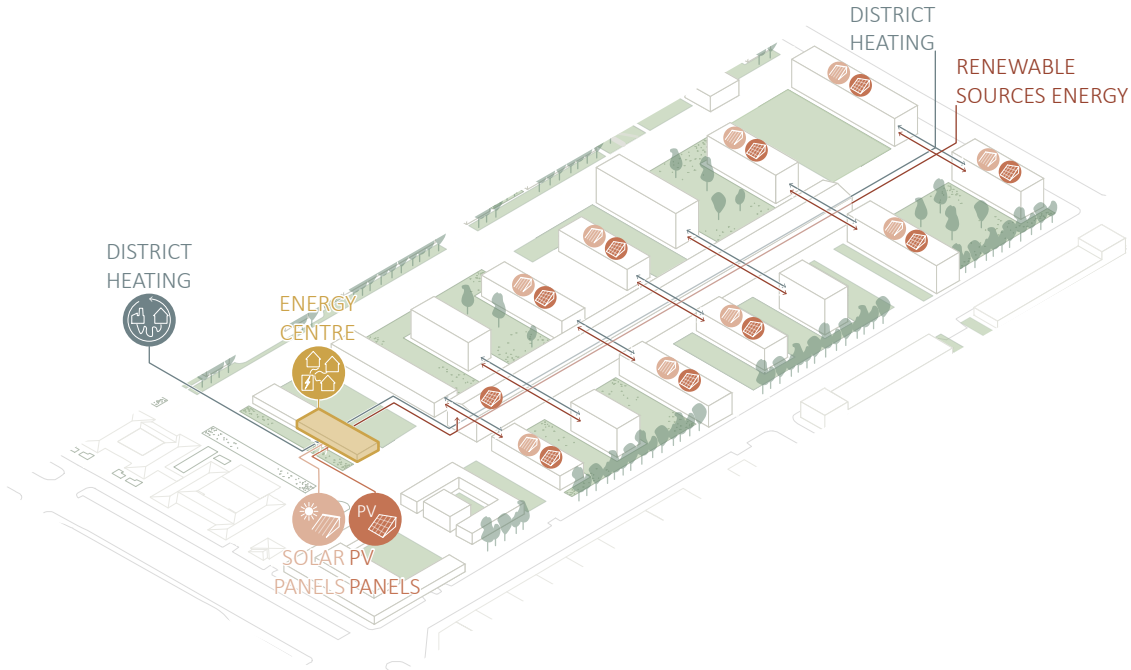
From the cooling point of view, the system is in charge to contrast the high temperatures. Even for this situation, the choice is intended to permit energy savings through underground air cooling. Outdoor air is properly filtrated and refreshed passing through underground pipes. The result is a naturally cooled environment, without mechanical efforts.

Finally, one last strategy, is the adoption of solar gain collection, receiving suitable energy production.

## 2.2 SYSTEMS CONFIGURATION

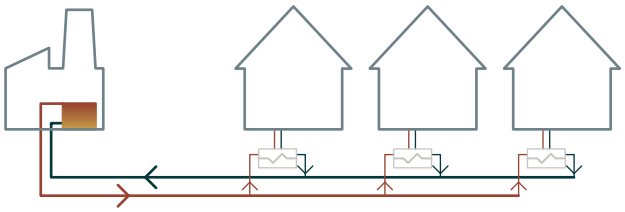
### *HEATING AND ENERGY*

Speaking of systems and energy, the site must be considered as a unicum, working collectively to achieve better results. The building and the outdoor spaces are powered by two types of sources: district heating




*F.4.6 - Energy and heating distribution*

## DISTRICT HEATING

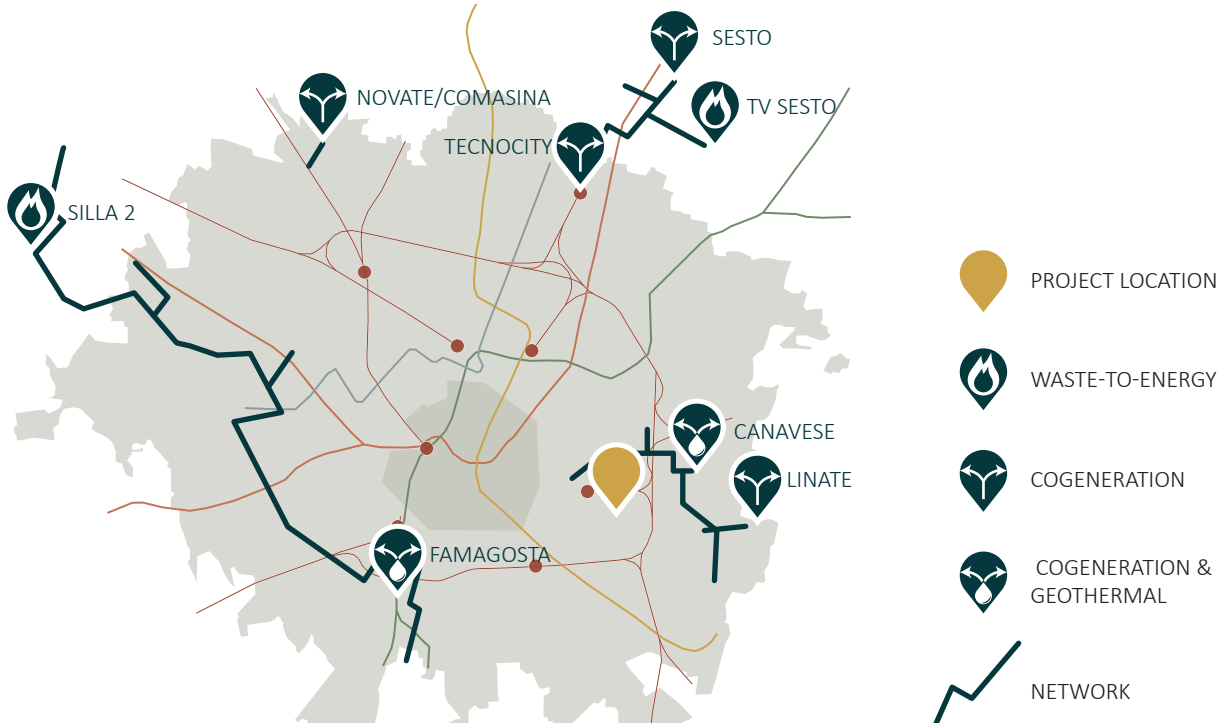


*F.4.7 - District heating indirect connection scheme*

and energy produced by renewable sources on the site.

The district heating, in Italian "teleriscaldamento", exchanges heating power delivering hot water through a network, which starts from production plants. The network works with a double pipe for the distribution of heat and the return of the cooled water, as for a normal heating system. The production plants exploit various sources for heat production, particularly used are cogeneration plants and the heat generated through the waste-to-energy process of municipal solid waste. In other cases, are exploited geothermal energy through heat pumps or waste heat coming from industrial processes.

In a city, district heating is as much convenient, from an environmental point of view, as it uses renewable energy sources and helps to implement the air quality reducing the emission of pollutants and greenhouse gases. Milan, as from the picture, counts eight district heating plants and two of them are located near the




*F.4.8 - district heating network of A2A in Milan*

project area. The Canavese one is powered by energy from cogeneration plus geothermal, while the Linate one works only with cogeneration.

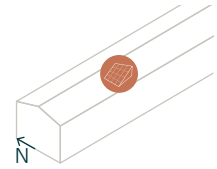
Beyond the district heating, hot water is supplied by solar panels production and additionally, PV panels are installed to produce energy on-site too. Both district heating and site production are brought to the energy centre, a building that is partially dedicated to heat and energy management. The district heating is connected indirectly to the site, which means that it takes place through heat exchangers. From the energy centre, heat and energy are then distributed to the buildings or the outdoor areas.

ON SITE HOT WATER PRODUCTION


ON SITE ENERGY PRODUCTION

The panels are generally located on the green flat roofs and the pitched one of the Galleria. This is north-south exposed and the slopes are doubly inclined at 17° and 34° degrees. Even if the panels are south exposed, the angle of incidence affects their performance. Moreover, also the localization contributes to the PV panels energy production. For instance, in the case of Milan, an inclination of 30° southerly, gives a 100% production, while northern the result is reduced to 68%. So that, for the 17° panels it is applied a correction factor of 95% and for the 34° inclined panels, it is used a 99% correction factor.

To approximately evaluate the number of panels positioned on the cover, they are considered panels 990x1660 mm (230 W) each. The 17° slope can host 282 panels while the one of 34° can receive 142 of them so that the total expected production is around 104518,9 kWh/year.



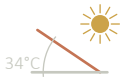

ESTIMATED PRODUCTION FOR THE GALLERIA:

Panels characteristics: 990 x 1660 mm (230 W);

SOUTH exposure;

Double inclination of 17° and 34° C.


x 282 panels; correction factor: 95%

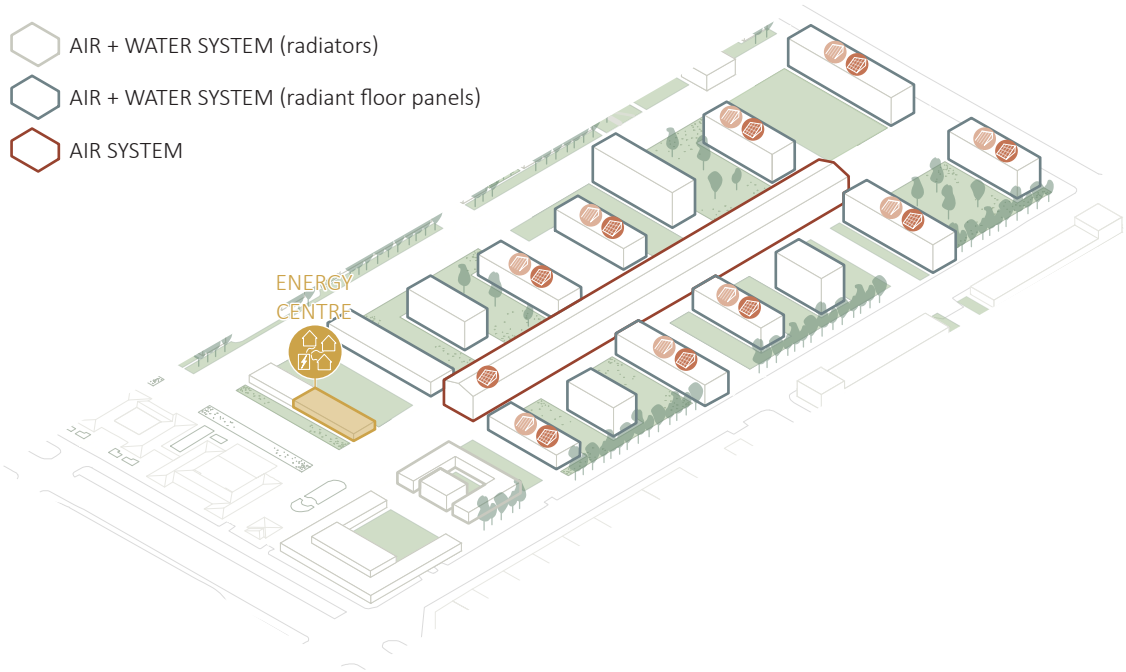



x 142 panels; correction facto: 99%

TOT expected production: 93,95 kW; 104518,9 kWh/anno

### *TYPES OF SYSTEMS*

Concerning the type of systems, they have been differentiated depending on the type of building and its function. Is it better to apply a total air system or a pure water one? And of what type? At this stage of the project, which is still too general and not focalized on the buildings themselves, the choice has been taken through logical reasoning.



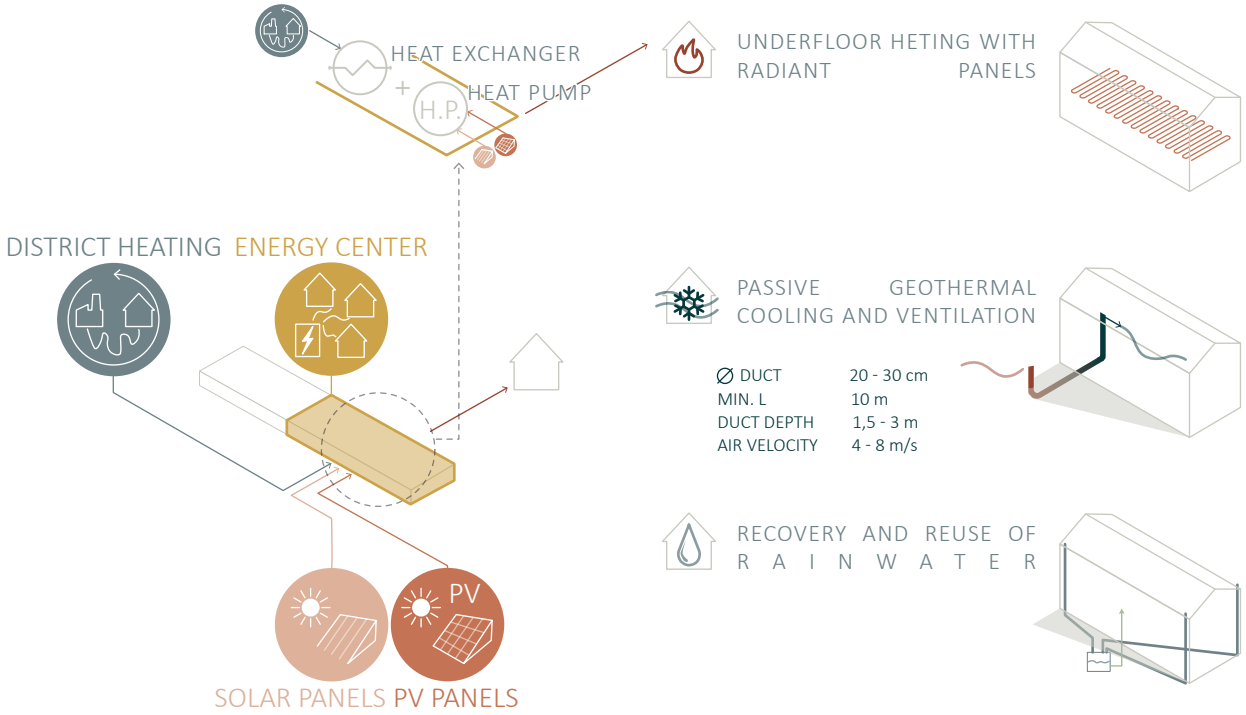

*F.4.9 - Building types of systems*

The Galleria doesn't really need a heating and cooling system, except for relatively small spaces. Those closed rooms have the privilege to be high and airy such as to be able to apply a total air system.

The new buildings are designed to withstand the most updated regulations on consumption and energy performance. Therefore, their good thermal properties allow adopting water systems at low temperatures, the radiant floor panels. Moreover, an air system provides the necessary exchange for cooling needs but not only.

In the existing maintained buildings, instead, are adopted air and water systems, with radiators.

Like already mentioned, the heat and power are managed by the energy centre. Then they are transferred to the buildings. In a general way, for the new fabrics, other than the plumbing, it is installed the underfloor heating system with radiant panels, the passive geothermal cooling and ventilation system and the recovery and reuse of rainwater system.

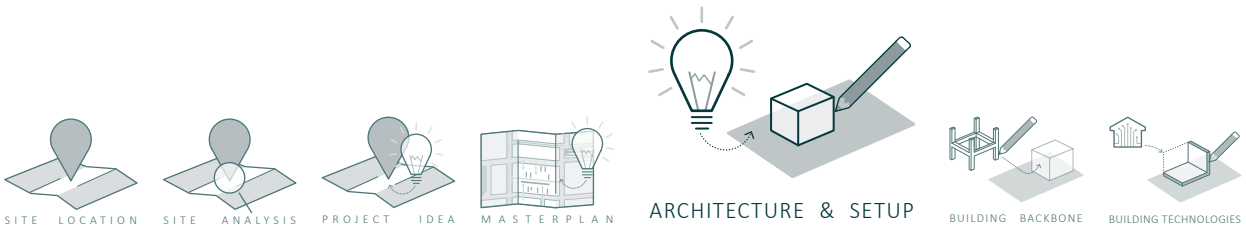



*F.4.10 - Utilities distribution*

CHAPTER 5

# The Galleria

## the “non-building” configuration



*VIEW 4 - Project idea level of detail, view on the Galleria's pedestrian road. Centre of the public functions block with the Galleria in front*

## GALLERIA SETUP

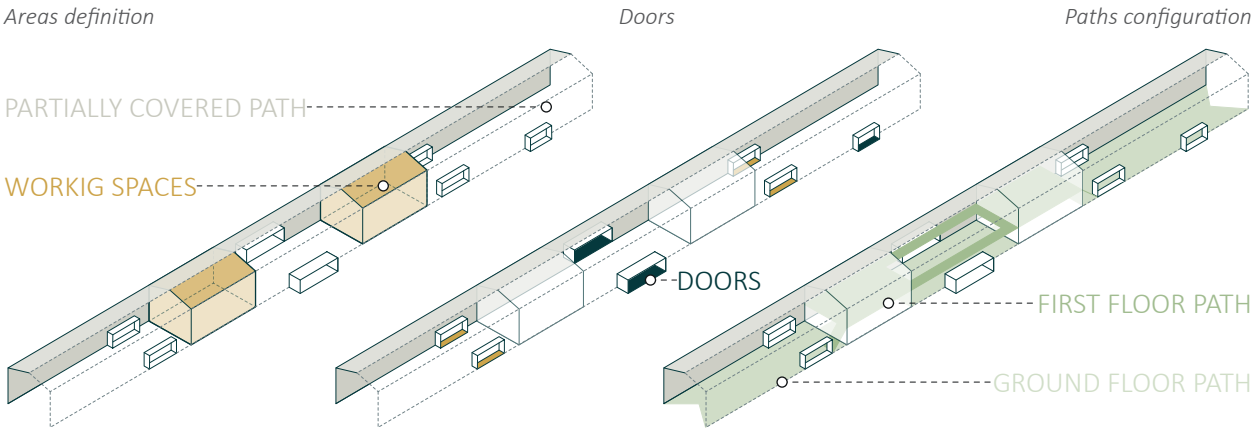
Soul of the comb, the gallery is an iconic building, an image of the project area and a link between today and the past. In chapter 1 it is firstly mentioned, with some pictures and its geometrical characteristics. In chapter 3, instead, some pages report the project idea with examples. Here, the Galleria is seen in detail with its design choices.

The building new life permits to maintain its structure unchanged as much as the functional needs allow it. The modifications work mostly with addition of volumes to the principal one. In fact, two boxes are added in strategic positions, and the adjunct of frames to announce entrances, allow to remove only small portions of walls. What is new is the presence of the roof, leaning against the particular steel structure, already existing. It is composed of light reticular trusses and depending on their conservation state, they will be maintained or substituted.

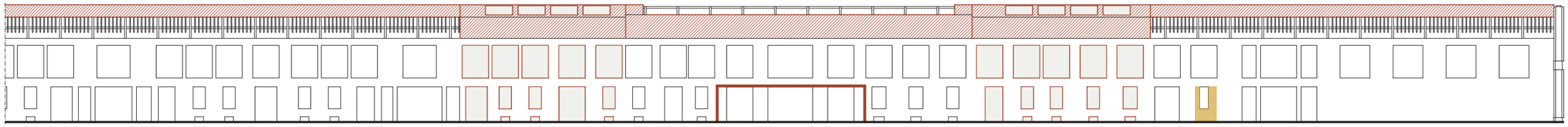
The ground floor of the Galleria, directly related to the masterplan pedestrian roads, works as a pleasant cover path. The additional boxes, instead, are dedicated to working areas. They frame the central space, where are the main entrances, creating a sort of piazza with greenery.

Above the piazza, a walkway is placed, connecting the two working boxes at the same level. Therefore, it takes life a double path, developed on two levels. One at the ground floor, busier and with green areas all along with the edges. The second one is located on the first floor, calmer and accessible through the closed building boxes.

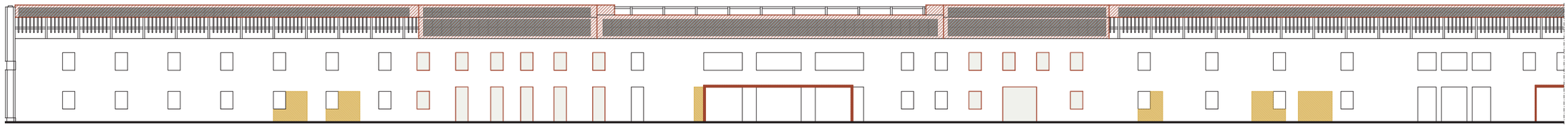
Moreover, the roof contributes to the definition of the spaces and their relative functions. The roof trusses present a double inclination for each side, so that, they can be visually subdivided into four parts for the



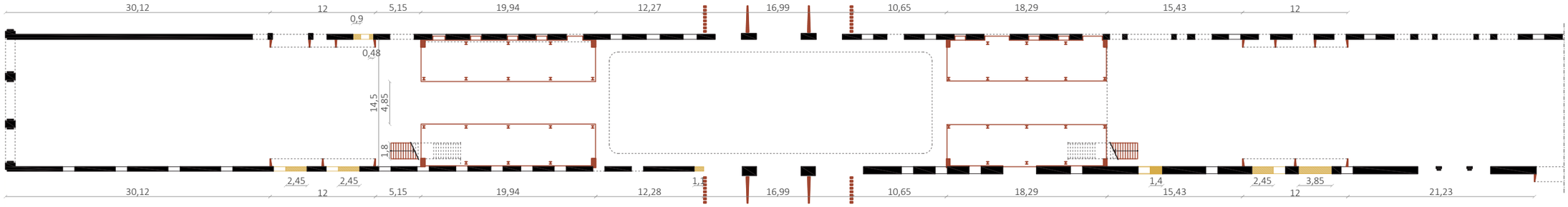

*F.5.1 - Introduction about the Galleria building*



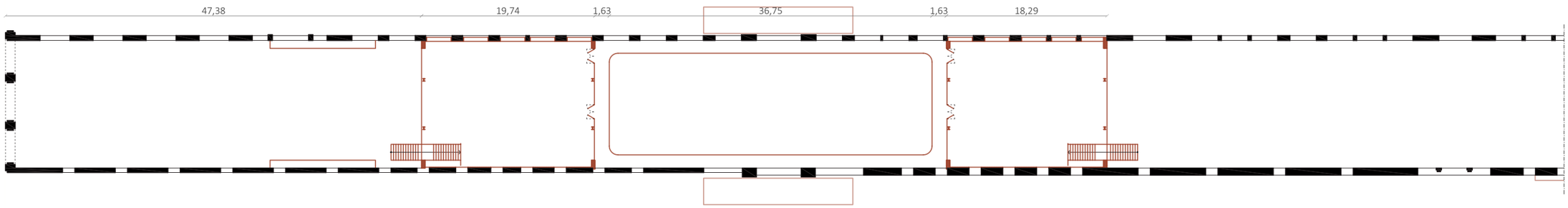
North facade



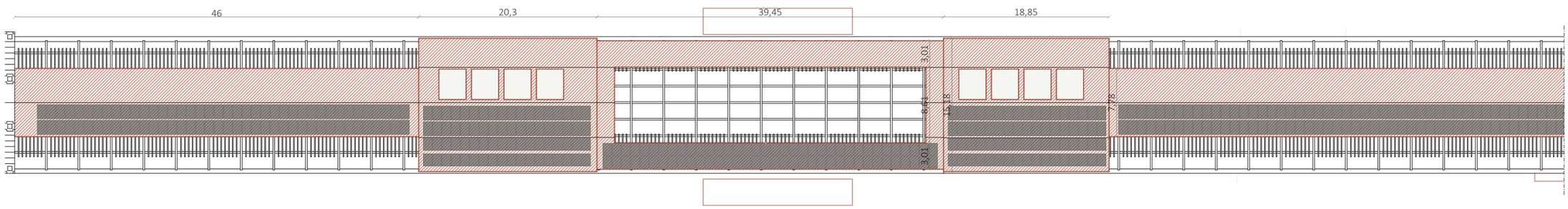
South facade




Ground floor plan




First floor plan




Roof plan

LEGEND
DEMOLISHED VOLUMES
BUILT VOLUMES
BUILT ROOF
PANELS
WINDOWS

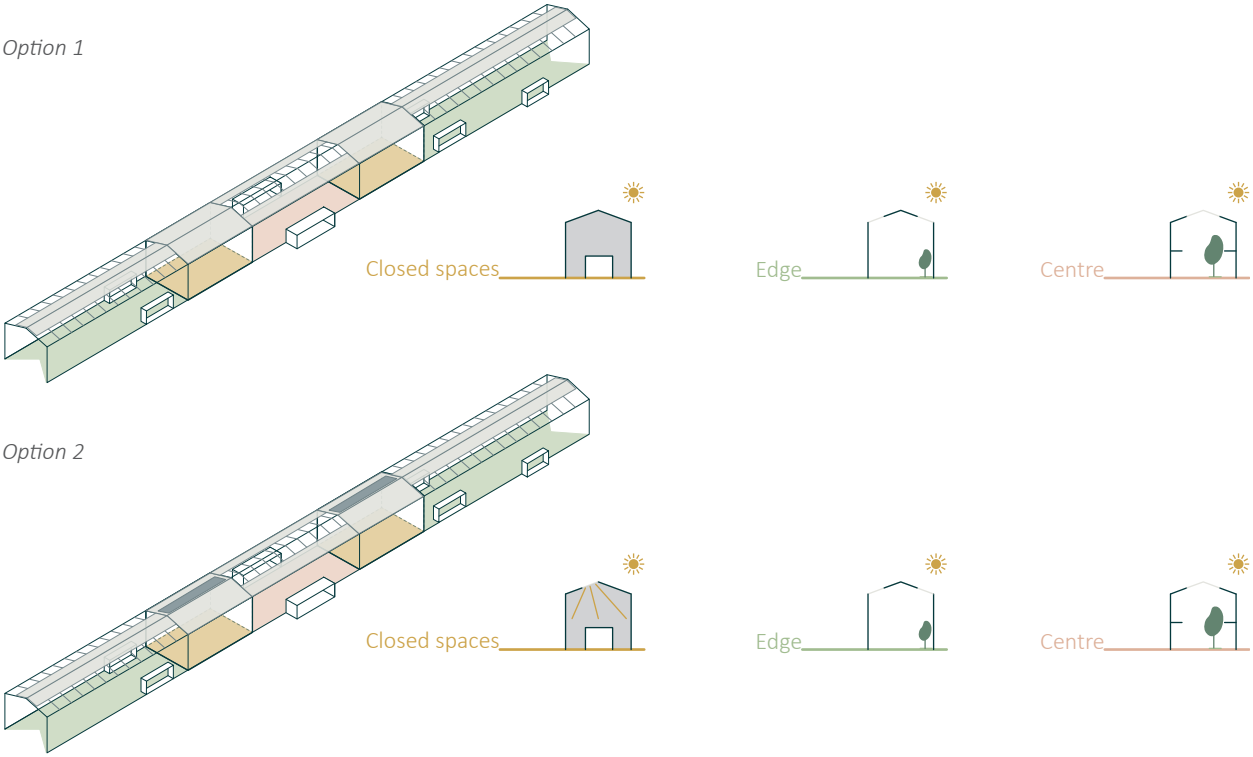
length of the volume. Starting from the short facades of the Galleria, in the two sections, the roof is positioned along the middle of the trusses, leaving free the lateral stripes along the walls. Above the piazza, only the four corners of the rectangle are covered, leaving visible the structure and the sky. The working spaces, instead, in the closed glass volumes, are completely covered by the roof.

Other small but essential modifications are the internal summation of an insulating layer in the proximity of the boxes, and the closing of opened windows with stained glass. The boxes are enclosed by glass facades and covered with a lightweight roof which leaves visible the trusses structure.

### *A. DAYLIGHT ANALYSIS*

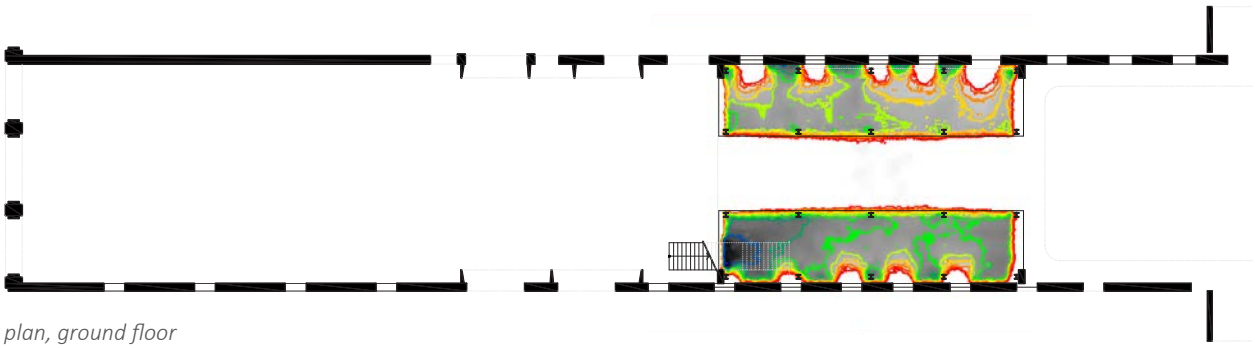
Concerning the roof of these glass volumes, it has been studied the configuration, to be sure to have sufficient natural light in the working spaces.

Keeping in mind that the original volume and openings layout is maintained, only the roof optioning is here evaluated. The opened corridors of the Galleria don't show any problem in terms of light, with the already discusses layout. Therefore again, the parts analysed are the boxes: firstly, the roof is designed as a completely opaque paper and then, partially transparent.

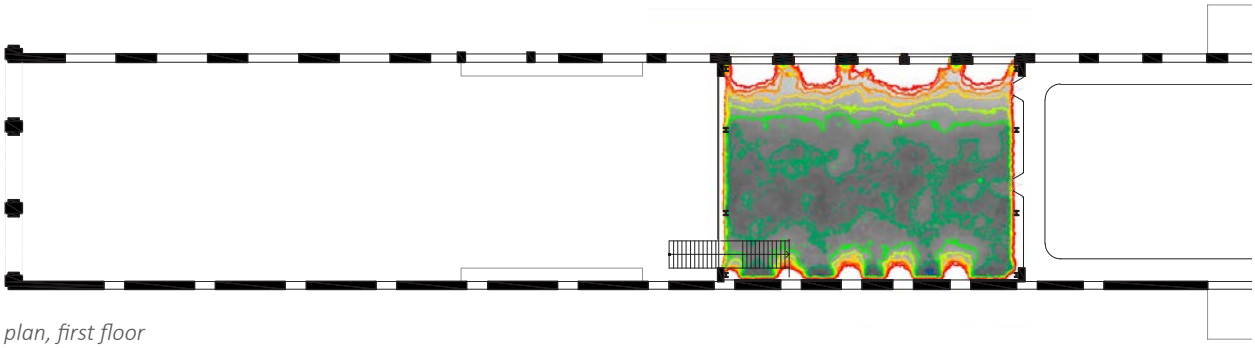



*F.5.2 - Spaces and roof definition and daylight options*


*F.5.3a - Daylight analysis of the Galleria, first option*



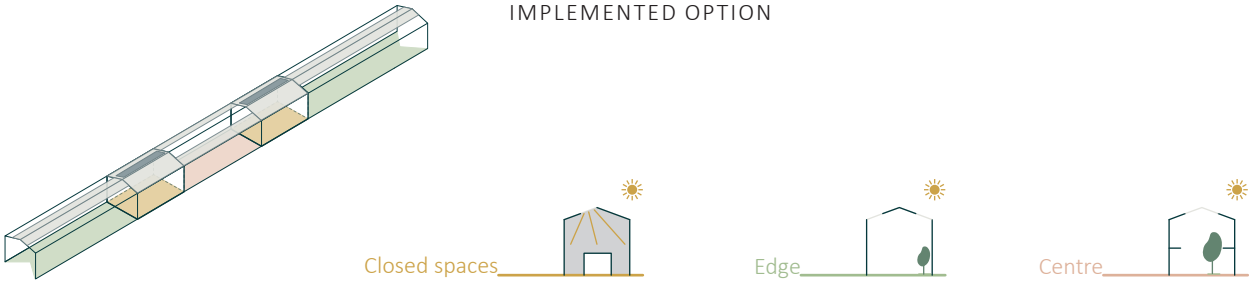
*plan, ground floor*



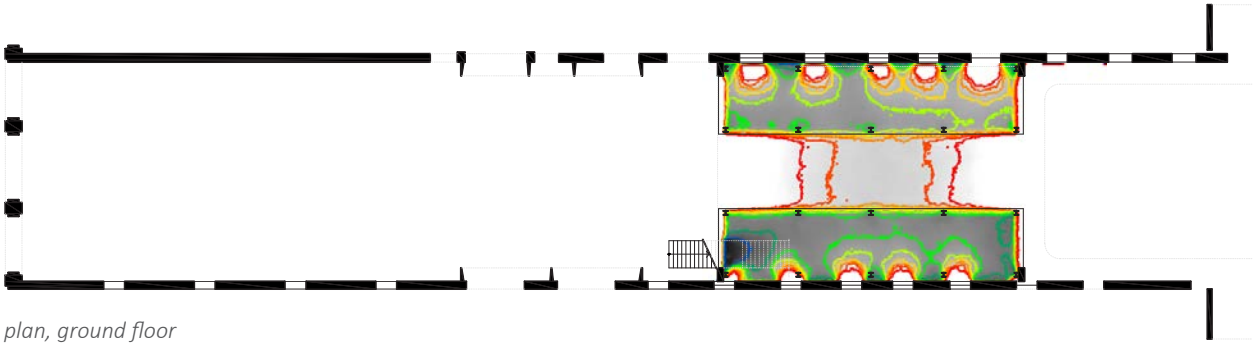
*plan, first floor*

From the initial option, we get a low daylight factor in the central zone of the first floor. The pattern shows a very poor contribution of the east and west glass facades but anyway a good one from the north and south windows.

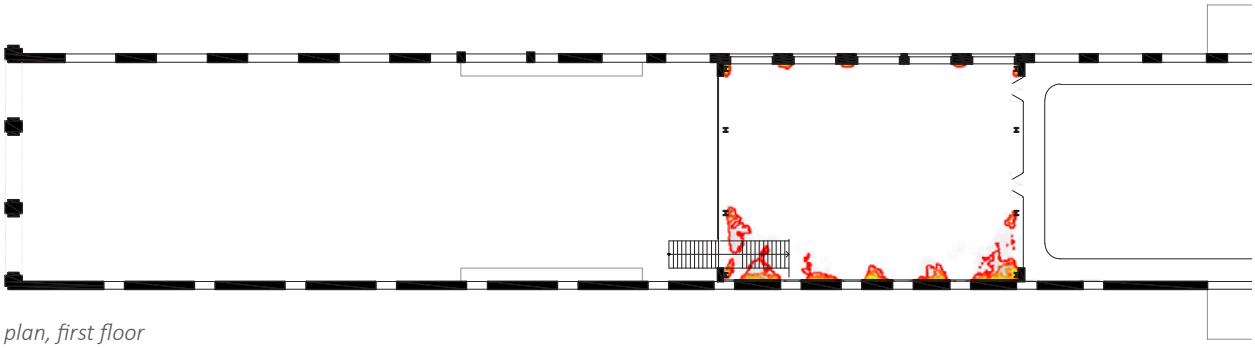
The situation can be implemented with some optional transparent surfaces on the roof. Due to the cover exposure (north-south), it is considered that the direct sunlight coming from the south, would cause glare and overheating of the environment. Having this in mind, the analysis has been made with a north-facing, glazed shape of the same width as the underlying volume.




*F.5.3b - Daylight analysis of the Galleria, second option*



*plan, ground floor*

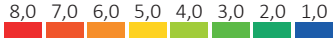


*plan, first floor*

In this second analysis, the solution gives a very high level of daylight, even too much, but it shows anyway that such type of implementation can work. Therefore, adjusting the dimensions, windows on the roof can provide a good amount of natural daylight without glare phenomena.

*F.5.3 - Daylight analysis*

LEGEND



*B. PLANS AND ELEVATIONS*

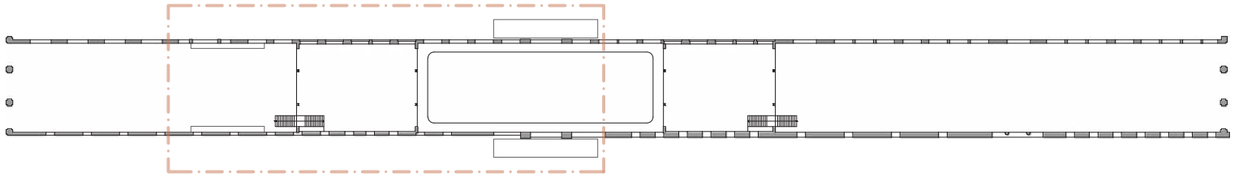
Coming back to the entire Galleria, from the east and west emblematic facade, the ground floor is characterized by grass beds all along the two long walls. The addition of greenery is good both from the aesthetics and natural point of view and from the functional one. In fact, it marks the presence of volumes or voids along the deep sides, giving continuity and rhythm. For example, it warns about the presence of entrances or closed boxes.

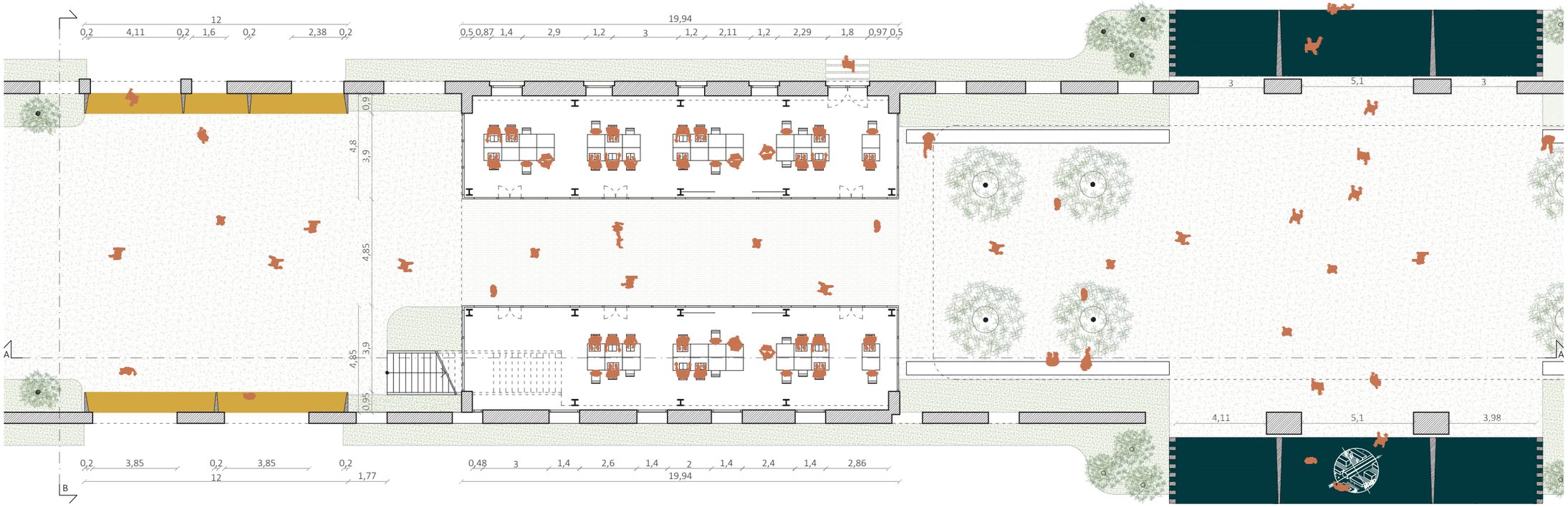
The building is opened and visually permeable, some "doors" characterize the space, interrupting the side walls linearity and leaning on them, denouncing the presence of something. They are represented through axonometric schemes in the following pages and later discussed hereafter. The other additions are the boxes already mentioned several times as the co-working spaces. On the ground floor, the boxes leave space for the passage of a central corridor which allows continuity with the Galleria path. The internal spaces are accessible from glass facades facing the just mentioned corridor and they are equipped with tables for free work. The walls exposed internally to the Galleria are therefore mostly glazed, to not create separation, to have an interconnection and direct relation between functions and peoples. These differentiations aren't visible from the outside of the building. Again, to have continuity, only interrupted by the entrance doors.

Remaining on the ground floor there is the so-called Piazza, born from a crossroad of people through the Galleria, passing by one of the main streets, which cut the area vertically, or who are walking in the building. People will expect to enter a closed and covered space, but the Galleria only partially meets their expectations. Here are present some trees in the corners and seat to have a rest from the working time.

