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Master's Thesis

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Risonanza del Suolo

Resonance of the Ground

Politecnico di Milano | School of Architecture, Urban Planning, and Construction Engineering | MSc Architecture - Building Architecture

Risonanza del Suolo

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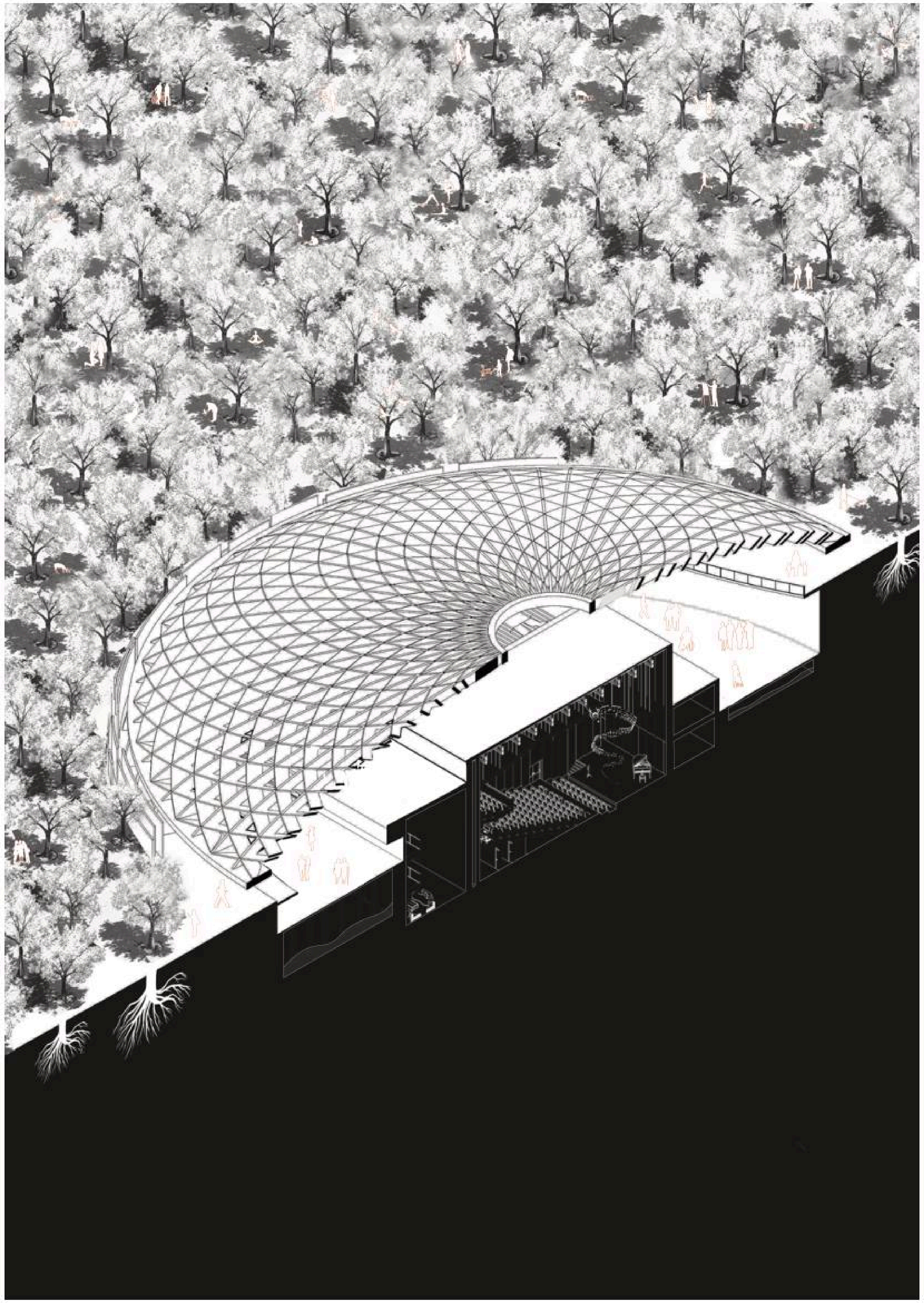

When I moved to Italy from America, I was struck not only by the permanence of its architecture, but by how deeply that permanence shaped the land and the people who lived upon it. The ground itself seemed to carry memory: an archive of voices, layers, and time. This experience became the seed of ***Risonanza del Suolo:*** *a project that listens to the earth, exploring how architecture can be both monumental and alive, both enduring and resonant.*

In an age when architecture is too often reduced to a fast, disposable commodity, this thesis seeks to challenge the culture of speed and surface, proposing a slower, heavier, more permanent architecture - one that values experience over efficiency, atmosphere over spectacle.

This work is less a project and more an experiment in feeling. It explores how sound, darkness, and material can evoke emotion and memory. During this period, perhaps my last true moment of unrestrained experimentation, I allowed myself to push the limits of buildability and logic, to design with curiosity and risk.

I am deeply grateful to the professors, mentors, family, and friends who helped shape this journey, and to those who reminded me that architecture, at its best, is not merely built: it is felt.

Abstract

Risonanza del Suolo (Resonance of the Ground) is a project that descends beneath the surface to rediscover the dialogue between sound, matter, and time. Conceived as a house of music embedded in the earth, it transforms a neglected urban fragment into a site of cultural and ecological renewal. Light filters through a rewilded canopy, breaking the darkness and revealing monumental volumes carved from concrete: raw, heavy, and enduring. Within this subterranean landscape, sound is not merely heard but absorbed and diffused, resonating through the ground as an echo of memory and regeneration. The project proposes an architecture of longevity, one that privileges endurance over novelty, circular systems over artifice, and a reconnection with the living soil. In its depths, Risonanza del Suolo seeks to evoke awe and quiet melancholy: a separation from the noise of the city above, and a return to the slow resonance of the earth itself.

Risonanza del Suolo è un progetto che esplora la relazione tra suono, materia e tempo attraverso un'architettura ipogea dedicata alla musica. Inserito in un contesto urbano marginale, il complesso diventa un centro culturale e paesaggistico capace di rigenerare il suolo e la comunità. La luce filtra dal paesaggio rinselvatichito sovrastante, penetrando in spazi monumentali scavati nella massa del calcestruzzo, grezza e duratura. In questo ambiente sotterraneo il suono non è soltanto percepito, ma assorbito e diffuso, come un'eco della memoria e della rinascita. Il progetto afferma un'etica della longevità e della sostenibilità: privilegia la permanenza alla novità, la circolarità alla finzione, e il ritorno a un rapporto diretto con la terra viva. Risonanza del Suolo invita a un'esperienza di stupore e malinconia, un distacco dalla città superficiale e un ascolto profondo della risonanza del suolo.

Contents

1. Introduction

This chapter establishes the territorial, historical, and institutional context within which the project is situated. It introduces Rogoredo as a marginal yet strategic urban fragment within the metropolitan structure of Milan, shaped by infrastructure, industry, and successive phases of neglect and transformation. Rather than approaching the site as an empty ground for intervention, the chapter frames it as a layered condition, whose physical, social, and cultural characteristics actively inform the project's trajectory.

Rogoredo occupies a critical threshold between the consolidated city and its infrastructural periphery. Historically defined by agriculture and later by heavy industry and logistics, the district developed as a landscape of production rather than representation. As industrial activities declined, large portions of the area were left fragmented, contaminated, and spatially unresolved. Despite its accessibility and proximity to major transport networks, Rogoredo remains weakly integrated into Milan's civic and cultural life, lacking shared spaces capable of fostering collective presence and identity.

This condition of marginality is not solely physical, but perceptual. The absence of cultural infrastructure, coupled with infrastructural barriers and residual land, has contributed to a persistent sense of detachment and avoidance. Rogoredo is often experienced as a place to pass through rather than destination, reinforcing cycles of neglect and underuse. Understanding this condition is essential, as it defines both the challenges and the latent potential of the site.

Within this context, recent planning initiatives mark a significant shift in the area's trajectory. The Bosco della Musica competition represents a decisive moment in Milan's approach to Rogoredo, introducing cultural infrastructure as a catalyst for ecological and social regeneration. By proposing a new music campus embedded within a rewilded landscape, the competition reframes the district as a site of cultural production rather than industrial residue. This framework creates an interesting intersection for the present thesis, situating it within an evolving institutional and urban vision while leaving critical questions unresolved.

The chapter proceeds by examining the site across multiple scales. It first outlines the broader urban and infrastructural context of Rogoredo, before tracing its historical development and the processes that led to its cultural absence. A detailed analysis of the current state follows, identifying the site as a dead zone within the urban fabric, characterised by fragmentation, underuse, and environmental stress. Finally, the planning framework and recent competition proposals are examined to clarify the constraints, opportunities, and gaps that shape the project's field of action.

Together, these sections construct a grounded understanding of Rogoredo not as a neutral backdrop, but as an active condition that demands a response attentive to history, landscape, and collective life. This contextual foundation prepares the ground for the conceptual, landscape, and architectural explorations that follow.

Theme: House of Music

The **House of Music** represents the central theme developed by the Architectural Design Studio for Complex Constructions 2 during the 2024–2025 academic year at Politecnico di Milano.

The studio explored the connection between architecture and reality, using the design of a concert hall as a critical instrument to investigate the cultural, structural, and environmental role of contemporary architecture. At its core, the theme examines how architecture can express the meaning and function of music in society, understanding the concert hall not simply as a building type but as a civic catalyst - a place where art, technology, and collective identity converge. As Nietzsche wrote, "*Without music, life would be a mistake*," and in this sense, the House of Music becomes an emblem of vitality within the urban landscape.

The objective was to conceive spaces that are attractive, emotional, and performative, where architecture itself becomes part of the musical experience. Light, colour, structure, and sound are understood as elements of one composition, recalling Le Corbusier's vision of the Philips Pavilion (1958) as a "*vessel containing the poem,*" in which multiple media are united in an organic synthesis.

Historical and contemporary precedents were analysed to reveal how music architecture can act as a driver of urban transformation. From Adler and Sullivan's Auditorium Building (Chicago, 1889)[3] to Scharoun's Berlin Philharmonie (1963)[1] and Herzog & de Meuron's Elbphilharmonie (Hamburg, 2016)[2], concert halls have often served as catalysts for urban change.

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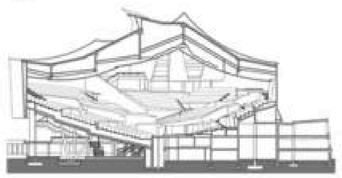

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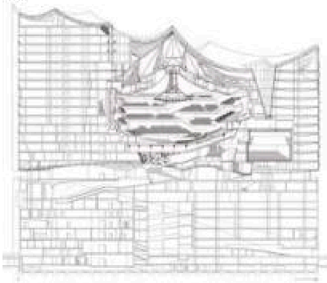

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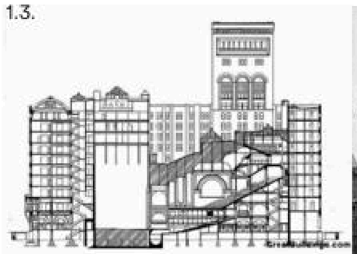


Within the broader urban framework, the theme investigates the relationship between the House of Music and the cityscape. Depending on its setting, the building may be incorporated into the urban fabric, appear as a freestanding object, or exist as a component of the natural or artificial landscape: three attitudes that determine its dialogue with context, scale, and public realm.(Folli, House of Music in Cityscape, 2024)

Finally, the theme integrates issues of environmental sustainability and urban resilience, encouraging architecture that unites form, structure, and technical innovation within a sustainable synthesis. The House of Music becomes both a symbolic and performative organism: an instrument for culture, a catalyst for urban life, and a test ground for the architectural discipline itself.
(Folli, Presentation Studio 2, 2024)

The House of Music theme set a broad disciplinary challenge: to explore architecture as a cultural instrument, a sustainable structure, and a catalyst for urban transformation. Building upon this foundation, the research focuses on four primary questions that guide the thesis across conceptual, spatial, and environmental scales.

Research Questions

I

Urban Catalyst
How can a House of Music act as a driver for urban and ecological regeneration, transforming marginal or post-industrial land into civic infrastructure? (Linked to: "Concert Halls as Catalysts for Urban Change," Folli, 2024)

II

City–Nature Relationship
How can music architecture redefine the boundary between urban fabric and natural systems, establishing continuity between the built and the rewilded environment? (Linked to: "House of Music in the Cityscape," Folli, 2024)

III

Structural and Environmental Synthesis
How can form, structure, and material converge into a sustainable synthesis that balances technical performance with expressive meaning? (Linked to: "Sustainable Technology and Materials," Folli, 2024)

IV

Experiential and Acoustic Space
How can the spatial, acoustic, and sensorial experience of a concert hall evoke resonance, emotion, and collective memory? (Linked to: "The Space of the Music," Folli, 2024)

Urban Context and Site Conditions

The Metropolitan Edge
Rogoredo, Milan marks one of the outer thresholds of Milan, a fringe zone where the city's grid begins to dissolve into infrastructures, wastelands and spontaneous vegetation. Situated roughly 6-7 km south-east of the Duomo, the area lies at the intersection of major rail corridors, highways and industrial platforms (Seat61, 2024; FS Italiane, 2024).

Historically, Rogoredo developed as a small rural settlement along the ancient Via Aemilia, later absorbed by Milan's twentieth-century expansion. The district retained its peripheral identity even after the major annexations of the early 1900s, when rural land south of Porta Romana and Chiaravalle was integrated into the growing metropolitan area (Comune di Milano, 2023).

This early-twentieth-century photograph shows the historic core of Rogoredo along the Vettabbia canal, when the area was still a rural hamlet south of Milan. The name Rogoredo derives from the Latin robur, meaning oak, a reference to the wooded landscape that once surrounded the village. Before industrialisation, the canal supported agriculture and small crafts, defining a close relationship between land, water, and community. The image captures a moment before transformation - when Rogoredo was still a landscape of continuity rather than fragmentation (I Borghi di Milano, 2022).

From the late nineteenth century onwards, Rogoredo underwent rapid industrialisation. The construction of railway infrastructure and tram connections to Lodi attracted large factories, including steel production and chemical industries, which anchored the district within Milan's productive belt. Over time, logistics depots and warehouses replaced much of the original settlement


1.4


1.5

pattern, leaving a fragmented territory marked by infrastructure and heavy industry. The Milano Rogoredo railway station, originally established as a freight yard and later expanded for passenger service, consolidated the area's infrastructural identity. Today it functions as one of Milan's principal southern gateways, connecting high-speed national lines with regional and suburban routes (Seat61, 2024; FS Italiane, 2024).

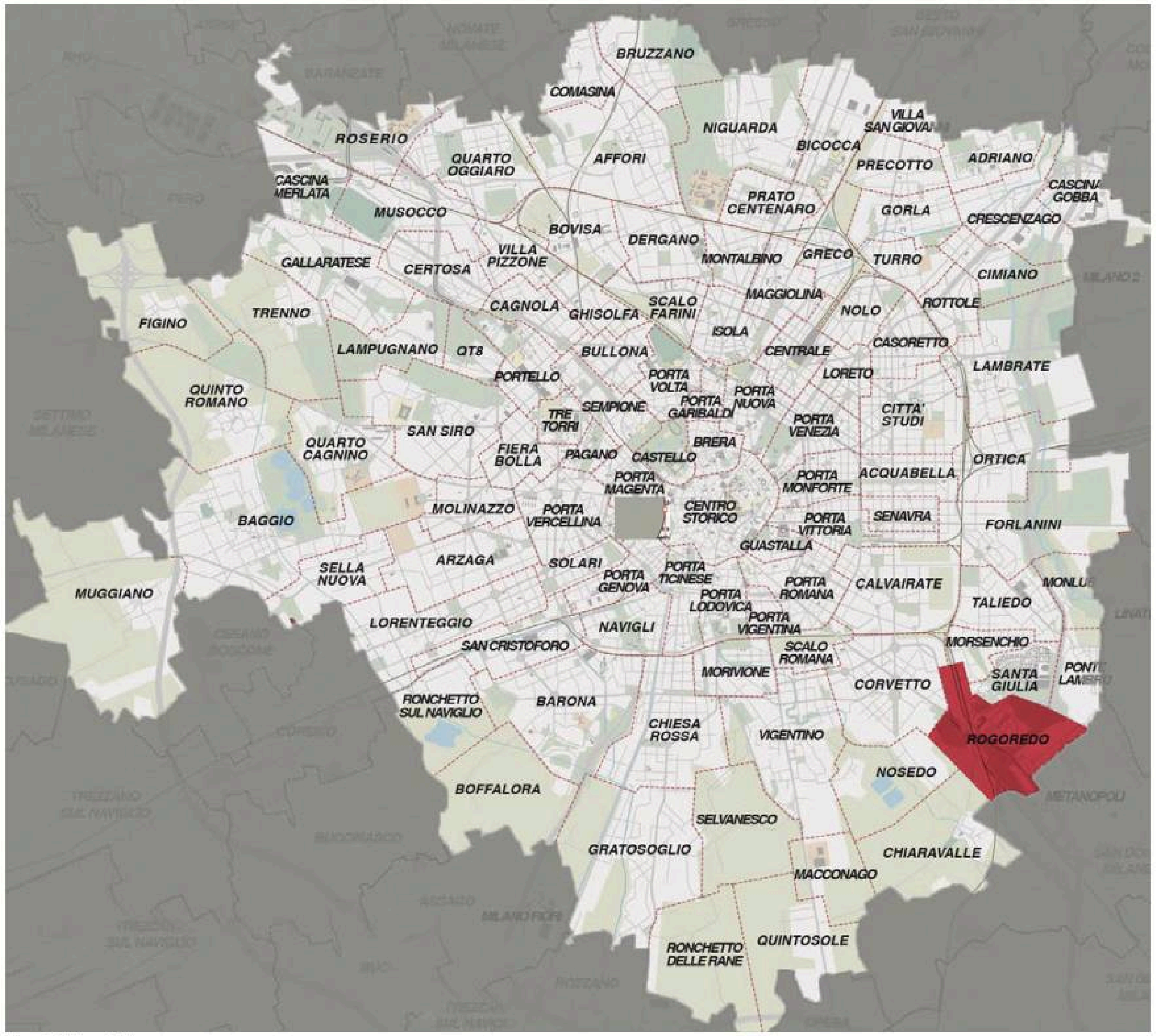


Figure 1.6: Map of Milan

Urban Context and Site Conditions

The Post-Industrial Landscape
Rogoredo's landscape bears the stratified marks of Milan's post-war industrial boom and its later decline. The district's physical identity was shaped by steel production, logistics, and chemical industries whose spatial footprints remain visible in the large blocks of impermeable ground and residual voids that stretch between the rail lines and the A1 motorway (SmartCitiesDive, 2021).

As factories closed during the 1980s and 1990s, the terrain was left contaminated and unsettled. Asphalted lots, concrete platforms, and fenced compounds fragmented the urban fabric, creating a mosaic of disconnected surfaces (Comune di Milano, 2023).

