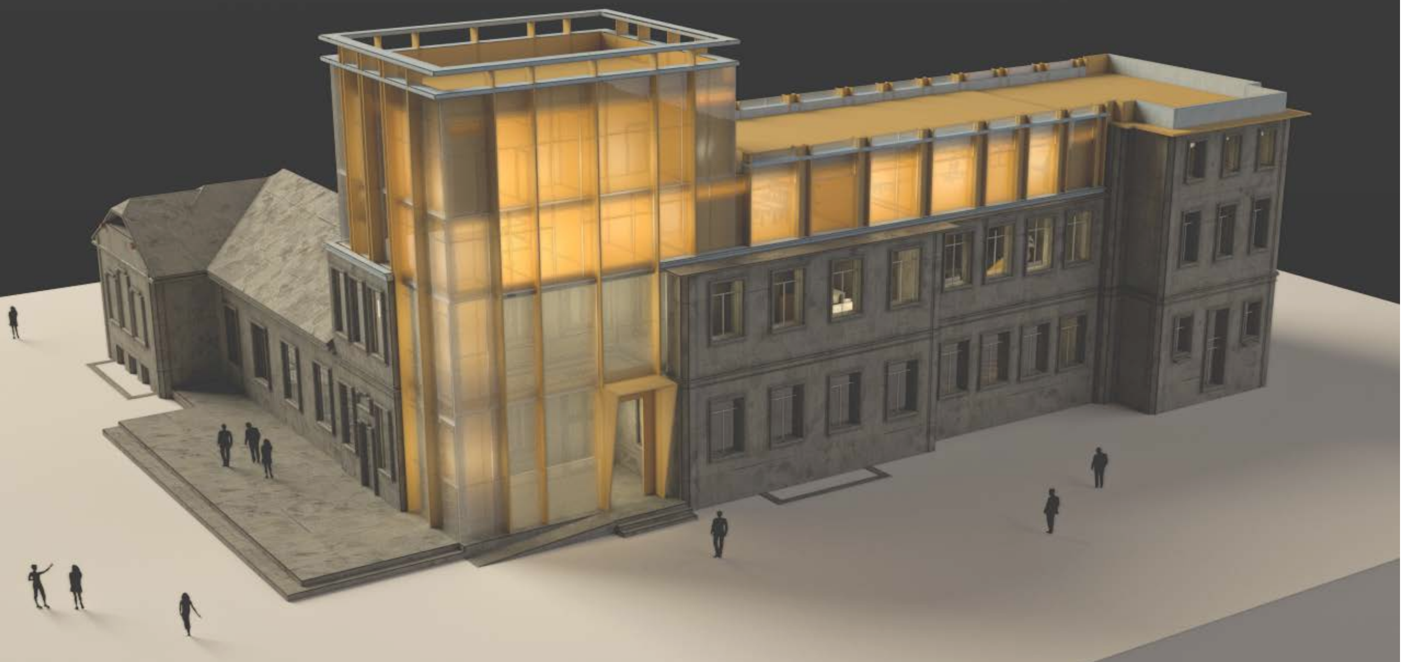
METAMORPHOSIS



Architectural Design Studio for the Restoration and Transformation of Complex Constructions

A.Y. 2021-22

School of Architecture, Urban Planning, Construction Engineering (AUIC)

Architecture - Building Architecture

POLITECNICO DI MILANO

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ABSTRACT

The idea of preservation and transformation has evolved from buildings of prime importance to buildings of local importance since the beginning of the late 19th century. In accordance with this idea, the thesis follows the transformation proposal for building ED-22080 located in the veterinarian block of the UNIMI campus, which has been recognized as a landscape and cultural heritage since 2004. This block belongs to the cluster of technical universities developed including Politecnico di Milano and the Agraria block under the Citta Studi plan, which was established at the beginning of the last century.
The project focuses on the preservation and transformation of building ED -22080 into the APICE center and exhibition hall. Lately, the building has been used as a veterinary school and consists of offices, medical rooms, a lecture hall, and animal stables. The transformation has been done by adding another floor to the already existing roof, which has been used for the exhibition hall, whereas the APICE is developed through the internal transformation of the building.
Historically, the building was composed of two separate building masses connected via a semi-open passage, later in 1958 the addition of the central mass unifies the two masses into one. This transformed the image of the building, as well as increased the complexity

due to the difference in construction techniques and the alignment of the spaces. This transformation also led to a disrupted hierarchy of the spaces. Apart from this, certain small interventions have been undertaken to make the building compliant with the new energy norms. These small interventions and repair works are visible on the façade. The incompatibility of these interventions has led to the reduced aesthetic quality of the building façade.

The addition to the existing structure has been developed as a light structure both in terms of visual effect and structural loads since it is located in a picturesque campus and has a delicate balance of solid masses and empty space. This visual and structural lightness has been conceived by using wood as the main structural material. An internal transformation has been proposed to transform the existing into the APICE, with the main focus on improving the hierarchy of spaces. The design language of the proposal has been inspired by the Milanese contemporary style, providing continuity to the present architectural language. This is an attempt to provide a new identity to the campus both in terms of function and architecture.

ABSTRACT

L’idea di conservazione e trasformazione si è evoluta da edifici di primaria importanza a edifici di importanza locale dall’inizio della fine del XIX secolo.

Coerentemente con questa idea, la tesi segue la proposta di trasformazione dell’edificio ED-22080 situato nel blocco veterinario del campus UNIMI, riconosciuto come bene paesaggistico e culturale dal 2004. Questo blocco appartiene al cluster di università tecniche sviluppate comprendente il Politecnico di Milano e l’isolato Agraria del piano Città Studi, istituito all’inizio del secolo scorso.

Il progetto si concentra sulla conservazione e trasformazione dell’edificio ED -22080 nel centro APICE e nella sala espositiva. Ultimamente l’edificio è stato adibito a scuola veterinaria ed è composto da uffici, sale mediche, un’aula magna e stalle per animali. La trasformazione è avvenuta aggiungendo un altro piano alla copertura già esistente, che è stata utilizzata per la sala espositiva, mentre l’APICE si sviluppa attraverso la trasformazione interna dell’edificio.

Storicamente l’edificio era composto da due distinti corpi edilizi collegati tramite un passaggio semiaperto, successivamente nel 1958 l’aggiunta del corpo centrale unifica i due corpi in uno solo.

Ciò ha trasformato l'immagine dell'edificio, oltre ad aumentarne la complessità dovuta alla differenza delle tecniche costruttive e all'allineamento degli spazi. Questa trasformazione ha portato anche a una gerarchia sconvolta degli spazi. Oltre a questo sono stati intrapresi alcuni piccoli interventi per adeguare l'edificio alle nuove normative energetiche. Questi piccoli interventi e riparazioni sono visibili sulla facciata. L'incompatibilità di questi interventi ha portato alla ridotta qualità estetica della facciata dell'edificio.
L'aggiunta alla struttura esistente è stata sviluppata come una struttura leggera sia in termini di effetto visivo che di carichi strutturali poiché si trova in un campus pittoresco e presenta un delicato equilibrio di pieni e spazio vuoto. Questa leggerezza visiva e strutturale è stata concepita utilizzando il legno come principale materiale strutturale. È stata proposta una trasformazione interna per trasformare l'esistente in APICE, con l'obiettivo principale di migliorare la gerarchia degli spazi. Il linguaggio progettuale della proposta è stato ispirato dallo stile contemporaneo milanese, fornendo continuità al linguaggio architettonico attuale. Questo è un tentativo di fornire una nuova identità al campus sia in termini di funzionalità che di architettura.

CONTENTS

MILAN: The context

The project is situated in the broader context of the metropolitan city of Milan. The city itself has gone through centuries of transformation. The study and understanding of the context set the tone of the project. The transformation of the city on urban and building levels can be studied in different timelines, which lead to the development of the contemporary style which we see today. Traces of this style of development can be witnessed throughout the city, from buildings ranging from the Roman time to the Avant-Garde style. Also, the organic construct of the urban fabric arises from the integration of the old and new. The city's growth as a series of concentric belts around the original core with its Roman matrix, fully developed in the middle ages and continuously remodeled since the sixteen century, is a constant that Cesare Beruto theorized in the presentation of his urban plan in the late nineteenth century by using organicist metaphors: " the plan of our city, represented on a small scale, is very much like the cross-section of a tree; you can see clearly the outgrowths and concentric layers. It is a highly rational scheme that is exemplified in nature.

Figure 1: View of Duomo di milano

HISTORICAL CITY

Milan was established in 590 BC by the Celtics which was later conquered by the Romans in 222 BCE. It was further developed under the rule of the Lombards in 569 CE. Developing from a Roman state of importance to an independent state in 1259 CE. During this period of Milanese history, the heritage center was developed in the most prominent way which later served as a reference to the architectural language that developed in the city. The initial examples are The Duomo of Milan, The Brera district, and St. Ambrogio's. The city has undergone various architectural styles from the Renaissance to Italian Gothic each having its effect on the architectural language and the urban fabric, Despite the heavy influence of these architectural styles and urban planning strategies the city has had its alterations to them finally merging and making its adaption of each particular style, be it the renaissance or the gothic style.

The integration of the old city into the new metropolitan of Milan is what gives Milan its unique essence, where you find the old city gates resting monumentally marking the history of the walled city that Milan once was. This unique integration of the historical structures is one of the strong reasons for the interesting amalgamation of architectural styles in present-day Milan ranging from historically preserved heritage to new modern day heritage.

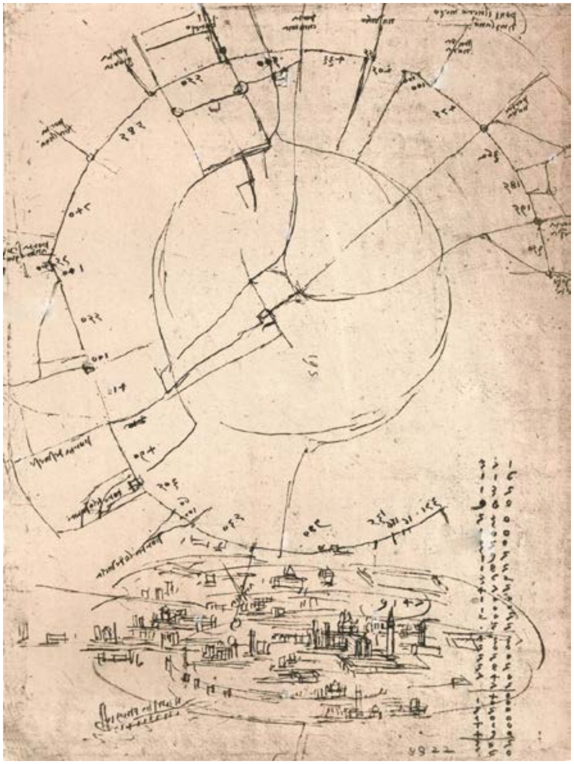


Figure 2: Sketch of Milan by Leonardo Da Vinci

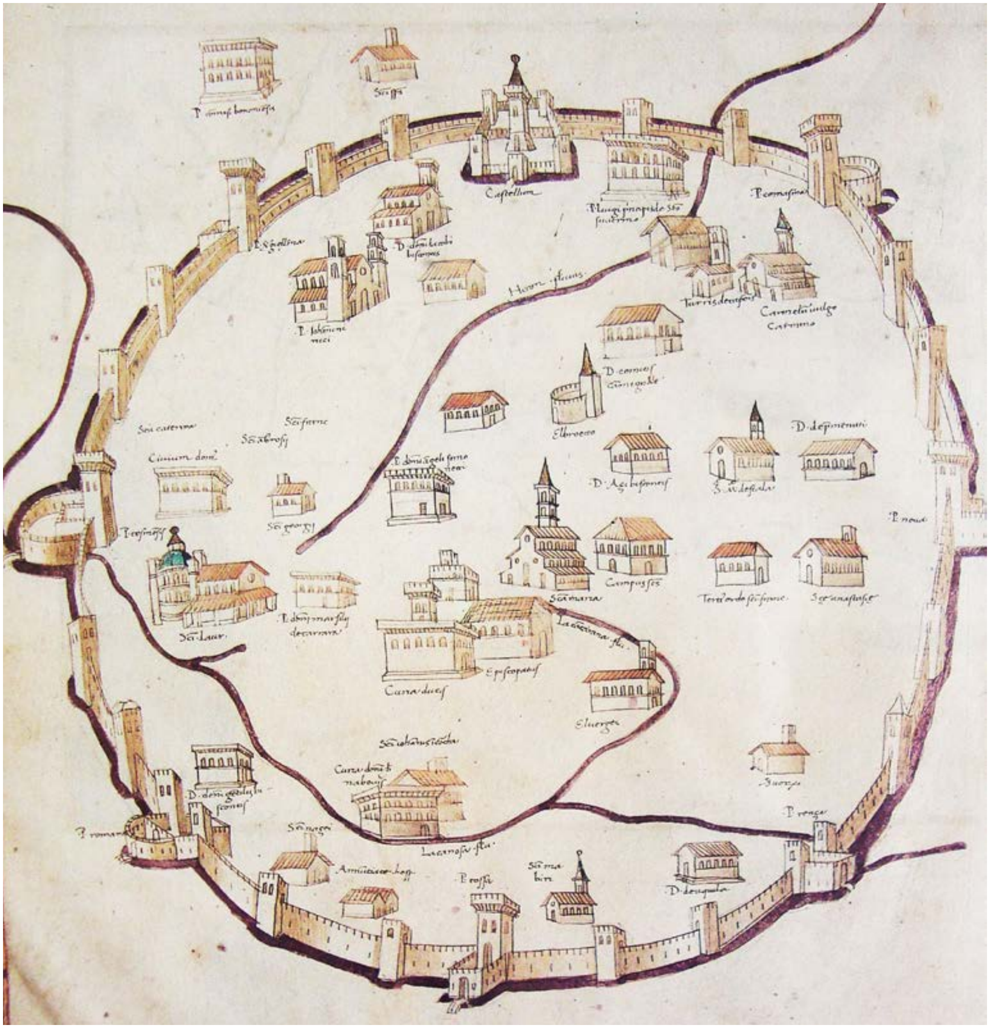


Figure 3: Map of milan by Pietro del massaio (1475)

Figure 4: 1590, Anonymous Sketch, View of the Palazzo della Ragione and the surrounding buildings of the Piazza dei Mercanti

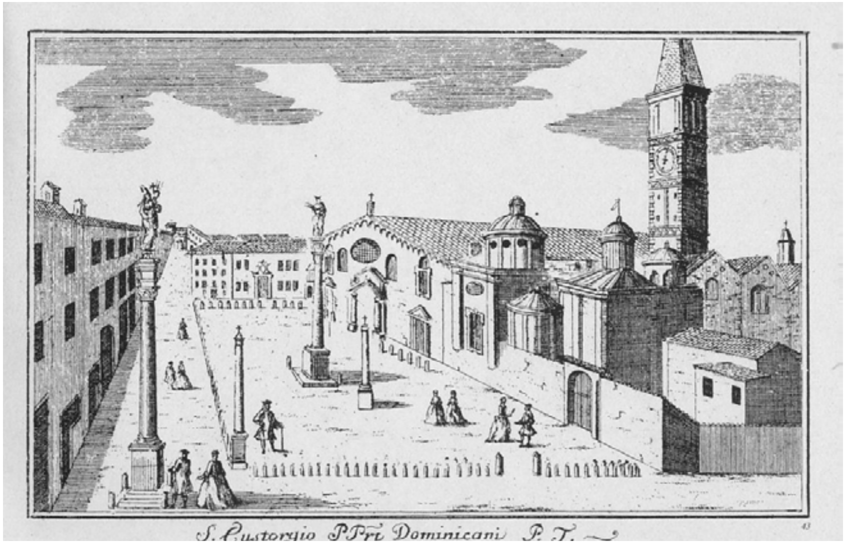


Figure 5: 1743, From the King Marc'Antonio Basilica of S. Eustorgio, Piazza S. Eustorgio

Figure 6: The arch of Porta Romana, 1800, Anonymous artist

PRE-WORLD WAR

During the 3 centuries of foreign Domination and the Spanish flu, it marked the expansion of Milan city with prominent expansion happening in places like Porta Ticinese. This further structured the city and lead to the formation of the 3 rings of the city.

March 1861, marking the birth of the kingdom of Italy. Milan became the economic center of the country, further pushing the need for development. The construction industry skyrocketed leading to many prominent structures, which by the start of the 20th century had been moved towards the Nove Cento style going hand in hand with the new futuristic and modernism that was born in northern Europe. During this period of development, new groups of architects can forward to work with the recently discovered Bauhaus and modern styles, eventually adapting and creating their style known as Italian modernism. Which worked with the principles of modernism with a huge influence from the context.

Before these the understanding of heritage as an asset had already been established which made space for the extension and transformation projects and hence making a culture of continuity and value addition.

Figure 7: 19th century photo of "Corso Vittoria Emanulle 2"

Figure 8: Piano plan of Milan with indication of the executive regulatory plans, 1884, Beruto Cesare

POST-WORLD WAR

Milan was a pioneering city during the course of the early 20th century, with the establishment of the first power plant in Europe in 1883, followed by the expo hosted in Parco Sempione in 1906.
But this progress stopped during the phase of world wars, which lead to heavy damage to the city. Entire neighborhoods were destroyed leading to an urgent need to reconstruct the certain area. This reconstruction provided an opportunity to integrate modernism into a heritage city. This period of architecture truly set the tone for future projects to come.
Restoration and transformation became a topic of discussion to preserve the heritage for future generations. Projects such as the Pirelli Tower and the Torre Velasca crowned the skyline of Milan, and the modernist movement was on a rise. The city underwent another expansion leading to the development of various new neighborhoods to accommodate the new influx of people. This largely shaped the urban model of the city as we can see it today.
The different rings of the city were decided and formulated. on an urban level, as Milan grew so did its need for connectivity.
Some of the most prominent preservation projects are “ ca granda” by Liliana Grassi and “the Umanitaria” Giovanni Romano. Also during this period, buildings of value for modern heritage were developed.

Figure 9: Photo of Galleria vittoria emanulle 1 after the bombardment

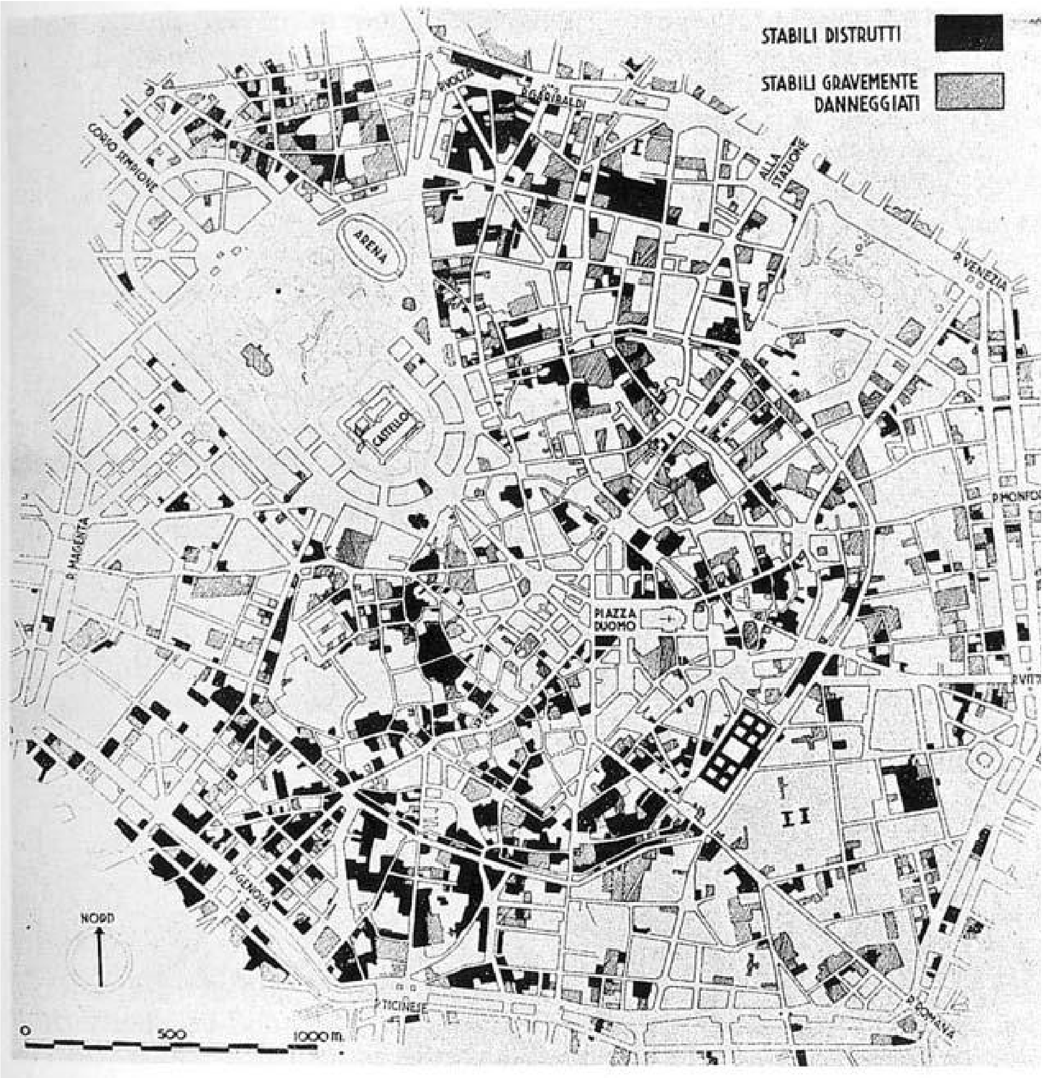


Figure 10: Map of Milan signifying the destruction in world war

Figure 11: Damage of the Basilica of Sant'Ambrogio

Figure 12: The Church of Santa Maria delle Grazie after the August 1943 bombings

Figure 13: Ca' Granda after the August 1943 bombings

CONTEMPORARY CITY

The contemporary city can be desricbed as a sensible mix of styles which seem to have merged together with a very sensitive aproach, eeading towards city building and largely focusing on common space creation.
The materials and styles of construction through out the era are traceable due to the conscious approach of preservation and transformation. The new intervention being highly readbale with the a prominent time stamp of the intervention in terms of materials and construction technology dicatted by the time of that intervention.
Also various neighbourhoods have developed there own unique characters with a story attached to each of these neighbourhoods, which increases the complexity of the space as well as adds a humane layer to the entire space.

Figure 14: Fondazione Prada, OMA

Figure 15: zonal plan of milan

Figure 16: Bocconi building by Grafton Architects

Figure 17: Bocconi building by SANAA

Figure 18: Bosco verticale, Isola District

UNIMI: Vetenaria Block

The project has been developed in the vetenaria Block of UNIMI campus. Aiming at transformation of the campus which has been previously used as a veterniary faculty, it is transformed to be used as a historical cultural centre for UNIMI.
The builiding complex provides a unique opportunity to be developed due to it's fine architectural character , important historical value and the urban location of the campus.
The composition of the campus itself has been of prime importance, to understand the composition of open spaces with regard to the built masses.

Figure 19: Aerial view of the citta studi , early 20th century

HISTORY

The campus was conceived as the headquarters of the Veterinary Faculty built in the 1920s. The seat of the faculty was developed with the overall planning of the Città Degli Studi di Milano complex already developed with the Milan Masera Pavia Town Plan of 1912
The complex, with entrance at via Celoria, is made up of several buildings and is organized around a beautiful tree-lined garden. The architectural features of the buildings in question are strongly inspired by that eclectic Liberty, which is rich in various stylistic references, which also looked at the rural architecture of northern Europe and which determined the use of housing typologies similar to those of "cottages" or "chalets" on the one hand, but on the other hand, it also led to a rich series of hotel typologies or important equestrian centers such as those designed in the same period by Eng. Paolo Vietti Violi (Monza racecourse, or the stables of the Milan racecourse).
The campus is designed with careful consideration of open and solid spaces, both working in harmony to organize a picturesque heritage that has undergone various interventions, compatible or incompatible. The campus is also developed in a symmetrical layout, also in a very close imitation of the campus adjacent to it. During the course of the late 20th century, there was a development of new structures in contemporary style which also serve as the language reference for our present project.

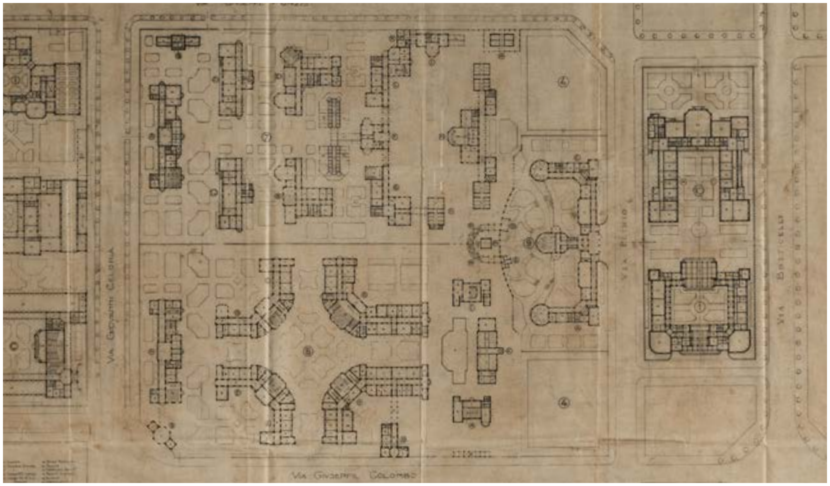


Figure 20: Intial planning of Citta Studi area , UNIMI Archive Map

Figure 21: View of Piazza leonardo da vinci

Figure 22: View of entrance Agraria block

URBAN ANALYSIS

Figure 23: Figure Ground Diagram

- Urban Mass
- Urban Spaces
- Project Area

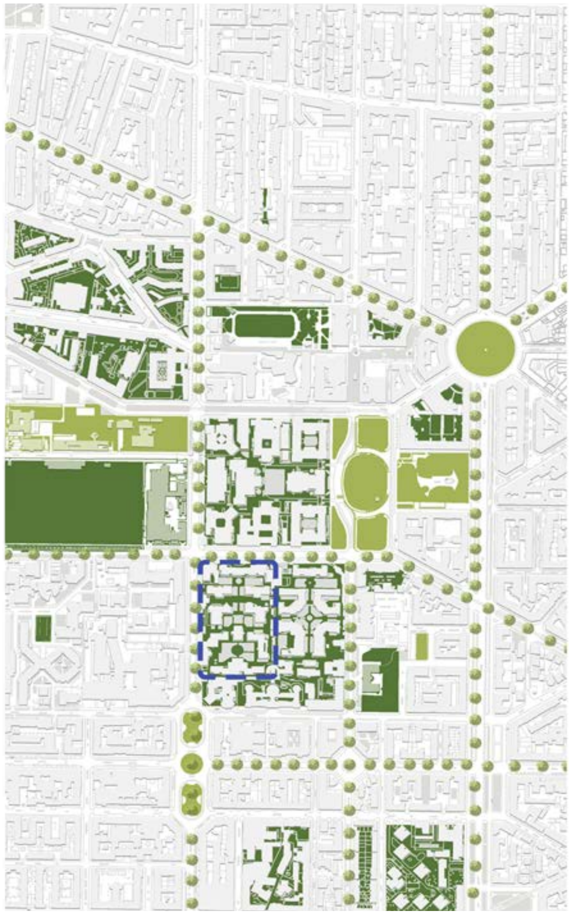


Figure 24: Public Private Diagram

- Private Areas
- Public Areas
- Tress
- Project Area

Figure 25: Timeline of Construction Diagram

- Constructed After 2000
- Constructed After 1972
- Constructed After 1965
- Constructed After 1956
- Constructed After 1930

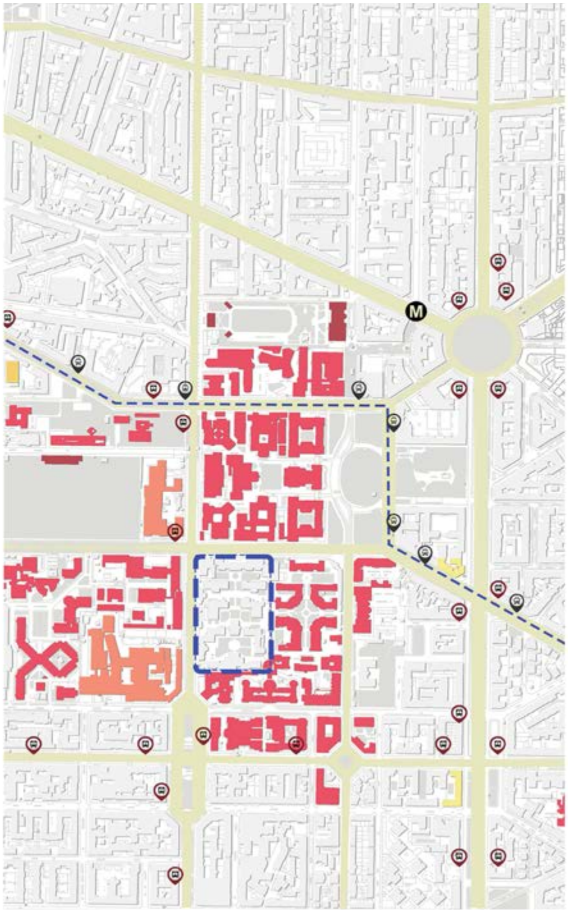


Figure 26: Building Typology Diagram

- Sports Complex
- University Buldings
- Medical Complex
- Residences
- Main Roads
- Bus Stops
- Tram Stops

SITE ANALYSIS

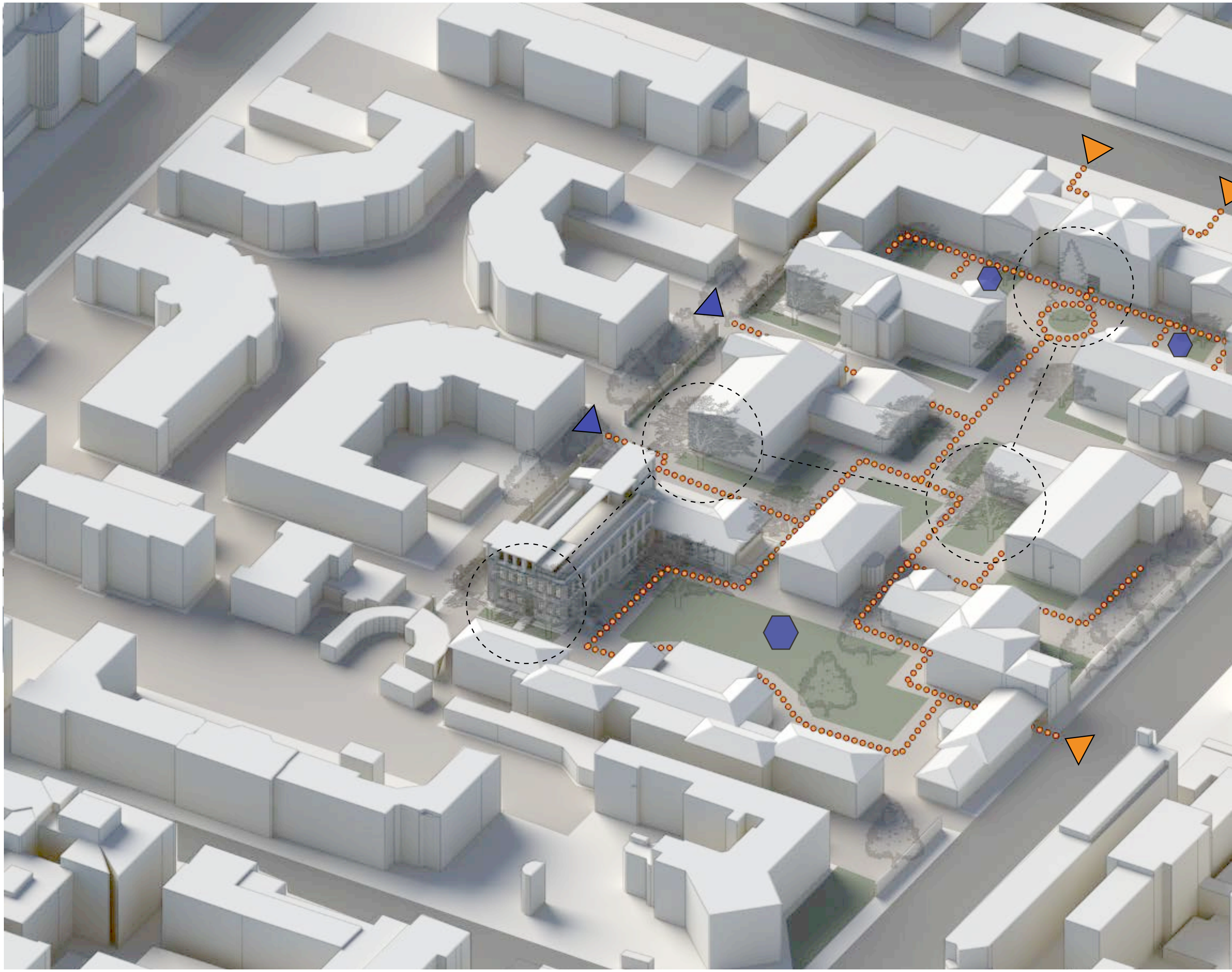
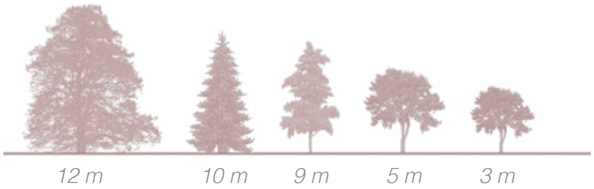


Figure 27: Pedestrian Analysis Diagram

PEDESTRIAN ANALYSIS



Vegetation Hotspots

The very initial conception of the campus plan indicates a strong movement of pedestrians throughout the campus, which was later hampered by the modification of service lanes. The primary pedestrian entrance being from via Celoria 10, through the main building. Leading to a central passage through the symmetrical campus. which is further divided into passages by the placement of the central building which breaks the central placement of the central open space and creates 2 nodes, one in front and one to the rear.

LEGEND

- Pedestrian Paths
- Pedestrian Entrance
- Adjacent Campus entrance
- Seating Space

SITE ANALYSIS

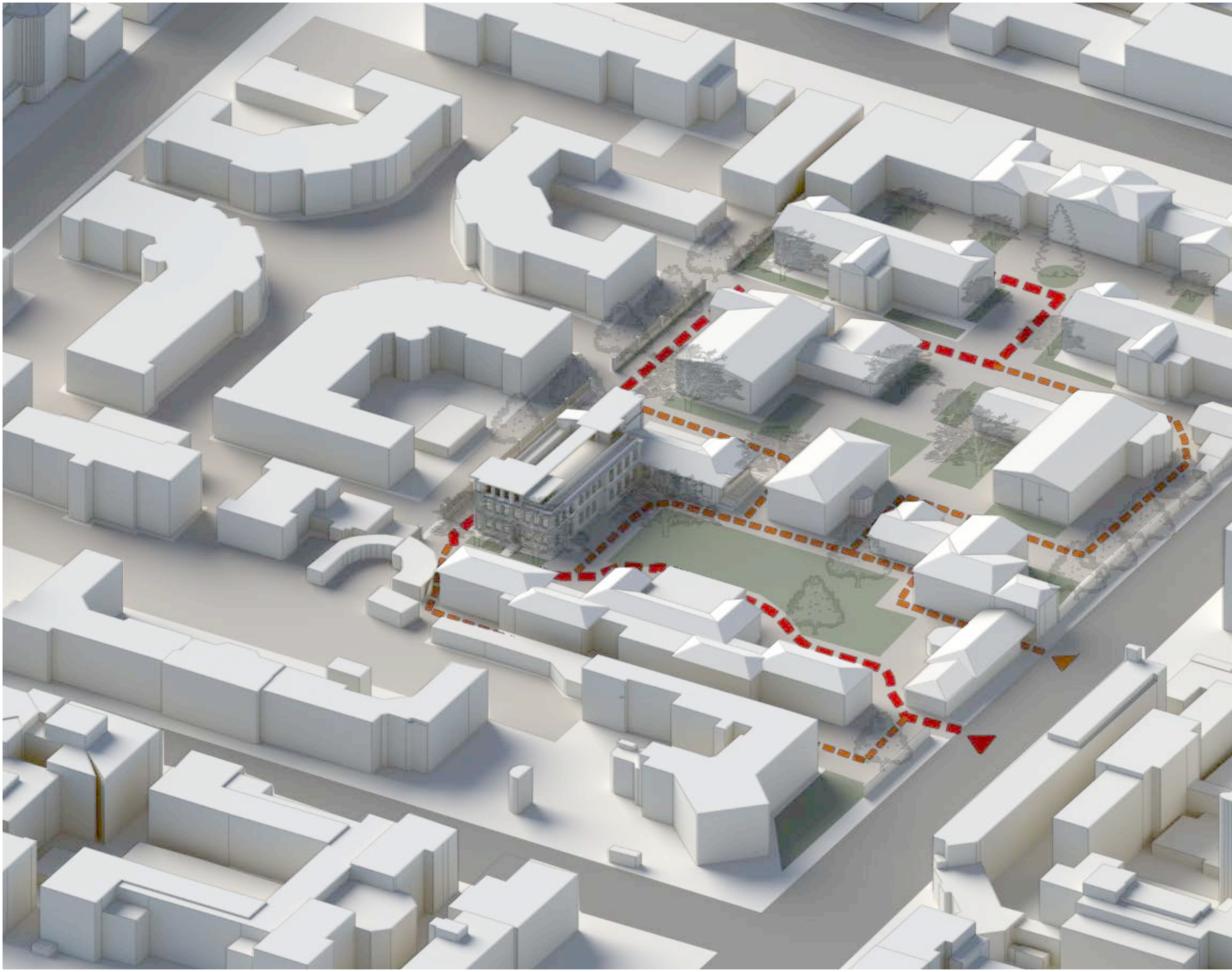
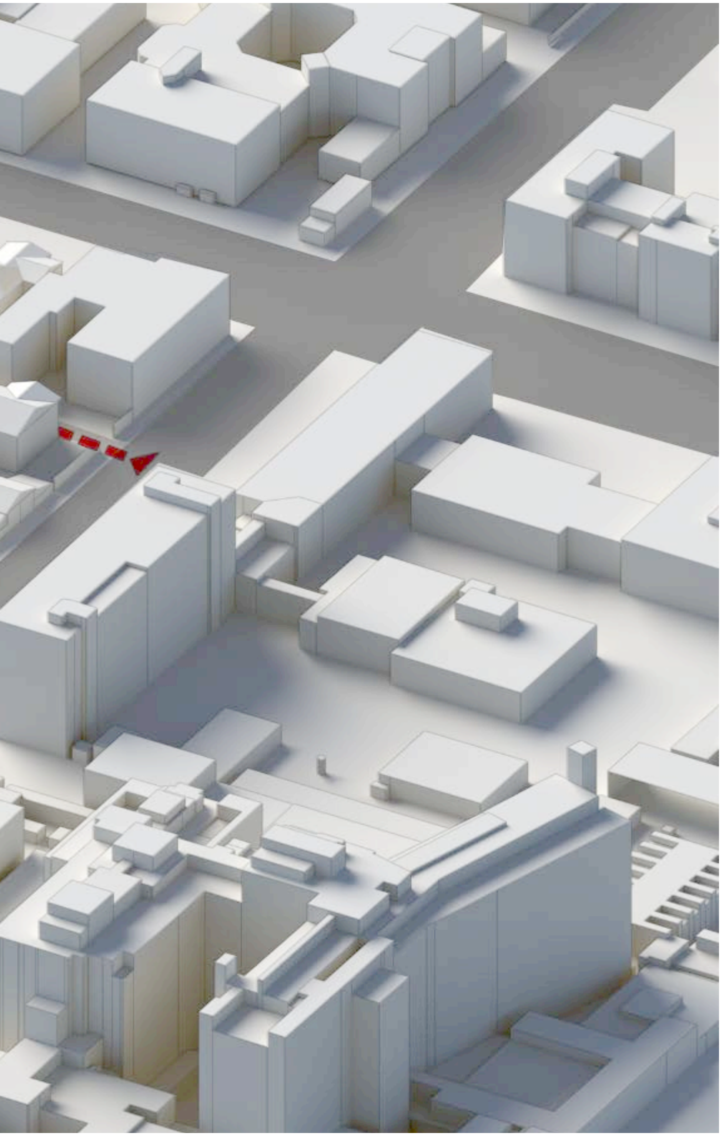
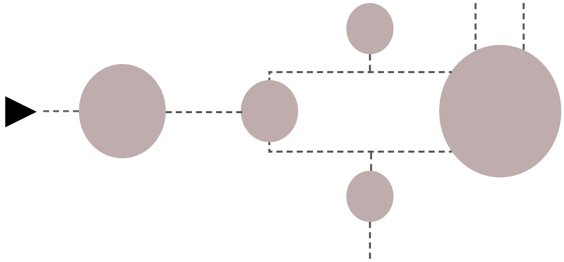


Figure 28: Vehicular Analysis Diagram



VEHICULAR ANALYSIS



Alignment Of Open spaces

Studying the Archived Plans for the campus we understand the initial intent to create a service lane for vehicular movement. Since the function of the campus transformed the need and use of vehicular movement can be seen more prominently leading to a shift from a pedestrian-friendly campus to a vehicular-friendly campus. This analysis explores the newly formed vehicular movement ways. due to the need for vehicular access to certain parts of the buildings, these new movements are established A hierarchy is needed to Transform the campus back into its original pedestrain friendly state.

Legend:

Service & Formal Vehicular Route

Adapted Vehicular Route

P *Parking Spots*

INTERPRETATION AND CHALLENGES

The site is developed as a part of the cluster of the UNIMI campus. it is broadly divided into three blocks veterinarian, Agraria, and administrative block. Each of these blocks has a unique orientation of open spaces and building shapes.

despite being unique in their orientation they co-relate to each other via routes that connect them internally. the major challenge is to integrate the functioning of the blocks.

The Agraria block works in the principle of serial vision due to the avenue that goes through the

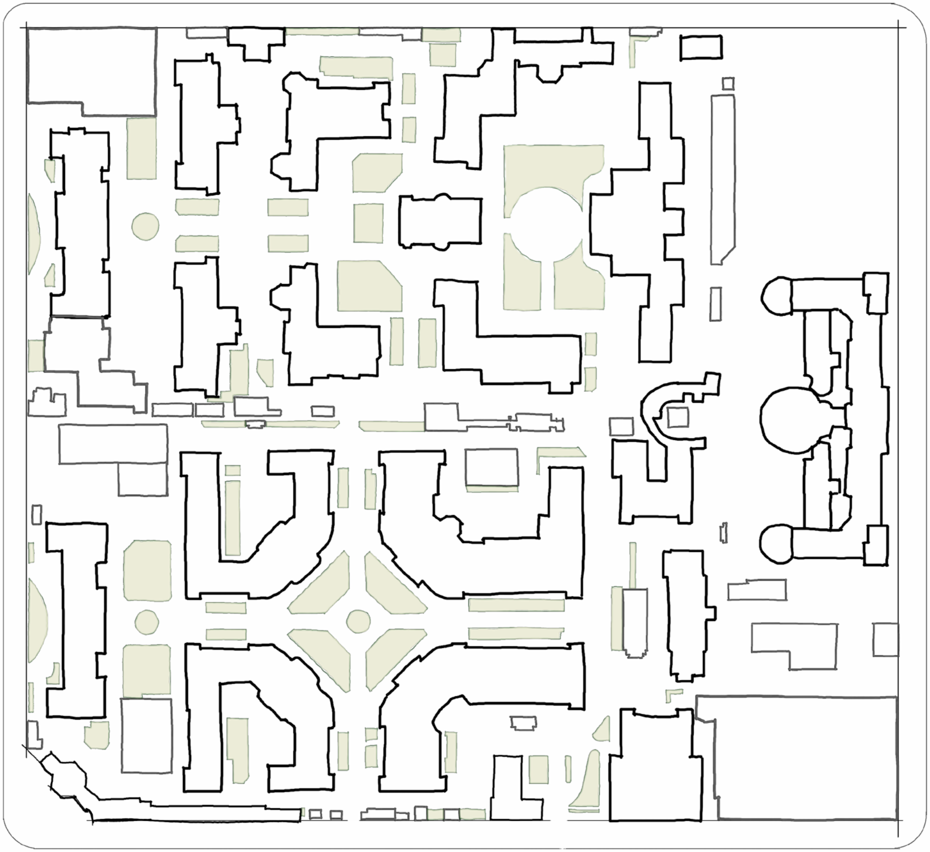


Figure 29: Layout of Green spaces

center of the entire block, whereas the veterinary block has a combination of serial vision and a nodal open space.
The originally built masses are aligned symmetrically to both sides of the central axis, very similar in the architectural character as well as the shape of the built mass.
Challenges :

1. Symmterical nature of the block.

2. Creating a new identity and a high note in the block.

3. Integrating the overall campus.

4. Identifying and removing the extra built masses which are irrelevant to the new function.

5. Restoring the pedestrian spaces by creating a clear hierarchy between pedestrian and vehicular movement.

6. Achieveing sustainability of built environment.

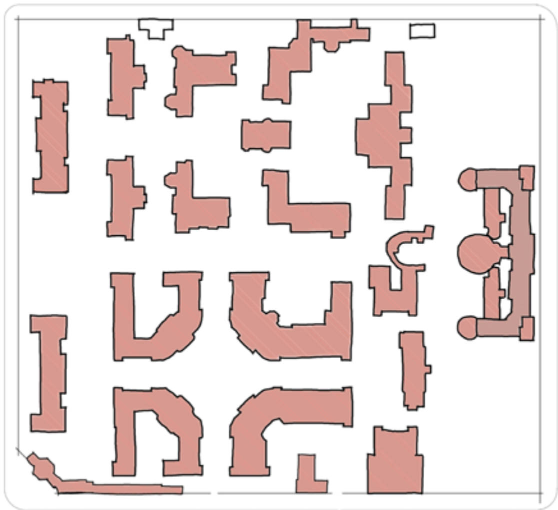


Figure 30: Orginal built mass

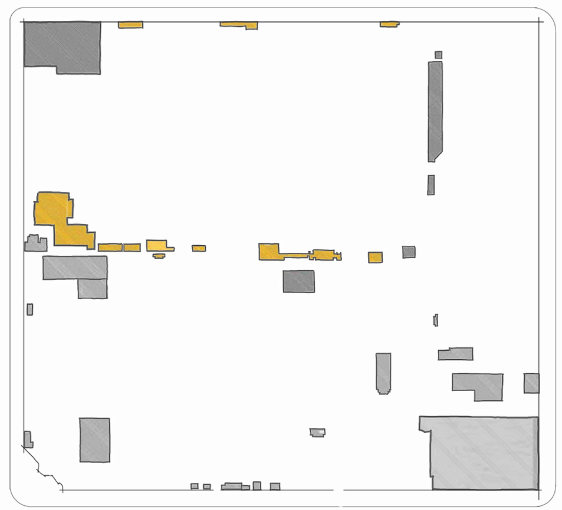


Figure 31: Additional built mass

Historical Building

The intervention in the campus has been planned in three different buildings, namely:

- A new library in the building ED22010,and a new entrance block adjacent to it.
- A new aula in a new intergrated volume with ED22090.
- Creation of apice and new exhibition area/ museum in ED22080 using a extended roof

The objective of this thesis is to transform the building 22080. To study and intergrate the new functions into the historically established building that has evolved overtime. containing namely all the promenient features of the campus both in terms or architecture and typology.

Figure 32: North western view of Building ED22080

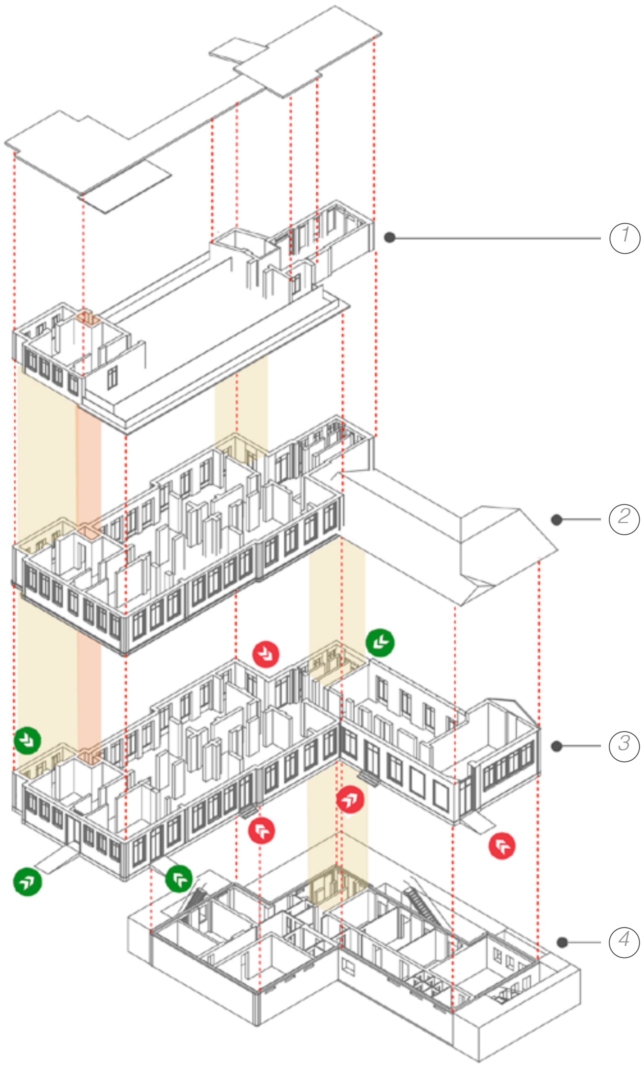


Figure 33: Exploded Axonometric for State of Art

These buildings were subjected to the protection of law 42 of 22 January 2004, on 19 August 2011 with a specific decree of the Regional Directorate for Cultural and Landscape Heritage of Lombardy.

The complex, with entrance at Via Celoria, is made up of several buildings and is organized around a beautiful tree-lined garden that still bears traces of the original design probably due to the handling of the animals that found shelter in the same faculty.

1 *The second floor consists of later added steel cabins for animals under medical care and observation and other ancillary facilities.*

2 *The first floor consists of mainly office and laboratory with a later added offices under the sloping roof*

3 *The Ground floor consists of office labs, a classroom, and the administration area for the facility*

4 *The basement floor consists of a bar, cafeteria , offices, storage, and area for the building services*

Considering and studying the archived documents for the complex and considering the techniques of the early 1900s, the structural type is mainly load-bearing with, load-bearing masonry walls done in brick with a vaulted roof at the basement level and mixed structural floors -i.e- Latero cement floors.
The sloping roofs are developed using a scissor truss done in wood and supported by heavy load-bearing masonry walls. They are covered using Marseilles tiles.
The aesthetic elements for the decorative elements of the facade are concrete pilasters with the window molding developed in an artificial cement stone reinforced using steel bars
In the later interventions, there is an addition of concrete structures for service functions and concrete and steel machinery and staircases, to acquire equip the complex with the ever-evolving functional needs.

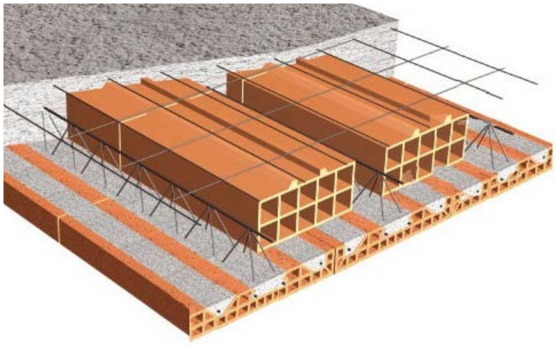


Figure 34: Latero cemento

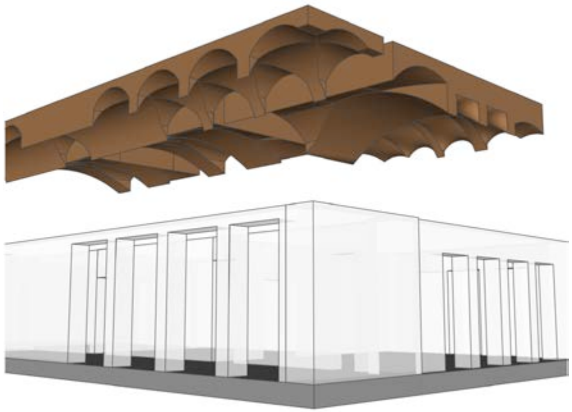
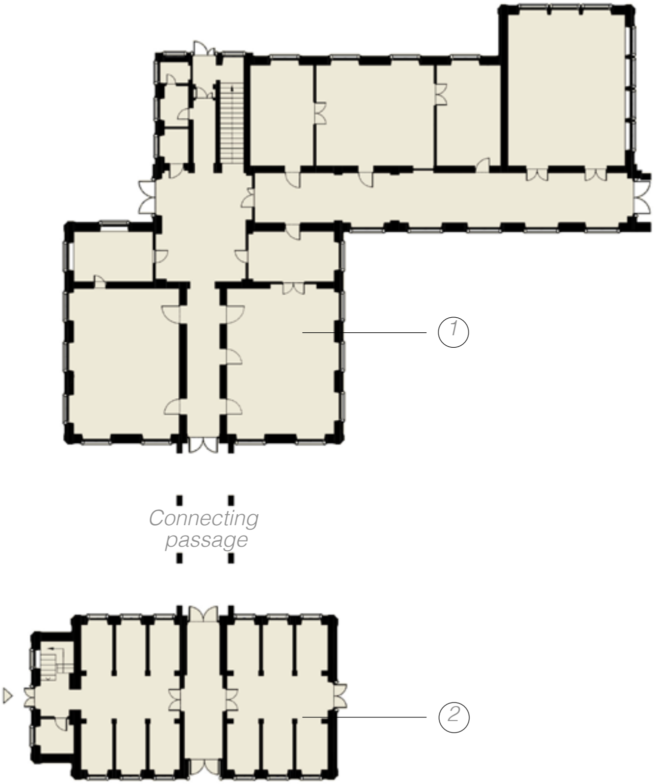


Figure 35: Basement Vaulting system

Figure 36: Intial building Massing

STATE OF BUILT- 1910



The 1910 plan for the building describes the configuration of the building as two separate blocks. One is the main block of the veterinarian with the sloping roof wing protruding out of it, whereas the other is the smaller animal clinic both connected with a colonnade passage right in the middle of the geometry. Designed as a Monza style house.

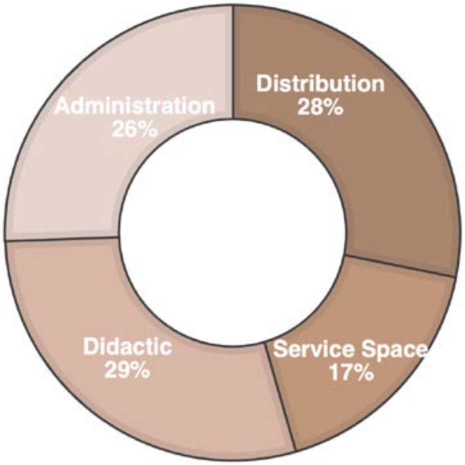


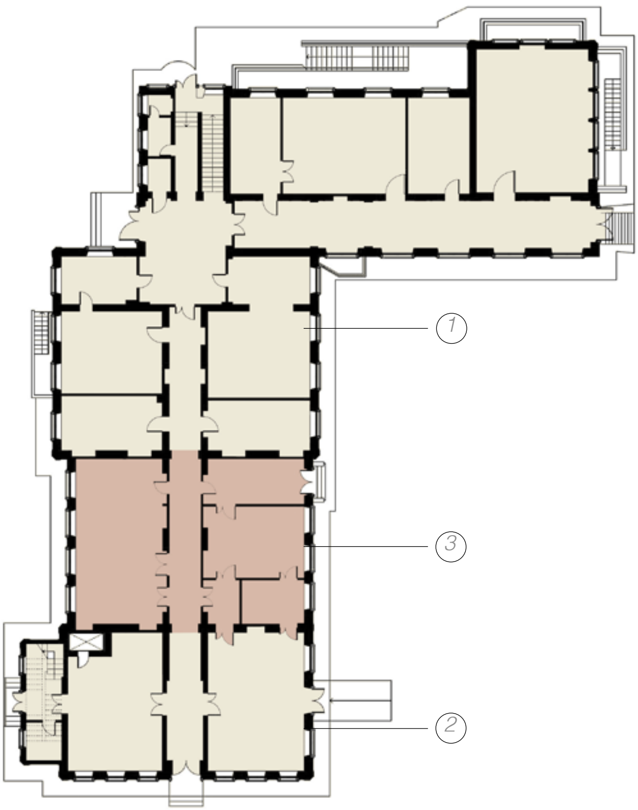
Figure 37: Functional distribution diagram 1910

① *Block '1':*
Consisted of medical rooms, examination rooms, lecture hall and the vertical circulation connecting the basement and first floor

② *Block '2':*
Consists of animal stables mostly catering to big animals, with a entrance vestible which is divided into two spaces.