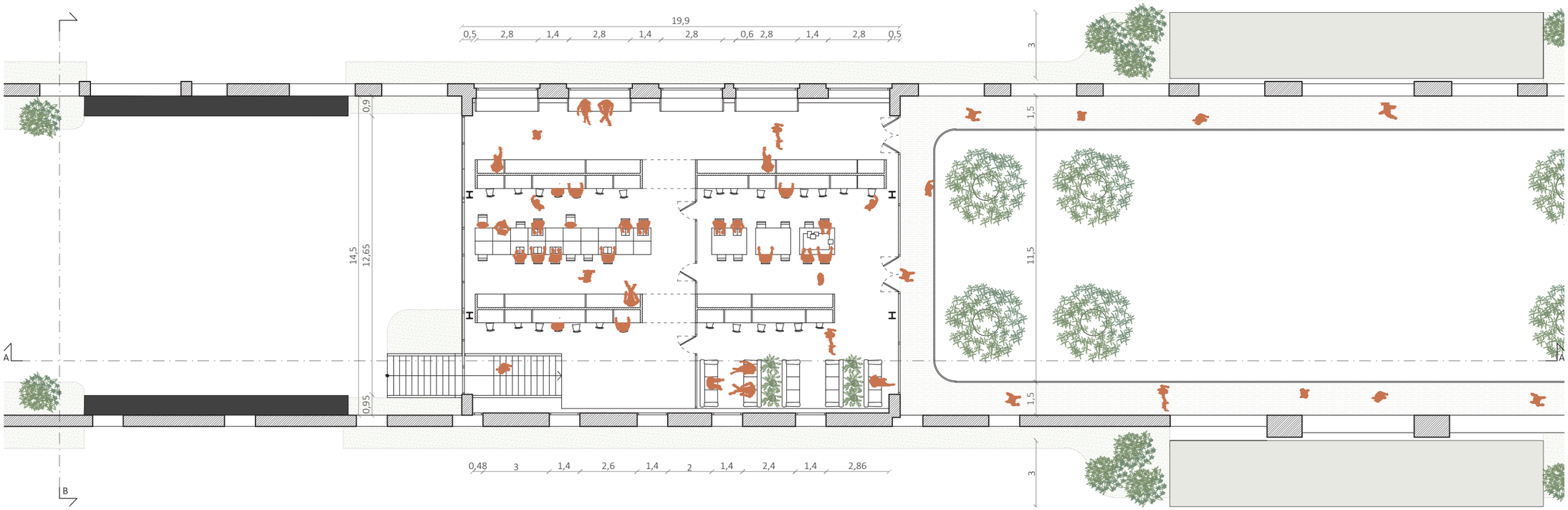
Let's now move to the upper floor, relative to the co-working spaces and the elevated walkway. The first level is accessible from the outdoor stairs which, at the level of the landing, crosses the glass to reach the

*F.5.4 - Example from an other project of a fishbone as a separation element with multiple functions: sofa and working station*

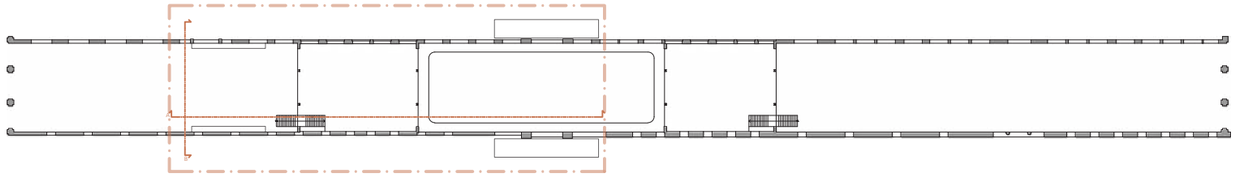




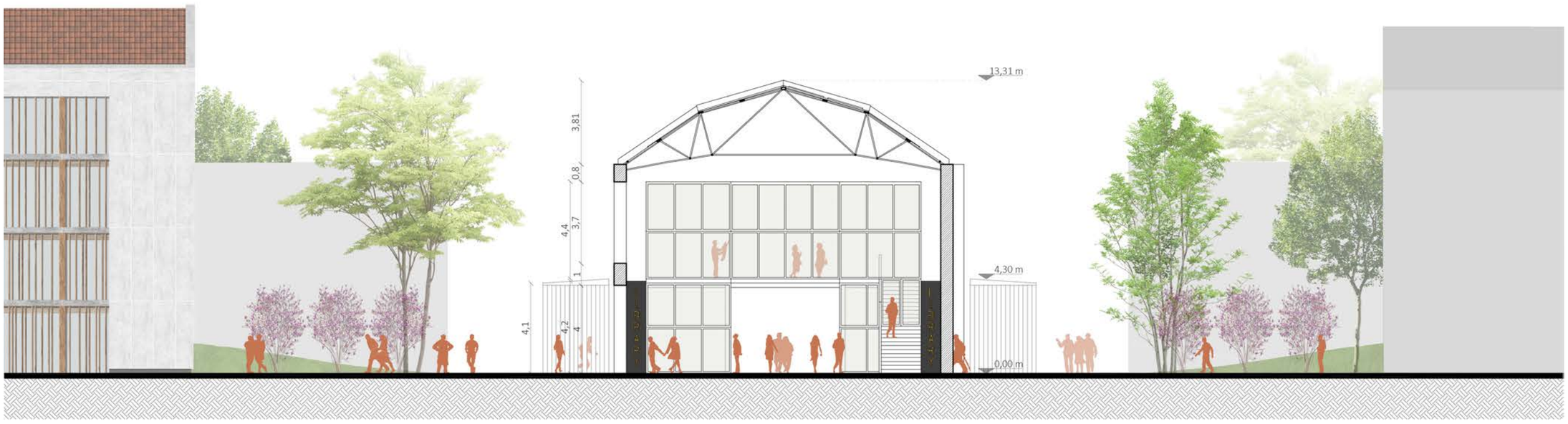

Ground floor plan




First floor plan




Section A




Section B

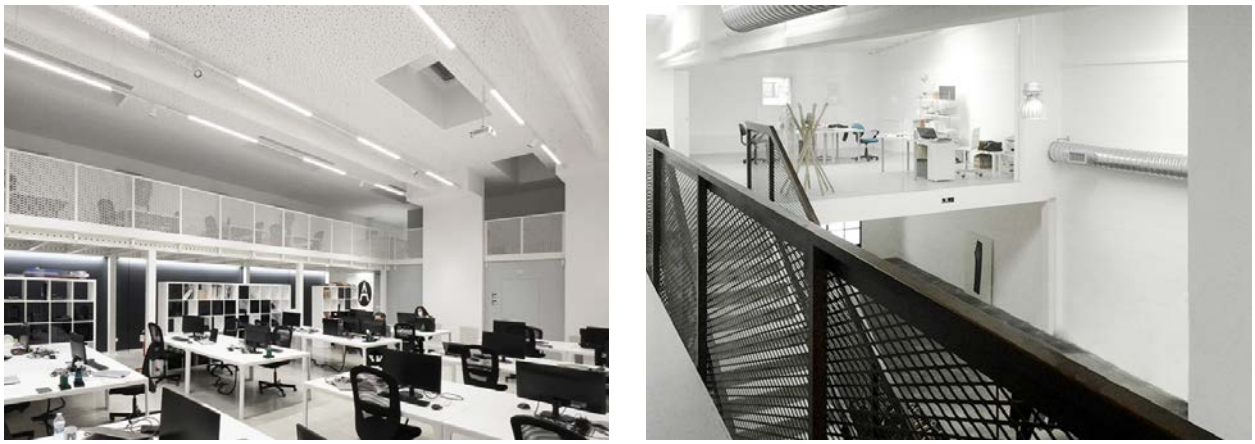
inside of the volume. This storey is internally defined by the furniture in separate areas. The furniture develops longitudinally and it consists of blocks including workstations for activities from both sides of the element. It can host seats and tables for private studying or sofas, as shown in the example image, that represents a different element but which is anyway based on the same concept. Those fishbones separate the space, without closing it and leaving it flexible and adaptable.

With the configuration shown in the plan, there is a sort of corridor northerly that exploits the big windows placing seats precisely underneath them. There are two central areas with tables and working zones and a souther one, more relaxed one with sofas and plants. The solution adopted is also thought relating the working zones with various types of activities together with their noises. It is to keep in mind that, since the site can be rent for events, the spaces have also to be adaptable for that.

These boxes, just described, add functionality and modernity to the original body of the Galleria, without distorting it. Also from a constructive point of view, the additional volumes are in fact as self-supporting as possible, leaving a gap between the new structure and the perimeter walls of the gallery.

As contemporary additions the offices' boxes lend themselves well to the adoption of a new type of bearing structure. They can be a good occasion for the adoption of structural systems coming from experimentation. The description which follows reguards a possible choice for the structure type of layout, which is not developed in plans yet. This would require the use of specific softwares and precise prescriptions given by the producer, for a correct design.

A possible choice, particularly interesting, can be the *Structura* line by "scaffsystem". This company applies the system of realization of shelving for warehouses in the architectural and engineering fields too. The proposal is based on the use of light, cold-worked steel profiles in modular and flexible construction.



*F.5.5 - Example of project designed with "Scaffsystem"*

The company claims to add a functional aesthetic component to efficiency, “integrating masterfully in contexts in which image and style play a role of central importance”. The change from the traditional steel structure system is evident but they are respected all the construction and ant-seismic regulations.

*F.5.6 - Scaffsystem construction elements*

As briefly described in the “Scaffsystem” website, the elements are produced industrially and, subsequently, undergo a dry assembly and fixing process, based on the project of the designer. The particular section of the profiles gives lightness and workability to the system with high performances and adaptability concerning the other construction components (implants). They are perforated so that any change is easily realized work in progress.

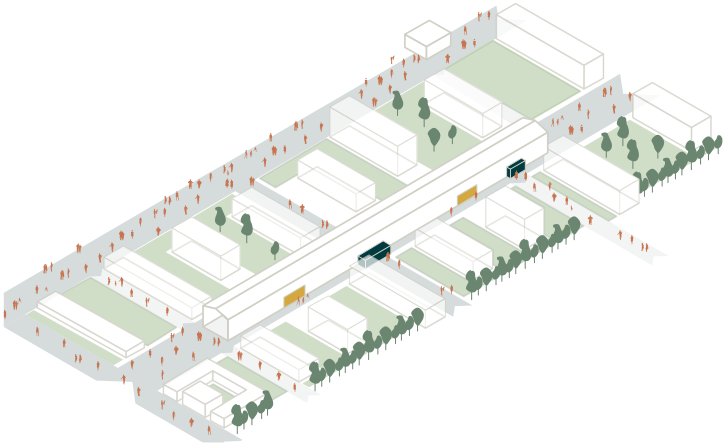
It’s about an efficient construction process from the functional and economic points of view. Manufacturers claim that costs prove to be 20% lower than any traditional construction system. As for a normal structure, the bearing elements can be finished in different ways, they can be covered or left exposed.

*F.5.7 - Example of structure with exposed frames*

*F.5.8 - Example with false ceiling between the frames*

### *C. PORTALS*

Directly accessible from the east glass facade of the just described volume, the elevated walkway shows all the cross-roads from the top and connects to the other symmetric box.



*F.5.9 - Doors positioning in the Galleria building*

The “doors” characterizes the points of access in correspondence with the main streets and the location of other functions. So, the portals are differentiated concerning the type and needs and the positioning: deep entrances and thin exits. Despite the definition just provided, certainly, the doors aren’t passable only in one sense of travel, but those definitions only concern the positioning with respect to the walls that enclose the Gallery: towards the inside or the outside.

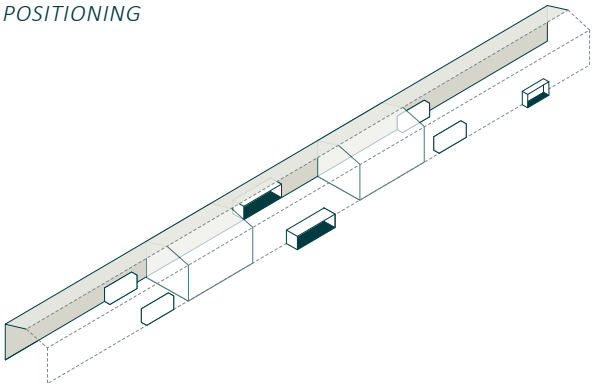
Aesthetically, both the structures deviate from the original building in the materials, the colours and the shape. It is so, precisely because the doors are treated as additional elements, which want to be easily recognizable and that don’t want to falsely copy the style of the original volume. Those additions are realized with steel and eventually wood, bright and evident colours and a modern style with clean lines.

Both the elements follow the Galleria scale so that the height is the same as the original openings, and the length is calculated to incorporate some of these voids. In this way, they are exploiting the existing passages highlighting the ones most related to the new masterplan layout.  Before looking in detail at the two types of doors, it is made a last common consideration from a constructive point of view: the elements are composed of a basement and vertical elements, which support the inclined cover.

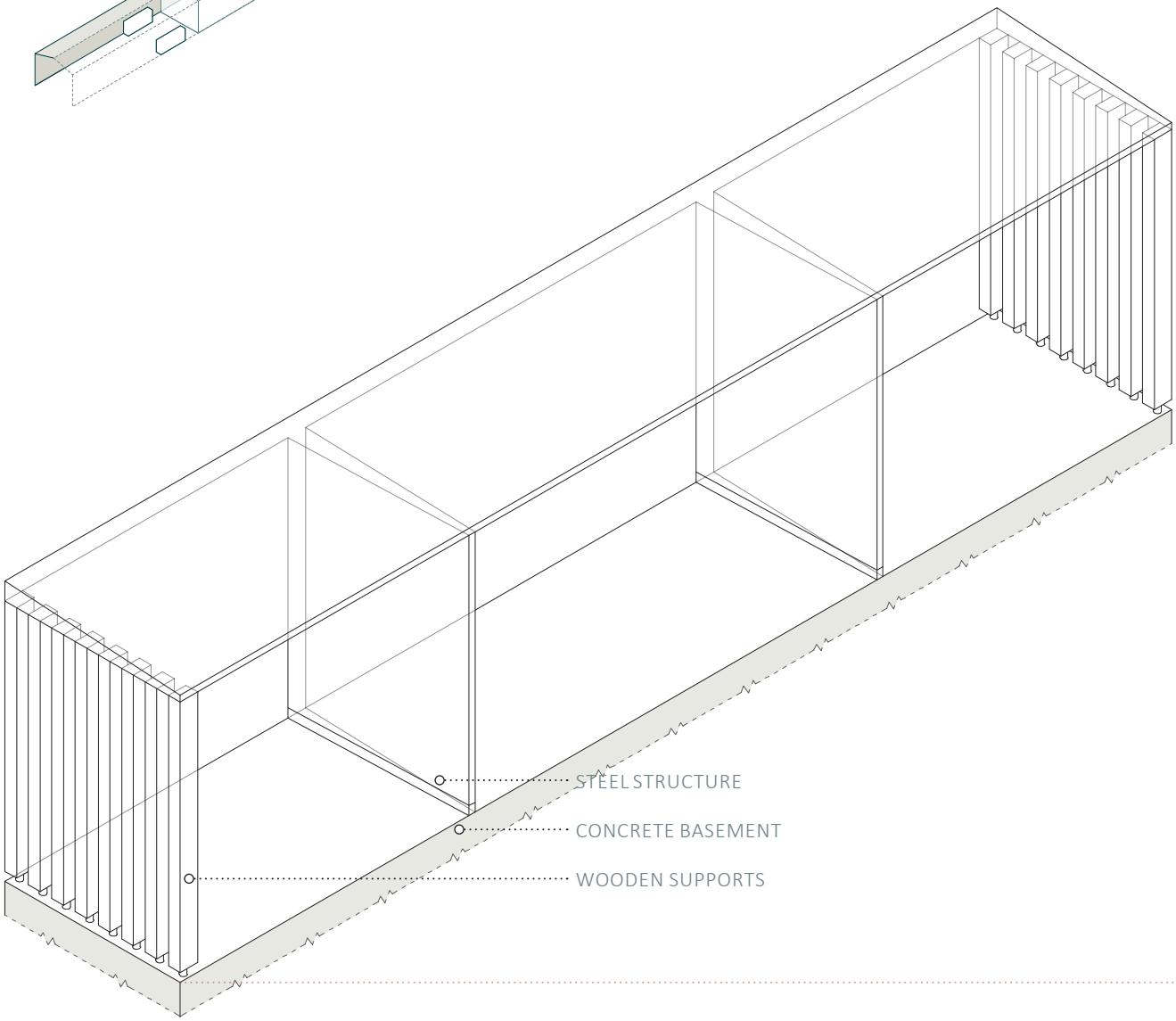
The two types of structures are reported in the descriptive boards on the following pages. The axonometric drawings show the relation between the elevation and the plan, while the sketches show some details.

before concluding it is however necessary to make a premise: all the design choices described in the chapter don’t find a practical and deeper definition here. Therefore, the following design step, concerning the Galleria building, should worry about the practical realization mechanisms. The same recommendation is made for the door, as in my opinion some aspects should be considered for the realization: the basement-foundation in reinforced concrete, the transportation of the preformed steel elements and eventually their critical issues, as can be the thermal expansion or the deterioration of the material. The best solution should be then adopted.

*POSITIONING*

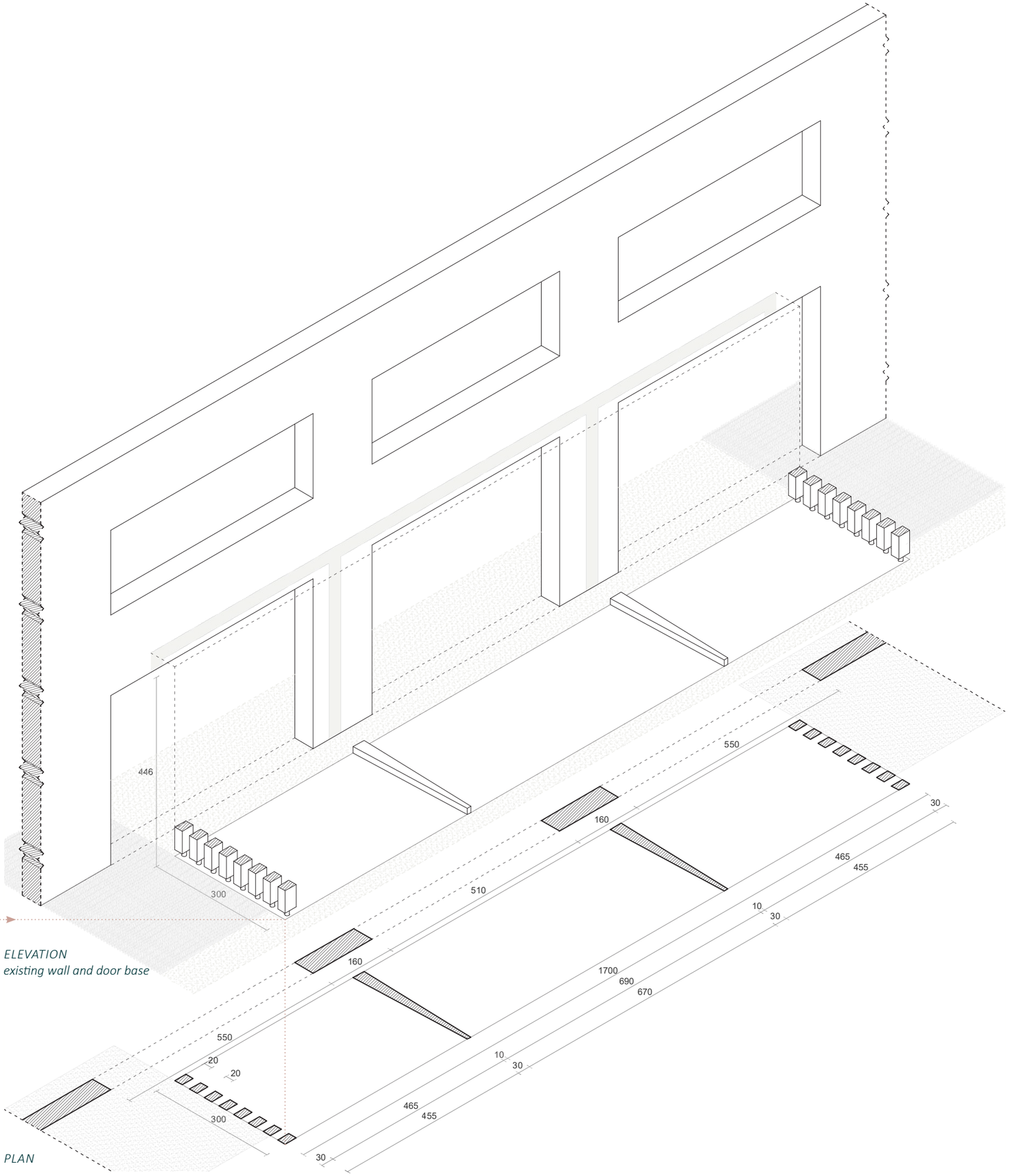


In both cases, the concrete basement permits a solid and safe anchorage to the ground, without connections to the existing facades. It works, in fact, as the foundation and with the proper calculation




*PORTALS*

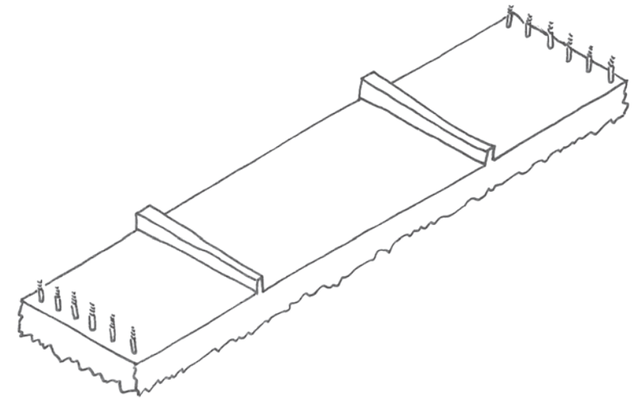
*F.5.10 - Entrance portals' plan and elevation in axonometry, scale 1:100*



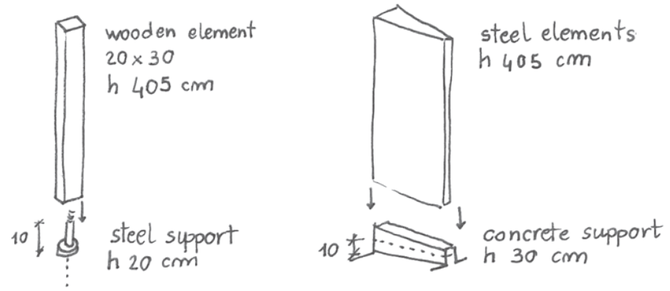

Axonometry - Plan; Elevation with positioning to the existing facade

Multiple elements combination - system description and details

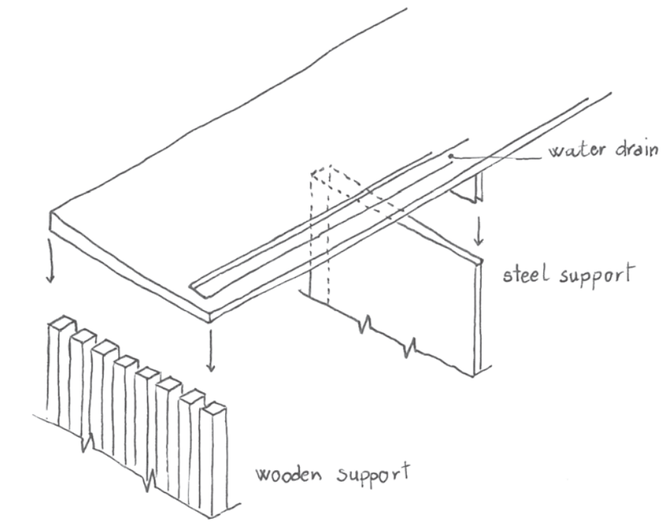
A. BASEMENT: Reinforced concrete block



B. VERTICAL SUPPORTS: Wood and steel elements




C. HORIZONTAL CLOSURE: steel element

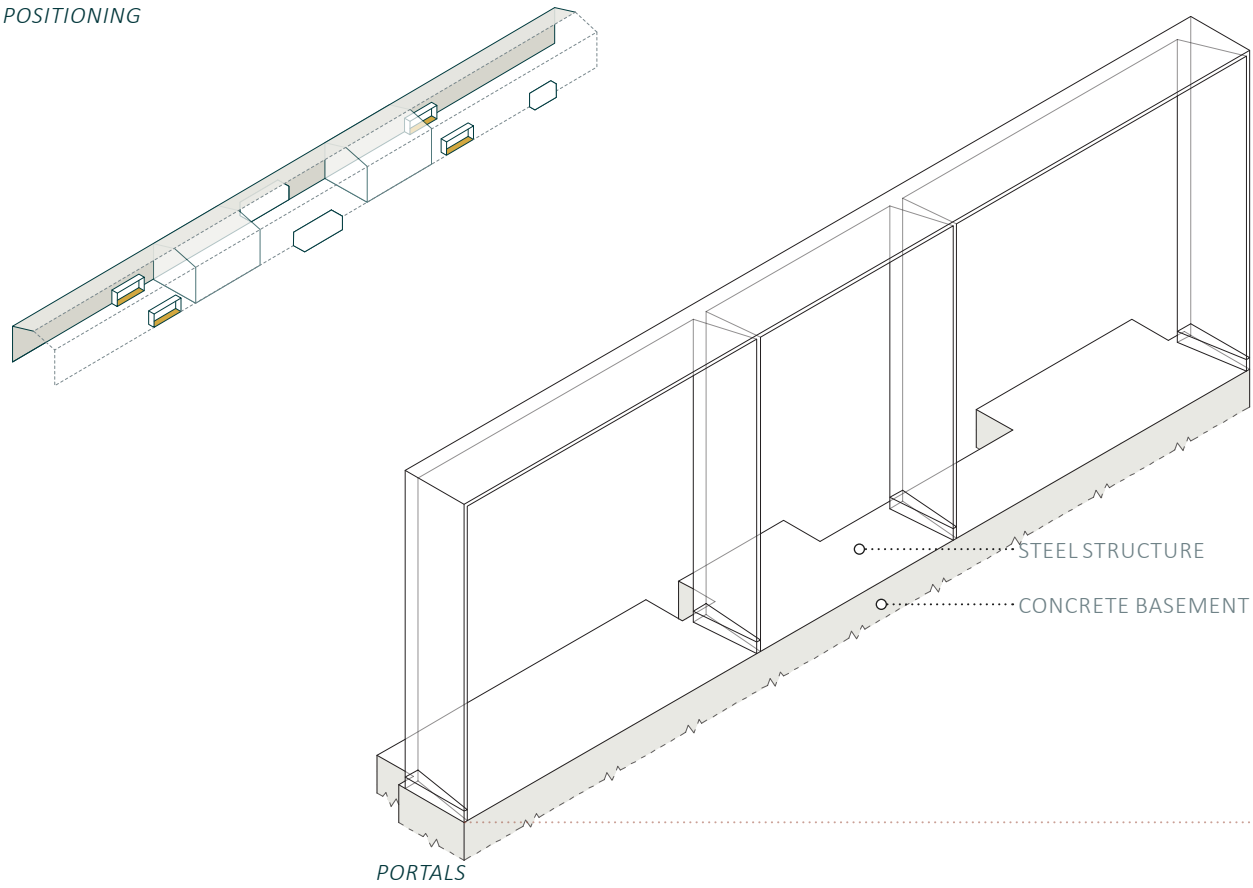



Technical sketches- fixing mechanisms and details

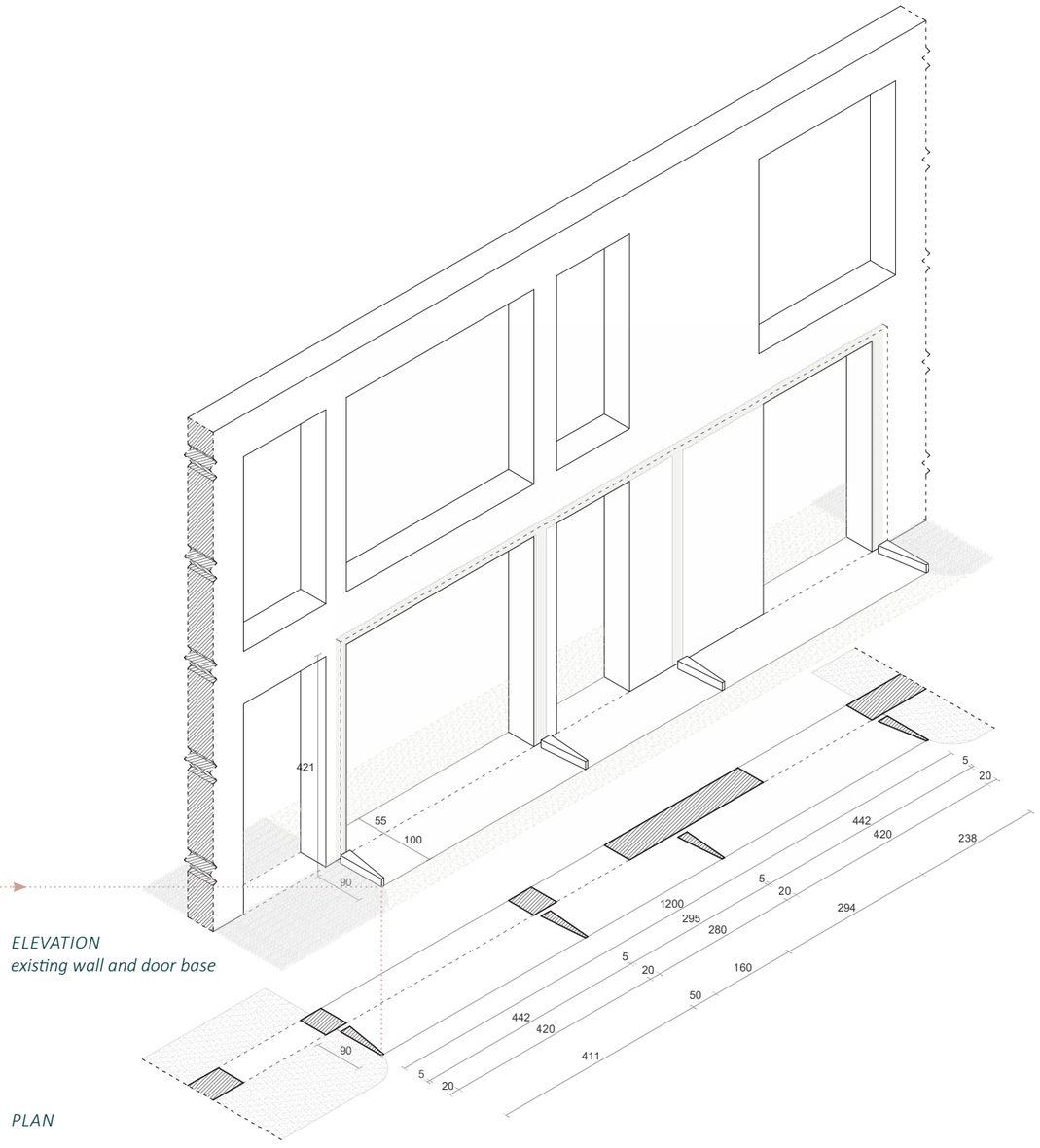
it will guarantee the necessary support. It also permits to raise the point of connection of the vertical supports, avoiding their degradation due to water stagnation. The vertical supports are constituted by pre-formed steel elements both in the case of entrances and exits, with some differences in terms of dimensions. The “entrance door” is 3 m deep and 4,46 m tall. Instead, the “exit door” is 1 m deep and 4,21 m


*F.5.11 - Doors, big entrance*

tall. The real difference between the two is given anyway by the lateral supports which are constituted by a couple of 8 wooden profiles, regarding the entrances. The cover of the passages is made of steel as well, with the same mechanism and style of the supports. Is expected a rainwater drain duct, connected to the collection system of the site. The roof it is incorporated the lighting system too.



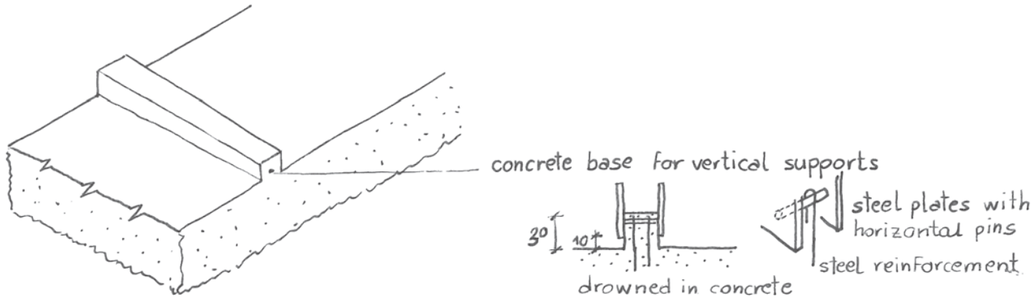

*F.5.12 - Exit portals' plan and elevation in axonometry, scale 1:100*



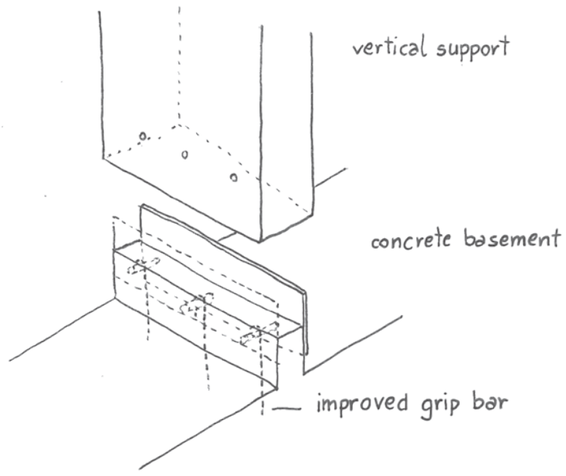

Axonometry- plan with dimensione; positioningin relation to the existing facade

Multiple elements combination - system description and details

A. BASEMENT: Reinforced concrete block



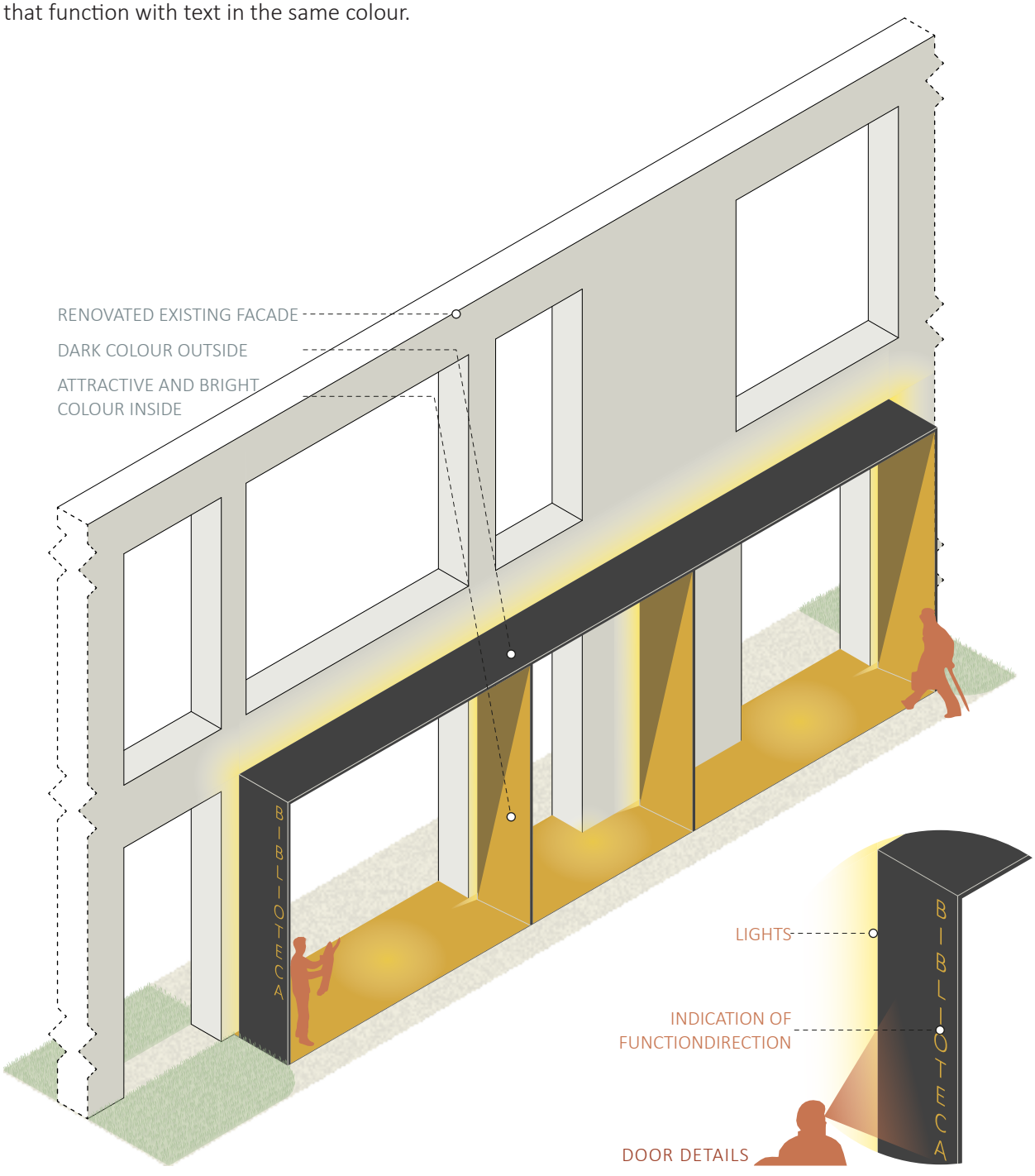

B. VERTICAL SUPPORTS: Pre-formed and painted steel elements




C. HORIZONTAL CLOSURE: steel element. Water drain mechanism detail


Technical sketches- fixing mechanisms and details

In terms of colours the “entrance door” is light and soft on the outsides and bright inside. The “exit door” contrarily is dark on the outer sides and coloured on the inside. The idea is to evidentiate the exits with different colours to identify the distinct achievable functions. A particular on the two vertical supports identify that function with text in the same colour.

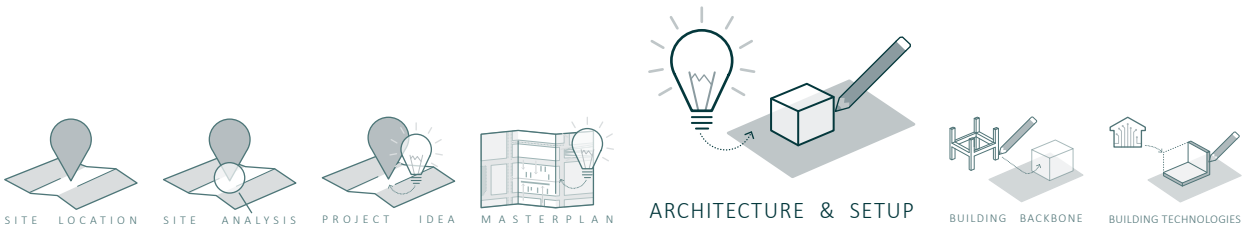



*F.5.13 - Doors, small exits*

CHAPTER 6

# The building

## library for materials configuration



*VIEW 5 - Building level of detail, evening view on the ground floor of the Library of materials, where is locates the study are*

*VIEW 6 - Building level of detail, view on the type floor of the Library of materials, where is locates the consulting area*

The Galleria comb implant is constituted by fabrics with similar characteristics to one another. The length and the solar exposition are regular between the buildings. Some differences are the type of roof (flat or pitched), the functions and, therefore architectural set-up.

In the following chapters, only one building is developed but, except for the functions, the same design considerations can be done for the buildings of the “comb”. In the architectural set up should be considered that some buildings present a retreat concerning the Galleria. This allows direct access through the “doors”, along the short sides. The others instead are accessible from the principal, pedestrian paths by the long facades, with east/west exposition.

The retreat permits a reserved, smooth and free of obstacles entrance. As anticipated in the previous chapters, the buildings interact with each other. There is always a visual contact but also functional integration and cooperation. For example, the library for materials could need an opened and/or closed area to use as a laboratory. The surrounding buildings, having a flat roof, can work together to solve the need.

## 1. LIBRARY FOR MATERIALS

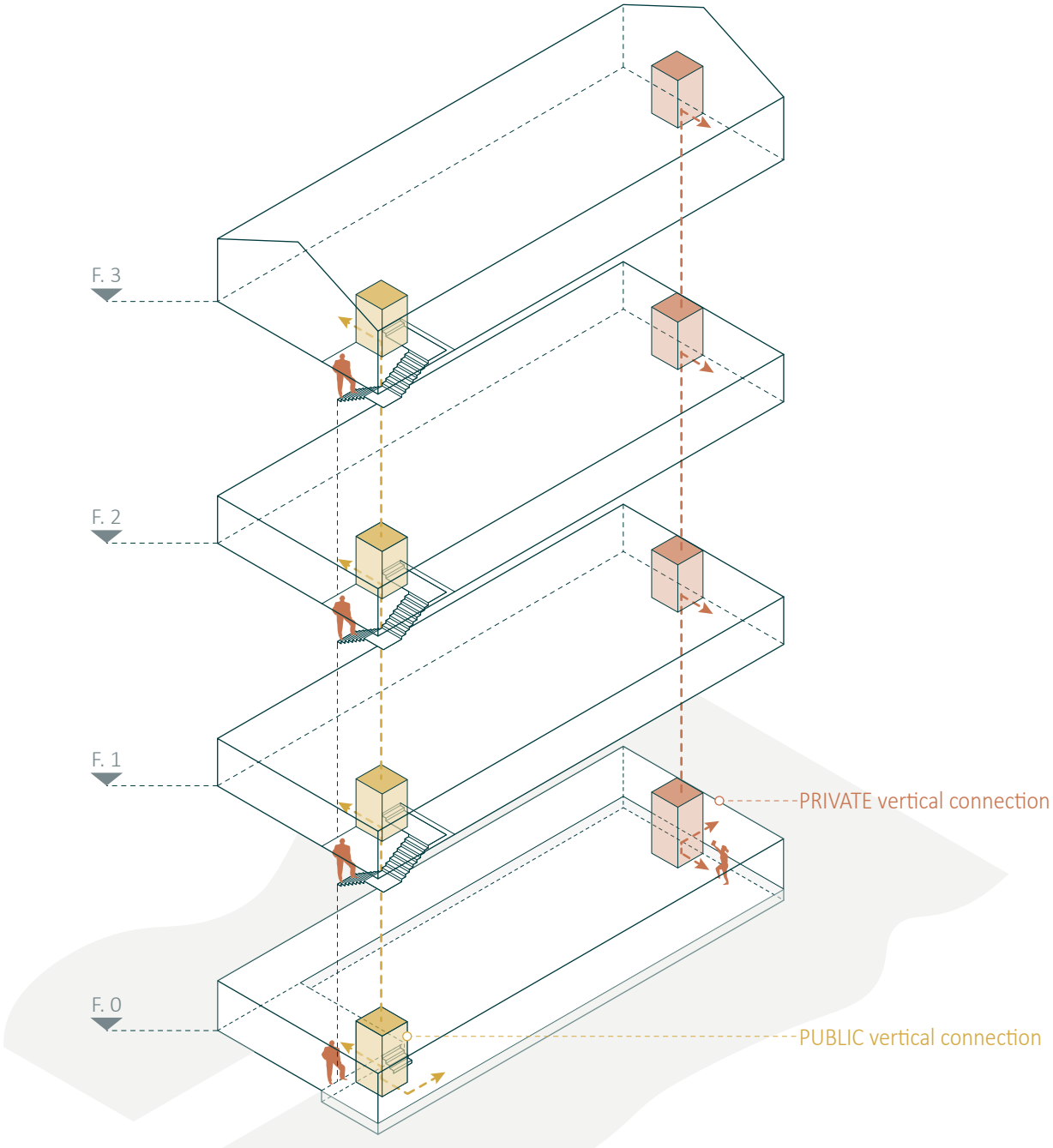
Precisely on the library, I want to dwell on the development of the architectural, structural and technological project. A library is an important resources for the community and I found particularly interesting implementing it into a material library. A library for material  is a place where samples of different materials are first hand touchable. The nearness of universities, like Politecnico di Milano, makes the library an important support for students. Furthermore, the material library represents an occasion for local and non-local companies, giving them the possibility to present their products and new technologies, allowing an economic yield.