Yet over time, abandonment allowed a new ecological layer to emerge. Spontaneous vegetation colonised the brownfields - pioneer species like birch, reed, and buddleia transforming derelict land into informal green corridors. These unplanned ecologies now extend toward the Parco Agricolo Sud Milano, hinting at a latent continuity between the infrastructural city and the rewilded periphery (Boeri, 2019).

Sound and movement animate this transitional ground: the constant rhythm of trains, the hum of highway traffic, and the rustling of vegetation. Rogoredo becomes a palimpsest of energy, where nature re-enters the industrial body of the city.

For Milan, such sites represent both a challenge and an opportunity: how to remediate contaminated soils while preserving the accidental ecologies that now thrive there. The district's open surfaces offer a testing ground for urban re-naturalisation, where landscape and infrastructure may coexist rather than compete.

Figure 1.8: Via Giovanni Battista Cassinis

Figure 1.9: Via Pietro e Giuseppe Pestagalli

Figure 1.10: Via Francesco Pizzolpasso

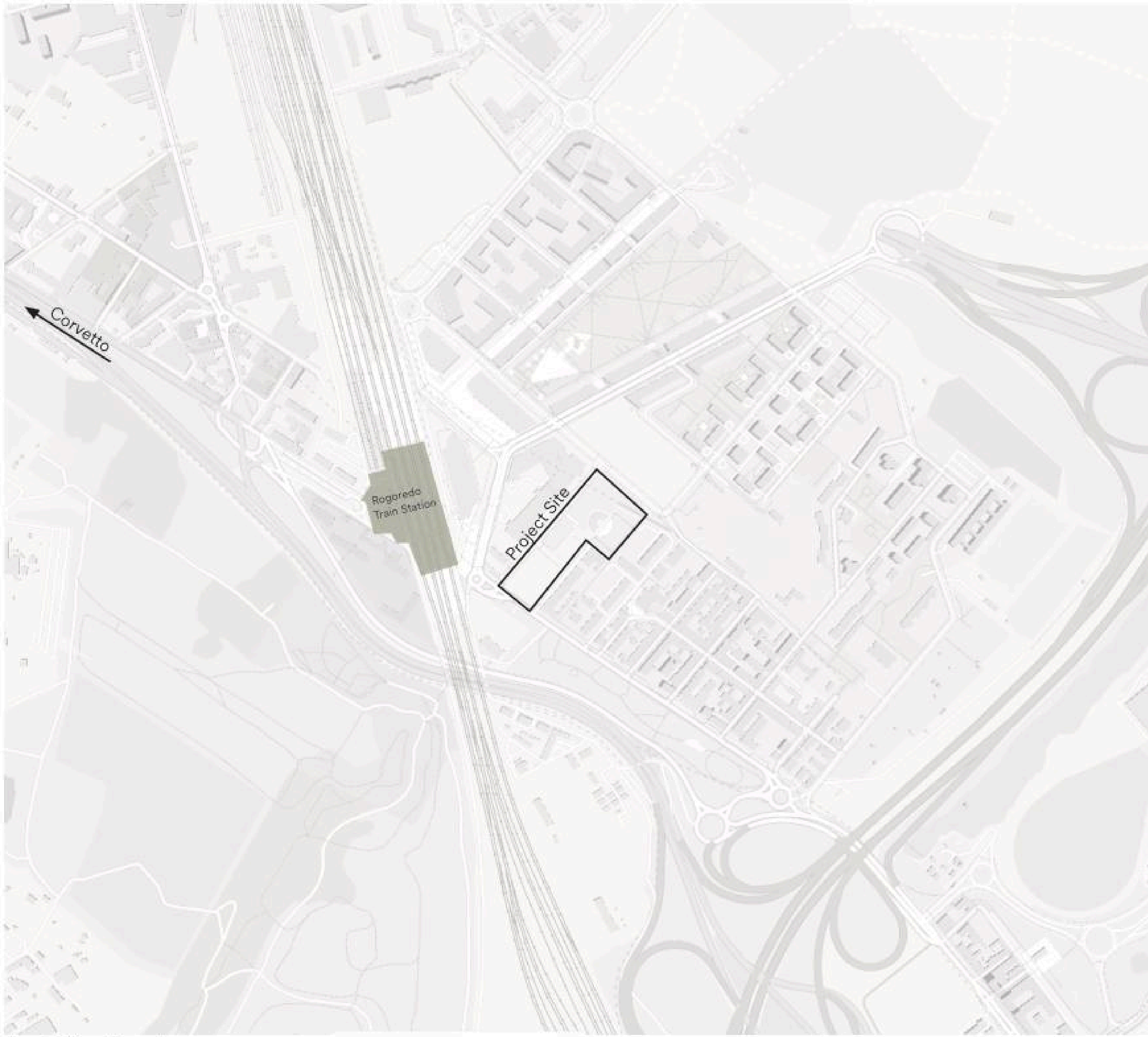


Figure 1.7: Map of Rogoredo

Urban Context and Site Conditions

Site Conditions
Rogoredo's ground tells the story of Milan's industrial century. Beneath its asphalt and rail embankments lie layers of compacted fill, residual contaminants, and traces of former factories. Environmental surveys conducted across the Municipio 4 and Santa Giulia - Rogoredo areas describe soils affected by hydrocarbons, heavy metals, and construction debris, a legacy of intensive industrial and logistic activity (Comune di Milano, 2023; ARPA Lombardia, 2024). These sealed surfaces, designed for production and transport, now form impermeable islands that prevent ecological exchange and water absorption.

Where the industrial crust has fractured, vegetation has begun to return. The spontaneous landscape that now occupies the voids between rail lines and warehouses follows the logic of disturbance: pioneer species such as birch, poplar, and buddleia colonise compacted soils, stabilising dust and initiating a slow process of re-naturalisation. Along drainage canals and embankments, reeds and grasses have created informal green corridors connecting the district to the Parco Agricolo Sud Milano (Boeri, 2019). These emerging ecologies coexist with fragments of planned green infrastructure, the linear parks of Santa Giulia and the perimeter planting around the rail yards, forming a hybrid landscape of resilience and adaptation.

The human layer mirrors this transitional condition. The Rogoredo - Santa Giulia area counts roughly 12,000 residents, a population that has grown slowly with new housing projects yet remains diverse in composition (Comune di Milano, 2023). Older working-class families live alongside younger households drawn by improved transport connections and lower rents compared to central districts. Despite redevelopment, Rogoredo still carries a reputation for isolation, marked by the physical barriers of rail infrastructure and the memory of its marginal past (Stefanizzi & Verdolini, 2022).


Figure 1.11: Giuseppe & Fratello Redaelli Polisportiva

Today, Rogoredo stands as a layered terrain: geologically, ecologically, and socially. The sealed soils of the industrial age coexist with spontaneous vegetation and new residential enclaves. Beneath these surfaces lies both contamination and potential: the capacity for remediation, re-vegetation, and renewed civic life. For the House of Music, this complexity defines the site's depth - an acoustic and material foundation from which the architecture must listen, filter, and respond.

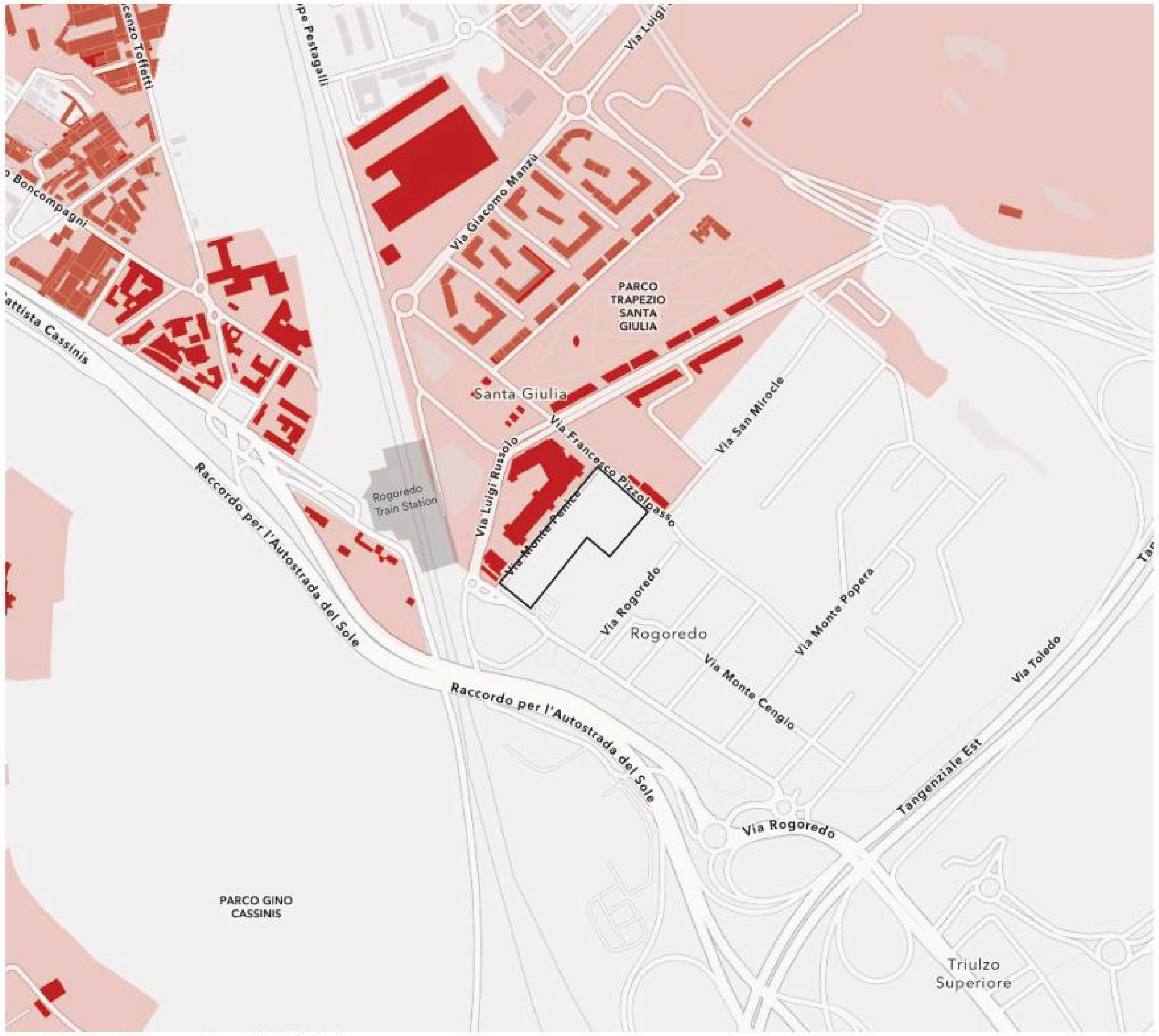


Figure 1.12: Rogoredo: Former and Current Industrial Lands

Current State and Site Analysis

Site Conditions

The site currently exists as a dead zone within the urban fabric. Although it remains physically present and clearly legible in plan, it no longer performs any meaningful urban function. It operates neither as a destination nor as a connective space, and its role within the city has been reduced to that of a residual condition. Viewed through satellite imagery, the site reads as a void produced by surrounding development rather than by intentional planning. Its geometry and boundaries are the result of subtraction and leftover space, shaped by adjacent construction and infrastructural decisions rather than by spatial coherence. Despite its centrality and proximity to active urban programs, the site remains disconnected.

At ground level, this condition is clear. The physical state of the site is defined by neglect, deterioration, and spatial ambiguity. Surfaces are uneven and unresolved, bearing signs of weathering, erosion, and prolonged lack of maintenance. Existing built elements appear fragmented and incomplete, suggesting previous occupation or use without offering any present function. These remnants do not operate as architectural features or historical markers. Instead, they persist as inert objects within the space, contributing to a sense of abandonment rather than continuity. There is no discernible hierarchy of spaces, no articulated sequence of movement, and no clear points of access or entry.

The relationship between the site and its surrounding urban context further reinforces its condition as a dead zone. Adjacent buildings engage the site passively, treating it as a buffer or leftover surface rather than as an active frontage. Edges remain undefined and unarticulated, offering no spatial invitation or visual connection. Pedestrian movement in the surrounding area bypasses the site entirely. Circulation flows around its perimeter, reinforcing its role as an interruption rather than a connector within the urban network. Rather than contributing to continuity within the city, the site functions as a spatial gap that disrupts movement and perception.

Use of the site is minimal and largely unofficial. Now, there is no formal program or sustained occupation. There are no actions to activate the space or establish social meaning. This highlights the absence of care, management, and intention. The site remains unprogrammed and unmanaged, existing outside both public and private domains. Such conditions reflect broader urban processes in which spaces of indeterminacy are produced and sustained through neglect and regulatory inaction (Stefanizzi and Verdolini, 2022).

This condition is not incidental. Planning constraints, regulatory inertia, and the absence of a coherent development strategy have rendered the site functionally inert. Rather than enabling meaningful use or transformation, existing frameworks have allowed neglect to persist as the default condition. Over time, this has normalized the presence of a non-functional urban fragment within an otherwise active city.

The problem, therefore, is not vacancy alone. It is the sustained acceptance of a dead zone within the urban fabric. The site remains an unresolved fragment that absorbs space, memory, and potential without offering use, meaning, or presence in return.

Figure 1.13-16: Images from winning project

Planning Framework

"Il Bosco della Musica" Competition

The Bosco della Musica competition represents a turning point in the recent planning vision for Rogoredo and the southern districts of Milan. Launched in 2022 by the Conservatorio di Milano "Giuseppe Verdi", the competition sought proposals for a new campus integrating an auditorium, teaching facilities, housing, and public green space (Concorrimi, 2022; Domus, 2022). The site, located near the Milano Rogoredo station and adjacent to the Santa Giulia redevelopment, was chosen precisely for its marginal and infrastructural condition - an area historically defined by industry and transport rather than culture. The brief emphasised the transformation of this terrain into a new urban forest and civic hub, reconnecting the periphery with Milan's cultural network (The Plan, 2023).

The winning proposal by Settanta7 Architects interprets the campus as a porous and permeable system: a constellation of pavilions embedded within a continuous green surface. The project merges education, music, and landscape under the concept of a "forest of sound" (bosco sonoro), where architecture dissolves into the rhythm of vegetation (Domus, 2022; The Plan, 2023). Through its open courtyards and accessible ground floor, the scheme aims to extend cultural life beyond the Conservatorio's walls, offering public space for performance, leisure, and encounter (3Ti Progetti, 2022).

The competition's sustainability strategy aligns with Milan's contemporary planning priorities: reduction of sealed surfaces, soil remediation, and enhancement of biodiversity. The project proposes an integrated landscape of native species, bioswales, and shaded pedestrian routes, echoing the Piano del Verde e della Biodiversità of the Municipality of Milan (Comune di Milano, 2023). At an infrastructural scale, it links directly to Rogoredo station, supporting intermodality and accessibility for both students and the wider public (FS Italiane, 2024).

Culturally, the Bosco della Musica marks a decisive shift: it introduces a major institution into an area historically deprived of civic and artistic facilities. Rogoredo, once associated with marginality, is reframed as a gateway for Milan's new cultural geography. For the House of Music, this framework provides both precedent and context - evidence that the city's regeneration is moving toward cultural infrastructure as a catalyst for ecological and social renewal.

1. Introduction

Figure 1.17-20: Images from winning project

2. The Conceptual Descent

This section establishes the conceptual and ethical framework through which the project is understood and developed. While the preceding chapters defined the urban context, historical conditions, and spatial absence that characterise the site, this chapter articulates the project's foundational position on architecture, experience, and duration. Rather than advancing a formal or programmatic proposal, the chapter defines the principles that guide how the project engages ground, sound, time, and collective presence.

The project approaches architecture not as a dominant object within the city, but as a condition embedded within it. In contexts shaped by stigma, marginality, and perceived danger, architectural visibility often reinforces separation rather than belonging. This chapter therefore introduces a logic of descent, in which architecture withdraws from prominence and operates through depth, atmosphere, and continuity. Architecture is understood as something encountered gradually, through experience and duration, rather than through immediate visual legibility.

Within this framework, resonance becomes a central conceptual lens. Resonance is understood not only in acoustic terms, but as the capacity of space to register presence, accumulate memory, and support shared experience over time. Sound, matter, and mass are approached as inseparable elements, shaping how architecture is felt rather than seen. By situating the primary architectural intervention within the ground, the project establishes a condition in which resonance anchors activity without overwhelming the landscape above.

The chapter further articulates an ethic of permanence that resists both monumentality and temporariness. Permanence is not understood as fixity or formal closure, but as the ability to endure, adapt, and remain relevant across changing social and environmental conditions. This position challenges short-term or event-driven interventions often deployed in marginal urban contexts, proposing instead a sustained presence grounded in care, repetition, and stewardship. Permanence is not a modern trend, but should be when considering environmental stewardship as well as economy.

Finally, the section introduces the spatial narrative that structures the project's experiential logic. Movement is conceived as a sequence of approach, descent, immersion, and return, privileging slowness, pause, and sensory awareness over efficiency or spectacle. Through this narrative, architecture operates as a mediator between ground and surface, sound and silence, withdrawal and re-entry.

Together, these conceptual positions establish the intellectual ground from which the project emerges. The following sections elaborate on architecture as resonance, the ethics of permanence, and spatial narrative, forming a coherent framework that informs the spatial and ecological strategies developed in subsequent chapters.

Architecture of Resonance

The project is grounded in the idea of architecture as a resonant condition rather than a dominant object. In contexts marked by stigma and perceived danger, architectural visibility often reinforces separation rather than belonging. This project therefore rejects the logic of iconic assertion and instead operates through descent, embedding its primary architectural intervention within the ground.

Resonance is understood here in multiple registers. Physically, it refers to the capacity of architecture to engage sound, vibration, and mass, allowing space to be felt rather than merely seen. Culturally, resonance describes the ability of a place to register collective presence over time, to accumulate memory, and to support shared experience without relying on constant activation or spectacle. By situating the music hall below ground, architecture becomes a quiet core, one that anchors activity without dominating the landscape above.

This approach directly responds to the condition of Rogoredo as a fragmented and marginal urban edge. Rather than attempting to correct stigma through surveillance, density, or commercial program, the project proposes architecture as a stabilizing presence that invites gathering through atmosphere, depth, and continuity. The ground itself becomes an active participant, capable of sheltering sound, hosting memory, and supporting life above.

Sound operates as a primary driver of the project's conceptual logic. Rather than treating acoustics as a technical requirement, the project understands sound as material, inseparable from the ground that contains and shapes it. By carving the music hall into the earth, sound is absorbed, reflected, and held within mass, allowing architecture to engage the city through resonance rather than noise.

Materiality is therefore approached not only in terms of structure and durability, but in relation to acoustic behavior and memory. Dense materials temper vibration, while voids allow sound to circulate and linger. Over time, repeated use, performance, and gathering inscribe memory into the space, allowing architecture to function as a cultural archive rather than a neutral container.

