Espace Culturel des Granges Collières

Example of revitalizing and refurbishing an ancestral farmhouse to bring out the heart of its district

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Example of valuing and refurbishing an ancestral farmhouse
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ABSTRACT

This thesis aims at restoring and revitalizing «Les Granges Collières», a 16th-century farmhouse in a district of Tours, France, named «Les Deux Lions». The intention is to transform this historically significant but underappreciated site into a vibrant cultural green space that enhances community engagement while preserving architectural heritage and biodiversity.

Initially, the thesis facilitates the formulation of a project request for the site, as it has not yet been officially subjected to one. The thorough analysis of the city, district, and site highlights the importance of integrating historical structures into modern urban landscapes to maintain cultural continuity and foster community development. The formulated request then aims at integrating the farmhouse into the contemporary urban fabric of the “Les Deux Lions” district, transforming it into a central, dynamic meeting place that meets the cultural and social needs of the community.

The state of fact is documented through photographic, geometric, material and decay surveys, providing a clear understanding of the farmhouse’s existing conditions and its surroundings, as well as to formulate a repair program for the ancestral farmhouse. Then, the architectural vision for the project includes extending the farmhouse into a multifunctional cultural center with spaces for exhibitions, conferences, and artistic endeavors. This vision aims at balancing the introduction of modern amenities with the preservation of the farmhouse’s historical character, while improving the comfort conditions and accessibility of both the site, the ancestral farmhouse and the new construction.

Structural and energy analyses ensure the project’s technical feasibility, focusing on structural stability, technical materials, and energy solutions needed to revitalize the farmhouse. The proposed interventions and materials chosen aim at improving the building’s energy efficiency and visual comfort by enhancing natural lighting through large glazed surfaces.

In a nutshell, The revitalization of «Les Granges Collières» seeks to create a cultural landmark that respects its historical significance while addressing the present and future needs of the local community, becoming a district’s heart with regional ambitions.

RÉSUMÉ

Ce projet de fin d'étude vise à restaurer et à revitaliser « Les Granges Collières », une ferme du XVIe siècle située dans le quartier des « Deux Lions » de la ville de Tours. L'intention est de transformer ce site historiquement significatif mais sous-estimé en un espace vert culturel dynamique qui améliore l'engagement de la communauté tout en préservant le patrimoine architectural et la biodiversité.

Le site n'ayant pas fait l'objet d'un appel à projets officiel, le projet facilite dans un premier temps la formulation d'une demande. L'analyse approfondie de la ville, du quartier et du site met en évidence l'importance de l'intégration des structures historiques dans les paysages urbains modernes afin de maintenir la continuité culturelle et de favoriser le développement de la communauté. La demande formulée vise alors à intégrer la ferme dans le tissu urbain contemporain du quartier des « Deux Lions », en la transformant en un lieu de rencontre central et dynamique qui répond aux besoins culturels et sociaux de la communauté.

L'état de l'art du site est documenté par des études photographiques, géométriques, matérielles et de dégradation, ce qui permet de comprendre clairement les conditions existantes de la ferme et de son environnement, ainsi que de formuler un programme de réparation pour la ferme ancestrale. La vision architecturale du projet comprend l'extension de la ferme en un centre culturel multifonctionnel avec des espaces pour des expositions, des conférences et des projets artistiques. Cette vision vise à équilibrer l'introduction d'équipements modernes avec la préservation du caractère historique de la ferme, tout en améliorant les conditions de confort et l'accessibilité du site, de la ferme ancestrale et de la nouvelle construction.

Des analyses structurelles et énergétiques garantissent la faisabilité technique du projet, en mettant l'accent sur la stabilité structurelle, les matériaux techniques et les solutions énergétiques nécessaires à la revitalisation de la ferme. Les interventions proposées et les matériaux choisis visent à améliorer l'efficacité énergétique et le confort visuel du bâtiment en favorisant l'éclairage naturel grâce à de grandes surfaces vitrées.

En résumé, la revitalisation des « Granges Collières » vise à créer un point de repère culturel qui respecte sa signification historique tout en répondant aux besoins actuels et futurs de la communauté locale, devenant ainsi le cœur d'un quartier aux ambitions régionales.

SINOSSI

Questa tesi di laurea mira a restorare e rivitalizzare “Les Granges Collières”, un casale del XVI secolo situata in un’area della città francese di Tours chiamata “Les Deux Lions”. L’intenzione è quella di trasformare questo sito storicamente significativo, ma sottovalutato, in un vibrante spazio culturale verde, che favorisca l’impegno della comunità preservando il patrimonio architettonico e la biodiversità.

Poiché il sito non è stato oggetto di un invito formale a presentare progetti, il progetto facilita inizialmente la formulazione di una domanda. Un’analisi approfondita della città, del quartiere e del sito evidenzia l’importanza di integrare le strutture storiche nei moderni paesaggi urbani per mantenere la continuità culturale e favorire lo sviluppo della comunità. La richiesta mira quindi a integrare il casale nel tessuto urbano contemporaneo del quartiere “Deux Lions”, trasformandolo in un luogo di incontro centrale e dinamico che risponda alle esigenze culturali e sociali della comunità.

Lo stato di fatto del sito viene documentato attraverso studi fotografici, geometrici, materici e di degrado, fornendo una chiara comprensione delle condizioni esistenti del casale e del suo ambiente, oltre a formulare un programma di riparazione. La visione architettonica del progetto prevede l’ampliamento del casale in un centro culturale multifunzionale con spazi per mostre, conferenze e progetti artistici. Questa visione mira a bilanciare l’introduzione di strutture moderne con la conservazione del carattere storico del casale, migliorando al contempo il comfort e l’accessibilità del sito, del edificio antico e del edificio nuovo.

Le analisi strutturali ed energetiche garantiscono la fattibilità tecnica del progetto, concentrandosi sulla stabilità strutturale, sui materiali tecnici e sulle soluzioni energetiche necessarie per rivitalizzare il casale. Gli interventi proposti e i materiali scelti sono pensati per migliorare l’efficienza energetica dell’edificio e il comfort visivo, favorendo l’illuminazione naturale grazie ad ampie superfici vetrate.

In breve, il recupero delle “Granges Collières” mira a creare un punto di riferimento culturale che rispetti il suo significato storico e risponda alle esigenze attuali e future della comunità locale, diventando il cuore di un quartiere con ambizioni regionali.

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Formulation of the request

PART 1 - TERRITORY FRAMING

TOURS, A BLOOMING CITY

1.1. Close-up on a picturesque french city

Located in the Center-West of France, around 200 kilometres south-west of Paris, Tours is a city that occupies a central position within France and exudes both charm and historical significance.Tours is renowned for its great city life, making it particularly appealing to students and young professionals seeking a vibrant urban experience. As one of the 22 official French metropolises and the 15th largest attractive area in the country, Tours holds a special place in the tapestry of France's geography and history.

Nestling in the Loire Valley, a UNESCO World Heritage Site, the city enjoys a picturesque setting, bordered by the majestic Loire and Cher rivers. This advantageous position has played a crucial role in its historical development, making it a strategic gateway between the north and south of the country. In addition, Tours is surrounded by a range of similar cities, such as Orléans, Blois and Angers, forming a region rich in history and architectural heritage. This proximity to other key cities has strengthened its influence and connectivity throughout France.

Tours' history runs deep, spanning centuries of captivating tales and momentous events. It important to point out now that Tours was once at the core of France's struggle to preserve its identity and sovereignty during the tumultuous «One Hundred Years War». In fact, after the fall of Paris, Tours emerged as the temporary capital of the nation, standing as a bastion of hope and resilience. As a result, the city's most illustrious era occurred during the French Renaissance. From 1422 to 1528 and later from 1588 to 1594, Tours flourished as the capital of France, a time of cultural awakening and intellectual brilliance. The Renaissance marked a period of immense progress in arts, architecture, and literature, attracting artists, scholars, and thinkers from all corners of Europe to this thriving center of knowledge and creativity.

Today, Tours remains a historic jewel in the heart of France, attracting visitors with its picturesque beauty, cultural festivals, and rich heritage. As the centuries pass, Tours continues to be a place where history, art and culture intertwine.

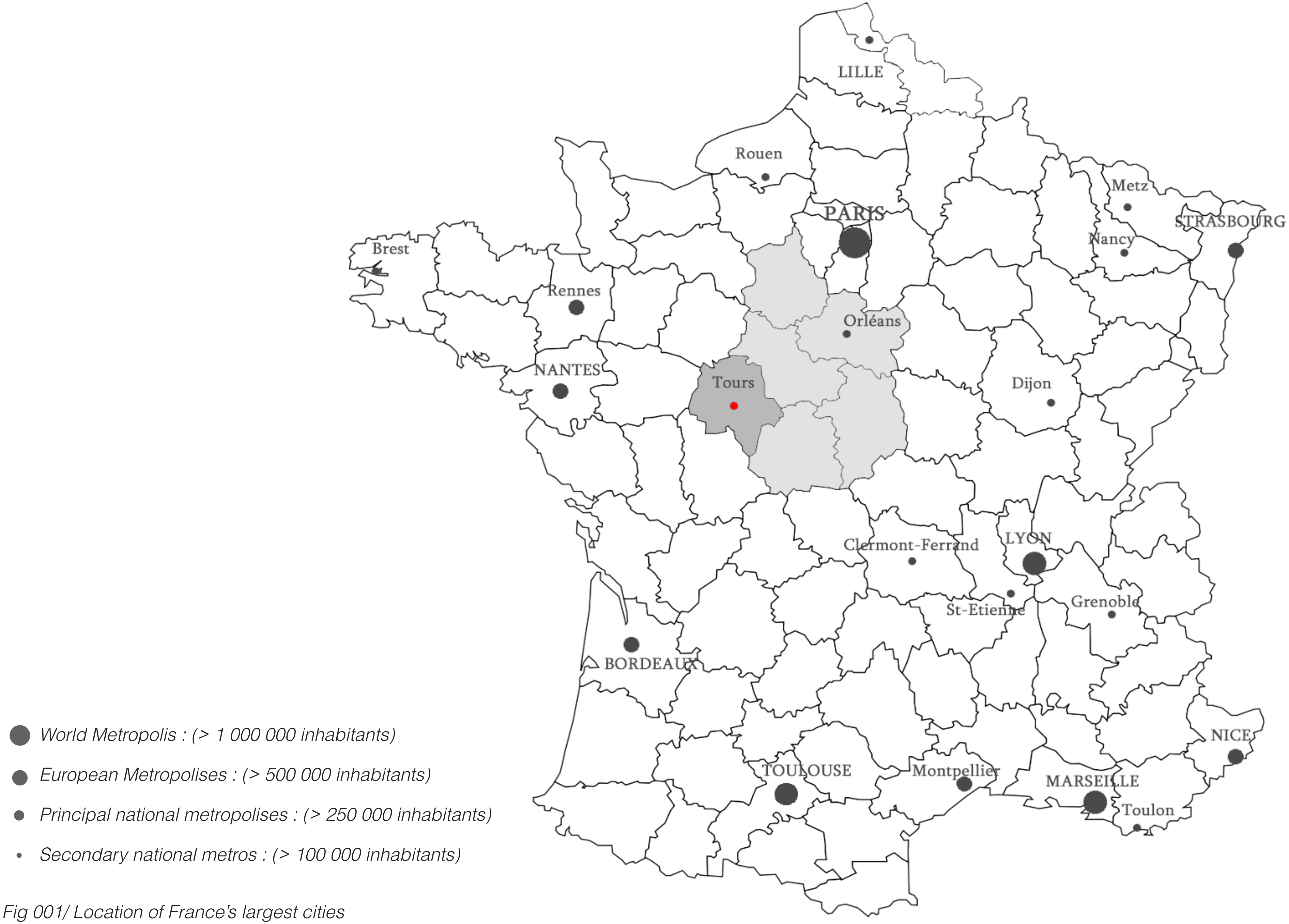


Fig 001/ Location of France's largest cities

Localition e general data

Citty and department	Tours Indre-et-Loire (37)
Region and Country	Centre-Val de Loire, France
Rivers	The Loire, The Cher
Surface area	3 460 ha (Paris : 10 000 ha)
Density	4k hab/km^2 (Paris : 20k hab/km^2)
Geographical coordinates	Lat. 47° 23 37 north Long. 0° 41 21 east
Climatic zone	Cfb
Most attractive areas in the country (rank)	15th
Distance from the capital	200km south-west
UNESCO membership	Yes
Touristic attraction	Chateaux de la Loire Loire à vélo

Land use

	cat. 1	cat. 2	cat. 3	cat. 4
Tours	81 %	9 %	9 %	1 %
Paris	93 %	0 %	7 %	0 %
France	8 %	64 %	1 %	2 %

cat. 1 : Human occupation
cat. 2 : Agriculture
cat. 3 : Water
cat. 4 : Forests

Fig 002/ General data description on Tours

< *Fig 003/ Mass and void - Tours*

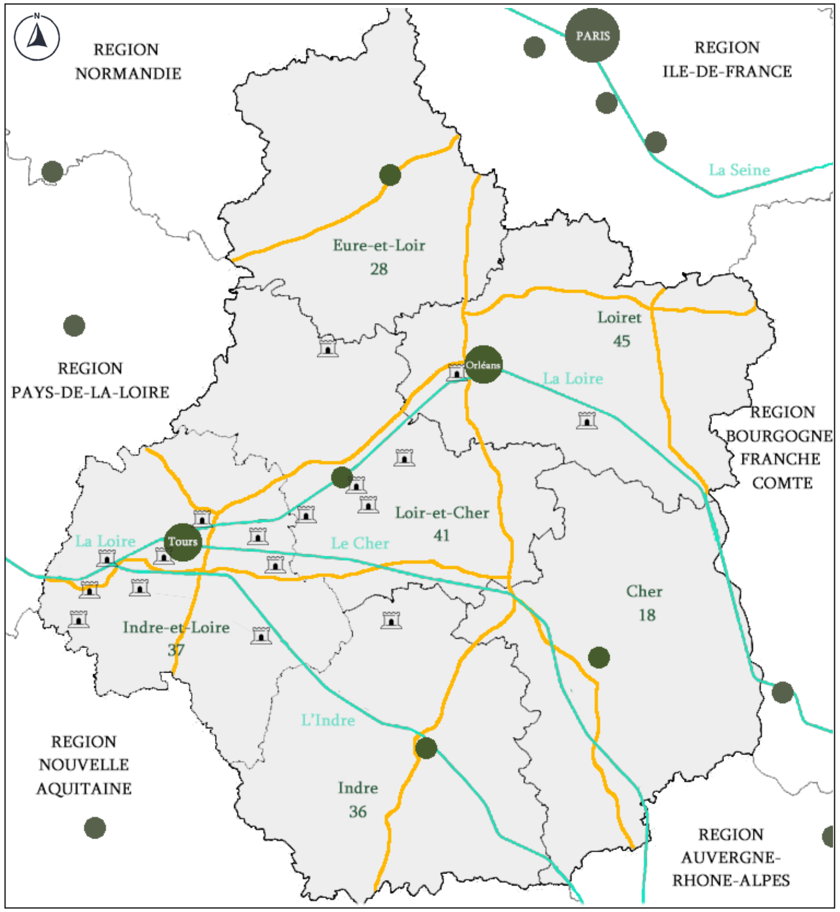


Fig 004/ Distribution of the flows in Centre-Val de Loire

Tours stands as a main protagonist in the regional dynamics of the Centre-Val de Loire region in France. Even if Orléans was named capital of the region, Tours assumes a central role within the Centre-Val de Loire region as it holds the distinction of being the largest municipality, urban unit, and attractive area.

The geographical location of Tours plays a pivotal role in linking six other regions, a unique aspect that sets the Centre-Val de Loire region apart. Positioned centrally within France, Tours serves as a crucial junction for transportation and communication networks, facilitating connectivity to neighboring regions. This strategic advantage fosters collaboration and exchange between regions, bolstering economic and cultural ties and strengthening the sense of unity within the country.

The region's historical importance is embodied in its magnificent «châteaux de la Loire,» a collection of castles that dot the landscape along the Loire River. Many of these castles, originally constructed during the Middle Ages, were reworked during the Renaissance, showcasing a fascinating blend of architectural styles. The Château de Chambord, the Château de Villandry, and the Château de Chenonceau are some notable examples that draw tourists from around the world, enhancing the region's cultural allure. All along the banks of the loire river, the chateaux unite the cities of the neighbouring regions to one another. Tours being halfway of that ininerary, it offers the main stop during the discovering of this chateaux.

As a result, the city serves as a center for architecture, but also for arts, literature, music, and intellectual pursuits, fostering a vibrant cultural scene for the neighbouring department. It hosts various festivals, exhibitions, and events that celebrate regional traditions and encourage creativity.

As the largest urban unit in the Centre-Val de Loire region, Tours is a driving force behind its economic development. The city's thriving commercial sector, industrial zones, and services contribute significantly to the regional economy. It serves as a hub for various industries, including tourism, healthcare, education, and research, generating employment opportunities and attracting a skilled workforce.

Tours' economic vitality and regional influence contribute to the overall growth and prosperity of the Centre-Val de Loire region.

In a smaller scale, Tours, as the capital of the metropolis «Tours Métropole Val de Loire,» holds a central position within the department. Comprising 22 municipalities, the metropolis is the largest in the department, making Tours a significant hub for economic, cultural, and administrative activities.

Tours stands as the administrative center and capital of the department of Indre-et-Loire in France. As such, it serves as the seat of government, hosting administrative offices and key institutions that govern the department's affairs. The city's role as the capital contributes to its status as the focal point for decision-making processes, policy implementation, and regional planning.

With its historical heritage and modern amenities, Tours exemplifies a balance between preserving the past and embracing the future. The metropolis brings together various communities, fostering collaboration and coordination for regional development projects. The metropolitan area serves as a magnet for investments, businesses, and cultural activities, contributing to the overall growth and prosperity of the department.

Tours'population dominance within the department is evident through its significant size when compared to other cities. The city's population is approximately ten times larger than that of the second most populated city in the department, Saint-Pierre-des-Corps. This demographic concentration reflects the allure of Tours as a vibrant urban center, drawing people from neighboring municipalities for employment, education, and cultural experiences.

As the heart of the department, Tours acts as an economic and cultural hub. Its strategic location facilitates connectivity to major transportation networks, making it an attractive location for businesses and industries. The city's commercial sectors, educational institutions, and research facilities stimulate economic growth and innovation.

Tours' cultural offerings, including museums, theaters, and festivals, enrich the lives of residents and attract tourists, further enhancing its regional significance. The collaboration within «Tours Métropole Val de Loire» ensures that resources are allocated effectively to promote sustainable development, infrastructure improvements, and social welfare programs for the benefit of the entire region.

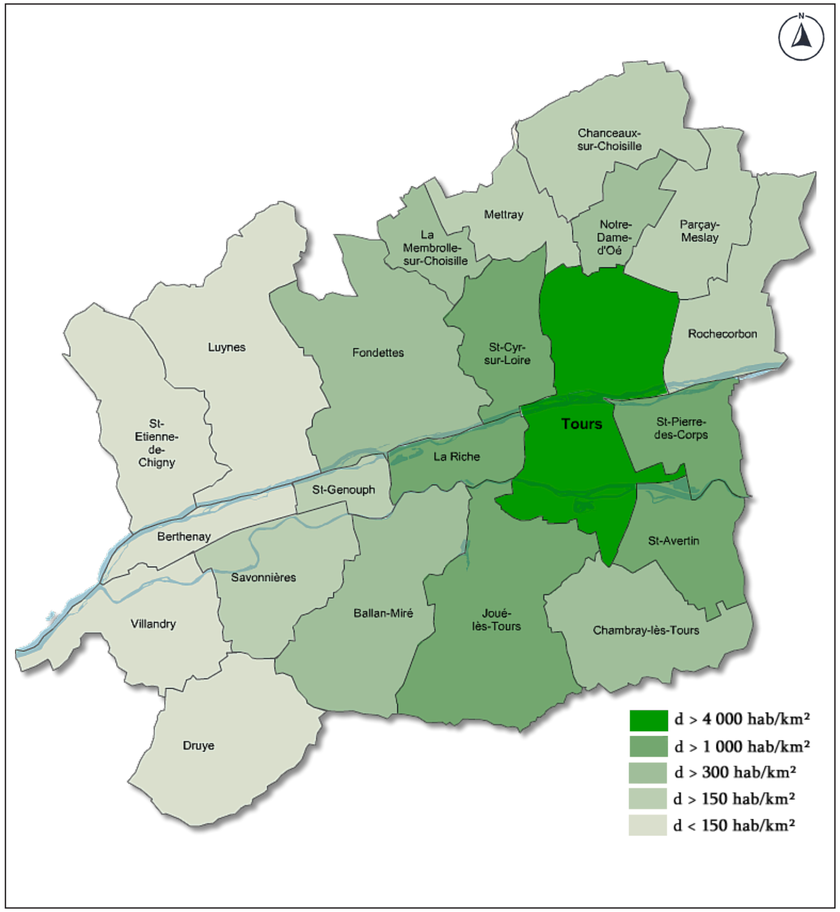


Fig 005/ Distribution of population density in Indre-et-Loire

1.2. Tours, a distinctive gem amidst French and Italian treasures

Compared to major French cities, Tours may seem less imposing in size, but its historical role should not be underestimated. While Paris undoubtedly remains the enduring capital and the most internationally recognized French city, Tours played the role of cultural and intellectual capital, attracting renowned artists and thinkers. Tours and Paris both offer distinct experiences that reflect their diverse characters. Paris, a vibrant hub of culture, fashion, and art, boasts iconic landmarks like the Eiffel Tower, the Louvre, and Notre-Dame Cathedral. On the other hand, Tours' historical significance during the French Renaissance is evident in its architectural treasures such as Tours Cathedral and the nearby Château de la Loire. Paris' cosmopolitan atmosphere and bustling city life contrast with Tours' more relaxed and nature-centric ambiance, attracting students and young workers seeking a different urban experience..

Tours and Lyon stand as distinct cultural gems, each boasting its unique heritage and atmosphere. In fact, Lyon's roots can be traced back to Roman times, so both cities exhibit unique cultural and historical identities. However, the landscape of Tours and Lyon showcases distinct characteristics that highlight their individual identities. Tours, located in the Loire Valley, is characterized by a more natural and picturesque environment compared to the urban expanse of Lyon. Tours' natural surroundings and green spaces create a charming contrast to Lyon's urban density, making Tours a haven for those seeking a more relaxed and nature-centric atmosphere. While Lyon's urban landscape offers a vibrant and cosmopolitan experience, Tours' natural allure adds a touch of serenity and tranquility, making it an enticing destination for nature lovers and those yearning for a calmer setting.

If we were to compare Tours with another city, it would be with the city of Angers, only a hundred kilometres apart. Tours and Angers are similar in density of population, even though Angers is sligthy bigger in size. Linked by their proximity and the Châteaux de la Loire, they share a rich cultural heritage and historical significance. Both cities showcase well-preserved medieval architecture and host vibrant cultural events. However, they differ in ambiance and focus. Tours, with its intimate setting and natural surroundings in the Loire Valley, exudes a serene and relaxed ambiance, appealing to those seeking a more laid-back experience. On the other hand, Angers has a more dynamic and modern energy, driven by its focus on education and the youthful atmosphere created by its university. Together, they form a remarkable duo that enriches the cultural tapestry of the Loire Valley and provides an enchanting experience for visitors exploring the treasures of the region.

Tours can be compared to the Italian city of Florence. Florence, renowned as the cradle of the Italian Renaissance, attracted illustrious artists like da Vinci and Michelangelo, while Tours served as a dynamic center of the French Renaissance, nurturing writers and philosophers. Both cities played essential roles in shaping European history, facing periods of political turbulence and emerging as resilient cultural centers. Both cities experienced power struggles and foreign invasions, leaving their marks on the urban fabric. Florence, as part of Italy, faced territorial disputes, while Tours, situated in France, endured changes in dynasties and the turbulence of the Hundred Years War. The natural beauty of the Loire Valley inspired Tours' artists and writers, just as Florence's landscape along the Arno River influenced countless works of Florentine art. While Florence remains the epicenter of Italian artistic and intellectual achievements, Tours' role as a vital hub of French humanism and cultural revival should not be underestimated. Their distinct contributions have left an indelible mark on history, making both cities precious gems in the crown of European heritage.

Tours and Padova are also two city with a similar size, and each with its distinct charm, yet sharing striking similarities. Both cities boast rich histories dating back to ancient times, and their historical centers are beautifully preserved, displaying architectural wonders that reflect their past glories. Both Tours and Padova have been centers of art, culture, and intellectual pursuits, making them cultural hubs in their respective regions. Both cities have a strong emphasis on gastronomy. Furthermore, Tours and Padova are vibrant university towns, fostering an atmosphere of youthful energy and intellectual curiosity. Both Tours and Padova recognize the value of nature in enhancing the quality of life for their residents and creating a welcoming environment for visitors. Their commitment to preserving natural aspects within their urban settings underscores their shared belief in the importance of balancing historical heritage with the splendor of the natural world. These cities serve as inspiring examples of how a thriving urban environment can coexist harmoniously with the surrounding nature.

1.3. Tours through time

As the first rays of dawn painted the horizon, long before recorded history, the region that would later be known as Tours held a significant role as a passage between vast plains, carved out by the graceful curves of two mighty rivers : the Loire and the Cher. In those prehistoric times, nomadic tribes traversed the land, leaving traces of their existence and establishing a connection with the fertile landscapes that would shape the city's destiny.

Around 500 BC, a tribe from the north, known as the Turones, settled in this alluring region, marking the beginnings of a settled community. Over the centuries, they left cultural imprints, sowing the seeds of a city that would stand the test of time.

In the 1st century, the Roman Emperor Augustus recognized the potential of this strategic location and initiated the process of urbanization. The town, referred to as «Caesarodunum,» emerged as a Roman castrum with a well-planned orthogonal grid system for its streets. The amphitheater's hemicycle, standing in the heart of the town center, testified to the grandeur of the Roman civilization.

By the year 300, the town embraced its Gallic roots, adopting the name «Turonorum.» The Gallic people fortified the city walls to create a sturdy Gallo-Roman enclosure. These ancient walls whispered tales of the city's past to those who dared to listen.

The Middle Ages saw Tours become a significant center of Christianity, largely due to the revered bishop, Saint-Martin. His influence turned Tours into a pilgrimage destination, drawing pilgrims seeking spiritual enlightenment and salvation.

In the 9th century, Tours experienced the Carolingian Renaissance, a period of flourishing art, culture, and learning. The city became a hub of knowledge and progress.

Despite facing Norman invasions in the 10th century, the city's strategic location along the Loire and its fortified enclosure provided protection. A new fortified area, «Chateauneuf,» was built around the church of Saint-Martin, enhancing the city's defenses.

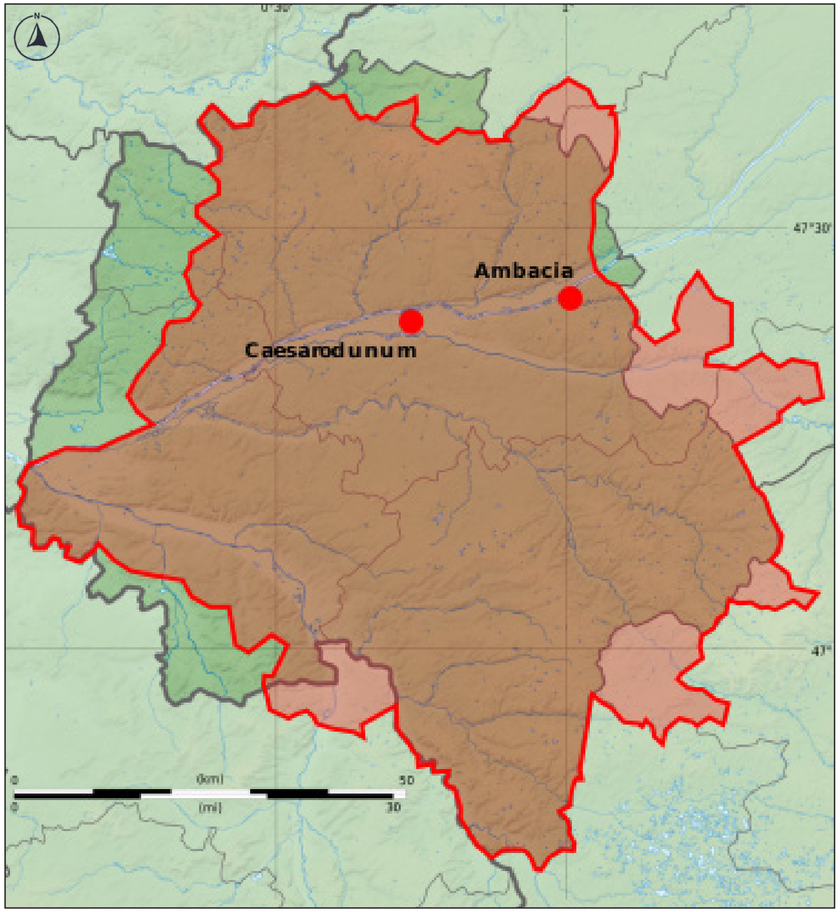


Fig 006/ Caesarodunum, Tours in the 1st century

The 14th century saw the fusion of the Gallo-Roman and Chateauneuf enclosures, marking a new era of growth and prosperity for Tours. The blending of cultures and architectural styles gave the city a unique identity. During the Hundred Years' War, as Paris fell to the English invasion, Tours emerged as a political and artistic bastion in 1422. The city attracted luminaries from various disciplines, turning it into a beacon of enlightenment.

Severe floods along the Loire in the late 16th century necessitated the construction of a dike to protect the city. The middle of the 15th century marked the Loire Valley as the favored abode of the kings of France. The French Renaissance breathed new life into the region, but by 1528, François I declared Paris as the capital, causing Tours to lose its former grandeur.

In 1588, Henry III reinstated Tours as the capital of France, but this was short-lived. Henry IV returned to Paris in 1594.

The 17th century brought a new city wall and architectural transformations that allowed the city to expand beyond its boulevards to the south. The arrival of the railway further spurred expansion, leading to the development of a new center with grand public buildings like the town hall, high school, theater, and a new station.

The 18th century saw Tours thrive as a center of commerce and trade, with its strategic location along the Loire contributing to its economic prosperity. The 19th century brought significant development, with the city expanding disproportionately towards the south. The charming Prébendes district emerged between the Loire and the Cher. During the First World War, Tours became a crucial railway junction and logistical hub.

The Second World War left a deep scar on Tours, with the northern part of the Rue Nationale suffering from German shelling, leading to the loss of historical monuments. The city's resilience saw it through these dark times, and post-war, Tours embarked on a path of rebuilding and rejuvenation. The demolished arches of the Wilson bridge were promptly rebuilt.

Post-war, Tours experienced dynamic urban development driven by modern visions, sometimes at the cost of significant heritage and archaeological elements. The Roman temple beneath the Rue Nationale and the eastern wall of Châteauneuf were among the casualties.

Tours grappled with urban expansion, leading to the construction of new neighborhoods like Quartier Giraudeau and Quartier du Sanitas. From 1960 onwards, Mayor Jean Royer's influential tenure led to the salvation of the Old Town from demolition, designating it as one of the first «protected sectors.» The Cher valley was transformed into a complex of collective housing and leisure areas.

As Tours expanded, it absorbed neighboring communes, facilitating growth to the north while facing resistance to western expansion. Significant public facilities were developed, including the University of Letters, an exhibition center, the CHRU hospital, and the Grandmont Campus.

In 1978, the Wilson Bridge collapsed, leading to strengthened bridge safety and maintenance regulations in France. The rebuilding process was timely, reflecting the city's determination to preserve its historical heritage.

From the 1980s to the mid-1990s, Tours transformed into a modern technology park, characterized by contemporary architecture and green spaces. This era saw the establishment of cutting-edge research facilities and improved accessibility and connectivity with pedestrian-friendly infrastructure.

Entering the 2000s, Tours' development continued within an inter-communal framework, fostering collaboration with neighboring communities. Redevelopment and requalification of public spaces sought to embellish the city and enhance its attractiveness.

The construction of the first tram line reshaped public spaces, revitalizing the Rue Nationale for pedestrians. The introduction of soft traffic on the Wilson Bridge allowed visitors to savor the splendid panorama of the Loire.

The future of urban planning in Tours holds great promise. Projects like the prospect of a second tramway line and urban renewal initiatives aim to preserve historical neighborhoods while integrating modern amenities. The city's dedication to balancing its rich heritage with modern life ensures that Tours will continue to evolve as an inviting and forward-thinking destination.

1.4. Tourism and cultural heritage in Tours

Tours stands as an epitome of cultural heritage and a true haven for travelers seeking an immersive experience into the history, art, and gastronomy of France. With UNESCO recognizing both the Loire Valley and the historic heart of Tours as World Heritage Sites, this enchanting region unfolds a captivating narrative that unfolds over vast landscapes and centuries-old architectural treasures. Spanning an impressive buffer zone of 300,000 hectares, Tours embodies a seamless fusion of natural splendor and human ingenuity, attracting visitors from across the globe.

The Loire River, affectionately referred to as the «last wild river of Europe,» meanders through the picturesque Loire Valley, bestowing it with breathtaking vistas. The valley's fertile lands give rise to abundant greenery, creating a captivating tapestry of vineyards, orchards, and lush gardens. As visitors traverse along the 280-kilometer stretch of the Loire, they are treated to an ever-changing landscape, from serene meadows to majestic cliffs. Lined along the Loire are the world-renowned «Chateaux de la Loire,» which serve as an exceptional display of architectural prowess and historical significance. From the grandiose Château de Chambord with its distinctive French Renaissance architecture to the elegant Château de Chenonceau gracefully spanning the river, each castle weaves a tale of royal heritage and artistic brilliance. Tours caters to cyclists with the famous «La Loire à Vélo» cycling route, providing a unique way to explore the region and each chateaux. Meaning «The Loire by Bike», it covers over 800 kilometers and is carefully marked and diligently maintained, making it suitable for cyclists of all skill levels and ensuring a safe and enjoyable exploration of the region's cultural and natural wonders.

Tours boasts an abundance of vegetation, thoughtfully integrated into its design along two main axes that contribute to its distinct charm. The East-West axis emphasizes the city's natural beauty, generously adorned with blue and green spaces. Both tourists and locals can relish leisurely strolls along tree-lined boulevards and meandering pathways, finding moments of tranquility amidst the urban environment. On the North-South axis, Tours proudly showcases its architectural heritage, with elegant buildings lining the streets. The perfect blend of modern and historic monuments emplifies Tours' respect for its heritage while embracing contemporary life.

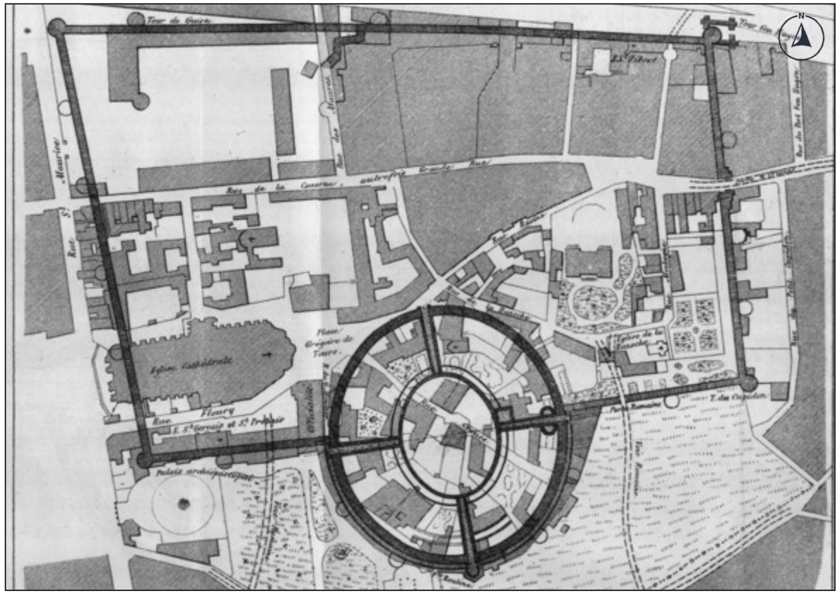


Fig 007/ The Gallo-Roman enclosure

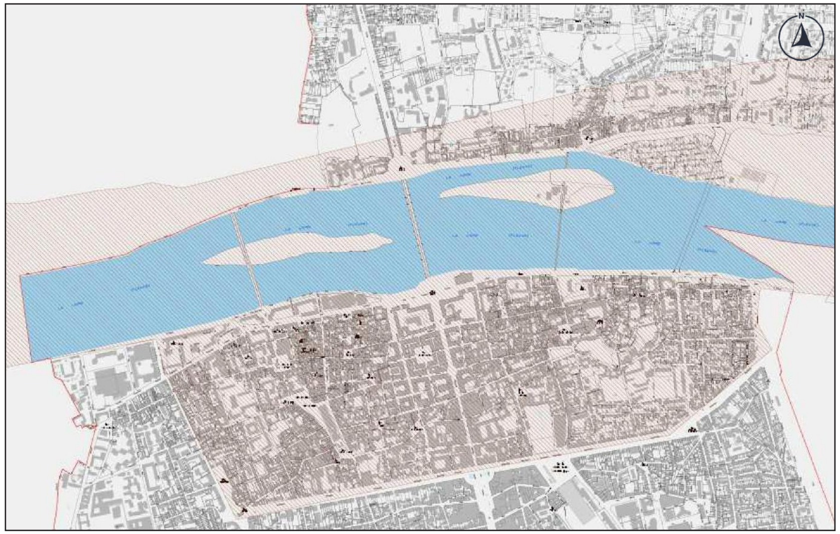


Fig 008/ Area classified as an unesco world heritage site

Fig 009/ Quick taste of Tours culture

At the core of Tours lies the «Vieux Tours,» the historical center that evokes the essence of medieval France. Cobblestone streets wind their way through the district, leading visitors to charming squares, quaint cafes, and artisan shops. The Cathédrale Saint-Gatien stands tall as a testament to the city's spiritual history, showcasing an exquisite blend of Gothic and Romanesque architecture.

The Passage of St. Jacques de Compostelle, a significant pilgrimage route, meanders through Tours, drawing pilgrims and travelers from all walks of life. This sacred path weaves through the city's streets, connecting it to a rich tapestry of religious traditions and historical significance. In close proximity to Tours lies the Clos Lucé, a magnificent château that served as the final residence of Leonardo da Vinci. Today, the Clos Lucé stands as a captivating museum, offering visitors a fascinating glimpse into the life and work of this Renaissance polymath.

Tours boasts the esteemed title of a «City of Art and History,» paying homage to its commitment to preserving and promoting its cultural heritage. The city's museums, galleries, and cultural centers showcase a diverse array of artistic expressions, offering visitors an immersive experience into the world of French art and creativity. Tours' literary significance extends beyond being the birthplace of the celebrated novelist Honoré de Balzac. The city has inspired countless writers, artists, and thinkers throughout history, leaving an indelible mark on the world of literature and creativity.

Tours pulsates with vitality as a thriving social and student city. With its esteemed universities and educational institutions, the city draws a diverse and intellectually dynamic community. The youthful energy of students and young professionals permeates through its bustling streets, creating an electric atmosphere that fuses seamlessly with the city's rich historical heritage. The synergy between tradition and modernity lends Tours an unmistakable vibrancy. Young talents create an unforgettable festival experience by taking center stage amidst the backdrop of centuries-old architectural wonders.

As an internationally recognized city of gastronomy by UNESCO, Tours is a paradise for food enthusiasts. Tours is in fact renowned for its connection to the world of wine, being a gateway to the esteemed wine regions of the Loire Valley. Touraine, the wider region surrounding Tours, boasts a diverse range of wines, including the famed Vouvray, Chinon and Bourgueil.

The city of Tours is also caractarised by a strong North-South avenue (Avenue de Grammont) that goes up the whole city until it becomes a pedestrian street and continues along «Rue Nationale» and «Pont Wilson». This axis enable to connect the three geographical part of Tours (Tours North - Tours Center - Tours South) by a simple and pure flow of mobility.

Touraine's architecture is characterized by a great urban mix where different built typologies of all ages are represented, from the medieval city to the rebuilt city. It goes from old buildings preserved since the medieval period and those in the old suburbs that was then included in a new enclosure, to the buildings developed as a result of the opening of the city to the outside in order to promote its expansion, passing of course by the ones born due to the destruction of the Second World War and from the urban renovation of the protected sector.

However, while walking in Tours, we can notice the omnipresence of the following two major kind of buildings, Timber framing houses « Maison à colombages / à pans de bois » and Tuffeau stone houses « Maison en pierre de Tuffeau ». This is due to the abundance of oak wood and tuff stone at the time, as well as their ease of implementation.

Tuffeau stone is abundant in Touraine because the region sits atop extensive deposits of this soft limestone. Its ready availability made it a practical choice for local builders throughout history. Additionally, its pale color not only imparts a distinctive visual charm but also helps regulate indoor temperatures, making it a pragmatic choice for construction in Touraine's variable climate.

Oak timber, on the other hand, thrives in Touraine's lush forests. The region's favorable climate and soil conditions have nurtured robust oak trees, providing an ample supply of this durable wood for construction. Its strength and resistance to decay made it a preferred material for framing and structural elements in buildings.

Fig 010/ Tours' main boulevard

Fig 011/ Tours' traditional houses
The tuffeau stone houses and the oak timber-framed houses

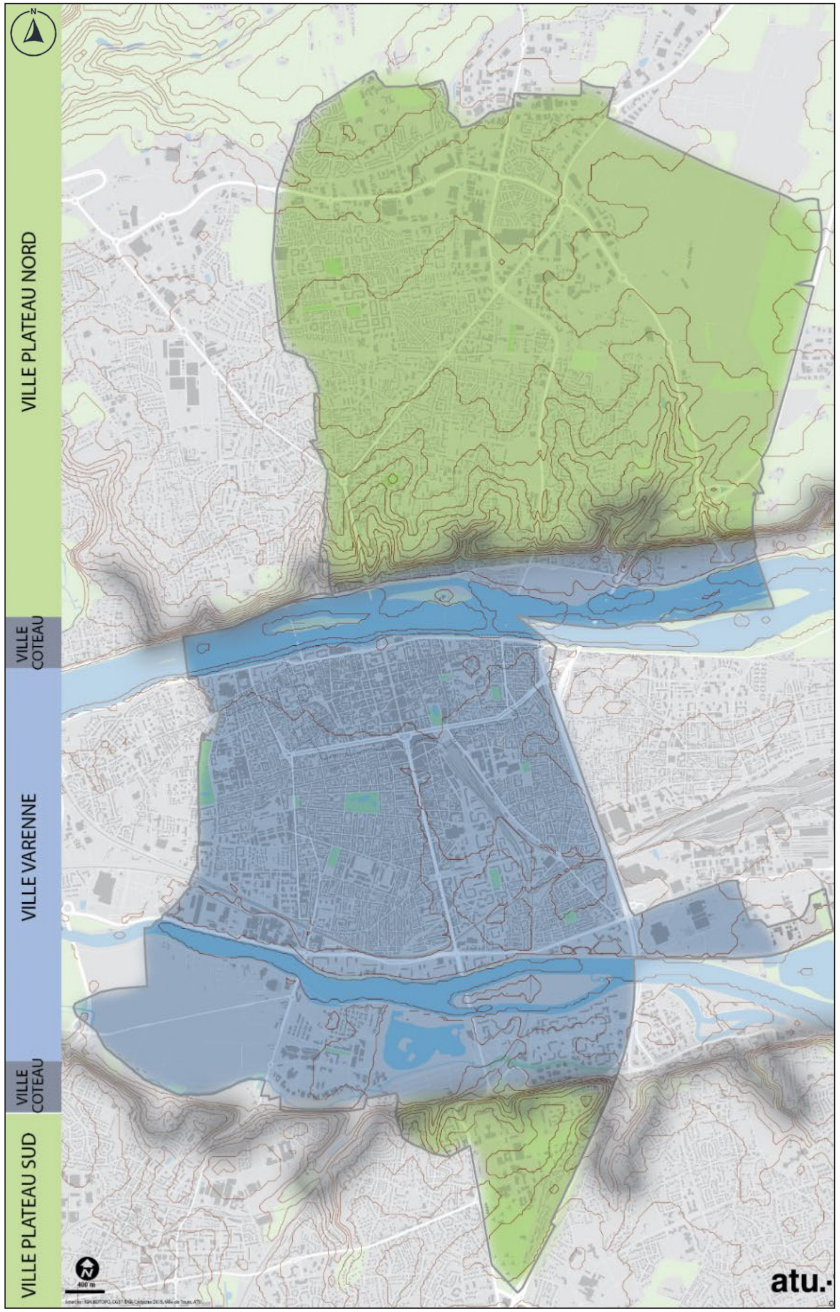


Fig 012/ Landspace morphology of Tours

1.5. Landscape and urbanscape morphology

Tours is crossed over by two rivers : The Loire (upper river, on the right in the scheme) and the Cher (lower river, on the left on the scheme). Tours is also divided into three symmetric landscape units :

- The alluvial plain : «ville Varenne»

The alluvial plain is situated between and nearby the Loire and the Cher. Three kilometers apart, these two rivers mark the landscape and give structure to the town, even though they make the area highly vulnerable to flooding. The green spaces on the rivers, whether developed (Simon Island on the Loire and Honoré de Balzac Park on the Cher) or not (natural islands, vegetation on the banks of the Loire and Cher), as well as the parks (green enclaves made up of public or private gardens), contribute greatly to the quality of the town center.

The scenic banks of the Loire River are an enchanting attraction that draws both residents and tourists alike. This picturesque setting offers a serene escape from the urban bustle and provides a tranquil backdrop to the city's vibrant life. On the southern bank of the Loire, we discover the Quartier du Vieux Tours, the historic district that stands as a timeless gem at the center of the city's night-time activities.

In the heart of the city, several other districts boast distinctive urban forms that contribute to the diversity of the urban fabric. The Rue Nationale, a bustling thoroughfare, promotes commerce and social interaction. Many parks, such as the Jardin des Prébendes d'Oé, serve as oases of greenery amidst the urban landscape, fostering a sense of tranquility and well-being for those who seek refuge in its lush gardens.

The landscape on the Cher is very different; it has been profoundly altered since the 1960s. Thus, the natural spaces have been erased in favor of an urban landscape supporting new districts. The «Barnier» Law of 1995 on the reinforcement of environmental protection made it possible to preserve part of the natural landscape south of the Cher, making it possible to reconcile nature and urban dynamism in this area.

- The hillsides : «ville Coteau»

The hillsides are still very visible in the landscape today and create breaks in the urban environment.

The northern hillside, a prominent feature of Tours' terrain, serves as an essential link between the valley and the plateau regions. Here, the natural topography melds with bridges elegantly traverse the terrain, symbolizing the city's unity. The hillside itself is cloaked in dense, wooded vegetation, creating a captivating visual contrast with the surrounding urban sprawl. It stands as a testament to the enduring coexistence of nature and civilization in Tours.

On the southern hillside, a different narrative unfolds. Here, the terrain takes on a more undulating character. The presence of a broader alluvial plain creates a sense of expansiveness, offering a stark contrast to the more confined spaces of the city center. The network of road infrastructures weaves through this landscape, a testament to modern urban planning and connectivity. Recent urbanization efforts have left their imprint on this part of the city, resulting in a more contemporary, open, and exposed landscape. Unlike the northern hillside's thick vegetation, the southern counterpart embraces a more welcoming and accessible character, inviting to engage with nature.

- The plateau : «ville Plateau»

After the devastation of the Second World War, Tours embarked on a transformative journey that would reshape its landscape. The city expanded beyond the confines of the river corridors and began to spill over the edges of the hillsides. This post-war era witnessed the emergence of the plateau city, a significant development that had a profound impact on the city's landscape.

The northern plateau, which now extends over an area larger than that of the alluvial plain became a thriving hub of housing and economic activities. New residential neighborhoods sprung up, accommodating the city's growing population. Simultaneously, economic activity zones took root, attracting businesses and industries that contributed to the city's economic vitality.

In contrast, the southern plateau retained its distinctive wooded character, serving as a testament to Tours' commitment to preserving its natural heritage amidst urban expansion.

Fig 013/ An ordered natural setting
the Loire and the Cher, the alluvial plain, the hillsides, the plateau

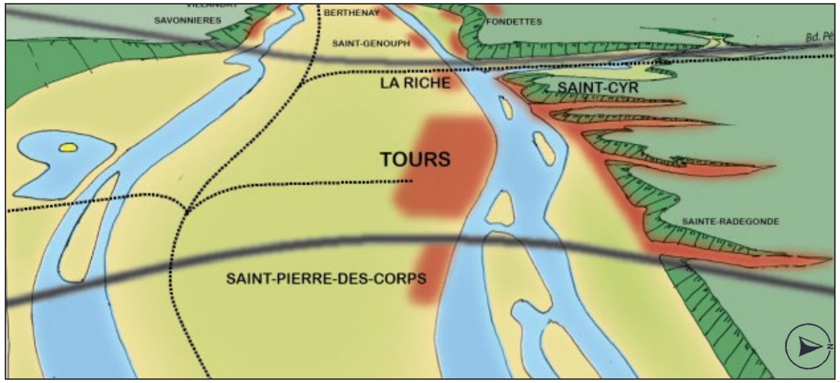


Fig 014/ Breaks in the organisation
New mobility axes that runs up the valleys

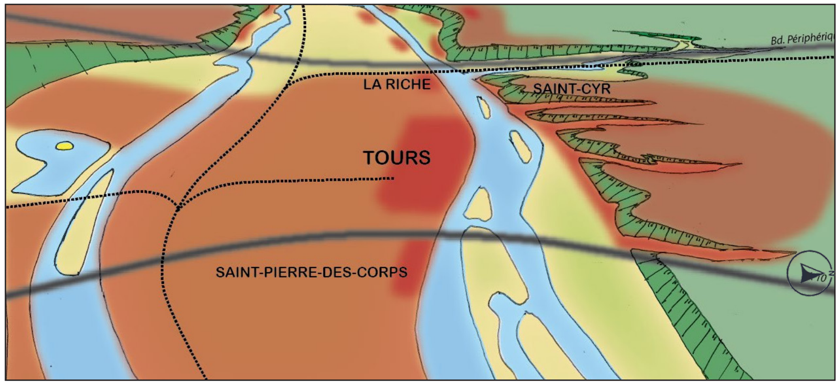


Fig 015/ An urban landscape
A city which today occupies the valley and the plateau

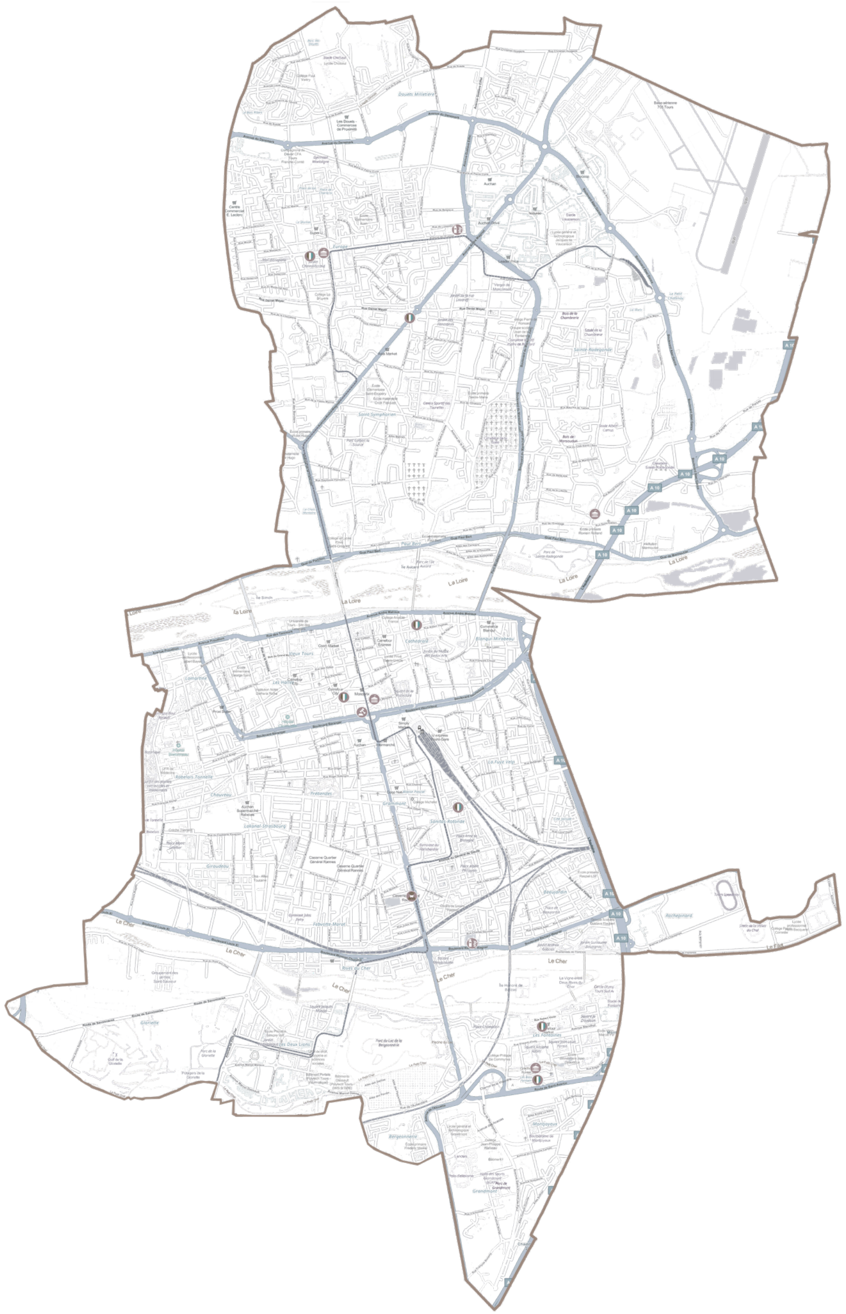


Fig 016/ Mobility axes of Tours

Tours' urban landscape is characterized by its distinct districts, urban spaces, mobility axes, and abundant green and blue spaces. These elements collectively contribute to a multifaceted urban morphology, catering to the diverse needs and preferences of both residents and visitors. The city's historic center, industrial zones, and natural features come together to create a unique and dynamic urban tapestry.

As it has been seen before, Tours is a city divided into distinct regions, offering a varied urban. Tours Centre is the heart of Tours resides in its central district, which is the core of the city's commercial and cultural life. The city boasts numerous well-designed public squares that serve as vibrant hubs for social interaction and gatherings. The northern part of Tours is predominantly characterized by its industrial activities. The landscape here is shaped by industrial infrastructure, reflecting the city's economic dynamism. In contrast, the southern part of Tours offers a different ambiance with a focus on green spaces and recreational areas. Green oases in the southern part of the city offer havens for relaxation and outdoor activities.

Scenic riverside walkways along the Loire and Cher rivers invite to appreciate the natural beauty of these waterways while promoting active transportation. Beyond its scenic beauty, it offers opportunities for recreation and relaxation along its banks. The omnipresence of wild area in Tours enable it to find a good way between urbanism and nature. Green spaces and blue spaces constituted the greatest character of the city and its borders. Grey spaces enable the city to concentrate activities and gather people with the well-marked mobility axes.

Tours follows a linear urban layout, where building facades align along urban mobility axes and natural river axes. This layout not only enhances the city's connectivity but also provides opportunities for picturesque views along the waterfront. The city's transportation network is defined by its robust urban mobility axes with a significant boulevard that traverses Tours from south to north, serving as a vital artery for regional and national transportation links.

As said previously, the city of Tours is caractarised by a strong North-South axis (Avenue de Grammont, Rue Nationale, Pont Wilson. Other smaller mobility axes also cross the city to delimit the urban areas from east to west, until reaching the highway A10 passing along the city from South to North.

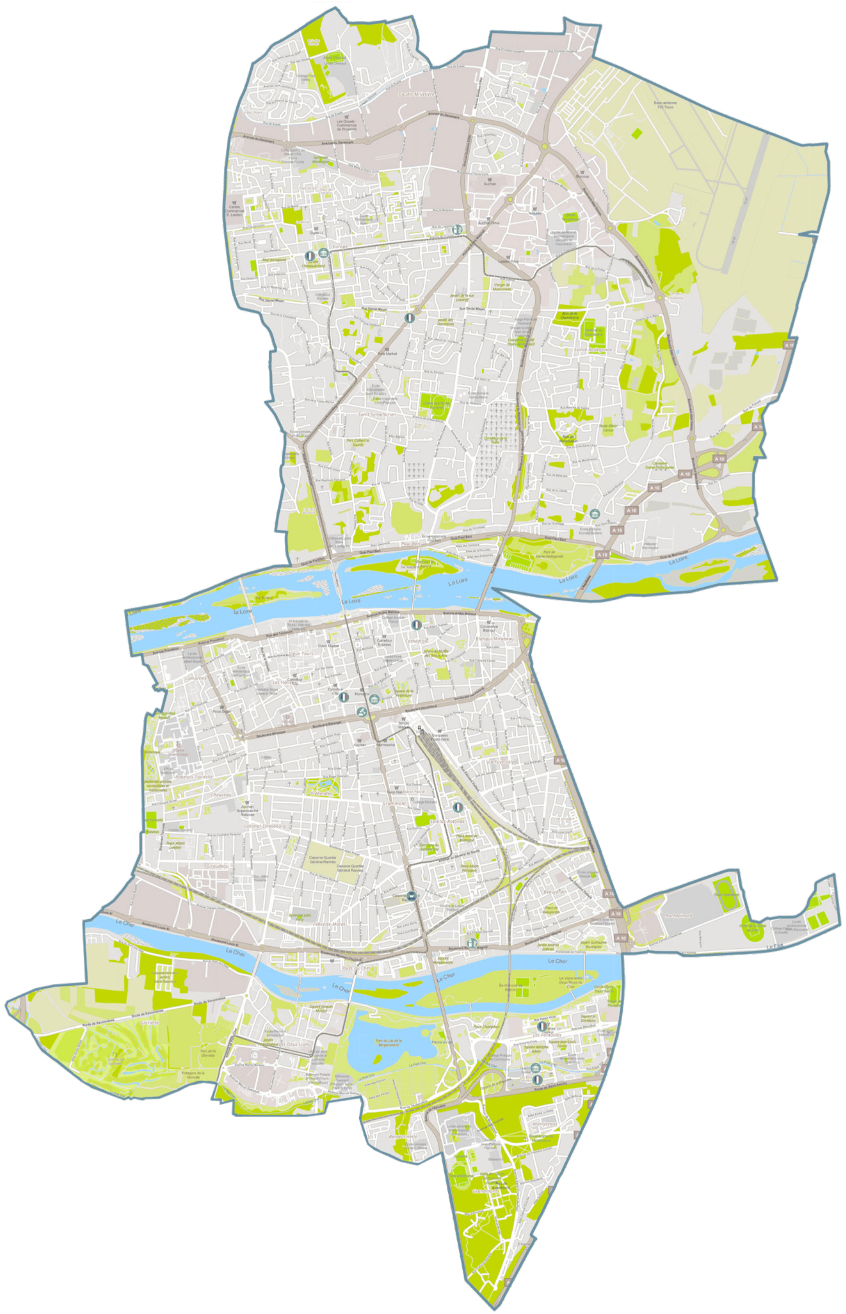


Fig 017/ Green and blue spaces

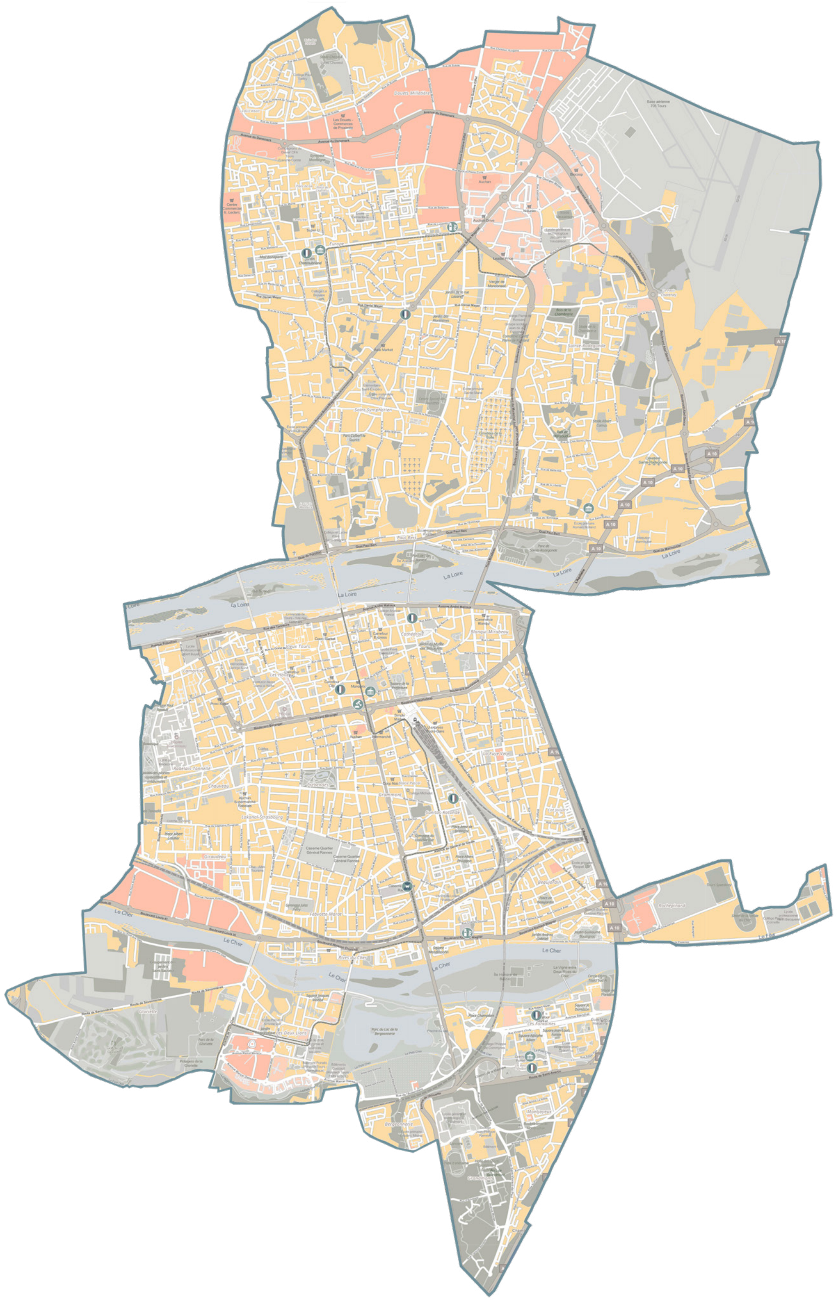


Fig 018/ Urban spaces

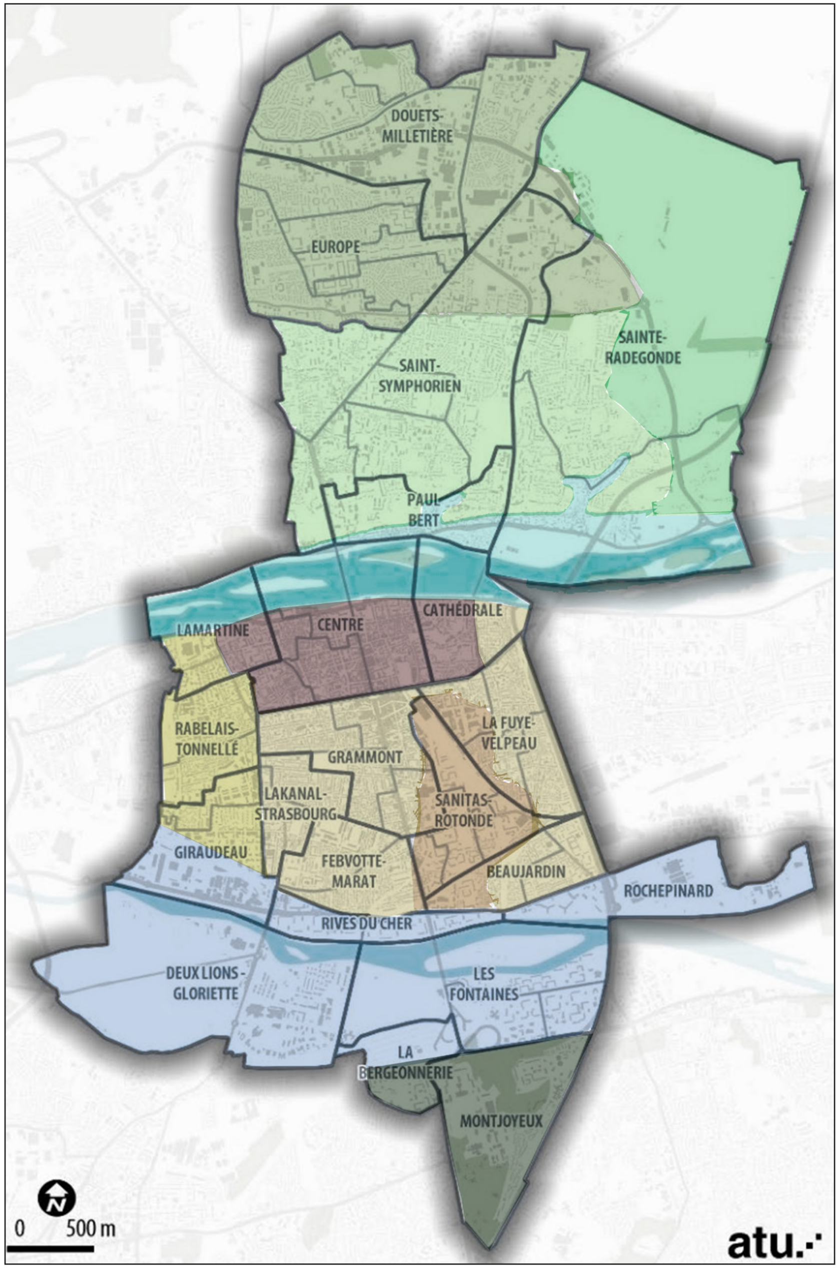
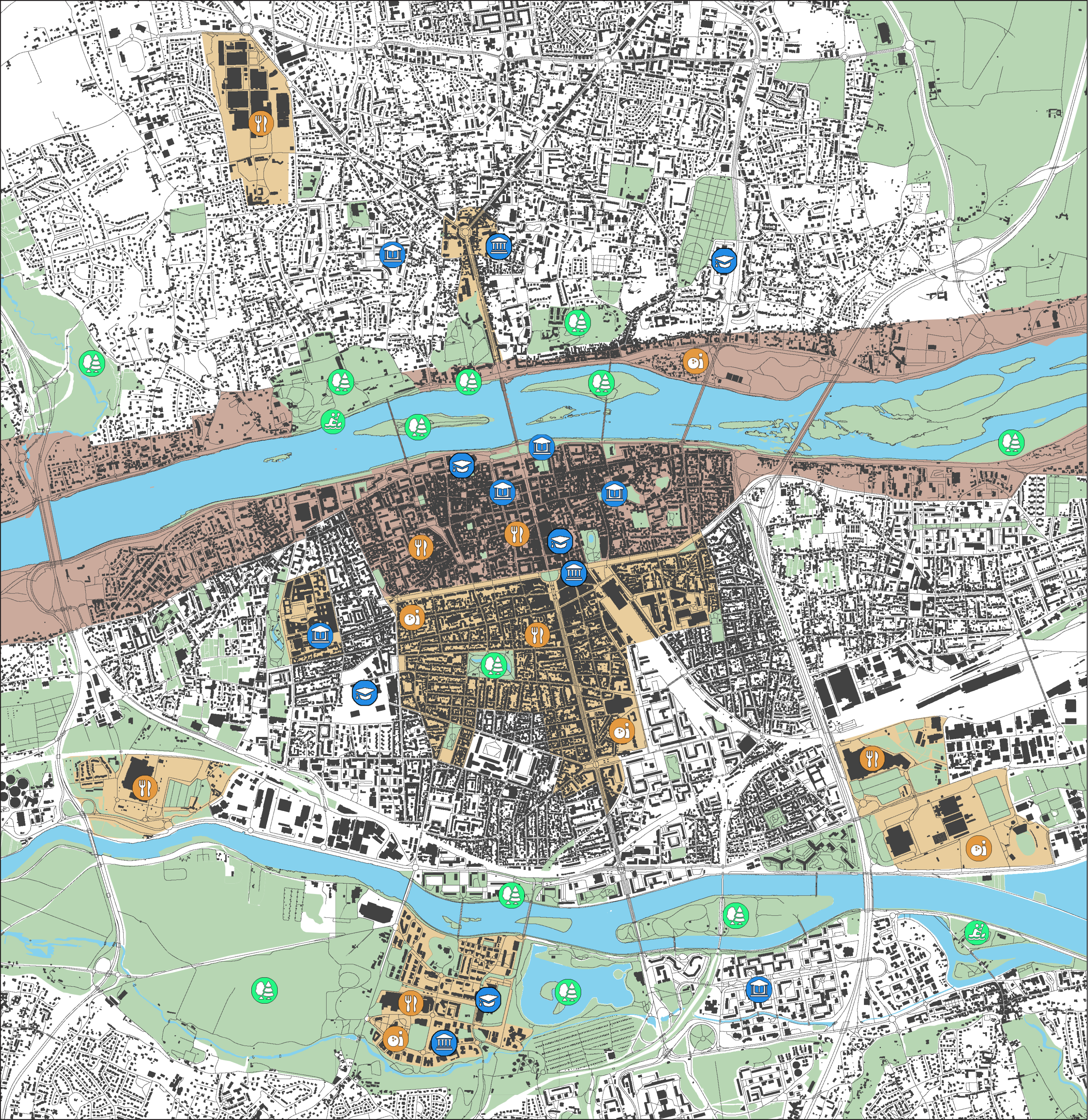


Fig 019/ Urbanscape morphology of Tours

Tours' urban landscape is a captivating blend of distinct districts, each contributing to the city's rich tapestry while fostering a harmonious coexistence. The historic town is situated along the southern bank of the Loire within the district called «Centre». It stands as a living testament to the city's historical significance. Its winding cobblestone streets and bustling squares make it the vibrant epicenter of nocturnal activities, drawing in both residents and tourists alike. Beyond the historic core, the Rue Nationale emerges as a bustling commercial thoroughfare, breathing life into the urban milieu. Here, the lively atmosphere promotes social interaction and economic vitality, making it a vital hub for the city.

The three districts in the centre of Tours are home to a large concentration of family dwellings. It is articulated around the Jardin des Prébendes d'Oé, a refreshing space into the urban landscape. Meanwhile, the «Sanitas-Rotonde» district showcases contemporary urban planning, embracing modernity in its layout and design, the Rabelais Tonnelé district presents a blend of residential and commercial zones known for its architectural diversity, featuring a mix of modern and traditional styles.The urban spaces is articulated through dense and rich networks of public spaces, numerous reference squares, small alleys with an intimate character and also a linear urban layout where the facades of the buildings face the urban mobility axes or the natural river axes.

- The worked and inhabited plateau
- Above the heritage hillside
- The agricultural and infrastructure plateau
- The foot of the hillside and the Loire
- The historic town
- Mixed sector of Tonnelé and Rabelais suburbs
- Tourangeaux individuals
- The railway triangle
- The artificial Varennes : the Cher and its slopes
- The southern plateau and Grammont Park



Green Spaces

Blue spaces
Upper river : The Loire
Lower river : The Cher

Area of attractiveness recognised by UNESCO : «Val de Loire» «Vieux Tours»

Other spaces of interest

Urban spaces

Parks and Nature

River-related activities

Libraries and museums

Universities

Public buildings

Shopping centres

Various activity centres (Gymnasium, Cinema, ...)

< *Fig 020/ Functional and morphological analysis of the city*

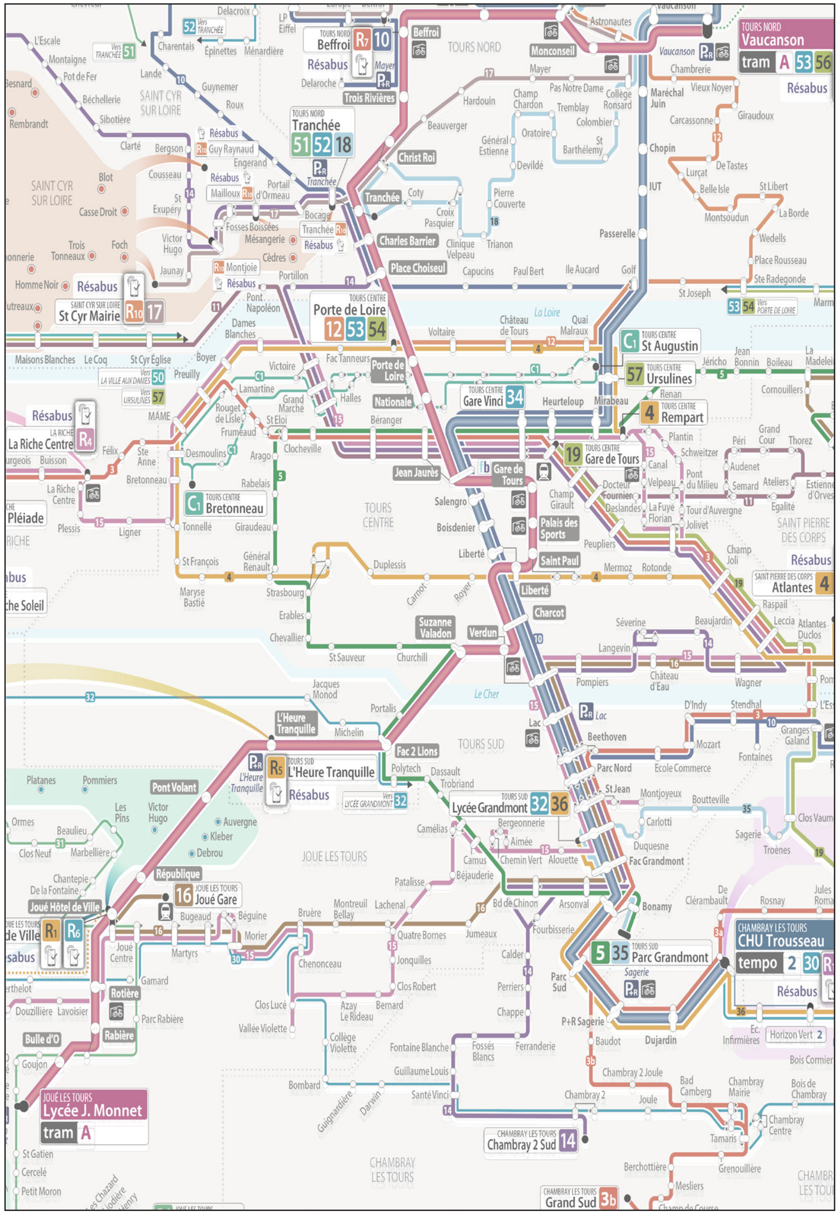


Fig 021/ Tours mobility network

1.6. Accessibility of the city

As with most cities in Europe, Tours has developed a comprehensive network of mobility resources that cater to different levels of connectivity, ranging from international connections to internal mobility networks.

Starting with road connections, Tours benefits from a ring road around the city, national and departmental roads linking Tours to neighboring cities, and several major highways. Notable highways include:
- A85: Connecting Angers (West) to Vierzon (East)
- A10: Connecting Poitiers and Bordeaux (South) to Orléans and Paris (North)
- A28: Leading towards Le Mans and Rouen (Northwest)

The city's train station is conveniently located in the heart of the city center. As it functions as a terminus, most main railway lines are concentrated in St-Pierre des Corps, a neighboring city. This station serves high-speed TGV trains for major routes, Intercités for interregional travel, and TER trains for intra-regional or nearby destinations.

The Tours Val de Loire Airport (TUF) enhances the city's connectivity, located just 5 km from the city center and served by a shuttle bus to the train station. The airport offers flights to several major cities, including Marseille (MRS), London (STN), Porto (OPO), Marrakech (RAK), and Dublin (DUB).

Tours and the surrounding region feature prominently on the «Loire à Vélo» itinerary, which is a 900-km-long route linking the source of the Loire River to the Atlantic Ocean. This scenic route is a major draw for cyclists and tourists alike.

Public transportation within Tours is robust, with Fil Bleu buses operating 46 lines that connect the city center to suburban areas. Additionally, the tramway line, stretching 15 km, links Joué-les-Tours in the south to the northern part of Tours, providing an efficient and eco-friendly transit option.

Recent initiatives by the city to enhance mobility have focused on prioritizing pedestrians and ensuring mobility for all residents. This includes reorganizing motorized roads, reducing car usage by 15%, and increasing the bus network by 40%. These measures aim to decrease car pollution and foster the development of a city designed for short distances, thereby improving the quality of life and environmental sustainability in Tours.

< *Fig 022/ Accessibility analysis of the city*

1.7. Demographical data

The following section will focus not only on the demographic data of Tours but also on that of the neighboring city of Joué-lès-Tours, the second most populous city in the department after Tours. This is relevant choice as the subject of the study is located in the district of «Les Deux-Lions», which lies between these two cities in the southern part of Tours.

Figure 18 shows that the population in Tours and Joué-lès-Tours has been growing steadily since the period when Tours began to develop as a technological park in 1990, which coincides with the construction of the district of «Les Deux-Lions.»

In Tours, the population is distributed between the north (28.3%), the center (58.2%), and the south (13.5%). The number of inhabitants in Tours accounts for more than a quarter of the entire department. The combined population of Tours and Joué-lès-Tours represents 60% of the whole metropolitan area (Figure 19).

Figure 20 indicates that the population is relatively young, with a youth-to-elderly ratio of 1.72. The district of «Les Deux-Lions» is even younger, with an average age of 28 years, compared to the overall average of 39 years for the two cities. This district constitutes a brand-new area for the population but is already quite accessible and dynamic.

Even though the population is young, many university students leave the city after completing their studies. The city attracts more working professionals and families; the older people get, the longer they tend to stay. Nevertheless, the city gathers a significant number of inactive inhabitants, whether they are students or retirees.

Disabilities are becoming more prevalent among the population, constituting 3% of the total population. The number of beneficiaries of the ASH (social assistance for the accommodation of people over 65 years old) has grown in five years by 1.3. These data underscore the importance of addressing accessibility in urban planning. It is crucial to ensure that buildings and public spaces are accessible to everyone, enabling all individuals, regardless of their physical abilities, to fully experience and enjoy the city's amenities and facilities. As Tours continue to grow and develop, prioritizing accessibility will be key to fostering a more inclusive and dynamic community.

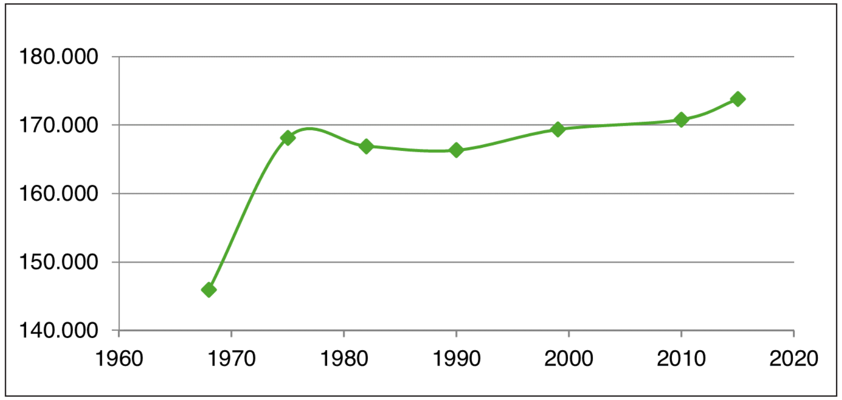


Fig 023/ Population growth in Tours and Joué-lès-Tours

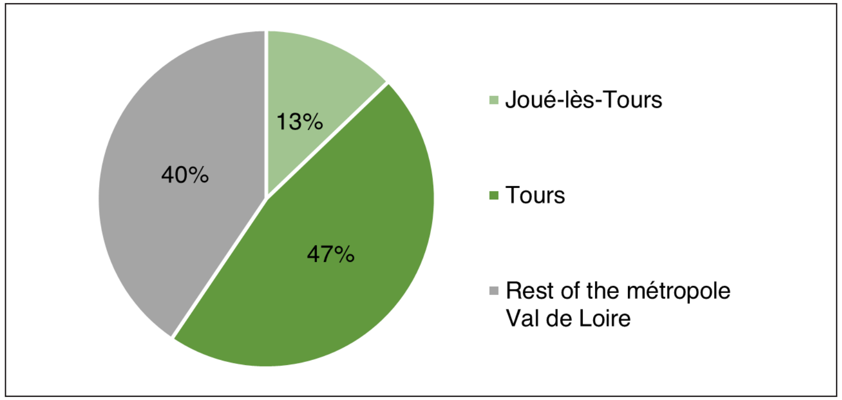


Fig 024/ Population distribution across the metropolis

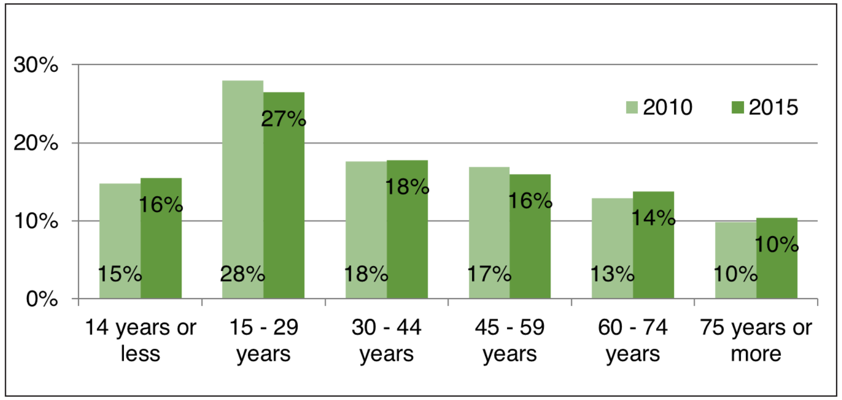


Fig 025/ Distribution by age group in both cities

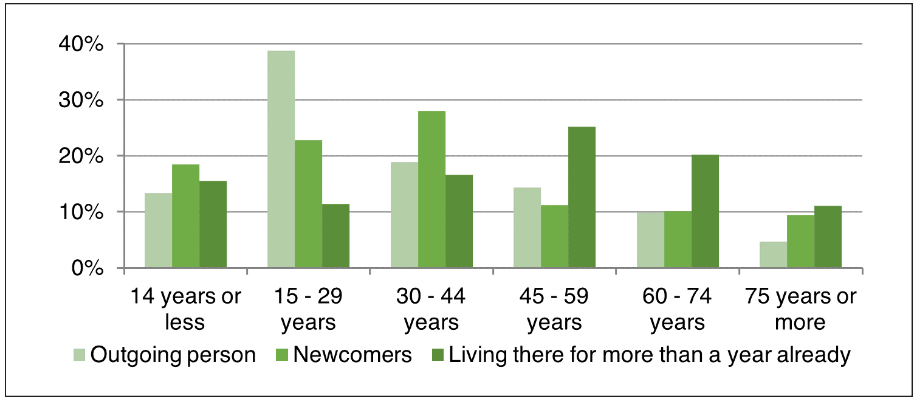


Fig 026/ Age of newcomers to the two cities in 2015

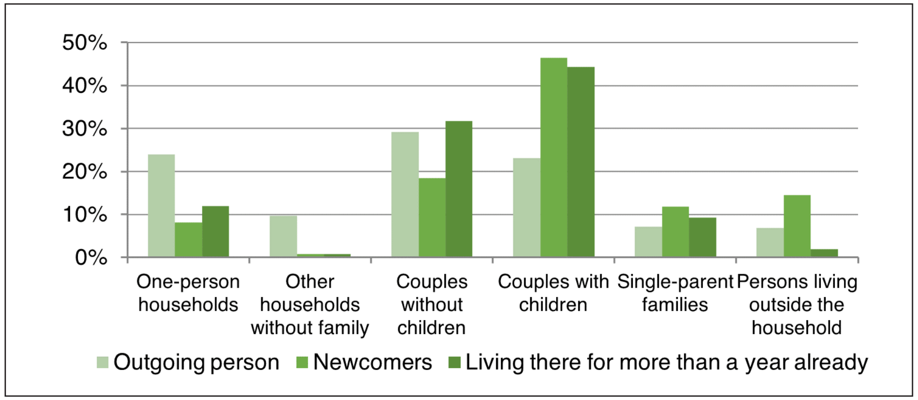


Fig 027/ Type of cohabitation in both cities in 2015

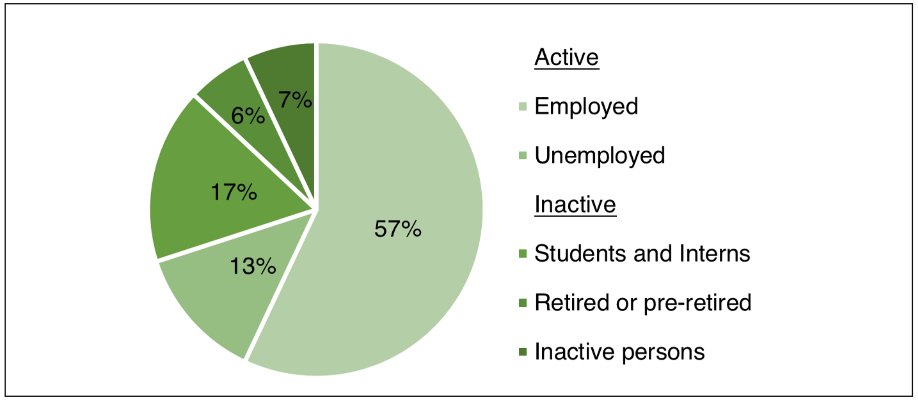


Fig 028/ Type of activity of people in both cities in 2015

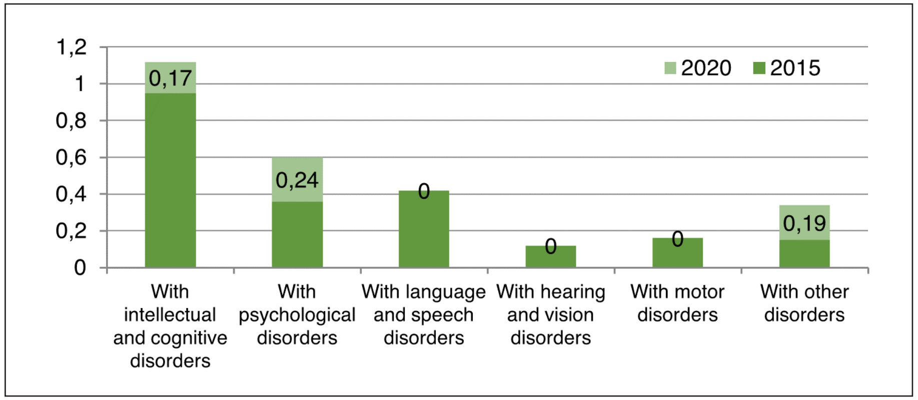


Fig 029/ Proportion of pupils with disability in % in both cities

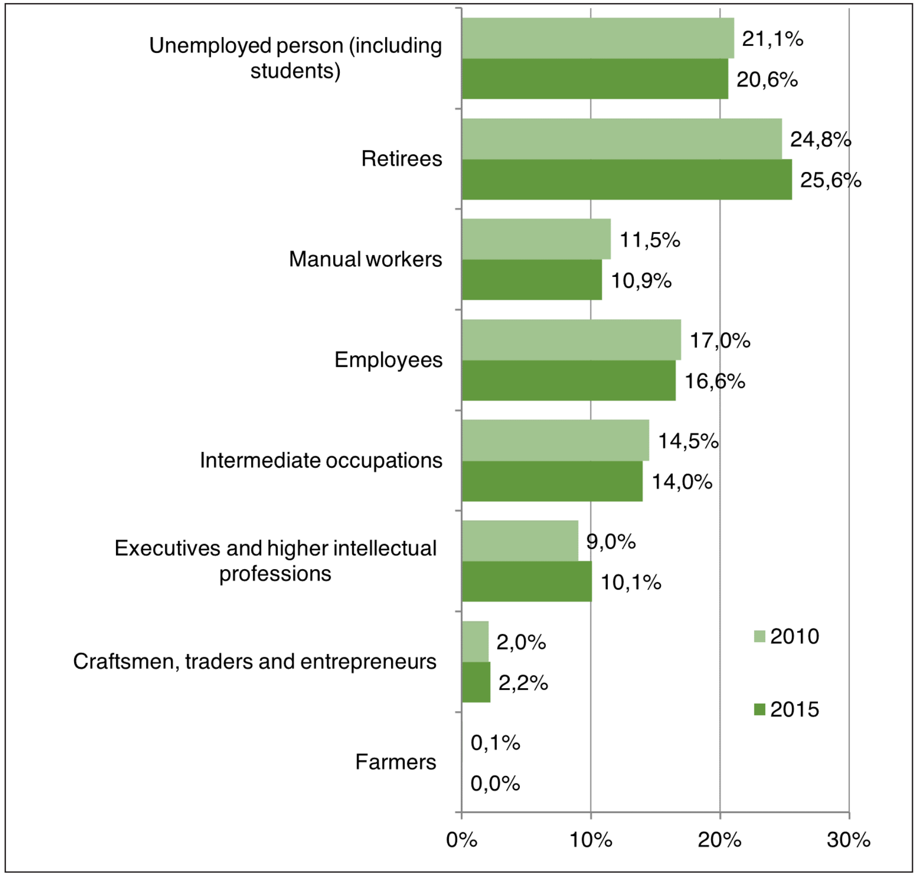


Fig 030/ Socio-professional categories in both cities in 2015

LES DEUX LIONS, A THRIVING NEIGHBOURHOOD

1.8. Close-up on Tours' most innovative district

At south of Tours lies a district named "Les Deux Lions" where the object of the thesis can be found. The district is named after two statues adorning a house's doorway at its edge. Just like Tours, the Deux-Lions district is also a harmonious blend of dynamic life and relaxing greenery. In fact, even if the district is surrounded by natural environments :

- To the north : The river named "Le Cher"
- To the south : A smaller river named "Le Petit Cher"
- To the west : A huge natural park named "La Gloriette"
- To the east : Another park named "Lac de la Bergeonnerie"

Before everything was built up, the district was an agricultural area named «Prairie de la Grande Rivière». The unique building was the farmhouse «Les Granges Collières» (circled in orange) built in the XVIth century. In the 1970s, a large flood of the Cher River flooded part of the meadow, forming a lake, which is called nowadays «Lac de la Bergeonnerie».

Its development began in the early 1990s under the last mandate of Mayor Jean Royer and was still ongoing at the end of the 2010s. As a result, from the 1990s, the SET (Tours urban planning office) set up its offices in the building of Les Granges Collières and built some extension. They started urbanising the whole area in order to extend the city. With the construction all around the Deux-Lions district on an embankment, Les Granges Collières farmhouse is now some meters below the level of the street.

Initially, it housed mainly higher education establishments, Polytech'Tours and the University of Tours' law faculty, followed by entertainment and a major shopping centre in 2009. Housing is gradually being developed, followed by areas for business start-ups. Mayor Jean Royer's team initially wanted to develop a technopole, i.e. an area that would bring together high-tech activities. However the urban development of the area has been guided then by a desire for a functional mix (housing/shops and services/businesses).

The opening of the tramway in August 2013 marks, in a way, the culmination of a huge project undertaken 20 years earlier.

General data

	District	City
Surface area	78 ha	3467 ha
Density	600 hab/ km²	4000 hab/ km²
Average age	28 y-o	39 y-o
Natural spaces	59%	26%
Retirees	4%	21%
School	3 build./km²	8 build./km²
Car use	29%	30%
Trade center	7 build./km²	2 build./km²

Fig 031/ General data description on the district

< Fig 032/ Mass and void - Les Deux Lions

1.9. Les Deux Lions through time


Fig 033/ Sky view of the “Deux Lions” district in 1960


Fig 034/ Sky view of the “Deux Lions” district in 1991


Fig 035/ Sky view of the “Deux Lions” district in 1995


Fig 036/ Sky view of the “Deux Lions” district in 2000


Fig 037/ Sky view of the “Deux Lions” district in 2010


Fig 038/ Sky view of the “Deux Lions” district in 2020

	Building of «Les Granges Collières» built in the 16th century
	Unreferenced building (probably built in the 20th century)
	Buildings constructed since 1990
	Buildings constructed since 2000
	Buildings constructed since 2010
	Buildings constructed since 2015
	Buildings constructed since 2020

< *Fig 039/ Historical evolution of the district*

1.10. Analysis of the district

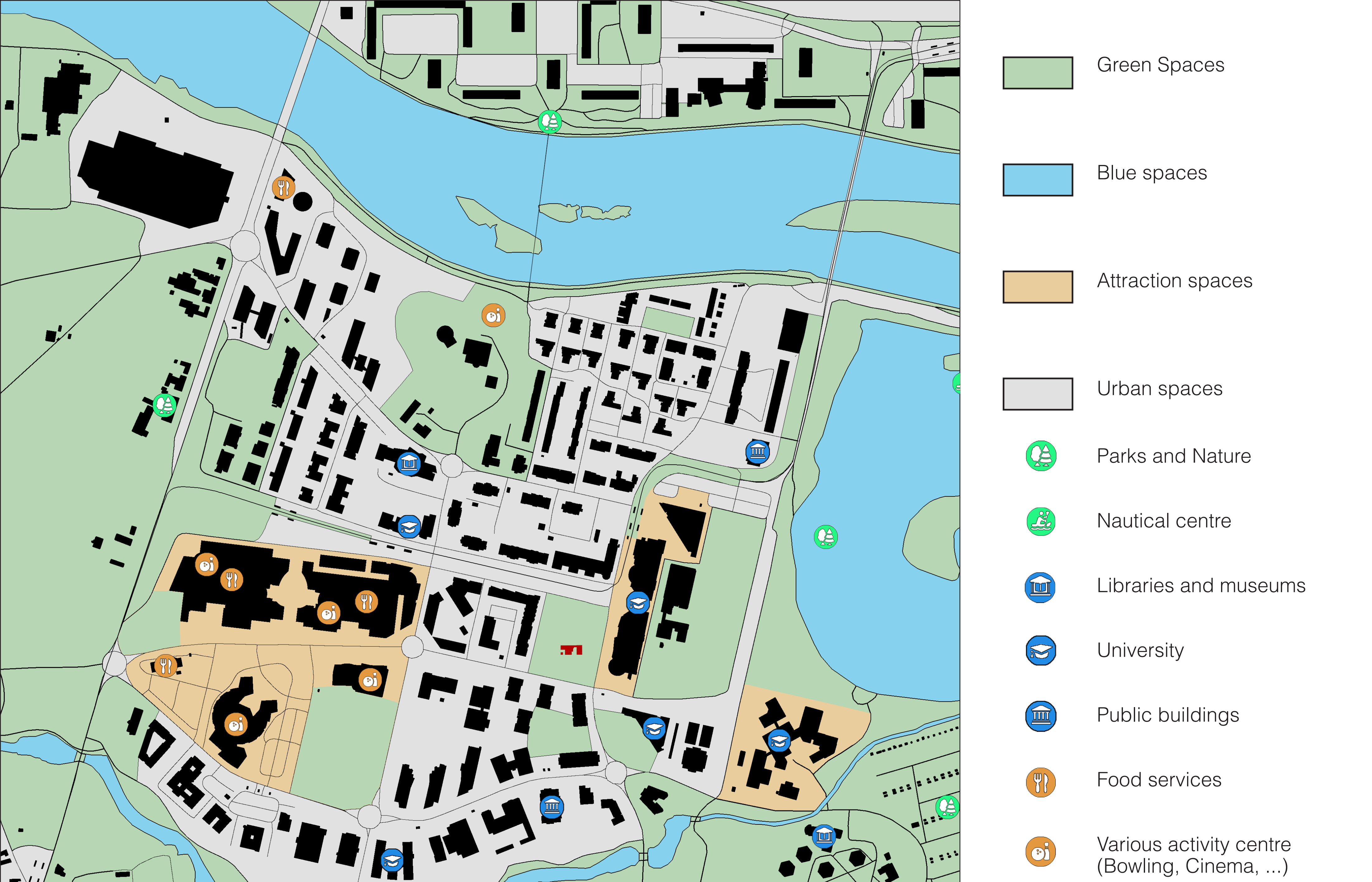
The district's surroundings are so natural because the area is young. When the city was expanding and the area was being developed, the mayor's office decided to protect certain parcels of land to limit its action. That's why the district has clear boundaries between inside and outside. A little further south, the neighboring city of Joué-les-Tours can be found. The district plays a role in interconnecting these two cities by attracting the inhabitants of both.

The district can be sub-divided into two areas : the northern section comprises residential houses and administrative centers or offices, while the southern section hosts recreational activities among the urban spaces. All these different activities make the district one of the strongest activity centers in the city. Its «brand new» character allows for the growth of new activities, and its deeply natural identity allows it to remain a peaceful and relaxing area.

The Deux-Lions district hosts a variety of services such as housing with diversified architectural typologies, offices of tertiary and high-tech activities, educational centers (Faculty of Law, Faculty of Urban Planning), commercial activities (Shopping center known as «L'Heure Tranquile,» cinema, bowling, etc.), and administrative centers (headquarters of the Val-de-Loire Metropole). This variety ensures that the district meets the diverse needs of its inhabitants and visitors, promoting a vibrant and sustainable urban lifestyle. However, the district does not include a proper central green space for gathering or a cultural public space for artistic activities.