A practical example is the Material Connexion library with offices in New York, but also across the globe, including two in China and two in South Korea. The Material Library collects the world’s largest selection of sustainable materials (based on the Cradle to Cradle life cycle criterion), divided into the following categories: polymers, ceramic, glass, metal, concrete, natural materials, carbon, production process.

*F.6.1 - Material library*

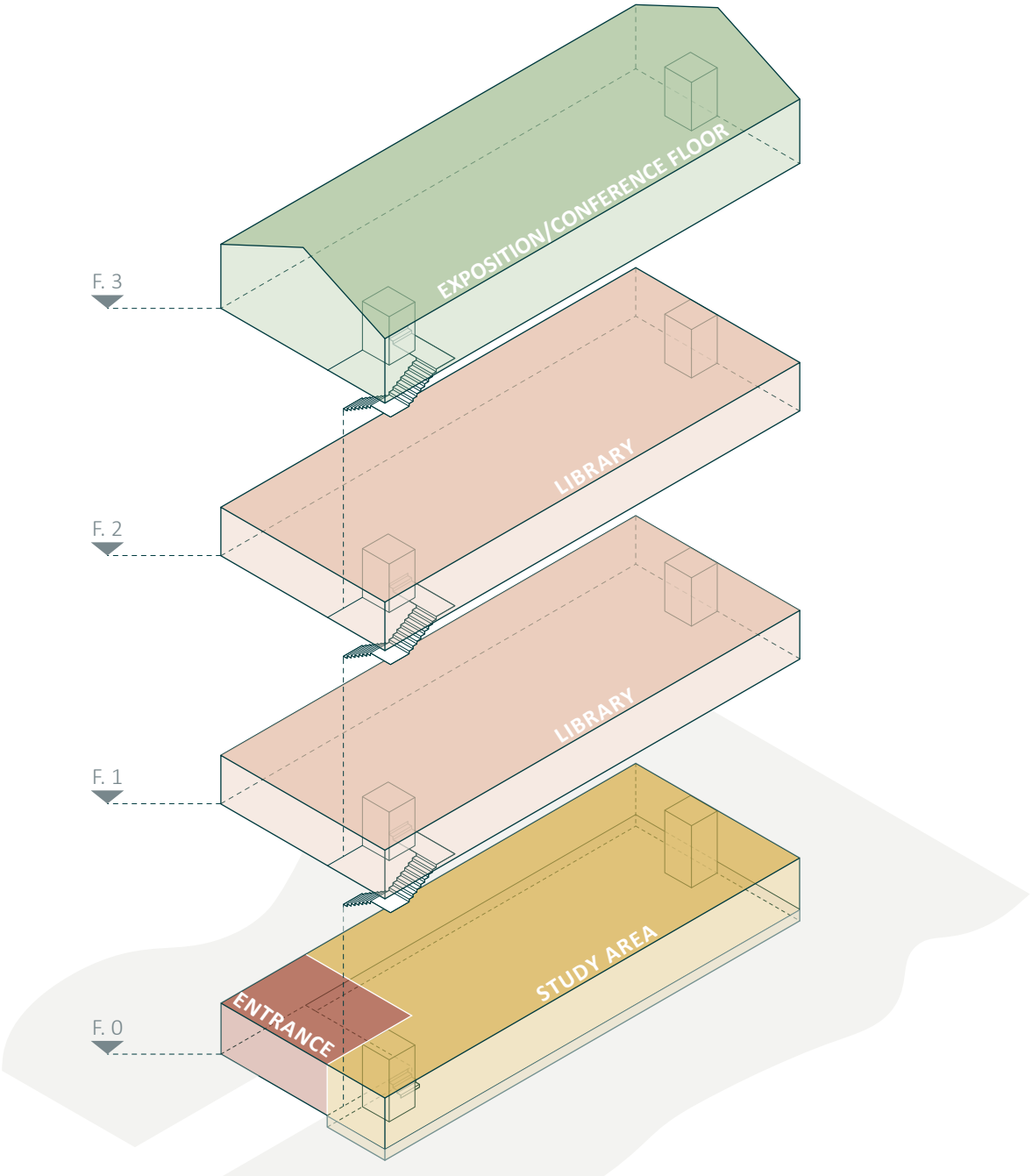
## 1.1 LIBRARY SETUP

This building is accessible from the “Galleria” road and fits into a green space (as evident from the Master-plan). The two long facades always maintain close visual contact with the natural external areas, thanks to continuous glazing. The south and north sides are instead close to outdoor, giving contrast.



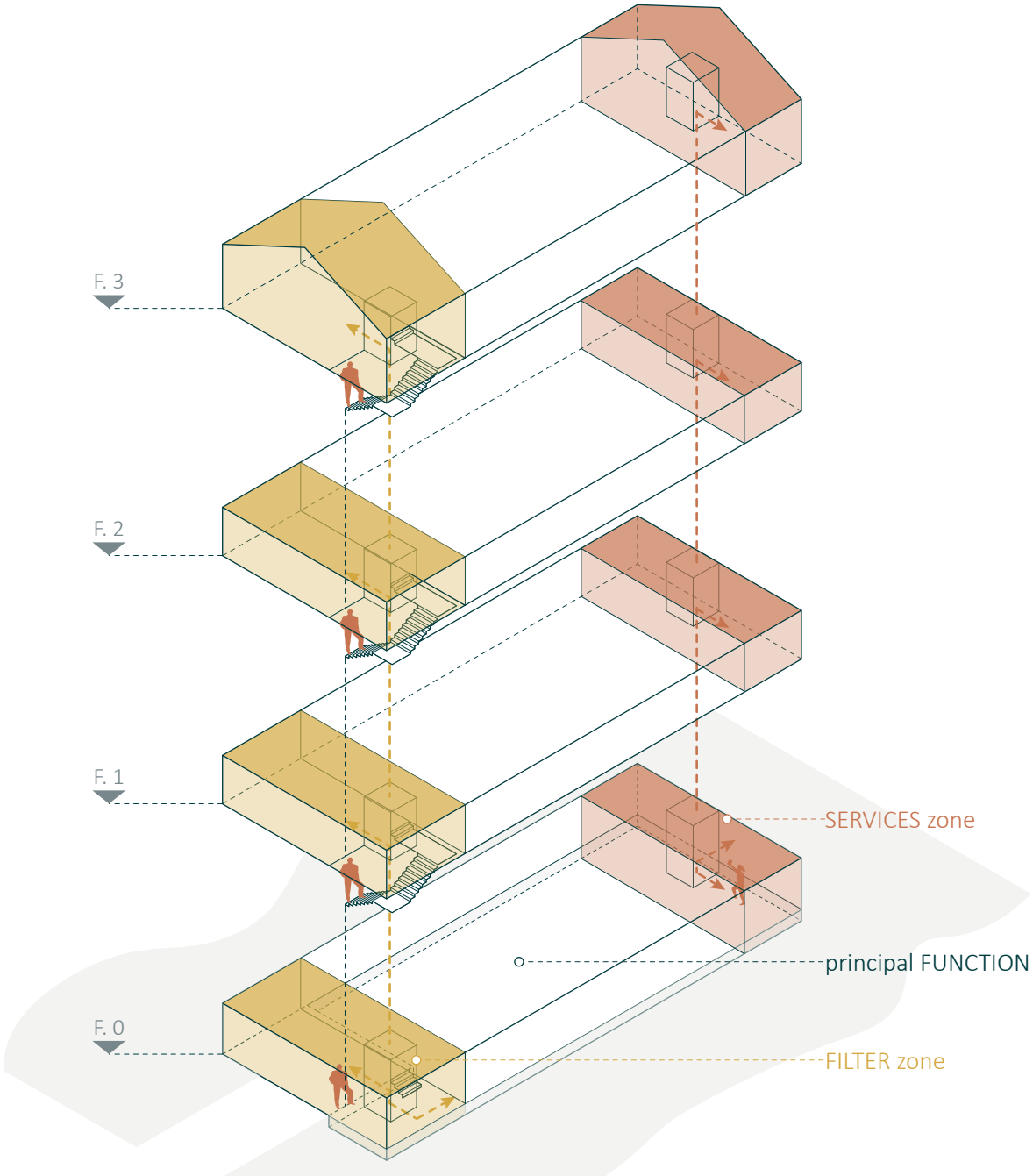

*F.6.2 - Library distributive systems*

The library is accessible from the south and rises four floors above ground. The public distribution system is located next to the entrance, in front of the reception, at the ground floor. The exposed stairs and the glazed elevator, which they revolve around, lead to the study area, on the ground floor, the material library, first and second floor, and to the top floor functionally flexible.




*F.6.3 - Library floor functions*

All the levels, in elevation, are subdivided in three functional areas; a first filter band, a second related to the floor function and a service band. The filter zone hosts the distribution system and, at the ground floor the reception, while in the others, at the same location, refreshment rooms. The services band is mainly dedicated to the archive, with a dedicated distribution system.




*F.6.4 - Library functional areas*

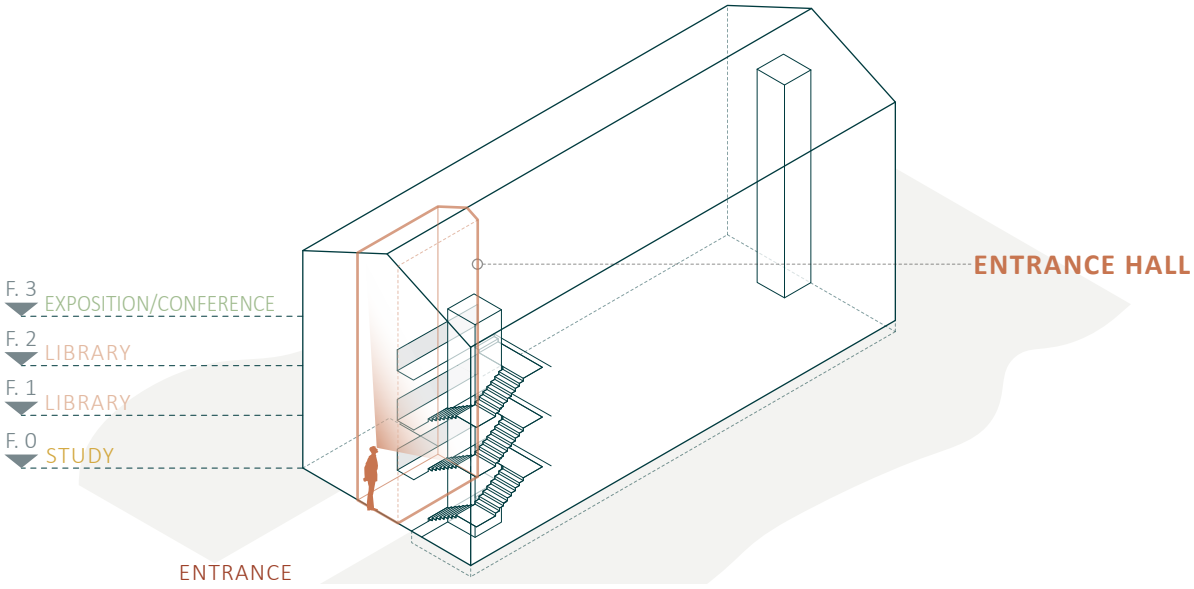
## 1.2 LIBRARY LEVELS

The ground floor spreads over two levels; entry takes place at zero altitude, same as the external soil. The study area is instead lowered, to-75 cm; the continuity with the floor is interrupted allowing to define different privacy levels. Consequently, some areas or noises can be isolated, and a different type of continuity is established in the study room, the one between study tables and the external green soil. Trying, with this, to increase closeness to nature through contact with the ground and turf level.

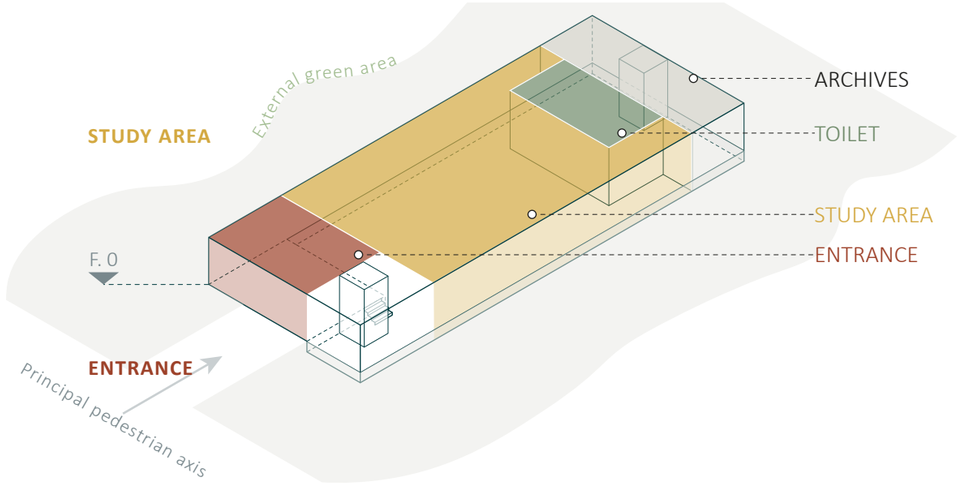
First and second floor are identical to one another. Two rows of exhibitors are disposed along the glazing facades, while in the centre are distributed tables for material consulting. The room near the archive with glazing walls facing only the corridors, it has multiple functions (it can hosts laboratories for schools, workers meetings or with companies), depending from the need. Looking more in detail, the exhibitors are thought to host material samples. Inside the boxes some consulting material related to the samples, can be archived.

At the third and last floor there is a big, opened and free space, with the exposed trusses and wooden ceiling. Some movable elements permit to transform the space, creating different configurations. In the boards are presented two solutions: a conference room configuration and an exhibition space configuration, supporting the material library. These elements can works as stands for presentations, or they can be moved along the glazing and used as additional shading system in case of conferences.

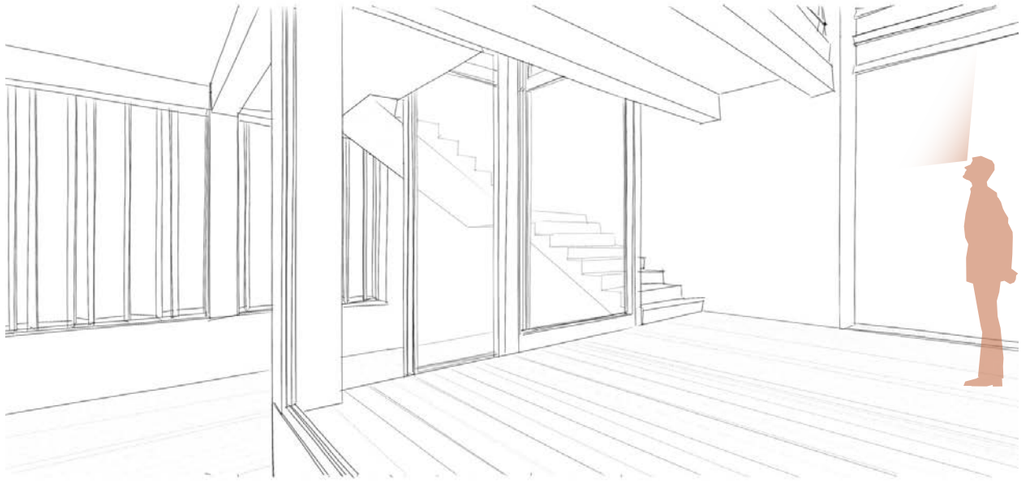
In elevation the floor have a visual connection, through a triple heigh drilling in the slab, above the entrance. Form here therefore, the floors and function positioning is clear and vice versa, they faces the hall and the entrance through it.



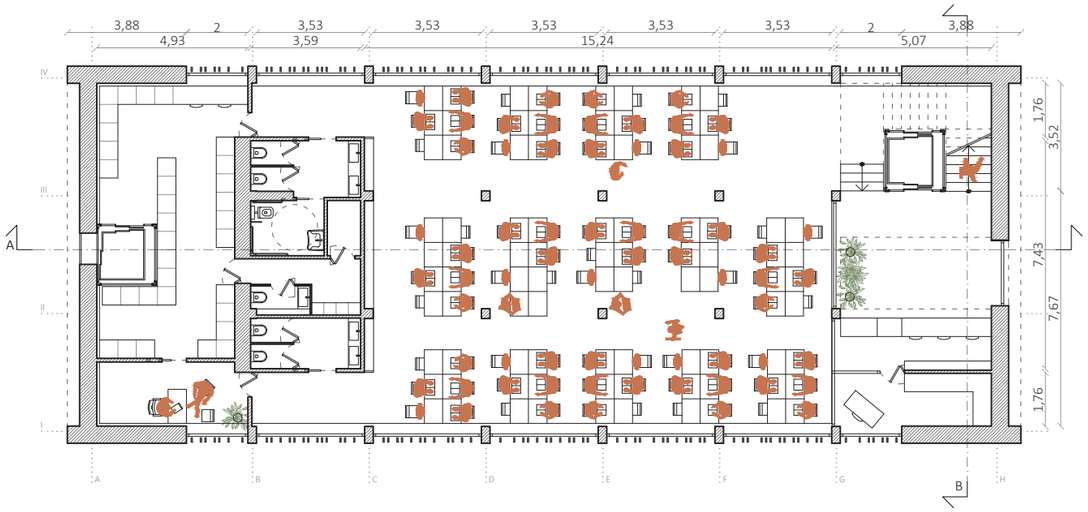

*F.6.5 - Library entrance hall*



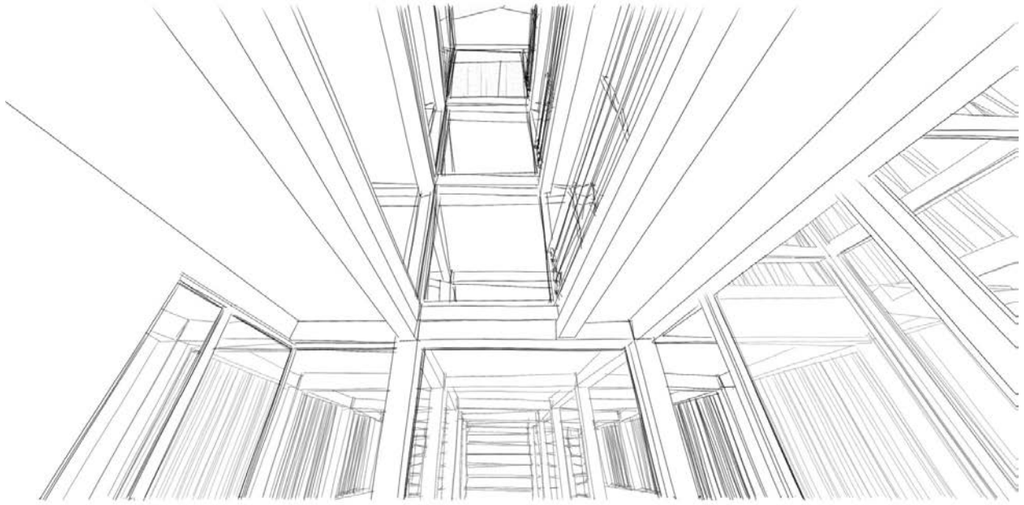

Floor functions and distribution



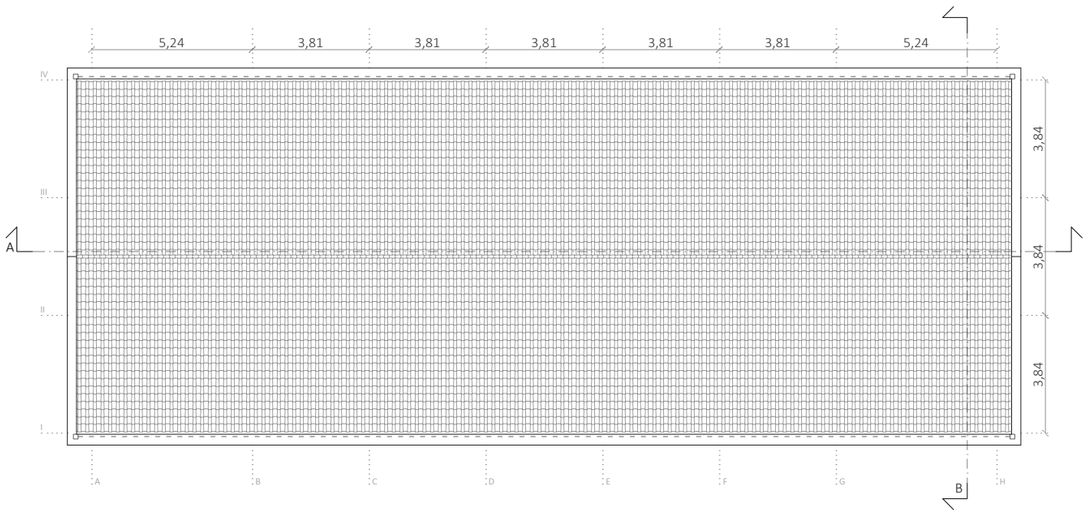
Entry sketch



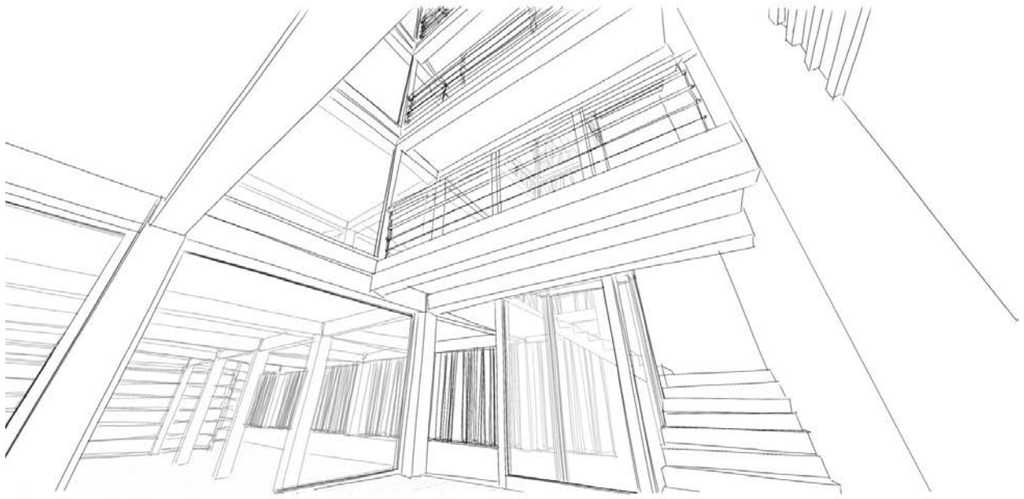

Ground floor plan - 1:200



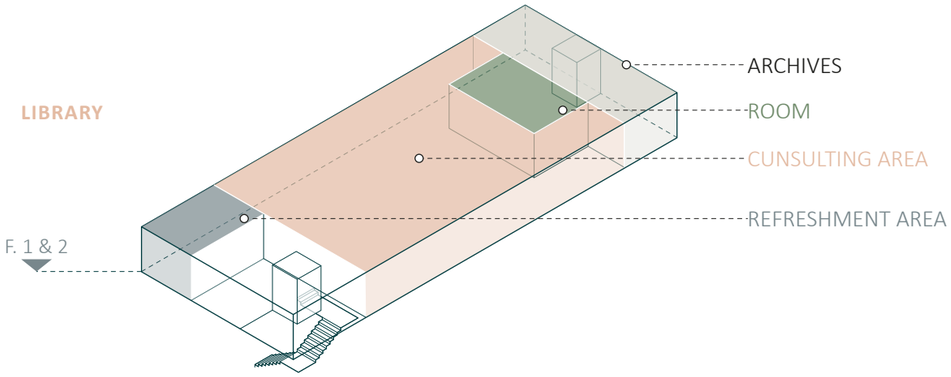
Entrance hall sketch



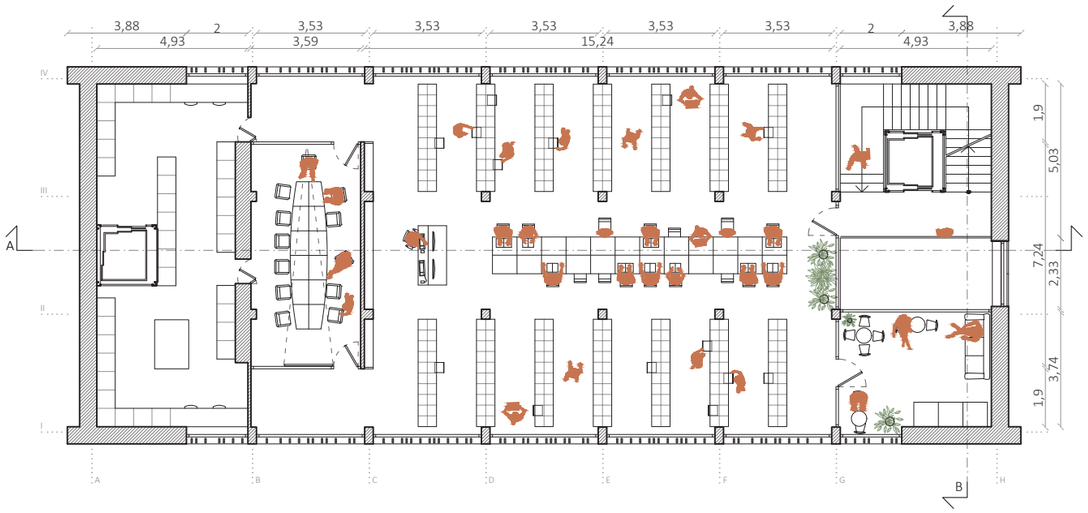

Roof plan - 1:200



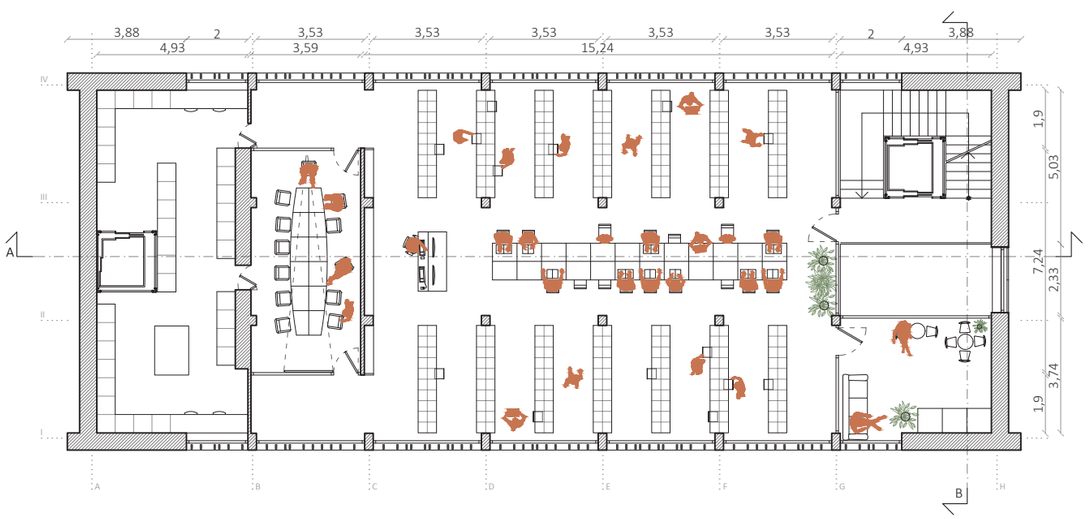
Entrance staircase sketch




Floor functions and distribution

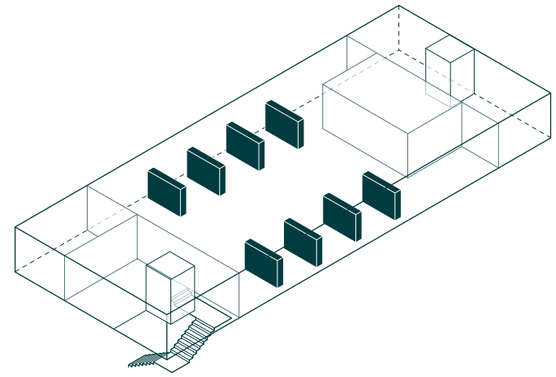


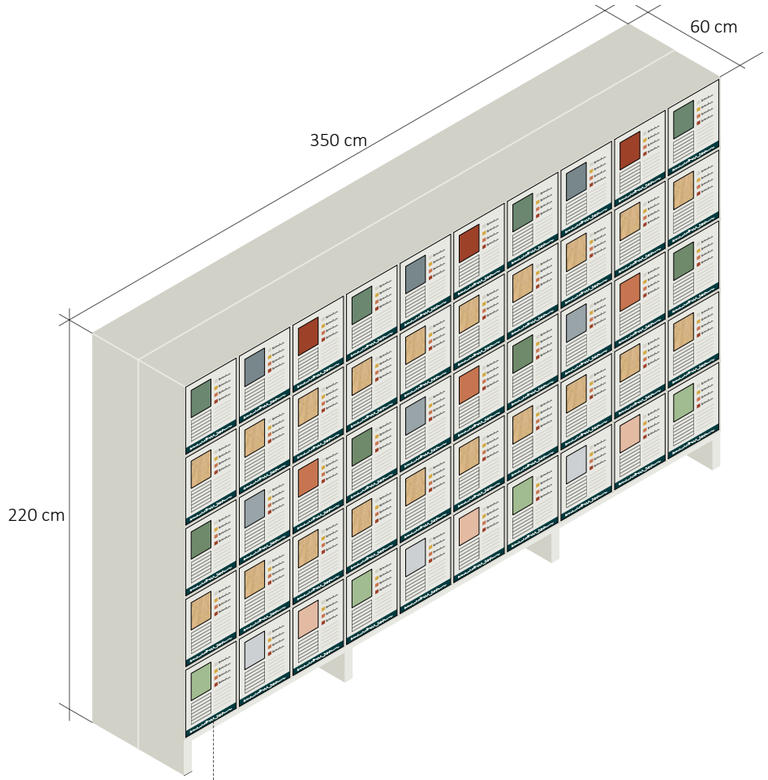

First floor plan - 1:200



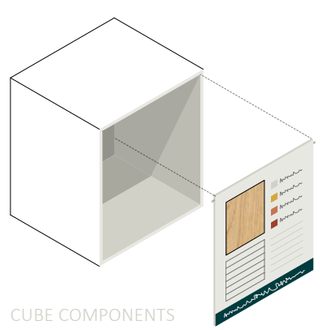

Second floor plan - 1:200

Sample exhibitors

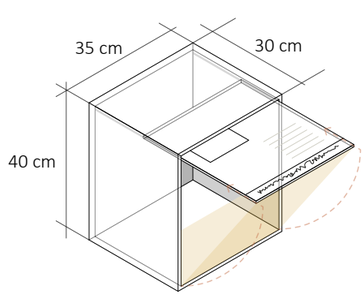




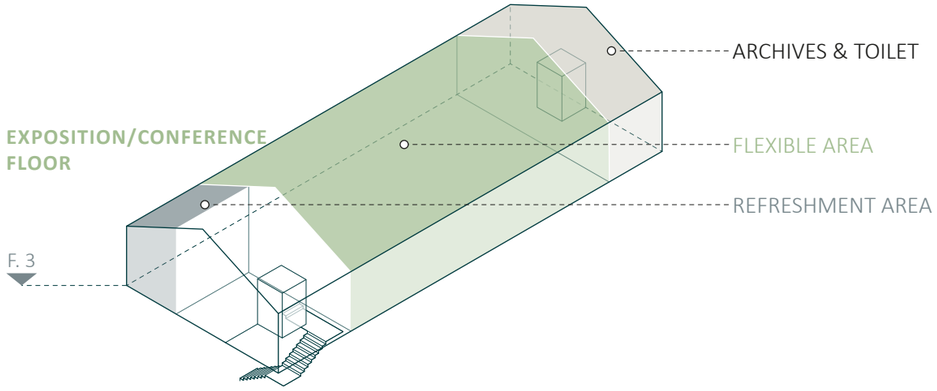

OPENED CUBE



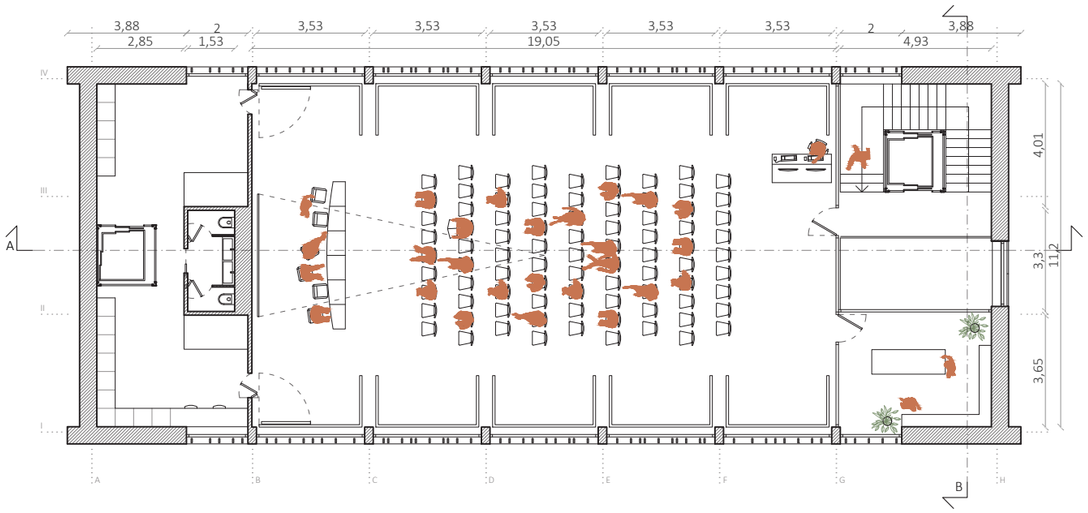
CUBE COMPONENTS



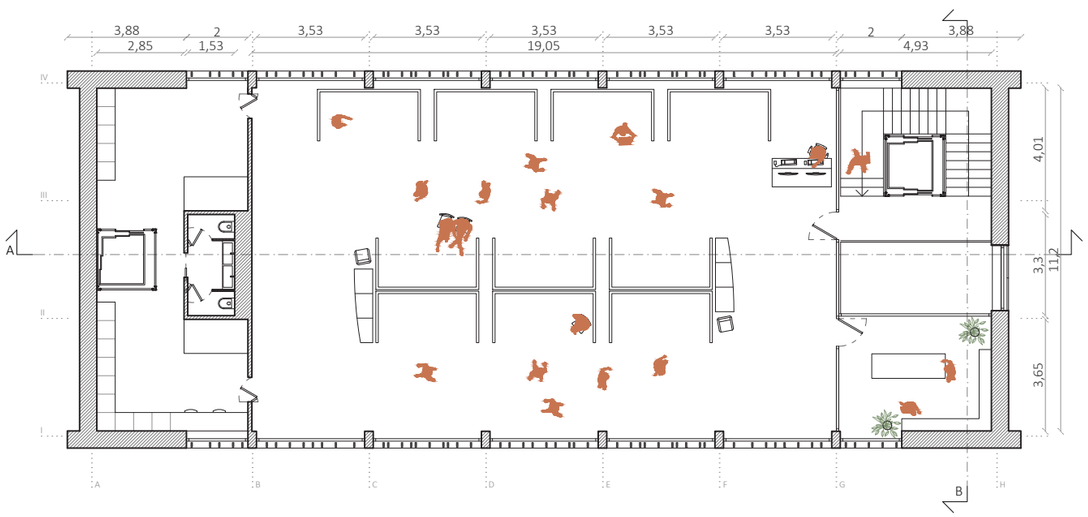

OPENING MECHANISM




Floor functions and distribution



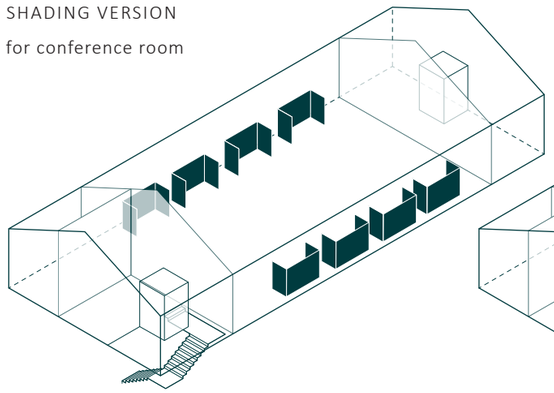

Third floor plan, conference room version - 1:200

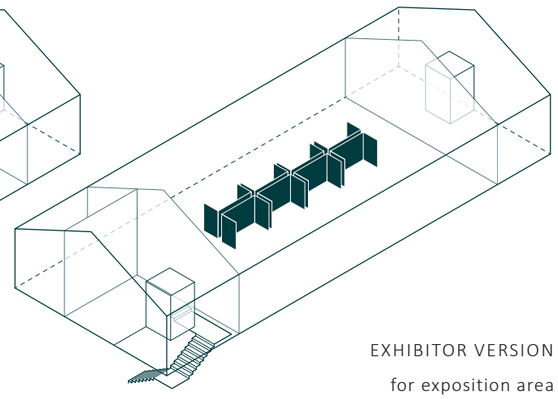



Third floor plan, exposition area version - 1:200

Shading / Exhibitors

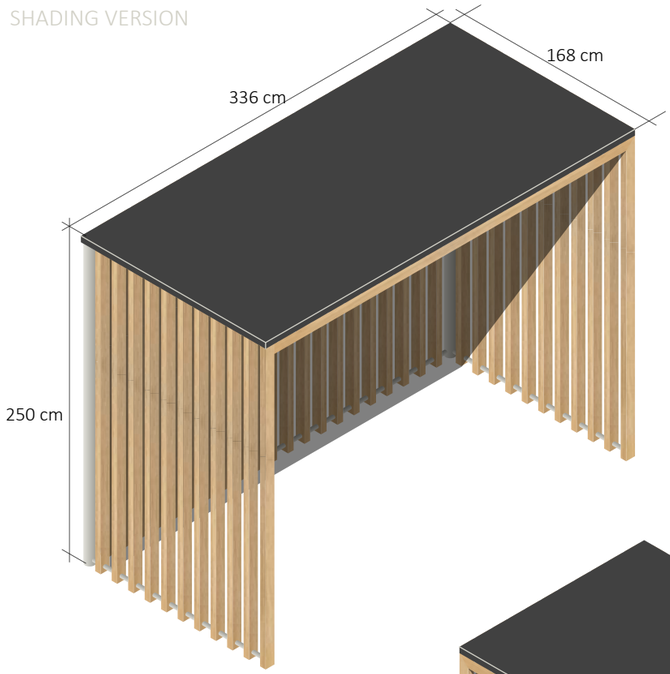
SHADING VERSION
for conference room

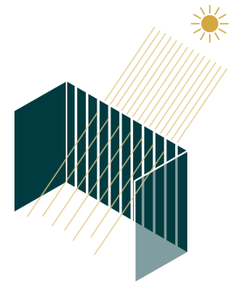




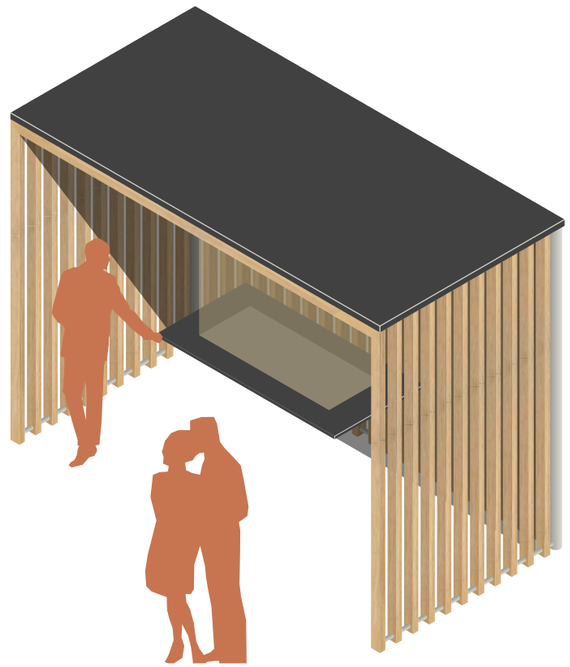
EXHIBITOR VERSION
for exposition area

SHADING VERSION



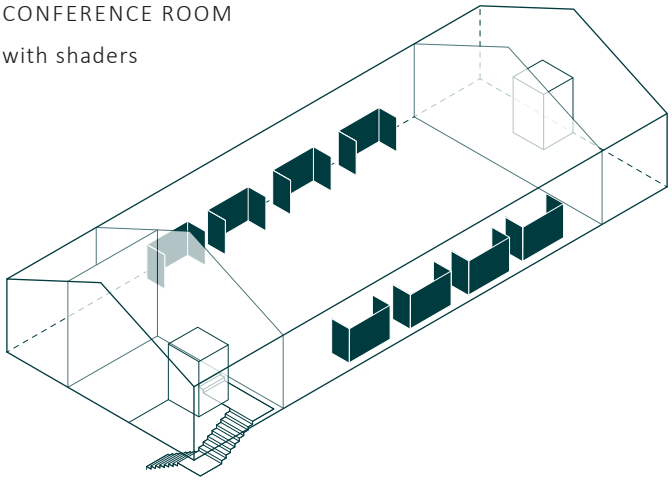



EXHIBITOR VERSION

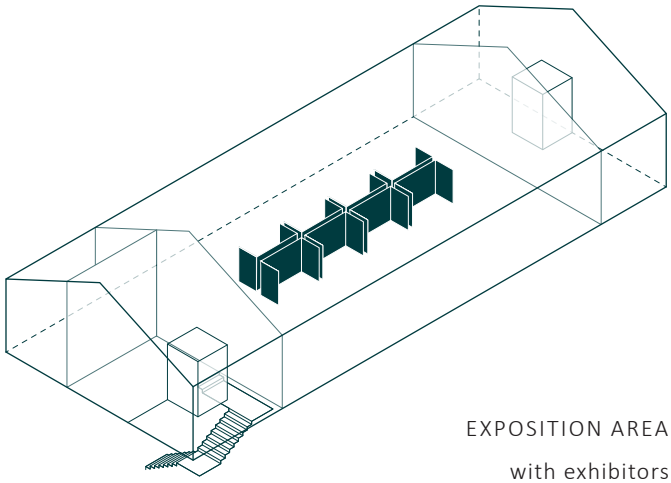


CONFERENCE ROOM

with shaders



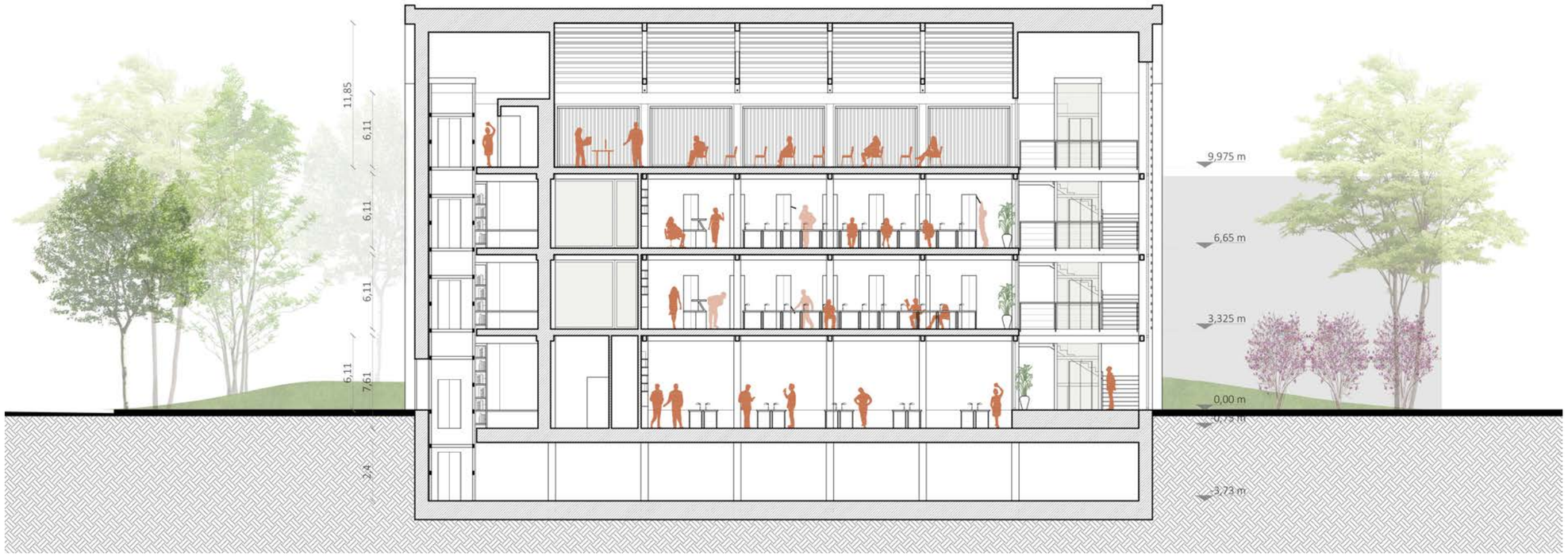
*VIEW 7a - Building level of detail, view of the last floor of the library building, in conference room with the wooden elements as shaders.*