This relationship between sound, matter, and memory is particularly significant in a context defined by absence. In Rogoredo, the lack of shared cultural spaces contributes to isolation and stigma. By centering sound as a collective experience, the project proposes an alternative mode of presence, one that privileges listening, gathering, and duration over consumption and throughput. Architecture becomes a medium through which collective life is reintroduced gradually and sustainably.

2. The Conceptual Descent

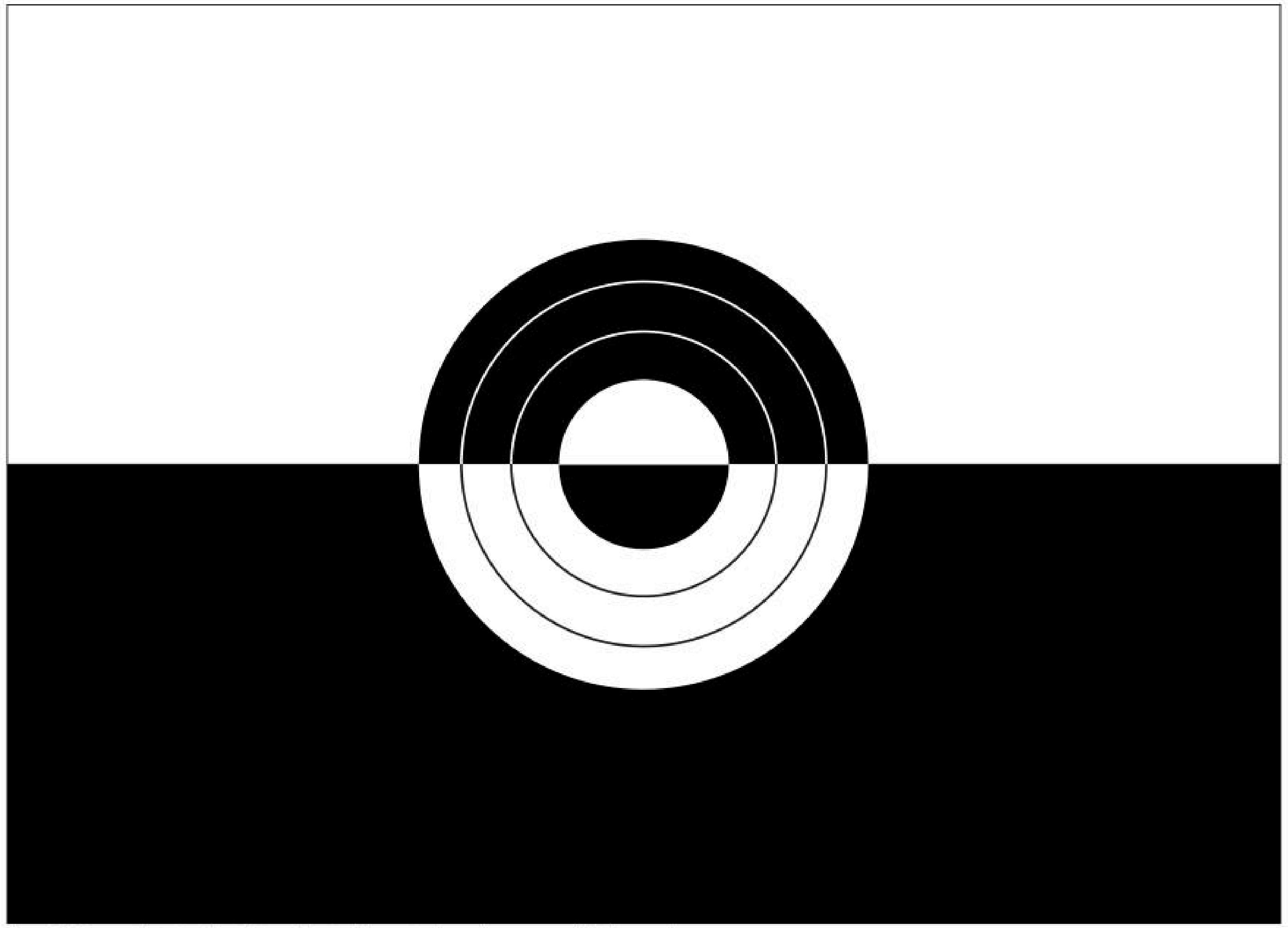


Figure 2.1: Conceptual section illustrating architectural descent and sound resonance within the ground.

Ethics of Permanence

The project is guided by an ethic of permanence that resists both monumentality and temporariness. In areas shaped by neglect and deferred investment, short-term interventions often fail to establish trust or continuity, producing moments of visibility without lasting presence. Such approaches risk reinforcing instability by treating marginal urban spaces as sites of experimentation rather than commitment. This project instead understands permanence as a form of responsibility, one that accepts duration, care, and long-term presence as essential architectural values.

Permanence is not conceived as fixity or formal closure, but as the capacity to endure, adapt, and remain relevant over time. Rather than seeking to impose a final image, the project establishes conditions capable of supporting change without erasure. Architecture is therefore understood as a stabilizing framework rather than a completed object, allowing the life of the site to unfold gradually within a coherent and supportive structure.

This ethic is expressed spatially through embedding rather than visual dominance. Architecture is placed within the ground, establishing a stable and protected condition, while the surface is left available for gradual change, growth, and reappropriation. Landscape is allowed to evolve, accepting uncertainty and variation as integral qualities rather than design failures. Seasonal rhythms, ecological succession, and informal patterns of use are understood as constructive forces, aligning architectural intervention with ecological time and long-term stewardship.

The ethic of permanence also operates at a social level. In stigmatized urban zones, trust cannot be produced instantaneously. It emerges through repetition, familiarity, and the sustained presence of shared spaces. By prioritizing non-commercial, collective environments and cultural gathering, the project seeks to counter cycles of abandonment and mistrust without relying on control or constant programming. The objective is not rapid activation, but continuity, allowing relationships between people and place to form over time.

Through this approach, permanence becomes an ethical position rather than a formal outcome. Architecture and landscape act together to anchor memory, support evolving forms of public life, and resist the erasure that often accompanies redevelopment. The site is not treated as a temporary intervention or experimental ground, but as a long-term commitment within the city, capable of accumulating meaning through care, use, and duration.

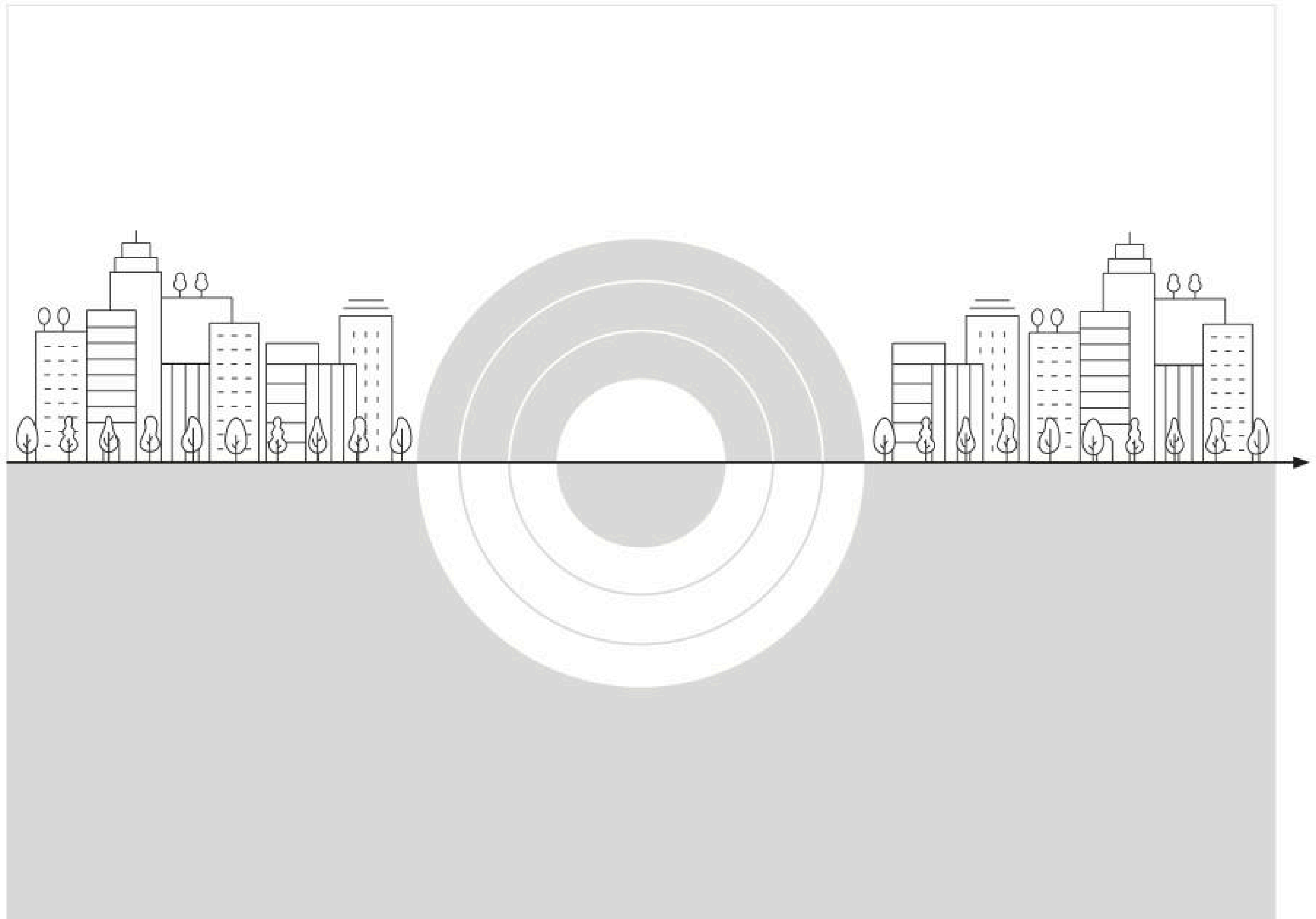


Figure 2.2: Conceptual diagram expressing permanence as an ethical commitment to duration, care, and continuity beneath evolving urban conditions.

Spatial Narrative

The project is structured as a spatial narrative defined by transition rather than destination. Movement through the site is conceived as a sequence of approach, descent, immersion, and return, encouraging a shift in perception rather than immediate consumption. This narrative resists speed and efficiency, instead privileging slowness, pause, and sensory awareness.

Arrival occurs within the landscape, where architecture remains largely invisible. The surface is encountered first as continuous ground rather than as a formal threshold, allowing entry without spectacle or clear demarcation. This condition maintains continuity with the surrounding urban fabric and establishes a sense of openness and accessibility. Movement across the landscape is guided subtly, encouraging attentiveness and gradual engagement rather than directed circulation.

The descent into the music hall marks a transition from openness to enclosure, from diffuse urban sound to focused resonance. As the visitor moves downward, the relationship between body, ground, and sound begins to shift. Light becomes more controlled, external noise is filtered, and the spatial atmosphere tightens, producing a heightened awareness of material, volume, and acoustics. This moment of descent operates as a spatial pause, separating the experience below from the intensity of the city above without fully severing their relationship.

Immersion occurs within the embedded architectural core, where sound, mass, and space converge. Here, architecture is not encountered visually as form, but sensorially through resonance, duration, and collective presence. The space encourages stillness and shared attention, allowing experience to unfold over time rather than through movement alone. This condition forms the experiential center of the project, anchoring the narrative through depth rather than visibility.

Emerging again to the surface, visitors re-enter the city through a space shaped by calm, continuity, and shared presence. The return is not abrupt, but gradual, allowing the memory of the subterranean experience to linger. The landscape above is no longer neutral ground, but carries the imprint of what has occurred below. This sequence establishes a reciprocal relationship between ground and surface, architecture and landscape, sound and silence.

The spatial narrative reinforces the project's conceptual goals. It allows architecture to operate as a mediator rather than a destination, supporting collective experience without imposing form or program. By structuring experience through transition and return, the project resists consumption and spectacle, instead fostering familiarity, repetition, and duration. In doing so, it prepares the ground for the spatial and ecological strategies developed in the following section.

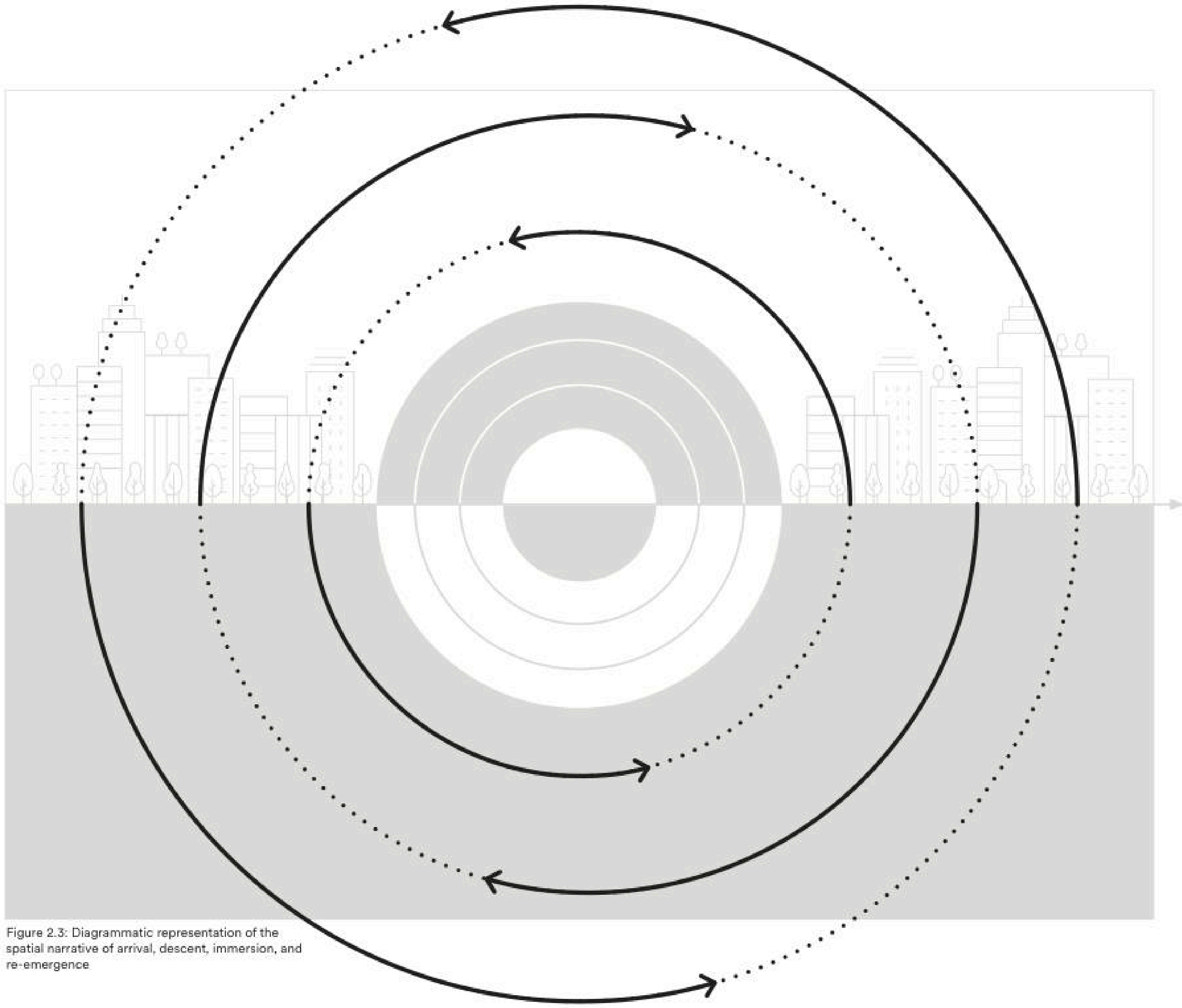


Figure 2.3: Diagrammatic representation of the spatial narrative of arrival, descent, immersion, and re-emergence

3. The Rewilded Landscape

This section translates the conceptual and ethical positions established in the previous chapters into a spatial and ecological framework. If the previous chapters defined the project's stance on resonance, permanence, and experience, this chapter addresses how these principles are grounded in the landscape as the primary medium of urban repair. The intervention is conceived not as an architectural object placed within a site, but as a reconfiguration of land itself, through which spatial continuity, ecological processes, and collective presence are reintroduced.

The project adopts landscape as its first and most fundamental act. In a context marked by fragmentation, neglect, and infrastructural separation, landscape operates as connective tissue rather than decoration. It absorbs discontinuities, accommodates uncertainty, and supports change over time. ***This approach aligns with the thinking of Gilles Clément, particularly his concept of the Third Landscape, which identifies residual, marginal, and undefined spaces as critical reservoirs of ecological and cultural potential.*** Rather than seeking control or formal completion, the project embraces indeterminacy, allowing natural processes to regain agency within the urban fabric.

Within this framework, rewilding is understood not as aesthetic naturalisation, but as a strategic act of urban healing. The landscape is allowed to emerge gradually through succession, seasonal rhythms, and informal use, guided rather than designed. Maintenance gives way to stewardship, and growth is valued as a process rather than a finished image. This position challenges conventional models of urban green space, which often prioritise order, visibility, and immediate legibility over long-term resilience (Clément, 2014).

A central operation of the project is the combination of two fragmented plots into a single continuous landscape system. Through the establishment of a green belt, the site is no longer read as isolated parcels, but as part of a unified ecological and spatial framework. This landscape continuity operates across infrastructural and urban boundaries, transforming separation into connection and redefining the area as a coherent ground condition rather than a collection of residual spaces.

By foregrounding landscape as structure, the project establishes the conditions within which architecture can later operate as a secondary and embedded intervention. The rewilded landscape performs the primary work of reconnection, remediation, and presence, preparing the ground for architectural insertion rather than being shaped around it. In this sense, landscape is not the setting for the project, but its foundational logic.

The following sections detail this approach through a landscape strategy informed by the Third Landscape, the spatial recomposition of the site into a continuous green framework, and the ecological cycles that govern planting, growth, and stewardship. Together, they demonstrate how rewilding functions as both a spatial and ethical response to urban fragmentation.