The Deux-Lions district enjoys a close and advantageous relationship with two prominent natural attractions in Tours : Lac de la Bergeonnerie and Parc de la Gloriette. Lac de la Bergeonnerie, situated to the east of the district, offers a tranquil setting for relaxation and outdoor activities in proximity to this picturesque lake. Parc de la Gloriette, on the other hand, lies a bit further to the west but remains easily accessible. This expansive park is renowned for its beautifully landscaped gardens, which serve as an idyllic backdrop for nature enthusiasts and families alike.

The urban fabric of the Deux-Lions district is embodied by strategically designed blocks. Here, the continuity of urban frontages and the careful arrangement of gables are evident, contributing to a harmonious streetscape. Roads within the district predominantly adhere to the North-South and West-East axes, aligning with the city's overall urban layout.



< *Fig 040/ Functional and morphological analysis of the district*

This amalgamation of architectural diversity, abundant greenery, tree-lined streets, well-maintained landscaping and thoughtfully planned pedestrian areas creates an urban fabric that encourages residents to fully enjoy their district while promoting a dynamic and sustainable way of life.

The district exhibits a deliberate organization of volumes, in line with the block-based composition plan. Collective housing structures typically rise to a maximum of four floors (R+4), intermediate and individual homes reach up to one floor (R+1), and tertiary buildings extend to two floors (R+2). This progressive variation in building heights, notably stemming from the «Petit Cher» area, contributes to the district's visually appealing skyline.

Fig 041/ Shopping center «L'heure Tranquille»

The architectural landscape boasts a vibrant diversity of contemporary materials, often combined to create composite facades. Some structures embrace bold and vivid colors, such as striking reds and yellows, lending an element of liveliness to the streets. The facades are characterized by their openness, featuring a significant number of balconies that not only provide outdoor spaces for residents but also add depth and character to the buildings.

The district is linked to the other bank of the Cher by four bridges. The Saint-Sauveur bridge is accessible by car, on foot, and by bike but provides a not-so-great experience for pedestrians. However, the Fil d'Arianne bridge provides a very pleasant environment as it is accessible only on foot and by bike, and as it crosses the Cher River passing by small islands. The Tramway line bridge (accessible on foot and by bike, taken by the tramway) also provides a positive experience for pedestrians as the users of the tramway can enjoy the landscape. The last one, Sanitas bridge, is not actually directly connected to the district but constitutes the main mobility axis to cross the Cher River. It is accessible by car, on foot, and by bike.

Fig 042/ Lac de la Bergeonnerie

The Deux-Lions district is connected to the center of Tours thanks to the mobility network provided by the city. People using public transportation can easily access the district by taking either the tramway line or the bus. The only tramway line in the city goes from Tours North to Joué-les-Tours (a city south of Tours) and passes through Tours city center. The bus lines reaching the district of «Les Deux Lions» are either Bus line 5, which connects Grandmont Park (Tours south) to Tours city center and St-Pierre-des-Corps Station (main train station, a city east of Tours), or Bus line 32, which connects Grandmont High School (Tours south) to Villandry and its castle (a city west of Tours).

< *Fig 043/ Accessibility analysis of the district*

Le Cher
RIVES DU CHER
Extension D3.3
Avenue de Pont-Cher
PARC DE LA GLORIETTE
PARC DU LAC DE LA BERGEONNERIE
Avenue Michelin
Avenue Watt
GRANGES COLLIERES
Avenue Mérieux
Avenue Dassault
RIVES DU PETIT CHER

LES GRANGES COLLIÈRES, AN UNSEEN VERDANT NOOK

1.11. Close-up on Les Deux Lions' only historic heritage

Nestled in the heart of the district and just steps away from the university, «Les Granges Collières» is a historic farmhouse dating back to the XVIth century, surrounded by nearly one hectare of natural space. This building is the sole remnant of the rural Touraine of yesteryear and now serves as a significant environmental asset in the evolving urban fabric.

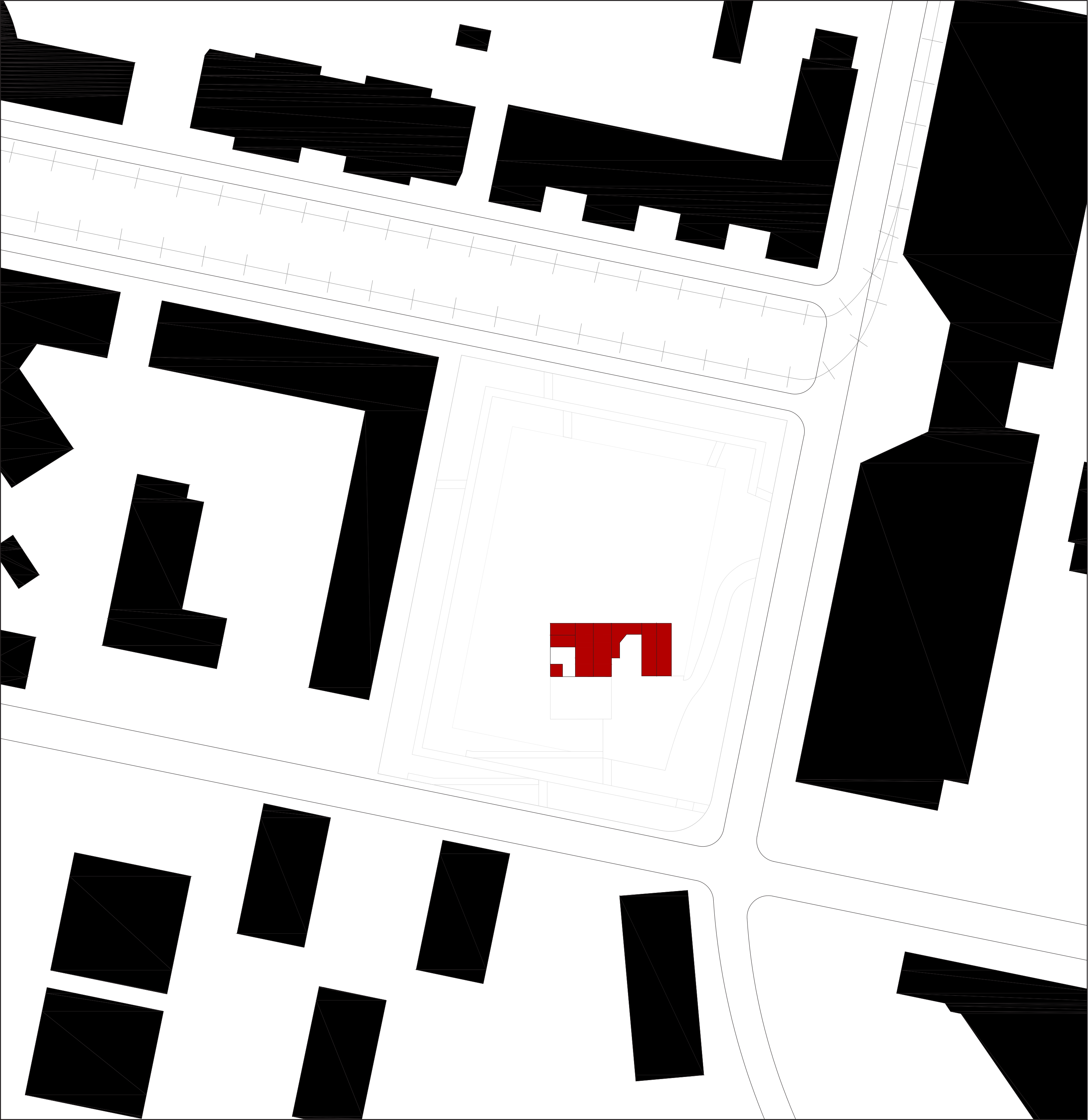
Over the years, the surroundings of «Les Granges Collières» have undergone a dramatic transformation from open fields to a densely populated and dynamic urban district. The former rural landscape gave way to the rapid urbanization of the neighborhood, leaving the ancient farmhouse somewhat isolated in its new context. Its unique historical significance sets it apart as the only remaining old building in the district and provides an anchor in an evolving urban landscape, providing a bridge between the district's past and its future, while serving as a symbol of preservation and renewal.

However, despite its historic and environmental value, «Les Granges Collières» appears visually out of place in the contemporary urban fabric of the district. The development around it has caused a noticeable temporal, visual, and geometric misalignment between the farmhouse and the surrounding buildings. As a result, «Les Granges Collières» is suffering from neglect and a lack of attachment on the part of the residents. What should have been the district's historic heart - or at least its green lung - is failing to beat or breathe properly. While the residents of Tours know the Deux-Lions district for its «L'heure tranquille» shopping centre or its university, they can't put a name to this odd farmhouse, which is in fact one of the oldest historical witnesses in this part of Tours.

Nowadays, the city's desire is to preserve this green space, which is ultimately the last presence of the old fields, while reaffirming the presence of the site in the district. The proposal for the project seeks to extend and integrate «Les Granges Collières» into the urban context, maintaining its historic and environmental significance. The objective is to transform the site into an attractive meeting place and cultural centre while preserving its greenery. The aims of the site is to gathers a cultural and social interest but also an environmental concern.

Fig 045/ Sky view on the site, 2022

<<Fig 044/ Summary map of the disctrict of «Les Deux Lions» (map provided by the city)



<< *Fig 046/ Google earth view on the site within the district*

< *Fig 047/ Mass and void - Les Granges Collières*

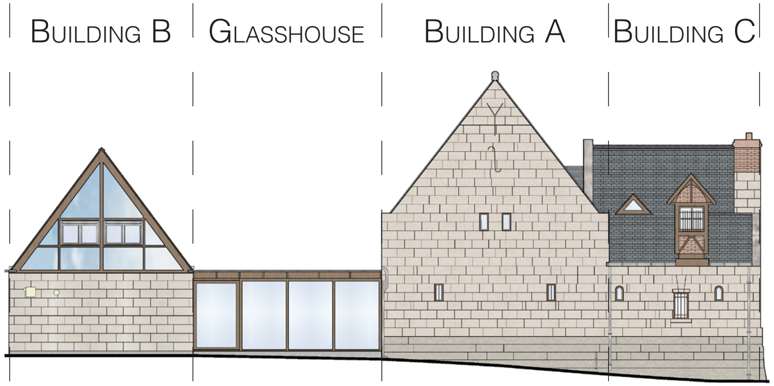


Fig 048/ Personal naming of the building of the farmhouse (North facade of the farmhouse)


Fig 049/ Current state of the farmhouse from North (photos taken on 30/11/2022)


Fig 050/ Current state of the farmhouse from South (photos taken on 30/11/2022)

1.12. Les Granges Collières through time

In the 90s, when the city has grown beyond the Cher river, a considerable effort was made to raise the ground level by filling in the area due to its location in the flood-prone Cher valley. Due to environmental concerns and protests, it was decided to urbanised a certain part of the former fields, leaving a hectare around the farmhouse in its original state. This raising of the ground level left the ancestral farmhouse standing in its original location while the district was raised by three metres.

Also, the SET (Société d'Equipement de la Touraine) - which was already evoked as Tours urban planning office - decided to renovate the Granges Collières to install its offices there since they were in charge of the whole urbanization of the district. The Granges Collières farmhouse was constituted of an agglomeration of four building. However, it saw its east part destroyed while the west buildings (Building A and C) remains unchanged. Then it benefited from the reconstruction of the actual east side (Building B) and a modern extension: (The glasshouse).

On December 28th, 2000, a fire ravaged the first floor of Building A and destroyed its roof, the elevated floor and the windows. The lack of funds necessary to restore the Granges Collières put it on hold for one year and a half. A diagnosis of is established in June 2001 and the restoration starts in 2002. After the incident, some part of Building A were just cleaned and some other had to be redone because they were destroyed.

In parralel of the tramway lines construction, the city (and not the SET who has left the farmhouse houses to leave room to administrative offices of six companies specializing in theatre, dance and street arts) undertook a urbanisation programme for the building site in 2016. In addition to the installation of bench, about thirty trees were added to the fifty already present, five hundred shrubs, two thousand seven hundred perennials and a thousand bulbs were planted. The site on the south side has been heavily landscaped to make room for ramps and vegetation. The city also removed some facilities such as air handling unit.

In April 2021, four sites were identified in the district (among them Les Granges Collières). Public spaces consultation / co-construction workshops are being held to give these spaces a new lease of life.

Fig 051/ Development of the site and the farmhouse over time >>

XVI century
Birth of the building
(and preservation until the 1990s)

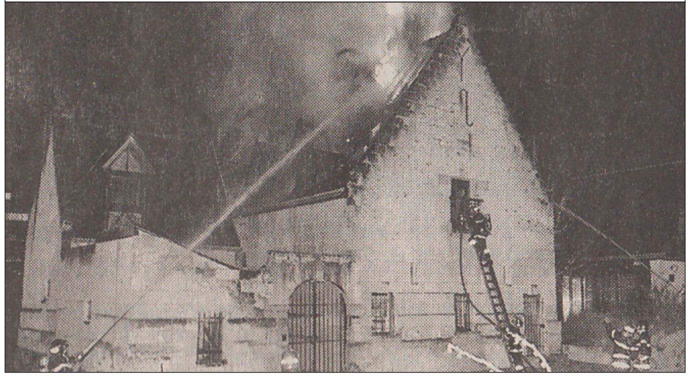
1991
Birth of the district
Urbanisation of the neighbourhood on its embankment
(The site is not filled in to preserve its historical and natural value)

Modern extension of the farmhouse and recovery of the interior spaces to house offices

2002
Restoration of fire-damaged parts
Restoration of the inner face of some Tuffeau stones

1910
Flooding caused by the Cher River up to the farmhouse

2000
Fire on the elevated floor of the farmhouse (demolition of the roof and of the elevated floor of the main part of the farmhouse)



2016
Enhancement of the site (addition of benches, trees and other plants)

In a nutshell, here the turning points of the modification of the site :

XVIth : Presumed period of construction of the farmhouse

1910 : First photographic image of the Granges Collières
(Publishing of a photo of the Cher river flooding in a local newspaper)

1991 : Refurbishment of the farmhouse (Purchased by the SET)
- Destruction of two buildings in the East side
- Complete rebuilding of the new East building (now called Building B)
- Manufacturing of the glasshouse (between Building A and Building B)
- Interior planning of Building A and C (staircase. kitchen, toilets, ...)
- Restoration of some Tuffeau stones in the facade

90's : Urbanisation program of the Deux-Lions district
Second photographic image of the Granges Collières
(Publishing of a photo of the building refurbishment in a local newspaper)

2000 : Fire of a part of the farmhouse

2002 : Restoration of the burned part of the farmhouse
- Demolition of the roof (Building A)
- Demolition of the elevated flooring (Building A)
- Demolition of the chimney cover
- Rebuilding of the roof structure in oak timber
- Rebuilding of a new wooden flooring with false floor
- Rebuilding of the internal wall
- Identical rebuilding of the flue cladding
- Identical rebuilding of windows doomers
- Restoration of the internal face of some Tuffeau stones (Building A)

2012 : Transfer of the farm ownership to the city

2016 : Enhancement of the garden / site of the Granges Collières

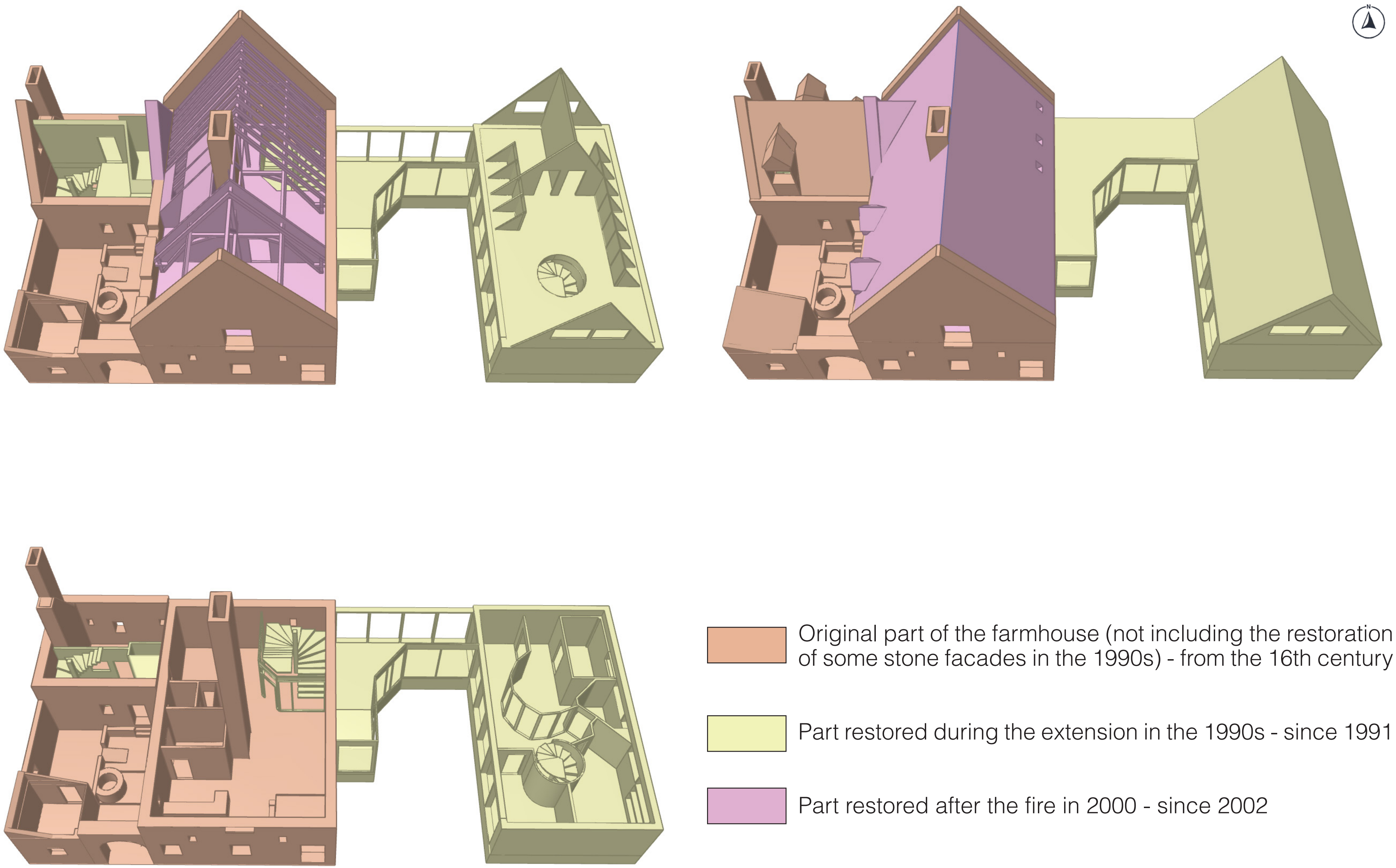


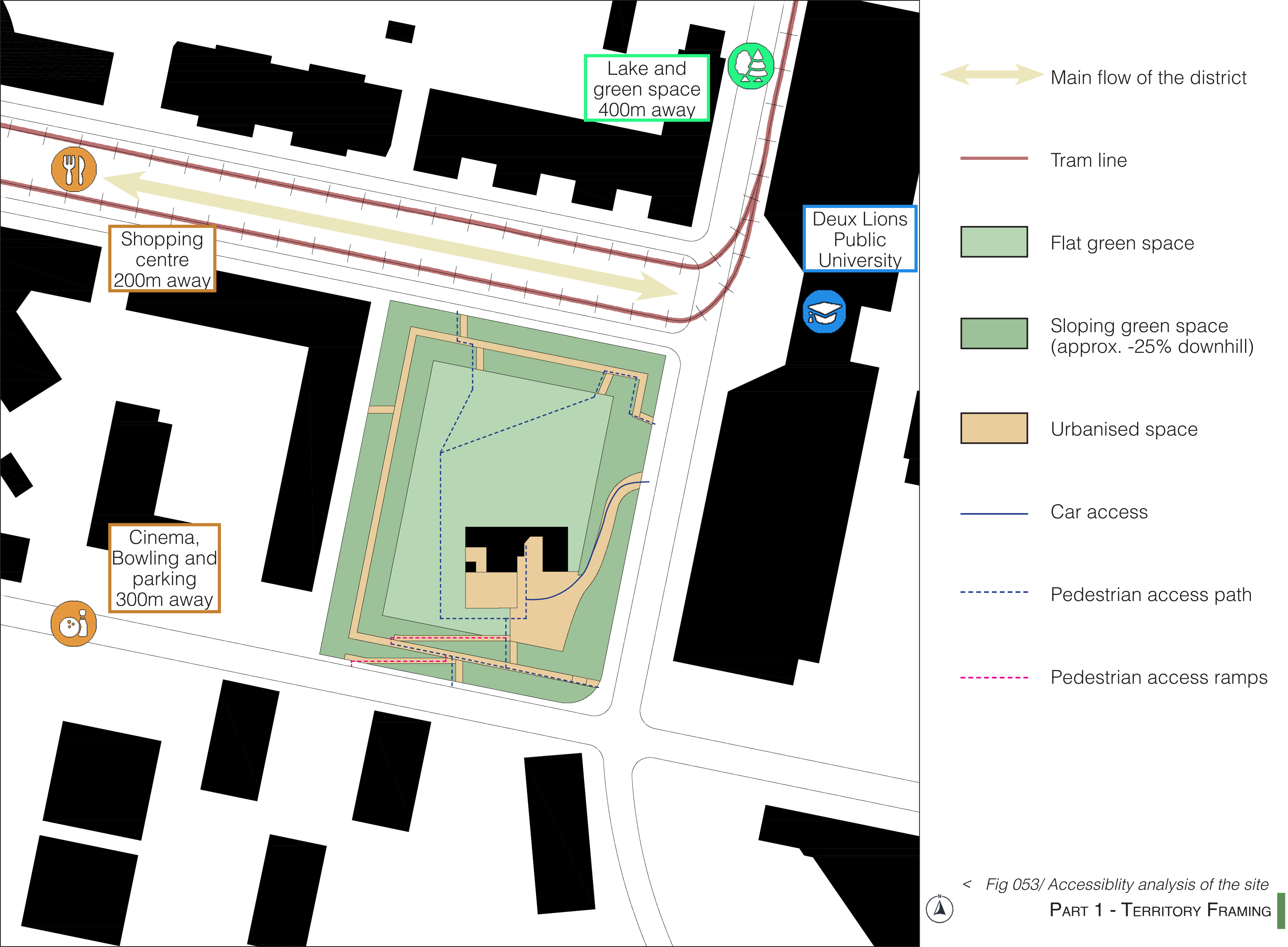
Fig 052/ Mapping of the original part of the farmhouse (from the south)

1.13. Accessibility of the site and the farmhouse

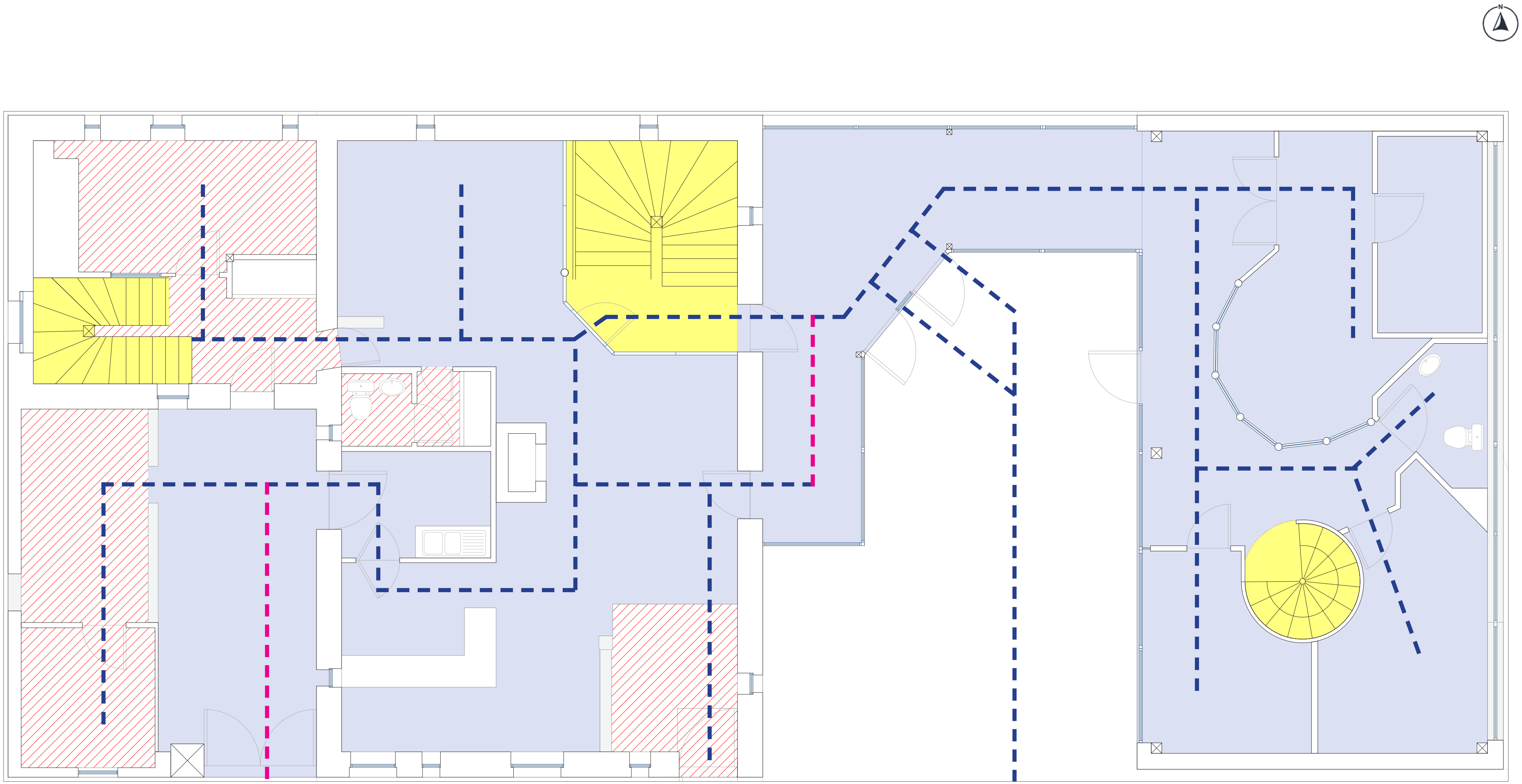
Accessibility of the site : The site is situated in a basin, with a significant altitude difference between the central flat area and the level of the surrounding neighborhood. A promenade surrounds this central area, separated from the neighborhood by a natural slope, and from the central flat area itself by another natural slope. Users can enter the site by taking the staircases to the north (unfortunately, there is no ramp at this location), by using the ramps designed for people with disabilities and other staircases to the south, or by arriving via the car ramp to the east. Thus, coming from the north and down the stairs, people end up on the grass if they want to reach the farmhouse.

Accessibility of the farmhouse : The farmhouse is accessible from the south by entering through the glasshouse that separates Building A and Building B. The farmhouse is therefore oriented only for entry from the south. This orientation is due to an intervention in the 1990s, at a time when the tram line, the university, and the shopping center, which are now the main attractions to the north, did not yet exist. Within the farmhouse, it is difficult to move freely when there are more than about twenty people. Wide staircases are placed in the center of the main room, significantly reducing the space available for artistic performances.

In summary : The inadequate accessibility to the site and the farmhouse is a crucial factor in its current lack of attractiveness. It is not very inviting: there is no direct path to the farmhouse from the north, and people with disabilities must go around the entire site. The farmhouse is at a considerable visual distance from the main street and at a lower level, making it less visible and accessible. Its orientation turns its back to the main street, and its internal layout does not support adequate activities throughout the year. The poor orientation and limited accessibility of the site and farmhouse relative to the surrounding urban fabric are significant obstacles. The farmhouse's location in a basin makes it difficult to access and less visible from main traffic areas. Additionally, the lack of ramps to the north and the need for people with disabilities to circumvent the site limits accessibility. Despite having vast green spaces and being surrounded by nature, the site suffers from insufficient connection with modern urban infrastructure such as tram lines, university establishments, and shopping centers, which are located to the north and were not present during the developments of the 1990s. This makes the farmhouse less attractive and less frequented, despite its potential to host various cultural and leisure activities.



< *Fig 053/ Accessiblity analysis of the site*



Pedestrian access path

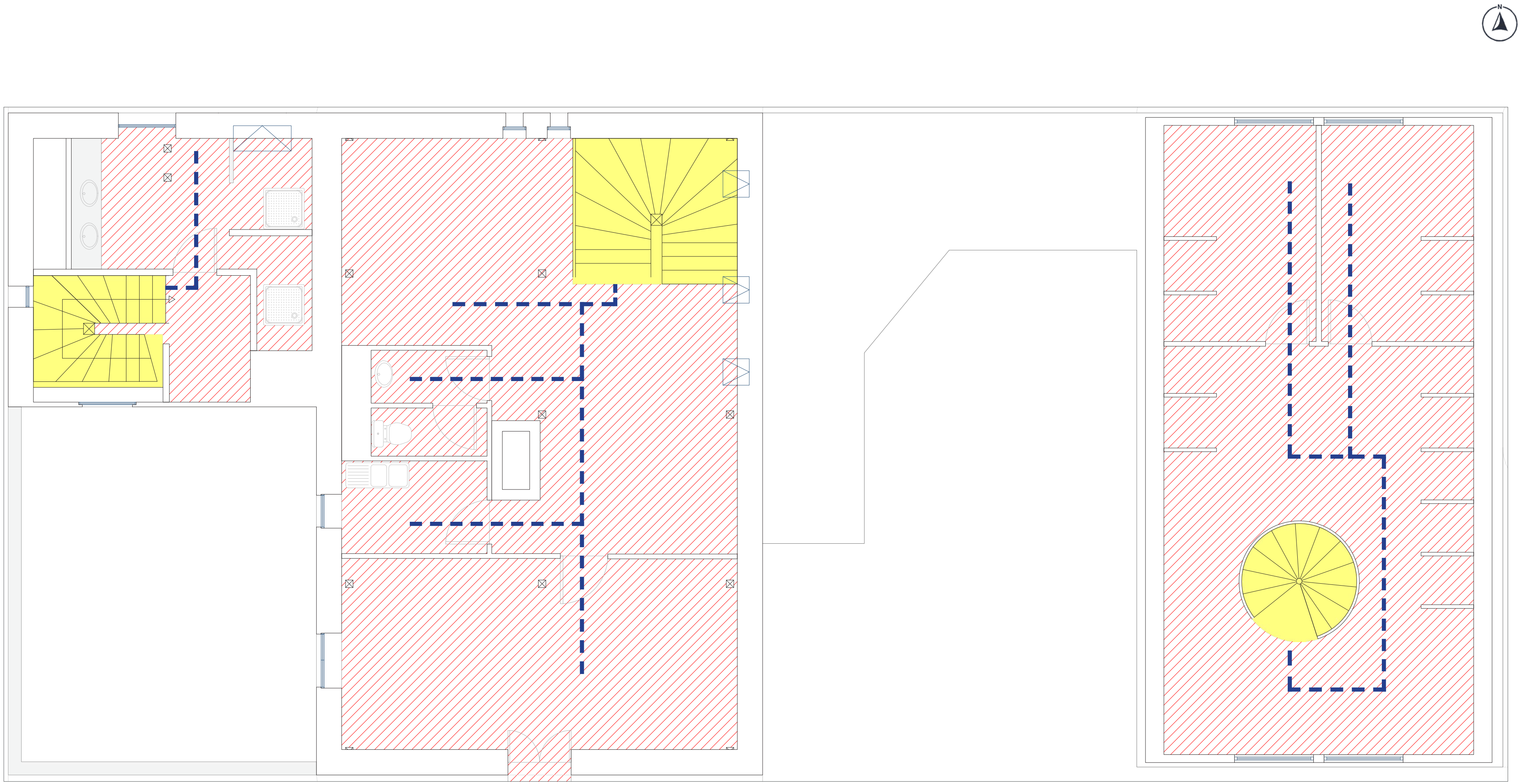
Accessible spaces for people with disabilities

Vertical distribution

Pedestrian access ramps

Non-accessible spaces for people with disabilities

Fig 054/ Accessiblity analysis of the farmhouse (ground floor)



Pedestrian access path	Accessible spaces for people with disabilities
Vertical distribution	Pedestrian access ramps
Non-accessible spaces for people with disabilities	

Fig 055/ Accessiblity analysis of the farmhouse (elevated floor)


Fig 056/ Tree loss within the site, 2008
(View of the site from north)


Fig 057/ Tree loss within the site, 2015
(View of the site from north)


Fig 058/ Tree loss within the site, 2022
(View of the site from north)

1.14. Risk identification for the site

Geological risks : The soil is constitued by a superficial layer of brown silt and a layer with some aliotic brown-green clay, then a layer of coarse tuffeau sand and a deeper layer of white chalk and lacustrine limestone. The soil is said to be unpolluted, with few risk of earthquakes or other sismic activities.

Flooding and humidity risks : The site has been subjected to heavy flooding, however, thanks to the infilling of the entire district, there is only a very minor risk of the Cher flood reaching the building. If this were to happen, the site would be considerably damaged, as it has not been filled in (and therefore remains in a basin). Also, heavy rain can also lead to a flooding of the site, however, as the soil is permeable, the rain is rapidly absorbed. It is therefore important to be careful not to waterproof the site too much. Given that Tours is a fairly humid city due to the proximity with the rivers, the humidity risk and froze cycle are to be considered.

Fire risks : The building has already been subject to a fire that damaged the main building. The possibility of a new one should be considered. The other parts of the site weren't damaged and the risk of a fire propagation on the filed remain low as trees and the farmhouse are meters away from each other.

Light at nightime : There is light within the site only when the building is used, otherwise, it is due to the street lamps surrounding the site. When the building is occupied at night, the light escapes from the few windows, the glasshouse and some lights outside. The lack of light at night creates an atmosphere of mistrust.

Shades at daytime : Due to the distance of the neighbouring buildings, there is almost no shades in the site. But as the site is below the level of the district, there are projected shadow during winter, or sunset and sunrise.

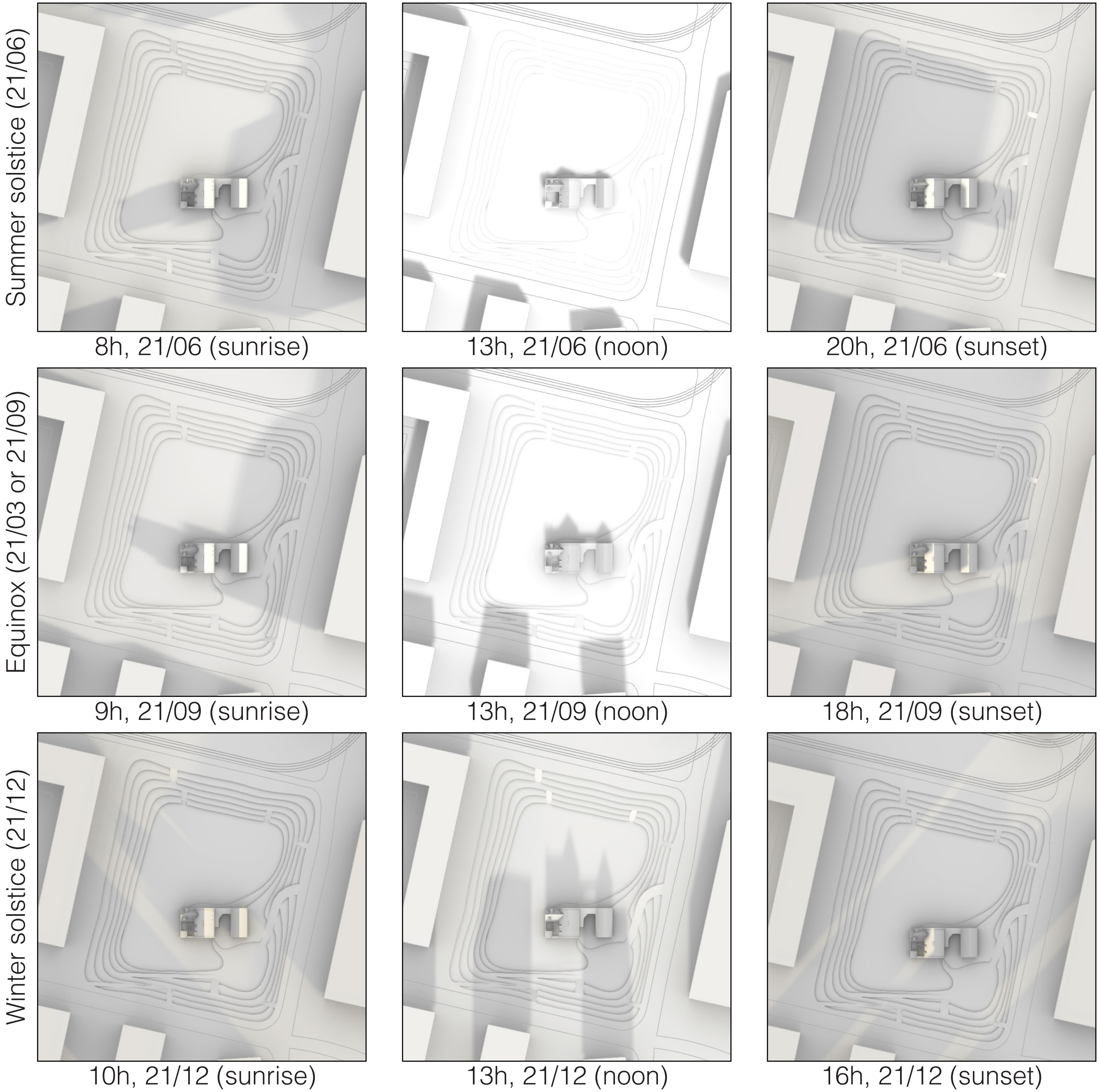


Fig 059/ Modelised views of the projected shadow on site

Fig 060/ View of the site from north at night (photo date : 17/12/2022)

Fig 061/ View of the site from south at night (photo date : 17/12/2022)


10 Nerium oleander


5 Prunus lusitanica


5 Arbutus unedo


14 Olea europaea


1 Ficus carica


Sonneur à ventre jaune


Azuré de la sanguisorbe


Tarier des prés

Fig 062/ Examples of site flora and fauna to preserve

Safety and security : From the district, it's actually possible to enter the site without passing through the stairs as the slopes are not that inclined, but it may be dangerous if the grass is wet. Also, even by taking the staircase made in bricks, it can get very slippery especially since there are no handrail along the stairs. As it was notice in the previous chapter, the setback of the house from the urban fabric and the absence of light at nigth could lead to bad behavior. Criminality is not really a problem in Tours, and all the more in the district of the Deux-Lions, but misbehaviours that can endeager people themselves or the farmhouse should be considered.

Anthropogenic impact : The roads surrounding the site are not that used given that there are not the principal axis of mobility. Atmospheric pollution is although not the main concern here. The presence of trees and the recess of the land from the level of the neighbourhood give the sensation to have fresh air and to enter a little garden. It also prevent the noise from entering and promute the presence of birds. Even though there is no much cars, the passage of the tramway actually make some noise in the North part of the site that can be really disturbing when people want to relax on site.

Lack of maintenance : Despite the few users of the place, we can find some pieces of glass or cigarette ends in the site. Although, the site is poorly maintained (dry vegetation, dirty pavement with weeds, ...).

Preservation of natural features : The trees, the land and the other natural features are the most important to protect. The wish of the city and yet the district is to preserved this aspect that constituted "le poumon vert du quartier" (the district's green lung). However, we can notice the loss of a lot of trees and vegetation over the years. In order to preserve the flora and fauna of the site, and considering that some species protected in France may nest on the site and that some tree species have been recently replaced (in 2016), it is important to take into account a minimization of the antropomorphic impact on the site.

1.15. Energy performance of the farmhouse

Sun hour : The opposite illustration represents the direct sun hours on the farmhouse (which means the amount of hour when the sun directly shine on the building) during three differents days (equinox and the two solstices of summer and winter) and considering the surrounding buildings. As a reminder, during the summer solstice (21/06) there are 16 hours of sun, at the equinox (21/09 and 21/03) there are 12 hours of sun, and during the winter solstice (21/12) there are 8 hours of sun.

As the farmhouse is exposed very parralel to the axis North-South, the roofs are enlighted equally during each period of the year (from 5 hours in winter to 10 hours in summer). However, the distribution of natural light between the northen facade and the sourthen one is very uneven. The study shows the north facade is barely directly enlightened by the sun, it's quasi only enlightened by diffusive radiation. The neighbouring buildings also shadows this facade with their projected shadows, especially during sunset and sunrise. The South facade is moslty directly enlightened by the sun all the time, and barely hides from surrounding buildings, even in winter when it catch 6 hours of the 8 hours direct sunshines.

Irradiance : The irradiance (that means the solar energy potential, direct and diffusive) is very unbalanced between the two facade. On the north facade, it remains quite low everytime on the year (below 100kWh/mq). On the south facade, it remains fairly high (around 200kWh/mq). However the irradiance on the roofs goes to 40kWh/mq in winter to 400kWh/mq in summer. Cumulated over the year, the annual irradiance on the roof reach 90kWh/mq monthly (oriented East) and 60kWh/mq monthly (oriented West).

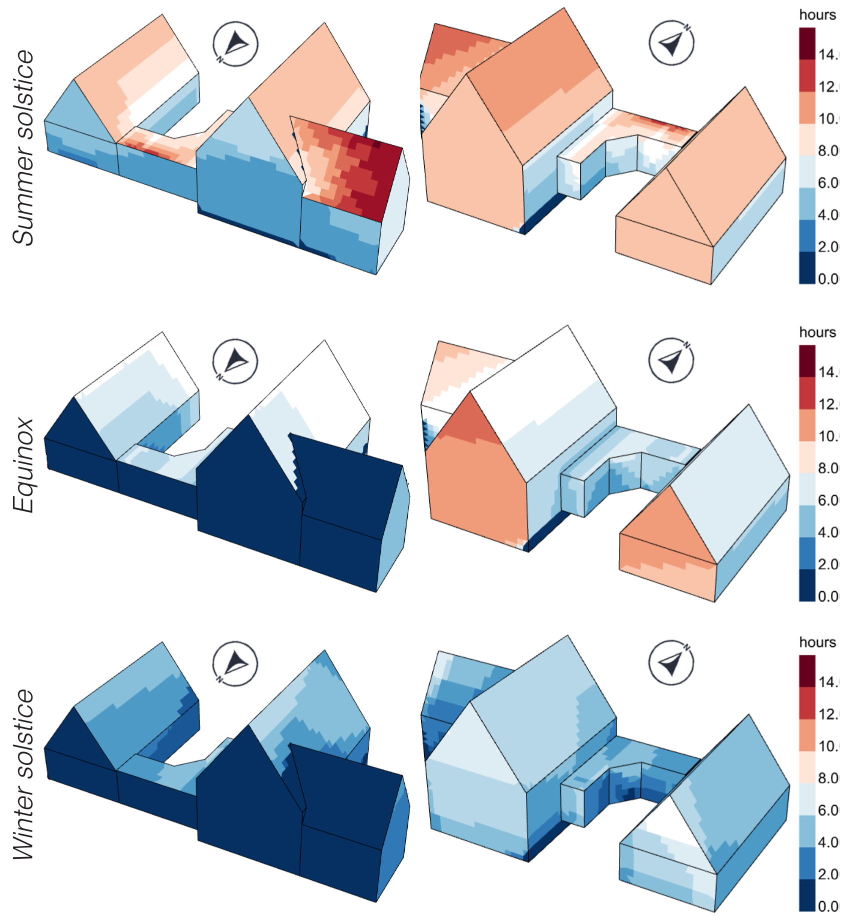


Fig 063/ Farmhouse's direct sun hour

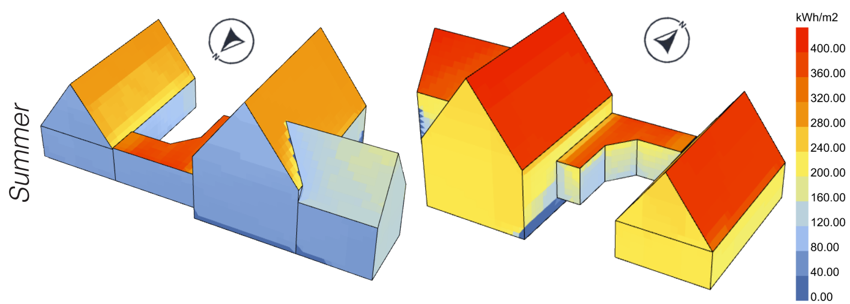


Fig 064/ Farmhouse's irradiance in summer

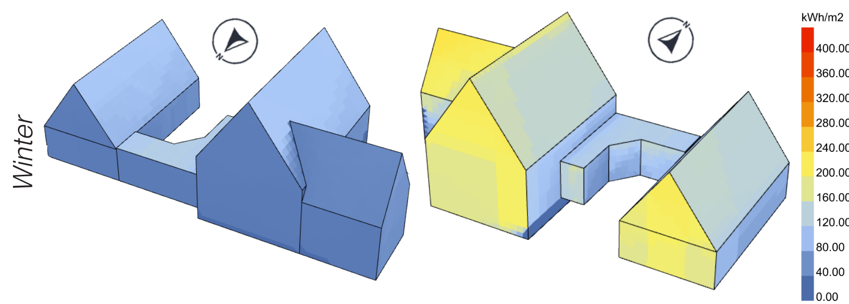


Fig 065/ Farmhouse's irradiance in winter

Illuminance : Considering the reference of a need of L_{min} = 120lux minimum everywhere (corresponding of normative framework in French and European legislation for simple tasks), illuminance studies has been made on the software Rhino7 and Grasshopper to simulate the behaviour of the illuminance inside the farmhouse between 8am and 7pm during a year (during the office hour a whole year).

The north part of the Building A (the main one) is unfailry distributed because of the orientation of the building. Whether on the ground floor or on the elevated floor, there is not enough light to enters in the building to illuminate the north part. The elevated floor of building B (the right one) is unevenly distributed. The lack of windows along the east and west facade doesn't enable a homogeneous distribution. Building C (the left one) is fairly distributed. As a result, a lack of light entering the farmhouse can be noticed, espacially at north. The project will therefore have to include a programme to open the farmhouse up to the outside to let the light in.

Glare : The glare happens only in the East building (Building B) nearby the glasshouse, but also at the elevated floor next to the windows at south. The maximum standard for μ_{max} is 0.4 cd/m^2. The glare increases during summer and decreases during winter. The inhomogeneous of the illuminance due to the presence of a glazed façade next to a farmhouse with few windows aperture leads to an uncomfortable lighting leading to glare. During the project, it should not be forgotten the implementation of sun protection.

Glazed performance : Thanks to the intervention on site, it has been possible to know the geometry of the farmhouse. It has been determine that in most rooms, the glazed area S_v is less than 15%, which is actually the recommended minimum standard. Thus, the farmhouse suffers from a lack of openings while the view on the site greenery could be marvelous.

Thermal performance : Combined with a technical survey, it has also been possible to determine the equivalent thermal conductance factor Ueq for each rooms of the farmhouse. For the rooms of the original part, the factor are all less than 0.33, which is the maximum standard for U_{eq}. A high factor can be observed for the glasshouse and the elevated floor of Building B due to the omnipresence of glass facade.

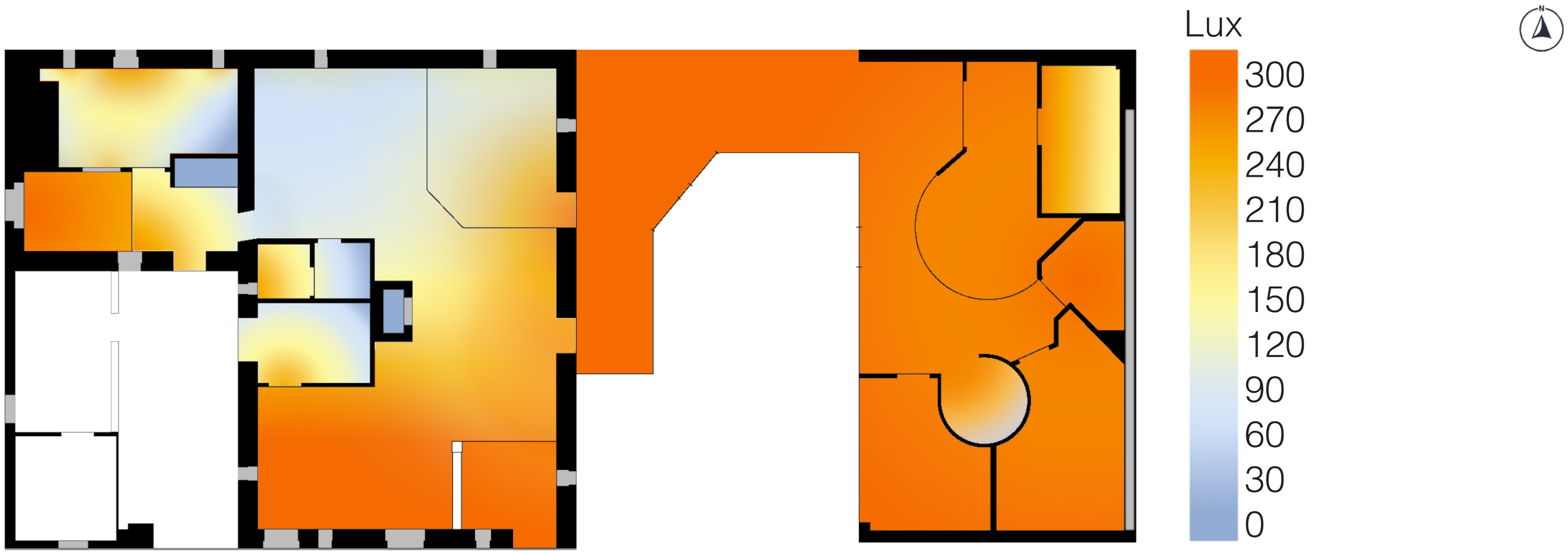


Fig 066/ Farmhouse's annual illuminance (ground floor)

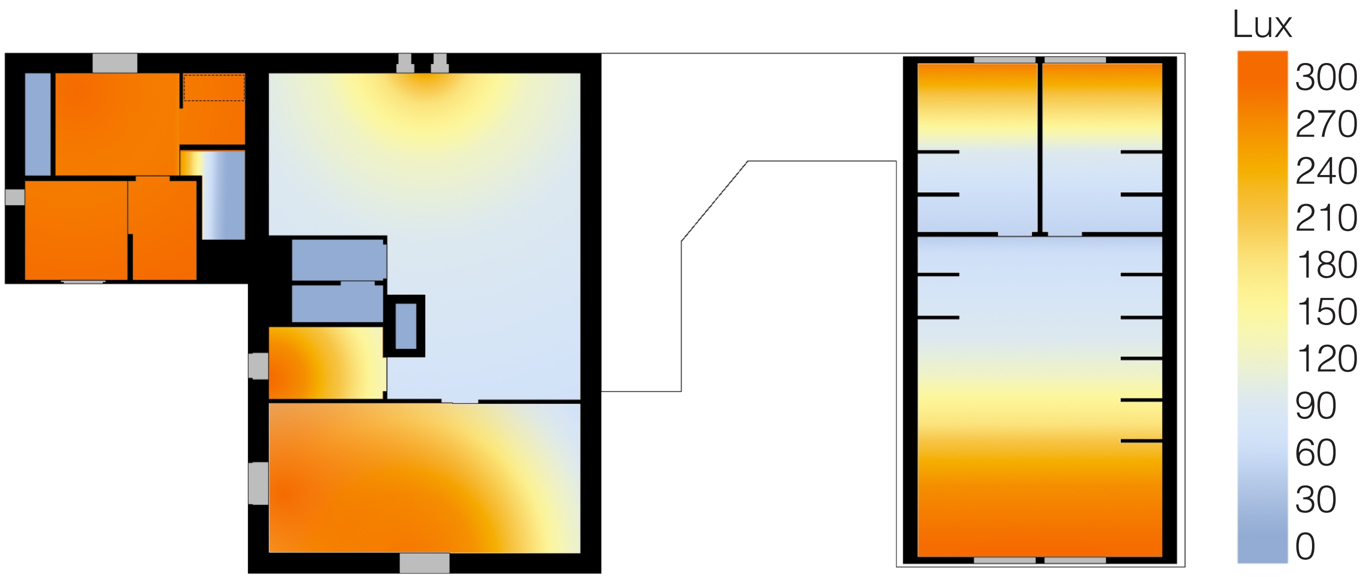


Fig 067/ Farmhouse's annual illuminance (elevated floor)

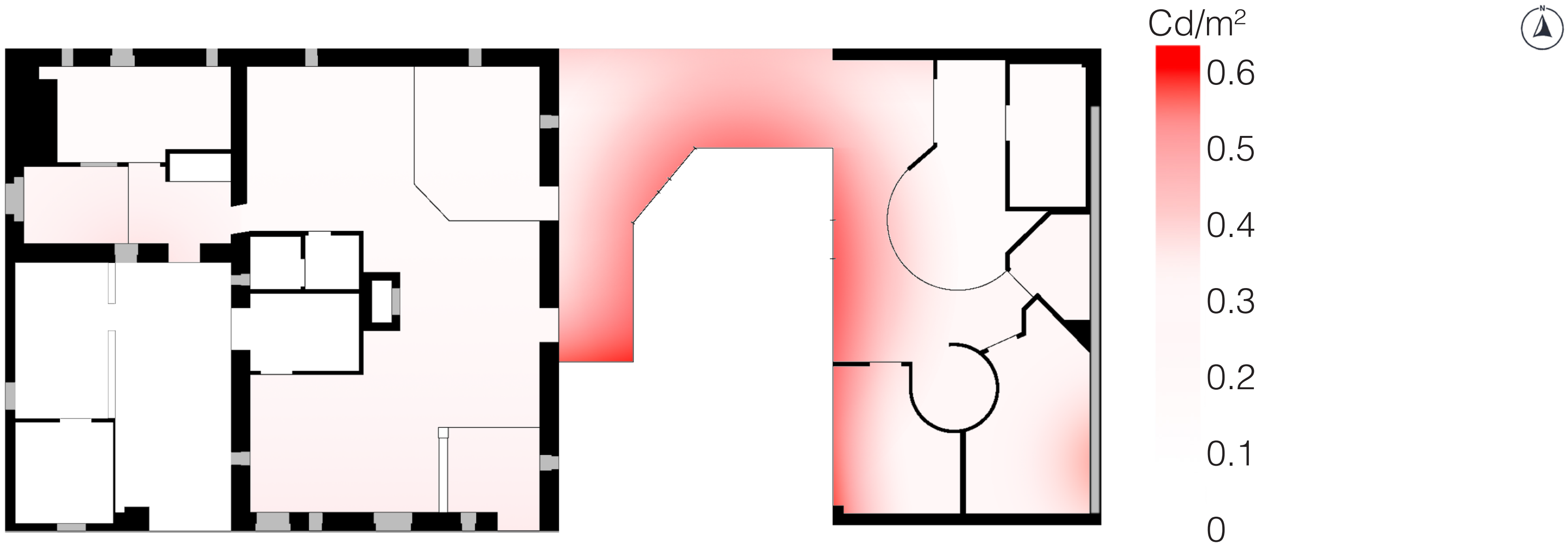


Fig 068/ Farmhouse's annual glare (ground floor)

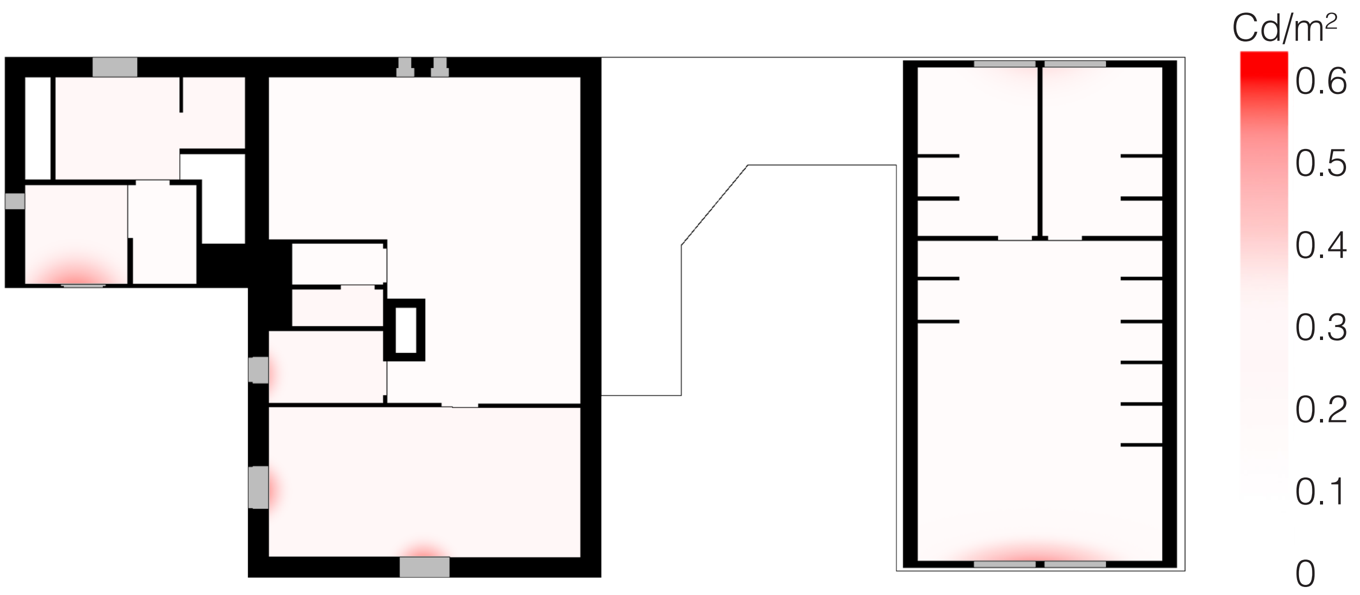


Fig 069/ Farmhouse's annual glare (elevated floor)

GROUND FLOOR, BUILDING C

U_{eq} = 0.25 W/m².K
S_v = 4 %
L_{min} = 150 lux
μ_{max} = 0.2 cd/m²

GROUND FLOOR, BUILDING A

U_{eq} = 0.27 W/m².K
S_v = 8 %
L_{min} = 30 lux
μ_{max} = 0.2 cd/m²

GROUND FLOOR, VETRATA

U_{eq} = 0.56 W/m².K
S_v = 39 %
L_{min} > 300 lux
μ_{max} = 0.6 cd/m²

GROUND FLOOR, BUILDING B

U_{eq} = 0.39 W/m².K
S_v = 44%
L_{min} > 300 lux
μ_{max} = 0.6 cd/m²

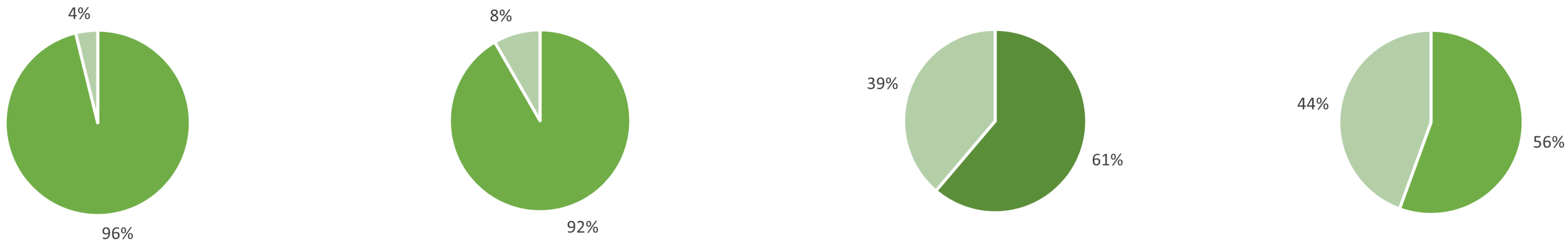


Fig 070/ Farmhouse's thermal performance (ground floor)

ELEVATED FLOOR, BUILDING C

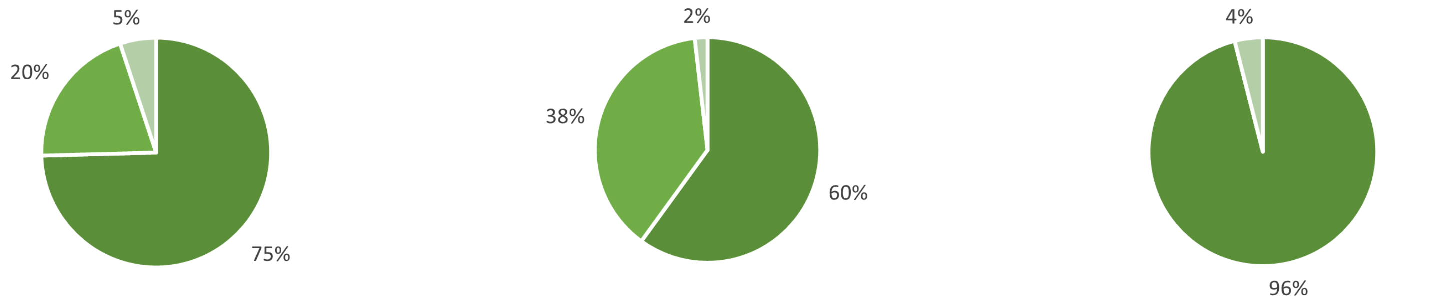
U_{eq} = 0.27 W/m².K
(standard S_v non applicabile)
L_{min} > 300 lux
μ_{max} = 0.3 cd/m²

ELEVATED FLOOR, BUILDING A

U_{eq} = 0.25 W/m².K
S_v = 2 %
L_{min} = 60 lux
μ_{max} = 0.3 cd/m²

ELEVATED FLOOR, BUILDING B

U_{eq} = 0.37 W/m².K
S_v = 4 %
L_{min} = 90 lux
μ_{max} = 0.3 cd/m²



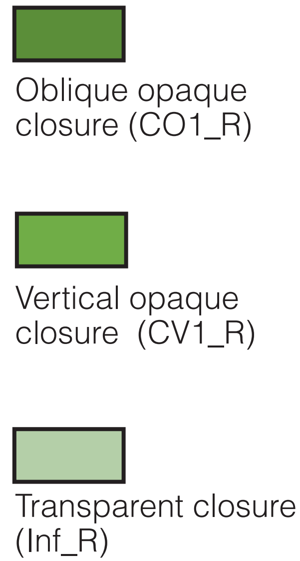


Fig 071/ Farmhouse's thermal performance (elevated floor)

1.16. Review of the district's needs and the site's potential

The district under consideration is a multifaceted urban enclave that boasts a harmonious blend of urban vibrancy, and natural surroundings. Even if the district is on the edge of the city center it can act as a competitive area by offering its own dynamic urban areas. It is strategically designed to be easily reachable, ensuring seamless connectivity for residents, neighbors and visitors alike. In its pursuit of being self-sufficient, this district functions as a micro-city, housing various amenities and services within its boundaries. This approach not only fosters a sense of community but also reduces the need for extensive travel to the city center.

However, while this district thrives in many aspects, it also faces some challenges. The absence of dedicated cultural public facilities might limit residents' access to artistic and intellectual experiences, highlighting the need for thoughtful urban planning to address this gap. Furthermore, the lack of an outdoor meeting space within the district can impact community interaction and cohesion. Outdoor spaces play a crucial role in fostering social interactions, community events, and a sense of belonging. The district's urban planning should consider the incorporation of open meeting spaces to encourage social engagement and gatherings.

Besides, nestled in the heart of this district, The Grange Collière site stands as a testament to the coexistence of urban dynamism and serene natural beauty. This verdant oasis is distinguished by its lush greenery, centrally located position, and remarkable ability to transport to a tranquil realm without living the vibrancy of the surrounding urban environment. It has the remarkable capacity to create an illusion of being far removed from the urban environment, allowing to immerse oneself in the tranquility of their surroundings. Its centrality within the district ensures that it remains easily accessible to residents, dwellers, neighbors, and visitors, making it an ideal meeting point for a diverse array of people.

The presence of a solitary historic edifice within this exceptional green space also establishes a connection to the district's past. The historical structure's age, coupled with its construction using traditional local methods and materials, enhances the feeling of authenticity and a deep bond with the district's origins.

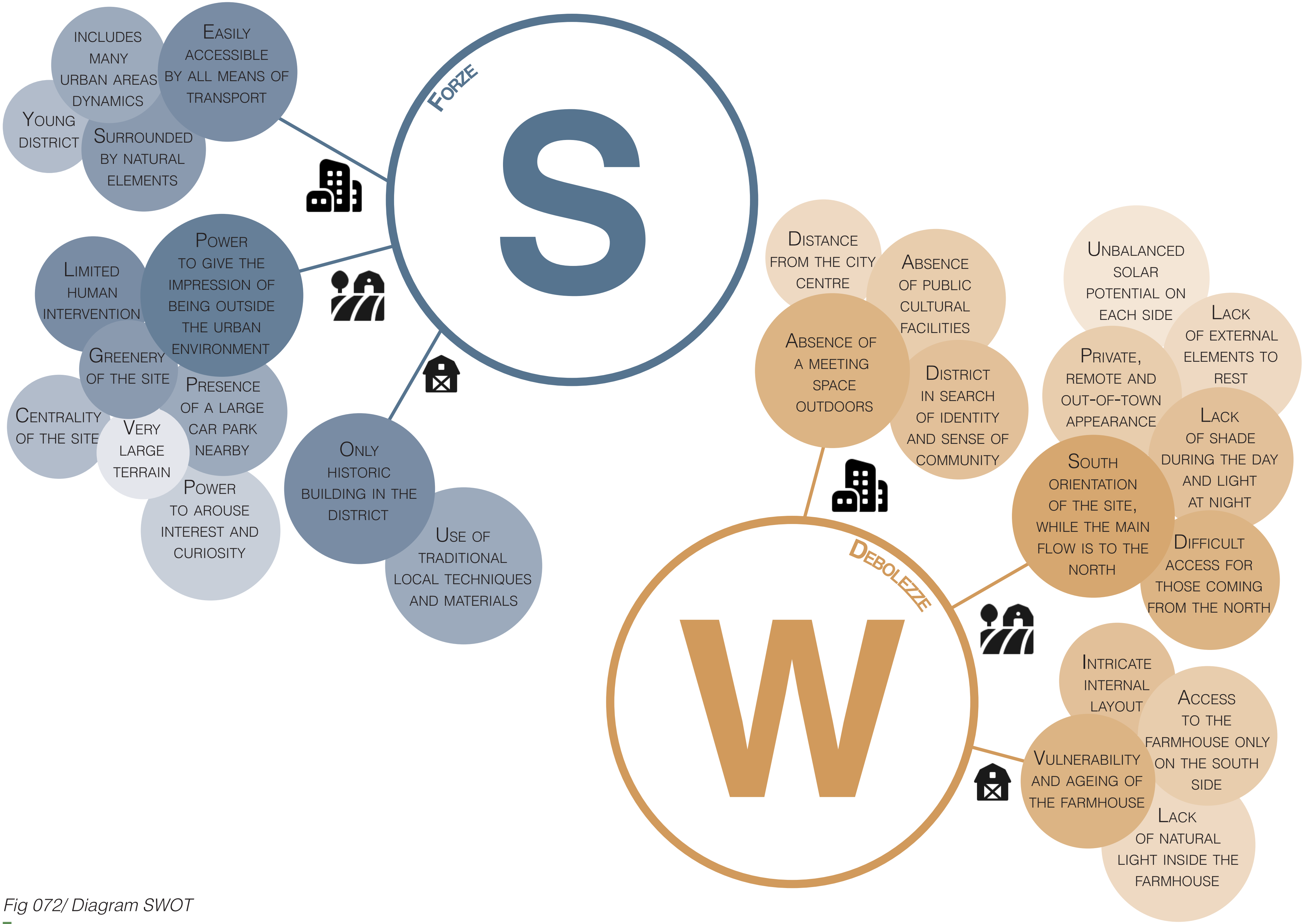


Fig 072/ Diagram SWOT

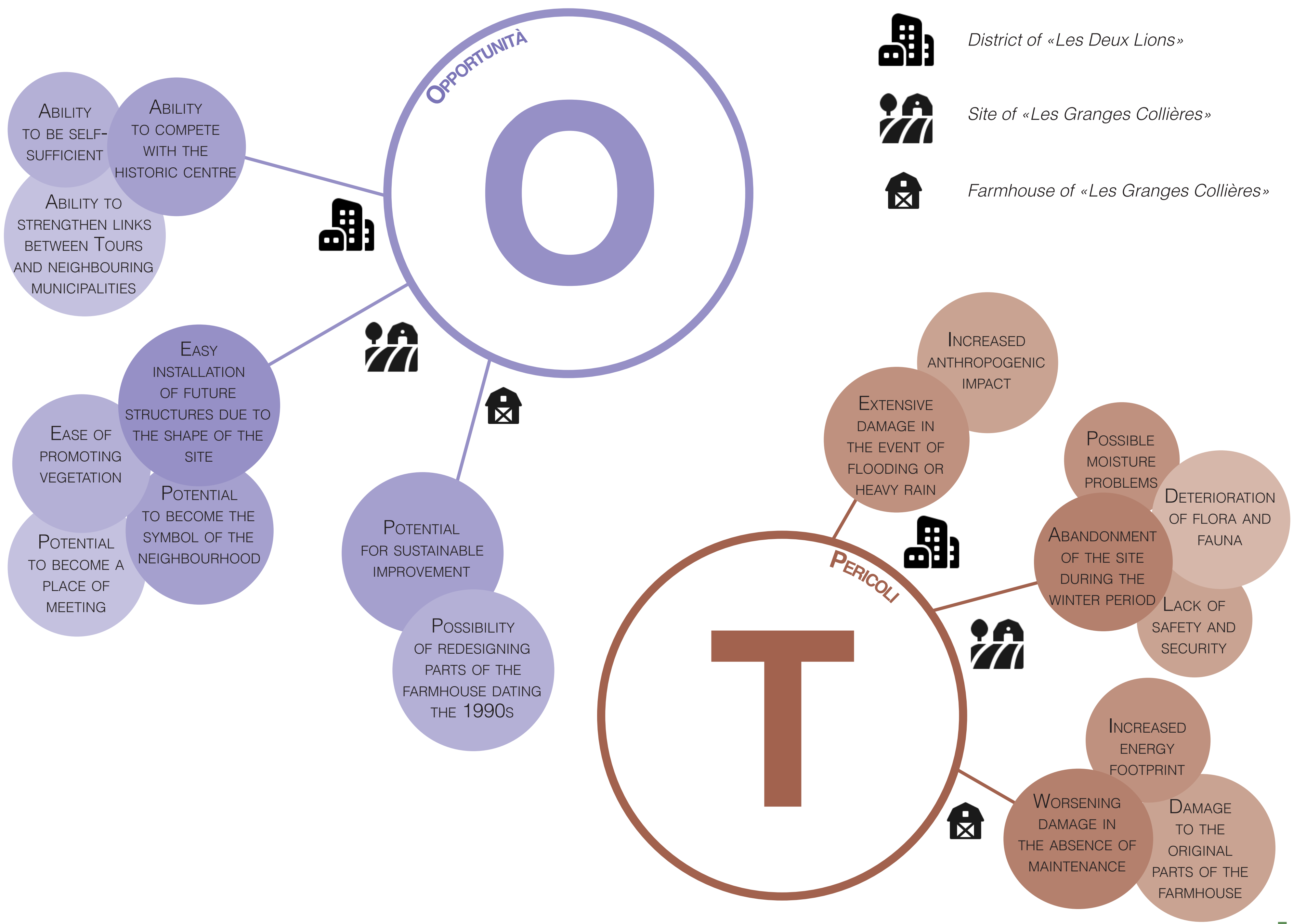

District of «Les Deux Lions»
Site of «Les Granges Collières»
Farmhouse of «Les Granges Collières»
Opportunità
O
Ability to be self-sufficient
Ability to compete with the historic centre
Ability to strengthen links between Tours and neighbouring municipalities
Easy installation of future structures due to the shape of the site
Ease of promoting vegetation
Potential to become the symbol of the neighbourhood
Potential to become a place of meeting
Potential for sustainable improvement
Possibility of redesigning parts of the farmhouse dating the 1990s
Pericoli
T
Increased anthropogenic impact
Extensive damage in the event of flooding or heavy rain
Possible moisture problems
Deterioration of flora and fauna
Abandonment of the site during the winter period
Lack of safety and security
Increased energy footprint
Worsening damage in the absence of maintenance
Damage to the original parts of the farmhouse


Fig 073/ Parc de la Villette as a serene area (Paris, France)
Example of an exhaustive cultural green space


Fig 074/ Parc de la Villette as a relaxing area (Paris, France)
Example of an exhaustive cultural green space


Fig 075/ Parc de la Villette as a collective area (Paris, France)
Example of an exhaustive cultural green space

CULTURAL GREEN SPACES AS A KEY TO VITALITY

1.17. How to define a cultural green spaces ?

A «cultural green space» can be define as outdoor public or semi-public area, that combines elements of nature and cultural activities. These spaces are designed to provide a harmonious environment for gatherings, where artistic, and recreational activities can take place while surrounded by greenery. The following references are described in depth in the Study Case (SC) in the appendice.

Cultural green spaces embody in a way the respite that city-dwellers seek amidst the clamor of modern life as they provide an urban oasis in the city. The Jardin des Vestiges in Marseille and Jardin des Vikings in Tours encapsulate this notion, with their expansive landscapes providing havens of tranquility. They are entrenched in historical remnants, creating a sanctuary that transports visitors to an age of antiquity, distanced from the urban turmoil. However a cultural green space is not equal to loneliness and isolation, as they attract the city-dwellers they start becoming less dilated. They keep of course the advantage of being relaxing but in a more lively way due to how people frequent this area. Bryant Park in New York City and Midtown Park in Houston exemplify how cultural green spaces redefine relaxation. While Bryant Park embraces a sense of spaciousness amidst urban architecture, it unfurls an ambiance of leisure where visitors find solace in the midst of bustling city life. Midtown Park, on the other hand, navigates the fine balance between tranquility and vibrancy. This duality is a testament to the versatility of cultural green spaces in fostering relaxation, whether in solitary introspection or amidst the hum of social interactions.

Moreover, as cultural hubs, cultural green spaces foster an environment of collective engagement and shared experiences. The Yards in Washington and Buckingham Reserve in Melbourne serve as expansive canvases for communal interactions. Their layout encourages social gatherings and active participation, generating a sense of unity and shared identity. These area remains spacious but they tend to welcome more bustling and dynamic activities. As a resut, Place Émilie-Gamelin in Montreal and Kunsthal in Rotterdam amplify this collective essence by being much denser place thanks to artistic and well-prepared outdoor performances. These spaces become stages where communities converge, celebrating cultural diversity and fostering social connections.

Transitioning to the realm of outdoor exhibition, the Cryptoportique in Reims and Campo della Marta in Cittadella epitomize the captivating potential of cultural green spaces. By hosting artistic performances within historic architectures, these spaces evoke emotions that resonate deeply. Therefore, these areas, even if they are dense and crowded, provide a very calm atmosphere as the visitors are speechless in front of the artistic performance and the charming view of historicity. Conversely, the Museum of Modern Art in Arnhem and Musée des Beaux-Arts in Tours beckon visitors to contemplate curated displays amidst serene surroundings. This fusion of art and nature stirs inspiration, illustrating how cultural green spaces serve as platforms for intellectual and emotional engagement.

But then, it seems that cultural green spaces can have opposite features such as being sometimes dense sometimes spacious, and also sometimes peaceful sometimes lively. Intriguingly, some areas manifest a harmonious convergence of these diverse features. These spaces serve as living testaments to the fusion of an urban oasis, a cultural hub, and outdoor exhibition. Parc de la Villette, with its innovative architecture and vast landscapes, stands as a quintessential embodiment of this fusion. It harmonizes relaxation, communal gathering, and artistic expression. Cultuurpark Westergasfabriek in Amsterdam embodies this equilibrium by juxtaposing industrial heritage with contemporary culture. Its seamless transition from tranquil reprieve to vibrant social space underscores its multifaceted nature. Similarly, being a arboretum, Biblioteca degli Alberi in Milan integrates greenery and displays with interactive spaces, encapsulating the essence of cultural green spaces as a holistic urban experience.

In summation, cultural green spaces transcend conventional notions of spaces by cultivating a nuanced interplay of diverse elements. They resonate as urban oases that offer solace, cultural hubs that foster collective engagement, and outdoor exhibition that foster artistic contemplation. The references underscore that role in enriching urban life by offering setting that can be serene, relaxing, collective, festive, captivating or inspiring.

It should also be noted that (cultural) green spaces do not have the particularity to be spaces where people pass through (unlike parks). Green spaces are spaces of destination rather than flow. Parks encourage movement through the multiplicity of paths, whereas (cultural) green spaces tend to offer a central, flat, cleared space where people are welcome to sit down.

NB : Please refers to Study Case (SC) in the appendice

Fig 076/ Parc de la Villette as a festive area (Paris, France)
Example of an exhaustive cultural green space

Fig 077/ Parc de la Villette as a captivating area (Paris, France)
Example of an exhaustive cultural green space

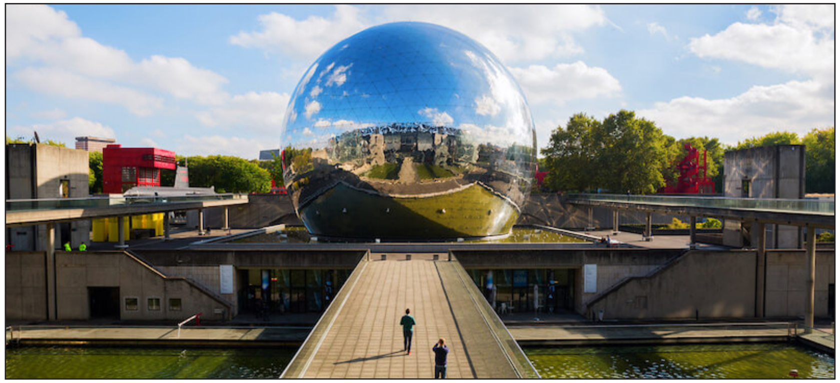


Fig 078/ Parc de la Villette as a inspiring area (Paris, France)
Example of an exhaustive cultural green space

Key words

Cultural green spaces serve as dynamic cultural sanctuaries, seamlessly blending nature’s serenity with communal engagement and artistic expression. It would be fair to describe it thank to the three following words: Urban Oasis, Cultural Hub, Outdoor Exhibition. As visitors navigate these spaces characterize by diverse atmospheres (serene, relaxing, collective, festive, captivating, inspiring), they embraces both stillness and movement, spontaneous and planned activities, fostering an experience that resonates with both the individual and collective spirit.

Urban Oasis

Serene

Relaxing

«Urban Oasis» signifies a peaceful and untouched natural setting that stands in stark contrast to the bustling urban surroundings. It can be characterize by the word «serene» that captures the essence of a tranquil and undisturbed atmosphere, but also by the word «relaxing» embodies a stress-free area that promotes leisure and unwinding. An urban oasis can also be «inspiring».

Cultural Hub

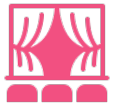
Collective

Festive

«Cultural Hub» embodies the notion of fostering a sense of community and social interaction within these spaces. A cultural hub goes from being «collective», meaning its capacity to allure people and make interact with each other, to being «festive» when the space around densify to gather wit each other both active and passive participants. A cultural hub can also be «relaxing».

Outdoor Exhibition

Captivating



Inspiring

«Outdoor Exhibition» encompass a spectrum of artistic showcases and performances held in open areas. While «captivating» accentuates the capacity to mesmerize emotions by spechless performance, «inspiring» alludes to an environment that nurtures contemplation, ignites imaginative thinking and encourage slow movement. An outdoor exhibition can also be «festive».

Cultural Center

The «Cultural Center», however, stands in opposition to the urban oasis, while at the same time embracing the captivating and festive character of the cultural green space. It can be seen as the reason that leads «green spaces» to become «cultural». It ensure the orderly progress of any exhibitions (both indoor and outdoor) thanks to its capacity to welcome organizer and artist, and welcomes some activities that can’t be done outside.

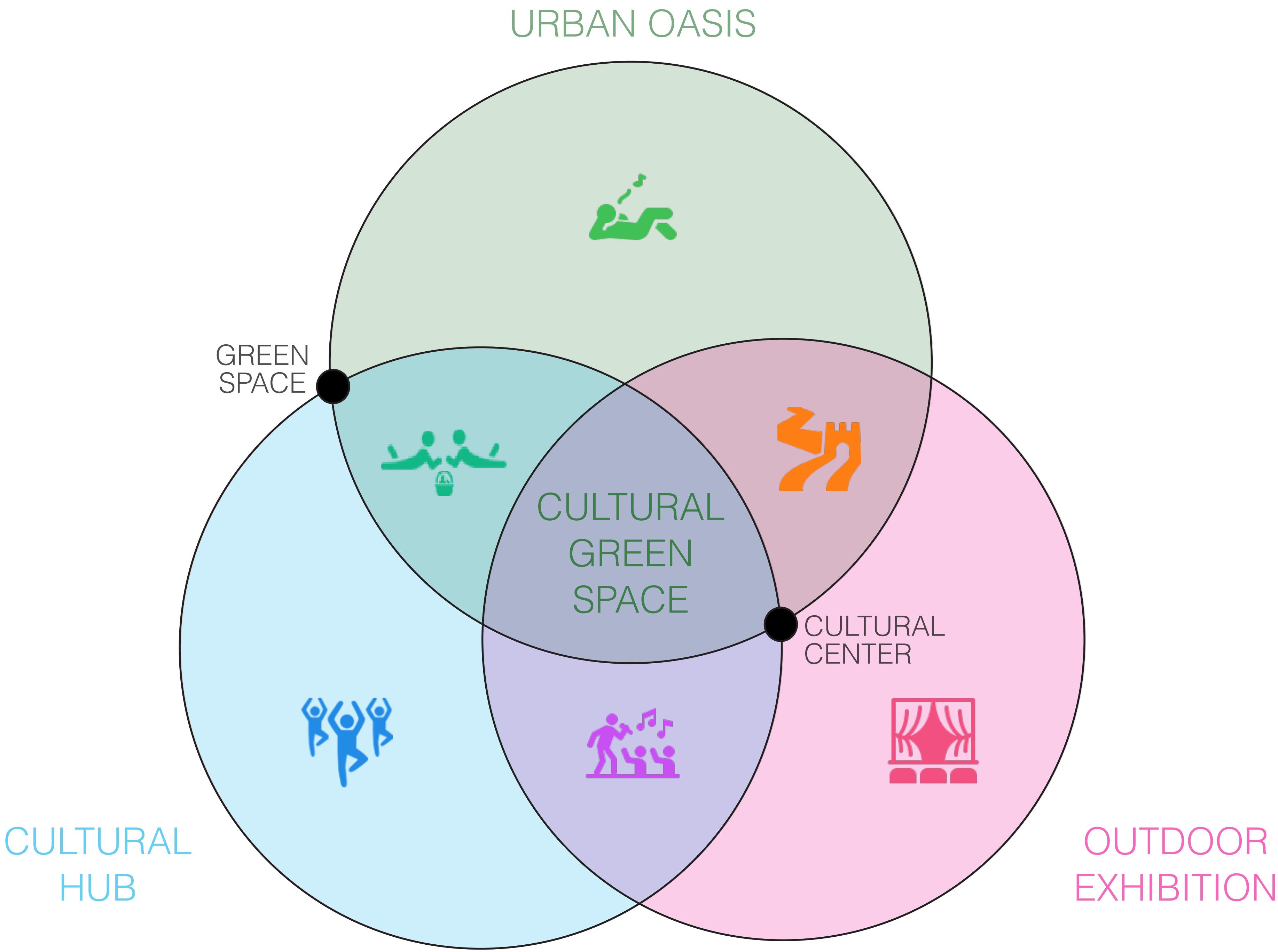


Fig 079/ Concept map of a cultural green space

1.18. Cultural green spaces' outdoor and indoor activities

Cultural green spaces offer a diversity of outdoor activities through the different atmospheres it creates. In essence, cultural green spaces serve as versatile canvases that cater to a myriad of activities, each thriving within a specific context. The environment, density, spaciousness, movement, and planning all contribute to shaping the diverse range of engagements that these spaces can offer. From serene reflections to festive celebrations, these spaces embody the essence of artistic contemplation and both communal and individual engagement with the environment.

Serene : In areas that emphasize serenity, facilities such as shaded seating under trees or pergolas, along with pathways leading to secluded spots, facilitate activities like napping, reading, and leisurely strolls. The design prioritizes spacious layouts, inviting introspection and offering an unhurried escape. Benches and reading nooks provide comfort, enabling spontaneous moments of serenity. In a space with this kind of ambience, the emphasis is on individual privacy and a calm atmosphere.

Relaxing : An area tending to be more relaxing aims at encouraging casual social interactions while retaining an intimate feel for each group of people. Picnic tables and shaded areas accommodate activities like chatting in the grass, meeting friends, and picnicking. Well-maintained lawns and seating clusters support both planned gatherings and impromptu interactions. The ambiance fosters a leisurely pace, encouraging relaxation and connection.

Collective : Where the area offers a more collective dynamic, open expanses facilitate outdoor personal development activities, while designated play areas and interactive facilities encourage outdoor sports and school events. Clear zones ensure an efficient distribution of space, encouraging group interaction and shared experiences. The movement is more dynamic, but retains a airy atmosphere.

Festive : Festive areas come alive with well-prepared installations that encourage celebration. Designated stages, open spaces for vendors, and communal tables accommodate activities like outdoor fairs, voluntary work, crafts, discovery pursuits, and festivals. Well-marked pathways guide visitors through dynamic movements, creating a balance between planned events and spontaneous exploration. The atmosphere in this kind of areas is vibrant and dense and the movement is continuous and very concentrated.

Captivating : Areas that want to captivate visitors require immersive installations. A large patch of grass and a well-placed screen enhance open-air cinemas, while amphitheater-style seating and an elevated or non-elevated stage facilitates engagement with artistic performances. Specialized facilities such as stages and sound systems create an environment for captivating displays. Other cultural activities planned in advance, like reading sessions or environmental awareness session, are also made to captivate the audience, needind less material of course. In this areas, the movement is quite static, and the gaze is focus on one point.

Inspiring : Inspiring areas tend to blend art, history, and nature. Outdoor art displays are well-lit and feature guided pathways, while historical ruins are preserved and augmented with informative signage. Meticulously curated botanical gardens and arboretums provide also educational signage and rest areas, striking a balance between exploration and inspiration. These kind of installation demands organisation in advance but do not depend of a schedule (unlike outdoor performance). The fairy promenade is lead by a slow movement, increasing the contemplation feeling.

Cultural center (indoor activities) : Outdoor artistic performances, festivals, and displays naturally thrive in cultural green spaces due to the synergy between their atmospheres. However, practical considerations, the allure for visitors, and the desire to create optimal experiences often necessitate the construction of cultural centers. These centers facilitate indoor activities, providing shelter from weather fluctuations and ambient noise, ensuring performances can continue uninterrupted.

Within cultural centers, indoor art displays flourish, offering an ideal environment for meticulously curated exhibitions. These displays, often smaller than outdoor ones, showcase diverse artworks, including paintings, sculptures, and multimedia installations. Controlled lighting and climate conditions indoors ensure each piece is displayed as intended, allowing viewers to fully engage with the artist's vision. Ample wall space, pedestals, and interactive displays enhance visitor engagement and understanding of the artworks.

Workshops, conferences, and art lessons benefit significantly from the conducive learning atmosphere within cultural centers. Indoor settings provide comfortable seating, proper lighting, and necessary equipment, fostering focused learning and collaboration. The controlled environment allows organizers to manage schedules, facilitate interactions, and provide essential resources for a seamless learning experience. Technology such as projectors and presentation tools further enhance these activities, enabling comprehensive audience engagement.

Certain artistic performances benefit immensely from the controlled environment of indoor spaces. Factors like lighting, acoustics, and stage design can be meticulously curated to enhance the overall impact of a performance. Indoor settings allow for the use of specialized equipment like sound systems and projection screens, ensuring every aspect of the performance reaches the audience with precision and clarity. Cultural centers also offer a warm welcome to artists, providing dedicated spaces for them to engage with organizers and audiences through talks, sharing insights into their creative process and themes. Artists' well-being and focus are supported by private resting rooms, offering a quiet retreat where they can unwind and prepare for their performances. These facilities ensure that artists can perform at their best, contributing to the overall success of the event.

Outdoor activities requiring specialized equipment, props, or logistical coordination benefit from the meticulous planning enabled by cultural centers. These centers are equipped with administrative offices, open offices, and meeting rooms, facilitating organized group activities. Both indoor and outdoor performances necessitate an indoor space for planning and coordination, ensuring smooth execution of events.

Catering services during festivals or events highlight the interconnection of indoor and outdoor dynamics. Outdoor food stations or stalls complement festivities, allowing visitors to enjoy meals while engaging in the lively atmosphere. These facilities depend on built-up areas for transporting and storing food stocks. Similarly, storage for artistic materials like theater costumes, exhibit objects, or supplies is crucial for the smooth running of activities. Protected and accessible storage ensures that any event, exhibit, or show runs smoothly, enhancing the quality of the activity and minimizing potential disruptions.

In a nutshell : The integration of cultural centers within green spaces provides a harmonious balance between outdoor and indoor activities. These centers enhance the visitor experience by offering controlled environments for performances, displays, and logistical planning, ensuring that both artists and audiences enjoy a seamless and enriching cultural experience.

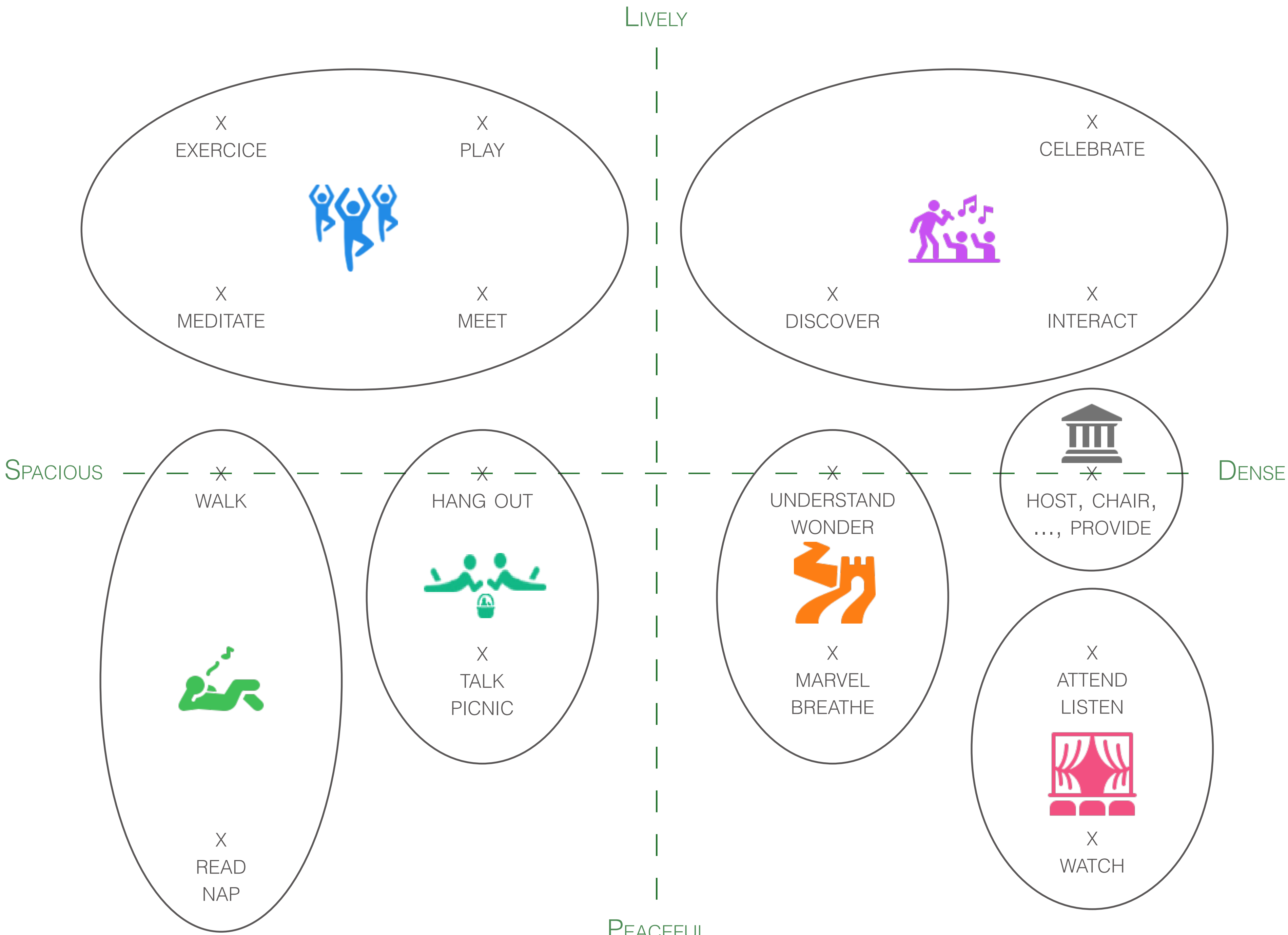


Fig 080/ Concept diagram of cultural green space's activities

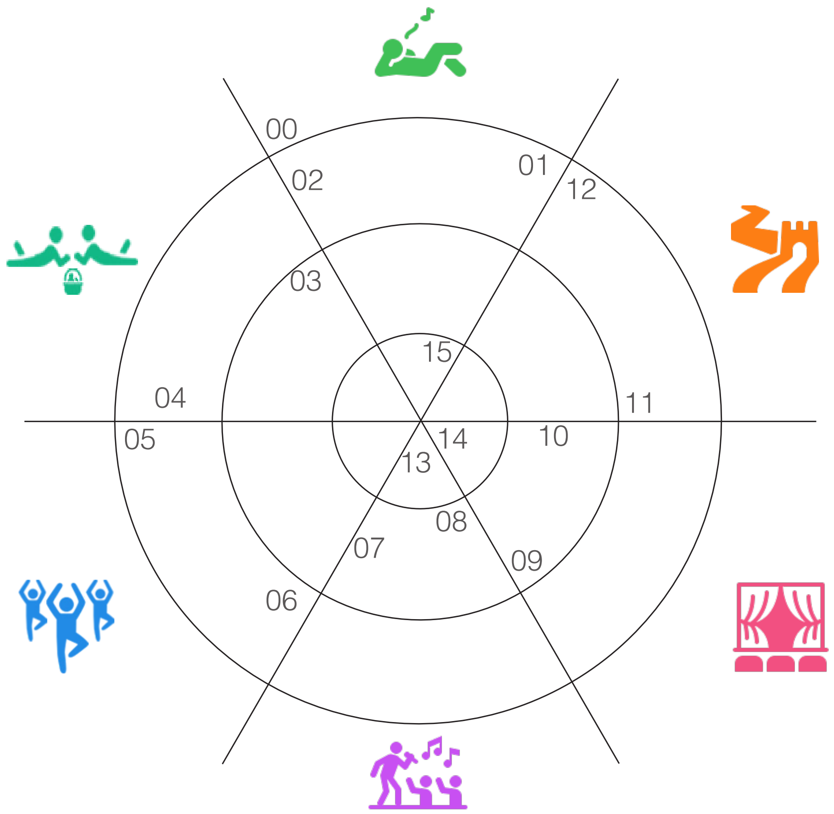


Fig 081/ Embodiment map as cultural green spaces

<u>How to read the diagram :</u>
The numbers represent the references (see appendices).
For examples, n°14 is Parc de la Villette, Paris, France.

The more they are positionned in the center, the more they approach the caracteristic of a cultural green space. The more they are positionned on the edge, the more they represent only the selected atmosphere.

Besides, n°00 is the site of the Granges Collières itself.

1.19. Cultural green spaces morphologies

Studying cultural green spaces morpgologies helps to understand how a the space is shaped and how the atmpospheres are linked with each other.

It is however important to focus on the reference that really works as cultural green spaces to determining that. The diagram opposite shows how accurately the references represent the concept of cultural green space (Findable in the appendices - SC). After analysing the shape of each reference, it is possible to point out three concepts, explained in the page opposite. Here the list of the references that better represent this ideal :

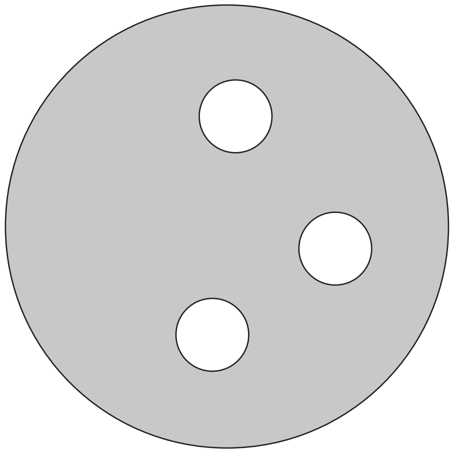
- n°07 : Place Emilie-Gamelin, Montréal, (Canada)
- n°08 : Kunsthal, Rotterdam (Netherlands)
- n°09 : Cryptoportique, Reims, (France)
- n°10 : Campo della Marta, Cittadella (Italy)
- n°13 : Cultuurpark Westergasfabriek, Amsterdam (Netherlands)
- n°14 : Parc de la Villette, Paris, (France)
- n°15 : Biblioteca degli Alberi, Milano (Italia)

Concept A is illustrated by Parc de la Villette, Paris (n°14) and Biblioteca degli Alberi, Milano (n°15). The French park is a large relaxing area (people relaxes and picnics) that includes severals captivating spots (open air cinema, «les folies»,...). The Italian one is a large collective area (people plays and gathers) with severals inspiring spots (trees' circles).