Figure 38: Building addition, 1958

STATE OF BUILT- 1958



1 *Block '1':*
Transformed to offices, examination rooms, lecture hall and the vertical circulation connecting to the basement , first floor and second floor

2 *Block '2':*
Transformed to medical rooms with addition of new staircase and elevator to reach on roof animal rooms.

3 *Block '3':*
Consists of the new fromal entrance with waiting and reception, and new labs.

The 1958 additions complete the building as we see it today leading to a unified geometry of the two blocks creating the state of the art of the building. This intervention also changes the materiality and the construction technology of the building in the central addition The change in the Net area of the building is one outcome as well as the change in the connections of the old and new.

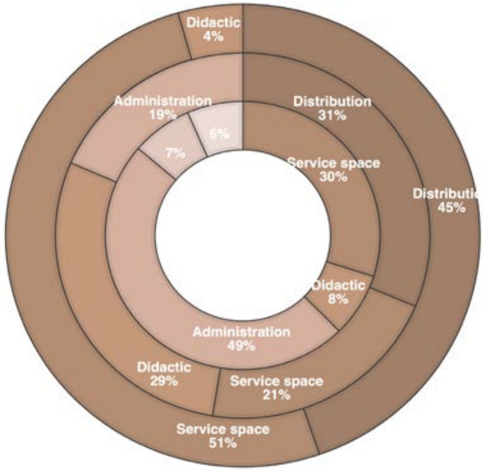


Figure 39: Functional distribution diagram 1958

FACADE STUDY

Originally the building was designed in Monza cottage style, with prominent elements like corner moldings and concrete cast window moldings. Most of the molding elements are constructed in concrete with a layer of reinforcement.

The facade is covered with a layer of crimson-red graphito plaster. with a yellow frame detail around the windows and the facade divisions. These elements define the architectural language of the building.

Figure 40: Corner moldings on the existing building

Figure 41: Window moldings on the existing building

The aesthetic quality of the facade is degraded due to the continuous interventions on the building, these interventions are minor repair works as well as the installation of new HVAC systems which are reflected on the facade.

The interventions are not completely compatible with the building, and in the long run, create compatibility issues.
This creates an opportunity to rehabilitate the facade and restore the existing facade to its former state.

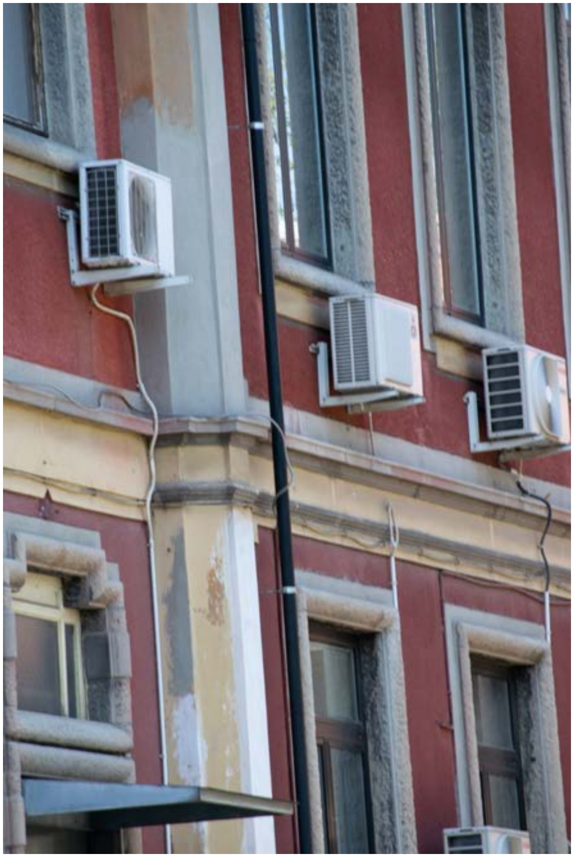


Figure 42: Added elements to the eastern elevation

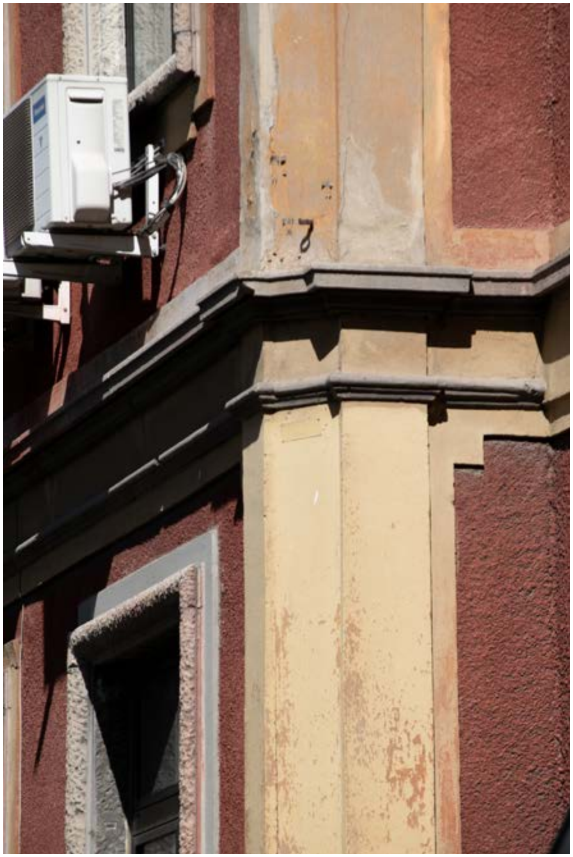
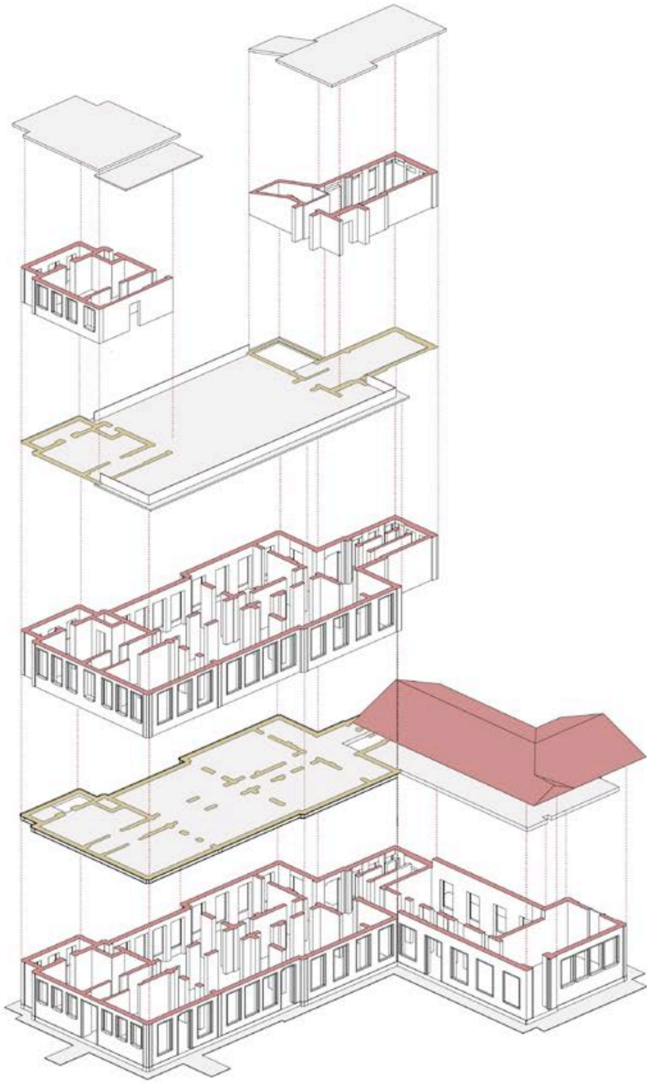


Figure 43: Added elements to the Western elevation

STRUCTURAL STUDY



The original structure is mostly supported by load-bearing walls. The main load-bearing walls are 54mm thick on the exterior and 43 mm thick on the interior.

Other internal walls are 25 and 15 mm thick as per the complete masonry sizes and the floor is Latero Cemento above ground and a vaulted roof over the basement is done more traditionally.

The building is composed of smaller rectangular boxes with the edges being the load-bearing walls, the free span being not more than 6m on the lateral axis and 15 m on the longitudinal axis which is further supported by thinner walls within.

The load-bearing walls is not continuous but rather broken into segments, due to the windows which have a thinner section of wall beneath them.

Since the structure was developed in two different timelines there is a mix of construction technology, which requires further study and intrusive testing to completely understand the routes of load transfer as well as the vulnerabilities of the structure.

Figure 44: Existing structural distribution diagram

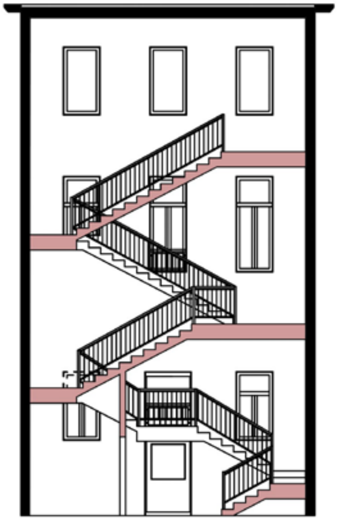


Figure 45: State of the art Cross-Section 2

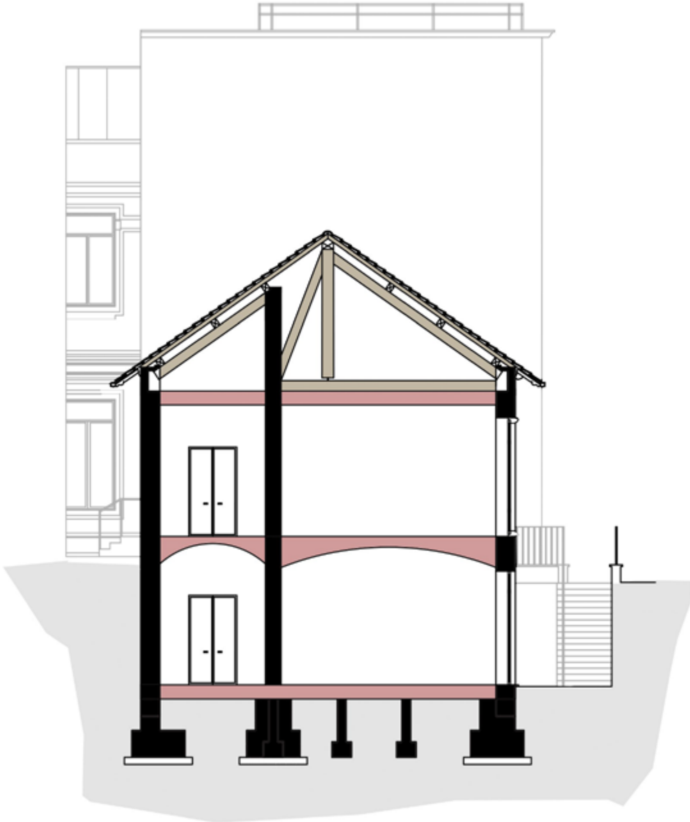


Figure 46: State of the art Cross-Section-1

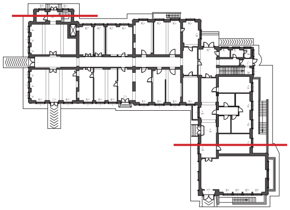


Figure 47: Reference key plan

PART SECTION:

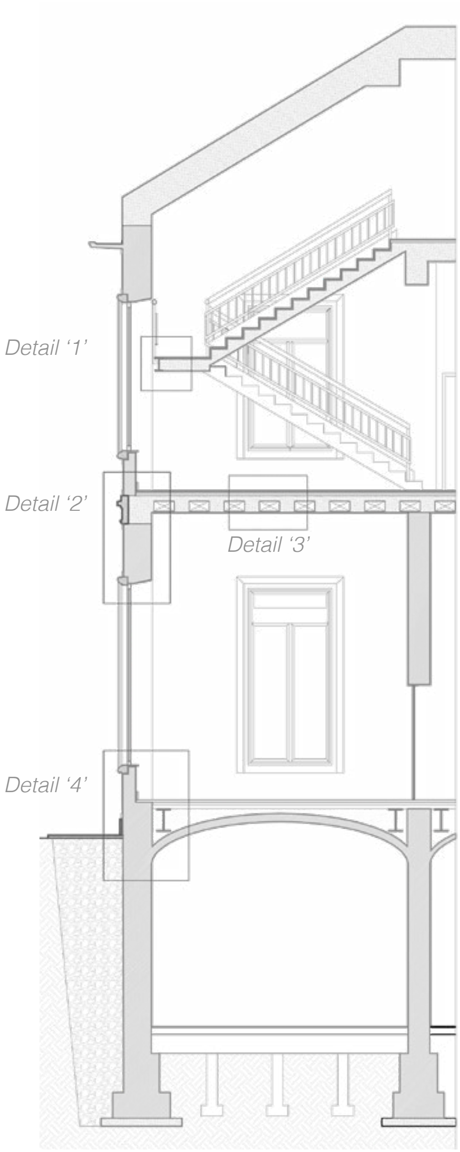


Figure 48: Part section-1

From the archived documents of UNIMI, there is an understanding of the constructional composition of the existing structure.

The initial structure has been done in masonry walls and the later additions are done in more modern techniques like Latero Cemento for the slab and the use of steel-based elements for the construction of the staircase and the roof addition.

The connections are of prime importance and depict the construction style of its time.

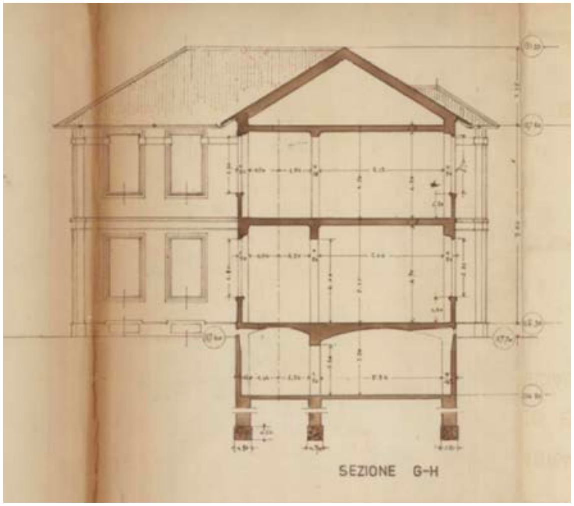
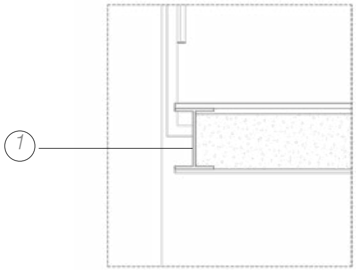
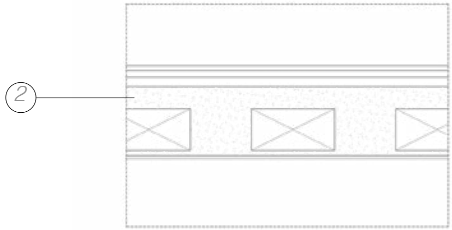


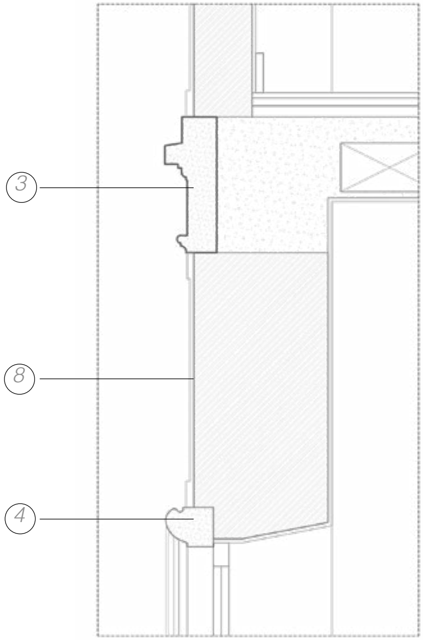
Figure 45: Reference section for Agraria block main building



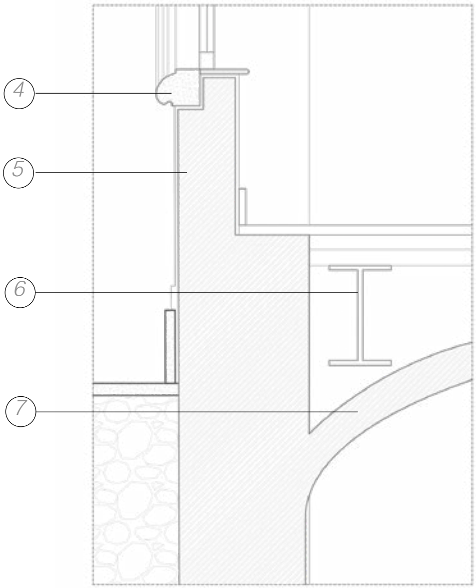
Detail '1'



Detail '2'



Detail '3'



Detail '4'

Legend:

1. Steel beam for Staircase
2. Latero Cemento slab
3. Facade molding
4. Window moldings
5. 24 Thk Masonry wall
6. cast iron girder
7. brick vault
8. 54 thk Masonry wall

REFERENCE

THE GLASS CHURCH

KUNSTHAUS BREGENZ

DUO SUITES

SEDE DEGLI UFFICI DELLA FINANZIARIA

PALAZZO MONDADORI

THE GLASS CHURCH

Via Conciliazione, 22, Baranzate, Milano
Angello mangiarotti, Bruno Morasutti,
Aldo Favini , 1958 *(Original Construction)*
SBG Architetti , 2014 *(Restoration)*

Originally designed in 1958, the church is an outstanding example of structural engineering and holistic design, with its pioneering use of pre-fabricated / pre-stressed systems with glass and steel.
It is one of the first industrialized buildings in post war era. it went out of use due to unacceptable thermal conditions.
This was later fixed with the restoration project developed by SBG Architectti in 2014. This involved restoration of the external walls with the services with the structure remaining the same.

Figure 48: Interior view 'The glass church' Baranzate

ORIGINAL PROJECT

The Project is one of the prime examples of prefabricated buildings in Italy. Originally constructed in 1958, under the supervision of architects Angelo Mangiarotti and Bruno Morassutti, with the structural design by Aldo Favini.

The church is an outstanding example of outstanding integration of structural design and architectural design. The structural simplicity of the building is an outcome of a complex integration of structural understanding and space creation.

The structure is composed of four columns resting on the base which support two main beams spanning 5.25 m with an overhang of 3.05 m. Six secondary beams rest over the two main beams which span 16.80 m with an overhang of 5.90 m, these beams compose of prefabricated components and are stressed on site.

The facade is purely constructed out of glass panels with polystyrene contained inside them. This particular facade system brings in a diffused light during the daytime and at night the entire building serves as a dimly light lamp as diffused light escapes from the translucent facade.

The facade system was susceptible to internal cracking and damage, due to the material properties of the polystyrene integrated with the glass. Apart from this, the building became absolute due to the unfulfilled energy requirements. This led to the abandonment of the building. later on, a restoration project was undertaken to bring it back to its former glory and usability.

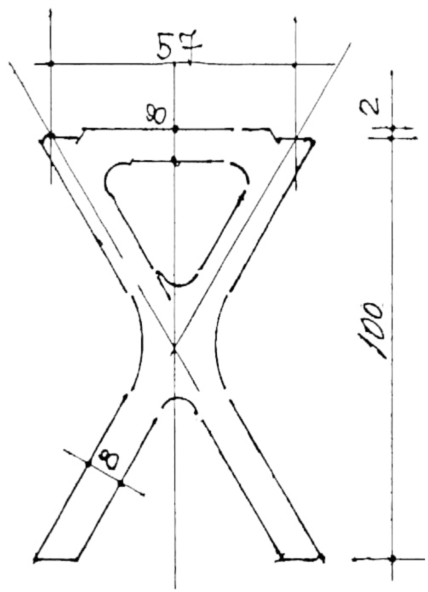


Figure 49: Sketch for the modular units for the secondary beams

Figure 50: Sideview of the structural project for the glass church

Figure 51: Front view of the structural system

RESTORATION PROJECT

As the building could not satisfy the energy and thermal requirements, also with the crumbling facade. it went unused and ignored until 2004. The restoration project for this modern heritage was undertaken by SGB Architect.
The main objective of the Project was to restore the building to its original from as it was when it opened in 1958, adapting it to modern requirements. The major interventions were on the facade, the flooring, and the service systems.
The first step of the restoration project was the conservation of the entire structure of the building. Also, certain spaces were transformed to support new functions but remained inside the constraints of the structure.
The second concern is the facade that was developed as the play of light. which was done through an intense study of the new glass material available which would provide the same effect as the original Facade. Also developing a curtain wall system that is inspired by the old facade with the integration of ventilation space.
The flooring of the Building was redone with similar tiles, developed especially for the project. The restoration project was finished in 2015. Finally reopening the building and making it functional again.

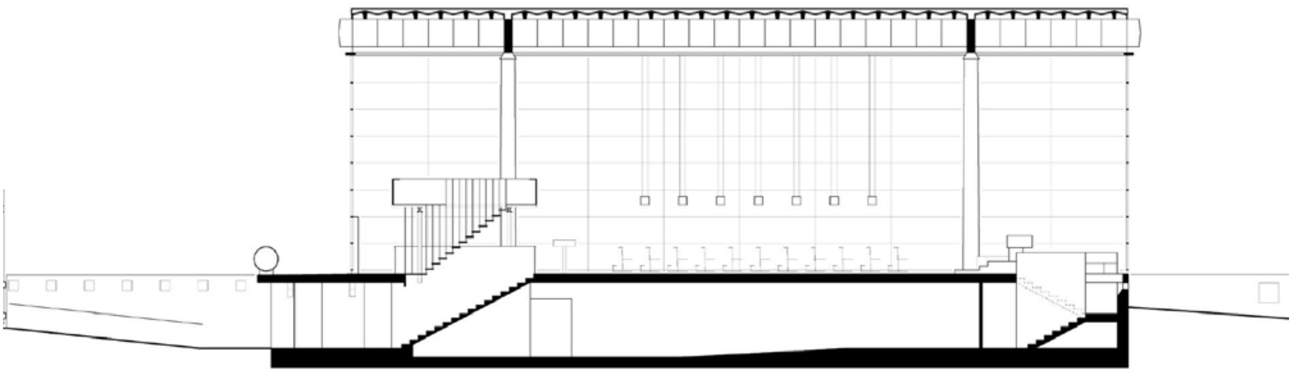


Figure 52: Longitudinal section. describing the arrangement of spaces (courtesy of SGB architectti

Figure 53: Interior view after restoration with the new facade and flooring tiles

Figure 54: Interior view from the alter towards the main entrance

Figure 55: Front facade image with the translucent glass material

The Initial approach to the restoration project is the conservation and restoration of modern heritage. This leaves a more technical time stamp, both respecting the originality of the initial structure and adding value to the existing in terms of usability and transformation.
The major work was to understand the history and the problems which lead to the absolution of the building and then work around these constraints to reach a minimal intervention for the maximum transformation effect. Hence retaining the identity of the building and yet making it workable.

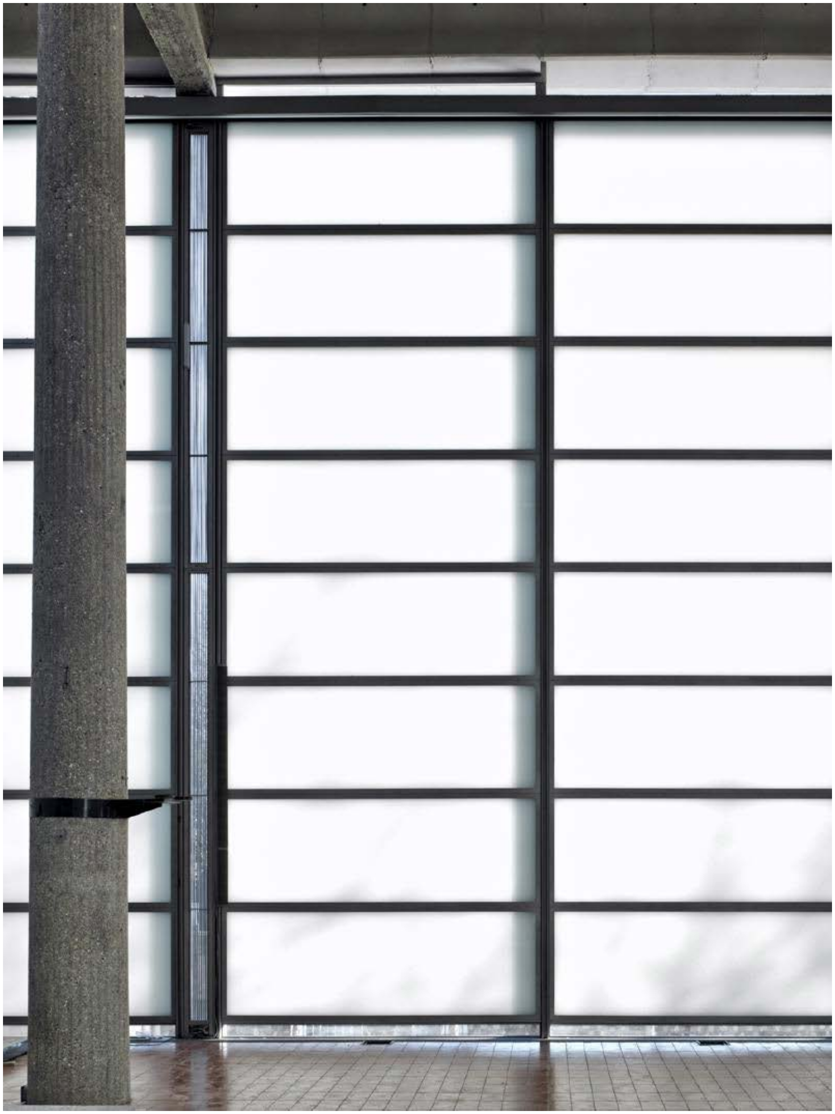


Figure 56: Interior view of the connection of the curtain wall with the primary beams, which gives an opportunity for the ventilation panels

Kunsthaus Bregenz

Karl-Tizian-Platz, Bregenz, Austria
Peter zumthor, 1997

Figure 57: 3d section for the Facade system

“The art museum stands in the light of Lake Constance. It is made of glass and steel and a cast concrete stone mass which endows the interior of the building with texture and spatial composition. From the outside, the building looks like a lamp. It absorbs the changing light of the sky, the haze of the lake, it reflects light and colour and gives an intimation of its inner life according to the angle of vision, the daylight and the weather.” - Peter Zumthor

Figure 58: Exterior view of Kunsthaus Bregenz

DESCRIPTION

Kunsthaus Bregenz has served as an exhibition space and an archive of art and architecture. The building is conceived in a minimalistic style, which is delivered with a very limited material palette -i.e- concrete structure with a frosted glass facade, giving it visual lightness despite being a complete concrete structure.

This glass exterior facade looks like the spacial design of the building without entering the space.

The facade also acts as a double skin and is an important part of the light guide. it is made of 712 panels of etched glass, each with a size of 1.72 x 2.93 m, which absorbs the changing daylight and filters it before it enters the interior space, providing diffused light into the interiors. the facade is self-supporting like a shell around the actual building. The structural construction of the shell is composed of steel structure. The 90 cm gap between the shell and interior facade allows for maintenance space and is equipped with spotlights that illuminate the Kunsthaus at night.
The building is designed as a daylight building, the light first falls on the exterior glass shingles

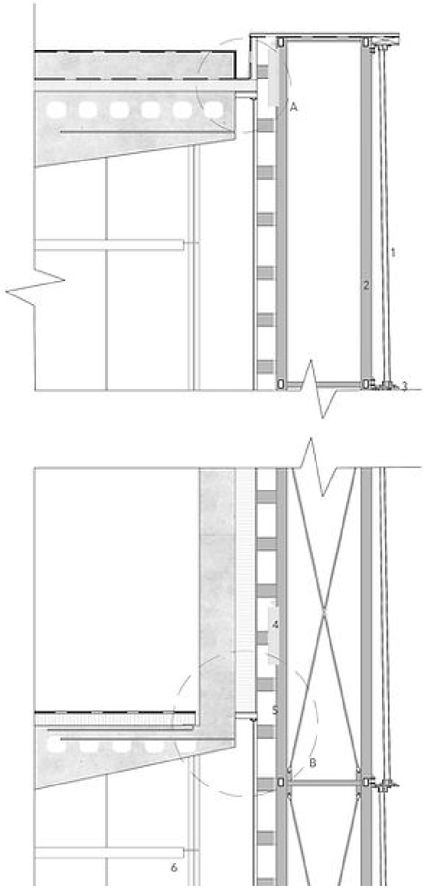


Figure 59: Sectional detail of the envelope

Figure 60: Section through the Facade and the Building

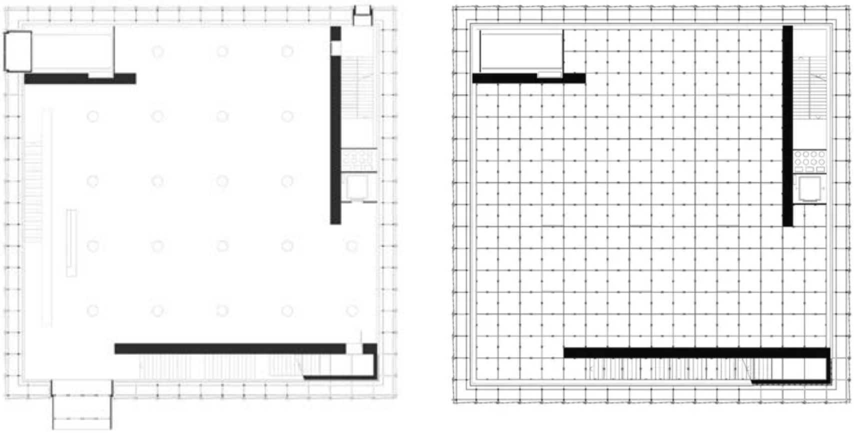


Figure 61: Ground floor and typical floor plan

which are further directed to the interiors via window bands finally leading the light to the ceiling that is further supplemented with the artificial lights still maintaining the natural feel of the light.
The interesting conception of the structure is possible due to the skeleton construction of the internal structure which is usually found in high-rise buildings. The interior walls are 72 cm thick. made of exposed concrete.
Considering the building from an urban context it stands light in a heritage area which leads to a very respectful intervention to the heritage around it. which visual effect with such a heavy intervention makes it a building of interest for our transformation project.

Figure 62: Physical Model For the light Diffusion system

Figure 63: Front view of building W.r.t to the heritage context

Figure 64: Rear view of building W.r.t to the context

Duo Suites, Residences

Limonluk, Hüseyin Okan Merzeci Blv,
Yenişehir/Mersin, Türkiye
Slash Architects, 2015

The name of the project, Duo-Suites is derived from the two masses of separate buildings joined with a single highly transparent circulation system. The building is situated on the southwest–northeast axis considering the maximum and optimum benefits of wind and sunlight on the site. The two blocks are slightly shifted from each other while being located on the site and these separate two masses create the delicate, high-rise effect of the building.

The project is designed considering the interior and exterior spatial usages of the local area. The exterior landscape is designed as if it was an interior courtyard, the necessities and daily life of inhabitants are considered while shaping the landscape.

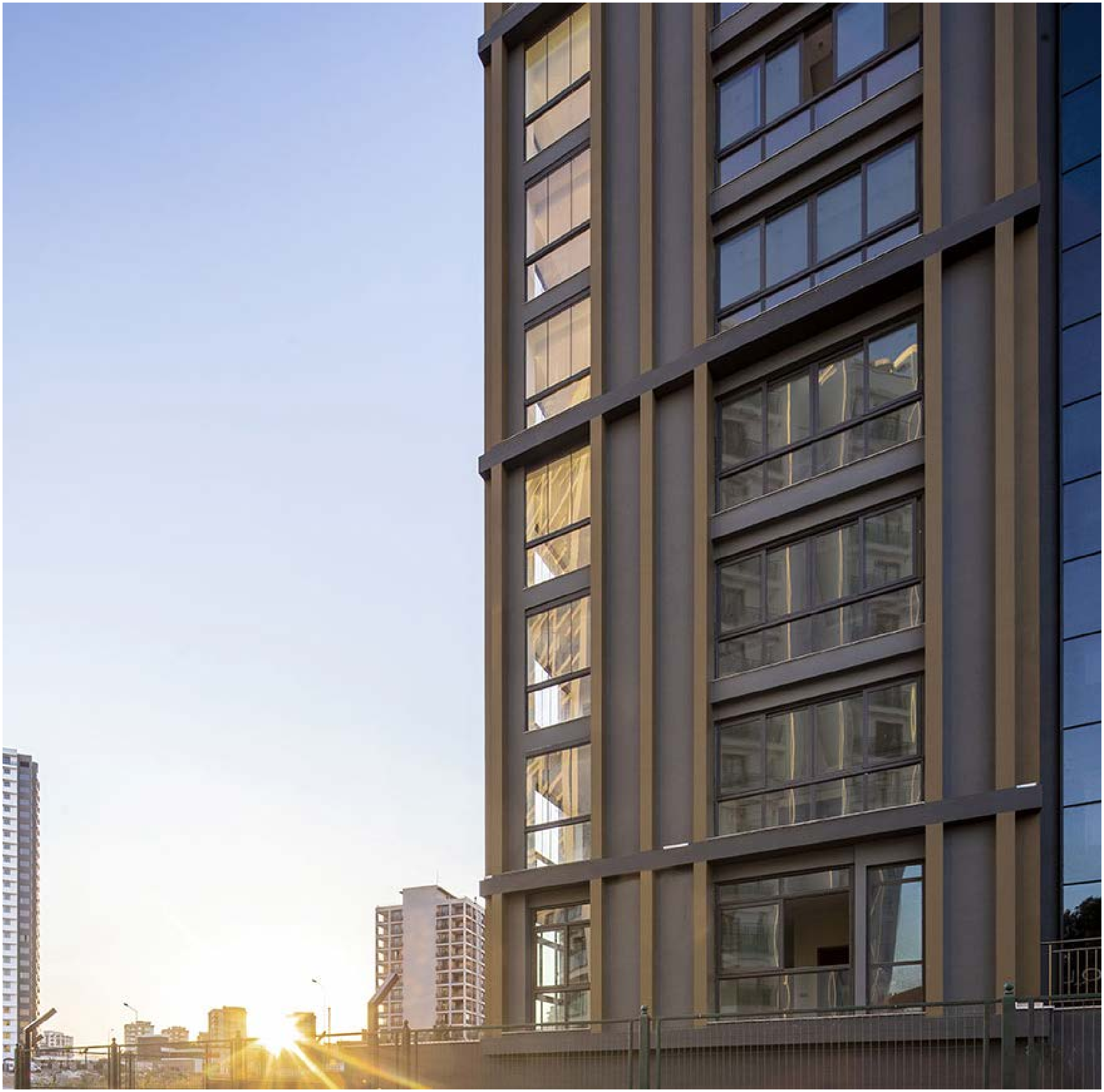


Figure 65: Evening View duo Suites

DESCRIPTION

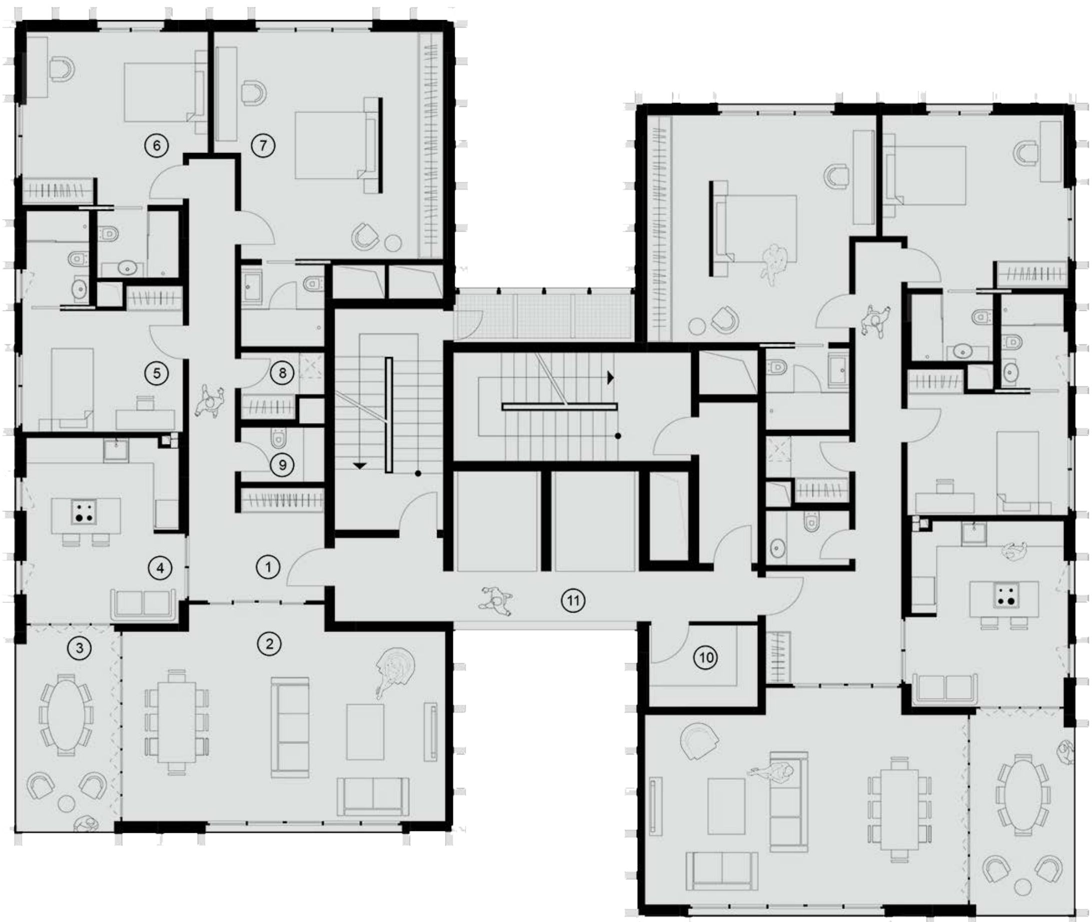
The two towers provide a good mix of structural presence on the facade, which is also used as an architectural element. This interesting use of the structure on the facade gives a unique aesthetic quality to the buildings.

The unique crown of the building provides a sense of verticality to the towers. The rhythm of the facade is uniquely designed and asymmetrical yet balanced.

The windows used as filler in between creates multiple layers of facade giving a sense of simplicity. This concept of structural revelation on the building also makes the building self-explanatory.

The main element of our concern is the crowning provided on top of the tower which completes and extend the towers to make them look more vertical and enclose the frame of the tower.

Figure 66: View of the Residential towers



Typical floor plan
I. Entrance
2. Living room
3. Balcony
4. Kitchen
5. Bedroom 1
6. Bedroom 2
7. Master bedroom
8. Storage
9. WC
10. Office
11 Hall way

Figure 67: Typical floor plan

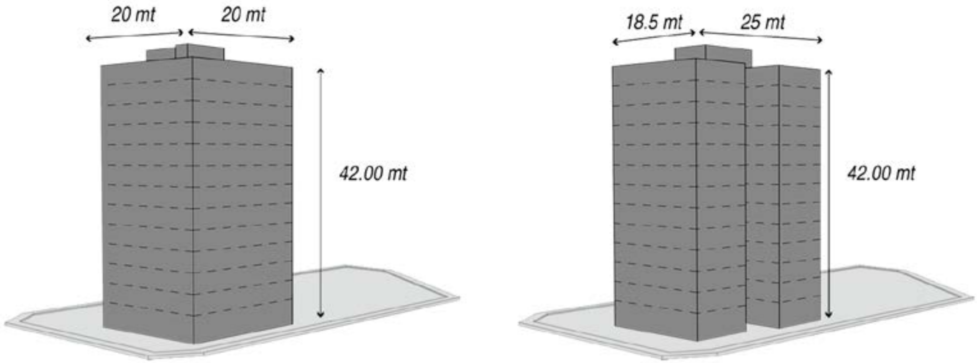
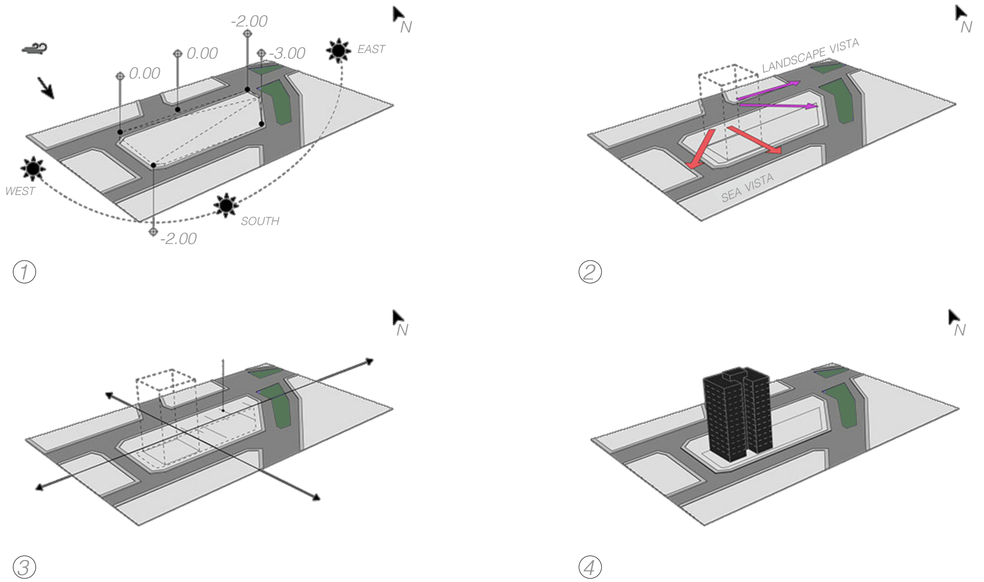


Figure 68: Building massing diagrams



Formation diagrams:

1. Ground levels
2. Views
3. Axis of design
4. Building mass

Figure 69: Design concept

Figure 70: view of elevation

SEDE DEGLI UFFICI DELLA FINANZIARIA

Piazzata bossi 2, Milano
Pietro Lingeri, 1958

The building is also a consequence of the urban scenario. The idea of the lower wings brings a sense of urban continuity to the urban structure also the wings align the streets to form a uniform urban space whereas the setback of the central eight-story volume provides a sense of importance and also creates a welcoming space in the area. the heights of the floor don't directly align with the neighboring buildings as they are relatively lower and fit on four floors whereas the older buildings fit on only three. This also raises a question of the continuity of the facade continuity which has been tried to maintain using a raised plinth for the ground floor.

Figure 71: view of building from Piazzatta Bossi

DESCRIPTION

This building generates the corner of the block, also defining Piazzetta Bossi as a place. With a partial step back of the building, it seems like a background of the road.

. The set out of the new building was done considering the enlargement of the intersection of the three roads by setting it back and formulating a building defined by a set of volumes that work together in harmony to define a single structure

Figure 72: Street map of Piazzata Bossi

Figure 73: Picture from Piazzatta Bossi prior to the construction of the building

Figure 74: view from north western corner

The initial idea was to conceive a building consisting of four different volumes which were working together, two of these volumes are four-story-high wings to the north-west and south-east which maintain an urban continuity with the context as all it is the general height of the buildings in the area; whereas the central volume is an eight-story high structure set back from the street to create a piazza in the junction which also provide a sense of monumentality to the building in the public realm. The Fourth volume which was never conceived as an auditorium block to the back of the middle volume which was to have a parabolic concrete roof. The intersection of the two wing blocks with the central block is defined with subtraction at the points of intersection to include more natural light in the internal spatial environment.

Figure 75: Physical model of the building

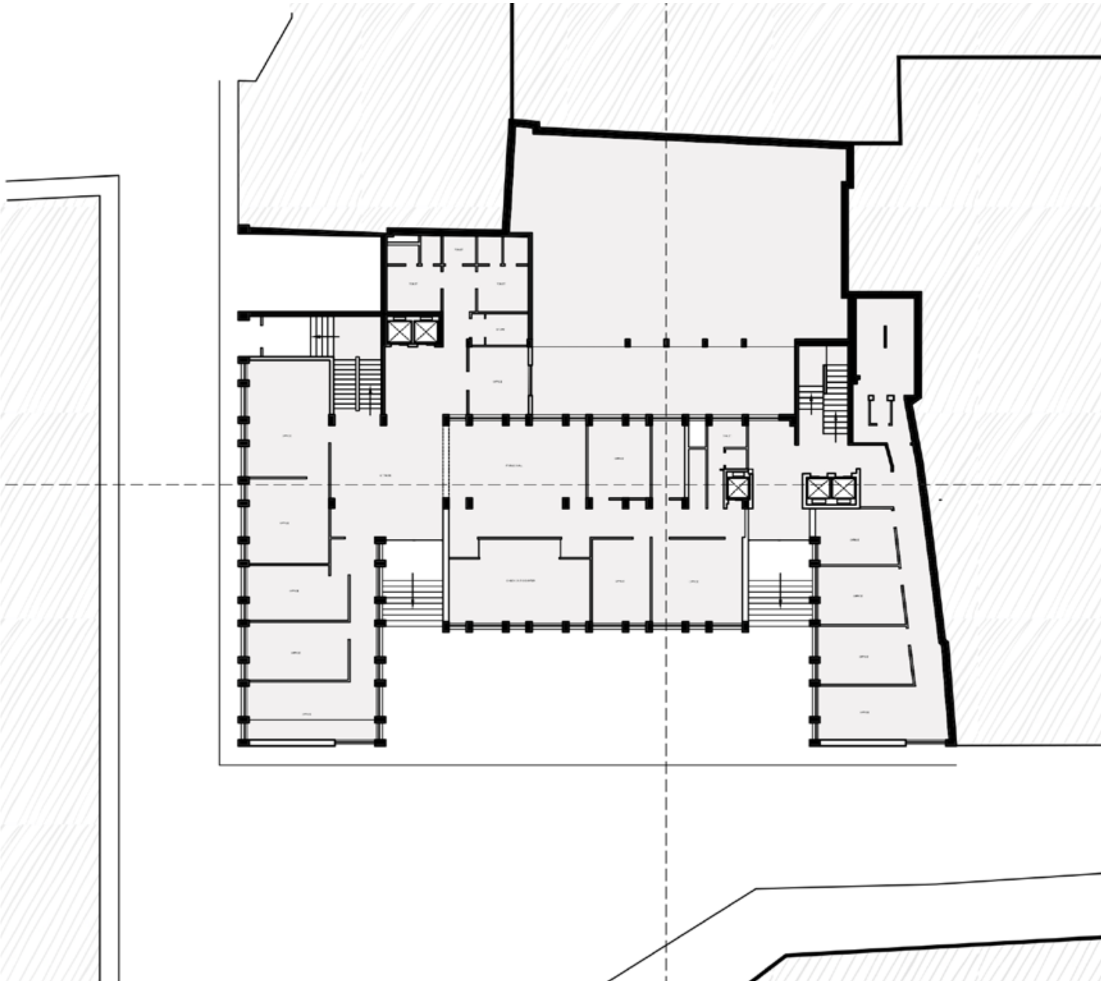


Figure 76: Ground floor plan

Figure 76: Facade view

PALAZZO MONDADORI

Via Arnoldo Mondadori, 1, Milano MI
Oscar Niemeyer, 1975

Palazzo Mondadori was inaugurated in Segrate, in the province of Milan, in 1975. It is the first project that the Brazilian architect Oscar Niemeyer The new company headquarters in Segrate, entrusted to the South American architect, occupies a plot of land surrounded by fields and agricultural areas. The main building consists of two dialogues and interconnected parts. It is built by replicating a model, architectural and structural, conceived in Brasilia, 1960 the new federal capital of Brazil.

Even in Segrate he, therefore, realizes a glass box supported by a monumental and elegant structure in exposed reinforced concrete and steel, which fuses architecture and structure.

Figure 77: view of Palazo Mondadori

DESCRIPTION

The building complex is composed of three elements. The five floors of the main building are suspended within a parallelepiped, fronted by a series of arches and containing offices and newsrooms. This is set against two low, sinuous structures that emerge from a stretch of water. Their irregular and wave-like forms, which resemble that of a leaf, are made even more suggestive by a 20,000 square-meter artificial lake. The building is surrounded by a large park, laid out by landscape architect Pietro Porcinai. After the number of Mondadori employees jumped to 3,000 in 1965 from 335 in 1950, the company decided to construct a new headquarters on the outskirts of Milan in the town of Segrate, near the city’s Linate airport and the motorway to Verona. In 1968, Giorgio Mondadori, Arnoldo’s son, and chairman of the publishing house, decided to hire Brazilian architect Oscar Niemeyer for the building, three years after admiring the Foreign Ministry (Palácio Itamaraty) he designed in Brasilia. The plan for the new head office would be a kind of “architectural advert”, as Niemeyer termed it, a building that doesn’t need to be identified by a sign but is impressed in people’s memory.

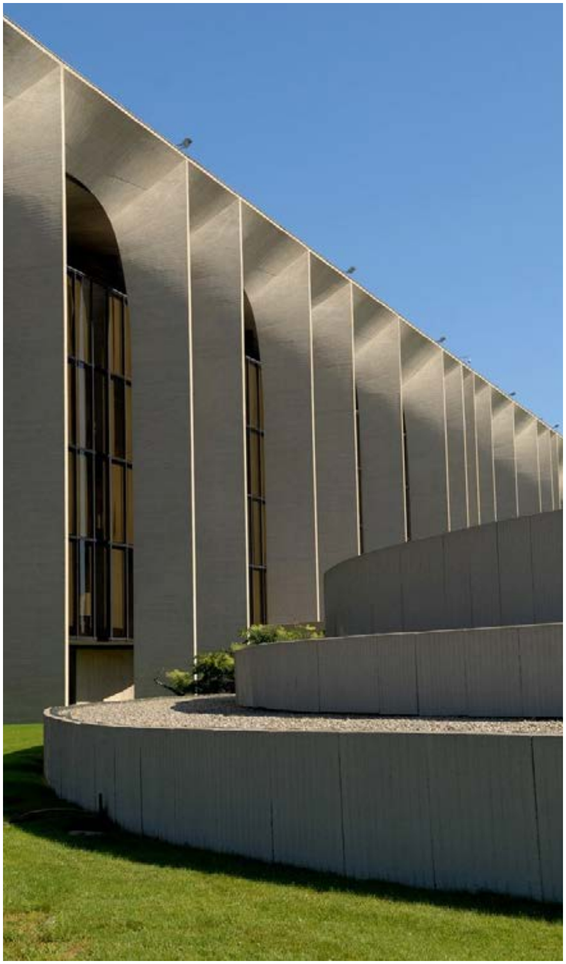


Figure 78: PIcture of the columns

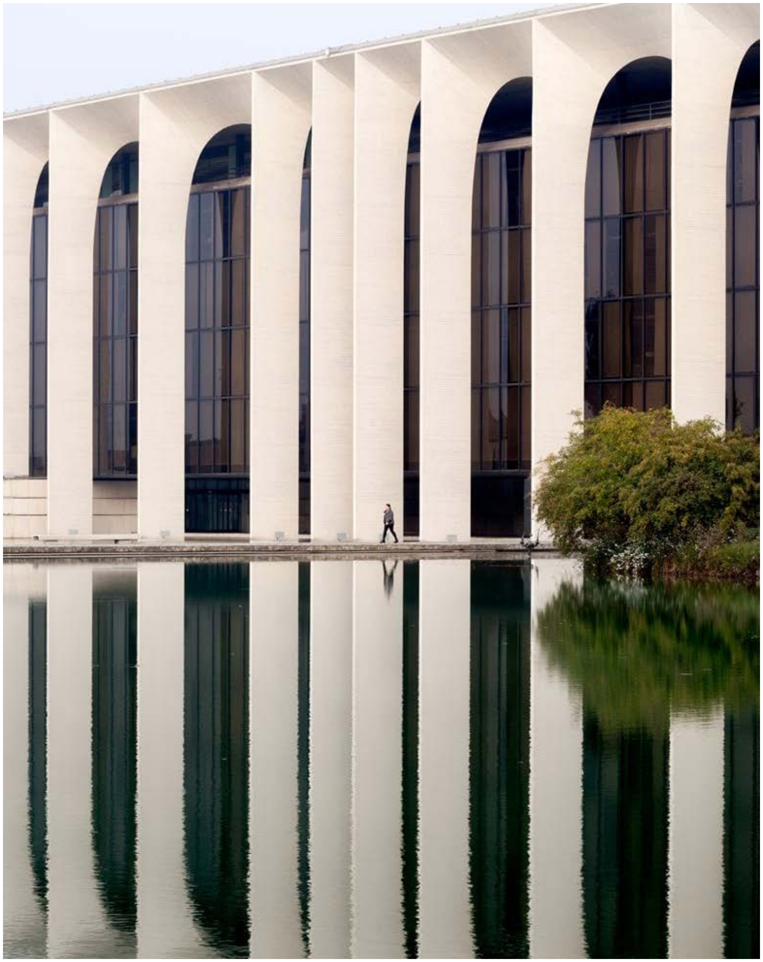


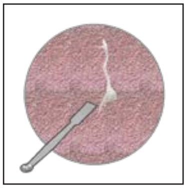
Figure 79: PIcture of facade Rhythm

CONSERVATION

DIAGNOSTIC APPROACH

MATERIAL AND DETERATION MAPPING

INTERVENTION



DIAGNOSTIC APPROACH

Following the process of documentation of the existing structure, firstly through measurements and then through photogrammetry, the study generated needs to be deepened further to understand the structural aspect as well as the internal damages in the building.
This internal malfunction could be a possible reason for certain deterioration, so, there is a need for further testing and documentation of the existing to correctly execute the conservation project.
This is the synthesis of tests required for the further elaboration of the study.

Figure 80: Point Cloud for North-Western elevation

1.THERMOGRAPHY

It is required to identify roof structures, closed openings, and humidity mapping. It may explain flaking caused by humidity and water. This approach is more important for the southern facade close to trees.

2.ULTRASONIC INVEST.

To identify the presence of existing rainwater pipes in the external walls. It is required to investigate further any sort of deterioration based on internal leakage.

3.FACADE SAMPLE

To identify and understand the composition of the overlapping layers on the facade. And finally, implement material specific conservation strategy rather than using a generic one.

Figure 81: East Facade

Figure 82: North-West Facade

Figure 83: South Facade

4.FLAT-JACK TEST

To understand the possibility of addition by computing the compressive strength of the existing masonry structure.

5.ENDOSCOPY

To understand the construction technique as well as the thickness of the horizontal elements in the existing building.

6.MAGNOMETER

To identify the position of any sort of metallic components underline on the facade and to ensure the position of the horizontal and vertical elements in the building section.

Figure 84: Ground Floor Plan

Figure 85: East Facade

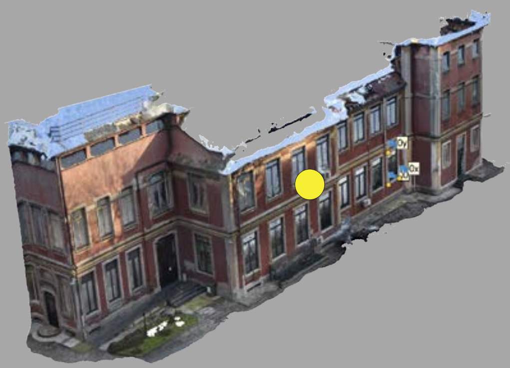


Figure 86: West Facade

MATERIAL AND DETEORATION MAPPING

Since 1910, the building has been damaged over years due to the presence of water, salt, humidity, physical damages, and other many reasons. On the other hand, considering different material usage, the building had to be evaluated in its features and interventions in the appropriate way to gain the same properties as it was, before either adding new elements or transforming.

Therefore, the process was started by analyzing all different kinds of element applications including visual analysis, and point cloud, to understand how to approach the building as well as create hypothesis to intervate.