Landscape Strategy

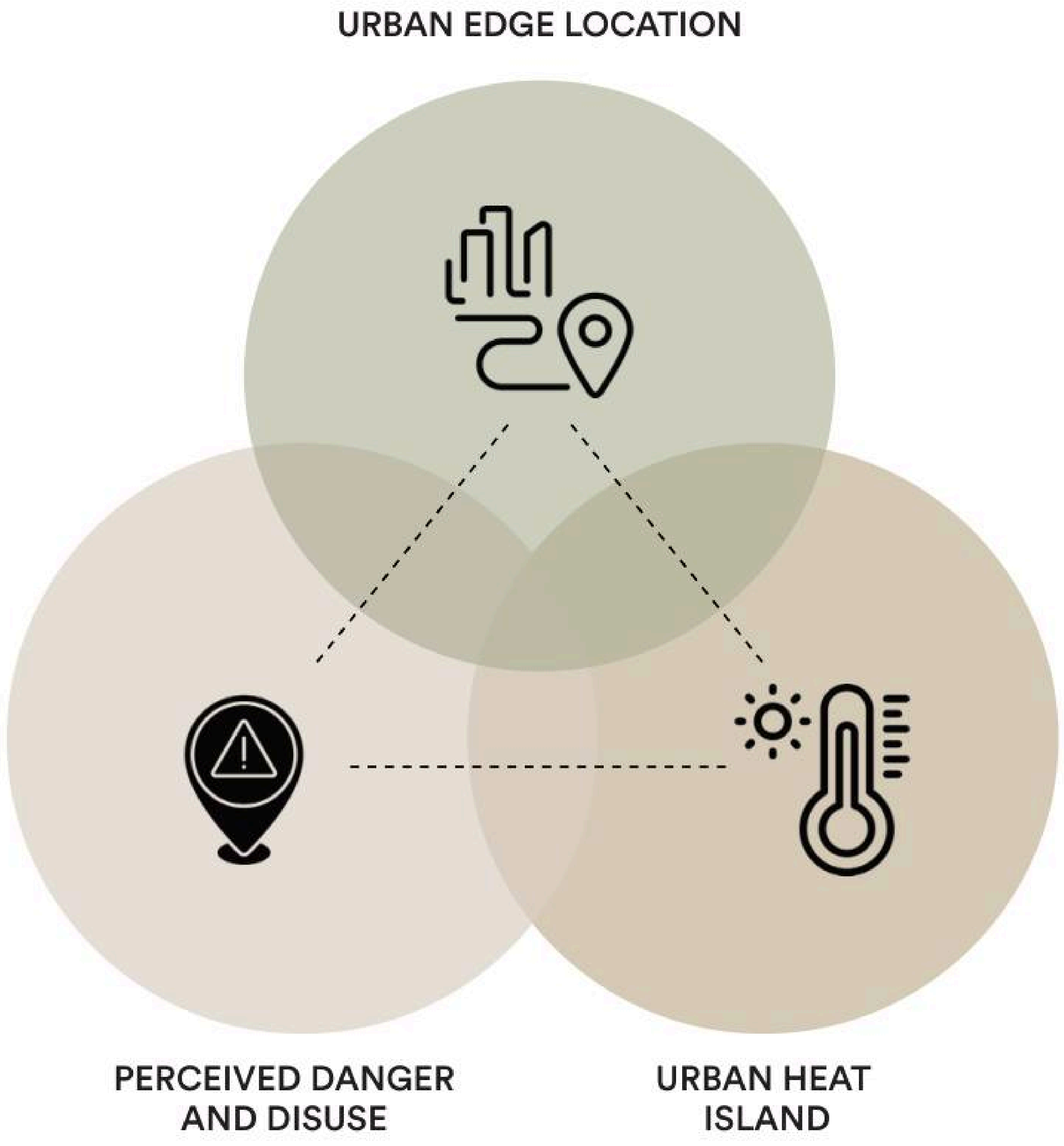
Drivers of the Landscape Strategy
The landscape strategy emerges in response to a set of interrelated social, environmental, and spatial conditions that shape both perception and use of the site. These conditions do not operate independently, but reinforce one another through fragmentation, neglect, and the absence of continuity. Together, they establish the need for an intervention that operates at the scale of land rather than object.

A primary driver of the project is the condition of perceived unsafety associated with spatial absence. In Rogoredo, large open areas, infrastructural edges, and residual land are avoided not because of inherent danger, but because they lack everyday presence, legibility, and continuity. Spaces that are disconnected or underused foster mistrust and avoidance, reinforcing cycles of abandonment. The project therefore understands safety not as a matter of control, surveillance, or intensive programming, but as a consequence of collective presence sustained over time. Safety is approached as an emergent quality, produced through continuity, familiarity, and repeated use rather than imposed through design measures.

Closely linked to this condition is the environmental stress generated by the urban heat island effect. Extensive sealed surfaces, limited canopy cover, and fragmented green spaces contribute to elevated temperatures and thermal discomfort, particularly during warmer periods. These conditions discourage lingering and further reduce occupation of open space, intensifying perceptions of hostility and exclusion. Urban heat is therefore understood not only as an environmental issue, but as a social barrier that directly affects accessibility, comfort, and patterns of use.

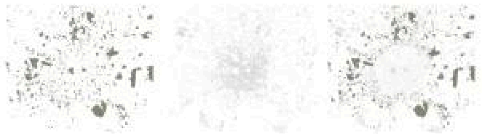
Both perceived unsafety and environmental stress are amplified by the spatial fragmentation of the site. Infrastructural corridors, isolated plots, and discontinuous open spaces prevent the formation of a coherent landscape system capable of supporting ecological processes and everyday activity. Fragmentation limits the capacity of green spaces to function ecologically and socially, reducing their ability to moderate microclimate, support biodiversity, or attract sustained public presence.

These conditions position landscape as the primary medium through which the project responds. Rather than addressing each issue separately, the landscape strategy seeks to operate simultaneously across social and environmental scales. By restoring continuity, increasing ecological presence, and enabling gradual reoccupation, landscape becomes an active form of urban infrastructure. It establishes the conditions necessary for comfort, safety, and collective use to emerge over time, preparing the ground for subsequent spatial and architectural interventions.



3. The Rewilded Landscape

UNDERSTANDING THE CITY



DISCONNECTED GREEN SPACES | PERIPHERAL EDGE GROWTH | UNSAFE URBAN EDGES

Milan's contemporary growth is shaped by disconnected green spaces, unsafe urban edges, and peripheral development across residual land. While these processes increase density and accommodate demand, they often fail to establish continuous public landscapes capable of mitigating environmental stress. The absence of connected green infrastructure intensifies the urban heat island effect and limits access to shaded, breathable public space, contributing to fragmented and insecure environments with reduced opportunities for collective life.

Rogoredo exemplifies these conditions at the urban periphery, where major infrastructure, former industrial land, and recent development coexist without spatial or social continuity. Despite its strategic location within Milan, Rogoredo remains characterised by fragmented open space, limited public amenities, and a perception of insecurity that restricts everyday use and collective presence.

Within this context, the project positions itself as a landscape-led response to the spatial and social fragility of Rogoredo. Rather than introducing a new object or isolated programme, the intervention operates by reconnecting land, cooling the urban environment, and re-establishing conditions for safe and continuous public use. Through the creation of a rewilded green framework, the project addresses the urban heat island effect while transforming a historically unsafe area into an active and accessible public landscape. By prioritising open space, visibility, and everyday occupation, the proposal seeks to shift Rogoredo's perception from marginal territory to shared ground, supporting long-term ecological repair and collective life within the broader structure of Milan.

+ CHALLENGES ?

ADDRESSING THE URBAN HEAT ISLAND EFFECT WHILE SUPPORTING OUTDOOR USE.

TRANSFORMING A HISTORICALLY UNSAFE AREA INTO ACTIVE PUBLIC SPACE.

Landscape Strategy

The Landscape Strategy

The landscape strategy is informed by the work of Gilles Clément, and in particular by his concept of the Third Landscape, which identifies residual, marginal, and undefined spaces as critical reservoirs of ecological and cultural potential (Clément, 2004). Rather than viewing such spaces as failures of planning or gaps to be filled, the Third Landscape recognises their capacity to support biodiversity, adaptation, and informal use precisely because they escape strict control and formal design.

Within this project, the Third Landscape is not applied as a literal condition of non-intervention. Instead, it operates as a guiding ethic that informs how landscape is allowed to behave over time. The project adopts Clément's emphasis on indeterminacy, succession, and ecological agency, while acknowledging the necessity of care, access, and stewardship within an urban context. This interpretation positions rewilding not as abandonment, but as a calibrated withdrawal of control, allowing natural processes to regain agency without disengaging from social life.

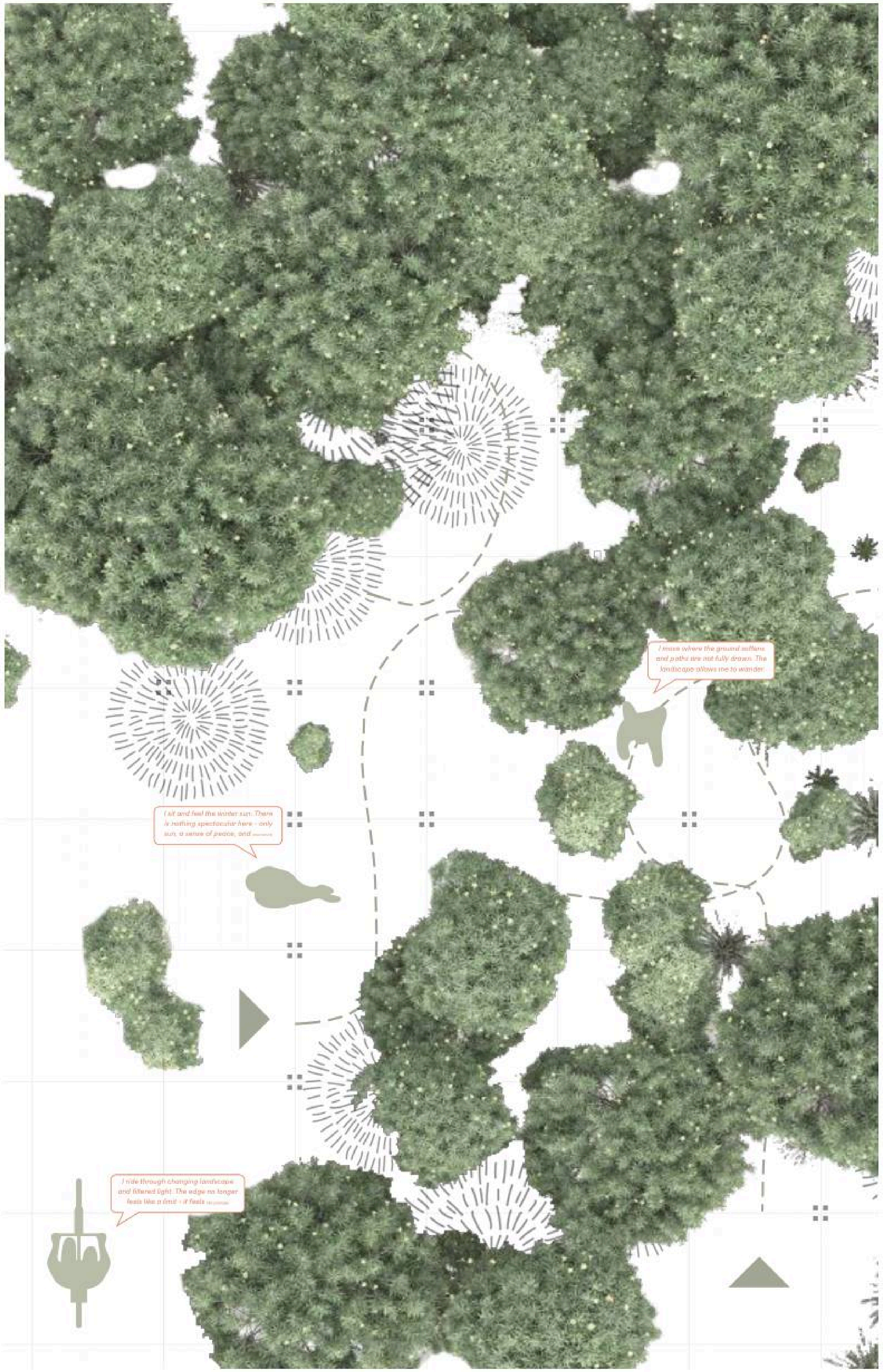
Rewilding is therefore understood as a strategic act rather than an aesthetic one. The landscape is conceived as a living system that evolves through seasonal rhythms, spontaneous growth, and gradual succession. Design operates through guidance rather than prescription, establishing conditions in which vegetation, soil, and water can respond to environmental stress while accommodating informal and unprogrammed use. Upkeep shifts from control toward stewardship, accepting variation and change as integral qualities rather than failures of design (Clément, 2014).

This approach directly addresses the drivers identified in the previous section. By increasing ecological presence and allowing landscape continuity to emerge, ***rewilding contributes to microclimatic moderation***, reducing thermal stress associated with sealed and exposed surfaces. At the same time, the gradual occupation of the landscape through shade, comfort, and informal gathering supports everyday presence, countering the perception of unsafety associated with spatial absence. Safety and comfort are not imposed outcomes, but emergent conditions produced through continuity, familiarity, and repeated use.

The Third Landscape also reframes the role of public space within the project. Rather than prioritising clearly defined programs or intensive activation, the landscape supports a range of overlapping uses that evolve over time. Open, unprogrammed spaces allow for appropriation by different groups, fostering intergenerational interaction and shared ownership. In this sense, ***the landscape operates as a social infrastructure as much as an ecological one, supporting collective life without relying on constant management or spectacle.***

This strategy places the landscape as a core structure of this project. Architecture is not the organising element, but a secondary and embedded intervention that responds to the conditions established by the land. By allowing the landscape to absorb fragmentation, moderate environmental extremes, and support gradual reoccupation, the project establishes a resilient ground condition capable of accommodating change over time.

The principles outlined in this section provide the conceptual foundation for the spatial operation that follows. If the Third Landscape informs how the land should behave, the recomposition of fragmented plots into a continuous landscape system becomes the necessary spatial consequence. The following section therefore examines how this strategy is translated into a territorial operation through the establishment of a connective green framework.



Landscape Strategy

Recomposition of a Fragmented Territory
Despite their physical proximity, the project site and the adjacent plot to the north currently operate as separate and unrelated parcels, shaped by distinct planning designations and development trajectories. While the northern plot is designated for residential development under existing planning frameworks, this parcel-based logic fails to address the broader condition of landscape fragmentation that characterises the area.

The project therefore re-reads both plots as components of a single territorial condition. Rather than accepting zoning boundaries as fixed determinants of use, the intervention operates at the scale of landscape continuity, identifying the need for a connective green framework capable of linking surrounding open spaces and mitigating environmental and social fragmentation. This recomposition does not negate future development, but temporarily suspends a purely plot-based approach in favour of a landscape-led logic that prioritises ecological performance, microclimatic moderation, and collective accessibility.

By combining the two plots into a continuous landscape system, the project establishes the spatial foundation for a green belt that connects nearby green spaces across infrastructural and urban barriers. This operation transforms isolated residual land into a coherent ecological corridor and reinforces landscape as an active form of urban infrastructure rather than a residual amenity. The recomposed territory enables continuity of vegetation, movement, and experience, creating the conditions for long-term reoccupation and environmental repair.

The green belt is not conceived as a singular park or destination, but as a spatial framework that reorganises the relationship between built form, open space, and movement. It mediates between residential fabric, infrastructural corridors, and recreational areas, allowing transitions to occur gradually rather than abruptly and softening the edges between previously disconnected spaces.

This territorial recomposition represents the first concrete spatial translation of the landscape strategy outlined in the previous section. It shifts the project from conceptual principles to spatial action, establishing continuity as a prerequisite for subsequent ecological, public, and architectural interventions. By redefining the site as a continuous landscape rather than a collection of parcels, the project prepares the ground for architecture to operate as a secondary and embedded element.

3. The Rewilded Landscape

Planting Design and Ecological Cycles

Rewilding Through Succession

The planting strategy is grounded in the principle of ecological succession, allowing vegetation to establish gradually through phases of growth rather than through a fully predetermined composition. Initial planting focuses on resilient pioneer species capable of stabilising soil, improving microclimatic conditions, and creating the first layer of shade and habitat. These early stages prepare the ground for more complex plant communities to emerge over time.

Rather than enforcing a fixed hierarchy of species, the project accepts variation and unpredictability as essential qualities of a rewilded landscape. Natural processes such as seed dispersal, seasonal dieback, and spontaneous growth are allowed to influence the character of the site. In this way, planting acts as an initiator rather than a controller, guiding ecological development while avoiding rigid maintenance regimes.

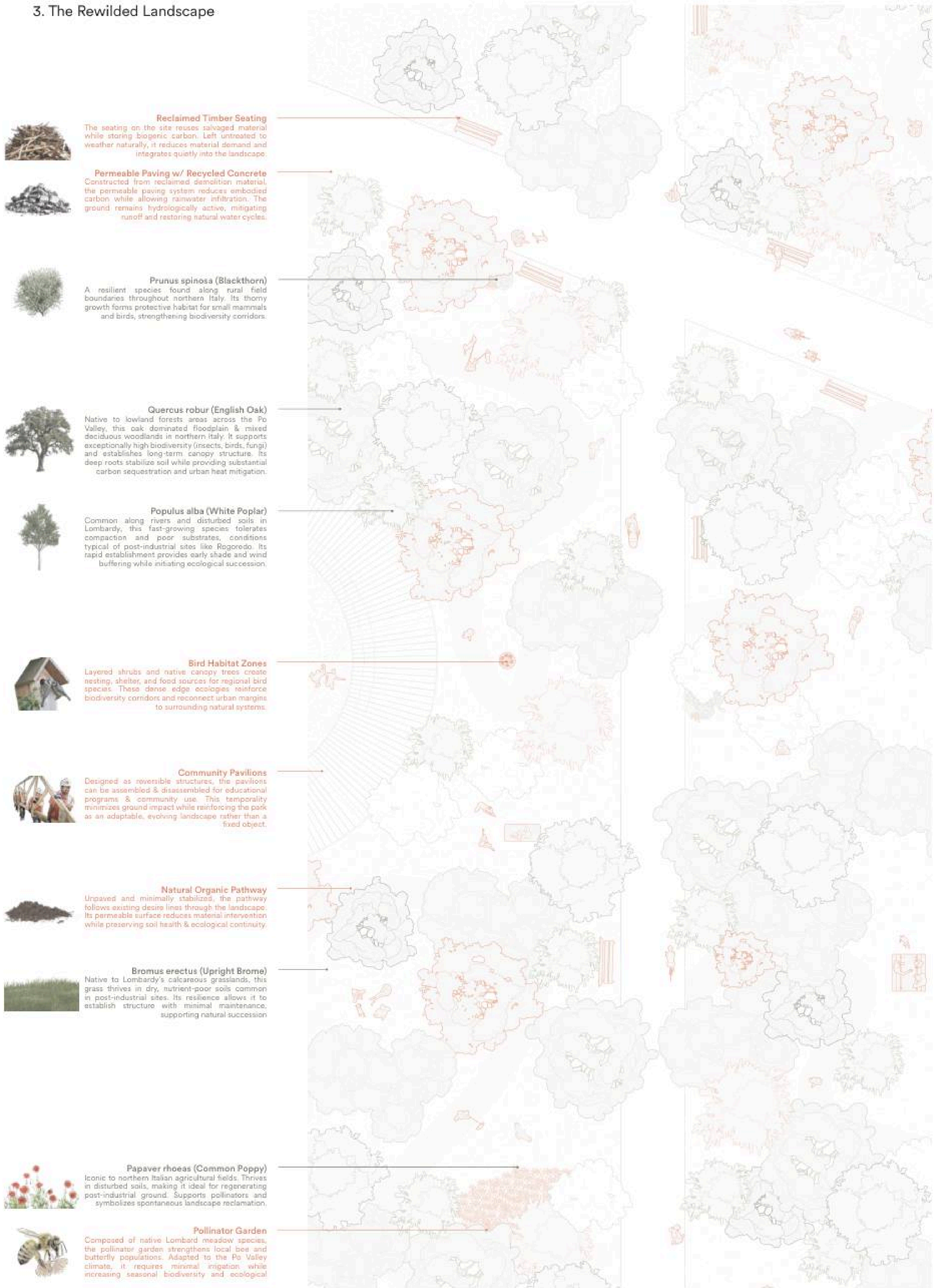
Succession also supports the project's broader social and spatial ambitions. As vegetation density increases over time, the landscape becomes progressively more comfortable, legible, and inhabitable. Early openness allows visibility and orientation, while later stages introduce enclosure, shade, and refuge. This gradual transformation aligns ecological growth with the slow reoccupation of the site, reinforcing the ethic of permanence established earlier in the thesis.