Concept B is illustrated by Place Emilie-Gamelin, Montréal (n°07), Cryptoportique, Reims (n°09) and Campo della Marta, Cittadella (n°10). For example, Place Emilie-Gamelin is an area divided in a collective sub-zone and an inspiring one, but bound by a stage in the center that brings a captivating, yet festive, atmosphere

At last, concept C is illustrated by Kunsthal, Rotterdam (n°08) and Cultuurpark Westergasfabriek, Amsterdam (n°13). In Amsterdam, the «Atelier des lumières» captivate the glare and spread a festive atmosphere with the surronding stalls, but then, it let people move toward to an increasingly spacious space, from the alley through the trees to the rivesided area.

CONCEPT A :
THE CONSTRAST

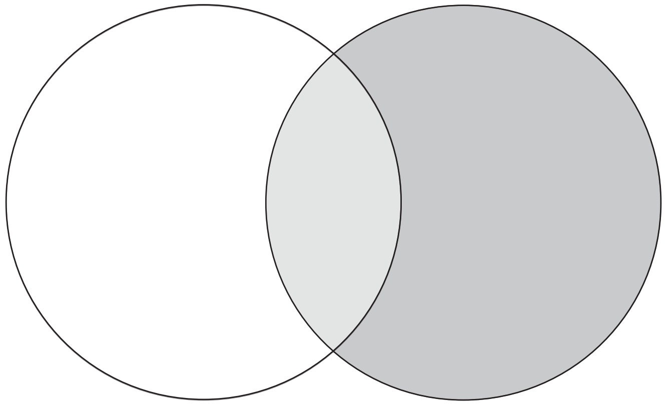


EXPLANATION :

Predominance of one type of atmosphere over the whole space. Presence of the opposite type of atmosphere here and there. The predominant atmosphere works like if there was no interference with any other atmosphere. At particular concentrated spot, the atmospheres become suddenly the opposite, but remain located.

BEST MATCH :
- Very large space

CONCEPT B :
THE DUALITY

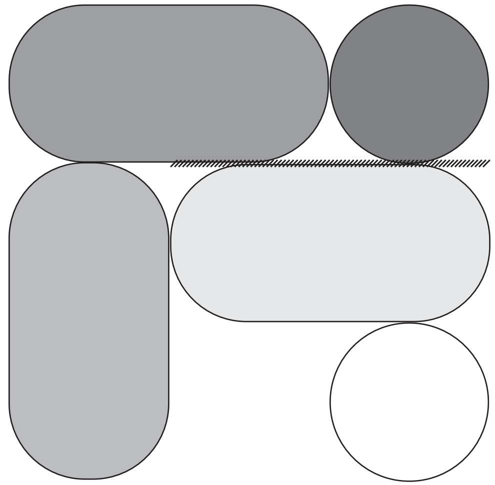


EXPLANATION :

Duality between two opposite types of atmosphere dividing the space. Presence of another one that blend both. The two sub-zone works like if there was no interference between each other. The presence of the smaller third atmospheres enable the harmony of the space by making a transition between the two first ones.

BEST MATCH :
- Small space
- No edifice to interfere the blending

CONCEPT C :
THE THEMATIC SORTING

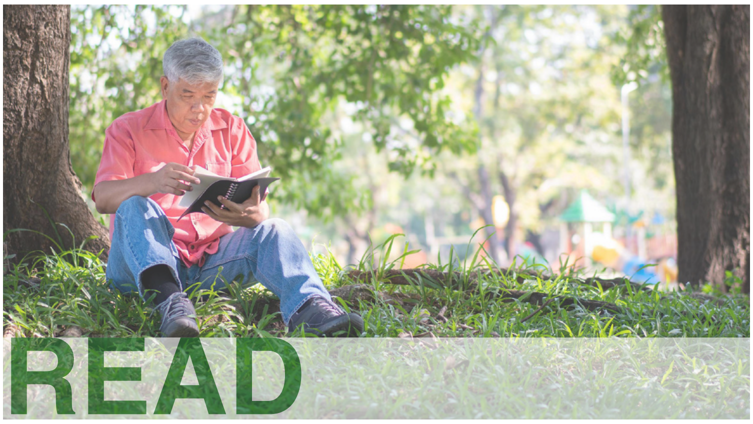


EXPLANATION :

Presence of severals atmospheres, sometimes strongly isolated the one to the others. Each atmosphere works quite independently. Moving from one to another involves gradually changing zones, moving from spacious to denser, from peaceful to livelier. As a fact, there is no confrontation between two opposite atmosphere, but two close atmospheres can overlap and merge at their limit.

BEST MATCH :
- Medium-sized space
- Visually divided space

Fig 082/ Concept of cultural green space's morphologies


READ


WALK


NAP


TALK


HANG OUT


PICNIC


MEDITATE

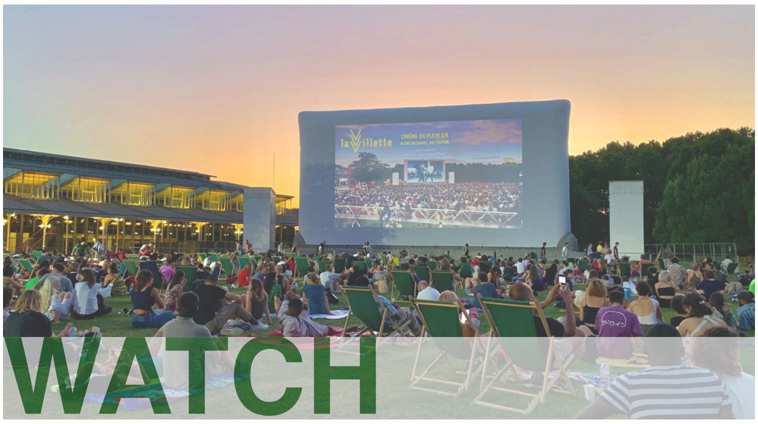

EXERCISE


PLAY


MEET


INTERACT

DISCOVER

CELEBRATE

WATCH

ATTEND

LISTEN

UNDERSTAND

WONDER

MARVEL

ARBORETUM
BREATHE


HOST


CHAIR


HOLD


TEACH

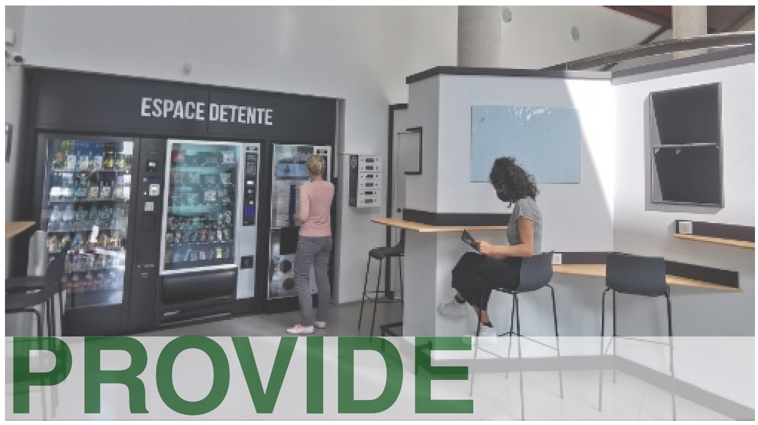

PRODUCE


WELCOME


ORGANISE


WORK


1900-1910
(A)
STORE


ESPACE DETENTE
PROVIDE

1.20. The request : Les Granges Collières as a Cultural Green Space

In essence, Les Granges Collières are a natural green space within a vibrant urban district and embodies the true spirit of unity between the urban and the natural. Its lush greenery, central location, historical value and capacity to captivate curiosity converge to make it a symbol of the district.

The analysis tend to underline that the suitable use of this area is a space where people can breathe, gather and marvel. It will enable the site of Les Granges Collières to regain his legitimate status as a central figure in his district.

The request is therefore to transform Les Granges Collières into the heart of the district by converting it into a Cultural Green Spaces

Besides implementing a extension of the cultural center with the new uses of the Grange Collière, the site has also to be reshaped following the weaknesses it has. Enhancing accessibility, indoor brightness, energy impact - both inside and outsite the farmhouse. These improvements have to however be balanced with the threats we list, such as the risk of degradation of the site and the existing farmhouse that constitute the spirit of the area.

NEEDS OF THE DISTRICT

Lack of cultural facilities
Lack of public spaces
Lack of meeting spaces

POTENTIAL OF THE FARMHOUSE

Historical value of the farmhouse
Charm of the materials used
Potential for expansion and improvement

POTENTIAL OF THE SITE

Centrality of the site
Greenery of the site
Ample land available
Unique and original location

BRINGING OUT THE HEART OF THE DISTRICT TRANSFORMING LES GRANGES COLLIÈRES INTO A CULTURAL GREEN SPACE

STRATEGY 1	RELATED ACTIONS
INDOOR SPACE PLANNING Inclusion of various features for indoor activities to create a cultural centre and promote the attractiveness of the site even during the winter.	Inclusion of a new volume housing a large room for art exhibitions, a conference amphitheatre and a meeting space with views of the building and the ancestral tree. --- Destruction of the extension built in the 1990s and reconstruction of a new building with a more suitable high floor housing a workshop room, an open space for artists, a terrace and a vertical connection block. --- Redesign of the interior layout of the ancestral house to create private offices for the administration and private rooms for the artists. Change of location of some areas such as toilets.

STRATEGY 2	RELATED ACTIONS
PLANNING OUTDOOR SPACES Incorporating different features in different areas to promote a variety of types of outdoor activities and create the right functional mix for an outdoor cultural space.	Promotion of the walk to allow transit within the site. --- Promotion of a more intimate area where users can relax and breathe in the shade of the trees. --- Inclusion of a more urbanised area that can accommodate temporary stands and outdoor picnic benches at festivals, exhibitions or fairs.

STRATEGY 3	RELATED ACTIONS
IMPROVING ACCESS Improved site access, safety and security for all types of mobility.	Reorientation of the site towards the main axis of the district to the north (where the tram passes), while maintaining access to the south for users coming from the large car park on that side. -- Improvement of the north and south access according to standards for people with disabilities and promotion of the north access to invite users into the site. -- Improvement of path safety standards (lighting, handrails, ...). -- Improvement of on-site parking for cars and bicycles for workers at the building. -- Improvement of access to the main building for firefighters or movers.

STRATEGY 4	RELATED ACTIONS
BIODIVERSITY CONSERVATION Conservation of the site and its biodiversity and minimisation of anthropogenic damage.	Reforestation of the site to promote shading, noise reduction, biodiversity development and maximum conservation of the trees already planted on the site. -- Establishment of a vegetation maintenance programme for the site. -- Maintenance of the in/out effect by prohibiting access by car for visitors.

STRATEGY 5	RELATED ACTIONS
REFURBISHMENT OF THE HISTORIC BUILDING Preservation and promotion of the architectural heritage of the ancestral farmhouse, while integrating new functions.	Repair and treatment of damaged parts of the farmhouse. -- Connection of the new volume to the farmhouse, preserving the original (16th century) part as best as possible. -- Remodelling of parts of the farmhouse based on the light and thermal analysis. -- Installation of a walkway to access the upper floor after the removal of the wide internal stairs. -- Removal of features of the ancestral farmhouse that are no longer suitable for use or that make the rooms insufficiently spacious (such as the stairs).

STRATEGY 6	RELATED ACTIONS
ENERGY PERFORMANCE Optimisation and improvement of lighting, thermal, energy and humidity comfort conditions.	Natural light enhancement in the designed building, taking into account the energy performance of the glass used -- Enhancement of the parts of the farmhouse that do not let in enough natural light, preserving the original part of the farmhouse as best as possible. -- Over-insulation or renovation of thermally obsolete parts of the farmhouse. -- Installation of appropriate system (heating, cooling, ventilation, artificial lighting) and sustainable energy improvement system for self-sufficiency.

Reply of the resquest

PART 2 - STATE OF FACT

In order to obtain the best understanding possible of the site, some surveys were conducted, facilitating the retrieval of comprehensive data.

2.1. Photographic survey

The photographic survey plays a foundational role in both the survey operations and subsequent analysis and design stages. In this case, the acquisition of photographic equipment constituted a critical element in assessing materials and the degree of deterioration. Multiple site visits (two indoor, and at least 5 outdoor) were conducted to comprehensively examine the building, both its interior and exterior.

The photographic study, therefore, represented the initial documentation essential for advancing the design process, particularly when dealing with a traditional architectural system. The acquired images served as vital preliminary tools, allowing for an immediate assessment of the artifacts' preservation status and the formulation of appropriate intervention plans. The in-depth Photographic Database (PD) that has helped to understand the geometry of the farmhouse is available in the appendices.

List of the intervention date on site :
- 22/12/2021 : First pre-Tesi photographic statement
- 11/01/2022 : Additional photographic statement
  Start of the Tesi
- 22/03/2022 : Photographic survey outdoor (for photometrical survey)
  Material survey outdoor
- 10/06/2022 : Geometric survey outdoor (Laser measurement)
  Decay survey outdoor
- 23/08/2022 : Quick visit of the interior of the site
  Photographic, material and decay statement indoor
- 30/11/2022 : Photographic survey indoor
  Geometric survey indoor (Laser measurement)
  Additional material and decay survey indoor and outdoor
- 23/05/2023 : Complementary surveys
- 28/10/2023 : Complementary surveys

NB : Please refers to Photographic Database (PD) in the appendice

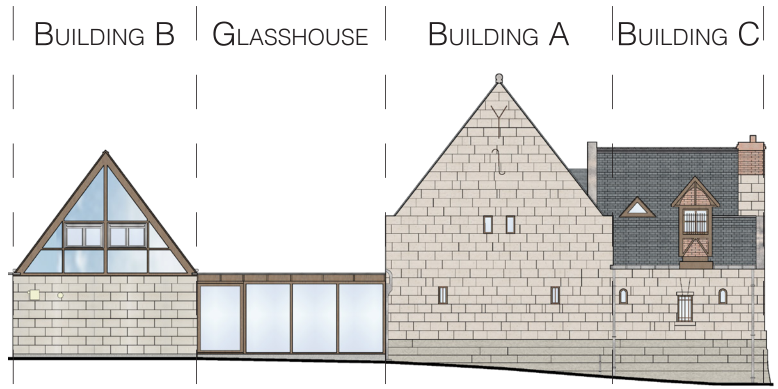


Fig 083/ Reminder of the personal naming of the farmhouse. (North facade of the farmhouse)






bouygues


GrangEs

2.2. Archive researches and subjective survey

Before the beginning of a site description, it is imperative to initiate a strategic planning phase, which commences with the acquisition of all available data concerning the site and its historical context.

Historical documentation of the site was researched, which, however, did not yield immediate positive results. In fact, there was a fire in the farmhouse in 2000 that destroyed the upper floor and the roof of the main building. The fire took with it the documentation on the refurbishment there was ten years ago (in 1991) when the whole district and the farmhouse were modified. As a result, no precise information has been gathered on the changes that took place at that time, however, the archives on the fire has enabled to determine the modification there has been conducted during the renovation after the fire. It was therefore possible to make so assumption on the construction techniques of the refurbishemend with the hypothesis that some of the modification in 1991 were the same in 2002.

Besides the objective aspects of the farm that can be known thanks to the documentation, the intervention on site has also enabled to better understand the site.

I'd now like to paint a more personal picture of the farmhouse. During my studies on the site, I wanted to get a feel for it. How would people like to be there ? What do we feel ? To do this, I walked around the site to determine which of my senses were being stimulated. I lay down in different parts of the site to find the quietest place (the northern part is quite noisy because of the tramway, the southern part doesn't allow much lying down), I looked for the best places to listen to the birds (there are a lot more of them in the eastern part), I tried to find out whether the paths leading to the farm are safe (they're not, they're slippery and there are no handrails), I noticed that the site is not very well maintained. However, I felt like I could breathe, a little lost given the vast space available, but the expanse that was available to me was limitless. According to me, the untapped potential of this site had all the makings of a lively meeting place : it can be a good beating heart and lungs to breathe through.

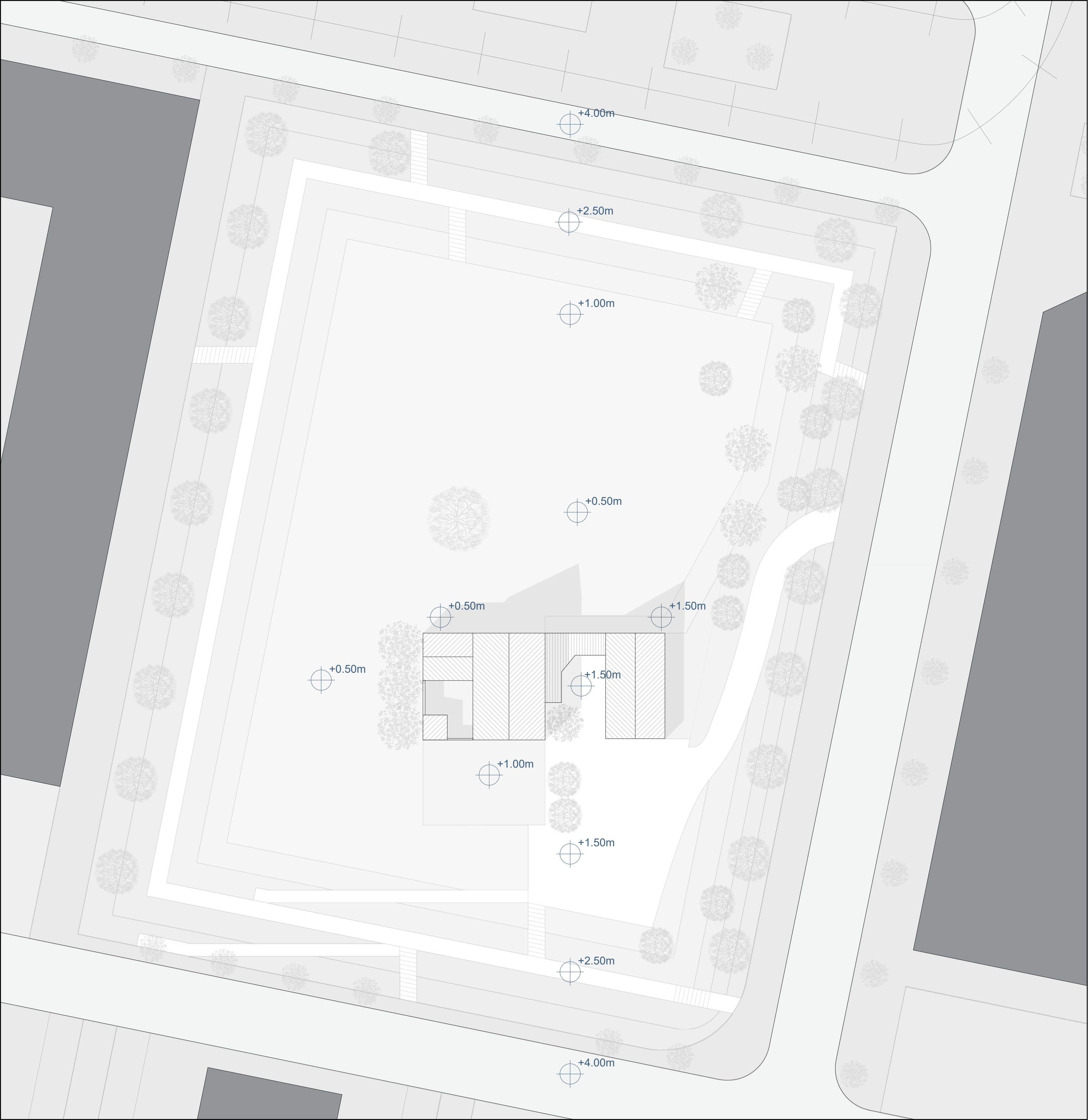
Gatherings theses different ways of knowing the site (sometime objective, sometimes subjective) have enabled to describe the building as well as possible and to establish a reliable state of fact.

2.3. Description of the farmhouse

The site spend over 0.8 ha (while the farmhouse occupies 355 m^2 (12.5m by 28.4m). The site is formed in a bassin of about +3.00m of altitude difference between the central flat area and the level of the district. The site is surronded by very tall modern building giving the impression that the farmhouse and the site are way below the level of the disctrict than they are.

The site is separated from the district level by two natural slope of 6m wide and 1.5m high. The first one separated the level of the street from a 2 meter-wide promenade that goes all around the site. The second one separate that very same promenade from the central flat area. The central flat area enables to care out activities over 0.35 ha including the surface of the farmhouse (thus, 355 m^2 in the 3500m^2 of flat surface area, representing 10%).

The site offers a large green space for leisure activities in the northern part of the flat area, while it allows for more settled activities in the southern part, as the site is more urbanized. The site is surronded by trees and welcome in its core a big lonely tree that face the northern facade of the farmhouse. However, just a few activities are organised in this site (around 1 artistic show monthly during the spring-summer period). A few visitor are also used to go there during sunny days to relax on the grass.



< *Fig 084/ Site's masterplan*

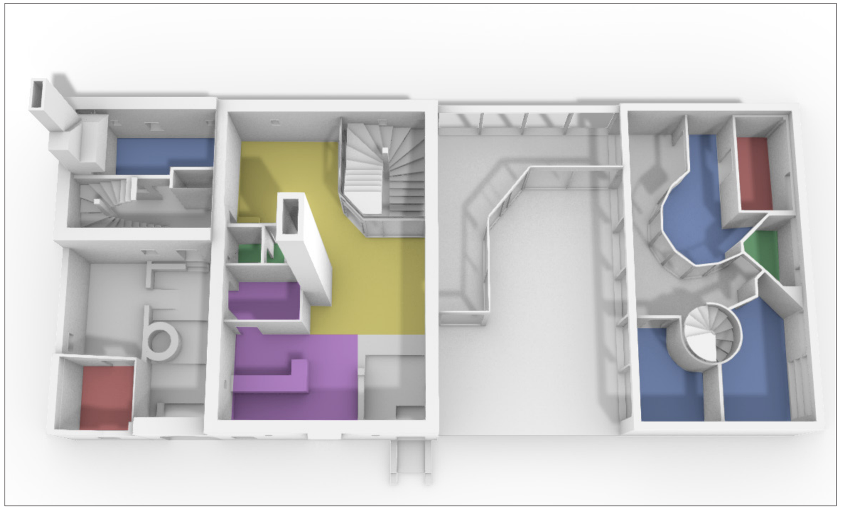


Fig 085/ 3D model view of the farmhouse's ground floor

Access to the building is from the south via the glasshouse, which was built in the 1990s after the barn was extended. This glasshouse, taht spans 28m², serves as a distribution area that seamlessly leads on the left to the original building, comprising buildings A and C, and on the right to the more recent 1990 Tuffeau stone extension, designated as building B.

Building A is, therefore, the main room in the barn, providing a welcoming meeting place for the various cultural associations that use the building. This area is particularly valued for its south-facing living space of 17m², which has been adapted to function as a kitchen. Despite its charm and the presence of all necessary household equipment, the space is still too small to be considered a real reception area. Additionally, adjacent to the kitchen, there is a small room of 6m² specifically designated for storing water, which is essential for the kitchen's operations. The central space within Building A covers 20m² and is utilized to welcome visitors during exhibitions, though it must be noted that this area is somewhat restricted in size, which is exacerbated by the presence of a wide staircase that significantly reduces both visibility and mobility within the room. Central to this layout are the 4m² toilets, which are conveniently located in the centre of the room to ensure easy access for all visitors, but maybe not that well located in case of a indoor performance.

On the west side of the main building, there is a discreet artist's lodge covering 11m², designed to offer performers a private and restful space away from the public eye, particularly those who come to perform small concerts. Exiting in front of the artist's lodge, it can be found a spacious 32 m² outdoor courtyard, and a 7 m² storage room for keeping various items and equipment.

Moving to Building B, which is the Tuffeau extension located in the eastern part of the farmhouse, one will find two rooms primarily used as offices (one that spans over 14m², and a smaller one covering 10m²). This part of the building also boasts a central meeting room, which is essential for coordinating various activities and discussions. Additionally, there is a lodge for the heaters (8m²) and toilets that are accessible for persons with disabilities (4m²).

Public facilities

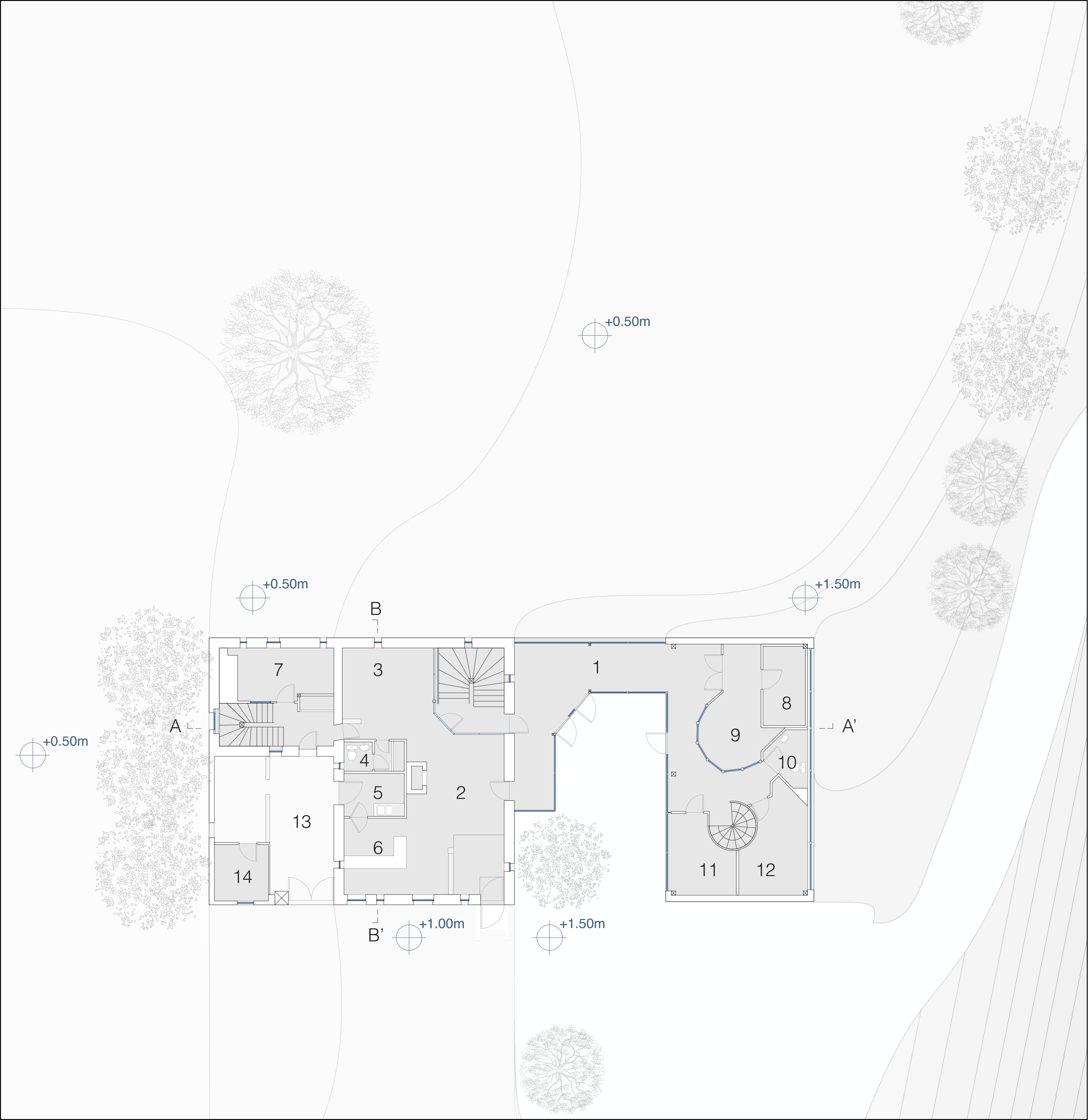
Personal facilities

Offices

Sanitaries

Technical spaces

Circulation



1 - Glasshouse / Entrance : 28 m²

2 - Foyer : 20 m²

3 - Display area : 20 m²

4 - Toilet : 4 m²

5 - Kitchen : 6 m²

6 - Living room : 17 m²

7 - Artists' lodge : 11 m²

8 - Boiler room : 8 m²

9 - Open office : 14 m²

10 - Toilet : 4 m²

11 - Private office : 10 m²

12 - Private office : 14 m²

13 - Outside courtyard : 32 m²

14 - Warehouse : 7 m²

< *Fig 086/ Farmhouse's ground floor plan*

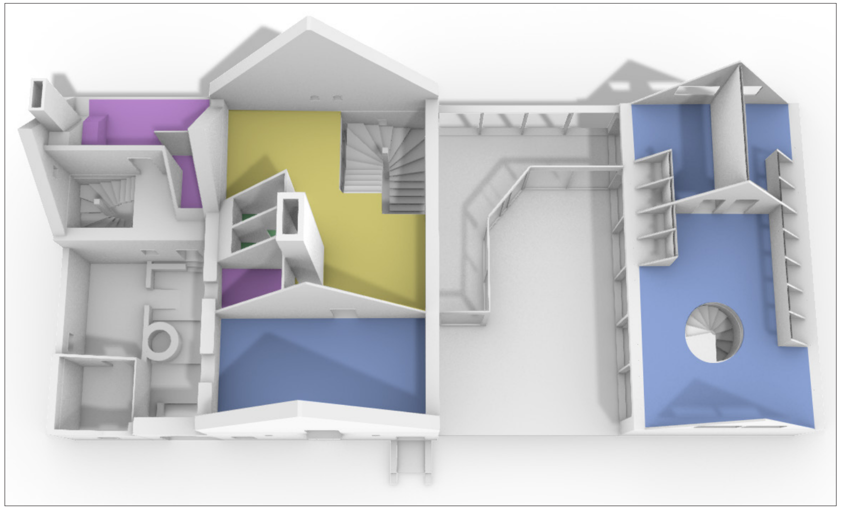


Fig 087/ 3d model view of the farmhouse's elevated floor

The upper floor of the building is divided into three distinct areas, each accessible via separate staircases, ensuring privacy and specialization of spaces.

The upper floor of the main building, designated as Building A, features a large mezzanine measuring 34 m², which is primarily used by associations to store their equipment. This mezzanine also includes a 5 m² kitchen and a 4 m² toilet, providing essential amenities. Additionally, there is a private office, measuring 10 m², accessible from the southern part of the mezzanine, offering a secluded workspace.

In contrast, the upper floor of the east wing of the main building, known as Building C, is more specialized, containing only a 13 m² bathroom. This area is accessible via a staircase located next to the artist's lodge, ensuring that it remains private and exclusive for performers and artists who may require these facilities.

The upper floor of the 1990s extension, referred to as Building B, is designed to foster collaboration and shared workspaces. It includes two private offices, each measuring 12 m², and a 14 m² open office, providing ample space for associations to work together. This arrangement enables the various associations using the premises to share a workspace, promoting interaction and cooperation among different groups.

Public facilities

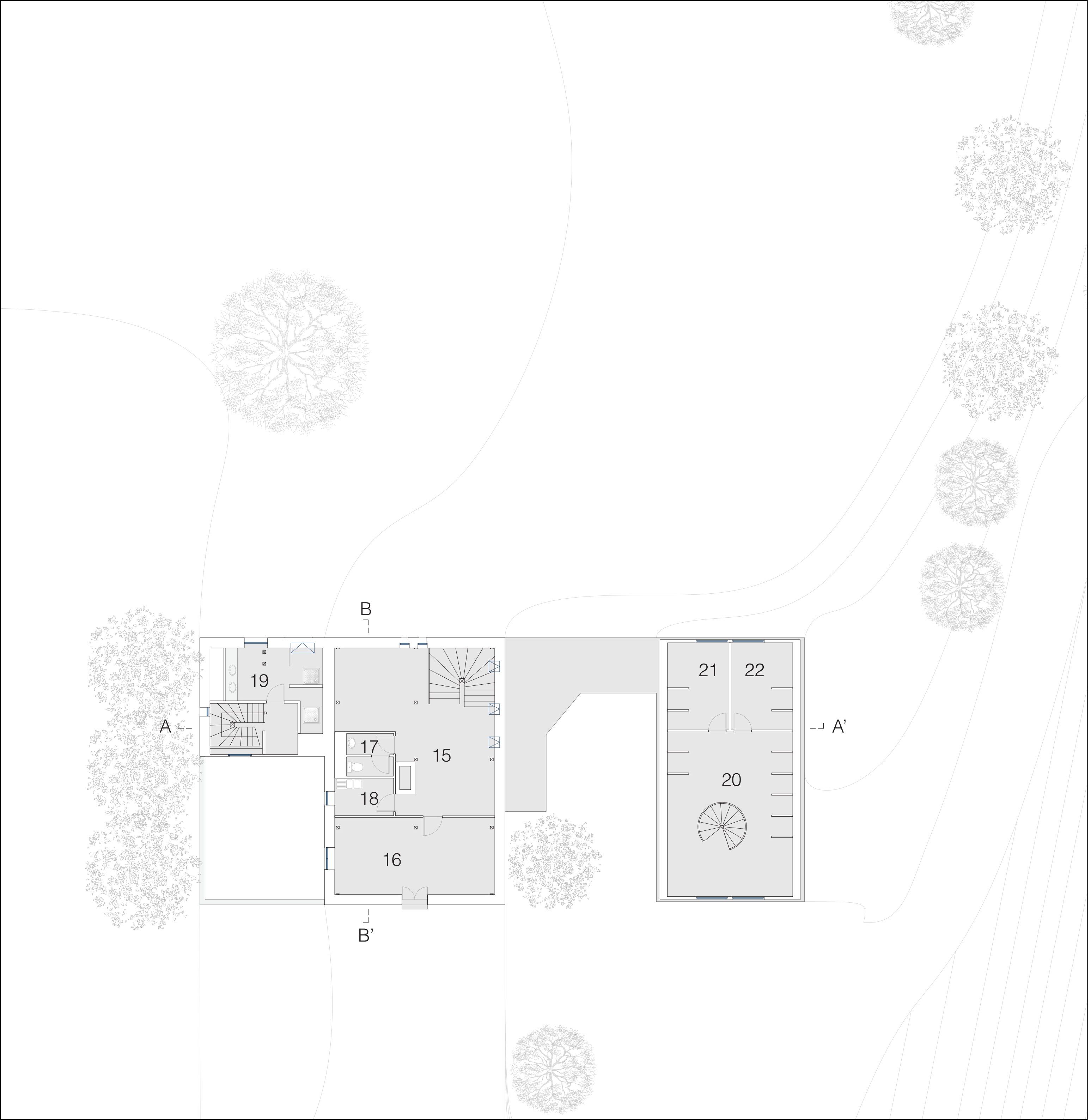
Personal facilities

Offices

Sanitaries

Technical spaces

Circulation



15 - Mezzanine : 34 m²

16 - Private office : 10 m²

17 - Toilet : 4 m²

18 - Kitchen : 5 m²

19 - Bathroom : 13 m²

20 - Open offices : 14 m²

21 - Private office : 12 m²

22 - Private office : 12 m²

< *Fig 088/ Farmhouse's elevated floor plan*

Fig 089/ Interior layout of the farmhouse's ground floor

Public facilities

Personal facilities

Offices

Sanitaries

Technical spaces

Circulation

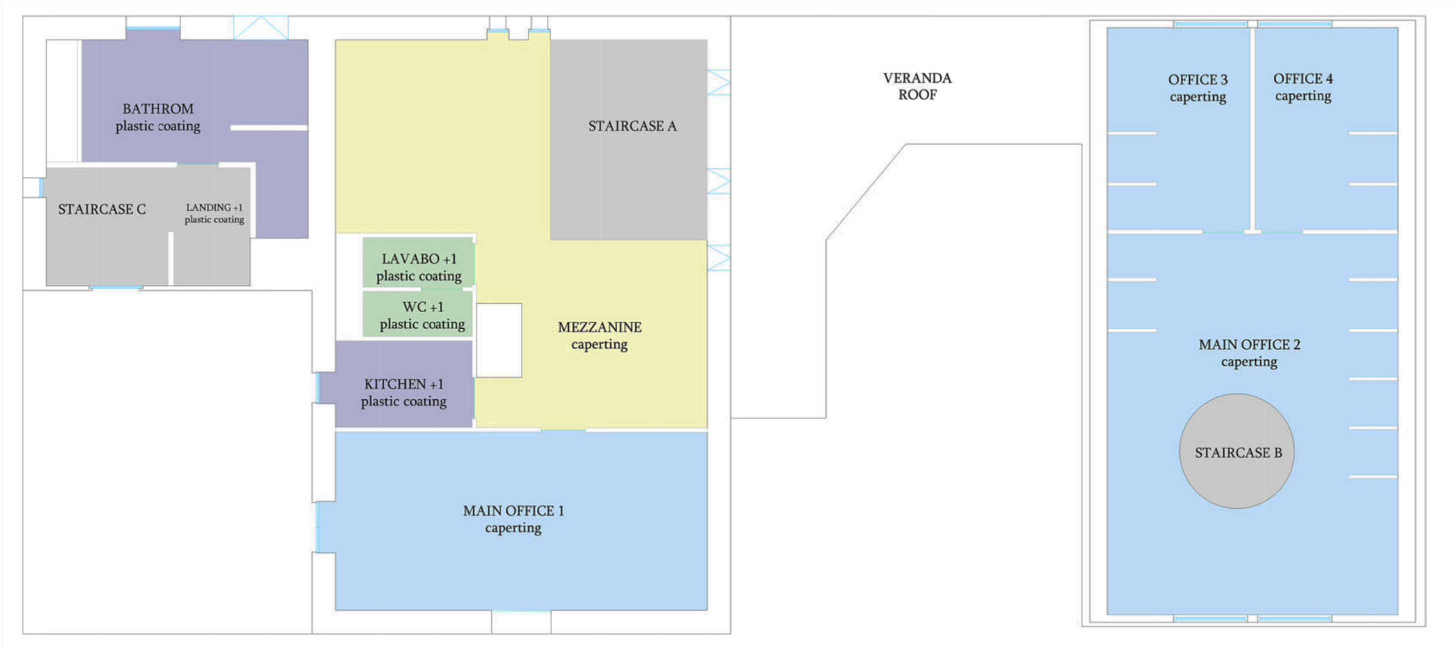


Fig 090/ Interior layout of the farmhouse's elevated floor

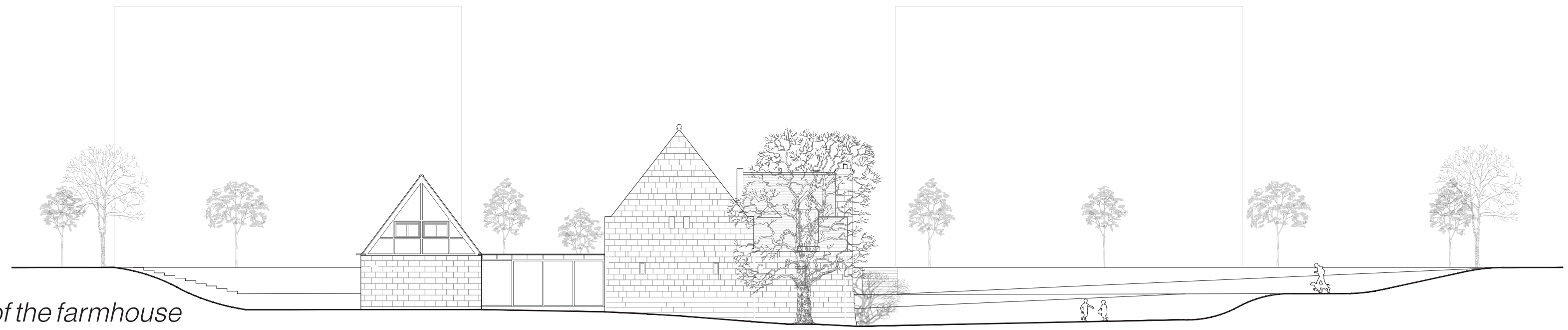


Fig 091/ North elevation of the farmhouse

Fig 092/ South elevation of the farmhouse

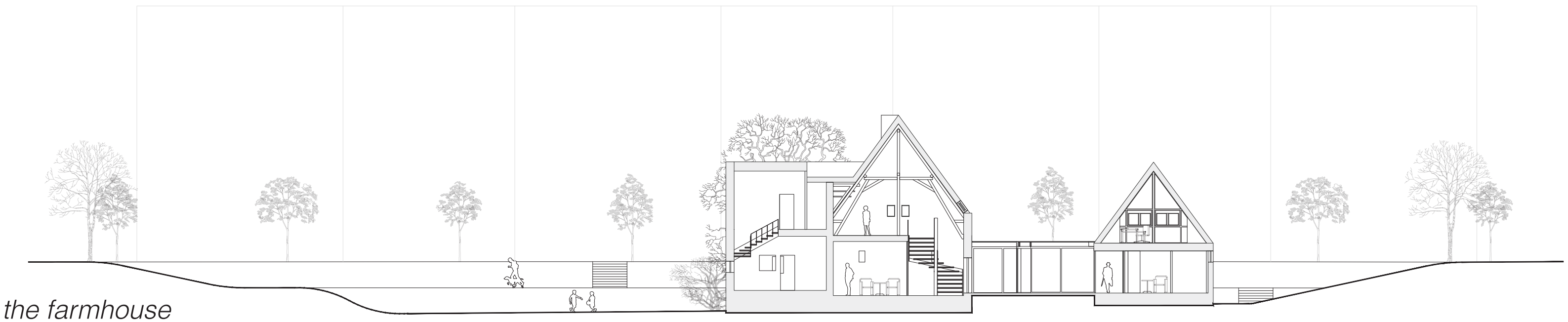


Fig 093/ Section AA' of the farmhouse
(from north)

Fig 094/ Section BB' of the farmhouse
(from east)

2.4. Metric survey

The cognitive phase of the complex is inseparable from a campaign of precise metric surveys. Prior to the survey, documentation from the city was requested, and an initial perspective was gained thanks to the dwg files provided by SET (Société d'Equipement de la Touraine), which served as a basis. However, to assert and enhance the understanding of the farmhouse, measures with a lasermeter were conducted to set up a trustworthy plan.

Given that the access of the inside of the farmhouse was limited to the members of Tours cultural committee, it was at first impossible to conduct any measurement inside the building. The measures indoor were conducted after having taken an appointment with the cultural administrator of the farmhouse. It was possible then to better understand the farmhouse.

By consolidating all the measurements, a complete plan of the farmhouse was created, along with an accurate 2D and 3D model. This data was translated into AutoCAD and Rhino7. Google Maps was used to ensure accuracy for larger distances (particularly for the width of the site).

2.5. Material survey

The materials survey conducted during the site inspection and utilizing the acquired photoplans facilitated the analysis of the building materials. The analysis process was undertaken selectively, focusing primarily on the buildings surveyed during the geometric survey. Various stone types and their conditions were identified, allowing us to assess the state of preservation and degradation. This information was instrumental in formulating strategies for material conservation and restoration, ensuring that the building's historical character is preserved.

Among the traditional material of Tourraine used for the farmhouse we can list these ones :

- MS.01 and MS.02 : Tuffeau stone, as elevation wall
- MS.03 : Blocks of harder sandstone, as footing
- MS.04 : Air limed and Loire-sanded, as mortar
- MS.05 and MS.06 : Schist slate from Angers-Trélazé basin, as roof covering
- MS.07 : Oak wood, as timber beam or framework
- MS.08 : Leopard flamed brick, as masonery for windows dormers

MS.01 - Tuffeau stone (from XVIth century)
White-yellowed, regulary cut block of fine-grained and tender sedimentary limestone, stuck together with a few of air limed and Loire-sanded mortar. Used as elevation wall structure for building A and C. Possibly modified since XVI°.

MS.02 - Tuffeau stone (from the 90s)
White-yellowed, regulary cut block of fine-grained and tender sedimentary limestone, stuck together with a few of air limed and Loire-sanded mortar. Used as elevation wall structure since the 90s for building B.

MS.03 - Sandstone
Orange-yellowed, rough appearance blocks of sedimentary stones, more roughly cut and stuck together with some mortar. Used as footing.

MS.04 - Air limed and Loire-sanded mortar
Protective and decorative coat based on mortar (mixture of binder and aggregate based on lime) which is applied to exterior architectural surfaces. Used as binder or rendering.

MS.05 - Schist slate plate tiles
Fine-grained grey/blue metamorphic stone split into smooth and flat plates. Used as roof tiles or as façade below some windows.

MS.06 - Schist slate round tiles
Fine-grained grey/blue metamorphic stone split into smooth and rounded plates bounded with lime mortar. Used as roof ridge tiles for roof coating.

MS.07 - Oak Timber
Hard fibrous beam coming from the oak tree. Used as structural beam and windows frames.

MS.08 - Leopard Flamed Bricks
“Jaune ocre” with darker flame patterns rectangular block made of fired or sun-dried clay, stuck together with a few of air limed and Loire-sanded mortar. Used as masonry for the chimney and the windows dormers.

MS.09 - Glass
Hard, brittle and transparent substance, made by fusing sand with soda and lime and cooling rapidly. Used as windows glasses

MS.10 - Mirror paper
Lacquered tempered glass paper made by fusing sand with soda and lime and cooling rapidly. Used on some windows.

MS.11 - Aluminium
Strong, hard magnetic silvery-grey metal. Used for the roof structure or windows frames.

MS.12 - Grey Granit
Coarse-grained intrusive igneous blocks of stones, stuck together with cement. Used as footing.

MS.13 - Zinc
Silvery-white metal which is protected against corrosion. Used for the gutters.

MS.14 - Cast iron
Iron-carbon alloy with high carbon content that has a low melting temperature, allowing for it to be casted in molds. Used as gates and bars.

MS.15 - Plastic
Coarse-grained intrusive igneous blocks of stones, stuck together with cement. Used as footing.

Fig 095/ Material statement found on the farmhouse

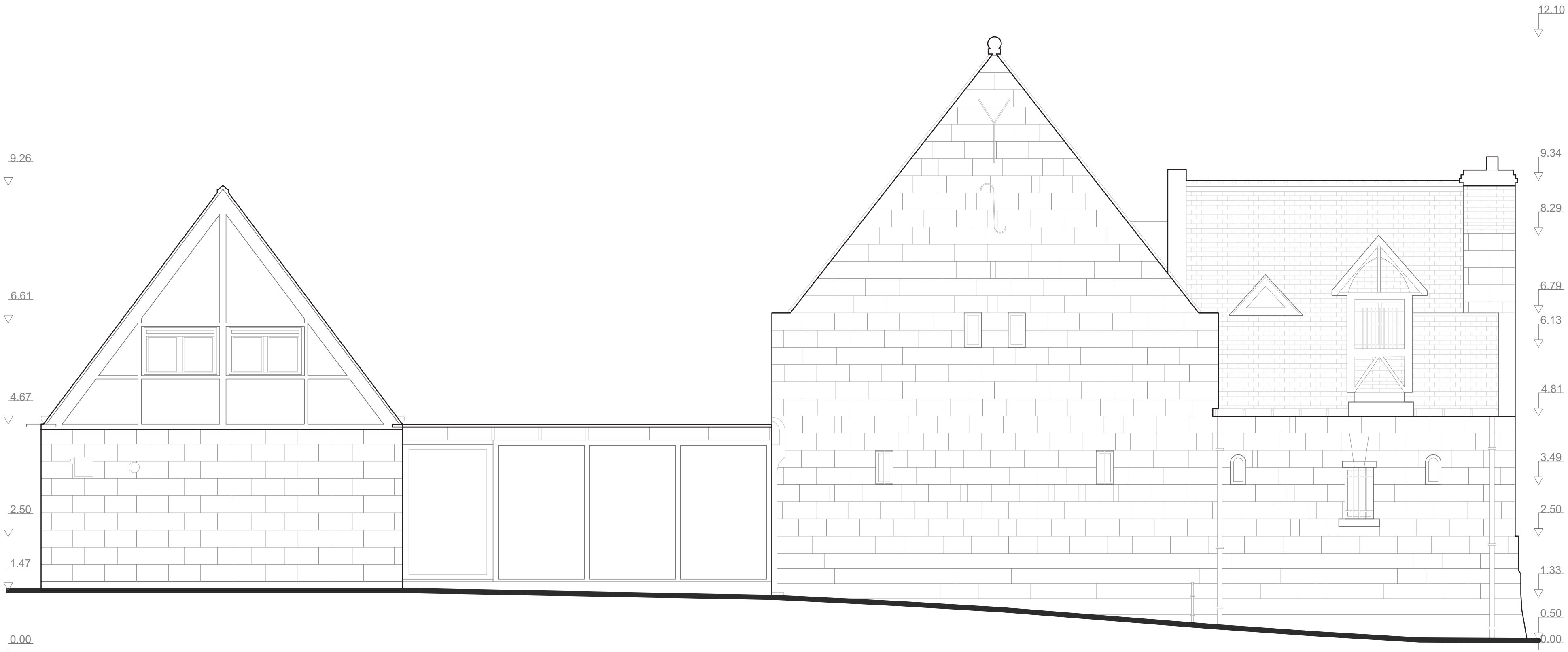


Fig 096/ Geometrical survey of the northern facade

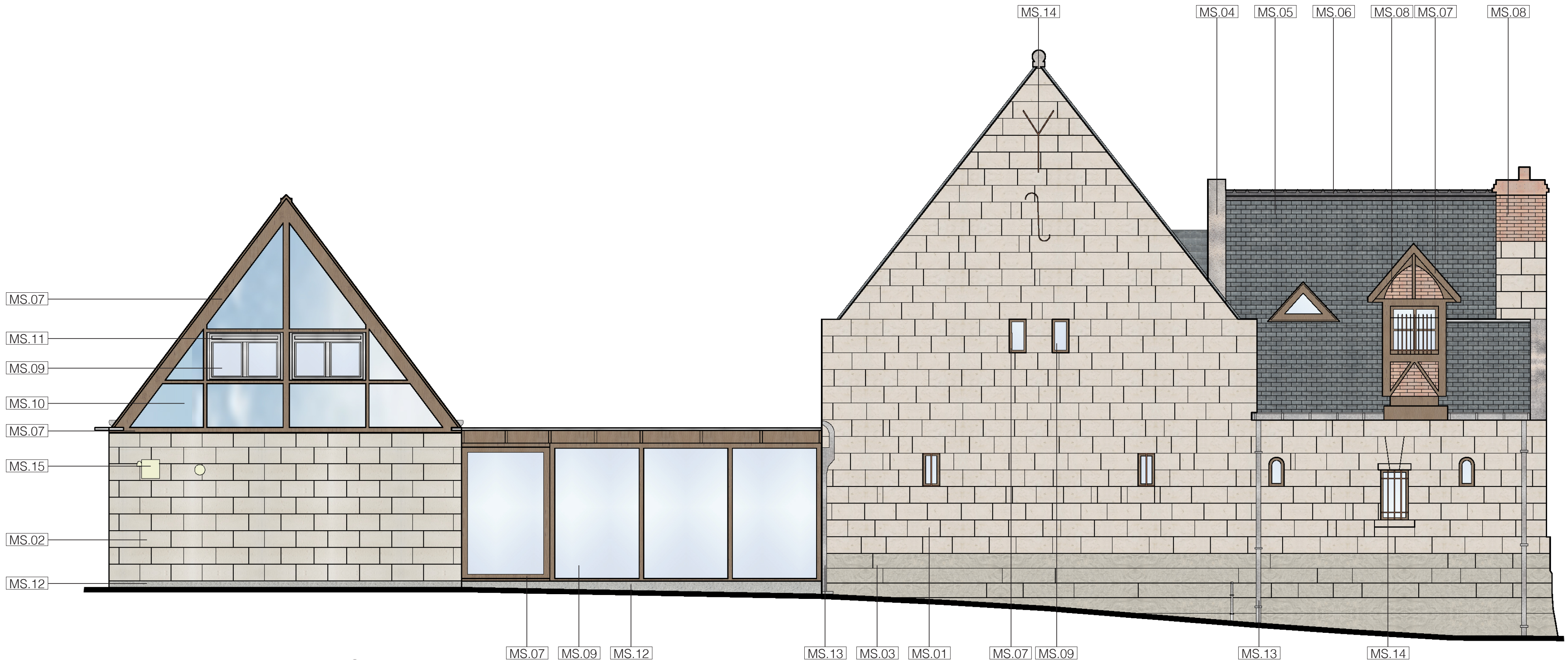


Fig 097/ Material survey of the northern facade

MS.01 - Tuffeau stone (from XVIth century)
MS.02 - Tuffeau stone (from the 90s)
MS.03 - Sandstone
MS.04 - Air limed and Loire-sanded mortar
MS.05 - Schist slate plate tiles
MS.06 - Schist slate round tiles
MS.07 - Oak Timber
MS.08 - Leopard Flamed Bricks
MS.09 - Glass
MS.10 - Mirror paper
MS.11 - Aluminium
MS.12 - Grey Granit
MS.13 - Zinc
MS.14 - Cast iron
MS.15 - Plastic

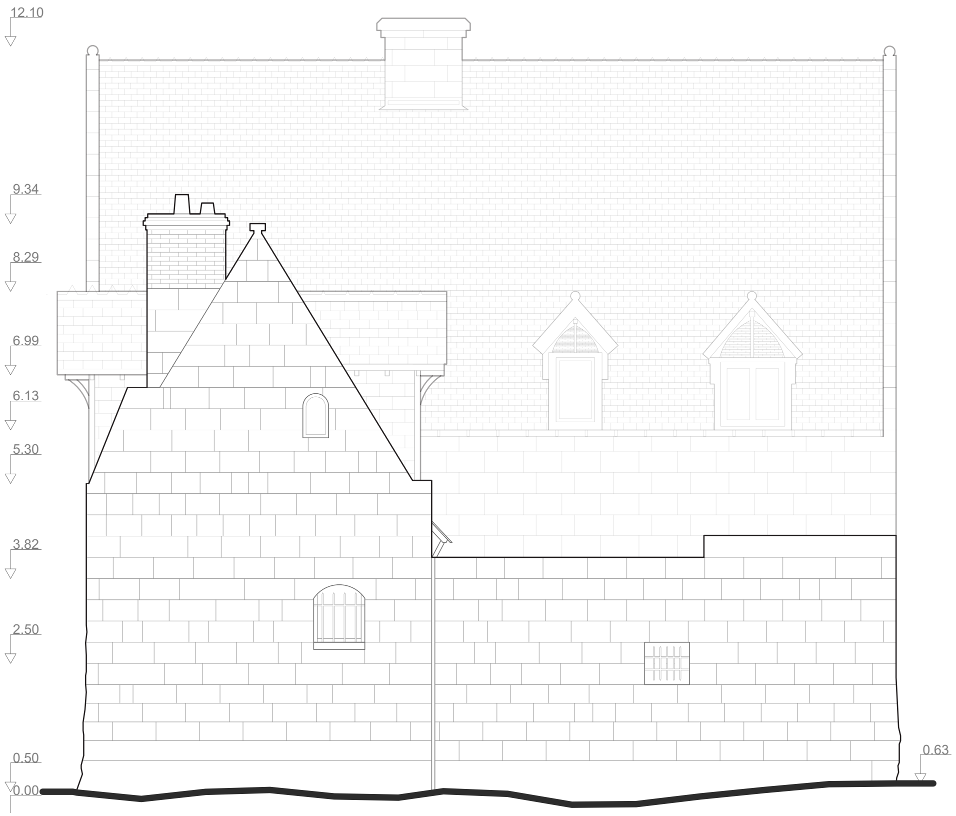


Fig 098/ Geometrical survey of the western facade

Fig 099/ Geometrical survey of the southern facade (edif A)

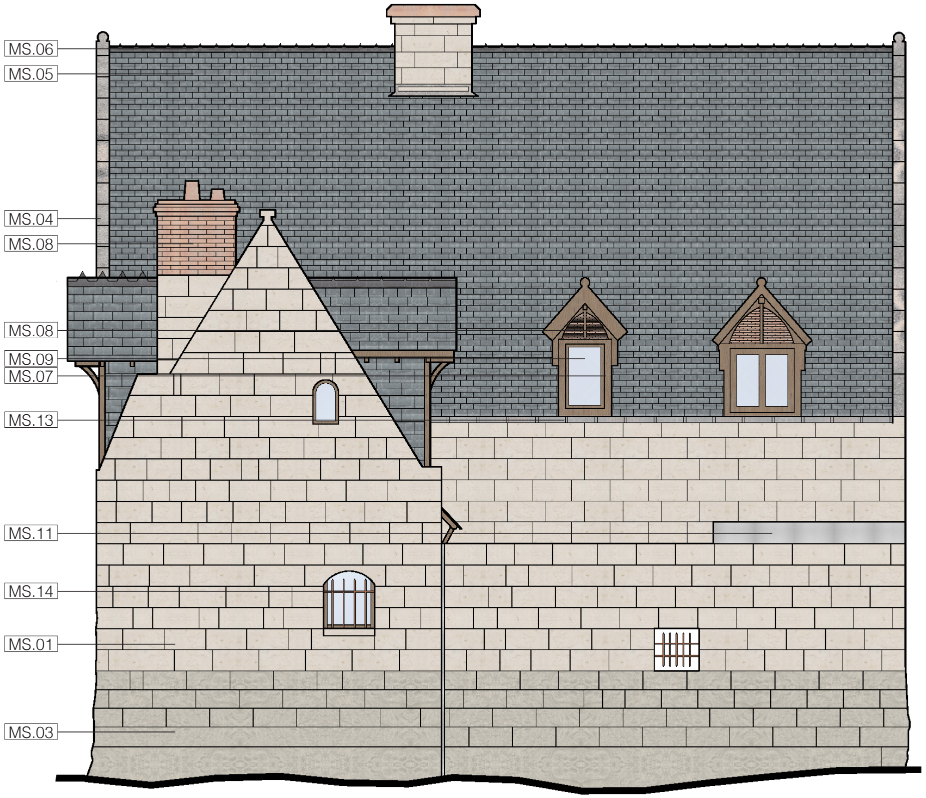


Fig 100/ Material survey of the western facade

Fig 101/ Material survey of the southern facade (edif A)

MS.01 - Tuffeau stone (from XVIth century)
MS.02 - Tuffeau stone (from the 90s)
MS.03 - Sandstone
MS.04 - Air limed and Loire-sanded mortar
MS.05 - Schist slate plate tiles
MS.06 - Schist slate round tiles
MS.07 - Oak Timber
MS.08 - Leopard Flamed Bricks
MS.09 - Glass
MS.10 - Mirror paper
MS.11 - Aluminium
MS.12 - Grey Granit
MS.13 - Zinc
MS.14 - Cast iron
MS.15 - Plastic

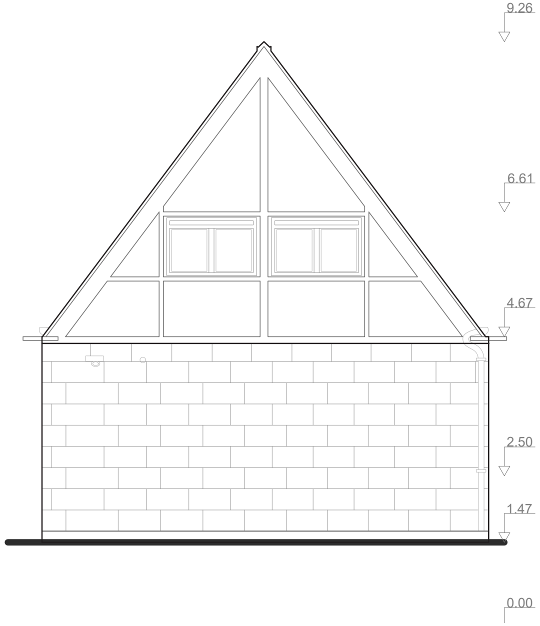


Fig 102/ Geometrical survey of the southern facade (edif B)

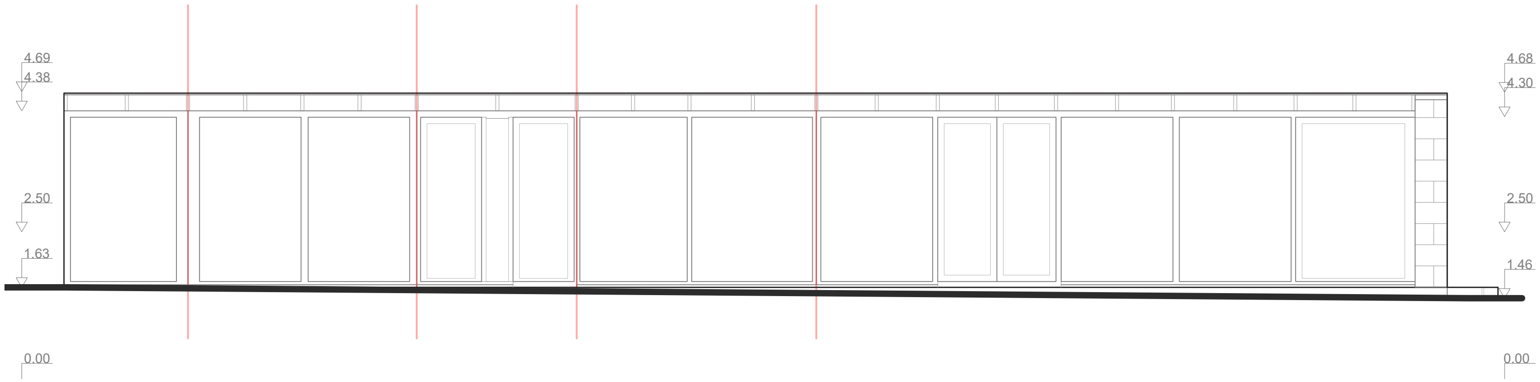


Fig 103/ Geometrical survey of the glasshouse

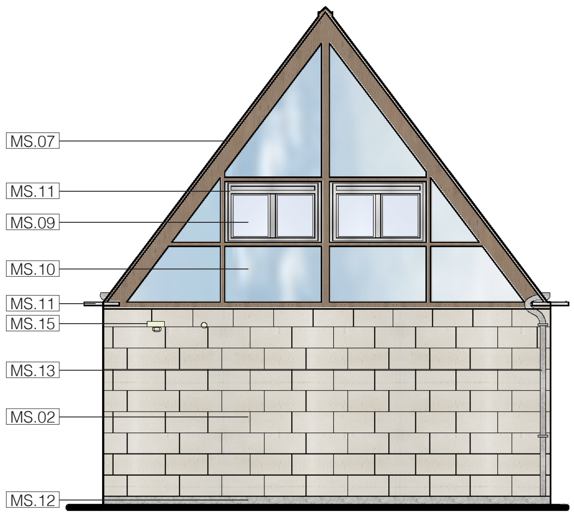


Fig 104/ Geometrical survey of the southern facade (edif B)

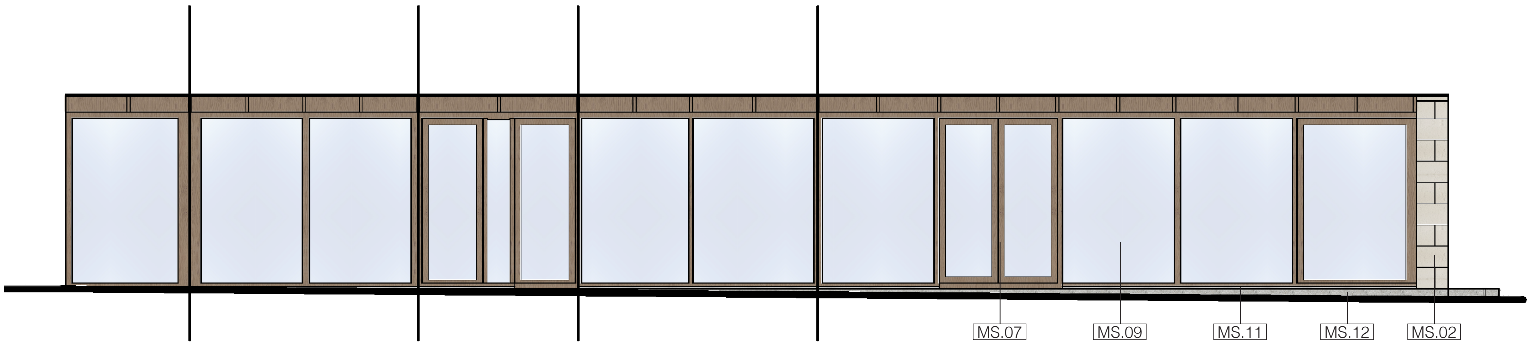


Fig 105/ Geometrical survey of the glasshouse

MS.01 - Tuffeau stone (from XVIth century)
MS.02 - Tuffeau stone (from the 90s)
MS.03 - Sandstone
MS.04 - Air limed and Loire-sanded mortar
MS.05 - Schist slate plate tiles

MS.06 - Schist slate round tiles
MS.07 - Oak Timber
MS.08 - Leopard Flamed Bricks
MS.09 - Glass
MS.10 - Mirror paper

MS.11 - Aluminium
MS.12 - Grey Granit
MS.13 - Zinc
MS.14 - Cast iron
MS.15 - Plastic

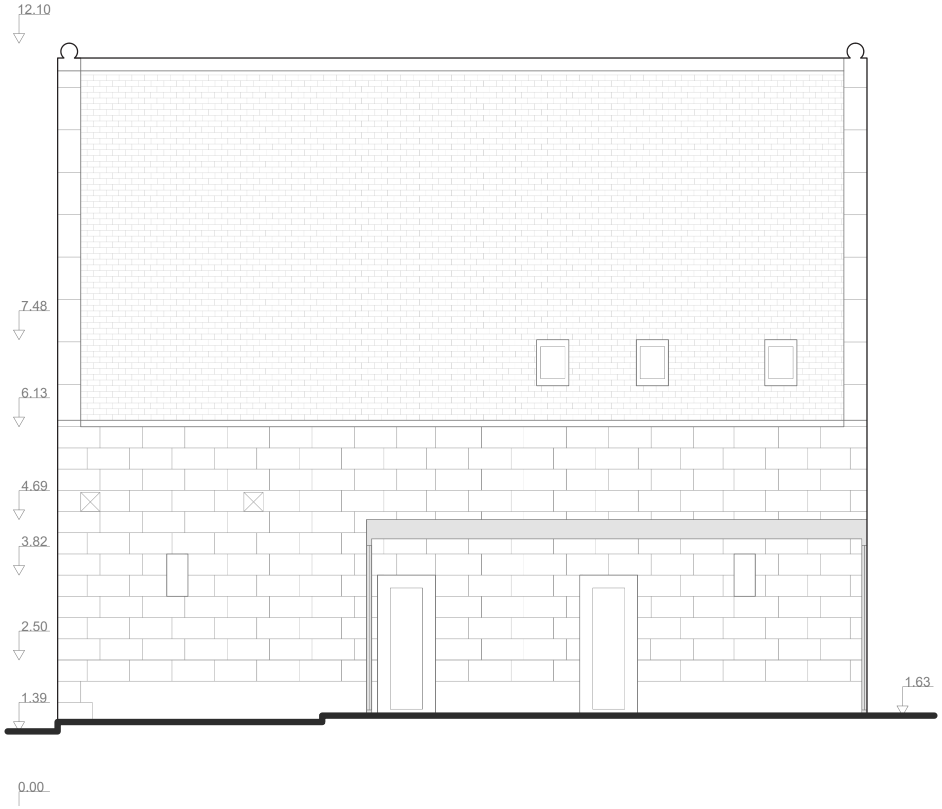


Fig 106/ Geometrical survey of the eastern facade (edif A)

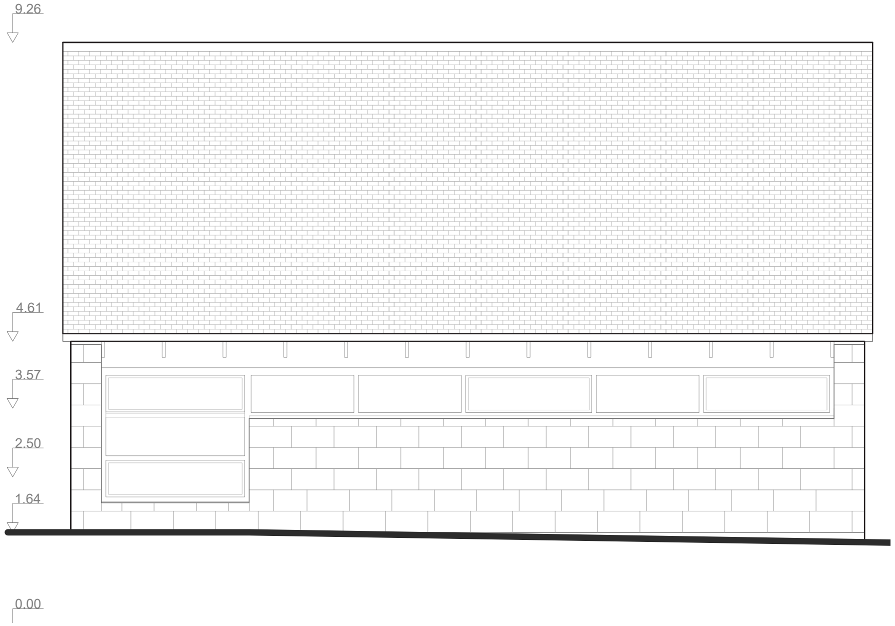


Fig 107/ Geometrical survey of the eastern facade (edif B)

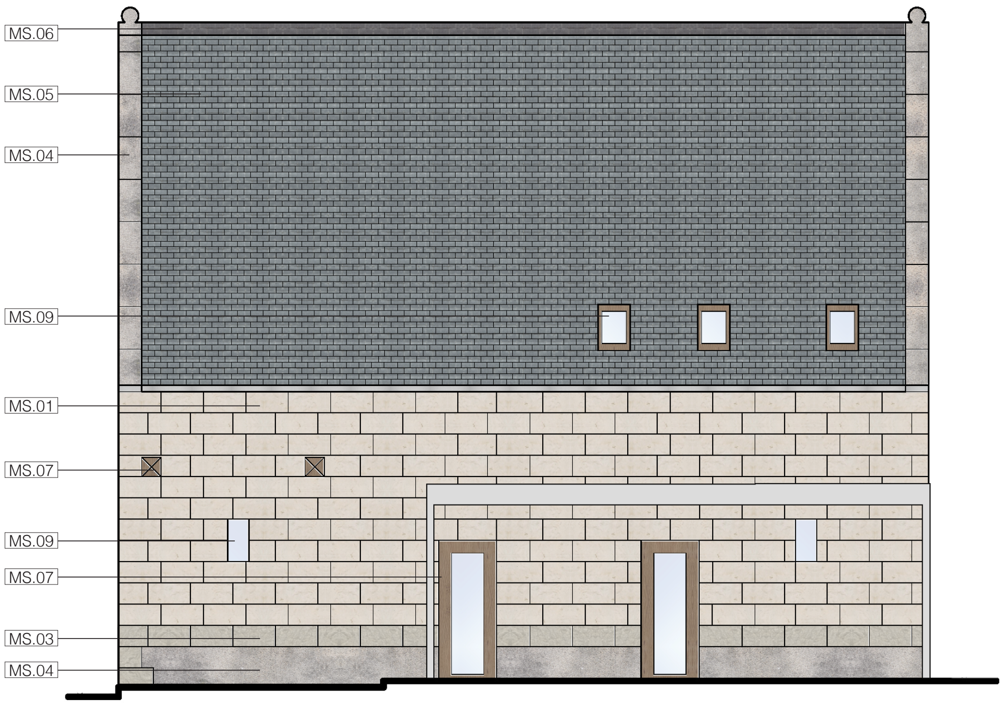


Fig 108/ Geometrical survey of the eastern facade (edif A)

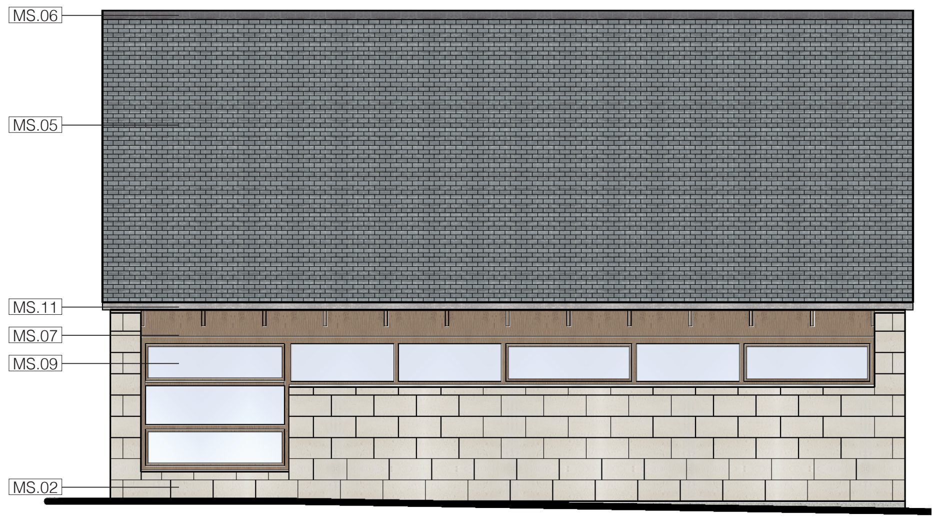


Fig 109/ Geometrical survey of the eastern facade (edif B)

MS.01 - Tuffeau stone (from XVIth century)
MS.02 - Tuffeau stone (from the 90s)
MS.03 - Sandstone
MS.04 - Air limed and Loire-sanded mortar
MS.05 - Schist slate plate tiles

MS.06 - Schist slate round tiles
MS.07 - Oak Timber
MS.08 - Leopard Flamed Bricks
MS.09 - Glass
MS.10 - Mirror paper

MS.11 - Aluminium
MS.12 - Grey Granit
MS.13 - Zinc
MS.14 - Cast iron
MS.15 - Plastic

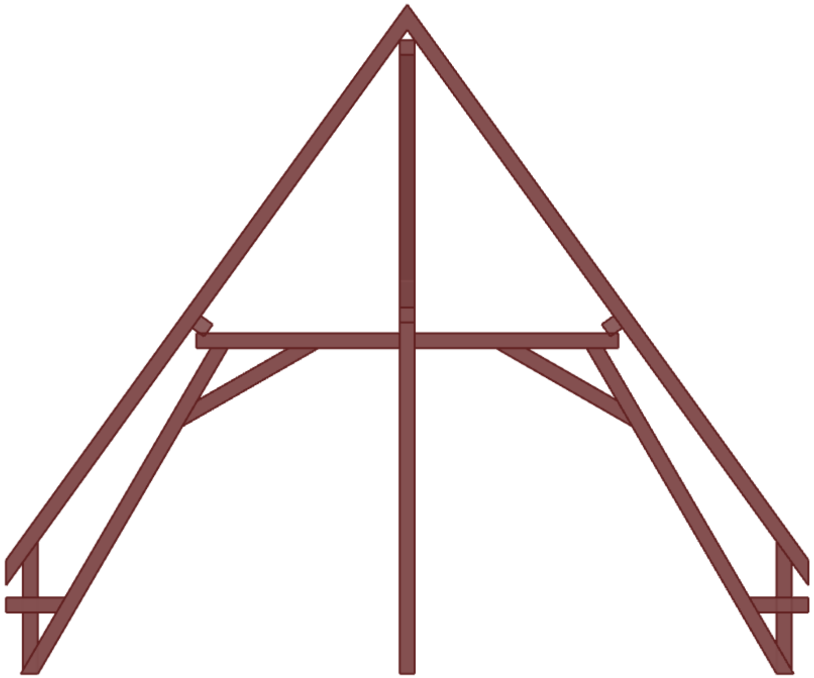


Fig 110/ Modelisation of the roof framework (front view)

Fig 111/ Modelisation of the roof framework (front view)

2.6. Technological survey

A comprehensive technical survey is essential to assess the building's overall technical condition. This includes the examination of utilities and any modifications or alterations that may have occurred over time. The technical survey is crucial in identifying the necessary technical interventions required for the renovation process.

Thanks to the research of historic documentation, it was possible to find the exact way the upper floor and the roof of building A was done after the restoration in 2002 following the fire that destroyed a part of the farmhouse. Additionaly, thanks to the documentation of the traditional techniques used in Tourraine, it was possible to make confident guesses on the way the original part of the farmhouse was done. However, as already stressed out before, due to the fire in 2000, no documentation was found for the refurbishment of 1991 as they were destroyed by it.

It was however possible to know more about the technique used during the visit of the inside of the farmhouse. In fact, exploring the farmhouse enabled to understand for example how the different flooring were made. Some other detail with minor importance were however impossible to describe well.

After having collected enough information on every material and on the technical construction method (thanks both the study on site and in the archives), it was possible to elaborated the Technical Database (TD) of the different element of the farmhouse. This database is thoroughly explained in the appendices and in the boards.

The opposite figures show the roof structure of the main building. It is based on a traditional method using oak wood. It was unfortunately destroyed in the fire of 2000 but archive documents show that during the restoration of 2002 this same roof structure was made «ditto existant» which means that the same technique was used. It was possible to model this structure using Rhino7 software (The).

NB : Please refers to Technical Database (TD) in the appendice

**The first wood beams have been removed in this view for better visibility.*

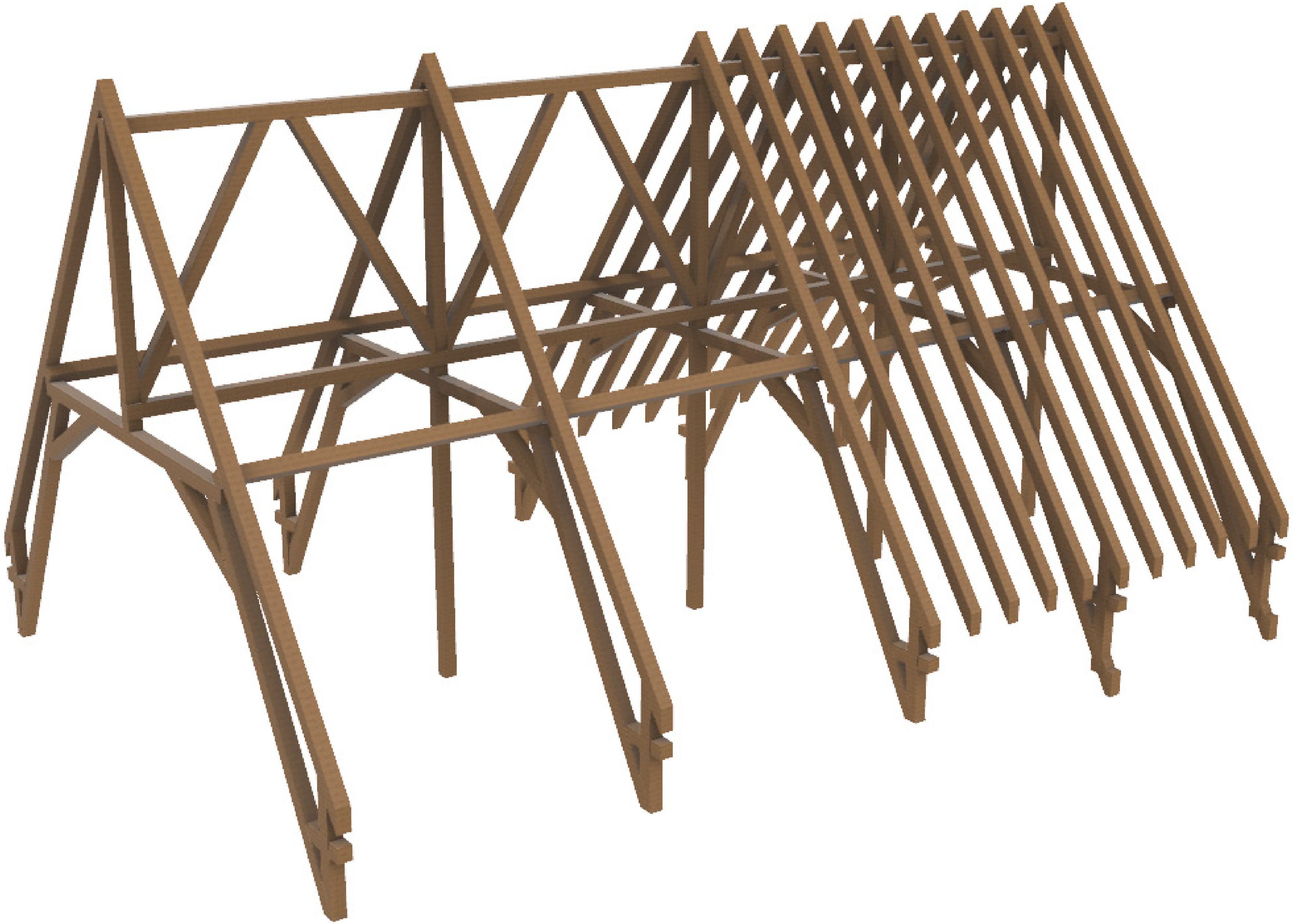


Fig 112/ 3D Modelisation of the roof framework

2.7. Decay survey

Building degradation represents a corrosive process affecting construction materials, leading to the deterioration of their chemical, physical, and structural properties. The objective of this analysis is to identify both external and internal factors that have impacted the building, causing alterations to the material composition and structural integrity. Based on the confrontation between the photographical survey / visits on site and the documentations / online ressources (ICOMOS-ISCS), the decays were identified.

In the specific case of the farmhouse, it is imperative to highlight that neglect and a lack of maintenance have invariably resulted in widespread degradation across all structures. Moreover, it was observed that the decays were caused by technical problem such as the lack of a waterproof barriers or of protection against storm water that lead to the eccesive exposure to moisture and humidity.

After having detailed the pre-analysis of the different decays, only the top 8 (the eight first ones) were selected and studied in depth. Therefore, the «Decay Survey» (DS) becomes the «Decay and prediagnosis Database» (DD) that are thoroughly explained in the appendices and in the boards.

DS.01 - Powdering → DD.01 - Powdering

DS.02 - Scaling → DD.02 - Scaling

DS.03 - Alveolization → DD.03 - Alveolization

DS.04 - Moss → DD.04 - Moss

DS.05 - Encrustation → DD.05 - Encrustation

DS.06 - Soiling → DD.06 - Soiling

DS.07 - Moist area → DD.08 - Moist area

DS.08 - Patina → DD.09 - Patina

DS.01 - Powdering
Decohesion manifested by the spontaneous fall of material in the form of finely grained stones or dust. It affects only the surface of the stone or can occur in depth.

DS.02 - Scaling
Degradation that is manifested by the total or partial detachment of parts (scales) often in correspondence with breaks in continuity of the original material.

DS.03 - Alveolization
Formation, on the stone surface, of cavities (alveoles) which may be interconnected and may have variable shapes and sizes (generally centimetric, sometimes metric).

DS.04 - Moss
Mosses look generally like dense micro-leaves (sub- to millimetric size) tightly packed together. Mosses grow on stone surface open cavities, cracks, and in any place permanently or frequently wet, and usually shady.

DS.05 - Encrustation
Compact, hard, mineral outer layer adhering to the stone. The term encrustation is preferred to crust when the accumulation clearly results from water infiltration followed by precipitation.

DS.06 - Soiling
Deposit of a very thin layer of exogenous particles giving a dirty appearance to the stone surface. The substrate stucture is not considered as affected.

DS.07 - Moist area
Change of the stone colour generally of unattractive appearance and corresponding to the darkening (lower hue) of a surface due to dampness.

DS.08 - Patina
Change of the stone colour in one to three of the colour parameters : hue, value and chroma. It can be seen with a unfavourable connotation (yellowing, darkening) or a favourable connotation (iron rich patina).

DS.09 - Bursting
Local loss of the stone surface from internal pressure usually manifesting in the form of an irregularly sided crater.

DS.10 - Fragmentation
Breaking off of pieces, called chips, from the edges of a block into portions of variable dimensions that are irregular in form, thickness and volume.

DS.11 - Mechanical damage
Loss of stone material clearly due to a mechanical action. It can be due to the impact of a projectile or of a hard tool.

DS.12 - Perforation
A single or series of surface punctures, holes or gaps, made by a sharp tool or created by an animal. Perforations are deeper than wide, and penetrate into the body of the stone.

DS.13 - Deposit
Accumulation of exogenic material (splashes of mortar, atmospheric particles such as dust or birds droppings).

DS.14 - Efflorescence
Generally whitish, powdery or whisker-like crystals on the surface. Efflorescences are generally poorly cohesive and commonly made of soluble salt crystals.

DS.15 - Stain
Change of the stone colour of limited extent and generally of unattractive appearance in one to three of the colour parameters : hue, value and chroma. Iron oxides can be driven by water from a rusted iron.

DS.16 - Lichen
Vegetal organism forming rounded millimetric to centimetric crusty or bushy patches, often having a leathery appearence, growing generally on outside parts of a building.

DS.17 - Biological presence
Colonisation by all eco-system that gives evidence of actual living beings. It can be animals nesting (bird nest, spider web) or higher plants grow.

Fig 113/ Decays statement found on the farmhouse

Fig 114/ Photometrical survey of the northern facade

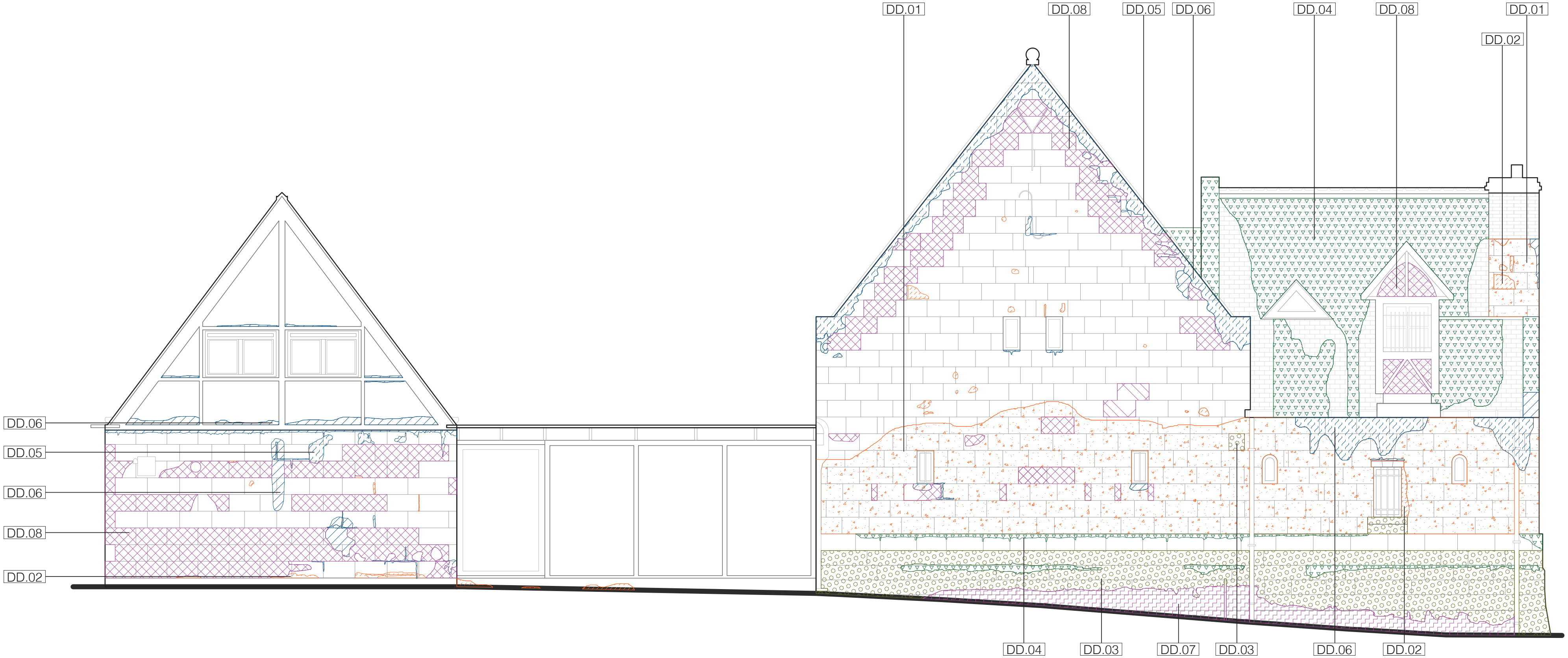


Fig 115/ Decay survey of the northern facade

DD.01 - Powdering
DD.02 - Scaling

DD.03 - Alveolization
DD.04 - Moss

DD.05 - Encrustation
DD.06 - Soiling

DD.07 - Moist area
DD.08 - Patina

Fig 116/ Photometrical survey of the western facade

Fig 117/ Photometrical survey of the southern facade (edif A)

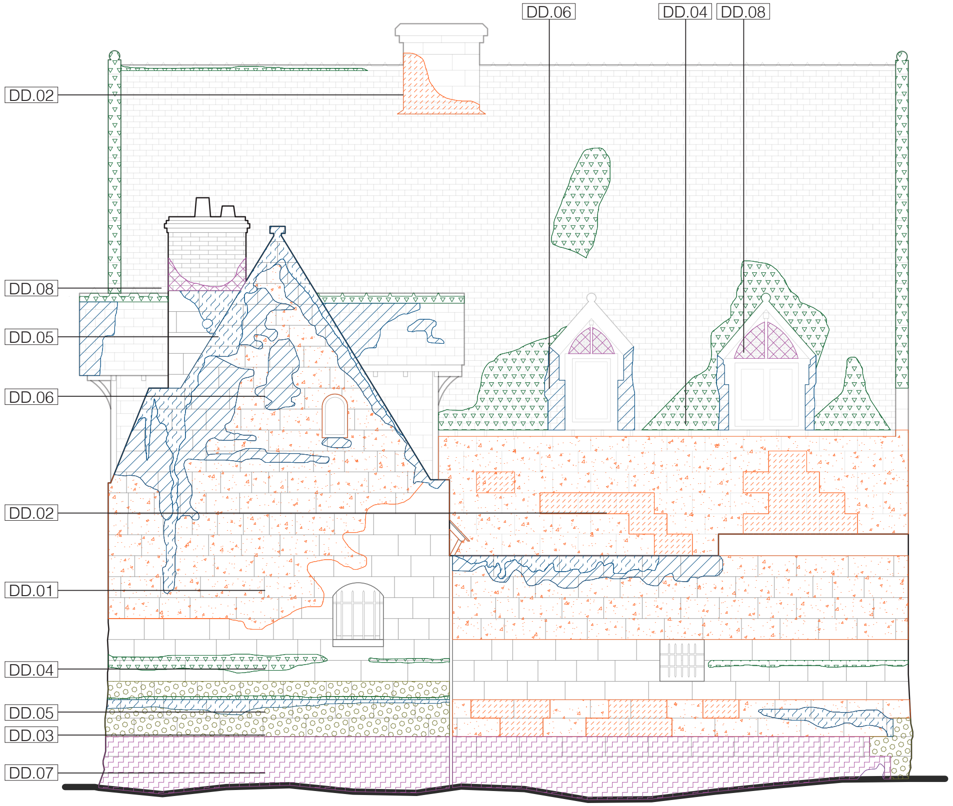


Fig 118/ Decay survey of the western facade

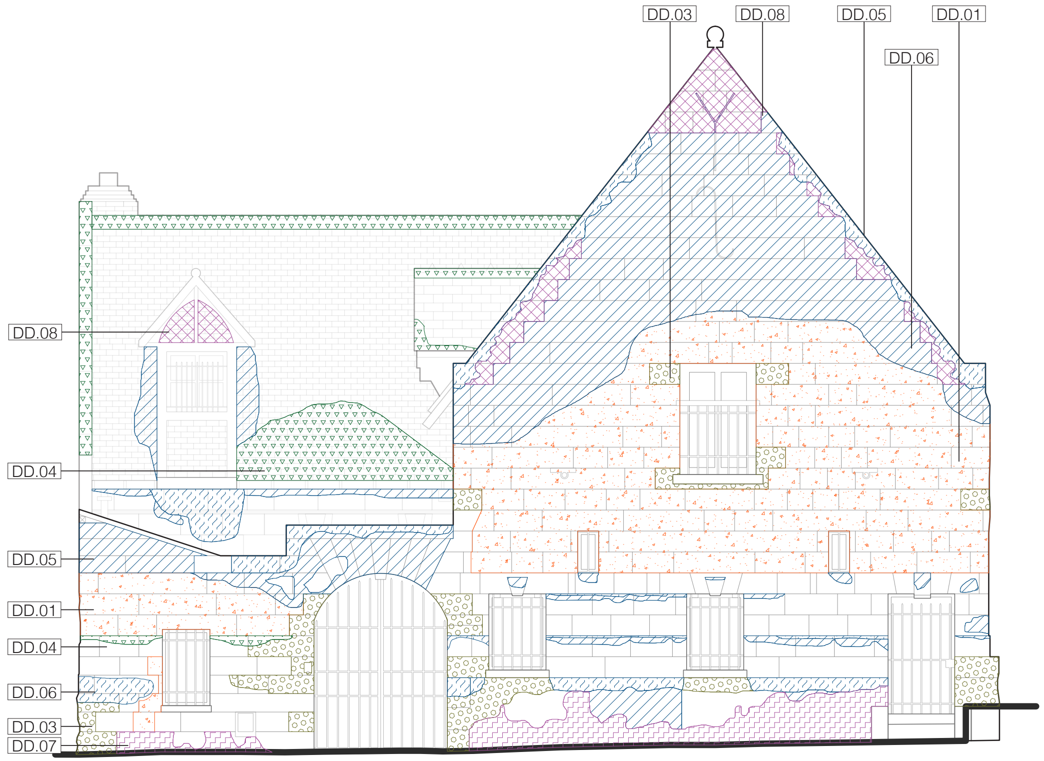


Fig 119/ Material survey of the southern facade (edif A)

DD.01 - Powdering
DD.02 - Scaling

DD.03 - Alveolization
DD.04 - Moss

DD.05 - Encrustation
DD.06 - Soiling

DD.07 - Moist area
DD.08 - Patina

Fig 120/ Photometrical survey of the southern facade (edif B)

Fig 121/ Photometrical survey of the glasshouse

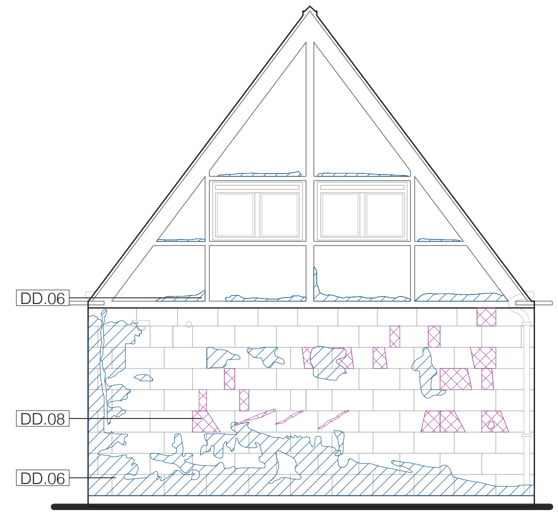


Fig 122/ Decay survey of the southern facade (edif B)

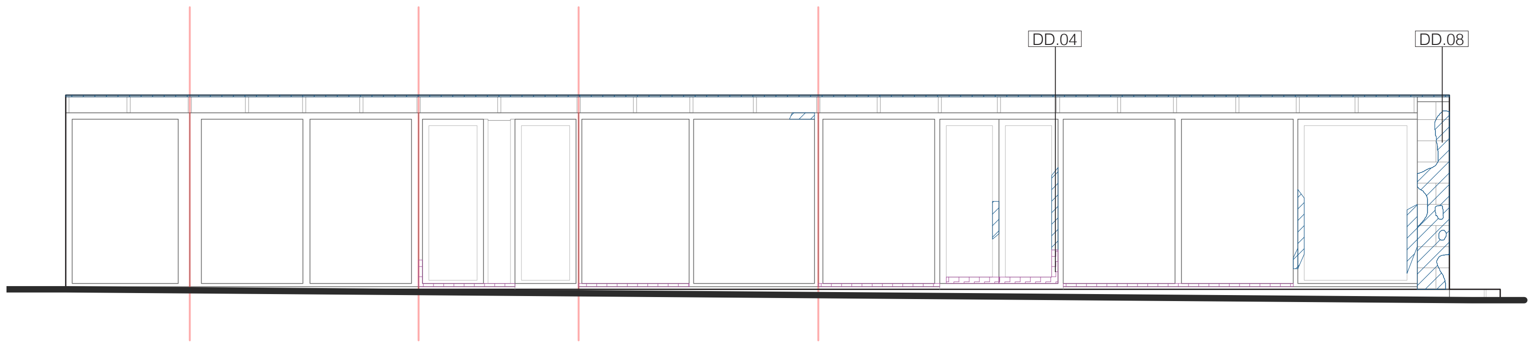


Fig 123/ Decay survey of the glasshouse

DD.01 - Powdering
DD.02 - Scaling

DD.03 - Alveolization
DD.04 - Moss

DD.05 - Encrustation
DD.06 - Soiling

DD.07 - Moist area
DD.08 - Patina

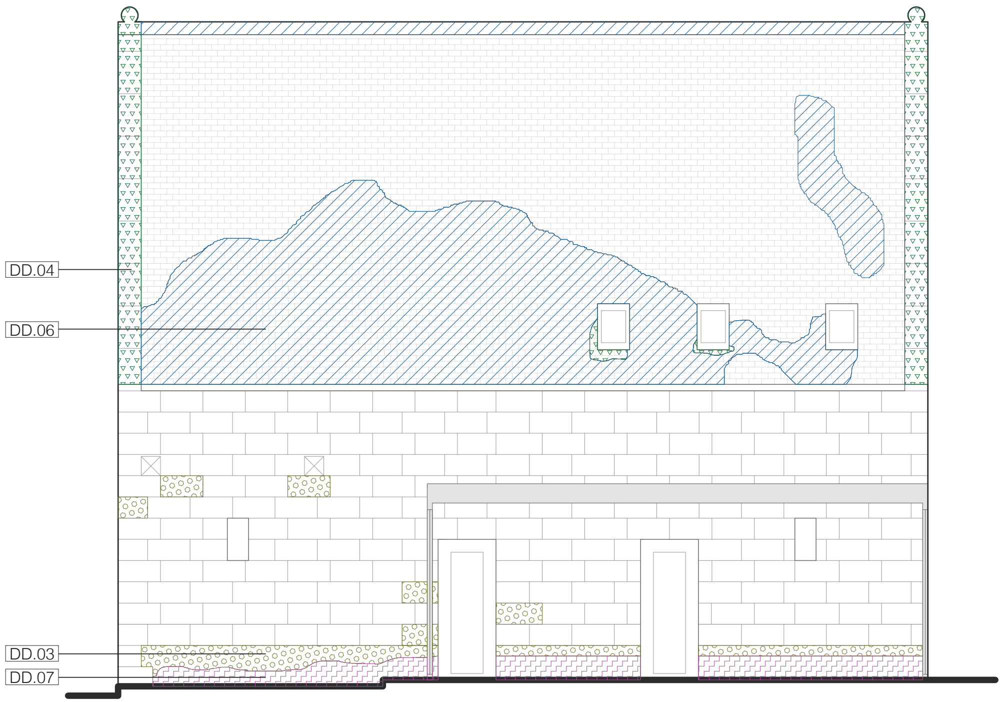


Fig 124/ Decay survey of the eastern facade (edif A)

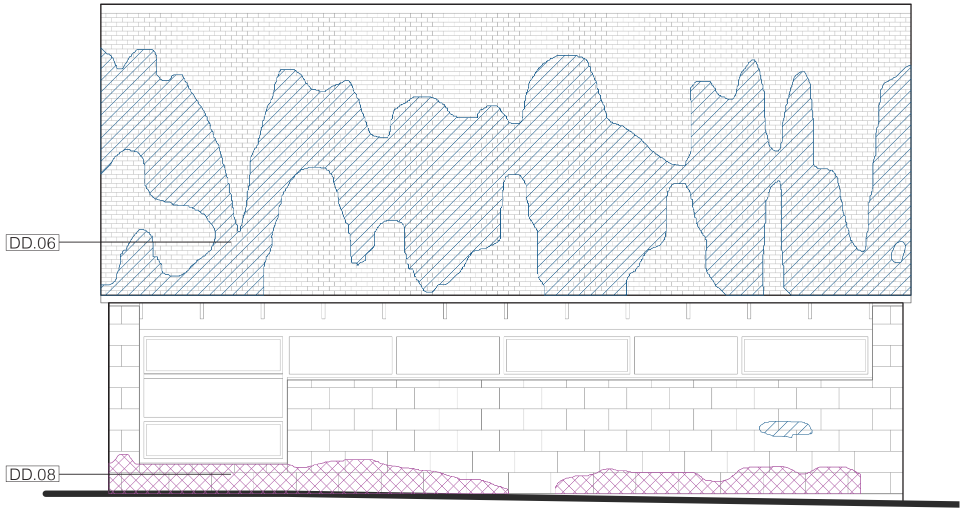


Fig 125/ Decay survey of the eastern facade (edif B)

DD.01 - Powdering
DD.02 - Scaling

DD.03 - Alveolization
DD.04 - Moss

DD.05 - Encrustation
DD.06 - Soiling

DD.07 - Moist area
DD.08 - Patina

	MS.01	MS.02	MS.03	MS.04	MS.05	MS.06	MS.07	MS.08
DS.01	x							
DS.02	x	x						
DS.03	x		x					
DS.04	x		x	x	x	x		
DS.05	x	x	x					
DS.06	x	x		x	x	x		
DS.07			x	x			x	
DS.08	x	x						x
DS.09	x							
DS.10	x	x					x	
DS.11	x	x					x	
DS.12	x	x	x					
DS.13	x						x	
DS.14								x
DS.15		x						
DS.16			x					
DS.17	x	x	x				x	

This array indicates the presence of every particular decay in relation to the traditional material in Tours (the eight more present material in the farmhouse). However, as explained previously, only the eight more present decays are studied in depth in the appendice and have been studied for the conservation intervention.