Figure 87: Image of Facade layers of the existing building

HISTORICAL TRANSFORMATION OF THE BUILDING

Figure 88: Original Construct

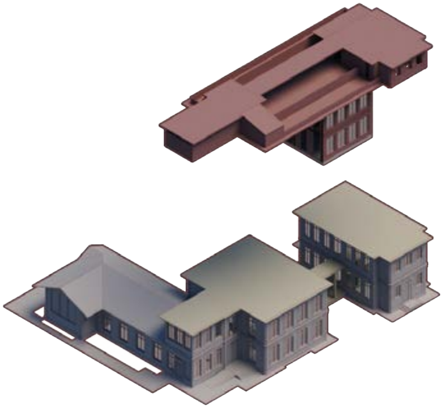


Figure 89: Addition and Transformation 1958

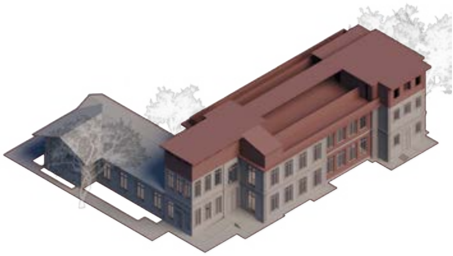


Figure 90: State of the Art 2022

The building was constructed initially in 1910 into two separate units which were later consolidated into a single unit with the addition of the center building completing the present state of the structure. After this, the new addition was constructed in 1950, which calls for an investigation into the materials and structural compatibility of not just the original but also the new addition, to understand the tectonics of the construct of the new and the old building over the years.

ANALYSIS PROCESS

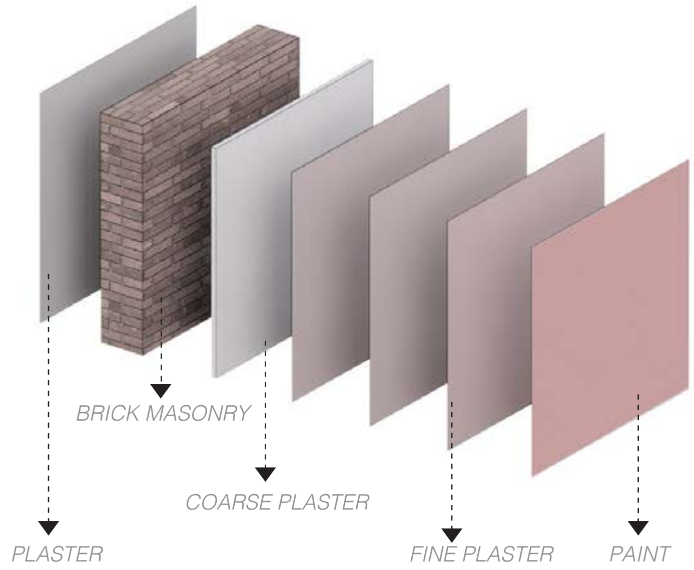


Figure 91: Layering of the outer Wall

1.Visual Analyses

The initial step in the investigation of the project is to use nonintrusive methods of analysis like visual analysis, to locate the decays and materials on the facade, and establish some logic for the decay patterns based on the visual inspection to develop a diagnostic project and the conservation project.

2.Point Cloud & Ortho Photos

Based on the historical data and the visual analysis of the project helps generate various hypotheses largely revolving around the idea of incompatibility of the materials of all the interventions that took place on the project. mainly the outer surface coverings used for ordinary maintenance purposes.

3. Hypothesis

The second step is to digitally capture the building using the meta shape program to have a point cloud, having a 3D model with all deterioration and materials ensures the base for visual mapping of materials and deterioration hence facilitating the process of understanding the structure and the materials.

MATERIAL SURVEY

A.RED PLASTER

Used for covering all facade.

Figure 92: Red Plaster

B.LIGHT YELLOW PLASTER

Used for covering all facade.

Figure 93: Light yellow Plaster

C.REINFORCED CONCRETE

Generally used in the mouldings surrounding of the present doors and windows.

Figure 94: Reinforced Concrete

D.ALUMINIUM

Used for framing of the latest windows.

Figure 95: Aluminium

E.STAINLESS STEEL

Largely present in the railings.

Figure 95: Stainess Steel

F.COPPER

This material used for rain water pipes , which are resting on the building facade.

Figure 96: Copper

G.WOOD

Used in the original window frames and to for the truss structure of the roof.

Figure 97: Wood

H.GLASS

Generally used in windows and doors but not as a seperation element.

Figure 98: Glass

I.MARSEILLE TILES

Used in the roof as a covering.

Figure 99: Marseille Tiles

J.CEMENT PLASTER

Used as method of conservation.

Figure 100: Marseille Plaster

MATERIAL AND DETEORATION MAPPING

LEGEND

A.		RED PLASTER
B.		LIGHT YELLOW PLASTER
C.		REINFORCED CONCRETE
D.		ALUMINIUM
E.		STAINLESS STEEL
F.		IRON
G.		WOOD
H.		GLASS
I.		MARSEILLE TILES
J.		CEMENT PLASTER

Figure 101: Material map Western Facade

DETEORATION SURVEY

01.FLACKING

Peeling of the facade. It is caused by the movement of moisture through the wall section and the presence of an incompatible top layer added to the existing

Figure 102: Flacking

02.CRACKS

Superficial crevices on the surface of the facade developed due to varying thermal responses of the interacting materials and further expanded from a freeze-thaw mechanism.

Figure 103: Cracks

03.DETACHMENT

Due to the existence of salt and water, the layers lose their adhesive strength. Due to salt crystalization, the layers tend to detach from the wall substrate.

Figure 104: Detachment

04.BIOCOLONIZATION

This form of deterioration showed up because of the lack of sun, the presence of humidity, and water. Particularly on the northern facade. Mostly harmless in nature.

Figure 105: Biocolonization

05. MATERAIL LOSS

Largely located on the skirting of the facade due to physical damages and movement of water.

Figure 106: Material Loss

06. DEPOSIT

Depositing of black soot on the surface of the facade is largely composed of carbon and dirt. The presence of this is in areas that are protected from the rain

Figure 107: Deposit

07.MECHANICAL DAMAGE

This sort of damage is present at the place of the addition of signage which was added later on the original structure.

Figure 108: Mechanical damage

08.CORRESION

Staining of the moldings as well the corrosion of the internal bars of the window molds due to the carbonation which occurs largely due to the weather conditions.

Figure 109: Corresion

09.DISCOLORATION

Caused by the movement of water on the facade, the Discoloration effect varies with the varying volumes of water movement influenced both by the architectural elements and lack of maintenance.

Figure 110: Discoloration

10.EFFLORESCENCE

This decay is largely oriented with the presence of salts in the new interventions as well as the presence of salts in the water.

Figure 111: Efflorescence

Figure 112: Deterioration map Western Facade

INTERVENTION

After undertaking the analysis and developing the hypothesis for the deterioration patterns. The intervention Proposal has been conceived to restore the facade as it was. This proposal is conceived in two phases. Removals, cleaning, consolidation, protection, and punctual interventions are the main types to approach the building in the first place. Using the information provided by material and deterioration survey improves the possibility of correct application.

Figure 113: Dry Cleaning process

PHASE1

R.01

Removal of any type of residues by using tools.

R.02

Removal of hardly attached residues by using spatula, scarper etc.

R.03

Removal of incompatible and unnecessary materials from the facade and surrounding of building.

Pl.02

General dry cleaning by using brushe and sponge.

Pl.03

Application of the suitable biocide by injection into the plant roots or diffusion by spray. After treatment , nebulized and deionized water must be used to remove any trace of product.

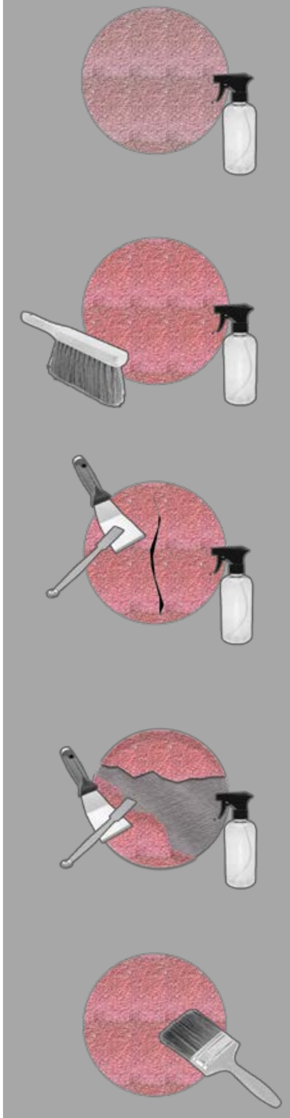
Figure 114: Consolidation Process Phase-1

Figure 115: Conservation Intervention map Phase-1

LABEL

R.01		Removal of Incompatible Material
R.02		Removal of plaster strongly detached
R.03		Removal of unnecessary elements
PI.01		General Dry Cleaning
PI.02		Application of Biocides by Brush

PHASE 2



Pl.03

Cleaning by deonized water at low pressure to remove any material residue.

Co.01

General consolidation using ethyl silicate to slow down exfoliation, pulverization, disintegration on the all facade by using brush, spray and airless. (For deep consolidations, injections can be used)

Co.02

Consolidation of cracks by integration of compatible plaster by using spatula etc. Before application of consolidation , the wall must be prepared as dry, clean and rough.

Co.03

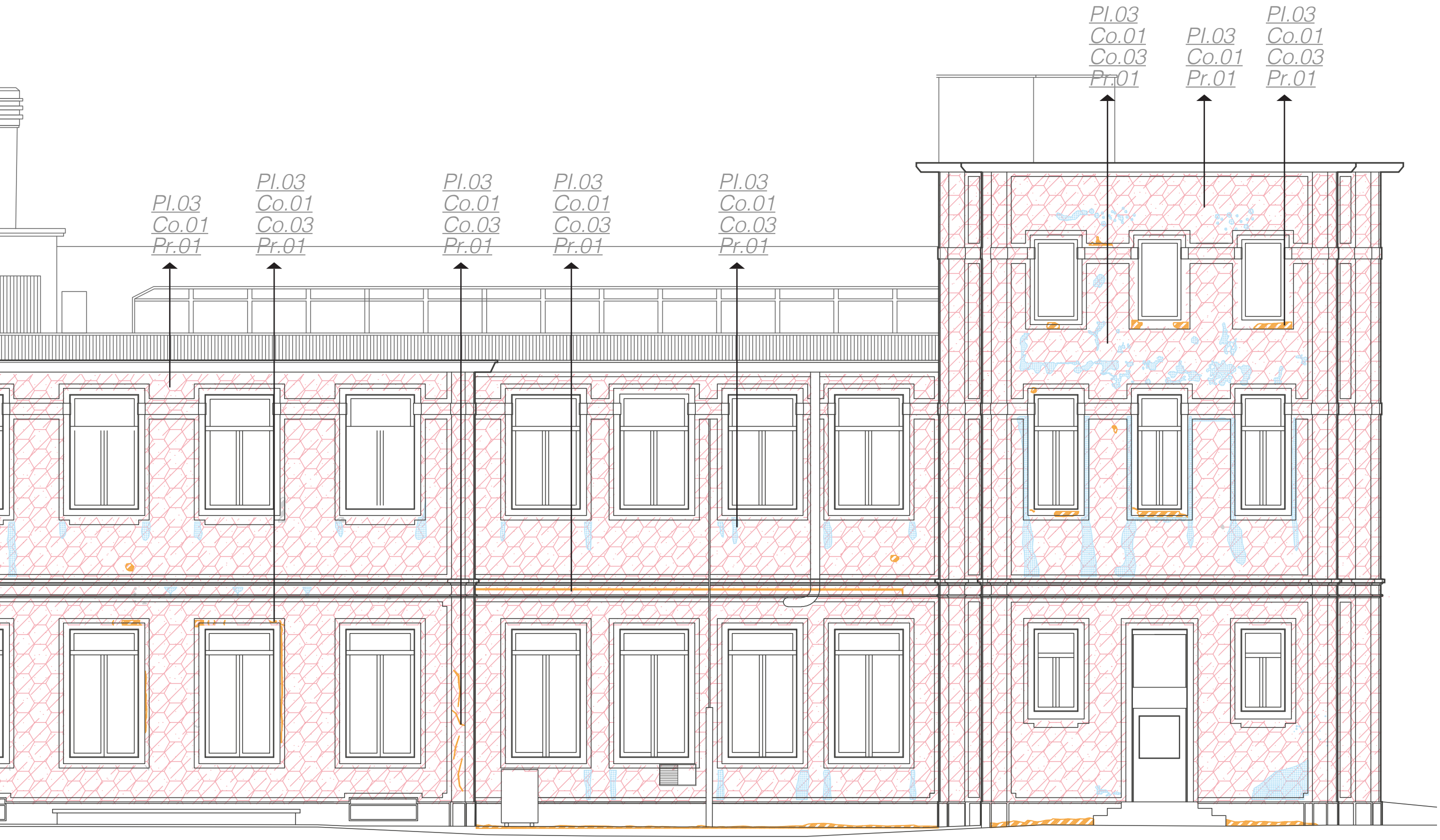
Consolidation of detachments and corners must be filled up with compatible mortar. Before application ,the gap must be cleaned up and wetted with clean water to avoid the absorption of liquid and new mortar.

Pr.01

Application of breathable,not glossy, light stability plaster on the facade to avoid the agresion to the wall structure by using brush on small parts and by using spray.

Figure 116: Consolidation Process Phase-2

Figure 117: Conservation Intervention map Phase-2

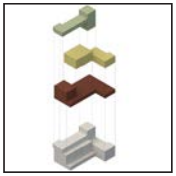


LABEL

Pl.03		General Cleaning with Deionized Water
Co.01		General Consolidation of Ethyl Silicate
Co.02		Integration of Compatible Plaster for Cracks
Co.03		Integration of Compatible Mortar for Missing Parts
Pr.01		Lying a Breathable Plaster on Facade by Spray
I.01		Particular Parts to be Threated Seperately

CONCEPT § STRATEGIES

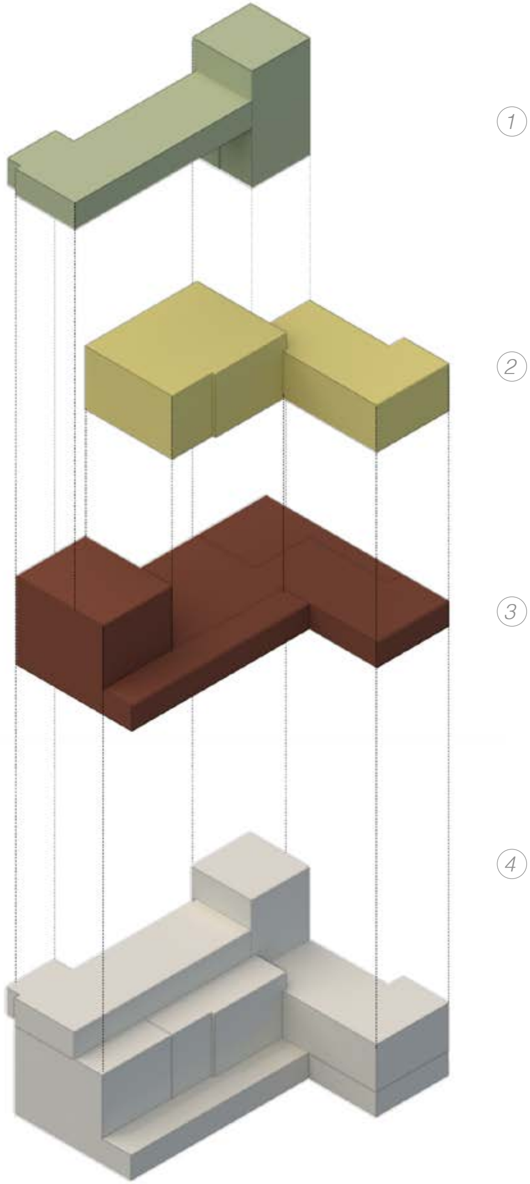
DESIGN CONCEPTS



SUSTAINABILTIY CONCEPTS

DESIGN CONCEPTS

The building massing concept has been developed keeping in mind the transformation of the existing building. The addition has been designed to add to the geometry as well as create a focal point in the vetenaria block.
The addition has been conceived as two volumes, one completely on the top of the roof and the other one partially rising from the ground floor then going up forming a tower at the corner of the exiting building.



1 Public access area

2 Controlled access area

3 Restricted access area

4 Built form

Figure 118: Building massing as per Access

REMOVAL AND INTERNAL ADDITION

Considering building needs and functional transformations, some slabs, roof elements, and stairs were removed to not just open up the building and create new areas, but also arrange the functions and circulation inside of the building. Thanks to underpinning, the basement has been enlarged for archive in the south and north direction mainly. Furthermore, new circular stairs were added into the middle of the building to provide a service between till basement to the first floor.

Figure 121: First floor Demolition and Addition

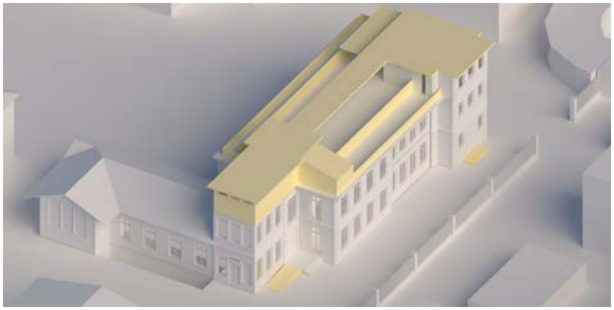


Figure 119: Demolition on Terrace

Figure 122: Ground Floor Demolition and Addition

Figure 120: Second floor Demolition and Addition

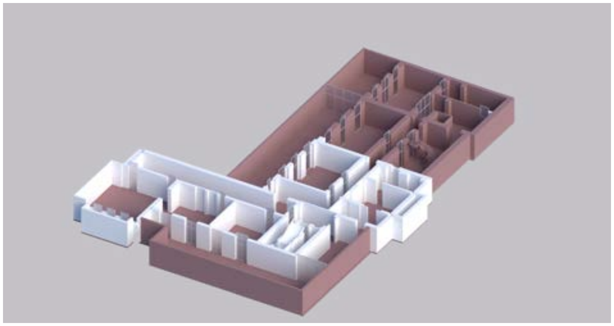


Figure 123: Basement Addition

MASSING DIAGRAM

The external additions were added taking into account area requirements for needed functions to integrate into the building. Firstly the corner addition was designed purposing to allow vertical direction starting from the ground floor to the second floor and third floor considering public usage and private usage separation. Besides the addition completed the missing geometry on the corner as a translucent element respecting the old facade to not close up completely.

Moreover considering functional needs, the addition to the main obtain area was located on the second floor between the corner addition and the existing south part of the building. This area serves mainly public usage and has the functions such as an exhibition area and multi-purpose hall.

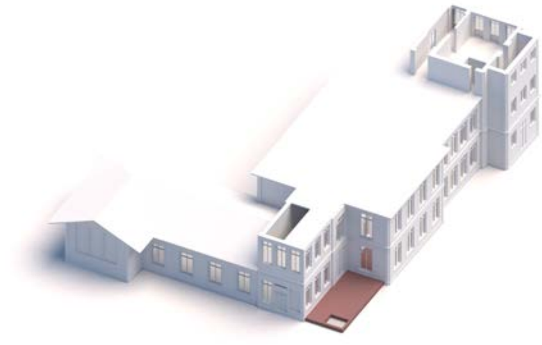


Figure 124: Corner Addition for development of the tower

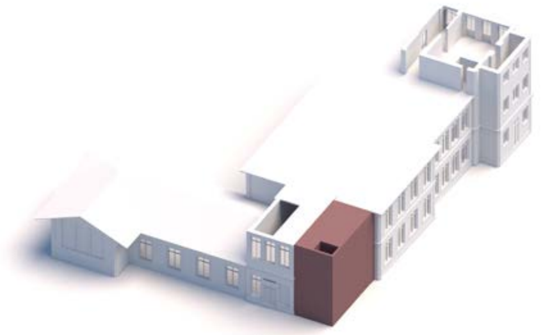


Figure 125: Corner Addition for new vertical circulation

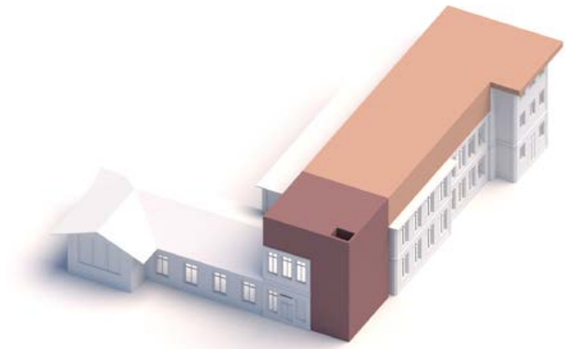


Figure 126: Addition of exhibtion space on second floor

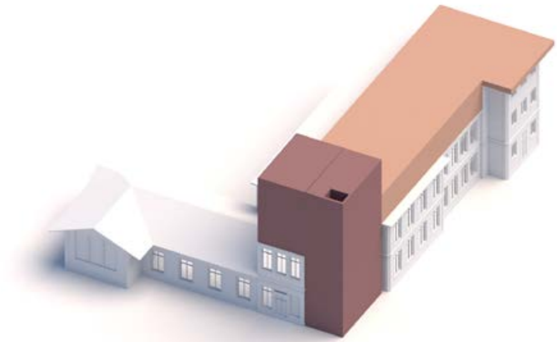
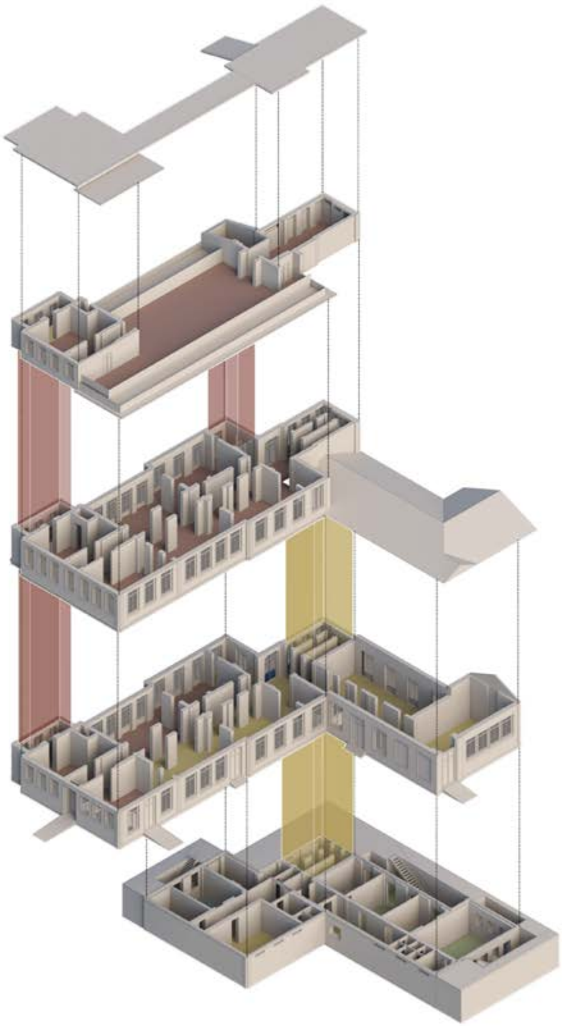


Figure 127: Extrusion of corner to create the tower

EXISTING BUILDING FUNCTIONAL DIAGRAM



Initially building itself has mainly private and restricted areas more than public services. The circulation was provided by 3 different staircases which have different starting points and finishes. On the other side, some of them added the building over time to connect the required slabs.

PUBLIC ACCESS
Caffe

RESTRICTED ACCESS
Seminar

PRIVATE ACCESS
Offices
Director's Office
Laboratories
Animal Resting Room
Operation Theathers

SERVICE AREAS

Figure 128: Exploded axo for Existing Building

NEW DESIGN FUNCTIONAL DIAGRAM

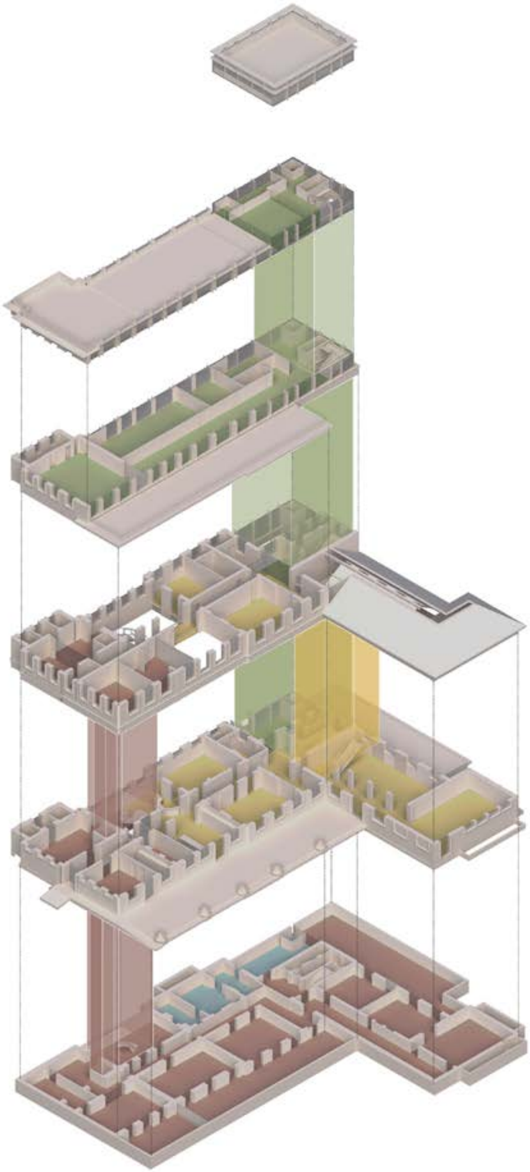


Figure 129: Exploded axo for The design Proposal

The transformation as demolition and addition required not just for the massing but also for a functional system. With the help of additions to the building, mostly the public spaces increased as well as restricted and private areas. On the other hand, the arrangament of circulation between spaces is distinguished considering access separation.

PUBLIC ACCESS
Caffe
Exhibition Hall
Conference Room

RESTRICTED ACCESS
Consultation Rooms
Researches Hall
Seminar

PRIVATE ACCESS
Offices
Director's Office
Meeting Room
Staff Locker Room
Receiving, Shipping, Packaging
Repositories
Document Repair Room
Disinfection Room
Pre-Storege Room

SERVICE AREAS

SUSTAINABLE CONCEPTS

Sustainable concepts are used to make less impact on the natural world as much as possible. It is crucial not just promoting the health of the building occupants, and improve productivity but also to reduce the negative effects of the construction process on the environment. Using planet- friendly approach conceives the project to bring towards a more energy-efficient way such as reducing the energy requirement for cooling and heating, reducing the carbon foot print of the building, reusing water, and increasing thermal mass.

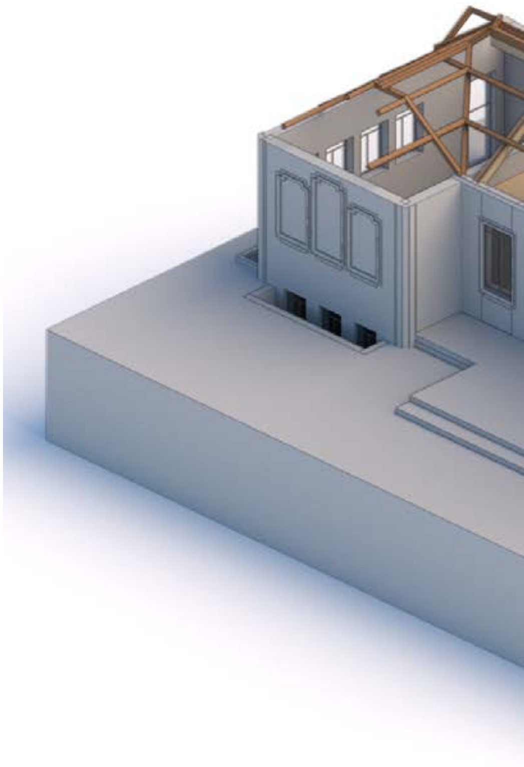
Figure 130: Aerial view of the Addition

1.Wooden Structure

The usage of wood structures has variable advantages in terms of the sustainability concept. The wood itself has a low carbon footprint in its industrial application. Besides it is a renewable resource, biodegradable. Wood consumes only a small amount of fossil fuels in the opposite way of other construction materials.

On the other hand, considering the lifecycle of the building, wood is less demanding in terms of air and water pollution, solid waste, and the usage of energy. When it comes to production, it is far less consumption of energy comparing others.

In the project, the chosen materials are LVL, Glulam, and CLT panels which served as a different types of elements in the building and integrated with frosted glass and solid elements to create a combination considering functional requirements to build a ventilated facade.



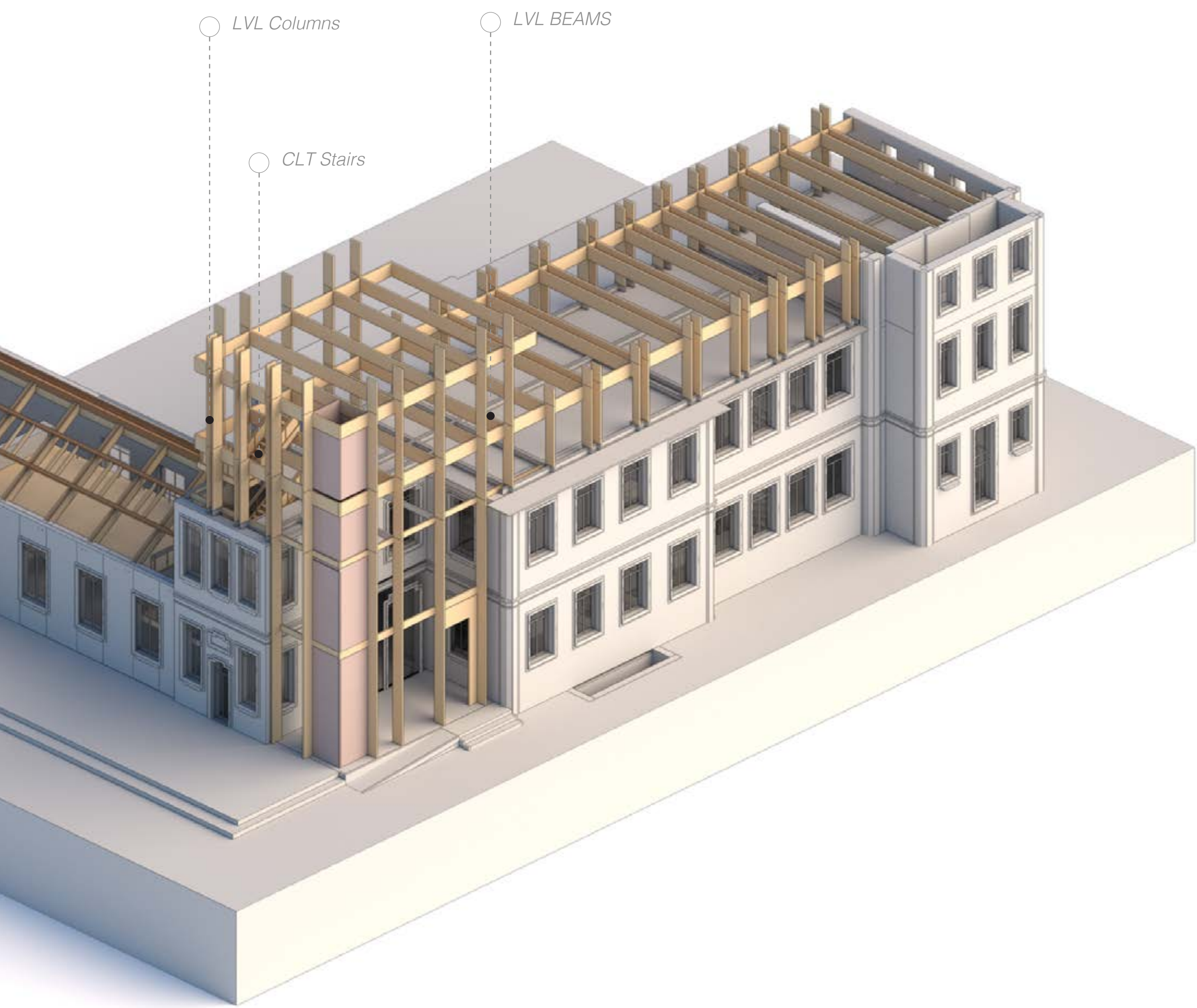


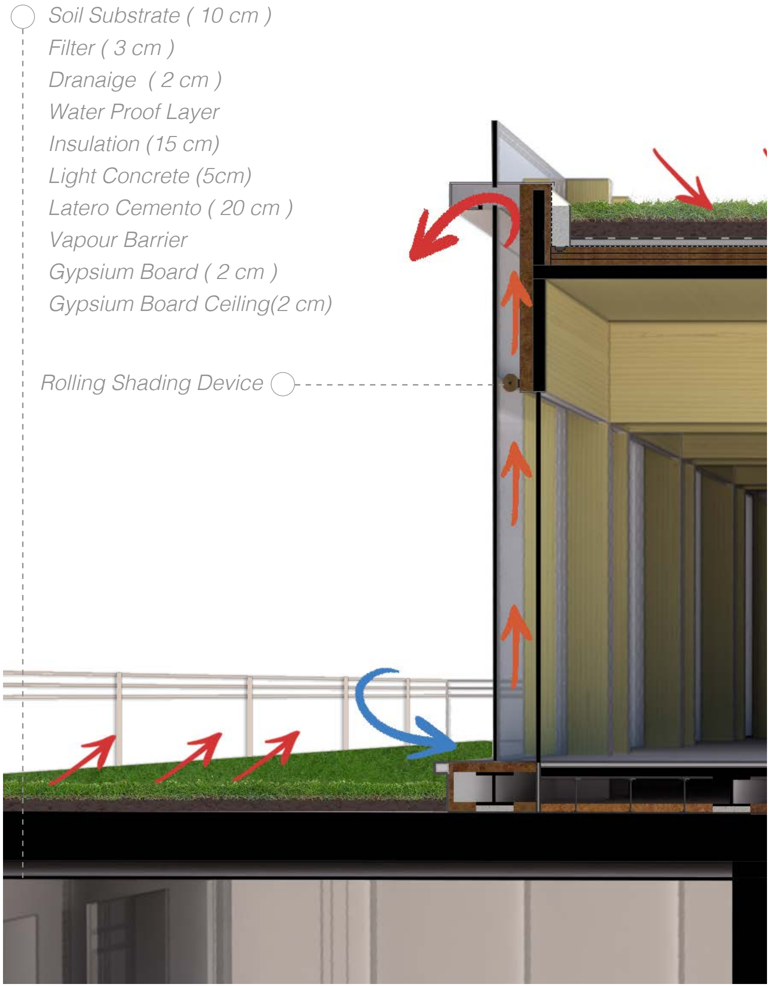
Figure 131: Axo for Wooden Construct

2.Ventilated Facade System

Creating a second skin of the building makes it possible to maximize energy efficiency and makes it sustainable from an environmental point of view. In winter, the gap between frosted glass and clear glass helps to thermally insulate the building. On the other hand, in summer the gap decreases overheating of the exterior part of the building and the usage of air conditioning. As a consequence, the reduction is in both consumption and pollution in the atmosphere.
Besides this, using the ventilated system has other advantages such as dropping the thickness of the facade, and having light weight. Furthermore, in the construction site, it gives a reduction in transport needs, logistic costs, and operating times.
Considering all the aspects, the ventilated facade system used in the parts that have additional tower on the north-west part of the building and one-floor addition on the second floor hence the all facade system was conceived in frosted glass and as a light structure addition

3.Green Roof

Green roof integration to the design strategies allows to gain multiple advantages. On the top , it reduces energy cost by absorbing heat instead of attracting it, and provides natural isolation into the building. Considering energy consumption , it is very effective in the way that



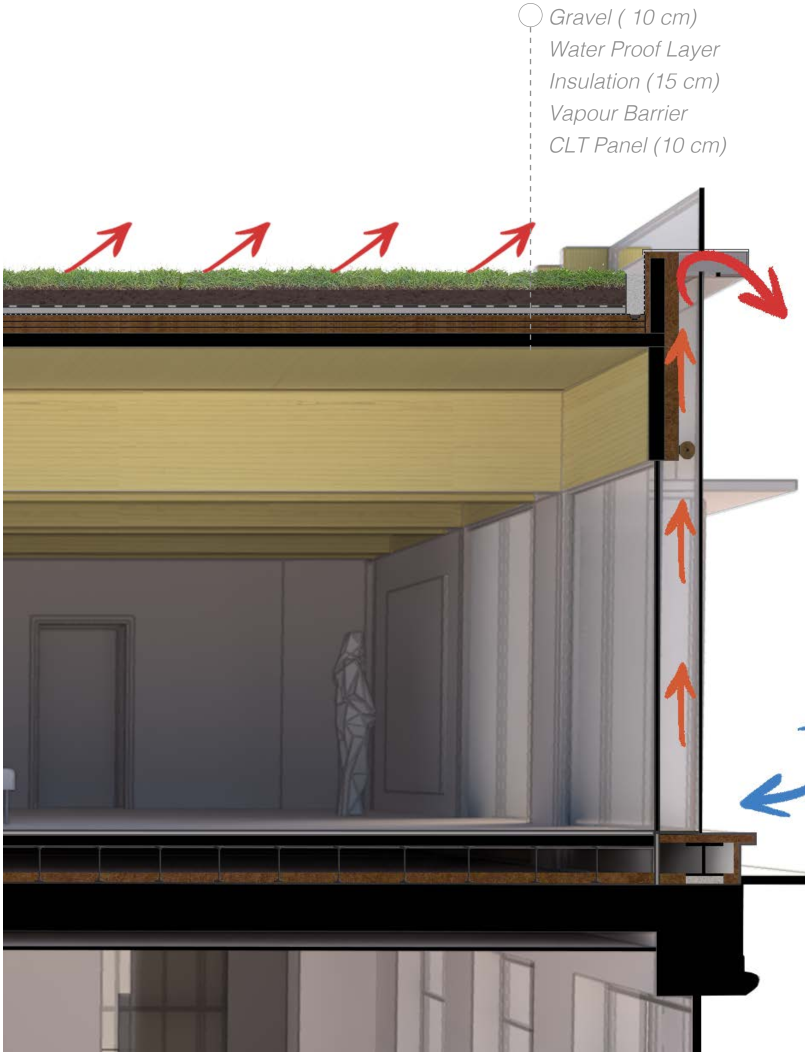


Figure 132: Sustainability concept building section

it reduces demans for energy , air conditioning, production of air pollution and greenhouse gas emission.Besides reducing urban heat island effect, it hepls removing air particules, produces oxygen and shades.

Taking into account all the benefits , roofs are designed in this fashion except for green roof . One of them located in the second floor where big terrace. The other one designed in the third floor ,as an extension of restaurant and caffe as a relaxing place.

4.Shading Devices

The usage of shading devices prevents the penetration of solar radiation into the building in summer times, on the other hand, while winter allows the needed solar gains. This features leads to better thermal comfort with significant energy savings in the building.

Considering the aspects, hence all facades designed as glass, to use of shading devices is crucial. Regarding the building needs as well, the rolling shading shutters are used in the facade gap to reduce the thermal gains. It is designed as a controlled system from inside the building with switches. Therefore, the building is protected by a shading system where there is a solid system between outdoor and indoors.

5.Rain Water Harvesting System

Rainwater harvesting is one of the efficient ways to make the building sustainable in terms of reusing a huge amount of water.

This system collects and stores the rainwater before it is dispersed as surface run-off, and afterwards passes the accumulated rainwater into a storage vessel.

Considering the high water quality, in the building, it was decided to use the collected water for various needs such as WC flushing, garden and green roof irrigation vehicle washing, and many other nonpotable reasons.

The system requirements such as filters and the tank have been provided in appropriate locations for the building. Some elements which are gutters and pipes have replaced with new ones in the same location except for additional needs for third floor and roof

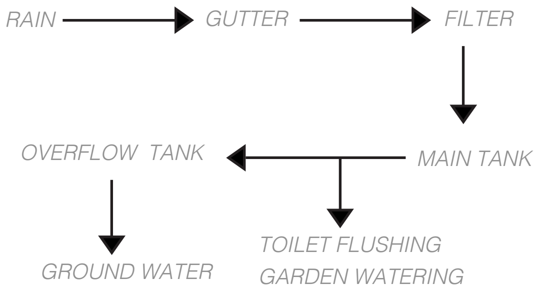
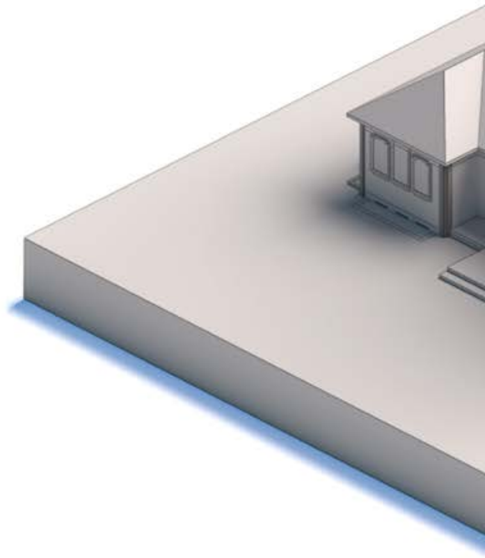


Figure 133: Rainwater colllection schematic



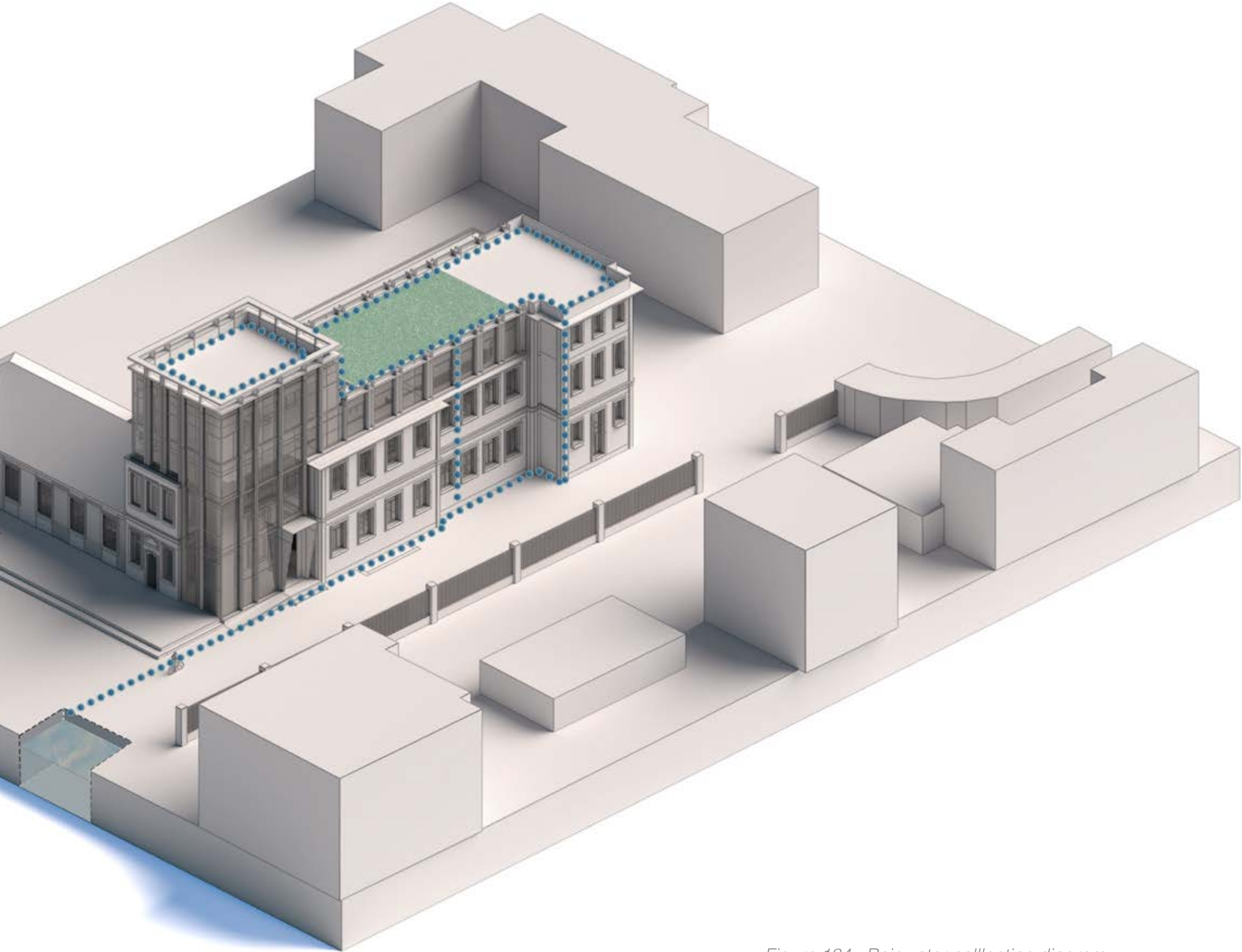


Figure 134: Rainwater colllection diagram

DESIGN PROPOSAL

PLANS

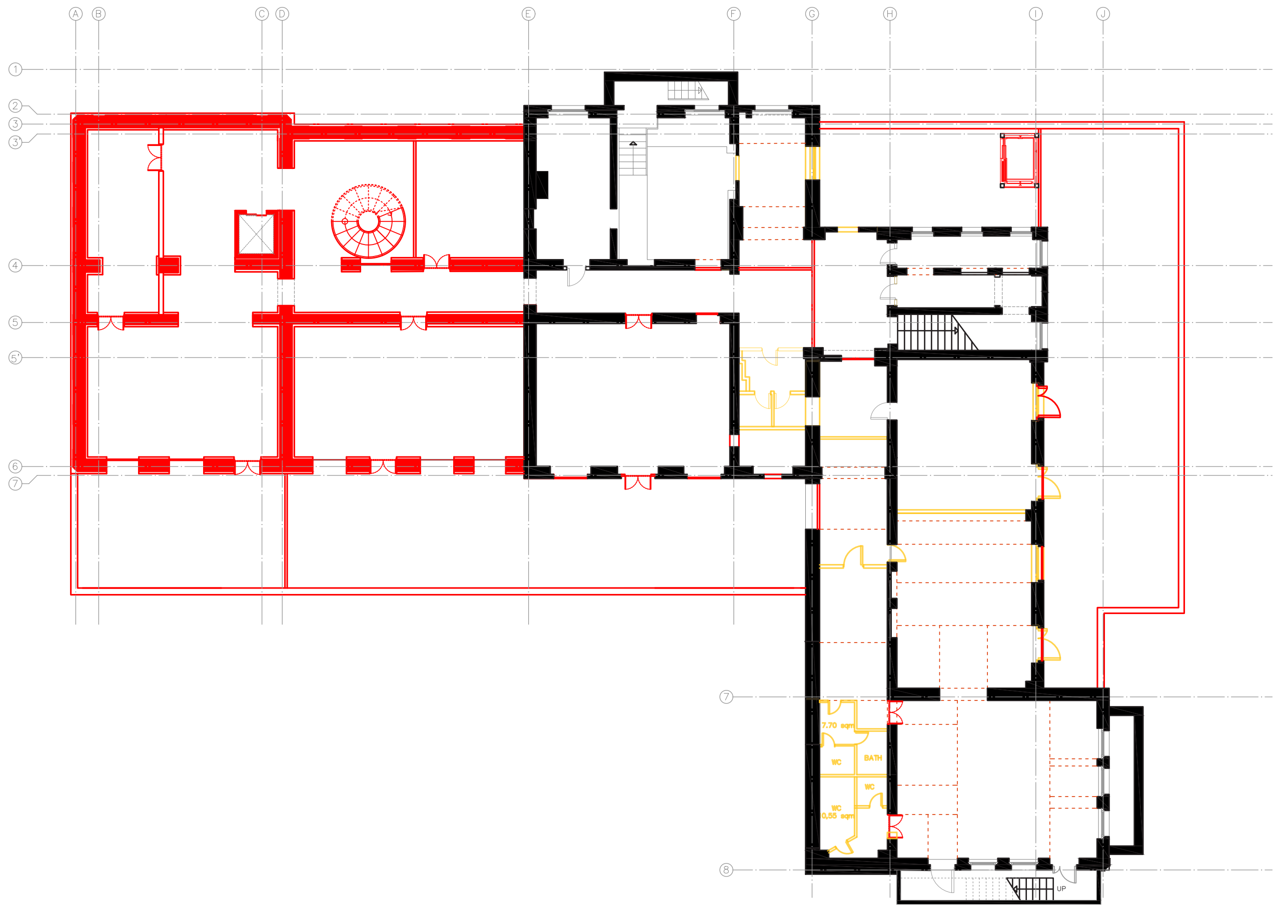
SECTIONS

ELEVATIONS

PLANS

Figure 135: Digitial macquette view for Ground floor axo

BASEMENT FLOOR

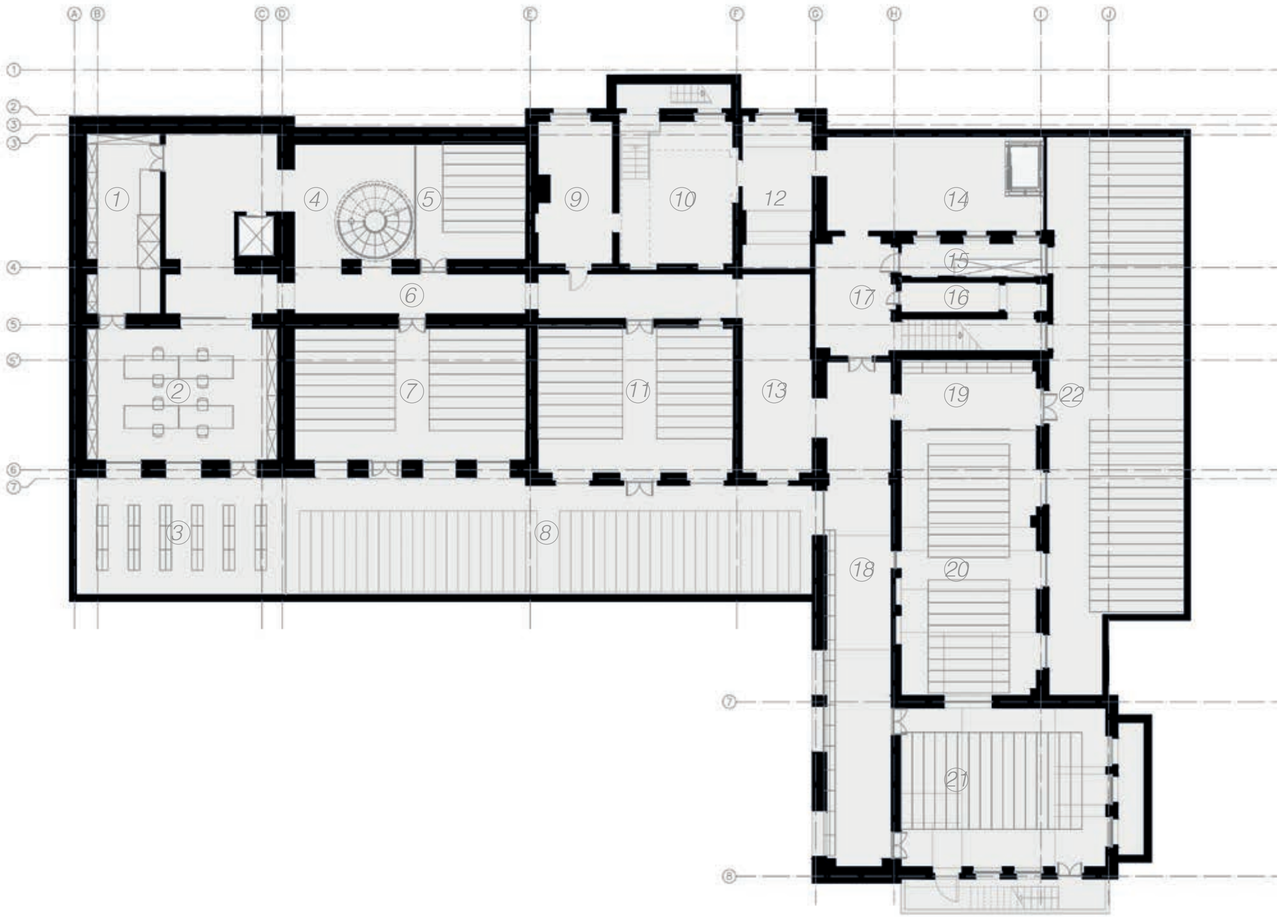


Existing Building

Demolition

Addition

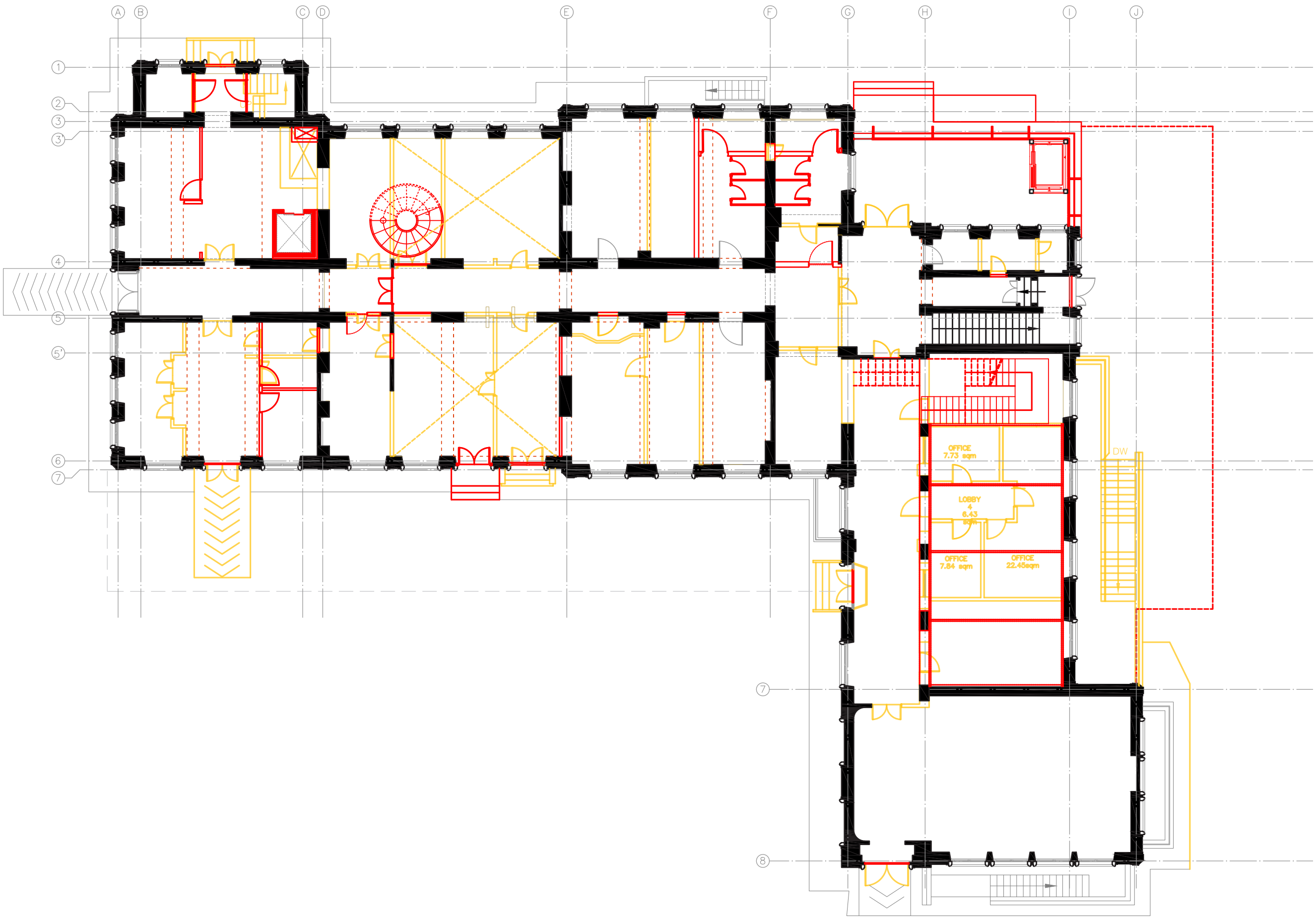
DEMOLITION / NEW CONSTRUCTION



1. Disinfection Room 26 sqm
2. Doc. Repair R. 51 sqm
3. Pre Storage Space 51 sqm
4. Lift Lobby 41 sqm
5. Repository1 25.4 sqm
6. Corridor 50.2 sqm
7. Repository2 60.6 sqm
8. Repository3 122 sqm
9. Elec. / Com. 21 sqm
10. Service Area 34 sqm
11. Repository4 58 sqm
12. Tech. Area 20.4 sqm
13. Corridor 29 sqm
14. Lift Lobby 38 sqm
15. Service Shaft 9.8 sqm
16. Storage 9 sqm
17. Lobby 18 sqm
18. Corridor 64 sqm
19. Lobby 19.3 sqm
20. Repository5 73.4 sqm
21. Repository6 66 sqm
22. Repository7 135 sqm