Microclimate and Urban Heat Mitigation

The rewilded landscape plays a central role in moderating microclimatic conditions across the site. Extensive sealed surfaces and limited vegetation currently contribute to elevated temperatures and thermal discomfort, reinforcing patterns of avoidance and underuse. The planting strategy addresses these conditions by prioritising canopy formation, evapotranspiration, and ground permeability.

As vegetation matures, increased canopy cover reduces direct solar exposure, while layered planting improves air movement and humidity regulation. Shaded ground surfaces and permeable soils contribute to lower surface temperatures, creating more comfortable conditions for movement, pause, and gathering. These effects are cumulative and intensify over time, reinforcing the value of a long-term ecological approach rather than immediate transformation.

Microclimatic comfort is treated as a prerequisite for collective presence. By reducing heat stress and improving thermal conditions, the landscape enables longer occupation and varying patterns of use. In this sense, ecological performance and social accessibility are inseparable. Cooling is not introduced as a technical optimisation, but as an environmental condition that supports everyday life and safety through presence.



Public Realm and Urban Connection

From Ecological Continuity to Collective Presence

The public realm emerges from the rewilded landscape rather than being imposed upon it. Instead of organising the site through formal plazas or fixed programmes, the project allows collective life to develop through environmental comfort, spatial continuity, and accessibility. The landscape itself functions as the primary public infrastructure, shaping how people move, gather, and remain within the site over time.

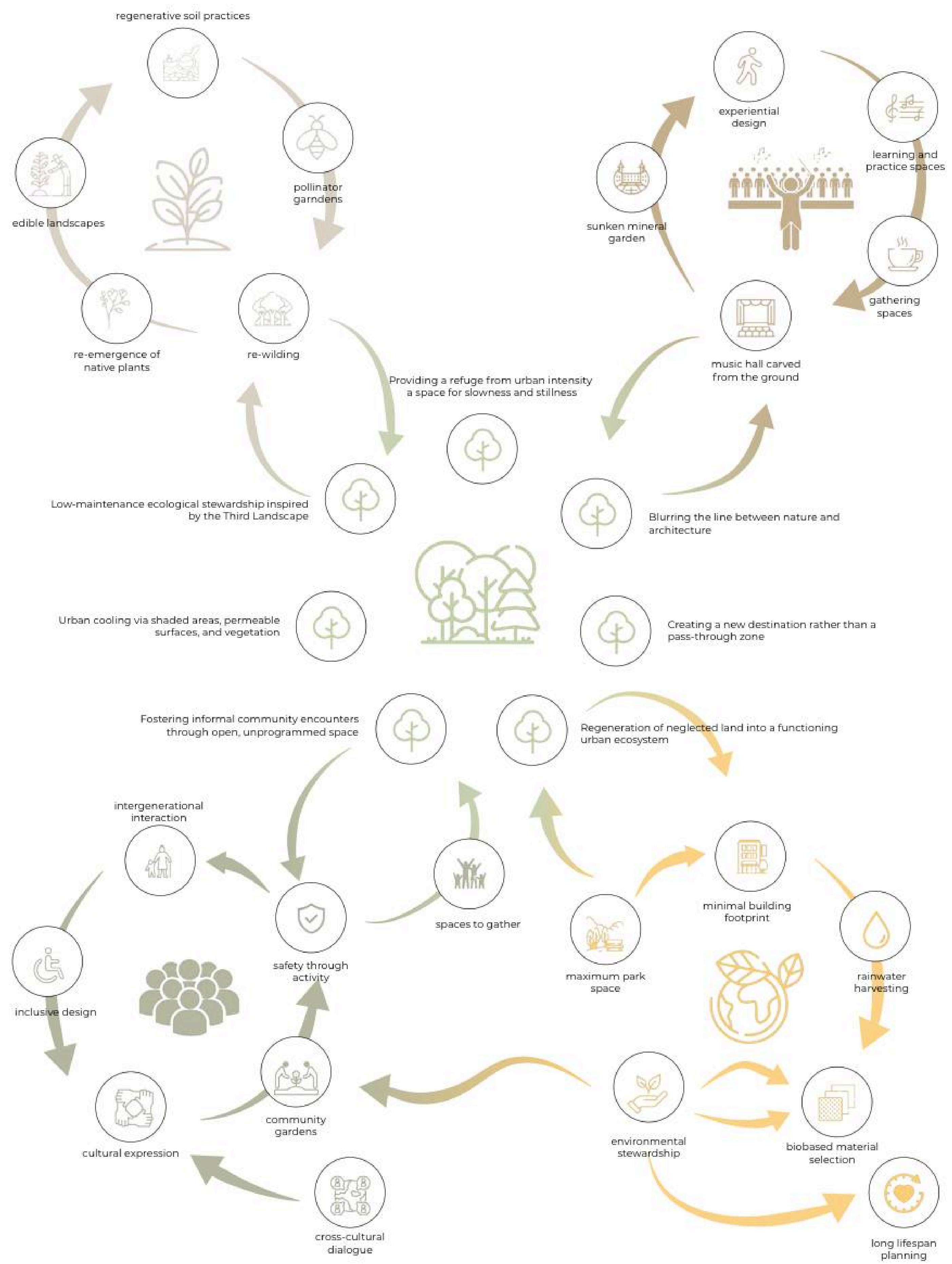
In a context historically associated with disuse and perceived unsafety, the project approaches public space as a condition produced through presence rather than control. Safety is not achieved through surveillance or intensive activation, but through familiarity, repetition, and shared use. As ecological processes reduce thermal stress and improve comfort, the landscape becomes increasingly inhabitable, encouraging lingering, informal gathering, and everyday occupation. Public life is therefore understood as an outcome of environmental and spatial conditions rather than a predefined programme.

The spatial organization of the rewilded landscape supports multiple forms of use without rigid zoning. Open and unprogrammed areas accommodate spontaneous encounters, while more defined clearings and edges allow for learning, practice, and cultural exchange. This flexibility enables the site to respond to different rhythms of use across seasons and times of day, reinforcing inclusivity and adaptability. Rather than concentrating activity in a single destination, the landscape distributes opportunities for engagement, transforming the site from a pass-through zone into a place of gradual involvement.

Urban connections are reinforced through continuity rather than hierarchy. The green belt operates as a connective tissue linking surrounding neighbourhoods, recreational areas, and infrastructural edges. Transitions between the project and the city are softened, allowing everyday routes to intersect naturally with moments of pause and gathering. In this way, the landscape functions simultaneously as corridor, refuge, and shared ground, integrating the site into the broader urban fabric without isolating it as a separate enclave.

Architecture participates in the public realm as a secondary and embedded presence. By remaining largely within the ground, architectural elements support collective experience without dominating the surface. The boundary between landscape and architecture is intentionally blurred, allowing built form to enhance spatial, acoustic, and social conditions while preserving the continuity of the rewilded terrain above.

Together, these strategies redefine the public realm as a slow and accumulative process. Rather than relying on spectacle or event-based activation, the project supports collective life through time, care, and repeated use. This approach aligns with the ethic of permanence developed throughout the thesis, positioning the rewilded landscape as a long-term social infrastructure capable of supporting safety, inclusion, and urban repair.



Spatial Framework of the Rewilded Landscape

Master Plan

The spatial framework of the project is organised around a clear hierarchy between landscape and built form. Rather than dispersing architecture across the site, the intervention concentrates built elements into a limited number of defined structures, allowing the majority of the ground to remain continuous, permeable, and rewilded. Architecture operates as a series of thresholds and anchors within the landscape, supporting use and orientation without fragmenting the open space.

The first element of this framework is the gate building positioned along the existing road edge. This building maintains the continuity of the streetscape, preserving the familiar urban profile and avoiding a sudden rupture between city and park. From the street, the project reads as an extension of the existing fabric rather than an isolated enclave. The gate building mediates between public urban life and the rewilded landscape beyond, marking entry without spectacle.

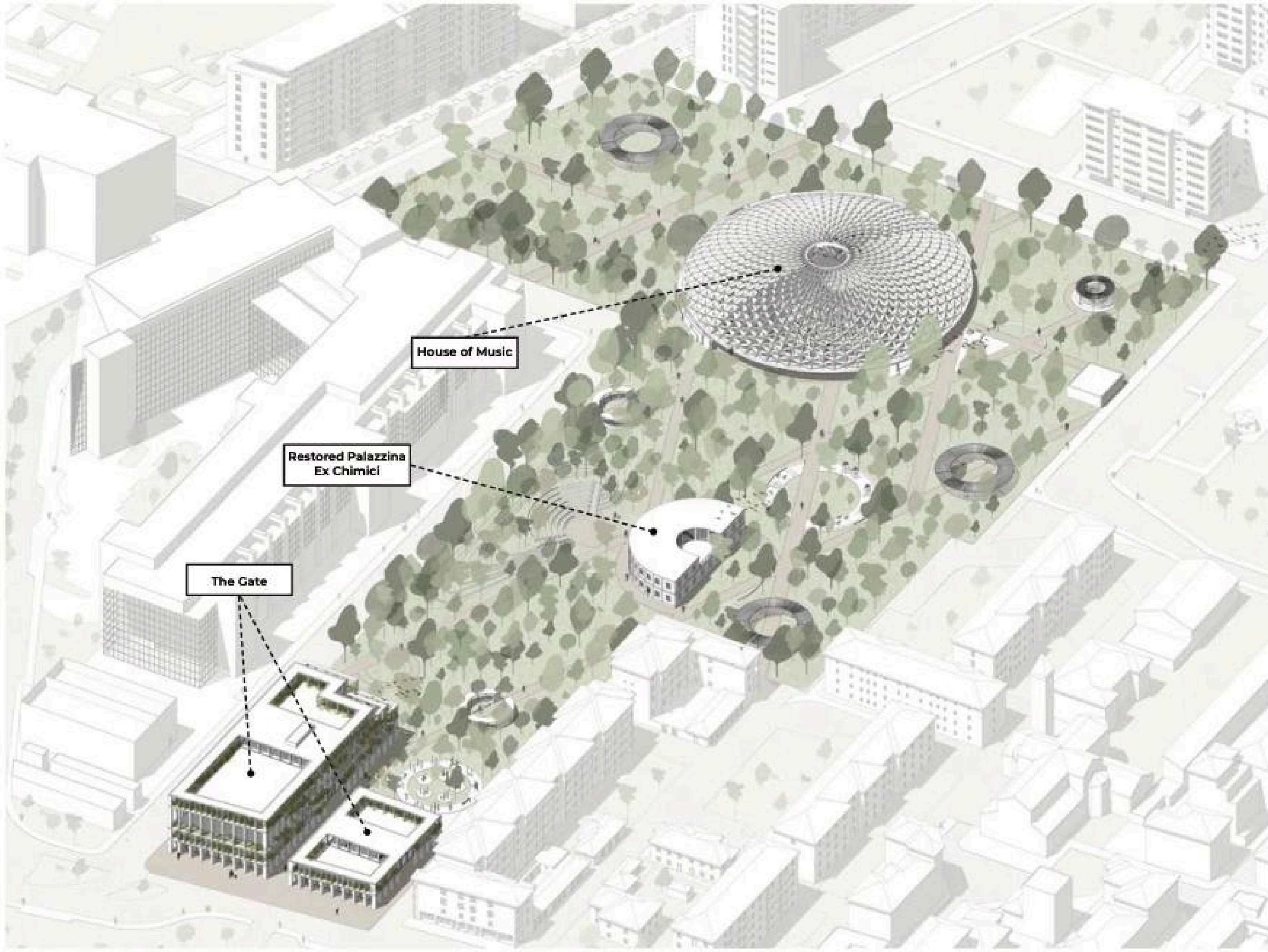
Programmatically, the gate building accommodates student housing above a publicly accessible ground floor. Cafés and a library activate the street edge and establish everyday use throughout the day, reinforcing safety through presence. This mixed condition ensures that the project remains embedded within the rhythms of the surrounding neighbourhood, while also supporting the academic and cultural life associated with the music school and performance spaces deeper within the site.

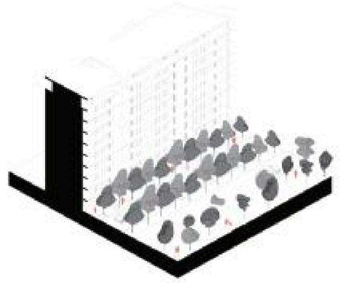
Beyond the gate, the landscape opens into the rewilded park, which forms the primary spatial condition of the project. The landscape takes over and movement is guided through open ground, vegetation, and subtle topographic shifts rather than formal paths or axial routes. The park functions as both connective tissue and inhabitable ground, linking the different programmatic elements while remaining legible as a single continuous space.

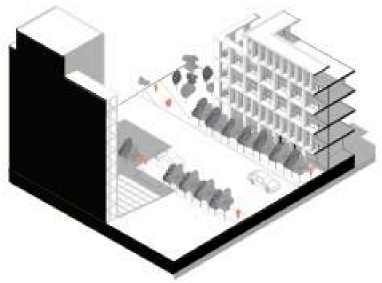
The second architectural element is the adaptive reuse of the existing ex chimici building, which is repurposed as the music school. Retaining this structure preserves material memory and reduces the need for new construction, aligning with the project's ethic of permanence and stewardship. The building is integrated into the landscape rather than set apart from it, allowing teaching, practice, and informal activity to extend outward into the surrounding park.

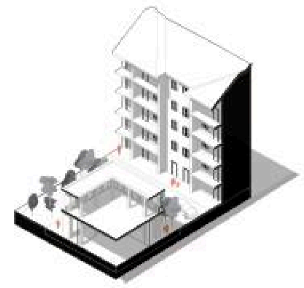
The third element is the music hall, positioned as a deeply embedded structure within the landscape. Rather than asserting itself as a dominant object, the hall is carved into the ground, allowing the park to pass over and around it. This placement reinforces the project's conceptual emphasis on resonance, shelter, and continuity, with architecture operating as an infrastructural support for sound, gathering, and shared experience rather than as a visual landmark.

Together, these three elements establish a spatial framework in which architecture supports the landscape without interrupting it. The gate building mediates between city and park, the reused industrial structure anchors everyday academic life, and the music hall provides a cultural core embedded within the ground. Their arrangement reinforces the primacy of the rewilded landscape, ensuring that built form enhances continuity, accessibility, and collective presence rather than fragmenting the site.