NB : Please refers to Decay and prediagnosis Database (DD) in the appendice

Fig 126/ Synthetic survey of decays

2.8. Intervention proposal

Following a study of the degradation of the building stones, a strategy for conservative restoration work was decided in order to maintain the integrity of the building and preserve its original materials. It includes general conservation interventions, such as the cleaning of deposits and care for the various types of damage identified.

While some of the damage needs special treatment, the personal choice to leave the traces of time on the building has been taken for certain particularly characteristic and aesthetic degradations that do not harm the structural integrity of the building. For instance, Simple cleaning was recommended for alveolization (DD.03) and patina (DD.08) .

However, some damage, such as powdering (DD.01) and scaling (DD.02) of the tufa stone, needs to be treated to prevent further deterioration of the stone. Interventions range from simple cleaning and filling of minor cracks with Loire sand mortar, to stone replacement for severe damage.

Other damage is treated by removing heavy surface deposits such as moss (DD.04), encrustation (DD.05) and soiling (DD.06) by carefully washing the surfaces with brushes or cleaning colour changes with rice paper for the moist areas (DD.07).

A budget estimate has been simulated for this restoration work, and is put at 29,000 euros, including safety costs, scaffolding, taxes, and a margin for unforeseen circumstances.

In addition, a study of the energy services provided has led to an improvement strategy aimed at improving natural lighting. The insertion of windows and a sun tunnel is designed to maximise natural lighting inside the building, providing greater visual comfort in this very opaque building. The study will be detailled during the energy project (part 5 of the tesi)

This conservation and improvement approach, combined with the extension of the cultural centre with the architectural programme, ensures that the Granges Collières farmhouse is not only preserved for its historic value but also adapted to its new use, providing a revitalised and comfortable cultural space for the local community.

STRATEGY 1	RELATED ACTIONS
IMPROVED RESTORATION Improvement of the energy performance of the existing building.	Insertion of window frames to improve the natural illumination inside the old building, as well as providing the best possible view of the outside environment. --- Connection of the new technical system to the existing one. --- There are no particular thermal improvements as the thermal energy performance of the old building is quite adequate.

STRATEGY 2	RELATED ACTIONS
CONSERVATION RESTORATION Preservation of the integrity of the existing building and preservation of its constituent materials.	Implementation of conservation and care measures to be carried out on the various types of damage identified. --- Implementation of annual or ten-year preventive maintenance.

1. Pre-consolidation of objects with deteriorated and/or fragile surfaces

2. Cleaning of deposits on degraded surfaces

2.1 - Mechanical removal of consistent deposits on resistant and well-preserved material surfaces by means of a high-pressure hydro-blaster.

2.2 - Chemical removal of consistent deposits on less resistant or more damaged surfaces using saturated solutions and subsequent manual mechanical removal using brushes, brushes and hoovers.

2.3 - Mixed removal, both mechanical (for more resistant parts) and chemical (for less resistant parts).

3. Specific interventions on degraded

3.0 - No specific intervention to leave the traces of time on the building. Architectural bias applied only to parts that provide a singular and aesthetic appearance to the building and do not damage its structural safety.

3.1 - Repair of damaged Tuffeau stones

3.1.1 - Cutting the degraded parts of the Tuffeau stone using a brush and trowel. Intervention for stones damaged by slightly (degradation < 1 cm).

3.1.2 - Cutting the deteriorated parts of the Tuffeau stone using a brush and trowel, and completing by plastering with Loire sand mortar. Intervention for stone damaged by moderate detachment (degradation < 8 cm).

3.1.3 - Cutting the deteriorated parts of the stone using a brush and trowel, bonding with Loire sand mortar and laying a new stone. Intervention for stones damaged by heavy chipping (degradation > 8 cm).

3.2 - Removal of large surface deposits, incrustations and soluble stains by applying a biocide solvent by means of a poultice and thorough washing of the surfaces with brushes and trowels.

3.3 - Cleaning of colour changes using rice paper.

4. Restoration of cohesion by spray impregnation with ethyl silicate in cases of disintegration

5. Colour revision to eliminate excessive imbalances by glazing with pigmented lime water

Decay (name and code)	Area of intervention	Conservation measures											
		1	2			3						4	5
			2.1	2.2	2.3	3.0	3.1.1	3.1.2	3.1.3	3.2	3.3		
Powdering (DD.01)	86.9 m²	~		x			80%	15%	5%			~	x
Scaling (DD.02)	5.5 m²	~		x			20%	30%	50%			~	x
Alveolisation (DD.03)	25.8 m²	~			x	x						~	x
Moss (DD.04)	36 m²	~	x							x		~	x
Encrustation (DD.05)	13.3 m²	~	x							x		~	x
Soiling (DD.06)	66.4 m²	~	x							x		~	x
Most area (DD.07)	22 m²	~			x						x	~	x
Patina (DD.08)	25.4 m²	~			x	x						~	x
Total intervention area	282 m²	14.1	104	92.4	58.6	36.6	70.6	14.7	4.6	7.1	22	14.1	282
Intervention price per m² (in euro/m²)	-	5.00	15	85	100	0	20	70	200	22	2.00	110	2.65
Total intervention price (in euro)	20 k circa	71	1566	7854	5860	0	1412	1029	1420	2296	44	1551	747

Total restoration work : 20 k €
Total safety and scaffolding (+ 10%) : + 2 k €
Total technical part (+ 15%) : + 3 k €

Total without taxes : 25 k €
Total with taxes (+ 10%) : + 2.5 k €
Total with contingency (+ 6%) : + 1.5 k €

Total gross works : 29 k €

Legend :

% : Percentage of secondary cases estimated at a certain fixed value of the total area (based on on-site surveys)

x : Predefined percentage fixed at 100% of the total area

~ : Predefined risk percentage fixed at 5% of the total area

Fig 127/ Conservation measures and estimated price

PART 3 - ARCHITECTURAL PROJECT

3.1. Introduction to the whole design of the cultural center

The three next parts (the architectural project, the structural project, and the energy project) focuses on the realization of a cultural center. Each part addresses critical aspects of the building's design, construction, and operation, ensuring a comprehensive and integrated approach. Using architecture and building engineering software, it was possible to proceed with the design of the cultural centre.

The Architectural Project (Part 3) section analyzes and understands the architectural intervention, detailing how flows occur within the building, the functions of different spaces, the extension in relation to the existing building, the fire safety standards and the management of accessibility. The goal is to create a functional, safe, and welcoming environment for all users. The use of Autodesk Autocad and Rhino7 software has given a better understanding of how to design the cultural centre

The Structural Project (Part 4) section addresses the technical aspects of the design, focusing on the structural integrity of the building. It details structural characteristics such as foundations, elevation, and roofing, as well as the connections between structural elements, the loads they bear, and the sizing of the structure. Additionally, this section examines the composition of walls and floors, specifying the materials used, the type of insulation, and the thermal properties of each component. The use of the RFEM6 software has helped to design and validate the structure of the cultural center.

The Energy Project (Part 5) section explores the building's energy behavior, considering energy needs met by natural solutions (natural light, ventilation) and mechanical solutions (artificial lighting, mechanical ventilation, heating, cooling, photovoltaic panels). The aim is to minimize the building's carbon footprint while ensuring optimal comfort for its occupants. The use of Rhino7 and Grasshopper software, has helped to simulate the energy behaviour of the cultural centre and design the energy system.

3.2. Organigram

The organigram chart for the project describes a functional organisation structured around several themes. The main entrance (North), designed for visitors, leads directly to the reception area of the exhibition space or to the foyer of the event space. The secondary entrance (South), designed for employees and artists, facilitates direct access to the administrative or creation areas without disrupting the flow of visitors. The main corridor runs in a north-south direction, providing a fluid transition between the public areas, synonymous with freedom for visitors, and the private areas, synonymous with organisation for employees.

The spaces dedicated to the administrative areas of the cultural centre consist of a common room where employees can meet in private. It leads on to private offices, the archive, the storerooms and all the other living areas. The creative space is directly linked to the administrative space to facilitate good management and encourage collaboration and artistic production. It includes a workshop room and a storage area for workshops and group activities. The artists' refuge, meanwhile, is rather far from the main flow, so that workers who come to hold activities can find a rather quiet place. These spaces consist of private bedrooms, a living room with kitchen and a roof terrace.

The exhibition spaces are essential for presenting the artworks. The vast surface area allows a large number of works to be stored, and its flexibility means that it can be used for other events if there is no exhibition. The event space consists of an auditorium for conferences and shows, while the lounge area provides space for informal discussions and meetings between users.

The outdoor area complements each indoor space by embracing the cultural centre. A tree-lined walkway completes the main entrance, giving visitors the choice of entering the cultural centre or continuing to walk around it to relax and enjoy the natural surroundings. Located opposite the auditorium, the arboretum sublimates the view and creates a sense of calm inside and out. A rest and meeting area has been created close to the aula lounge to provide physical access to the outdoors. Moving further south (towards the organisational areas), an outdoor events courtyard, linked to the administrative area can be found. Finally, car parks have been installed near the secondary entrance to enable workers to get there as easily as possible.

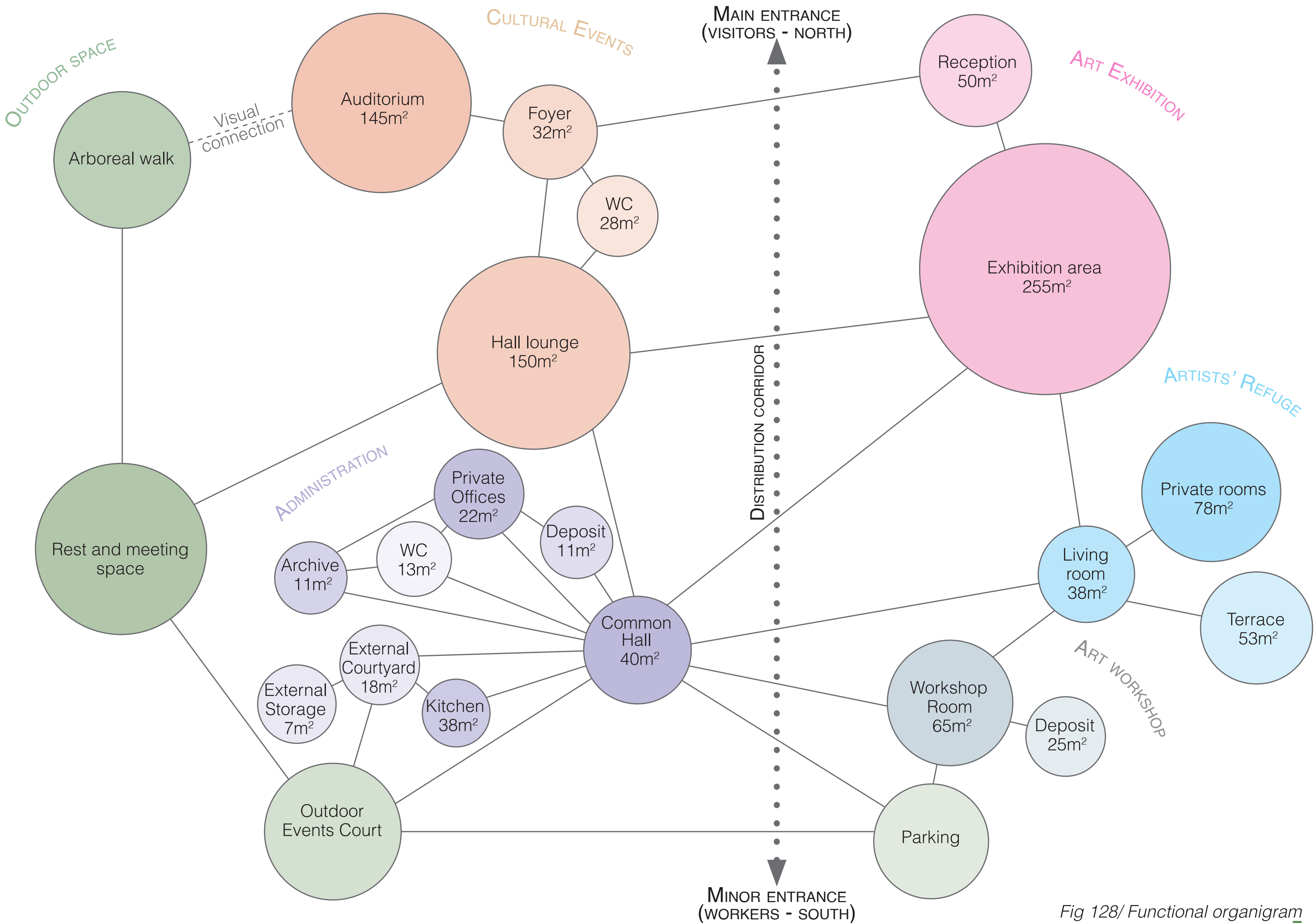


Fig 128/ Functional organigram

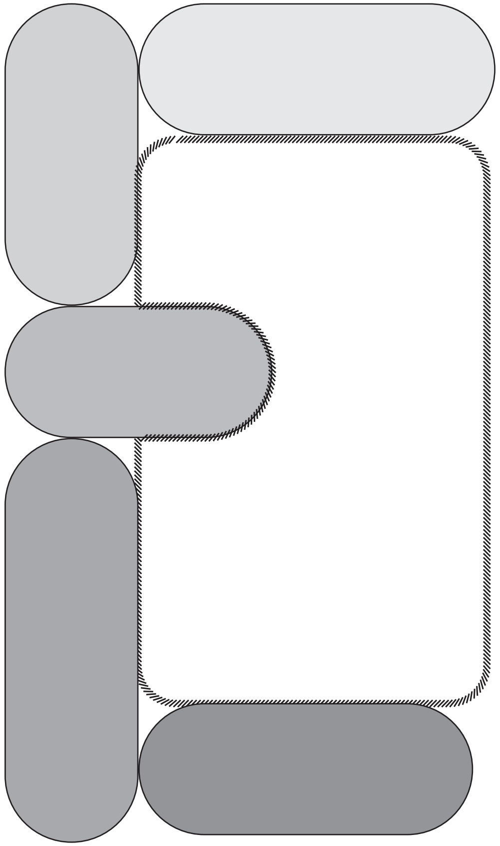


Fig 129/ Thematic sorting concept adapt to the project

The existing and new volume works as visual separation while welcoming the indoor activities of a proper cultural center.

Possible outdoor display in front of the entrance (inspiring)

Arboretum and promenade (serene and somehow still inspiring)

Wooded rest and meeting space nested next to the arboretum (relaxing)

Extended area of the rest and meeting space without trees (collective, yet festive or relaxing)

Outdoor events court (festive or captivating)

3.3. Architectural concept

The architectural concept of the Espace Culturel des Granges Collières is rooted in creating a dynamic cultural green space that revitalizes the neighborhood and serves as the heart of the district. This vision is realized through the integration of a modern cultural center at the core of the site, offering both indoor and outdoor spaces. It encourages a harmonious balance between indoor and outdoor activities, promoting community engagement and personal relaxation. As a result, it enriches the life of the neighborhood and aspires to regional ambitions.

Educational spaces foster personal growth and skill development, providing essential resources, while recreational spaces offer venues for leisure activities and social gatherings. These areas support lifelong learning and enhance the overall educational landscape, attracting individuals from the region seeking to expand their knowledge, and improve the quality of life in the neighborhood by providing places for residents to relax and interact.

Exhibition spaces are designed for showcasing art and cultural displays, while creative spaces support artistic expression and innovation. They enrich the neighborhood by providing platforms for local artists and residents to experience or take part in diverse forms of art. These spaces also attract visitors from afar, promoting cultural tourism and contributing to the area's cultural vibrancy and economic development.

Administrative spaces are crucial for efficiently managing the center's activities, ensuring smooth operations and providing resources for organizing local events but also supporting the coordination of larger regional initiatives. Private lodging for visiting artists, lecturers, or guests fosters cultural exchange and collaboration, making it easier to organize extensive cultural events.

The outdoor event courtyard hosts cultural events, becoming a focal point for neighborhood gatherings and celebrations, and serving as a landmark venue for large-scale events, contributing to the district's cultural identity. Rest and meeting spaces offer tranquil settings that enhance social ties and provide peaceful retreats, promoting hospitality and connection. The arboreal walk provides a scenic pathway surrounded by trees, encouraging outdoor activities and promoting physical well-being. It also becomes a destination for nature enthusiasts and tourists, stopping by during their Loire à Vélo journey for instance, enhancing the area's appeal as a green, healthy environment.

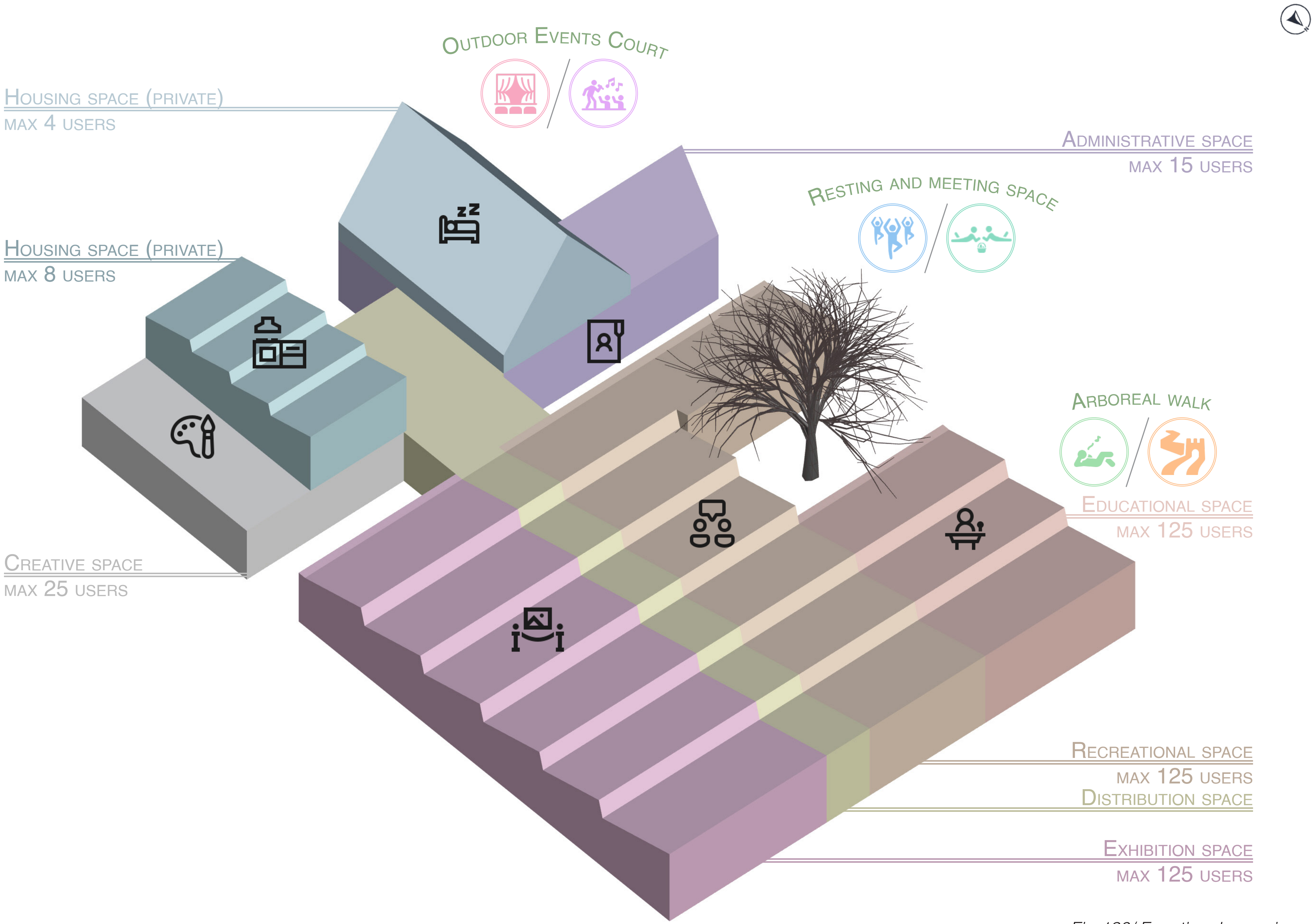


Fig 130/ Functional organigram

Fig 131/ Lieu totem de la French Tech, Lyon
by AIA Life Designers, Theme of the shed roof and the truss beam

Fig 132/ Fondation Beyeler, Basel
by Renzo Piano, Theme of curtain walling and external bonding

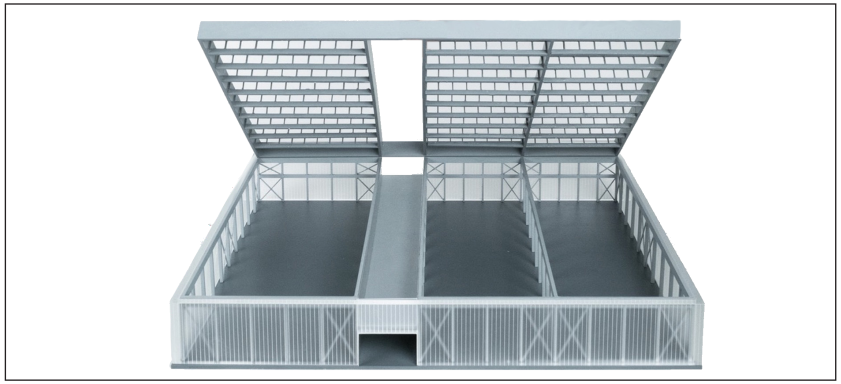


Fig 133/ Piazza della frutta, San donà di piave
by ETB, Theme of interior layout and space distribution

The main facade of the building is characterized by its clean lines and the use of modern materials such as glass and steel. This design choice not only enhances the aesthetic appeal but also allows for abundant natural light to permeate the interior spaces, creating a bright and welcoming environment.

The shed roof with north-oriented glass maximizes natural light and ventilation while optimizing the potential for solar panels on the south-facing side. The design prioritizes the use of natural and warm materials to create an inviting atmosphere conducive to creativity. This design ensures optimal natural light and ventilation while supporting the effective use of solar panels on the south-facing roof as seen in the Lieu Totem de la French Tech in Lyon.

The continuous facade strengthens the connection between the interior and exterior, providing views of the site's natural elements and contrasting with the existing structures. The continuous facade, inspired by the Fondation Beyeler in Basel by Renzo Piano enhances the building's integration with its natural surroundings, offering views of the site's greenery and creating a dialogue between the interior spaces and the external environment. This facade contrasts with the existing opaque structures, further highlighting the modern approach of the new design.

The internal layout and spatial distribution of the Espace Culturel des Granges Collières draw inspiration from the architectural principles observed in the Piazza della Frutta in San Donà di Piave, designed by ETB. This approach emphasizes the creation of open, flexible spaces that facilitate both community interaction and individual activities within a cohesive environment. The interior layout is designed to promote a smooth flow and interaction among various spaces. The open and flexible areas accommodate a wide range of functions, from exhibitions and performances to workshops and administrative activities. This flexibility ensures that the facility can adapt to diverse cultural and community activities, making it a versatile hub for the neighborhood. The internal layout and north-south flow enhance the site's attractiveness from the north and propose very open and flexible spaces, facilitating a smooth transition from public to private areas.

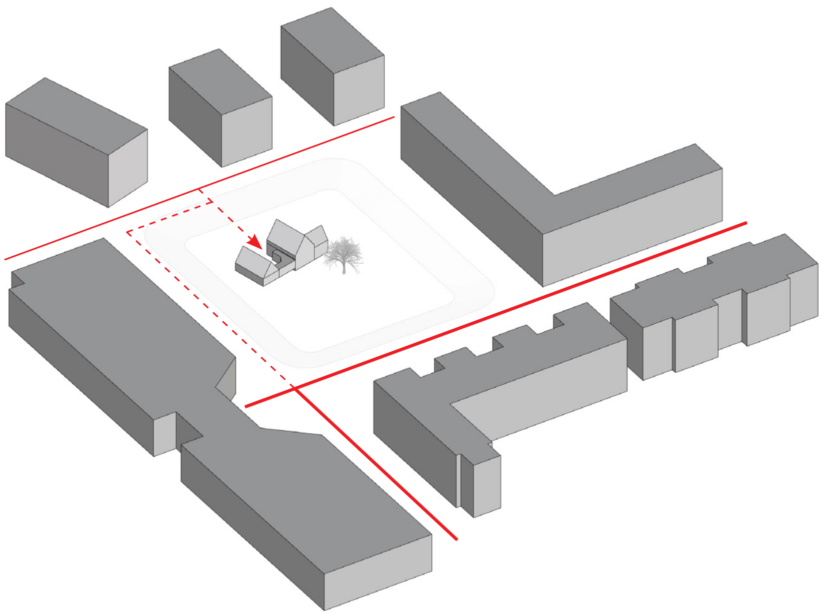


Fig 134/ State of facts, flows and access

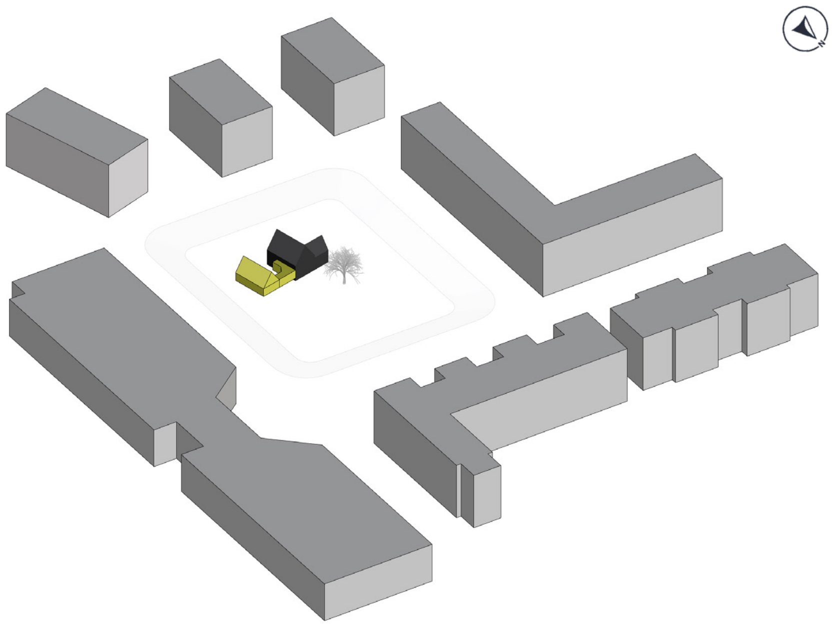


Fig 135/ Demolition

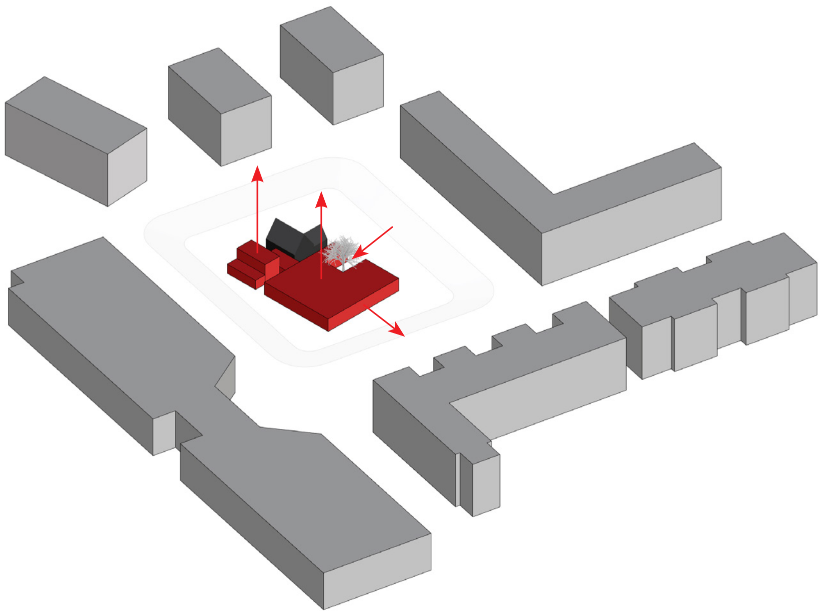


Fig 136/ Addition

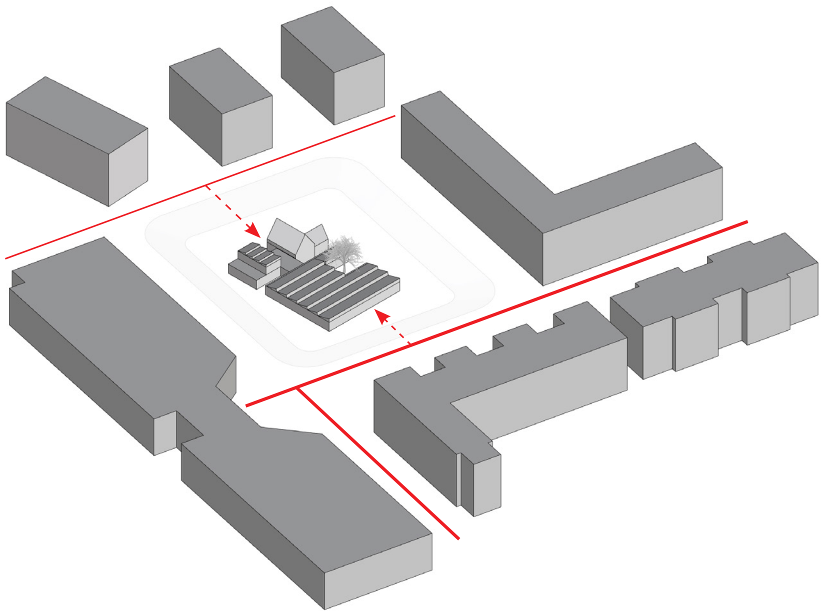
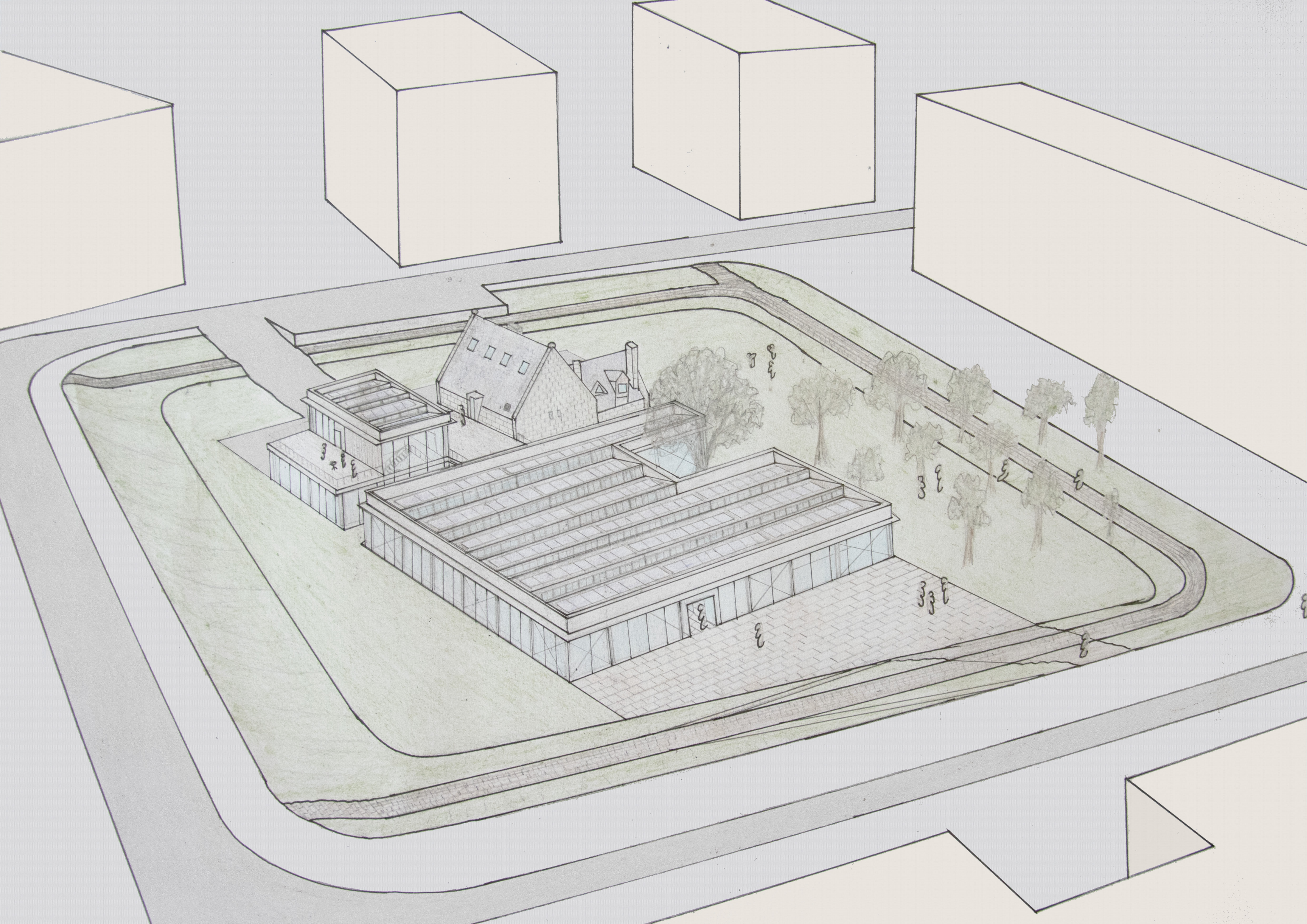


Fig 137/ State of project, flows and access

Fig 138/ Bird's eye view of the project >>
(from north east)



3.4. Description of the cultural center

The project is designed to foster a connection between various functional spaces, creating a cohesive environment that balances indoor and outdoor activities while addressing accessibility and usability.

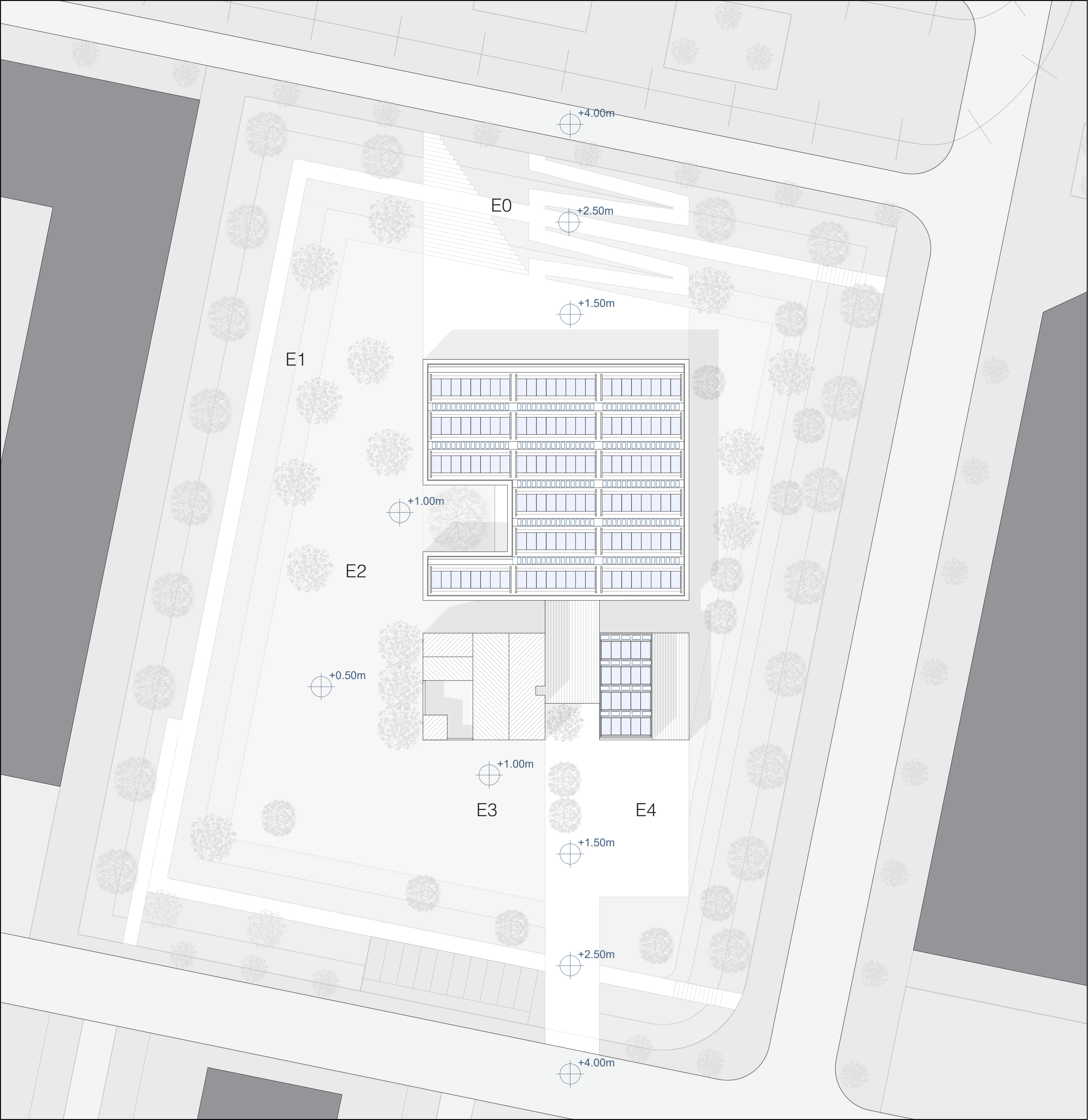
The reorientation of the building towards the north significantly enhances its attractiveness by aligning it closer to the main visitor flow. The primary entrance to the site, accessible via stairs or a ramp, leads to an entrance plaza. This plaza not only serves as a gathering space where visitors can congregate before entering the building, but it also doubles as an outdoor exhibition area, offering flexibility in its use.

Surrounding the site is an arboreal walk with a preserved brick pathway that promotes a scenic route around the area. This pathway allows for transit within the site, giving visitors the feeling of leaving the urban environment without entering the cultural center directly. The arboretum, which is part of this walk, aims to reforest the site, providing essential shade, noise reduction, and a boost to biodiversity. The visual link established by the continuous facade of the new building between the arboretum and the auditorium fosters a dialogue between indoor and outdoor spaces, enhancing the overall aesthetic and functional appeal.

Adjacent to the arboretum, a designated rest and meeting space offers a more intimate setting for users to gather, rest, and relax in the shade of trees. This area is directly connected to the lounge room inside the building, allowing for an easy transition between indoor comfort and outdoor relaxation.

The project includes an outdoor event court, an urbanized area designed to host various cultural events such as festivals, exhibitions, and fairs. During the summer, this space can be transformed with temporary stands and picnic benches, making it a vibrant hub of activity.

Additionally, a modest parking area provides access for workers and emergency services, while other users can utilize off-site parking or the shopping center parking located nearby.



E0 - Stairs and main plaza

E1 - Arboreal walk

E3 - Rest and meeting space

E3 - Outdoor event court

E4 - Parking

< *Fig 139/ Espace culturel's masterplan*

The internal layout of the Espace Culturel des Granges Collières is meticulously planned to facilitate smooth movement and interaction between different areas. Visitors enter the building through a spacious main corridor, which extends over 85 m^2 and sets the tone for the overall experience by leading them from the entrance plaza into the heart of the cultural center.

The foyer, encompassing 32 m^2, serves as a welcoming introductory area where visitors can gather before exploring further into the 145 m^2 auditorium, which acts as the central venue for performances, conference and showcases. Conveniently located within the center are the restrooms, occupying 28 m^2, ensuring accessibility for all visitors.

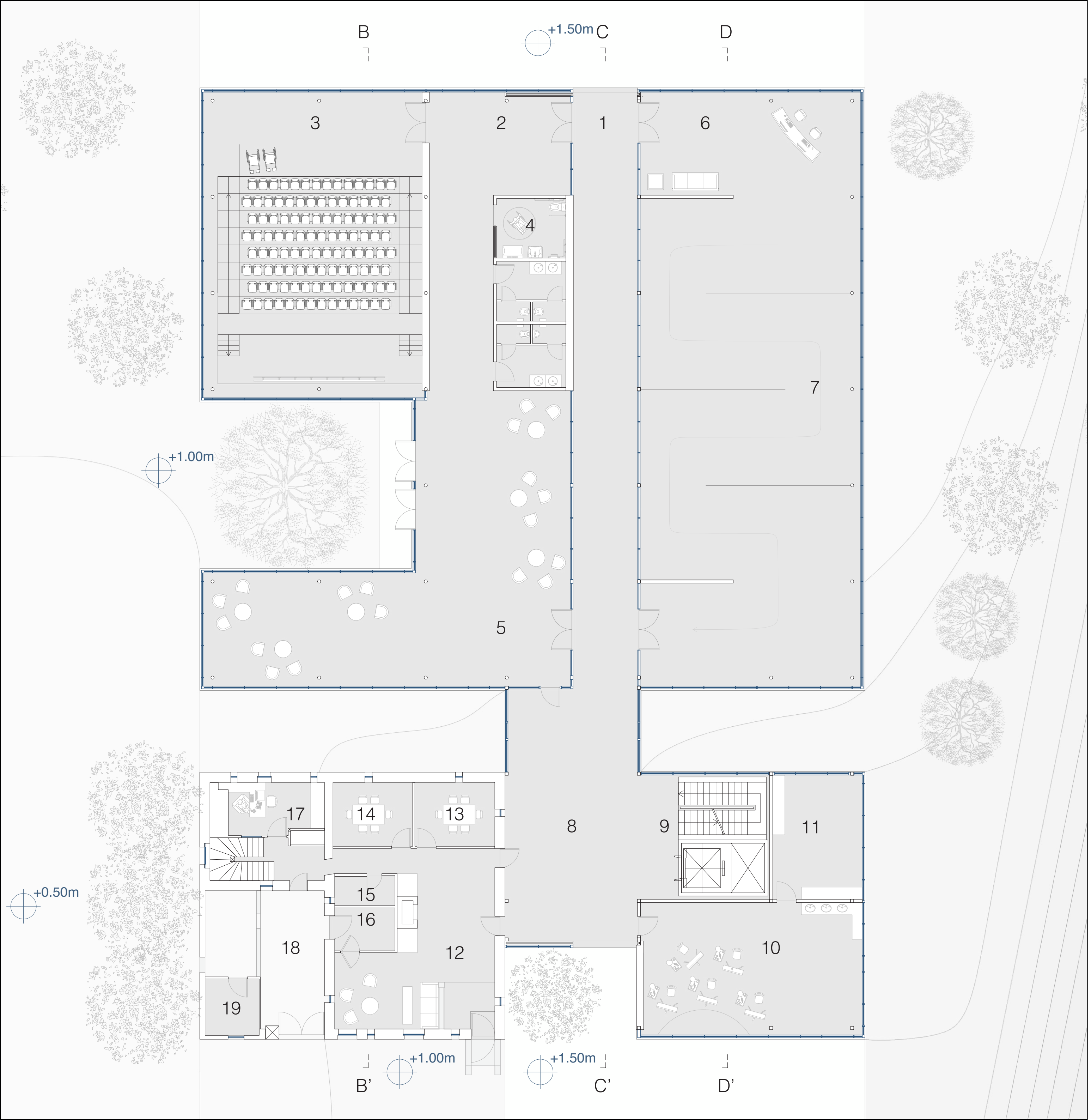
The lounge room, an expansive 150 m^2 area, provides a relaxed environment for socializing and informal meetings. An acces to the outdoor environnement enables visitor to move freely inside and out from the cultural center, putting first and foremost the free will of the visitor and the link between indoor and outdoor environnement.

The 50 m^2 reception area is the main point of contact and information, guiding visitors to their destinations with ease into the large exhibition area, covering 255 m^2. This area is dedicated to displays and connects seamlessly with other public areas, allowing for an uninterrupted flow of visitors. The flexibility of this space, where the room can be divided by display panels, or removed to create a vast uninterrupted room, points out the capacity of the cultural center to adapt its activities.

A 74 m^2 distribution space acts as a central nucleus between the new building and the old one. It enables to reunite the private spaces, designed for workers and artists, to the publics ones, designed for visitors.

The 65 m^2 workshop area is specifically designed for hands-on activities and creative programs, fostering an environment of innovation and learning. This spaces is complemented by a 25 m^2 storage space for equipment.

Administrative tasks are efficiently managed within a 40 m^2 shared office space and two private offices each measuring 11 m^2. Theses paces helps promoting organized and effective operations or more quiet and dedicated ones. Important documents and records are securely stored in an 11 m^2 archive in the weastern wind of the ancestral building. Supporting the needs of staff and visitors, the center includes a 4m^2 storage instead of the toilets which are now concentrated upstairs .



1 - Entrance / Main corridor : 85 m²

2 - Foyer : 32 m²

3 - Auditorium : 145 m²

4 - Restrooms : 28 m²

5 - Lounge hall : 150 m²

6 - Reception : 50 m²

7 - Exhibition area : 255 m²

8 - Distribution area : 74 m²

9 - Vertical connect : 38 m²

10 - Workshop : 65 m²

11 - Storage : 25 m²

12 - Administrative room : 40 m²

13 - Private office : 11 m²

14 - Private office : 11 m²

15 - Kitchen : 6 m²

16 - Storeroom : 4 m²

17 - Archive : 11 m²

18 - Outside courtyard : 32 m²

19 - Outside storeroom : 7 m²

< *Fig 140/ Cultural center's ground floor plan*

At both the ground floor and the elevated floor, vertical connections within the building, encompassing 38 m^2, include stairways and elevators that enable easy access between different floors.

The elevated floor is designed for ponctual workers, such as artists, that comes in the cultural center to performs or hold artistic activities or conferences.

A shared living room and kitchen, spanning 38 m^2, fosters social interaction and dining amoung the artist and / or the administration, creating a communal atmosphere.

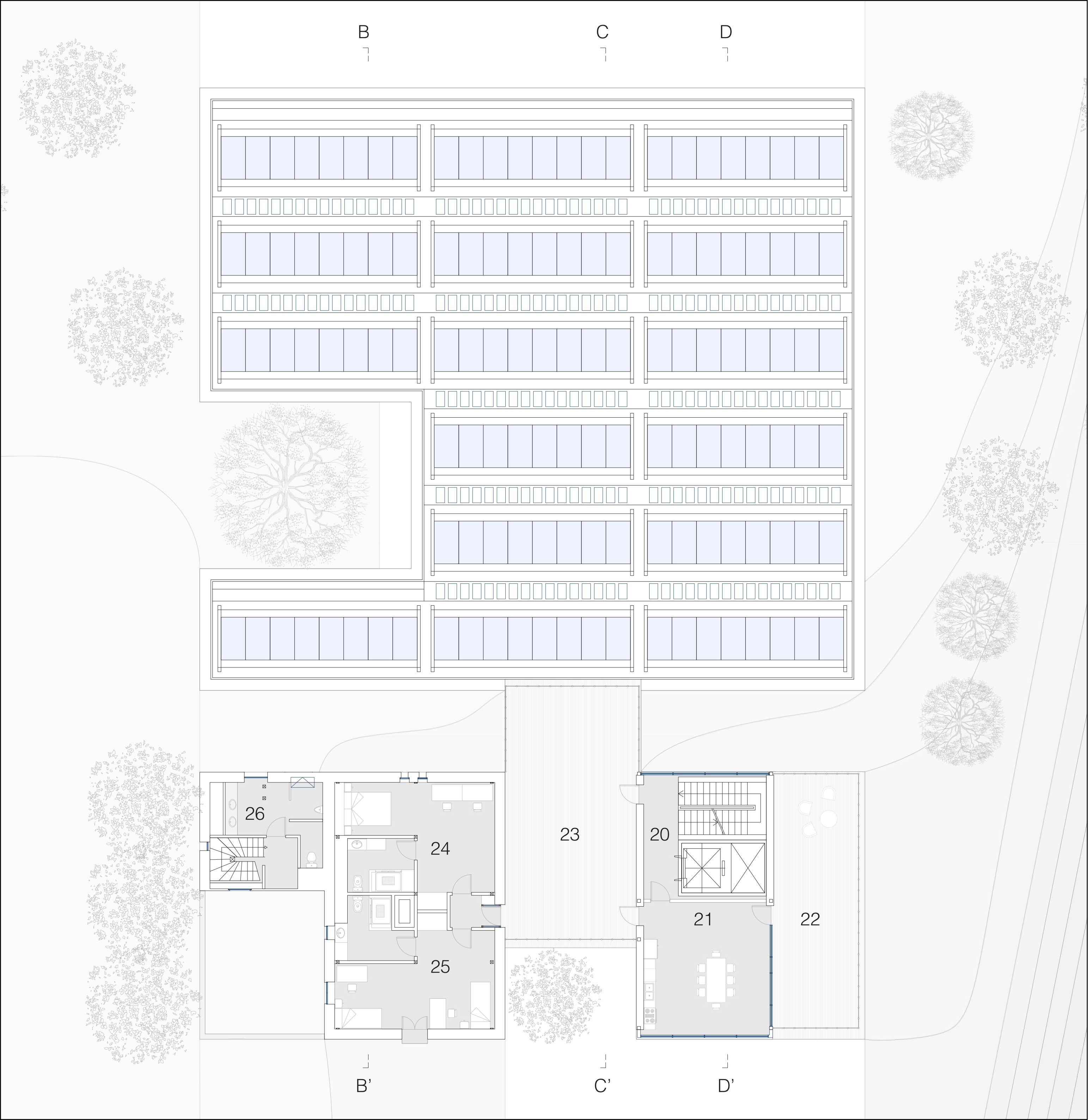
The 53 m^2 terrace offers an outdoor relaxation space that is seamlessly connected to indoor areas, allowing for a blend of indoor comfort and outdoor enjoyment.

An external dock, measuring 77 m^2, is designed for outdoor activities and interactions, further extending the center's versatile use, but first and foremost to reach the privated rooms of the artists. The private rooms with attached bathrooms, each measuring 38 m^2 and 40 m^2 respectively, provide comfort and privacy for guests or staff. Restroom facilities on the upper floor, occupying 13 m^2, ensure convenience for all users.

As a result, the elevated floor of the ancestral building (building A) and the modern extension (new building B) are now connected to each other by the same vertical distribution.

However, the western wind of the ancestral building (building C) is still separated from the other spaces and accessible from the staircase located next to the archive room in the administrative area. It concentrates now the toilets for the workers of the cultural center.

The shed roof of the modern extension allows solar panels to be placed in the best possible orientation, facing directly south with a pitch of 15°. For aesthetic reasons, and to avoid giving the new building an overly industrialt tone, an aluminium acroterion has been installed on the perimeter of the roof to hide the shed roof from the outside. It then enable to give less impact to the shed roof from the outside : The modern extension can still keep it clean and refine look so that the ancestral farmhouse can have more presence.



20 - Vertical connection : 38 m²

21 - Shared living room (and kitchen) : 38 m²

22 - Terrace : 53 m²

23 - External pontoon : 77 m²

24 - Private room with bathroom : 38 m²

25 - Private room with bathroom : 40 m²

26 - Private restroom : 13 m²

< *Fig 141/ Cultural center's elevated floor plan*

Fig 142/ View on the main entrance of the project >>
(from north west)

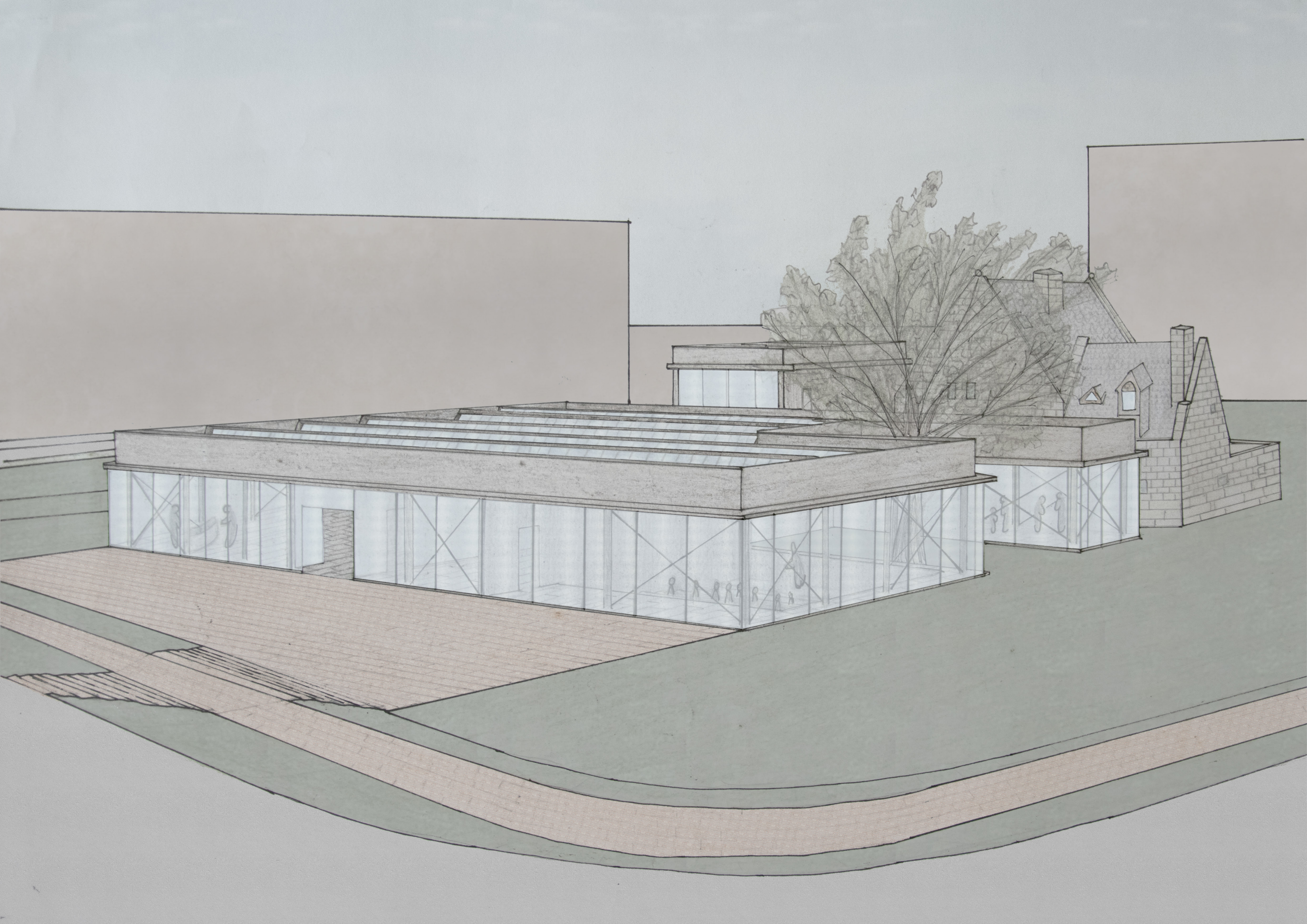


Fig 143/ South elevation of the cultural center

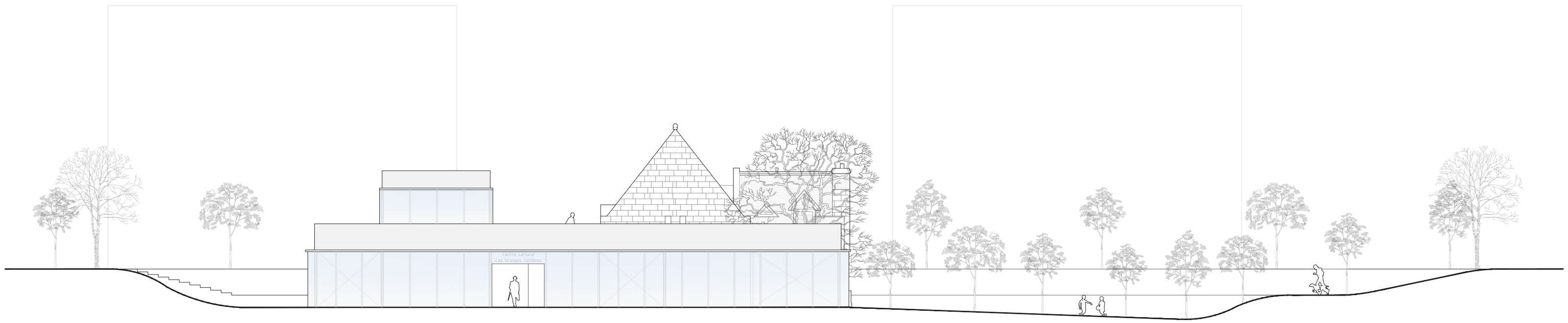


Fig 144/ North elevation of the cultural center

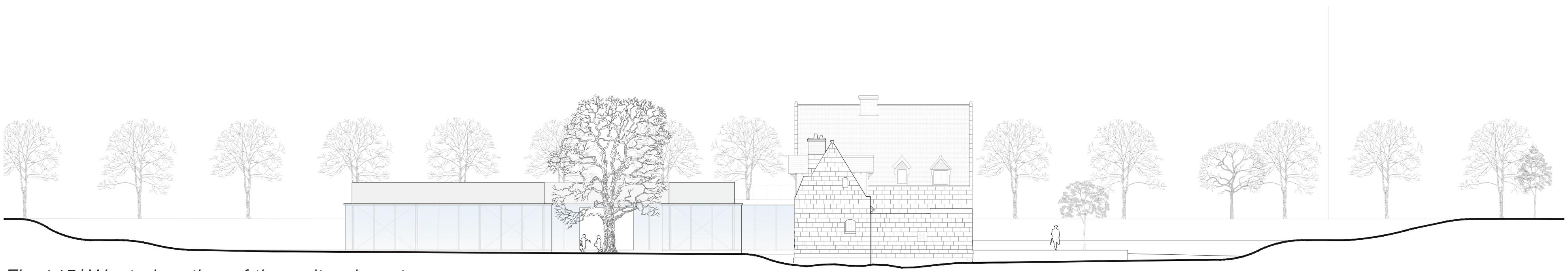


Fig 145/ West elevation of the cultural center

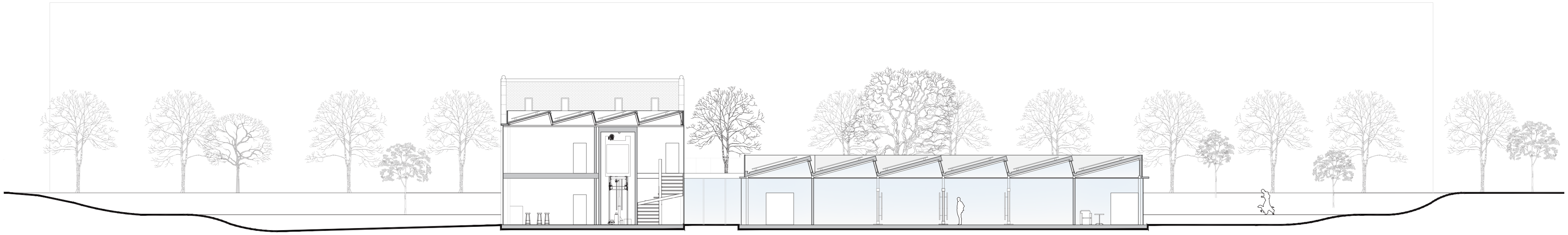


Fig 146/ Section DD' of the cultural center
(from east)

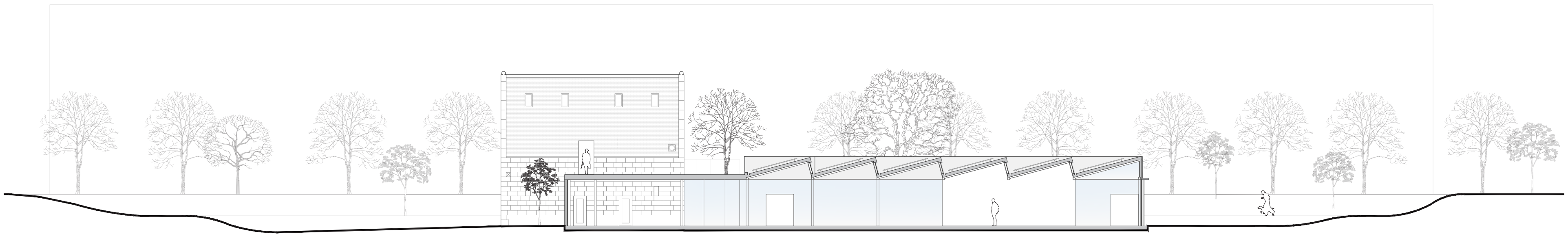


Fig 147/ Section CC' of the cultural center
(from east)

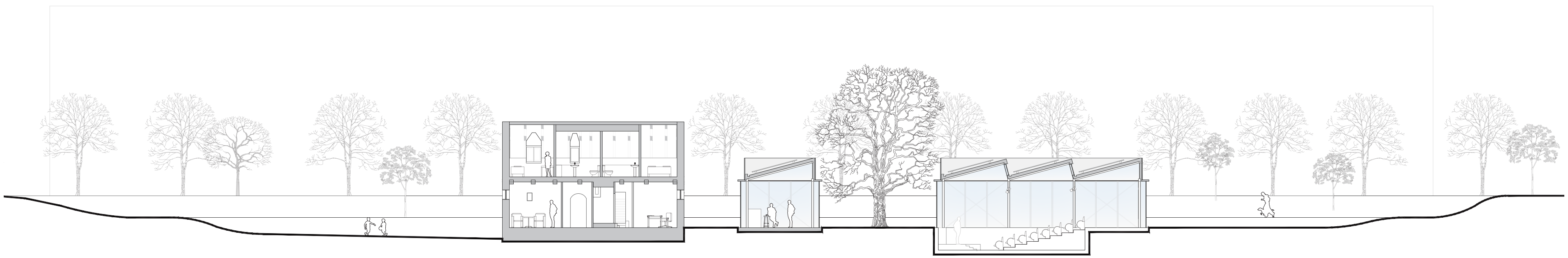


Fig 148/ Section BB' of the cultural center
(from east)

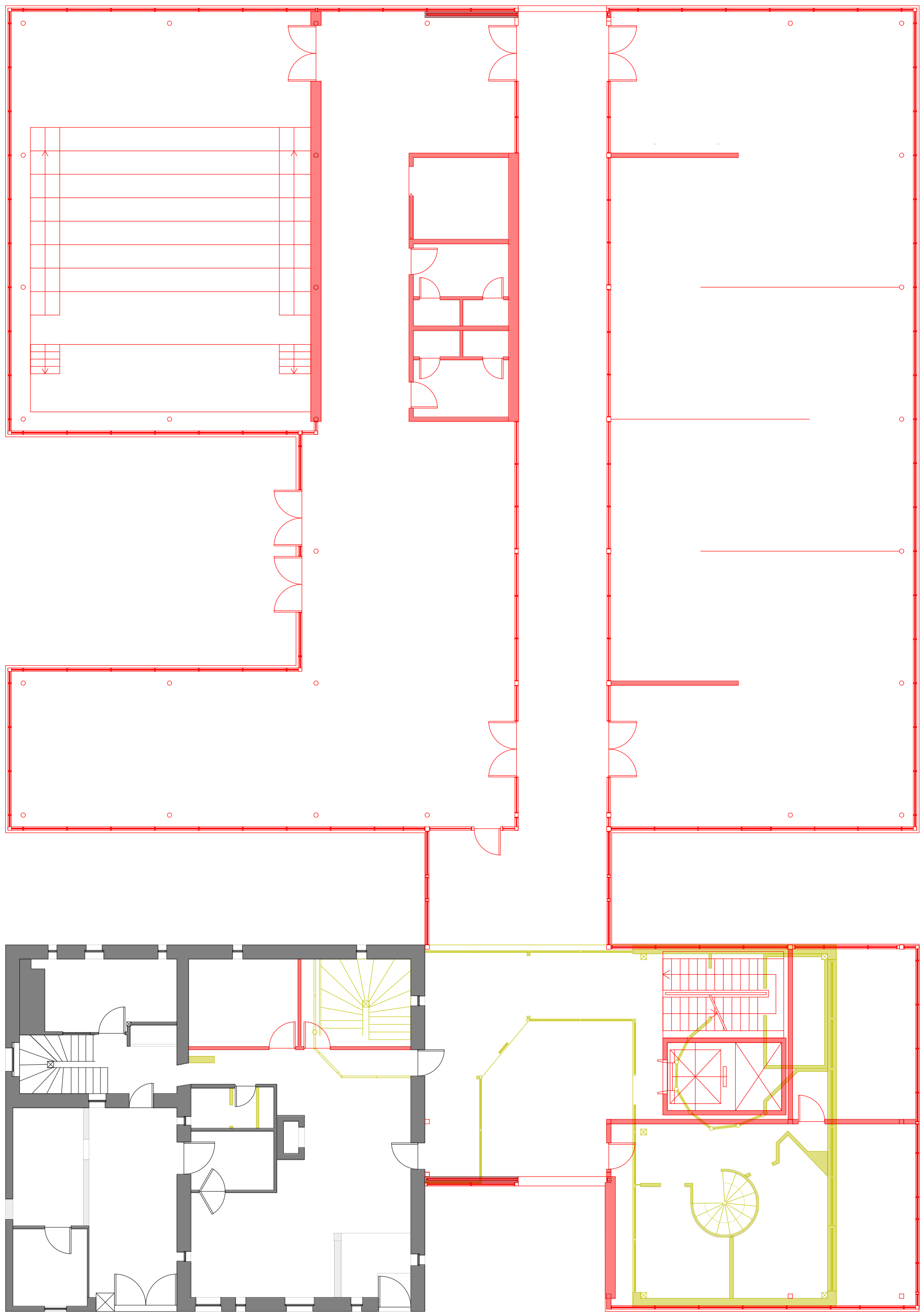
Fig 149/ View indoor on the exhibition hall >>

3.5. Construction and demolition

By wanting to extend the existing building into a modern cultural center, it is essential to reference relevant laws and regulations to ensure the project's compliance and alignment with national guidelines. Two critical legislative documents that support such an initiative are the regulations on extensions and modifications of establishments receiving the public (ERP) by the French Ministry of the Interior and the «Loi Malraux» (Law No. 62-903 of August 4, 1962) concerning the restoration of protected sectors by the French Ministry of Cultural Affairs.

The Ministry of the Interior's regulations on ERP extensions and modifications, submitted on June 25, 1980, outline the legal framework governing the expansion of buildings intended for public use. According to these regulations, any extension project must ensure that the modified establishment continues to meet safety, accessibility, and operational standards. These comprehensive guidelines are pivotal in ensuring that public buildings, especially those serving as cultural hubs, provide a safe and welcoming environment for all users. The law mandates that extended buildings must incorporate modern safety features such as advanced fire suppression systems, clear evacuation routes, and accessibility provisions for individuals with disabilities. By adhering to these regulations, the extension project not only modernizes the existing building but also enhances its functionality and safety, making it more suitable as a cultural center. This regulation will be explained in depth in the two next paragraphs on fire safety and accessibility for all

The regulations emphasize also the importance of maintaining architectural harmony between the existing structure and the new extension. This requirement ensures that the extension does not detract from the aesthetic value of the original building but rather complements and enhances it. In the context of transforming the building into a cultural center, this architectural cohesion can serve to preserve the historical and cultural significance of the original structure while providing a modern, functional space that meets contemporary needs. The seamless integration of new and old elements can elevate the cultural center's appeal, attracting visitors and fostering a deeper appreciation for the site's historical legacy. That's why it was chosen to use glazed surface, allowing therefore to still enjoy the aestetic of the traditional material used in the region of the Touraine.



Existing

Addition

Demolition

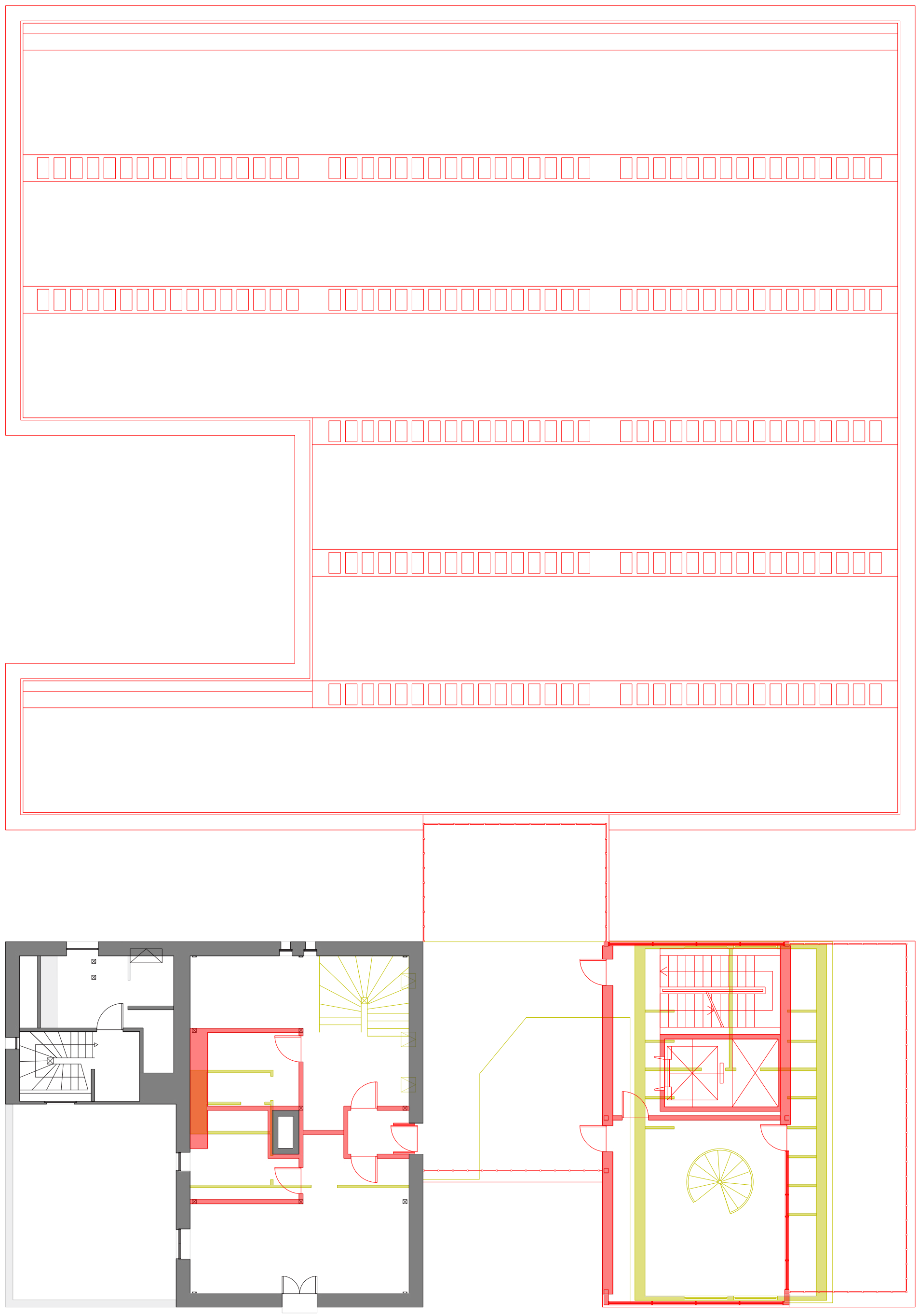
< *Fig 150/ Demolition and addition plan of the ground floor*

Furthermore, the «Loi Malraux» (Law No. 62-903 of August 4, 1962), known for its role in protecting and restoring historic urban sectors, provides a robust legal foundation for the extension of historic buildings. This law recognizes the need to balance preservation with modernization, allowing for extensions that respect the historical and cultural heritage of the site. The «Loi Malraux» supports projects that aim to revitalize historic buildings by repurposing them for contemporary use, provided that the extensions do not compromise the integrity of the original structure. This legislation is crucial for ensuring that the new development harmonizes with the existing urban fabric, preserving the character and charm that define historic districts.

The «Loi Malraux» also encourages the adaptive reuse of historic buildings, promoting their conversion into public cultural spaces. This law underscores the significance of cultural centers as vital community assets that contribute to the cultural and social fabric of urban areas. By extending the existing building to create a modern cultural center, the project aligns with the objectives of the «Loi Malraux» by preserving the historical essence of the structure while enhancing its utility and accessibility for public use. The adaptive reuse of the building can breathe new life into the site, making it a focal point for cultural activities and community engagement.

In addition to these legislative frameworks, the project must consider environmental guidelines. Modern extensions should incorporate energy-efficient systems and suitable materials to reduce the carbon footprint. These considerations not only align with contemporary architectural trends but also comply with broader environmental regulations aimed at reducing the ecological footprint of new constructions.

The integration of these legislative guidelines into the extension project justifies the transformation of the existing building into a modern cultural center. The adherence to safety, accessibility, and architectural harmony as stipulated by the Ministry of the Interior's regulations ensures that the new cultural center will be a safe, inclusive, and aesthetically coherent space. Meanwhile, the principles outlined in the «Loi Malraux» support the preservation and revitalization of historic buildings, allowing them to serve contemporary functions while maintaining their cultural significance. These dual considerations ensure that the project respects the past while embracing modern needs and technologies.



■	Existing
■	Addition
■	Demolition

< *Fig 151/ Demolition and addition plan of the elevated floor*

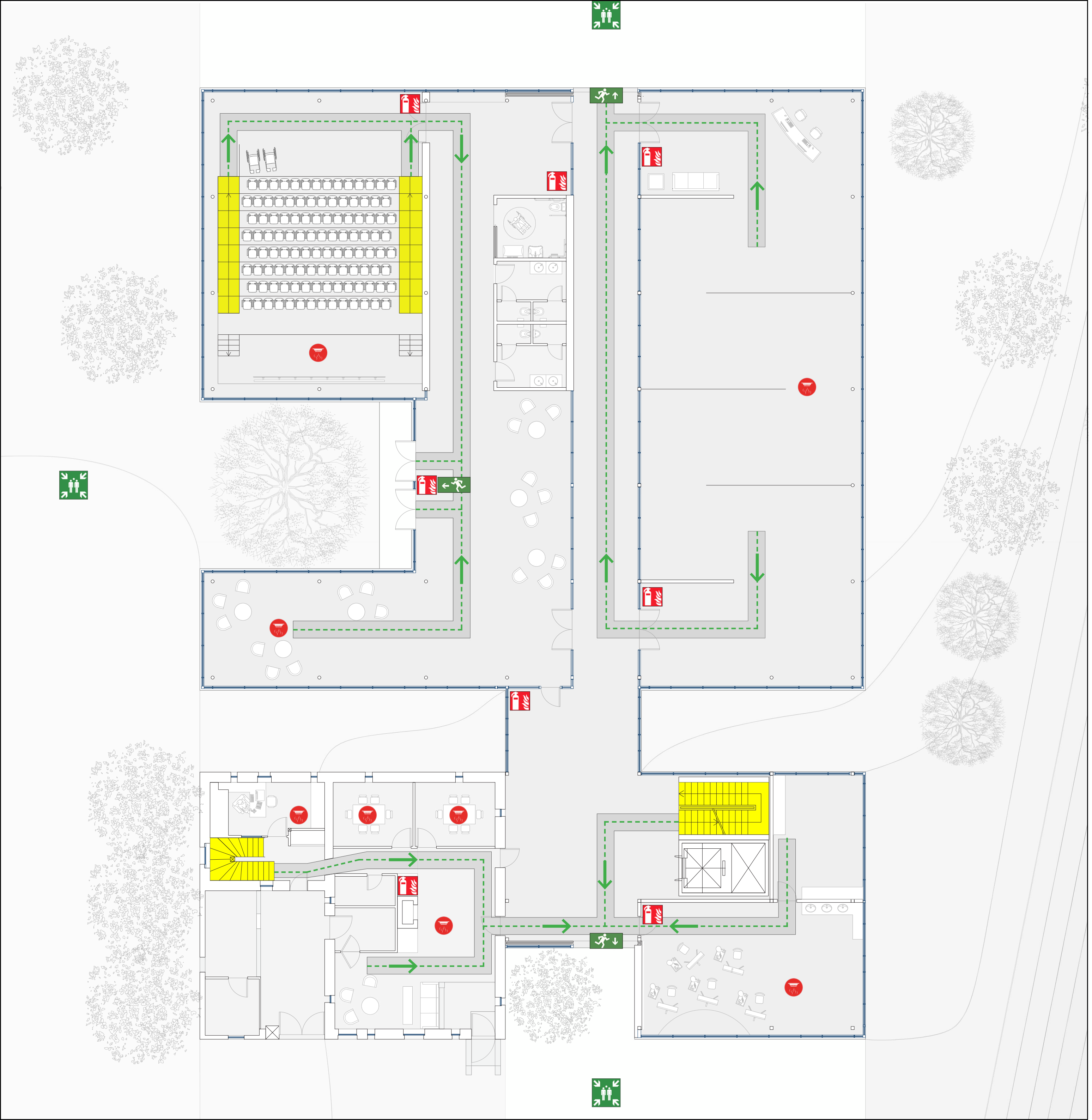
3.6. Fire evacuation

After having studied the reglementation on the extension of the building, it is now explained fire safety and evacuation standards to respect. The project compliance not only ensures the safety of the building's occupants but also aligns with national and international regulations, thereby legitimizing the project's implementation. Key legislative documents and guidelines that support this initiative include the Code du Travail, regulations from the Institut National de Recherche et de Sécurité (INRS), the Arrêtés of June 25, 1980, and June 22, 1990, and the NF S 61-937 standards.

The Code du Travail, specifically Articles R. 4216-1 to R. 4216-34, provides a comprehensive legal framework for workplace safety, including fire safety measures. According to these articles, any public building, especially one receiving the public such as a cultural center, must implement rigorous fire prevention and evacuation protocols. These protocols include the installation of fire detection systems, the provision of adequate firefighting equipment, and the establishment of clear and accessible evacuation routes. By adhering to these regulations, the extension project ensures that the cultural center is equipped to prevent fire incidents and manage emergencies effectively, safeguarding the lives of its occupants.

The Institut National de Recherche et de Sécurité (INRS) further reinforces these safety measures by providing specific regulations and reference texts on fire safety in the workplace. According to INRS guidelines, fire safety management involves regular maintenance of fire detection systems, the strategic placement of firefighting equipment, and the training of staff and visitors in fire response procedures. These measures are essential for creating a safe environment within the cultural center, ensuring that all stakeholders are prepared in case of a fire emergency. The INRS guidelines also emphasize the importance of regular fire drills and the updating of safety protocols to align with the latest safety standards.

The NF S 61-937 standards provide detailed guidelines for fire safety, including the construction and maintenance of fire-resistant structures, the implementation of automatic fire detection and alarm systems, and the creation of fire response plans. These standards ensure that the cultural center is built and maintained to the highest fire safety specifications, minimizing the risk of fire incidents and enhancing the overall resilience of the building.



Horizontal distribution

Vertical distribution

Escape route

Emergency exit

Safe place

Fire extinguisher and fire alarm

Smoke detector

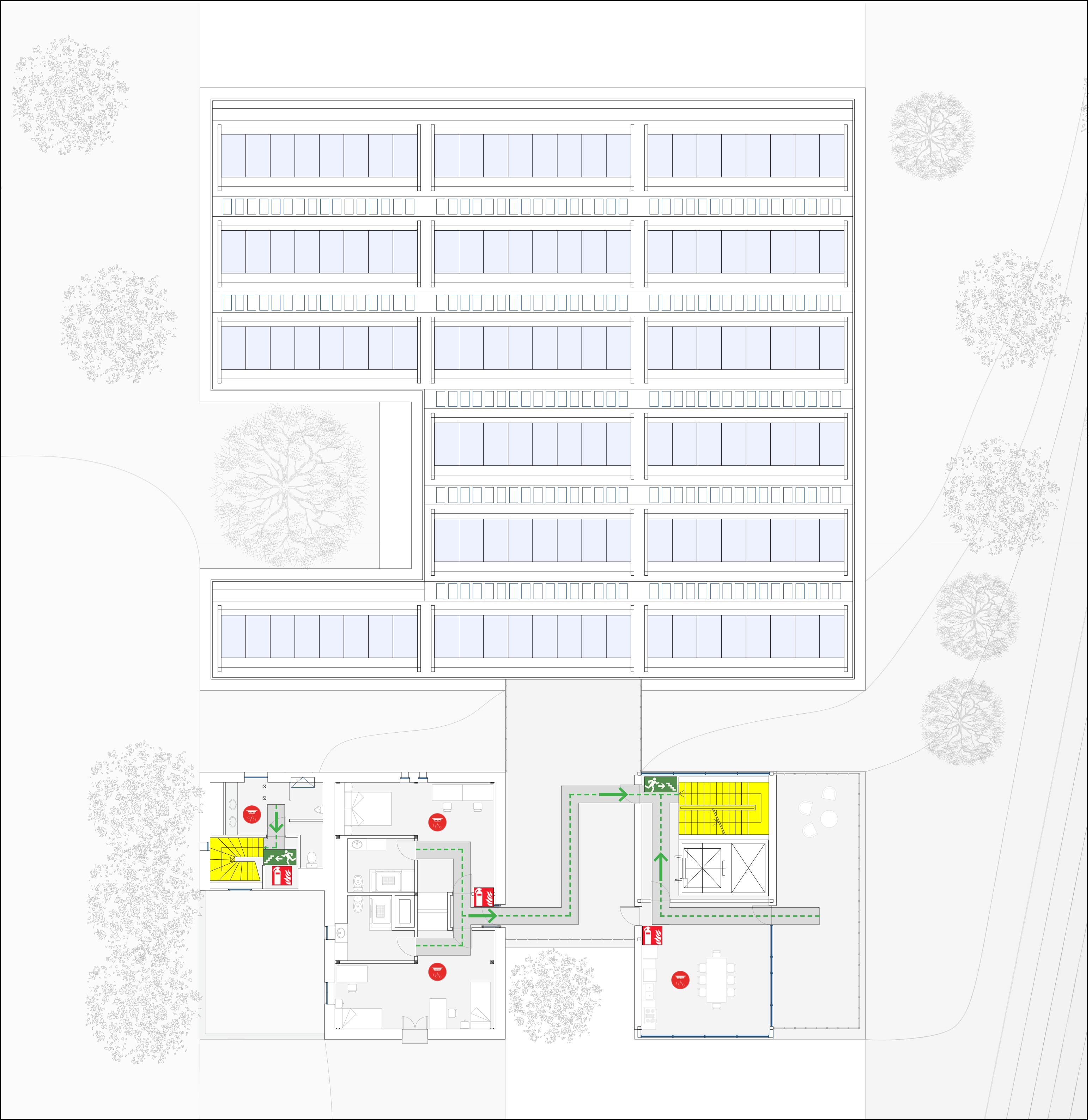
< *Fig 152/ Fire evacuation plan of the ground floor*

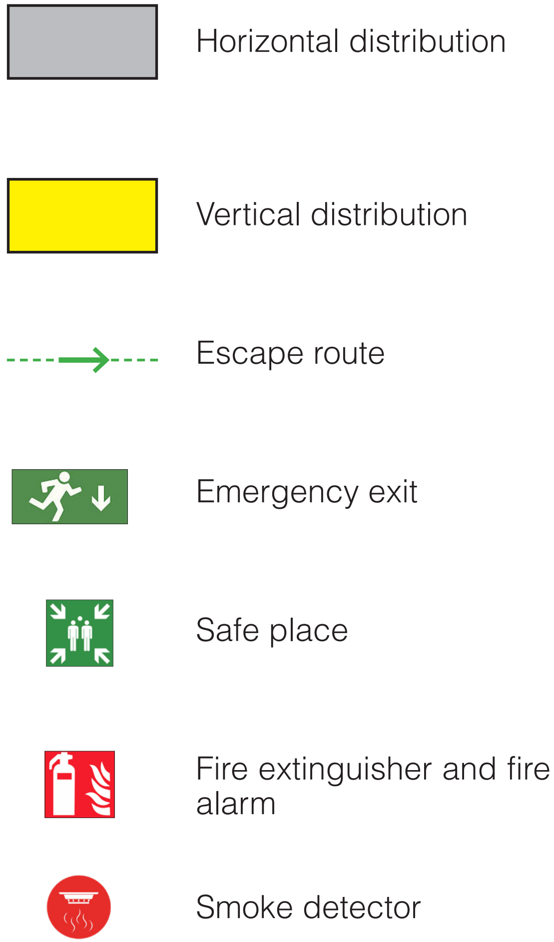
Additionally, the Arrêté of June 25, 1980, specifically Article CO 13, stipulates the placement of portable fire extinguishers at regular intervals along escape routes, with a maximum distance of 15 meters between two extinguishers. This requirement ensures that firefighting equipment is readily accessible in case of an emergency. The article also mandates the installation of smoke detectors in conference rooms, exhibition halls, offices, private rooms, and shared kitchens. These smoke detectors provide early warning in the event of a fire, enabling timely evacuation and reducing the risk of harm to occupants.

The Arrêté of June 22, 1990, particularly Article AM 7, addresses the proximity of emergency exits. It specifies that exits must be arranged to ensure rapid and efficient evacuation, with no occupant required to travel more than 30 meters from any point within the building to reach an exit. This regulation is crucial for preventing congestion and panic during evacuations, allowing for a smooth and orderly exit from the building. The strategic placement of exits in accordance with this regulation enhances the safety and accessibility of the cultural center, making it a secure environment for large public gatherings.

Integrating these legislative and regulatory guidelines into the design and operation of the cultural center ensures that it meets the highest standards of fire safety and evacuation preparedness. The compliance with the Code du Travail and INRS regulations ensures a proactive approach to fire safety management, emphasizing prevention, detection, and response. The implementation of the NF S 61-937 standards guarantees that the building's structural integrity and fire response systems are robust and reliable. Finally, the adherence to the Arrêtés of June 25, 1980, and June 22, 1990 ensures that firefighting equipment is strategically placed and that emergency exits are optimally positioned for rapid evacuation.

By following the guidelines set out by the Code du Travail, INRS, and the relevant Arrêtés, the project ensures a safe and secure environment for all occupants. The integration of these regulations into the building's design and operational protocols not only enhances the safety and functionality of the cultural center but also reinforces its role as a responsible and sustainable public establishment. This comprehensive approach to fire safety and evacuation preparedness will make the cultural center a benchmark for safety standards in public buildings, providing peace of mind to visitors and contributing to the overall safety infrastructure of the region.





< *Fig 153/ Fire evacuation plan of the elevated floor*

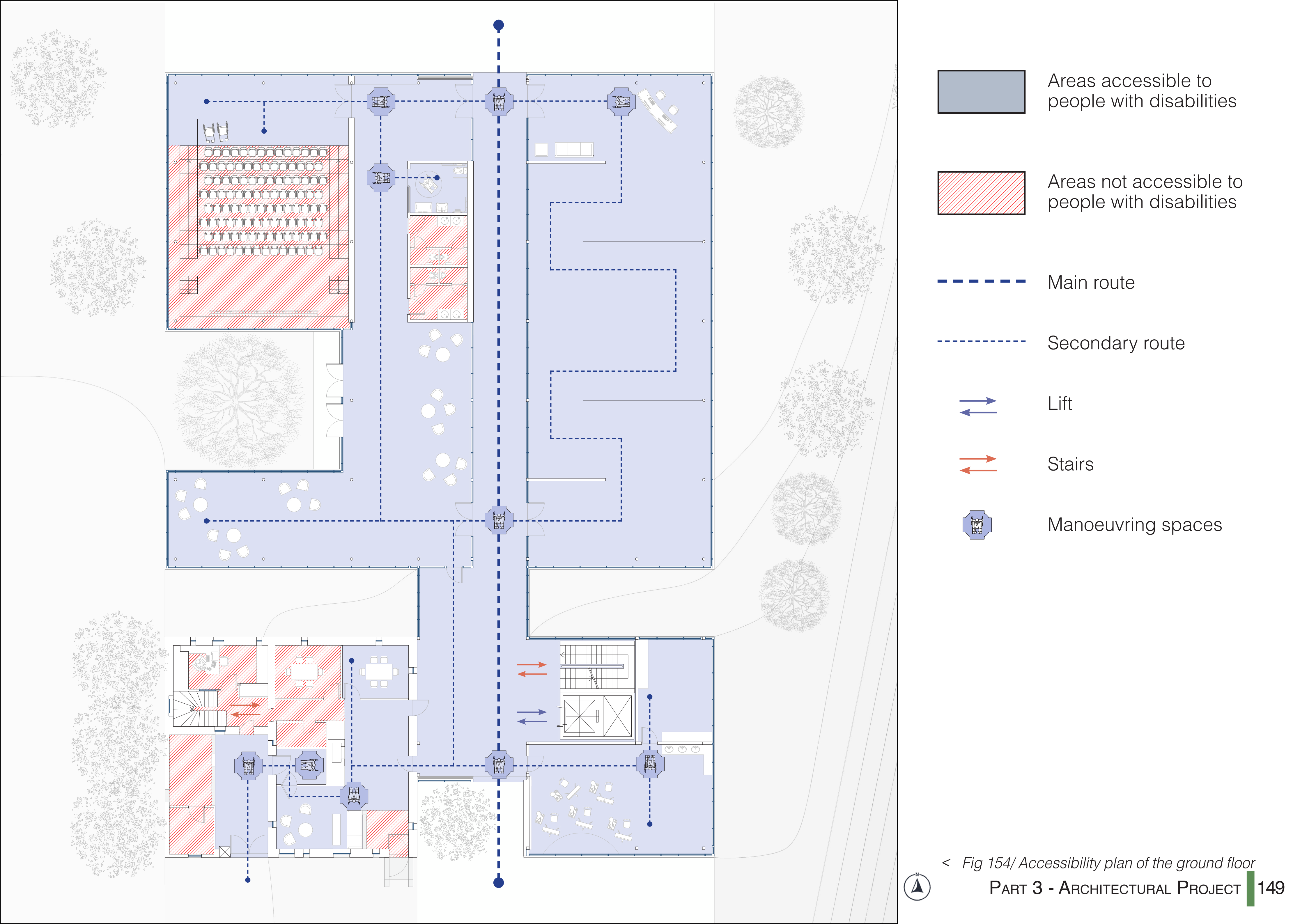
3.7. Accessibility study

The project has also to adhere to stringent accessibility standards and follows best practices for internal layout design. This compliance ensures that the cultural center is inclusive and user-friendly while aligning with national and international regulations. Key legislative documents and guidelines that support this initiative include the Guide de l'accessibilité by the Direction Départementale des Territoires (DDT 36), the United Nations' Global Survey on Government Action on Disability, the French Law No. 2005-102, Decree No. 2006-555, and the NF P 98-350 standards.

The Guide de l'accessibilité (DDT 36, Edition 2022) provides comprehensive guidelines for making public buildings accessible to all, including people with disabilities. According to this guide, accessibility involves more than just physical access; it encompasses the usability of spaces and the provision of necessary services to ensure that everyone can participate fully. The guide emphasizes the importance of wide, unobstructed pathways, appropriately designed restrooms, and accessible signage. By adhering to these guidelines, the cultural center ensures that all visitors, regardless of their physical abilities, can navigate the building comfortably and safely.

The United Nations' Global Survey on Government Action on Disability underscores the importance of inclusive design in public buildings. This survey, submitted on April 12, 2006, highlights global efforts to implement the standard rules for equalizing opportunities for persons with disabilities. It stresses the need for buildings to be designed and operated in ways that facilitate equal access to services and opportunities. Applying these principles to the cultural center means creating an environment where everyone can engage with cultural activities, thus promoting social inclusion and diversity.

The French Law No. 2005-102, specifically Article L111-7, mandates that existing buildings must be accessible to people with disabilities, allowing them to access and use all spaces. This law ensures that the cultural center will be retrofitted and redesigned to meet these accessibility standards. This includes installing ramps, elevators, tactile indicators, and auditory signals to accommodate various disabilities. The law also encourages the use of universal design principles, ensuring that all aspects of the building are inherently accessible to the broadest range of users.