NEW CONSTRUCTION

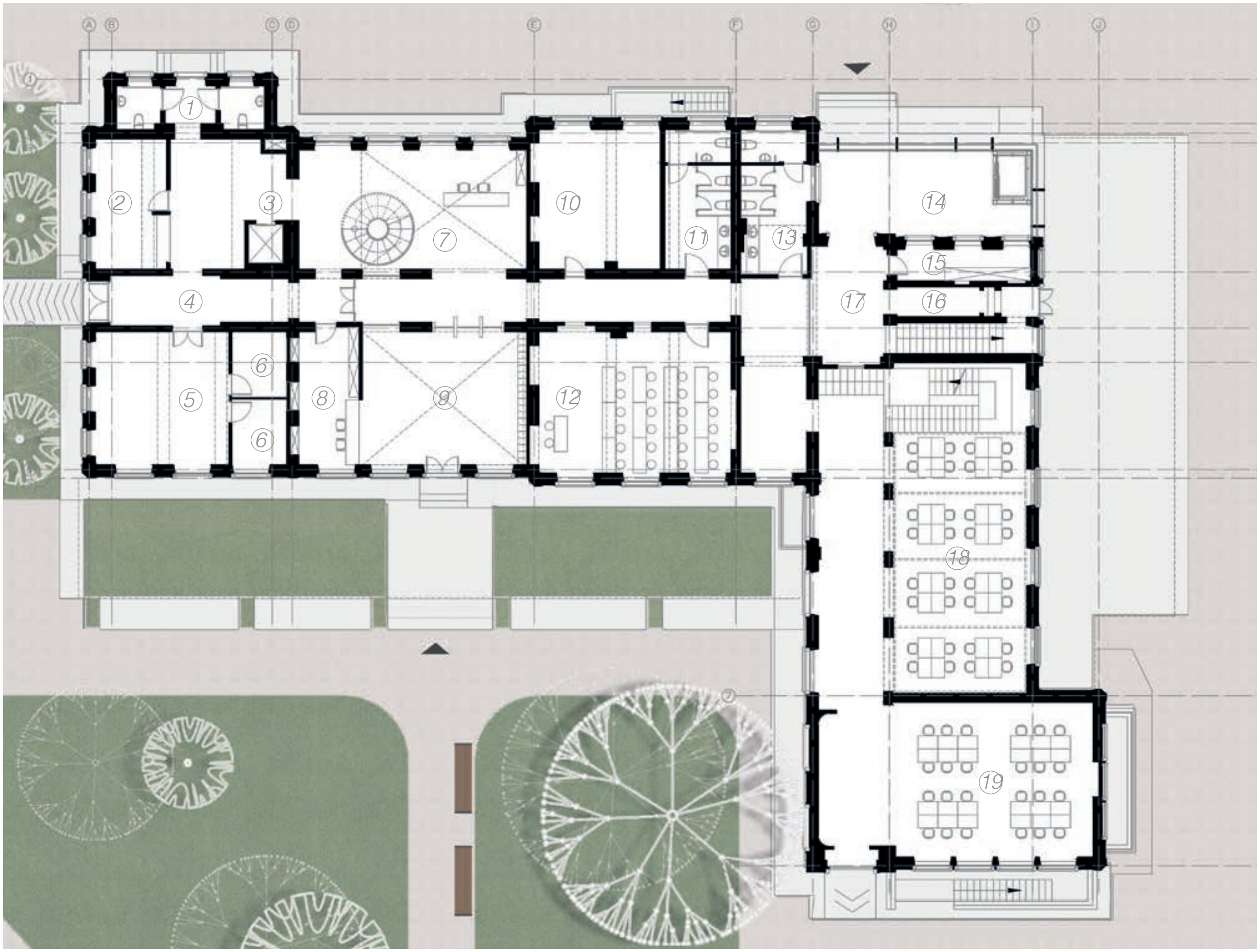
GROUND FLOOR



Existing Building

Demolition

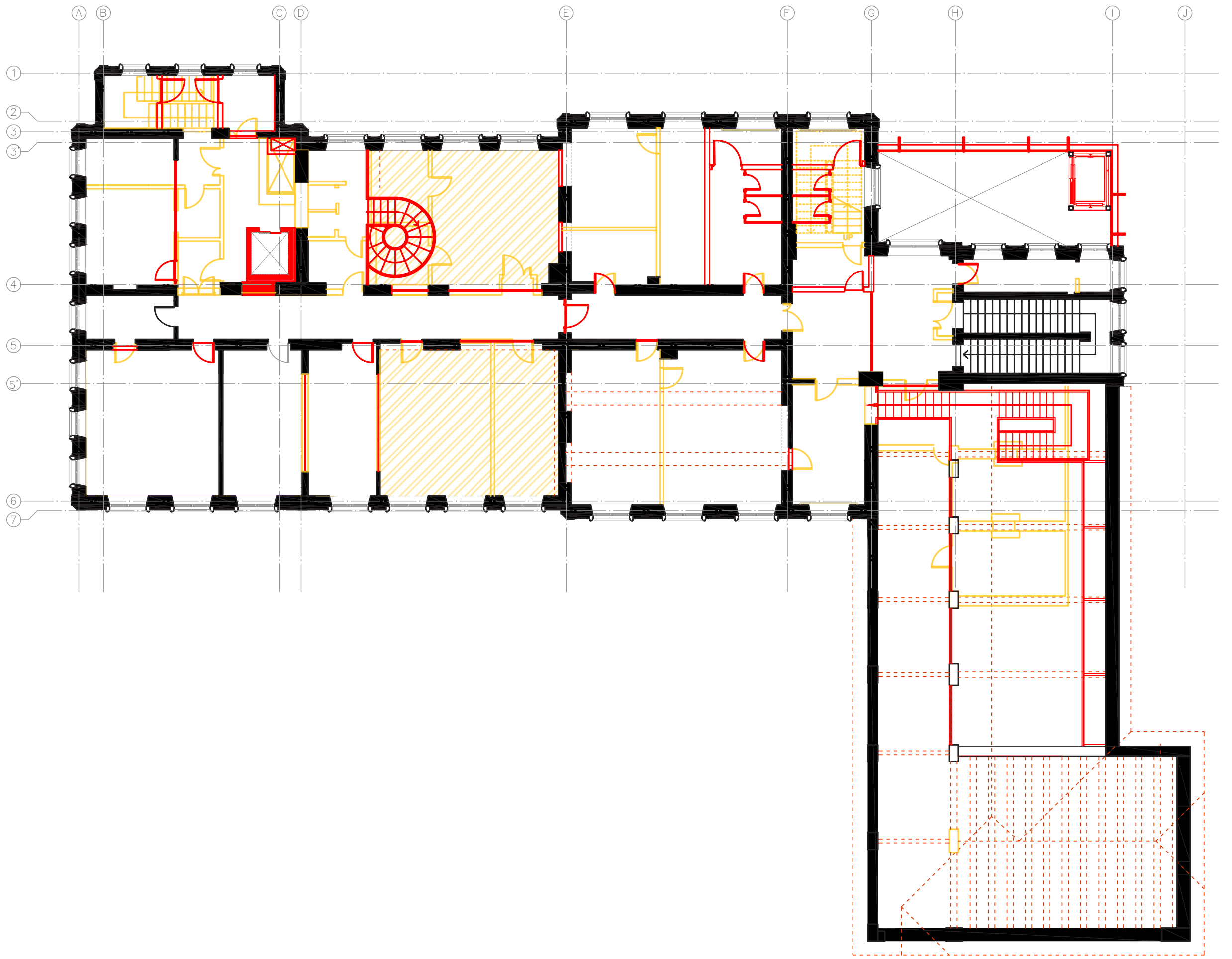
Addition



NEW CONSTRUCTION

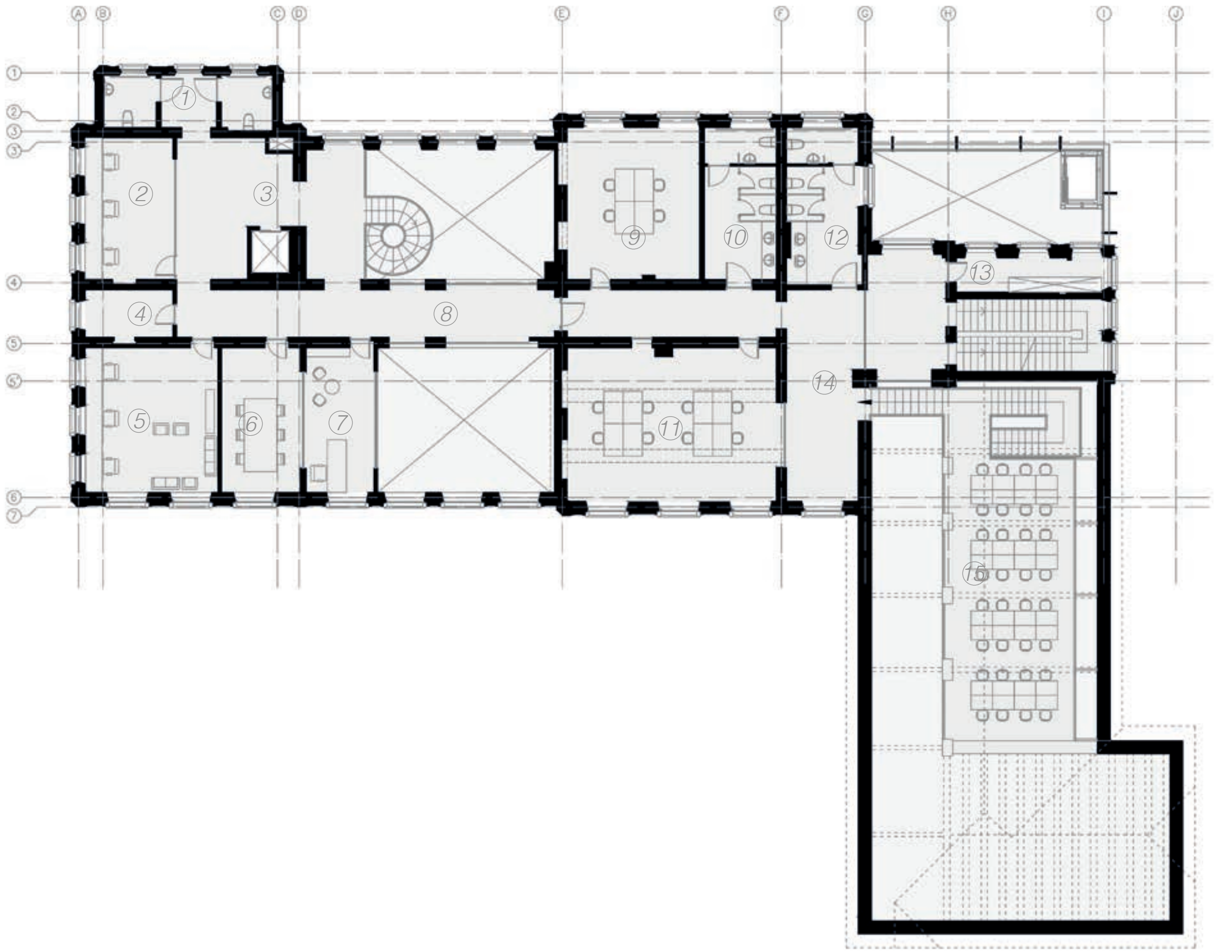
1. WC 13.5 sqm
2. Receiving, Shipping 19 sqm
3. Lift Lobby 45.5 sqm
4. Corridor 24.2 sqm
5. Office 38.2 sqm
6. Staff Locker 7.7 sqm
7. Doc. Receiving 28.2 sqm
8. Reception 18.7 sqm
9. Lobby/Lockers 46 sqm
10. Consultation 37.9 sqm
11. WC 19.4 sqm
12. Seminar Hall 60 sqm
13. WC 19.8 sqm
14. Lift Lobby 35 sqm
15. Service Shaft 9.8 sqm
16. Lobby 9.2 sqm
17. Lobby 19 sqm
18. Reading Hall 144 sqm
19. Consultation 85.4 sqm

FIRST FLOOR



Existing Building
Demolition
Addition

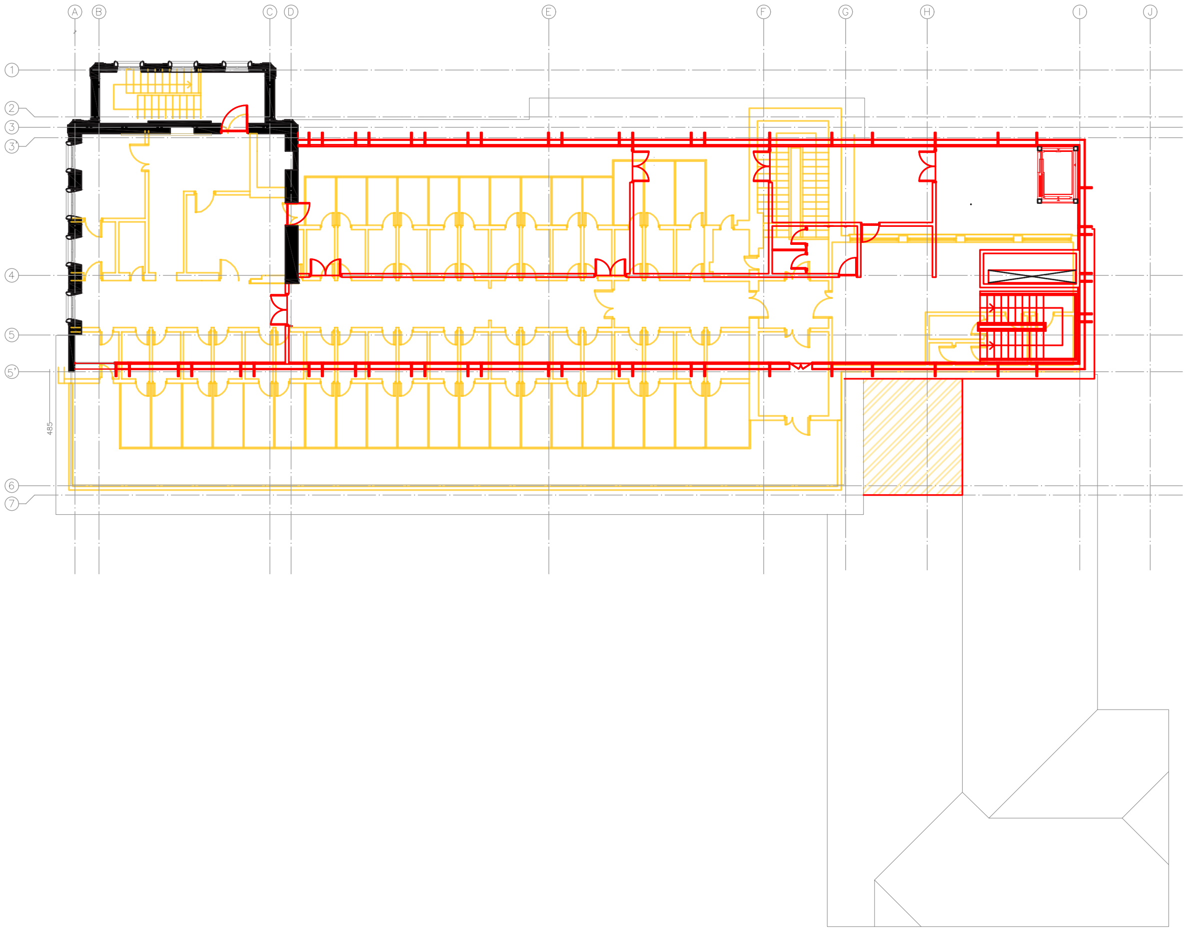

DEMOLITION / NEW CONSTRUCTION



NEW CONSTRUCTION

1. WC 13.5 sqm
2. Shared Office 22.6 sqm
3. Lift Lobby 39.7 sqm
4. Storage 7.7 sqm
5. Shared Office 35 sqm
6. Meeting R. 20.8 sqm
7. Direc. Office 18.2 sqm
8. Corridor 35 sqm
9. Map Reaing R. 37 sqm
10. WC 19.4 sqm
11. Spec. Cons. 58.9 sqm
12. WC 20.2 sqm
13. Service Shaft 10.1 sqm
14. Lobby 18.3 sqm
15. Reading Hall 80 sqm

SECOND FLOOR

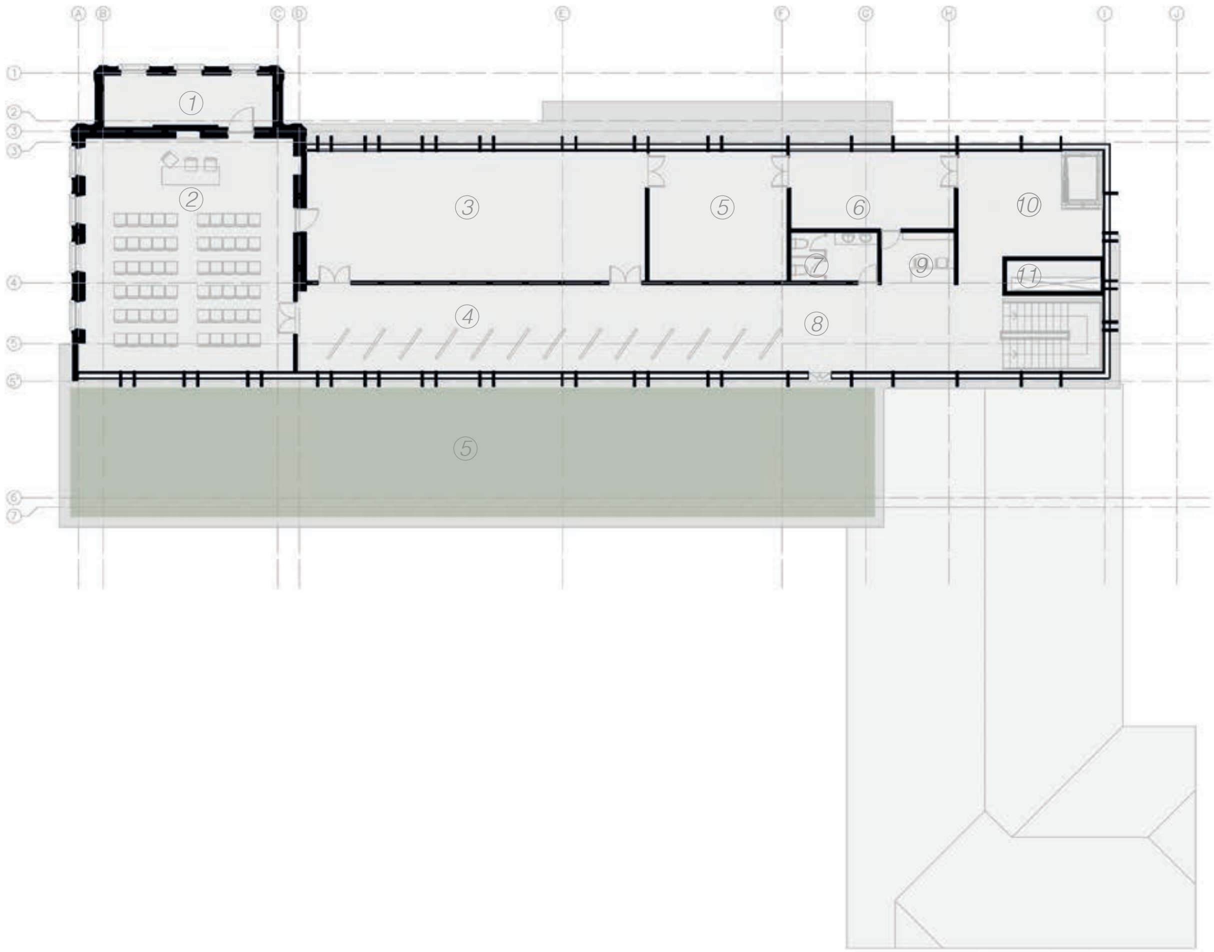



DEMOLITION / NEW CONSTRUCTION

Existing Building

Demolition

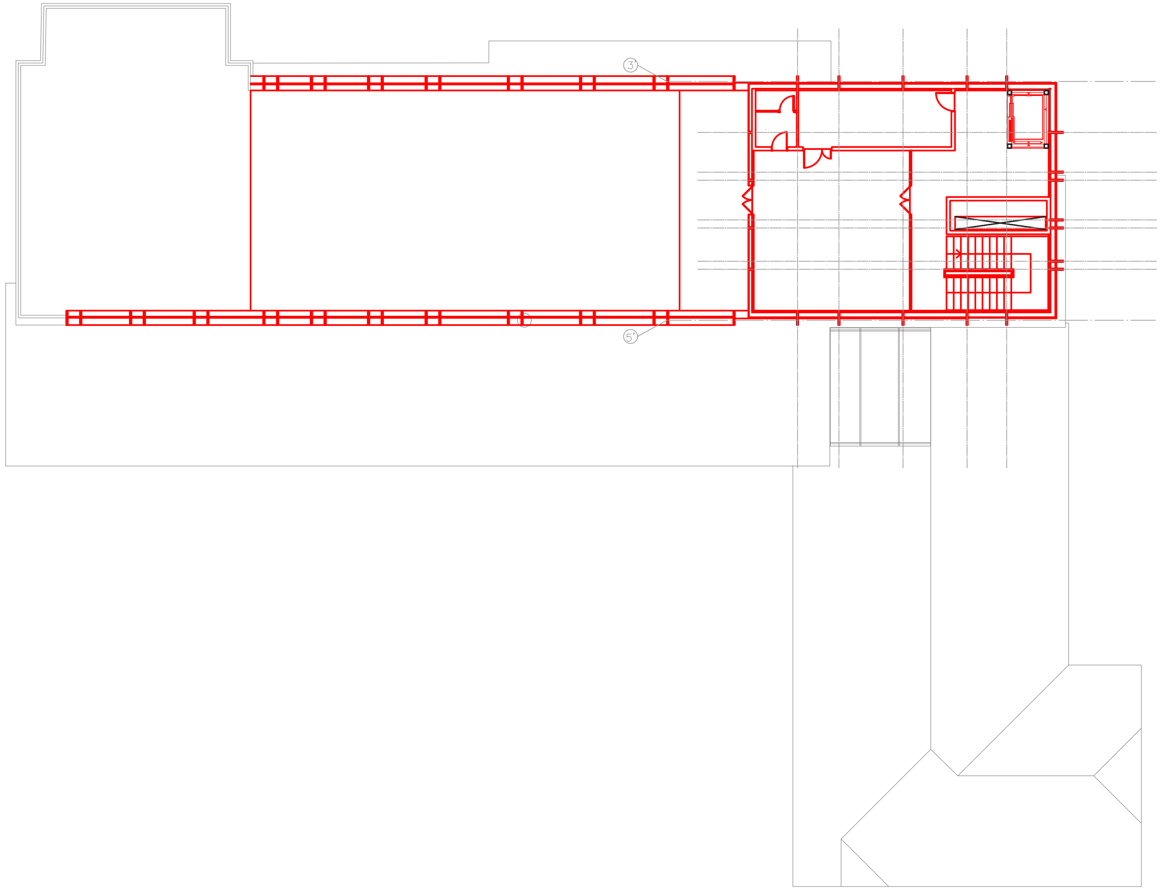
Addition



① Storage 15.7 sqm
② Conference Room 87 sqm
③ Exhibition Area 78.7 sqm
④ Gallery 88 sqm
⑤ Workshop 29.8 sqm
⑥ Storage 24.8sqm
⑦ WC 7.9 sqm
⑧ Entrance Hall 18.5 sqm
⑨ Reception 7.2 sqm
⑩ Lift Lobby 23.4 sqm
⑪ Service Shaft 4.8 sqm

NEW CONSTRUCTION

THIRD FLOOR

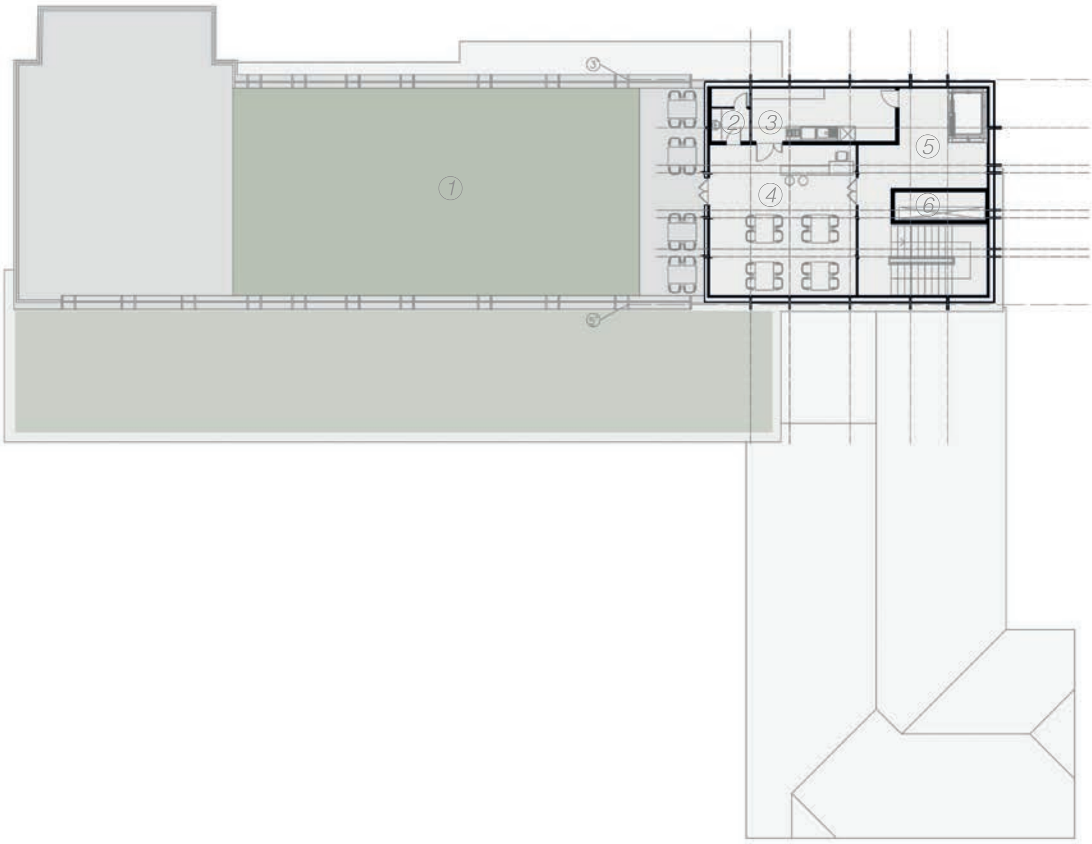


Existing Building

Demolition

Addition

DEMOLITION / NEW CONSTRUCTION



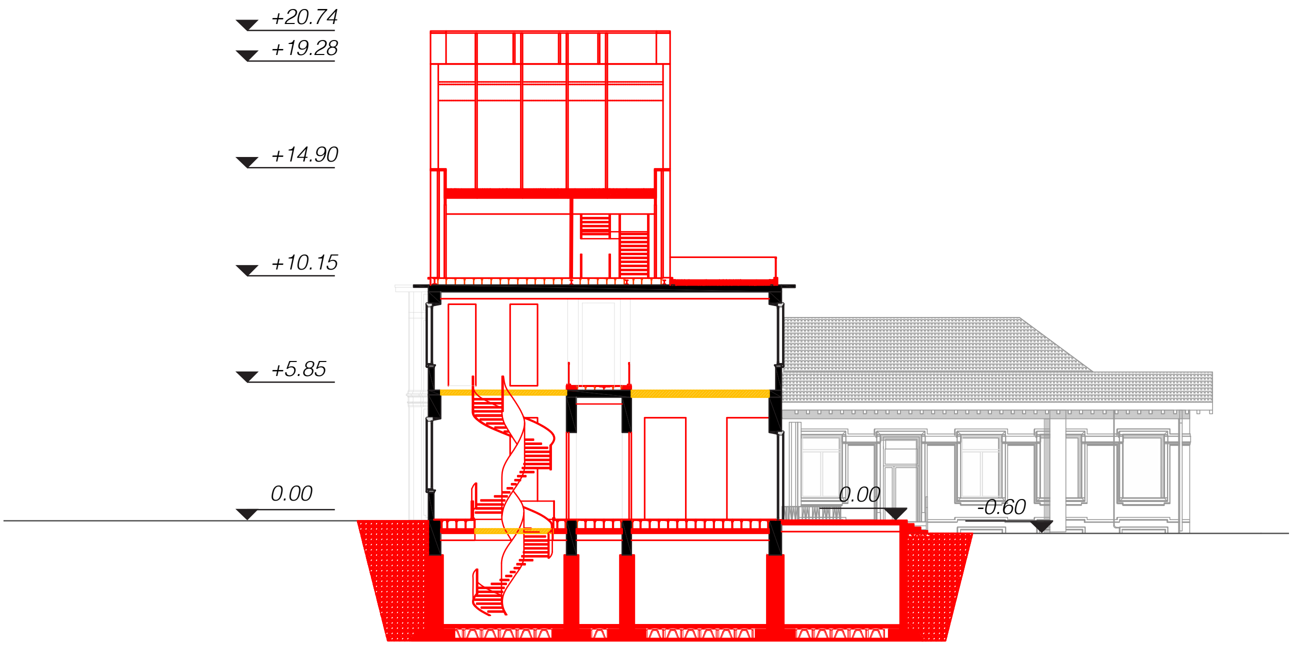
1 Terrace 316.6 sqm
2 WC 4.7 sqm
3 Kitchen 11.5 sqm
4 Seating 44.1 sqm
5 Lift Lobby 23.5 sqm
6 Service Shaft 4.8 sqm

NEW CONSTRUCTION

SECTIONS

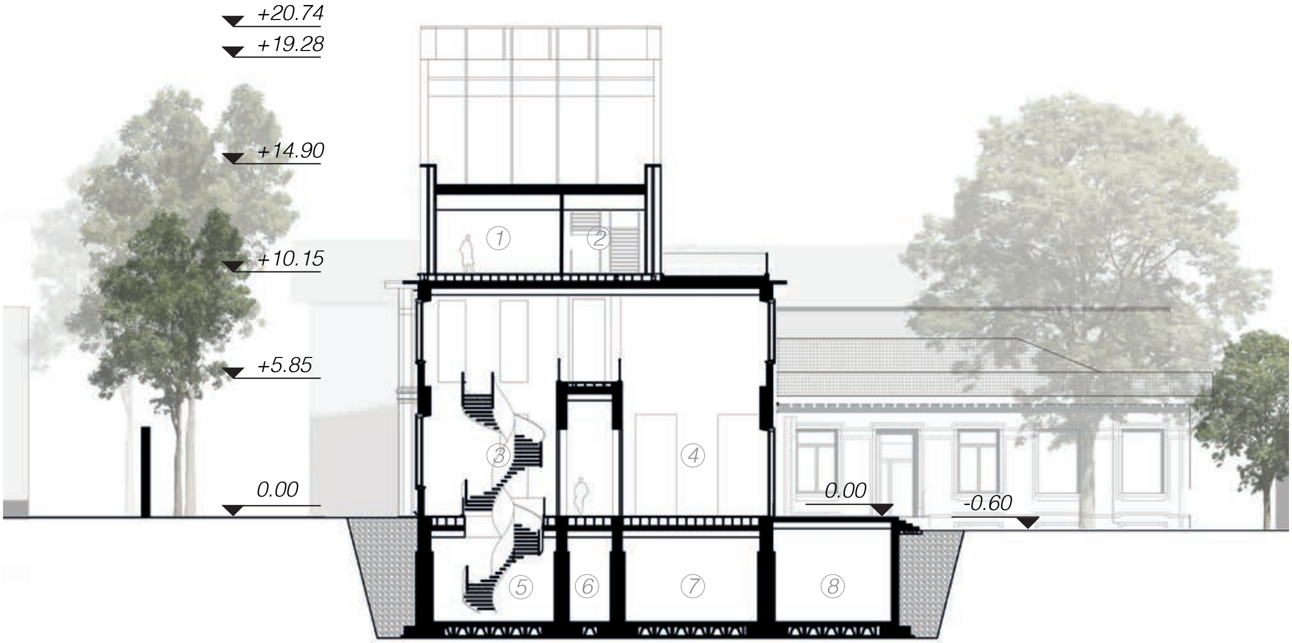
Figure 136: Digitial macquette view for Spiral staircase

A-A SECTION



Existing Building
Demolition
Addition

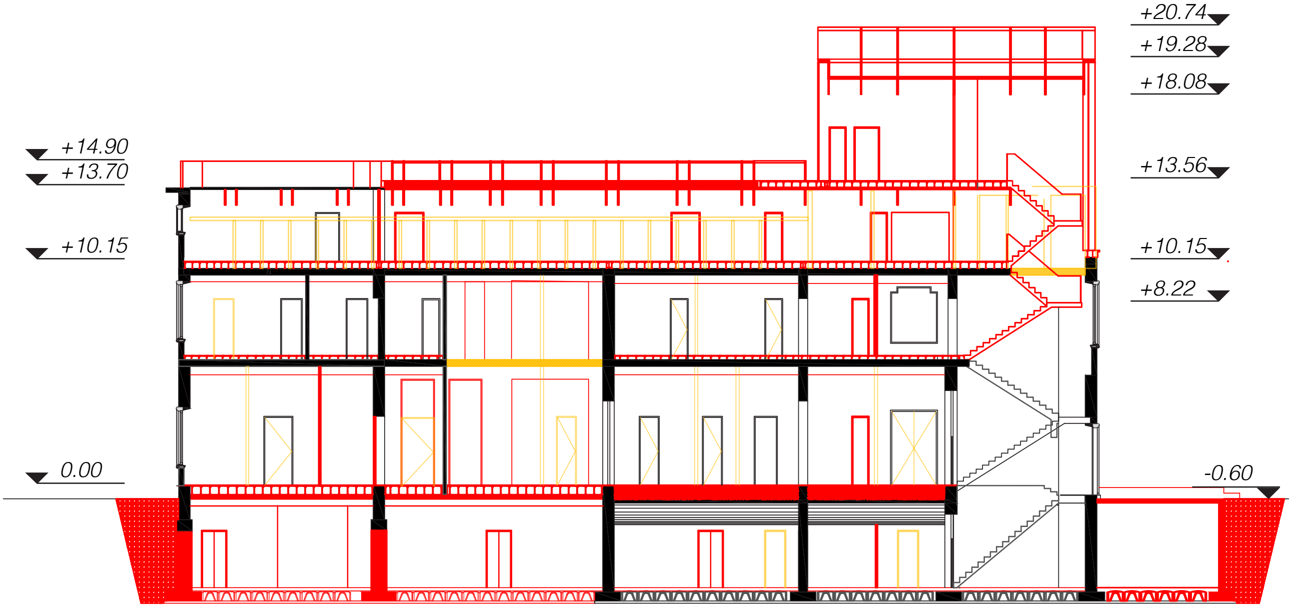
DEMOLITION / NEW CONSTRUCTION



1 Exhibition Area 78.7 sqm
2 Gallery 88 sqm
3 Doc. Receiving 28.2 sqm
4 Reception 18.7 sqm
5 Lift Lobby 41 sqm
6 Corridor 50.2 sqm
7 Repository2 60.6 sqm
8 Repository3 122 sqm

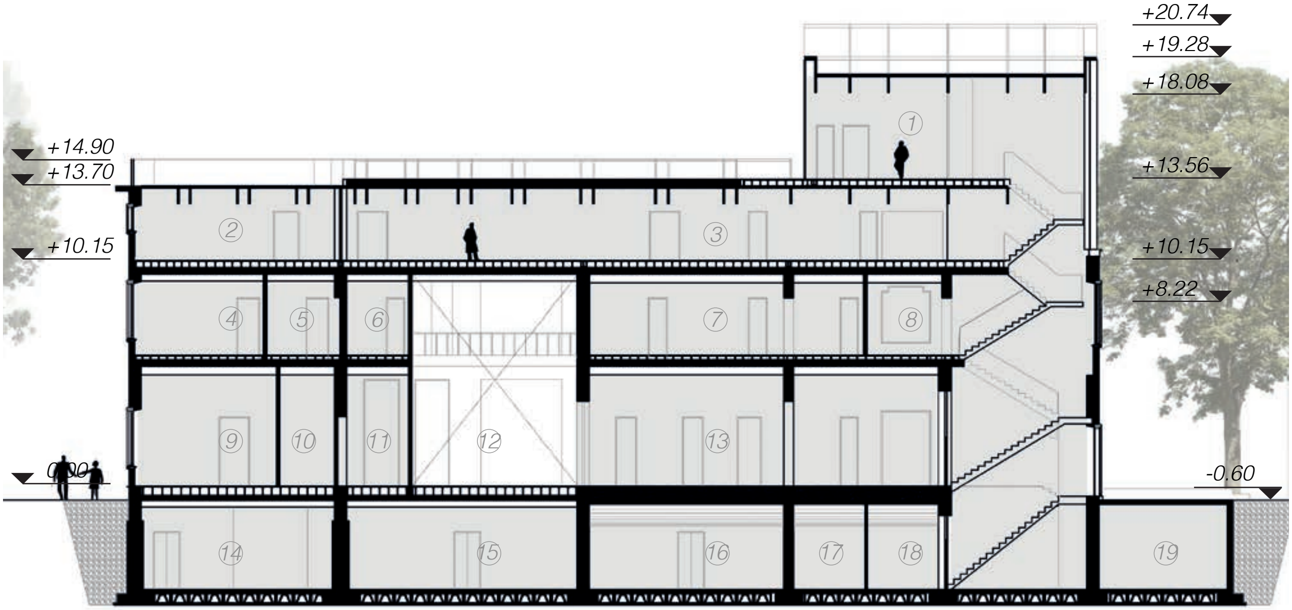
NEW CONSTRUCTION

B-B SECTION



DEMOLITION / NEW CONSTRUCTION

- Existing Building
- Demolition
- Addition



NEW CONSTRUCTION

1. Seating 44.1 sqm
2. Conference Room 87 sqm
3. Exhibition Area 78.7 sqm
4. Shared Office 35 sqm
5. Meeting R. 20.8 sqm
6. Direc. Office 18.2 sqm
7. Spec. Cons. 58.9 sqm
8. Lobby 18.3 sqm
9. Shared Office 35 sqm
10. Staff Locker 7.7 sqm
11. Reception 18.7 sqm
12. Lobby/Lockers 46 sqm
13. Seminar Hall 60 sqm
14. Doc. Repair R. 51 sqm
15. Repository2 60.6 sqm
16. Repository4 58 sqm
17. Corridor 29 sqm
18. Lobby 18 sqm
19. Repository7 135 sqm

ELEVATIONS

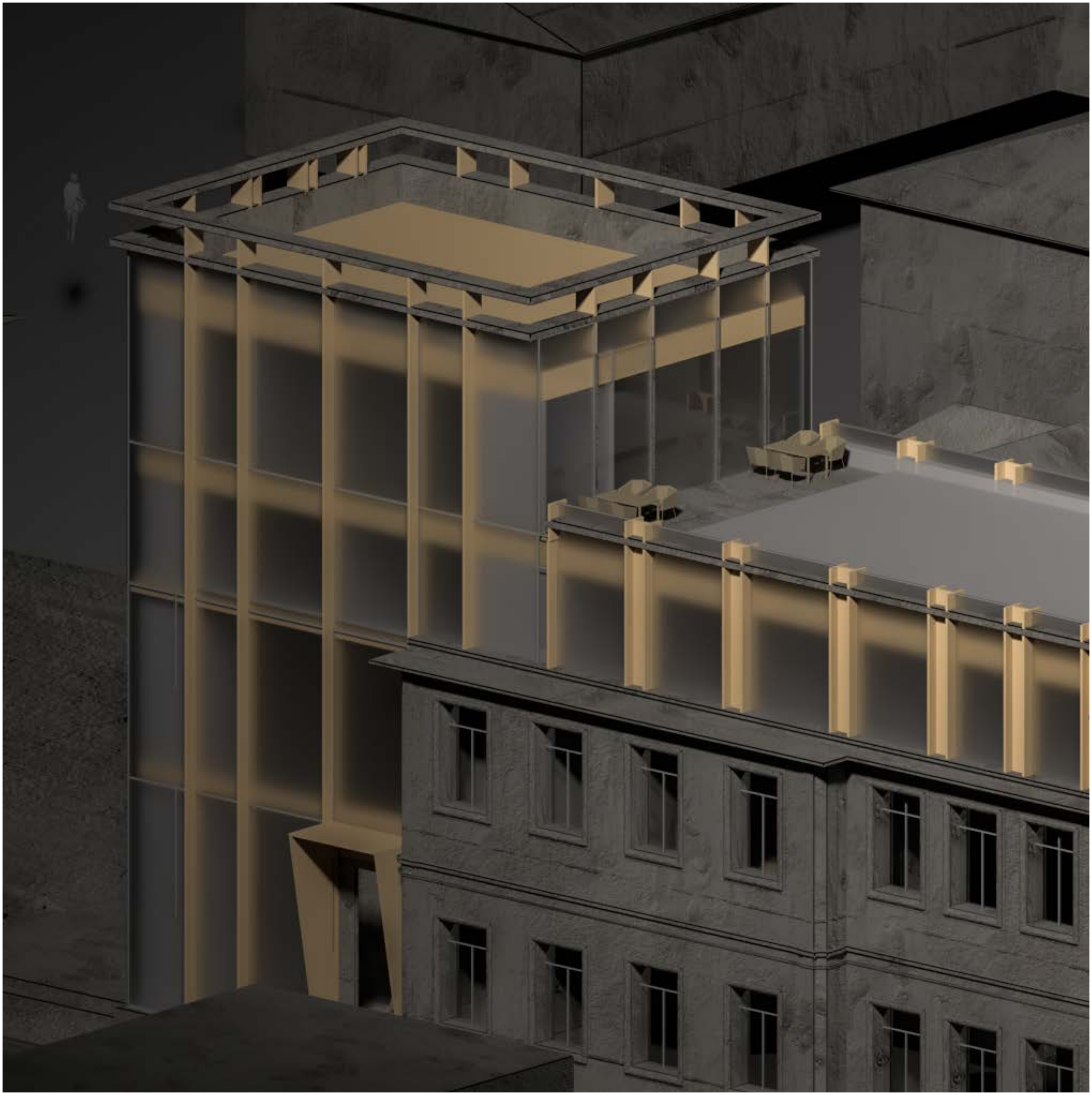
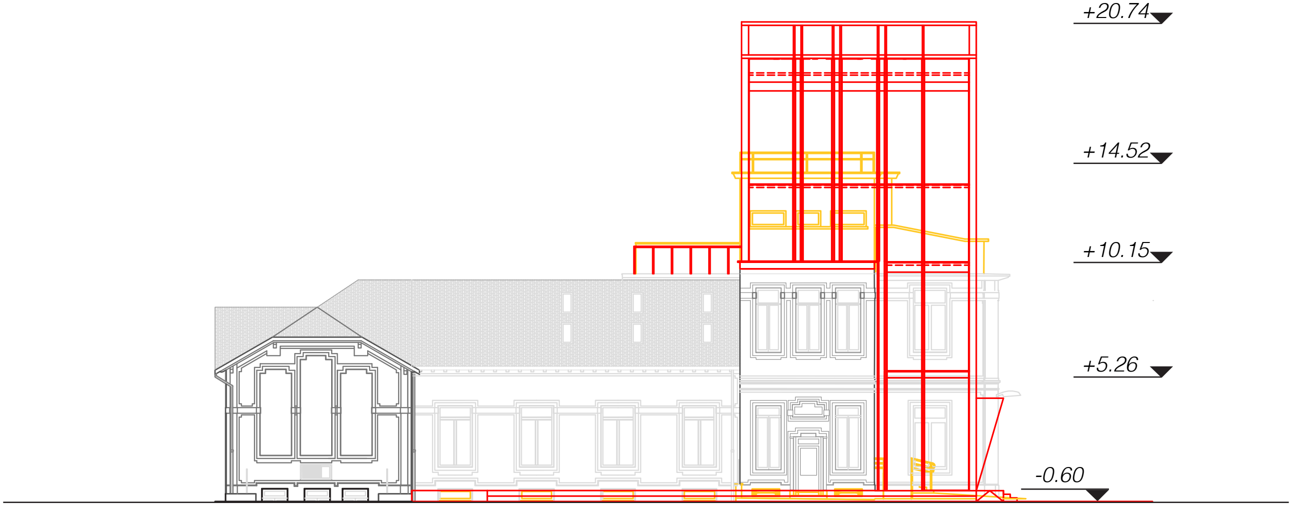


Figure 137: Digitial macquette view for The Tower

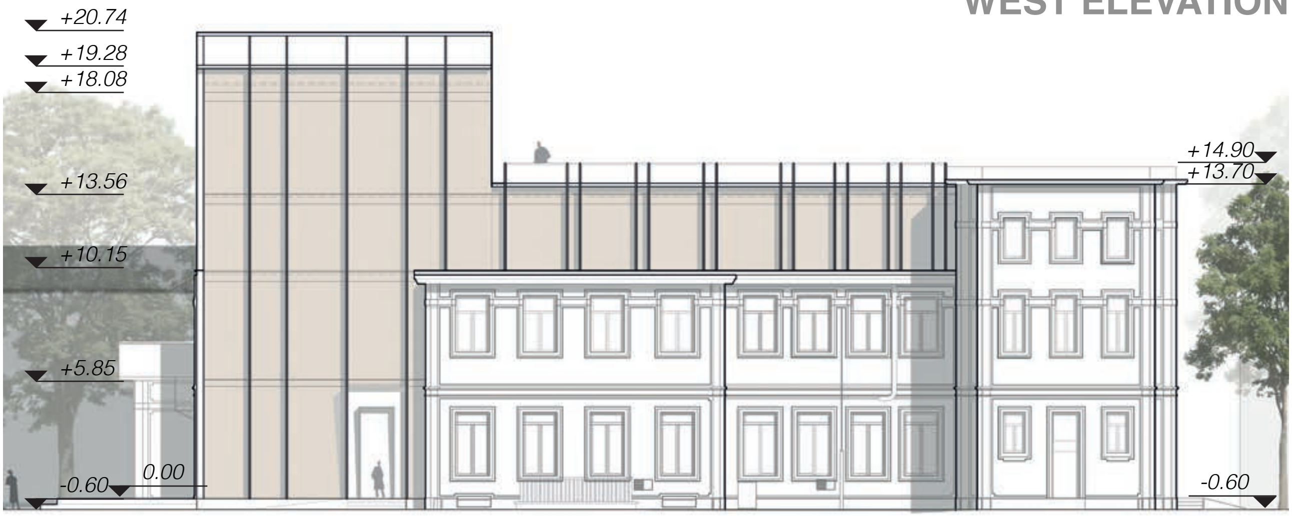
NORTH ELEVATION

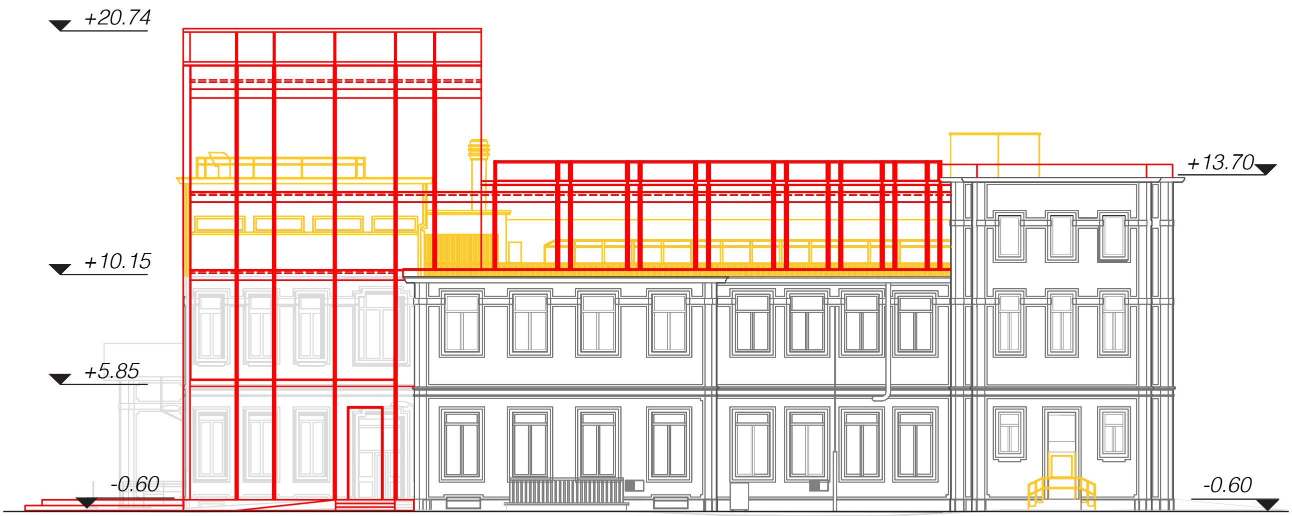


DEMOLITION / NEW CONSTRUCTION

Existing Building
Demolition
Addition

WEST ELEVATION





DEMOLITION / NEW CONSTRUCTION

Existing Building

Demolition

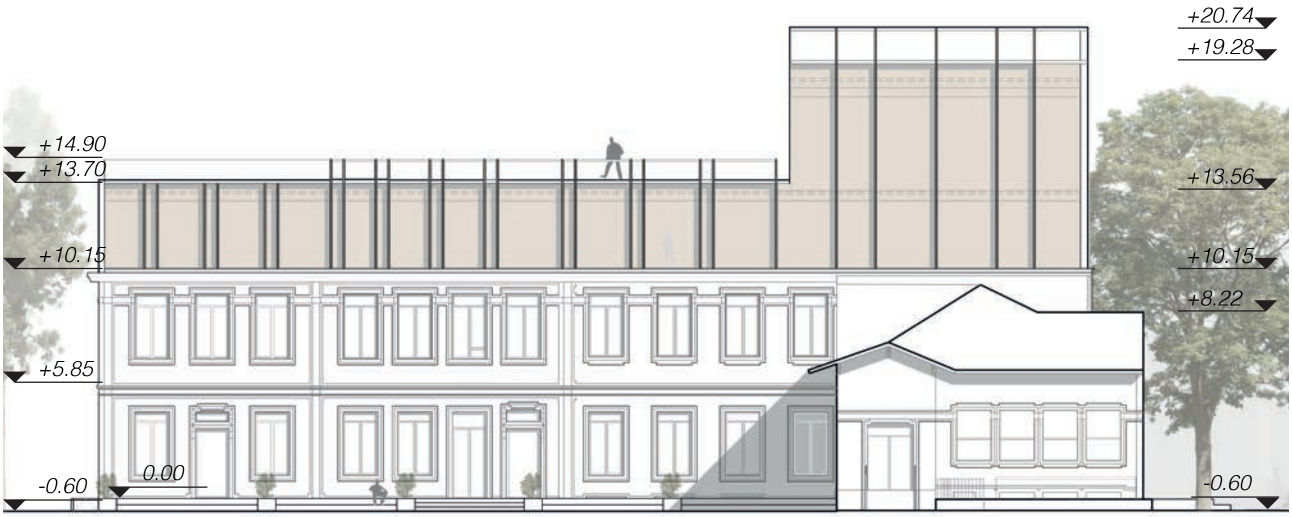
Addition

SOUTH ELEVATION

DEMOLITION / NEW CONSTRUCTION

Existing Building
Demolition
Addition

EAST ELEVATION



DEMOLITION / NEW CONSTRUCTION

Existing Building

Demolition

Addition

Structural Proposal

The additional volume of the intervention is the primary concern for the structural design. The structural system comes out of the need for an environmentally sustainable solution as well as the need for a lighter structure on the load-bearing heritage building.

The primary objective is to integrate a wooden structure which also forms the rhythm of the facade as it is exposed and this is one reason to use level columns as it also serves as a natural insulation to make the envelope more efficient

Figure 138: Close up render of tower

DESIGN REQUIREMENTS:

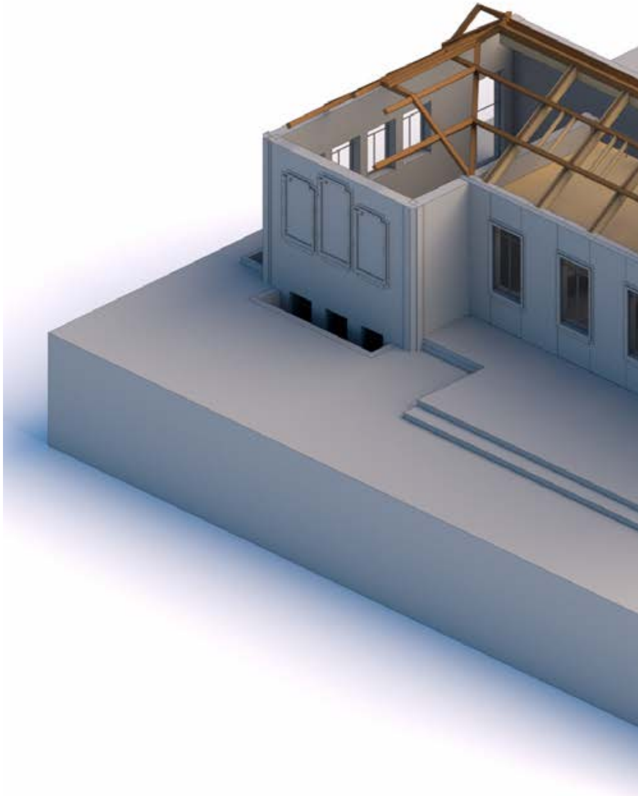
Considering the type of intervention and the context, There are certain important constraints to take into consideration while developing the structural conception of the new.

one of the major considerations is the initial study of the existing structure and its state of working. As the heritage structure is developed as a load-bearing structure with a certain masonry style. The structural system that needs to be developed is based on the load transfer on these structural walls that carry the load to the ground.

Another constraint was to extend the basement under the building. which has been proposed to be achieved using the underpinning method of basement extension.

Since the sustainability part of the intervention demands the use of sustainable materials like wood. For the same purpose, we use LVL beams as the main structural elements. These structural interventions are largely composed of the same material which is exposed on the facade as well to develop the rhythm and style of the facade.

Another major intervention is the demolition of the slab of the attic and creation a double height space which is later occupied by a mezzanine floor.