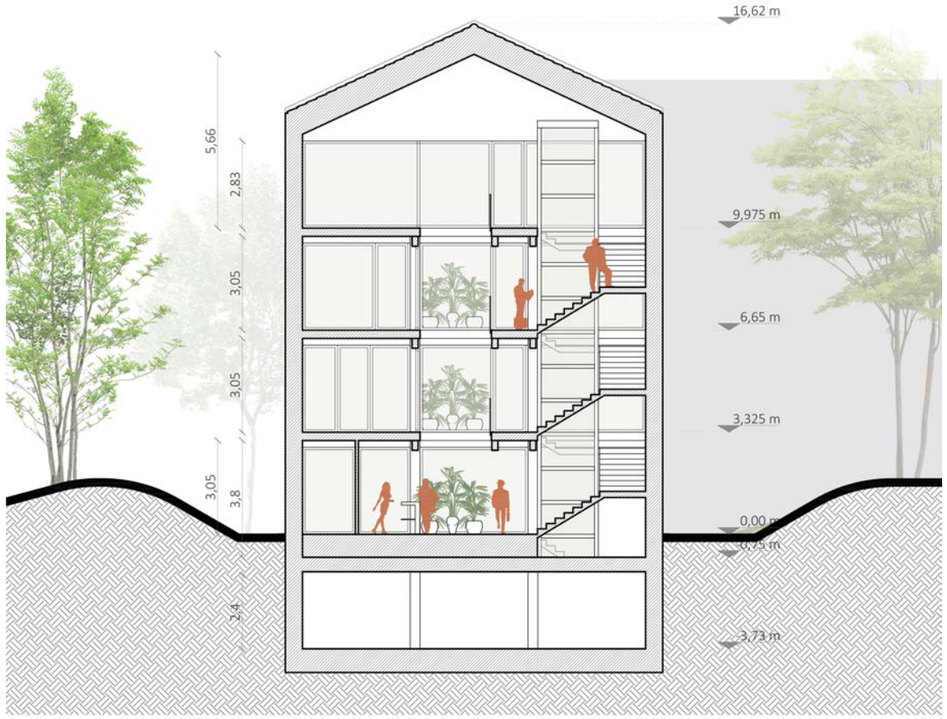
EXPOSITION AREA

with exhibitors

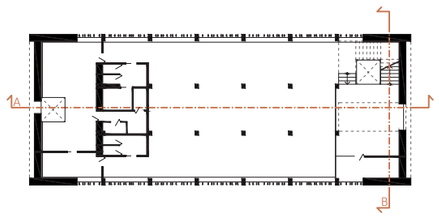
*VIEW 7b - Building level of detail, view of the last floor of the library building, in exposition area with the wooden elements as exhibitors.*




Section A - scale 1:200



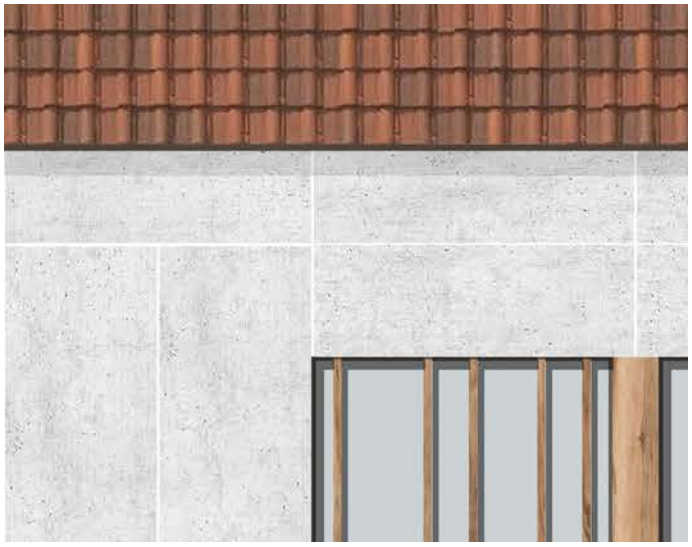

Section B - scale 1:200



## 1.3 LIBRARY FACADES

The building's facades are generally differentiated based on the solar exposition and the overlooking: the short facades are opaque, and the long sides are visually opened. Specifically, in the library, the south facade presents a continuous vertical closure interrupted by the vertical glazed cut, where's the entrance at the ground level. The two long, mirrored sides face the green areas; due to that, they are partially opaque but mainly glazed, and the position of the floors is denounced by a thin string course. The glass windows of the library don't permit access to the outdoor space for functional needs. In other buildings, dedicated to co-working, for instance, the glazed facades on the ground floor are permeable. The passage through the building is therefore allowed and the use of the external space as an extension of the internal space is favoured.

The vertical continuous opaque closures are realized through the ventilated facade mechanism. The coating is realized by thin, layered panels, which are light, available in various aspects and characterized by good environmental properties.



*F.6.6 - West facade detail 1:50, materials*

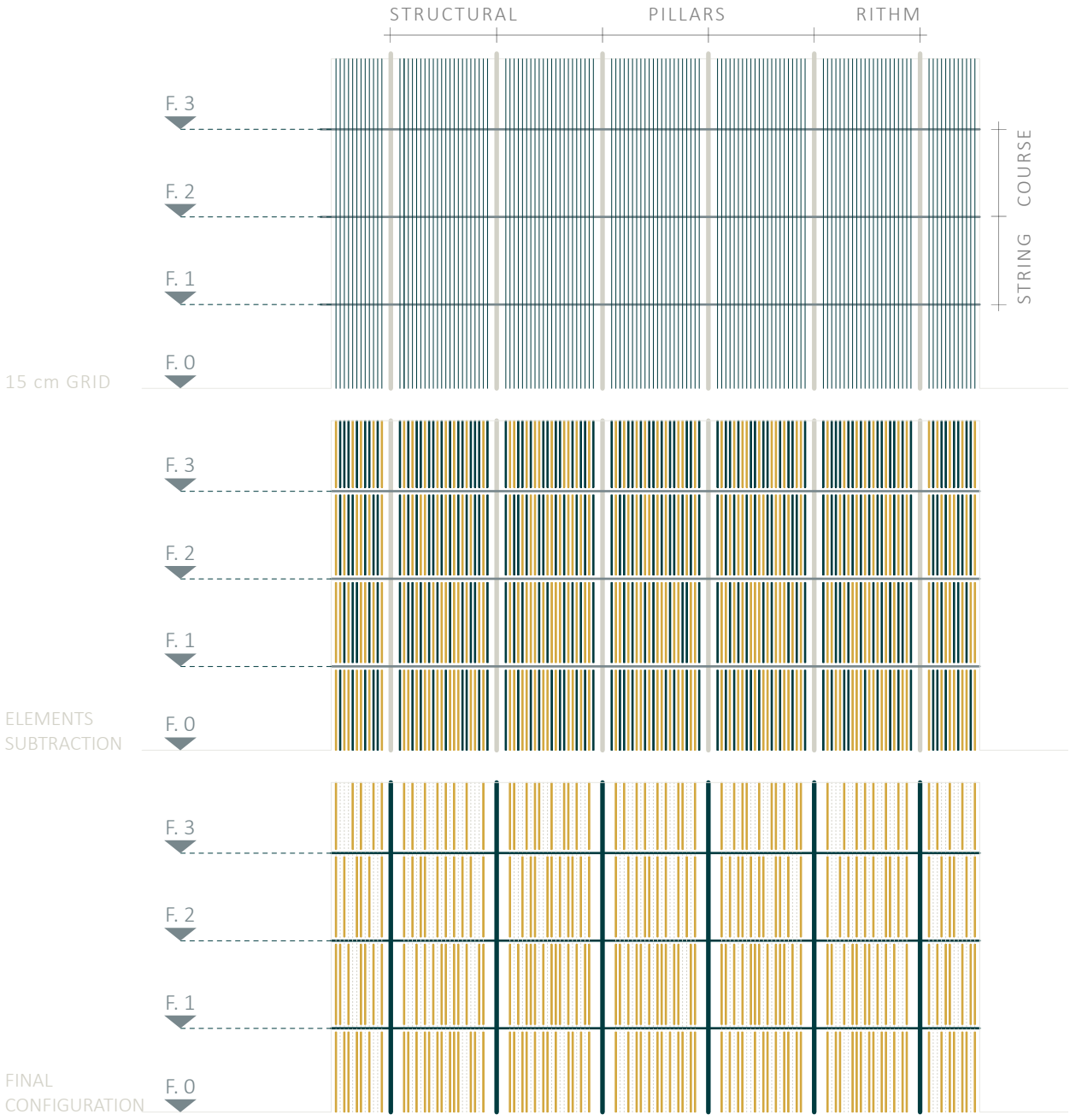
The aesthetic choices are immediately visible from the facades board (*BOARD 6E and 8A*). The coating simulates the light concrete texture, in this way, the use of light colours and appear familiar to the Italian construction context is guaranteed. The same is considered for the roof coating, realized in terracotta natural coloured tiles.

The shading systems will be deeply addressed in the technologies section, chapter 8, here the topic is introduced superficially, only from an aesthetic and material point of view.

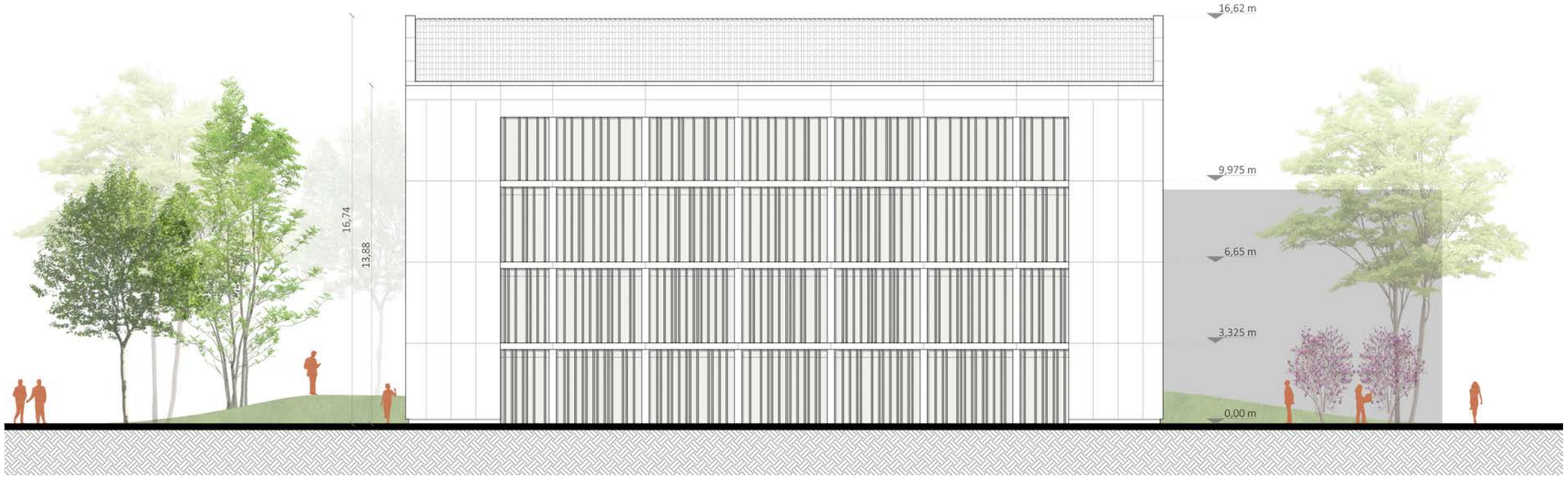
For a matter of functionality and effectiveness, the shading systems are differentiated basing on the solar exposition, while the material is related to the positioning and the location of the facade concerning the masterplan and the other fabrics. In the south facade, close to the vertical glass cut, the shadings are distributed horizontally, keeping a regular distance and they are made by terracotta, recalling the roof tiles.

The shading devices are instead distributed vertically in the east and west sides with an irregular, regularly based distance. To emphasise the continuity with the natural external areas, the elements are in the wood, contrasting with the grey concrete facade.

Hereafter, a scheme of the east/west sides shading system positioning is shown, in agreement with the daylight analysis, reported later on. Like already mentioned it works with irregular spacing between the singular elements. At the base of this positioning, there is a regular vertical grid of 15 cm.

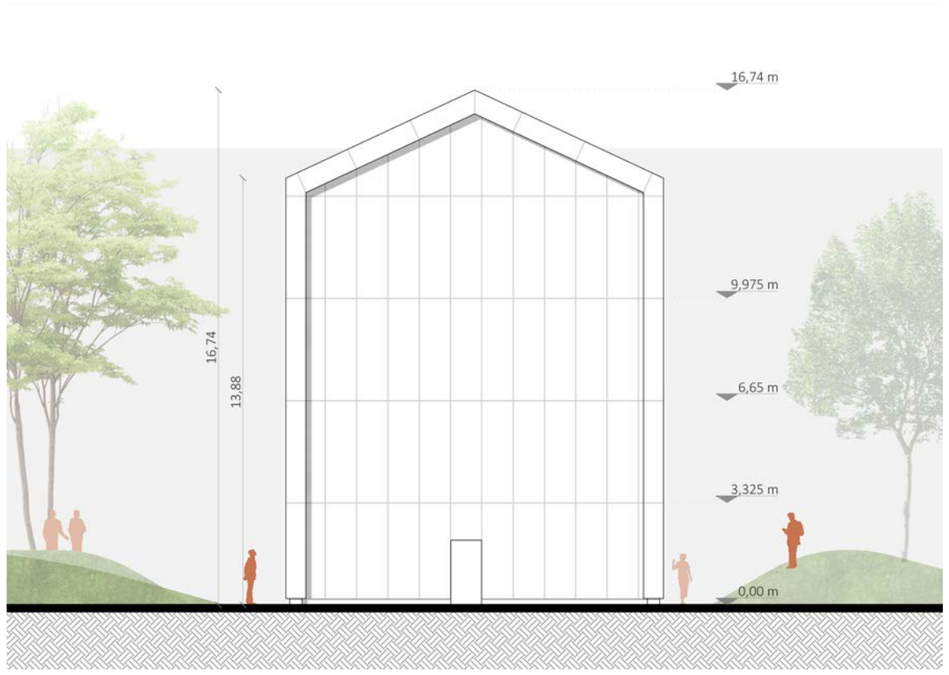



*F.6.7 - west facade shading positioning*




Facade west - scale 1:200


Facade south - scale 1:200

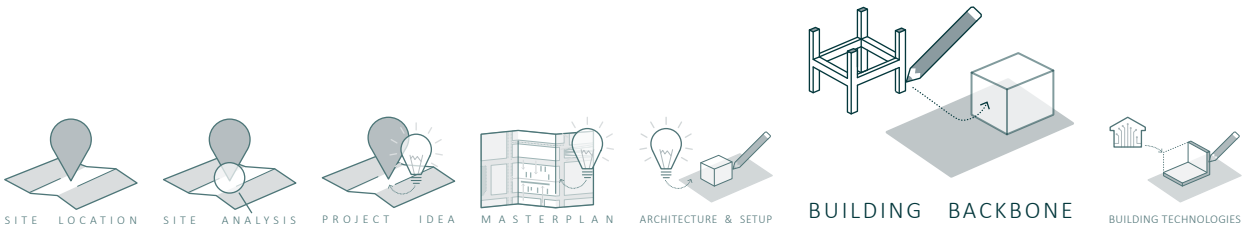


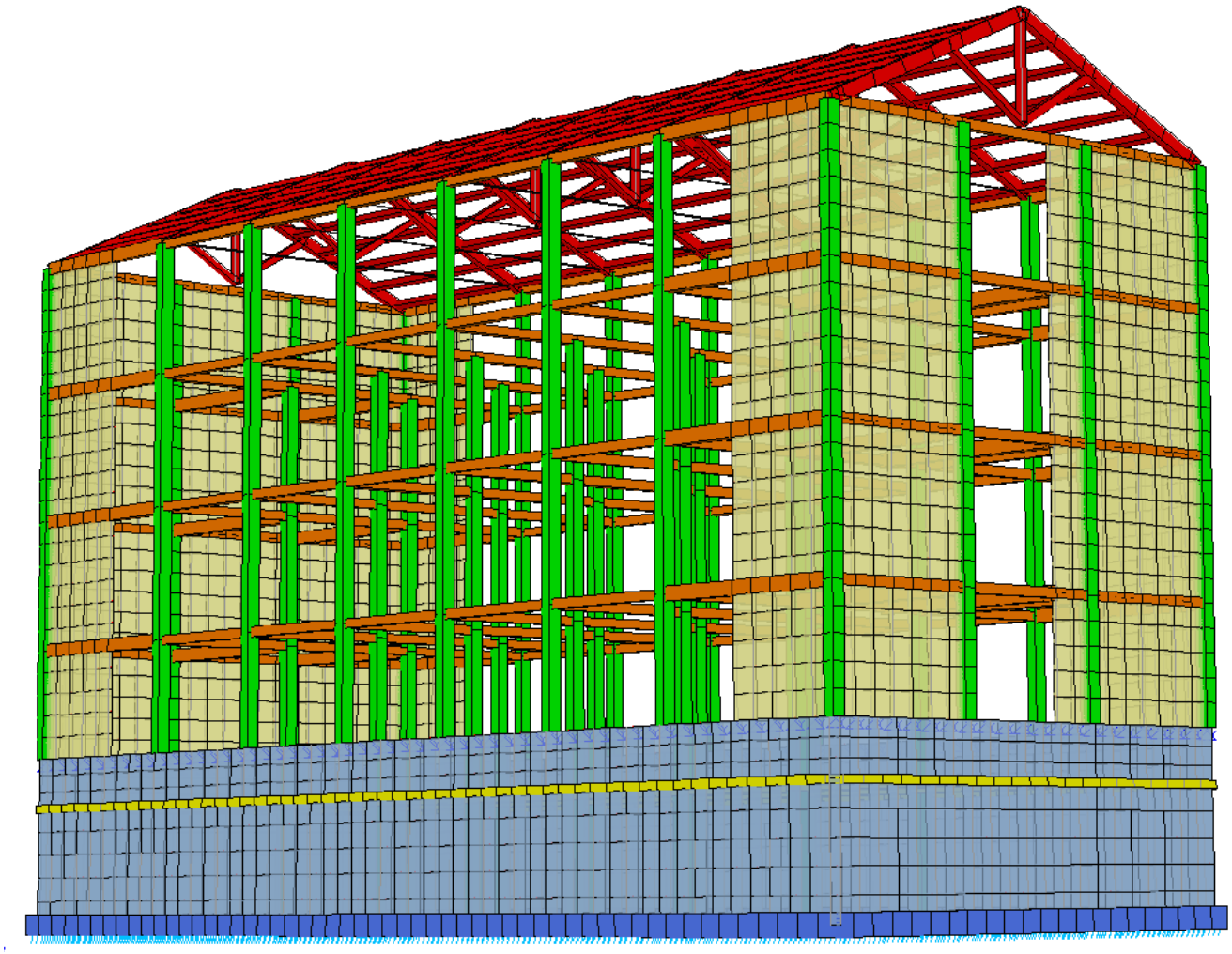

Facade north - scale 1:200

CHAPTER 7

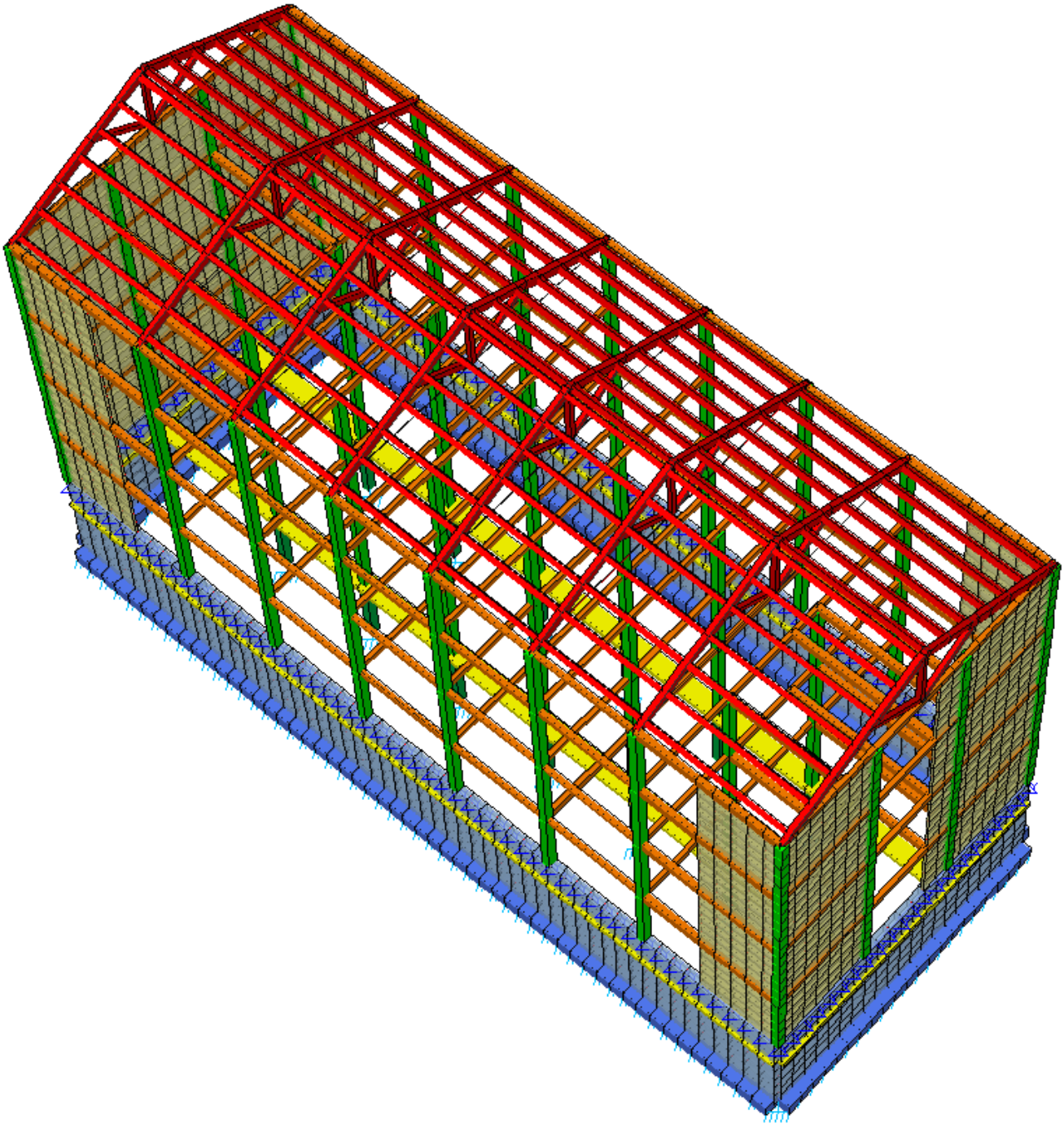
# Backbone

## structural design





*VIEW 7 - Building level of detail, 3D model of the structure, realized with a software for structural design and verification*

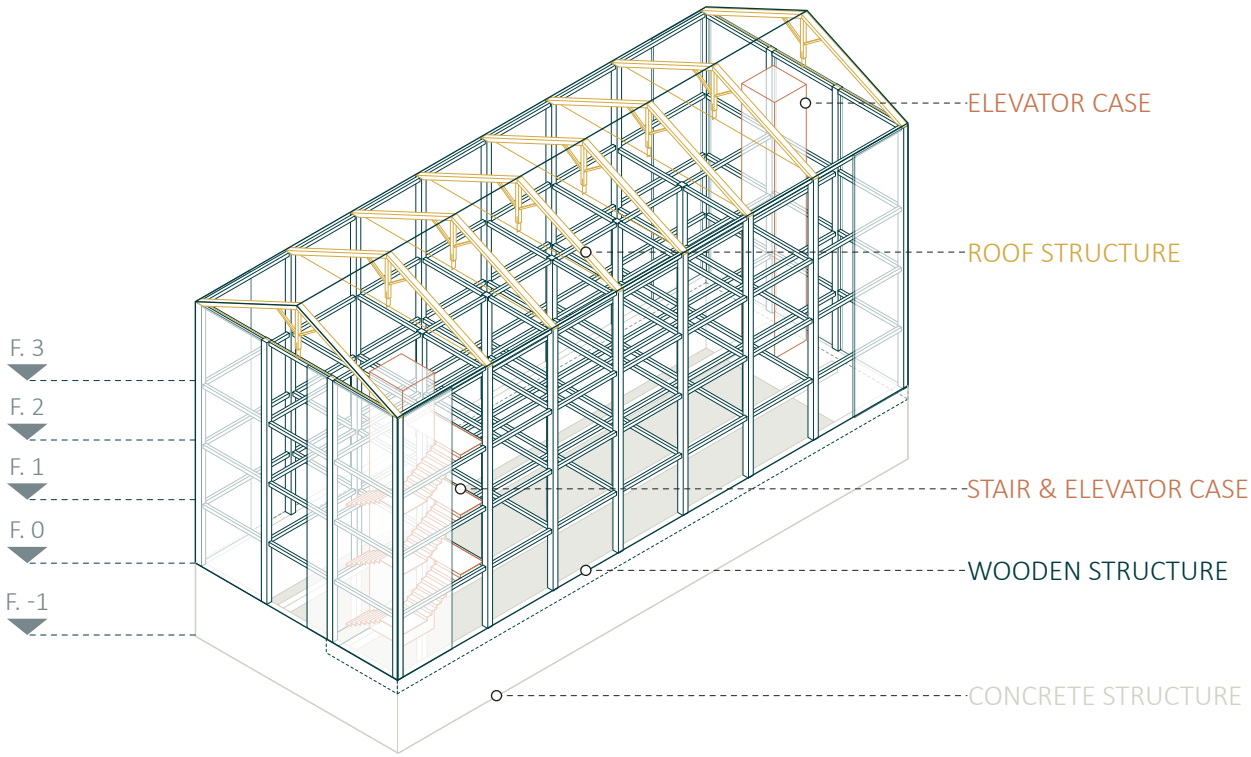


*VIEW 8 - Building level of detail, 3D model of the structure, realized with a software for structural design and verification*

The backbone of the building, that is the supporting structure, is made up of a regular grid of beams and pillars. The design choice is to leave the structure exposed, following the openness and breadth of the spaces. Thinking back to the contest in which we are, the load-bearing structures are generally made of reinforced concrete or in some cases of steel.

Throughout the project, however, the gaze was turned towards a new type of construction, which could be sustainable, made with recyclable materials and innovation. The unusual challenge, in this case, is represented by the desire to apply a structure made mainly of wood. The lights and the reduced heights of the building allow you to create a resistant frame. Particularly at this point of the design phases, it can be seen how the various design choices and steps mix and therefore how much it is necessary to think about the project cooperatively, for a smarter design. A practical example is the possibility to have lightweight systems acting in the building, permitting to have thinner and less invasive structural elements. This is now possible thanks to architectural and technological choices, such as opened spaces and dry construction, to lighten some built volumes, translated now in weighing less on the structure.

As just mentioned, the structure is hybrid, realized partially in reinforced concrete (underground) and partially in laminated wood. The base of the volume is realized by a reinforced concrete structure. It constitutes a support base for the wooden structure, used in the above-ground floors.




*F.7.1 - Backbone frame scheme*

## REINFORCED CONCRETE ELEMENTS

The underground levels are characterised by the reinforced concrete structure. The foundations are constituted by isolated footings from which the pillars extend. The entire perimeter is ralized with earth retaining walls till 0 altitude, of the external ground. The reinforced concrete elements ends with two longitudinal beams extended for the entire length of the building. At the same altitude the corner is closed and reinforced with the curb. The design material parameters are here reported and a single structural element for each type (foundation, column, beam) are represented in the following board.

### *MATERAIL CHARACTERISTICS*

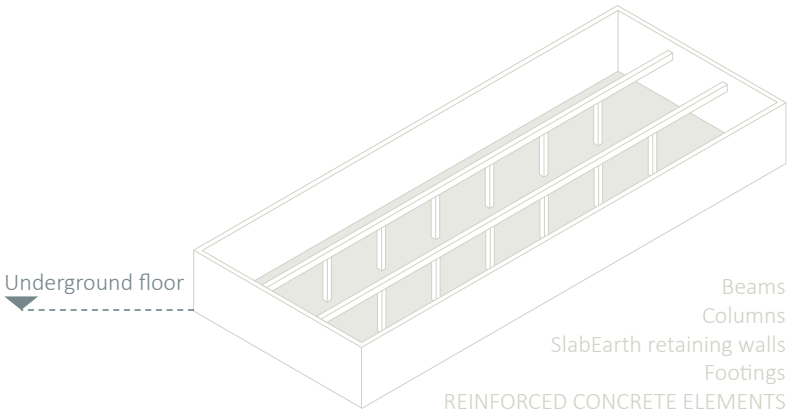
#### CONCRETE C30/37

| | | | |
|---|---|---|---|
| Specific weight | | 25 | $kN/m^3$ |
| Characteristic cubic compressive strength | $R_{ck}$ = | 37 | $MN/m^2$ |
| Characteristic cylinder compressive strength (28 days) | $f_{ck}$ = | 30 | $MN/m^2$ |
| Design compressive strength | $f_{cd}$ = | 17 | $MN/m^2$ |
| | $f_{cm}$ = | 38 | $MN/m^2$ |
| | $R_{cm}$ = | 46 | $MN/m^2$ |
| Medium tensile strength | $f_{ctm}$ = | 3,1 | $MN/m^2$ |
| Characteristic tensile strength | $f_{ctk}$ = | 2,1 | $MN/m^2$ |
| Design tensile strength | $f_{ctd}$ = | 1,4 | $MN/m^2$ |
| Modulus of elasticity | $E_c = 22000 (f_{cm}/10)^{0,3}$ | | |
| Reduction coefficient for long-lasting resistors | $\alpha_{cc}$ = | 0,85 | |
| Concrete partial safety factor | $\gamma_c$ = | 1,5 | |
| Admissible compressive stress under ch. Load combination | $\sigma_{c,max}$ = | 18 | $MN/m^2$ |

#### STEEL B450C

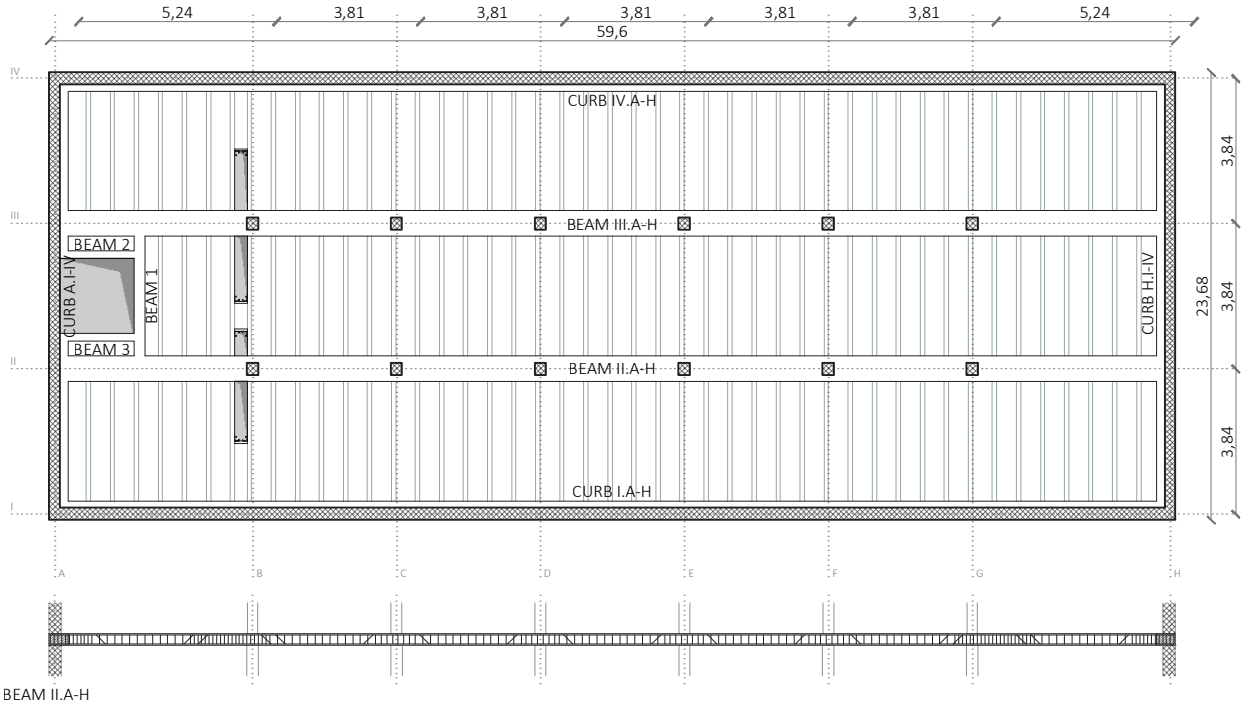
| | | | |
|---|---|---|---|
| Characteristic yielding strength for the bar | $f_{yk}$ = | 450 | $MN/m^2$ |
| Modulus of elasticity | $E_s$ = | 205000 | $MN/m^2$ |
| Design yielding strength | $f_{yd}$ = | 391,30 | $MN/m^2$ |
| Steel partial safety factor | $\gamma_s$ = | 1,15 | |
| Admissible compressive stress under ch. Load combination | $\sigma_{s,max}$ = | 360 | $MN/m^2$ |

It is necessary to mention in advance that the calculation has been made without considering the presence of holes for implants and elevators. Looking at the beam design, it is a single symmetrical element, on several supports. A constant beam reinforcement guarantees a minimum resistance for the entire length while the thickenings compensate when higher resistances are required.




*F.7.2 - Reinforced concrete structural elements scheme*

The structural slab is realized with precast reinforced concrete beams of small dimensions posed transversally over the longitudinal beams. After the positioning on site, concrete is poured together with the metal mesh.