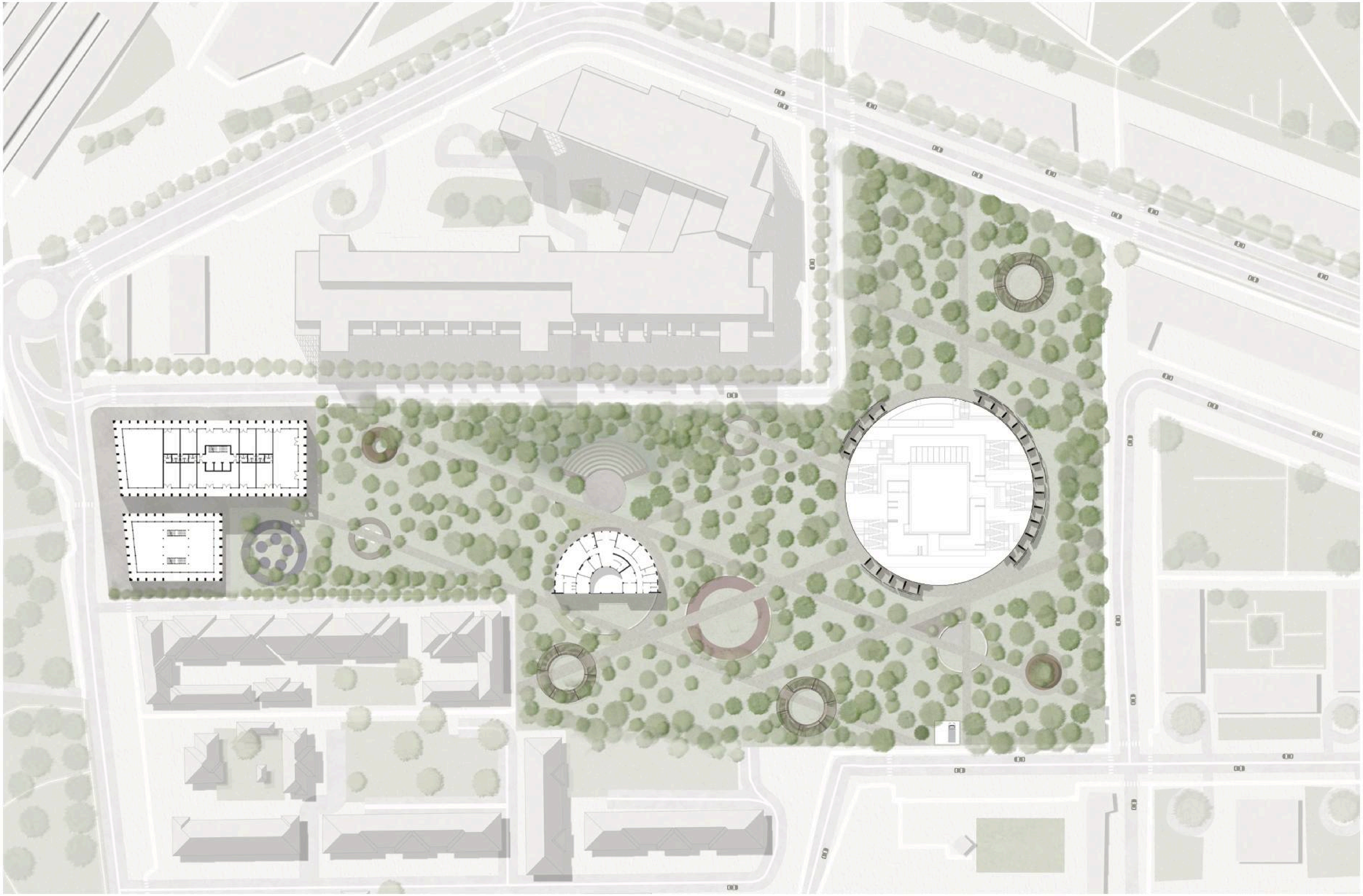




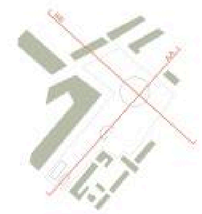
3. The Rewilded Landscape

Figure 3.6: Master Plan

3. The Rewilded Landscape



3. The Rewilded Landscape



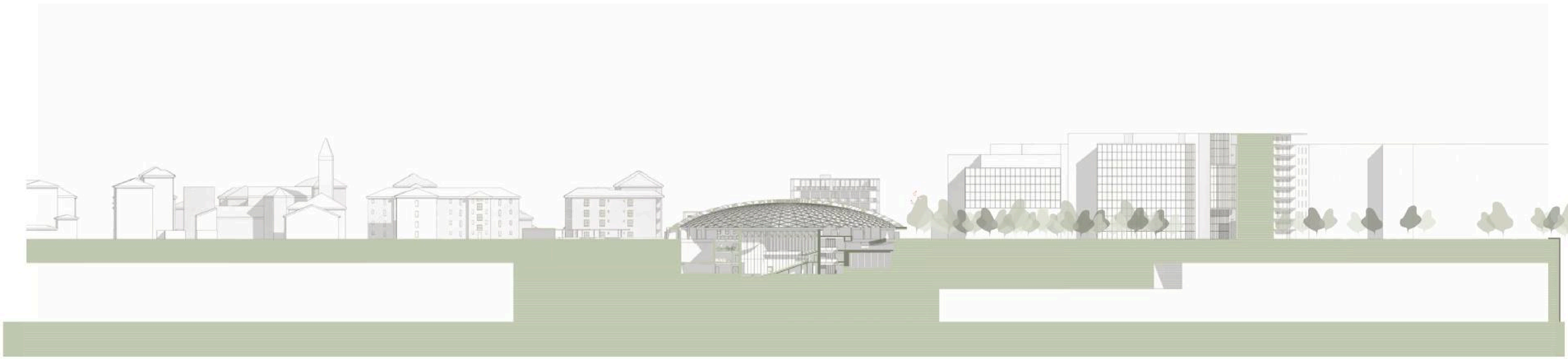


Figure 3.8: Site Sections

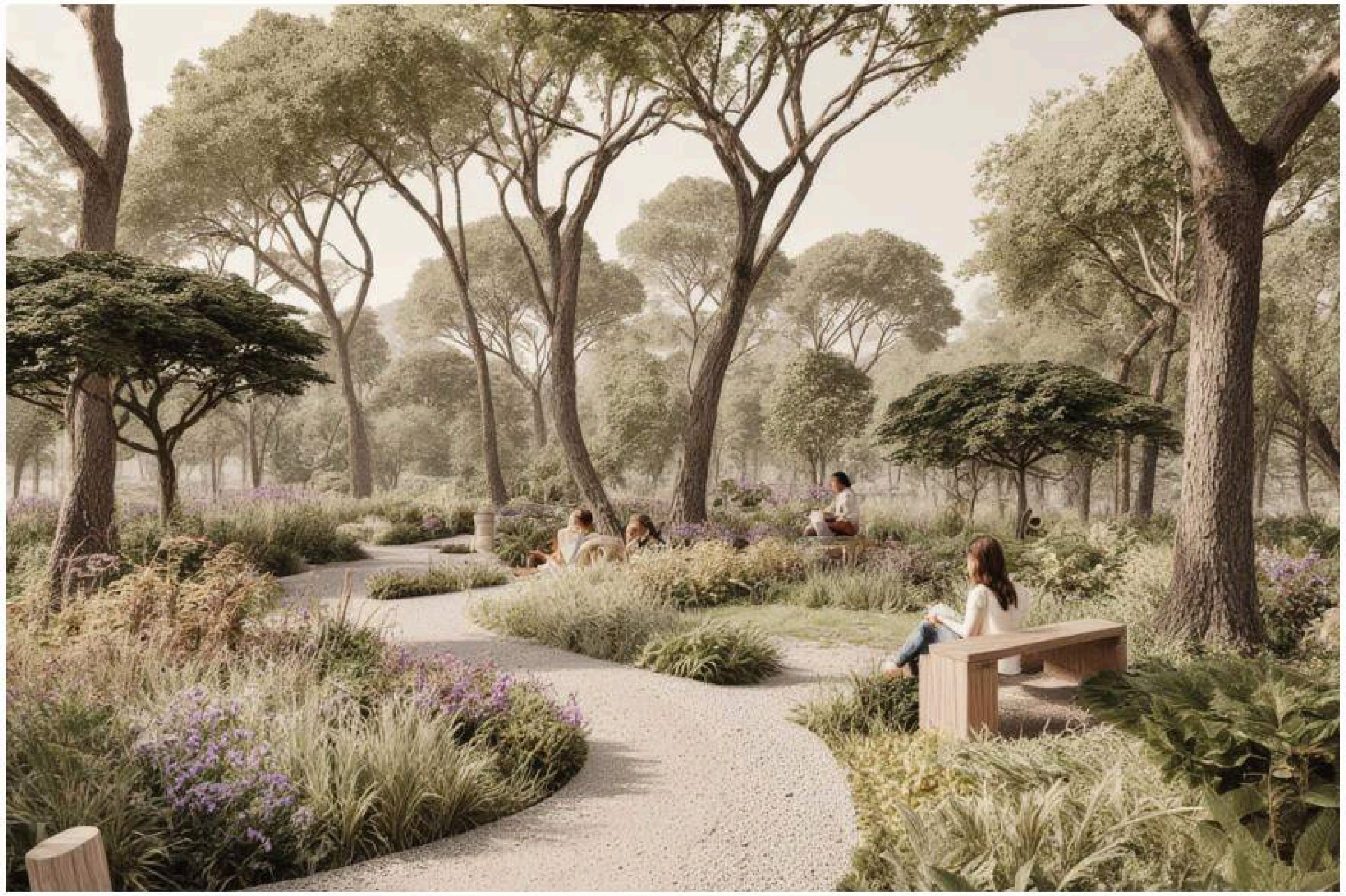


Figure 3.8: Site Sections

4. The Architecture Below

This section translates the conceptual and ethical positions established in the previous sections into an architectural framework. If the earlier chapters defined the project's stance on resonance, permanence, and collective experience through landscape, this chapter examines how those principles are embodied spatially through architecture. The architectural intervention is not treated as an object placed within the landscape, but as a condition embedded within it, shaped by depth, mass, and continuity rather than by visibility or form.

The project adopts the ground as its primary architectural medium. In a context marked by fragmentation, exposure, and overstimulation, the earth offers both physical and symbolic stability. By situating the principal architectural spaces below ground, the project allows the rewilded landscape above to remain continuous and adaptable, while architecture operates as a sheltered and resonant interior condition. This approach positions architecture as an infrastructural support for collective life rather than a visual marker within the city.

Within this framework, subterranean architecture is understood not as concealment, but as a spatial strategy. The descent into the building establishes a gradual transition from openness to enclosure, from diffuse urban noise to focused acoustic space. Mass and depth become active architectural elements, shaping sound, atmosphere, and perception. Rather than isolating the interior from its surroundings, the ground mediates between landscape and space, allowing architecture to register the thickness and materiality of the site.

Embedding architecture within the land also reinforces the project's ethic of permanence. The surrounding earth provides thermal stability, acoustic insulation, and structural support, reducing reliance on expressive form or surface articulation. Architecture is anchored rather than imposed, aligned with long-term use and adaptability. In this sense, the building does not compete with the landscape, but is sustained by it.

The sections that follow examine how this subterranean strategy is translated into spatial organisation, acoustic performance, and material logic. Through plans, sections, and atmospheric studies, the chapter demonstrates how architecture operates as a consequence of the rewilded landscape, supporting resonance, shelter, and collective attention without interrupting the continuity of the ground above.

Subterranean Strategy

Conceptual Foundations

The project has been developed through a long-term, iterative design process beginning in September 2024. Rather than emerging from a fixed formal intention, the architectural language evolved gradually through continuous testing, revision, and refinement. Throughout this process, early conceptual investigations played a critical role in establishing the project's spatial and material direction.

Initial studies focused on the relationship between mass, ground, and enclosure. Through abstract models, sectional sketches, and material explorations, architecture was approached as a condition embedded within the earth rather than as an object placed upon it. These early investigations explored ideas of excavation, compression, and spatial depth, establishing a conceptual framework in which the ground was understood as an active architectural medium.

The notion of architecture as a mineral or geological condition emerged through this phase, not as a literal metaphor, but as a way of understanding space as something shaped by subtraction, thickness, and time. Volumes were conceived as differentiated masses embedded within a continuous ground, defined more by their spatial role than by formal consistency. Light was explored as something that penetrates and reveals depth, rather than illuminating surfaces.

These conceptual foundations established the project's core ambitions. Architecture was positioned as something restrained, embedded, and experiential, operating through section rather than elevation, and through continuity rather than objecthood. This phase did not seek resolution, but clarity of intent, providing a conceptual base against which subsequent design decisions could be tested and strengthened.

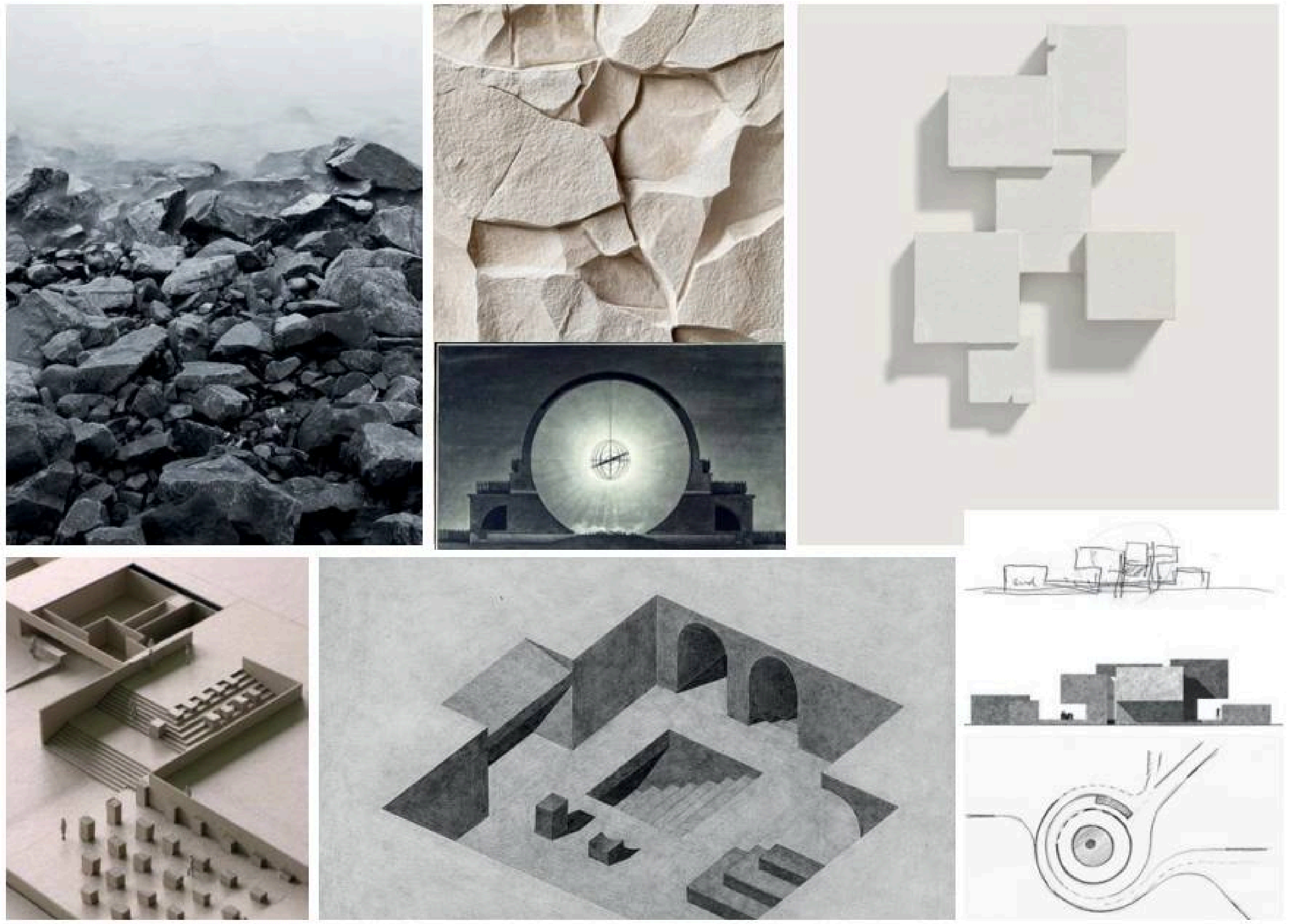


Figure 4.1: Collage of reference designs

Subterranean Strategy

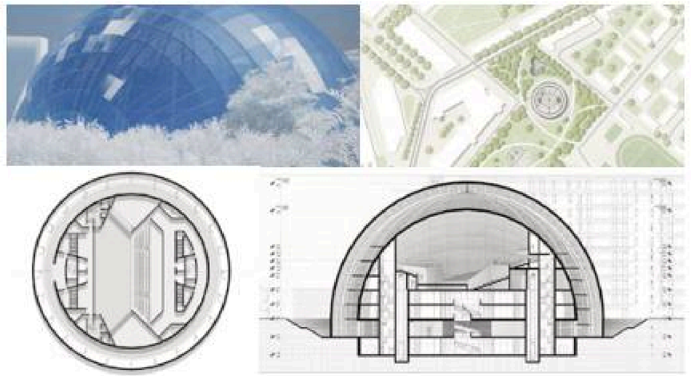
Design Evolution and Refinement
As the project developed over the academic year, these initial concepts were continuously reworked in response to spatial, programmatic, and technical considerations. The design underwent multiple iterations, each refining the relationship between architecture, landscape, and programme while remaining aligned with the original project goals.

Early configurations explored a range of volumetric arrangements and enclosure strategies, testing different degrees of exposure, depth, and formal expression. Through these iterations, the project gradually moved toward greater clarity and restraint. Volumes were consolidated, relationships between spaces were clarified, and the central role of the music hall as a spatial and acoustic core became more pronounced.

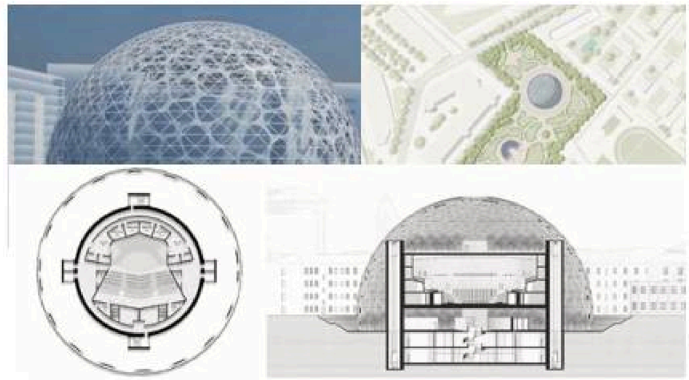
Sectional development played a particularly important role in this evolution. As the design progressed, increasing attention was given to vertical relationships, accessibility across multiple hypogeal levels, and the continuity of circulation. Rather than simplifying the project, this process allowed complexity to be absorbed into the section, ensuring that the building remained permeable, legible, and spatially coherent despite its depth.

The dome and the embedded volumes emerged not as formal gestures, but as outcomes of this iterative process. Each design stage strengthened the alignment between architectural form, acoustic performance, and landscape continuity. Decisions were tested, revised, and refined over time, allowing the project to mature into a cohesive architectural system rather than a fixed image.

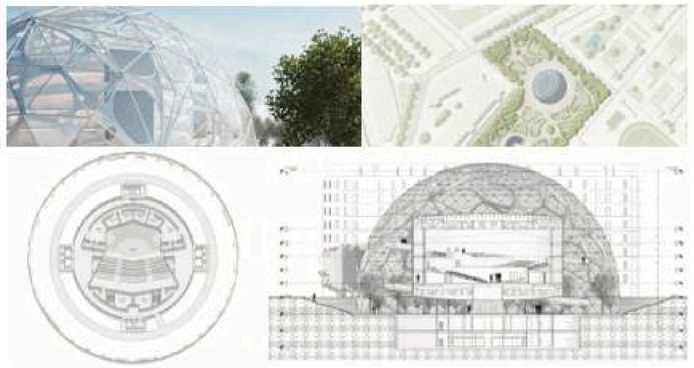
This iterative development reinforces the project's broader ethic of permanence. Rather than seeking immediate resolution, the design evolved through sustained engagement, allowing ideas to deepen and relationships to stabilise. The final architectural strategy is therefore understood not as a departure from the initial concept, but as its gradual clarification.



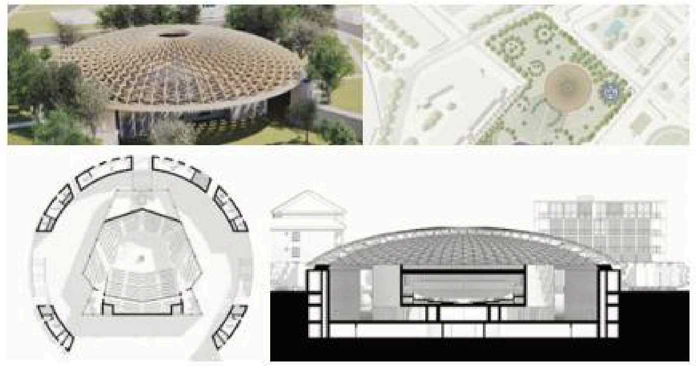
FALL STEP 2 DESIGN



FALL STEP 3 DESIGN



SPRING STEP 1 DESIGN



SPRING STEP 2 DESIGN

Spatial Organization

Programmatic Structure and Spatial Assembly

The spatial organisation of the music hall is structured around a central core and a system of supporting volumes embedded within the ground. Rather than being conceived as a single unified object, the architecture develops through a process of programmatic accretion, in which distinct functions are added incrementally around the main hall. This approach allows the building to grow spatially while maintaining clarity of organisation and orientation.

At the heart of the project lies the music hall itself, which functions as both the acoustic and spatial center. All primary circulation routes and programme elements converge toward this space, reinforcing its role as the focal point of collective experience. The hall is not isolated, but surrounded by a series of interdependent volumes that support its operation, including the foyer, music school, backstage areas, and service spaces.