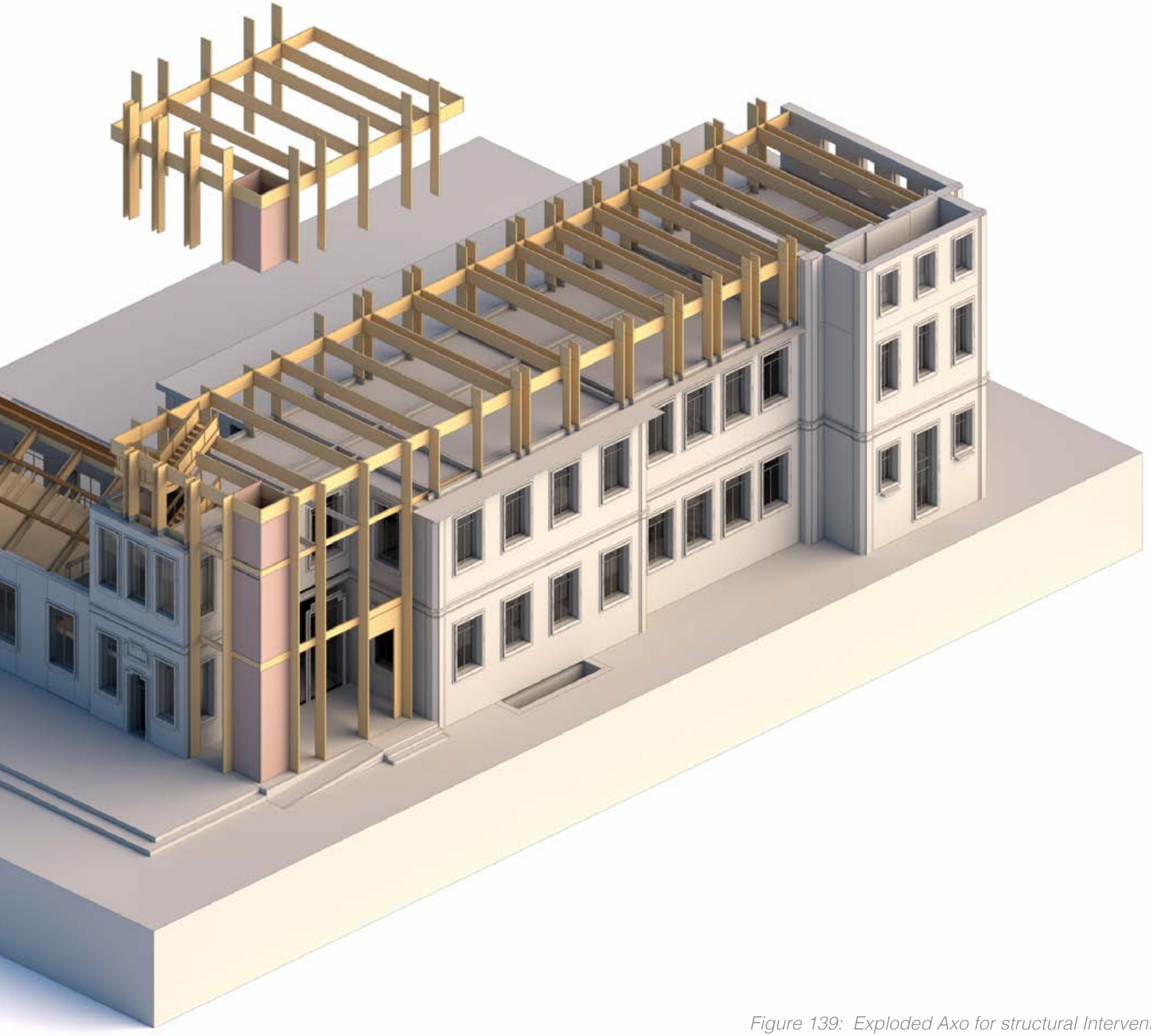


Figure 139: Exploded Axo for structural Intervention

DESIGN PROPOSAL:

The general structure is designed in 3 layers which are the CLT slabs which act as a one-way slab, bringing the load of the green roof and the museum live load to the main beams.
These main beams are formulated using the LVL beams 7.5 x 70 cm cross-section and they span 918 cm. These beams are further connected to the columns using a steel plate connection which goes 20 cm deep in the beam to avoid shear failure.
The Columns are composed of LVL Sections 7.5 X 50 cm in cross-section. which further takes the load to the bottom surface, which in this case is the slab of the old building and partly the ground where the geometry is completed. In the case where they are resting on the existing second-floor slab, they rest on the i-beam sections which convert this point load to evenly distributed loads and hence distribute the load evenly on the load-bearing walls.
The entire section is composed of LVL beams that sandwich the steel section in between. hence providing the seismic proof layer in the middle of the structure. For the case of lateral movement, we use bending-resistant connections in the structure by providing steel connections and a pair of sub-beams, which help stop lateral movement within the structure.

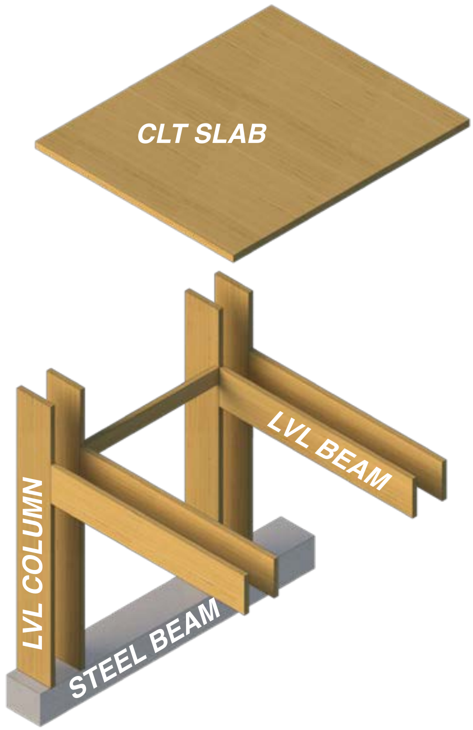


Figure 140: Structural system

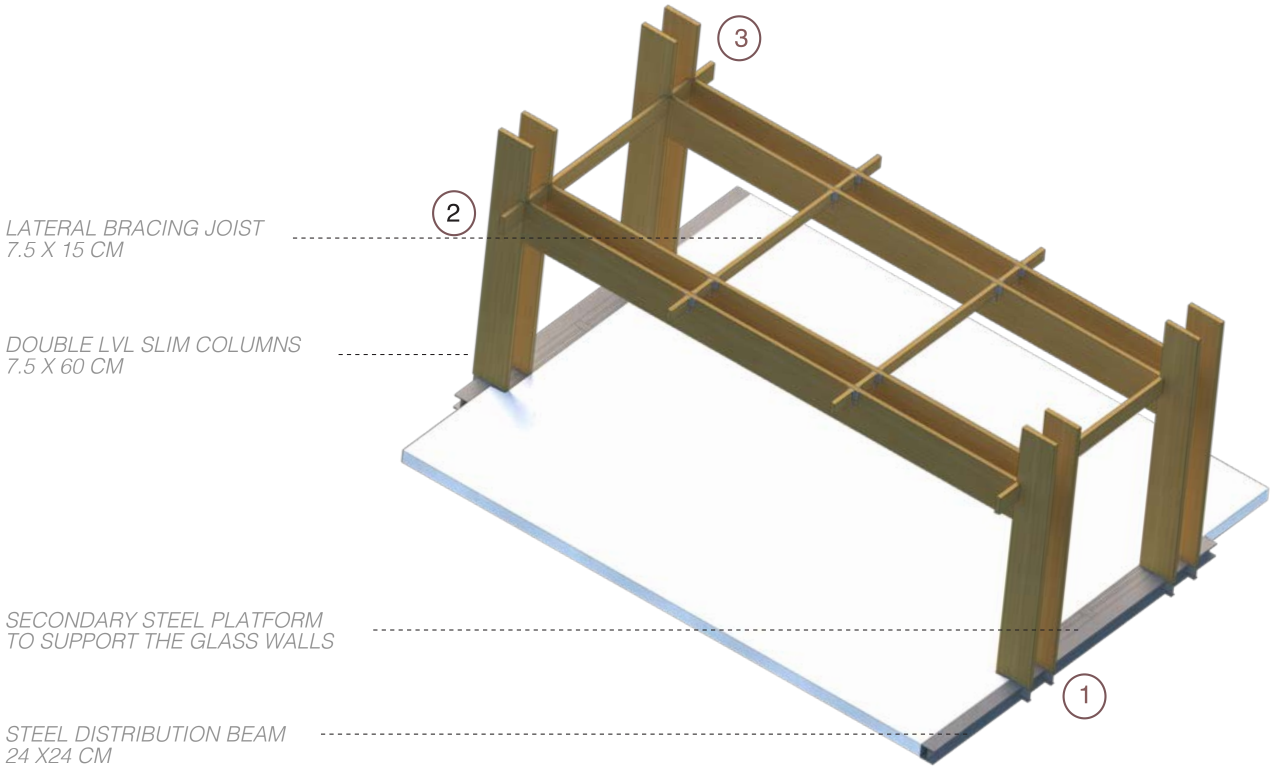


Figure 141: Single Structural Module

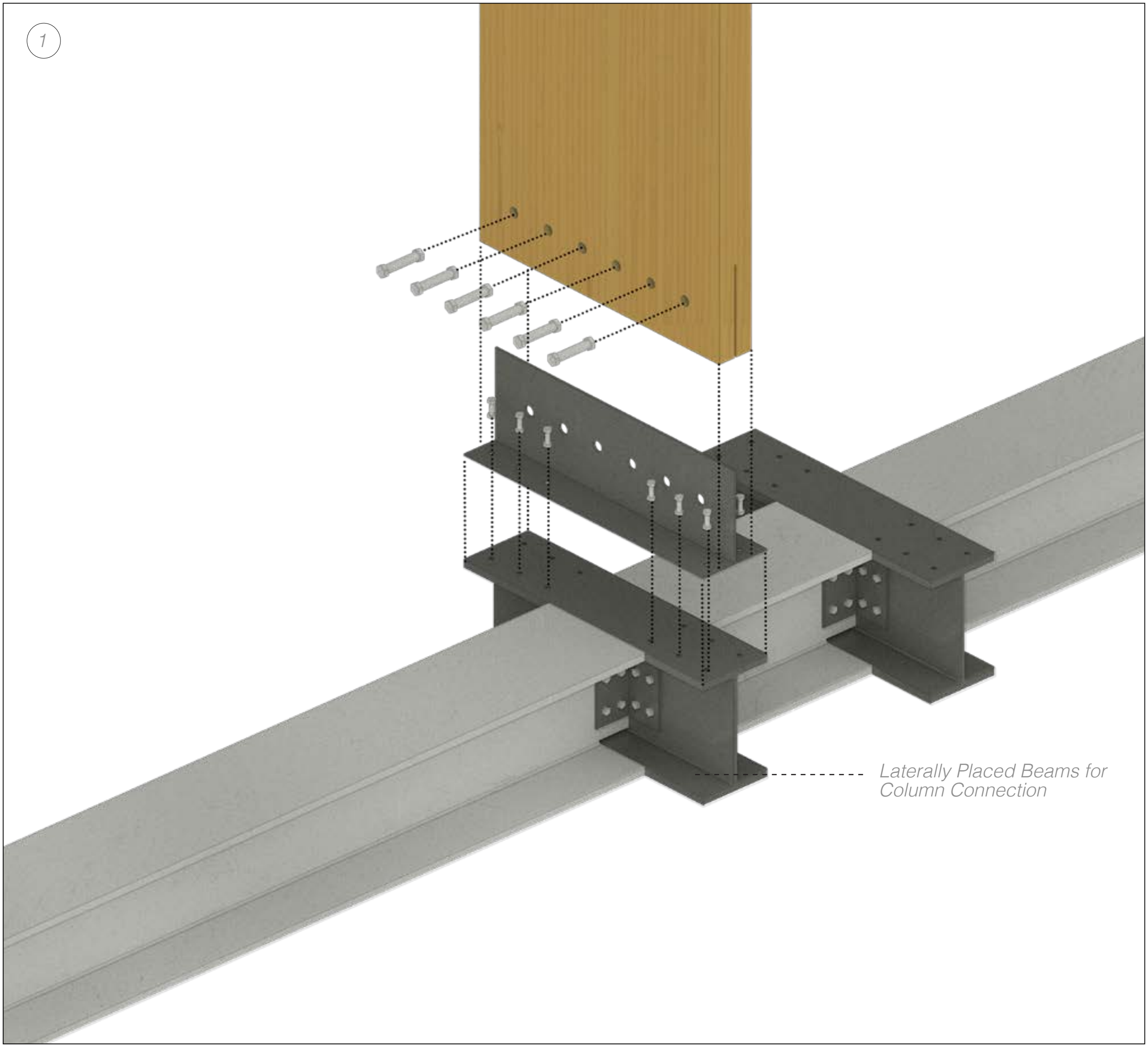


Figure 142: Column and Distribution Beam connection (M25 Bolts)

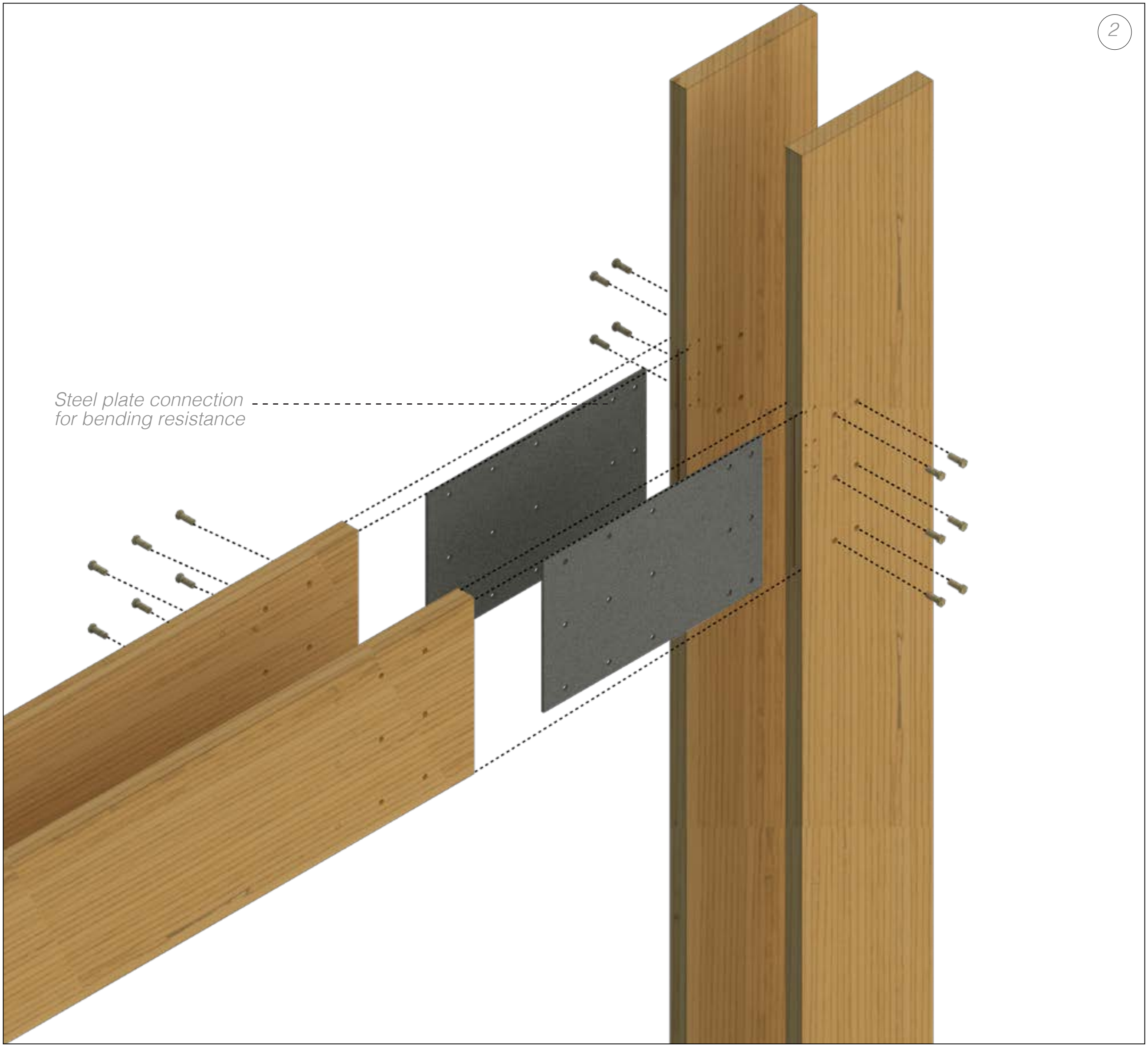


Figure 143: Main Beam connection (M25 Bolts)

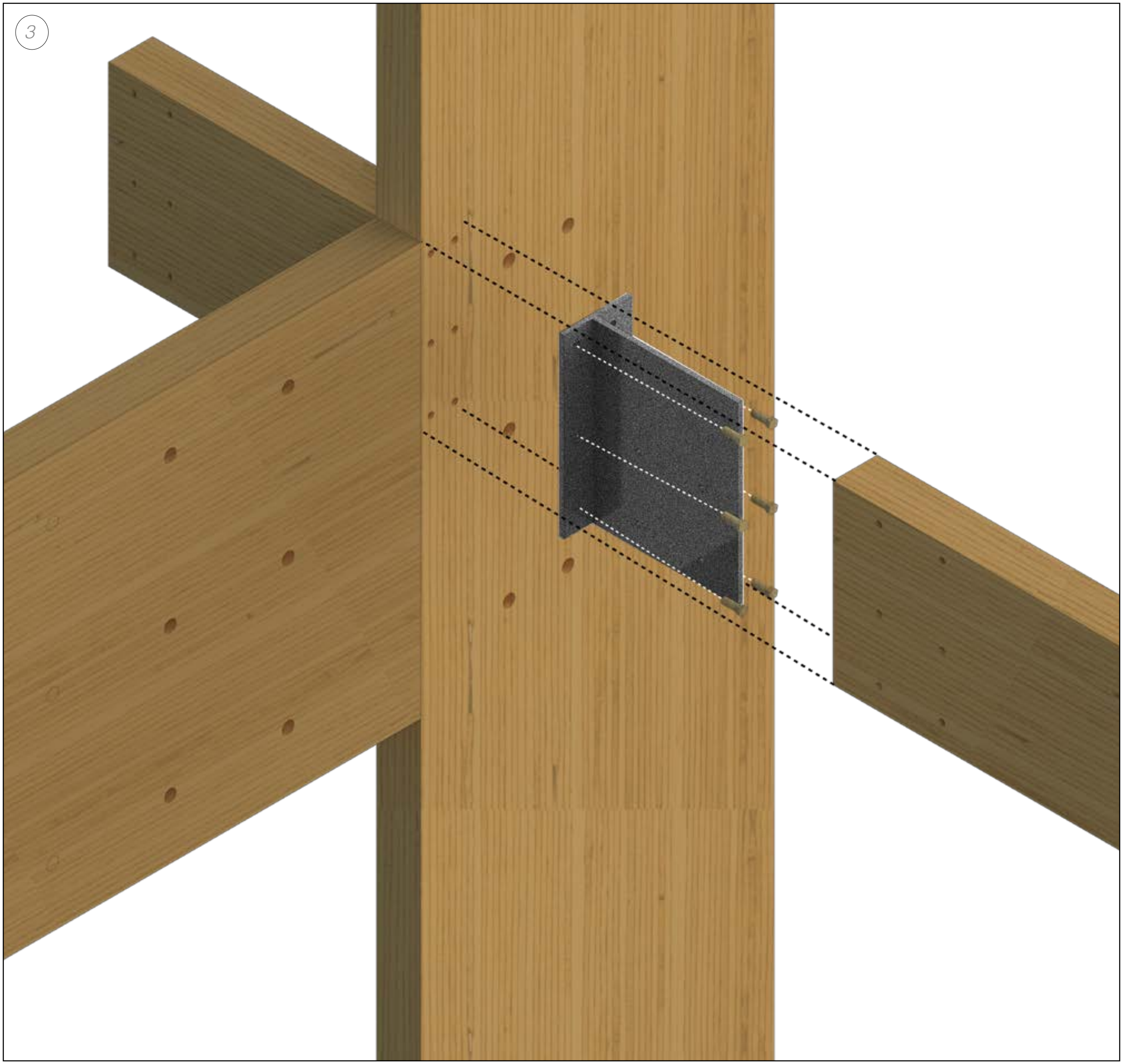


Figure 144: Lateral Beam Connection

Mezzanine Design :

The transformation of the new mezzanine floor in the smaller wing is conceived removal of the existing Latero Cemento slab and the transformation of the existing truss system into a rafter system.
This is conceived by using LVL beams for the rafters and a Glulam beam to support the existing ridge beam.
whereas the mezzanine floor itself is conceived in CLT panel Floors and LVL beams which are supported by existing Load bearing walls. These are walls are shaped into columns to free up space and to work as columns.

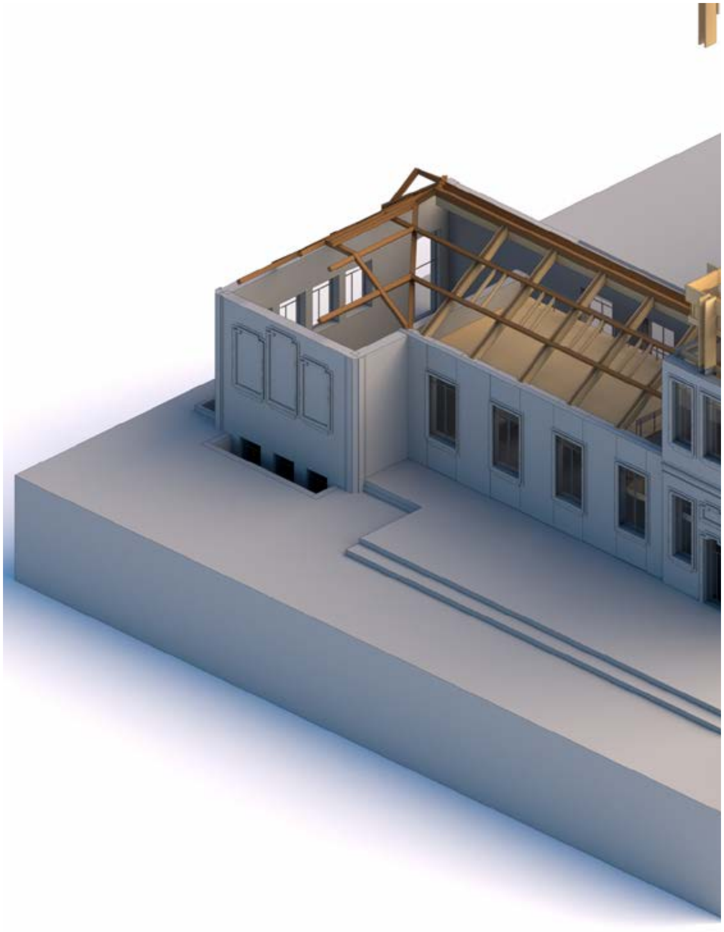


Figure 145: Axo for the Mezzanine Transformation

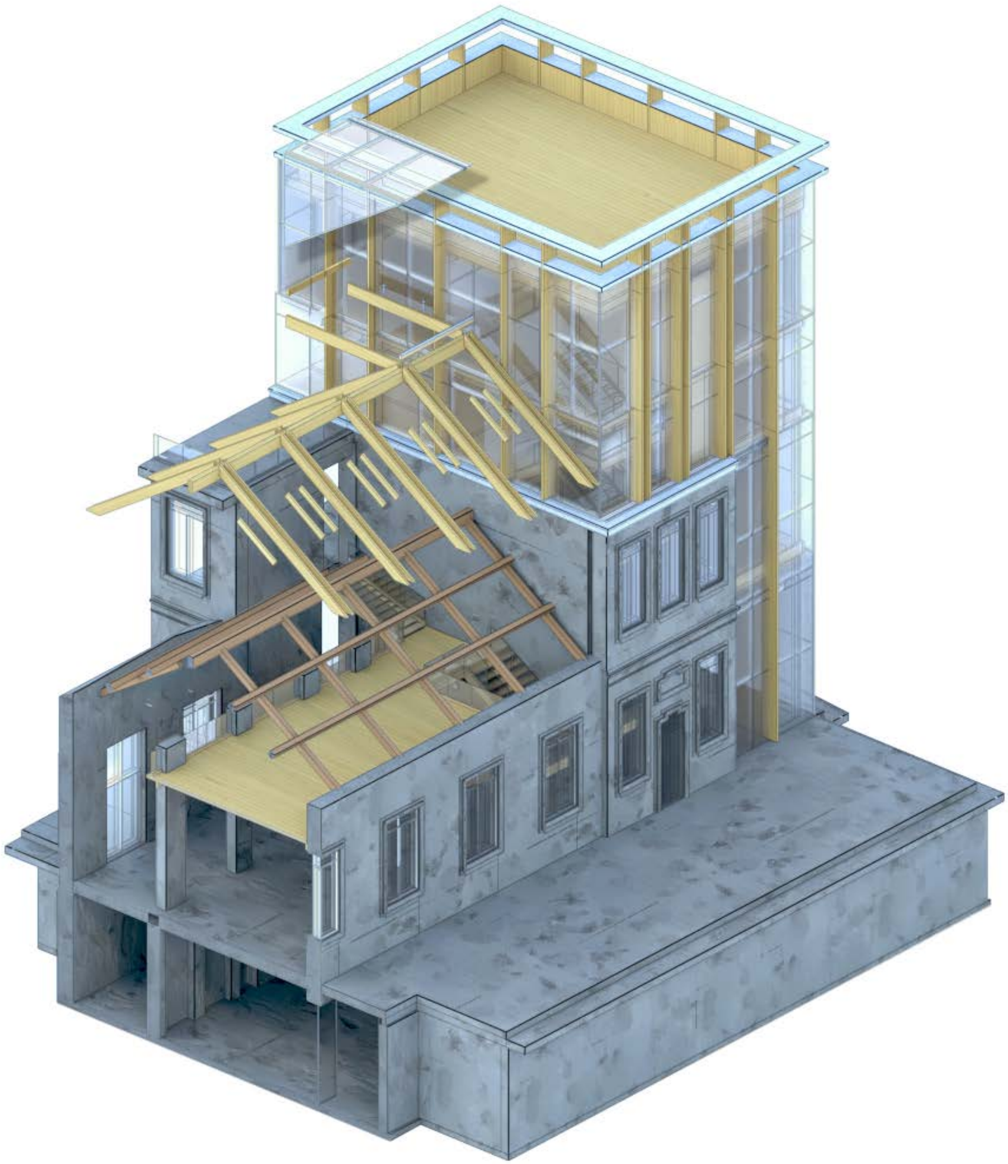


Figure 146: Exploded diagram for the construct of the Rafter System

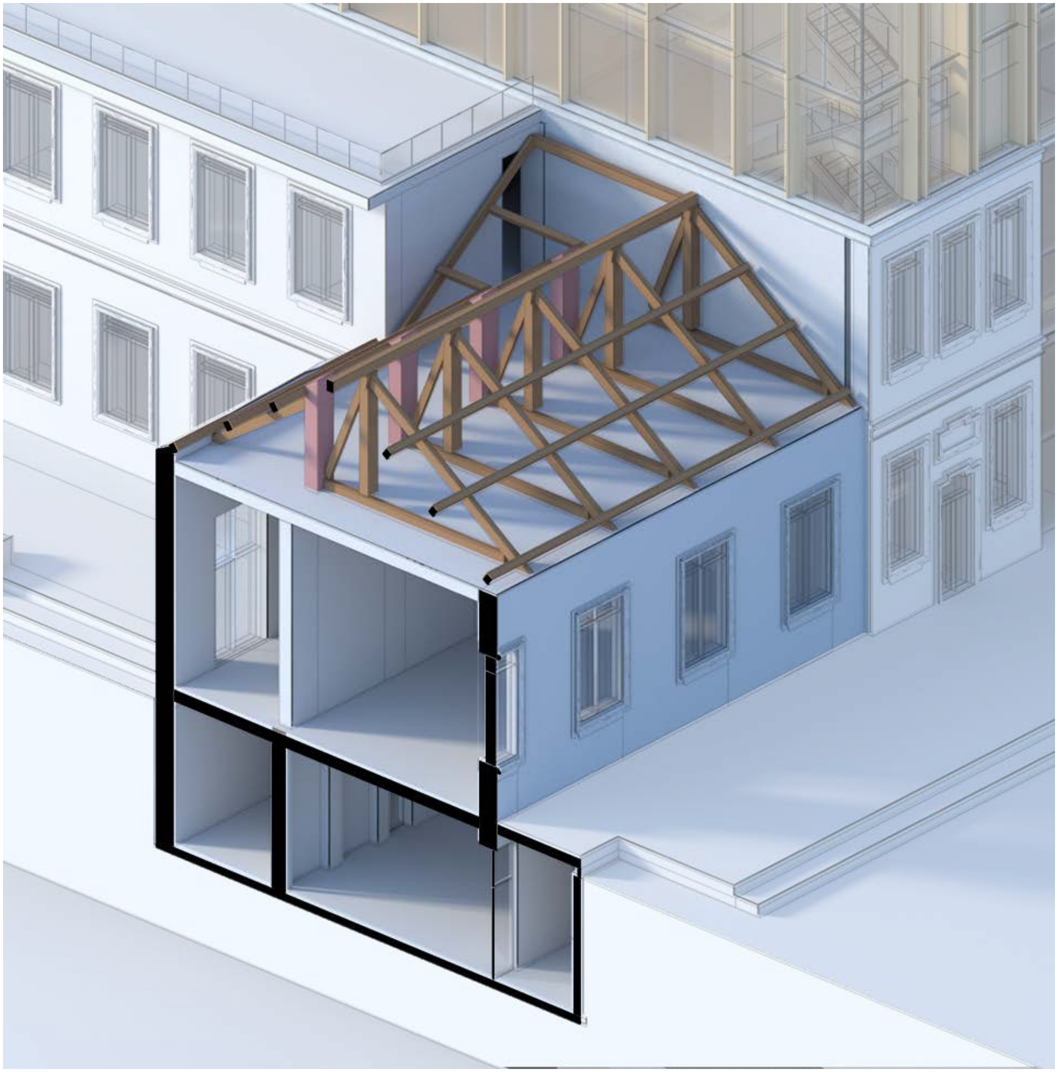


Figure 147: Existing Truss system for the building

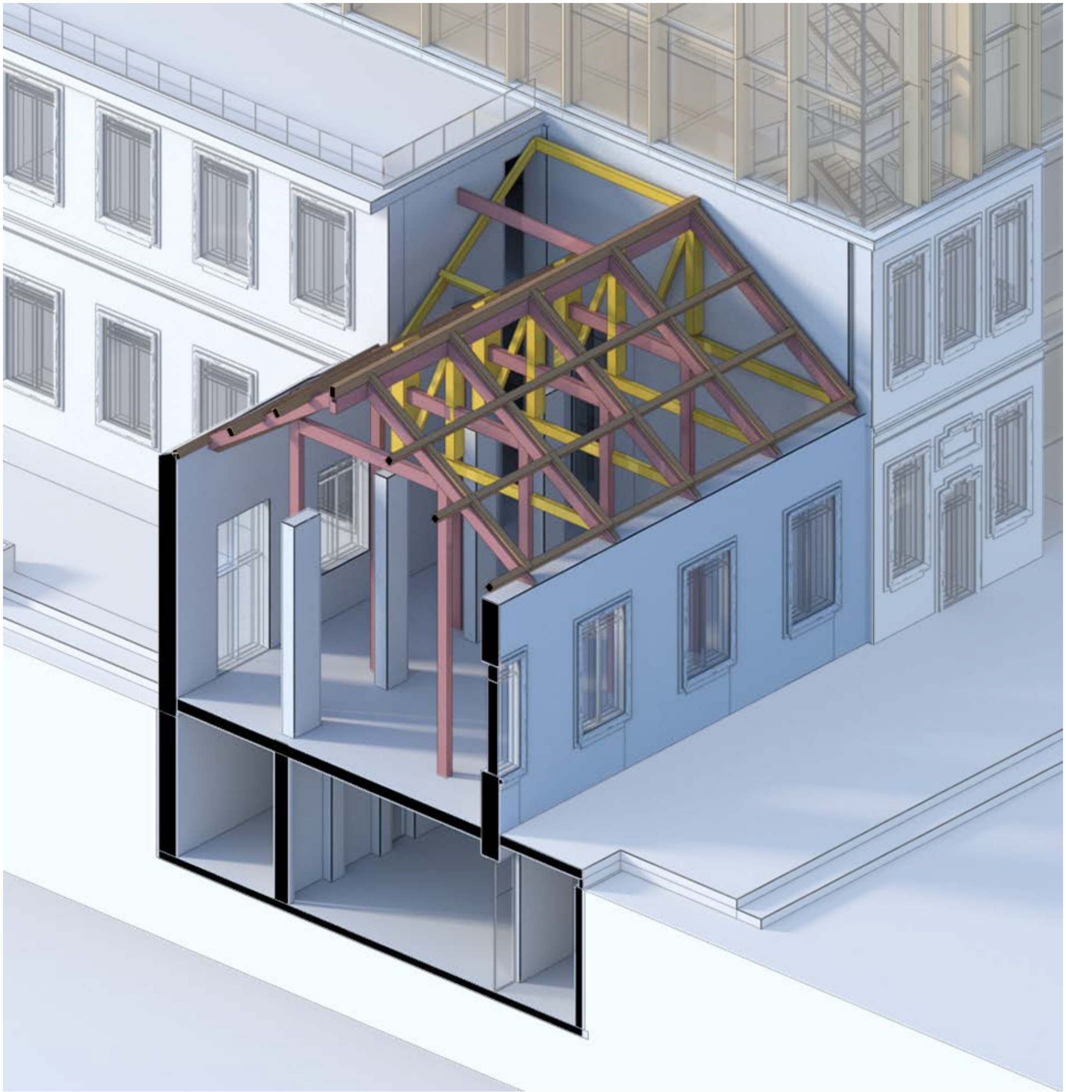


Figure 148: Transformation process for the Rafter system

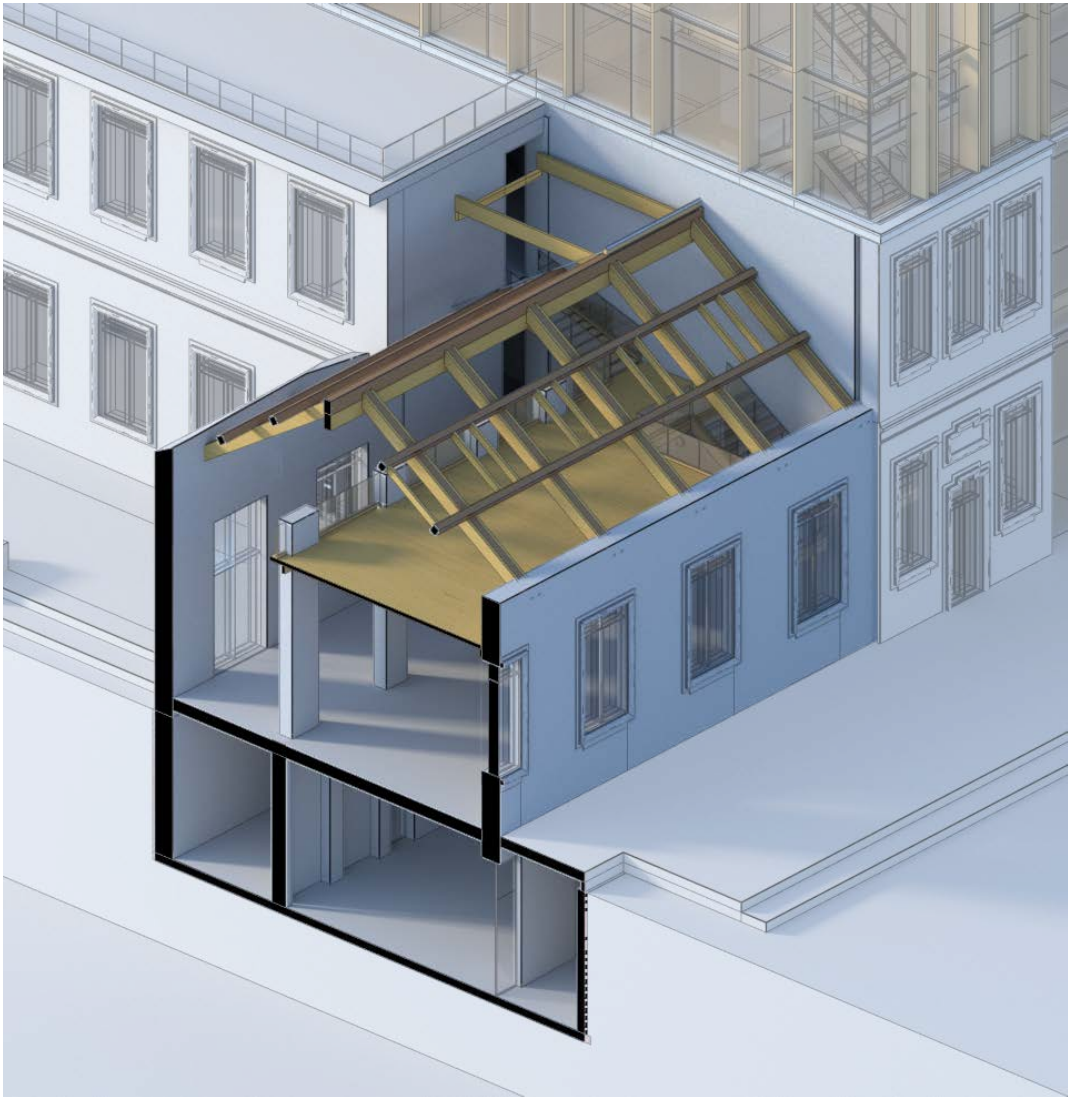


Figure 149: Final Transformed roof with mezzanine

CALCULATION:

The scope of this computation is to calculate the general layout of the main structure, to compute the cross sections for the beams and columns to be used.

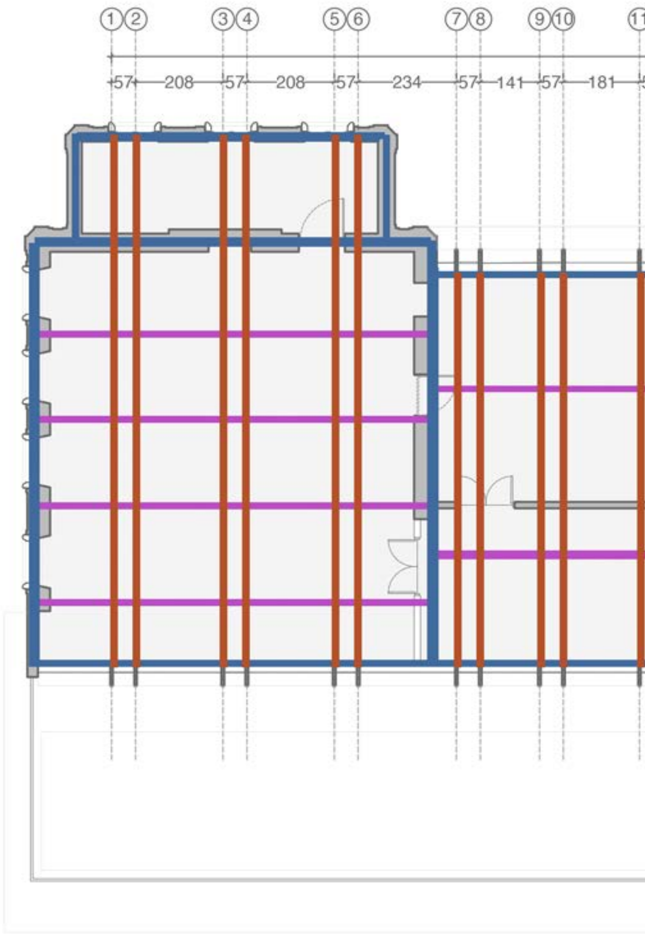
The structure can be divided into two parts:

- Tower
- Exhibtion volume

The columns are laid in a didactic grid in the exhibtion volume whereas the tower is a construct of unequally placed columns with a certain level of symmtery to the facade.

For the computation a general cross section size we use the biggest slab size which is 918 x 306 cm.

The Initial step being the categorization of the load types through the building,-i.e.-



Live load:

Load category :

From Table 6.1. EN 991-1-1:2002(E)

Café – C1

Exhibition – C3

Green terrace - C5

Roof for basement extension – C5

Slab for ground floor (new basement generation) – C5

C1 : qk=2.0 - 3.0 kN , Qk= 3.0 - 4.0 kN

C3 : qk=3.0 - 5.0 kN , Qk= 4.0 - 7.0 kN

C5 : qk=5.0 - 7.5 kN , Qk= 3.5 – 4.5 kN

E1 : qk=7.5 kN , Qk= 7.0 kN

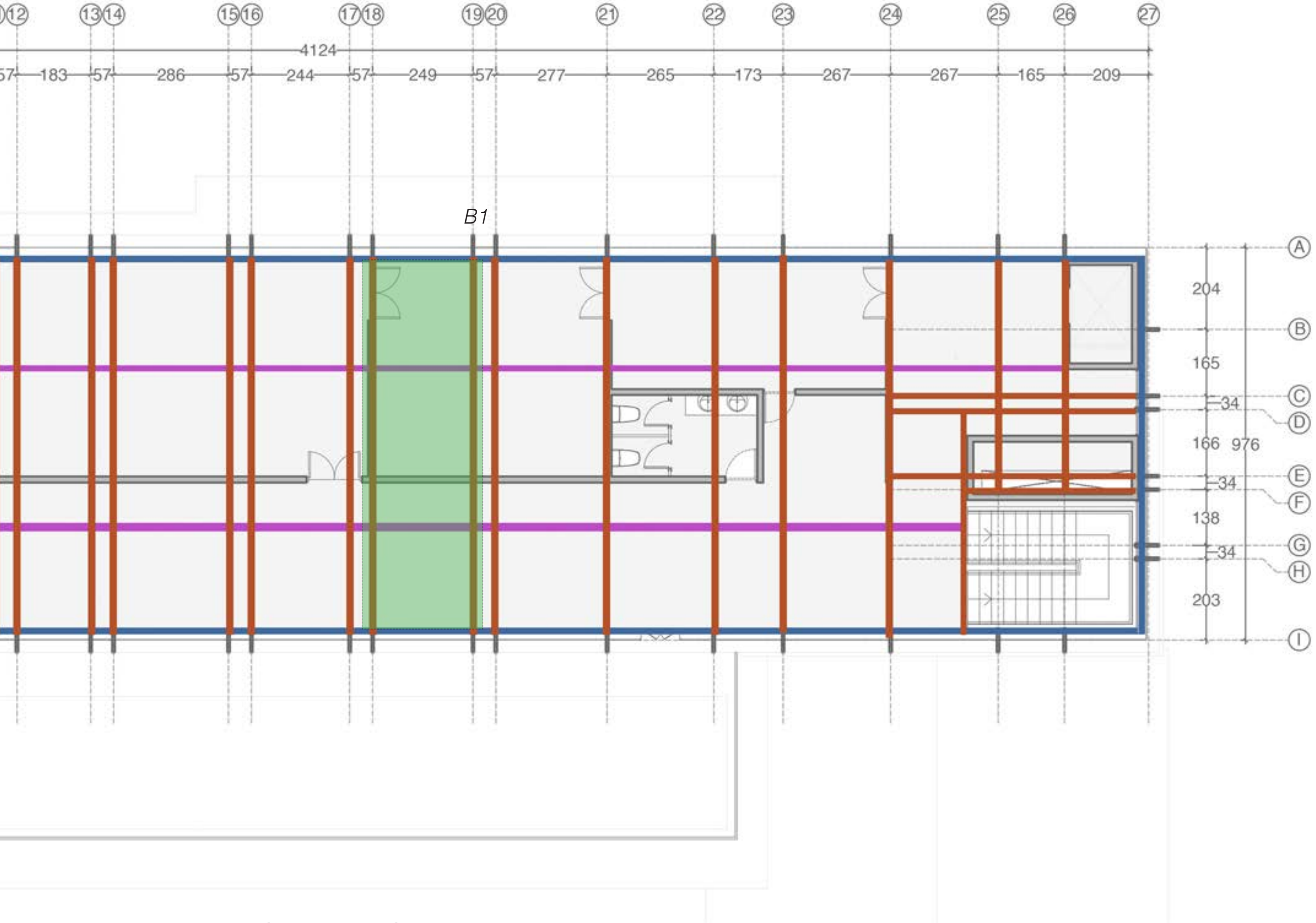


Figure 150: Second Floor Structural Plan

Types of beams

- Main beams
- Edge beams
- Joist beams

Slab to calculated

Live Load calculation:
For caffe- live load = *3.0 KN/m²*
For green roof - live load = *7.5 KN/m²*
For museum Space - live load =*5.0KN/m²*

Dead Loads:
To compute the dead load on the structure we compute the dead loads of various floor sections available throughout the building. Three major floor sections throughout the building are listed below:

1. Section-1: Green roof Section:

Refering to the figure, we compute the self weight of the green roof;
$D.L._{green}$= 1.12 kn/m²

2. Section-2: Floor of museum in the tower:

Refering to the figure, we compute the self weight of the floor;
$D.L._{floor}$= r

3. Section-3: Floor of exhibtion space over existing :
This section rests on the existing structure. The assumption here is that the existing structure is sufficiently designed to support this load. But to be sure there is a need to further investigate with the use of intrustive tests for structural capacity of the existing structure.

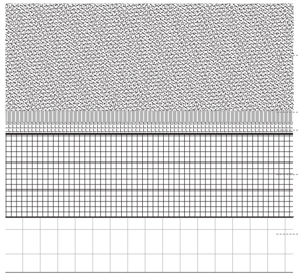


Figure 151: Green roof Section

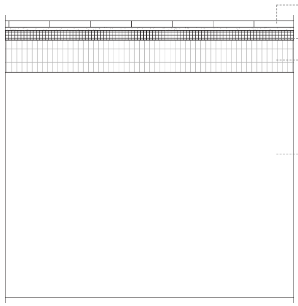


Figure 152: Museum Floor section

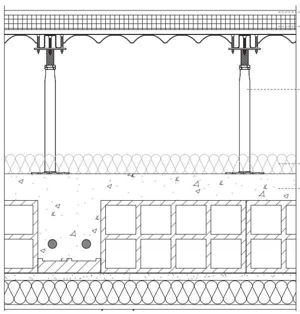


Figure 153: Raised floor for exhibition space

Materials:

BEAMS AND COLUMN :

LVL S-Beam-
majority of the structure is composed of LVL beams. For the LVL beams we use the Metsa wood Production. We use the Available sections as a reference to size our section.
This material is used for both beams and columns.

Kerto® LVL
S-beam

Overall dimensions

	MINIMUM (mm)	MAXIMUM (mm)
Thickness	27	75
Width/height	40	2,500
Length	2,000*	25,000**

* Short lengths are available on request (< 2,000 mm).
** For products wider than 1,830 mm, maximum length is 20,000 mm.

Figure 154: LVL beam Sizes

SLABS

CLT Panels-
For the application of oneway slabs we use the cross laminated timber panels. These are Prefabricated panels , Which are three layered (3Cs).
The technical data is taken from Stora Enso Brochure.

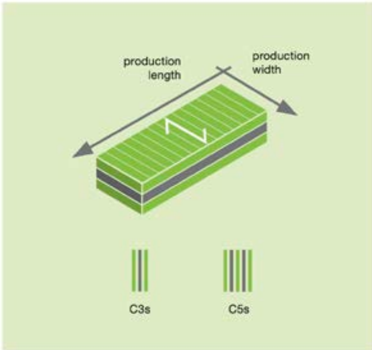


Figure 155: CLT Panel design

C panels
The grain direction of the cover layers is always parallel to the production widths.

Thickness [mm]	Panel type [–]	Layers [–]	Panel design [mm]						
			C***	L	C***	L	C***	L	C***
60	C3s	3	20	20	20				
80	C3s	3	20	40	20				
90	C3s	3	30	30	30				
100	C3s	3	30	40	30				
120	C3s	3	40	40	40				
100	C5s	5	20	20	20	20	20		

Figure 155: CLT Panel Sizes

Calculations:

WOODEN BEAM CALCULATION:

1. Load information

Beam Lenght L	8.98	m	8980 mm
Influence area width "a"	1.65	m	
Linear load g1'	0.268	kN/m	Dead load: Beam self weig
load from joist	NA	kN/m2	Dead load: Floor Self weig
actual load from joist	4.35	KN/m	
Area load Q1	5	kN/m2	
Linear load q1	8.3	kN/m	Live load: green roof

2. M_ED External Bending Moment Calculation

Load ULS COMB	16.99	kN/m	$1.35\,G + 1.5\,Q$
Load RARA COMB	4.62	kN/m	

M_ED_ULS (ql^2/2 or software value)	171.29	**kNm**	**171287770 Nmm**

3. Choose Timber Class

lvl class	**48p**	
fm,k	44	MPa
γM	1.2	
fm,d	**29.3**	**MPa**
fv,k	**4.2**	MPa
γM	1.2	
fv,d	**2.80**	**MPa**

4. Choose the cross section such as it satisfies all the checks

Beam chosen

h	**700**	**mm**	**0.7**
b	**75**	**mm**	**0.075**

W	6,125,000	**mm3**
Iy	2,143,750,000	**mm4**
E0,05	**11600**	**MPa**

5. Bending stress check

27.97 < fm, d **OK**

6. Check maximal instantaneous displacements for RARA combination (D + L)

delta_max L/400 **22.45 mm**

delta simple beam $\delta = \frac{5}{384}\frac{ql^4}{EI} =$ **15.7 mm** **OK**

7. Check Shear ULS COMB

Av (area resisting in shear)	**52500**	**mm2**	
V_Ed_ULS	**76297**	**N**	*Note: only one value*
$k_{cr} \cdot f_{v,d}$ =0.67 * fv,d	1.88	MPa	
$\tau_{v,d} = \frac{3}{2}\frac{V_d}{A}$ =	**2.18**	MPa	**KO** $\tau_{v,d} \leq k_{cr} \cdot f_{v,d}$

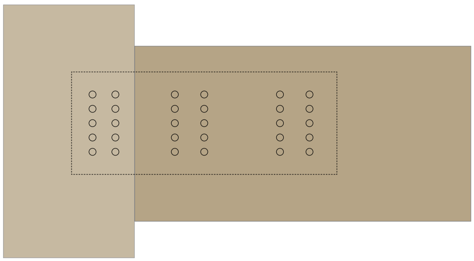


Figure 156: Beam-Column Connection with Steel plate

Following the calculations fo the wooden beams we use a steel plate insert in the lvl beam, which should be 20 cm deep into the beam also serving as the connection type this helps stablize the beam in shear. Hence roviding a solution for the beam. This helps us use a smaller wooden section for the beam.