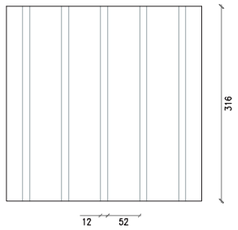



*F.7.3 - Reinforced concrete structure plan and beam section, scale 1:200*

## Structural slab

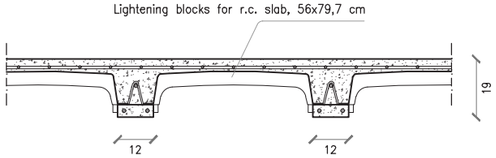
realized with precasted reinforced concrete beams for slab

Slab h = 19 cm, L = 3.16 m

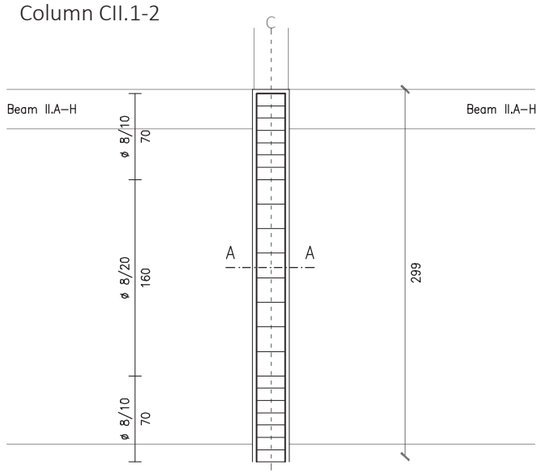



Applied loads:
Q = 5,00 kN/m²
$G_2$ = 1,62 kN/m²
$G_1$ = 2,46 kN/m²

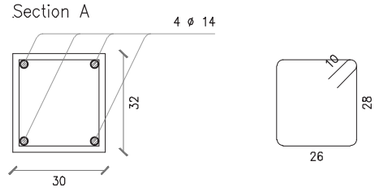
Section




## Column CII.1-2

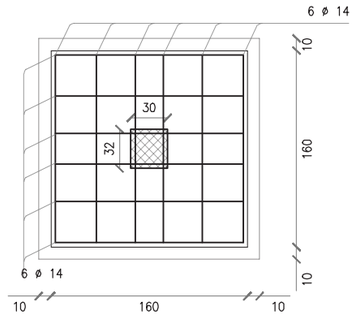



Section A

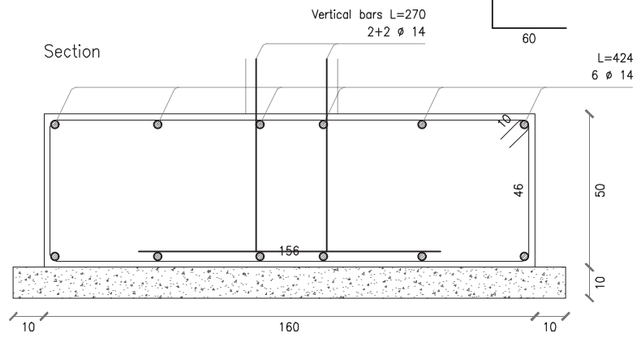



Stirrups ø8
L=128

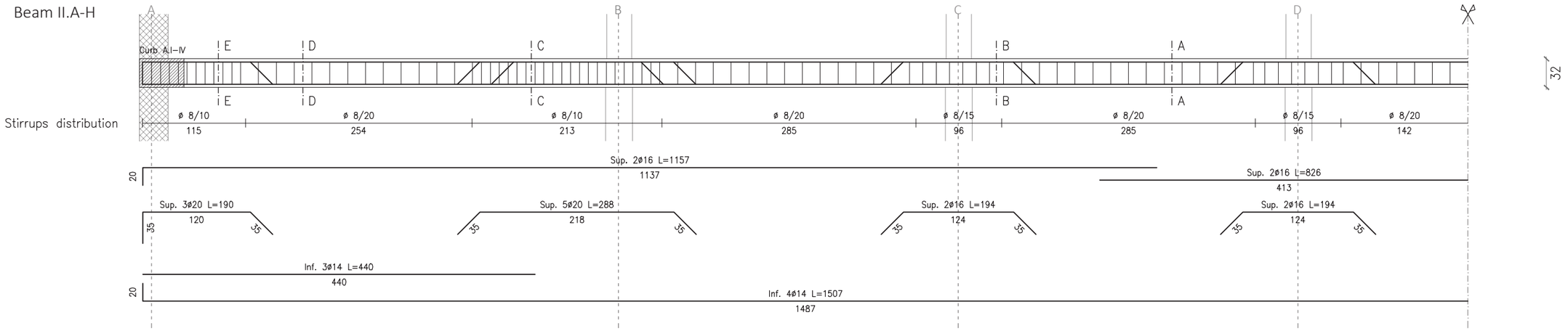
## Isolated footing CII.1-2




Section

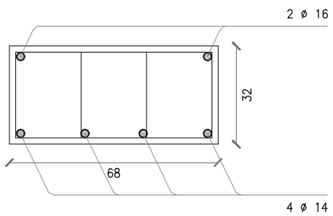


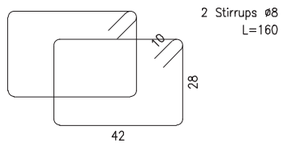

## Beam II.A-H



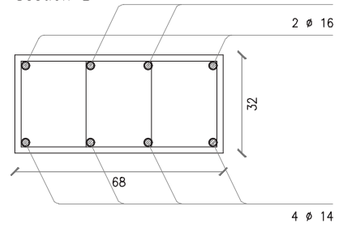

Longitudinal reinforcement distribution

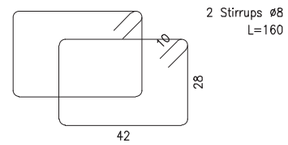
Section A



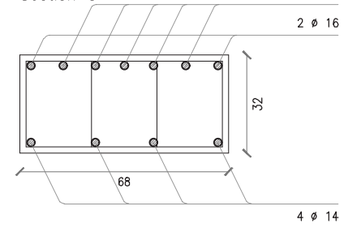



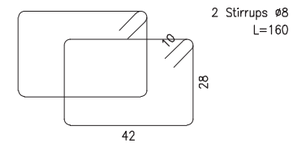

Section B



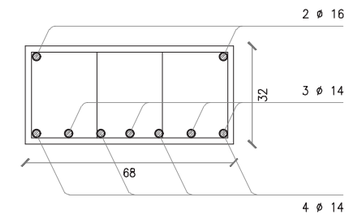



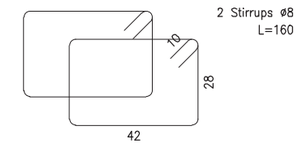

Section C



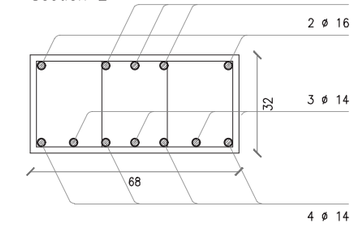



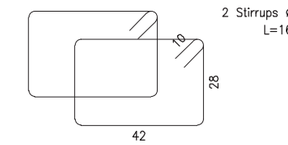

Section D




Section E



## WOODEN ELEMENTS

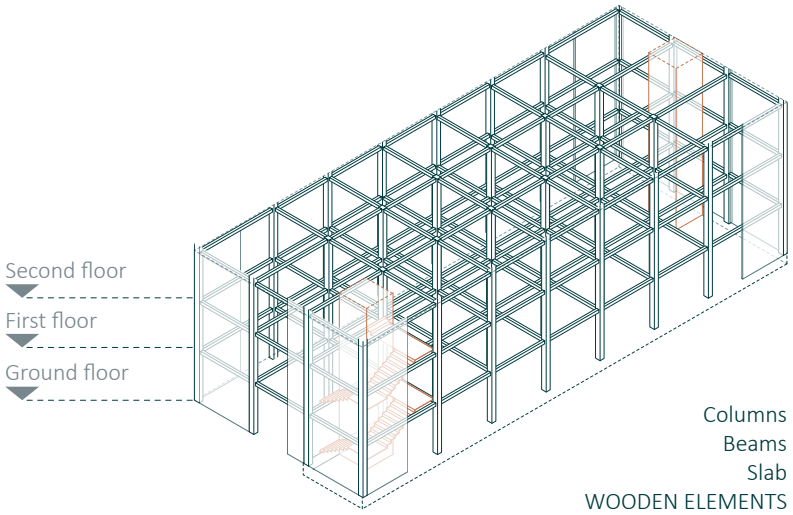
The above-ground levels are characterized by the wooden structure, composed of columns, beams and walls. The frame elements are designed using laminated spruce of the type GL32h with the lamellae being 4 cm thick. While the structural XLam panels, used as a load-bearing component for the vertical closure, are 10 cm thick. They play an important role, as we'll see later, in displacement prevention in the seismic analysis.

### *MATERAIL CHARACTERISTICS*

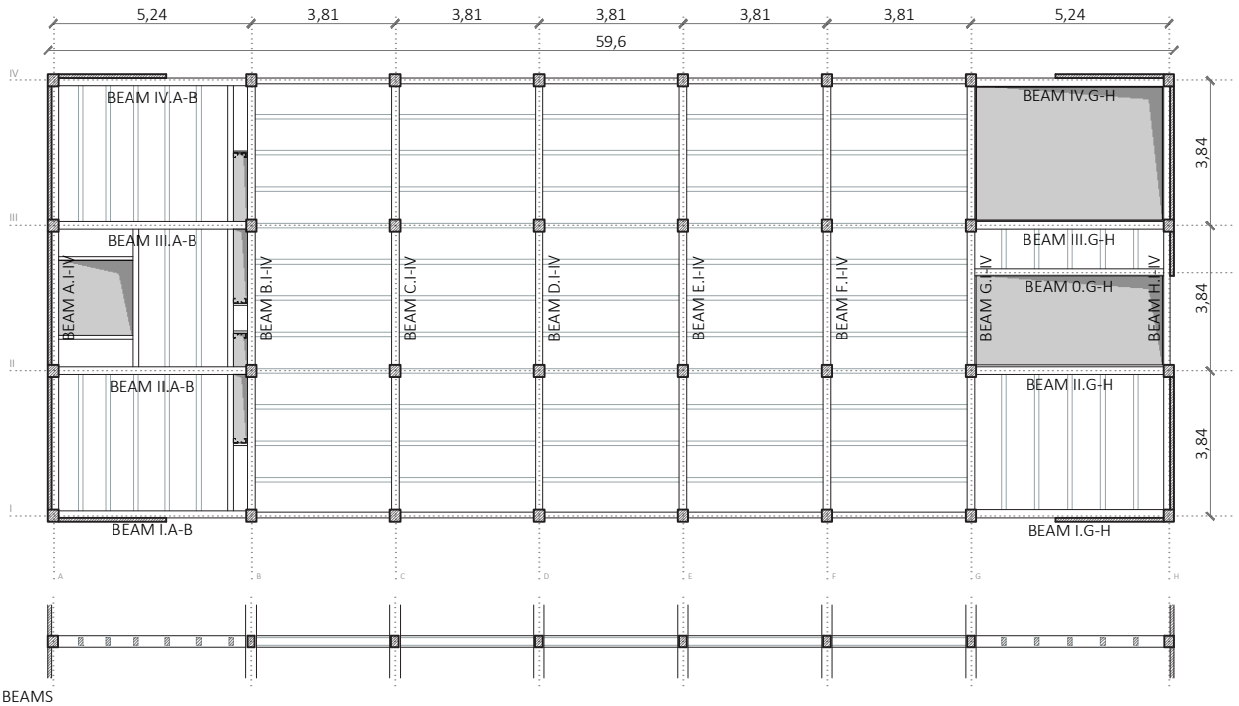
TIMBER GL32h (laminated spruce structure)

| | | | |
|---|---|---|---|
| Specific weight | | 6 | kN/m$^3$ |
| Characteristic esistances | | | |
| flexural resistance | $f_{mgk}$ = | 32 | MN/m$^2$ |
| tensile strength parallel to the fibers | $f_{t0gk}$ = | 22,5 | MN/m$^2$ |
| tensile strength perpendicular to the fibers | $f_{t90gk}$ = | 0,5 | MN/m$^2$ |
| compressive strength parallel to the fibers | $f_{c0gk}$ = | 29 | MN/m$^2$ |
| compressive strength perpendicular to the fibers | $f_{c90gk}$ = | 3,3 | MN/m$^2$ |
| shear resistance | $f_{vgk}$ = | 3,8 | MN/m$^2$ |
| Design resistances | | | |
| flexural resistance | $f_{mgd}$ = | 25,6 | MN/m$^2$ |
| tensile strength parallel to the fibers | $f_{t0gd}$ = | 18 | MN/m$^2$ |
| tensile strength perpendicular to the fibers | $f_{t90gd}$ = | 0,4 | MN/m$^2$ |
| compressive strength parallel to the fibers | $f_{c0gd}$ = | 23,2 | MN/m$^2$ |
| compressive strength perpendicular to the fibers | $f_{c90gd}$ = | 2,64 | MN/m$^2$ |
| shear resistance | $f_{vgd}$ = | 3,04 | MN/m$^2$ |
| Modulus of elasticity | | | |
| medium modulus of elasticity parallel to the fibers | $E_{0gm}$ = | 13700 | MN/m$^2$ |
| characteristic modulus of elasticity parallel to the fibers | $E_{0g0,5}$ = | 11100 | MN/m$^2$ |
| medium modulus of elasticity perpendicular to the fibers | $E_{90gm}$ = | 420 | MN/m$^2$ |
| medium shear modulus | $G_{gm}$ = | 780 | MN/m$^2$ |
| Safety factor | $\gamma_M$ = | 1,25 | |

The wooden structures have to be assigned to a specific class of service, which defines values of resistances and calculations of deformations in determining environmental conditions. The service classes are 3, classified according to the environmental conditions of the place where the structure operates. Class 1 is specific for indoor environments, with reduced and controlled humidity percentages of less than 65%. Class 2 includes elements also placed in external environments but protected, at least partially from the elements. Finally, class 3 concerns worse environmental conditions and/or total exposure to atmospheric agents. For the library we can apply the first class: “Class



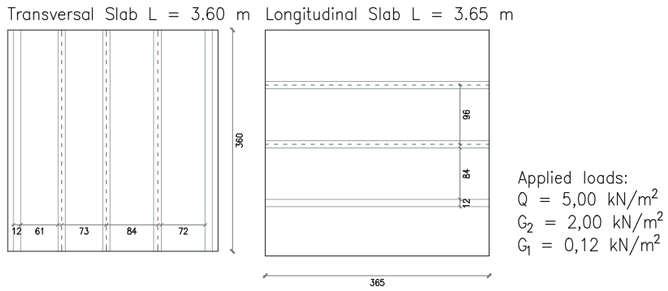

*F.7.4 - Wooden structural elements scheme*

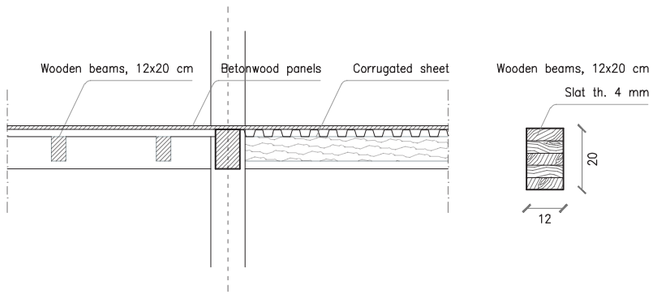



*F.7.5 - Wooden structure plan and beam section, scale 1:200*

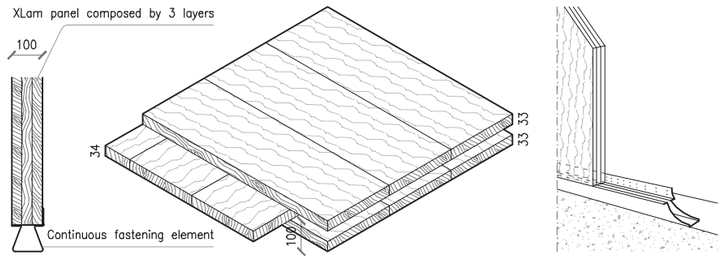
## Structural slab

realized with wooden beams for slab

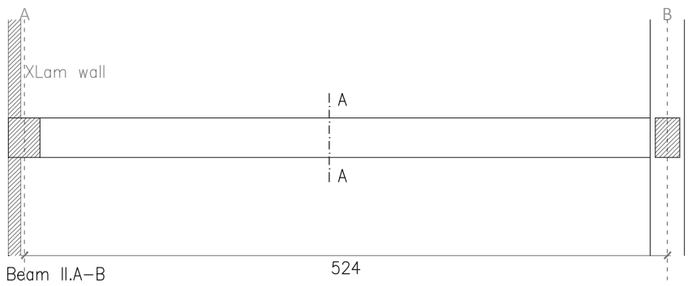


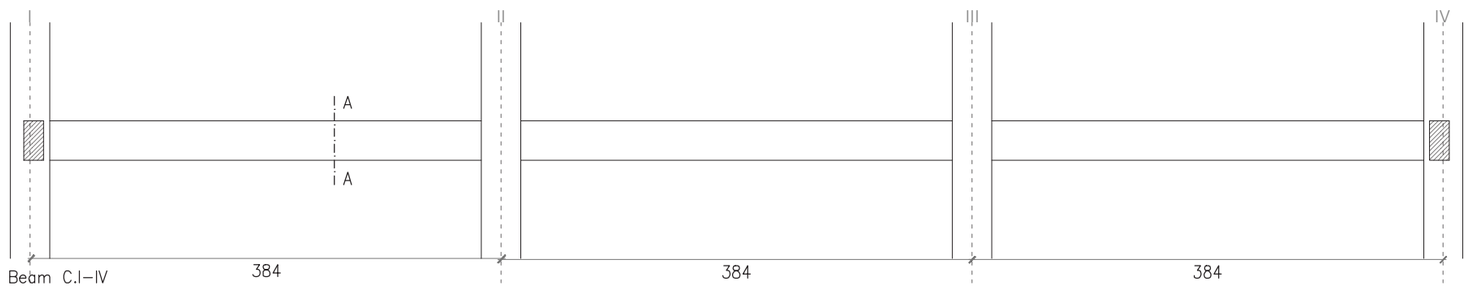




## XLam wall detail




## Beam design

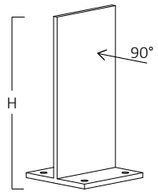



## Structural elements connections and details

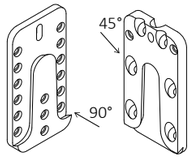
### "T" PILLAR-HOLDER WITH INTERNAL CORE *for COLUMNS*

*Fastening with pins or bolts*
*Codes*




### CONCEALED TIMBER-TO-TIMBER CONNECTOR *for SLAB BEAMS*

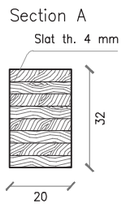
*Quick installation and easy removal*
*Codes*

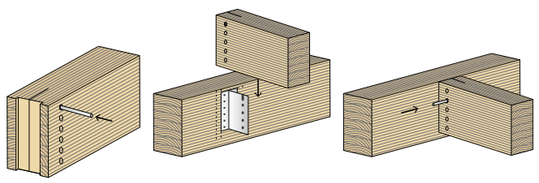



### CONCEALED ALUMINIUM ALLOY BRACKET *for BEAMS*

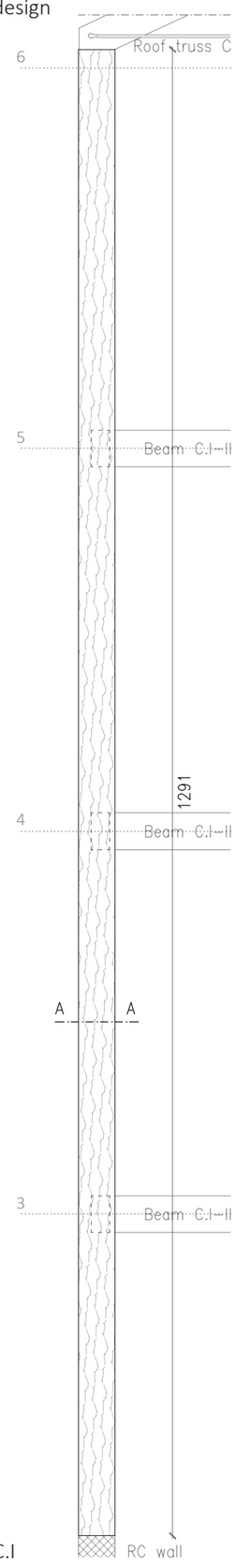
*Timber-to-timber/concrete*
*Large load capacities*

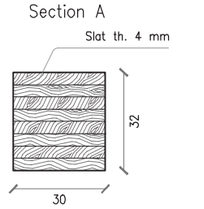


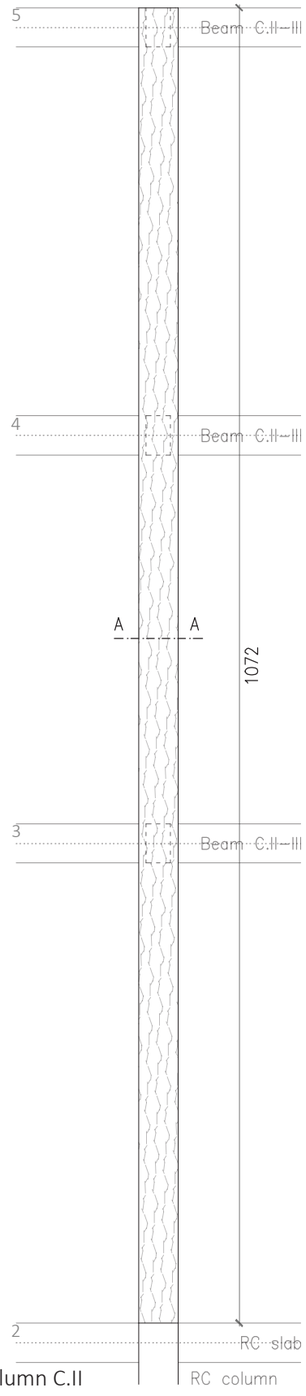



## Column design



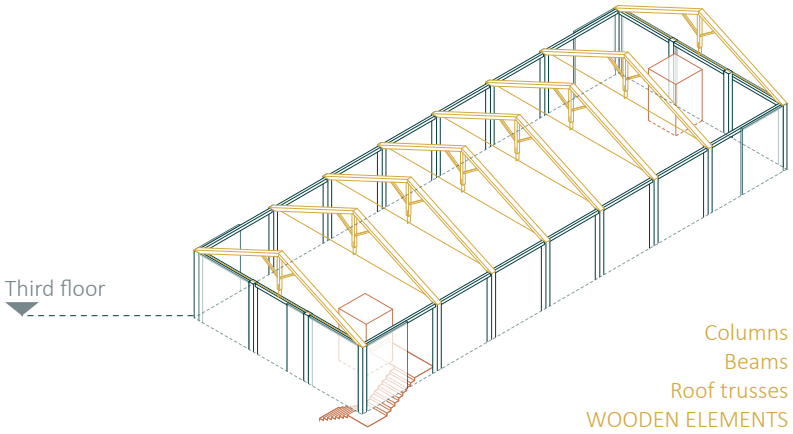
of service 1 is characterized by a level of material humidity in equilibrium with an environment of 20°C and relative humidity in the surrounding air less than 65%, except only for a few weeks per year. Wooden elements protected against bad weather such as those placed inside buildings in conditioned environments can belong to this class."

Looking now at the designed elements and following the board storytelling, we observe the slab, a detail of the XLam panels, the beam and the column.

First of all the slab is constituted by a grid of parallel secondary beams connected to the main ones. A corrugated metal sheet is then applied transversally to the beams and the structural slab is finished with a consolidating level in betonwood panels. In absence of the classic concrete cast with electro-welded mesh, the problem, in this case, is the formation of the rigid surface. Some solutions can be applied: one case is to mechanically fix the three layers together with screws and another one consists in inserting a system of steel tie rods to form x in the slab areas. Depending on the deepness or complexity of the slab, the grid made by the secondary beams is longitudinal or transversal.

The primary beams supporting the slab are constituted by 8 lamellae of 4 mm each for a total of 320 mm in height and 200 mm wide. The same is applied to the columns with a different length of 300 mm. The columns are whole pieces while the beams are interrupted and their major length is equal to 524 cm. As from the architectural project, the corners of the building are opaque and transparent. Where they are opaque it is positioned an XLam panel, for the entire height of the floor. The panel is 10 cm thick and characterised by 3 layers of 33, 34 and 33 mm.

Here beside is represented the roofing system of two inclined pitches. It was not dimensioned even being very simple: it consists in a regular grid, whose trusses rest on the rows of external pillars.

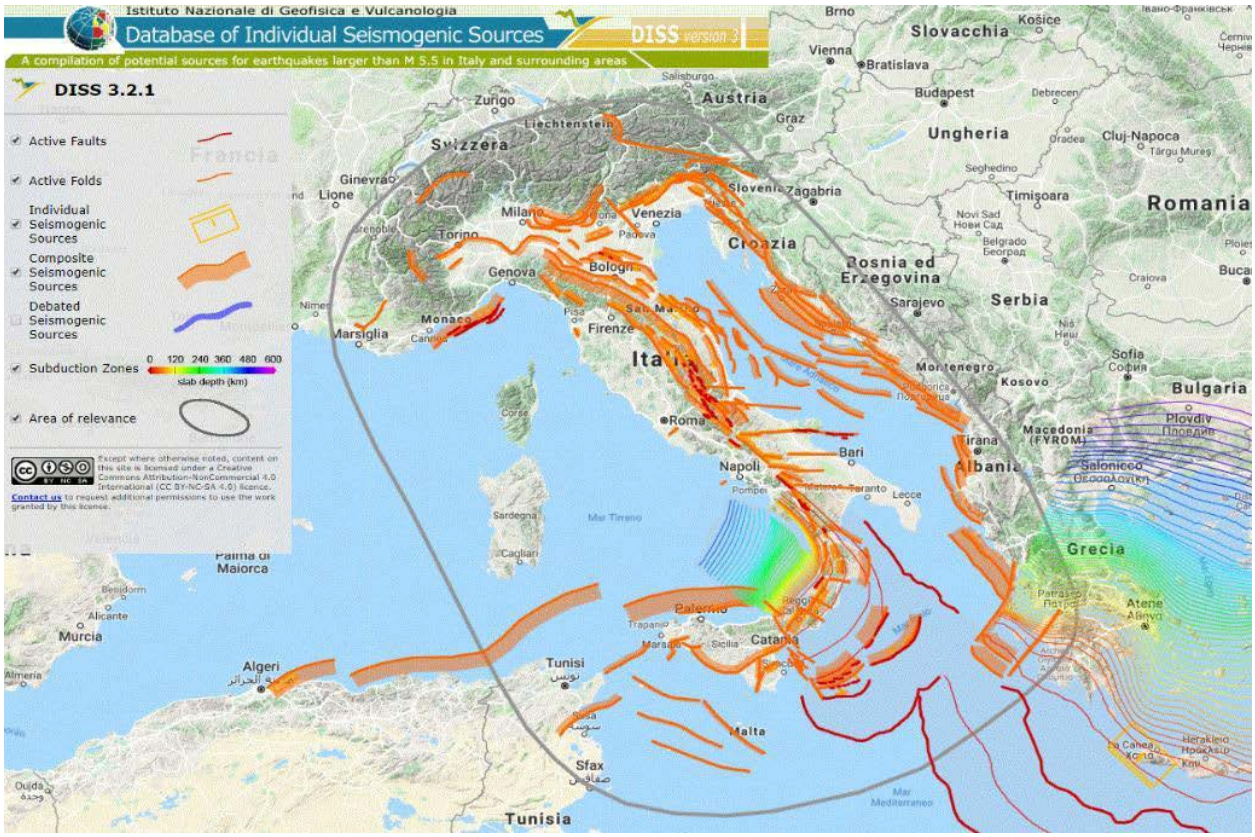



*F.7.6 - Roof structural scheme*

One of the most important things together with the correct design is the choice and the application of the proper junction elements. They should guarantee the structural requirements and also prevent the deterioration of the structural components. Some joints are therefore designed to specifically prevent the formation of humidity between two materials. The deterioration

of the structural elements constitutes a lowering of the structural performance. In this regard, trying to combine the aesthetic and functional technical aspects, was the application of certain fixings, represented on the board.

A fundamental aspect of nowadays construction is the prevention of seismic risk. The entire Italian peninsula is an earthquake zone, characterized by many faults, as evidenced in the picture with orange blocks of different dimensions. Even North of Italy is characterized by rather frequent earthquakes even if of small magnitude.



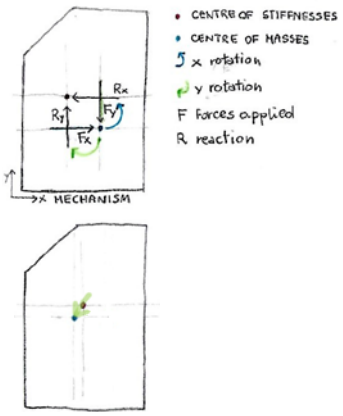
*F.7.7 - Compilation of potential sources of earthquakes in Italy*

Therefore, in the building design, the designer must apply some precautions. An earthquake subjects a built volume to vertical and horizontal stresses. Of the two conditions, the most dangerous are the horizontal ones to which the building is not designed to withstand. It can move in space, along the vertical and horizontal axis, and rotate, causing displacement. The regulations for structural design dictate some limits of displacement depending on the type of earthquake. During my study path I have learned that the rotation of the volume should be always avoided and to do this are usually applied rigid elements in specific points of the plan to prevent this type of behaviour. This function is generally performed by stairwells and lift shafts,

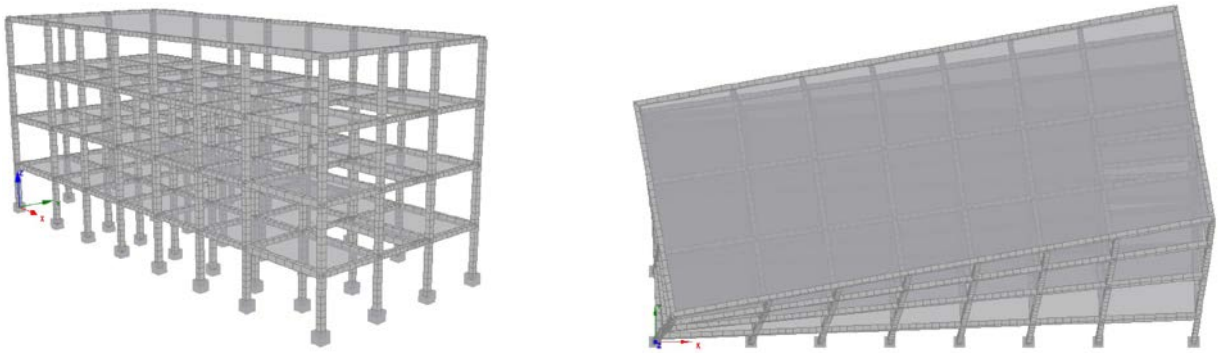
in particular in reinforced concrete structures, as they constitute a rigid body, extended for the entire height of the building. With the aim of avoiding rotational behavior in the building in the project, I have decided to develop an analysis of the simplified structure of the library building.

The behaviour models of the wooden structure are qualitatively compared below. The first version is made without the adoption of XLam walls, the second instead includes these walls, which at this point no longer have a function of purely supporting the masonry but also structural.

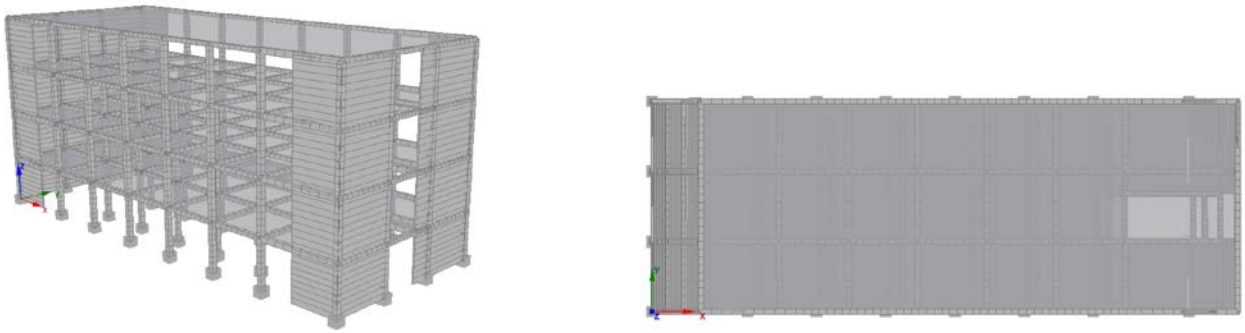
The rotation is happening due to the no coincidence of the location of the centre of the masses and the centre of the stiffnesses points. The little scheme here on the side shows that, once the force is applied to the structure, it acts in the centre of the masses point, while the reaction is acting on the centre of the stiffnesses point. If they are not on the same axis the structure starts rotating. Adding the walls, the translation along the y direction is almost eliminated. It can be deduced that the addition of the walls, moved the centre of the stiffnesses nearer and more in axis with the centre of the masses.




*F.7.8 - Centre of masses and stiffnesses*



*F.7.8 - Frame model structure and deformation of the first period of vibration*

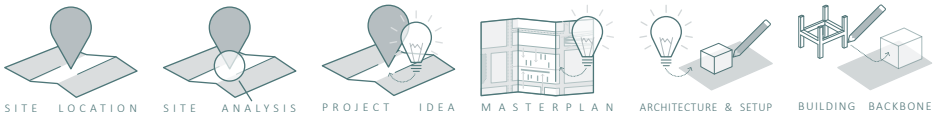


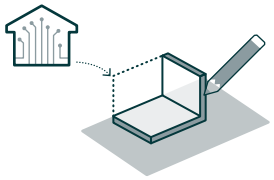
*F.7.9 - Frame and walls model structure and deformation of the first period of vibration*

CHAPTER 8

# Technologies

## envelope, daylight and systems



BUILDING TECHNOLOGIES

Starting the deepening of the project, with the Galleria Comb generation phase in chapter 4, they have been indicated different strategies concerning the design phases to get a whole sustainable project. Step by step, different degrees of sustainability is reached concerning every deepening passage and, reminding picture 4.1 on page 72, each of those steps is suitably associated with a level of sustainability, bringing multiple and collaborative sustainability typologies. In building technologies, environmental sustainability is reached through the innovation of systems and materials.

As an entire project works on multiple levels, the technologies stratify functional solutions to get a complex and efficient construction. In the previous chapter, we have seen the building structure, now the systems and envelope stratigraphy are defined. Moreover, special and additional attention is given to the daylight analysis and the consequent shading system adopted.

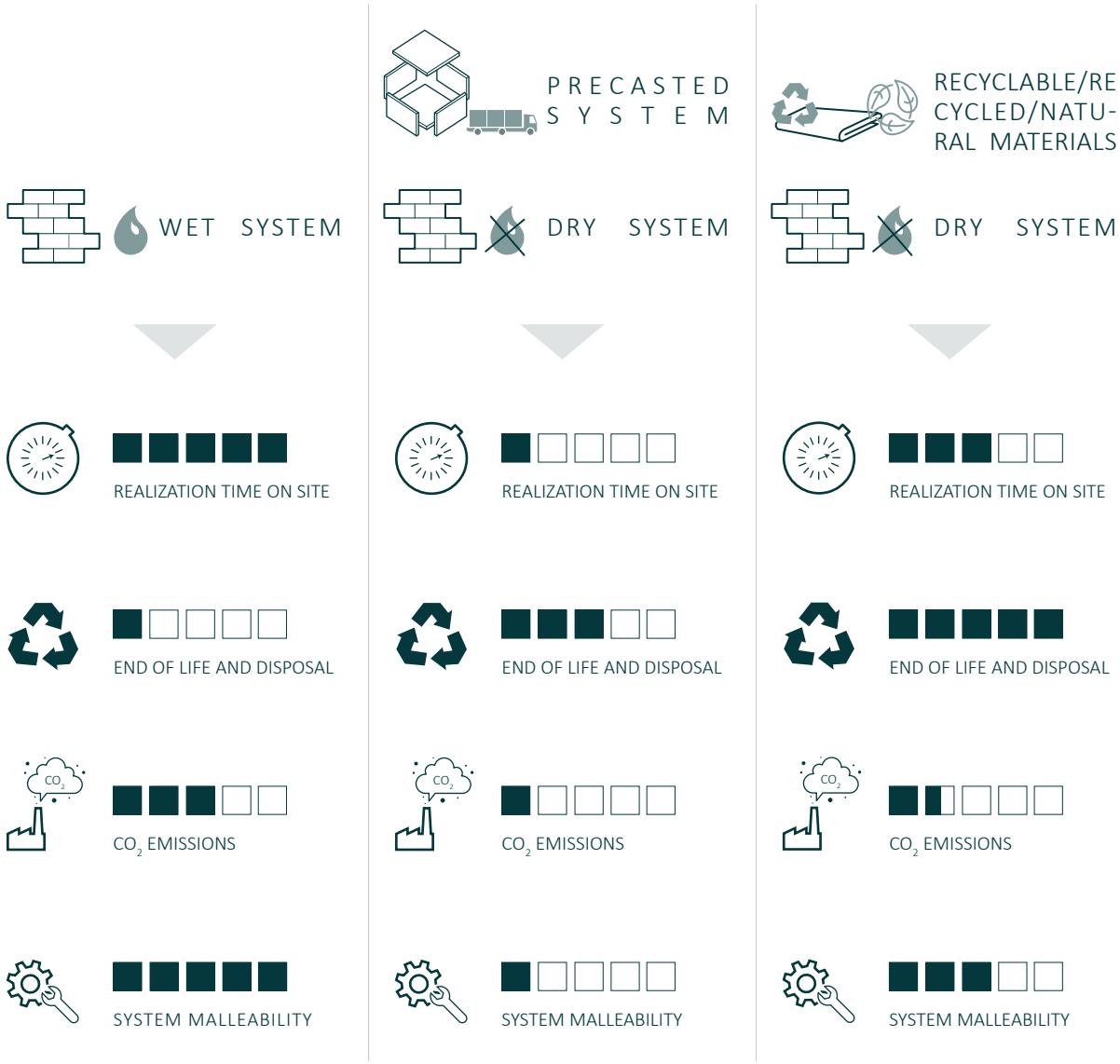
Approaching therefore the end of the design steps treated for this project, hereafter, are firstly observed the stratigraphies and nodes. Secondly, the daylight analysis and finally the configuration and disposition of the implants.

## 1. BUILDING STRATIGRAPHIES AND NODES

The innovation strategy just mentioned above, consists of the use of as much as possible, recyclable materials, coming from recycled or natural sources. The attention to the future disposal of the building components is crucial to not postpone the solution of a problem created today, tomorrow: it is better to think in advance. For this purpose, is particularly useful the application of a dry system too. Comparing this type of construction system, with other solutions: the traditional wet system and the pre-casted dry system, which benefits can be reached?

The picture on the side shows a comparison between three different construction systems, including qualitative evaluations of parameters such as the realization time on site, the end of life and future disposal management, the $CO_2$ emissions and the system malleability. Before to a deeper look at those contributions, it is necessary to specify that for some evaluations, e.g. the emissions it should be performed a more accurate estimation concerning all the factors influencing the results, like the production, transportation etc. While the estimation made here, considers only a generic production of emissions on-site, although it would be closely connected to the materials chosen.

Considering the realization time on site, the times are considerably extended due to the drying periods in the case of wet systems. Dry systems permit smoother disposal of the components at the end of life too. On the other hand, the malleability of the elements in the construction phase is higher when wet workable materials are used. The emissions on-site can be related to the realization time and the weight and labour associated with the components.




*F.8.1 - Comparison between three construction systems*

The dry system was chosen for this project which uses materials that pay attention to their origin and future disposal. Despite this, it doesn't mean that it is the best, especially in the face of such a generic analysis, but some of the advantages that characterize the three construction systems emerge anyways.

The present design phase is uncharged to define the lightweight construction systems with high-performance dry layers and understand their assembly and connections. The assembly is firstly developed investigating the horizontal and vertical construction elements, both in the case of closures and partitions.

*ABACUS OF STRATIGRAPHIES*

The construction elements are constituted by multiple operational layers, the structural ones, optional functional layers and the finishing ones. For this building, the structural layer is in reinforced concrete or wood, as known from the previous chapter. Concerning the floor slabs, the upper layers adopt solutions applicable in both the concrete and wood cases. Interesting is the optional functional layer in the slabs, dedicated to the underfloor screed, which is realized in granular clay and wooden chip blend. Its height of 10 cm is perfectly suited to the passage of the implants, and the particular granular mix used, helps in the natural humidity regulation, in improving thermal and acoustic comfort and it is natural and ecological.

Concerning instead the roof and the external walls, an interesting solution is given by the combination of two materials for a more efficient insulating layer. The whole packet is realized with thermoacoustic insulation panels in wood wool bonded with Portland cement plus other ones in recycled cellulose fibres three-dimensionally heat-fixed.

The insulating layers are the main ones responsible for the thermal seal of the building and the reduction of thermal emission. The right amount of insulation derives from the thermal transmittance (U) calculation, evaluated through the characteristics of the materials. By law, the stratigraphies should guarantee a minimum value of U, dependent on the climate zones[6] in which the building under analysis is located.

| Climate zone **E**, U-values prescriptions | U thermal transmittance [W/m²k] |
|---|---|
| Horizontal opaque bottom closures to external or not heated spaces or against grund | 0,26 |
| Horizontal opaque upper closures to external or not heated spaces | 0,22 |
| Vertical opaque closures to external or not heated spaces or against grund | 0,26 |
| Technical transparent closures to external or not heated spaces | 1,40 |

6 The definition of the bands is done through the degree-day (“gradi-giorno” in italian: GG or gr-g). They correspond to the sum, every day of the year, of the difference (only the positive ones) between the internal ambient temperature (by convention at 20°C) and the average daily external temperature: GG = $\sum_{e=1}(20\text{-}T_e)$. This means that the higher this number, the more severe the climate in that area will be. The Presidential Decree n. 412 of the 26th August 1993 introduces six climate zones on the Italian territory:

- Zone A: municipalities with GG below 600;
- Zone B: municipalities with GG between 600 and 900;
- Zone C: municipalities with GG between 901 and 1400;
- Zone D: municipalities with GG between 1401 and 2100;
- Zone E: municipalities with GG between 2101 and 3000;
- Zone F: municipalities with GG above 3000.

*F.8.2 - Climate zones*

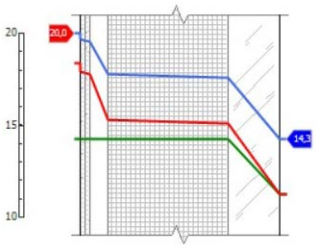
In addition to the tendency of an element to exchange energy, or in other words, the inverse of the insulating capacity of a body, another important characteristic is the thermal phase shift[7]. It is fundamental to guarantee good behaviour also in that sense, to prevent heat losses or gains. Unfortunately, positive thermal insulation characteristics don't go at the same pace as good thermal displacement ones. The more the material absorbs heat, the slowlier it will be returned to the environment. Most of the time, for thermal insulation, are used plastic materials with very low density, making them unable to absorb heat, while still providing good insulation performances. When the displacement is low, a good approach is to increase the thermal inertia[8], increasing the mass of the wall. The coupling of two very different insulating panels, described above, is to the advantage of good results both in terms of resistance and thermal displacement.

The coupling of two very different insulating panels, described above, is to the advantage of good results both in terms of resistance and thermal displacement.

The following pages contain an abacus of systems adopted in the building and studied specifically. It encloses detailed information about the materials implied, and about the arrangement of the entire system. All the solutions are matched with the thermal characteristics just described in this introduction, geometrical characteristics and verification about the occurrence of condensation:

U thermal transmittance [W/m$^2$K];
ϕ thermal phase shift [h];
Total thickness [cm];
Weight [kN/m$^2$];
Occurrence of condensation, both interstitial or superficial.

The condensation can provoke serious consequences, decreasing the material properties or the healthiness of the environment. A software (Termolog), simulates the behaviour of temperature (blue line) and vapour (green line) and saturation pressure (red line) in the walls, through the Glazer diagram, using on the system arrangement and characteristics.