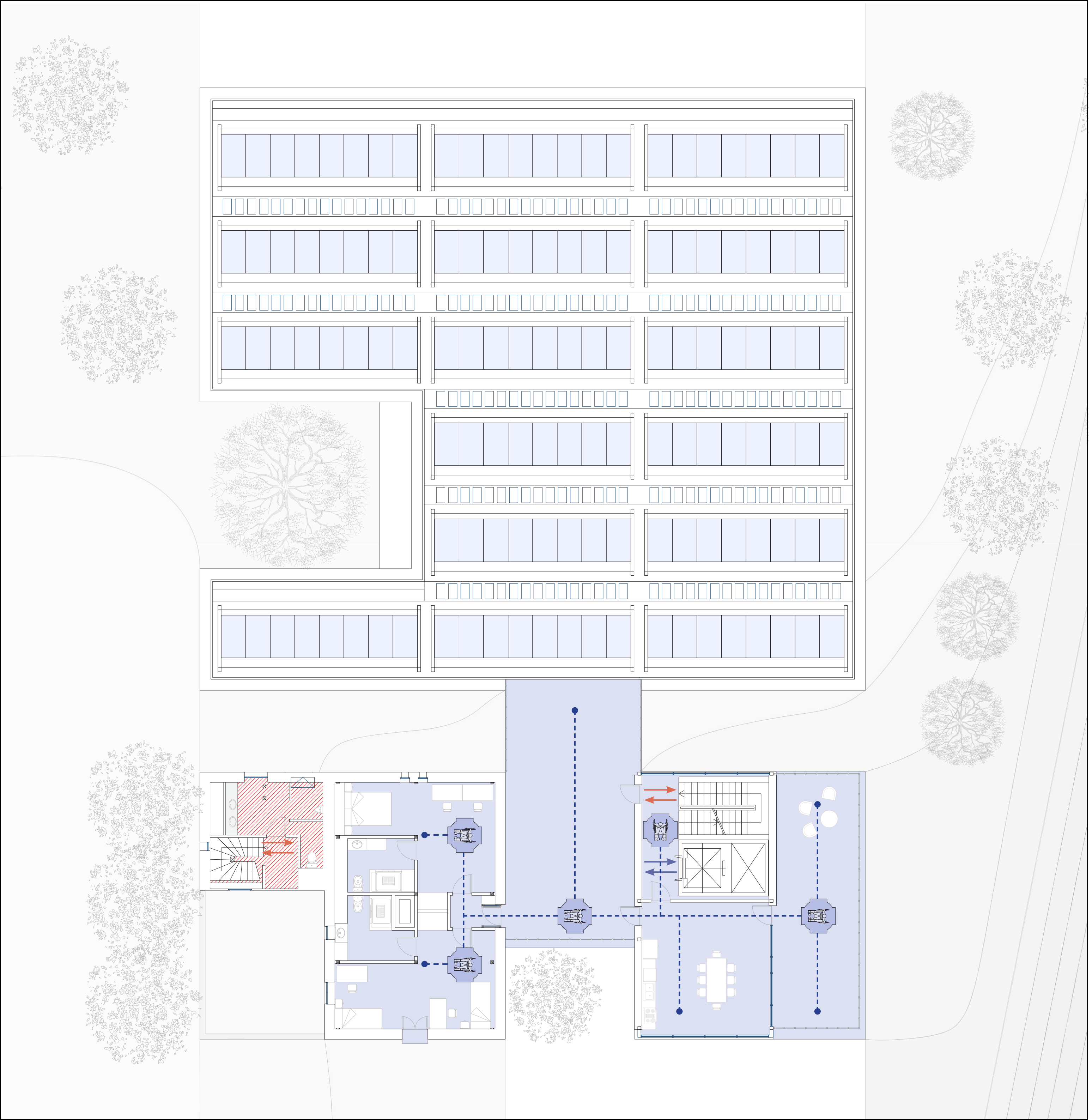
< *Fig 154/ Accessibility plan of the ground floor*

Decree No. 2006-555, particularly Article R*111-19, further reinforces the need for public establishments to provide services that ensure equal access for people with disabilities. This decree mandates that disabled individuals must be able to benefit from the services offered to the public under conditions that guarantee their access to all services. For the cultural center, this means not only physical accessibility but also the availability of assistance services, such as accessible ticket counters, hearing loops in auditoriums, and staff trained to assist visitors with special needs.

The NF P 98-350 standards provide detailed guidelines for the accessibility of public buildings. Article 2 of these standards offers specific instructions for ensuring that cultural centers are accessible to people with disabilities. This includes guidelines on the dimensions of doors and corridors, the placement of signage, the design of seating arrangements in performance spaces, and the availability of accessible restrooms. By following these standards, the cultural center can ensure that every aspect of the building is designed with accessibility in mind, creating a welcoming environment for all.

The integration of these guidelines ensures that the cultural center is a space where all members of the neighborhood and visitors from the region can participate in cultural activities without barriers. The internal layout of the cultural center is designed to facilitate smooth movement and interaction between different spaces. Wide corridors and open spaces ensure that visitors can move freely and comfortably. The placement of key facilities, such as restrooms, exhibition areas, and performance spaces, is planned to be easily accessible thanks to the main central corridor. This layout enhances the user experience, making the cultural center not only accessible but also enjoyable to navigate.

By following the guidelines set out by the Guide de l’accessibilité (DDT 36), the United Nations’ Global Survey on Disability, French Law No. 2005-102, Decree No. 2006-555, and the NF P 98-350 standards, the project ensures a safe, inclusive, and user-friendly environment for all visitors. This comprehensive approach to accessibility and internal layout design underscores the cultural center’s potential to become a landmark development that enriches the cultural landscape and promotes social inclusion in the neighborhood and the broader region.



Areas accessible to people with disabilities

Areas not accessible to people with disabilities

Main route

Secondary route

Lift

Stairs

Manoeuvring spaces

< *Fig 155/ Accessibility plan of the elevated floor*

PART 4 - STRUCTURAL DESIGN

4.1. Overview of the structure

The structure of the cultural center was design to ensures the building's stability and durability. The combination of steel and concrete (steel for the superstructure and reinforced concrete for the infrastructure) guarantees great strength and flexibility in the architectural design, enabling the creation of open, modular spaces.

Steel provides high tensile strength, flexibility, and resistance to both dynamic and static loads, while concrete, with its excellent compressive strength, forms a solid foundation and structural support, effectively distributing loads and minimizing settlement risks. By integrating these materials, the building benefits from the complementary strengths of each: steel's ability to handle tension and dynamic forces, and concrete's capacity to support heavy loads and provide a stable base.

This synergy ensures that the structure is resilient against various stresses, including wind, snow, and daily operational loads. Expansion joints allow the building to accommodate thermal expansion and contraction that could result from temperature fluctuations. They also make each part of the cultural center independant from each other.

As a result, building A+C (i.e. the ancestral farmhouse), new building B (i.e. the modern double-storey extension with smaller sheds), and building D (i.e. the modern single- storey extension with larger shed) are all three structurally independant.

The choice of materials and construction techniques was then dictated by the need to create a durable structure capable of withstanding mechanical and environmental stresses, as well as minimizing minimise downward loads and heat loss.

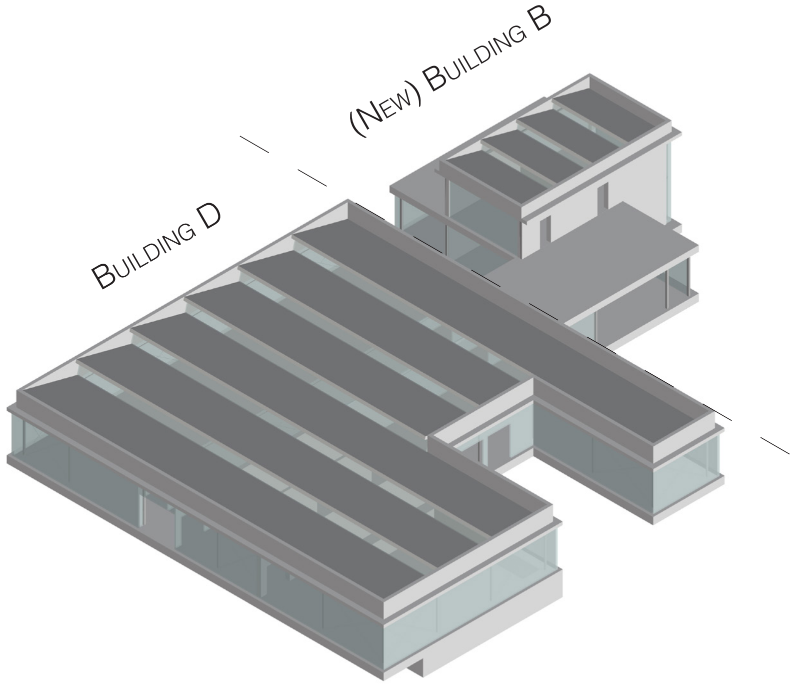


Fig 156/ Naming of the buildings of modern extension

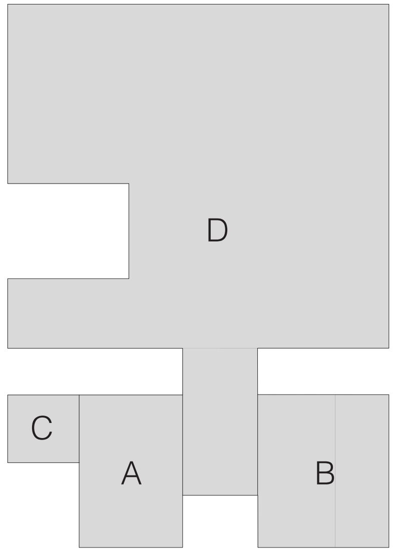


Fig 157/ Naming of the parts of the whole cultural center

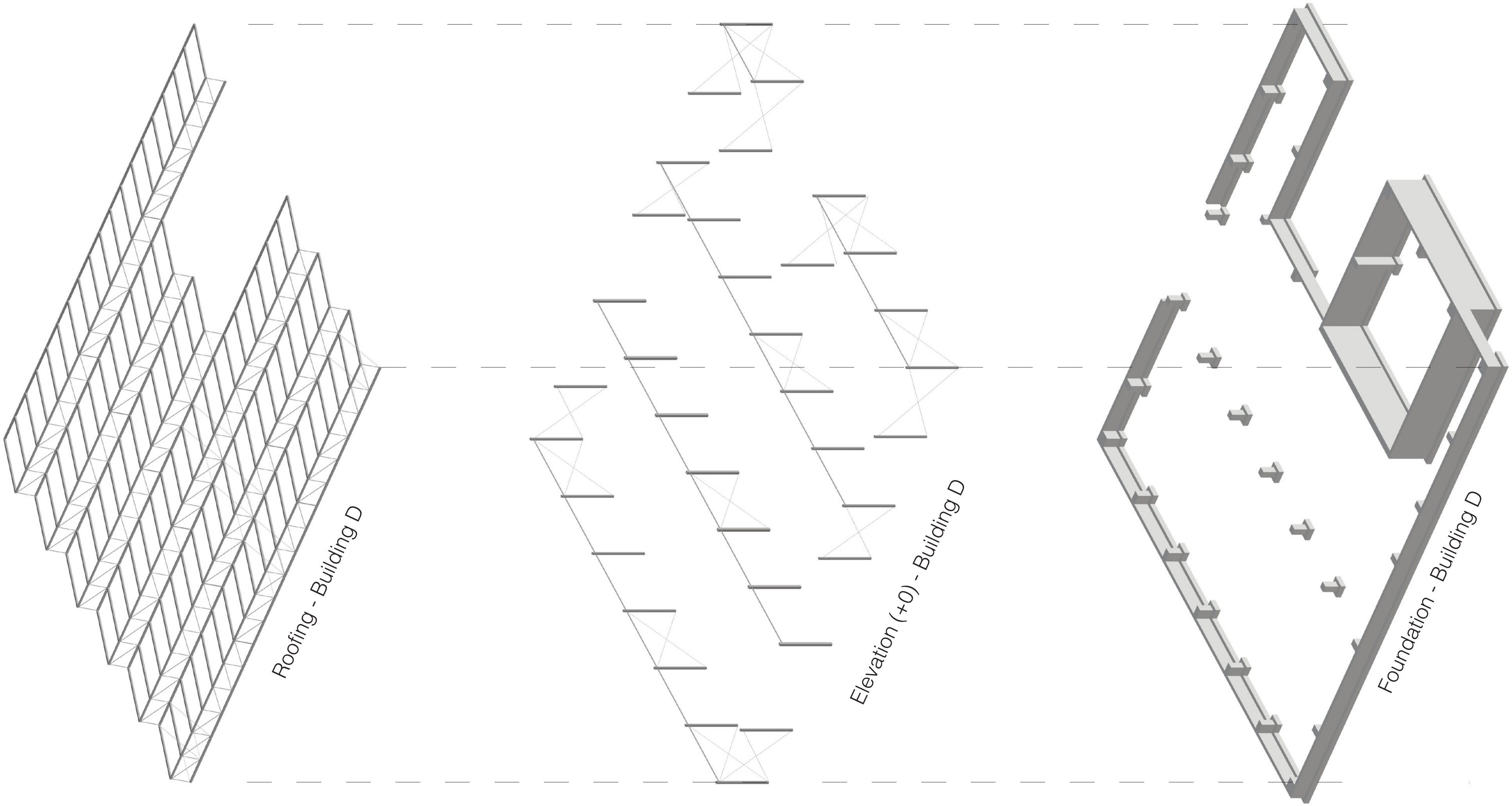


Fig 158/ Structural blow-up of the building D

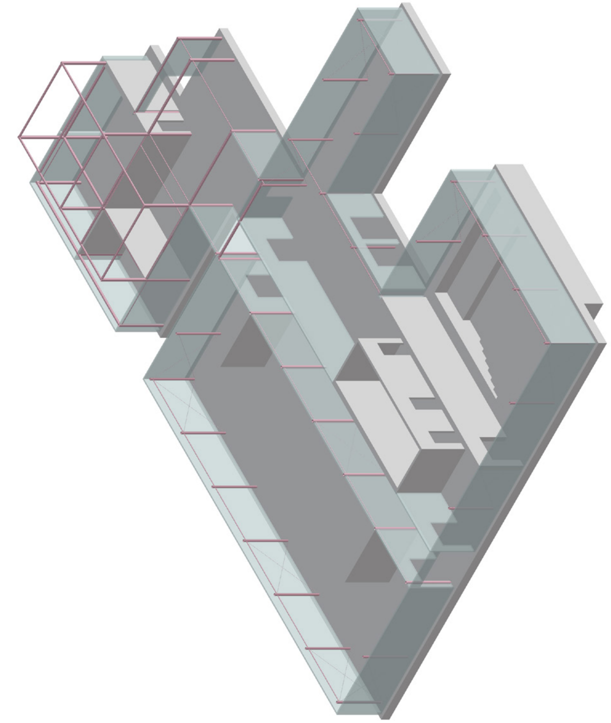


Fig 160/ Model view with the elevation structure in evidence

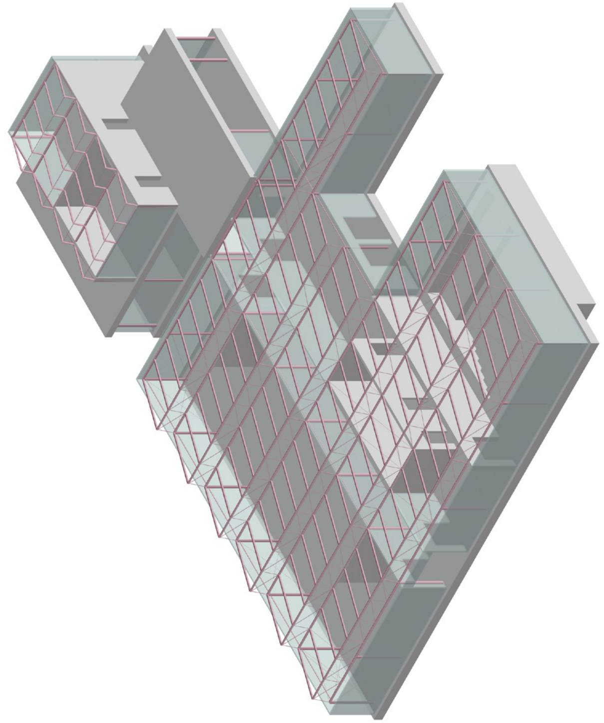


Fig 161/ Model view with the roof structure in evidence

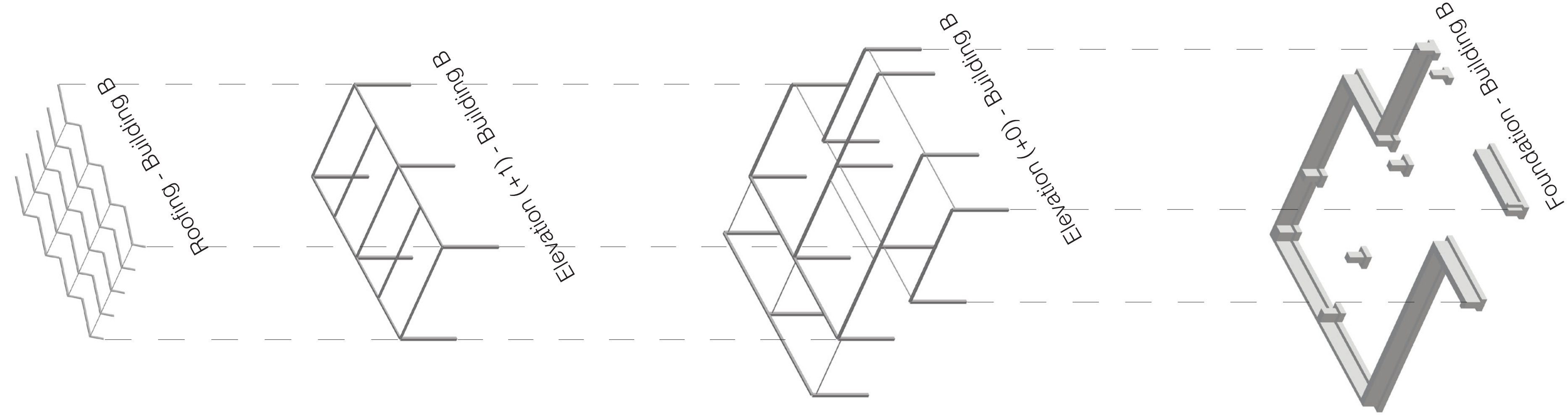


Fig 159/ Structural blow-up of the building B

4.2. Foundation

Reinforced concrete strip footings distribute the building's loads evenly across the ground, preventing differential settlement and ensuring structural stability. The use of steel reinforcement within the concrete increases its tensile strength, allowing it to resist cracking and deformation under load. This combination of concrete and steel reinforcement ensures that the foundations can support the weight of the building and any additional loads imposed by occupancy and environmental factors such as wind and seismic activity.

Furthermore, strip footings are cost-effective and relatively easy to construct, making them a practical choice for the cultural center. Their linear design allows for efficient use of materials and labor, reducing overall construction time and costs. The regulation emphasize the importance of using materials and construction methods that provide long-term durability and require minimal maintenance, making reinforced concrete strip footings a suitable choice for the foundation of the cultural center.

To address potential soil movement and ensure uniform load distribution, the design includes both isolated footings for individual columns within the perimeter of the cultural center and continuous footings and retaining wall all around the perimeter for support to the curtain wall. The foundation's design and construction adhere to Eurocode 7 standards, ensuring safety and reliability.

The footings and retaining wall have been designed considering both the structural loads they bear and the adequate sizing to enable the connection with the elevation structure.

The integration of waterproofing membranes and drainage systems prevents water infiltration, protecting the foundation from moisture-related issues. Expansion joints are incorporated to accommodates thermal expansion and contraction, preventing cracks and structural damage, but also to preserve the independancy of each part of the cultural center, espacially the ancestral farmhouse.

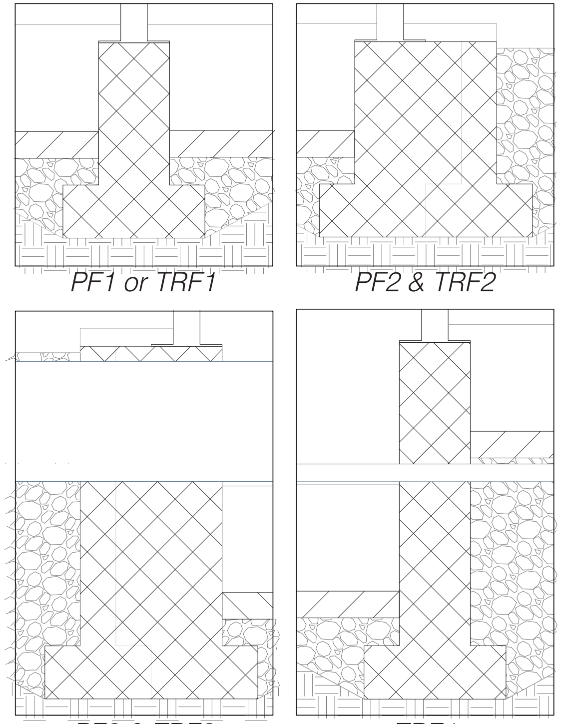
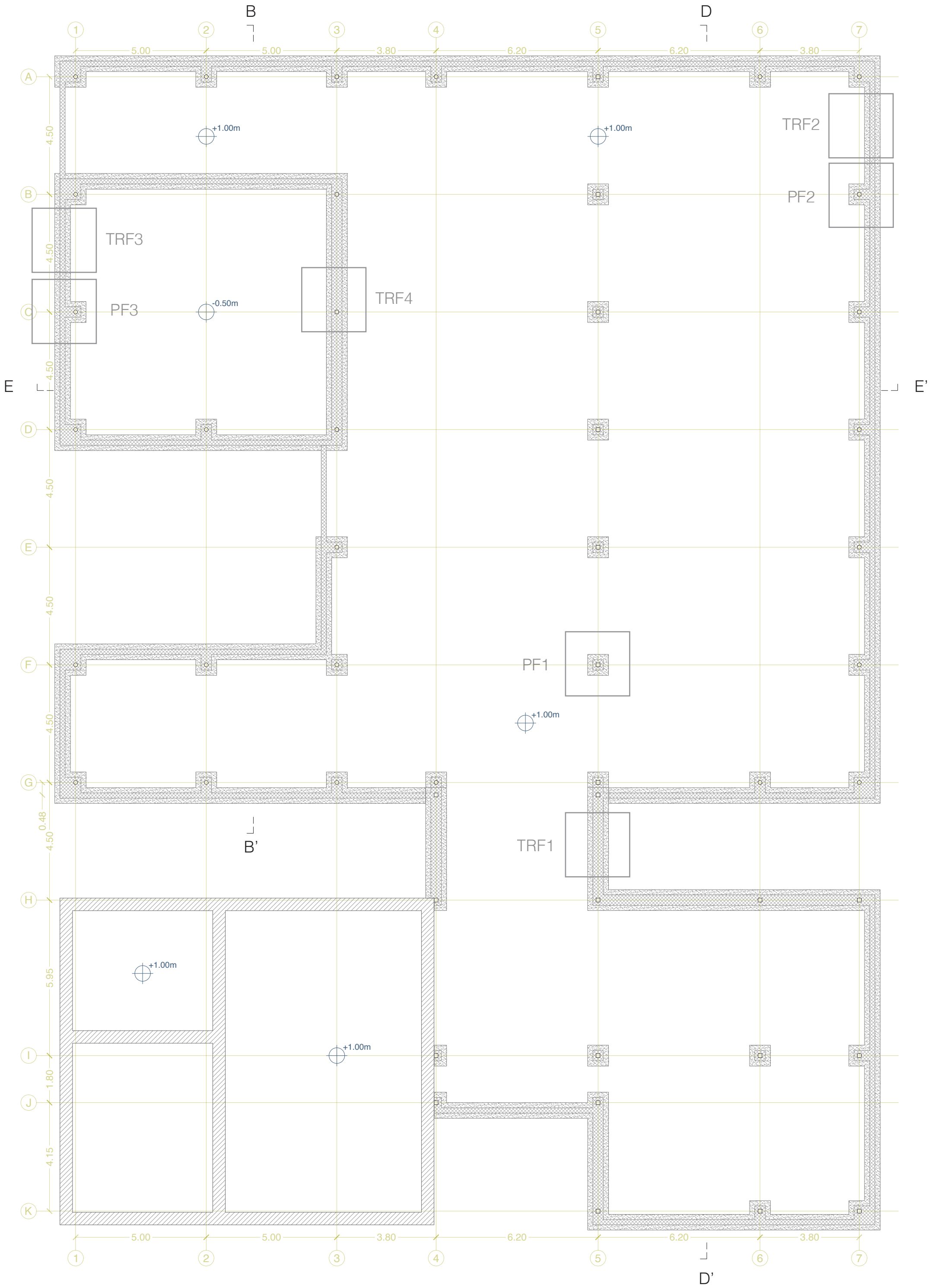


Fig 162/ Overview of the foundation used



< Fig 163/ Structural plan of the foundations

4.3. Elevation

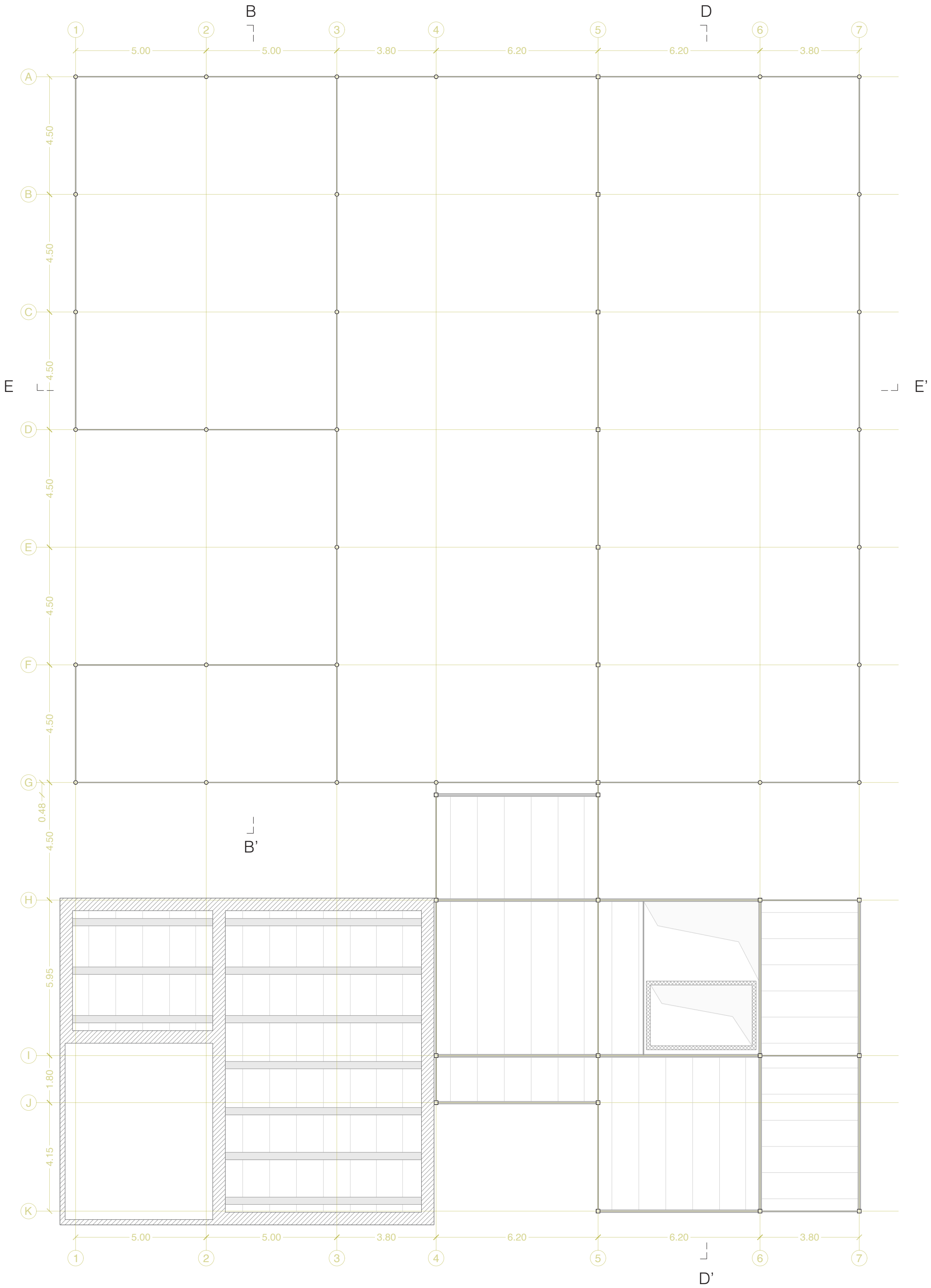
The choice of Hybox 355 steel tubes for the elevation structure of the cultural center is driven by both structural and aesthetic considerations. Hybox 355 is a high-strength, cold-formed steel that offers excellent performance characteristics, including high yield strength, good weldability, and resistance to corrosion. These properties make it ideal for use in the structural elements of buildings, ensuring that the cultural center is both strong and durable.

Using steel tubes in both round and square profiles provides an aesthetic advantage, creating a visually appealing structure that aligns with the modern design of the cultural center. The CTICM's guide on curtain walls highlights the importance of aesthetic considerations in public buildings, emphasizing that the structural elements should complement the overall architectural vision. By choosing Hybox 355 steel tubes, the design ensures that the structural elements are not only functional but also contribute to the building's visual appeal by adressing the same very bare aesthetic design than the curtain wall in aluminium and glass. In fact, the elevation of the cultural center was designed to reflect a modern aesthetic while integrating essential functional elements. The building's facades are clad in contemporary materials such as glass and steel, which lend an elegant appearance and ensure both abundant natural light inside and a perspective on the surronding nature.

Additionally, the use of steel tubes for the elevation structure allows for greater flexibility in design and construction. Steel's high strength-to-weight ratio enables the creation of slender, elegant structures that can support large spans and open spaces, essential for the cultural center's multifunctional areas. This choice aligns with the principles outlined by the IDA, which advocate for the use of steel in creating flexible and adaptable building designs.

The use of a truss beam of 10m as roofing structure enables having very large surface without any elevation structure within. As a result, the main part of the cultural center (named as building D) is composed with 3 large areas of 270m^2 (10m x 27m), although one of them (at west) is subdivided because of the interruption of the cultural center.

The use of corrugated sheets for the upper flooring provides continuity of material, although the importance is based on the connection of the material with the steel elevation structure, since there are no aesthetic reasons to make this choice as they are not visible.



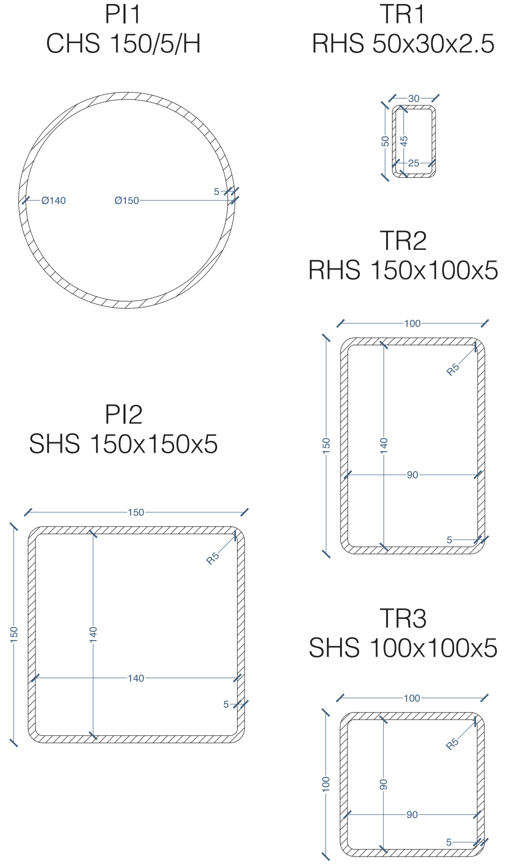


Fig 164/ Overview of the structural beam used (part 1/3)

< *Fig 165/ Elevation structure from the ground floor*

4.4. Roofing

The roof structure of the cultural center also benefits from the use of Hybox 355 steel tubes, but also from developing a prefabricated welded truss beam also composedin Hybox 355 steel tubes (that will be seen in depth in the next chapter).

Similar to their use in the elevation structure, steel tubes offer the necessary strength and durability to support the roof's loads, including the weight of roofing materials, environmental loads such as snow and wind, and any additional operational loads. The use of Hybox 355 steel ensures that the roof structure is robust and capable of withstanding various stresses.

From an aesthetic perspective, the use of steel tubes in the roof structure maintains visual consistency with the elevation structure, contributing to the overall design coherence of the cultural center. The square profiles of the steel tubes create a modern, clean look that enhances the building's architectural appeal. The choice of steel for the roof structure also facilitates the integration of sustainable features such as solar panels. Steel's high strength allows for the support of additional loads without compromising the structural integrity of the roof. This aligns with the sustainability principles advocated by the IDA and the CTICM, promoting the use of materials and designs that support environmental sustainability.

The roofing system of the Espace Culturel des Granges Collières is designed for durability, energy efficiency, and aesthetic appeal. The primary structure consists of steel trusses and beams, supporting a lightweight, insulated roofing material. The roof design includes a combination of flat and shed roofs. The shed roofs oriented to maximize natural light through north-facing glazing and support solar panels on the south-facing slopes, while the flat roof allowing to create walkable roof for terrace for the elevated floors (see previous chapter). As a result, the sheds roof and its beams are either at 75° or at 15° to create the orientation of the shed. As particular exeption is made for the first truss beams that consitute the exterior roof facade of the building.

The roofing material, typically metal or composite panels, is chosen for its longevity and low maintenance requirements. The design also incorporates drainage systems, including gutters and downspouts, to manage rainwater and prevent water accumulation.

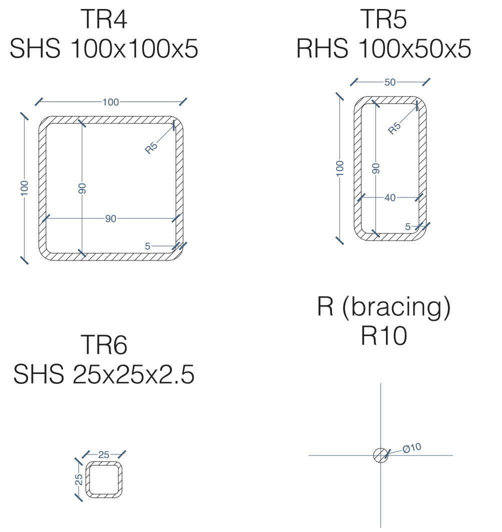


Fig 166/ Overview of the structural beam used (part 2/3)

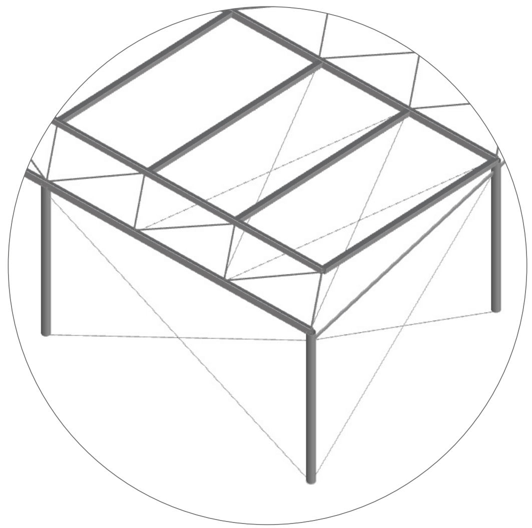


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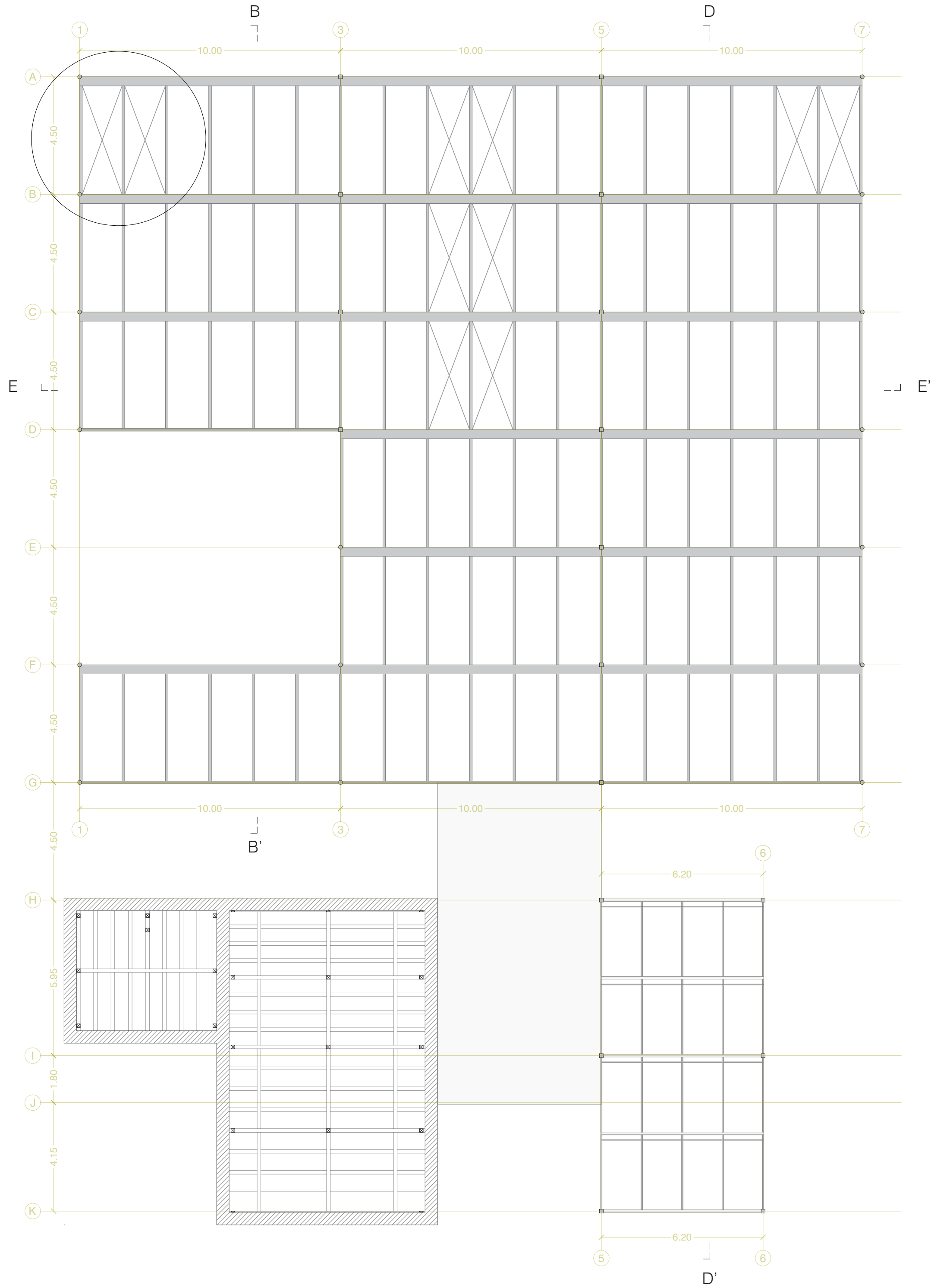
Fig 167/ Zoom in on the bracings



< *Fig 168/ Structural plan of the roof structure*

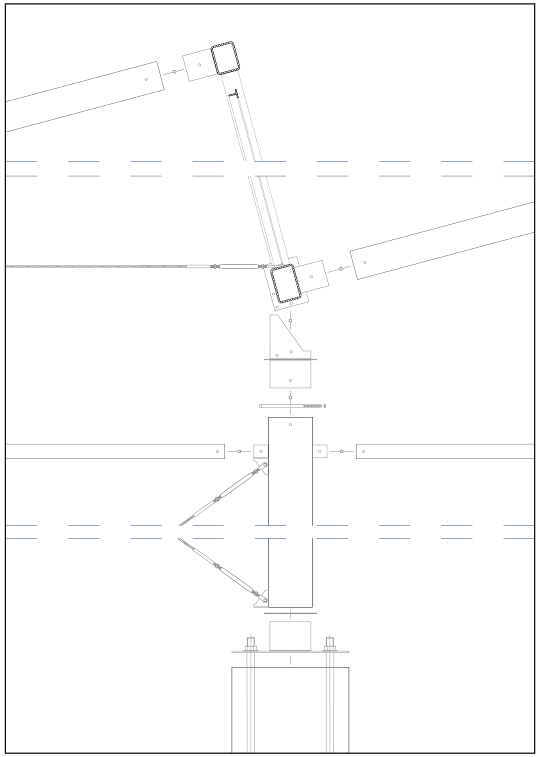


Fig 169/ Node of the roof structure (Building D)
Node in board n°69

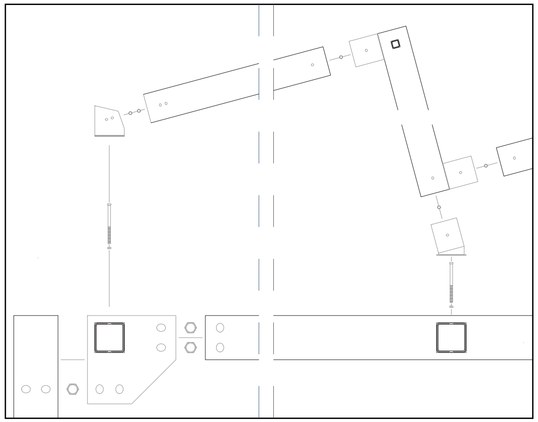


Fig 170/ Node of the roof structure (Building B)
Node in board n°70

4.5. Structure assembly

The connection method used for joining steel components in the cultural center is a combination of welded connections, both on-site and in the factory, and bolted connections.

Nuts & bolts : Bolted connections offer several significant advantages. They provide ease of assembly and disassembly, making them particularly useful for future modifications, expansions, or repairs. Bolts also allow for slight adjustments during assembly, ensuring that components are accurately aligned and securely fastened. Additionally, bolted connections can be inspected and maintained more easily than other types of connections, allowing for ongoing assessment and ensuring long-term reliability.

The use of high-strength bolts, as recommended by the IDA and the CTICM, ensures that the connections can withstand significant loads and stresses. High-strength bolts are designed to handle the high levels of shear and tensile forces that can occur in structural applications. This capacity is vital for maintaining the integrity of the structure under varying operational conditions.

Weldings : Welded connections, on the other hand, provide a continuous bond between steel components, creating a strong and rigid joint. Welding is particularly useful for connecting components that will experience high stresses or need to resist dynamic loads. Welded joints are capable of withstanding greater loads than bolted connections in many cases because they provide a seamless transfer of stress between connected elements. This strength is crucial for ensuring the stability of the structure, particularly in areas where the loads are concentrated or where dynamic forces such as wind and vibration are present.

Factory welding ensures high quality and consistency, as it can be performed under controlled conditions. Factory settings allow for better control over the welding environment, including temperature, humidity, and cleanliness, leading to higher quality welds with fewer defects. Additionally, factory welding uses advanced equipment and techniques that may not be feasible on-site. On-site welding is used for final assembly and adjustments, ensuring that all components are securely connected and allows for flexibility during construction, accommodating any last-minute adjustments or alignments that are necessary.

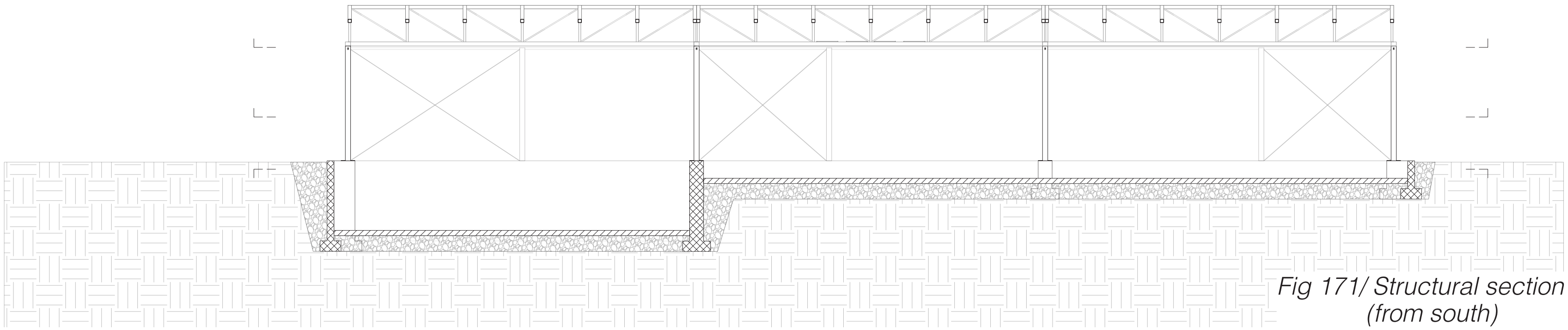


Fig 171/ Structural section EE'
(from south)

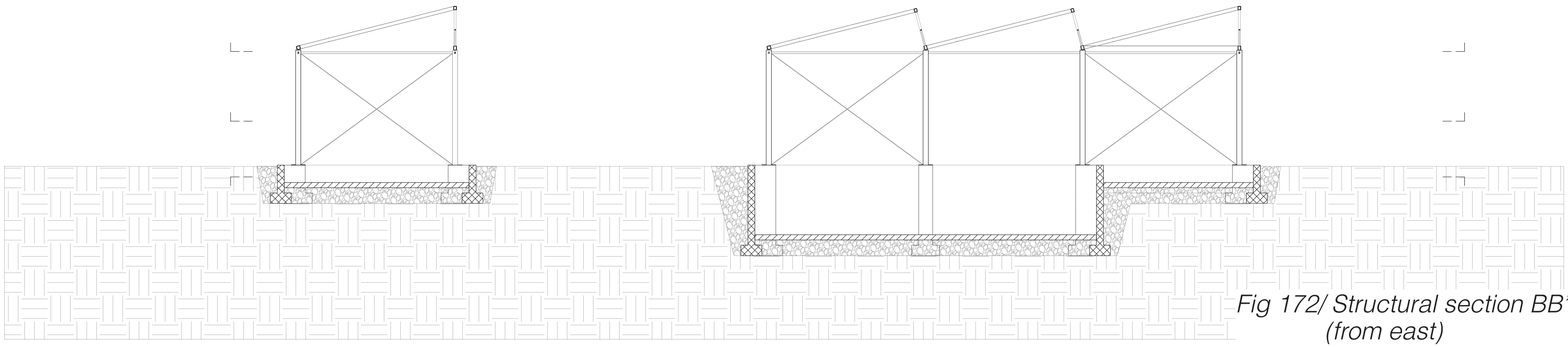


Fig 172/ Structural section BB'
(from east)

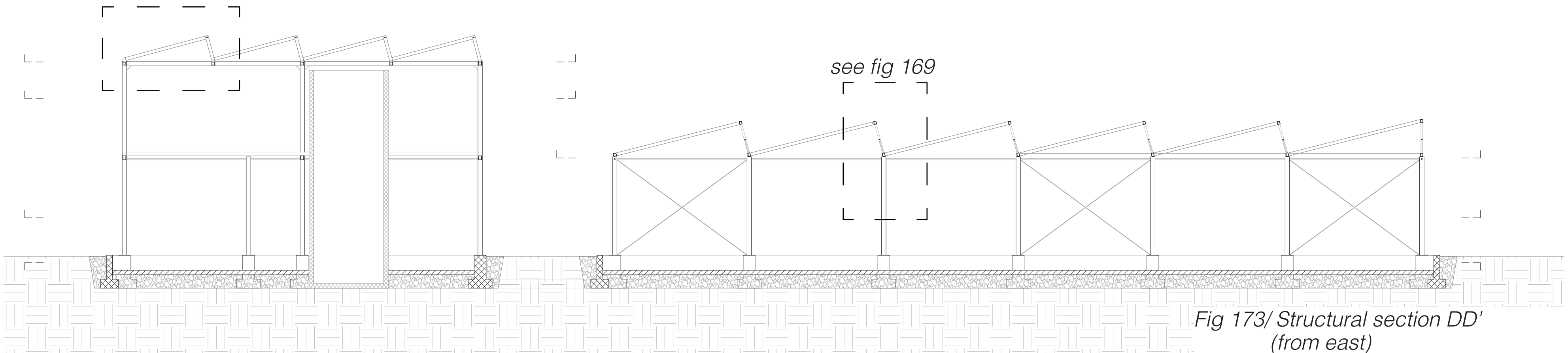


Fig 173/ Structural section DD'
(from east)

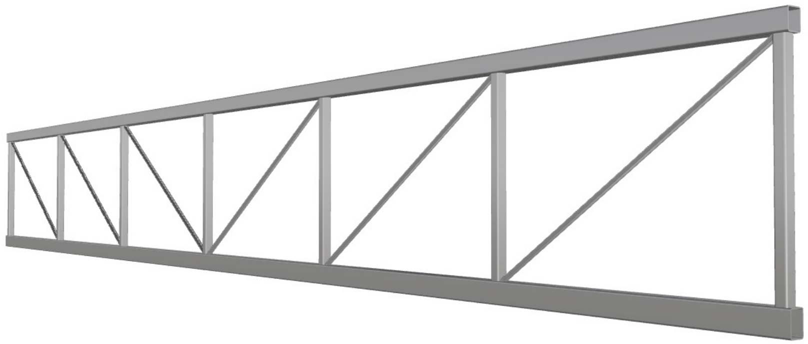


Fig 174/ 3D view of the prefabricated welded truss beam

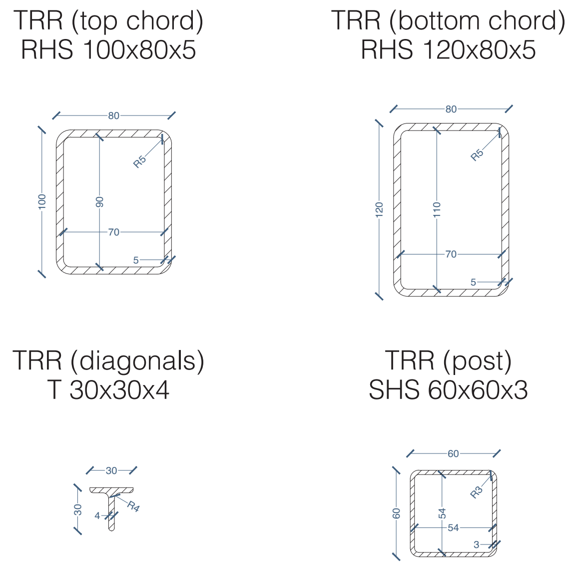


Fig 175/ Overview of the structural beam used (part 3/3)

Prefabricated welded truss beam : The decision to use prefabricated Hybox 355 steel trusses for the cultural center's structure is based on several practical, logistical, and performance-related advantages. The choice of a truss system, prefabrication, and factory welding each offer specific benefits that together ensure the success of the project.

Made up of triangular steel segments, the truss beam allow large spans to be created without the need for intermediate supports, thus providing open and flexible spaces within the building. This characteristic is particularly beneficial for the cultural center, where open, unobstructed spaces are crucial for accommodating large gatherings and diverse activities. The use of Hybox 355 steel squared tubes, offers an harmonious blending with the elevation structure and high performances in terms of durability and loadings. Additionally, the lightweight nature of steel trusses reduces the overall weight of the structure, minimizing the demand on the foundation and allowing for more cost-effective construction.

Prefabrication offers numerous advantages that make it an ideal choice for the construction of the cultural center. One of the primary benefits of prefabrication is the enhanced quality control it allows. Prefabrication also significantly accelerates the construction process. Trusses can be manufactured simultaneously while site preparation and foundation work are underway, reducing the overall construction timeline. This efficiency minimizes disruption to the surrounding area and allows the cultural center to be completed and operational more quickly. Additionally, prefabrication allows for precise engineering and assembly of complex truss designs. This precision ensures that the trusses fit together perfectly during assembly, enhancing the structural integrity and aesthetic quality of the building. Moreover, prefabricated trusses can be designed to comply with transportation regulations, ensuring that they can be safely transported without exceeding road size and weight limits as their size does not exceed the maximum road gauge in France, which is 2.50 m x 16.50 m.

Welding in a factory setting ensures a high level of precision and consistency in the welds. The controlled environment of a factory also reduces the risk of welding defects, such as porosity, cracking, and incomplete fusion. These defects can compromise the strength and durability of the welds, potentially leading to structural failures. By conducting welding in a factory, it is possible to perform thorough inspections and quality assurance tests, ensuring that each weld meets the required standards.

4.6. Choice of the surface finishes

The choice of materials for the cultural center was guided by criteria of durability, performance, and aesthetics. In addition to the steel and concrete used for the structure, the materials used include glass, wood, and aluminum.

Glass is used extensively in the perimetral curtain wall but also in the transparent part of the shed, optimizing the intake of natural light, enhancing occupant comfort, and reducing the need for artificial lighting. The expansive use of glass creates an open, airy feeling inside the building, fostering a sense of connection with the surrounding environment and offering panoramic views. This not only makes the interior spaces more pleasant and inviting but also allows visitors to enjoy the views of the exterior landscape. Furthermore, high energy-efficient glazing contributes significantly to the thermal efficiency of the building, reducing energy consumption for heating and cooling.

Wood, used for interior coverings, adds a warm, natural touch, creating a welcoming atmosphere. The tactile quality and aesthetic appeal of wood make the interior spaces feel more comfortable and inviting. Wood is also a renewable and carbon-storing material, which helps to reduce the building's ecological footprint. Its use demonstrates a commitment to sustainable building practices and contributes to the overall environmental performance of the cultural center. The use of bamboo exterior cladding for the terrace emphasises the desire to retain the welcoming aspect of the wood, which is also reflected in the top cladding of the intermediate floor. Compared to wood, bamboo is highly resistant to rain, which is why it is used for decking.

Aluminum is utilized for window frames, but also for the roof exterior cladding, where its properties of lightness, durability, and resistance to corrosion are particularly beneficial. Its reflective quality complement the glass façades, contributing to a cohesive and elegant exterior look and adding to the building's modern, clean lines, reinforcing its contemporary design. The corrugated sheet used for the roofing is used to better support the photovoltaic pannels as they are not that visible from the outside. However, using aluminium for the acroterion all around the roof contributes to the building's clean lines.

The combination of these materials results in a building that is visually appealing from inside and outside. It keep a very uncluttered appearance so that it make the most of the views of the site, its trees and its ancestral farmhouse in Tuffeau stone.

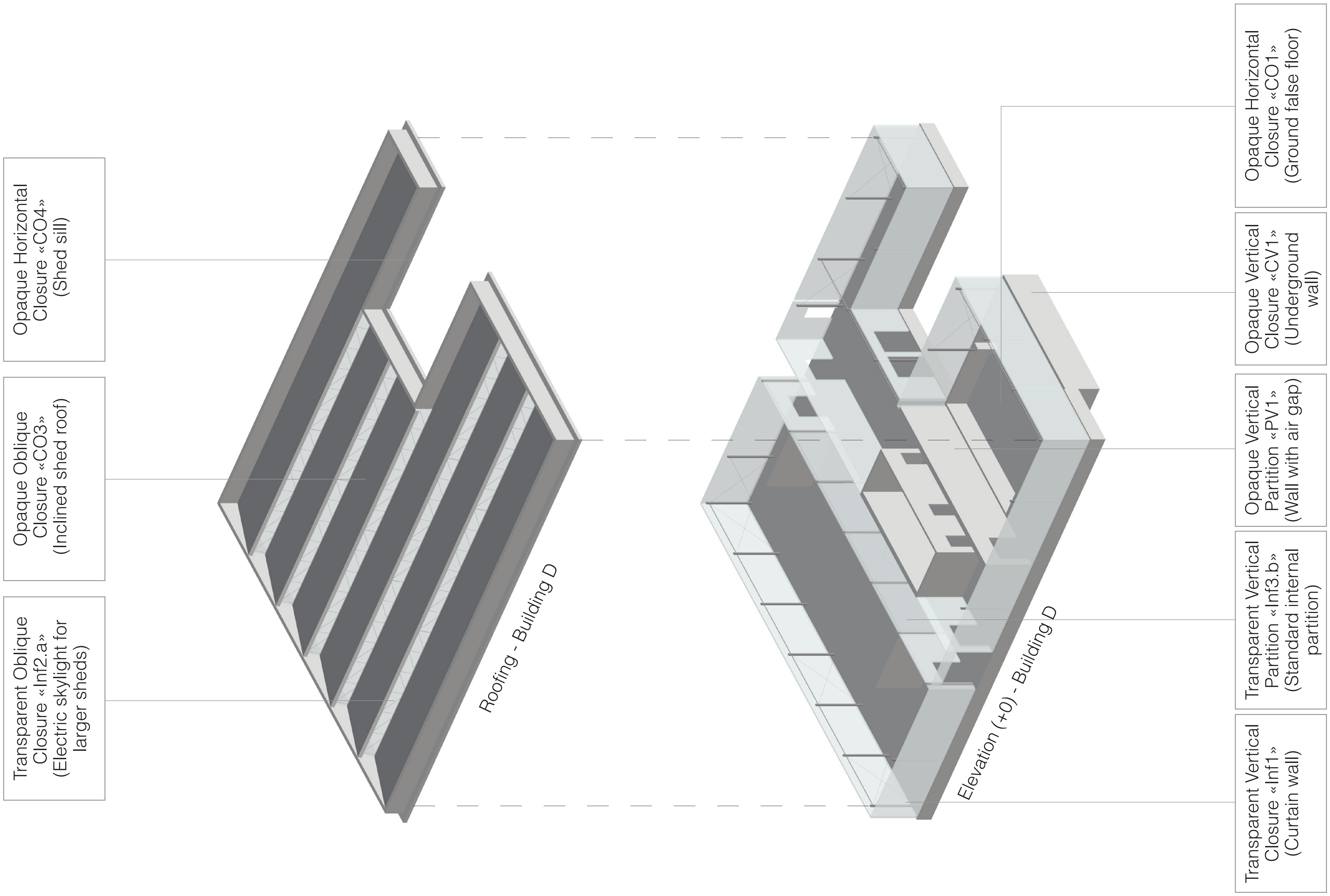


Fig 176/ Technical blow-up of the building D

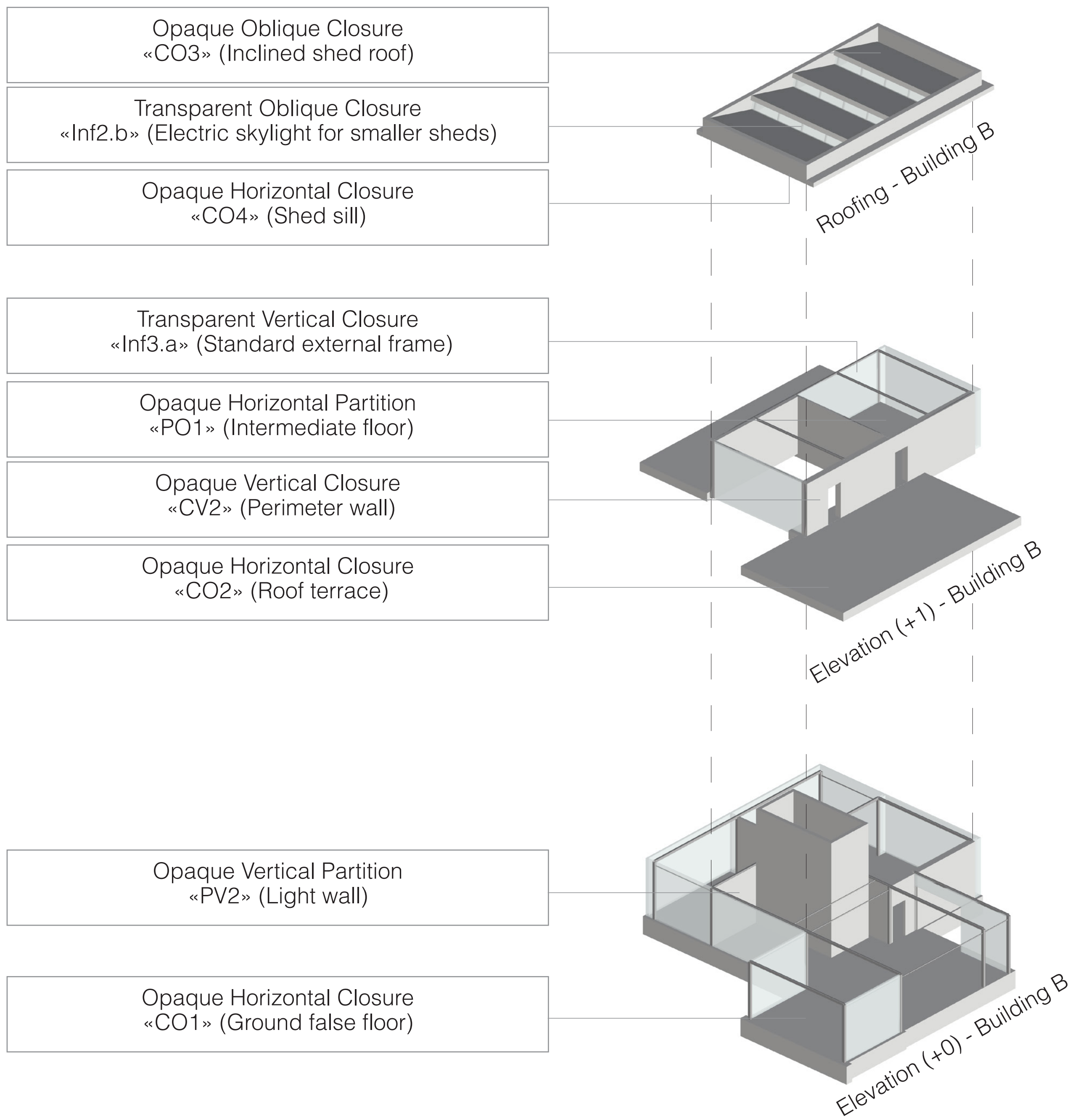


Fig 177/ Technical blow-up of the building B

4.7. Element assembly

The components of the cultural center must be carefully assembled to ensure the strength and durability of the structure as a whole. In addition to the structural elements, such as the bolting of the steel components together or the fixing of the steel columns to the reinforced concrete foundations, the junctions between the waterproofing and thermal insulation elements have been meticulously designed to prevent thermal bridging. This comprehensive approach helps maintain energy efficiency and overall structural integrity.

The glazed facade units are fitted into frames made of thermally broken aluminum, which includes a plastic section that prevents the transfer of heat through the frame. This ensures that the frames themselves do not conduct heat, thereby reducing the risk of thermal bridges. Additionally, the transition areas between glass and opaque surfaces are insulated with materials like expanded polystyrene (EPS) and rock wool to further enhance thermal resistance. These materials provide excellent insulation properties, minimizing heat loss and contributing to the energy efficiency of the building.

The sloped roof of the cultural center is designed to efficiently manage rainwater discharge, preventing water accumulation and potential damage. The roof is constructed with corrugated aluminum sheets, which guide rainwater towards designated drainage points. The slope ensures that water flows naturally away from the roof surface, reducing the risk of leaks and water damage. The gutters are then directed through downspouts to the drainage system. This setup minimizes the load on the roof structure by preventing water pooling on the roof, thereby enhancing the longevity and durability of the roof.

Furthermore, the assembly of gutters is a crucial aspect of the building's water management system. Gutters are meticulously installed along the edges of the roof to collect and channel rainwater effectively. The positioning and slope of the gutters are calculated to ensure optimal water flow towards the downspouts, which then direct the water into the drainage system. The materials used for the gutters, typically durable metals like aluminum or galvanized steel, are selected for their resistance to corrosion and ability to withstand varying weather conditions. Proper sealing and fastening techniques are employed not only to prevent leaks and ensure the longevity of the gutter system but also to facilitate maintenance.

Thermal expansion joints are essential to compensate for the expansion and contraction of building materials caused by changes in temperature, but also to enable the structural independence between the buildings in case of removal or for the sake of preserving the ancestral farmhouse. In the cultural center, these joints are located both in the elevation structure and the foundation to enable a perfect self-reliance of each part and to allow for movement without causing structural damage. As a result, buildings A+C, the new building B, and building D are all three structurally isolated. The joints are filled with flexible materials, such as thermoplastic polymer, which can compress and expand as needed. This flexibility prevents cracks and ensures the structural integrity of the building over time. Smaller expansion joints are also typically concealed within the building's design, such as at the junctions between the glass façades and the opaque walls, or between different flooring sections, ensuring both functionality and aesthetic continuity.

In addition to thermal considerations, the cultural center also prioritizes sound insulation, particularly for the interior partitions for the auditorium or else for the restroom box. Acoustic insulation is crucial in creating a comfortable and functional environment within the center. Partitions are constructed using materials with high sound-absorbing properties, such as mineral wool. These materials help to reduce noise transmission between different rooms and areas, ensuring privacy and minimizing disturbances. The use of resilient channels and soundproofing sealants further enhances the acoustic performance of the partitions, creating a serene and conducive atmosphere for various activities within the cultural center.

Prefabricated steel stairs are an ideal solution for the auditorium, offering durability, strength, and modern aesthetics. These stairs are manufactured off-site in a controlled environment, ensuring high-quality standards and precise measurements. Once fabricated, they are transported to the auditorium and assembled quickly, minimizing on-site construction time and disruption.
Non-Accessible False Floor for Vent Passage

A non-accessible false floor is an efficient solution for ensuring the passage of ventilation ducts within a building. Although this false floor is not intended for access, it plays a crucial role in maintaining the functionality and aesthetics of the interior space by keeping mechanical systems hidden from view while allowing easy maintenance access through strategically placed access panels. This setup not only enhances the building's ventilation efficiency but also contributes to a clean and uncluttered architectural design.

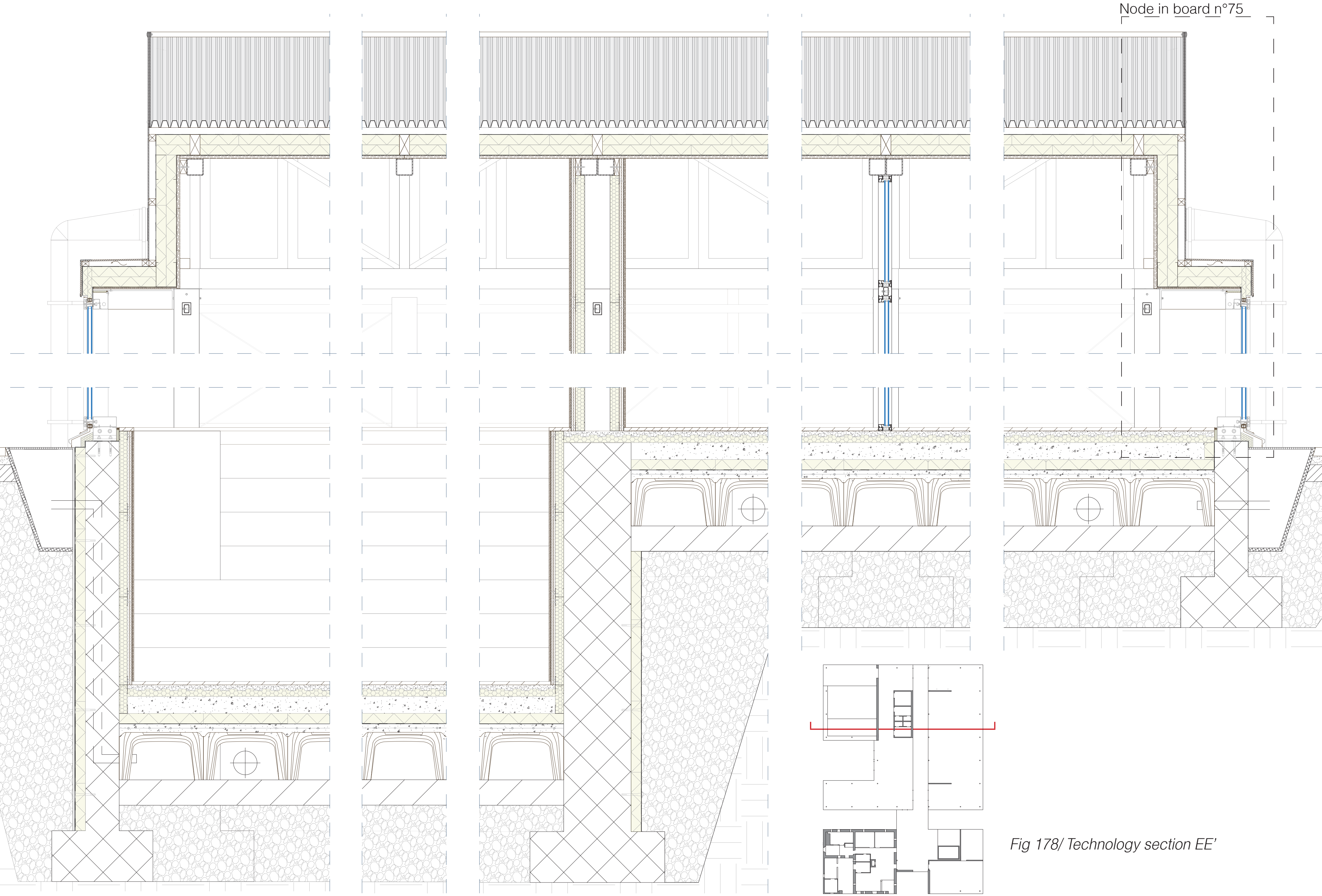
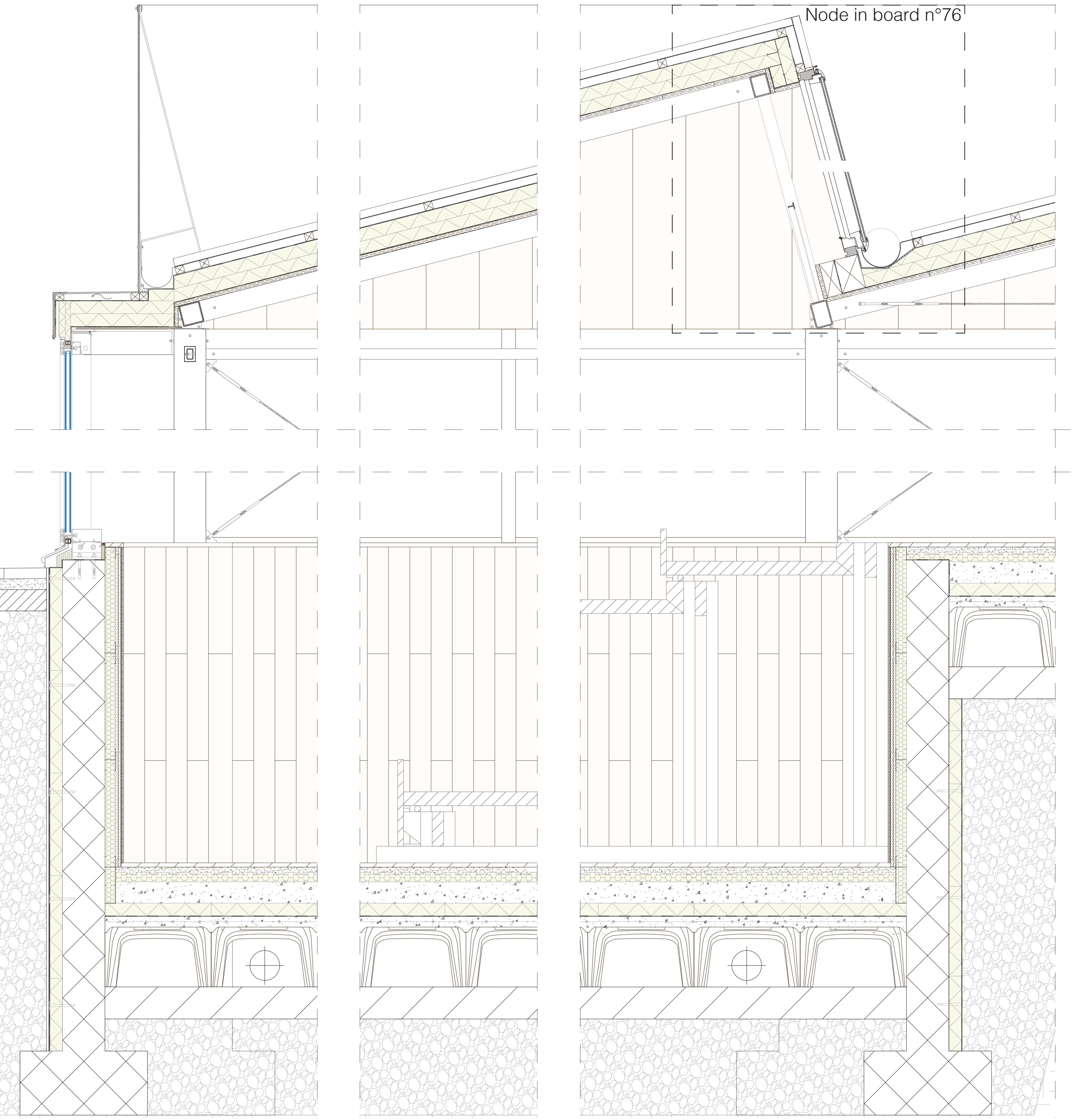


Fig 178/ Technology section EE'



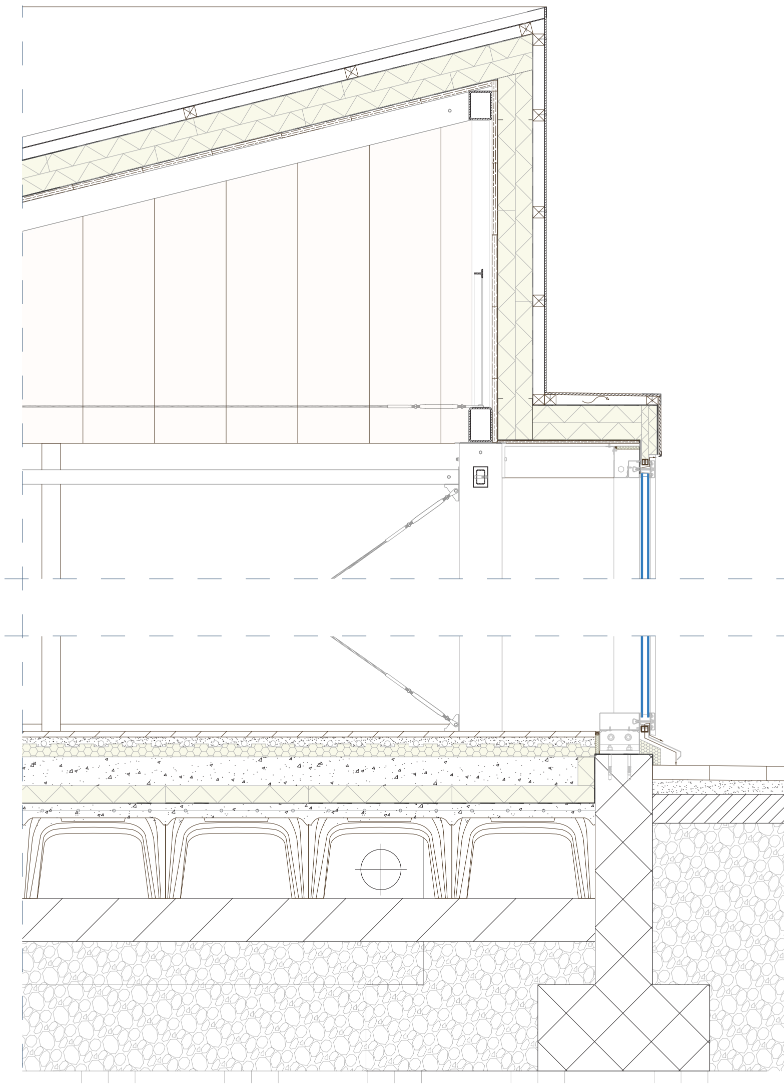
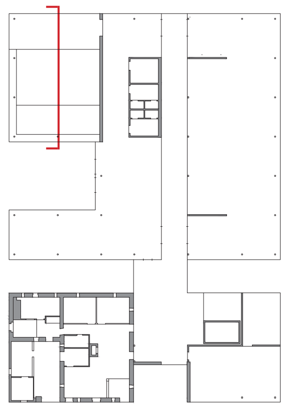



Fig 179/ Technology section BB'

4.8. Thermal performance and features of the technical elements

The design of the walls and floors enable to enhance the building's thermal performance and reduce the loads on its structure. By carefully selecting and layering materials, the construction maximizes insulation and distributes loads efficiently. The constitution of each floors, walls, glazed element are described in depth in the appendice. Their study has enabled to estimate their thermal transmittance and surface weight.

The nearly 0.1 ha ground floorings are the most imposing in terms of size and weigth as they are the first barrier against the outside environment. The top layer comprises porcelain stoneware tiles, known for their durability and easy maintenance. These tiles are bonded to a sand-cement screed with a thin layer of cement adhesive. The screed, designed with a slope for drainage, contains radiant heating panels made of EPS with integrated heating pipes, ensuring consistent heat distribution. A lightweight concrete layer embeds mechanical systems, providing protection without adding excessive weight. Additional EPS insulation further reduces heat loss. A non-woven polyester waterproofing layer protects the insulation, and a reinforced concrete slab, with an electro-welded steel mesh, provides structural strength. A ventilated crawl space below the slab enhances moisture control and insulation. It also gives pride of place to piping and air circulation, which will complete the project from an energy point of view. The foundation of the floor rests on a concrete footing, which interfaces with a gravel drainage layer to ensure effective water management and structural stability.

In constrast, the roofing elements, also with a surface area of almost 1000m^2, significantly contributes to the building's load reduction. The Hybox 355 steel tubes in square profiles support a lightweight roofing system with layers of EPS insulation, minimizing heat transfer and reducing energy consumption. A non-woven polyester waterproofing layer ensures the insulation remains dry and effective. The corrugated sheet used for the roofing cladding enable lightness, durability, resistance to corrosion and especially a ideal support for the addition of photovoltaic pannels.

While enhancing the aesthetic appeal, the glazed elements in the building (with an estimated surface area of 600m^2) are integral to upgrade both the building's thermal performance and lightweight. Double or triple-glazed units with low-emissivity (Low-E) coatings and inert gas fills between the panes are used to minimize heat transfer. Besides, the perimetral windows are fitted with reinforced insulation glazing, reducing heat loss in winter and heat gain in summer. This design prevents unwanted heat loss during the winter and reduces heat gain in the summer, thereby maintaining a comfortable indoor temperature year-round and contributing to lower heating and cooling costs. Solar shading devices have also been integrated to regulate natural light and prevent the interior spaces from overheating.

The interior walls, with a total surface of 280m^2, are designed to optimize space and enhance acoustic and thermal insulation. These partitions typically include a core of lightweight, high-density insulation material, such as rock wool or mineral wool, which provides excellent soundproofing and thermal resistance. Gypsum boards are used on either side of the insulation for a smooth finish that is easy to paint or decorate. The use of metal studs within the walls ensures structural stability while allowing for the integration of electrical wiring and plumbing. The use of noble wood as internal coating on both side strengthens the feeling of visual confort in the cultural center.

The small 76 m^2 intermediate flooring is designed in a similar way to the adjacent 130m^2 terrace roof to ensure continuity and ease of installation between the two elements. Starting with a top layer, a cladding of bamboo imitates the interior comfort of wood coating on the wall, making it however more resistant to outdoor conditions than wood. The floors include then a layer of underlayment for sound insulation and comfort. Below this, a layer of EPS insulation helps at minimizing heat loss for the terrace roof, and a layer made of perlite granule helps at giving a gateway to the plant integration for the intermediate flooring. The structural support is provided by a corrugated metal sheet which distributes loads evenly and enhances stability. The element is finally concluded by a false ceiling allowing to pass cables and having another layer of thermal insulation for heat insulation efficiency.

The few exterior walls, 70m^2, and the underground walls, 60m^2, work simillary of than the other separating elements, as they are consposed by the same kind of materials.

In a nutshell, the extensive use of insulation materials like rock wool and EPS provides high thermal resistance while moisture control layers ensure long-term thermal efficiency. Structurally, lightweight concrete and ventilated crawl spaces ensure loads are minimized and distributed evenly.

NB : Please refers to Technical Project (TD) in the appendice

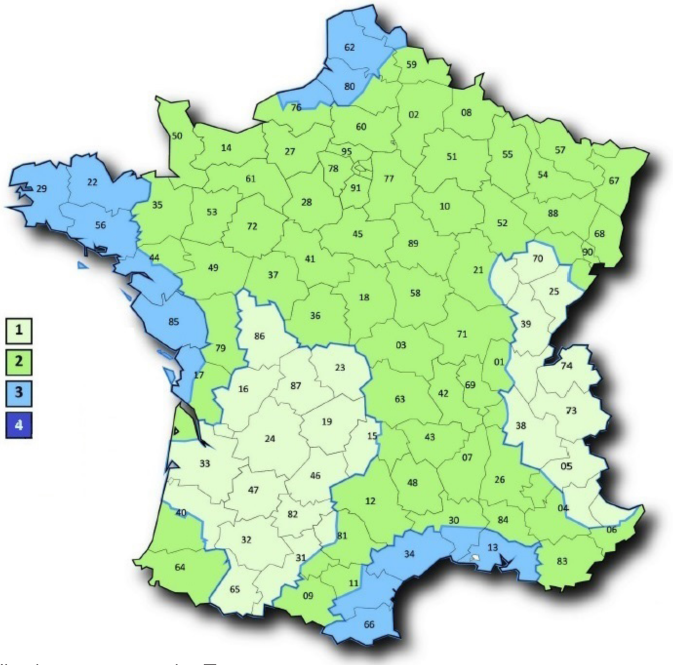


Fig 180/ Wind zone map in France

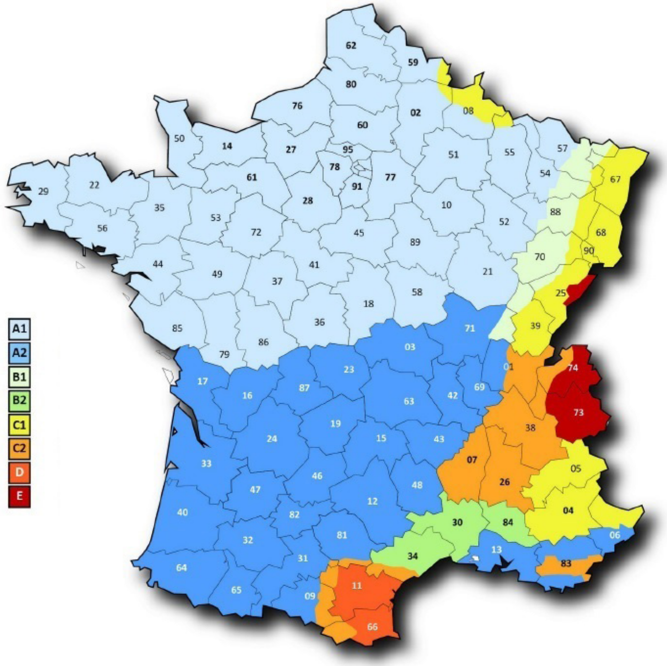


Fig 181/ Snow zone map in France

4.9. Loadings and calculation for steel design

The load analysis for the cultural center includes considerations for permanent, operational, wind, snow, and thermal expansion loads. This comprehensive analysis ensures that the structure can safely support all expected loads throughout its lifespan. The inclusion of cross-bracing, both vertical and horizontal enhances the structure's resistance to lateral forces. The foundation system, comprising reinforced concrete footings and piles, ensures stable load distribution and resistance to soil movement. All structural elements are designed and constructed in compliance with Eurocode standards, ensuring they meet safety and performance criteria.

Permanent loads include the weight of the building materials (permanent equipement included) and structural components itself, which are constant and do not change over time. These loads determine the strength and stability of the foundation and primary structural elements.

Operational loads refer to the weight of occupants, furniture, and equipment, which can vary depending on the building's use. The cultural center must be designed to accommodate varying operational loads, ensuring that it remains safe and functional under different conditions.

Wind and snow loads are environmental loads that can significantly impact the building's structural performance. Wind loads vary depending on the building's location and height, requiring careful analysis to ensure that the structure can resist wind forces without excessive movement or deformation. Snow loads depend on the regional climate and must be considered to prevent roof collapse or other structural failures. Through the Eurocode 1, EN 1991-1-4 and EN1991-1-3 indicates Tours is located in wind zone 2 IIIb and snow zone A1

Thermal expansion loads arise from temperature changes that cause materials to expand and contract. It was chosen to take more seriously this parameter into account due to the fact the whole elevation and roof structure is made in steel. The use of expansion joints and flexible connections helps to accommodate thermal movements, ensuring that the structure remains stable and undamaged. One expansion joints was placed at the connection between the existing farmhouse and the new building, while another one was placed between the new building B and the modern extension (building D).

Fig 182/ Table of the permanent loads

Permanent loads		
Stratigrafy	Lin. load	Load G_k
CO1	/	3.2 kN/m^2
CO2	/	0.79 kN/m^2
CO3	/	0.24 kN/m^2
PO1	/	0.91 kN/m^2
CV1	0.7 kN/m	0.50 kN/m^2
CV2	1.9 kN/m	0.80 kN/m^2
PV1	1.5 kN/m	0.80 kN/m^2
PV2	1.4 kN/m	0.80 kN/m^2
Equipment	/	0.10 kN/m^2

Fig 184/ Table of the operating loads

Operating loads		
Room involved (n° in plan)	Categories	Load Q_k
1 - 2	C3	4 kN/m^2
3 (auditorium)	C2	4 kN/m^2
4 - 9	C3	4 kN/m^2
10 - 11	C3	4 kN/m^2
20-21	C3	4 kN/m^2
22-23 (terrace)	C5	5 kN/m^2
(shed roof)	H	0.4 kN/m^2

Fig 185/ Table of the wind load

Wind load	
Terrain category	IIIb Urbanized countryside
Wind region (EN)	Zone 2
Air density	1,225 kg/m3
Average wind speed	v_m = 15,8 m/s
Basic wind speed	v_b = 24.0 m/s
Basic velocity pressure	q_b = 0,36 kN/m^2
Maximum wind speed for service boundary states	$V_{p,sls}$ = 28 m/s
Maximum wind speed for ultimate boundary states	$V_{p,uls}$ = 35 m/s
Peak dynamic pressure	q_p = 0,5 kN/m^2

Fig 183/ Table of the load on foundation and verification

Load verification on foundations		
Soil strength	μ = 3.2 bar (320 kN/m^2)	
Minimum foundation plinth size	S = 0.8 x 0.8 m^2 | h = 0.3 m	
Density of the reinforced concrete plinths	ρ = 2 500 kg/m^3	
Maximum allowable load | F_{max} = S.(μ - ρ.g.h)	200 kN	
Maximum applied load on the plinths (ULS)	102 kN < 200 kN	Verified

A quick verification on the foundation loads has been made using the RFEM6 software. After having modelled the entire structure and chosen the elevation and roofing structural element, the software was able to give for each columns the resultant of axials forces. The maximal resultant in the whole structure was estimated to 102 kN.

Considering the soil study in the first part of the Tesi, it was possible to estimate the soil strenght of the ground's site (μ = 3.2 bar) and to verify if the minimim dimension of the concerete plinths was enough to endure the loads.

Fig 186/ Table of the snow load

Snow load	
Altitude	h < 1000 m
Zone (EN)	A1
Characteristic snow load	s_k = 0.45 kN/m
Coefficients (exposure and thermal)	C_e = C_t = 1.00

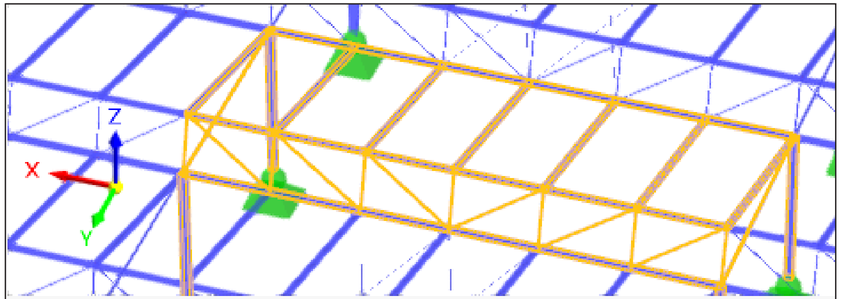
Fig 187/ Table of the thermal expansion load

Thermal expansion load	
Minimum temperature	0°C
Maximum temperature	30°C
Temperature delta	15°C
Averaged temperature	15°C

Fig 188/ Table of structural beams' characteristics

Code	Use in project	Product name	Size and thickness	Net weight G	Sectional area A	Shear area A_y and A_z
Pl1	Main column (rounded column)	Hybox 355 CHS 150/5/H	Ø = 150mm Th = 5mm	17.9 kg/m	22.8 cm^2	11.4 cm^2
Pl2	Main column (squared column)	Hybox 355 SHS 150x150x5	150x150mm^2 Th = 5mm	22.3 kg/m	28.4 cm^2	12.2 cm^2
TR1	Non loaded beam (column ties)	Hybox 355 RHS 50x30x2.5	50x30mm^2 Th = 2.5mm	2.8 kg/m	3.59 cm^2	1.00 cm^2 (y) 2.18 cm^2 (z)
TR2	Loaded beam (internal floor beam)	Hybox 355 RHS 150x100x5	150x100mm^2 Th = 5mm	18.4 kg/m	23.4 cm^2	7.17 cm^2 (y) 13.1 cm^2 (z)
TRR	Primary truss beam oriented 75° or 90° (larger shed) 10 m x 1.22 m M_{tot} = 330 kg	Hybox 355 RHS 120x80x5	120x80mm^2 Th = 5mm	14.4 kg/m	18.4 cm^2	5.69 cm^2 (y) 10.4 cm^2 (z)
		Hybox 355 RSH 100x80x5	100x80mm^2 Th = 5mm	12.9 kg/m	16.4 cm^2	6.05 cm^2 (y) 8.42 cm^2 (z)
		Hybox 355 SHS 60x60x3	60x60mm^2 Th = 3mm	5.2 kg/m	6.61 cm^2	2.90 cm^2
		T 30x30x4	30x30mm^2 Th = 4mm	1.8 kg/m	2.26 cm^2	0.99 cm^2 (y) 0.87 cm^2 (z)
TR3	Primary loaded beam (smaller shed)	Hybox 355 SHS 100x100x5	100x100mm^2 Th = 5mm	14.4 kg/m	18.4 cm^2	8.05 cm^2
TR4	Secondary loaded beam oriented 15° (larger shed)	Hybox 355 SHS 100x100x5	100x100mm^2 Th = 5mm	14.4 kg/m	18.4 cm^2	8.05 cm^2
TR5	Secondary loaded beam oriented 15° or 75° (smaller shed)	Hybox 355 RHS 100x50x5	100x50mm^2 Th = 5mm	10.5 kg/m	13.4 cm^2	3.05 cm^2 (y) 8.81 cm^2 (z)
TR6	Non loaded beam (beam ties)	Hybox 355 SHS 25x25x2.5	25x25mm^2 Th = 2.5mm	1.6 kg/m	2.09 cm^2	0.97 cm^2
R	Bracing in St. Andrew's cross	R10	Ø = 10mm	0.6 kg/m	0.79 cm^2	0.66 cm^2

Moment of inertia I_y and I_z	Elastic sectional modulus W_{el}	Platic secional modulus W_{pl}	Platic limiting axial force N_{pl}	Platiclimiting shear force V_{pl}	Platic limiting bending force M_{pl}	Ultimate resistance to axial force N_u	Instability curve (EN)
599 cm^4	79.9 cm^3	105 cm^3	627 kN	230 kN	28.9 kN.m	935 kN	a_0
982 cm^4	131 cm^3	153 cm^3	780 kN	230 kN	42.1 kN.m	1160 kN	c
11.3 cm^4 (y) 5.05 cm^4 (z)	4.52 cm^3 (y) 3.37 cm^3 (z)	5.70 cm^3 (y) 3.98 cm^3 (z)	98.7 kN	21.8 kN (y) 37.7 kN (z)	1.57 kN.m (y) 1.10 kN.m (z)	154 kN	c
719 cm^4 (y) 384 cm^4 (z)	95.9 cm^3 (y) 76.8 cm^3 (z)	117 cm^3 (y) 88.3 cm^3 (z)	642 kN	151 kN (y) 230 kN (z)	32.1 kN.m (y) 24.3 kN.m (z)	957 kN	c
353 cm^4 (y) 188 cm^4 (z)	58.9 cm^3 (y) 46.9 cm^3 (z)	72.4 cm^3 (y) 54.7 cm^3 (z)	505 kN	119 kN (y) 183 kN (z)	19.9 kN.m (y) 15.1 kN.m (z)	752 kN	c
226 cm^4 (y) 160 cm^4 (z)	45.2 cm^3 (y) 39.9 cm^3 (z)	55.1 cm^3 (y) 47.2 cm^3 (z)	450 kN	119 kN (y) 151 kN (z)	15.2 kN.m (y) 13.0 kN.m (z)	670 kN	c
35.1 cm^4	11.7 cm^3	14 cm^3	182 kN	54.3 kN	3.84 kN.m	284 kN	c
1.72 cm^4 (y) 0.87 cm^4 (z)	0.80 cm^3 (y) 0.58 cm^3 (z)	1.50 cm^3 (y) 1.00 cm^3 (z)	62.3 kN	19.1 kN (y) 17.8 kN (z)	0.41 kN.m (y) 0.27 kN.m (z)	92.8 kN	c
271 cm^4	54.2 cm^3	64.6 cm^3	505 kN	151 kN	17.8 kN.m	751 kN	c
271 cm^4	54.2 cm^3	64.6 cm^3	505 kN	151 kN	17.8 kN.m	751 kN	c
158 cm^4 (y) 52.5 cm^4 (z)	31.6 cm^3 (y) 21.0 cm^3 (z)	40.8 cm^3 (y) 25.0 cm^3 (z)	367 kN	71.4 kN (y) 151 kN (z)	11.2 kN.m (y) 6.86 kN.m (z)	547 kN	c
1.69 cm^4	1.35 cm^3	1.71 cm^3	57.4 kN	17.9 kN	0.47 kN.m	89.8 kN	c
0.05 cm^4	0.10 cm^3	0.17 cm^3	21.6 kN	/	/	30.4 kN	c



Design Ratios on Members by Design Situation | Steel Design | ...

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Steel Design | Design Ratios o...

Design Situation	Member No.	Location x [m]	Str Po	Loading No.	Design Check Ratio η [--]
DS1	ULS (STR/GEO) - Permanent and transient - Eq. 6.10				
	189	0.000		CO53	0.000 ✓
	549	1.997		CO133	0.978 ✓
	355	0.000		CO133	0.973 ✓
	13	0.000	1	CO37	0.175 ✓
	374	3.800		CO149	0.102 ✓
	219	6.200		CO155	0.075 ✓
	272	10.000		CO149	0.060 ✓
	219	6.200		CO55	0.049 ✓
	17	0.000		CO146	0.018 ✓
				CO144	0.017 ✓
	19	0.000		CO36	0.000 ✓
	316	0.000		CO133	0.554 ✓
	219	0.000		CO54	0.549 ✓
	316	0.000	...	CO135	0.789 ✓
				CO128	0.446 ✓
	626	5.000 ½		CO143	0.370 ✓
	34	0.000		CO37	0.447 ✓
	471	10.000		CO130	0.326 ✓
	182	0.000		CO1	0.823 ✓
DS2	SLS - Characteristic				
	1	0.000		CO190	0.000 ✓

Fig 189/ Screenshot of the RFEM6 software

Compliance with Eurocode 3, specifically Part 1-1, is crucial for the design of the steel structures in the cultural center. Eurocode 3 sets the European standard for steel structure design, ensuring the highest levels of safety, durability, and performance. Eurocode 3 covers comprehensive aspects of steel structure design, including material properties, structural analysis, and detailed design methods. It ensures that all components of the structure are appropriately sized, connected, and capable of withstanding various loads and stresses, including permanent, operational, wind, snow, and thermal expansion loads. This approach guarantees that the structural elements are robust and reliable, providing long-term safety and stability.

Compliance with Eurocode 3 also involved using structural analysis software, specifically RFEM 6. This software allowed for detailed simulations and calculations of the building's structural performance under various load conditions. By using RFEM 6, we could model the behavior of the steel structures with high accuracy, ensuring that the design adheres to the principles and requirements of Eurocode 3. The software's ability to handle complex load combinations and provide precise results was instrumental in validating the structural integrity and safety of the design.

One of the key capabilities of RFEM 6 is its ability to perform detailed finite element analysis (FEA). The software's robust analysis engine can simulate the response of the structure to the loads, providing insights into potential stress points, deflections, and overall stability. RFEM 6 includes specific modules for designing and verifying steel structures according to Eurocode 3. These modules provide automatic checks for compliance with the code's requirements, such as member stability, connection design, and serviceability limits. The software can generate detailed reports that document the compliance of each structural element, providing a clear and comprehensive record of the design process.

By simulating the model on RFEM 6, it was possibile to optimize the design and to minimize material usage and construction costs while maintaining compliance with Eurocode 3. The ability to optimize the design ensures that the cultural center is not only safe and compliant but also cost-effective. The steel design and the verification on the governing results are therefore explained in the appendice.