The final main beam section utilized is :

7.5 X 70 cm

Calculations:

WOODEN COLUMN CALCULATION:

1. Obtain N_ED Axial force		Obtain N_ED data from "Part 3: Pillar Total Load Calculation"		
N_ED	**62**	**kN**	**62000**	**N**
2. Choose Timber Class				
LVL class C…	**48p**			
fc,0,k	35	MPa		
γM	1.3			
$f_{c,0,d} = k_{mod} \frac{f_{c,0,k}}{\gamma_M}$:	**21.5**	**MPa**		
3. Choose the cross section such as it satisfies all the checks				
Beam chosen				
h	**500**			
b	**75**			
W	3,125,000	**mm3**		
Iy	781,250,000	**mm4**		
E0 mean	**10000**	**MPa**		
E,005	**6700**	**MPa**		
A	37500	mm2		
i_min	**144.5**	**144.3**		
4. Calculate design compressive stress				
$\sigma_{c,0,d} = \frac{N_d}{A}$	**1.65**	**MPa**		
5. Calculate λ				
l=	**9**	**m**	**koef=**	**1**
lo=	**9000**	**mm**		
λ=	**62.3**	**<**	**180**	**OK**

6. Calculate Buckling resistance

$\sigma_{c,crit} = \pi^2 \frac{E_{0,05}}{\lambda^2}$	**17.03** MPa			
$\lambda_{rel} = \sqrt{\frac{f_{c,0,k}}{\sigma_{c,crit}}} =$	**1.43**	$\lambda_{rel,y} = \frac{\lambda_y}{\pi}\sqrt{\frac{f_{c,0,k}}{E_{0,05}}}$		1.43
$k = 0,5\left[1 + \beta_c\,(\lambda_{rel} - 0,3) + \lambda_{rel}^2\right] =$	**1.64**		**beta_c**	**0.2**
$k_c = \frac{1}{k + \sqrt{k^2 - \lambda_{rel}^2}} =$	**0.41**			

7. Verification of the failure condition

$\frac{\sigma_{c,0,d}}{k_c\, f_{c,0,d}}$	0.19 <1	**check**	**OK**

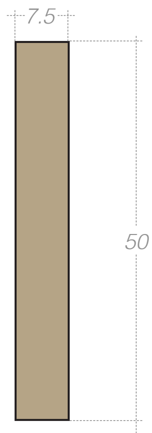


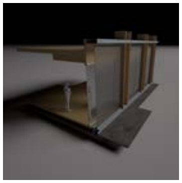
Figure 157: Column Cross-section

From the following calculations we compute the final size for the columns which is:

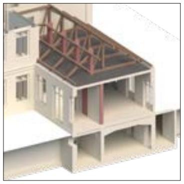
7.5 X 50 cm

DETAILS

FACADE DETAILS



MEZZANINE DETAILS



FACADE DETAILS

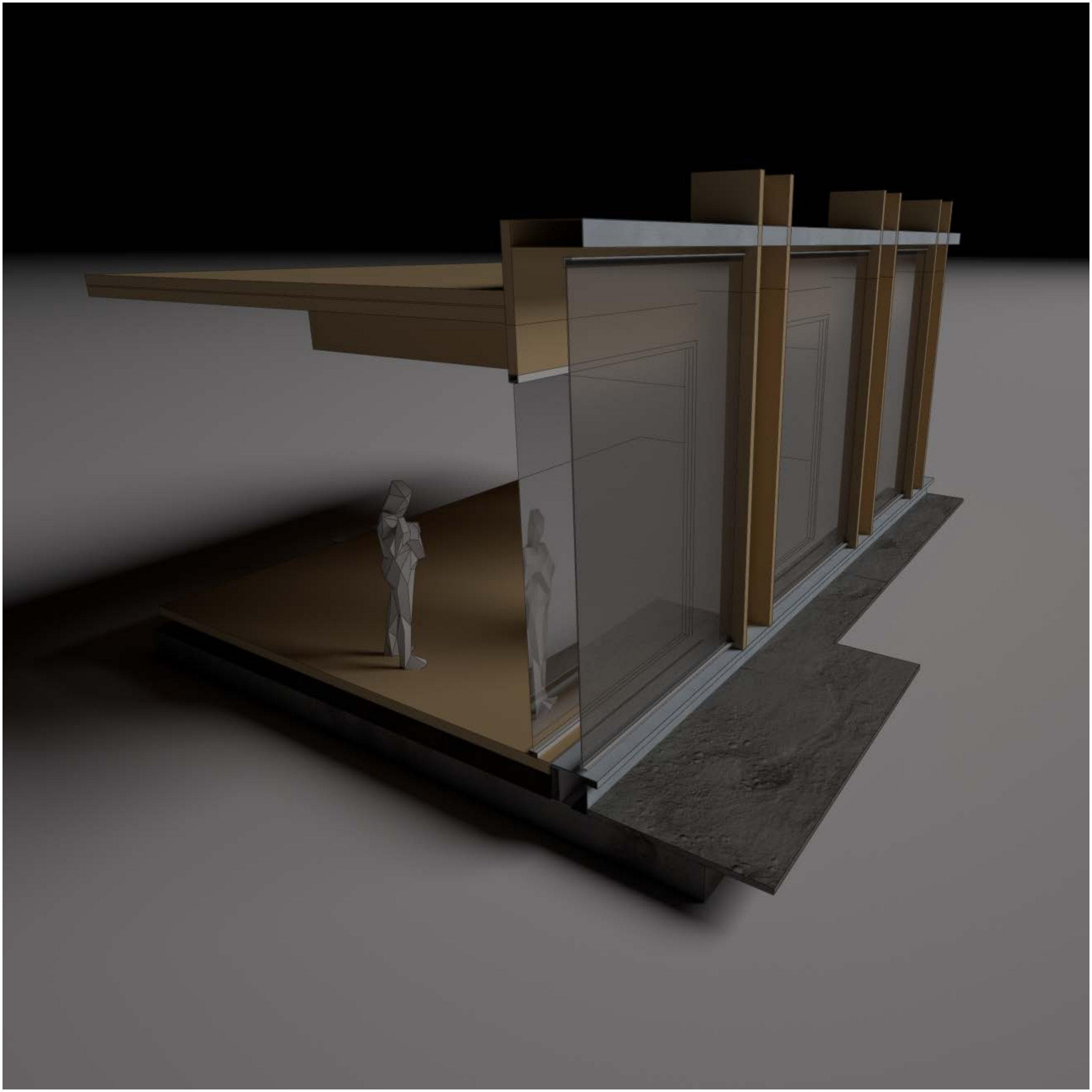
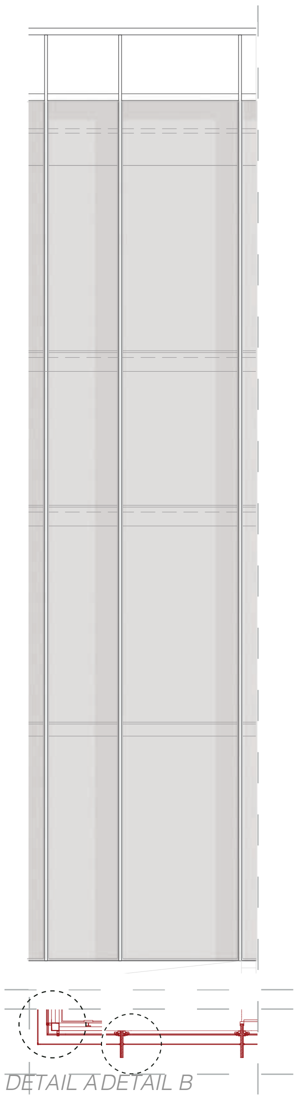
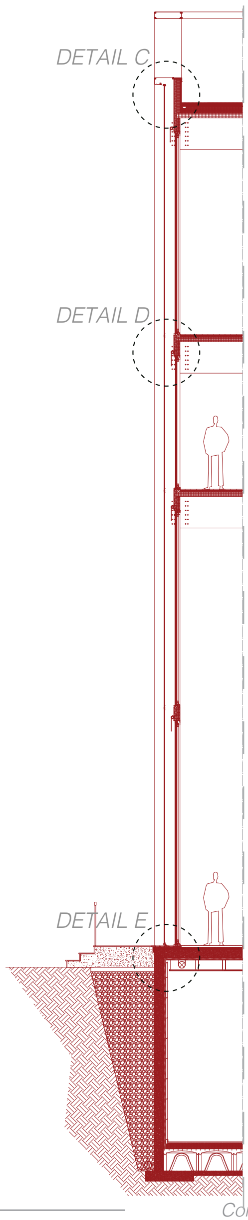


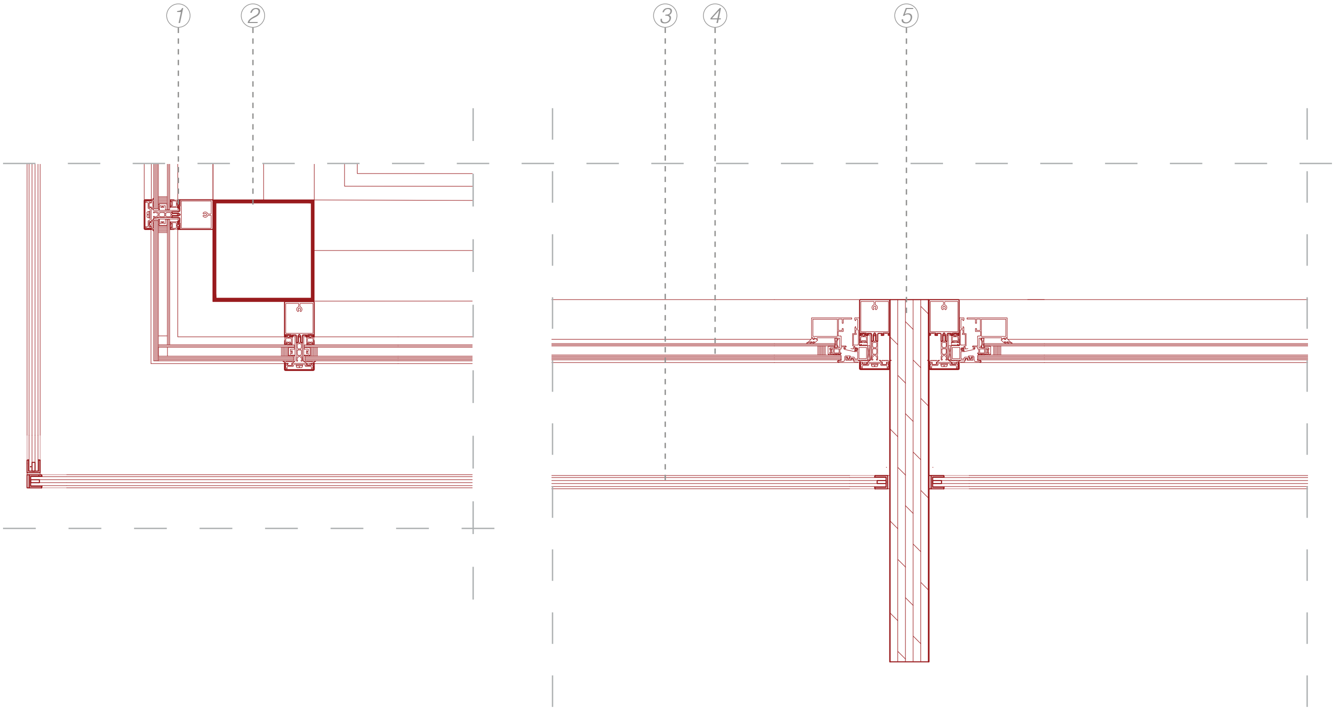
Figure 158: Elevation System digital macquette

FACADE SECTION 1





DETAIL A & B



① *Window Framing*

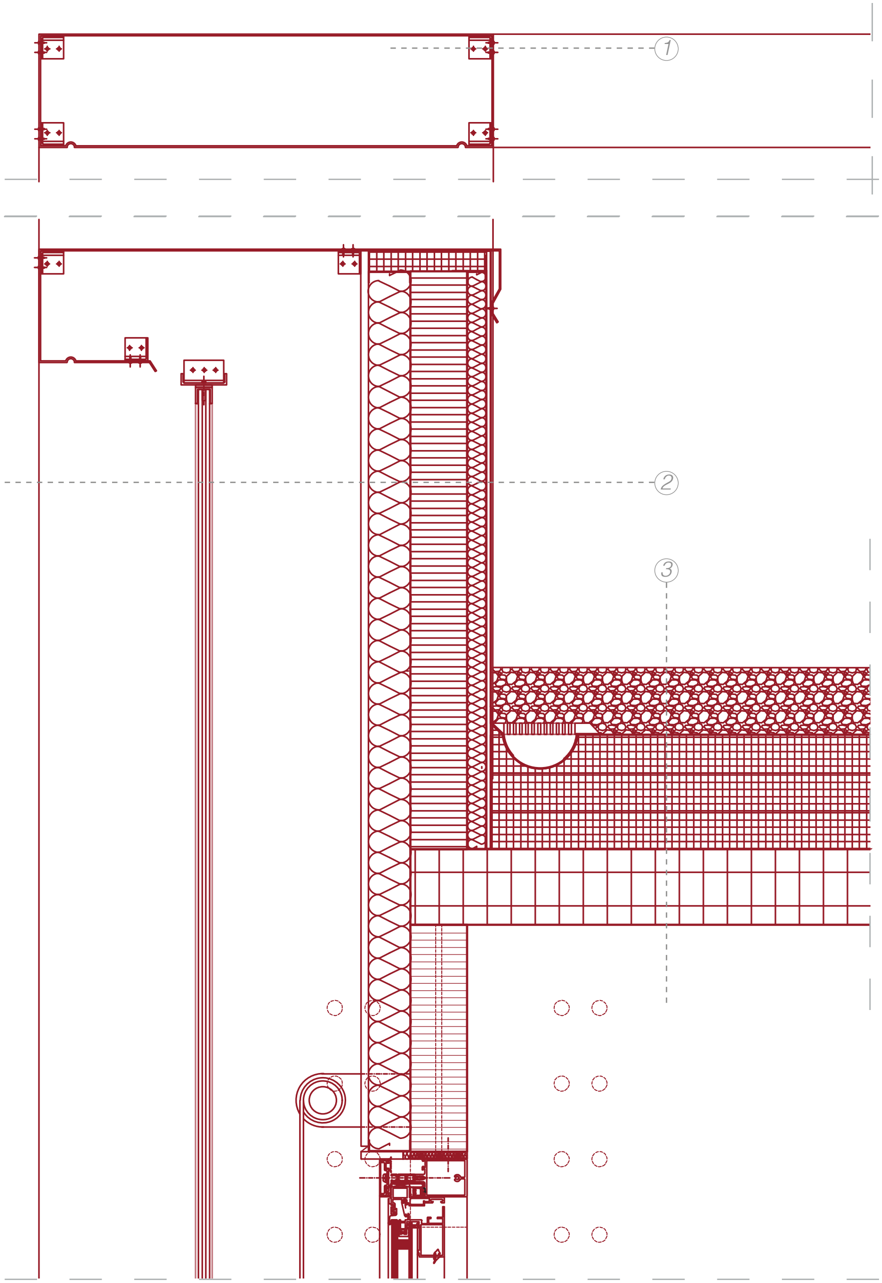
② *Hallow Steel Column (20 x 20 cm)*

③ *Frosted Glass*

④ *Toughened Glass (1.2 cm)*

⑤ *LVL Column (60 x 7.5 cm)*

DETAIL C



LEGEND

1. *L Profile*
   Aluminium Sheet

2. *Frosted Glass (0.2 cm)*
   Air Gap (20 cm)
   Gypsium Board (1 cm)
   Water Proof Layer
   Insulation (5 cm)
   LVL Panel (7.5 cm)
   Insulation (3 cm)
   Water Proof Layer
   Gypsium Board (1 cm)

3. *Gravel (10 cm)*
   Water Proof Layer
   Insulation (15 cm)
   Vapour Barrier
   CLT Panel (10 cm)
   LVL Beam (70 x 7.5 cm)

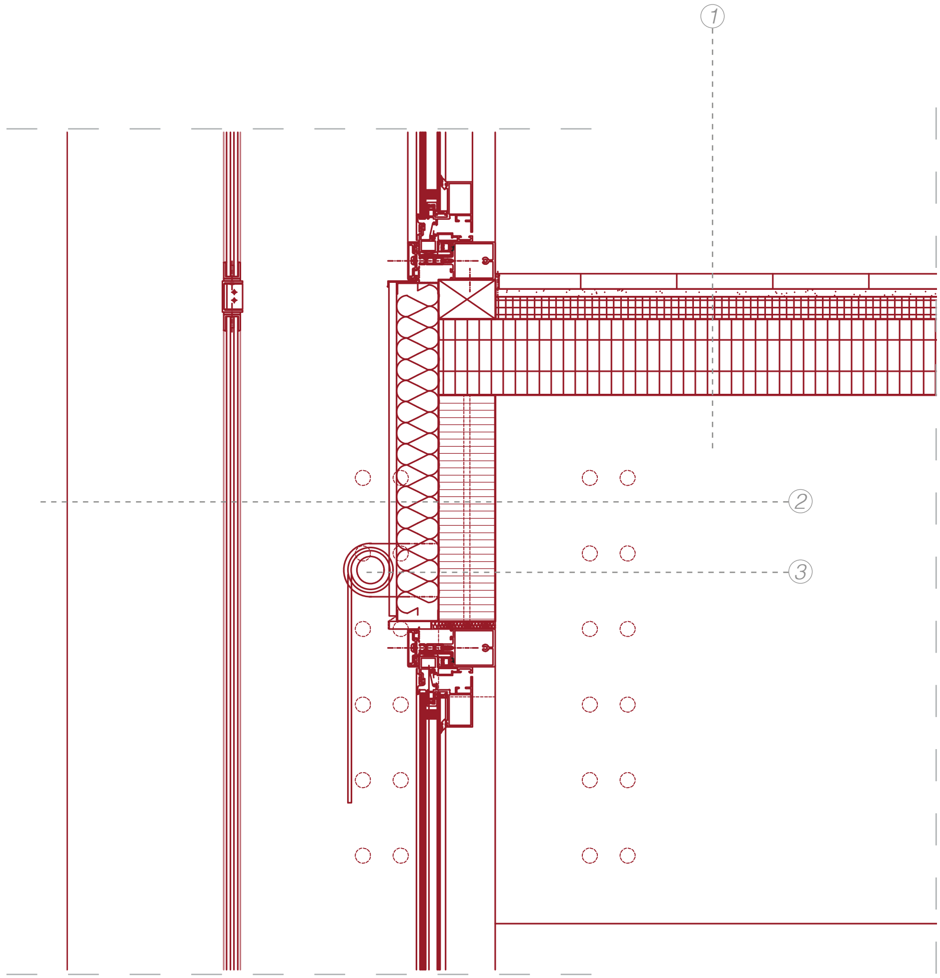
DETAIL D

LEGEND

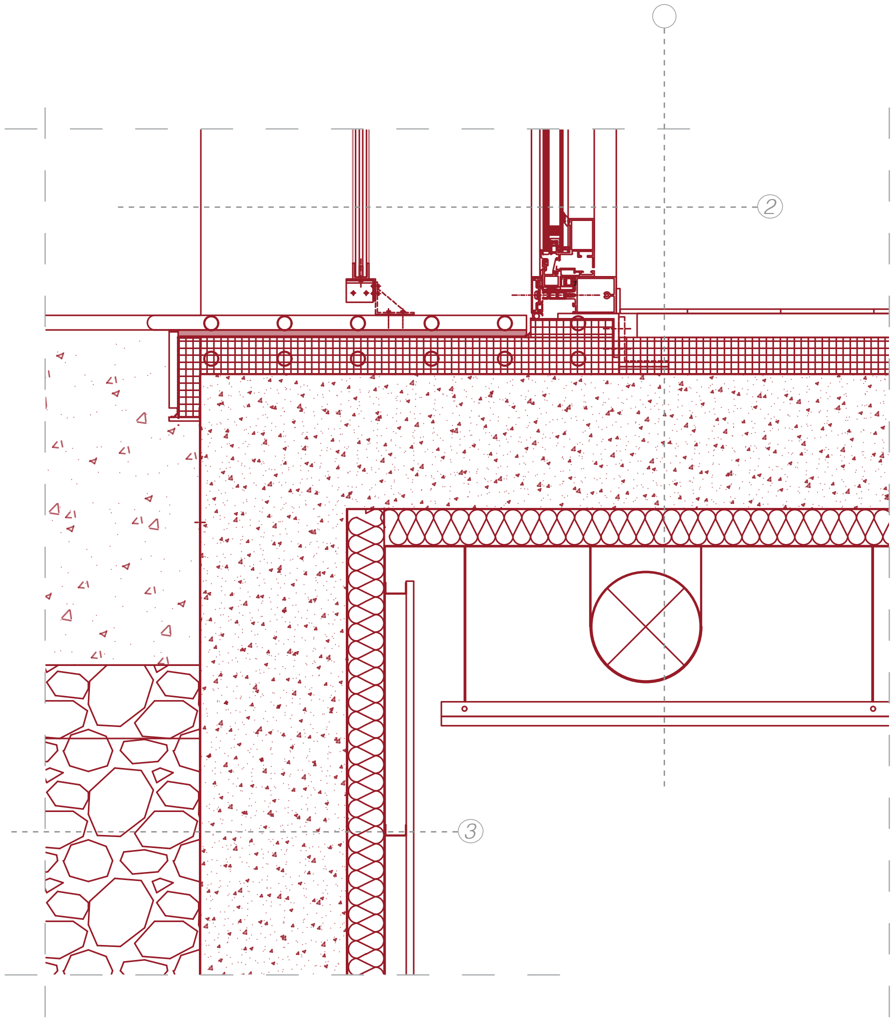
Stone Tiles (2 cm) (1)
Adhesive Screed
Aquistic Insulation (3 cm)
CLT Panel (10 cm)
LVL Beam (70 x 7.5 cm)

Frosted Glass (0.6 cm) (2)
Air Gap (20 cm)
Gypsium Board (1 cm)
Water Proof Layer
Insulation (5 cm)
Vapour Barrier
LVL Beam (30 x 7.5 cm)

Rolling Curtain (3)



DETAIL E



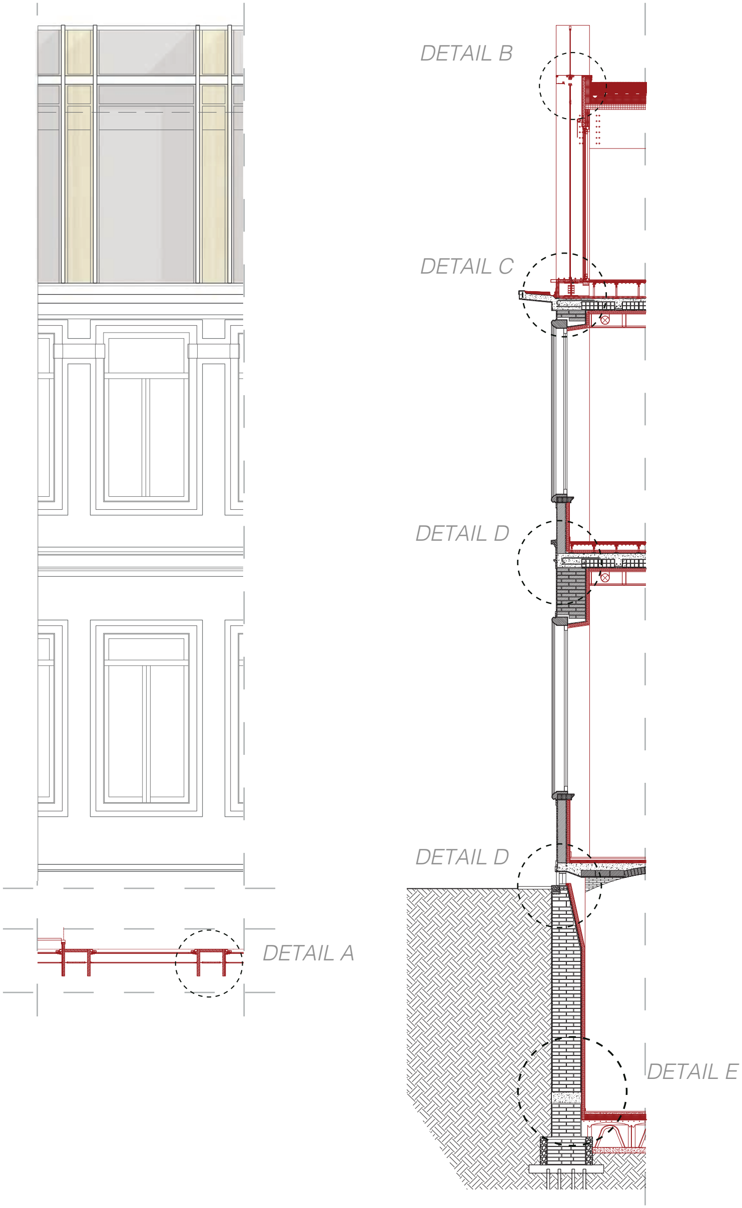
LEGEND

1. Stone Tiles (2 cm)
   Adhesive Screed
   Insulation (5 cm)
   Reinforced Concrete Slab (15 cm)
   Insulation (10 cm)
   Air Conditioning Duct (r : 7.5 cm)
   Gypsum Board Ceiling (2 cm)

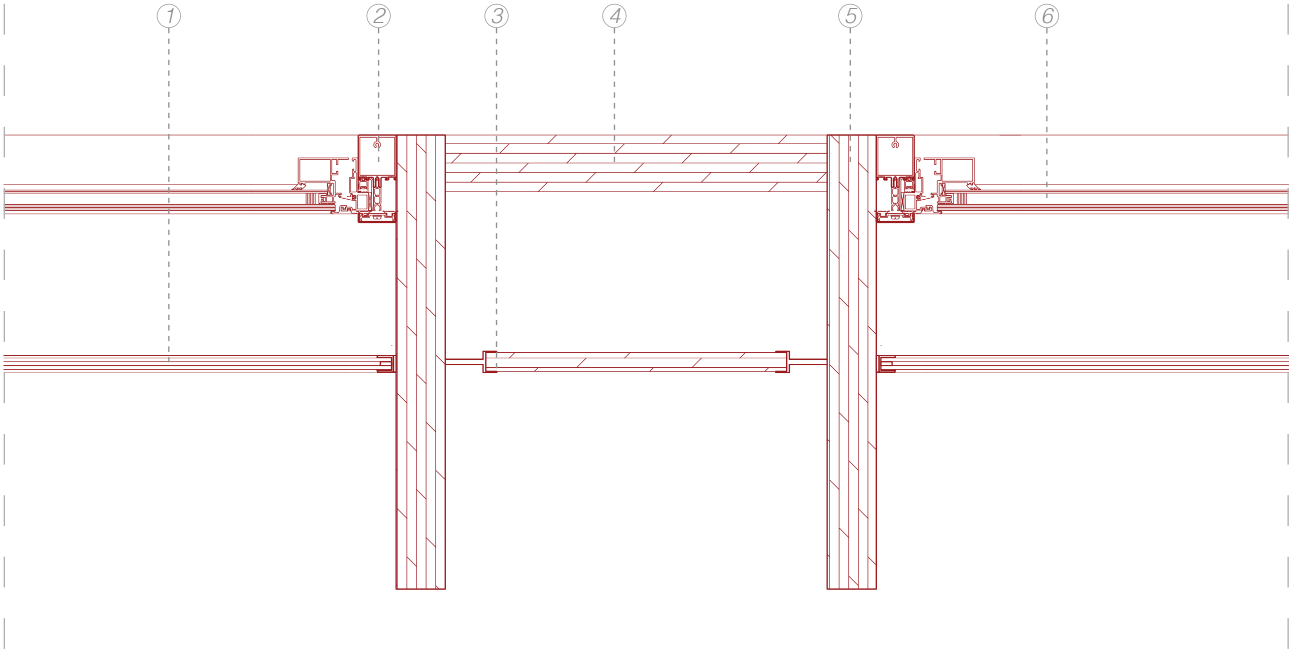
2. Frosted Glass (06 cm)
   Air Gap (20 cm)
   Toughened Glass (1.2 cm)

3. Gravel
   Water Proof Layer
   Reinforced Concrete Wall (30 cm)
   Vapour Barrier
   Insulation (5 cm)
   U Profile
   Concrete Panel (2 cm)

FACADE SECTION 2



DETAIL A



① Frosted Glass

② Window Framing

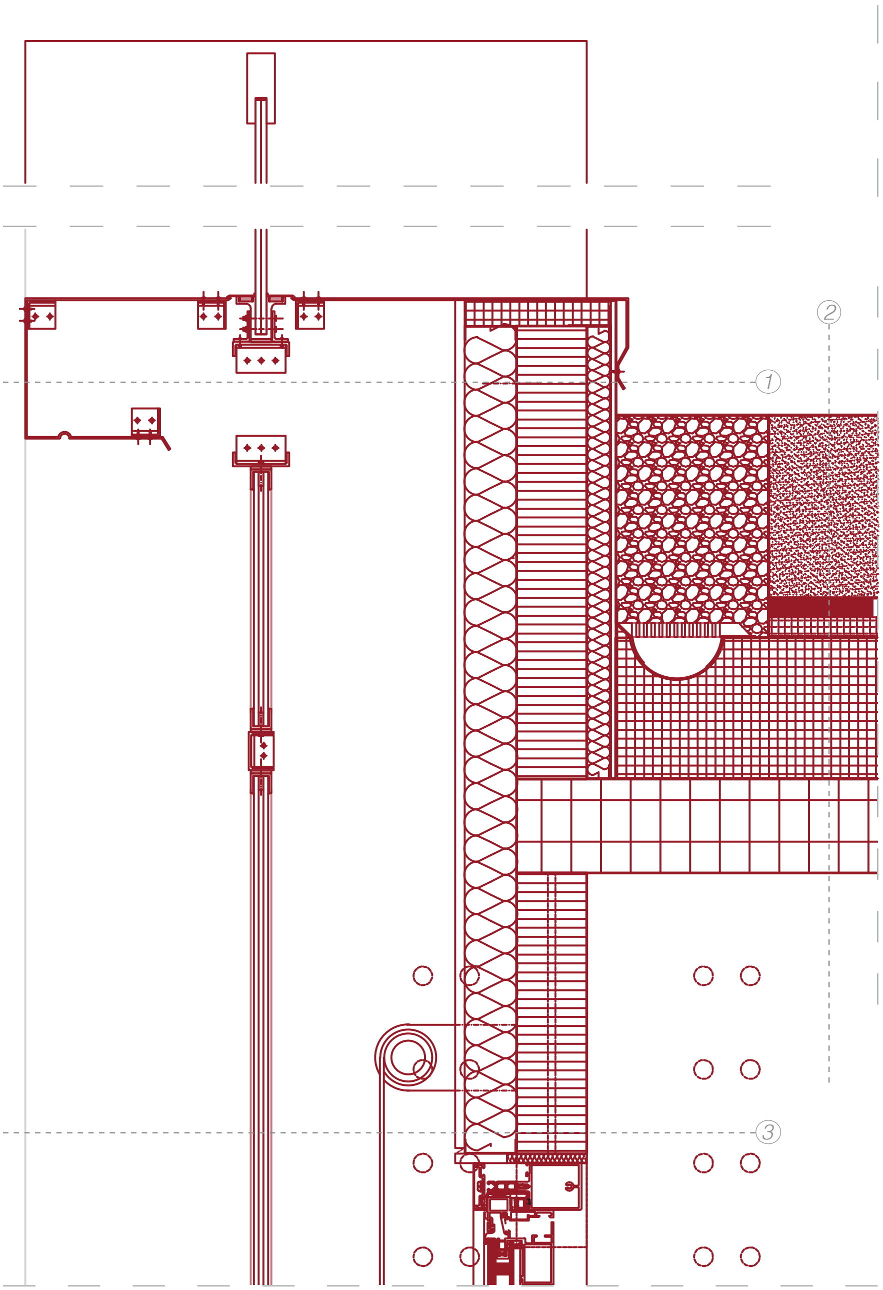
③ CLT Panel (5 cm)

④ CLT Panel (10 cm)

④ LVL Column (60 x 7.5 cm)

⑤ Toughened Glass (1.2 cm)

DETAIL B



① *Aluminium Sheet*
Gypsium Board (1 cm)
Water Proof Layer
Insulation (5 cm)
LVL Panel (7.5 cm)
Insulation (3 cm)
Water Proof Layer
Gypsium Board (1 cm)

② *Soil Substrate (20 cm)*
Filter (2 cm)
Dranaige (2 cm)
Water Proof Layer
Insulation (15 cm)
Vapour Barrier
CLT Panel (10 cm)
LVL Beam (70 x 7.5 cm)

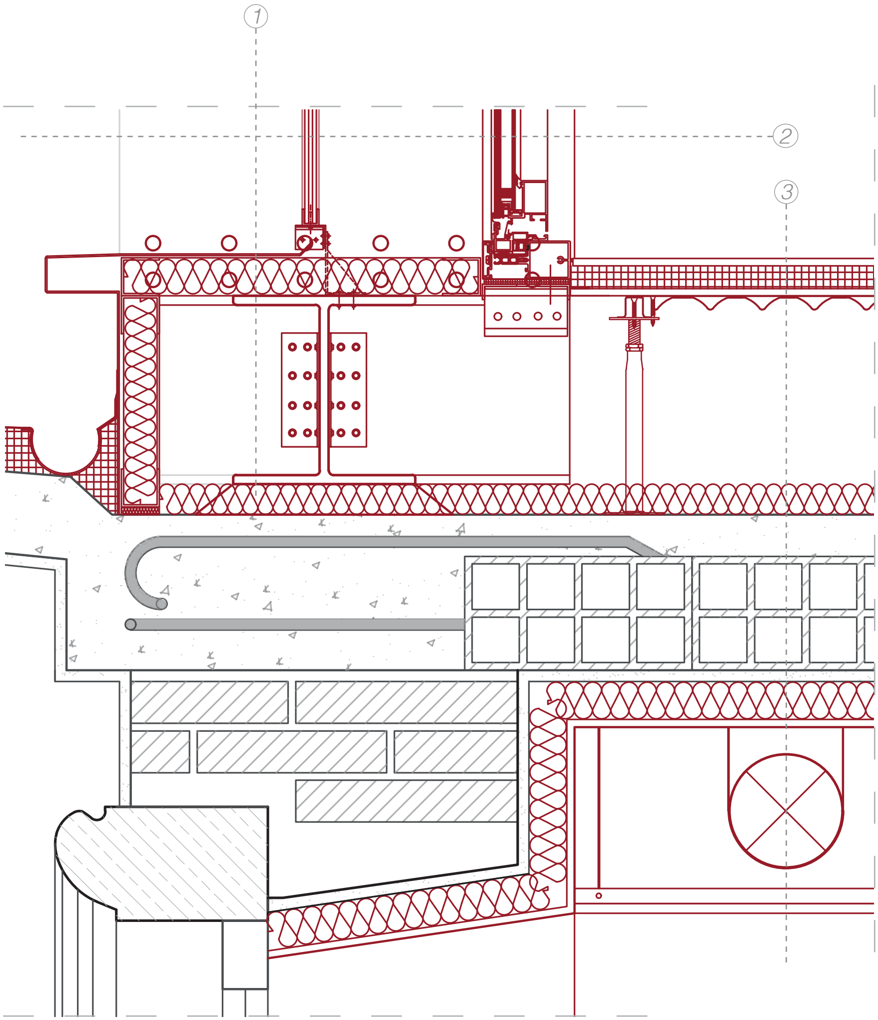
③ *Frosted Glass (0.2 cm)*
Air Gap (20 cm)
Gypsium Board (1 cm)
Water Proof Layer
Insulation (5 cm)
Vapour Barrier
LVL Beam (30 x 7.5 cm)

DETAIL C

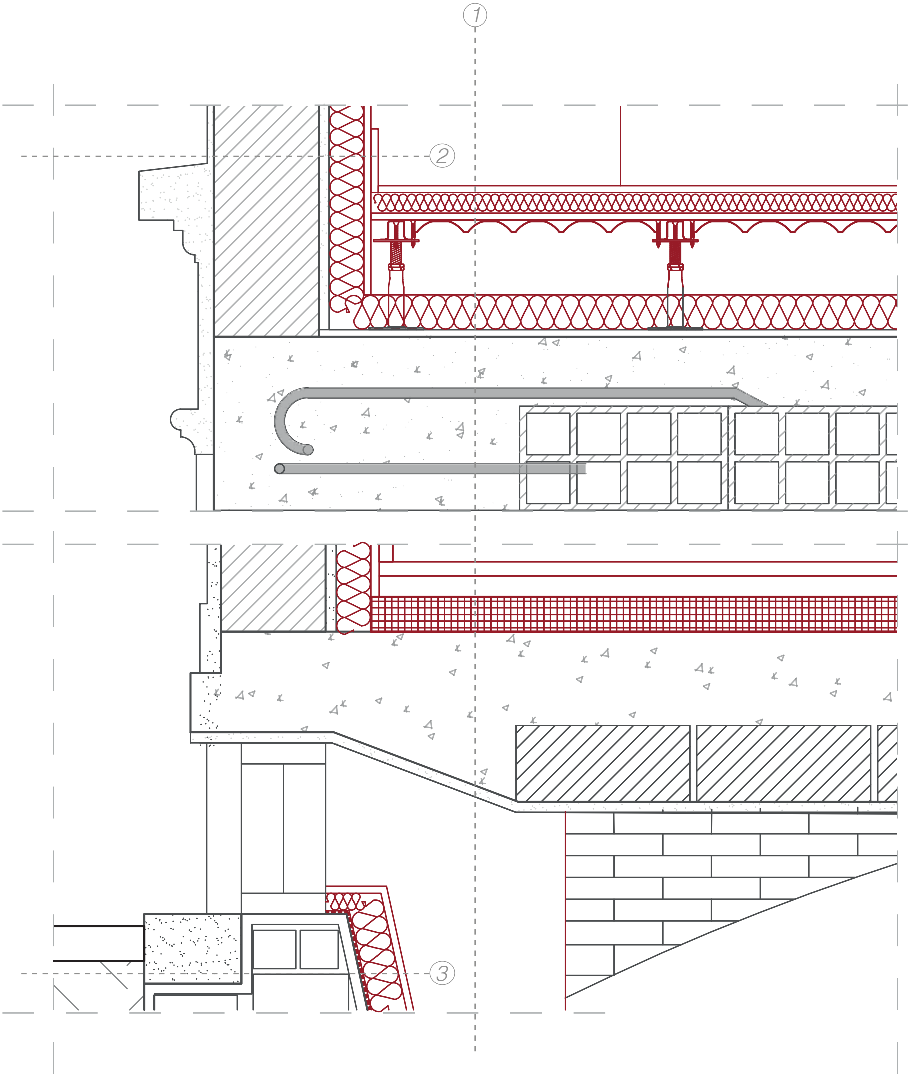
Metal Sheet ①
Water Proof Layer
Insulation (3 cm)
U Profile
HEA 240 Beam
Concrete Fill (3 cm)
Latero Cemento (20 cm)

Frosted Glass (06 cm) ②
Air Gap (20 cm)
Toughened Glass (1.2

Stone Tiles (2 cm) ③
Aquistic Insulation (3 cm)
Raised Floor System (28 cm)
Insulation (3 cm)
Latero Cemento (20 cm)
Insulation (5 cm)
Air Conditioning Duct (r : 7.5 cm)
Gypsium Board Ceiling (2 cm)



DETAIL D



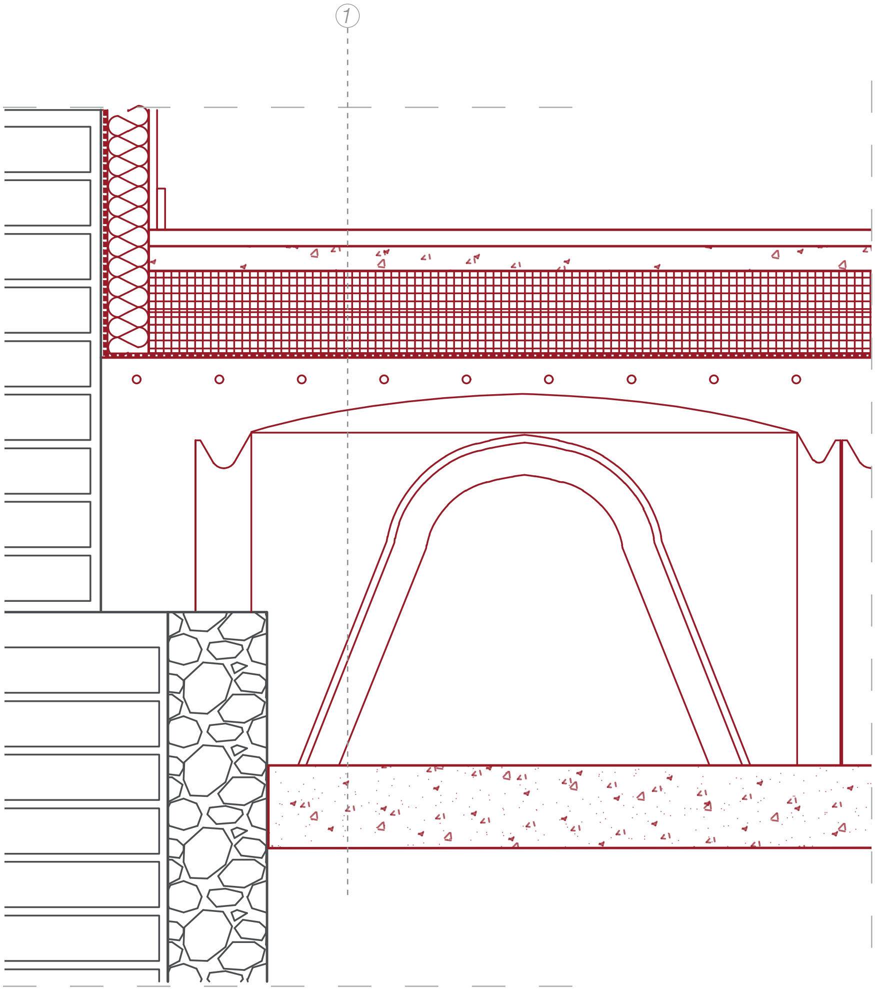
1. Stone Tiles (2 cm)
   Aquistic Insulation (3 cm)
   Raised Floor System (15cm)
   Insulation (5 cm)
   Latero Cemento (20 cm)
   Stone Tiles (2 cm)
   Adhesive Screed (3 cm)
   Insulation (5 cm)
   Latero Cemento

2. Existing Wall
   Vapour Barrier
   Insulation (5 cm)
   Gypsium Board (2 cm)
   Finishing Tile (2 cm)

3. Existing Wall
   Vapour Barrier
   Insulation (5 cm)
   Gypsium Board (2 cm)

DETAIL E

Stone Tile (2 cm) (1)
Adhesive Screed (3 cm)
Insulation (10 cm)
Water Proof Layer
Ventilation Crawl
Reinforced Concrete Slab (10 cm)



MEZZANINE DETAILS

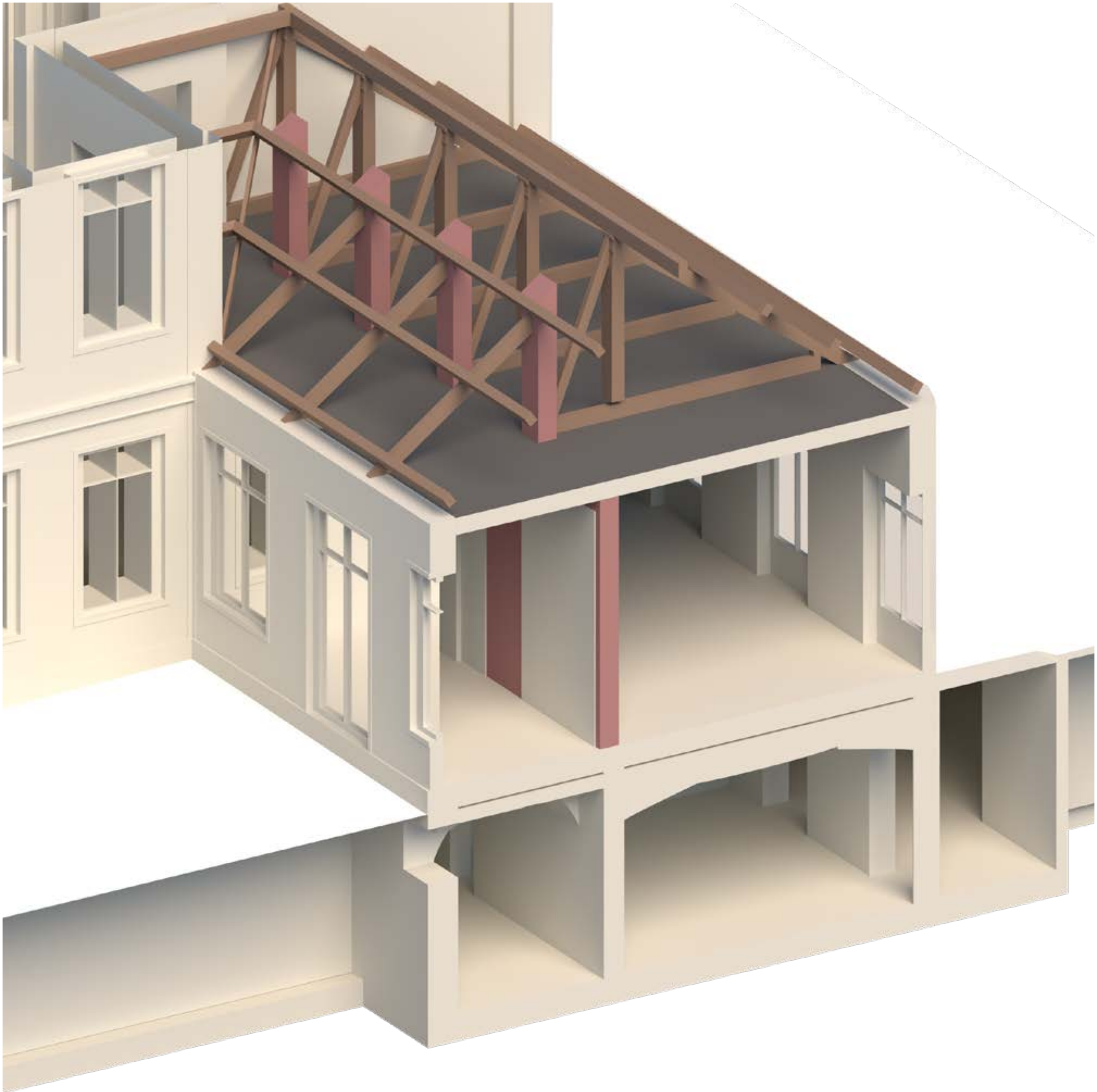
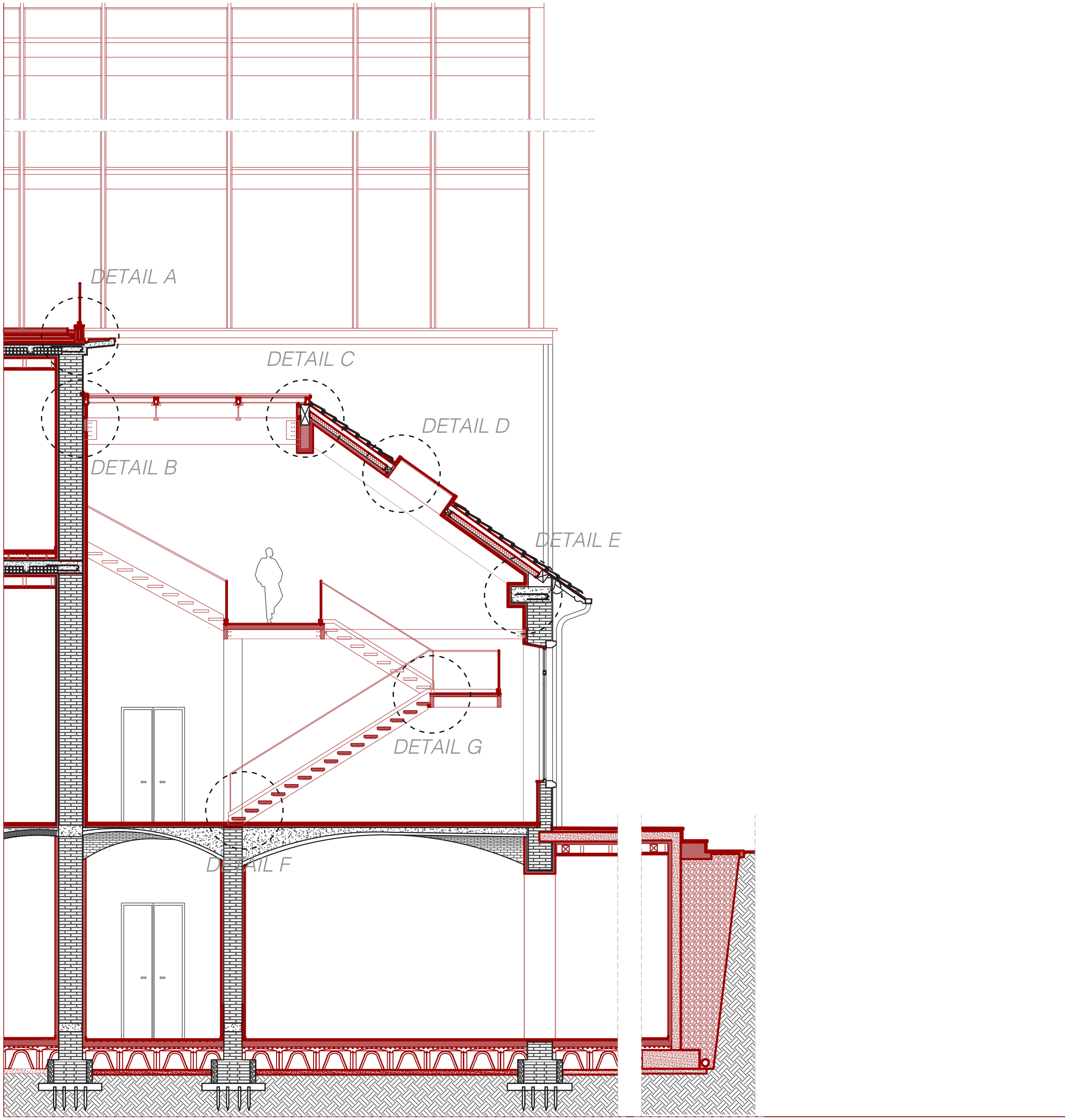
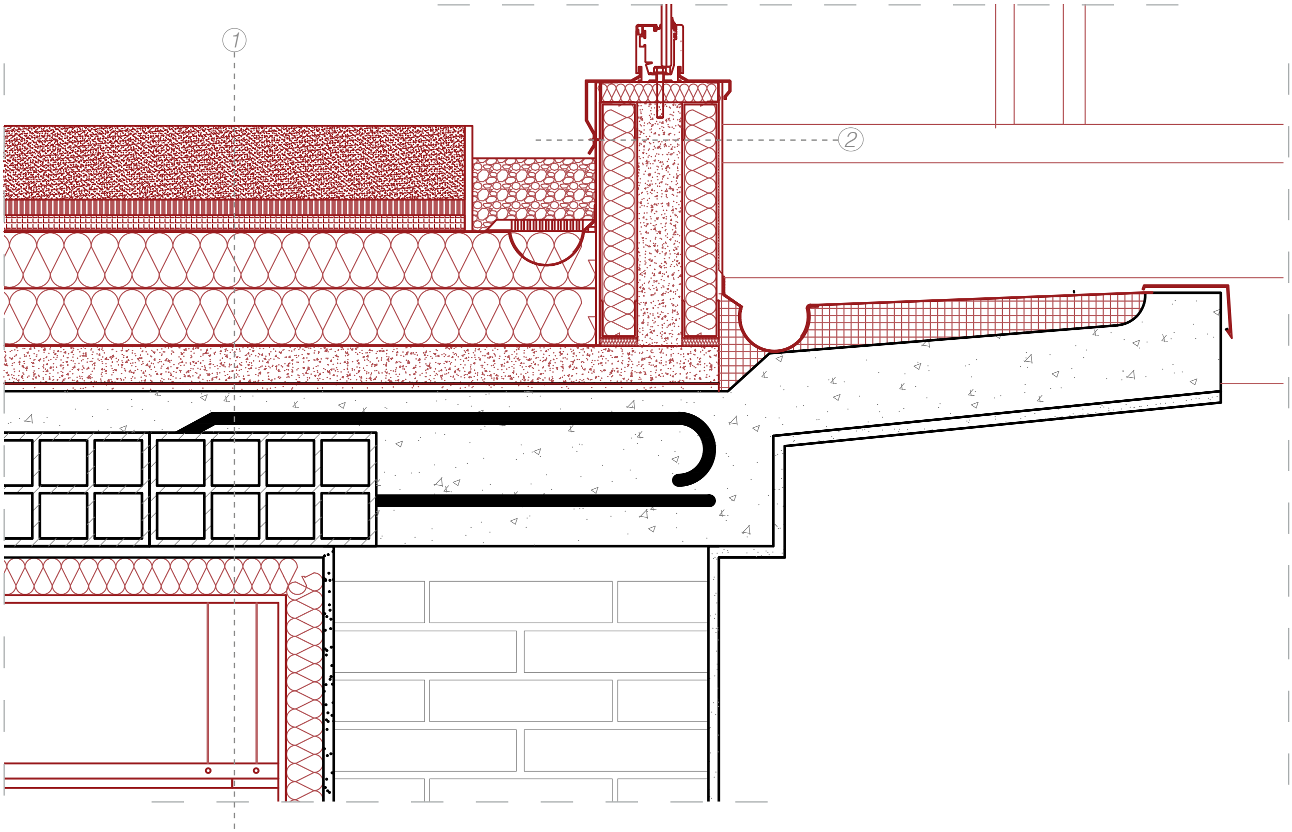


Figure 159: Original truss system for Existing block

MEZZANINE SECTION



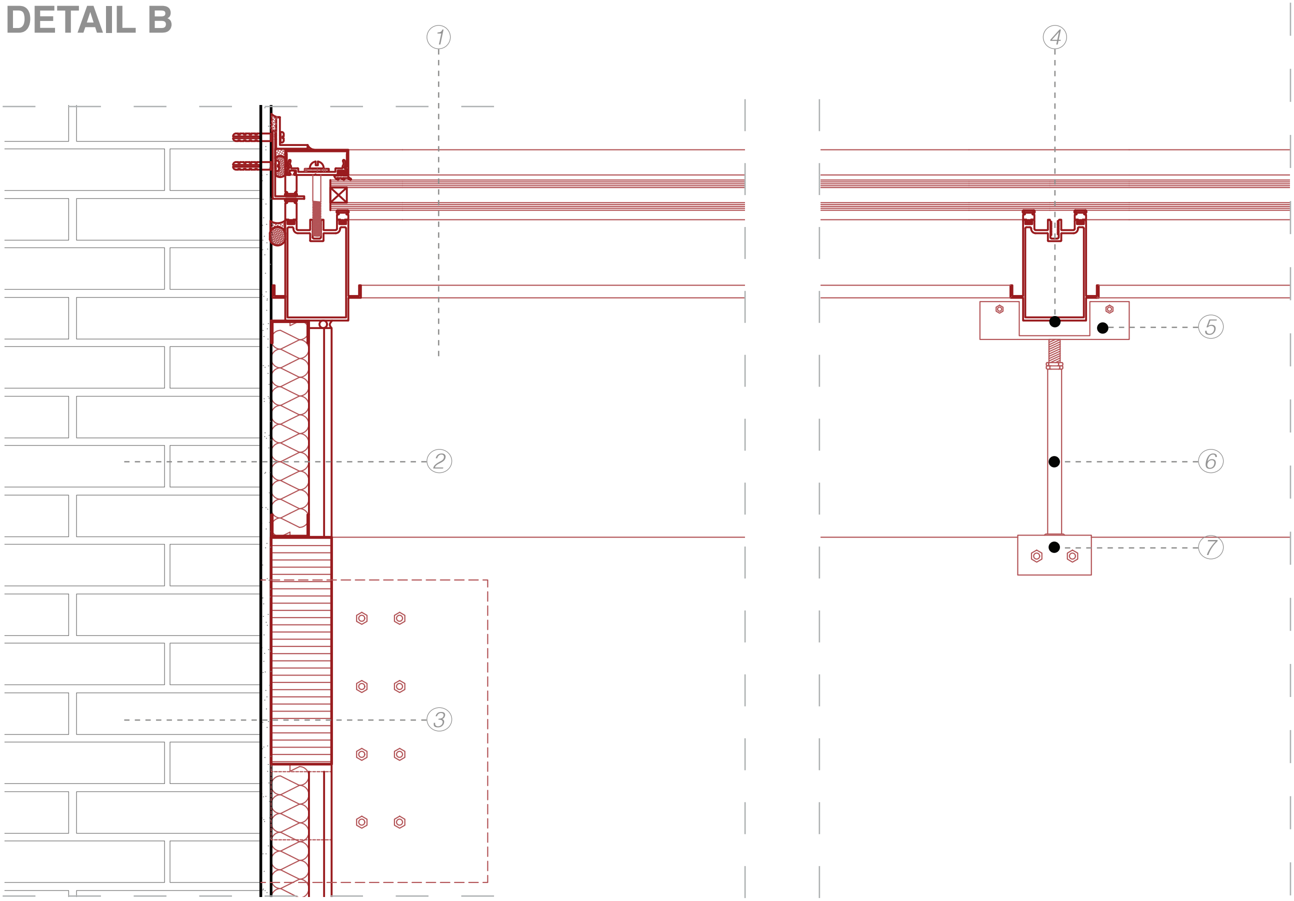
DETAIL A



1. Soil Substrate (10 cm)
   Filter (3 cm)
   Dranaige (2 cm)
   Water Proof Layer
   Insulation (15 cm)
   Light Concrete (5cm)
   Latero Cemento (20 cm)
   Vapour Barrier
   Gypsium Board (2 cm)
   Gypsium Board Ceiling(2 cm)

2. Water Proof Layer
   Gypsium Board (1 cm)
   Rigid Insulation (5 cm)
   Reinforced Concrete (5cm)
   Rigid Insulation (5 cm)
   Water Proof Layer
   Gypsium Board (1 cm)

DETAIL B



1. Pressure Cup (3 cm)
   Glass (2 cm)
   Aluminium Window Frame (5 cm)

2. Existing Wall
   Vapour Barrier
   Insulation (5 cm)
   Gypsium Board (1 cm)

3. Existing Wall
   Vapour Barrier
   LVL Beam (30 x 7.5 cm)

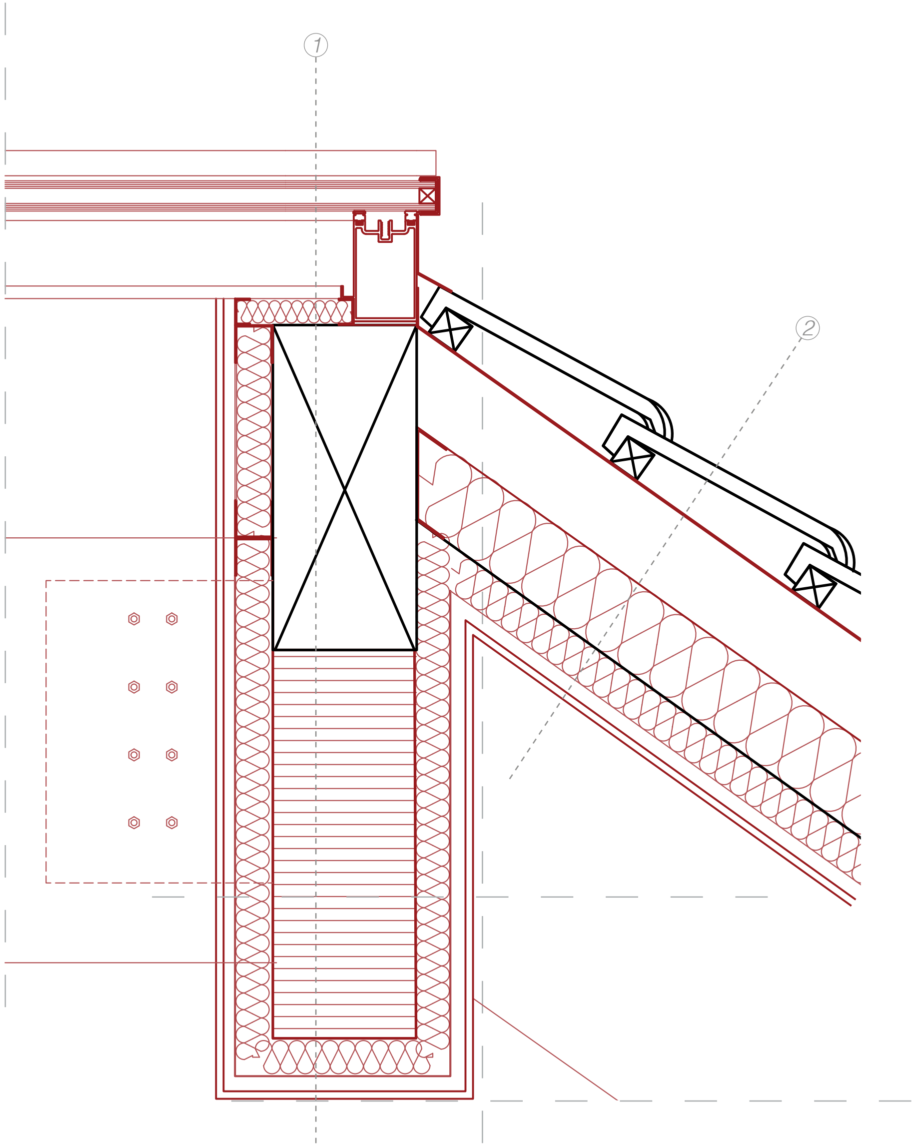
4. Auminium Window Frame (5 cm)

5. Pedestal Head

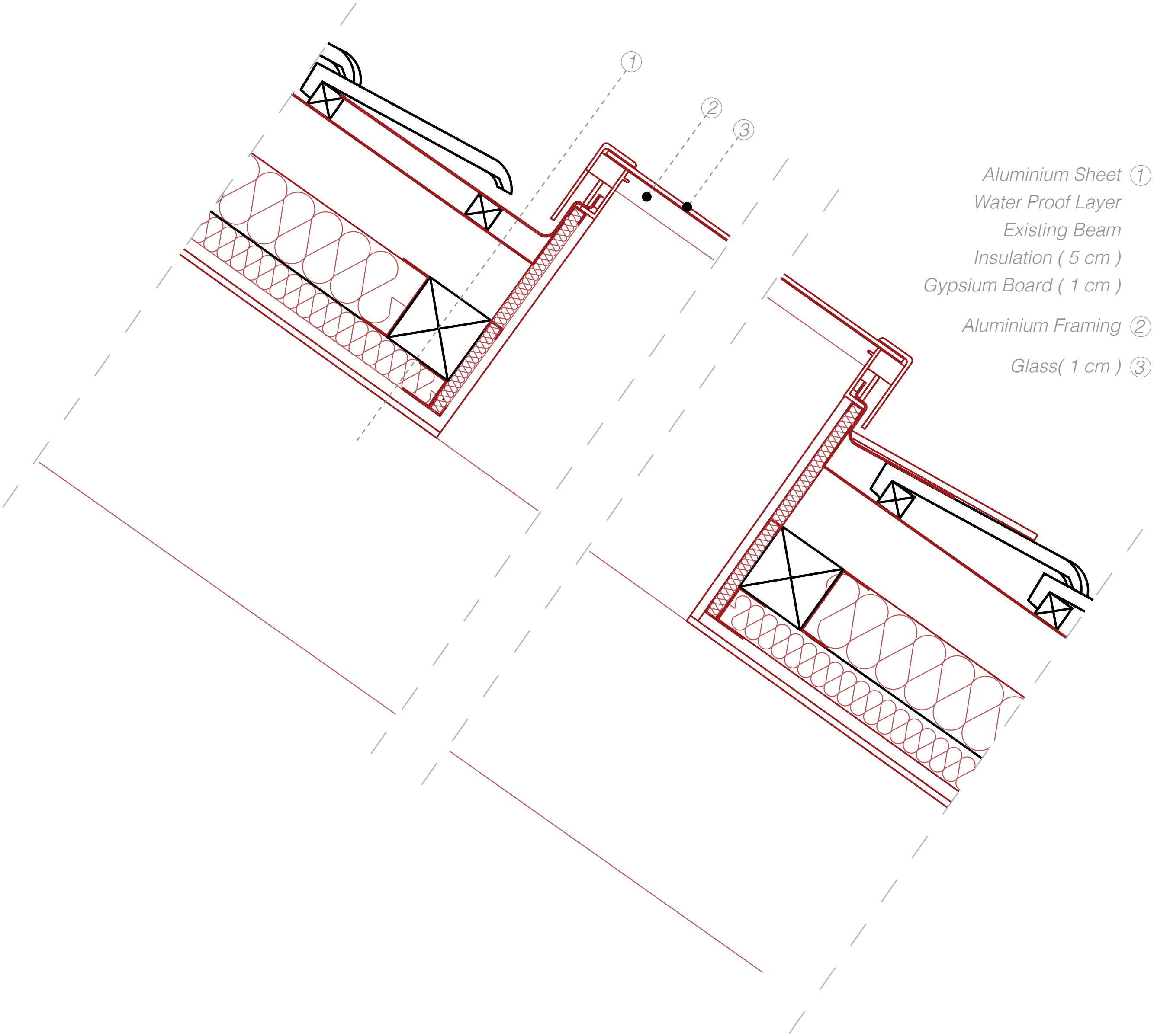
6. Pedestal Tube

7. Pedestal Base Clamp

DETAIL C


Glass (2 cm) 1
Insulation (3 cm)
Existing Beam
Glulam Beam (50 x 19 cm)
Insulation(5 cm)
Gypsium Board (1 cm)
Marselle Tiles 2
Water Proof Layer
Existing Beam
Insulation (10 cm)
Insulation (5 cm)
Gypsium Board (1 cm)
1
2