*F.8.3 - Glazer diagram example*

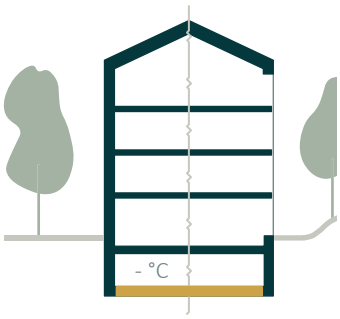
7 The insulation is mostly seen concerning the winter thermal insulation, protecting from heat dispersion. The traditional evaluations of the thermal behaviour are based on the thermal transmittance, which considers a stationary regime of heat transmittance. The parameter "thermal phase displacement" instead, combines the effects of the thermal accumulation and resistance of the structures. It indicates the difference in time between the moment for which the maximum temperature on the external surface is measured and the one on the internal surface. The optimum value considered for the thermal phase displacement is superior to 12 hours and, at least 8 hours. This parameter depends on the physical characteristics of the material used for the structures and their assembly. Concerning the characteristics of the material, the higher is the specific heat, the higher is the thermal displacement. In a general way, the thermal insulation layers made of artificial materials are characterized by low density and therefore they absorb little heat amount, this means they have low volumetric heat capacity.

8 In thermodynamics, thermal inertia refers to the ability of a material or structure to vary its temperature more or less slowly as a response to changes in external temperature or a source of internal heat/cooling.

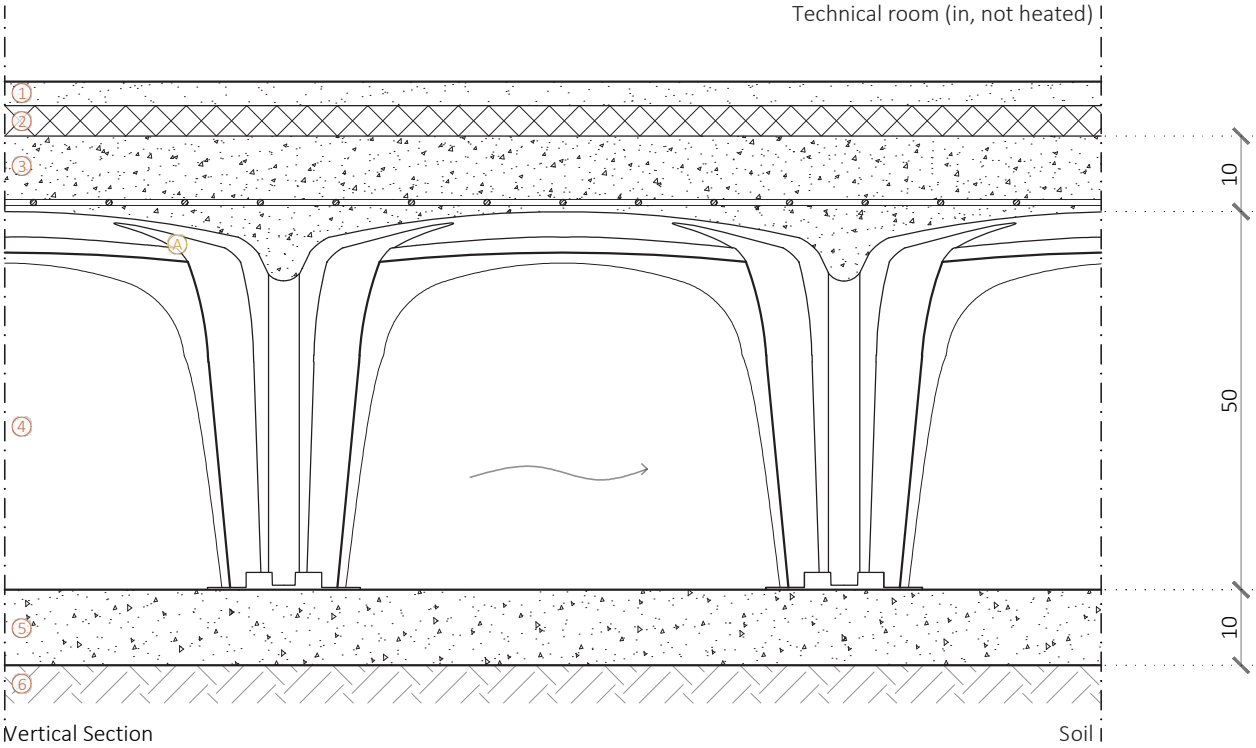
*INFERIOR HORIZONTAL CLOSURE*

*Earth retaining floor*

| | |
|---|---|
| TOT tk. | 77,20 cm |
| U value | - $W/m^2K$ |
| Climate zone E: limit value U | - $W/m^2K$ |
| ϕ | -h-’ |
| In & Surf. Condensation | not occur |
| Weight | - $kN/m^2$ |



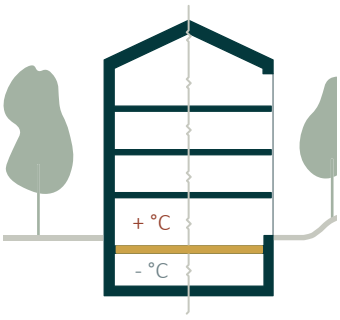

| Layers | | thickness [mm] | λ [W/mK] |
|---|---|---|---|
| 1 | Finishing layer, in cement; ρ=1800 kg/m³ | 32 | 1,600 |
| 2 | Thermoacoustic insulation layer, in igniferous, hypoallergenic, recycled PET fibres; ρ=60 kg/m³, μ=3,1, Cp=1200 J/kgK | 100 | 0,034 |
| 3 | Load distribution layer, in concrete reinforced with electrowelded steel mesh; ρ=2400 kg/m³ | 100 | 2,300 |
| 4 | Ventilatedunder-floor cavity layer | 450 | 0,500 |
| 5 | Levelling layer, in light concrete; ρ=1100 kg/m³ | 100 | 0,450 |
| 6 | Soil | - | - |
| A | Plastic formworks for crawl space, h=500 mm, dim. 510x510 mm, “Geoplast MODULO H60”, piece weight=3,85 kg | | |


Technical room (in, not heated)
1
2
3
A
4
5
6
10
50
10
Vertical Section
Soil

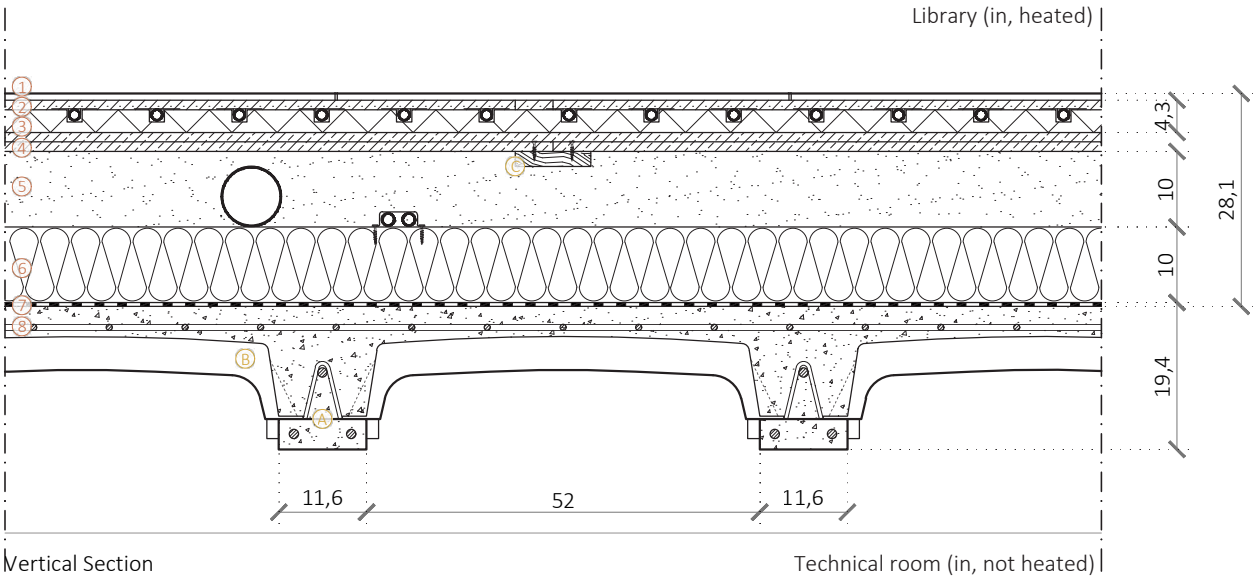
*INSULATED HORIZONTAL PARTITION*

*Insulated floor with reinforced concrete structural slab*

| | |
|---|---|
| TOT tk. | 47,07 cm |
| U value | 0,191 W/m²K |
| Climate zone E: limit value U | 0,260 W/m²K |
| ϕ | 11h 45’ |
| In & Surf. Condensation | not occur |
| Weight | 3,95 kN/m² |



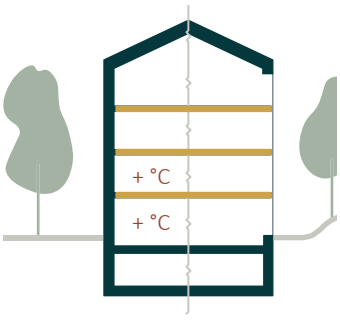

| Layers | | thickness [mm] | λ [W/mK] |
|---|---|---|---|
| 1 | Finishing layer, in porcelain stoneware, tk. 0.9cm, dim. 300x600 mm, “FAP Ceramiche, Milano&Floor”; ρ=2000 kg/m³ | 9 | 1,300 |
| 2 | Infill layer, in high conductivity and resistance, pressed asbestos sheeting, acrylic-cased, dim. 1210x710x12 mm; 15,60 kg/m², μ=66 (if dry), 30 (if wet) | 12 | 0,270 |
| 3 | Heating distribution layer, composed by insulating panel “ECO DRY FloorTech” with multilayer tubes for under-floor heating and pre-glued aluminium slats; ca. 10,40 kg/m² | 30 | 0,042 |
| 4 | Load distribution layer, composed by two gypsum and cellulose fibres sheeting “fermacell Lastra in gessofibra greenline”; ρ=1150 kg/m³, μ=13, Cp=1100 J/kgK | 25 | 0,320 |
| 5 | Dry slab layer, in granular clay and wooden chip blend “GEOSANA® SOTTOFONDO A SECCO D750”; ρ=750 kg/m³, μ=5, Cp=1400 J/kgK | 90 | 0,065 |
| 6 | Thermoacoustic insulation layer, in italian hemp fibres, three-dimensionally heat-fixed with corn starch “Canaton® D40 Natur”, dim. 600x1200 mm; ρ=40 kg/m³, μ=1,5, Cp=2300 J/kgK | 100 | 0,040 |
| 7 | Structural layer, in concrete reinforced with electrowelded steel mesh; ρ=2400 kg/m³ | 40 | 2,300 |
| A | Floor joist in vibration-compressed reinforced concrete, stiffened with triangular steel bent | | |
| B | Lightening for reinforced concrete slab, with polypropylene formwork “fit slab”, dim. 560x797 h.90 mm; piece weight=1,95 kg, piece volume=0,0326 m³ | | |
| C | Wooden elements gypsum and cellulose fibres sheeting fixing | | |


Library (in, heated)
1
2
3
4
5
6
7
8
A
B
C
4,3
10
10
19,4
28,1
11,6
52
11,6
Vertical Section
Technical room (in, not heated)

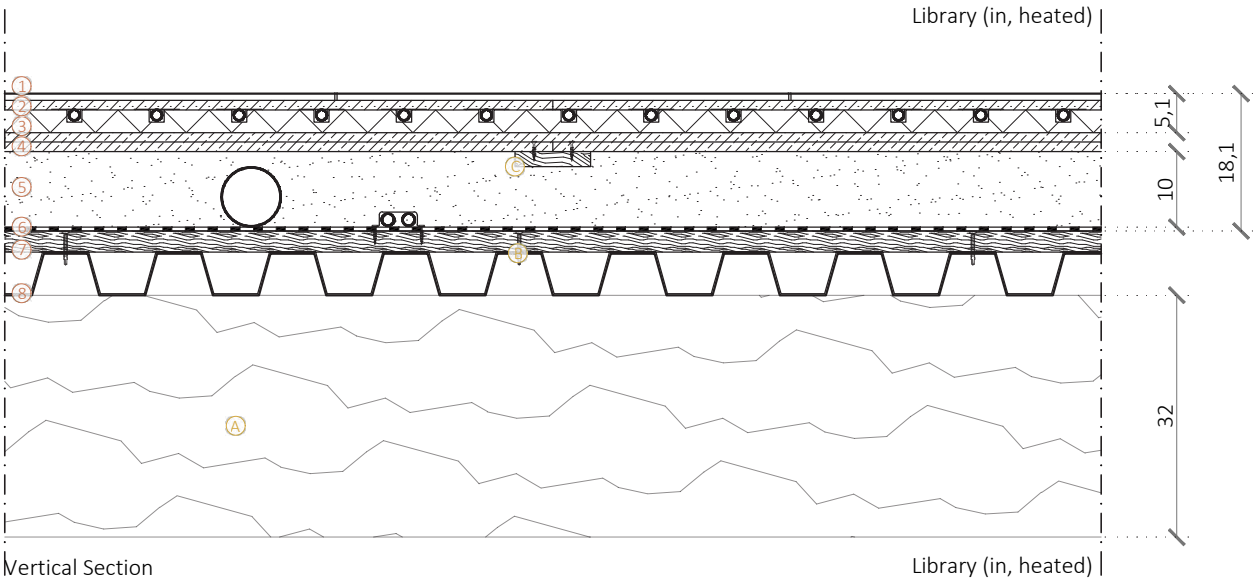
*HORIZONTAL PARTITION*

*Internal floor with wood and steel corrugated sheet structural slab*

| | |
|---|---|
| TOT tk. | 26,6 cm |
| U value | 0,188 W/m²K |
| Climate zone E: limit value U | - W/m²K |
| ϕ | 10h 18’ |
| In & Surf. Condensation | not occur |
| Weight | 1,98 kN/m² |



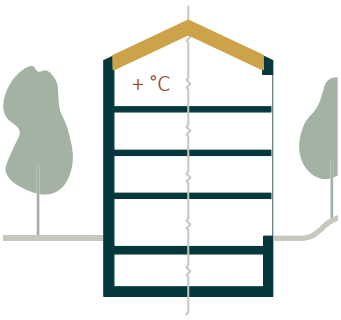

| | Layers | thickness [mm] | λ [W/mK] |
|---|---|---|---|
| 1 | Finishing layer, in porcelain stoneware, tk. 9 mm, dim. 300x600 mm, “FAP Ceramiche, Milano&Floor”; ρ=2000 kg/m³ | 9 | 1,300 |
| 2 | Infill layer, in high conductivity and resistance, pressed asbestos sheeting, acrylic-cased, dim. 1210x710x12 mm; 15,60 kg/m², μ=66 (if dry), 30 (if wet) | 12 | 0,270 |
| 3 | Heating distribution layer, composed by insulating panel “ECO DRY FloorTech” with multilayer tubes for under-floor heating and pre-glued aluminium slats; ca. 10,40 kg/m² | 30 | 0,042 |
| 4 | Load distribution layer, composed by two gypsum and cellulose fibres sheeting “fermacell Lastra in gessofibra greenline”; ρ=1150 kg/m³, μ=13, Cp=1100 J/kgK | 25 | 0,320 |
| 5 | Dry slab layer, in granular clay and wooden chip blend “GEOSANA® SOTTOFONDO A SECCO D750”; ρ=750 kg/m³, μ=5, Cp=1400 J/kgK | 100 | 0,065 |
| 6 | Anti-dust layer, in corrugated cardboard | 5 | - |
| 7 | Reinforcement layer, in Portland cement and wood fibers “BETONWOOD, Cementolegno ad alta densità”, dim. 2800x1250 mm; ρ =1350 kg/m³, ; μ=22,6 | 28 | 0,260 |
| 8 | Corrugated sheet, in stainless steel with anti-condensation felt “SANDnodrip”, h=5,5cm, “SANDRINI METALLI, SANDA55 P600”; 13,08 kg/m² | 1 | 60,00 |
| A | Wooden XLam beam, dim. 280x320mm | | |
| B | Self-drilling screw for wood-metal connections, in stainless steel, L=4,5cm, Ø=0,48cm, “Rothoblaas, SBS A2 AISI304” | | |
| C | Wooden elements gypsum and cellulose fibres sheeting fixing | | |


Library (in, heated)
1
2
3
4
5
6
7
8
A
C
D
5,1
10
18,1
32
Vertical Section
Library (in, heated)

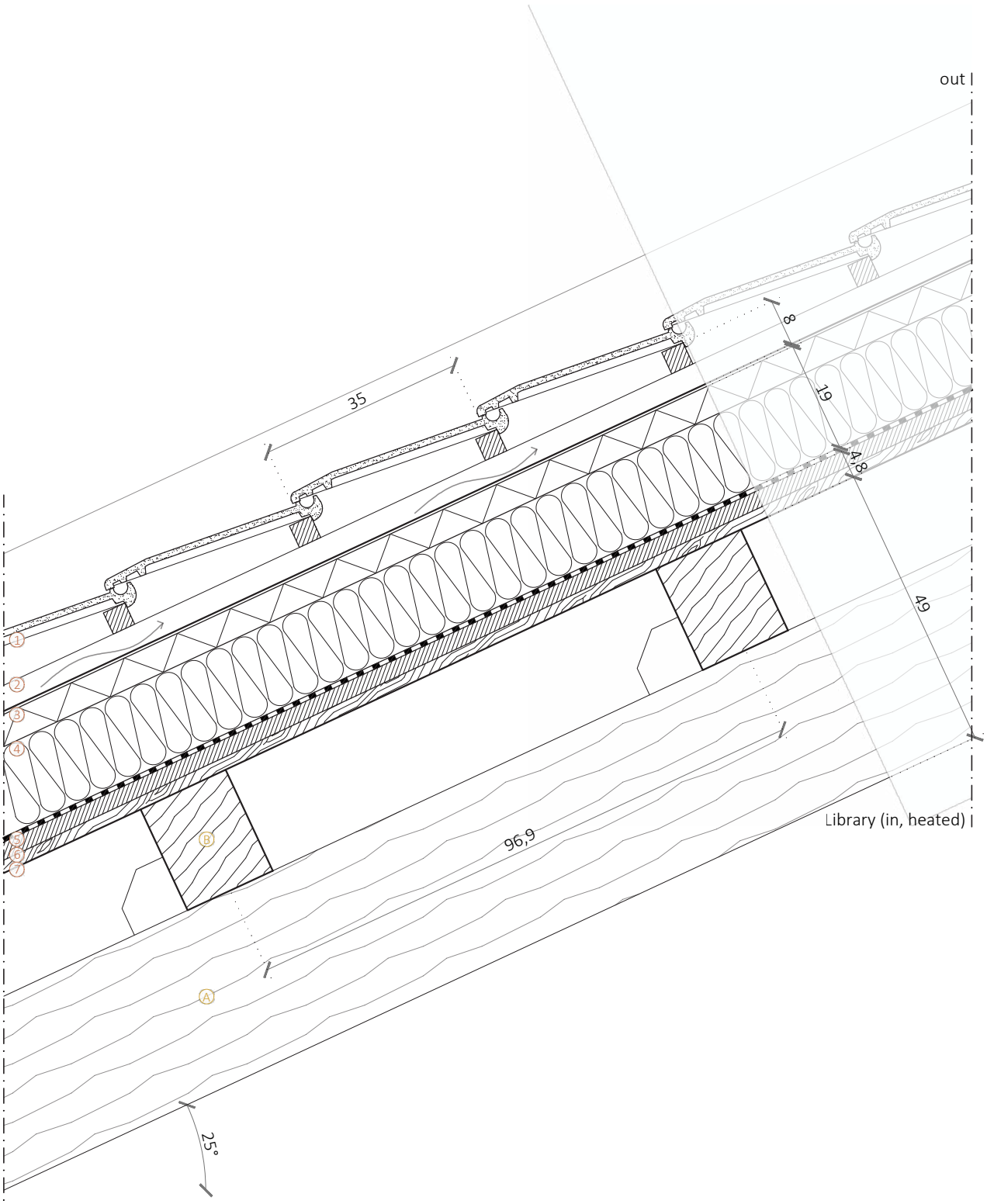
*SUPERIOR HORIZONTAL CLOSURE*

*Pitched roof*

| | |
|---|---|
| TOT tk. | 33,0 cm |
| U value | 0,182 W/m$^2$K |
| Climate zone E: limit value U | 0,220 W/m$^2$K |
| ϕ | 14h 41’ |
| In & Surf. Condensation | not occur |
| Weight | 4,00 kN/m$^2$ |




| | Layers | thickness [mm] | λ [W/mK] |
|---|---|---|---|
| 1 | Finishing layer, in Marsigliese terracotta tiles, dim. 395x235x11 mm; ρ=2000 kg/m$^3$, 43,5 kg/m$^2$ | 11 | 0,825 |
| 2 | Ventilated cavity layer, with double roof lathing, dim. 40x40 mm | 80 | - |
| 3 | Protective layer, in breathable sheet with low emissivity, able to reflect and avoid the heat loss in summer and winter “DUPONT™ TYVEK® ENERCOR®”; 148 g/m$^2$ | 0,48 | - |
| 4 | Thermoacoustic insulation layer, in a composite panel “CELENIT F2”, dim. 1200x600 mm; 39,2 kg/ m$^2$<br>layer 1: wood wool bonded with Portland cement layer; μ=5, Cp=1810 J/kgK<br>layer 2: wood fibers panel; μ=3, Cp=2000 J/kgK | <br>50<br>140 | <br>0,065<br>0,037 |
| 5 | Vapour protaction layer, with a three layers membrane “KLÖBER WALLINT® T3”; 160 g/m$^2$ | 0,75 | - |
| 6 | Reinforcement layer, in Portland cement and wood fibers “BETONWOOD, Cementolegno ad alta densità”, dim. 2800x1250 mm; ρ =1350 kg/m$^3$, ; μ=22,6 | 28 | 0,260 |
| 7 | Reinforcement layer, in spruce wooden boarding “Tavole Piallate, 4 Lati Smussate PACCHIANI HOLZ srl”, dim. 150x20 mm; ρ=460 kg/m$^3$, μ=60 | 20 | 0,133 |
| A | Wooden beam, dim. 190x300mm | | |
| B | Wooden transversal beam, dim. 160x190mm “Arcarecci” | | |

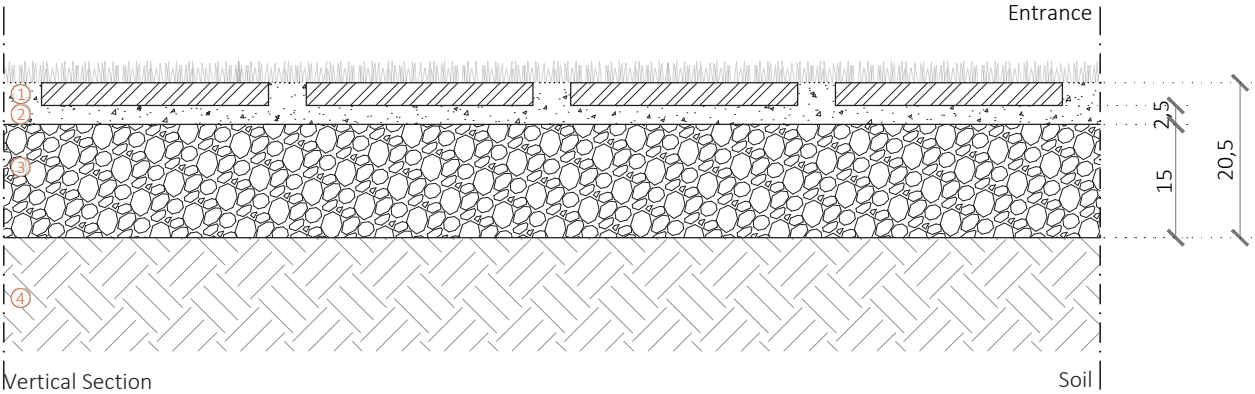



Vertical Section

*External entrance pavement*

TOT tk. 20,50 cm

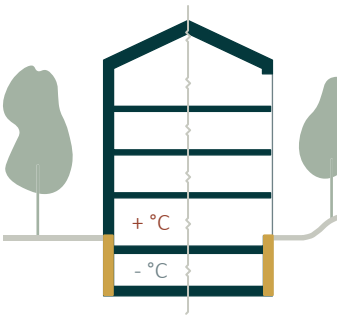
| Layers | | thickness [mm] |
|---|---|---|
| 1 | External tile layer, in cement, tk. 30 mm, dim. 300x1500 mm | 30 |
| 2 | Equilizing bed, in compacted sand, tk. 25 mm | 25 |
| 3 | Dranage and backfilling layer, in gravel, tk. 150 mm | 150 |
| 4 | Soil | - |


Entrance
1
2
3
4
2,5
15
20,5
Vertical Section
Soil

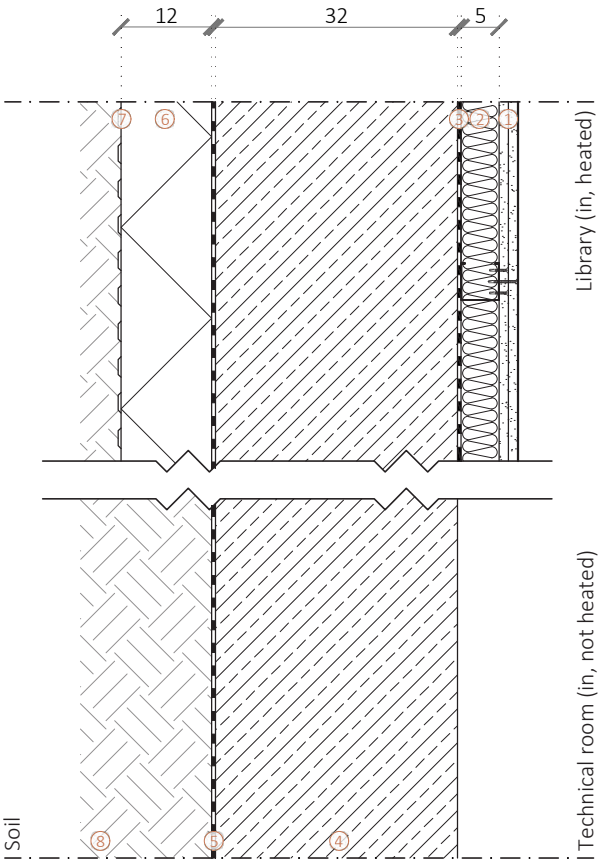
*VERTICAL OPAQUE CLOSURE*

*Earth retaining wall with reinforced concrete structural layer*

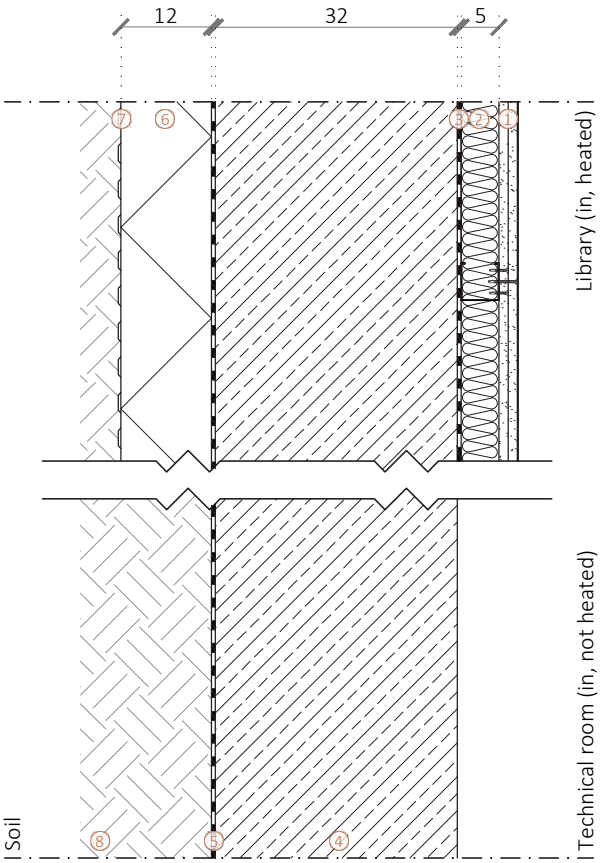
| | |
|---|---|
| TOT tk. | 32,1 - 53,6 cm |
| U value | 0,206 W/m$^2$K |
| Climate zone E: limit value U | 0,260 W/m$^2$K |
| ϕ | 12h 23’ |
| In & Surf. Condensation | not occur |
| Weight | 8,02 kN/m$^2$ |




| Layers | | thickness [mm] | λ [W/mK] |
|---|---|---|---|
| 1 | Finishing layer, composed by two gypsum and cellulose fibres sheeting “fermacell Lastra in gessofibra greenline”; ρ=1150 kg/m$^3$, μ=13, Cp=1100 J/kgK | 25 | 0,320 |
| 2 | Thermoacoustic insulation layer, in recycled textile fibers with short chain panels “RECYCLETHERM km0”, dim. 1200x600 mm; ρ=50 kg/m$^3$, μ=2,2 | 50 | 0,036 |
| 3 | Vapour protaction layer, with a three layers membrane “KLÖBER SEPA® FORTE”; 145 g/m$^2$ | 0,5 | - |
| 4 | Reinforced concrete earth retaining wall and wooden pillars support; ρ=50 kg/m$^3$ | 320 | 2,300 |
| 5 | Vapour protaction layer, with a three layers membrane “KLÖBER SEPA® FORTE”; 145 g/m$^2$ | 0,5 | - |
| 6 | Thermic insulation layer, in foam glass panels “Board PG 600, DECORUS”, dim. 800x600 mm; ρ=130 kg/m$^3$, μ=40, Cp=900J/kgK | 120 | 0,045 |
| 7 | Drainage jacket | - | - |
| 8 | Soil | - | - |
| A | Aluminium substructure, in DX51 steel, tk. 0.08cm, dim. 5x5x5cm, “KNAUF C stud” | | |




Horizontal Section

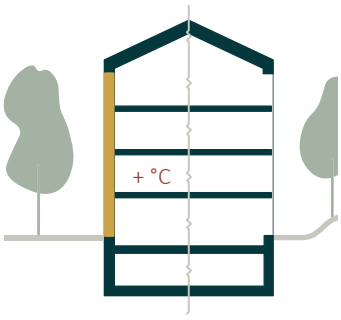



Vertical Section

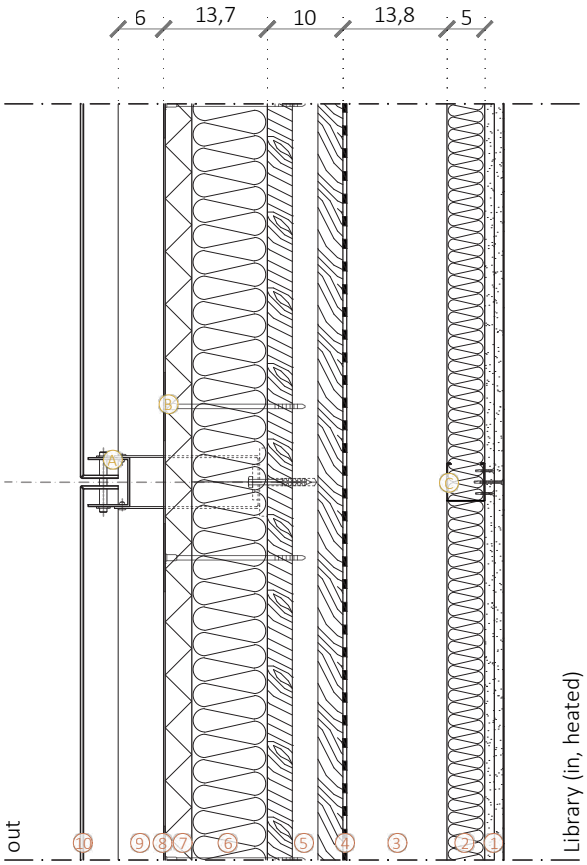
*VERTICAL OPAQUE CLOSURE*

*External wall with wooden structural layer*

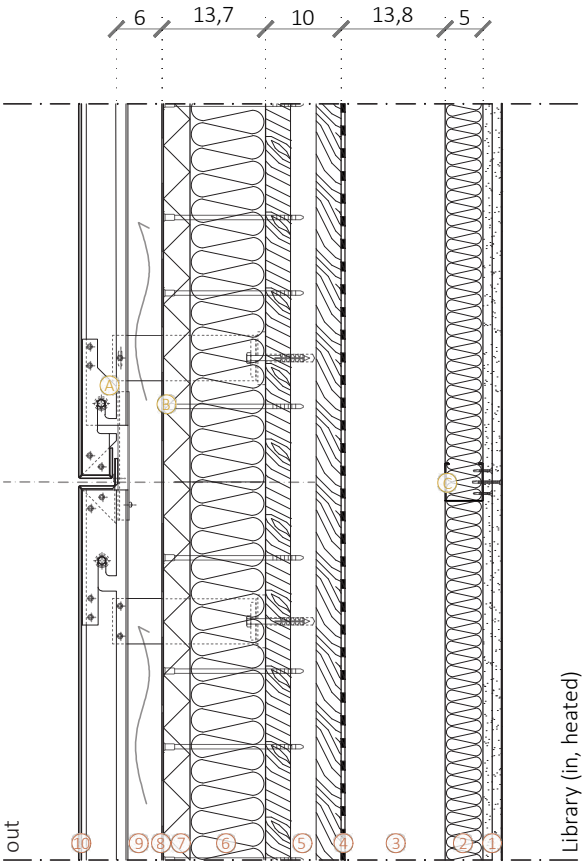
| | |
|---|---|
| TOT tk. | 56,0 cm |
| U value | 0,142 W/m$^2$K |
| Climate zone E: limit value U | 0,220 W/m$^2$K |
| ϕ | 22h 02’ |
| In & Surf. Condensation | not occur |
| Weight | 0,90 kN/m$^2$ |




| | Layers | thickness [mm] | λ [W/mK] |
|---|---|---|---|
| 1 | Finishing layer, composed by two gypsum and cellulose fibres sheeting “fermacell Lastra in gessofibra greenline”; ρ=1150 kg/m$^3$, μ=13, Cp=1100 J/kgK | 25 | 0,320 |
| 2 | Thermoacoustic insulation layer, in recycled textile fibers with short chain panels “RECYCLETHERM km0”, dim. 1200x600 mm; ρ=50 kg/m$^3$, μ=2,2 | 50 | 0,036 |
| 3 | Dead air space for installations passage | 132,5 | - |
| 4 | Vapour protaction layer, with a three layers membrane “KLÖBER SEPA® FORTE”; 145 g/m$^2$ | 0,5 | - |
| 5 | Structural layer, in XLam panel of 3 layers (33-34-33 mm) ; ρ=350 kg/m$^3$, Cp=1600 J/kgK | 100 | 0,120 |
| 6 | Thermoacoustic insulation layer, in recycled cellulose fibers three-dimensionally heat-fixed “Isocell, Euchora”, dim. 1000x600 mm; ρ=40 kg/m$^3$, μ=4 | 100 | 0,039 |
| 7 | Thermoacoustic insulation layer, in wood wool bonded with Portland cement panel “CELENIT N/C”, dim. 1000x600 mm; 14,0 kg/m$^2$; μ=5, Cp=1810 J/kgK | 35 | 0,065 |
| 8 | Protective layer, in breathable sheet with low emissivity, able to reflect and avoid the heat loss in summer and winter “DUPONT™ TYVEK® THERMAFORT™”; 83 g/m$^2$ | 0,2 | - |
| 9 | Ventilated cavity | 60 | - |
| 10 | Finishing layer, in composite panels covered by an aluminium skin “ALUCOBOND® PLUS” dim. 1000x3130 mm; 7,6 kg/m$^2$ | 4 | 0,440 |
| A | Alucobond panels anchors, composed by stainless steel bolt,dia. 10 mm, fixed to U-Section 65/55/2,5 and wall bracket | | |
| B | Insulation fastener, in HDPE with metallic core | | |
| C | Aluminium substructure, in DX51 steel, tk. 0.08cm, dim. 5x5x5cm, “KNAUF C stud” | | |




Horizontal Section

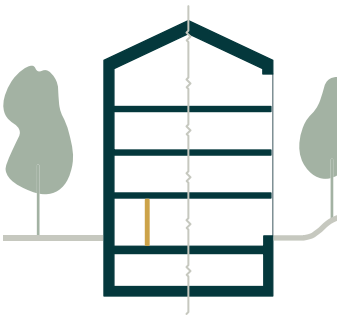



Vertical Section

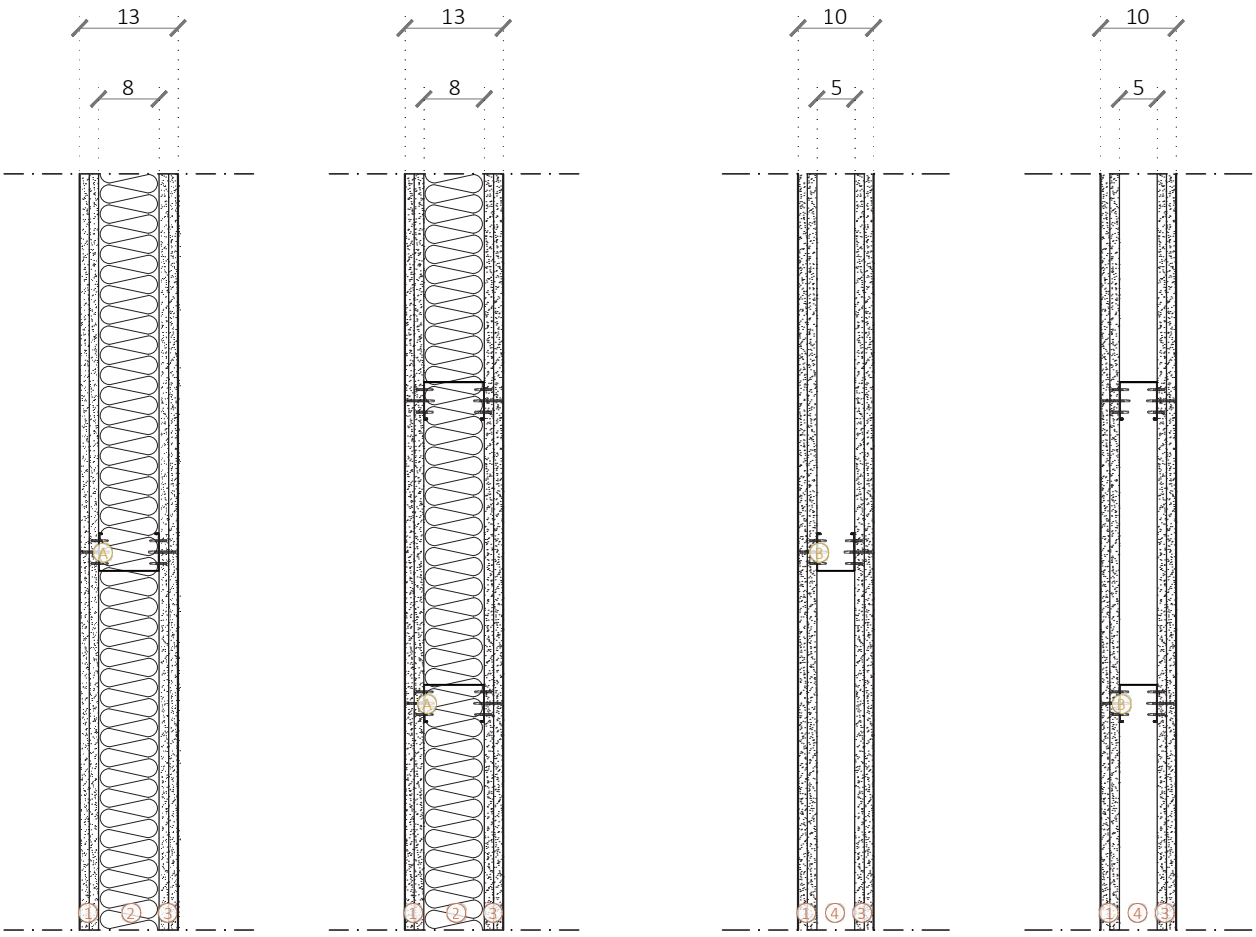
*VERTICAL OPAQUE PARTITION*

*Internal wall*

| | |
|---|---|
| TOT tk. | 13,0 - 10,0 cm |
| Weight | 0,60 - 0,56 kN/m$^2$ |



| Layers | | thickness [mm] | λ [W/mK] |
|---|---|---|---|
| 1 | Finishing layer, composed by two gypsum and cellulose fibres sheeting “fermacell Lastra in gessofibra greenline”; ρ=1150 kg/m$^3$, μ=13, Cp=1100 J/kgK | 25 | 0,320 |
| 2 | Thermoacoustic insulation layer, in recycled textile fibers with short chain panels “RECYCLETHERM km0”, dim. 1200x600 mm; ρ=50 kg/m$^3$, μ=2,2 | 80 | 0,036 |
| 3 | Finishing layer, composed by two gypsum and cellulose fibres sheeting “fermacell Lastra in gessofibra greenline”; ρ=1150 kg/m$^3$, μ=13, Cp=1100 J/kgK | 25 | 0,320 |
| 4 | Dead air space for installations passage | 50 | - |
| A | Aluminium substructure, in DX51 steel, tk. 0.08cm, dim. 8x5x5cm, “KNAUF C stud” | | |
| B | Aluminium substructure, in DX51 steel, tk. 0.08cm, dim. 8x5x5cm, “KNAUF C stud” | | |

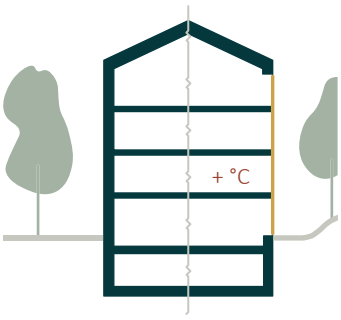



Horizontal Section | Vertical Section | Horizontal Section | Vertical Section

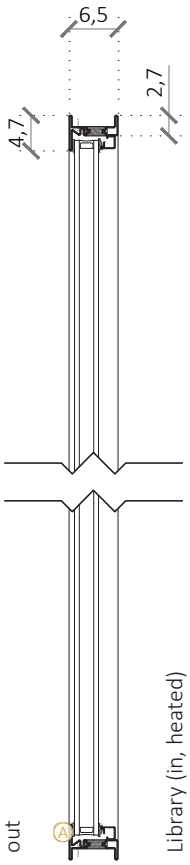
*VERTICAL TRANSPARENT CLOSURE*

*External glass wall*

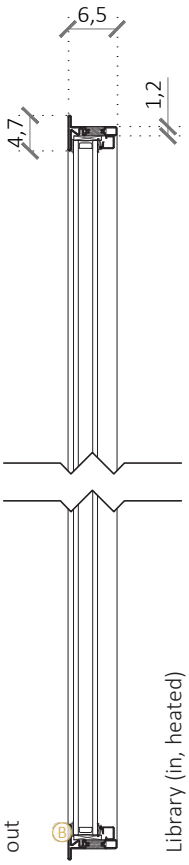
| | |
|---|---|
| TOT tk. | 6,5 cm |
| U value | 1,380 W/m$^2$K |
| Climate zone E: limit value U | 1,400 W/m$^2$K |



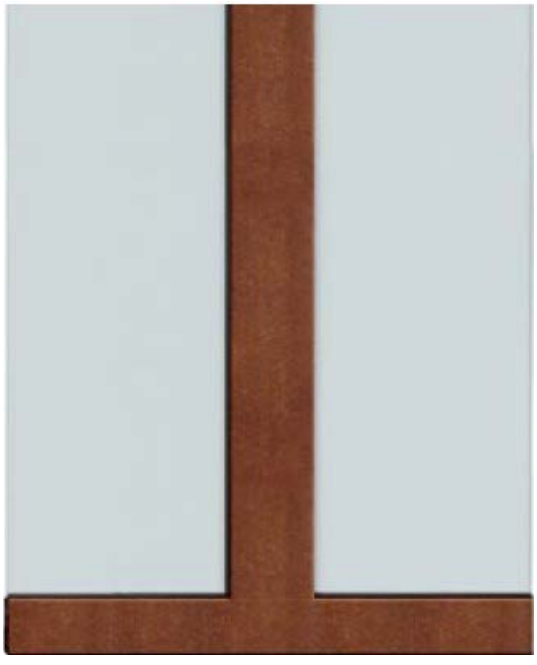

| | External window in brunished steinless steel type OS2 65 “Secco Sistemi” |
|---|---|
| A | Steel fixed profile, dim. 6,5x4,7 cm, type P.2805 + P.2607 “Secco Sistemi” |
| B | Steel fixed profile, dim. 6,5x4,7 cm, type P.2822 + P.2607 “Secco Sistemi” |




Horizontal Section




Vertical Section

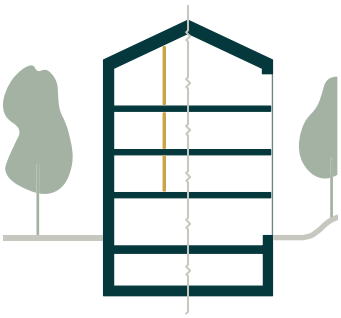


*F.a.1 - Example of a fixed glass profile aspect, type OS2 65 by "Secco Sistemi" in corten steel*

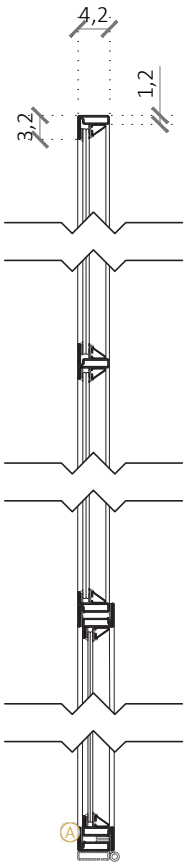
*VERTICAL TRANSPARENT PARTITION*

*Internal glass wall*

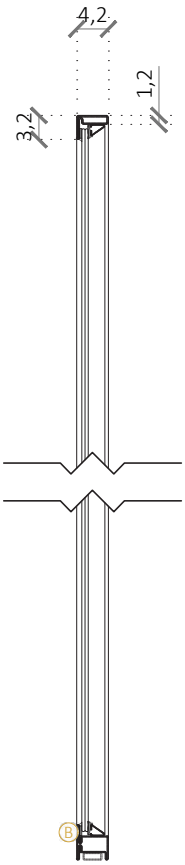
TOT tk. 4,2 cm



| | Internal window in in painted pickled steel type OS2 40 “Secco Sistemi” |
|---|---|
| A | Steel fixed profile, dim. 4,2x3,2 cm, type PR.2461 + PR.2482 + PR.2463 + PR.2429 “Secco Sistemi” |
| B | Steel fixed profile, dim. 4,2x3,2 cm, type PR.2461 + PR.2455 + PR.2429 “Secco Sistemi” |




Horizontal Section




Vertical Section

*F.a.2 - Example of a fixed glass profile aspect, type OS2 40 by "Secco Sistemi" in painted pickled steel*

*NODES*

As can be seen from the description of the vertical opaque closure, the building is covered by finishing panels that permit airflow. The opaque facade is therefore ventilated, transmitting multiple benefits to the wall and the environment. the ventilated cavity allows the steam and humidity of the structure and the home to transpire naturally, favoring a healthier environment, avoiding condensation or mold on the walls.