NB : Please refers to Steel Design (SD) in the appendice

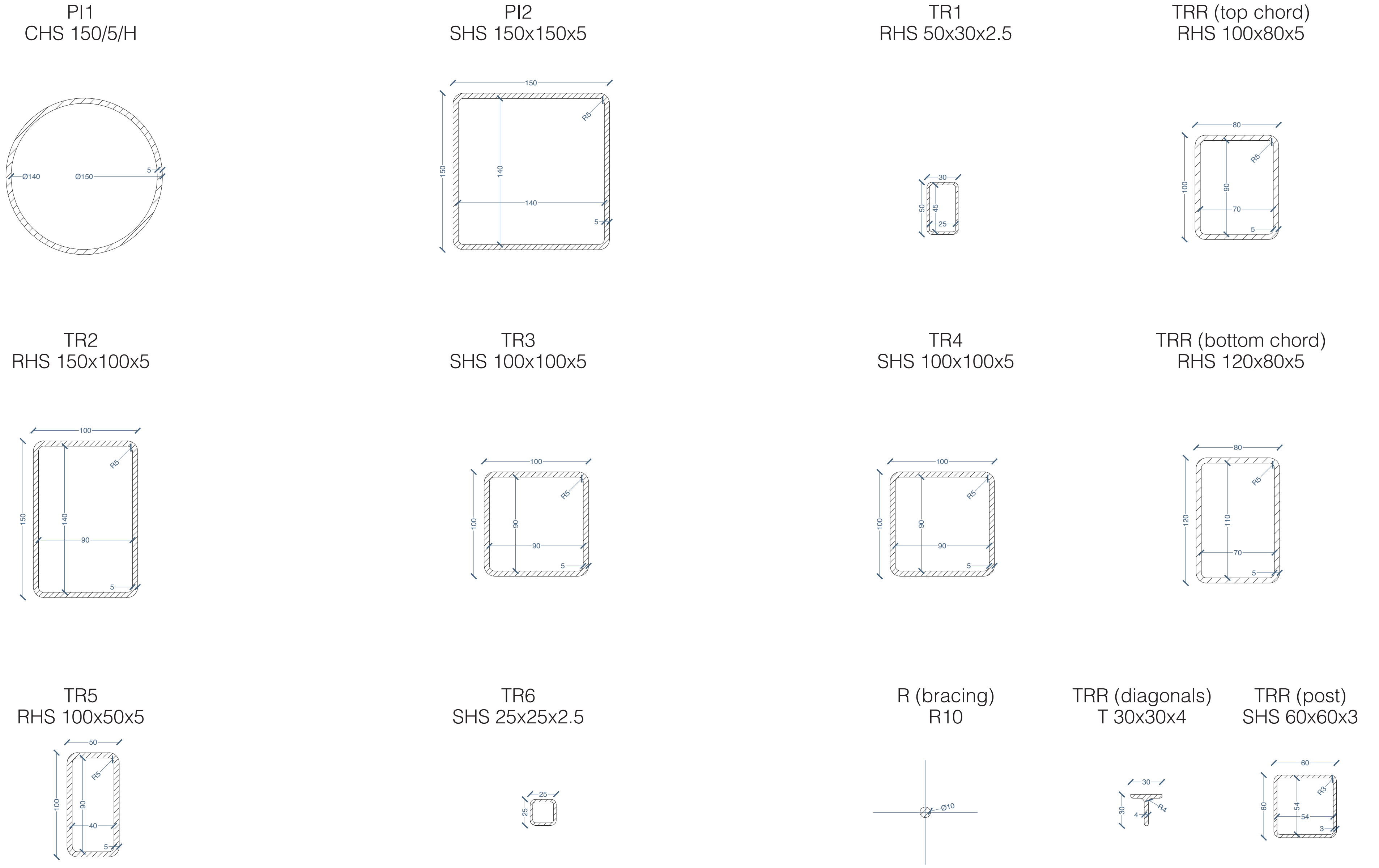


Fig 190/ Overview of the structural beam used

PART 5 - ENERGY DESIGN

5.1. Climatic analysis

Tours, located in the Indre-et-Loire department (37) within the picturesque Centre-Val de Loire region of France, enjoys a «Cfb» climate. This type of climate is characterized by warm summers and consistently humid conditions throughout the year.

In terms of temperature, Tours experiences a range that typically spans from 0°C during the colder months to a comfortable 25°C in warmer periods. In the summer, temperatures can peak, but they rarely exceed 30°C, making for a pleasantly mild climate. The wind patterns in Tours are quite specific; the predominant direction is along a Southwest-Northeast axis. Strong winds are an uncommon occurrence, especially during the summer, while they are somewhat more frequent in the winter months. Throughout the year, a gentle breeze is a constant companion, providing a continuous sense of air movement that contributes to the city's charm.

Humidity levels in Tours are notably influenced by the nearby rivers, with relative humidity averaging around 75%. This figure can vary, with summer humidity dropping to around 20% and winter levels around 10%. The high humidity levels make the area susceptible to moisture-related issues. The atmosphere in Tours is often a blend of partial cloud cover and a generally humid environment, contributing to its unique meteorological identity.

The local climate in Tours is typically calm, with minimal risk of severe weather events such as storms or snow. However, fog is a relatively common phenomenon, occurring about 14% of the time due to the prevalent humidity. Rainfall is a frequent feature throughout the year, with approximately one out of every three days being rainy. During the summer, the frequency of rainy days decreases slightly to about one in every five days.

Overall, Tours boasts a pleasant climate characterized by moderate seasonal variations and a significant level of humidity. The weather conditions are generally stable, making it an appealing destination for those who appreciate a mild and consistent climate.

The energy analysis is therefore based on the weather data of Tours and the geometry of the project and be simulated on Grasshopper and Rhino7.

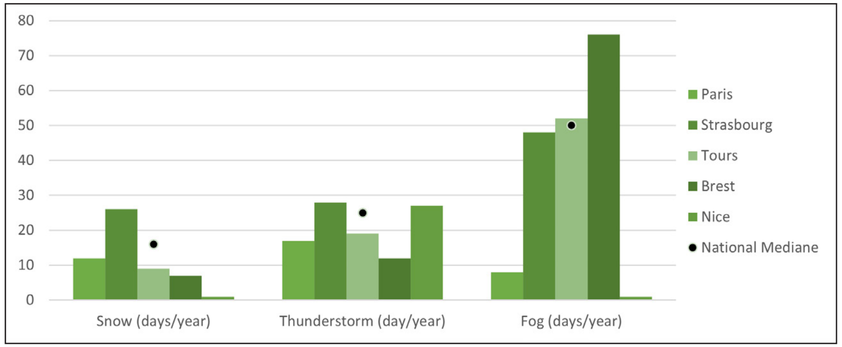


Fig 191/ Occurence of days with bad weather
(in days per year, by city)

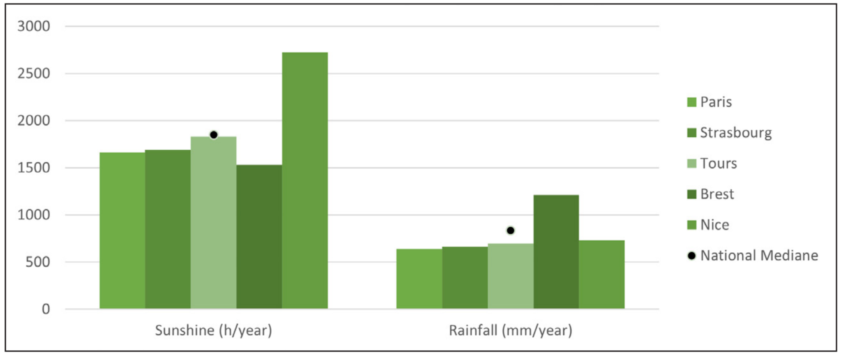


Fig 192/ Annual sunshine and precipitation
(in hour per year / milimeter per year, by city)

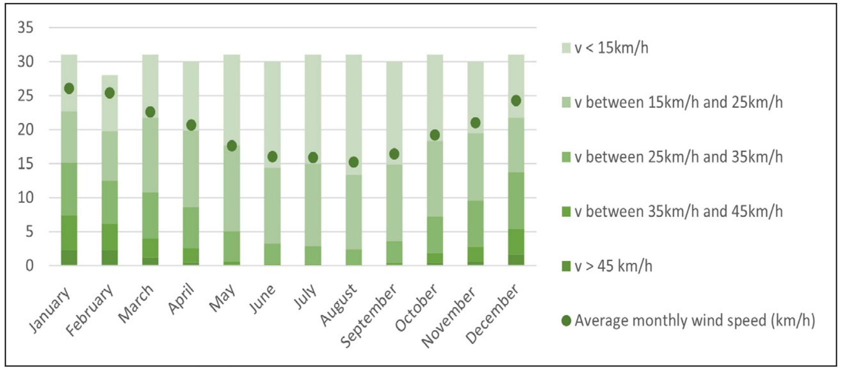


Fig 193/ Occurence of wind speed in Tours
(in days per month)

5.2. Shading analysis

Shading is a critical component of the building's energy efficiency strategy. Proper shading devices are essential in reducing cooling loads by minimizing direct solar gains during the summer months while allowing beneficial solar heat during the winter. The Granges Collières Cultural Center employs various shading elements, such as overhangs and vertical fins, strategically placed on the façade. These elements help control the amount of sunlight entering the building, thus maintaining a comfortable indoor temperature throughout the year.

The Granges Collières Cultural Center benefits from its location, being situated at a distance from other surrounding buildings, which means their shadows have minimal impact on the building. However, the building is located approximately three meters below the level of the surrounding neighborhood. This lower elevation means that during the winter months, when the sun is lower in the sky, the shadows cast by nearby buildings can significantly impact the building.

The study of shadows shows that during the winter solstice, shadows are cast longer and can obstruct sunlight from reaching parts of the building, particularly in the morning and late afternoo. This necessitates careful planning of both artificial lighting and heating systems to compensate for the reduced natural light and solar heat during these times. By understanding these shadow patterns, the design can incorporate measures to mitigate their effects, such as strategic placement of windows and the use of reflective surfaces to maximize the available light.

In addition to architectural shading devices, the integration of deciduous trees around the building plays a significant role in seasonal shading. During the summer, these trees provide ample shade, reducing the cooling demand. In the winter, when the leaves fall off, they allow sunlight to penetrate, contributing to passive heating. This natural shading strategy not only enhances the building's energy performance but also complements the surrounding environment, providing an aesthetic and functional benefit.

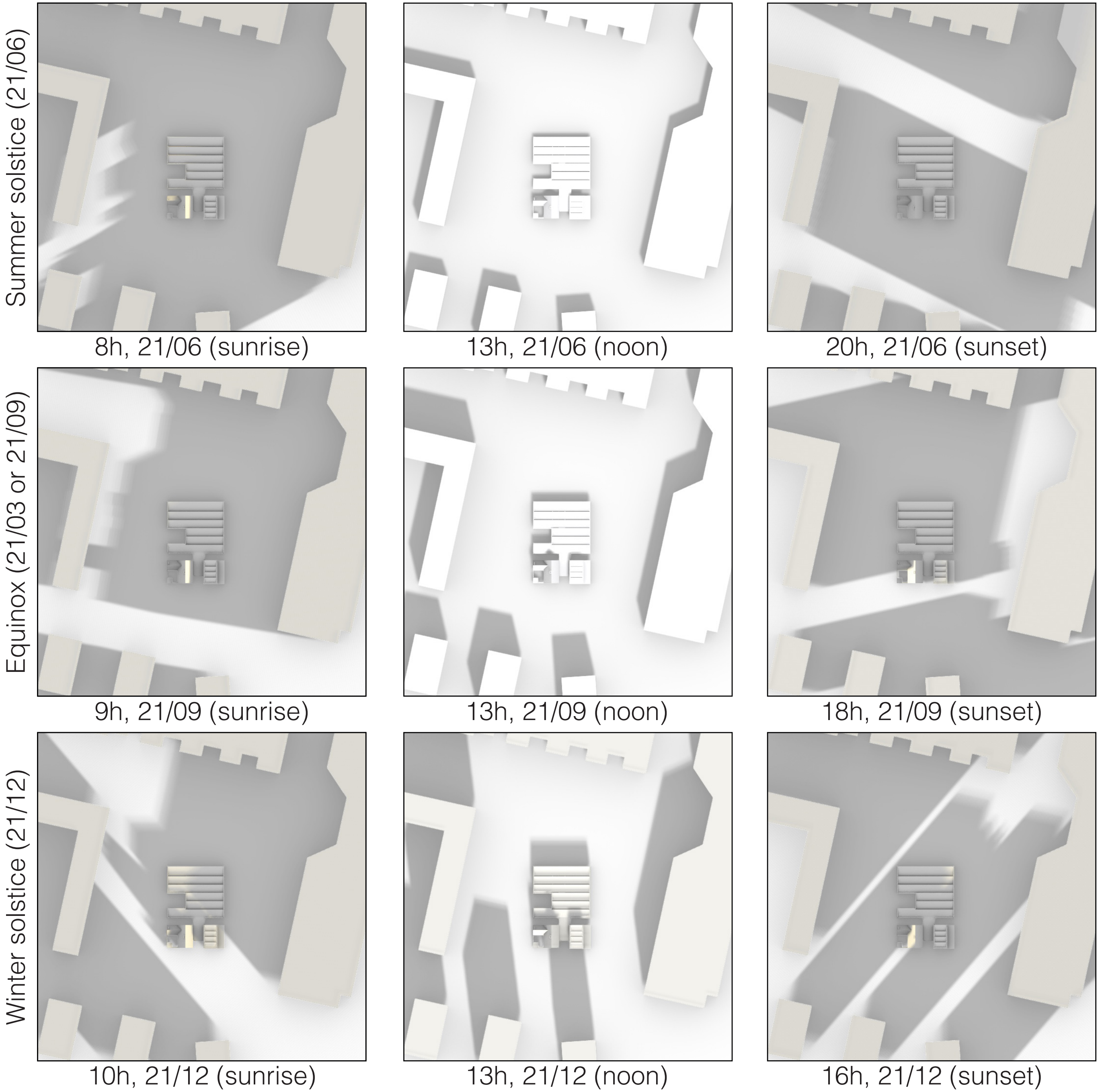


Fig 194/ Projected shadows on the project area

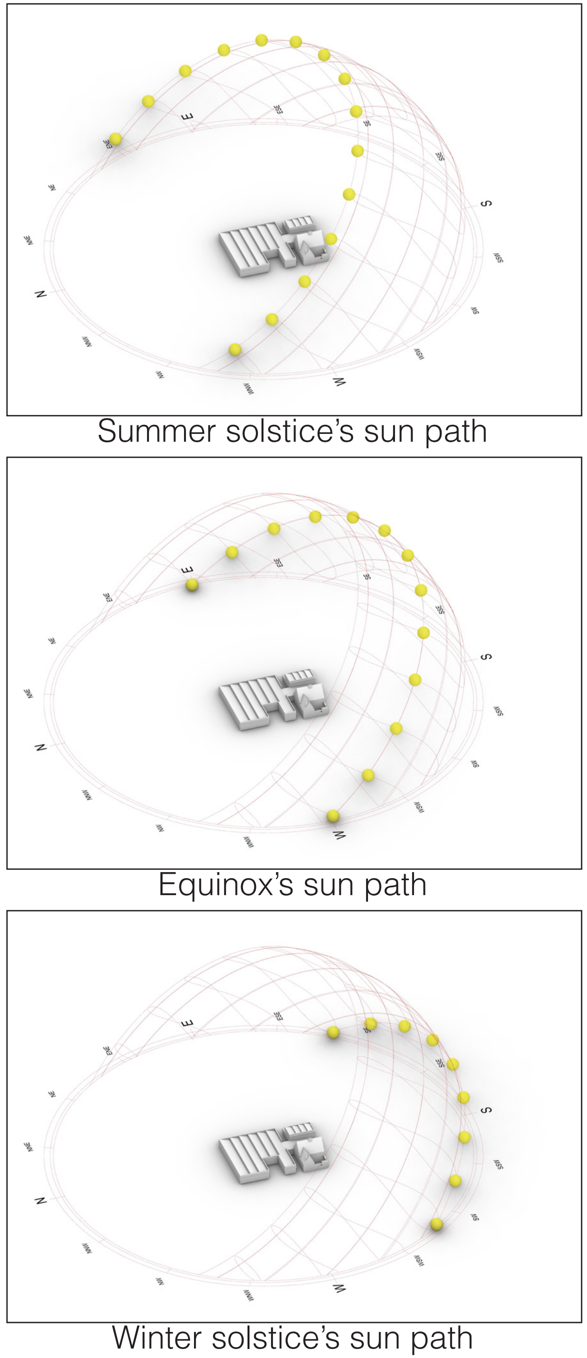


Fig 195/ Sun paths of the project area

5.3. Influence of the architectural identity of the cultural center

The design of the Granges Collières Cultural Center incorporates a curtain wall system intended to maximize natural light penetration while minimizing heat loss. The curtain wall consists of high-performance double-glazed units with low-emissivity coatings, which reduce thermal transmittance and improve insulation. This setup ensures that the building maintains a stable indoor temperature, reducing the need for additional heating or cooling. The benefits of curtain walls include a also aesthetic appeal, flexibility in design, and enhanced natural lighting which contributes significantly to the well-being and productivity of occupants.

The shed roof design is another crucial element, featuring north-facing windows that optimize daylighting without causing significant heat gains. Shed roofs are particularly advantageous due to their ability to provide uniform and diffused lighting to indoor spaces, enhancing visual comfort and potentially reducing the need for artificial lighting during the day. This design choice allows the building to harness natural light effectively, thus reducing the reliance on artificial lighting. Furthermore, shed roofs facilitate better drainage of rainwater and snow, improving the building's overall durability and reducing maintenance costs.

The orientation of the building itself plays a pivotal role in its overall energy performance. A study conducted on the impact of building orientation in New Minia, Egypt, highlighted that a north-facing orientation can reduce annual energy consumption by 5.8% compared to a south-facing orientation, with variations in consumption reaching up to 7.5% (Elhadad, Baranyai, & Gyergyák, 2018). This study underscores the importance of optimal building orientation in managing solar energy and reducing the need for heating and cooling, thereby enhancing the building's energy efficiency. Proper orientation also maximizes the benefits of both the curtain wall and shed roof designs by aligning them to capture the most advantageous natural light and heat.

According to Altan and Mohelnikova (2015), the size, style, and position of windows significantly impact the levels of natural light inside buildings. Higher windows allow better light penetration into deeper areas of rooms, while wide windows offer more uniform light distribution (Altan & Mohelnikova, 2015). In the Granges Collières Cultural Center, wider windows on the façade were chosen to provide this more even distribution of light, while the north-facing windows on the shed roof allow deeper light penetration.

5.4. Natural lighting

As natural light has been shown to have numerous benefits for occupants, maximizing natural lighting was the key design principle for the Granges Collières Cultural Center. According to research, exposure to natural light can significantly improve mood, increase happiness, and enhance overall well-being (UCLA Health, 2022). Studies have demonstrated that natural light can help regulate circadian rhythms, which are essential for maintaining healthy sleep patterns and overall health. Daylight exposure has been linked to reduced levels of stress and depression, as well as increased productivity and mental alertness.

To enhance the natural lighting in the ancestral building, specific measures were implemented. Solar tunnels were installed to bring light into the interior spaces of the ground floor in the northern section without affecting the XVIth-century tuff stone walls. The solar tunnels goes from the celling of the ground floor to the roof, so it passes thought the corner of the elevated floor. Additionally, Velux windows were installed on the roof to illuminate the upper floor. These windows are the same electric skylights used in the shed roofs of the new structure, ensuring a consistent approach to daylighting throughout the building.

In the new part of the building, daylighting is achieved through the use of electric skylights in the shed roofs, oriented north to provide consistent and diffused illumination. These skylights not only enhance natural lighting but also facilitate natural ventilation. As said earlier, the continuous curtain wall surrounding the new building strengthens the connection between the interior and exterior, offering expansive views of the natural landscape and further enhancing the sense of openness and light within the space.

However, excessive natural light can sometimes lead to glare, which can be uncomfortable for occupants. To mitigate this, the building design includes internal blinds that help control the intensity of natural light entering the spaces. These features ensure that natural light enhances the indoor environment without causing discomfort, providing a balanced approach to natural lighting that supports both energy efficiency and occupant comfort.

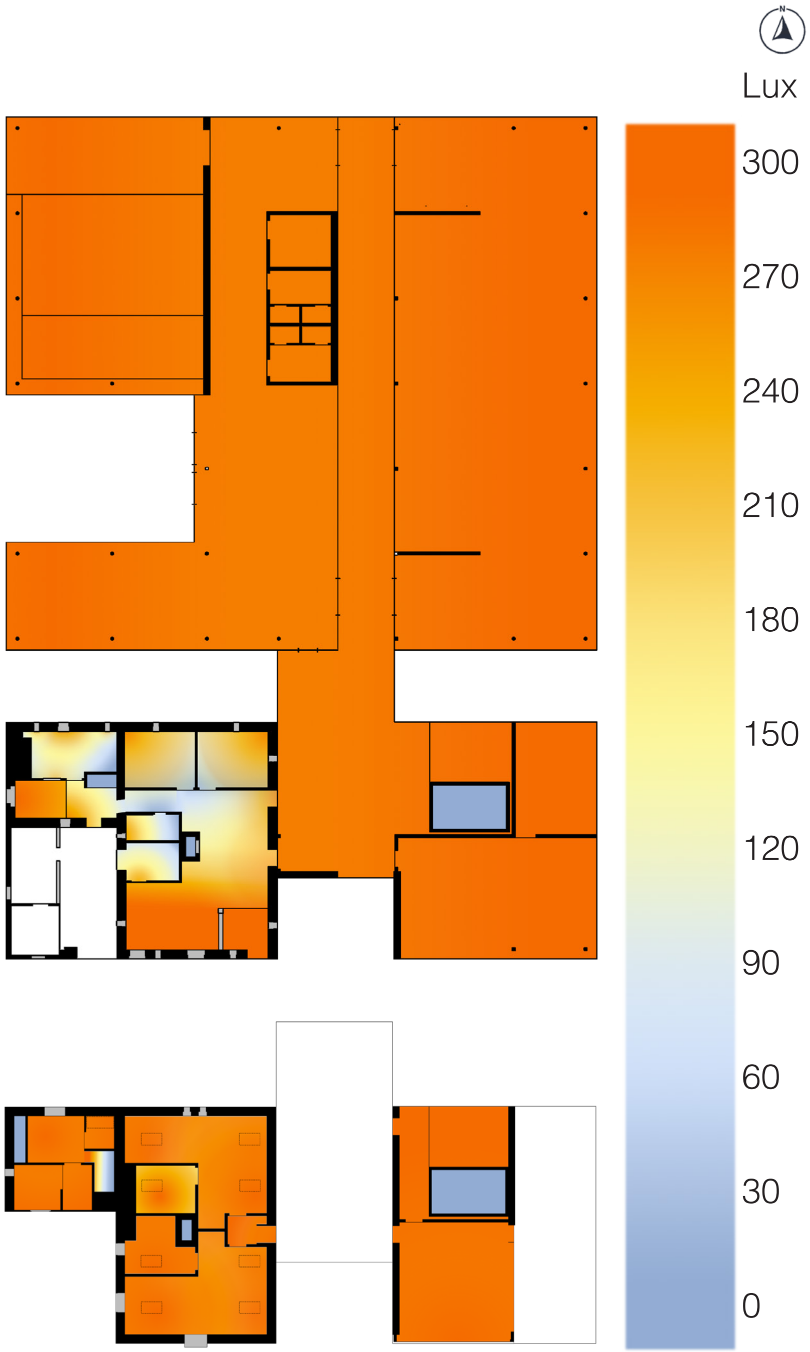


Fig 196/ Annual illuminance

Additionally, the internal blinds are designed to be user-controlled, allowing occupants to adjust them according to their personal preferences and needs. This user-centric approach empowers occupants to interact directly with the building's systems, ensuring a more personalized and satisfying experience. By giving users the ability to manage their environment, the design not only enhances comfort but also promotes a sense of ownership and engagement with the space.

5.5. Artificial lighting

In scenarios where natural lighting is insufficient, high-efficiency LEDs are employed to ensure uniform and energy-efficient artificial lighting. These LEDs are strategically placed throughout the building to maintain a minimum illumination level of 150 lux, which is particularly useful during nighttime and in winter months when daylight is limited.

To maintaining a minimum illumination level, it is important to meet specific requirements for visual comfort. According to industry standards, different spaces within a building require varying levels of illumination to ensure comfort and functionality. For instance, general office spaces should have an illumination level of at least 300-500 lux to prevent eye strain and improve productivity, while areas such as corridors and common spaces can function effectively with lower levels, around 100-200 lux.

Furthermore, the color temperature of the lighting plays a crucial role in visual comfort. LEDs used in the building provide a range of color temperatures from warm white (around 2700K) to cool white (up to 6500K), allowing for flexibility in creating different atmospheres. Warmer tones are typically used in relaxation areas to create a cozy ambiance, whereas cooler tones are preferred in workspaces to enhance alertness and focus.

The implementation of these lighting strategies not only meets the technical requirements for energy efficiency but also ensures that the occupants of the Granges Collières Cultural Center experience optimal visual comfort and functionality in all areas of the building. The artificial lighting system comprises LEDs strategically placed in regular positions to ensure a minimum illumination of 150 lux throughout the space. Given that the new building is designed to maximize natural light during the day, the artificial lighting system will primarily function during the winter or at night.

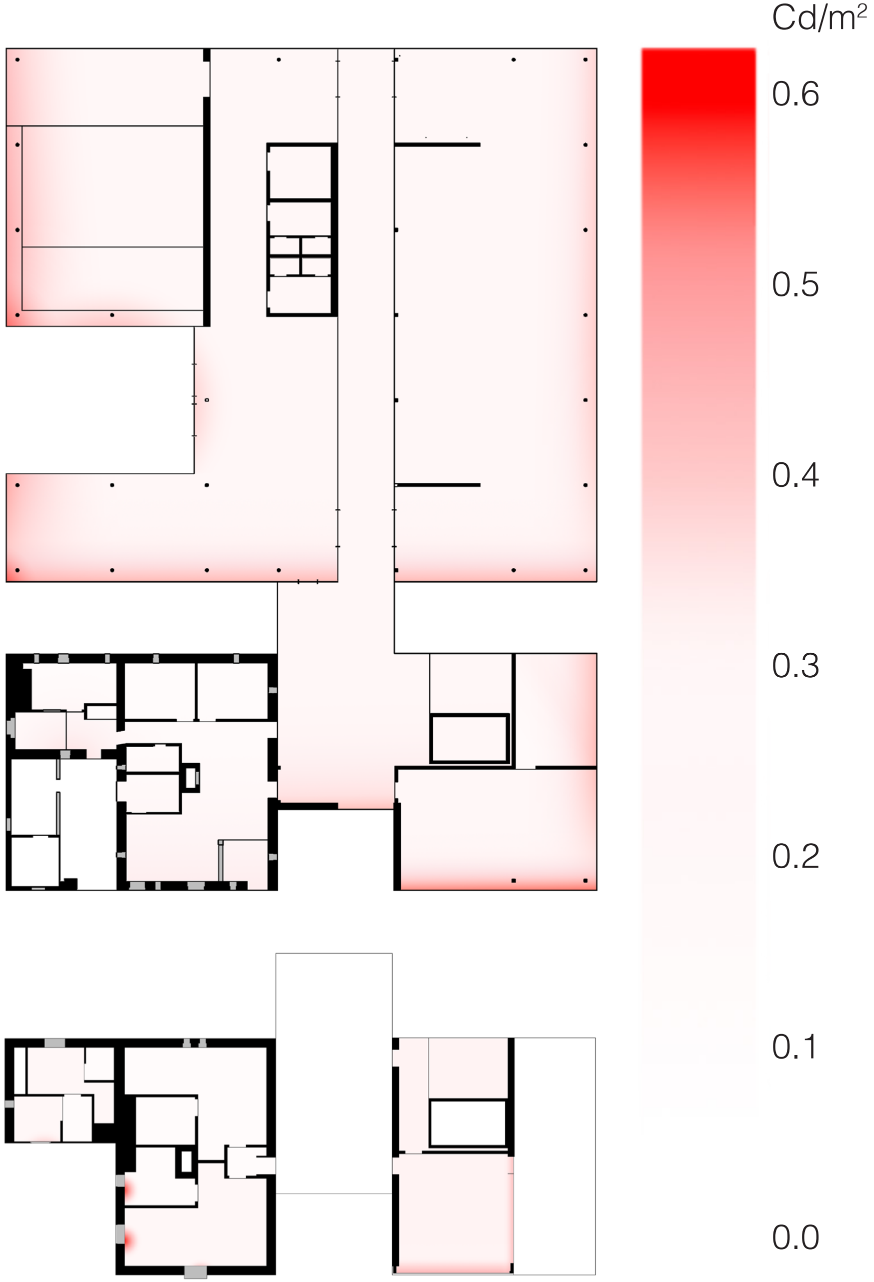


Fig 197/ Annual barking with solar shading

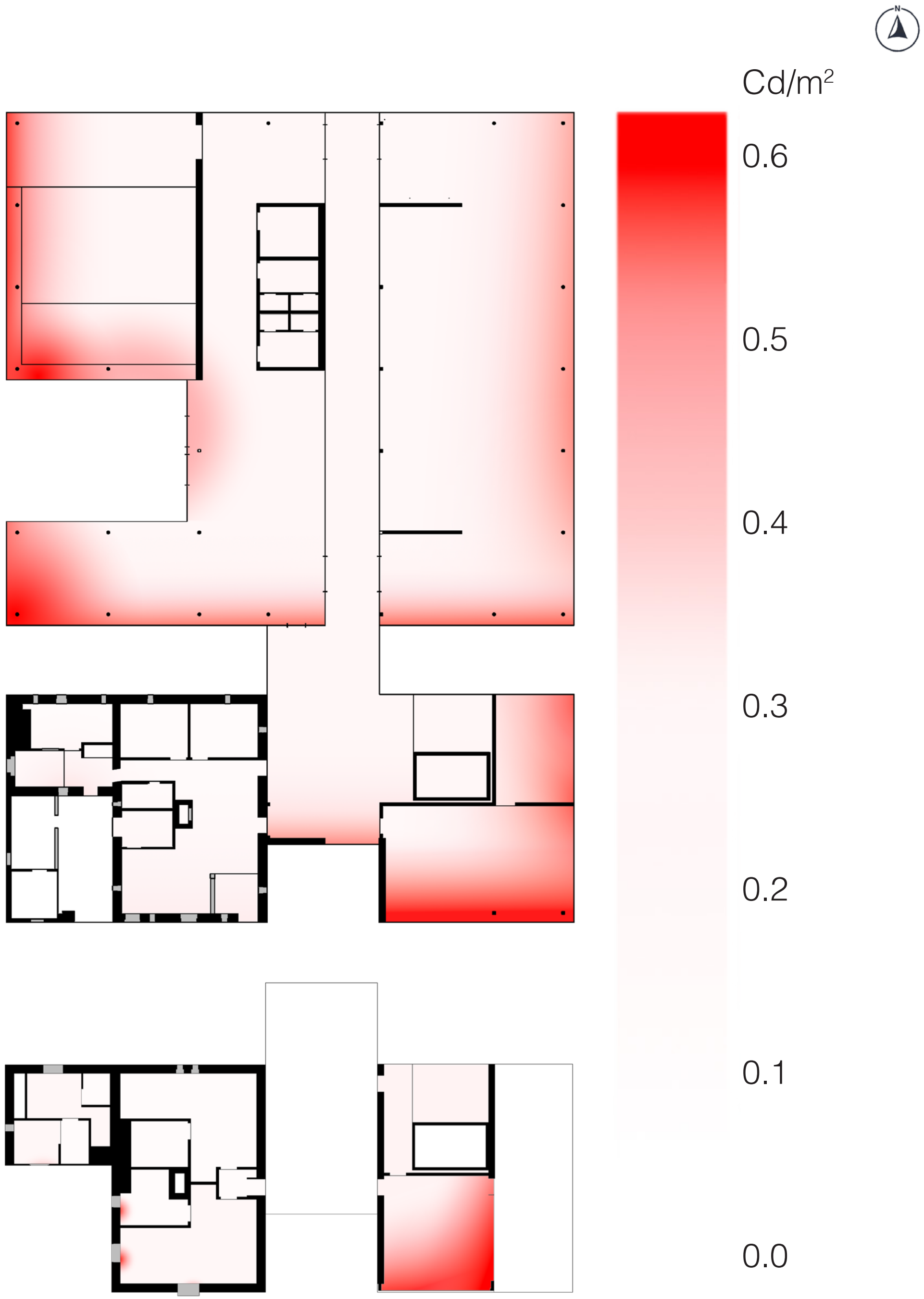


Fig 198/ Annual barking without solar shading

5.6. Heating and cooling

The heating and cooling needs of the Granges Collières Cultural Center are addressed through a state-of-the-art radiant floor system, which uses a thermal module with hot water in winter and cold water in summer. This technology ensures a uniform distribution of heat and cold, thereby optimizing thermal comfort for occupants while minimizing energy consumption.

The radiant floor system is highly efficient, allowing for direct thermal conduction and limiting energy losses typically associated with traditional heating and cooling systems. During winter, the hot water radiant floor heating system maintains optimal thermal comfort even when outdoor temperatures average 5°C, with occasional drops to 0°C. In summer, the cold water thermal module ensures uniform coolness distribution, keeping indoor temperatures comfortable without relying on energy-intensive air conditioning systems. This approach to heating and cooling significantly enhances the building's energy efficiency and sustainability.

Given that the Granges Collières Cultural Center is extensively glazed and thus lacks thermal inertia, an effective heating and cooling system is crucial. Buildings with large glass surfaces do not retain heat as well as opaque building due to the low thermal mass of glass. As a result, they are more susceptible to rapid temperature fluctuations, both from solar gain during the day and heat loss during the night. This makes the role of a consistent and efficient climate control system even more critical. Therefore, the radiant floor system must respond quickly to changing thermal loads to maintain a stable indoor environment.

5.7. Mechanical and natural ventilation

Ventilation technology is essential to help maintain a comfortable indoor environment while significantly reducing energy demand. The mechanical ventilation system at the Granges Collières Cultural Center is achieved through a dual-flow unit with heat recovery, which captures heat from the extracted air to preheat the incoming air. The ventilation ducts are discreetly integrated under the main floor, allowing efficient air distribution without compromising the building's aesthetic appeal. The fans are equipped with modulating electronic motors that provide adaptable and energy-efficient ventilation tailored to the building's occupancy and usage patterns.

The system's air extraction and supply vents are designed as pylons that mimic the steel structure of the building. These pylons emerge from the floor, seamlessly blending with the building's architectural elements while providing a functional role in air circulation. This design not only ensures efficient air distribution from the subfloor but also enhances the visual aesthetics of the space by making the air inlets and outlets less conspicuous.

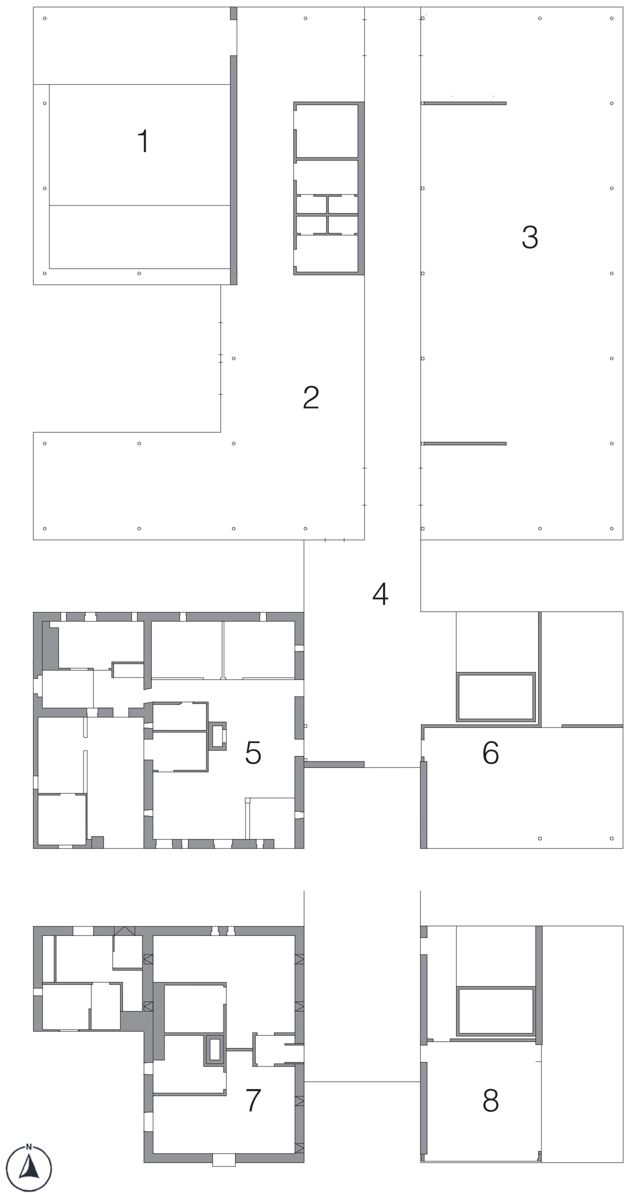
Natural ventilation is a complementary strategy to the mechanical ventilation system, further enhancing the building's energy efficiency. This is facilitated by north-facing dormers and strategically placed operable windows that allow effective cross-ventilation. During temperate periods, this natural ventilation reduces the reliance on mechanical systems, thereby lowering overall energy consumption.

The utility of the shed roof is particularly significant in this context. Shed roofs, with their distinct angled design, enhance the effectiveness of natural ventilation by allowing warm air to rise and exit through the higher points, while cooler air enters through lower doors openings. This design naturally facilitates the stack effect, where the difference in air density between cooler and warmer air creates a natural flow that aids in ventilation.

5.8. Thermal performance and energy consumption

The building's thermal transmission equivalent coefficient (Ueq value) indicates the building's capacity to minimize thermal losses, ensuring optimal energy efficiency year-round.As a reference, the value of Ueq < 0.33 W/m^2.K was taken to ensures the best thermal capacity each rooms can provides while maximazing external viewingon the site. The highest value goes to the auditorium, with a Ueq value just equal to the limit, because it is the rooms with the highest (and worse) ratio perimeter windows / interior wall partition. Every other rooms are lower than the limits, ranging from 0.25 to 0.31 W/m^2.K.

After considering the geometry of the building, the climatic context and the technological feature of each material, a simulation on the sofware Rhino7 and Grasshopper has enables to estimate the energy consumption of the building which amounts to 95 kWh/year/m^2 (representing 125 GWh/year).



Oblique opaque closure

Oblique transparent closure

Vertical opaque closure

Vertical transparant closure

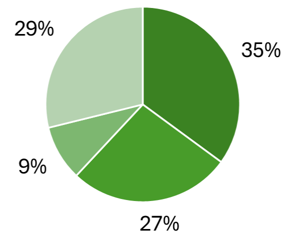
1. Auditorium

S_{floor} = 145 m²

U_{eq} = 0.33 W/m².K

S_v = 38 %

L_{min} > 300 lux



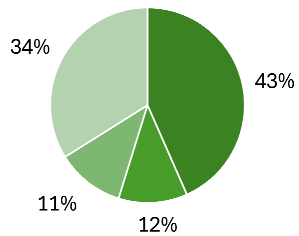
2. Foyer and lounge hall

S_{floor} = 210 m²

U_{eq} = 0.28 W/m².K

S_v = 45 %

L_{min} > 300 lux



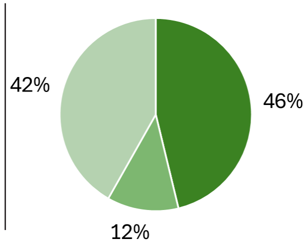
3. Exhibition room

S_{floor} = 255 m²

U_{eq} = 0.31 W/m².K

S_v = 54 %

L_{min} > 300 lux



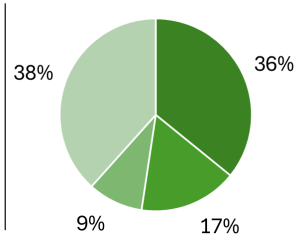
4. Distribution space

S_{floor} = 197 m²

U_{eq} = 0.25 W/m².K

S_v = 48 %

L_{min} > 300 lux



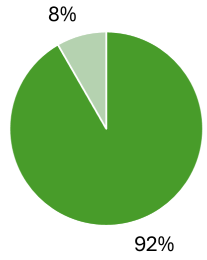
5. Amministration

S_{floor} = 78 m²

U_{eq} = 0.26 W/m².K

S_v = 8 %

L_{min} > 300 lux



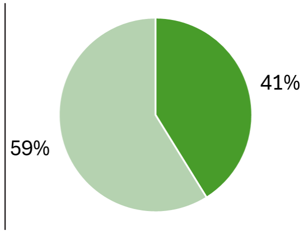
6. Workshop

S_{floor} = 90 m²

U_{eq} = 0.28 W/m².K

S_v = 59 %

L_{min} > 300 lux



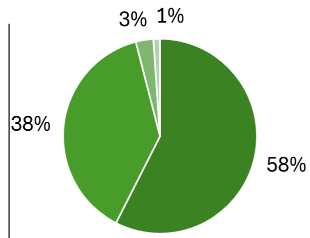
7. Private rooms

S_{floor} = 78 m²

U_{eq} = 0.27 W/m².K

S_v = 4 %

L_{min} > 300 lux



8. Shared accommodation

S_{floor} = 76 m²

U_{eq} = 0.31 W/m².K

S_v = 38 %

L_{min} > 300 lux

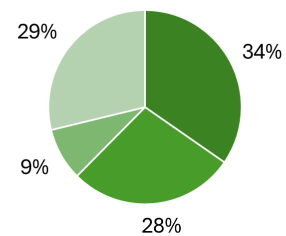


Fig 199/ Box thermal behaviour of each room

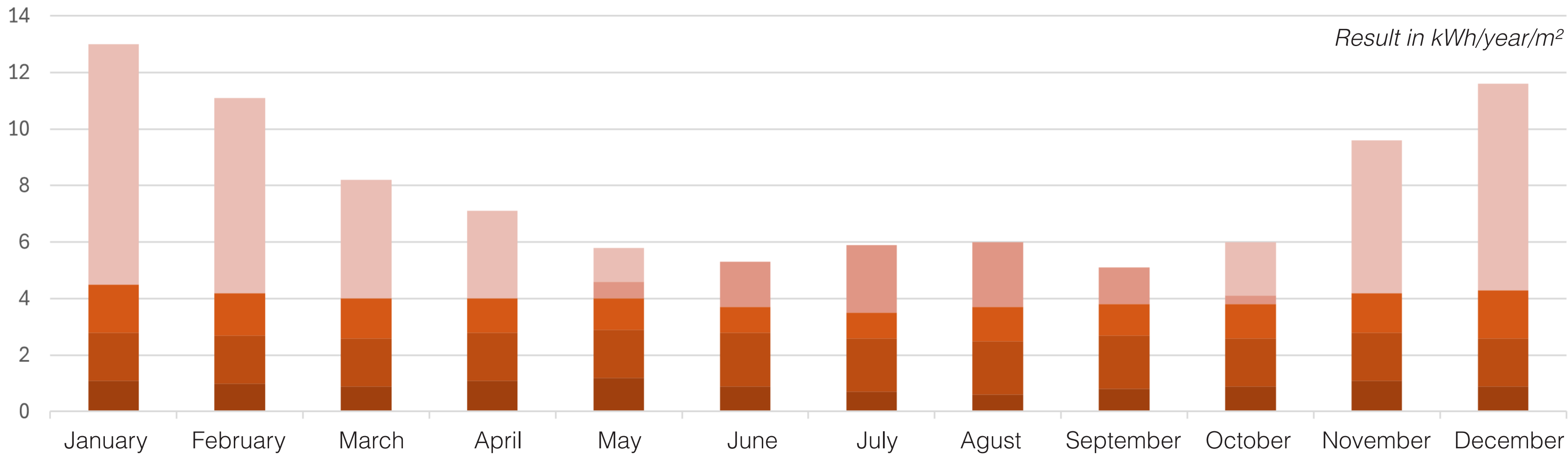
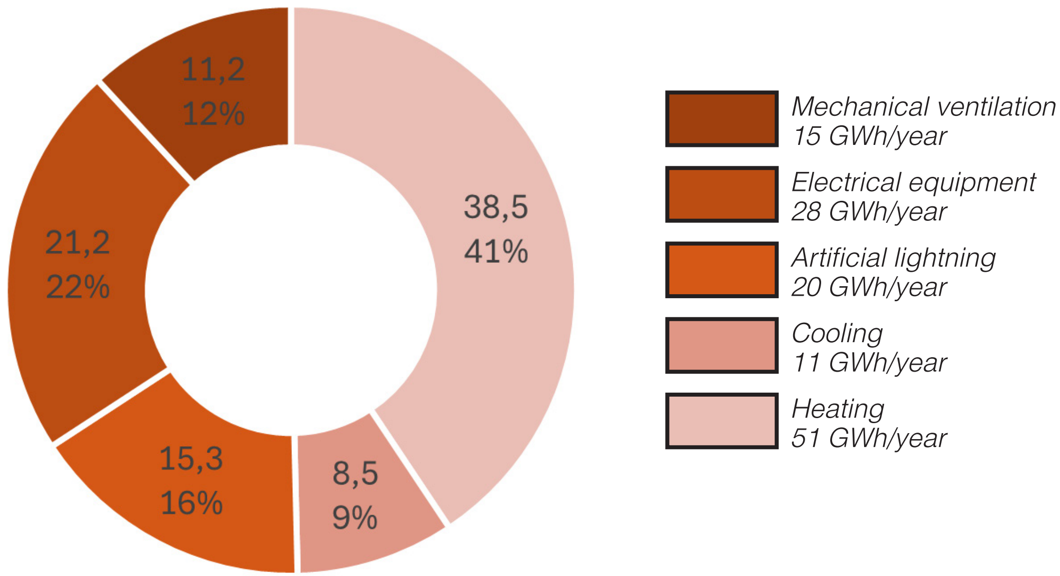


Fig 200/ Annual demand for monthly energy consumption



Result in kWh/year/m² and %

Fig 201/ Annual demand energy consumption

5.9. Implementation of photovoltaic panels

To address energy dependency and enhance sustainability, the Granges Collières Cultural Center has integrated an extensive photovoltaic system. The strategic placement of these panels on the shed roofs maximizes their exposure to sunlight while minimizing shading from other structures. With their distinctive angled design that facilitate optimal placement of solar panels, buildings with shed roofs benefit from contribute to overall energy savings and occupant comfort.

The chosen system comprises 148 monocrystalline silicon PERC 182 x 91 mm monocrystalline silicon panels having a peak power output of 450 Wp. The panels provided by WccSolaras were selected as an example for their high efficiency and reliability.

Each panel has dimensions of 228 x 114 cm and a thickness of 3.5 cm. It weighs 29kg for an area of 2.6m^2.These photovoltaic panels are strategically installed on both large and small sheds ((8 panels on the 16 plots of 10m on the larger sheds and 5 panels on the 4 plots of 6m20 on the smaller sheds), covering a total area of 384.8 m^2. With a performance factor of 0.8 and annual solar hours amounting to 3530 hours, the system captures approximately 489 GWh of solar energy annually.

After the transformation in eletricity with a efficiency of 0.21, it results in an annual electricity production of 103 GWh, meeting 82.4% of the building's annual energy needs - which are estimated at 125 GWh yearly.

The remaining 22 GWh per year corresponds to fossil fuel dependency. With a surface area of 1317 m^2, the cultural centre's dependence on fossil fuels amounts to 16.7 kWh/m^2/year, which is well below the consumption limit of 50 kWh/m^2/year set by French thermal regulations for new buildings (RT 2012).

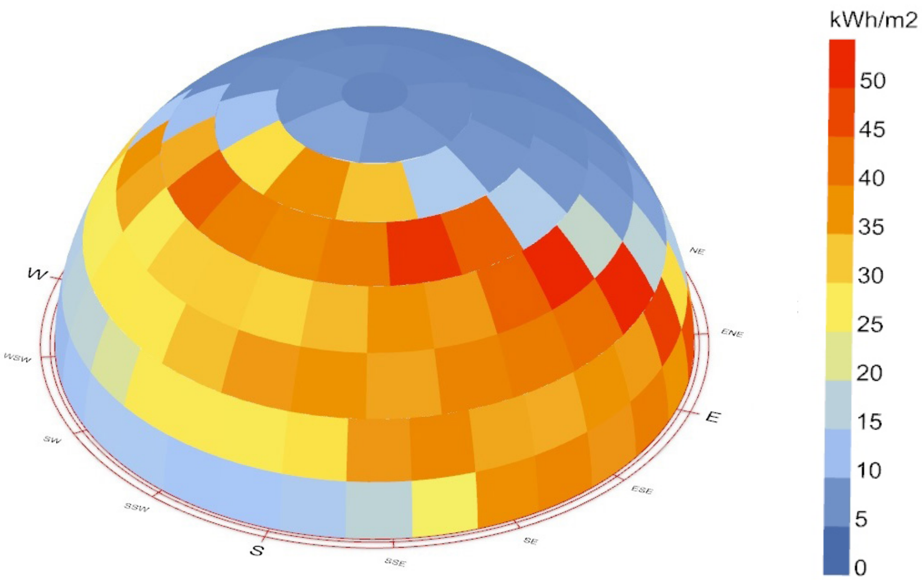


Fig 202/ Dome of the sky with average annual total radiations

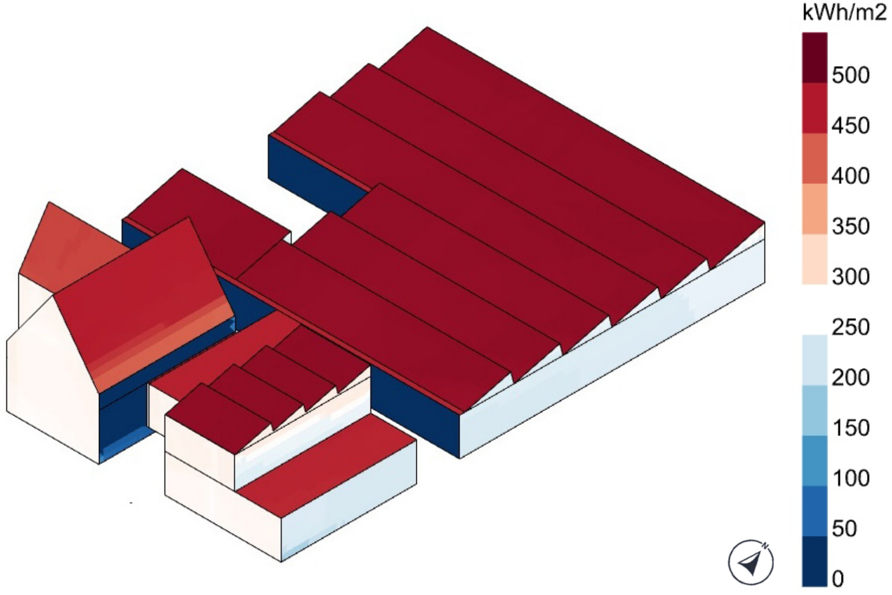


Fig 204/ Total summer radiation on the building
(accumulated over 3 months)

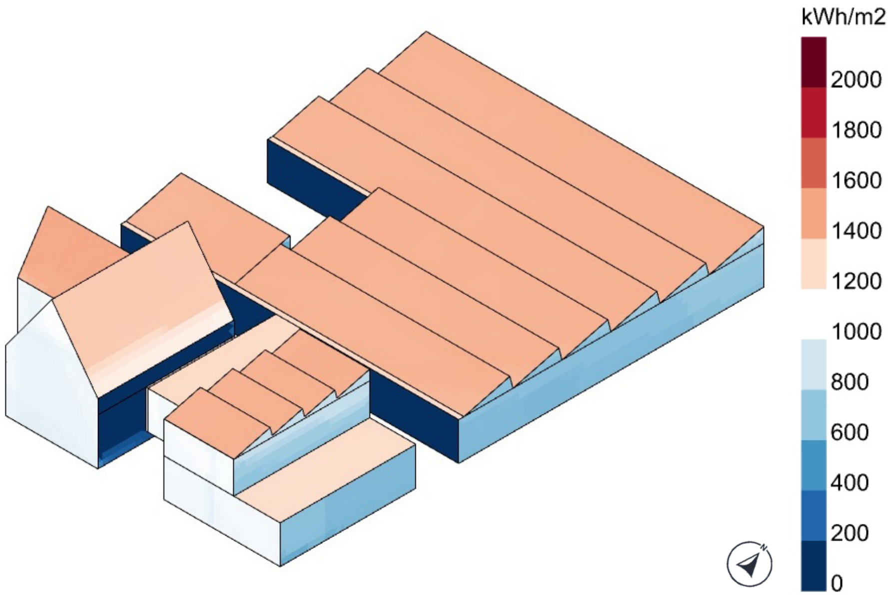


Fig 203/ Total annual radiation on the building
(accumulated over 12 months)

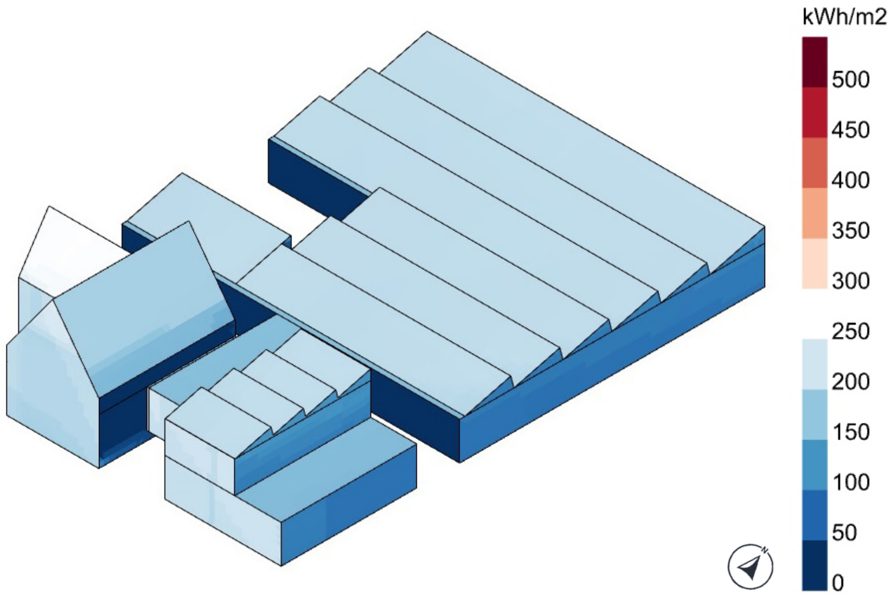
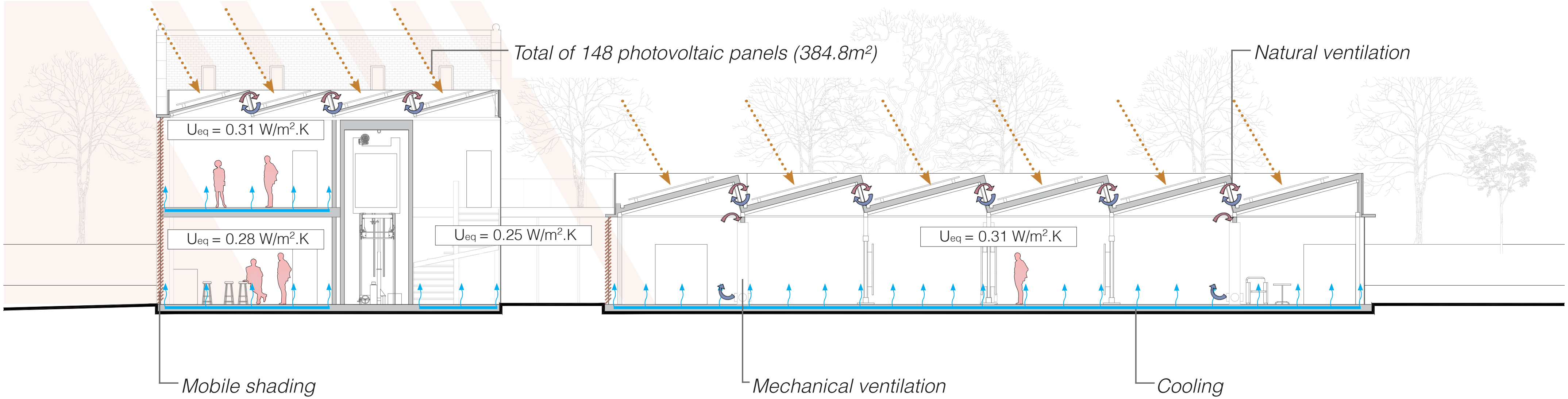


Fig 205/ Total winter radiation on the building
(accumulated over 3 months)

Summer condition :
Direct light entering at 62° at summer solstice
Constant high diffuse light
Average temperature: 25°C
Peak temperature : 30°C



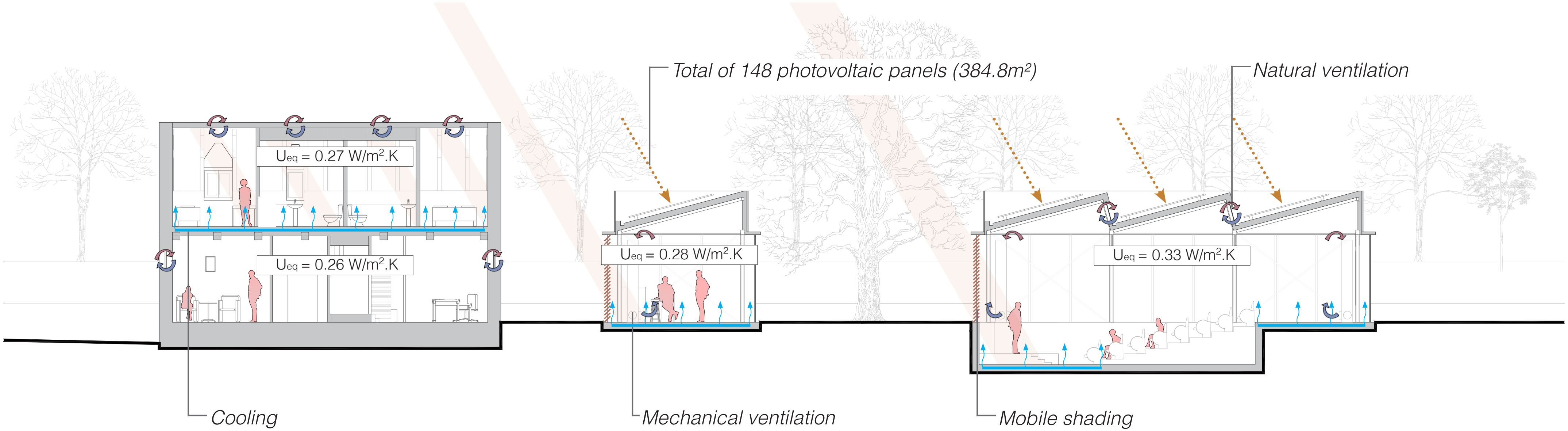


Fig 206/ Summary scheme - summer energy behaviour

Winter condition :
Direct light entering at 19° at summer solstice
Constant but fairly diffuse light in the morning and evening
Average temperature: 5°C
Peak temperature : 0°C

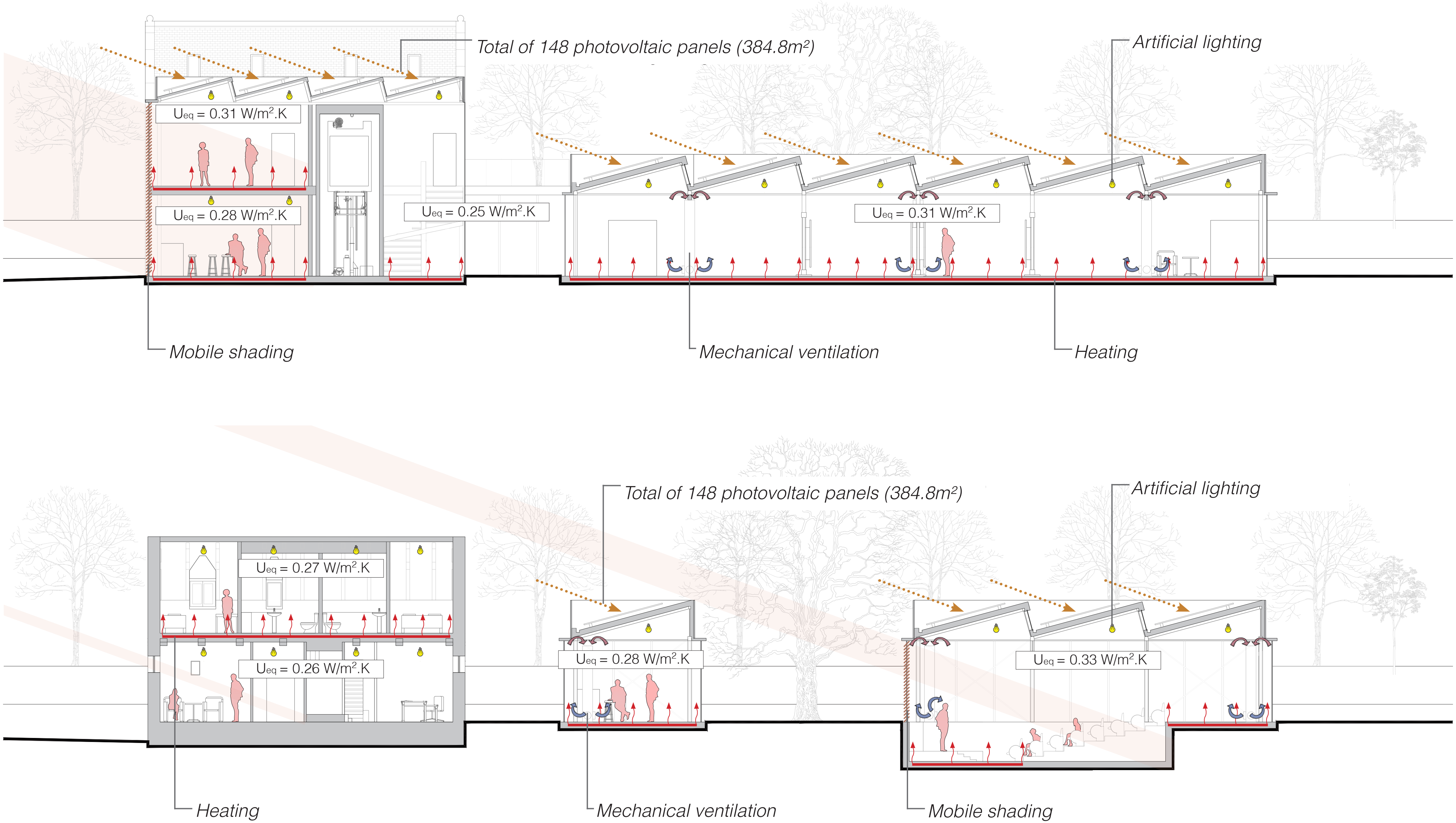
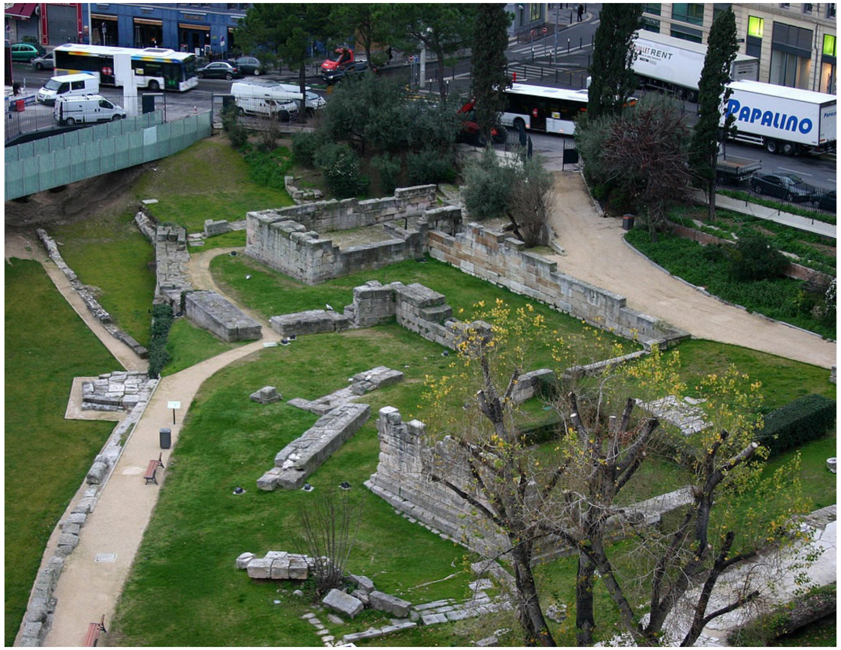


Fig 207/ Summary scheme - winter energy behaviour

APPENDICES



Jardin des vestiges, Marseille

Jardin des Vestiges is an archaeological garden situated in the heart of Marseille. Spanning about 1 hectare, it showcases ancient ruins from Greek and Roman times, offering a unique blend of history and nature.

Connections

Visitors traverse pathways amid the ancient ruins, seamlessly connecting with Marseille's historic district. Accessible entrances designed for all and makes the area a central point of exploration for both locals and tourists.

Volumetric Distribution

The garden surrounds and showcases historical structures, emphasizing their significance. Visitors' gaze is drawn towards the well-preserved ruins, creating a harmonious relationship between the past and the present.

Programme

Jardin des Vestiges fosters cultural appreciation and reflection. Archaeological exhibitions, guided tours, and artistic events are organized, imparting a sense of wonder and connection to Marseille's rich heritage.

Environment

The garden encourages slow movement, allowing visitors to absorb the ancient ambiance. Limited shadows cast by remnants create an intimate atmosphere, inviting contemplation and exploration.

Key Words

Historical, Serene, Picturesque, Inspiring, Urban Oasis

Reference

https://musees.marseille.fr/musee-dhistoire-de-marseille-requalification-du-port-antique

Jardin des vikings, Tours

Nestled within the historical fabric of Tours, the Jardin des Vikings boasts 0.5 hectares, offering a harmonious blend of heritage and nature.

Connections

Located in proximity to Tours' city center, the Jardin des Vikings invites easy exploration for residents and tourists alike. A natural parthway enables to take visitors on a tour of the park.

Volumetric Distribution

Anchored by the historical Gallo-Roman enclosure, the garden embraces both the history of the city and the greenery, creating a unique dialogue between nature and architecture.

Programme

The Jardin des Vikings serves as a cultural venue, hosting both community groups and individuals that are searching a moment of calm in the city. The green enclave evokes a tranquil ambiance.

Environment

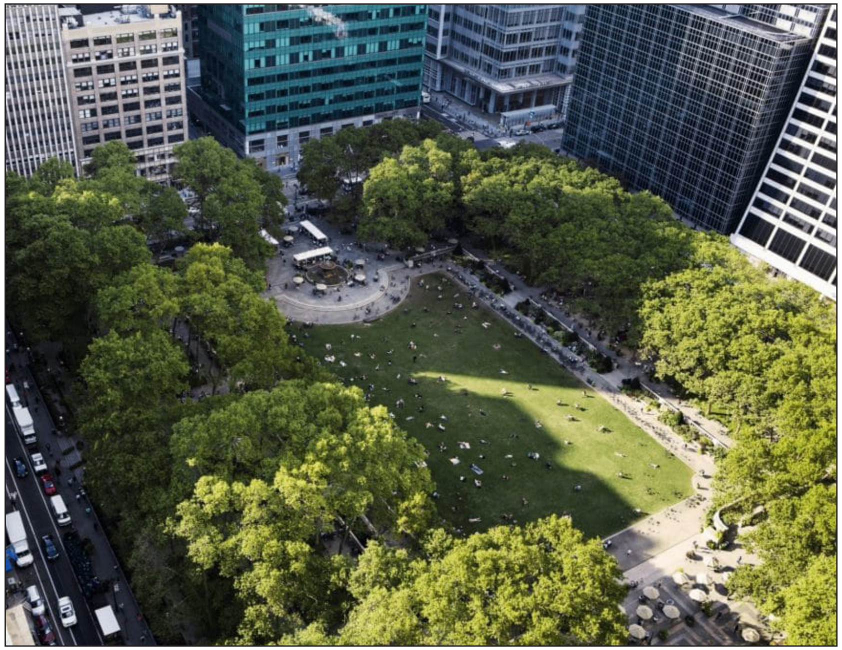
The park provides visitors with a serene space for relaxation, contemplation, and leisurely activities amidst greenery and shaded corners. The motion is characterized by greater calmness and subdued movement.

Key Words

Historical, Picturesque, Serene, Collective, Nature-infused

Reference

https://www.tours.fr/equipement/jardin-des-vikings/
https://monumentum.fr/monument-historique/pa00098158/tours-enceinte-romaine



Bryant Park, New York City

Nestled in the heart of New York City, Bryant Park spans over 3 hectares and has flourished since the 19th century. It offers a central green parcel of 0.5 hectares, embodying a vibrant urban oasis with rich cultural offerings..

Connections

Bryant Park's strategic location in Midtown Manhattan ensures easy access, forming an integral part of the city's bustling energy. The wide pathway delimits the central area thus creating a large hub.

Volumetric Distribution

Surrounded by iconic skyscrapers, Bryant Park features the New York Public Library as its centerpiece, enhancing the synergy between literature, architecture, and green spaces.

Programme

An eclectic range of events takes place here, from open-air film screenings to outdoor concerts and from knitting circles to literary gatherings. These activitys enable to create either a lively and warm mood or a serene and interactive atmosphere.

Environment

Bryant Park enable visitor to take a rest while surronded by the urban environment. Shaded by trees and enhanced by well-manicured lawns, it provides a tranquil haven amid the urban hustle.

Key Words

Central Hub, Urban Oasis, Lively, Events, Relaxing

Reference

https://bryantpark.org/
https://www.pps.org/projects/bryant-park

Midtown Park, Houston

Situated in the heart of Houston, the Midtown Park is a public place encompassing 1 hectare of open-air leisure with a central green parcel of 0.2 hectare. Revitalize in 2006, it stands as a testament to urban rejuvenation.

Connections

Well-marked walkways navigate the park, seamlessly integrating it into the surrounding urban fabric. Midtown Park serves as a green oasis amid Houston's urban landscape, easily reached via the adjacent tramway line.

Volumetric Distribution

Midtown Park features a captivating stage nestled amidst greenery. Its design accentuates the park's focal points, offering a dynamic visual experience from various angles.

Programme

Midtown Park thrives as an outdoor cultural haven, bringing the community together through an array of captivating activities. Its open-air stage hosts a diverse lineup of events, such as film screenings under the stars. Throughout the year, it serves as a dynamic platform for local and international artists, fostering creativity and artistic exploration.

Environment

Midtown Park encourages movement and relaxation, with open spaces inviting leisurely strolls. The presence of a few shade-giving trees ensures comfort, creating a balance between natural serenity and urban energy.

Key Words

Collective, Dynamic Hub, Urban Oasis, Serene, Interactive

Reference

https://midtownhouston.com/midtown-park/
https://www.designworkshop.com/projects/midtown-park.html

Buckingham Reserve, Melbourne

The Buckingham reserve is a public green space spanning over 1.5 hectares. It was established in 2012 to provide a serene retreat within the bustling city.

Connections
Situated in a lively district, the reserve offers a tranquil escape amidst urban life. Visitors access the reserve through well-marked paths.

Volumetric Distribution
The reserve is adorned with pathways and seating areas, allowing people to relax and connect. It boasts a large playground and a modern pavilion that serves as a focal point, seamlessly blending with the natural surroundings.

Programme
The reserve hosts community events, yoga sessions, and picnics, fostering a sense of togetherness. It offers a peaceful ambiance for leisure activities and outdoor gatherings.

Environment
Buckingham Reserve invites movement and exploration, while a few tall trees provide some shade and a serene atmosphere. The natural elements harmonize to create a space where both relaxation and social interaction thrive.

Key Words
Collective, Urban Oasis, Serene, Interactive, Lively

Reference
https://www.brimbank.vic.gov.au/map/buckingham-reserve
https://www.portphillip.vic.gov.au/about-the-council/projects-and-works/tt-buckingham-reserve-upgrade

The Yards, Washington

The Yards is a dynamic urban public space in Washington, offering 2 hectares of open-air charm. It was established as part of a revitalization project in the early 2000s, transforming former industrial land into a vibrant mixed-use area.

Connections

Well-marked pathways interconnect inviting green pockets. Its strategic location within the city ensures seamless integration. With its waterfront location, The Yards has become a bustling hub that contributes to the city's social life.

Volumetric Distribution

The Yards seamlessly merges green landscapes with modern architecture. A central plaza and surrounding buildings engage with the surroundings, creating a harmonious blend of nature and urban elements. The gaze is both drawn toward the activities taking place in the area and the Anacostia river.

Programme

The Yards hosts diverse events including markets, concerts, and cultural festivals. It also provides a dynamic environment for various personal activities, fostering community engagement and offering opportunities for relaxation and gatherings

Environment

The Yards offers an engaging environment for social interactions, with open spaces encouraging movement and interaction. A few natural elements and shaded areas provide respite, enhancing the area's appeal.

Key Words

Collective, Dynamic Hub, Interactive, Modern, Riverside

Reference

https://theyardsdc.com/
https://www.brookfieldproperties.com/en/our-approach/case-studies/the-yards.html

Place Émilie-Gamelin, Montreal

The Émilie-Gamelin place is a bustling public square known for its lively and community-focused atmosphere. This public space, half urban, half green, covers an area of 1 hectare. The square has undergone various revitalizations to welcome both cultural event and artistic structure.

Connections
Situated in the heart of Montreal, the place is easily accessible. Its central location within a vibrant urban context makes it a pivotal gathering spot, drawing residents and visitors alike for various events and gatherings.

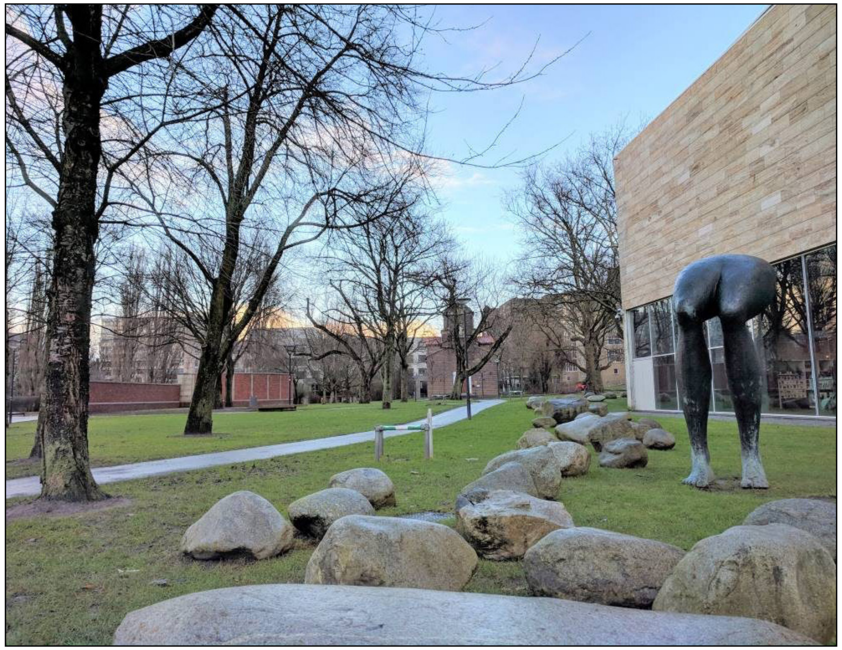
Volumetric Distribution
The square features an expansive open area with a combination of paved pathways, seating arrangements, and green spaces. There may also be a central stage for artistic performances, where the eye is naturally drawn to the various cultural activities taking place there.

Programme
The place hosts both live music concerts, art installations or outdoor markets. The diverse range of activities can create either a relaxing and contemplative atmosphere or a lively and interactive place.

Environment
The open layout encourages movement and interaction between the inside and the outside of the place. The availability of seating, some shaded areas, and green elements allows for relaxation and socialization.

Key Words
Central Hub, Collective, Artistic, Urban Oasis, Dual Environment

Reference
https://www.quartierdesspectacles.com/en/location/29/place-emilie-gamelin/
https://montreal.ca/lieux/place-emilie-gamelin



Kunsthal, Rotterdam

Kunsthal is a renowned contemporary art museum located in Rotterdam. It was established in 1992, showcasing contemporary art forms. The museumpark works as a harmonious extension of the Kunsthal art gallery. Covering about 3 hectares, it offers both art exposition and a place for gatherings.

Connections

Visitors access Kunsthal via a welcoming entrance plaza, which seamlessly connects to the surrounding urban fabric. The Museum Park's pathways create a network that invites exploration.

Volumetric Distribution

The Kunsthal building stands as a modern focal point, with its unique design and eye-catching presence. The park's layout allows for visual engagement with the Kunsthal and other art installations.

Programme

Kunsthal hosts a rich variety of rotating exhibitions, encompassing visual arts, design, and photography. The atmosphere promotes contemplation, fostering artistic dialogue and expression. The park hosts a diverse array of events, from sculpture displays to open-air performances and film screenings. Collaborations between Kunsthal and other cultural organizations create a lively atmosphere.

Environment

The Kunsthal encourages movement and exploration while some other spot enable to relax or to enjoy social interactions. Natural light filters in through the expansive glass surfaces, creating a play of shadows.

Key Words

Outdoor Exhibits, Modern, Collective, Lively, Promenade

Reference

https://www.kunsthal.nl/en/
https://www.oma.com/projects/kunsthal

Cryptoportique, Reims

The cryptoportique is an ancient Roman underground structure dating back to the 3rd century. It serves as a historical landmark and offers a large stage of 100m^2 in front of the well-preserved Roman ruins.

Connections
Situated in the heart of Reims, just next to a lively place, the cryptoportique is easily accessible, attracting both locals and tourists fascinated by the historical significance of the site.

Volumetric Distribution
The Roman arches give a picturesque backdrop to the stage. The eye is both drawn to the well-preserved arches and the cultural performances. Its stairs cleverly transformed into bleachers offer a unique seating arrangement.

Programme
As an archaeological site, the cryptoportique offers guided tours and historical exhibitions. It provides visitors with an educational and immersive experience into the ancient Roman era. As for the stage in front of the Roman arches, it serves as a venue for various cultural events, including open-air concerts, theatrical performances, and art exhibitions. Its historical setting creates an immersive and dramatic atmosphere for artistic experiences.

Environment
The stage area, oriented South-West fosters a lively but static environment during performances, while the ancient Roman ruins provide a fairly calm flow. The underground location also offers a sheltered space from the elements.

Keywords
Historical, Picturesque, Cenral Hub, Immersive, Dual environment

Reference
https://www.reims-tourisme.com/activite/cryptoportique/
https://www.bm-reims.fr/patrimoine/le-cryptoportique-de-reims.aspx

Campo della Marta, Cittadella

Campo della Marta in Cittadella is a charming open-air space of 0.5 hectares that seamlessly blends cultural activities with natural surroundings. This public area offers a unique blend of history and contemporary performance thanks to an recent amphiteatre in timber.

Connections

The campo is easily accessible and centrally located within the city, inviting residents and visitors to enjoy its offerings. Its integration into the urban fabric encourages pedestrian flow all around the historical wall.

Volumetric Distribution

Surrounded by historical architecture, the campo features a focal point embodied by the place between the city hall and the amphiteatre. This place enable to host cultural activities while the green space behind the amphiteatre now creates a calmer atmosphere.

Programme

Campo della Marta hosts open air performances and art exhibitions, fostering an inclusive atmosphere that encourages artistic expression and social interaction. Visitors can also just rest on the green parcel or contemplate the historical building

Environment

The pathway and the historical wall encourages movement and exploration, while the greenery provide relaxation and the open-air amphiteatre enables enthousiam and a lively but static atmosphere.

Key Words

Historical, Exploration, Events, Serene, Dual environment

Reference

https://www.antichemurateatrofestival.com/
https://www.vallearchitettura.it/progetti/edifici-pubblici/36/Teatro-all-aperto-Cittadella-Pd-/

Museum of Modern Art, Arnhem

The Museum of Modern Art in Arnhem boasts an engaging outdoor area that complements its contemporary collections. This open-air space spans approximately 0.5 hectare and seamlessly merges art and nature.

Connections
Visitors flow between the museum's interior and its outdoor extension. Centrally located, the area welcomes art enthusiasts and passersby to enjoy the museum's exhibits amidst a lively urban atmosphere.

Volumetric Distribution
The open-air space is carefully integrated with the museum's architectural design, blurring the boundary between indoors and outdoors. The building's modern facade and sculptures create a visually captivating experience.

Programme
The outdoor area hosts art installations, performances, and cultural events. Concerts, film screenings, and workshops engage visitors, fostering a vibrant fusion of contemporary creativity and natural surroundings.

Environment
The museum garden encourages a continual leisurely exploration and interaction with art. Varied landscaping elements offer moments of shade and openness, enhancing the interplay between nature, modernity, and artistic expression.

Key Words
Outdoor Exhibits, Modern, Artistic, Inspiring, Urban Oasis

Reference
https://www.museumarnhem.nl/nl
https://archello.com/project/museum-arnhem

Musée des beaux arts, Tours

The garden of the Musée des Beaux-Arts in Tours offers a serene outdoor space that complements the museum's artistic treasures. This open-air area extends over 1 hectare and serves as an extension of the museum.

Connections

Visitors seamlessly transition from the museum's interior to its outdoor counterpart. Convenient access from the city center encourages locals and tourists to engage with the museum's collections in an alfresco setting. The garden access is slightly hidden offering a tranquil promenade to the visitors.

Volumetric Distribution

The open-air space showcases sculptures and artistic installations that harmonize with the museum's aesthetic. The building's elegant facade and the museum garden form a cohesive visual experience.

Programme

The outdoor area hosts art exhibitions, cultural events, and workshops, fostering a creative atmosphere. Concerts, performances, and interactive displays enhance the museum's ambiance, inviting artistic exploration.

Environment

The museum garden encourages a calm movement of visitors while allowing moments of contemplation. Filtered sunlight through trees and sculptures create a serene ambiance for engaging with art and nature. There are also a few hidden spots with benches where visitors can rest.

Keywords

Outdoor Exhibits, Intimate, Artistic, Inspiring, Tranquil

Reference

https://mba.tours.fr/
https://www.valdeloire-france.com/site-culturel/musee-des-beaux-arts-et-son-jardin/

Cultuurpark Westergasfabriek, Amsterdam

The Cultuurpark is a vibrant park that spans approximately 14 hectares. Originally a gasworks site, it was transformed into a cultural hub in the late 20th century, retaining some industrial structures that add to its unique character.

Connections

The Cultuurpark's pathways wind through industrial remains and canals, converging on creative spaces.Located in Westerpark district, it marries culture and nature in a revitalized urban setting.

Volumetric Distribution

The park features both historical monuments and modern buildings, such as the Westergasfabriek complex housing various cultural activities. The eye is drawn to the industrial-era structures, which blend with the open landscape.

Programme

Cultuurpark Westergasfabriek hosts a wide range of cultural events, including festivals, art exhibitions, concerts, theater performances, and outdoor cinema screenings. The vibrant atmosphere invites both locals and tourists to engage in artistic experiences.

Environment

With a dynamic program, the park creates a lively movement of people enjoying cultural activities. The atmosphere is energetic, yet tranquil spots amid green spaces offer relaxation. A few trees provide shade and seating areas invite people to unwind and socialize.

Keywords

Lively, Festive, Riverside, Relaxing, Interactive

Reference

https://www.gp-b.com/cultuurpark-westergasfabriek
https://www.archdaily.com/803228/cultuurpark-westergasfabriek-gustafson-porter-plus-bowman

Parc de la Villette, Paris

Located in the 19th arrondissement of Paris, Parc de la Villette is one of the largest urban parks in the city, spanning approximately 55 hectares. It was created in the 1980s on the site of a former slaughterhouse and is renowned for its avant-garde architecture and cultural offerings.

Connections

The park's location near the Canal de l'Ourcq encourages visitors to explore the surrounding waterways. Meticulously designed paths guide visitors through Parc de la Villette's diverse landscapes.

Volumetric Distribution

Within the park, iconic structures like the Geode and the Cité des Sciences et de l'Industrie stand alongside vast open spaces. The eye is drawn to the futuristic architectural elements that coexist with natural landscapes.

Programme

Parc de la Villette hosts a diverse range of cultural events, including concerts, theatrical performances, art installations, film screenings, and outdoor exhibitions. Its vibrant program creates a dynamic and artistic atmosphere.

Environment

The park's rich program fosters a constant movement of people participating in various cultural activities. It offers both lively areas bustling with visitors and quieter spots that provide opportunities for relaxation. Ample tree-lined pathways offer shade and encourage leisurely strolls.

Keywords

Iconic, Festive, Riveside, Relaxing, Interactive

Reference

https://lavillette.com/
https://www.paris.fr/evenements/cine-villette-du-cinema-en-plein-air-tout-l-ete-38851

Biblioteca degli Alberi, Milano

Inaugurated in 2018, Biblioteca degli Alberi, meaning « Tree Library », is a magnificent public place in Milan. Situated right next to Garibaldi trains station and a iconic ubran place named Piazza Gae Aulenti, it embrace the fusion between nature and urban life with it 9 hectares of open space filled with trees.

Connections

Well-marked pathways designed for all weave through the Biblioteca degli Alberi, linking it to the surrounding neighborhoods and creating a seamless transition between urban and natural spaces.

Volumetric Distribution

The Biblioteca degli Alberi boasts a contemporary design that complements the historical Palazzo di Giustizia nearby. This harmony of old and new directs attention towards the majestic greenery.

Programme

The park hosts large parcels delimited by the wide parthways, allowing however to create a sense of unity. It enable each parcels to have it own activity, going from a playground, to a fitness area and relaxation and picnic spots. Besides, the park is likened to a library because of its vegetation, which includes more than 100 different species of trees arranged in 22 rings.

Environment

Dynamic movement characterizes the park, where visitors engage in recreational activities. Trees provide a refreshing canopy, offering solace from the bustling city and encouraging relaxation.

Key Words

Urban Oasis, Collective, Interactive, Horticultural, Recreational

Reference

https://bam.milano.it/
https://www.insideoutside.nl/Biblioteca-degli-Alberi-Milan

PD.01

Subject

Name : Les Grange Collière's site
Year of first settlement : XVI th century
Year of urbanisation : 1991 (district and farmhouse)
2016 (site only)
Legal condition : Public, owned by the city
Original intended use : Cultivatable field
Current use : Green space
Description : Large space below district level (in a basin). After crossing two sucessive slopes (separated by a promenade), it can be found a large flat green space with the farmhouse at its heart.

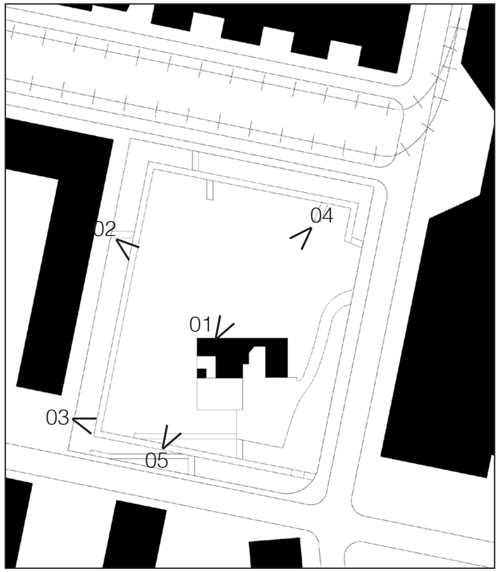
Geometric data of the site

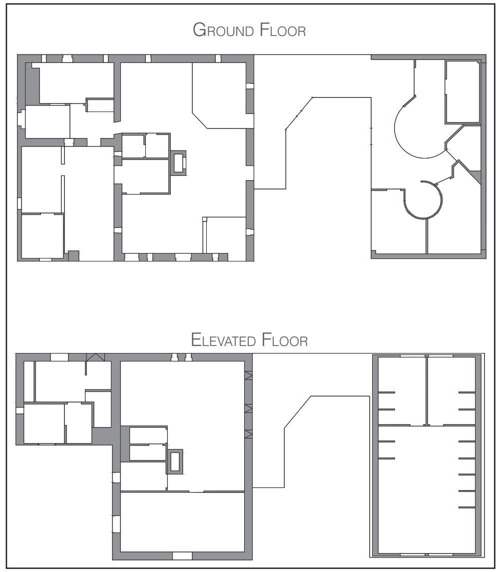
Gross area : 8 000 m^2 (100m x 80m) | 0.8 ha
Flat area surface : 3 500m^2 (70m x 50m) | 0.35 ha
Reference point (zero) : 4m below the district's level
Level of the district : +4.00m
Flat area's lowest point : +0.30m
Flat area's highest point : +1.00m (before the slopes)
Promenade's level : +2.50m (between the slopes)
Slopes' high : 1.50m for both
Average slopes' width : 6m for both (promenade's : 2m)

Geometric data of the farmhouse

Building gross area : 355 m^2 (12.5m x 28.4m)
Lowest point : +0.50m (south-west edge)
Highest point : +12.1m (Building A's top)
Distance from the district : 55m from north
34m from west
33m from south
16m from east

Navigators :





Photographic Database PD.01 N°01

Subject : View on the site at north (from the farmhouse)
Date : 30/11/2022
Camera : Huawei P20 (DPI. 429 ppp)

Photographic Database
PD.01
N°02

Subject : View on people enjoying the site (from west)
Date : 10/06/2022
Camera : Huawei P20 (DPI. 429 ppp)

Photographic Database
PD.01
N°03

Subject : View on the access ramp (from south-west)
Date : 10/06/2022
Camera : Huawei P20 (DPI. 429 ppp)

Photographic Database
PD.01
N°04

Subject : View on the farmhouse (from north)
Date : 30/11/2022
Camera : Huawei P20 (DPI. 429 ppp)

Photographic Database
PD.01
N°05

Subject : View on the farmhouse (from west)
Date : 28/10/2023
Camera : Huawei P20 (DPI. 429 ppp)

Subject

Name :	Farmhouse - Building A
Year of construction :	XVI th century
Year of refurbishment :	1991 (Indoor only)
Year of restoration :	2002 (Elevated floor only)
Legal condition :	Owned by the city of Tours
Original intended use :	Farmhouse
Current use :	Living room and Offices
Description :	Building with rectangular base and two-pitched roof.

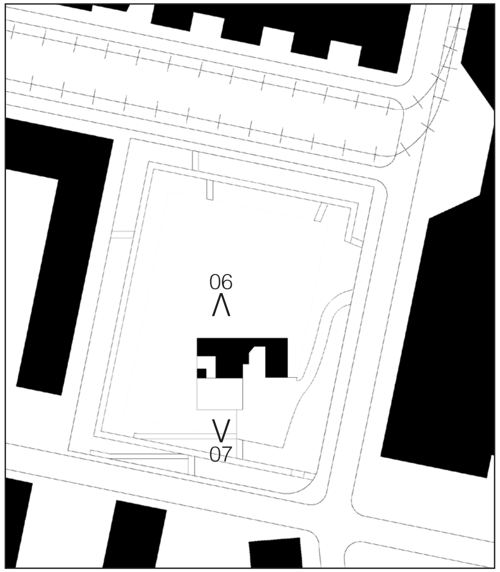
Geometric data

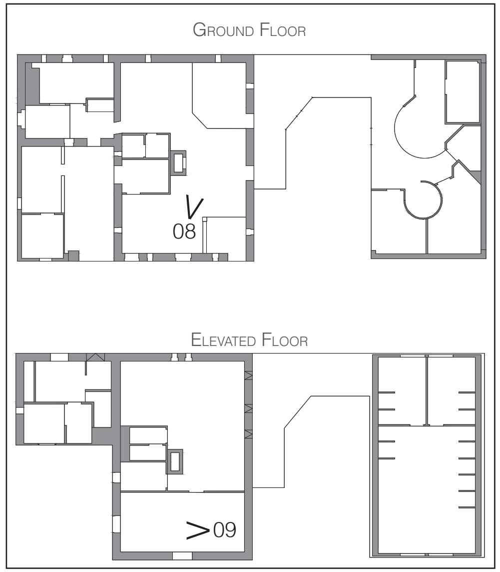
Gross floor area :	106 m^2 (12.5m x 8.50m)
Building height :	11 m
Building volumetry :	138 m^3
Number of floors :	2 (Ground and Elevated floors)
Ground floor height :	3.15 m
Elevated floor height :	6.50 m (1.30 m on the edge)

Structure and materials

Supporting structure :	Tuffeau stones
External coating :	--
Internal coating :	--
Vertical partitions :	Tuffeau or wallboard
Roofing :	Natural schist slates
Roof framework :	Oak timber
Horizontal partitions :	Oak-beamed flooring
Ground floor coating :	Tiling
Elevated floor coating :	Carpeting
Windows and doors :	Timber-framed windows

Navigators :





Photographic Database PD.02 N°06

Subject : View on the north facade of building A
Date : 22/03/2022
Camera : Huawei P20 (DPI. 429 ppp)

Photographic Database
PD.02
N°07

Subject : View on the south facade of building A
Date : 30/11/2022
Camera : Huawei P20 (DPI. 429 ppp)

Photographic Database
PD.02
N°08

Subject : View on the main room of building A groundfloor
Date : 23/08/2022
Camera : Huawei P20 (DPI. 429 ppp)

Photographic Database
PD.02
N°09

Subject : View on an office in building A elevated floor
Date : 30/11/2022
Camera : Huawei P20 (DPI. 429 ppp)

Subject

Name :	Farmhouse - Building B
Year of construction :	1991
Year of refurbishment :	--
Year of restoration :	--
Legal condition :	Owned by the city of Tours
Original intended use :	Offices
Current use :	Offices
Description :	Building with rectangular base and two-pitched roof.

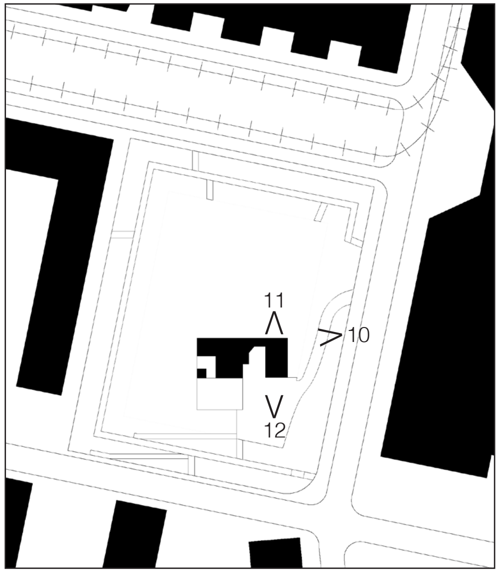
Geometric data

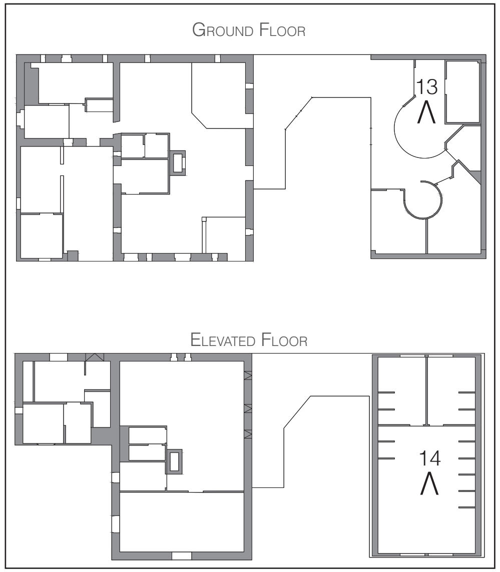
Gross floor area :	86 m^2 (12.4m x 6.90m)
Building height :	7.8 m
Building volumetry :	96.7 m^3
Number of floors :	2 (Ground and Elevated floors)
Ground floor height :	2.45 m
Elevated floor height :	4.20 m (0.00 m on the edge)

Structure and materials

Supporting structure :	Tuffeau stones
External coating :	--
Internal coating :	--
Vertical partitions :	Wallboard
Roofing :	Natural schist slates
Roof framework :	Oak timber
Horizontal partitions :	Metal-beamed flooring
Ground floor coating :	Plastic coating
Elevated floor coating :	Carpeting
Windows and doors :	Aluminium-framed windows

Navigators :





Photographic Database PD.03 N°10

Subject : View from east of building B (and A)
Date : 30/11/2022
Camera : Huawei P20 (DPI. 429 ppp)

Photographic Database PD.03 N°11

Subject : View on the north facade of building B
Date : 22/03/2022
Camera : Huawei P20 (DPI. 429 ppp)

Photographic Database PD.03 N°12

Subject : View on the south facade of building B
Date : 22/03/2022
Camera : Huawei P20 (DPI. 429 ppp)

Photographic Database PD.03 N°13

Subject : View on an office in building B groundfloor
Date : 30/11/2022
Camera : Huawei P20 (DPI. 429 ppp)

Photographic Database PD.03 N°14

Subject : View on building B elevated floor
Date : 23/08/2022
Camera : Huawei P20 (DPI. 429 ppp)

PD.04

Subject

Name : Farmhouse - Building C
Year of construction : XVI th century
Year of refurbishment : 1991 (Indoor only)
Year of restoration : --
Legal condition : Owned by the city of Tours
Original intended use : Farmhouse
Current use : Dressing room and bathroom
Description : Building with rectangular base and two-pitched roof, connected to building A on the ground floor.