DETAIL D

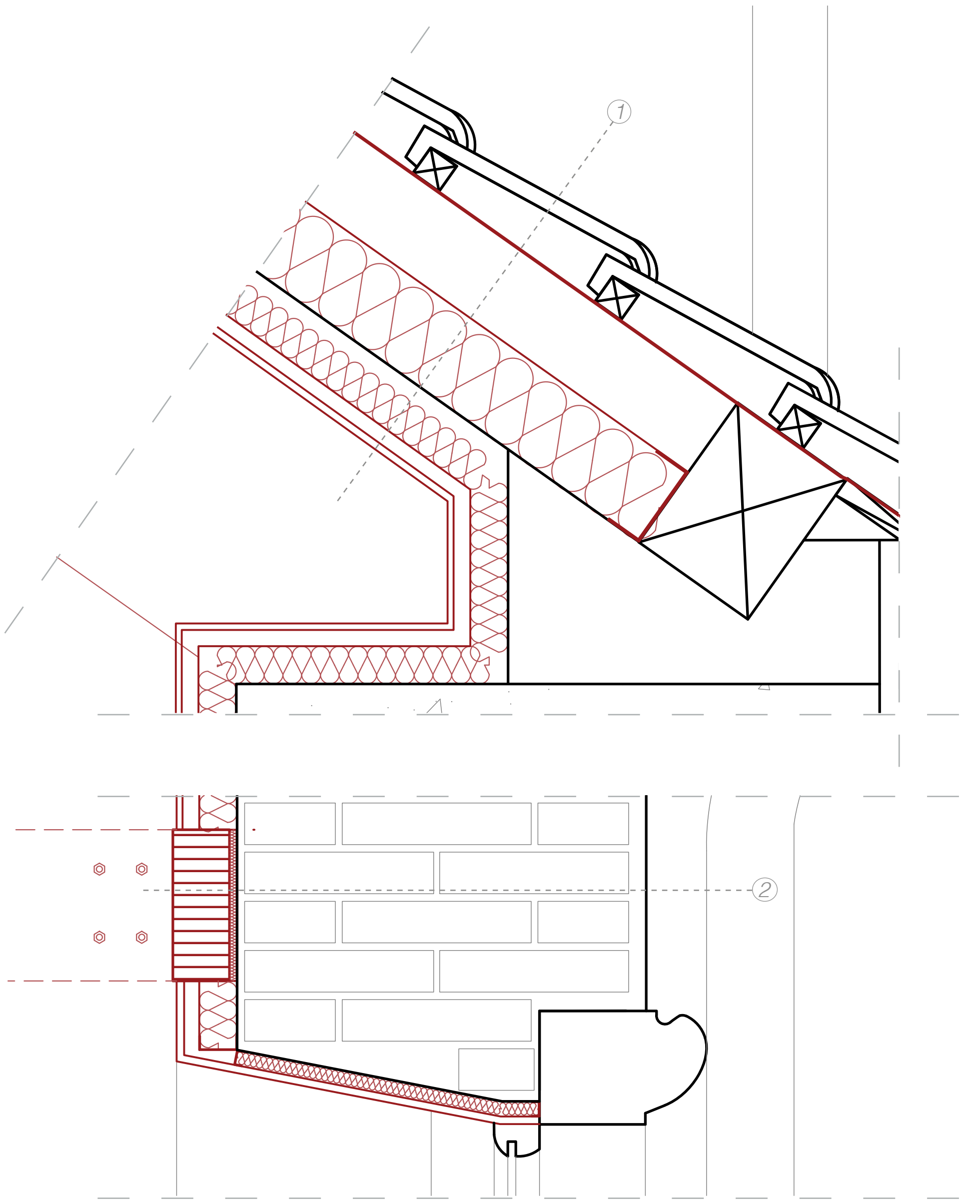


Aluminium Sheet ①
Water Proof Layer
Existing Beam
Insulation (5 cm)
Gypsium Board (1 cm)
Aluminium Framing ②
Glass(1 cm) ③

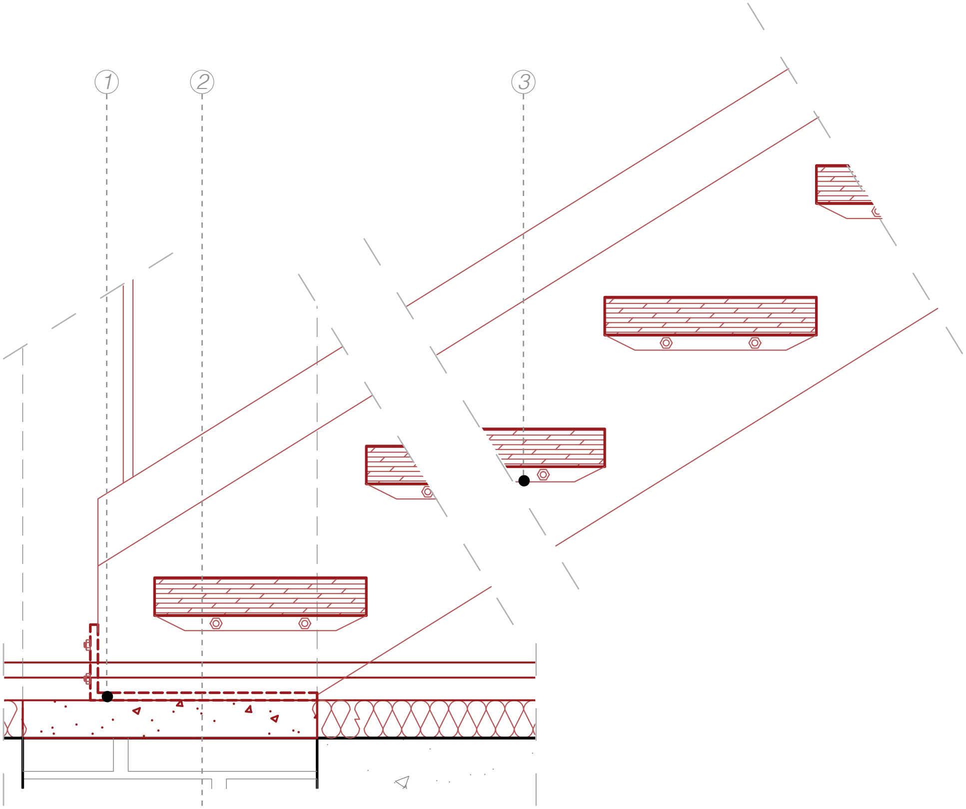
DETAIL E

1. *Marselle Tiles*
   Water Proof Layer
   Existing Beam
   Insulation (10 cm)
   Insulation (5 cm)
   Gypsium Board (1 cm)

2. *LVL Beam (20 x 7.5 cm)*
   Rigid Insulation (1 cm)
   Vapour Barrier
   Existing Wall



DETAIL F

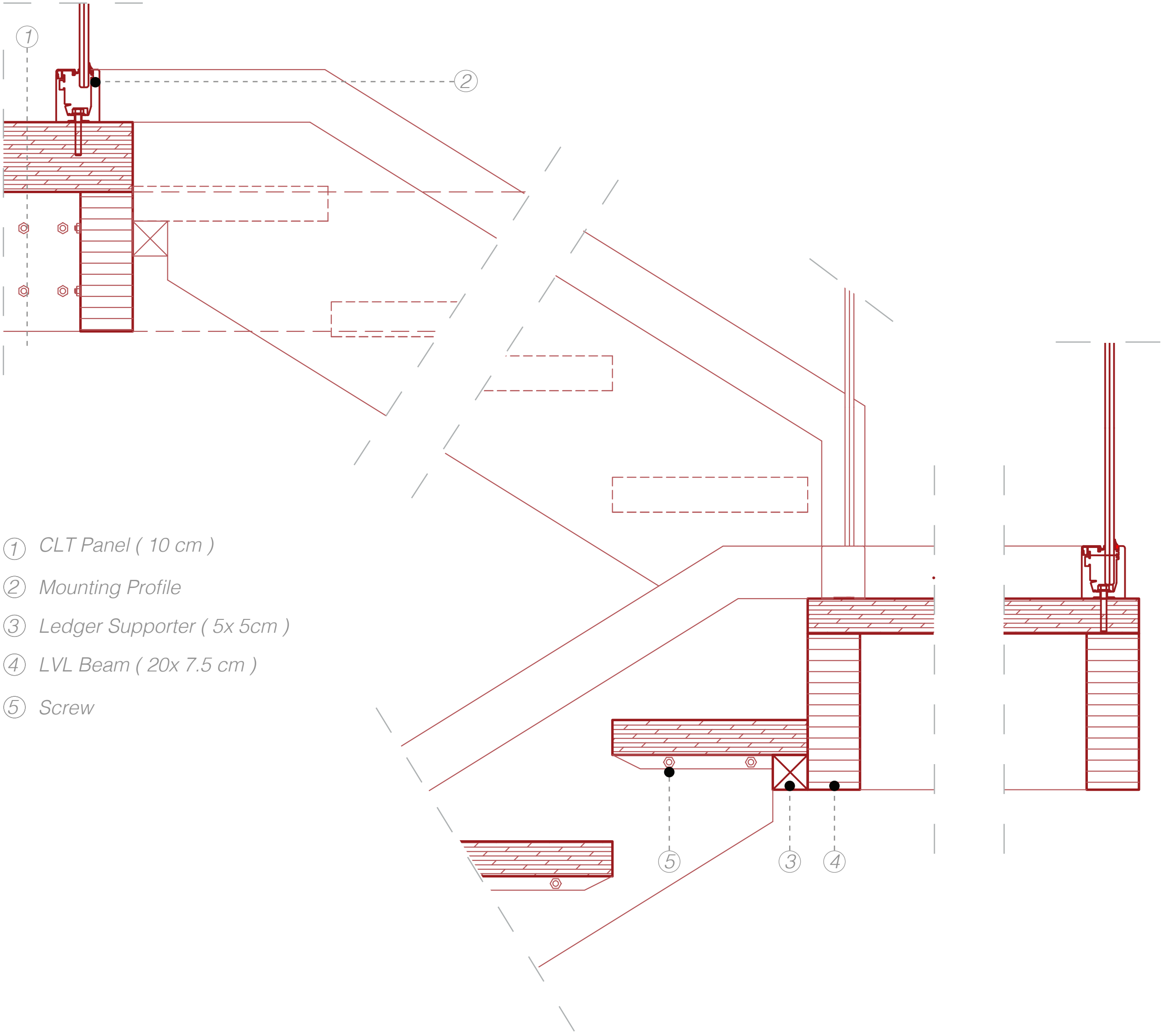


L Profile ①

CLT Thread (5 cm) ②
Stone Tiles (2 cm)
Screed (3 cm)
Light Concrete (5 cm)
Existing Wall

Bracket ③

DETAIL G



(1) CLT Panel (10 cm)

(2) Mounting Profile

(3) Ledger Supporter (5x 5cm)

(4) LVL Beam (20x 7.5 cm)

(5) Screw

Service Design

One of the major reasons for deterioration of the structure is the imcompatible installation of the Service systems which were not very well planned. Thus, the proposal has been generated keeping in mind these challenges:

1. Minimal visual effect.
2. Maximum Flexibility of use.
3. Ease of Installation

Figure 160:

Water Supply System

The building is composed of various units that require two different branches for plumbing work. Studying the existing plumbing scenario, and based on the new planning scheme the toilet units are divided into two branches, namely Branch A & B.

Considering the existing ducts and pipes. The older lift well is a potential place for the development of the new duct for the water supply system.

we compute the branch pipes and main pipes dimensions for the two branch systems, using the loading unit method (EN 806). Further, for the supply system, we include the use of harvested rain water along side the main water supply. Harvested rainwater is used for flushing water purposes.

The supply system further consists of hot water and cold water branches. For the overall hot water supply, we use heat pumps, with staff lockers being an exception which is provided with a local heating system- geysers for better control.

Legend:

1 *Basement level :*

Branch 'A'

Book repair workshop- 2 X Sink

2 *Ground floor :*

Branch 'A'

Staff toilets X2 - 1X WC & 1X WB

Staff Lockers X2 - 1X WC , 1X WB & 1X Shower

Branch 'B"

Toilet X2 - 4X WC & 3X WB

3 *First floor:*

Branch 'A'

Staff toilets X2 - 1X WC & 1X WB

Pantry - 1X sink

Branch 'B"

Toilet X2 - 4X WC & 3X WB

4 *Second floor:*

Branch 'B'

Toilet - 2X WB & 2X WC

Workshop - 2X Sink

5 *Third Floor :*

Branch 'B'

Toilet - 1X WC & 1X WB

Kitchen - 2X Sink

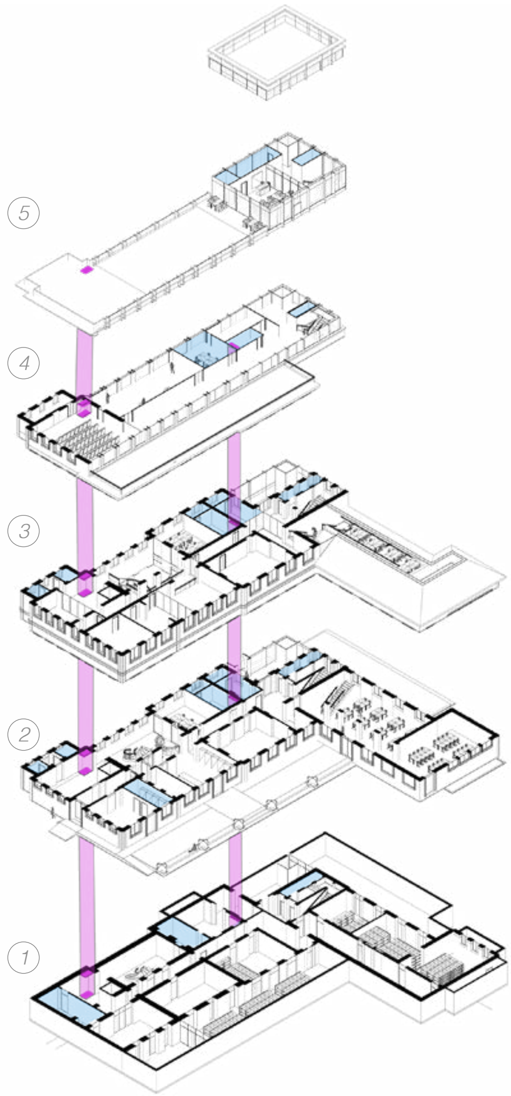


Figure 161: Exploded Axonometric view with location of faucets

Schematic System :

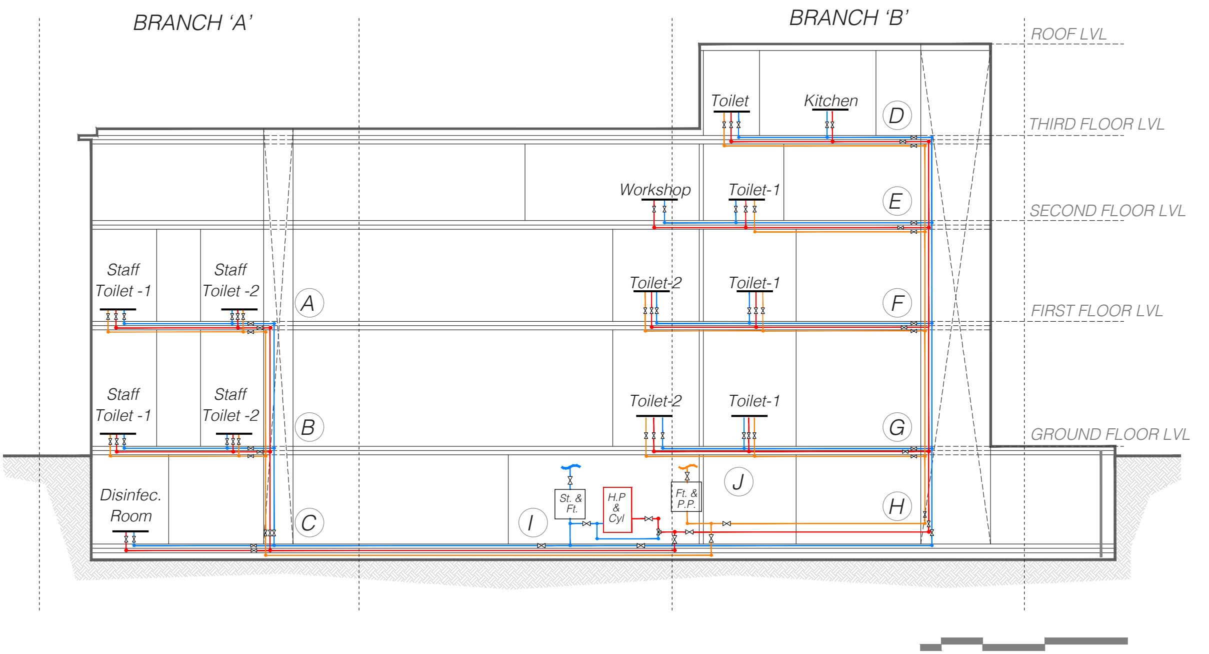


Figure 162: Schematic for water supply system

The water supply system is divided in two branches which are further branched out into different sections. The firgure explains the initial scheme of the network of connectivity from the main supply to the terminal sections. The system is composed of main supply which is further branched into cold, hot and flushing water. This serves a footprint to compute the various sections. which is followed in the computation before.

Legend:

St. *Softner*
Ft. *Filter*
H.P. *Heat pump*
Cyl. *Cylinder*
P.P. *Pressure pump*
Hot water supply
Cold water supply
Flushing water supply

Requirements:

BRANCH 'A'						
FLOOR	**ROOM**	**SECTION**	**WC**	**WB**	**SINK**	**SHOWER**
Basement Floor	Book Disinfec. Room	C	0	0	2	0
Ground Floor	Staff toilet-1	B	1	1	0	0
	Staff toilet-2		1	1	0	0
	Staff Locker-1		1	1	0	1
	Staff locker-2		1	1	0	1
First Floor	Staff toilet-1	A	1	1	0	0
	Staff toilet-2		1	1	0	0
	Pantry		0	0	1	0
	Total		6	6	3	2

Table 1: Branch 'A' Number of units

BRANCH 'B'						
FLOOR	**ROOM**	**SECTION**	**WC**	**WB**	**SINK**	**SHOWER**
Ground Floor	Toilet-1	G	3	3	0	0
	Toilet-2		3	3	0	0
First Floor	Toilet-1	F	3	3	0	0
	Toilet-2		3	3	0	0
Second Floor	Toilet	E	2	2	0	0
	Workshop		0	0	2	0
Third Floor	Toilet	D	1	1	0	0
	Kitchen		0	0	2	0
	Total		15	15	4	0

Table 2: Branch 'B' Number of units

BRANCH	WC	WB	SINK	SHOWER
A	6	6	3	2
B	15	15	4	0
Total	21	21	7	2

Table 3: Total number of units

We water supply system is concieved in two branches with that split from the mains for both cold, hot and harvested rain water.

Calculations:

Computation of the pipe sizes is based on the Valsir manual for water supply using the loading unit method. (LU)

Table 5.1 Loading units for different points of use (EN 806-3).

Point of use	Flow rate Q_A [l/s]	Loading unit (LU)
Washbasin, bidet, WC	0.1	1
Domestic sink, dishwasher, domestic washing machine, shower	0.2	2
Urinal with outlet valve	0.3	3
Domestic bathtub	0.4	4
Garden or garage taps	0.5	5
Non-domestic sinks and bathtubs DN20	0.8	8
DN20 outlet valve	1.5	15

Figure 163: Table 5.1 Valsir manual for water supply systems

Using table 5.1 we compute the total number of loading units per each branch and finally the mains.

BRANCH 'A'								
FLOOR	SECTION	ROOM	FIXTURE	NO. OF UNITS	FLOW RATE (L/S)	LU	TOTAL LU	LU MAX
Basement Floor	C	Book Disinfec. Room	Sink	2	0.8	8	16	8
							16	8
Ground Floor	B	Staff toilet-1	WC	1	0.1	1	2	1
			WB	1	0.1	1		
		Staff toilet-2	WC	1	0.1	1	2	1
			WB	1	0.1	1		
		Staff locker-1	WC	1	0.1	1	10	8
			WB	1	0.1	1		
			Shower	1	0.8	8		
		Staff locker-2	WC	1	0.1	1	10	8
			WB	1	0.1	1		
			Shower	1	0.8	8		
							24	8
First Floor	A	Staff toilet-1	WC	1	0.1	1	2	1
			WB	1	0.1	1		
		Staff toilet-2	WC	1	0.1	1	2	1
			WB	1	0.1	1		
		Pantry	Sink	1	0.8	8	8	8
							12	8
TOTAL							52	8

Table 4: Loading unit calculation for branch 'A'

BRANCH 'B'								
FLOOR	SECTION	ROOM	FIXTURE	NO. OF UNITS	FLOW RATE (L/S)	LU	TOTAL LU	LU MAX
Ground Floor	G	Toilet-1	WC	4	0.1	1	7	1
			WB	3	0.1	1		
		Toilet-2	WC	4	0.1	1	7	1
			WB	3	0.1	1		
							14	1
First Floor	F	Toilet-1	WC	4	0.1	1	7	1
			WB	3	0.1	1		
		Toilet-2	WC	4	0.1	1	7	1
			WB	3	0.1	1		
							14	1
Second Floor	E	Toilet	WC	2	0.1	1	4	1
			WB	2	0.1	1		
		Workshop	Sink	2	0.8	8	16	8
							20	8
Third Floor	D	Toilet	WC	1	0.1	1	2	1
			WB	1	0.1	1		
		Kitchen	Sink	2	0.8	8	16	8
							18	8
TOTAL							66	8

Table 5: Loading unit calculation for branch 'B'

using the table we have the total loading units for:
Branch ‘A’ - ***52 LU*** Branch ‘B’ - ***66 LU***

Total Loading units For the Building = ***118 LU***
Total UC_{max} = ***8 l/s***

using ***Figure 5.13*** from the valsir manual we compute the ***Design flow rate*** corresponding to the derived values of ***UC_{max}*** and ***Total loading units***.

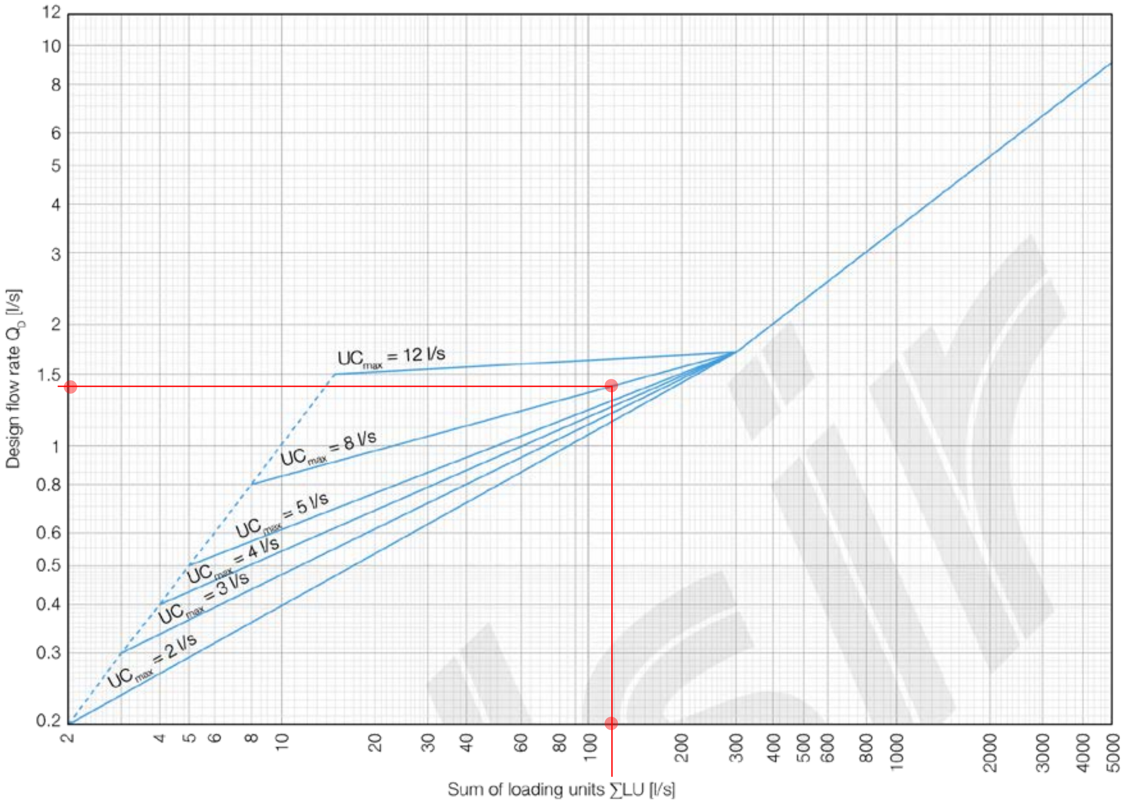


Figure 164: Chart for design Flow rate Valsir Manual

Design Flow Rate from the Figure is :

$Q_D \sim 1.4$ *l/s*

Pipe DImensioning:

we use Table 5.12 to dimension the size of the pipes starting from the section to the main supply pipes.

Table 5.12 Diameters of the multilayer pipes in relation to the LUs in compliance with EN 806-3.

∑LU	**LU**	3	4	5	6	10	20	55	180	540	1300	2200*	3400*
LU_{max}	**LU**			4	5	5	8						
d_e x s	**mm**		16x2.25/16x2		18x2	20x2.5	26x3	32x3	40x3.5	50x4	63x4.5	75x5	90x7
d_i	**mm**		11.5/12		14	15	20	26	33	42	54	65	76
max pipe length	**m**	9	5	4									

*Values not indicated in EN 806 standard, obtained by interpolating.

Figure 165: Pipe dimensioning tabel from valsir

Pipe diameter for section -A -

This terminal section pipe provides for the staff toilets in First floor in Branch ‘A’.

Total Loading Units = *12 LU*

LU_{max} = *8 LU*

Using Table 5.12,

for LU_{max} = 8 ;

$d_e \times s = 26 \times 3$ *mm*

$d_i = 20$ *mm*

Pipe diameter for section -B -

This terminal section pipe provides for the staff toilets in Ground floor in Branch ‘A’.

Total Loading Units = *24 LU*

LU_{max} = *8 LU*

Using Table 5.12,

for LU_{max} = 8 ;

$d_e \times s = 26 \times 3$ *mm*

$d_i = 20$ *mm*

Pipe diameter for section -C -

This terminal section pipe provides for the staff toilets in Basement floor in Branch ‘A’.

Total Loading Units = *16 LU*
LU_{max} = *8 LU*

Using Table 5.12,
for LU_{max} = 8 ;
$d_e \times s = 26 \times 3$ mm
$d_i = 20$ mm

Pipe diameter for section -E -

This terminal section pipe provides for the staff toilets in Second floor in Branch ‘B’.

Total Loading Units = *20 LU*
LU_{max} = *8 LU*

Using Table 5.12,
for LU_{max} = 8 ;
$d_e \times s = 26 \times 3$ mm
$d_i = 20$ mm

Pipe diameter for section -D -

This terminal section pipe provides for the staff toilets in Third floor in Branch ‘B’.

Total Loading Units = *18 LU*
LU_{max} = *8 LU*

Using Table 5.12,
for LU_{max} = 8 ;
$d_e \times s = 26 \times 3$ mm
$d_i = 20$ mm

Pipe diameter for section -F -

This terminal section pipe provides for the staff toilets in First floor in Branch ‘B’.

Total Loading Units = *14 LU*
LU_{max} = *1 LU*

Using Table 5.12,
for LU_{max} = 1 ;
$d_e \times s = 26 \times 3$ mm
$d_i = 20$ mm

Pipe diameter for section -G -

This terminal section pipe provides for the staff toilets in Ground floor in Branch ‘B’.

Total Loading Units = *14 LU*
LU_{max} = *1 LU*

Using Table 5.12,
for LU_{max} = 1 ;
$d_e \times s = 26 \times 3$ mm
$d_i = 20$ mm

Pipe diameter for section -H -

This terminal section pipe serves as the main pipe for Branch ‘B’.

Total Loading Units = *66 LU*
LU_{max} = *8 LU*

Using Table 5.12,
for LU_{max} = 8 ;
$d_e \times s = 40 \times 3.5$ mm
$d_i = 33$ mm

Pipe diameter for section ‘I’ -

This terminal section pipe serves as the main pipe for Branch ‘A’.

Total Loading Units = *52 LU*
LU_{max} = *8 LU*

Using Table 5.12,
for LU_{max} = 8 ;
$d_e \times s = 32 \times 3$ mm
$d_i = 26$ mm

Pipe diameter for main supply pipe -

This is a simplified dimensioning of the main supply pipe for both the branches.

Total Loading Units = *118 LU*
LU_{max} = *8 LU*

Using Table 5.12,
for LU_{max} = 8 ;
$d_e \times s = 40 \times 3.5$ mm
$d_i = 33$ mm

Computing the pipe dimensions for various sections of the system depending total loading units accumalated. using table 5.12 from the valsir manual.

SECTION	A	B	C	D	E	F	G	H	I
LU TOTAL	12	24	16	18	20	14	14	66	52
DIAMETER(mm)	26 X 3	26 X 3	26 X 3	26 X 3	26 X 3	26 X 3	26 X 3	40 X 3.5	32 X 3

Table 6: Section pipe sizes

The main pipes run through a series of softeners and filters. They distribution units are isolated using the interceptions valves and a mixer for the hot water supply.

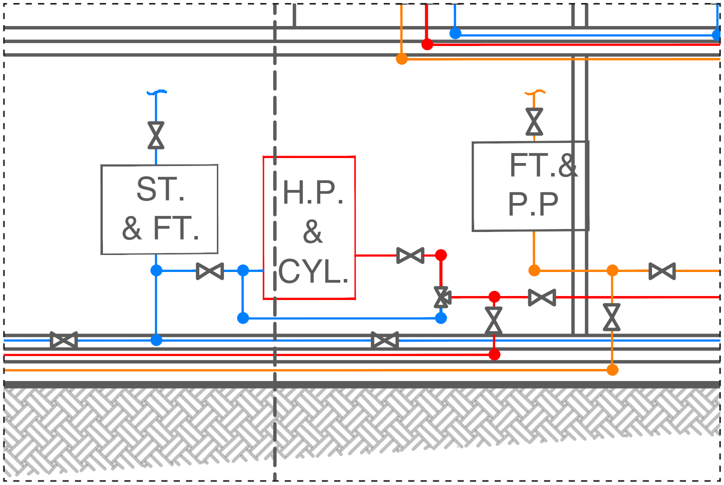


Figure 166: Water supply circuit at the mains

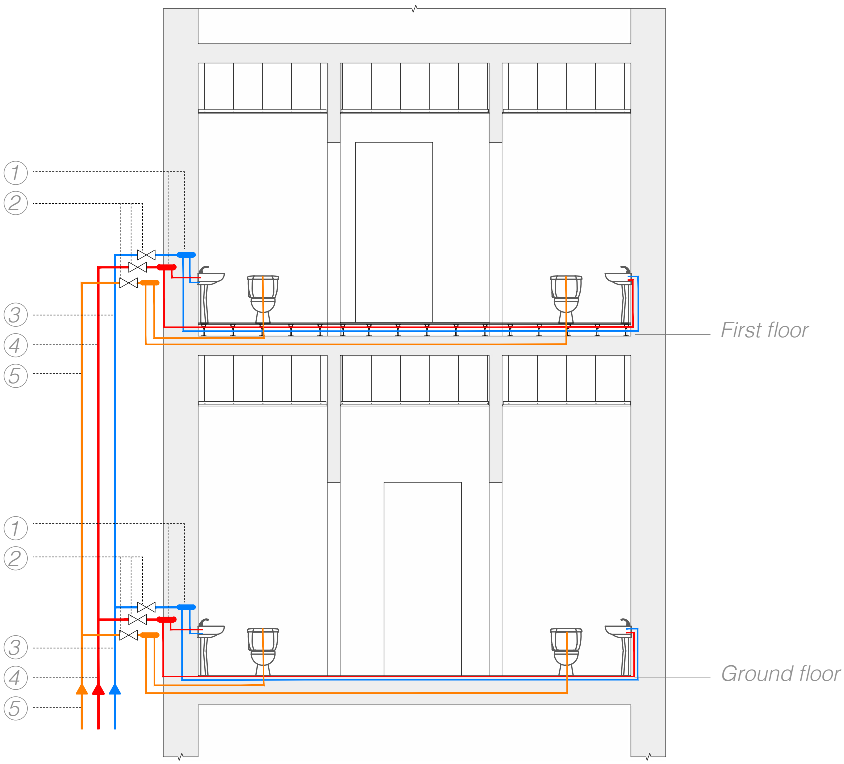
Legend:

St. *Softner*
Ft. *Filter*
H.P. *Heat pump*
Cyl. *Cylinder*
P.P. *Pressure pump*
Hot water supply
Cold water supply
Flushing water supply

INTERNAL BRANCHING SYSTEM:

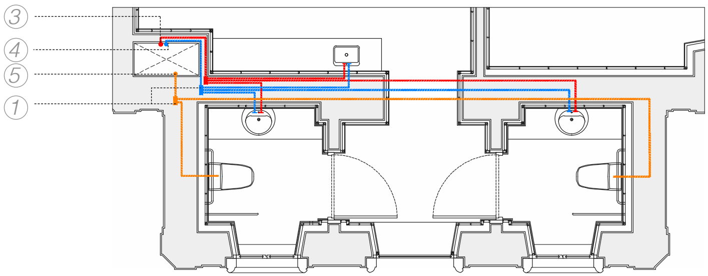
For the internal distribution of the hot and cold water supply we use a manifold system of distribution at each unit with a interception valve to have a absolute control over the supply system in case of maintenance and accidental breakdown.

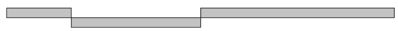
BRANCH 'A':



Legend:

1. *Manifolds*
2. *Interception valve*
3. *Recycled water pipe 26 mm*
4. *Hot water pipe 26 mm*
5. *Recycles water pipe 26 mm*

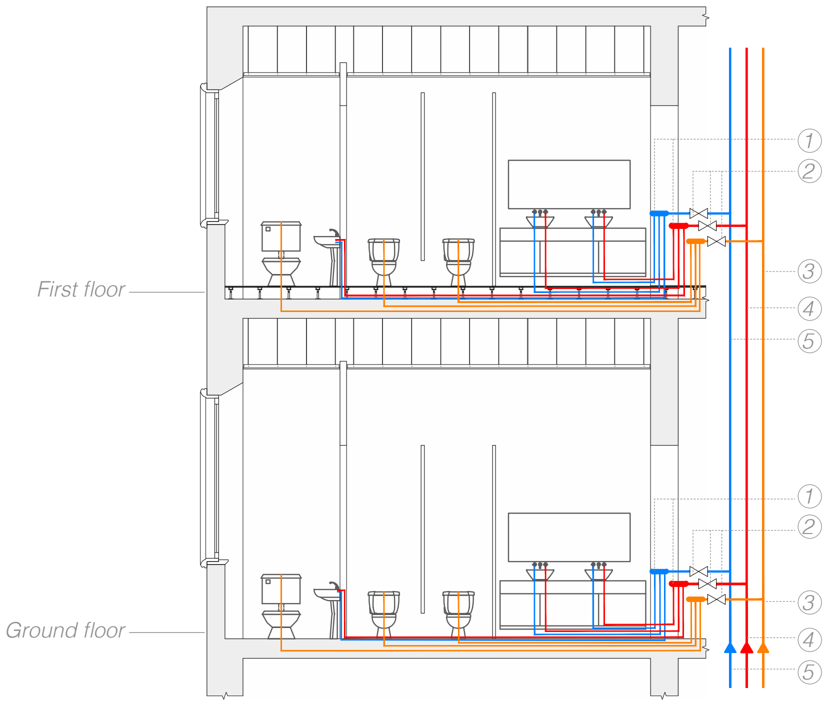


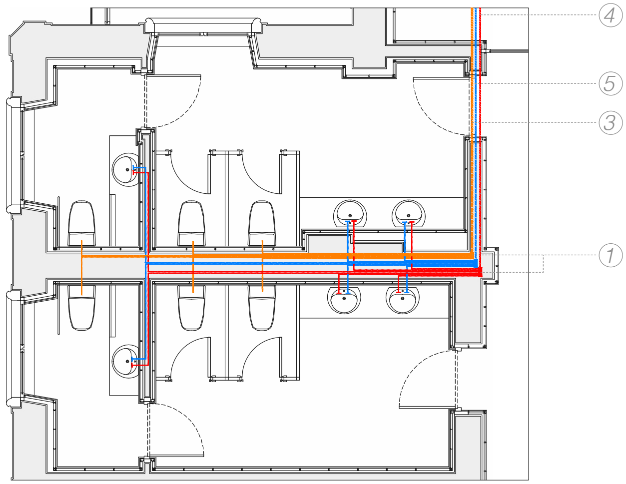


BRANCH 'B':

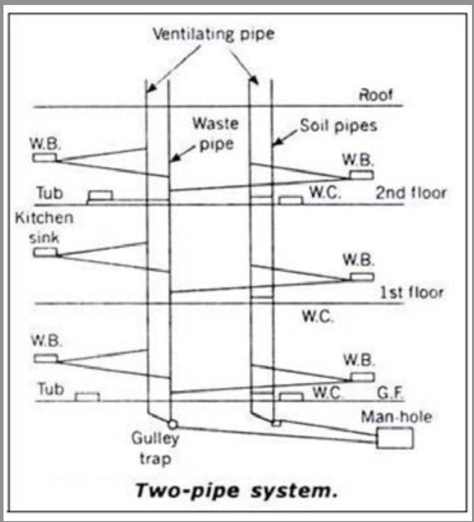
Legend:

1. *Manifolds*
2. *Interception valve*
3. *Recycled water pipe 26 mm*
4. *Hot water pipe 26 mm*
5. *Recycles water pipe 26 mm*





WASTE SYSTEM



Two pipe system illustration

the proposal of waste system consists of two pipe system with different pipes for grey water and soil waste. This requires an intergretation with the manifold system to connect the branches to the main stack.

Similar to the water supply system there are two branches which go individually into the main sewer line of the site. since there are some functions in the basement, the use of a sump is necessary to move the grey water to the main sewer.

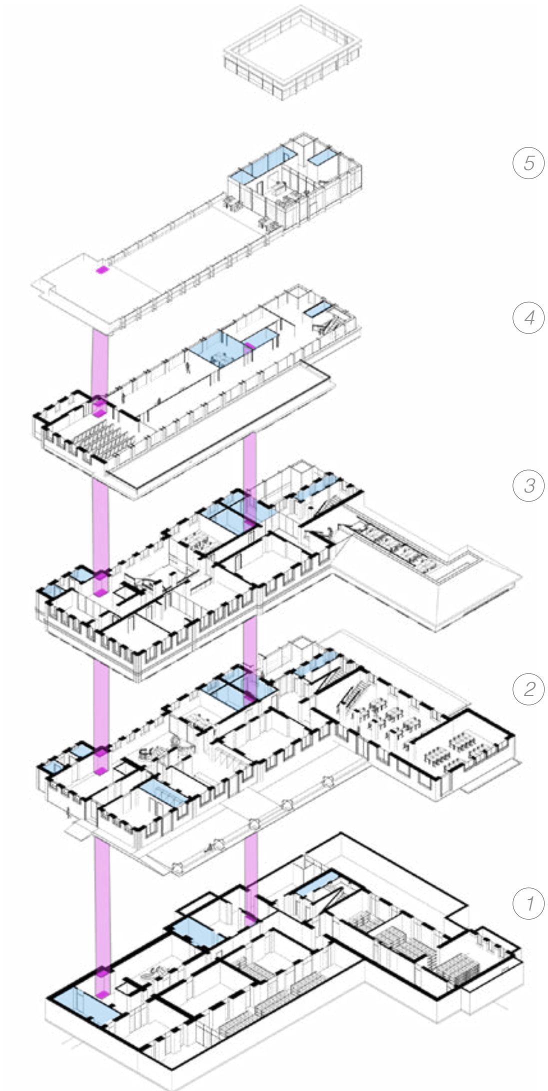


Figure 167: Exploded Axonometric view with the location of faucets

Legend:

1 *Basement level :*

Branch 'A'

Book repair workshop- 2 X Sink

2 *Ground floor :*

Branch 'A'

Staff toilets X2 - 1X WC & 1X WB

Staff Lockers X2 - 1X WC , !X WB & 1X Shower

Branch 'B"

Toilet X2 - 4X WC & 3X WB

3 *First floor:*

Branch 'A'

Staff toilets X2 - 1X WC & 1X WB

Pantry - 1X sink

Branch 'B"

Toilet X2 - 4X WC & 3X WB

4 *Second floor:*

Branch 'B'

Toilet - 2X WB & 2X WC

Workshop - 2X Sink

5 *Third Floor :*

Branch 'B'

Toilet - 1X WC & 1X WB

Kitchen - 2X Sink

Schematic System :

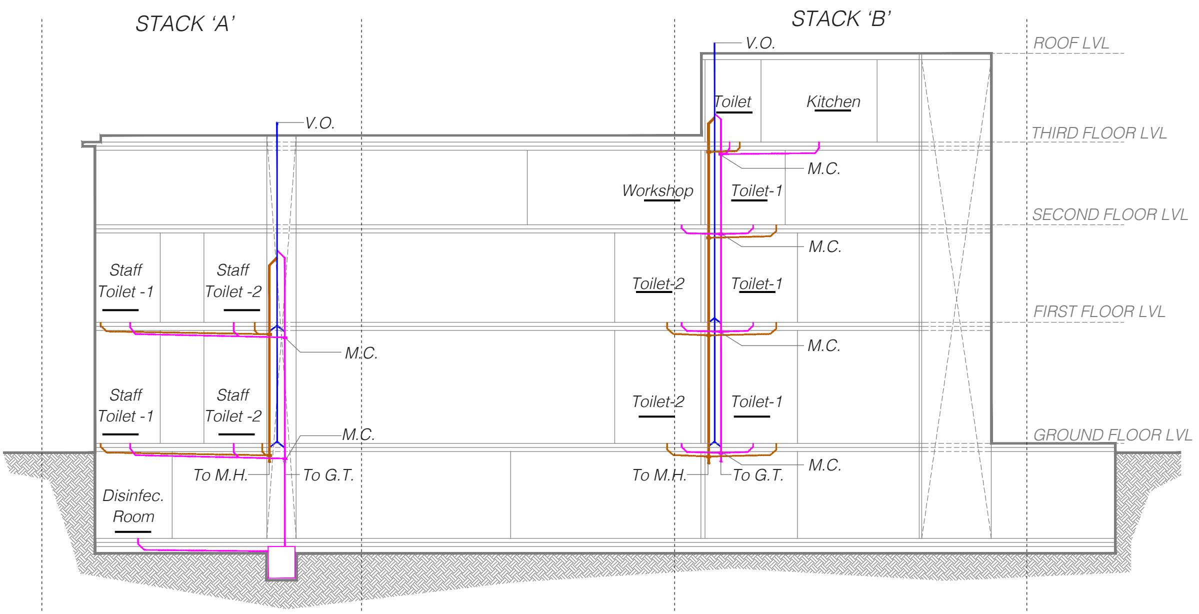


Figure 168: Waste system schematic layout

Similar to the water supply, waste system is also composed of two different stacks. so we describe the number of units and the total number. The two different stacks go directly to main sewer system via a gully trap and manhole.

Legend:

G.T. Gully Trap
M.H. Man Hole
M.C. Manifold connections
S.U Sump
V.O. Vent outlet
Grey water pipes
Ventilation pipes
Solid waste pipe

Requirements:

Table 7: Stack 'A' number of units

STACK 'A'					
FLOOR	ROOM	WC	WB	SINK	SHOWER
Basement Floor	Book Disinfec. Room	0	0	2	0
Ground Floor	Staff toilet-1	1	1	0	0
	Staff toilet-2	1	1	0	0
	Staff Locker-1	1	1	0	1
	Staff locker-2	1	1	0	1
First Floor	Staff toilet-1	1	1	0	0
	Staff toilet-2	1	1	0	0
	Pantry	0	0	1	0
	Total	6	6	3	2

Table 8: Stack 'B' number of units

STACK 'B'					
FLOOR	ROOM	WC	WB	SINK	SHOWER
Ground Floor	Toilet-1	4	3	0	0
	Toilet-2	4	3	0	0
First Floor	Toilet-1	4	3	0	0
	Toilet-2	4	3	0	0
Second Floor	Toilet	2	2	0	0
	Workshop	0	0	2	0
Third Floor	Toilet	1	1	0	0
	Kitchen	0	0	2	0
	Total	19	15	4	0

Calculations:

Computation of the pipe sizes is based on the Valsir manual for waste systems in compilance with UN EN 12056 using the ***Drainage units.***

$$Q_{tot} = Q_{ww}$$

$$Q_{ww} = K. \sqrt{\Sigma DU}$$

Table 4.4 Typical flow rates for various types of sanitary fixtures (domestic).

Sanitary fixture	DU [l/s]
Washbasin	0.5
Bidet	0.5
Shower without plug	0.6
Shower with plug	0.8
Urinal with cistern	0.8
Urinal with flush valve	0.5
Wall urinal	0.2
Bathtub	0.8
Kitchen sink	0.8
Dishwasher (domestic)	0.8
Washing machine, max. load 6 kg	0.8
Washing machine, max. load 12 kg	1.5
WC with 6 l cistern	2.0
WC with 7.5 l cistern	2.0
WC with 9 l cistern	2.5
Floor drain DN 50	0.8
Floor drain DN 70	1.5
Floor drain DN 100	2.0

Figure 169: Table 4.4 valsir manual of waste systems

Using table 4.4 we compute the total number of Drainage units per each stack using table 4.4 we compute the drainage unit for each toilet and unit. with the summation of the same we get the total number of drainage units.

STACK 'A'						
FLOOR	ROOM	FIXTURE	NO. OF UNITS	DU (l/s)	Soil DU	Grey water DU
Basement Floor	Book Disinfec. Room	Sink	2	0.5	0	1
					0	1
Ground Floor	Staff toilet-1	WC	1	2	2	0.5
		WB	1	0.5		
	Staff toilet-2	WC	1	2	2	0.5
		WB	1	0.5		
	Staff locker-1	WC	1	2	2	1.1
		WB	1	0.5		
		Shower	1	0.6		
	Staff locker-2	WC	1	2	2	1.1
		WB	1	0.5		
		Shower	1	0.6		
					8	3.2
First Floor	Staff toilet-1	WC	1	2	2	0.5
		WB	1	0.5		
	Staff toilet-2	WC	1	2	2	0.5
		WB	1	0.5		
	Pantry	Sink	1	0.8	0	0.8
					4	1.8
TOTAL					12	6

Table 9: Stack 'A' DU computing table

For Stack'A' the total number of DU for soil pipe and grey water pipe are 12 l/s and 6l/s respectively.

STACK 'B'						
FLOOR	ROOM	FIXTURE	NO. OF UNITS	DU (l/s)	Soil DU	Grey water DU
Ground Floor	Toilet-1	WC	3	2	6	1.5
		WB	3	0.5		
	Toilet-2	WC	3	2	6	1.5
		WB	3	0.5		
					12	3
First Floor	Toilet-1	WC	3	2	6	1.5
		WB	3	0.5		
	Toilet-2	WC	3	2	6	1.5
		WB	3	0.5		
					12	3
Second Floor	Toilet	WC	2	2	4	1
		WB	2	0.5		
	Workshop	Sink	2	0.5	0	1
					4	2
Third Floor	Toilet	WC	1	2	2	0.5
		WB	1	0.5		
	Kitchen	Sink	2	0.8	0	1.6
					2	2.1
TOTAL					30	10.1

Table 10: Stack 'B' DU computing table

For Stack'B' the total number of DU for soil pipe and grey water pipe are 30 l/s and 10.1l/s respectively.

After the computation of Σ ***DU*** of both the stacks, next consideration is the value of 'K'. The purpose of simplification we assign a single value of 'K' for each stack which is the highest one observed in the system. This value of 'K' is choosen from Table 4.2.

Table 4.2 Coefficient of contemporary use as a function of use and type of building.

Use	Building type	Coefficient K
Intermittent	Homes and offices	0.5
Frequent	Hospitals, schools, restaurants, hotels	0.7
Very frequent	Public bathrooms and showers	1.0
Special	Laboratories	1.2

Figure 170: Table 4.2 valsir manual of waste systems for Value of 'K"

considering the K value for the two stacks, for **Stack 'A'** since all the functions are oriented for office use we use,

$$K = 0.5$$

whereas for **Stack 'B'** there is a collection of function from public to academic use, so for the sake of simplification we use the highest value,

$$K = 1.0$$

STACK 'A'									
FLOOR	ROOM	FIXTURE	NO. OF UNITS	DU (l/s)	Soil DU	Grey water DU	K	Qww for S.P.	Qww for W.P.
Basement Floor	Book Disinfec. Room	Sink	2	0.5	0	1	0.5	0	0.5
					0	1		0	0.50
Ground Floor	Staff toilet-1	WC	1	2	2	0.5		0.71	0.35
		WB	1	0.5					
	Staff toilet-2	WC	1	2	2	0.5		0.71	0.35
		WB	1	0.5					
	Staff locker-1	WC	1	2	2	1.1		0.71	0.52
		WB	1	0.5					
		Shower	1	0.6					
	Staff locker-2	WC	1	2	2	1.1		0.71	0.52
		WB	1	0.5					
		Shower	1	0.6					
					8	3.2		1.41	0.89
First Floor	Staff toilet-1	WC	1	2	2	0.5		0.71	0.35
		WB	1	0.5					
	Staff toilet-2	WC	1	2	2	0.5		0.71	0.35
		WB	1	0.5					
	Pantry	Sink	1	0.8	0	0.8		0	0.45
					4	1.8		1.00	0.67
TOTAL					12	6		1.73	1.22

Table 11: Q_{ww} value computation for stack 'A'

The Q_{ww} for stack 'A' =

Soil pipe - 1.73 l/s

Waste pipe- 1.22 l/s

STACK 'B'									
FLOOR	ROOM	FIXTURE	NO. OF UNITS	DU (l/s)	Soil DU	Grey water DU	K	Qww for S.P.	Qww for W.P.
Ground Floor	Toilet-1	WC	3	2	6	1.5	1	2.45	0.61
		WB	3	0.5					
	Toilet-2	WC	3	2	6	1.5		2.45	0.61
		WB	3	0.5					
					12	3		3.46	1.73
First Floor	Toilet-1	WC	3	2	6	1.5		2.45	1.22
		WB	3	0.5					
	Toilet-2	WC	3	2	6	1.5		2.45	1.22
		WB	3	0.5					
					12	3		3.46	1.73
Second Floor	Toilet	WC	2	2	4	1		2.00	1.00
		WB	2	0.5					
	Workshop	Sink	2	0.5	0	1		0.00	1.00
					4	2		2.00	1.41
Third Floor	Toilet	WC	1	2	2	0.5		1.41	0.71
		WB	1	0.5					
	Kitchen	Sink	2	0.8	0	1.6		0.00	1.26
					2	2.1		1.41	1.45
TOTAL					30	10.1		5.48	3.18

Table 11: Q_{ww} value computation for stack 'B'

The Q_{ww} for stack 'B' =

Soil pipe - 5.48 l/s

Waste pipe- 3.18 l/s

After computing the maximum flow rate for the stacks we can dimension the pipe size of the stack using table 4.10 from the valsir manual

Table 4.10 Flow rate of the waste stack with parallel or secondary ventilation.

Waste stack DN	Vent stack DN	Max. flow rate Q_{max} [l/s] Square branch	Angle branch
60	50	0.7	0.9
70	50	2.0	2.6
80	50	2.6	3.4
90	50	3.5	4.6
100*	50	5.6	7.3
125	70	7.6	10.0
150	80	12.4	18.3
200	100	21.0	27.3

* Minimum dimension allowed if waste water from at least one WC flows through the branch.

Figure 171: Table 4.10 valsir manual of waste systems

Stack 'A'

Soil pipe -
70 mm dia as per flow rate of *1.73l/s* using *100 mm dia* as per recommendation from the manual

Waste pipe -
70 mm dia as per flow rate of ***1.22l/s*** using

Vent pipe -
50 mm dia as per the table

Stack 'B'

Soil pipe -
100 mm dia as per flow rate of *5.48l/s* using

Waste pipe -
90 mm dia as per flow rate of *3.18l/s* using

Vent pipe -
50 mm dia as per the table

Branch Pipe sizes:

To compute the size of the soil branch and the waste water branch in every unit we use table 4.6 from the valsir manual.

Table 4.6 Maximum flow rates and nominal diameters of the branches without vents.

Branch DN	Maximum flow rate Q_{max} [l/s]	Typical sanitary fixture
40	0.50	Washbasin, bidet, urinal without cistern
50	0.80	Shower, bathtub, sink, dishwasher, washing machine max. load 6 kg
60	1.00	
70	1.50	Washing machine max. load 12 kg
80	2.00	
90*	2.25	WC with cistern up to 7.5 l
100	2.50	WC with 9 l cistern

* In the presence of a WC the minimum diameter allowed is DN 90 as long as there are no more than two WCs on the same branch and the total change in direction is no greater than 90°, if this is not the case then diameter DN 100 should be used.

Figure 172: Table 4.6 valsir manual of waste systems

For branches we use :

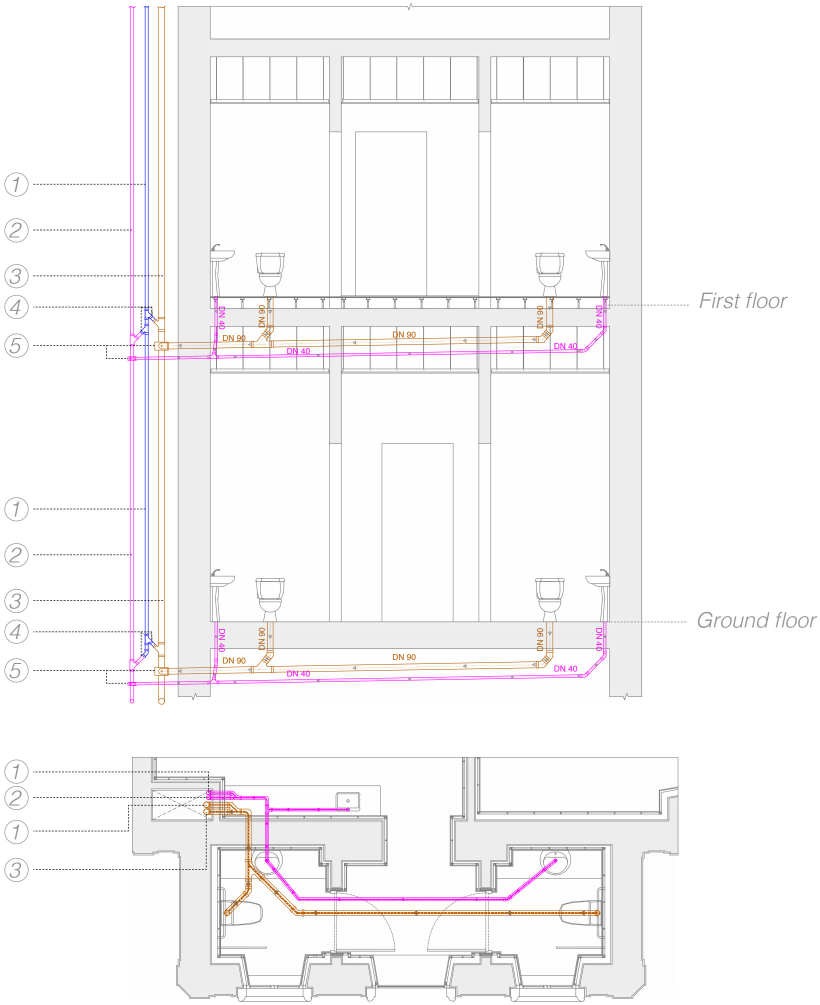
soil pipe - ***90 and 100 mm*** dia with ***1%*** incline.

waste water pipe - ***40 , 60 and 70mm*** dia with ***1%*** incline.