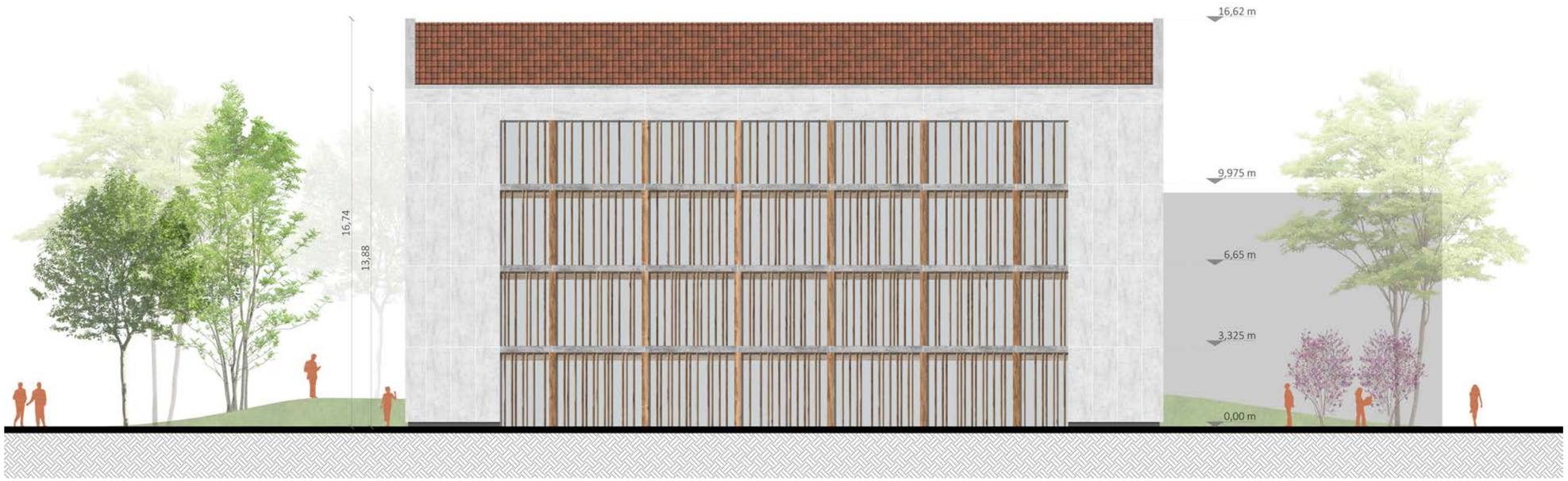
Although this chapter investigates the systems at a detailed scale, the board 8A recalls the rendered facades drawing in 1:200 scale, giving an overview of the solutions adopted. However, how do the stratigraphies described in the abacus combine with each other?

The most intricate and laborious joints are those that combine very different systems, in particular, for example, for the load-bearing structure in terms of materials and dimensions. All this must take place guaranteeing all the performances, such as water tightness and preventing the creation of thermal bridges.

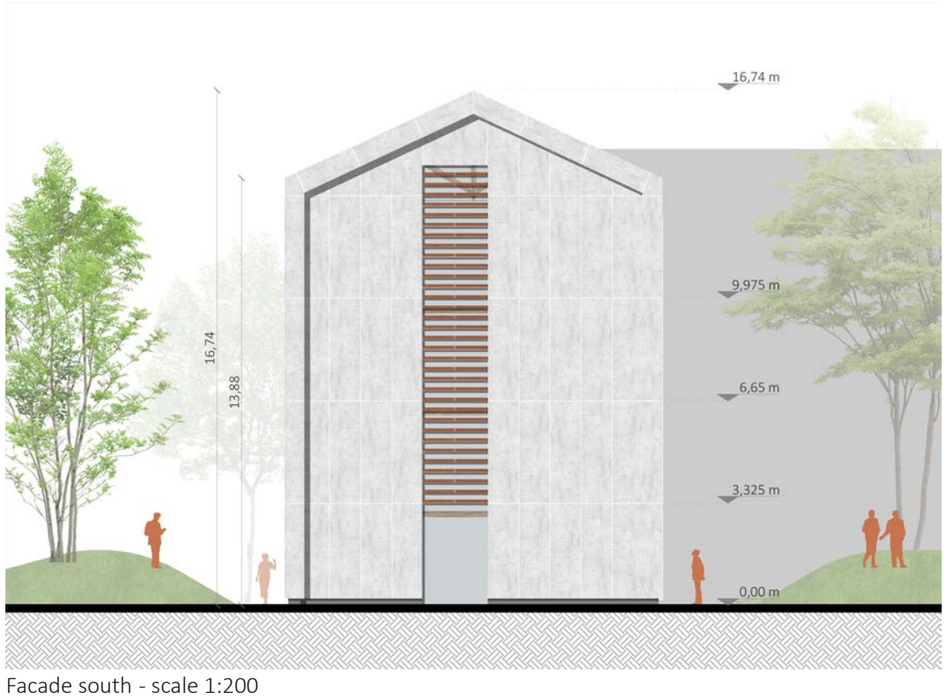
I have decided to represent two nodes, a first node related to the opaque envelope and a second one related to the transparent envelope.

Node 1, is developed referring to the east or west facade and along with its entire height. The bottom level is the ground floor with the structure in reinforced concrete, on top, the roof instead, as well as the upper floors are sustained by a wooden structure. Particularly difficult, as was just mentioned, have been the junction between the earth retaining wall and the external wall with cladding. The problem was the necessary adoption of different materials with different thicknesses and positioning, without causing thermal bridges. The structural X-lam panel, for example, need a solid basement for its anchorage. Concerning the roof-wall junction instead, the problem of different structures is avoided, as well as the discontinuity between the two. There is a continuous line between the wall and the roof, without any projection. This fact can easily avoid thermal bridges, ensuring continuity in the insulation layer. Contrarily, the eave (the lower edge of a roof overhanging a wall) usually present in a pitched roof, doesn't allow continuity of the insulation material. Nevertheless, on the other hand, in node 1, more complexity is given by the gutter tube for rainwater harvesting. The collecting system should be hidden between the roof tiles and wall cladding, passing over the insulation. The single elements require a correct fit in dimensions and position.

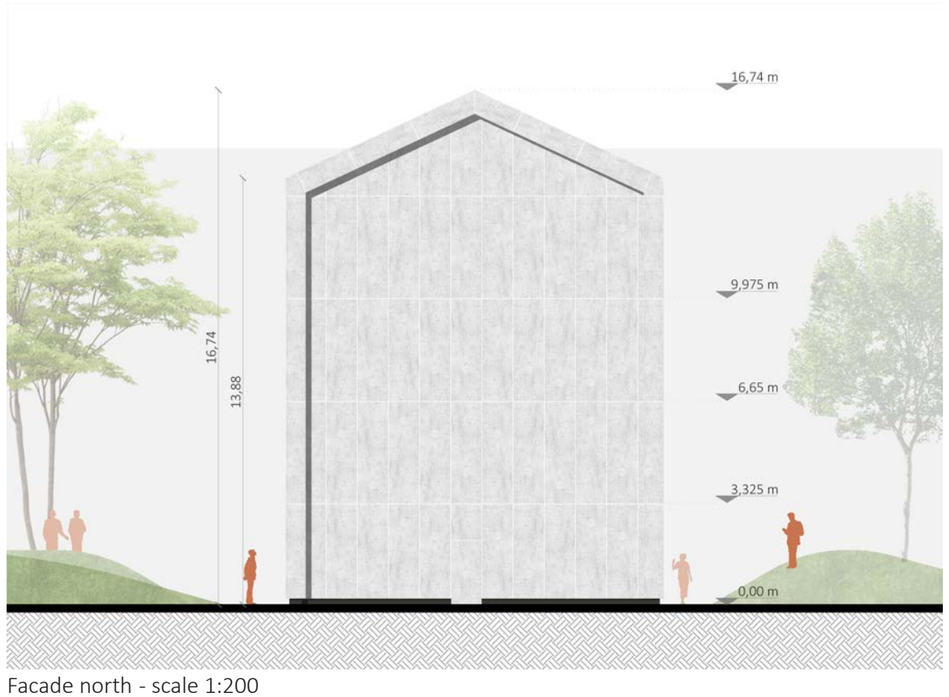
The building cladding is made of a very thin composite material, constituted by multiple layers: two external films in aluminium and an internal layer in polymer with added mineral components (70% of mineral content). This material respects the rigorous international standards in the field of firefighting. The panels are they are hooked on pins, mechanically fixed to the bearing part of the wall. In terms of commitment to the environment, and of future possible disposal, Alucobond promises characteristics favourable to a logic of environmental sustainability. In fact, the panels, in their components, are completely recyclable and can be



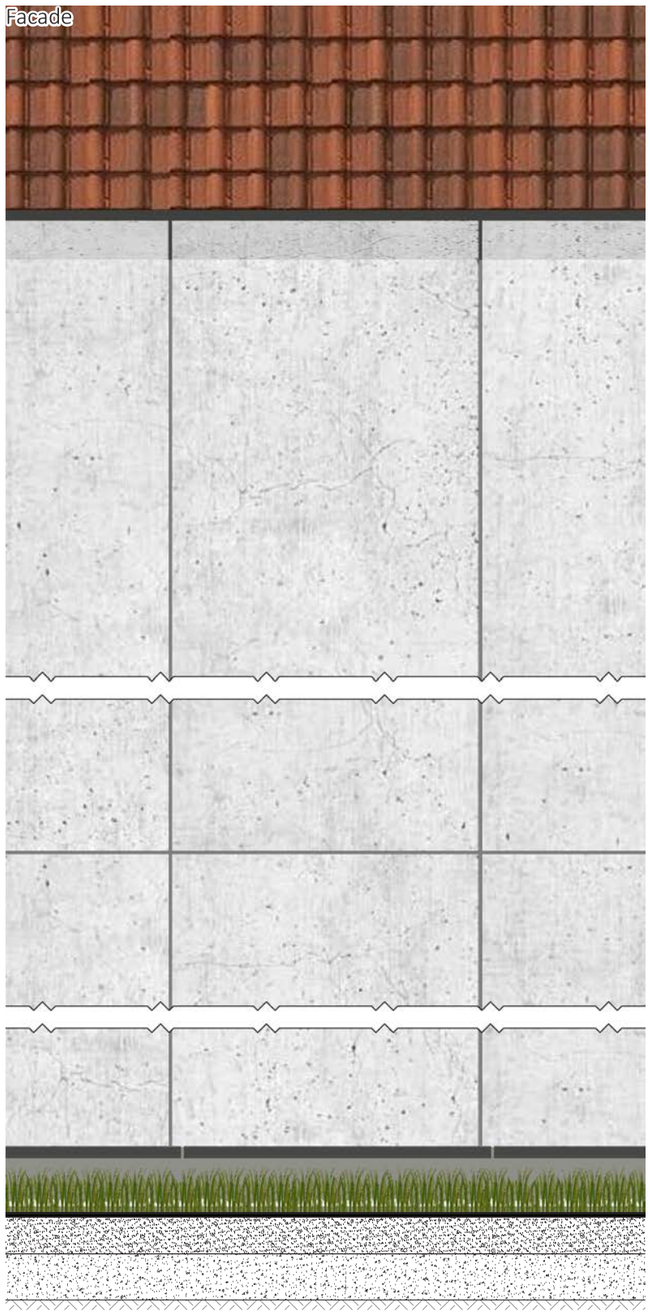

Facade west - scale 1:200



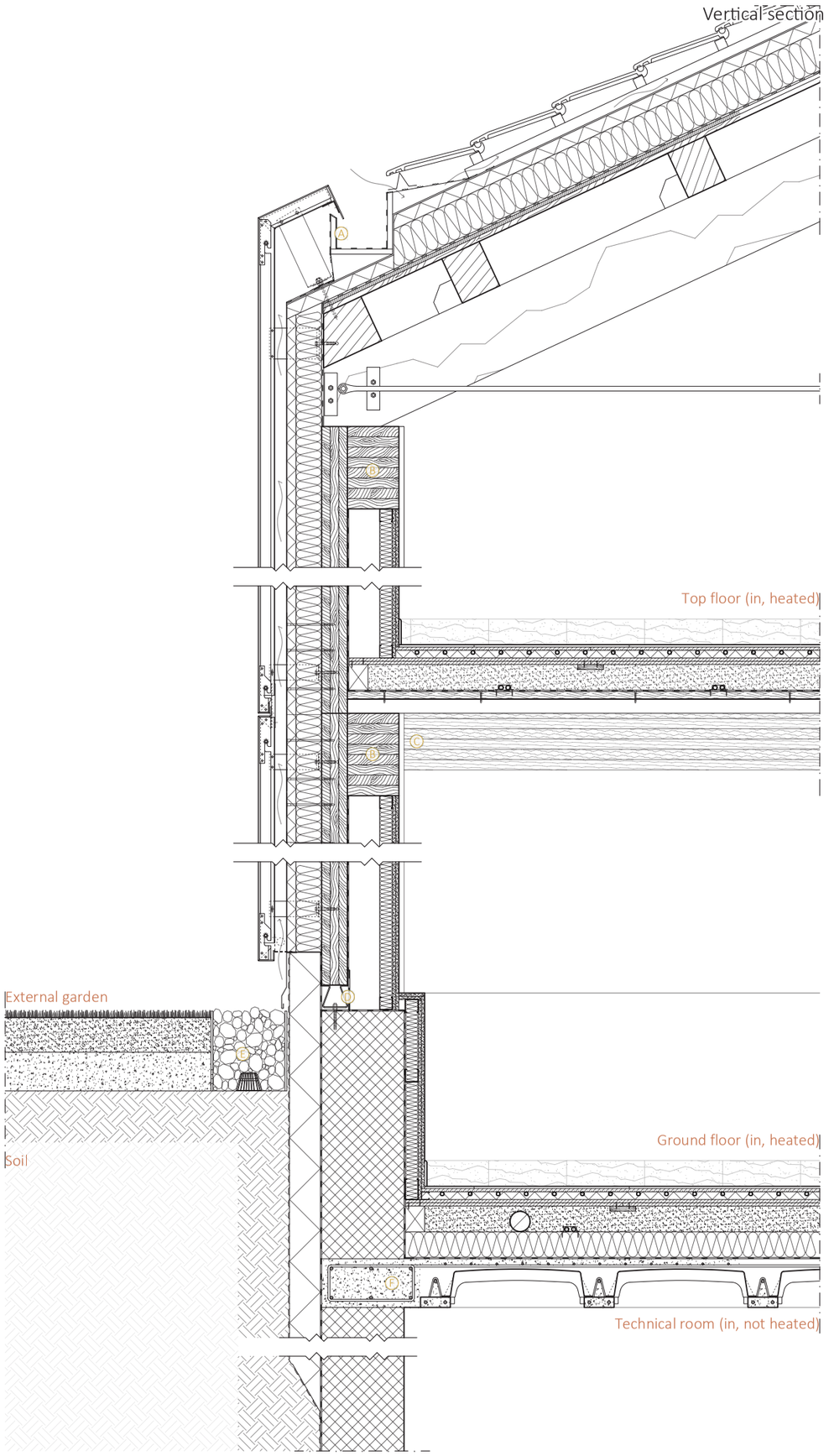

Facade south - scale 1:200




Facade north - scale 1:200



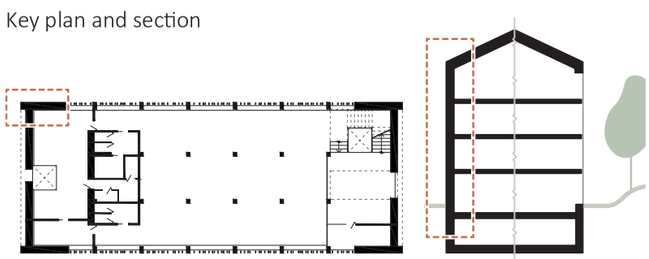

Vertical section



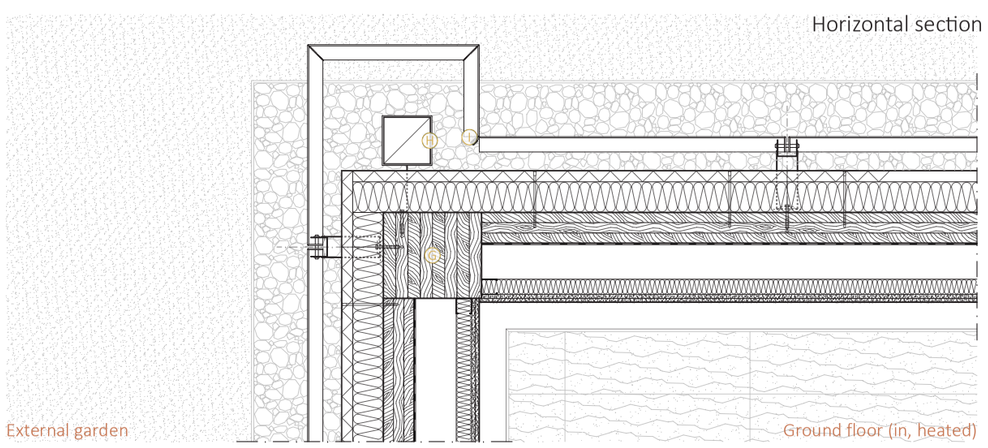

## Legend

| | |
|---|---|
| A | Parallel gutter, in anodized aluminium, dim. 240x150 mm |
| B | Structural beam in laminated wood GL32h, dim. 200x320 mm; specific weight=6 kN/m$^3$ |
| C | Structural beam in laminated wood GL32h, dim. 160x320 mm; specific weight=6 kN/m$^3$ |
| D | Ventilated boot, in galvanized steel “AIRTECH”, dim. 104x86 mm |
| E | Loose stone drainage system, with mixed dimensions rubble, to avoid water accumulation |
| F | Structural reinforced concrete beam |
| G | Structural column in laminated wood GL32h, dim. 280x320 mm; specific weight=6 kN/m$^3$ |
| H | Rectangular water drain pipe, in anodized aluminium, dim. 150x150 mm |
| I | Extruded edge section of two Alucobond panels and their anchorage |

Key plan and section

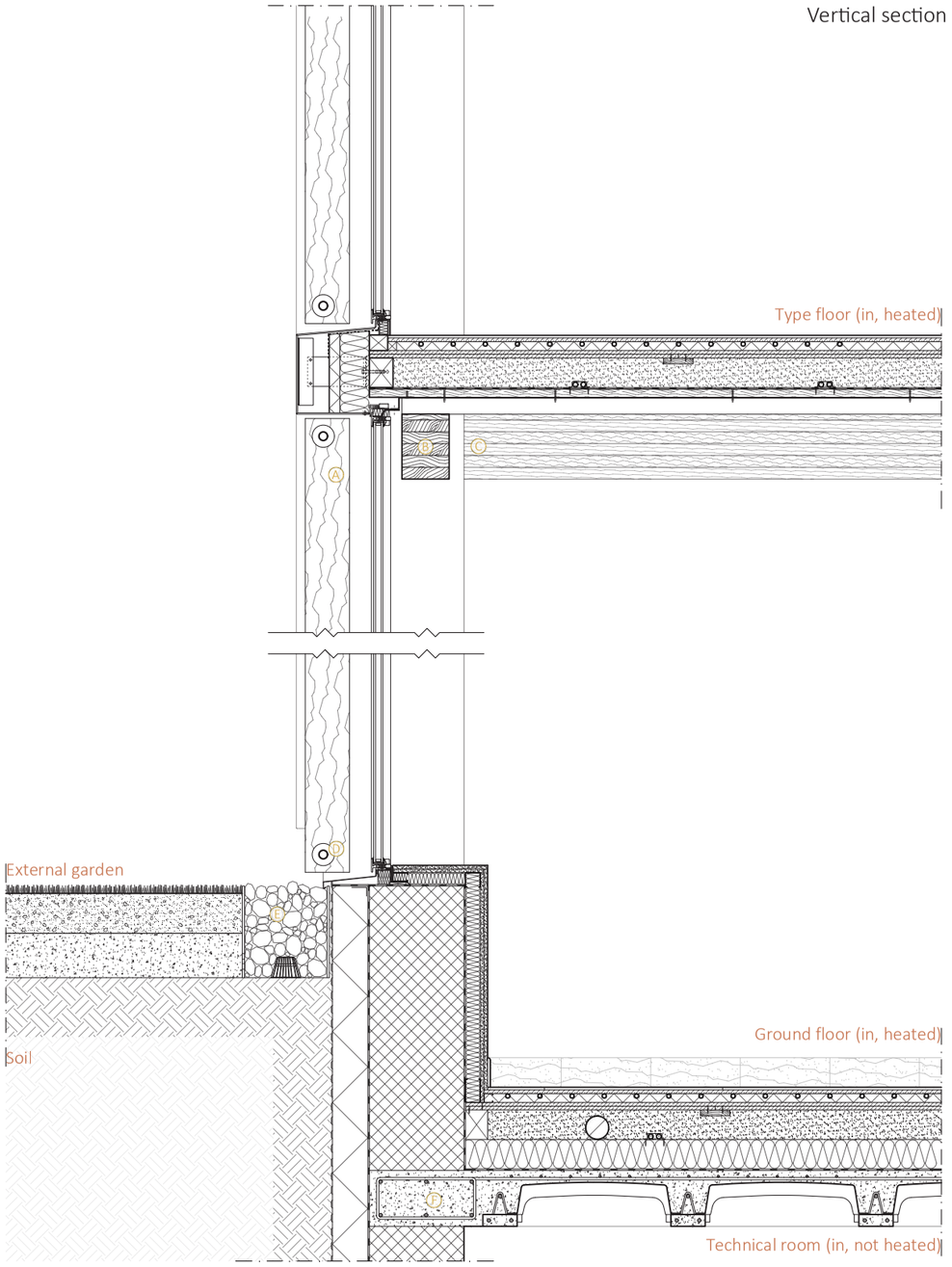


Horizontal section



Facade

Vertical section

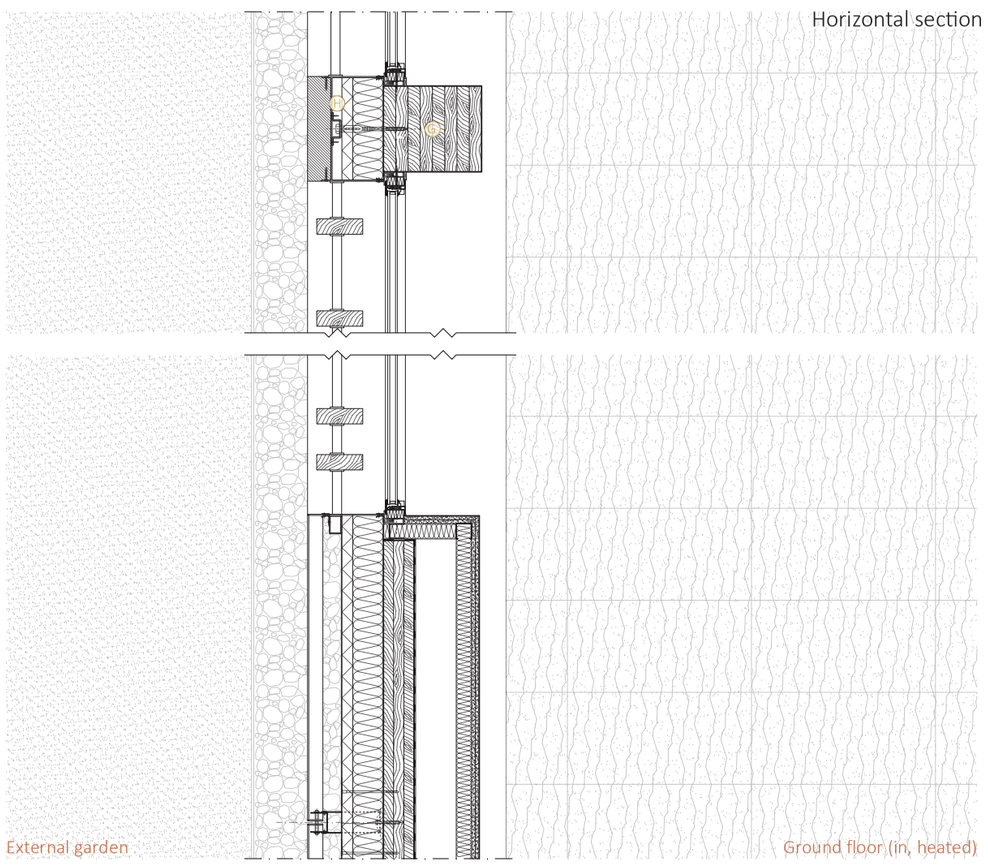



Legend

| | |
|---|---|
| A | Wooden shading element, dim. 50x150 mm |
| B | Structural beam in laminated wood GL32h, dim. 200x320 mm; specific weight=6 kN/m³ |
| C | Structural beam in laminated wood GL32h, dim. 160x320 mm; specific weight=6 kN/m³ |
| D | Anchor system made of circular hollow section, d. 30 mm |
| E | Loose stone drainage system, with mixed dimensions rubble, to avoid water accumulation |
| F | Structural reinforced concrete beam, |
| G | Structural column in laminated wood GL30h, dim. 280x320 mm; specific weight=6 kN/m³ |
| H | External cladding system, composed by a steel frame pre prepared with the insulating layers and the post anchored wooden column cladding |

Key plan and section

Horizontal section



used to produce new materials. Environmental certifications also comply with ISO international standards.

If in the case of the opaque wall, for the external cladding, it was possible to adopt a consolidated mechanical system defined by the company, node 2 requires a more careful and targeted design. First, the thinness of the string course requires the use of a mechanical system other than the one with pins. As well as its C-shape, necessary to cover the flaps on the horizontal plane, upper and lower parts, as well.

Secondly, the wooden covering of the pillars should be combined with the thermal insulation and should permit the anchorage to the columns without excessive invasiveness.

finally, the most tricky problem has been finding a solution for positioning and anchoring the shaders, which combined with the two already adopted for the coating of the string course and the pillars.

All this must be carried out with limited availability of load-bearing elements, which instead are aimed inside the glass wall.

Therefore, the following choices and considerations have been made: the Alucobond cladding of the string courses is made with panels folded and fixed by gluing on brackets mechanically fixed to the floor. This solution allows you to save space and elements, without sacrificing classic performance and ease of assembly.

The covering of the pillars, made with wooden elements, is fixed to a pre-formed metal element and which encloses the thermal insulation preventing it from getting wet. The chosen option would allow you to comfortably position the insulation and thin vertical brackets, to which the metal element and the wood would then be fixed. the metal element, similar to an H, also constitutes the “load-bearing” element to which the tubular for supporting the shaders are fixed. This mode leaves the shaders slightly detached from the string course, thus avoiding having to create holes in the Alucobond, which could possibly cause water penetration.

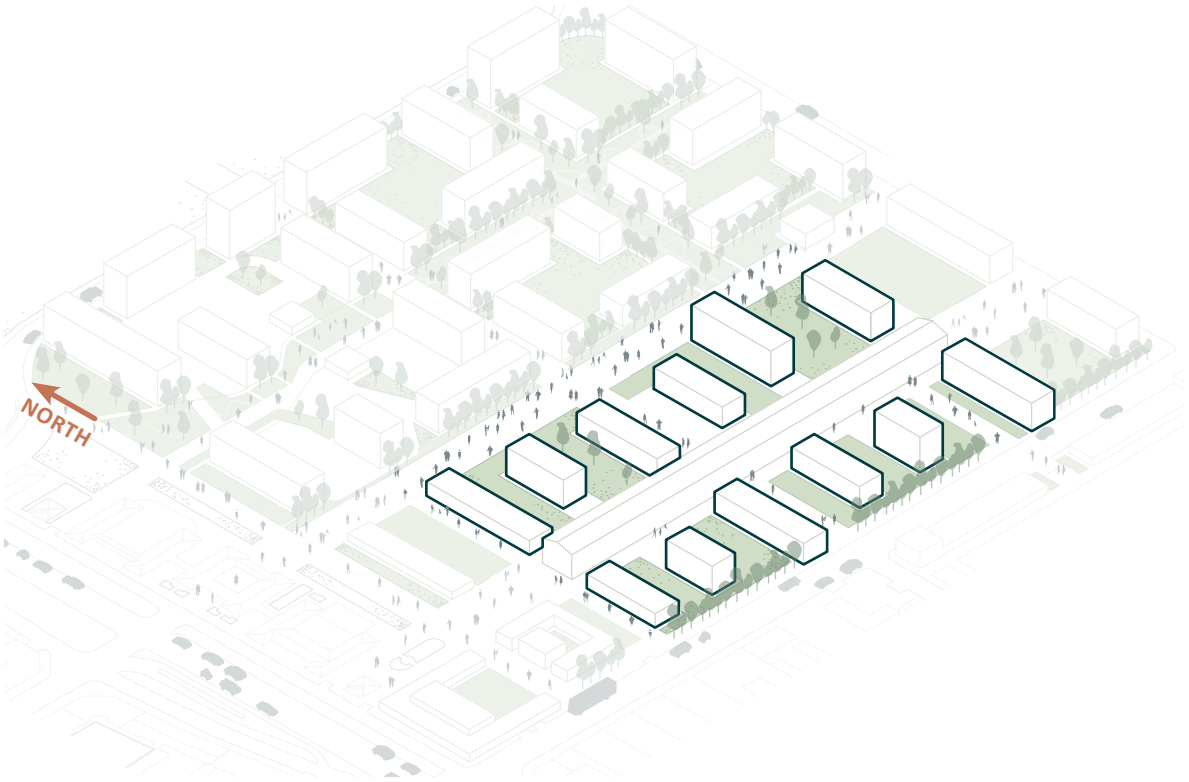
While there may be more functional or precise solutions, in particular by communicating and collaborating with the manufacturers of the various systems, the current ones, on paper, solve the many problems of nodes 1 and 2.

## 2. DAYLIGHT

I think that in architecture natural elements, like vegetation, are important because they are aimed at satisfying the physical and psychological well-being of the human person. The same purpose is carried out by the natural light too, which gives warmth to the rooms. Additionally, from an environmental point of view, it reduces energy consumption for the lighting of spaces in buildings. This condition should however be balanced, inasmuch the overlight of the rooms may need cooling due to the overheating of the space during the summer season.

### *DAYLIGHT ANALYSIS*

The daylight analysis is therefore intended to evaluate the quantity and quality of the natural light inside the buildings which have to be related to the room functions and activities. Following the Italian D.M. 5/7/1975 prescriptions, the daylight factor obtainable from the software analysis indicates, “the ratio, expressed in percentage, between the medium illumination of the space and the one that is, at the same instant, on an outdoor horizontal surface exposed to the celestial vault with the cloudy sky”. Moreover, based on Federico Butera research (professor in Politecnico of Milan) a good result is reached when the daylight factor is higher than 4%. This parameter is obtained by software, it is an average value estimated with “daylight visualiz-




*F.8.4 - Buildings disposition in the masterplan*

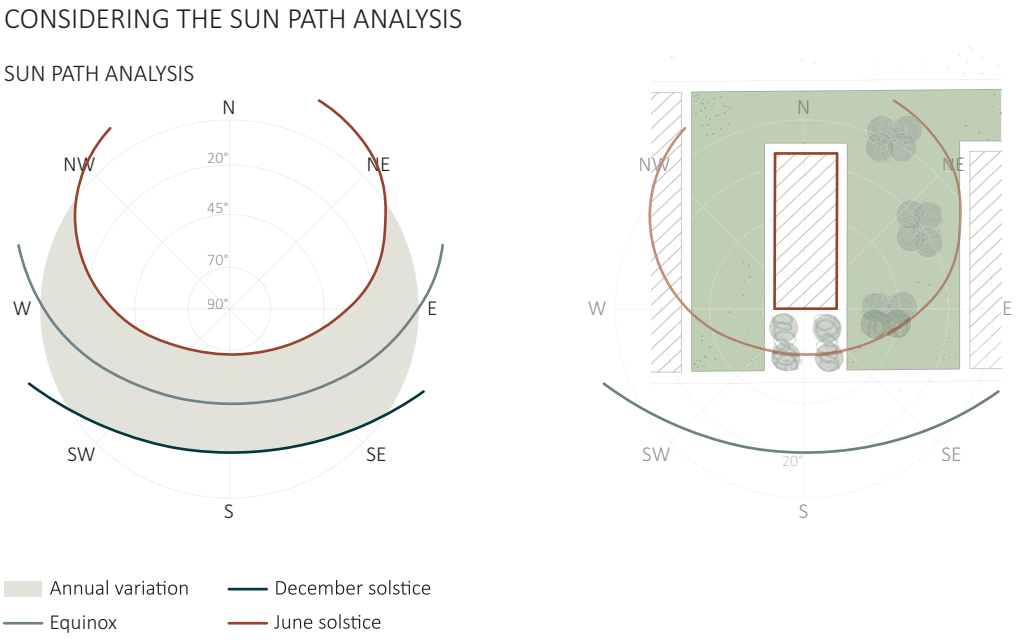
er" by VELUX for the natural light calculation. Other than estimate the natural light quantity it is interpreted its quality through false colour renders in plan, produced by the software itself.

Therefore, a very first evaluation is realized without applying any type of sun protection or shading system. It demonstrates a daylight factor very high in the plan, except for the bathroom and archives areas where, however, natural light isn't strictly necessary.

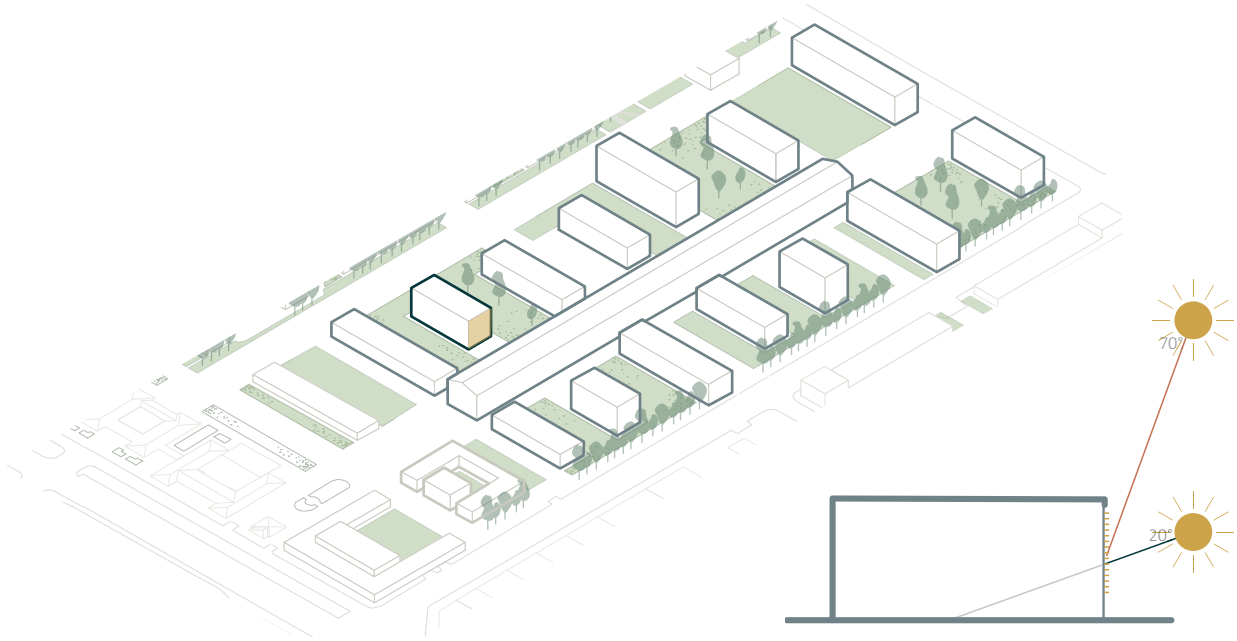
Some interesting aspects can be observed from this situation: along the glass facades (east and west side) the render shows an entire light zone, demonstrating very high daylight level. In general, this is considered as a benefit, confirming itself as a good starting point possibly improved by the adoption of specific shading systems. On the other hand, the observation just done, put in evidence some problems related to the dazzle and localized superheating phenomenon. Furthermore, it is evident how different light and shadow gradations are defined by rather net lines.