Geometric data

Gross floor area : 35.3 m^2 (5.60m x 6.30m)
Building height : 8.8 m
Building volumetry : 55.5 m^3
Number of floors : 2 (Ground and Elevated floors)
Ground floor height : 3.15 m
Elevated floor height : 3.40 m (1.30 m on the edge)

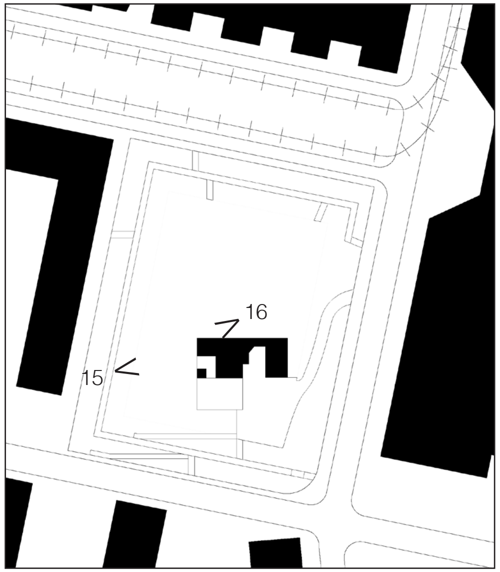
Structure and materials

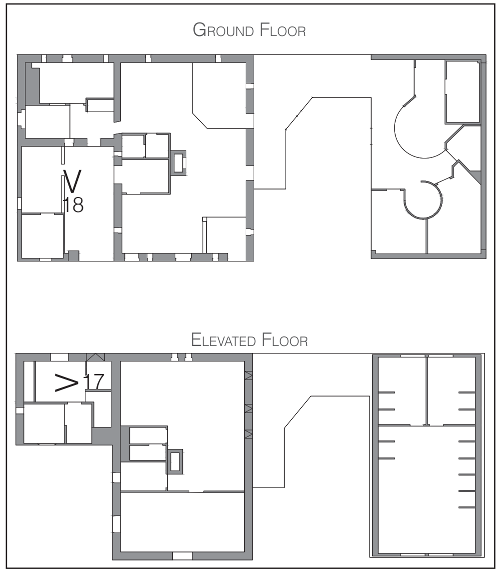
Supporting structure : Tuffeau stones
External coating : --
Internal coating : --
Vertical partitions : Wallboard with tiling

Roofing : Natural schist slates
Roof framework : Oak timber

Horizontal partitions : Oak-beamed flooring
Ground floor coating : Tiling
Elevated floor coating : Carpeting
Windows and doors : Timber-framed windows

Navigators :





Photographic Database PD.04 N°15

Subject : View on the west facade of building C
Date : 22/12/2021
Camera : Huawei P20 (DPI. 429 ppp)

Photographic Database
PD.04
N°16

Subject : View on the north facade of building C
Date : 22/12/2021
Camera : Huawei P20 (DPI. 429 ppp)

Photographic Database
PD.04
N°17

Subject : View on building C elevated floor's bathroom
Date : 23/05/2023
Camera : Huawei P20 (DPI. 429 ppp)

Photographic Database
PD.04
N°18

Subject : View on the south facade of building C
Date : 30/11/2022
Camera : Huawei P20 (DPI. 429 ppp)

Subject

Name :	Farmhouse - Glasshouse
Year of construction :	1991
Year of refurbishment :	--
Year of restoration :	--
Legal condition :	Owned by the city of Tours
Original intended use :	Main entrance
Current use :	Main entrance
Description :	Glasshouse that connects building A and B

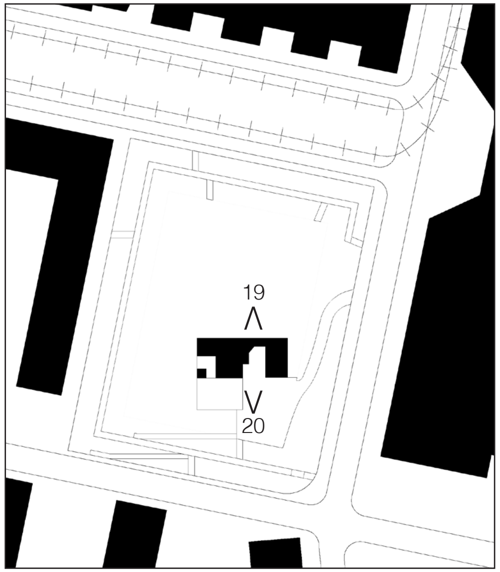
Geometric data

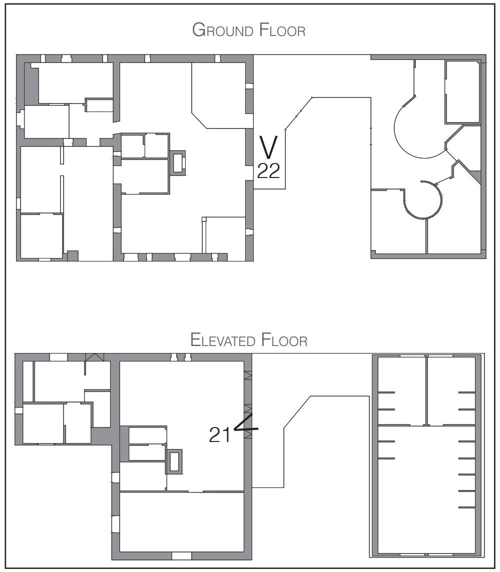
Gross floor area :	28 m^2
Glasshouse height :	3.0 m
Glasshouse volumetry :	84 m^3
Number of floors :	1 (Ground Floor)
Ground floor height :	2.70 m

Structure and materials

Supporting structure :	Oak timber and aluminium
External coating :	--
Internal coating :	--
Vertical partitions :	--
Roofing :	Aluminium
Roof framework :	Metal beam
Horizontal partitions :	--
Ground floor coating :	Carpeting
Windows and doors :	Oak timber or Aluminium-framed windows

Navigators :





Photographic Database PD.05 N°19

Subject : View on the north facade of the glasshouse
Date : 23/05/2023
Camera : Huawei P20 (DPI. 429 ppp)

Photographic Database
PD.05
N°20

Subject : View on the south facades of the glasshouse
Date : 23/05/2023
Camera : Huawei P20 (DPI. 429 ppp)

Photographic Database
PD.05
N°21

Subject : View on the roof of the glasshouse
Date : 30/11/2022
Camera : Huawei P20 (DPI. 429 ppp)

Photographic Database
PD.05
N°22

Subject : View on the entrance (Building A / glasshouse)
Date : 30/11/2022
Camera : Huawei P20 (DPI. 429 ppp)

PD.06

Subject

Name :	Farmhouse - Courtyard
Year of construction :	XVI th century
Year of refurbishment :	--
Year of restoration :	--
Legal condition :	Owned by the city of Tours
Original intended use :	Courtyard with a well
Current use :	Courtyard and storage
Description :	The courtyard leads to building A and C. Include a storage with a one-pitched roof

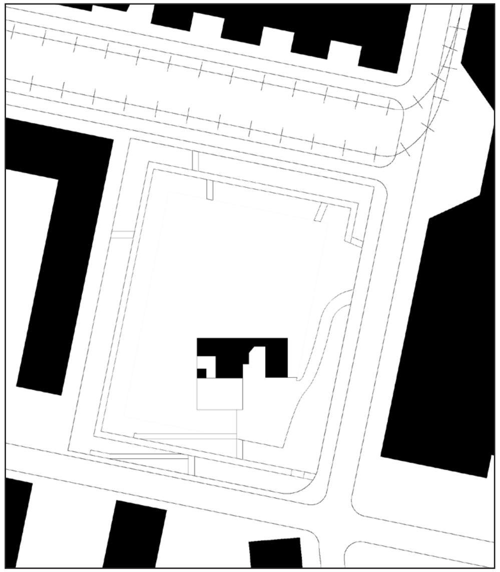
Geometric data

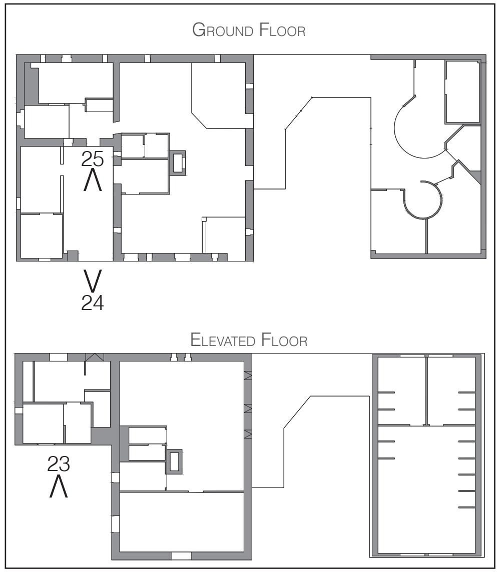
Gross floor area :	38 m^2 (5.60m x 6.80m)
Storage floor area :	6.8 m^2 (2.65m x 2.55m)
Storage height :	from 1.8m to 2.8m
Storage volumetry :	15.6 m^3

Structure and materials

Supporting structure :	Tuffeau stones
External coating :	--
Internal coating :	--
Vertical partitions :	--
Roofing :	Natural schist slates
Roof framework :	Oak timber
Horizontal partitions :	--
Ground floor coating :	Pavement
Windows and doors :	--

Navigators :





Photographic Database PD.06 N°23

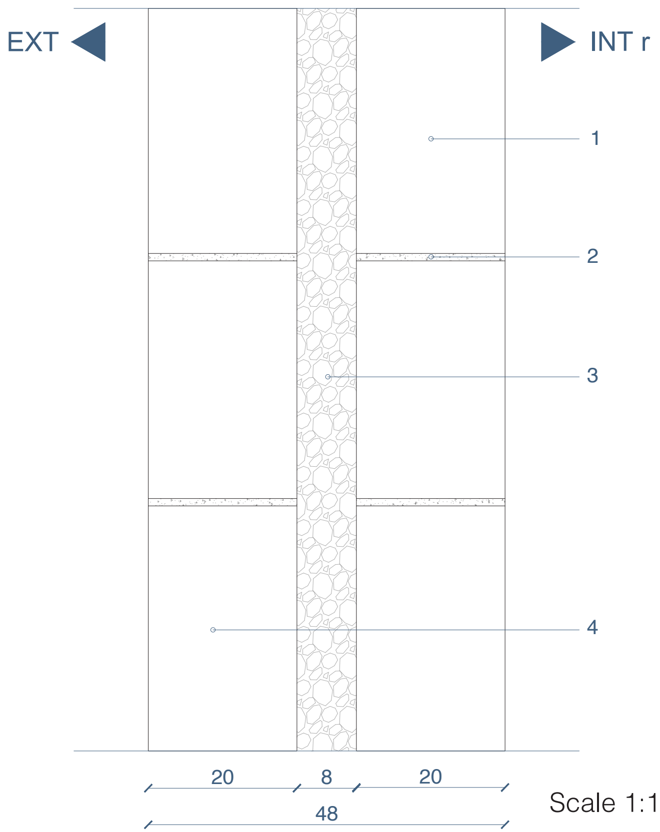
Subject : View on the courtyard from building C
Date : 30/11/2022
Camera : Huawei P20 (DPI. 429 ppp)

Photographic Database
PD.06
N°24

Subject : View on the gate outside the courtyard
Date : 10/06/2022
Camera : Huawei P20 (DPI. 429 ppp)

Photographic Database
PD.06
N°25

Subject : View on the gate inside the courtyard
Date : 23/08/2022
Camera : Huawei P20 (DPI. 429 ppp)



Scale 1:10

Annex number : TD.01

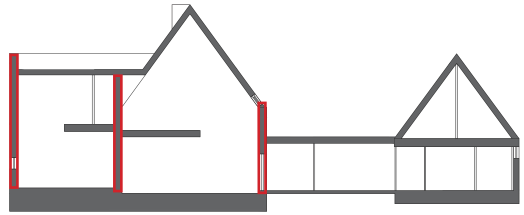
Construction code : CV1_R
CV1_R for «Chiusura Verticale n°1 (Rilievo stato di fatto)» meaning «Vertical Closure no. 1 (Survey of the state of fact)»

Technological element :
Vertical perimeter walls of the ancestral farmhouse (building A+C)

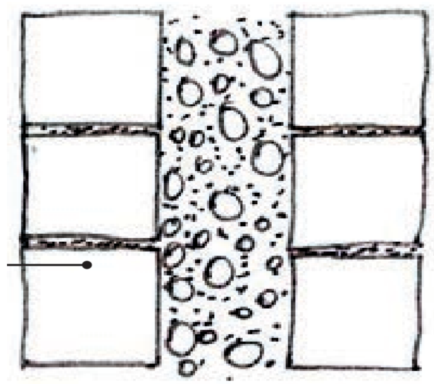
Date of construction :
Built in the 16th century, external cladding renovated in the 1990s

Overall state of the building :
- Overall integrity is preserved for each stone
- Surfaces are often damaged by mechanical actions and sometimes deterioration.
- Presence of some dirty appearance

Source of information based on archives of traditional construction techniques of tuff dwellings in the Tourraine region (among others, «Les secrets des maçons de Touraine : Techniques et savoir-faire» by Compagnons Tailleurs de Pierre du Devoir).



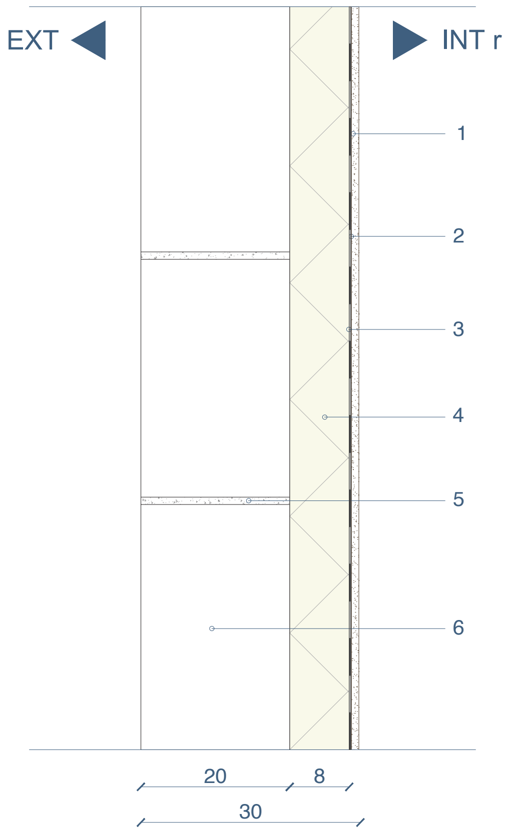
Code	CV1_R
Thickness	48 cm
Thermal resistance	3.8 m^2K/W
Thermal transm.	0.26 W/m^2K
Supported lineal mass (h=4m60)	3200 kg/m
Supported lineal weight (h=4m60)	31 kN/m



Technical aspect and use on site :
In this region of France at this time (16th century), walls are built using the double facing method with earth or aerial lime and filling with sandy mortar from the Loire. Stone is the only material used for the entire elevation structure. Stone placed on the inside serves as the structure because it is better preserved. The stone placed outside, on the other hand, is affected by the external environment and is damaged.

Legend
1. Structural stone block wall of «Tuffeau de Tourraine» 66 x 33 x 20 cm3 - 20 cm
2. Binding layer of Loire sand mortar - 1 cm
3. Earth, straw, hemp and Loire sand mortar infill for thermal insulation - 8 cm
4. External cladding of «Tuffeau de Tourraine» stone block 66 x 33 x 20 cm3 - 20 cm

N°	Th. (cm)	Conduct. (W/mK)	Resist. (m^2K/W)	Density (kg/m^3)
1.	20	0.2	1.0	1500
2.	--	--	--	--
3.	8	0.045	1.8	1200
4.	20	0.2	1.0	1500



Scale 1:10

Annex number : TD.02

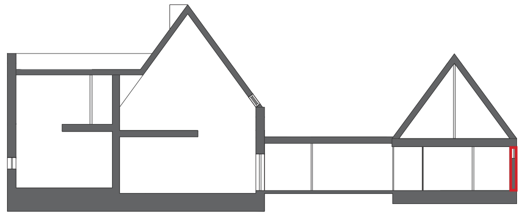
Construction code : CV2_R
CV2_R for «Chiusura Verticale n°2 (Rilievo stato di fatto)» meaning «Vertical Closure no. 2 (Survey of the state of fact)»

Technological element :
Vertical perimeter walls of the 90's extension (building B)

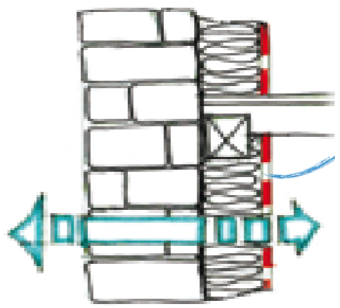
Date of construction :
Built in the 16th century, external cladding renovated in the 1990s

Overall state of the building :
- Overall integrity is preserved for each stone
- Presence of some dirty appearance

Source of information based on archives of traditional construction techniques of tuff dwellings in the Tourraine region (among others, «Les secrets des maçons de Touraine : Techniques et savoir-faire» by Compagnons Tailleurs de Pierre du Devoir).



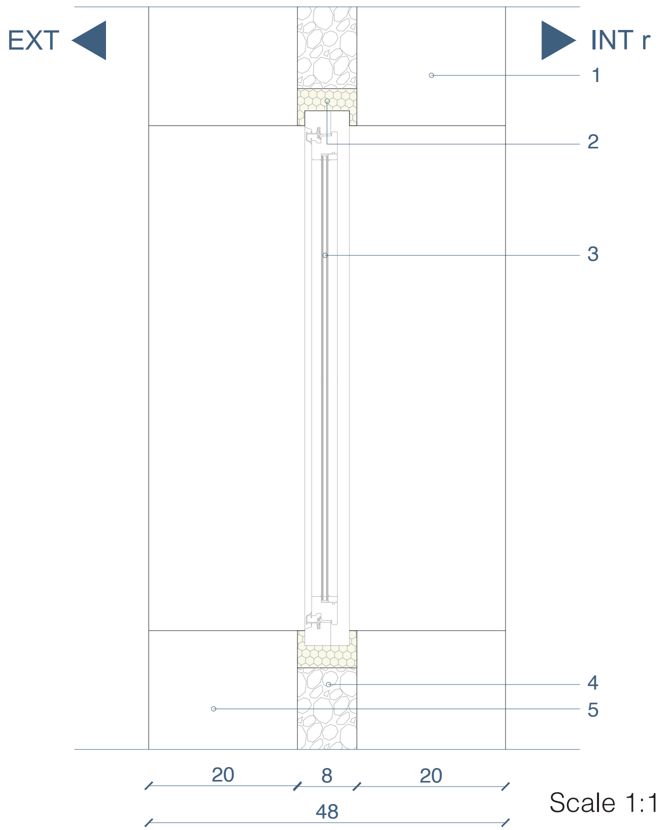
Code	CV2_R
Thickness	30 cm
Thermal resistance	3.3 m²K/W
Thermal transm.	0.30 W/m²K
Supported lineal mass (h=3m)	930 kg/m
Supported lineal weight (h=3m)	9.1 kN/m



Technical aspect and use on site :
The building made in the 1990s resumes the use of Tuff stone, but also with the use of modern insulation. The same mortar made from Loire sand and compressed air is used with binder. It is also used to repair the Tuff stones of the old building that are damaged.

Legend
1. Plasterboard facing layer, standard ivory CE RESI, 250 x 120 cm2 - 1cm
2. Synthetic resin-based binder layer, Knauf Tiefengrund - 0.2 cm
3. Kraft bitumen vapor brake and air sealing layer - 0.2 cm
4. Thermal insulation layer made of fiberglass panel, TELSTAR PB ISOVER - 8cm
5. Loire sand mortar binder layer - 1 cm
6. Structural exposed stone block wall of «Tuffeau de Tourraine» 66 x 33 x 20 cm3 - 20 cm

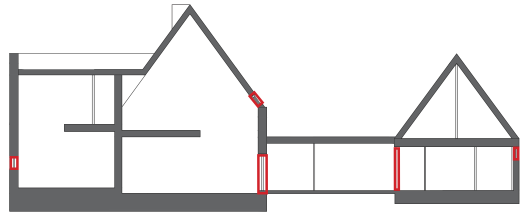
N°	Th. (cm)	Conduct. (W/mK)	Resist. (m²K/W)	Density (kg/m³)
1.	1	0.2	0.05	800
2.	0.2	--	--	--
3.	0.2	--	--	--
4.	8	0.035	2.3	30
5.	--	--	--	--
6.	20	0.2	1.0	1500



Scale 1:10

Annex number : TD.03

Construction code : Inf_R
Inf_R for «Infissi (Rilievo stato di fatto)» meaning «Frames (Survey of the state of fact)»

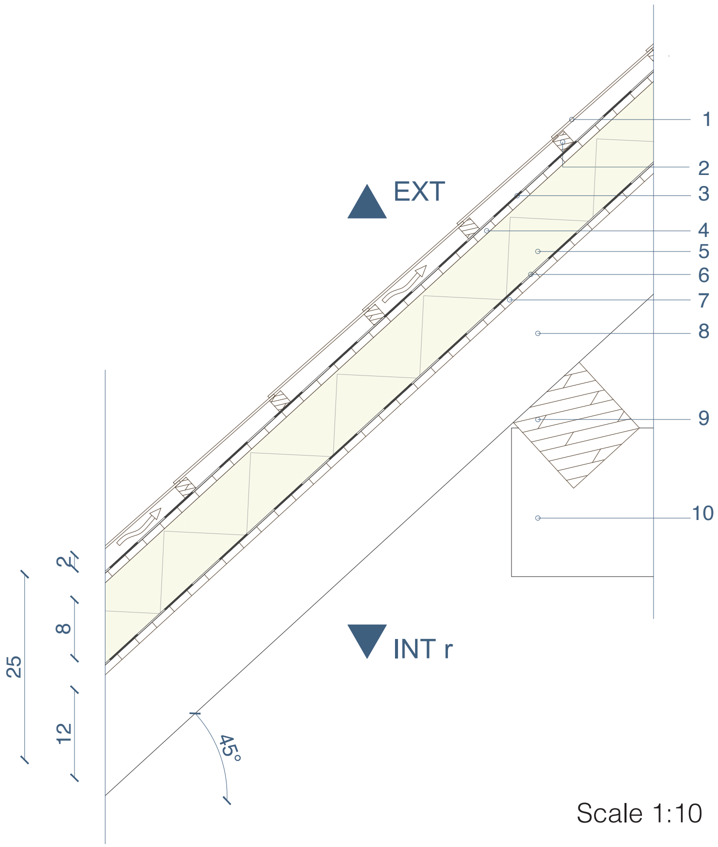


Code	Inf1_R	Inf2_R	Inf3_R
Thickness	4 cm	14 cm	28 cm
Glass thickness	4	4/6/4	4/20/4
Thermal resistance	0.40 m^2K/W	0.77 m^2K/W	0.91 m^2K/W
Thermal transmittance	2.5 W/m^2K	1.3 W/m^2K	1.1 W/m^2K
Light Transmission (TL)	0.9	0.8	0.7
Solar factor (g)	0.9	0.7	0.5
Selectivity (TL/g)	1	1.2	1.4
Acoustic attenuation	28 dB	33 dB	37 dB
Date of construction	unknown	90's	90's
Localisation	Ground floor building A, C + glasshouse	Ground floor building B + glasshouse	Elevated floors of building A, B and C

Source of information based on archives of traditional construction techniques of tuff dwellings in the Tourraine region and on hydrological surveys conducted at the site

Legend	N°	Th. (cm)	Conduct. (W/mK)	Resist. (m^2K/W)	Density (kg/m^3)
1. Structural stone block wall of «Tuffeau de Tourraine» 66 x 33 x 20 cm3 - 20 cm	1.	20	0.4	0.5	1500
2. Polyurethane foam insulation layer - 8cm	2.	8	0.028	2.9	25
3. Frame made of oak wood **(features depending on the type of glazing)*	3.	*	*	*	*
4. Earth fill, air calcined and sanded Loire mortar for thermal insulation - 8cm	4.	8	0.1	0.8	1200
5. Exterior stone block cladding of «Tuffeau de Tourraine» 66 x 33 x 20 cm3 - 20 cm	5.	20	0.4	0.5	1500

TD.04 - Traditional insulated and ventilated sloping roof (CO1_R)



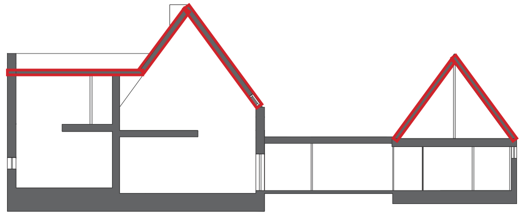
Scale 1:10

Annex number : TD.04

Construction code : CO1_R
CO1_R for «Chiusura Orizzontale n°1 (Rilievo stato di fatto)» meaning «Horizontal Closure no. 1 (Survey of the state of fact)»

Technological element :
Discontinuous roof of the ancestral farmhouse (building A+C).
Structure assumed similar in the 90's extension (building B).

Date of construction :
Rebuilt existing finger in 2002 after the fire of the old building in 2000



Code	CO1_R
Thickness	25 cm
Thermal resistance	2.9 m²K/W
Thermal transm.	0.35 W/m²K
Supported surface mass	31.2 kg/m²
Supported surface weight	0.31 kN/m²

Source of information based on the description of the restoration work on the building after the fire in 2002 «Operation de restauration des granges collières» - Société d'Equipement de la Touraine

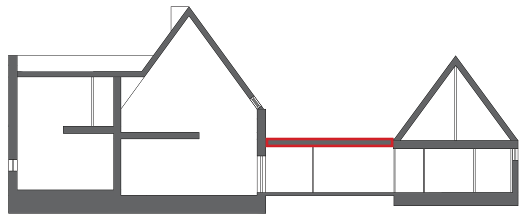
Legend

1. Cladding layer of natural slate tiles from Angers-Trelazé (30 x 18) x 0.3 cm³
2. Ventilation layer between the fir slats of 2 x 2 cm2 - 2cm section
3. Waterproofing layer non-woven polyester staple fabric - 0.2cm
4. ROLITOIT DELTA» sandwich panel support layer with CTBH panels, connected with galvanised spikes and plasterboard strips on the underside - 1cm
5. Insulation layer made of expanded polystyrene sandwich panels, «ROLITOIT DELTA» - 8cm
6. Kraft bitumen vapour barrier and airtightness layer - 0.2 cm
7. Sandwich panel support layer «ROLITOIT DELTA» with CTBH panels, connected with galvanised spikes and plasterboard strips on the underside - 1 cm
8. Oak tertiary battens - 12 x12 cm2
9. Secondary oak warping - 12 x12 cm2
10. Oak primary warping - 20x20 cm

N°	Th. (cm)	Conduct. (W/mK)	Resist. (m²K/W)	Density (kg/m³)
1.	0.3	180	0	2800
2.	2	--	--	--
3.	0.2	--	--	--
4.	1	*	0.3	*
5.	8	0.035	2.3	20
6.	0.2	--	--	--
7.	1	*	0.3	*
8.	12	--	--	null
9.	(12)	--	--	null
10.	(20)	--	--	null

*Features are included in layer n°5

TD.05



Annex number : TD.05

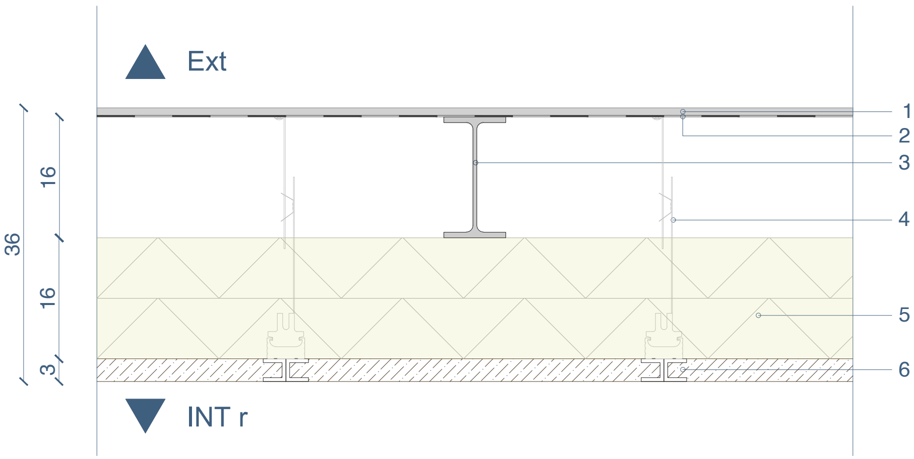
Construction code : CO2_R
CO2_R for «Chiusura Orizontale n°2 (Rilievo stato di fatto)»
meaning «Horizontal Closure no. 2 (Survey of the state of fact)»

Technological element :
Non-walkable continuous roof of the glasshouse

Date of construction :
Made in 1991 during the construction of the stained glass window

Code	CO2_R
Thickness	36 cm
Thermal resistance	5.5 m^2K/W
Thermal transm.	0.18 W/m^2K
Supported surface mass	32 kg/m^2
Supported surface weight	0.31 kN/m^2

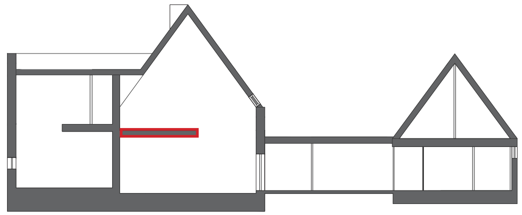
Source of information based on the investigations carried out on the site



Scale 1:10

Legend
1. Cladding layer with aluminum panel - 1 cm
2. Waterproofing layer non-woven polyester staple fabric - 0.2cm
3. Galvanized steel beam IPE 160 - 16 cm
4. Metal hook suspension system for suspended ceilings
5. Double layer of fiberglass thermal insulation - 16 cm
6. Basotect absorbent pad finishing layer, held by metal ordering - 3 cm

N°	Th. (cm)	Conduct. (W/mK)	Resist. (m^2K/W)	Density (kg/m^3)
1.	1	200	0	2700
2.	0.2	--	--	--
3.	16	--	--	null
4.	--	--	--	--
5.	16	0.035	4.6	30
6.	3	0.035	0.86	9



Annex number : TD.06

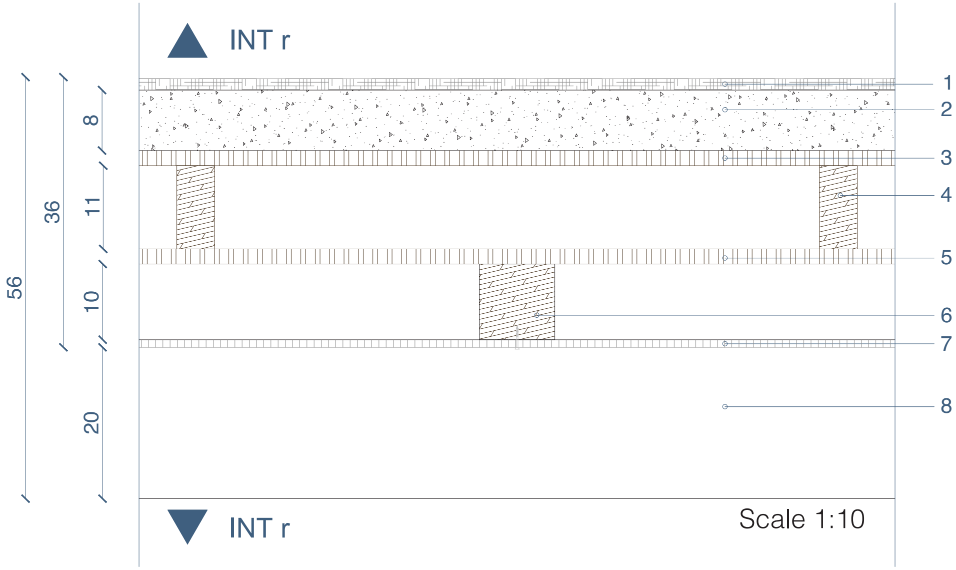
Construction code : PO1_R
PO1_R for «Partizione Orizzontale n°1 (Rilievo stato di fatto)»
meaning «Horizontal Partition no. 1 (Survey of the state of fact)»

Technological element :
Intermediate floor of the ancestral building (building A)

Date of construction :
Rebuilt in 2002 after the fire of the ancient building in 2000

Code	PO1_R
Thickness	36 cm
Thermal resistance	1.4 m²K/W
Thermal transm.	0.73 W/m²K
Supported surface mass	107 kg/m²
Supported surface weight	1.0 kN/m²

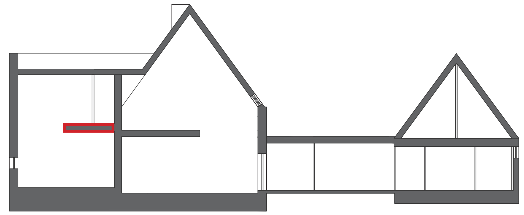
Source of information based on the description of the restoration work on the building after the fire in 2002 «Operation de restauration des granges collières» - Société d'Equipement de la Touraine



Legend
1. Layer of blue wool carpet covering - 1.5 cm.
2. Support layer made of LECAMIX lightweight aggregate screed - 8 cm
3. Support layer made of wood panels, NOVOPAN - 2 cm
4. Planting transition layer between fir planks - 11 cm *(adds 6kg per m²)*
5. Wood panel support layer, NOVODAL CTB-H - 2cm
6. Secondary wooden warping (10x10 cm2), pitch : 45 cm - 10cm **(adds 10kg per m²)*
7. Interior lining layer of plasterboard 250 x 120 cm2, standard ivory CE RESI - 1cm
8. Primary oak wood warping (30x30 cm2) - 20cm

N°	Th. (cm)	Conduct. (W/mK)	Resist. (m²K/W)	Density (kg/m³)
1.	1.5	0.04	0.38	300
2.	8	0.12	0.67	600
3.	2	0.13	0.15	700
4.	11	--	--	*
5.	2	0.15	0.13	800
6.	10	--	--	**
7.	1	0.25	0.04	800
8.	(20)	--	--	null

TD.07 - Wood-frame intermediate floor with false ceiling (PO2_R)



Annex number : TD.07

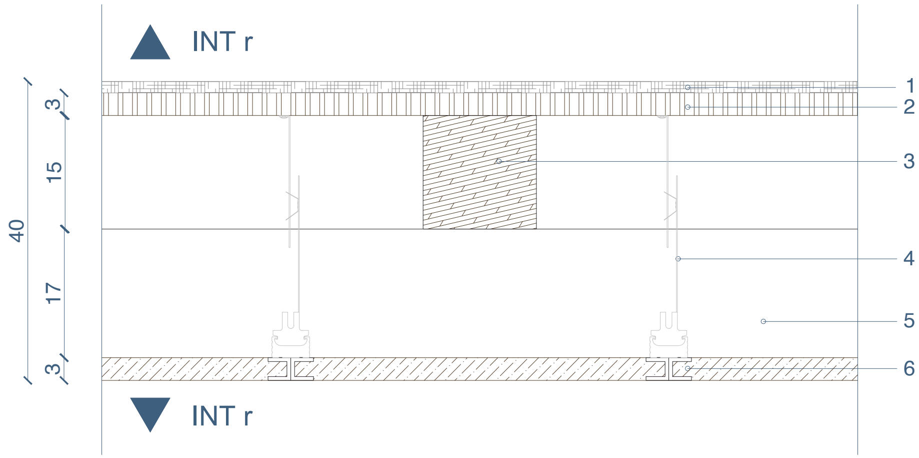
Construction code :
PO2_R for «Partizione Orizontale n°2 (Rilievo stato di fatto)»
meaning «Horizontal Partition no. 2 (Survey of the state of fact)»

Technological element :
Intermediate floor of the ancestral building (building C)

Date of construction :
Made in 1991 during the refurbishment of the ancient building

Code	PO2_R
Thickness	40 cm
Thermal resistance	1.5 m^2K/W
Thermal transm.	0.68 W/m^2K
Supported surface mass	24 kg/m^2
Supported surface weight	0.24 kN/m^2

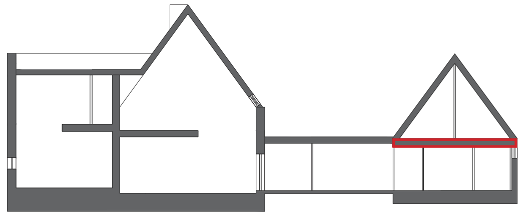
Source of information based on the investigations carried out on the site



Scale 1:10

Legend
1. Layer of blue wool carpet covering - 1.5 cm.
2. Backing layer of OSB reconstituted wood - 3 cm
2. Oak wood beam 15 x 15 cm2 - 15cm
4. Suspension system with metal hook for suspended ceilings.
5. False ceiling for plant passages 17cm
6. Basotect absorbent pad finishing layer, held by metal ordering - 3 cm

N°	Th. (cm)	Conduct. (W/mK)	Resist. (m^2K/W)	Density (kg/m^3)
1.	1.5	0.04	0.38	300
2.	3	0.13	0.23	650
3.	15	--	--	--
4.	--	--	--	--
5.	17	--	--	--
6.	3	0.035	0.86	9



Annex number : TD.08

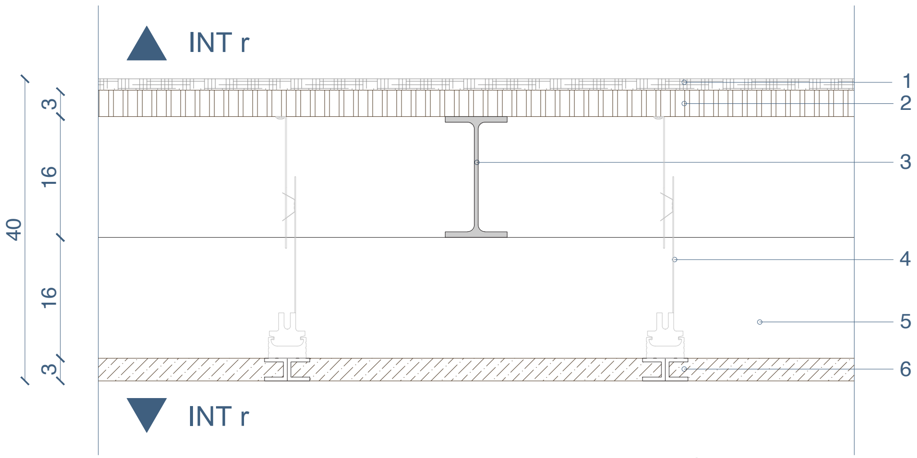
Construction code : PO3_R
PO3_R for «Partizione Orizontale n°3 (Rilievo stato di fatto)»
meaning «Horizontal Partition no. 3 (Survey of the state of fact)»

Technological element :
Intermediate floor of the 90's building (building B)

Date of construction :
Made in 1991 during the construction of the extension

Code	PO3_R
Thickness	40 cm
Thermal resistance	1.5 m^2K/W
Thermal transm.	0.68 W/m^2K
Supported surface mass	24 kg/m^2
Supported surface weight	0.24 kN/m^2

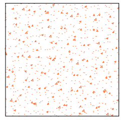
Source of information based on the investigations carried out on the site



Scale 1:10

Legend
1. Layer of blue wool carpet covering - 1.5 cm.
2. Backing layer of OSB reconstituted wood - 3 cm
3. IPE 160 galvanized steel beam - 16 cm
4. Suspension system with metal hook for suspended ceilings.
5. False ceiling for plant passages 16 cm
6. Basotect absorbent pad finishing layer, held by metal ordering - 3 cm

N°	Th. (cm)	Conduct. (W/mK)	Resist. (m^2K/W)	Density (kg/m^3)
1.	1.5	0.04	0.38	300
2.	3	0.13	0.23	650
3.	16	--	--	--
4.	--	--	--	--
5.	16	--	--	--
6.	3	0.035	0.86	9



Powdering

Code, name and category of decay (ICOMOS-ISCS)
DD.01 - Powdering [Detachment]

Definition (ICOMOS-ISCS)
Decohesion manifested by the spontaneous fall of material in the form of finely grained stones or dust. It affects only the surface of the stone or can occur in depth. Damage generally starts from the surface of the material.

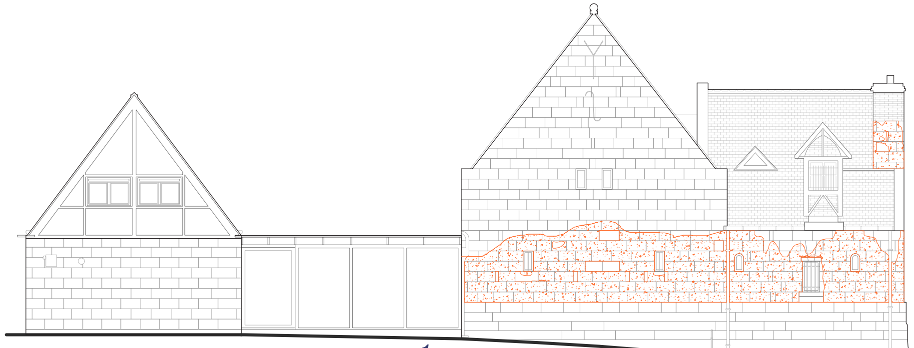
Affected material
MS.01 - Tuffeau stone (from XVIth century)

State of progress
Degradation is in progress, although it is a phenomenon fairly slow when not subjected to a human action. The degradation will continue until the repair of the stone.

Preliminary description
The phenomenon is not that common on the site. However, the powdering leads gradually to the destruction of the stone in surface.

This granular disintegration produces debris referred to as a rock meal and can often be seen accumulating at the foot of wall actively deteriorating.

If the stone surface forms a cavity (coving), the detached material may accumulate through gravity on the lower part of the cavity.



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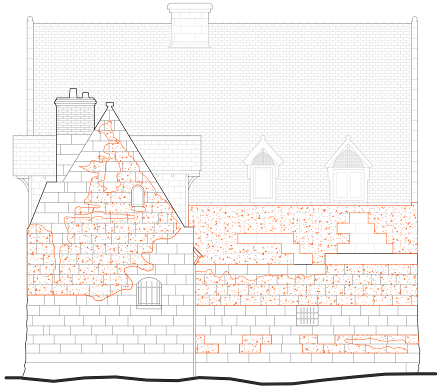

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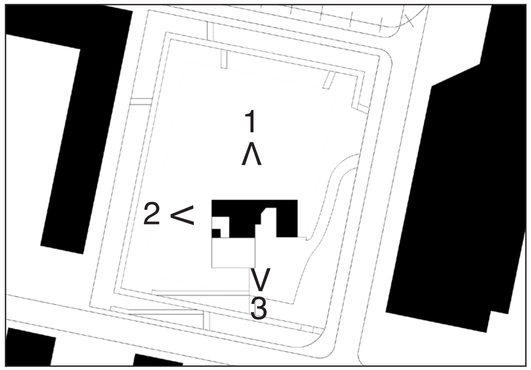
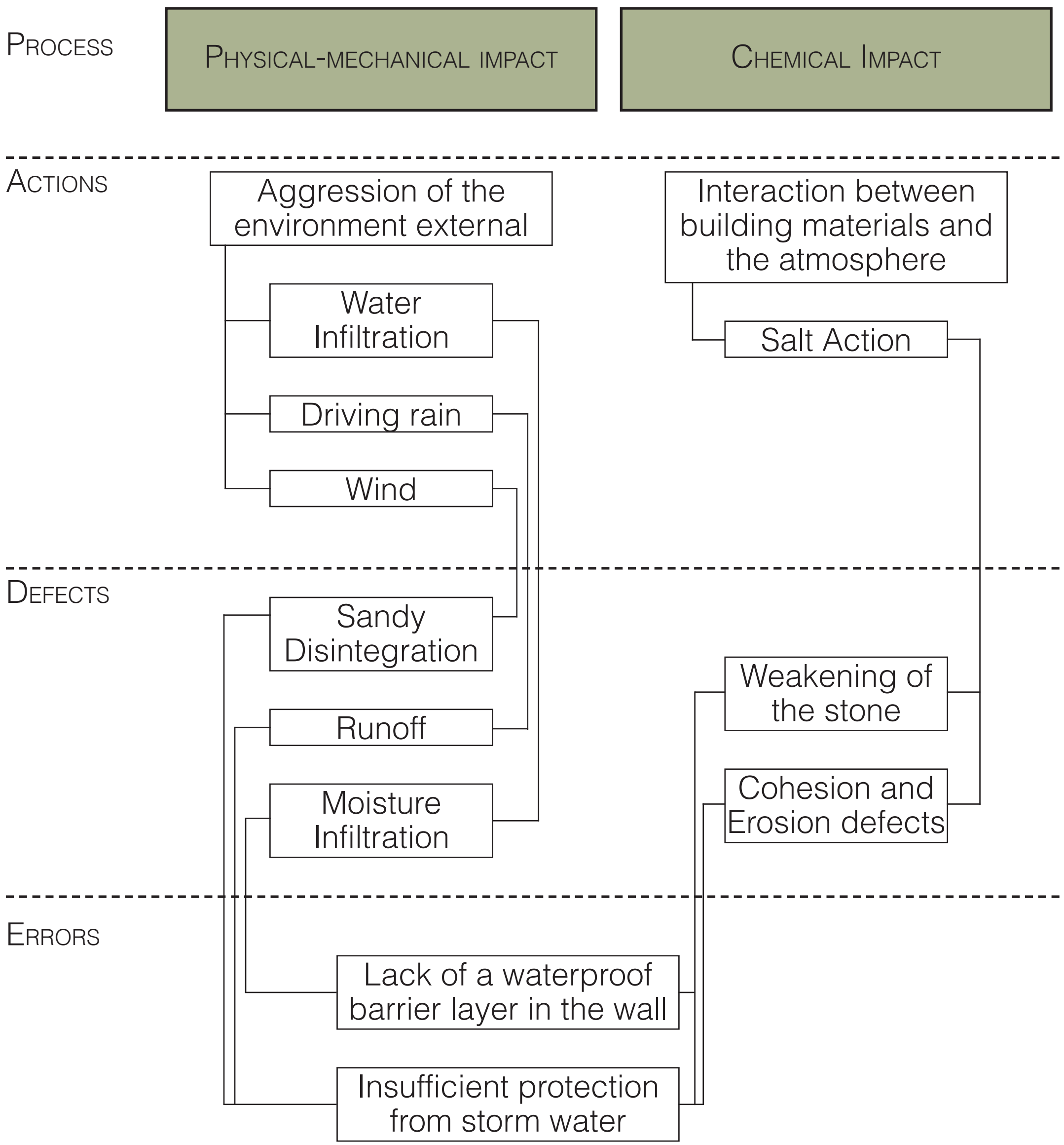
Photography :

Navigator :



Error tree



Main cause

Powdering results from the homogeneous loosening of the rock's grains caused by the dissolution of the calcite cement. This type of weathering occurs on the lower part of the building's walls (just above the footing).

Effects

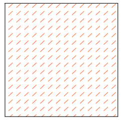
This disintegration causes the stone to pulverize, eroding into powder to the touch. A pulverulent stone is no longer solid, and you only have to rub it with your fingertip to see it turn to dust. The result is a powdery accumulation of sand and rock residues at the base of the walls.

Description

As with most granular limestones, this alteration is most characteristic of Tuffeau stone. It occurs on both the interior and exterior of the building, although the interior surface is much less degraded as it is not amplified by external conditions.

The crystallization of salts causes the grains to loosen considerably that leads to erosion. It is much more rapid under the action of rain and wind. This erosion is homogeneous, as condensation forces the water vapour contained in the air inside the building to transform into liquid water on contact with the stone. This causes the entire surface of the stone to recede by several centimetres.

When degradation is differential, we speak of alveolization.



Scaling

Code, name and category of decay (ICOMOS-ISCS)
DD.02 - Scaling [Detachment]

Definition (ICOMOS-ISCS)
Degradation that is manifested by the total or partial detachment of parts (scales) often in correspondence with breaks in continuity of the original material.

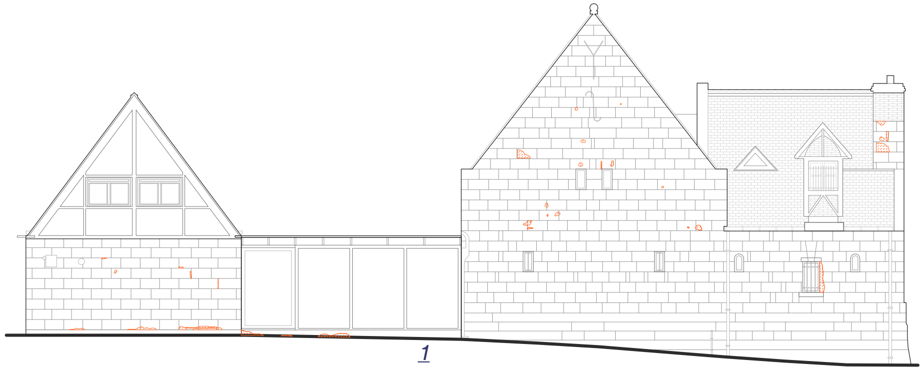
The scales, generally consisting of apparently unaltered material, have an irregular shape and a consistent and uneven thickness.

Affected material (and technological unit)
MS.01 - Tuffeau stone (from XVIth century)
MS.02 - Tuffeau stone (from the 90s)

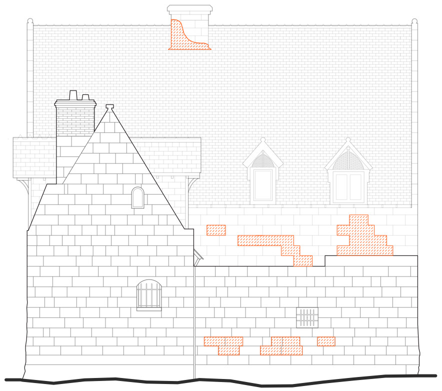
State of progress
The degradation is quite heavy (and common in the courtyard). It can lead to a more severe degradation. The stone is quite fragile at this point and the decay can therefore get worse.

Preliminary description
The phenomenon is not that common on the site. It affects especially the stones in the internal courtyard that seems to be the original stone (no repair on this stones since the farmhouse was built).

However, the scaling leads to the entire destruction of the stone in surface. The layer within the scale is subject to powdering.



1

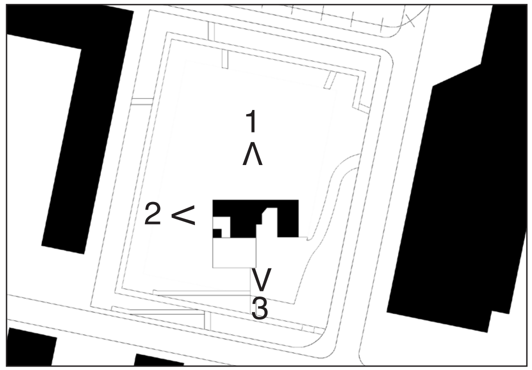


2

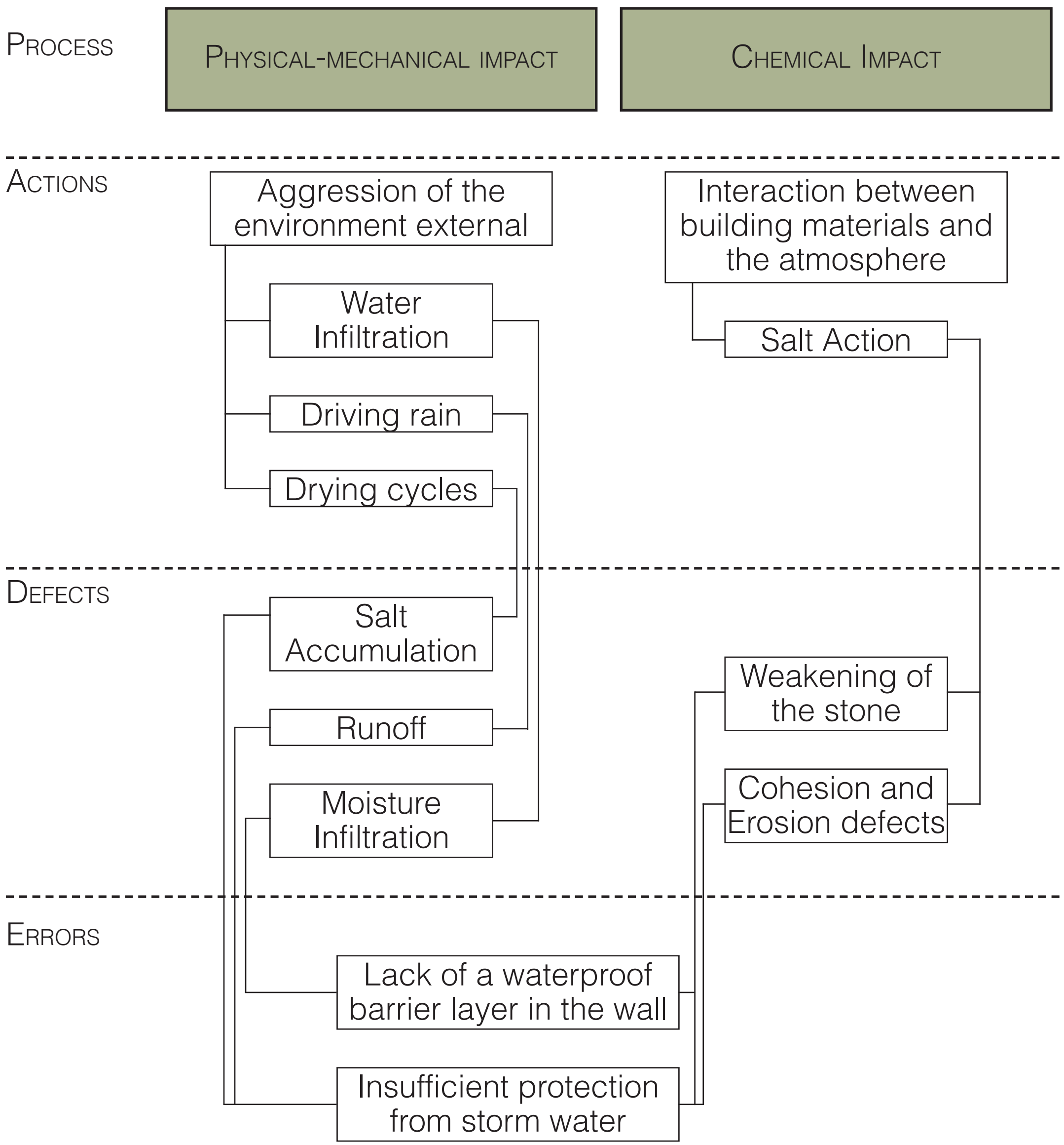
3

Photography :

Navigator :



ERROR TREE



MAIN CAUSE

Scaling occurs in wet areas subject to driving rain or intense evaporation.

EFFECTS

Stones affected by this process will lose their waterproofing properties, exacerbating the problem for neighboring stones. Scaled stone is also more prone to powdering.

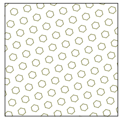
DESCRIPTION

These plates/scales develop independently of the stratigraphic bedding and run parallel to the wall surface. Beneath the plate is a layer of extremely porous, sandy stone. Once the plate is gone, the stone can disintegrate very quickly.

When drying is sufficiently slow and the pore network allows it, dissolved salts in solution can reach the surface and form efflorescences.

However, when capillary feed no longer compensates for evaporation flow, the zone of hydraulic discontinuity is located below the surface, and salts precipitate inside the rock, forming a horizon of salt accumulation by repetition of imbibition and drying cycles, and developing significant crystallization pressures, at the depth of hydrous equilibrium for which evaporation and imbibition flows cancel each other out, a depth which corresponds to the thickness of the plate.

Under the effect of significant salt crystallization, cracks develop along this horizon, then the stone surface cracks and the resulting slab can detach and fall. When a slab is detached, the new surface geometry, disintegrated by salts, is not conducive to the development of a new slab, but rather favors other types of weathering such as powdering.



Alveolization

Code, name and category of decay (ICOMOS-ISCS)
DD.03 - Alveolization [Features induced by material loss]

Definition (ICOMOS-ISCS)
Formation, on the stone surface, of cavities (alveoles) which may be interconnected and may have variable shapes and sizes (generally centimetric, sometimes metric).

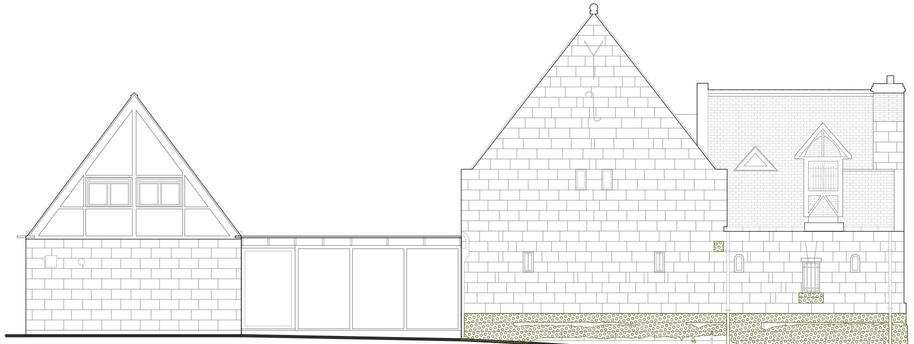
Alveolization is a kind of is a differential weathering possibly due to inhomogeneities in physical or chemical properties of the stone.

Affected material (and technological unit)
MS.01 - Tuffeau stone (from XVIth century)
MS.03 - Sandstone

State of progress
Degradation is in progress, although it is a phenomenon fairly slow. The degradation is heavy for some stone and will continue until the repair of the stone.

Preliminary description
The phenomenon is very common on the site, especially in the lower part of the walls. Maybe the other stone looked like the same before being repaired after a previous renovation on site (in 1990).

Alveolization develops here as cavities illustrating a combination of honeycombs and alignments following the natural bedding planes of the sandstone.



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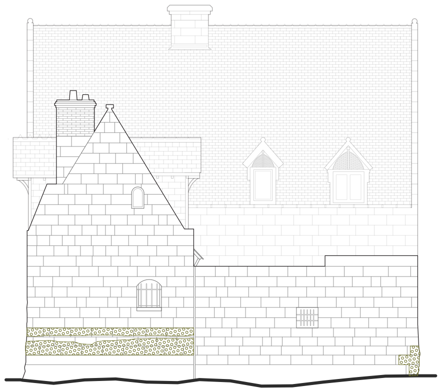

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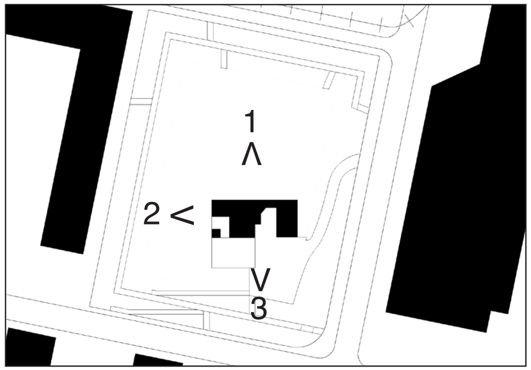
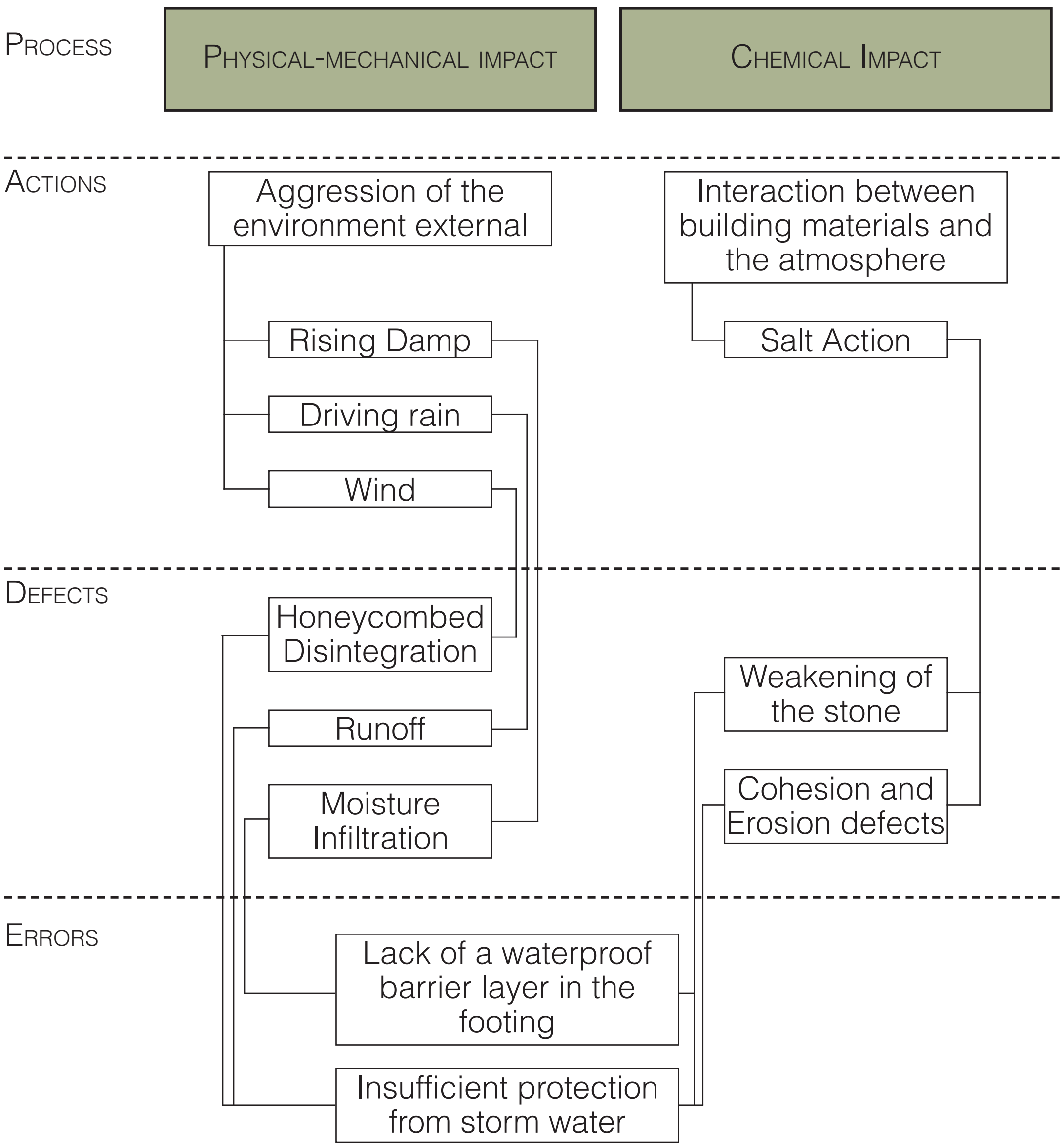
Photography :

Navigator :



Error tree



Main cause

Alveolization results from the differential loosening of rock grains caused by the dissolution of calcite cement. This type of weathering occurs in constantly damp areas, as in the case of footing.

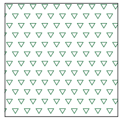
Effects

The alveolization lead to the gnawing of the stone, leaving honeycombed pattern. This hollowing seems to modify the stone's evaporation conditions.

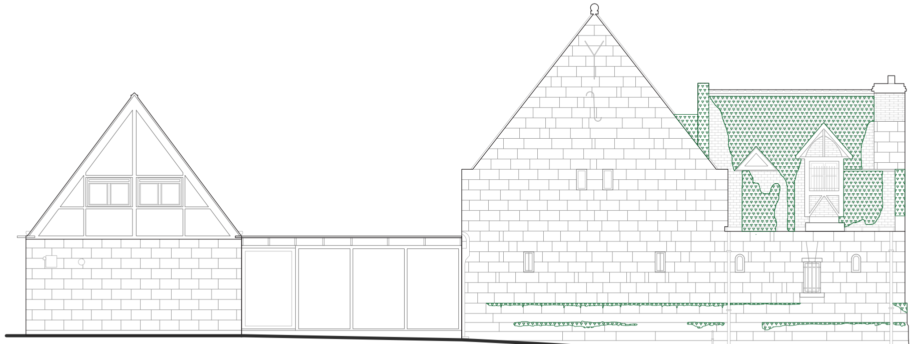
Description

The crystallization of salts causes significant grain loosening that leads to erosion. It is much more rapid under the action of rain and wind.

Unlike powdering, alveolization is linked to capillary action, i.e. the absorption of water from the soil into the stone. Instead of undergoing a horizontal humidity gradient that homogeneously alters the surface of the stone, Alveolized stone undergoes a vertical humidity gradient where the outer surface of the stone, exposed to the elements, is differentially altered.



Moss



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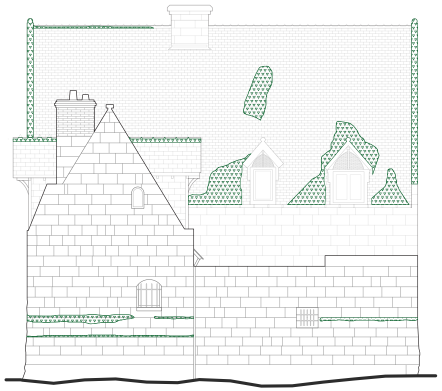

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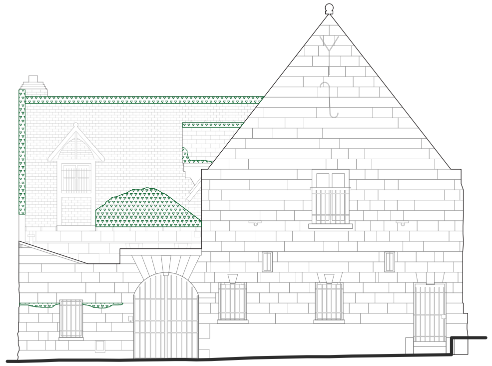


3

Code, name and category of decay (ICOMOS-ISCS)
DD.04 - Moss [Biological colonization]

Definition (ICOMOS-ISCS)
Mosses look generally like dense micro-leaves (sub- to millimetric size) tightly packed together. Mosses grow on stone surface open cavities, cracks, and in any place permanently or frequently wet, and usually shady. Mosses develop brown rhizines and may create a micro-soil zone between the stone surface and the green part.

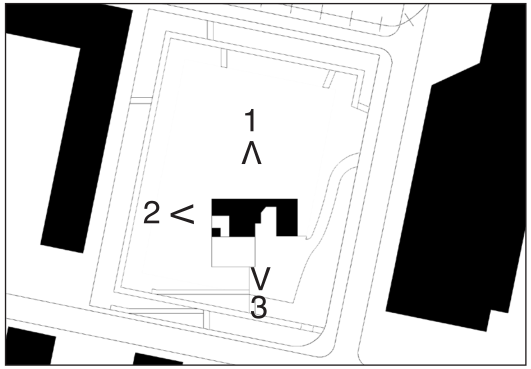
Affected material (and technological unit)
MS.01 - Tuffeau stone (from XVIth century)
MS.03 - Sandstone
MS.04 - Air limed and Loire-sanded mortar
MS.05 - Schist slate plate tiles
MS.06 - Schist slate round tiles

State of progress
The decay is common but does not endanger the stone.

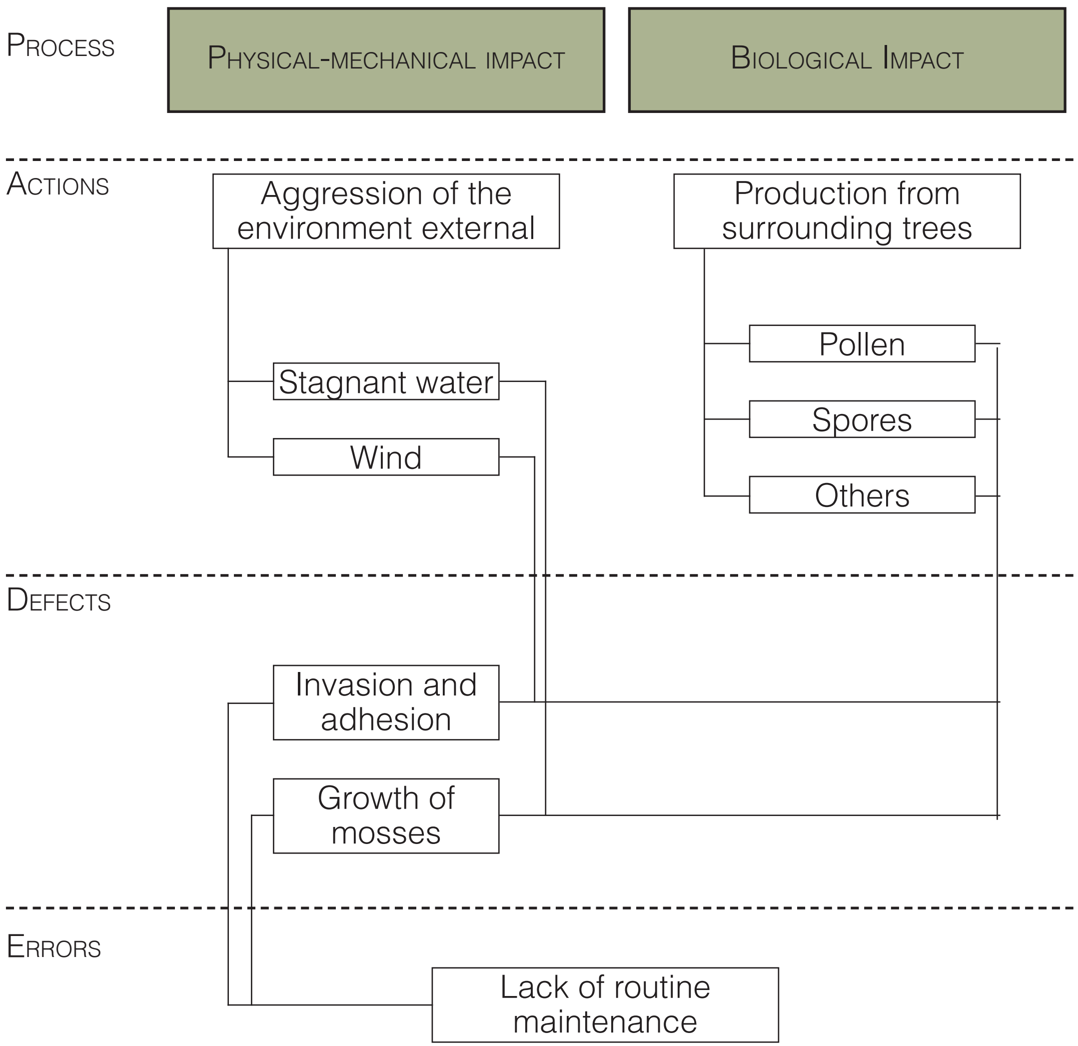
Preliminary description
The phenomenon affects most horizontal or inclined surfaces where water is stagnant. Mosses often change morphology and colour under lack or excess of water.

Photography :

Navigator :



Error tree



Main cause

The development of plant organisms are invevitable on humid stagnant areas, even more if there is a lack of maintenance of horizontal or sloping surfaces.

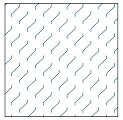
Effects

It accumulates dust and releases clear water. This greatly encourages the spread of algae and lichen on the roof, which can easily take root in the tile or slate. When mosses get wet by rain, the dust leak and may form crusts.

Description

Its origin is most often spores from trees. The development of moss is facilitated by the proximity of surrounding trees. All moss needs is a bit of wind and support to vegetate, as it has no roots and develops by retaining water and moisture. The south-facing facade is less degraded because it faces the sunlight, slowing moss growth.

Moss accumulates pollutants (dust) and then feeds by absorbing water and mineral salts directly through its stems, leaves and rhizoids (hairs).



Encrustation

Code, name and category of decay (ICOMOS-ISCS)
DD.05 - Encrustation [Features induced by material gain]

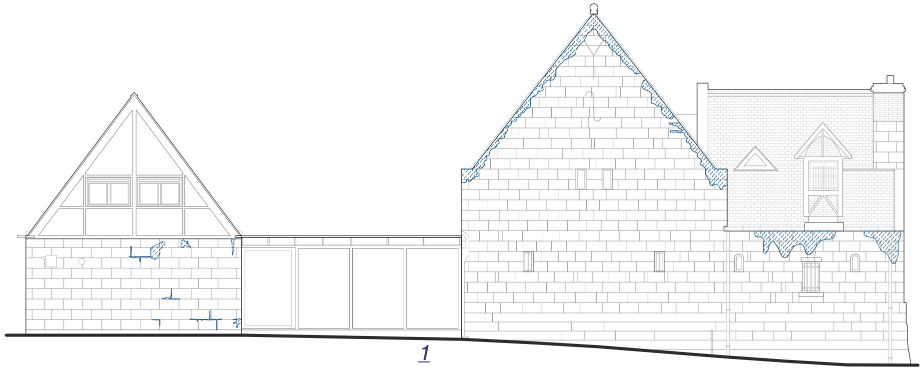
Definition (ICOMOS-ISCS)
Compact, hard, mineral outer layer adhering to the stone. The term encrustation is preferred to crust when the accumulation clearly results from water infiltration followed by precipitation.

When an encrustation is removed, adhering stone materials may be taken away with it.

Affected material
MS.01 - Tuffeau stone (from XVIth century)
MS.02 - Tuffeau stone (from the 90s)
MS.03 - Sandstone

State of progress
Degradation is in progress, although it is a phenomenon fairly slow. It however may leave an unaesthetic and irreversible mark after the repair. The repair might also endanger the stone if not done well.

Preliminary description
The phenomenon is located on the edges of the building and leave a black adherent crust on the stone. It seems coming from water precipitation and former deposit on the building.



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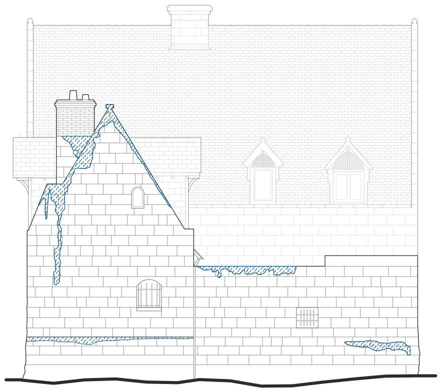

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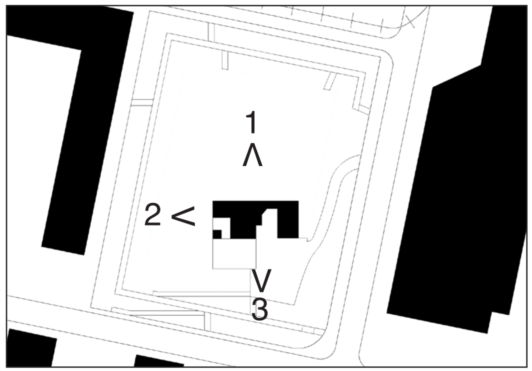
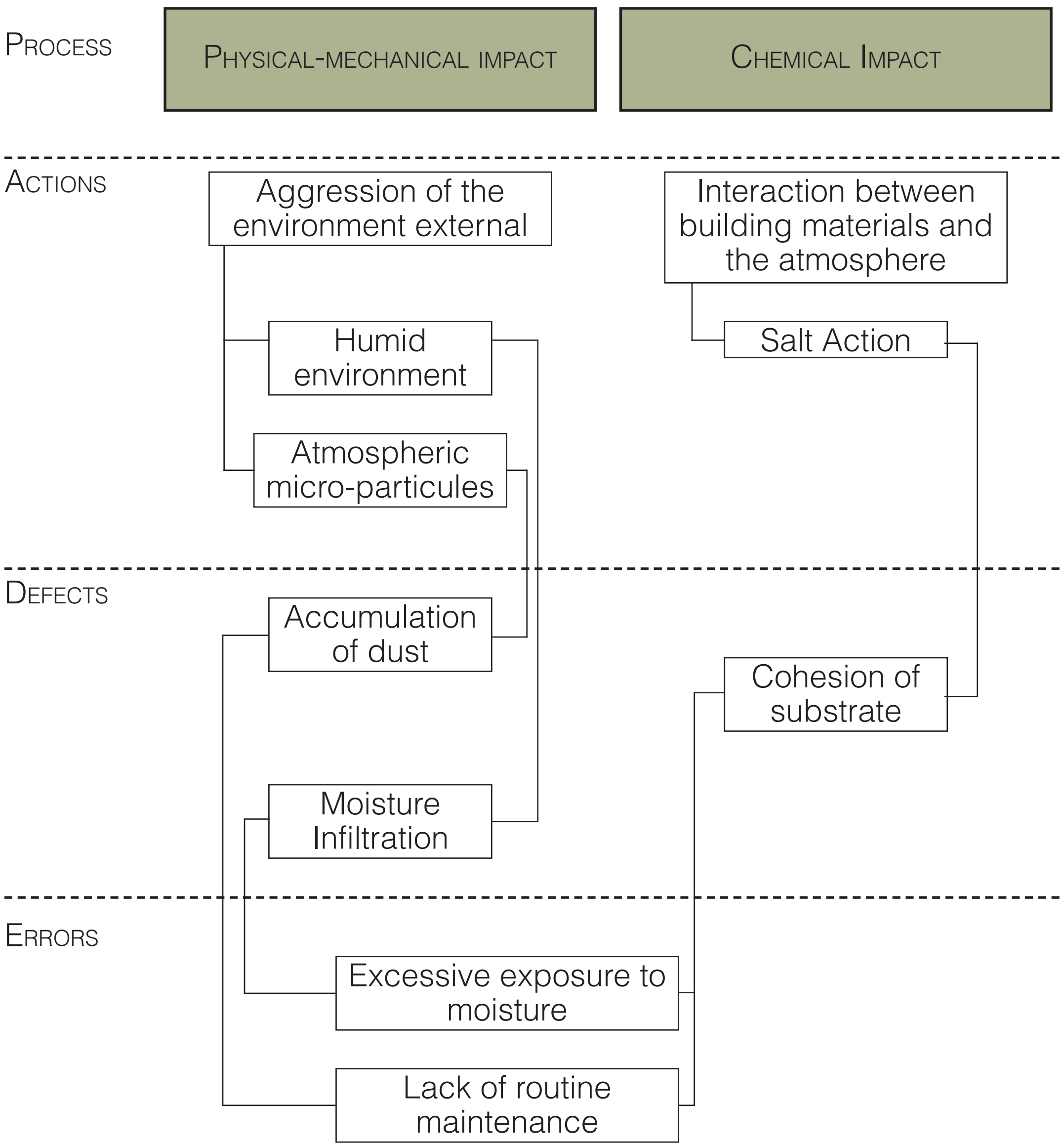
Photography :

Navigator :



Error tree



Main cause

Encrustation is formed mainly by the deposition of black micro-particles (atmospheric dust, soot, dust trapped by mosses), and cemented by a felting of salts from the stone.

Effects

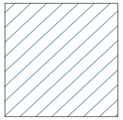
These black crusts eventually detach spontaneously from the substrate, systematically dragging the surface of the stone with them. This has the effect of exposing several millimeters of powdery, weakened stone, which can then be exposed to a new cycle of weathering.

When the black crust is too moist, dirty water begins to escape from the crust and spread over the entire surface, giving a fine soiled appearance.

Description

These encrustations only develop in damp, sheltered areas, where the solutions that pass through the rock evaporate. They are therefore well developed on the inside faces of cornices, balconies and in the recessed parts of sculptures.
In fact, sheltered from any leaching, black crusts can cover large surfaces and thicknesses of up to several centimetres.

In the case of porous stone, the encrustation easily incrustates the stone and a gradual transition is observed between the deposit layers and the gypsum-impregnated stone substrate, which becomes crumbly and powdery.



Soiling

Code, name and category of decay (ICOMOS-ISCS)
DD.06 - Soiling [Features induced by material gain]

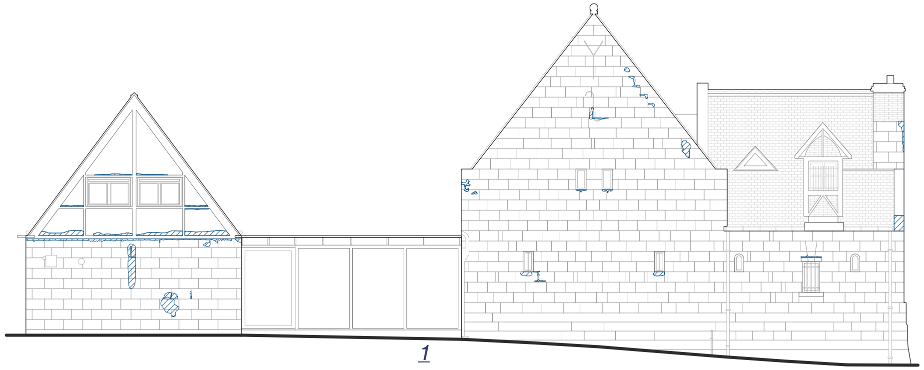
Definition (ICOMOS-ISCS)
Deposit of a very thin layer of exogenous particles giving a dirty appearance to the stone surface. The substrate stucture is not considered as affected. Soiling may have different degrees of adhesion to the substrate.

With increasing adhesion and cohesion, soiling can transform into a encrustation.

Affected material (and technological unit)
MS.01 - Tuffeau stone (from XVIth century)
MS.02 - Tuffeau stone (from the 90s)
MS.04 - Air limed and Loire-sanded mortar
MS.05 - Schist slate plate tiles
MS.06 - Schist slate round tiles

State of progress
Degradation is in progress, although it is a phenomenon fairly slow. The repair might endanger the material.

Preliminary description
The phenomenon is quite common on the site and leave a dirty aspect on the stone. It seems due to the leakage of former deposit on the wall.



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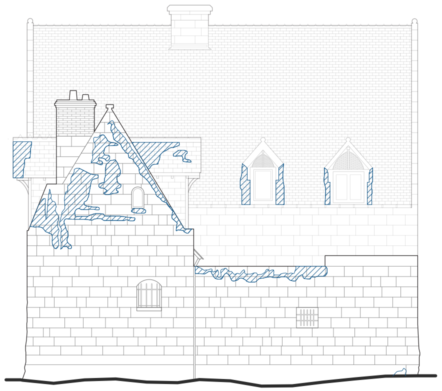

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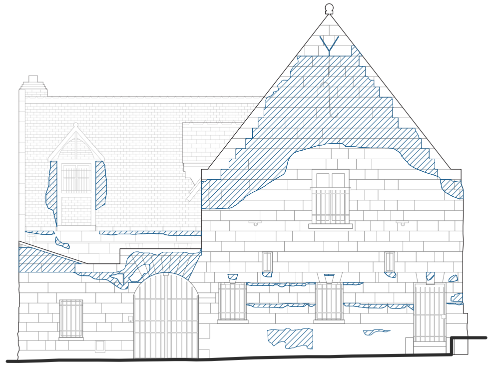

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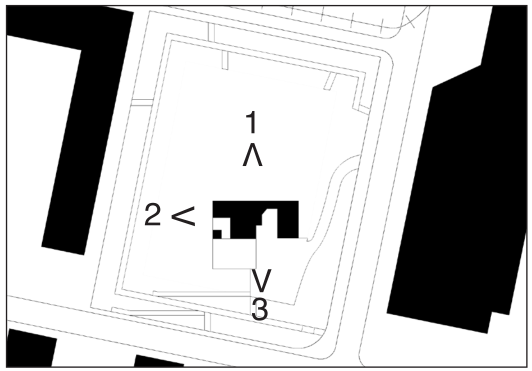
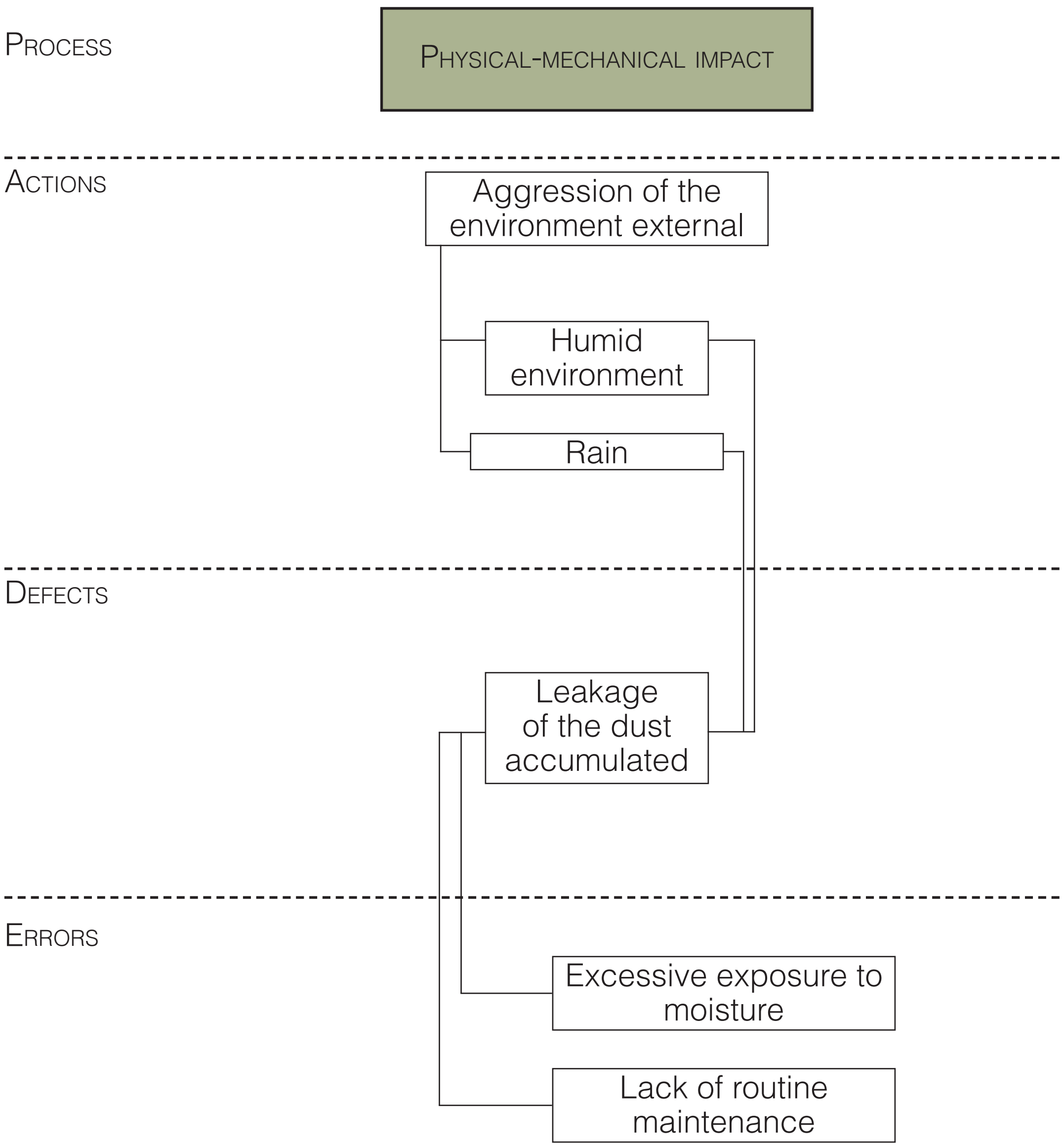
Photography :

Navigator :



Error tree



Main cause

Soiling comes from the leakage of a a acculumation of dust when wet by rain or too humid. As a result, it is led by encrustation or mosses.

Effects

Soiling does not attack the stone itself, but gives it a dirty appearance.

Description

The dirt that accumulates on the walls of buildings is the result of a natural process. One of the main sources of this dirt comes from the crusts and mosses that form on the surface of structures over time.

These crusts are generally composed of deposits of dust, fine particles or micro-organisms. When these crusts and mosses adhere to walls, they create a porous surface that can trap surrounding dirt and dust.

When it rains, this accumulation of dust and particles trapped in crusts and mosses becomes particularly problematic. As rainwater runs down the walls, it carries the accumulated dirt with it. This particle-laden rainwater runoff can leave unsightly marks on walls, leaving behind stubborn dirt.

Moist area

Code, name and category of decay (ICOMOS-ISCS)
DD.07 - Moist area [Discolouration]

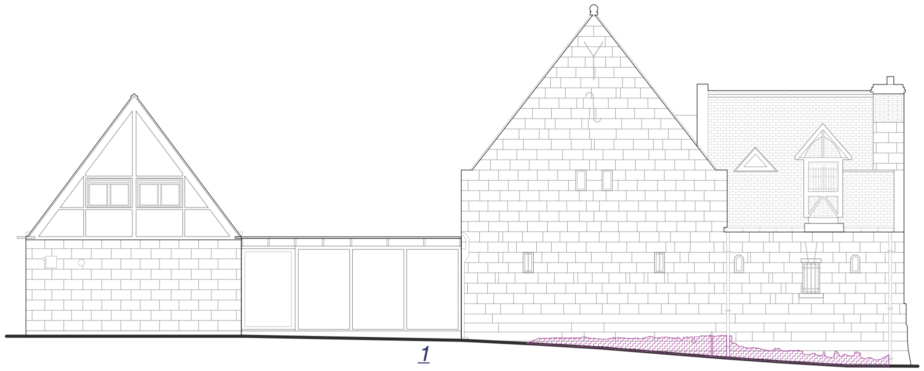
Definition (ICOMOS-ISCS)
Change of the stone colour generally of unattractive appearance and corresponding to the darkening (lower hue) of a surface due to dampness. Darkened areas due to moistening may have different shapes and extension according to their origin : pipe leakage, rising damp, hygroscopic behaviour (presence of salts), condensation.

Affected material (and technological unit)
MS.03 - Sandstone
MS.04 - Air limed and Loire-sanded mortar
MS.07 - Oak Timber

State of progress
Degradation is in progress and will leave an unaesthetic and irreversible mark. It may endanger the integrity of the stone. It may induce some lichen development on the wettest parts.

The lichen give a dirty yellow aspect to the the stone. It is a vegetal organism forming rounded millimetric to centimetric crusty or bushy patches, often having a leathery appearance, growing generally on outside parts of a building.

Preliminary description
The phenomenon affects most of all the footing in contact with the ground. It leaves a darkened aspect on the stone due to a process of rising damp through capillary action.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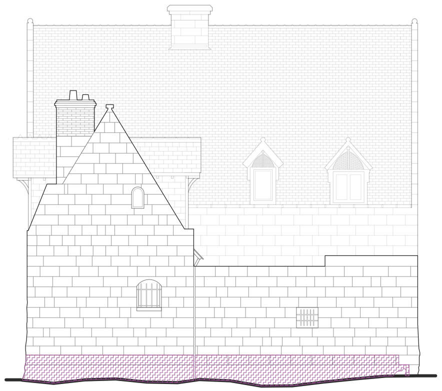
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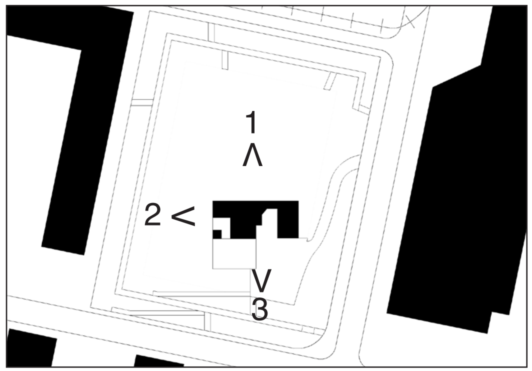
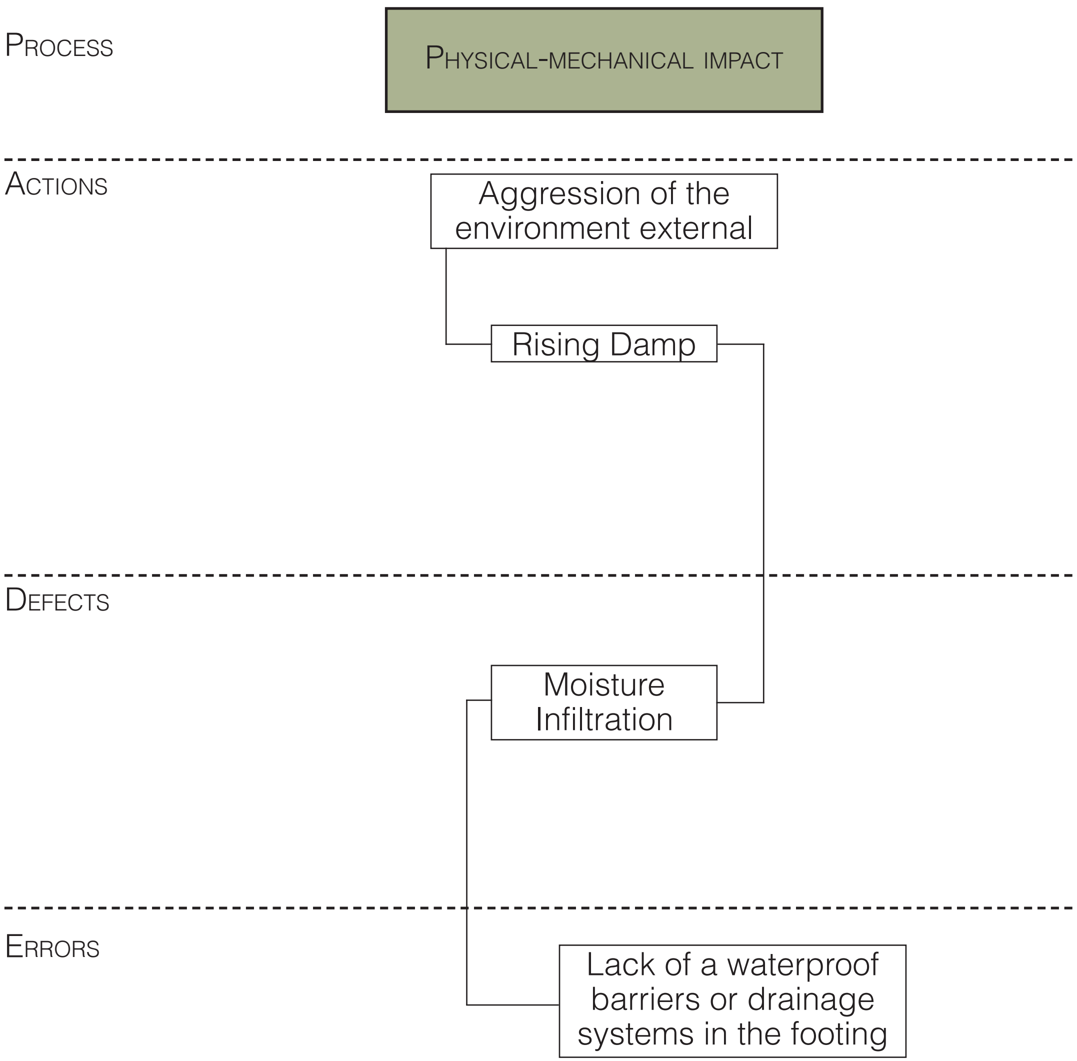
Photography :

Navigator :



Error tree



Main cause

Moist area comes from soil moisture that is then absorbed by the stone via capillary rise.

Effects

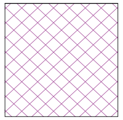
Over time, this accumulation of minerals can lead to dark discoloration on the stones, creating unsightly marks.

What's more, constant humidity can also encourage the growth of micro-organisms such as mold and lichen, further contributing to stone discoloration.

Description

Since foundations are exposed to soil moisture, water is absorbed by stone, which is a porous material. Capillary rise is the result of this water rising from the ground through the pores of the building materials.

Water transported by capillary rise often contains minerals and salts dissolved in the soil. When this water evaporates on the surface of the bedrock, the minerals and salts are left behind.



Patina

Code, name and category of decay (ICOMOS-ISCS)
DD.08 - Patina [Discolouration]

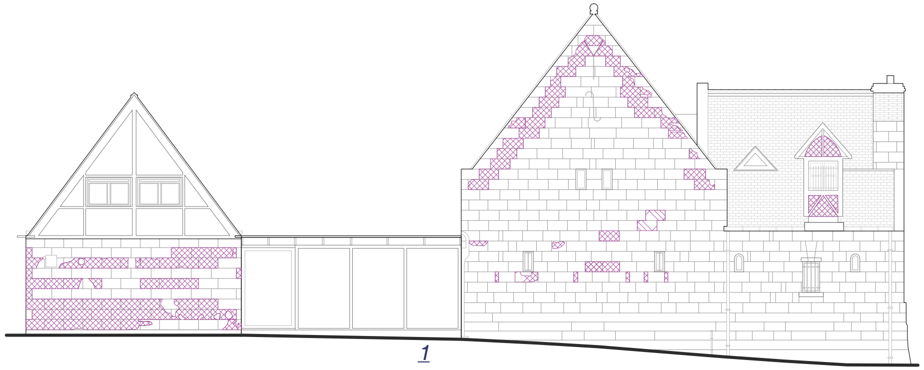
Definition (ICOMOS-ISCS)
Change of the stone colour in one to three of the colour parameters : hue, value and chroma.

It can be seen with a favourable connotation generally resulting from natural or artificial ageing enriched in iron/clay minerals (iron rich patina). It can give a yellowing or a brownish aspect to the stone.

Affected material (and technological unit)
MS.01 - Tuffeau stone (from XVIth century)
MS.03 - Sandstone
MS.04 - Air limed and Loire-sanded mortar
MS.05 - Schist slate plate tiles
MS.06 - Schist slate round tiles

State of progress
Degradation is in progress and will leave an irreversible mark (unaesthetic or not).

Preliminary description
The phenomenon is very common on the site and takes different colour (brownish, yellowish, …).