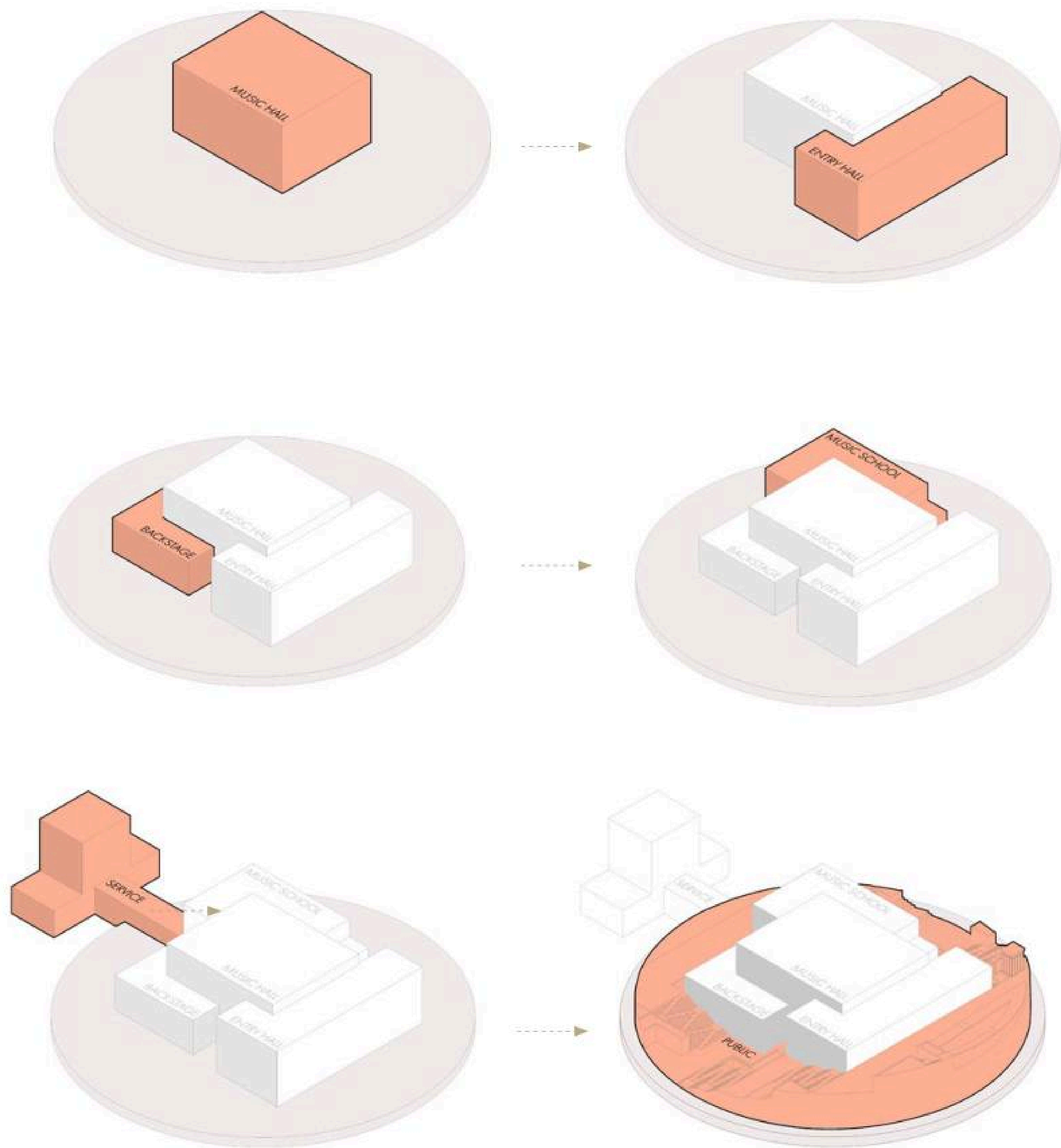
The aggregation diagram illustrates this logic of growth, beginning with the music hall as a singular core and progressively introducing additional volumes according to functional requirements. Each programme is expressed as a distinct spatial entity, allowing differences in scale, proportion, and spatial character to emerge naturally from use rather than from formal repetition. This strategy reinforces the project's emphasis on spatial differentiation within a coherent system.

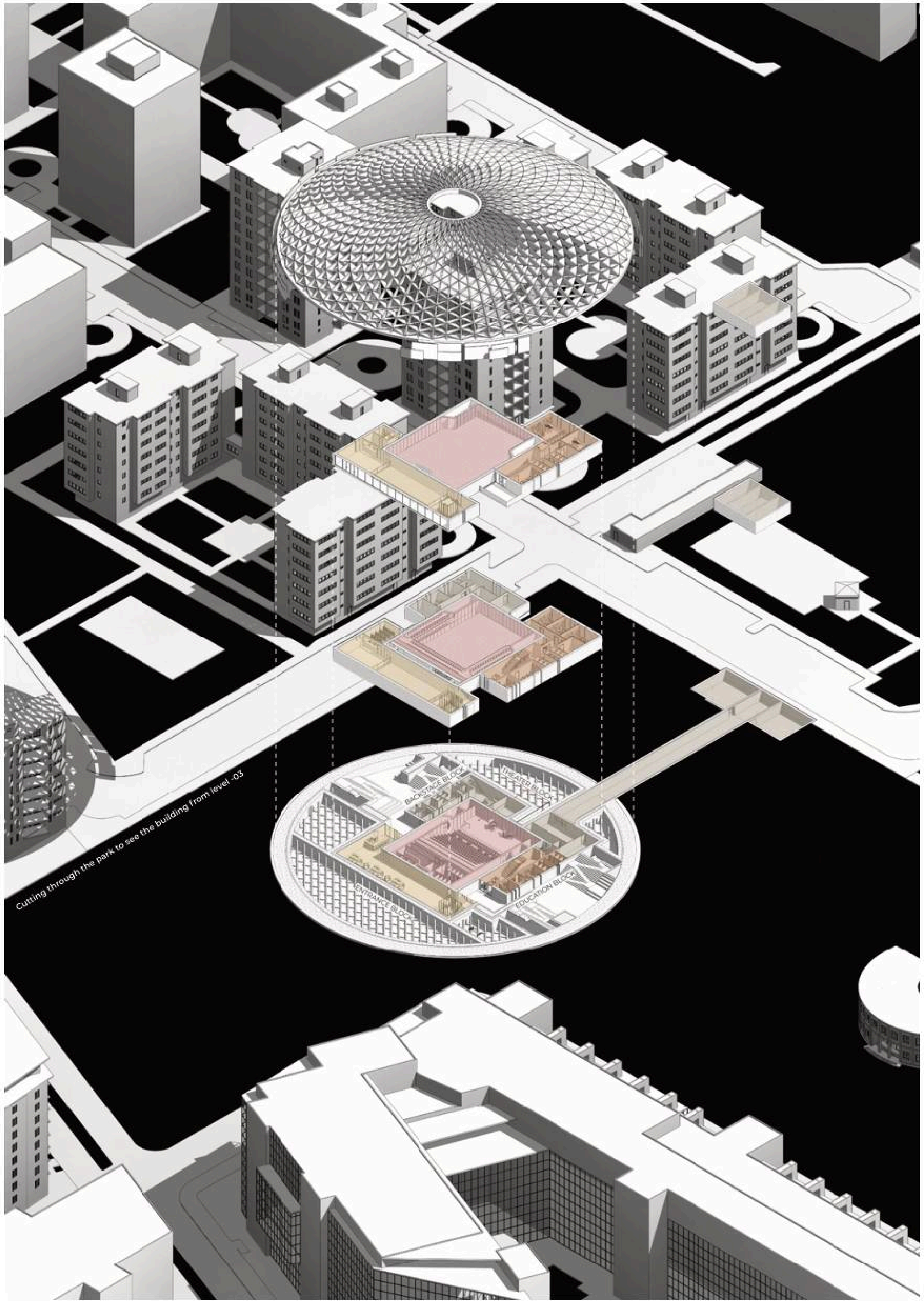
While the plan geometry of the project remains relatively simple, spatial complexity is primarily articulated through section. The various programme volumes are distributed across multiple hypogeal levels, responding to acoustic needs, circulation requirements, and spatial relationships. The main hall occupies the deepest and most protected position, while surrounding functions are arranged at higher levels, maintaining visual and spatial connections across depth.

The exploded axonometric and level drawings clarify this vertical organisation. At level -01, public-facing functions such as the foyer and primary circulation spaces establish a point of entry and orientation within the hypogeal environment. At level -03, the music hall and backstage functions are positioned to ensure acoustic isolation and spatial containment, while remaining directly connected to the circulation system above. This layered arrangement allows the building to be accessed and navigated from multiple points, reinforcing permeability and inclusivity.

Accessibility is treated as a core spatial principle rather than a secondary consideration. The building is designed to be fully navigable across levels through a continuous system of ramps, stairs, and horizontal connections. Movement through the hypogeal space is gradual and legible, allowing users to orient themselves through spatial relationships rather than through signage alone. Regardless of entry level, the central hall remains a consistent reference point within the spatial sequence.

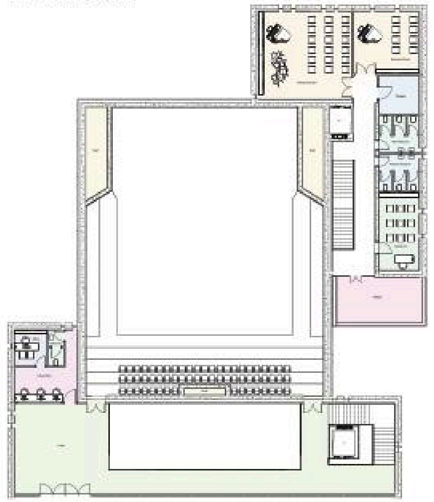
By organizing the project as an assemblage of embedded volumes around a central core, the architecture maintains flexibility while preserving clarity. Programme, circulation, and structure are integrated within a single hypogeal framework, allowing the building to function as a continuous interior landscape rather than as a collection of isolated rooms. This spatial organisation establishes the foundation for the sectional, atmospheric, and acoustic strategies developed in the following sections.





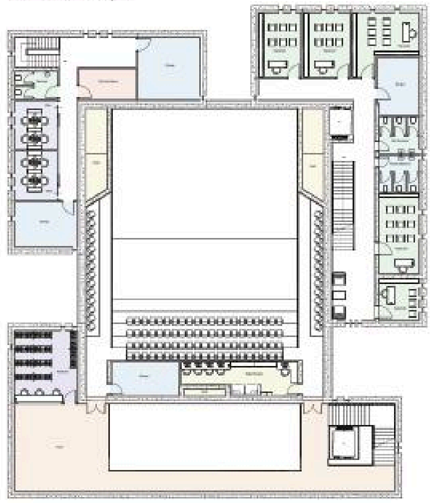
4. The Architecture Below

LEVEL -01



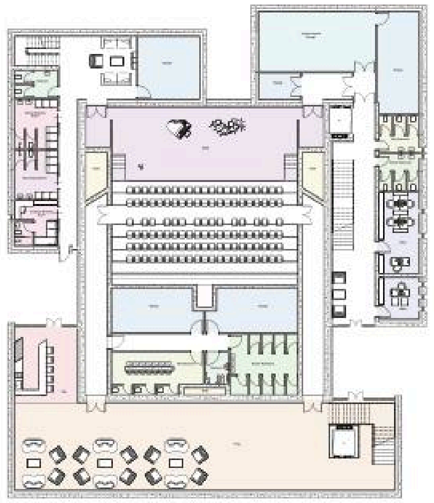
Level - 1	Lobby	125 m^2
Level - 1	Shaft	2 m^2
Level - 1	Ticket Office	17 m^2
Level - 1	Restroom	4 m^2
Level - 1	Office	8 m^2
Level - 1	Shaft	12 m^2
Level - 1	Shaft	12 m^2
Level - 1	Terrace	31 m^2
Level - 1	Classroom	21 m^2
Level - 1	Women Restroom	10 m^2
Level - 1	Man Restroom	10 m^2
Level - 1	Storage	10 m^2
Level - 1	Rehearsal Room	27 m^2
Level - 1	Rehearsal Room	54 m^2

LEVEL -02

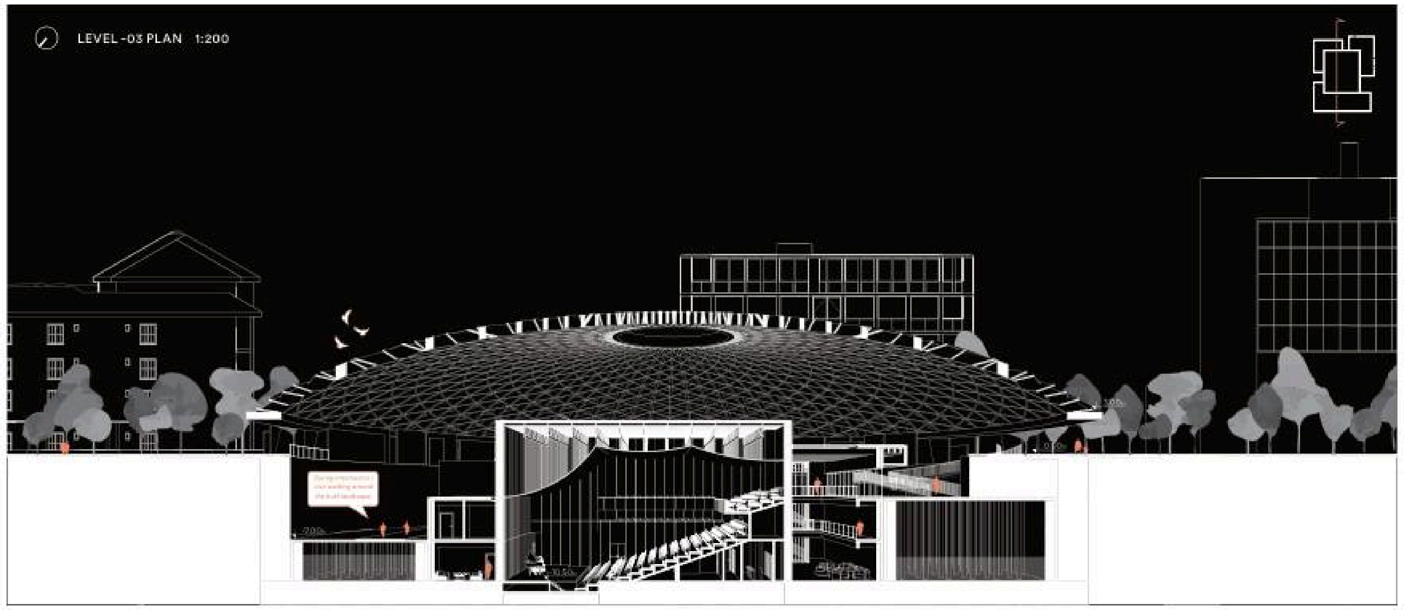


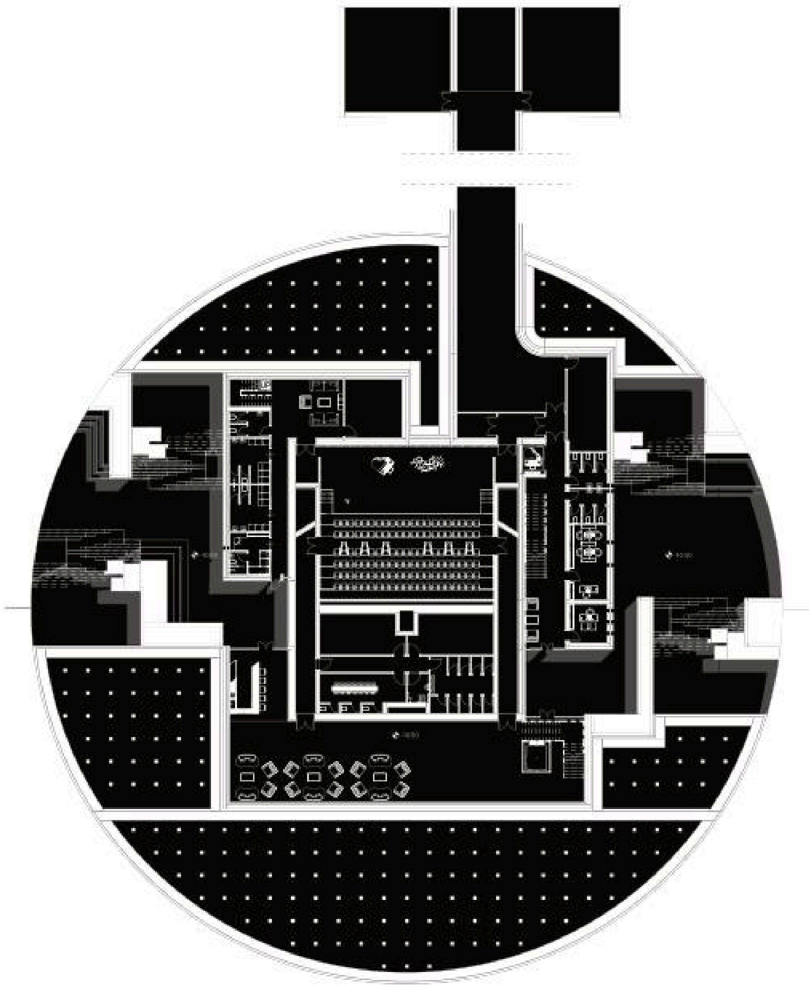
Level - 2	Foyer	125 m^2
Level - 2	Wardrobe	30 m^2
Level - 2	Storage	15 m^2
Level - 2	Shaft	2 m^2
Level - 2	Stage Manager	23 m^2
Level - 2	Storage	19 m^2
Level - 2	Office	14 m^2
Level - 2	Office	14 m^2
Level - 2	Restroom	8 m^2
Level - 2	Technical Space	12 m^2
Level - 2	Storage	26 m^2
Level - 2	Shaft	12 m^2
Level - 2	Shaft	12 m^2
Level - 2	Classroom	11 m^2
Level - 2	Classroom	22 m^2
Level - 2	Women Restroom	10 m^2
Level - 2	Man Restroom	10 m^2
Level - 2	Storage	16 m^2
Level - 2	Classroom	22 m^2
Level - 2	Classroom	20 m^2
Level - 2	Classroom	18 m^2