Considering the building under analysis (the library), its location, and the solar seasonal path in Milan, the two long glass facades will be exposed to the sun alternately and with different angles during the day. Instead, the high glass wall to the south will be lit up by the sun is higher in the sky and vertical to the ground and during the hotter hours of the day.

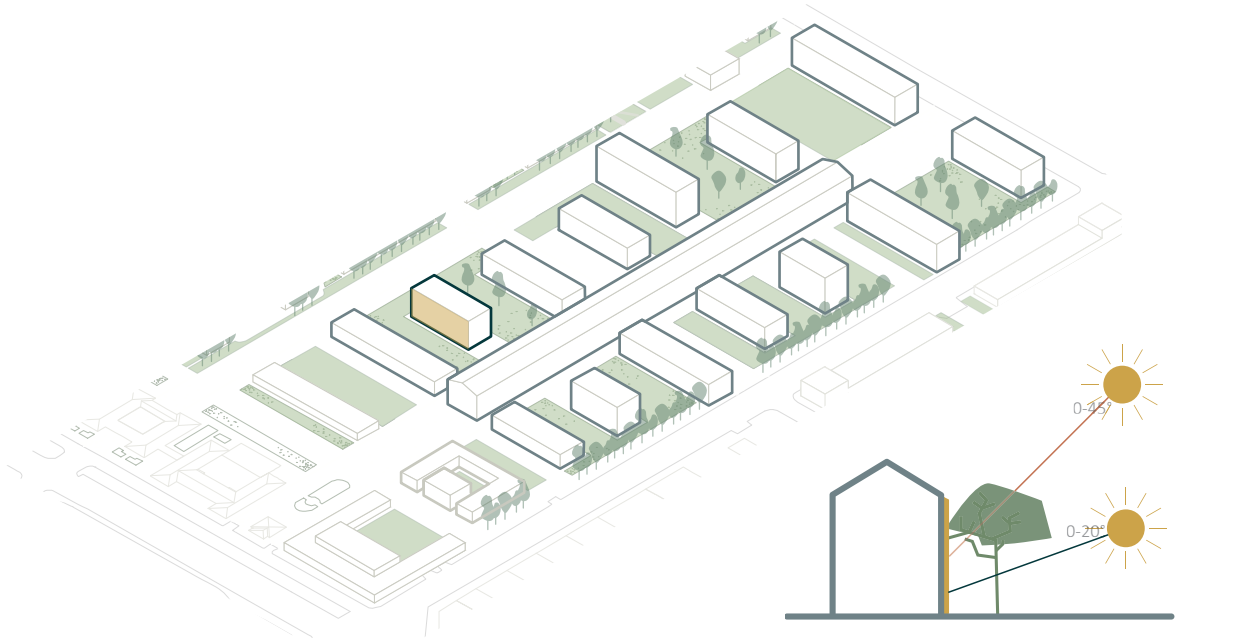
A fundamental consideration for a proper shading system design is that the illuminance from the east and west sides will penetrate more in-depth compared to the southern one, even if hotter and more constant.




*F.8.5 - Sun path analysis for the building*




*F.8.6 - South shading configuration and sun orientation*

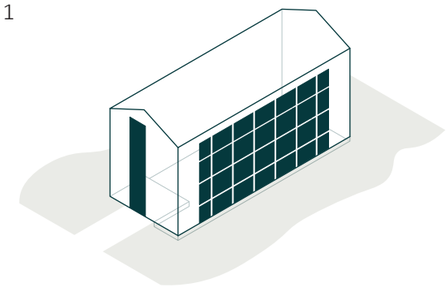



*F.8.7 - East and West shading configuration and sun orientation*

LEGEND - DAYLIGHT ANALYSIS

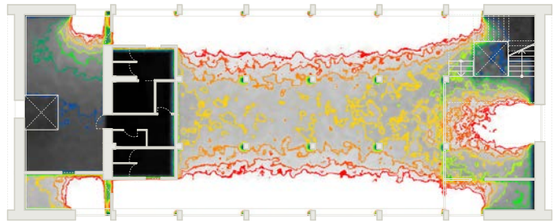
8,0 7,0 6,0 5,0 4,0 3,0 2,0 1,0

## Option 1

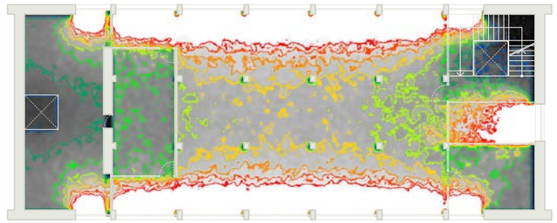


*SOUTH* No shading system

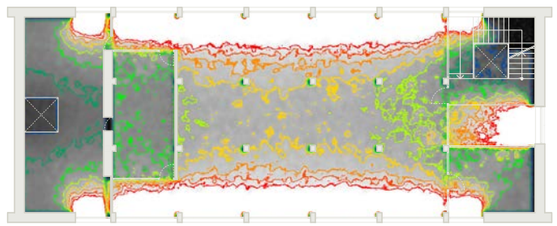
*EAST/WEST* No shading system



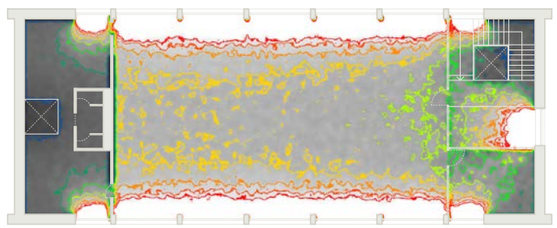
Ground floor plan



First floor plan

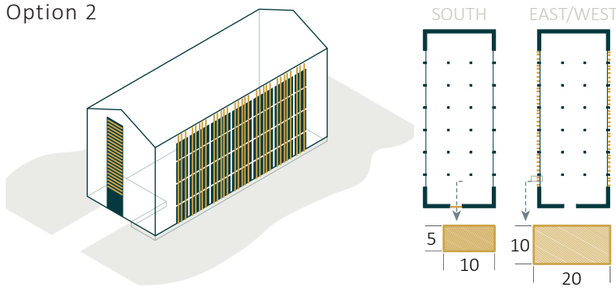


Second floor plan



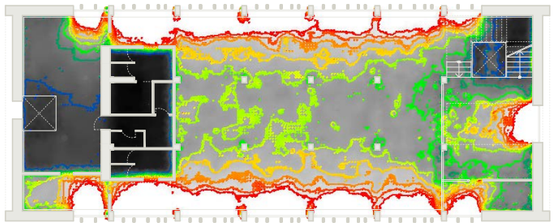
Trird floor plan

## Option 2

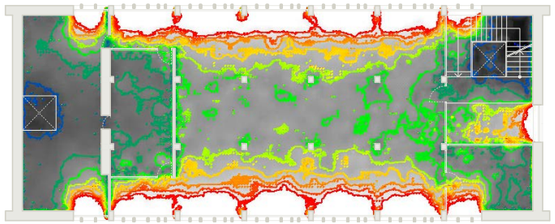



*SOUTH* Horizontal elements *b* 5cm, *h* 15 cm, constant spacing

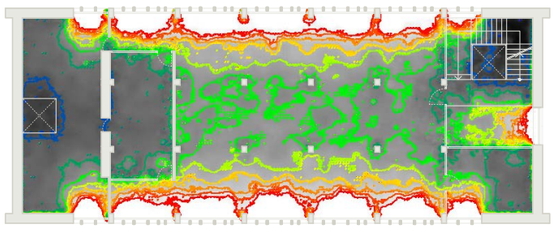
*EAST/WEST* Vertical elements *b* 10 cm, *h* 20 cm, different spacing for floor and same positioning for floors (in elevation)



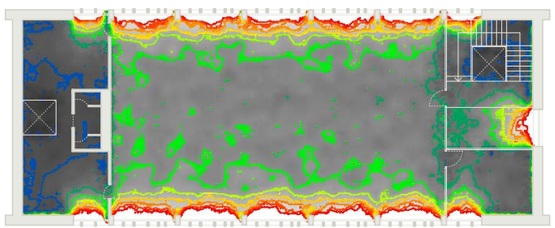
Ground floor plan



First floor plan

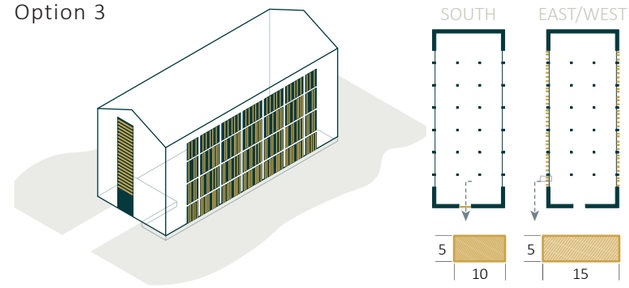


Second floor plan



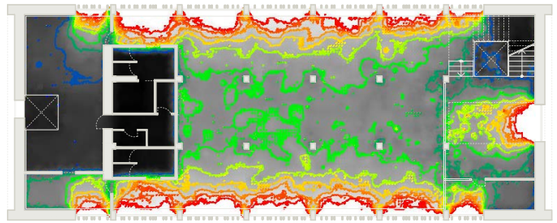
Trird floor plan

## Option 3

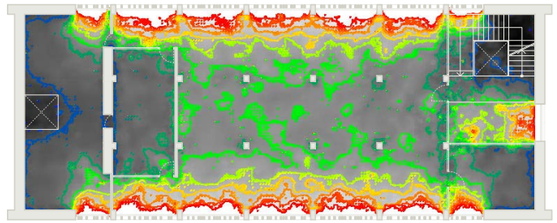



*SOUTH* Horizontal elements *b* 5cm, *h* 15 cm, constant spacing

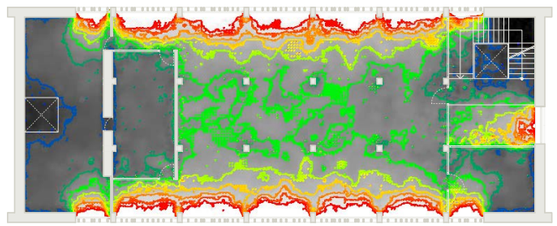
*EAST/WEST* Vertical elements *b* 5 cm, *h* 15 cm, different spacing for floor and different positioning for floors (in elevation)



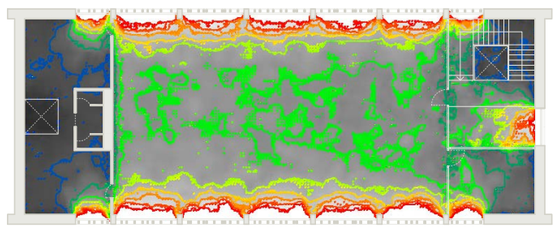
Ground floor plan



First floor plan



Second floor plan



Trird floor plan

About those reflections, the shading of the south facade can be more effective if characterized by a horizontal fixed system, regular in spacing.

Instead, concerning the other fronts, the system is constituted by vertical elements which play with thinness and deepness for the facade. They must contrast solar positions very different and rarely perpendicular to the glass if nothing else than parallel to the shaders.

It is drawn attention to the fact that the systems adopted and finalized hereafter, just as the cladding of the facade, should satisfy and be adopted also to the other buildings on the site. In the way that even deepening the design of just one building, the other volumes dedicated to the public can adopt the same finishing component reaching uniformity and aesthetic pleasure. The same is valid for the shading system from the functional point of view. The southern horizontal system is characterized by a constant and unchanging span inversely to the vertical one which is irregular for aesthetic and functional purposes.

### *SHADERS AND OPTIONEERING*

A first implementation option is evaluated by modelling horizontal shaders 10 cm high and 5 cm deep. The vertical elements are 10 cm large and 20 cm deep and they grow long the total building height and undifferentiated between the floors. The range established between every single element is again dependent on the sun irradiations and related to the columns positioning.

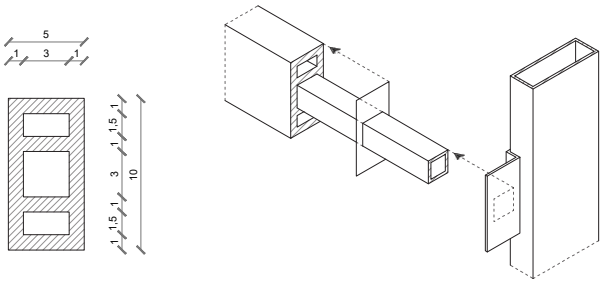
From the analysis progressed emerges the reduction of the overheated surface but maintaining a good daylight factor as well. Thoroughly interesting appears, more than in the initial situation is the different effect obtained at the distinct floors. Unexpectedly, getting up through the levels the daylight factor decreases and the white strips along the glass walls become smaller. This particular behaviour entrances the need for a differentiation between the floors concerning the east and west sides. To the south instead, the effect appears good enough, with some worsening only in the laterals zones, that is the stairwell and the relax rooms.

The third analysis is therefore carried out maintaining the same settings for the southern system and modifying the others. Now the elements are 5 cm large and 15 cm deep and their new disposition is different at each floor and considers the previously obtained results. The components are denser on the ground floor and thinned out at the upper storeys. It results in a light distribution similar floor to floor and differently from the previous situations, a great jaggedness of the lines which define the light ranges. This particular effect permits avoiding the glare phenomenon and the net overheating of the surfaces.

The intermediate options have been discarded to reach the solution which could answer multiple needs (the one just reported). It should be also reminded that from the very beginning of the masterplan development, the design involved the insertion of trees between the volumes, both as natural and seasonal shading elements.

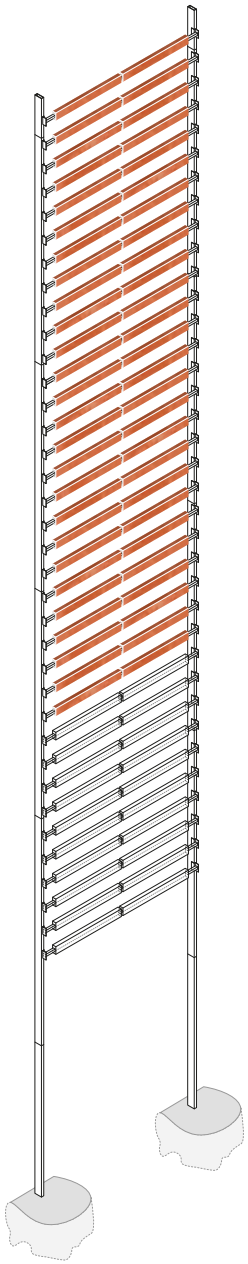
## *SHADERS DESCRIPTION*

The two shading systems are composed of individual elements anchored to a substructure. A complex composed of individual elements brings some benefits like ease of installation or either restoration.

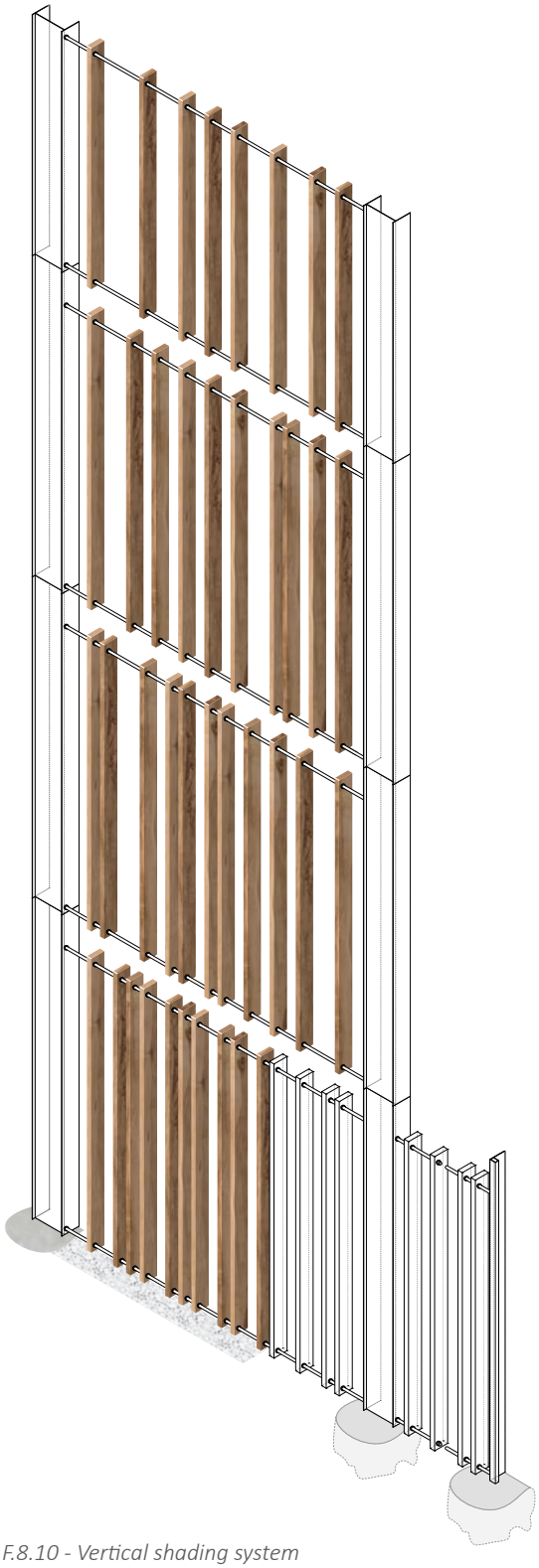



*F.8.8 - Shading elements dimensions, assembly and practical example from SanMarco Terreal*

The south system adopted in the project follows the one developed by Terreal San Marco, constituted by rectangular hollow elements anchored to the vertical supports through a metallic core. The elements are horizontally positioned and constituted by terracotta tubes of natural colour, which recalls the roof tiles one, typical of Milan and common to the Italian tradition. The clay tubes protect the internal supports from the constant solar and weather exposition to deformations or alterations. In the shader lines, two 100 cm long tubes are coupled together and each line is separated by 31,5 cm from the surrounding ones.



*F.8.9 - Horizontal shading system*



*F.8.10 - Vertical shading system*

Concerning instead the system on the east and west sides, it wasn't easy to find a solution that could meet the needs suitably combined with the mechanical cladding system of the facade.

The green spaces displayed on these sides are recalled and connected to the volumes by the glass walls and the shading components.

They are made of laminated wood contrastively aesthetically with the just described southern shaders. They are 5 cm large and 15 cm deep and in terms of height, they are included between the string courses along the front.

The shading complex is a multilayer structure made of metal: the principal one is vertical and spliced to the main building wooden structure; the lighter subframes are of course connected to the principal one and are encharged to bear the individual elements. Those are positioned and fixed floor by floor to metallic circular profiles.

Although the vertical wooden shaders are interspersed with an irregular distance, the distribution is therefore based on a rigid grid (see chapter 6 "1.3 LIBRARY FACADES" paragraph), playing on it, removing some elements alternatively and giving some movement to the rigid scheme. The starting axle base of the grid is about 15 cm which goes to the maximum one of 60 cm.

The tubes are rectangular with a base of 10 cm per 5 cm of deepness. The shading system is finally adopted, therefore reflecting that third and last option.

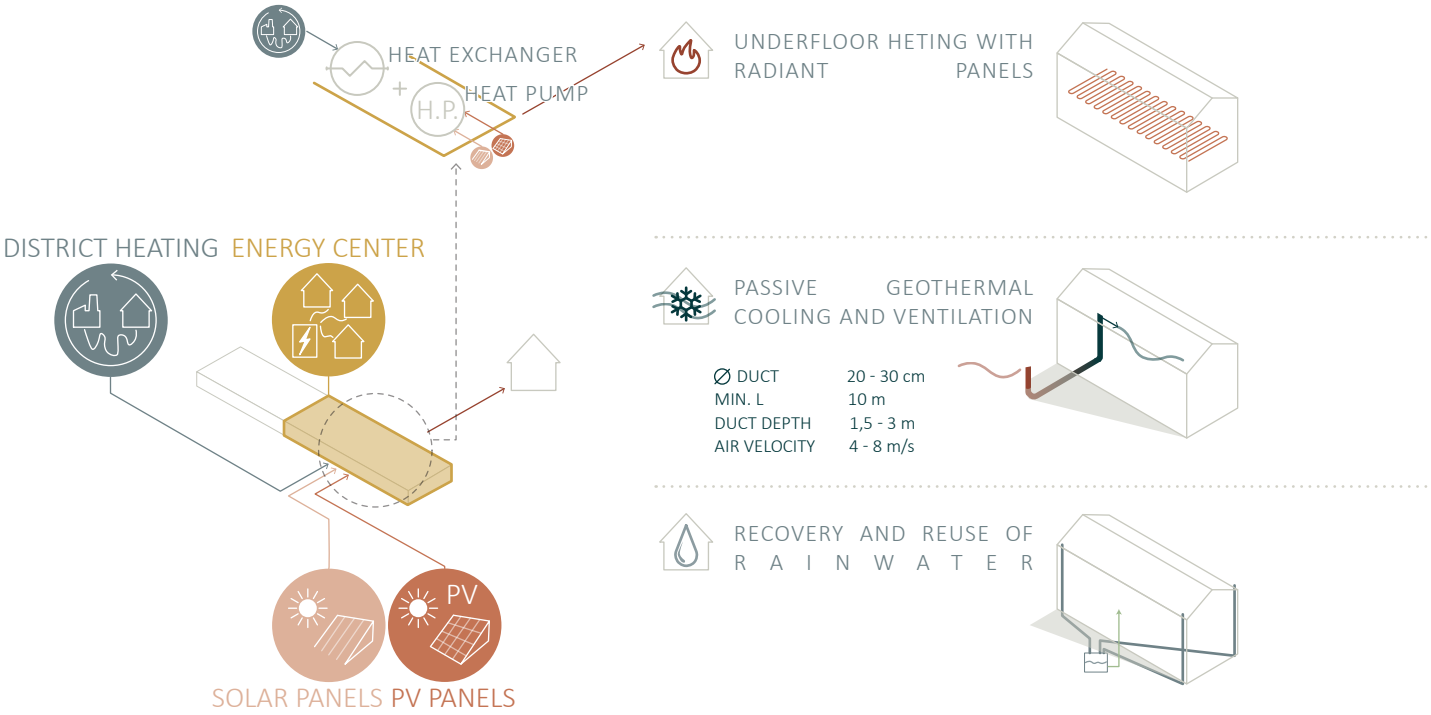
At the beginning of the deepening phases of the project, they have been mentioned different strategies, starting from the concept baselines. Those, in the different steps, bring multiple and collaborative sustainability typologies. In building technologies, environmental sustainability is reached through innovation of systems and materials, as indicated in “project phases goals”, chapter 4.

As an entire project works on multiple levels, the technologies stratify functional solutions to get a complex and efficient construction. In the previous chapter, we have seen the building structure, now the systems and envelope stratigraphy are defined. Moreover, special and additional attention is given to the daylight analysis and the consequent shading system adopted.

Approaching therefore the end of the design phases treated for this project, hereafter, are firstly observed the configuration and disposition of the implants. Secondly, the daylight analysis and in the end the envelope with some details. All three steps can be useful to have in mind the stratigraphy of the building. Therefore, they are reported in the appendix “ABACUS of construction system” at the end of this chapter.

## 3. BUILDING SYSTEMS

It is here recalled the topic of the systems introduced in chapter 4 at the masterplan level, now investigated at the building scale. The systems are subdivided into three implants, heating, cooling and ventilation, and




*F.8.11 - Utilities distribution*

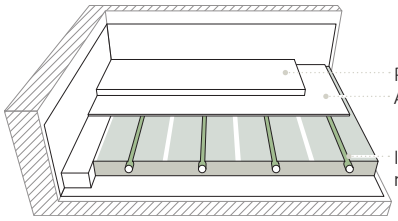
additionally the water one, not described in the chapter. The solutions described here for the library building are intended to be valid for the other new fabrics of the site too.

The systems listed and which are described in more detail below, are supported by a strategy for the reuse of rainwater. It would seem, and no wonder, a lot of drinking water used daily is consumed for showering and for the toilet. The use of rainwater can allow a saving of very significant drinking water, for the toilets and for the irrigation of outdoor green areas to begin with. Thus saving more than 30% of the daily requirement. Furthermore, special filtering systems could make rainwater suitable for even more uses.

The utility management and distribution are coordinated by the energy centre, at the masterplan level. It collects the heating and energy sources produced on and off-site. They are then delivered and exchanged with the building themselves. The library is organized with an underground floor from which are supplied the pipes, from the machines and boilers, passing through wall cavities.

### *HEATING SYSTEM*

During the so-called “thermal season”, which goes from the 15th October to the 15th of April in Milan, heating is distributed through underfloor radiant panels (for a maximum of 14h/day). This system works with a low-temperature fluid (generally water), allowing less energy consumption. Additionally, the legislation UNI

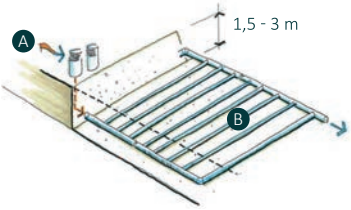


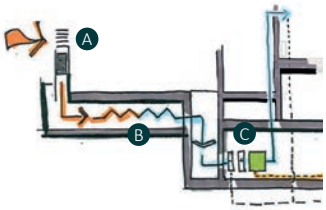

Underfloor heating - dry system

Multilayer pipes

tk. 2 mm

∅ 16 mm

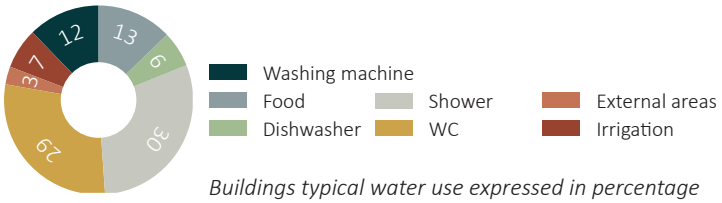



A Air intake with filtering system

B Horizontal heat exchanger for passive cooling

C Open cycle solar system for absorption dehumidification




*Buildings typical water use expressed in percentage*

Reuse of rainwater for:

A. Irrigation of green areas

B. WC cistern drain

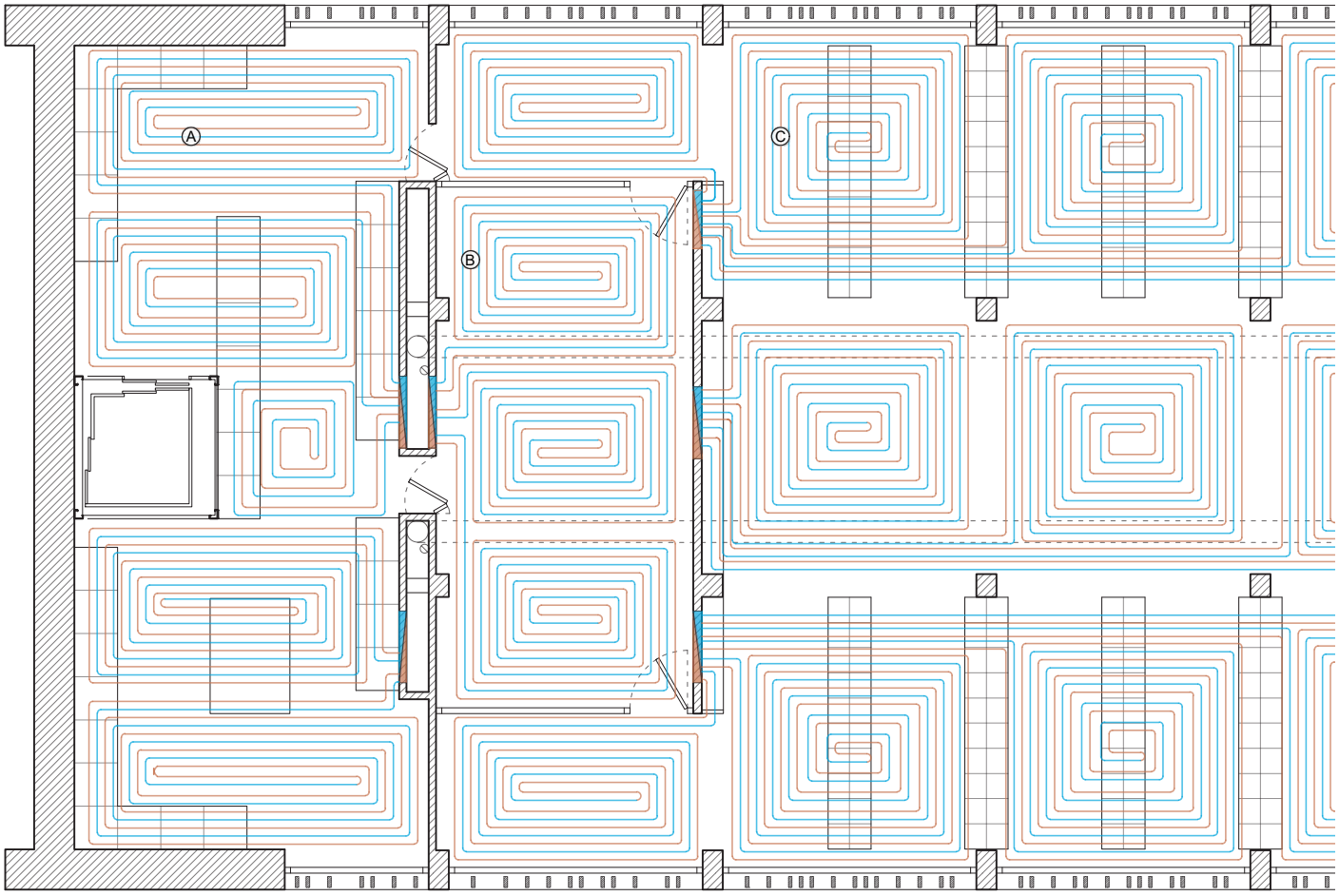
EN1264 prescribes that the pavement should not overcome 29°C (33°C for the bathroom) to avoid whichever type of legs' circulatory problem for users.

The fluid is transported to the floor by delivering pipes and, in the same way, it comes back to the boiler by return pipes. Water circulates continuously and it is considered that after 60 m length of the pipeline, the transmission fluid starts to decrease in temperature and, therefore, in performance.

The tubes in the pavement have an internal diameter of 16 mm and the external finishing is 2 mm thick. Usually, they are positioned on a mat and then drowned in concrete. In this case, the pipes are stuck in an insulating panel, 3 cm thick, with a covering aluminium slat on top.

### *COOLING SYSTEM*

The cooling is combined with the ventilation system through the passive geothermal cooling. It is one of the




*F.8.12 - Implants type floor*

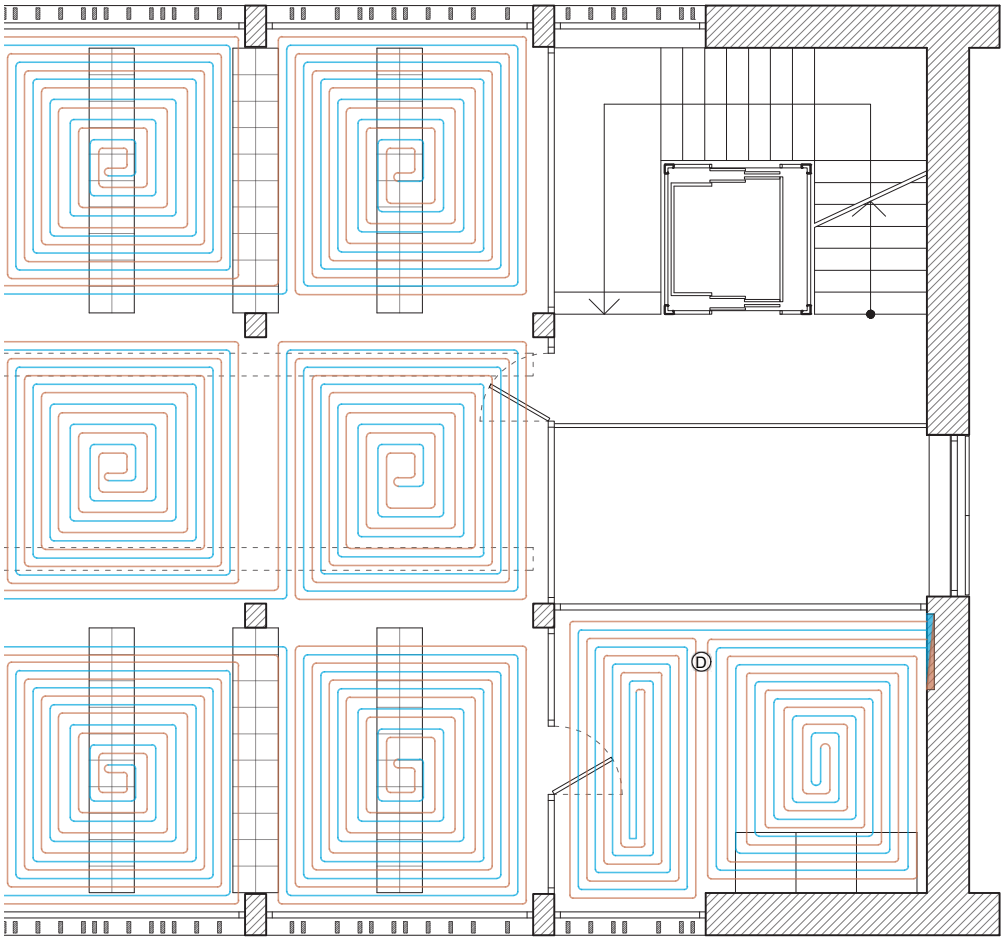
main natural cooling systems which exploits the temperatures of the subsoil which remains stable throughout the year. The soil temperature isn't constant bit it becomes more stable with increasing depth:

- For depth minor than 0,5 m Tsoil is equal to Tair;
- For depth between 1 and 5 m Tsoil follows the seasonal thermal variations;
- For depth major than 5 m Tsoil is equal to mid annual air temperature + 3°C.

This type of cooling works as a thermal well disperding heat in contact with the soil. The air temperature is circulated in underground pipes, through mechanical or passive systems for effect Bernoulli-Venturi. The thermal exchange with the soil permits to lower the air temperature from 5 to 10 degrees.

The system works entering external air in the building, it is called opened cycle and it needs filters, while a closed cycle uses the internal air. The design criteria to take in consideration are:

- Minimum length of the duct is 10 m, the air diameter can vary between 20 and 30 cm and the air velocity is 4-8 m/s;




Thermal zones

A ARCHIVE, STORAGE AREA

18°C required
mid pipes span 22,5 cm

B ROOM

21°C required when needed
mid pipes span 22,5 cm

C CONSULTING AREA

21°C required during the day
mid pipes span 22,5 cm

D REFRESHMENT AREA

21°C required
mid pipes span 22,5 cm

- For a correct thermal exchange between the ducts and the soil it is necessary to surround the pipes with a 5 cm layer of sand, which guarantee a good thermal conductivity and avoids the formation of air bubbles;
- An other problem particularly important is the possibility of condensation in the ducts. This issue favors the cultivation of mols and harmful microorganisms. There are two practical options to avoid the problem: the positioning of the ducts on a slope with the addition of holes at the base of the lower elbow, or placing appropriate filters at the outlet of the duct.

### *RAINWATER COLLECTION SYSTEM*

According to Istat data for the year 2018, in Italy, per capita, water consumption is estimated to be on average equal to 215 litres per day. The water use is to be mainly attributed to the toilet drain and shower and personal hygiene, as described in the previous introduction. To solve the problem, many legislations have been introduced favouring the use of recovered rainwater and the reuse of wastewater (greywater), with the purpose to save drinking water and take advantage of secondary sources still useful. This solution can save at least 50% of the entire percentage of water daily used. Rainwater properly collected and filtered can be used for toilet drain, domestic cleaning, washing machine, garden irrigation.

The code UNI/TS 11445:2012 standard “Plants for the collection and use of rainwater for uses other than human consumption- design, installation and maintenance”, regulates the recovery and reuse of rainwater in Italy.

The collecting and reusing system must be properly proportionated concerning the supply of rainwater and water needs. The rainwater supply is strictly related to the geographic context and building roof morphological characteristics (dimensions and type of roof covering). According to the roof characteristics are generated the relative runoff coefficient (from a minimum of 0.4 for the green roof to a maximum of 0.9 for the sloping roof with smooth tiles):

| Typo of collecting surface | runoff coefficient |
|---|---|
| Pitched roof in smooth clay tiles | 0,9 |
| Pitched roof in slate, concrete or rough tiles | 0,8 |
| Flat roof in gravel | 0,6 |
| Flat roof in flagstone | 0,5 |
| Green roof | 0,4 |

The necessary calculations to guarantee a correct design of the system are the contribution of rainwater and the tank volume, which considers the average dry period which is the number of days in the absence of

rain, generally considered equal to 21 days. The two formulas are:

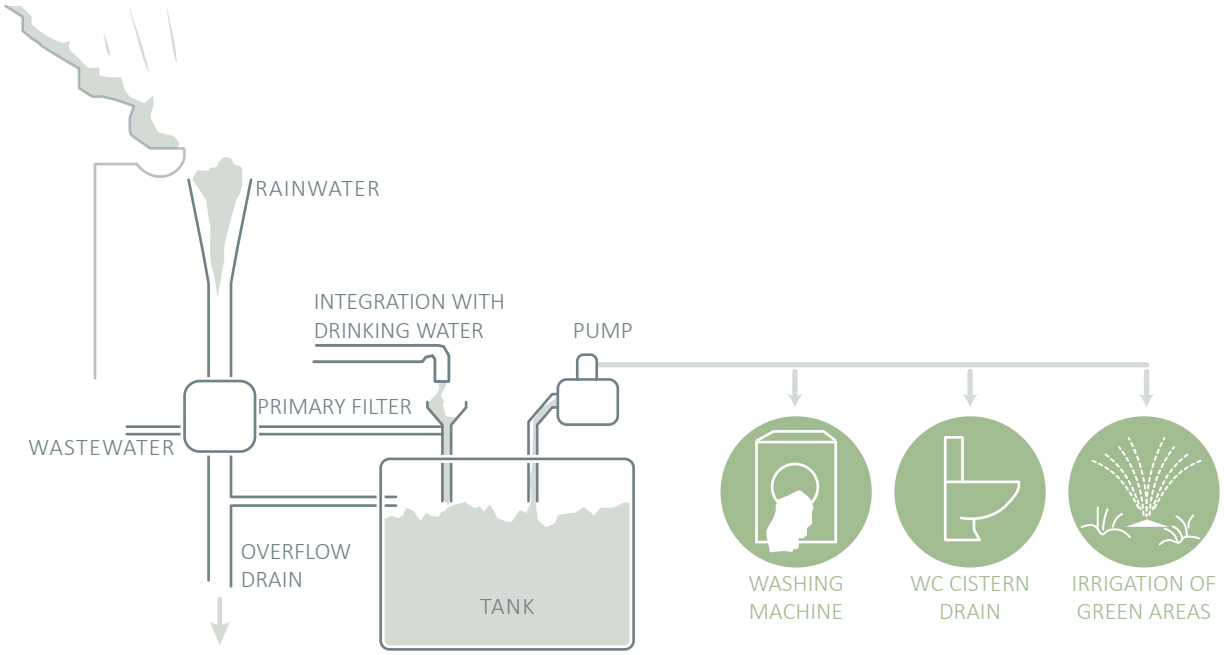
[(average annual precipitation) x (collecting surface) x (runoff coefficient)] = supply of rainwater [$m^3$/year]

[(average useful volume of water) x (average dry period) x (days per year)] = tank volume [$m^3$]

For the case of the library of materials:

| | |
|---|---|
| Runoff coefficient (Pitched roof in smooth clay tiles) | 0,9 |
| Collecting surface | 350,75 mq |
| Average annual precipitation | 801-1000 mm/y |
| Therefore: | 0,8 [mm/y] x 350,75 [$m^2$] x 0,9 = 252,54 [$m^3$/y] |

A waste and rainwater collection and reuse system generally consists of components such as a tank, filter, pump, integration with drinking water and the second network of pipes and overflow drain. Depending from the use of the collected water, the system is more or less complex with the addition of filters, submerged centrifuge for water distribution, control inverter, multi-stage filter, sterilization with UV lamp for disinfection.




*F.8.13 - Rainwater and wastewater recovery plant scheme*

# CONCLUSIONS

As shown in the first pages, this path of research and experimentation stems from the reinventing cities for Milan call. The call was used as a guideline and proposed 10 objectives divided into 3 macro categories, which the proposed project should have fulfilled.

The issue regarding $CO_2$ emissions was addressed at different project scales. From an energetic point of view, it has been paid attention to the use of renewable sources, both for energy production and natural light and ventilation, but also for the energy efficiency. Furthermore, at the urban scale, the design area is entirely pedestrian, disadvantaging the use of vehicles and favouring low mobility.

From the external space implant point of view, access to the volumes (opened functions buildings) is easy and immediate, for the exclusion of architectural barriers. Moreover, the introduction of a lot of natural elements creates a peaceful and stimulating environment. In this way, even aspect number 3 (architecture and social impact) from the call guidelines, is made proper to the project and deepened.

The spaces are studied to be multifunctional and adaptable to numerous needs, both at the masterplan and building scales. The integrated functions are innovative and versatile, answering the “green jobs” demand. Nature is the protagonist everywhere in the project integrating itself and collaborating with the built volumes, emphasizing the characteristics of the second macro category.

The project, in its complexity, has tried to consider in detail, all the aspects to reach a good project work.

As a whole, I was able to ascertain how much the architectural part and the technological (engineering and energetic) are, can and must complement and blend, to reach an ongoing design style, which underlines the need of having always more spaces and buildings corresponding to the modern world. This implies more respect e planning of the territory, more ecology and sustainability through the future, even in spaces adaptability.

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*Obviously, the references of the products composing the building, shown the stratigraphies reported in the appendix, also count as references. Each material is described in detail and the relative reference manu-*

*facturer is indicated in the attached descriptive table. They can all be found online with relative technical data sheets.*