STACK 'A':

Legend:

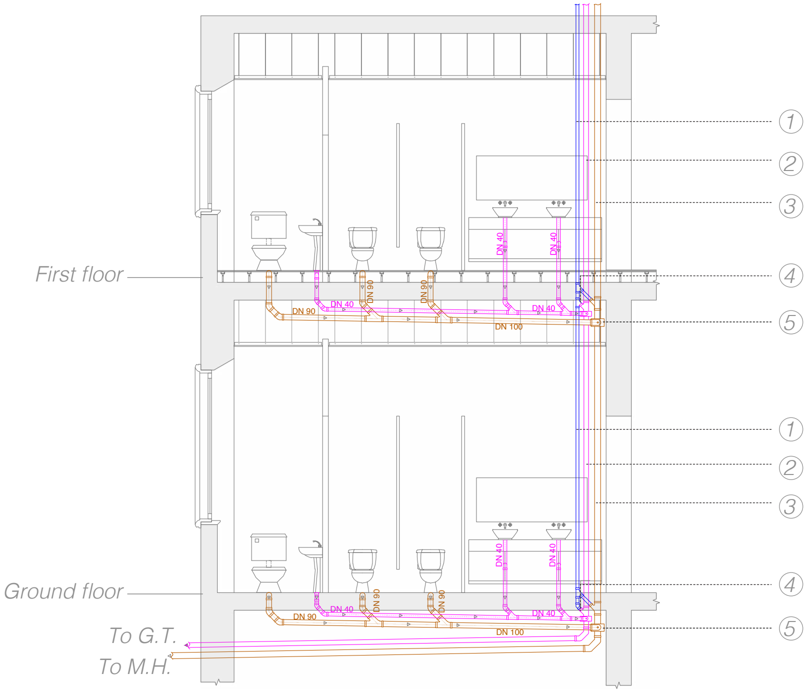
① *Vent pipe 50 mm dia*
② *Waste pipe 90 mm dia*
③ *Soil pipe 50 mm dia*
④ *Anti-siphonage Pipe*
⑤ *Manifold connections*

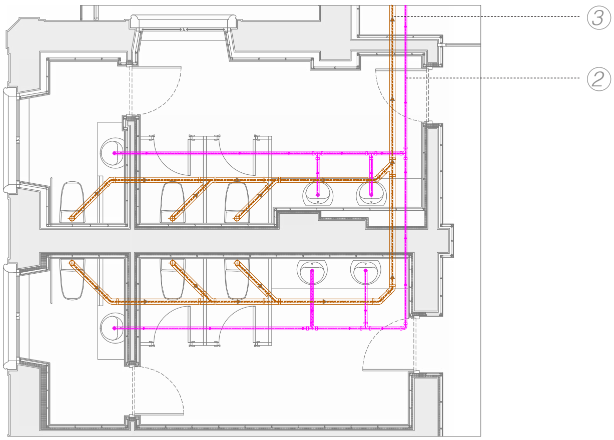


STACK 'B':

Legend:

1. *Vent pipe 50 mm dia*
2. *Waste pipe 90 mm dia*
3. *Soil pipe 50 mm dia*
4. *Anti-siphonage Pipe*
5. *Manifold connections*





RAIN WATER SYSTEM

Considering the state of art condition of the building we recoganize from the preserved plans the presence of existing rain water pipes, embedded within the walls of the existing structure.
As the new project adding a new volume on top the existing structure the area of collection will remain the same jst it get’s split in different levels.
so for the rain water we compute the down pipes that connect to these levels.
Retaining the existing systems and adding to the new levels developed.

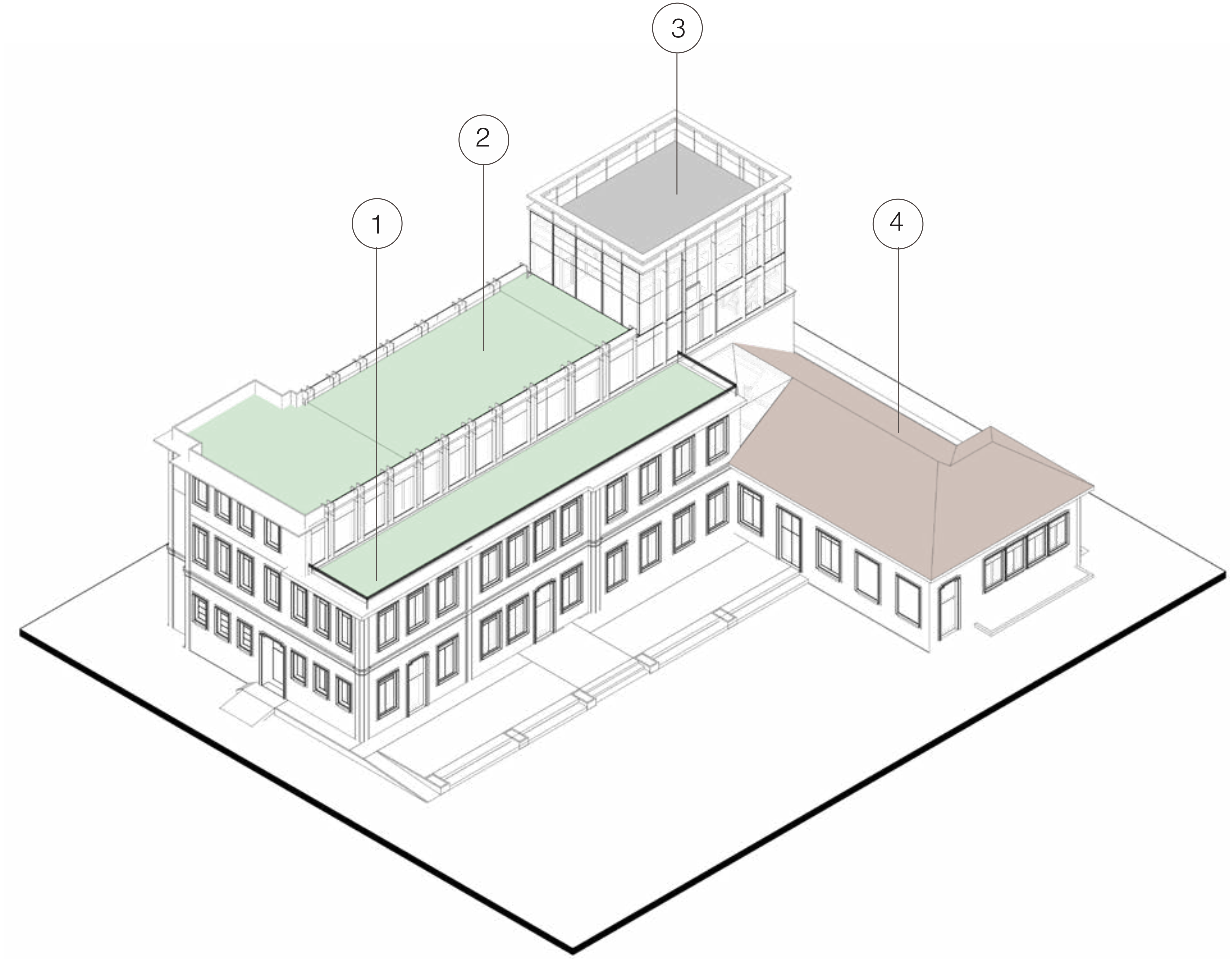


Figure 173: Axo of Building with terraces

1 Partial green terrace
2 Extensive Green terrace
3 Gravel covered service roof
4 Existing sloping roof with drainage system.

For the new rain water system we compute for a non syphonic drainage system, taking reference from the valsir manuals which are in comliance with the european standard EN 12056-3.
The steps of computation of the pipe sizes for the system are as follows :
1. Calculation of flow collected on the roof .
2. Calculation of the diameters of the rain water downpipes.
3. Calculation of the diameters of the rain water collector pipes .

STEP-1: CALCULATION OF FLOW COLLECTED ON THE ROOF:

To calculate the flow rate of the rain water we use :

$$Q = r \cdot A \cdot C_1 \cdot C_2$$

where ,
r - rainfall intensity (used as 0.04 $l/(s.m^2)$ in case of unavailability of data)
A - Surface area of roof covering (m^2)
C_1 - Flow coefficient value
C_2 - is the risk coefficient used from the table 6.1

Table 6.1 Coefficient of risk c_2.

Situation	Coefficient c_2
Eaves-gutter	1.0
Eaves-gutters situated in points where the overflow of water would be particularly inconvenient, for example, over the entrance to a public building.	1.5
Internal gutters or in the case of particularly intense rainfall that could cause the obstruction of rainwater drains and the consequent infiltration of water inside the building.	2.0
Gutters inside buildings where an exceptional degree of protection is required, such as hospitals, theatres, telecommunication systems, depots for storage of chemical substances that are dangerous when wet, museums, etc.	3.0

Figure 173: Table 6.1 valsir manual About coefficient of risk

Since there is an unavaiability of the r value for milano we use the value that is provided -i.e.-

$$r = 0.04\ l/(s.m^2)$$

C_1- FLOW COEFFICIENT VALUE
Since the terrace are largely composed of gravle and green roof for the sustainability of the project. We use the value of C_1 for these surface covers:

Gravel roof = 0.74
Green roof = 0.63

COMPUTATION OF AREAS OF TERRACES:

TERRACE-1:

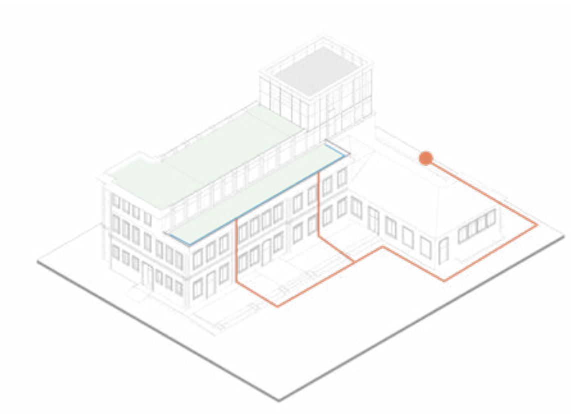
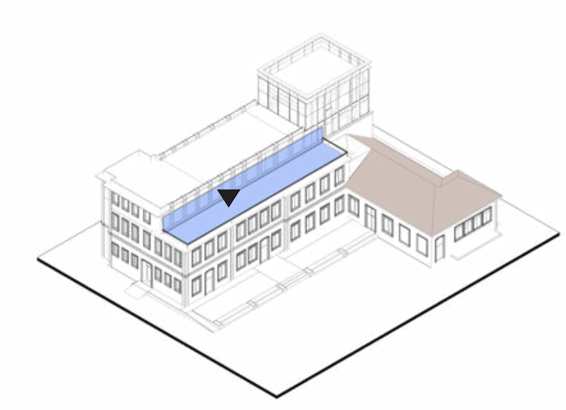


Figure 174: Downpipe schematic pipe layout



Area of influence

Since the terrace has an adjacent wall next to it so to compute the area of the terrace we use the area of the terrace + half the area of the adjacent wall.

$$A_1 = A_h + 1/2\ A_v$$

$$A_1 = 209.82 + 114.68$$

$$= 324.5\ m^2$$

since, we use three downpipes we use 1/3 the area for the computation of one stack.

Hence, for each branch,

$$Q = (0.04).(108.2).(0.63).(2)$$

$$= 5.45\ l/s$$

Using, the Q value derived from this calculation we use it against the table 6.2 from the valsir manual , to compute the value for the diameter of the down pipe.

Table 6.2 Maximum flows for rainwater downpipes with filling degree f = 0.33 (33%).

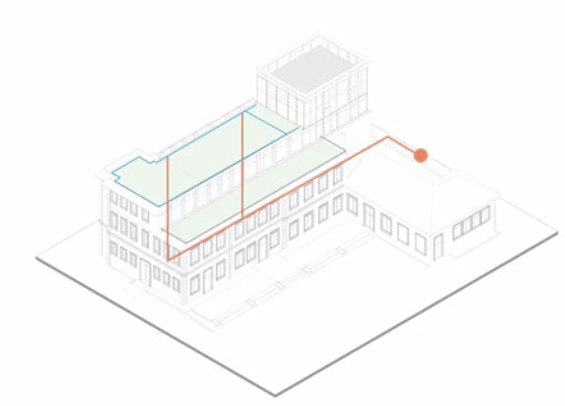
OD [mm]	Maximum flow Q_{max} [l/s]			
	Polyethylene	Polypropylene	Triplus®	Silere®
32	0.3	0.4	0.4	-
40	0.6	0.7	0.7	-
50	1.2	1.4	1.4	-
56	1.7	-	-	-
58	-	-	-	1.7
63	2.4	-	-	-
75	4.0	4.3	4.1	-
78	-	-	-	3.5
90	6.5	7.1	6.7	6.1
110	11.2	12.1	11.7	10.5
125	15.7	17.0	16.4	-
135	-	-	-	18.9
160	30.3	32.8	31.7	30.9
200	57.4	-	57.4	-
250	104.1	-	104.1	-
315	192.8	-	-	-

Figure 175: Table 6.2 valsir manual for pipe dimensioning

Hence for terrace-1 the pipe diameter is,

$$OD_1 = 90 \text{ mm Dia.}$$

TERRACE-2 :



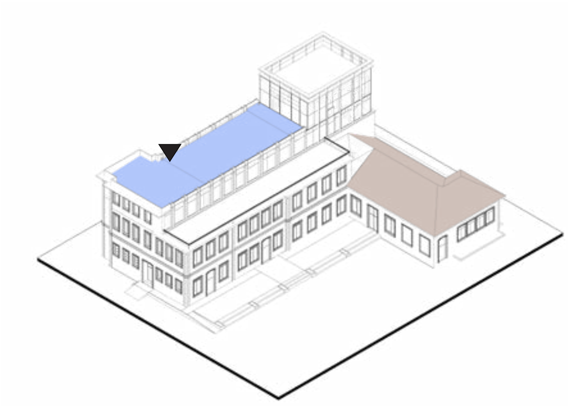


Figure 176: Downpipe schematic pipe layout

Area of influence

For this terrace we use the area of the horizontal terrace as the wall that is adjacent if not in the assumed direction of rain.

$$A_2 = A_h$$
$$A_2 = 316.6 \ m^2$$

we use two down pipes for this area so the area would be 1/2 for each stack.
Hence, for each branch,

$$Q = (0.04).(158.3).(0.63).(3)$$
$$= 12.0 \ l/s$$

Using, the Q value derived from this calculation we use it against the table 6.2 from the valsir manual , to compute the value for the diameter of the down pipe.
Hence for terrace-2 the pipe diameter is,

$$OD_1 = 125 \text{ mm Dia.}$$

TERRACE-3 :

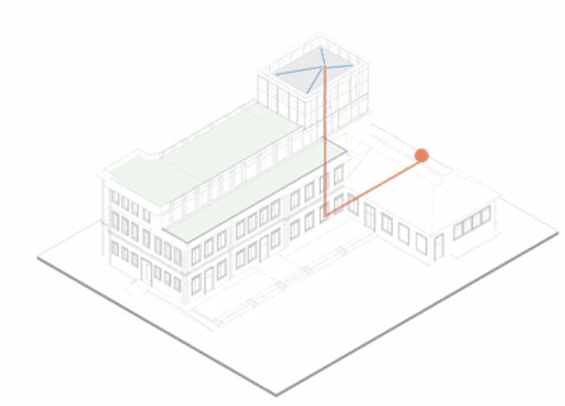
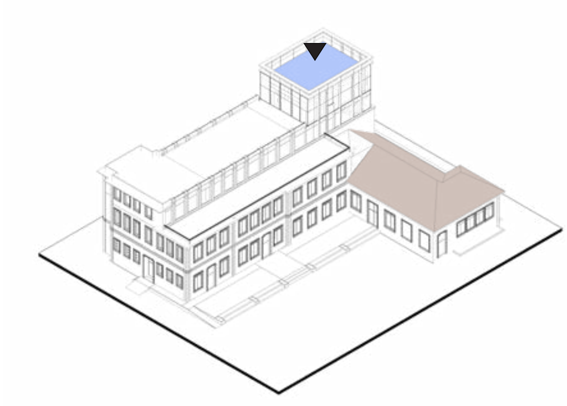


Figure 177: Downpipe schematic pipe layout



Area of influence

For this terrace we use the area of the horizontal terrace

$$A_3 = A_h$$
$$A_3 = 126\ m^2$$

Hence, for the down pipe,

$$Q = (0.04).(126).(0.74).(2)$$
$$\mathbf{=7.46\ l/s}$$

Using, the Q value derived from this calculation we use it against the table 6.2 from the valsir manual , to compute the value for the diameter of the down pipe.

Hence for terrace-3 the pipe diameter is,

$$OD_1 = 110\ mm\ Dia.$$

SCHEMATIC LAYOUT :

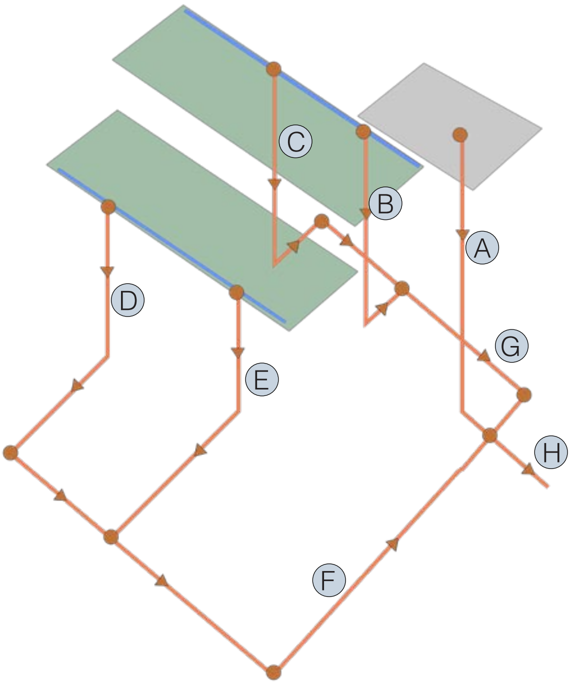


Figure 178: Downpipe schematic diagram

SECTION	OD
A	110 mm
B	125 mm
C	125 mm
D	90 mm
E	90 mm
F	125mm
G	160mm
H	200 mm

Table 12: Rainwater pipe diameter for sections

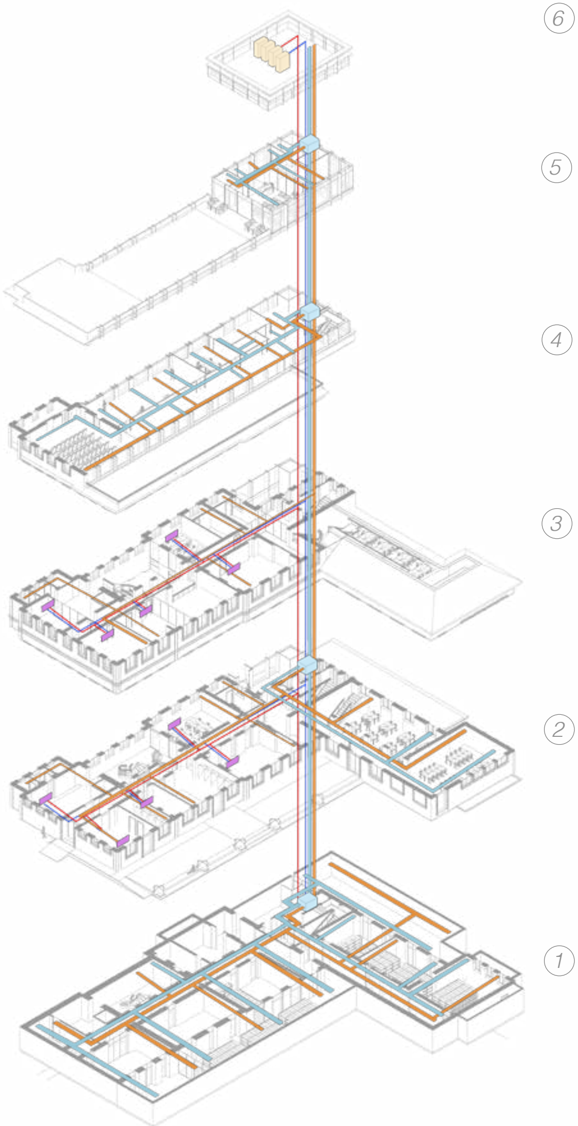
VENTILATION SYSTEM

The existing building is composed of the split ac system as of now to provide for the neccessary cooling and ventilation, with the outdoor units placed on the facade, which seems to be hinderance to the heritage building.

The proposal for the collective ventilation of the new transformation project is a composite system that is a mix of a VRV system with a ducted system. The usage of the ducted system is intergated in the floors with bigger spaces that require a heavier cooling and ventilation effect.

Whereas the VRV indoor units are used where there is a need for a micro controlled environment, like offices and other functions located at the ground and first floor.

To feed this ventilation system we place the air exchange outlets on the top of the restaurant terrace as a service terrace.



Legend:

1. **Basement level :**
Ducted ventilation and cooling system with a AHU cooled using the VRV outdoor unit

2. **Ground floor :**
Mircro controlled VRV indoor units and air exchange ducts
Ducted cooling and ventilation system in the readng hall

3. **First floor:**
Mircro controlled VRV indoor units and air exchange ducts

4. **Second floor:**
Ducted ventilation and cooling system with a AHU cooled using the VRV outdoor unit

5. **Third Floor :**
Ducted ventilation and cooling system with a AHU cooled using the VRV outdoor unit

6. **Terrace** of the restaurant is where the outdoor unit is placed, as well as the outlet for air exhange .

Figure 179: Exploded Axonometric view with ventilation systems per floor

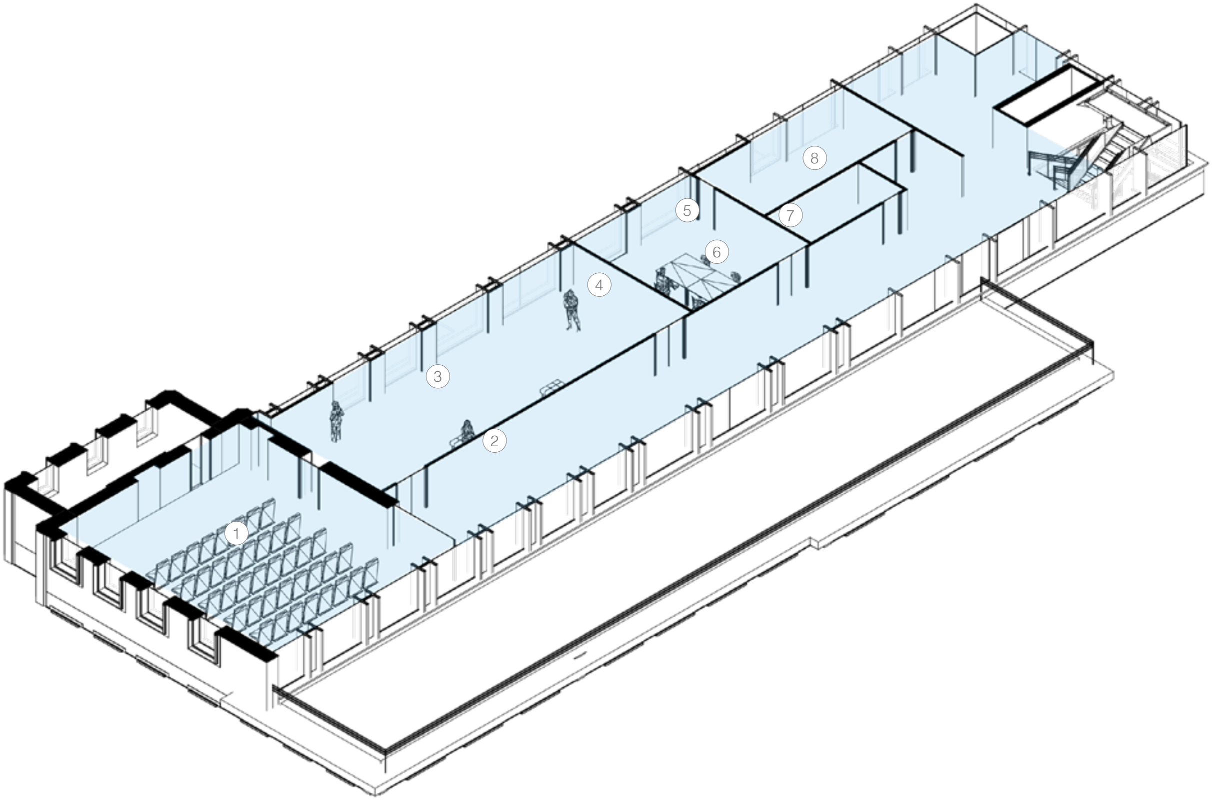


Figure 180: Exploded Axonometric of conditioned spaces for second floor

Second floor conditioned spaces

Legend:

1. Conference room
2. Gallery
3. Exhibition
4. Workshop
5. Toilet
6. Storage
7. Reception
8. Lift lobby

we choose the new addition part (exhibition floor) to make the computation of the ventilation system. This floor uses a ducted ventilation system which is computed using the air change requirement as per the number of people and the area of the spaces.

Steps to compute the duct size:
1. compute the area of the conditioned area.
2. compute the design air change volume.

$$Rx= (A.q_s + n_p.q_p)* 3.6$$

3. compute the duct sizes.

$$R_x=A_c.v$$

where,
R_x - Design air flow [m^3/h]
A_c - Conditioned Area [m^2]
V - Air velocity, [m/s]
The air velocity is considered 4-5 m/s for distribution ducts and 6-7 m/s for main ducts
n_p - Number of people
q_s - Air flow rate per surface [l/sm^2]
q_p - Air flow rate per person [l/s]

AIR FLOW CHANGES						
Second Floor (Exhibition)						
ROOM	AREA	qs	NUMBER OF PEOPLE	qp	Rx [m3/h]	Supply Duct Area
Conference room	87	0.6	40	7	1195.9	0.07
Exhibtion room	78.7	0.4	40	7	1121.3	0.08
Gallery	88	0.4	20	7	630.7	0.04
Workshop	30	0.7	5	7	201.6	0.01
Reception	7.2	0.4	2	7.5	64.4	0.00
Entrance hall & Lift Lobby	41.9	7	4	0.4	1061.6	0.07
			Total		4275.6	0.20

Table 13: Calculation of tentative duct radius

using the tentative radius against the table F-1.4 to assign a available diameter to each section.

Diametro nominale *d* [mm]	Spessore [mm]	Area della sezione trasversale A_c [m^2]	Area della superficie laterale A_i [m^2/m]	Tolleranze maschio/femmina [mm]
63	0,4	0,00312	0,198	0,50
80	0,4	0,00503	0,251	0,50
100	0,6	0,00785	0,314	0,50
125	0,6	0,01227	0,393	0,50
160	0,6	0,02011	0,503	0,60
200	0,6	0,03142	0,628	0,70
250	0,6	0,04909	0,785	0,80
315	0,8	0,07793	0,990	0,90
400	0,8	0,12566	1,257	1,00
500	0,8	0,19635	1,571	1,10
630	1	0,31172	1,979	1,20
800	1	0,50265	2,513	1,30
1000	1,2	0,78540	3,142	1,40
1250	1,2	1,22718	3,927	1,50

Figure 181: Table F-1.4 for circular duct diameter

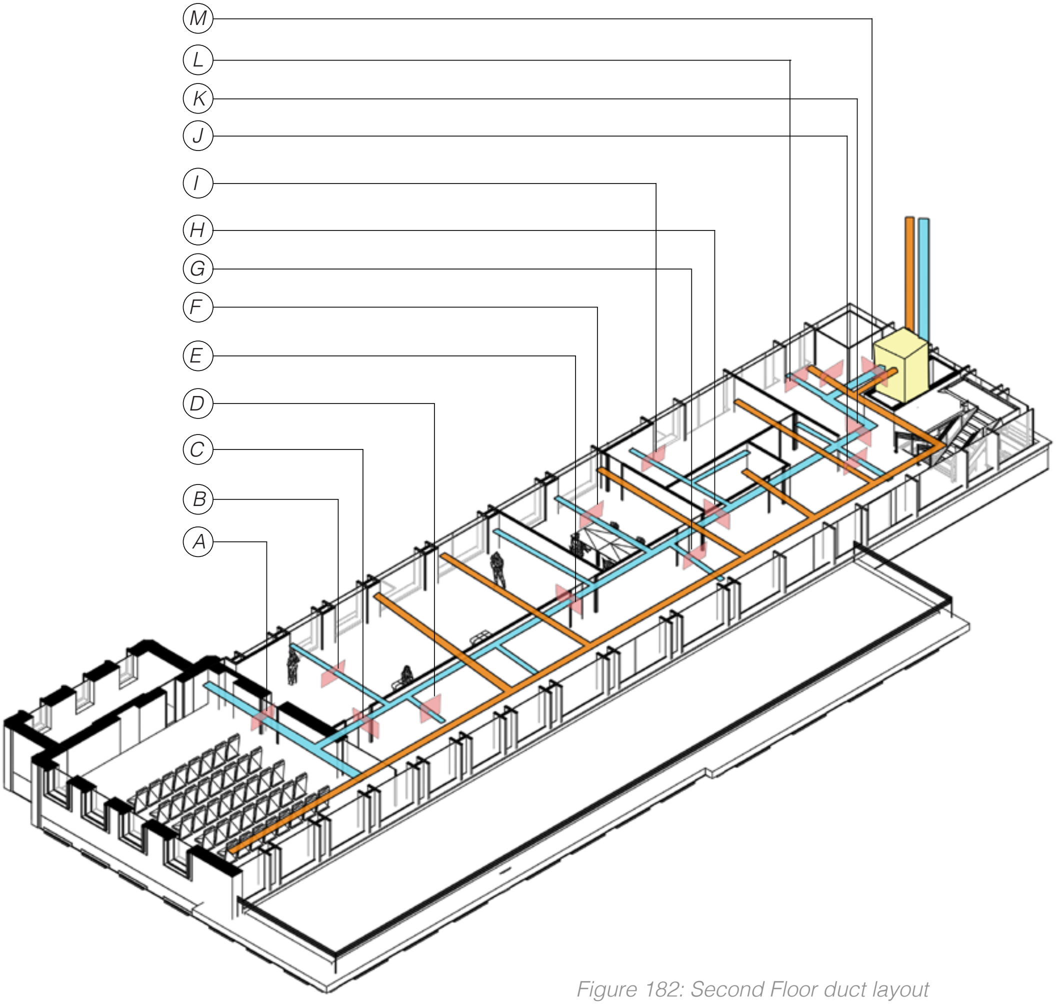


Figure 182: Second Floor duct layout

SECTION	A	B	C	D	E	F	G	H	I	J	K	L	M
DIAMETER (mm)	315	315	315	250	400	125	250	400	100	315	400	315	500

Table 14: Duct dia as per the sections

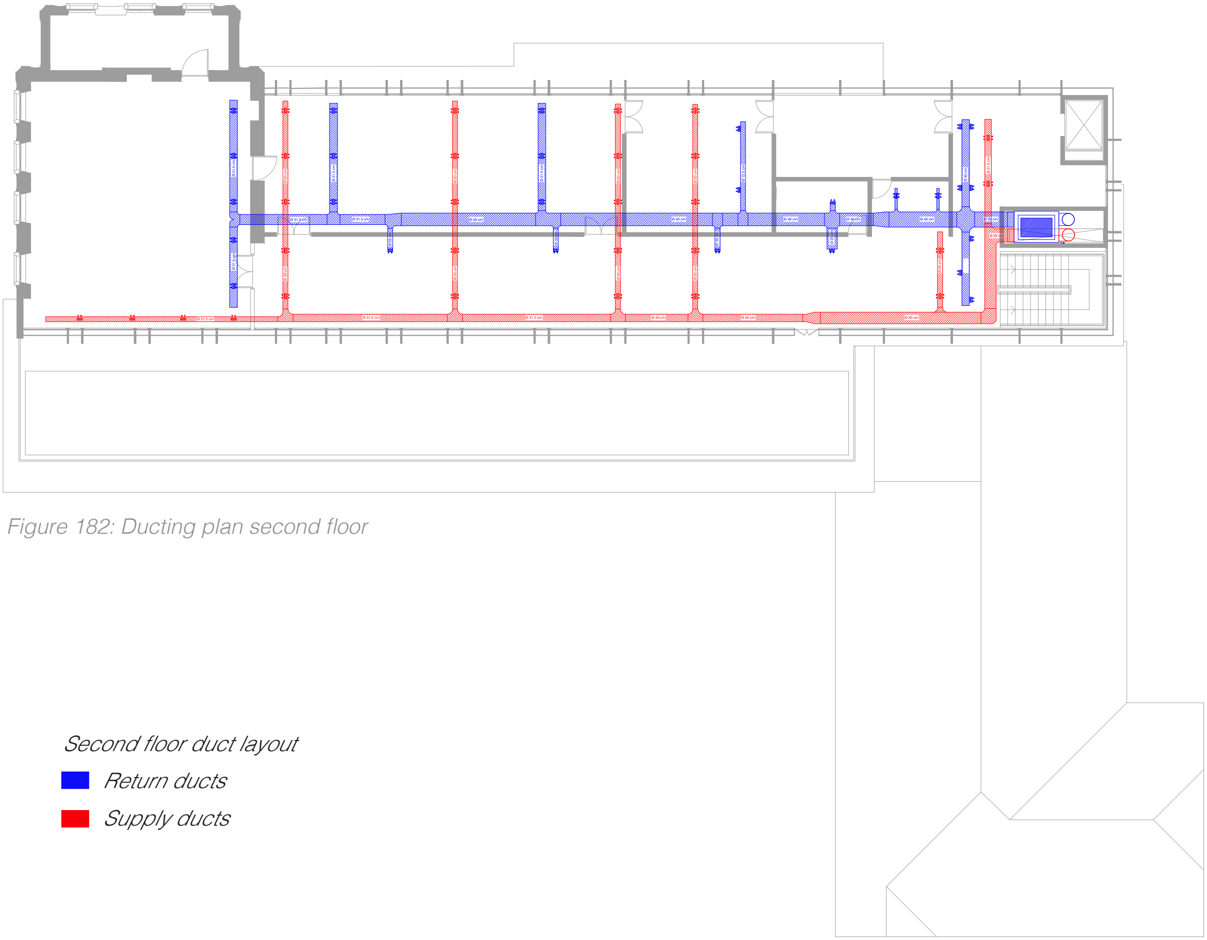


Figure 182: Ducting plan second floor

FLOOR HEATING SYSTEM

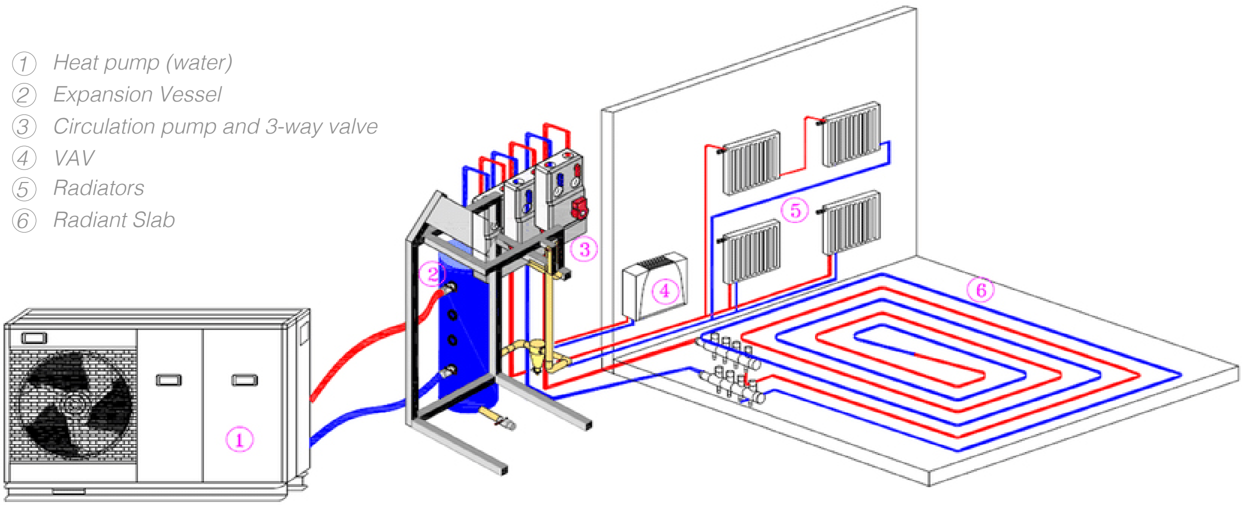


Figure 183: Hydronic floor heating system schematic

For the purpose of heating we propose to use a hydronic radiant floor heating system. Since the building usage hours are mostly during the day, so a more rapid heating system is necessary since there is less need for thermal storage capacity from the heating system, so, to use a more energy efficient system is a better solution.

This heating system is fueled by a water supply heatpump which is intergrated with the VRV system for the heat exchange that exchanges the heat to a boiler which further transfers this heat to the floor using the manifolds. The installation method used is the dry installation, due to the usage of raised floor system.

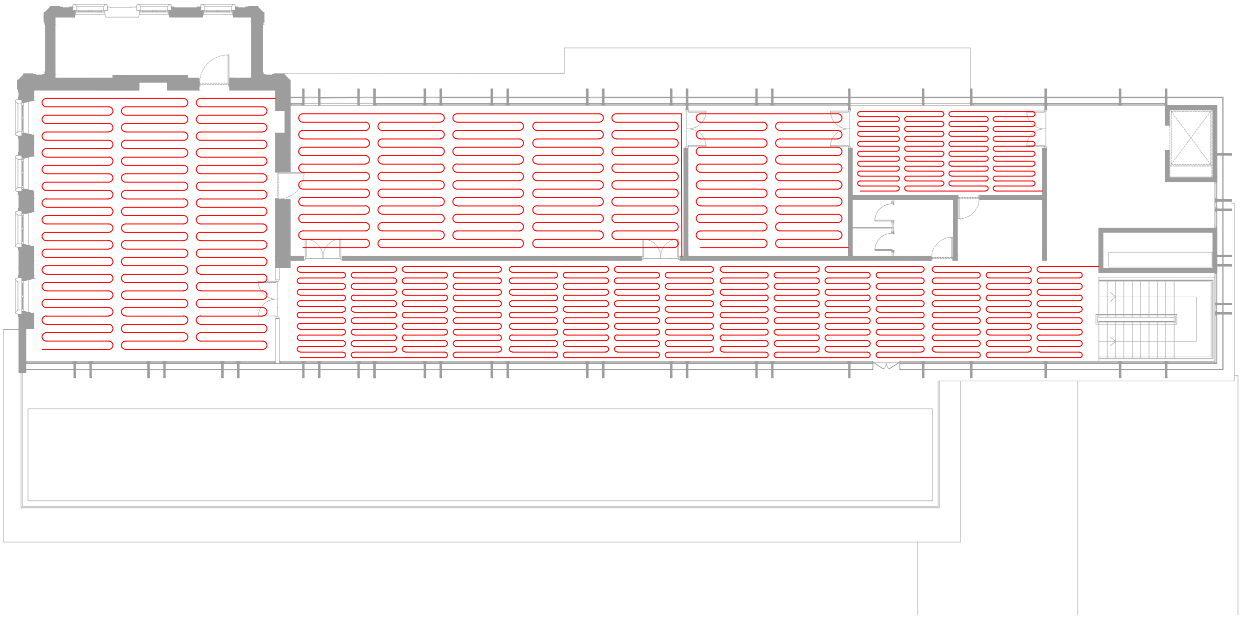
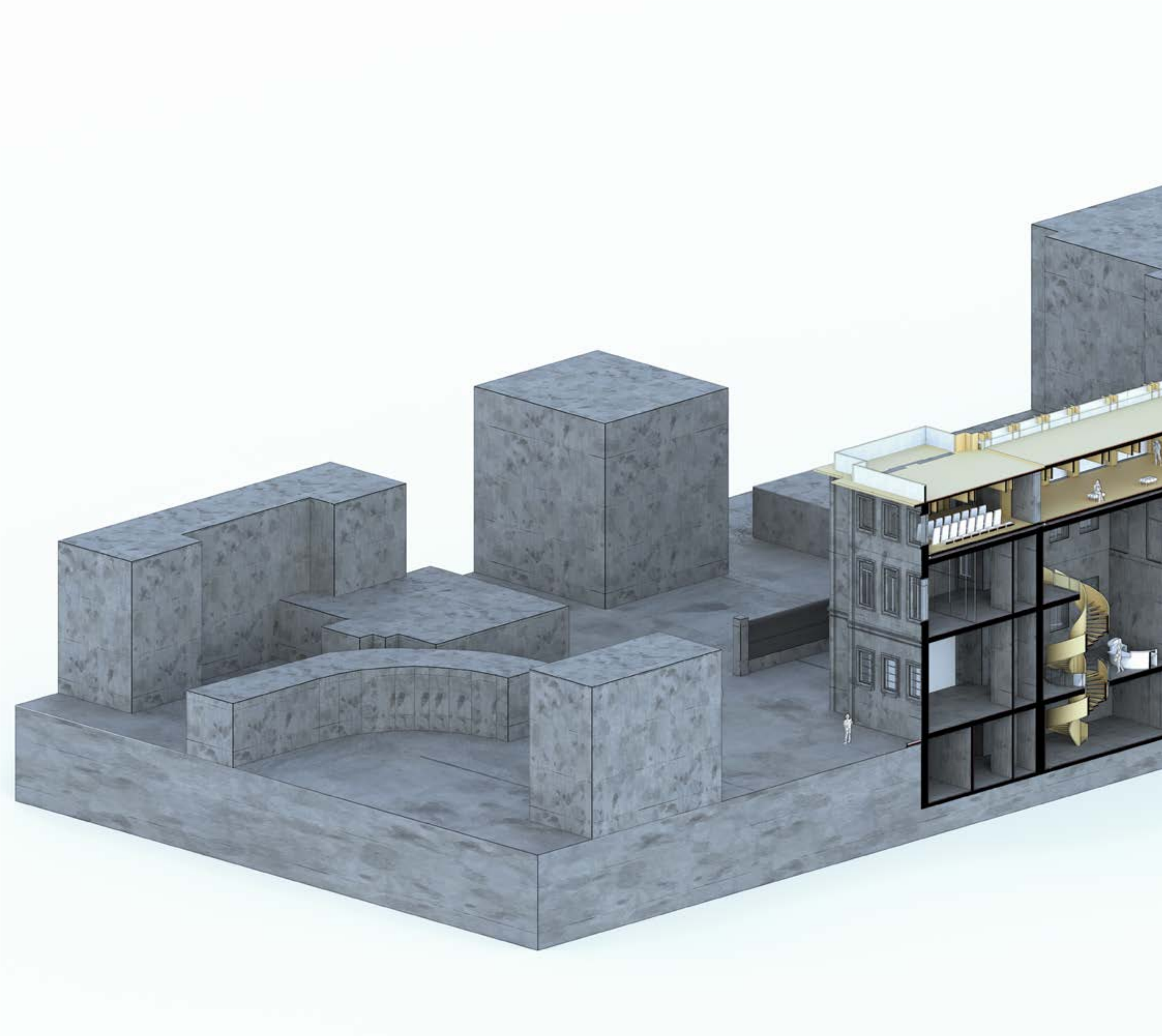


Figure 184: Second floor heating system layout

Conclusion

The design propoasl has been synthesized to fit the new functional brief on the existing building, with addition of the two new volumes which makes for a complex interaction with the existing volumes.
These volumes also contribute to the continuty of transformation of the structure. These intervention also incorporates the new service systems to simplify the existing complex Service systems which are not very compatible with the existing building structure.
In conclusion, there are space visulaiztion of the proposal both interior and exterior.

Figure 185: North-western exterior render



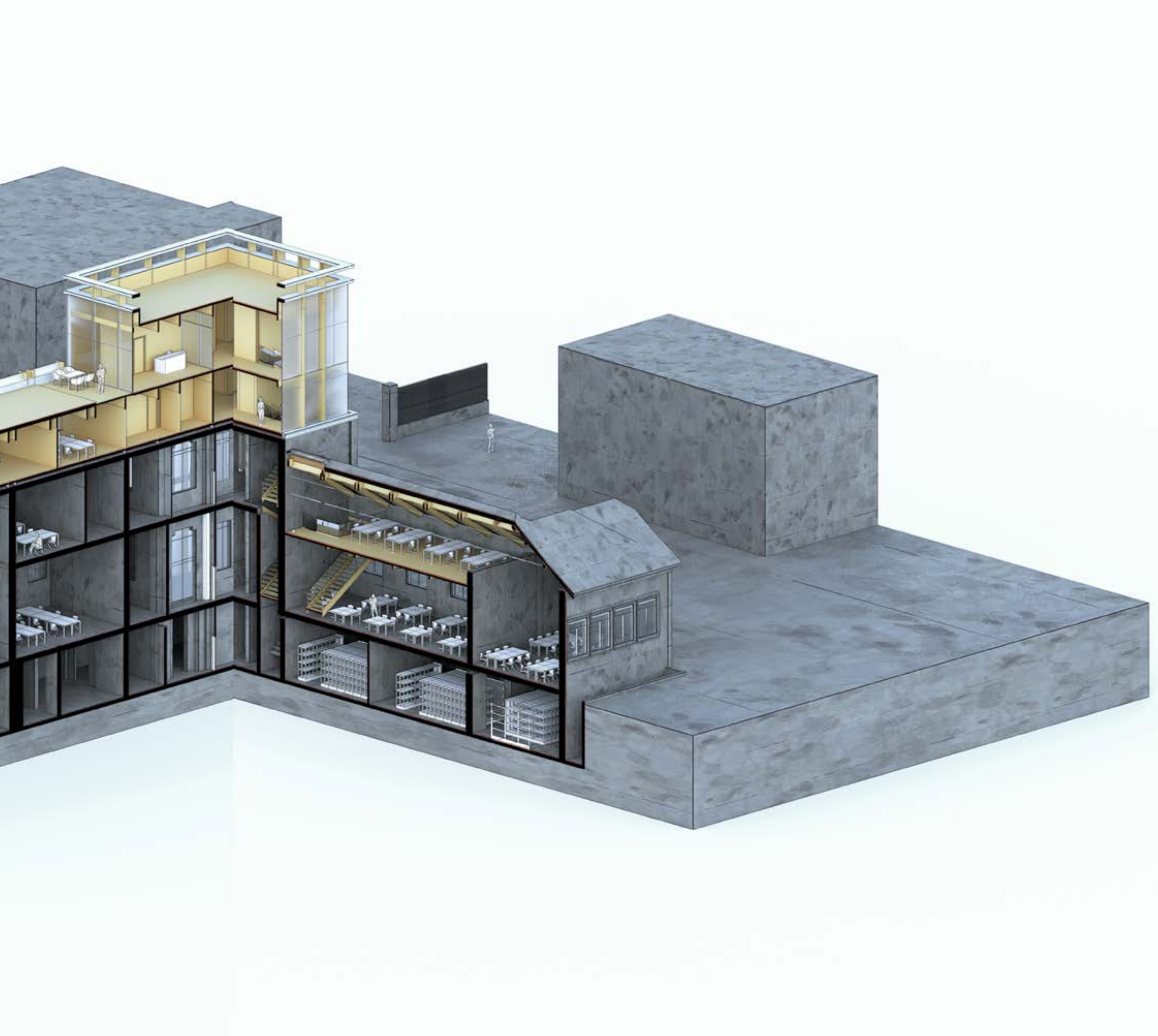


Figure 187: Exterior view from the courtyard

Figure 188: Interior view of the mezzanine

Figure 189: Interior view of the Spiral staircase

Figure 190: Interior view of the repositories

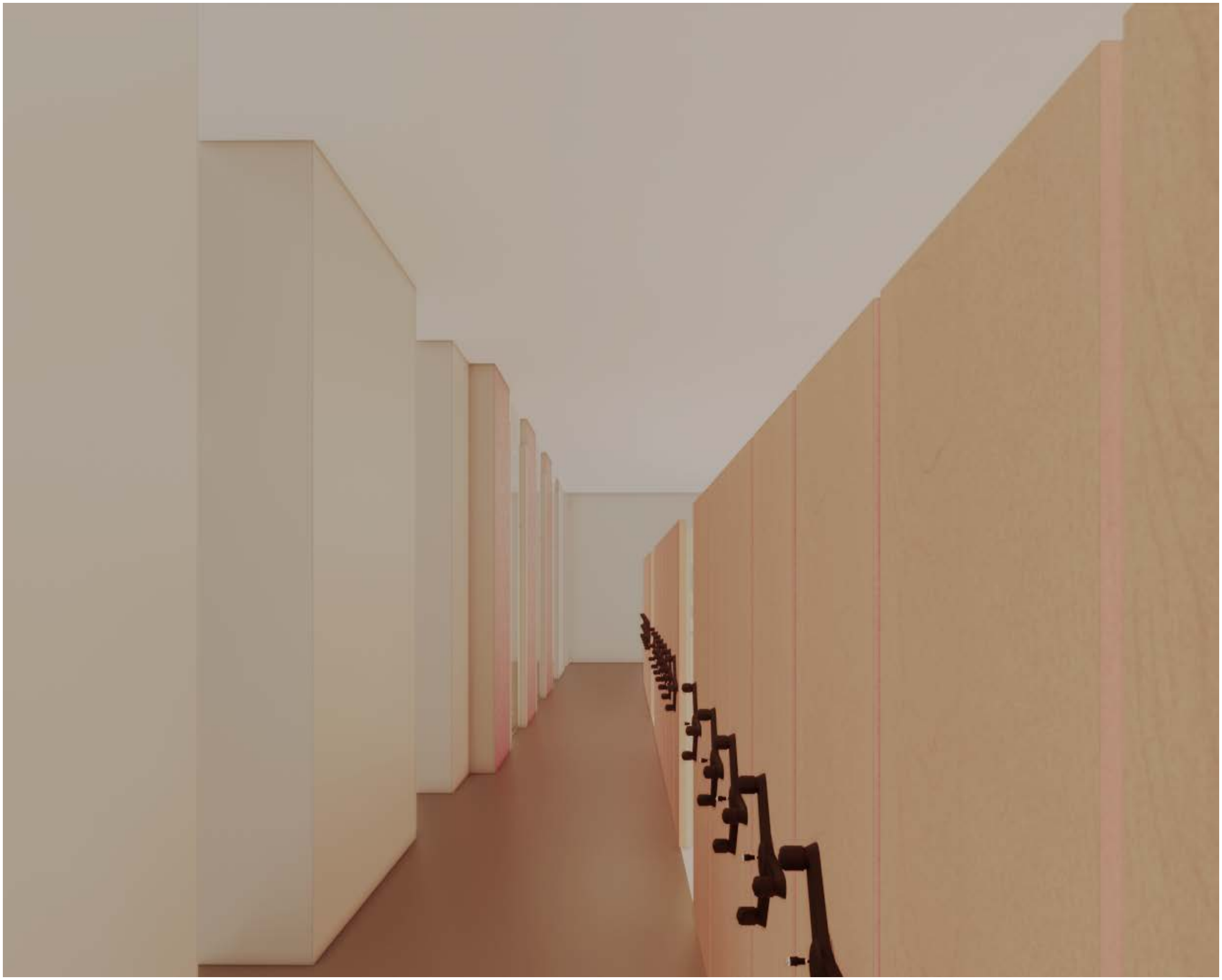


Figure 191: Interior view of the Spiral staircase

Figure 192: Interior view of the entrance foyer for the archive

Figure 193: Interior view of the Mezzanine

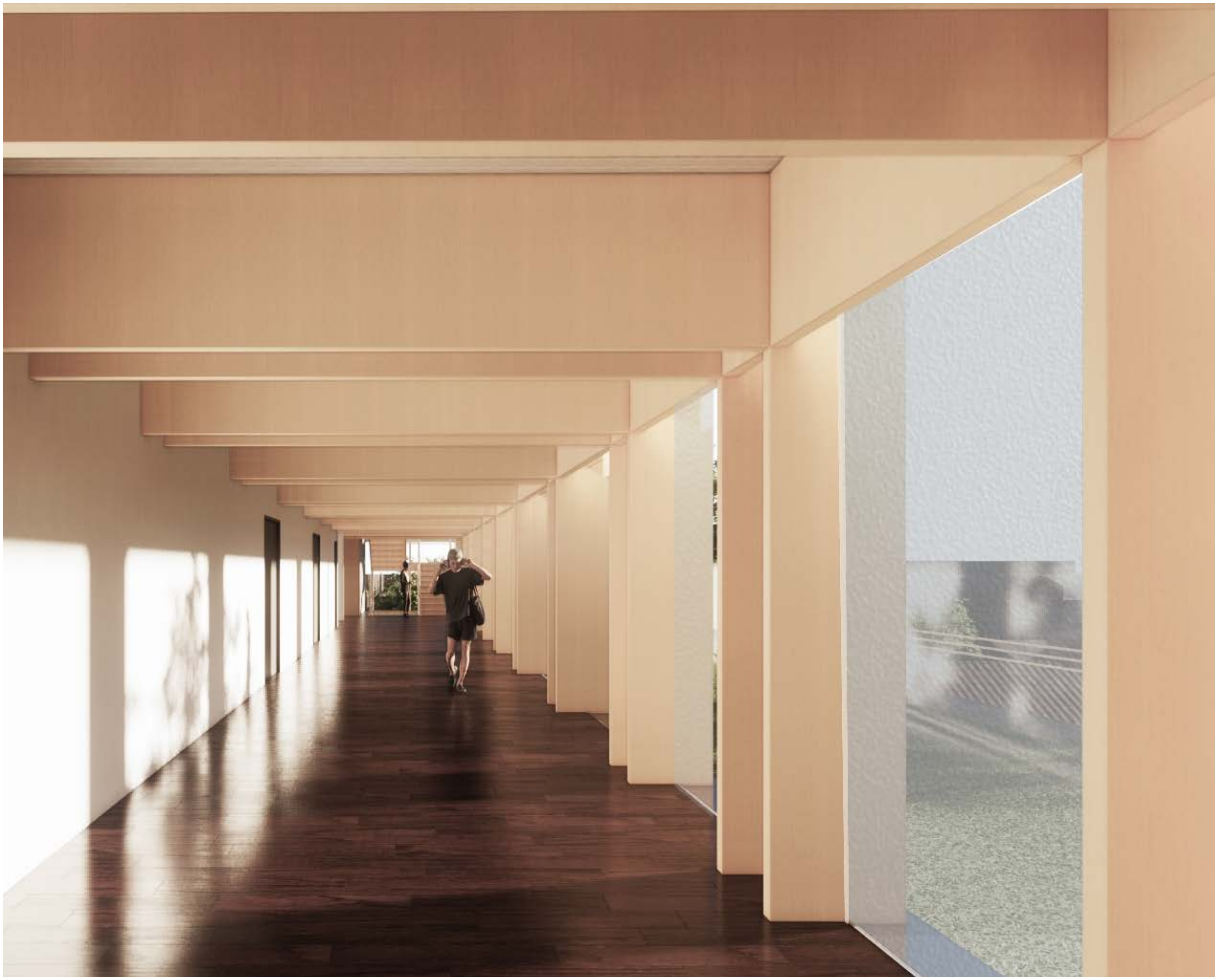


Figure 194: Interior view of the open gallery (Second floor)

Figure 195: Interior view of the Exhibition hall

Figure 196: Interior view of the caffe (Third floor)

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