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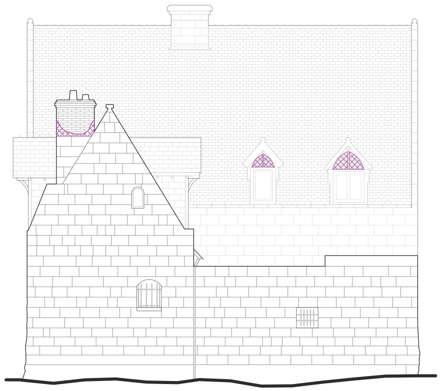

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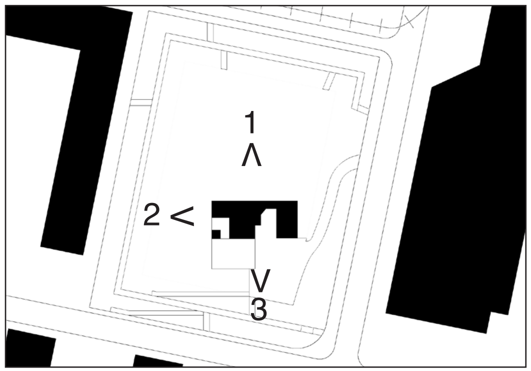
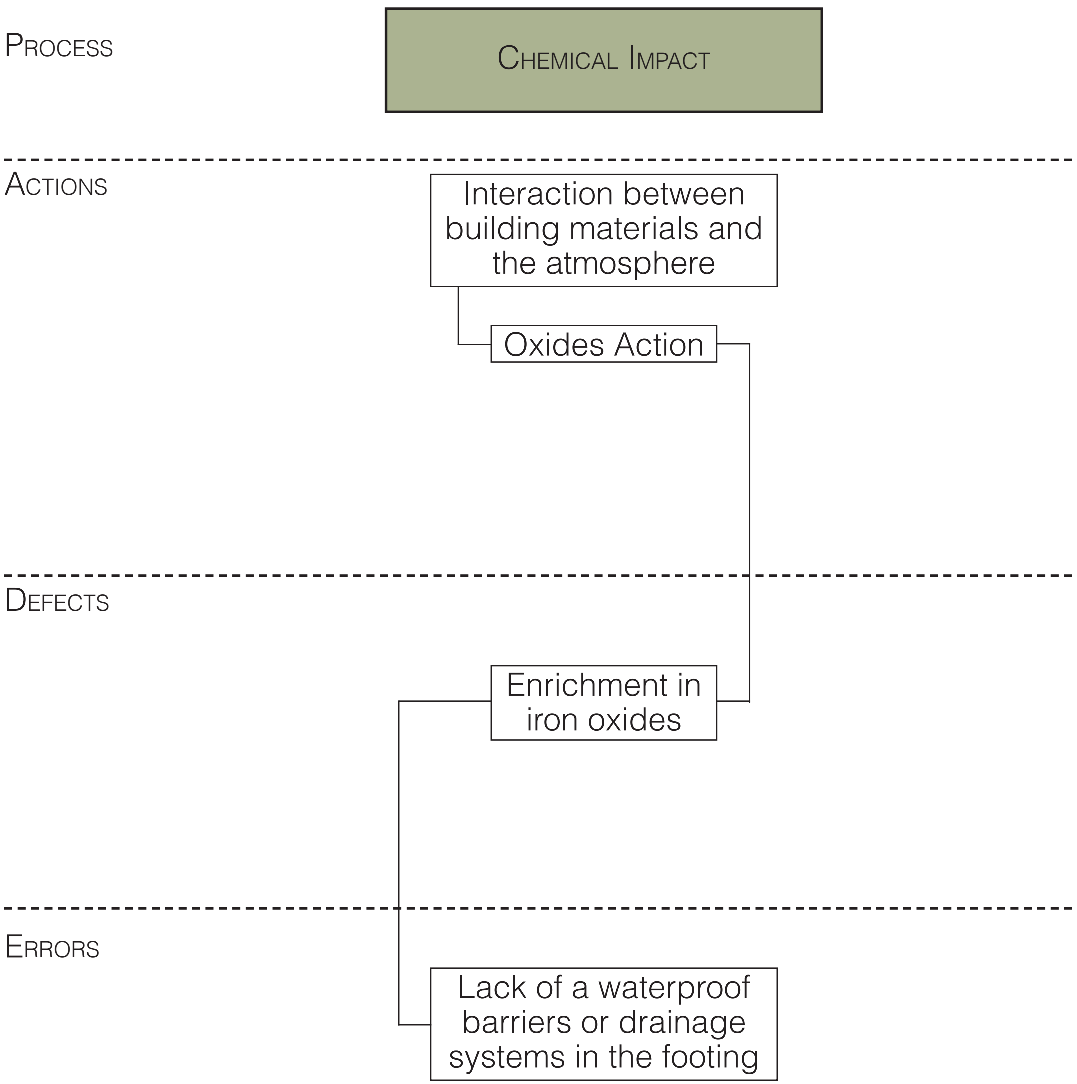
Photography :

Navigator :



Error tree



Main cause

The formation of a patina is the primary reaction of the rock when it is extracted from the quarry and processed.

Effects

This patina differs from destructive weathering in that there is no decohesion of the material's constituents. It is therefore a form of weathering, as it results from changes in the stone, but not degradation in the strict sense of the word.

Initially, patinas are protective in that they form an epidermis that limits the accessibility of the stone's internal structure to weathering agents, but this superficial modification of composition and structure modifies the circulation of fluids, and this inhomogeneity itself forms a kind of initiation to future degradation.

Description

Patinas are non-existent on stones that are sheltered from the elements, or, on the contrary, subject to washings that cause dissolution.

The acquisition of these superficial ochre hues is often due to a very slight enrichment in iron oxides in the outer layer of the stone (a few hundredths of a percentage are sufficient).

When fluids migrate by capillary action, the oxides disseminated in the stone are transferred to the evaporation surface, where they accumulate.

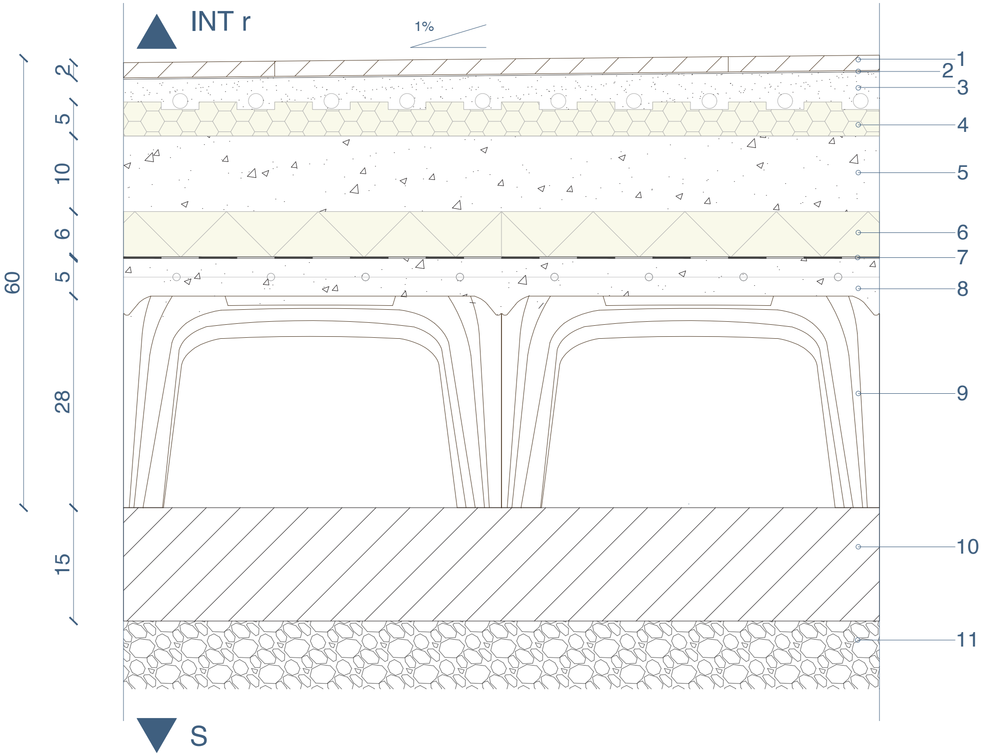
Surface induration is due to the enrichment of surface minerals such as gypsum, calcium carbonates and oxalates, which fill the porosity.

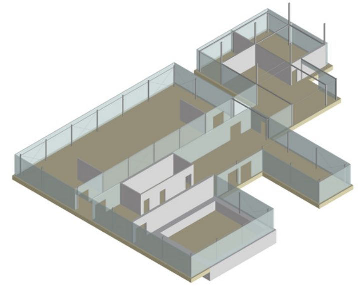
TP.01

TP.01 - Insulated radiant ground floor with crawl space (CO1)

Annex number : TP.01
Technological element : Ground floor of the modern extensions (building B + D)
Construction code : CO1 for «Chiusura Orizontale n°1» meaning «Horizontal Closure no. 1»

Scale 1:10





Code	CO1
Thickness	60 cm
Thermal resistance	3.2 m²K/W
Thermal transmit.	0.31 W/m²K
Supported surface mass	327 kg/m²
Supported surface weight	3.2 kN/m²

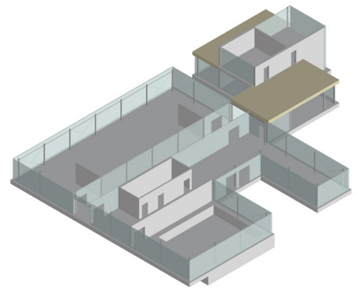
Legend

1. Porcelain stoneware tile covering layer, UP STONE type - 60cm x 20cm - 2cm
2. Layer of cementitious adhesive, such as MAPEI-ADESILEX P9 - 0.3cm
3. Slope layer in sand cement screed, type BACCHI - 1.5%, min 3cm - max 7cm
4. EPS radiant panels with heating pipes (Ø1), type ISOLCONFORT-FORMA - 4cm
5. Lightened concrete plant integration layer, type LECA CLS 1100 - 10cm
6. Synthesised expanded polystyrene thermal insulation layer, type ISOVER - 6cm
7. Non-woven polyester staple-fibre waterproofing layer, type BIOSCUD BT - 0.2cm
8. 5cm concrete completion pour with electrowelded steel mesh of 25x25cm2 / and Ø5mm - 5cm
9. Aerated crawl space in disposable formwork, type GEOBLOCK - 50cm x 50cm - 28cm
10. Lean concrete support slab - 15cm
11. Gravel drainage layer in contact with the ground

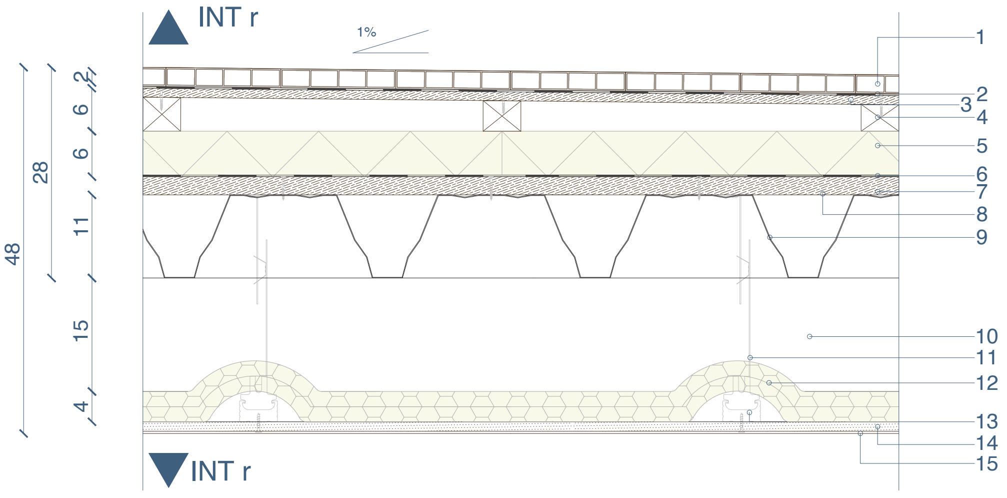
N°	Th. (cm)	Conduct. (W/mK)	Resist. (m²K/W)	Density (kg/m³)
1.	2	1.3	0.02	1050
2.	0.3	--	--	--
3.	5	1.4	0.04	2050
4.	4	0.035	1.2	35
5.	10	0.45	0.2	1100
6.	6	0.035	1.7	35
7.	0.2	--	--	--
8.	5	1.6	0.03	1800
9.	28	--	--	--
10.	(15)	1.6	0.03	null
11.	--	--	--	--

TP.02 - Steel-frame insulated terrace roof with false ceiling (CO2)

Annex number : TP.02
Technological element : Walkable continuous roof of the two-storey building (building B)
Construction code : CO2 for «Chiusura Orizzontale n°2» meaning «Horizontal Closure no. 2»



Scale 1:10



Code	CO2
Thickness	48 cm
Thermal resistance	3.1 m²K/W
Thermal transmit.	0.32 W/m²K
Supported surface mass	81 kg/m²
Supported surface weight	0.79 kN/m²

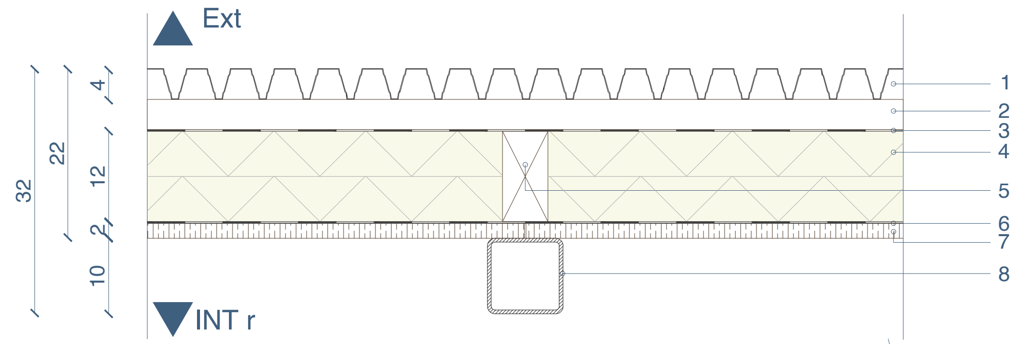
Legend
1. WPC cladding layer, type ARP WPC BAMBOO CLASSIC - 2m90 x 15cm - 2cm
2. Waterproofing layer non-woven polyester staple fabric, type BIOSCUD BT - 0.2cm
3. Stiffening layer made of OSB panels, class 3 - 25cm x 12.5cm - 1.2cm
4. Slope layer (1%) with wooden wedges - max sp: 6cm, min sp: 2cm
5. Synthesised polystyrene foam thermal insulation layer, ISOVER type - 6cm
6. Kraft bitumen vapour barrier and airtightness layer - 0.2cm
7. Cement-wood stiffening layer, type BETONWOOD - 320cm x 125cm - 2.4cm
8. Fixing with NF60 screw 6 - 3cm
9. Floor slab of 1.0mm thick trapezoidal steel sheet - 11cm *(* adds 10kg per m²)*
10. Cold-rolled steel square tube, type HYBOX 355 RHS 150x100x5 - 15cm
11. Suspension system with metal hook for suspended ceilings, type KNAUF D11
12. Acoustic insulation layer in rock wool panels, type KNAUF SMARTROOF BASE - 4cm
13. Galvanised steel C-beam, type: KNAUF C Plus - 5x2.7x0.6 cm
14. Plasterboard finishing layer, type KNAUF GKB (A) - 1.25cm
15. Smoothing layer of gypsum plaster filler, type KNAUF F2F - 0.5cm

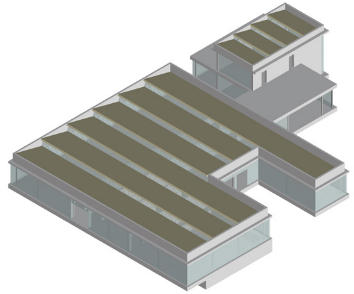
N°	Th. (cm)	Conduct. (W/mK)	Resist. (m²K/W)	Density (kg/m³)
1.	2	1.3	0.015	50
2.	0.2	--	--	--
3.	1.2	0.13	0.09	610
4.	4	--	--	--
5.	6	0.035	1.7	35
6.	0.2	--	--	--
7.	2.4	0.26	0.09	1350
8.	--	--	--	--
9.	11	--	--	*
10.	15	--	--	null
11.	--	--	--	--
12.	4	0.035	1.15	50
13.	--	--	--	--
14.	1.25	0.013	0.06	500
15.	0.5	--	--	--

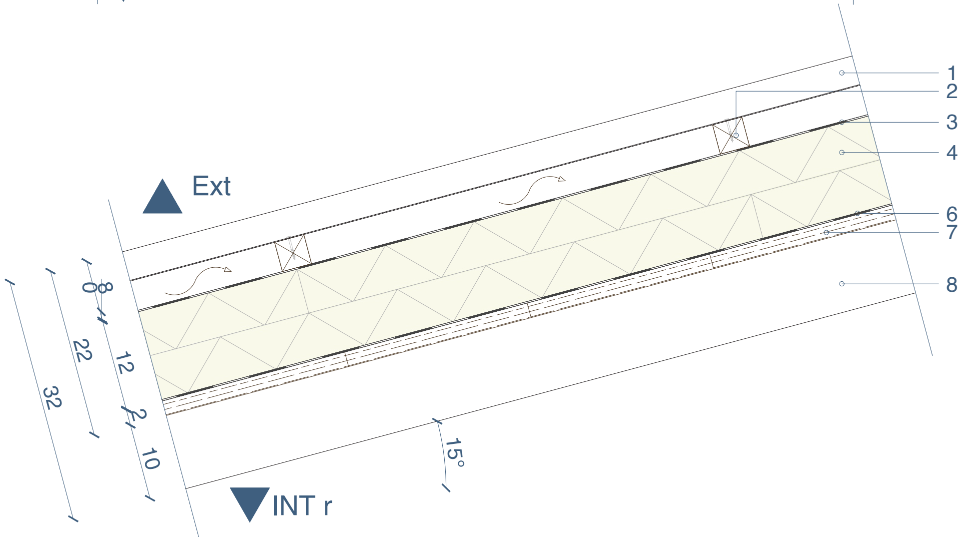
TP.03 - Insulated and ventilated sloping shed roof (CO3)

Annex number : TP.03
Technological element : Discontinuous roof of the modern extensions (building B + D)
Construction code : CO3 for «Chiusura Orizontale n°3» meaning «Horizontal Closure no. 3»

Scale 1:10







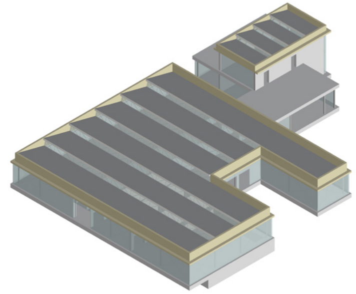
Code	CO3
Thickness	22 cm
Thermal resistance	3.6 m²K/W
Thermal transmit.	0.27 W/m²K
Supported surface mass	24.2 kg/m²
Supported surface weight	0.24 kN/m²

Legend
1. One-milimeter-thick aluminium trapezoidal sheet metal roofing membrane, mechanically fastened to wooden battens - 4cm *(adds 10kg per m²)*
2. Horizontal wooden laths for attachment of the covering and for air flow - 4cm
3. Waterproofing layer non-woven polyester staple fabric, type BIOSCUD BT - 0.2cm
4. Double layer of synthesised expanded polystyrene thermal insulation, type ISOVER - 12cm
5. Wooden strut, 30cm pitch, 3cm width, 12cm height
6. Kraft bitumen vapour barrier and airtightness layer - 0.2cm
7. Rough spruce laminated boards 165 x 25 cm - 2cm
8. Cold-rolled steel square tube all 165cm, typo Hybox 355 SHS 100x100x5

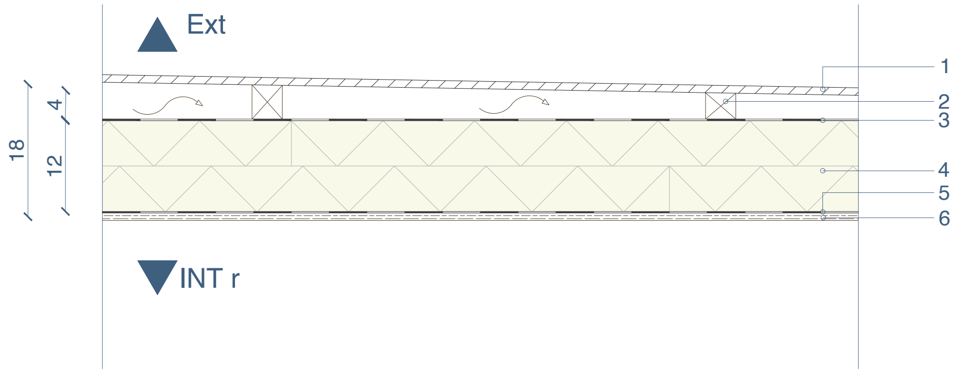
N°	Th. (cm)	Conduct. (W/mK)	Resist. (m²K/W)	Density (kg/m³)
1.	4	--	--	*
2.	4	--	--	--
3.	0.2	--	--	--
4.	12	0.035	3.4	35
5.	(12)	--	--	--
6.	0.2	--	--	--
7.	2	0.13	0.15	500
8.	(10)	--	--	null

TP.04

Annex number : TP.04
Technological element : Non-walkable continuous roof of the modern extensions (building B + D)
Construction code : CO4 for «Chiusura Orizzontale n°4» meaning «Horizontal Closure no. 4»



Scale 1:10



Code	CO4
Thickness	18 cm
Thermal resistance	3.5 m²K/W
Thermal transmit.	0.28 W/m²K
Supported surface mass	22.7 kg/m²
Supported surface weight	0.22 kN/m²

Legend
1. Stainless steel plate cover - 0.5cm
2. Horizontal wooden battens for attaching the stainless steel plate (and cavity) - 4cm
3. Waterproofing layer non-woven polyester staple fabric, type BIOSCUD BT - 0.2cm
4. Double layer of synthesised expanded polystyrene thermal insulation, type ISOVER - 12cm
5. Kraft bitumen vapour barrier and airtightness layer - 0.2cm
6. Cladding in raw squared spruce lamellar boards 50 x 25 cm - 1cm

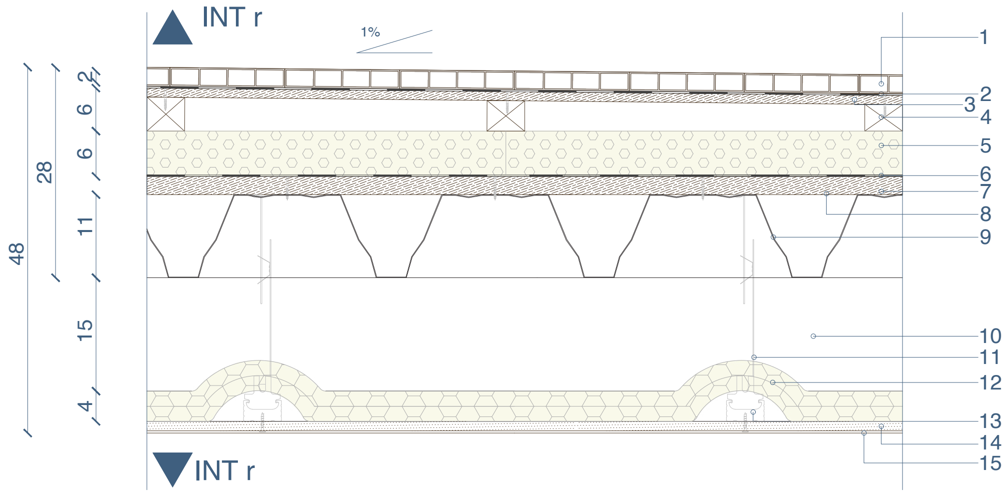
N°	Th. (cm)	Conduct. (W/mK)	Resist. (m²K/W)	Density (kg/m³)
1.	0.5	--	--	2700
2.	4	--	--	--
3.	0.2	--	--	--
4.	12	0.035	3.4	35
5.	0.2	--	--	--
6.	1	0.13	0.07	500

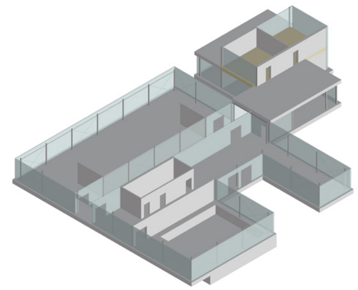
TP.05

TP.05 - Steel-frame intermediate floor with false ceiling (PO1)

Annex number : TP.05
Technological element : Intermediate floor of the two-storey building (building B)
Construction code : PO1 for «Partizione Orizzontale n°1» meaning «Horizontal Partition no. 1»

Scale 1:10





Code	PO1
Thickness	48 cm
Thermal resistance	2.6 m²K/W
Thermal transmit.	0.38 W/m²K
Supported surface mass	93 kg/m²
Supported surface weight	0.91 kN/m²

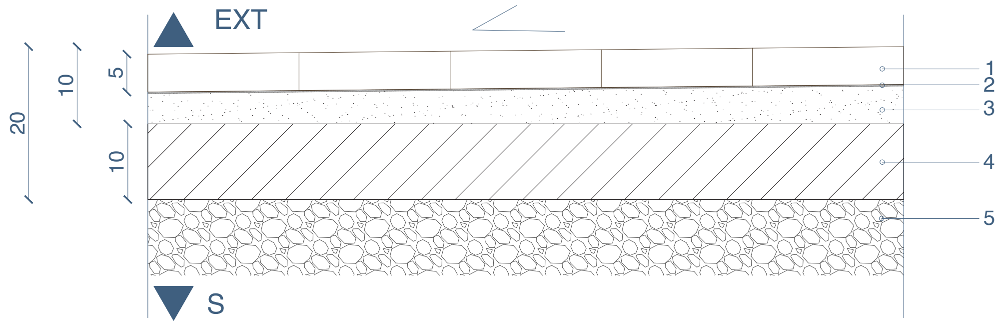
Legend
1. WPC cladding layer, type ARP WPC BAMBOO CLASSIC - 2m90 x 15cm - 2cm
2. Waterproofing layer non-woven polyester staple fabric, type BIOSCUD BT - 0.2cm
3. Stiffening layer made of OSB panels, class 3 - 25cm x 12.5cm - 1.2cm
4. Slope layer (1%) with wooden wedges - max sp: 6cm, min sp: 2cm
5. Plant integration layer made of perlite granules, type PERALIT 20 - 6cm
6. Kraft bitumen vapour barrier and airtightness layer - 0.2cm
7. Cement-wood stiffening layer, type BETONWOOD - 320cm x 125cm - 2.4cm
8. Fixing with NF60 screw 6 - 3cm
9. Floor slab of 1.0mm thick trapezoidal steel sheet - 11cm *(* adds 10kg per m²)*
10. Cold-rolled steel square tube, type HYBOX 355 RHS 150x100x5 - 15cm
11. Suspension system with metal hook for suspended ceilings, type KNAUF D11
12. Acoustic insulation layer in rock wool panels, type KNAUF SMARTROOF BASE - 4cm
13. Galvanised steel C-beam, type: KNAUF C Plus - 5x2.7x0.6 cm
14. Plasterboard finishing layer, type KNAUF GKB (A) - 1.25cm
15. Smoothing layer of gypsum plaster filler, type KNAUF F2F - 0.5cm

N°	Th. (cm)	Conduct. (W/mK)	Resist. (m²K/W)	Density (kg/m³)
1.	2	1.3	0.015	50
2.	0.2	--	--	--
3.	1.2	0.13	0.09	610
4.	4	--	--	--
5.	6	0.05	1.2	90
6.	0.2	--	--	--
7.	2.4	0.26	0.09	1350
8.	--	--	--	--
9.	11	--	--	*
10.	15	--	--	null
11.	--	--	--	--
12.	4	0.035	1.15	50
13.	--	--	--	--
14.	1.25	0.013	0.06	500
15.	0.5	--	--	--

TP.06 - Non insulated external brick paving (PO2)

Annex number :	TP.06
Technological element :	External paving around the modern extensions
Construction code :	PO2 for «Partizione Orizontale n°2» meaning «Horizontal Partition no. 2»

Scale 1:10



Code	PO2
Thickness	10 cm
Thermal resistance	0.17 m²K/W
Thermal transmit.	5.9 W/m²K
Supported surface mass	178 kg/m²
Supported surface weight	1.74 kN/m²

Legend
1. Solid brick facing layer, 'leopard flambée' type - 10cm x 20cm - 5cm
2. Layer of cementitious adhesive, such as MAPEI-ADESILEX P9 - 0.3cm
3. Slope layer in sand cement screed, type BACCHI - 1.5%, such as BIOSCUD BT - 0.2cm
4. Lean concrete casting - 10cm
5. Gravel drainage layer in contact with the ground

N°	Th. (cm)	Conduct. (W/mK)	Resist. (m²K/W)	Density (kg/m³)
1.	5	0.7	0.07	1500
2.	0.3	--	--	--
3.	5	1.4	0.04	2050
4.	(10)	1.6	0.06	null
5.	--	--	--	--

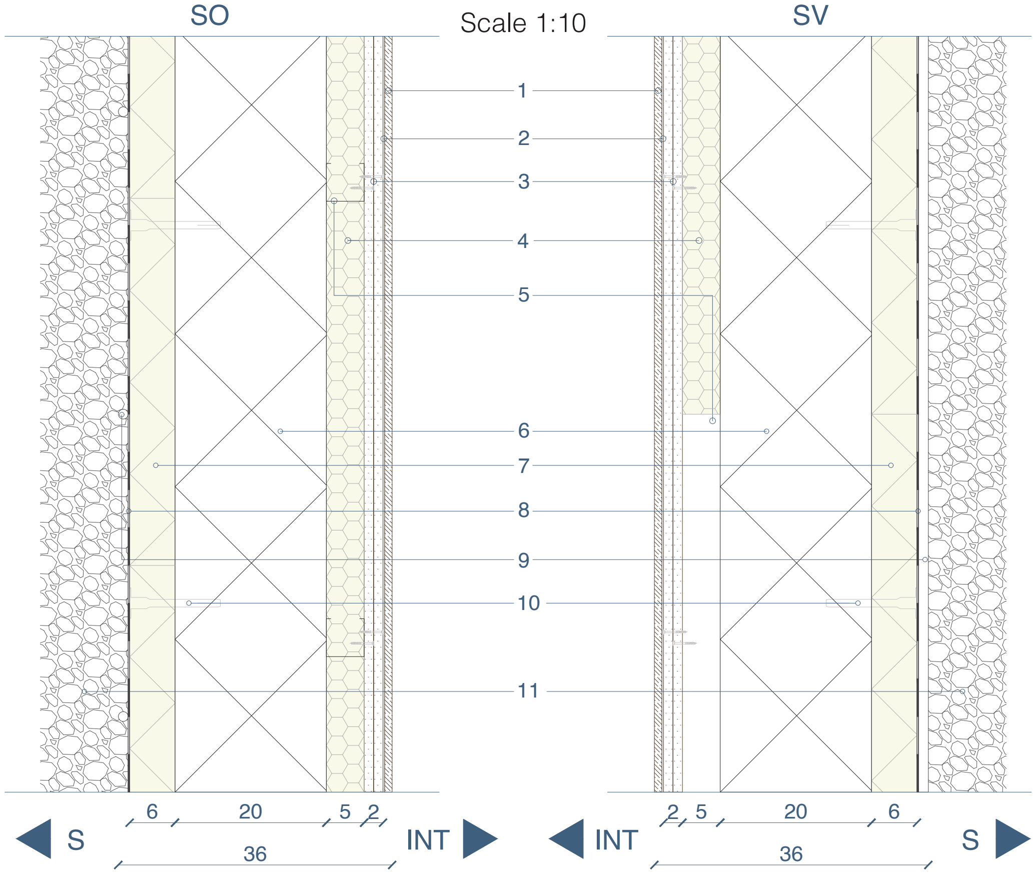
TP.07 - Insulated reinforced concrete retaining wall (CV1)

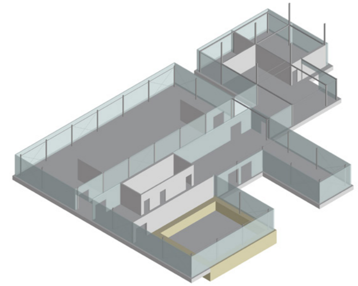
Annex number :
TP.07

Technological element :
Perimetral underground wall of the auditorium (building D)

Construction code :
CV1 for «Chiusura Verticale n°1» meaning «Vertical Closure no. 1»

Scale 1:10





Code	CV1
Thickness	36 cm
Thermal resistance	3.4 m^2K/W
Thermal transmit.	0.29 W/m^2K
Supported lineal mass (h=3m20)	70.7 kg/m
Supported lineal weight (h=3m20)	0.69 kN/m

Legend

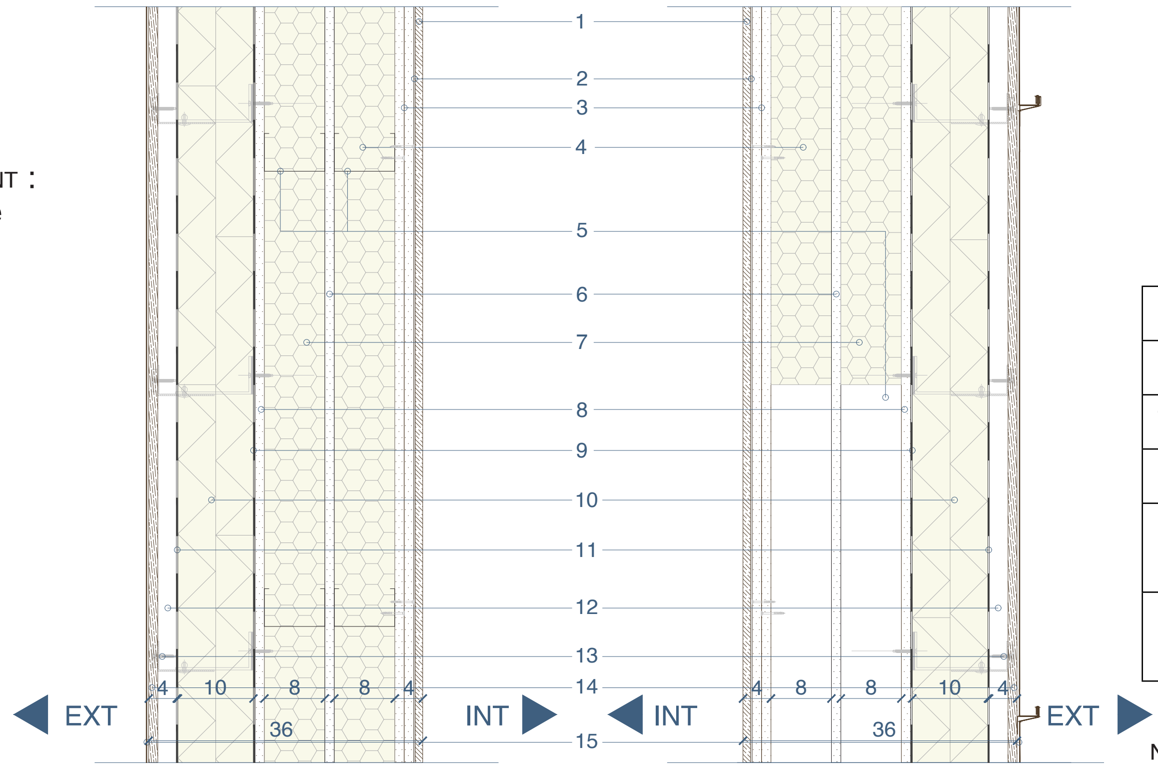
1. Noble wood veneer layer, type PATAGONIA OAK - 100 x 12 - 1 cm
2. Mounting adhesive layer, type CONFORTEC - 0.1cm
3. Gypsum board with vapour barrier, type: KNAUF GKB(A)-BV - 2 cm
4. Thermal and acoustic insulation layer Uncoated rock wool panel, 120cm x 60cm - 5cm
5. Metal frame in galvanised steel C-pillar profiles, type KNAUF C 50-100-50, 0.6 mm thick, pitch: 60 cm
6. Reinforced concrete - 20cm
7. Synthesised polystyrene foam thermal insulation layer, type ISOVER - 6cm
8. Non-woven polyester staple-fibre waterproofing layer, type BIOSCUD BT - 0.2cm
9. Closed-cell polyethylene geocomposite drainage layer - 1.3cm
10. Anchors for fixing insulation panels, type THERMAX 8/60 M 6 - 12cm
11. Gravel drainage layer in contact with the ground

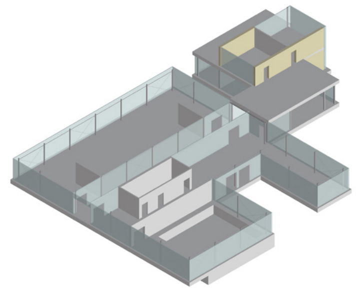
N°	Th. (cm)	Conduct. (W/mK)	Resist. (m^2K/W)	Density (kg/m^3)
1.	1	0.15	0.07	650
2.	0.1	--	--	--
3.	2	0.2	0.1	500
4.	5	0.035	1.4	70
5.	--	--	--	--
6.	20	2.3	0.09	null
7.	6	0.035	1.7	35
8.	0.2	--	--	--
9.	1.3	--	--	--
10.	--	--	--	--
11.	--	--	--	--

Annex number :
TP.08

Technological element :
Perimetral wall of the two-storey building (building B)

Construction code :
CV2 for «Chiusura Verticale n°2» meaning «Vertical Closure no. 2»





Code	CV2
Thickness	36 cm
Thermal resistance	7.8 m²K/W
Thermal transmit.	0.13 W/m²K
Supported lineal mass (h=3m20)	195 kg/m
Supported lineal weight (h=3m20)	1.9 kN/m

Legend

1. Noble wood veneer layer, type PATAGONIA OAK - 100 x 12 - 1 cm
2. Mounting adhesive layer, type CONFORTEC - 0.1 cm
3. Gypsum board with vapour barrier, type: KNAUF GKB(A)-BV - 2.5 cm
4. Thermal and acoustic insulation layer Uncoated rock wool panel, 120cm x 60cm - 8cm
5. Metal frame in galvanised steel C-pillar profiles, type KNAUF C 50-100-50, 0.6 mm thick, pitch: 60 cm
6. Concrete slab with reinforcement mesh, type KNAUF AQUAPANEL - 120 x 240 - 1.25 cm
7. Thermal and acoustic insulation layer Uncoated rock wool panel, 120cm x 60cm - 8cm
8. Coated gypsum board, type KNAUF GKB(A) with hydraulic lime mortar adhesive - 1.25cm
9. Kraft bitumen vapour barrier and airtightness layer - 0.2cm
10. ISOVER synthesised polystyrene foam thermal insulation layer - 10 cm
11. Polyester staple-fibre waterproofing layer, type BIOSCUD BT - 0.2cm
12. Ventilation layer with metal substructure - 3cm
13. Fixing system with steel L-bracket, type MFT MFI HILTI, 8x17 cm
14. OSB wood panel support layer, class 3, 250 x 125 - 1.2 cm
15. Zinc-titanium cladding layer, double corner seam, type ZINTEK - 0.7 cm

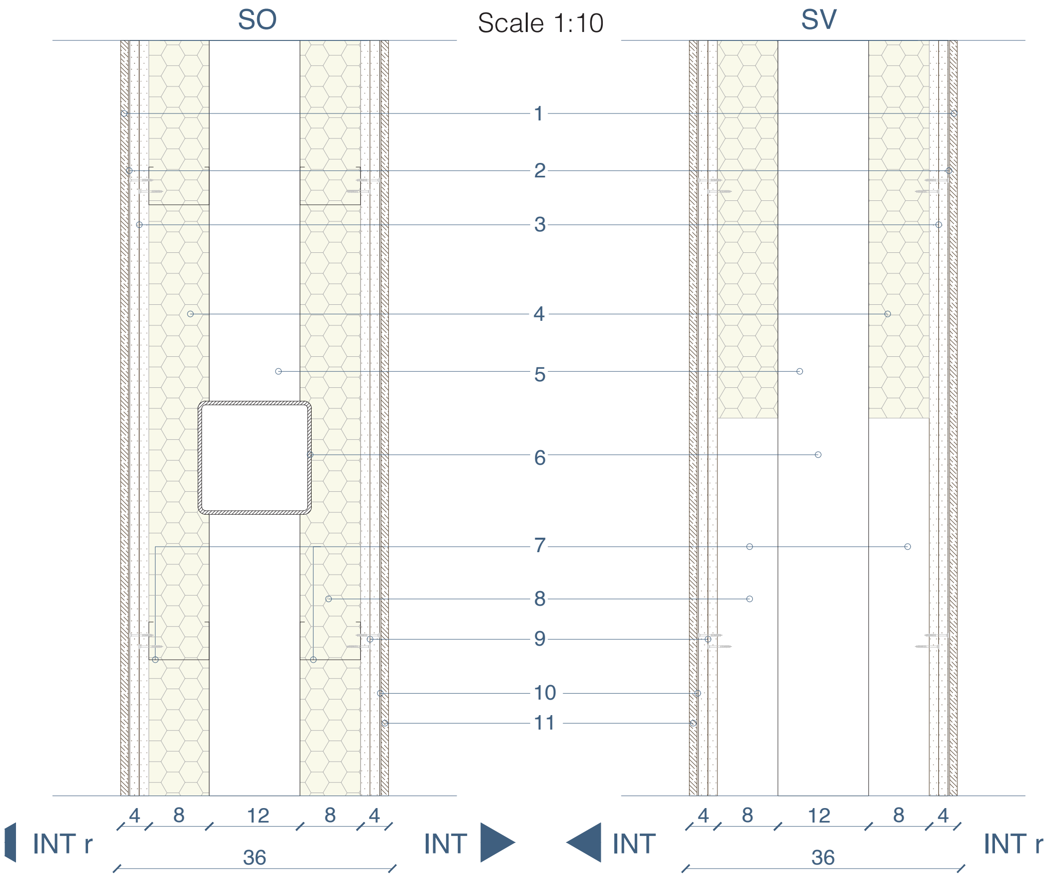
N°	Th. (cm)	Conduct. (W/mK)	Resist. (m²K/W)	Density (kg/m³)
1.	1	0.15	0.07	650
2.	0.1	--	--	--
3.	2.5	0.2	0.15	500
4.	8	0.035	2.3	70
5.	--	--	--	--
6.	1.25	0.35	0.04	1100
7.	8	0.035	2.3	70
8.	1.25	0.2	0.06	500
9.	0.2	--	--	--
10.	10	0.035	2.9	35
11.	0.2	--	--	--
12.	3	--	--	--
13.	--	--	--	--
14.	1.2	0.13	0.09	610
15.	0.7	--	--	--

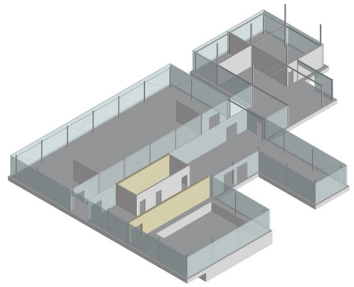
TP.09 - Sound isolated non bearing wall with air gap (PV1)

Annex number :
TP.09

Technological element :
Partional wall of the auditorium and box wc (building D)

Construction code :
PV1 for «Partizione Verticale n°1» meaning «Vertical Partition no. 1»





Code	CV1
Thickness	36 cm
Thermal resistance	5.0 m²K/W
Thermal transmit.	0.20 W/m²K
Supported lineal mass (h=3m20)	157 kg/m
Supported lineal weight (h=3m20)	1.5 kN/m

Legend

1. Noble wood veneer layer, type PATAGONIA OAK - 100 x 12 - 1 cm
2. Fitting adhesive layer, type CONFORTEC - 0.1 cm
3. Gypsum board with vapour barrier, type: KNAUF GKB(A)-BV - 2.5 cm
4. Thermal and acoustic insulation layer Uncoated rock wool panel, 120cm x 60cm - 8cm
5. Air cavity for system passage - 12 cm
6. Cold-rolled steel square tube, type HYBOX SHS 150x150x5
7. Metal frame in galvanised steel C-pillar profiles, type KNAUF C 50-100-50, 0.6 mm thick, pitch: 60 cm
8. Thermal and acoustic insulation layer uncoated rock wool panel, 120cm x 60cm - 8cm
9. Gypsum board coated with vapour barrier, type: KNAUF GKB(A)-BV - 2 .5cm
10. Mounting adhesive layer, type CONFORTEC - 0.1cm
11. Layer of noble wood cladding, type PATAGONIA OAK - 100 x 12 - 1 cm

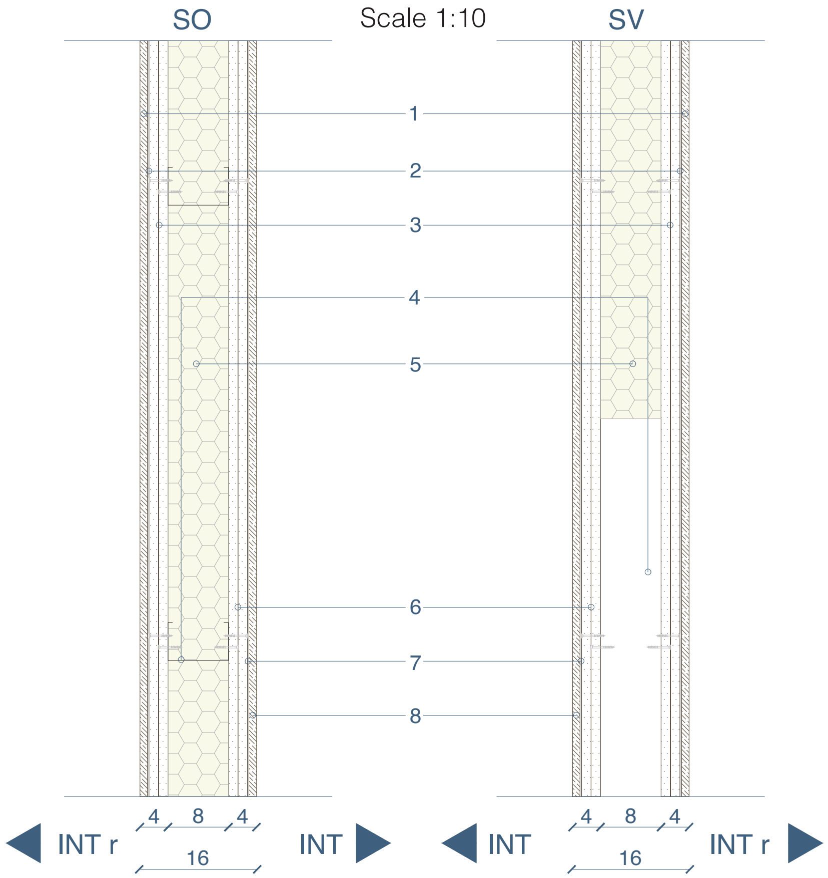
N°	Th. (cm)	Conduct. (W/mK)	Resist. (m²K/W)	Density (kg/m³)
1.	1	0.15	0.07	650
2.	0.1	--	--	--
3.	2.5	0.2	0.15	500
4.	8	0.035	2.3	70
5.	12	--	--	--
6.	(15)	--	--	null
7.	--	--	--	--
8.	8	0.035	2.3	70
9.	2.5	0.2	0.15	500
10.	0.1	--	--	--
11.	1	0.15	0.07	650

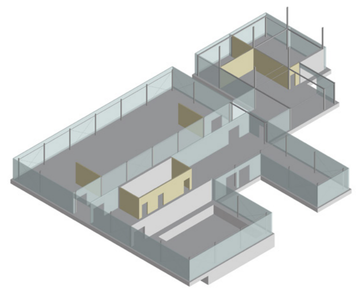
TP.10 - Lightweight non-load-bearing wall (PV2)

Annex number :
TP.10

Technological element :
Partional wall of the modern extension (building B + D)

Construction code :
PV2 for «Partizione Verticale n°2» meaning «Vertical Partition no. 2»





Code	PO2
Thickness	16 cm
Thermal resistance	2.7 m²K/W
Thermal transmit.	0.38 W/m²K
Supported lineal mass (h=3m20)	140 kg/m
Supported lineal weight (h=3m20)	1.4 kN/m

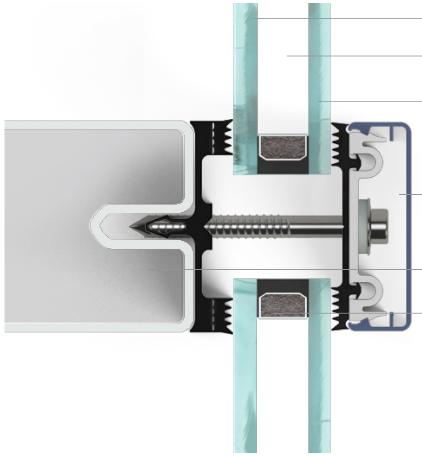
Legend

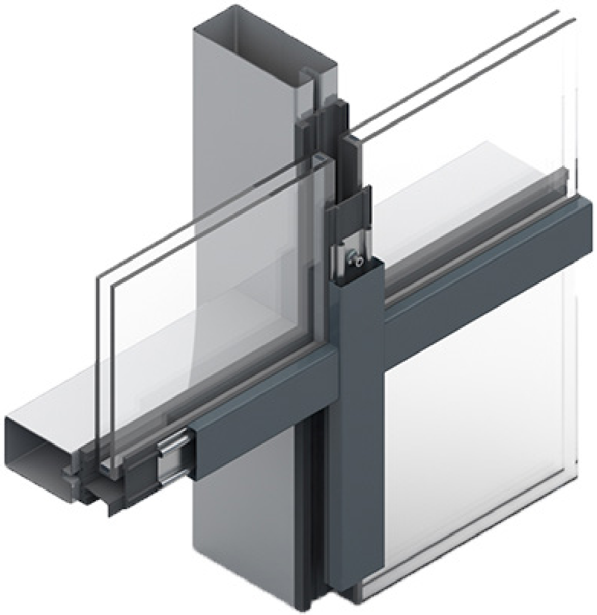
1. Noble wood veneer layer, type PATAGONIA OAK - 100 x 12 - 1 cm
2. Mounting adhesive layer, type CONFORTEC - 0.1 cm
3. Gypsum board with vapour barrier, type: KNAUF GKB(A)-BV - 2.5 cm
4. Metal frame made of galvanised steel C-pillar profiles, type KNAUF C 50-100-50, thickness 0.6 mm, pitch: 60 cm
5. Thermal and acoustic insulation layer uncoated rock wool panel, type ACOUSTIC 225 PLUS ROCKWOOL 120cm x 60cm - 8cm
6. Gypsum board coated with vapour barrier, type: KNAUF GKB(A)-BV - 2.5 cm
7. Mounting adhesive layer, type CONFORTEC - 0.1cm
8. Noble wood cladding layer, type PATAGONIA OAK - 100 x 12 - 1 cm

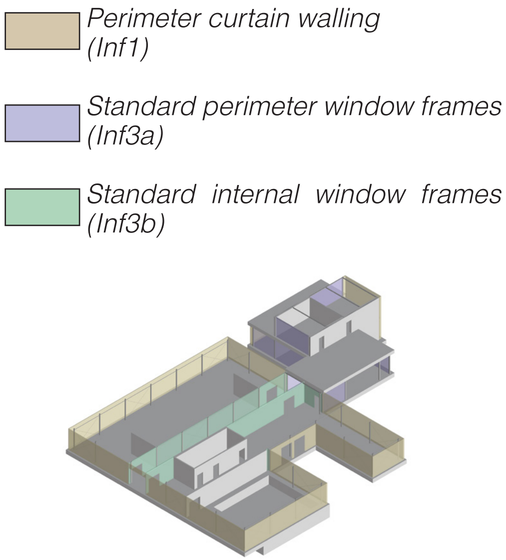
N°	Th. (cm)	Conduct. (W/mK)	Resist. (m²K/W)	Density (kg/m³)
1.	1	0.15	0.07	650
2.	0.1	--	--	--
3.	2.5	0.2	0.15	500
4.	--	--	--	--
5.	8	0.035	2.3	70
6.	2.5	0.2	0.15	500
7.	0.1	--	--	--
8.	1	0.15	0.07	650

TP.11 - Aluminium curtain wall (Inf1)

Annex number : TP.11
Technological element : Perimetral windows frame of the modern extension
Construction code : Inf1 for «Infissi n°1» meaning «Windows frame no. 1»







Name product : Curtain wall
Manufacturer : Reynaers Aluminium
Dati tecnici :

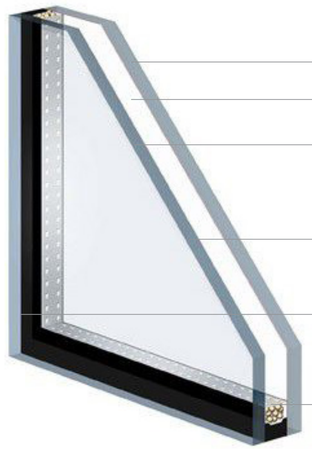
Use in the project	Curtain wall (all around building B + D)
Product code	SlimWall 35
Frame dimensions	150 x 330 cm^2 Th = 6.5cm
Glass dimensions	120 x 300 cm^2
Daylight area	3.6 m^2
Opening	No
Ventilation open sash	--
Inclination	90°
Quantity per weave	3 (on 4m50)
Unit weight	450 kg
Thermal resistance (Rw)	1.1 m^2K/W
Thermal transmittance (Uw)	0.9 W/m^2K
Glass thickness	28 mm
Light transmission (TL)	0.55
Solar factor (g)	0.4
Selectivity (TL/g)	1.38
Acoustic performance	40 dB

TP.12 - Electric shed skylight (Inf2)

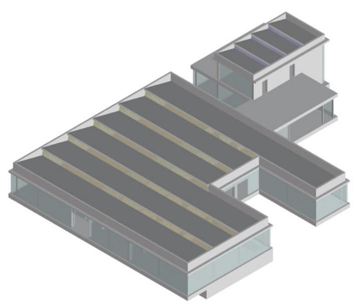
Annex number : TP.12
Technological element : Oblique windows frame of the modern extension’s roof
Construction code : Inf2 for «Infissi n°2» meaning «Windows frame no. 2»

Name product : VSE Electric Skylight
Manufacturer : Velux
Dati tecnici :

Use in the project	Larger shed (building D)	Smaller shed (building B)
Product code	C04	S01
Frame dimensions	55 x 95 cm^2	124 x 65 cm^2
Glass dimensions	40 x 80 cm^2	112 x 53 cm^2
Daylight area	0.32 m^2	0.59 m^2
Opening	A vasistas	
Ventilation open sash	0.44 m^2	0.68 m^2
Inclination	75° toward north	
Quantity per weave	16 (on 10m)	5 (on 6m20)
Unit weight	21.7 kg	31.2 kg
Thermal resistance (Rw)	1.1 m^2K/W	1.1 m^2K/W
Thermal transmittance (Uw)	0.9 W/m^2K	0.9 W/m^2K
Glass thickness	18 mm	
Light transmission (TL)	0.7	
Solar factor (g)	0.4	
Selectivity (TL/g)	1.75	
Acoustic performance	32 dB	



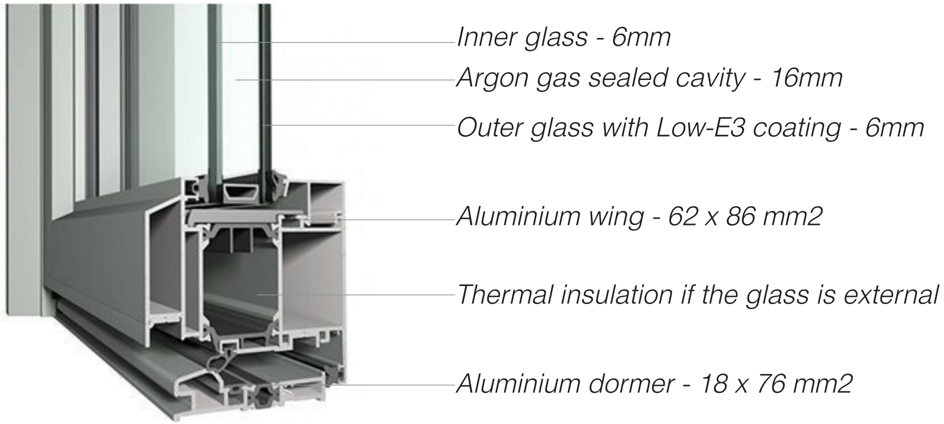
Velux VSE CO4 (Inf2a)
Velux VSE SO1 (Inf2b)



TP.13

TP.13 - Standard aluminium windows frames (Inf3)

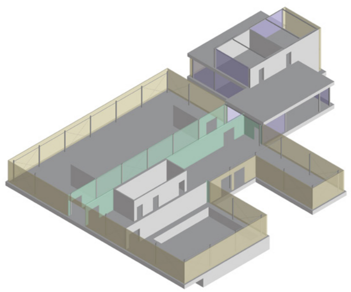
Annex number : TP.13
Technological element : Windows frame of the modern extension
Construction code : Inf3 for «Infissi n°3» meaning «Windows frame no. 3»



Perimeter curtain walling (Inf1)

Standard perimeter window frames (Inf3a)

Standard internal window frames (Inf3b)



Name product : Ferro Windows
Manufacturer : Reynaers Aluminium
Dati tecnici :

Use in the project	Exterior glazing	Interior glazing
Product code	SlimLine38	
Frame dimensions	150 x 330 cm2 Th = 6.5cm	
Glass dimensions	120 x 300 cm2	
Daylight area	3.6 m2	
Opening	Clapper opening (for those openable)	
Ventilation open sash	3.00 m2 (for those openable)	
Inclination and orientation	90°	
Quantity per frame	3 (on 4m50)	
Unit weight	160 kg	
Thermal resistance (Rw)	1.1 m2K/W	0.77 m^2K/W
Thermal transmittance (Uw)	0.9 W/m2K	1.3 W/m^2K
Glass thickness	28 mm	
Light transmission (TL)	0.55	
Solar factor (g)	0.4	
Selectivity (TL/g)	1.38	
Acoustic performance	40 dB	

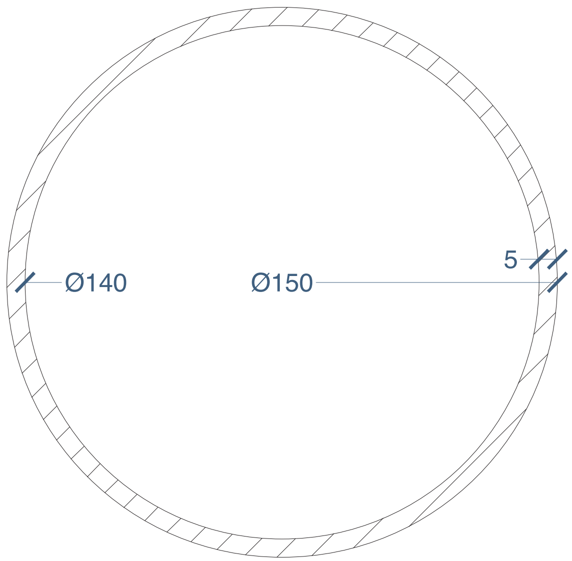
Product name and code
PI1 - Hybox 355 CHS 150/5/H

Use in the project
- Main load-bearing columns
carry TRR or TR4 trusses
carry TR1 beams
carried by the foundation

- Secondary (non-load-bearing) columns
carry only TR1 beams to allow their length to be cut and their dimensions reduced
carried by the foundation

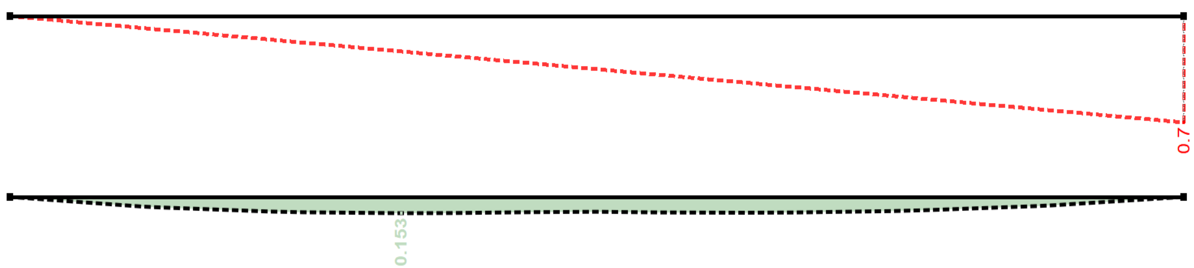
Loads taken into account
- Net weight
- Structural load
  (net weight TRR, TR1 and TR4)
- Permanent load CO3
- Operating load - category H
- Thermal expansion load
- Snow load
- Wind load
  (vacuum pressure)
  (overpressure)
  (lateral pressure)

Section - scale 1:2

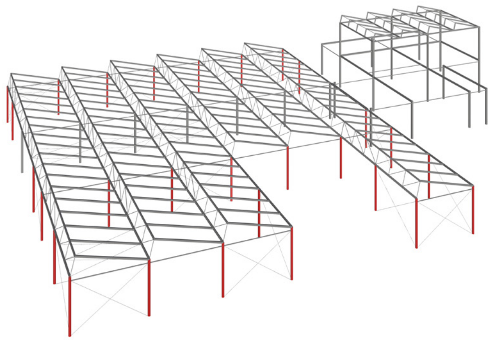


Product quantity and characteristics
23 galvanised round steel tubes
(of which 7 are non-load-bearing)
L = 320 cm
M = 57 kg

SLS vertical deformation diagram (in mm) and deflection checks ratio along the pipe



Navigator



Ultimate Limit State verifications (ULS)		
Governed by bending about the z-axis		
Shear force	$V_{y,Ed}$	3.68 kN
Shear force resistance	$V_{pl,y,Rd}$	230 kN
Contro ratio for Vy	η_{Vy}	0.016 *
Moment resistance	$M_{z,Ed}$	8.12 kN.m
Design beinding moment	$M_{pl,z,Rd}$	28.9 kN.m
Inspection ratio	η	0.281
EN 1993-1-1, 6.2.5 check	< 1	Verified

Serviceability Limit State verifications (SLS)		
Governed by deflection in y-direction		
Reference length	L	320 cm
Limit criterion for deflection	δ_w	300
Total Deflection	$w_{tot,y}$	1.6 mm
Deflection limit value	w_{lim}	10.7 mm
Inspection ratio	η	0.153
EN 1993-1-1, 7.2 check	< 1	Verified

* Acc. to 6.2.8(2) or 6.2.10(2), the effect of the shear force/stress in the z-axis is neglected because it is less than half of the shear resistance.

SD.02

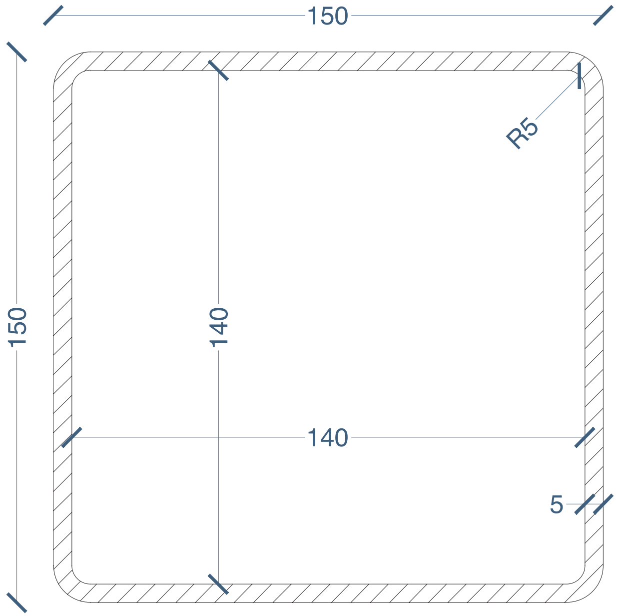
SD.02 - Hybox 355 CHS 150x150x5 (PI2)

Product name and code
PI2 - Hybox 355 SHS 150x150x5

Use in the project
- main load-bearing columns
carry TRR, TR2, TR3 or TR4 lattice girders
carry TR1 beams
carried by the foundation

Loads taken into account
- Net weight
- Structural load (net weight TR1-6)
- Permanent load CO3, CO2, CV1
- Operating load - category H, C3 or C5
- Thermal expansion load
- Snow load
- Wind load
  (vacuum pressure)
  (overpressure)
  (lateral pressure)

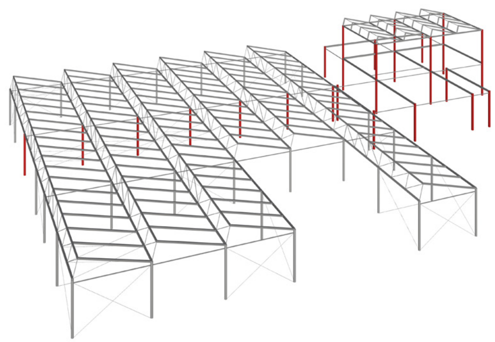
Section - scale 1:2



Product quantity and characteristics
21 galvanised steel tubes
L = 320 cm, M = 71 kg

6 galvanised steel tubes
L = 640 cm, M = 143 kg

Navigator

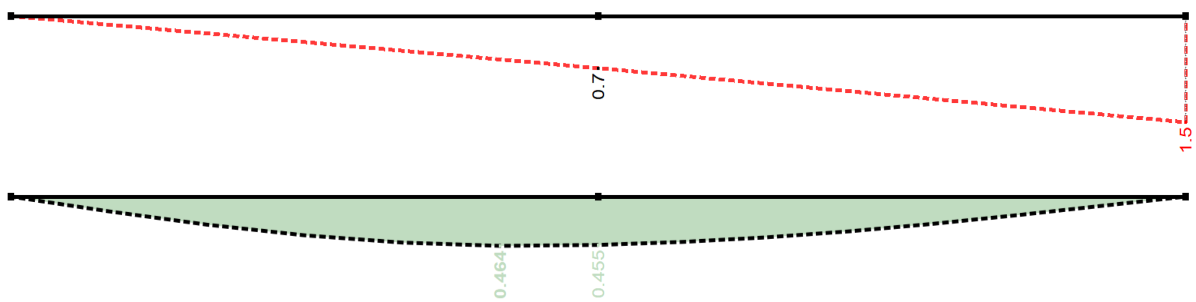


Ultimate Limit State verifications (ULS)		
Governed by bending about the y-axis		
Shear force	$V_{z,Ed}$	10.2 kN
Shear force resistance	$V_{pl,z,Rd}$	230 kN
Contro ratio for Vy	η_{Vz}	0.044 *
Moment resistance	$M_{y,Ed}$	16.3 kN.m
Design beinding moment	$M_{pl,y,Rd}$	42.1 kN.m
Inspection ratio	η	0.388
EN 1993-1-1, 6.2.5 check	< 1	Verified

Serviceability Limit State verifications (SLS)		
Governed by deflection in z-direction		
Reference length	L	640 cm
Limit criterion for deflection	δ_w	300
Total Deflection	$w_{tot,z}$	9.9 mm
Deflection limit value	w_{lim}	21.3 mm
Inspection ratio	η	0.464
EN 1993-1-1, 7.2 check	< 1	Verified

* Acc. to 6.2.8(2) or 6.2.10(2), the effect of the shear force/stress in the z-axis is neglected because it is less than half of the shear resistance.

SLS vertical deformation diagram (in mm) and deflection checks ratio along the pipe



SD.03

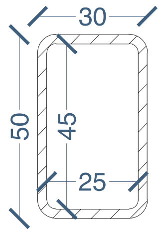
SD.03 - Hybox 355 RHS 50x30x2.5 (TR1)

Product name and code
TR1 - Hybox 355 RHS 50x30x2.5

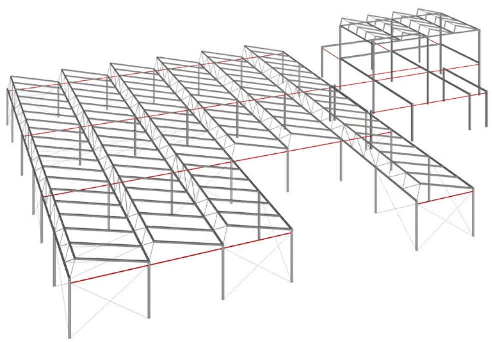
Use in the project
- Non-bearing beams
used to tie columns
carried by PI1 or PI2 columns

Loads taken into account
- Net weight
- Thermal expansion load

Section - scale 1:2

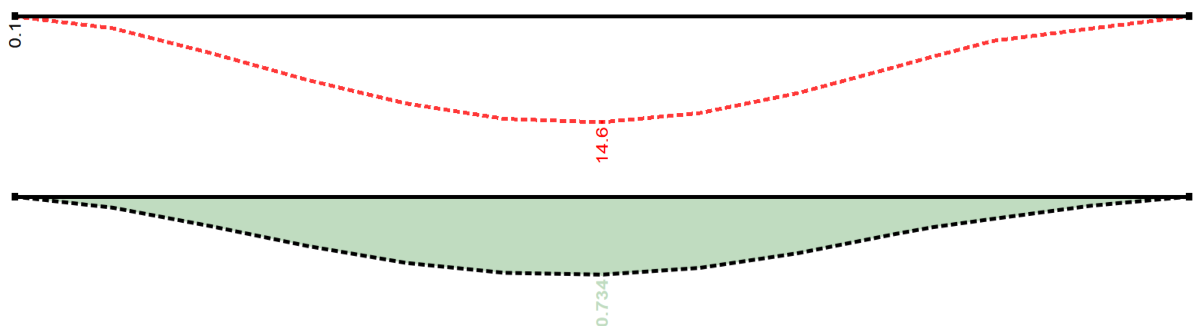


Navigator



Product quantity and characteristics
24 galvanised steel tubes, L = 450 cm, M = 13 kg
3 galvanised steel pipes, L = 595 cm, M = 17 kg
3 galvanised steel pipes, L = 380 cm, M = 11 kg
2 galvanised steel pipes, L = 180 cm, M = 5 kg
1 galvanised steel pipe, L = 415 cm, M = 12 kg

SLS vertical deformation diagram (in mm) and deflection checks ratio along the pipe



Ultimate Limit State verifications (ULS)		
Governed by bending about the y-axis		
Shear force	$V_{z,Ed}$	0.68 kN
Shear force resistance	$V_{pl,z,Rd}$	21.8 kN
Contro ratio for Vy	η_{Vz}	0.031 *
Moment resistance	$M_{y,Ed}$	0.66 kN.m
Design beinding moment	$M_{pl,y,Rd}$	1.09 kN.m
Inspection ratio	η	0.601
EN 1993-1-1, 6.2.5 check	< 1	Verified

Serviceability Limit State verifications (SLS)		
Governed by deflection in z-direction		
Reference length	L	595 cm
Limit criterion for deflection	δ_w	300
Total Deflection	$w_{tot,z}$	14.6 mm
Deflection limit value	w_{lim}	19.4 mm
Inspection ratio	η	0.734
EN 1993-1-1, 7.2 check	< 1	Verified

* Acc. to 6.2.8(2) or 6.2.10(2), the effect of the shear force/stress in the z-axis is neglected because it is less than half of the shear resistance.

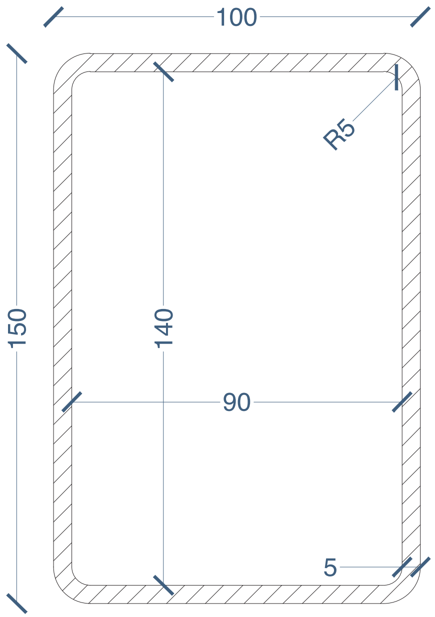
SD.04 - Hybox 355 RHS 150x100x5 (TR2)

Product name and code
TR2 - Hybox 355 RHS 150x100x5

Use in the project
- Supporting beams
carry terrace roofs or upper floor slabs.
carry sometimes CV2 perimeter walls
carried by 3m20 Pl2 columns

Loads taken into account
- Net weight
- Permanent load CO2 or PO1
- Permanent load CV2
- Operating load - category C3 or C5
- Thermal expansion load
- Snow load
- Wind load
  (vacuum pressure)
  (overpressure)
  (lateral pressure)

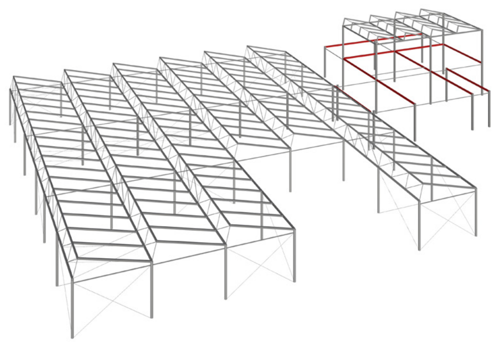
Section - scale 1:2



Product quantity and characteristics
7 galvanised steel tubes in the East-West axis
L = 620 cm, M = 114 kg

4 galvanised steel pipes in the North-South axis
L = 595 cm, M = 109 kg

Navigator

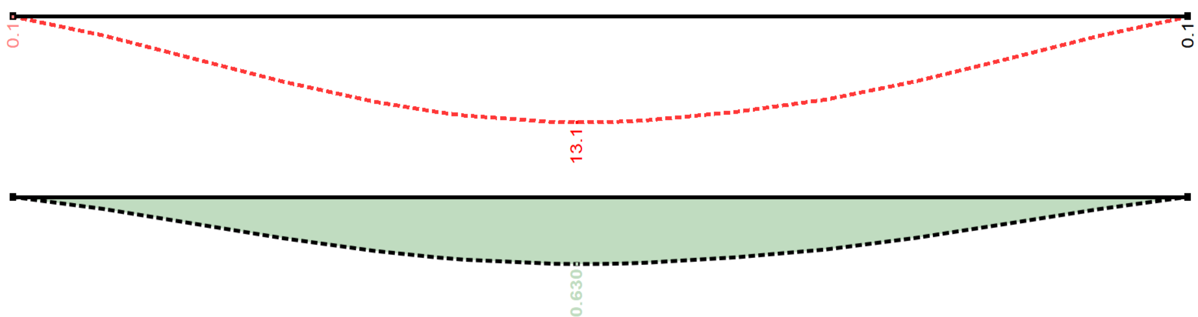


Ultimate Limit State verifications (ULS)		
Governed by bending about the y-axis		
Shear force	$V_{z,Ed}$	12.3 kN
Shear force resistance	$V_{pl,z,Rd}$	230 kN
Contro ratio for Vy	η_{Vz}	0.053 *
Moment resistance	$M_{y,Ed}$	16.5 kN.m
Design beinding moment	$M_{pl,y,Rd}$	32.2 kN.m
Inspection ratio	η	0.512
EN 1993-1-1, 6.2.5 check	< 1	Verified

Serviceability Limit State verifications (SLS)		
Governed by deflection in z-direction		
Reference length	L	620 cm
Limit criterion for deflection	δ_w	300
Total Deflection	$w_{tot,z}$	13.1 mm
Deflection limit value	w_{lim}	20.7 mm
Inspection ratio	η	0.630
EN 1993-1-1, 7.2 check	< 1	Verified

* Acc. to 6.2.8(2) or 6.2.10(2), the effect of the shear force/stress in the z-axis is neglected because it is less than half of the shear resistance.

SLS vertical deformation diagram (in mm) and deflection checks ratio along the pipe



SD.05

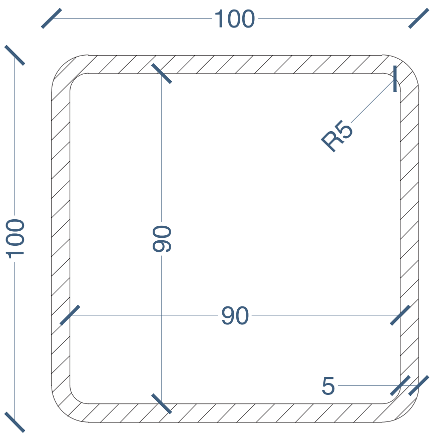
SD.05 - Hybox 355 CHS 100x100x5 (TR3)

Product name and code
TR3 - Hybox 355 SHS 100x100x5

Use in the project
Primary support beams
carry the TR5 beams (smaller shed)
carried by the 6m40 PI2 columns

Loads taken into account
- Net weight
- Structural load (TR6 and TR5 net weight)
- Permanent load CO3
- Operating load - category H
- Thermal expansion load
- Snow load
- Wind load
  (vacuum pressure)
  (overpressure)
  (lateral pressure)

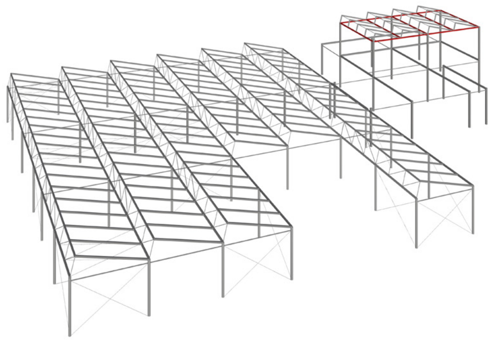
Section - scale 1:2



Product quantity and characteristics
5 galvanised steel pipes in the East-West axis
L = 595 cm, M = 86 kg

4 galvanised steel tubes in the North-South axis
L = 620 cm, M = 90 kg

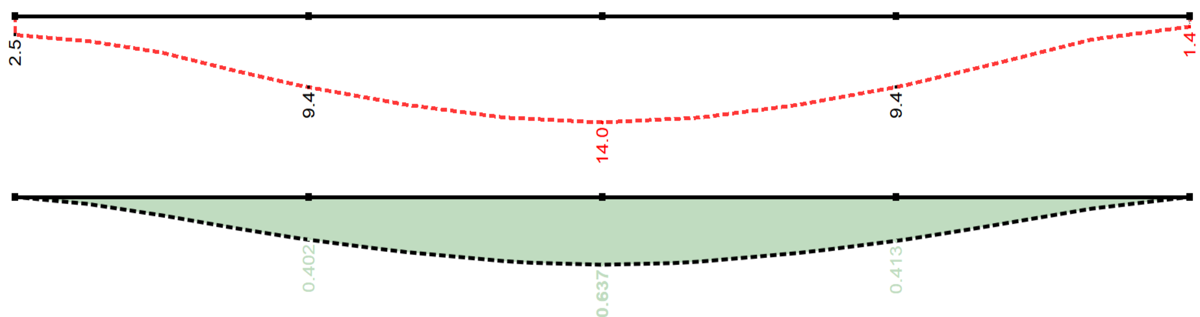
Navigator



Ultimate Limit State verifications (ULS)		
Governed by axial and shear stresses		
Yield strength	f_y	275 N/mm²
Partial factor	γ_{M0}	1.00
Axial stress	$\sigma_{x,Ed}$	187 N/mm²
Shear stress	τ_{Ed}	7.6 N/mm²
Inspection ratio	η	0.464
EN 1993-1-1, 6.2.1(5) check	< 1	Verified

Serviceability Limit State verifications (SLS)		
Governed by deflection in z-direction		
Reference length	L	620 cm
Limit criterion for deflection	δ_w	300
Total Deflection	$w_{tot,z}$	13.2 mm
Deflection limit value	w_{lim}	20.7 mm
Inspection ratio	η	0.637
EN 1993-1-1, 7.2 check	< 1	Verified

SLS vertical deformation diagram (in mm) and deflection checks ratio along the pipe



SD.06 - Hybox 355 CHS 100x100x5 (TR4)

Product name and code

TR4 - Hybox 355 SHS 100x100x5

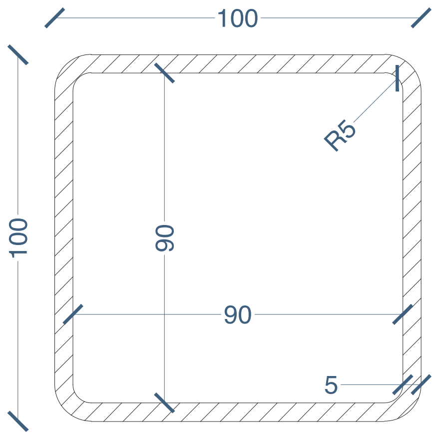
Use in the project

- Secondary support beams (inclined 15°) carry the roof of the one-storey building (larger shed) carried by TRR truss beams

Loads taken into account

- Net weight
- Permanent load CO3
- Operating load - category H
- Thermal expansion load
- Snow load
- Wind load
  (vacuum pressure)
  (overpressure)
  (lateral pressure)

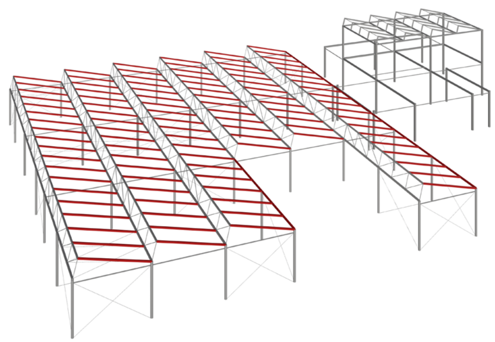
Section - scale 1:2



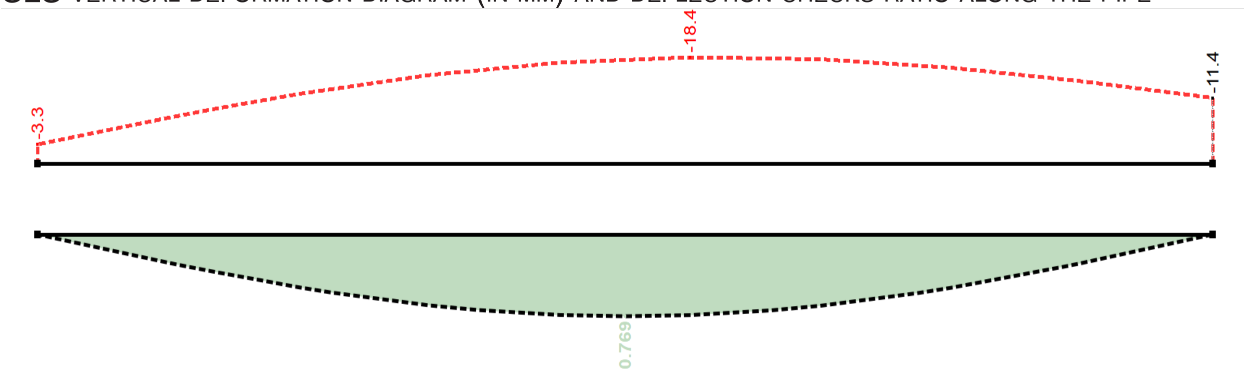
Product quantity and characteristics

102 galvanised steel tubes inclined at 75°
L = 435 cm
M = 63 kg

Navigator



SLS vertical deformation diagram (in mm) and deflection checks ratio along the pipe



Ultimate Limit State verifications (ULS)		
Governed by bending about the y-axis		
Shear force	$V_{z,Ed}$	6.65 kN
Shear force resistance	$V_{pl,z,Rd}$	151 kN
Contro ratio for Vy	η_{Vz}	0.044 *
Moment resistance	$M_{y,Ed}$	6.32 kN.m
Design beinding moment	$M_{pl,y,Rd}$	17.8 kN.m
Inspection ratio	η	0.356
EN 1993-1-1, 6.2.5 check	< 1	Verified

Serviceability Limit State verifications (SLS)		
Governed by deflection in z-direction		
Reference length	L	435 cm
Limit criterion for deflection	δ_w	300
Total Deflection	$w_{tot,z}$	11.1 mm
Deflection limit value	w_{lim}	14.5 mm
Inspection ratio	η	0.769
EN 1993-1-1, 7.2 check	< 1	Verified

* Acc. to 6.2.8(2) or 6.2.10(2), the effect of the shear force/stress in the z-axis is neglected because it is less than half of the shear resistance.

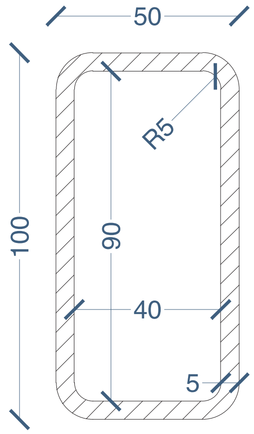
SD.07

Product name and code
TR5 - Hybox 355 RHS 100x50x5

Use in the project
- Secondary support beams (inclined 15° or 75°)
carry the roof of the building B (smaller sheds) and TR6 beams carried by TR3 beams

Loads taken into account
- Net weight
- Structural load (net weight TR6)
- Permanent load CO3
- Operating load - category H
- Thermal expansion load
- Snow load
- Wind load
  (vacuum pressure)
  (overpressure)
  (lateral pressure)

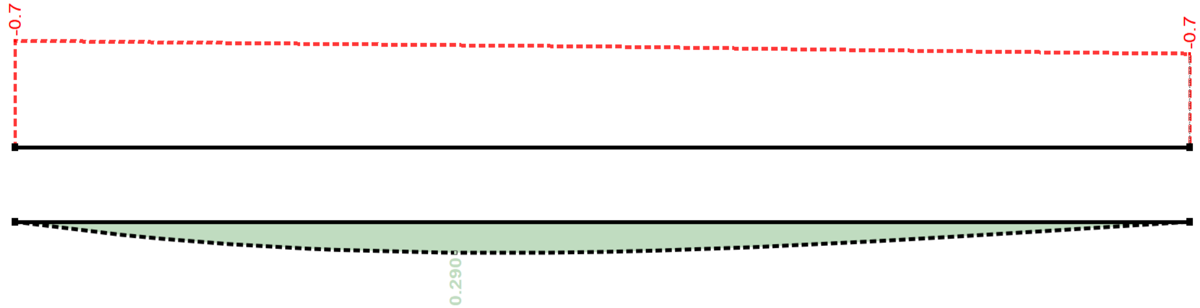
Section - scale 1:2



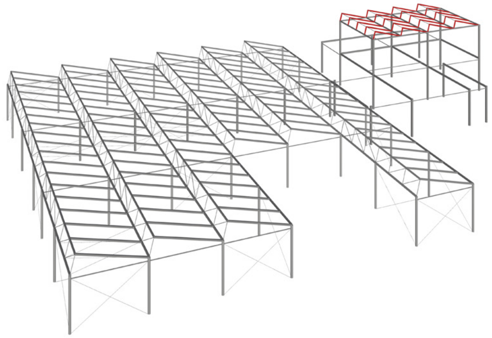
Product quantity and characteristics
20 galvanised steel tubes inclined at 15°.
L = 287 cm, M = 30 kg

20 galvanised steel pipes inclined at 75°
L = 75 cm, M = 8 kg

SLS vertical deformation diagram (in mm) and deflection checks ratio along the pipe



Navigator



Ultimate Limit State verifications (ULS)		
Governed by axial and shear stresses		
Yield strength	f_y	275 N/mm²
Partial factor	γ_{M0}	1.00
Axial stress	$\sigma_{x,Ed}$	191 N/mm²
Shear stress	τ_{Ed}	3.1 N/mm²
Inspection ratio	η	0.484
EN 1993-1-1, 6.2.1(5) check	< 1	Verified

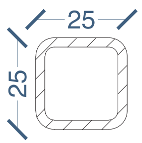
Serviceability Limit State verifications (SLS)		
Governed by deflection in y-direction		
Reference length	L	75 cm
Limit criterion for deflection	δ_w	300
Total Deflection	$w_{tot,y}$	0.7 mm
Deflection limit value	w_{lim}	2.5 mm
Inspection ratio	η	0.290
EN 1993-1-1, 7.2 check	< 1	Verified

Product name and code
TR6 - Hybox 355 SHS 25x25x2.5

Use in the project
- Non-bearing beams used to tie TR5 beams carried by TR5 beams

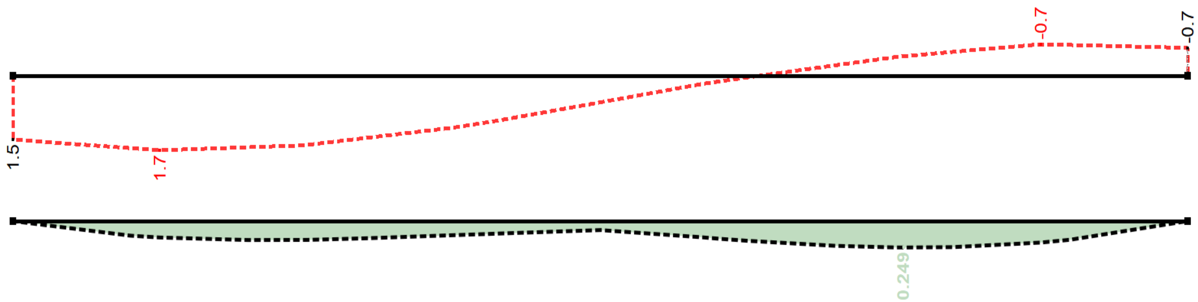
Loads taken into account
- Net weight
- Thermal expansion load
- Wind load
  (vacuum pressure)
  (overpressure)
  (lateral pressure)

Section - scale 1:2

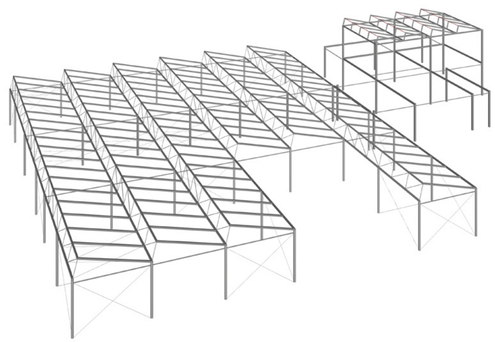


Product quantity and characteristics
102 galvanised steel tubes inclined at 75°
L = 435 cm
M = 63 kg

SLS vertical deformation diagram (in mm) and deflection checks ratio along the pipe



Navigator



Ultimate Limit State verifications (ULS)		
Governed by bending about the y-axis		
Shear force	$V_{z,Ed}$	0.21 kN
Shear force resistance	$V_{pl,z,Rd}$	17.9 kN
Contro ratio for Vy	η_{Vz}	0.012 *
Moment resistance	$M_{y,Ed}$	0.15 kN.m
Design beinding moment	$M_{pl,y,Rd}$	0.47 kN.m
Inspection ratio	η	0.313
EN 1993-1-1, 6.2.5 check	< 1	Verified

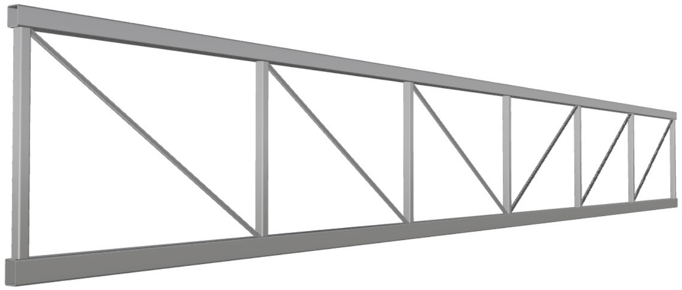
Serviceability Limit State verifications (SLS)		
Governed by deflection in z-direction		
Reference length	L	155 cm
Limit criterion for deflection	δ_w	300
Total Deflection	$w_{tot,z}$	1.3 mm
Deflection limit value	w_{lim}	5.2 mm
Inspection ratio	η	0.249
EN 1993-1-1, 7.2 check	< 1	Verified

* Acc. to 6.2.8(2) or 6.2.10(2), the effect of the shear force/stress in the z-axis is neglected because it is less than half of the shear resistance.

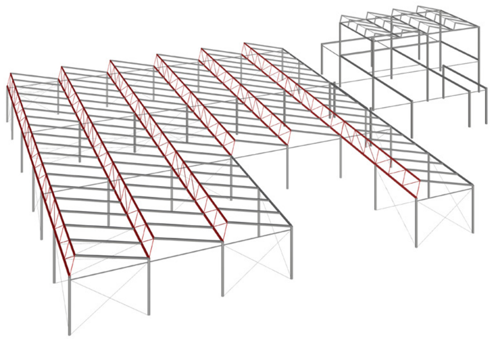
SD.09

Product name and code
TRR - Truss Beam

Use in the project
- Primary support beams
carry TR4 beams (larger shed structure)
carried by the 3.20m PI1 and PI2 columns



Navigator



Loads taken into account
- Net weight
- Permanent load CO3
- Operating load - category H
- Thermal expansion load
- Snow load
- Wind load
  (vacuum pressure)
  (overpressure)
  (lateral pressure)

Beam composition :

Upper chord : Hybox RHS 100x80x5 of 10m

Lower chord : Hybox RHS 120x80x5 of 10m

Post : 7 Hybox SHS 60x60x3 of 1m

Diagonals : 6 T 30x30x4 of 1m90

Product quantity and characteristics
16 Reticular beams in which :
12 inclined at 75° (window view)
4 inclined at 90° (blind view)

L = 1000 cm
h = 122 cm
M = 330 kg

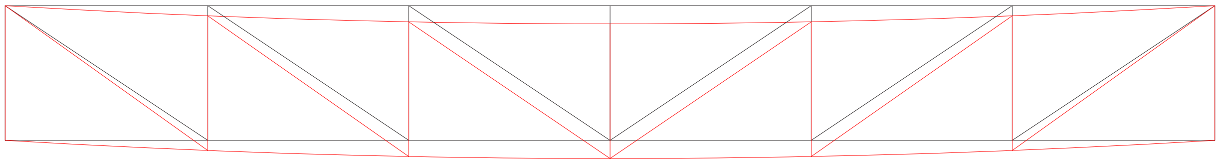
Service limit state (SLS) verifications - upper chord		
Governed by the deflection in the y-direction		
Reference length	L	1000 cm
Limit criterion for deflection	δ_w	300
Total deflection	$w_{tot,y}$	18.5 mm
Deflection limit value	w_{lim}	33.3 mm
Inspection ratio	η	0.555
EN 1993-1-1, 7.2 check	< 1	Verified

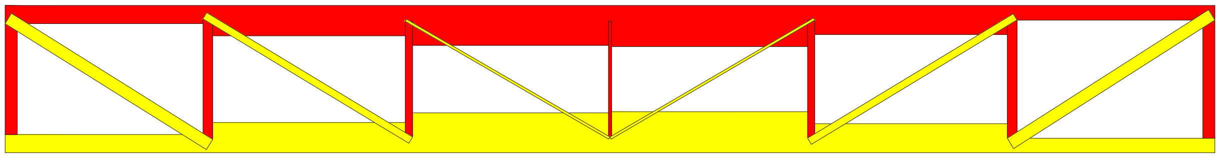
Service limit state (SLS) verifications - lower chord		
Governed by the deflection in the y-direction		
Reference length	L	1000 cm
Limit criterion for deflection	δ_w	300
Total deflection	$w_{tot,y}$	27.4 mm
Deflection limit value	w_{lim}	33.3 mm
Inspection ratio	η	0.823
EN 1993-1-1, 7.2 check	< 1	Verified

Ultimate limit state (ULS) verifications - upper chord		
Governed by axial and shear stresses		
Axial stress	$\sigma_{x,Ed}$	182 N/mm^2
Shear stress	τ_{Ed}	0.9 N/mm^2
Inspection ratio	η	0.438
EN 1993-1-1, 6.2.1(5) check	< 1	Verified

Ultimate limit state (ULS) verifications - lower chord		
Governed by axial and shear stresses		
Axial stress	$\sigma_{x,Ed}$	243 N/mm^2
Shear stress	τ_{Ed}	14 N/mm^2
Inspection ratio	η	0.789
EN 1993-1-1, 6.2.1(5) check	< 1	Verified

SLS vertical deformation diagram and axial forces diagram





Traction

Compression

Product name and code
R - Steel bracings R10 in St Andrew's Cross

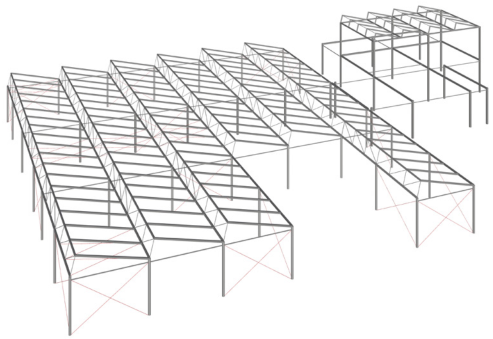
Use in the project
- Cross bracing (horizontal and vertical)

Loads taken into account
- Axial forces only
  (compression or tension)

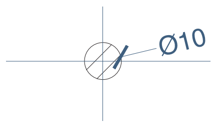
Product quantity and characteristics
Vertical bracings :
15 pairs of chain with cable sling
L = 500 cm to 600 cm, M = 3 kg to 4 kg

Horizontal bracings
10 pairs of chain with cable sling
L = 480 cm, M = 3 kg

Navigator



Section - scale 1:2



Ultimate limit state (ULS) verifications - post		
Yield strength	f_y	275 N/mm²
Axial force	N_{Ed}	43.9 kN
Resistance to axial force	N_{Rd}	182 kN
Inspection ratio	η	0.241
Verifiche EN 1993-1-1, 6.2.4	< 1	Verified

Ultimate limit state (ULS) verifications - diagonals		
Yield strength	f_y	275 N/mm²
Axial force	N_{Ed}	44.1 kN
Resistance to axial force	N_{Rd}	62.3 kN
Inspection ratio	η	0.708
Verifiche EN 1993-1-1, 6.2.4	< 1	Verified

Ultimate limit state (ULS) verifications - vertical bracings		
Yield strength	f_y	275 N/mm²
Axial force	N_{Ed}	16.1 kN
Resistance to axial force	N_{Rd}	21.6 kN
Inspection ratio	η	0.744
EN 1993-1-1, 6.2.4 check	< 1	Verified

Ultimate limit state (ULS) verifications - horizontal bracings		
Yield strength	f_y	275 N/mm²
Axial force	N_{Ed}	11.7 kN
Resistance to axial force	N_{Rd}	21.6 kN
Inspection ratio	η	0.543
EN 1993-1-1, 6.2.4 check	< 1	Verified

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NB : The boards have been made in italian and give a focus on each important part of this Tesi.

The boards provide plans, elevations and sections to scale, while the present document did not manage to respect the scale of each representation.

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