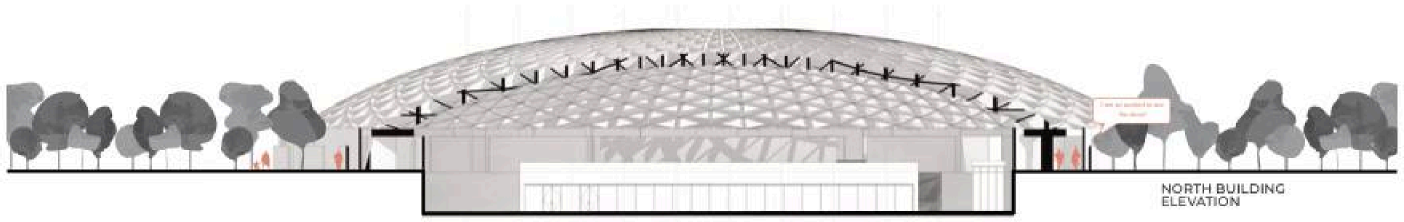
LEVEL -03

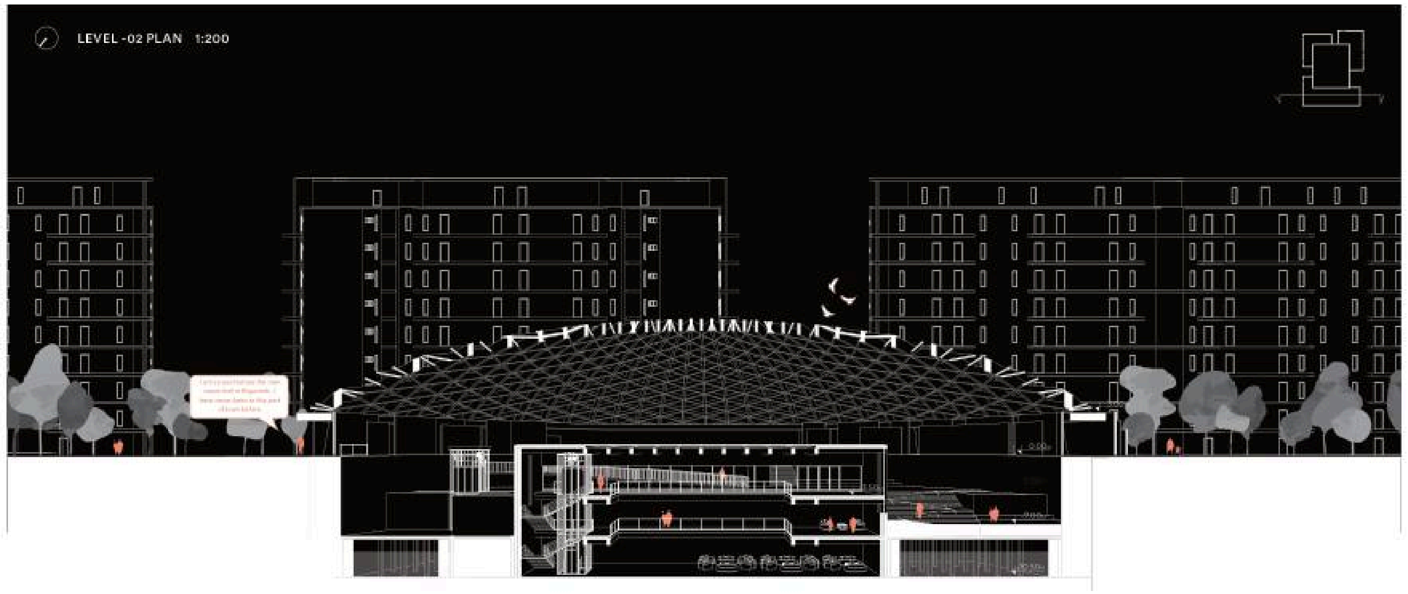


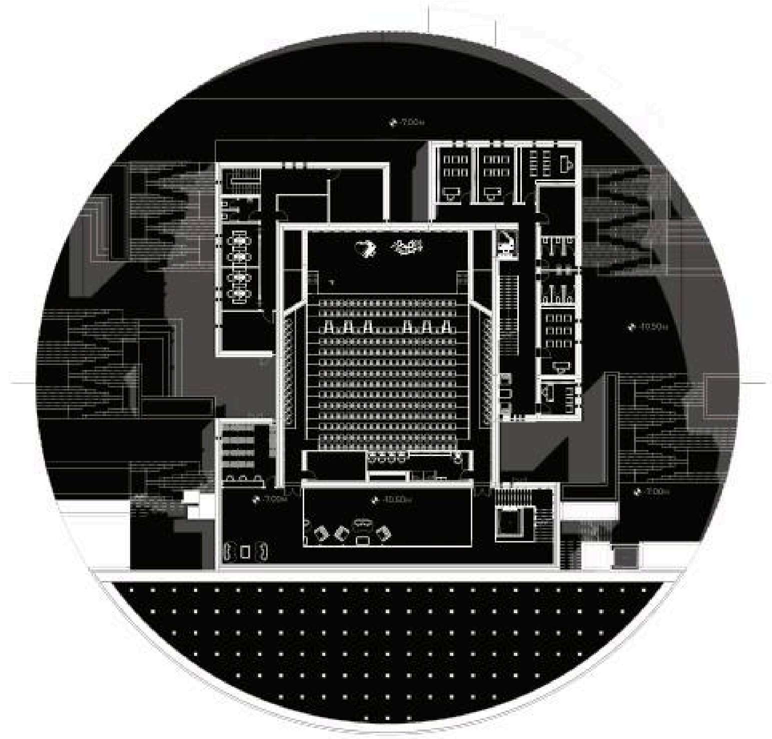
Level - 3	Cafe	31 m^2
Level - 3	Foyer	218 m^2
Level - 3	Shaft	2 m^2
Level - 3	Man Restrooms	24 m^2
Level - 3	Women Restrooms	27 m^2
Level - 3	Restroom	5 m^2
Level - 3	Storage	26 m^2
Level - 3	Storage	26 m^2
Level - 3	Office	11 m^2
Level - 3	Office	22 m^2
Level - 3	Women Restrooms	10 m^2
Level - 3	Man Restrooms	10 m^2
Level - 3	Storage	7 m^2
Level - 3	Storage	29 m^2
Level - 3	Veichle Area and Storage	47 m^2
Level - 3	Stage	104 m^2
Level - 3	Shaft	6 m^2
Level - 3	Shaft	6 m^2
Level - 3	Storage	26 m^2
Level - 3	Restroom	8 m^2
Level - 3	Women Dressing Room	14 m^2
Level - 3	Man Dressing Room	14 m^2
Level - 3	Conductor Dressing Room	13 m^2

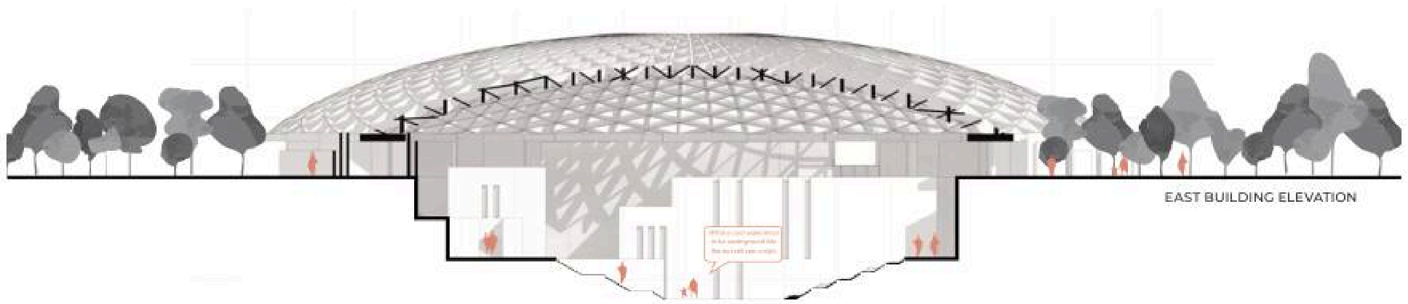

LEVEL -03 PLAN 1:200

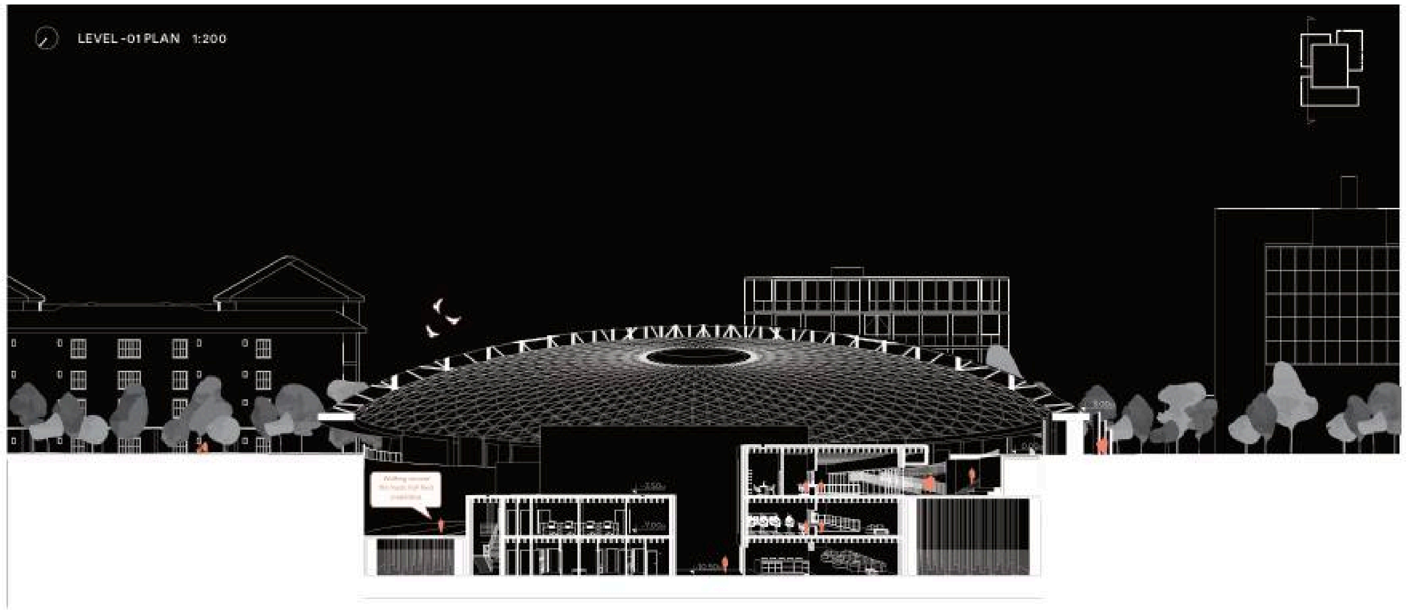


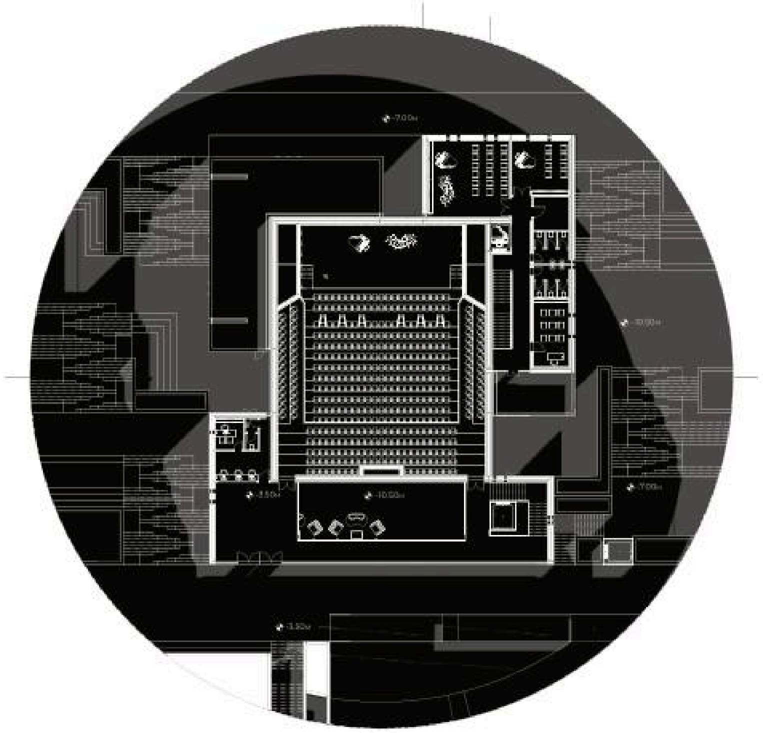

NORTH BUILDING
ELEVATION

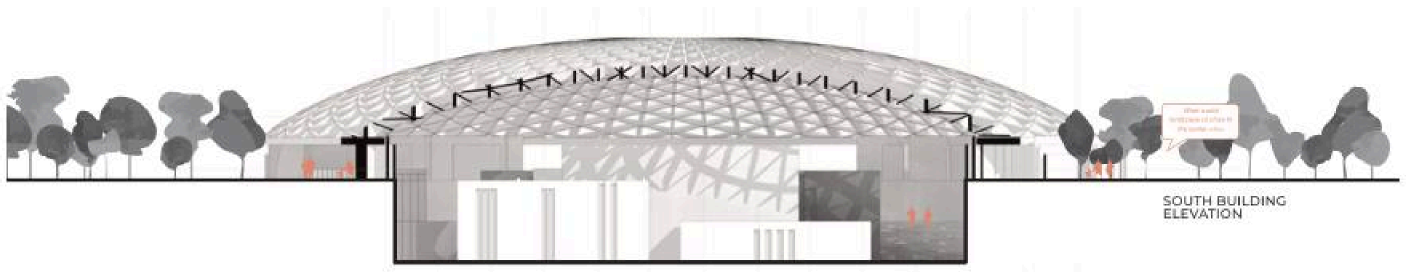

LEVEL -02 PLAN 1:200

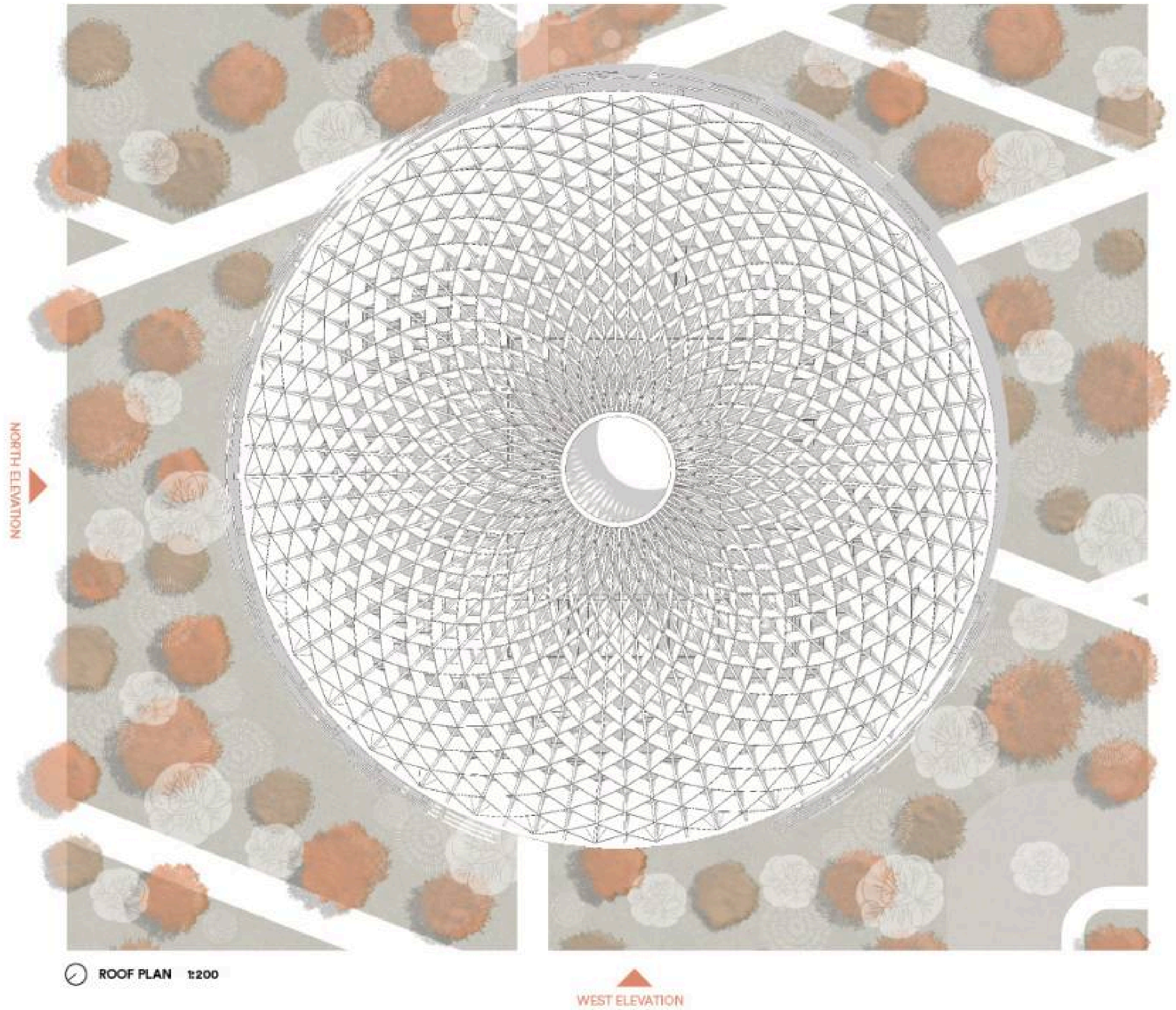



EAST BUILDING ELEVATION

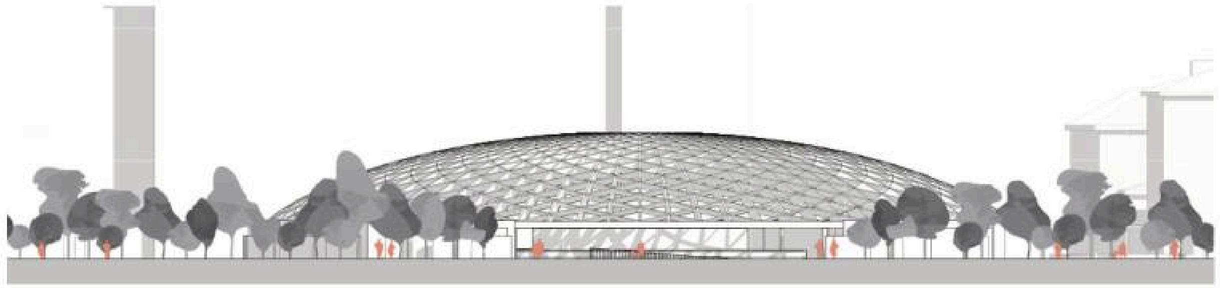




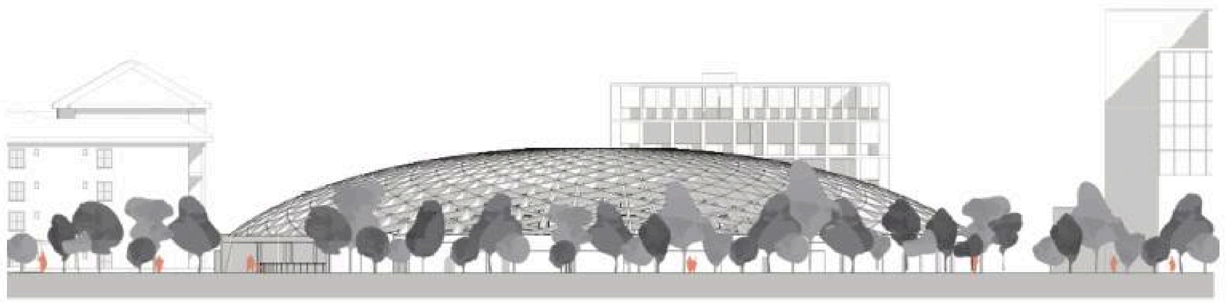




ROOF PLAN 1:200

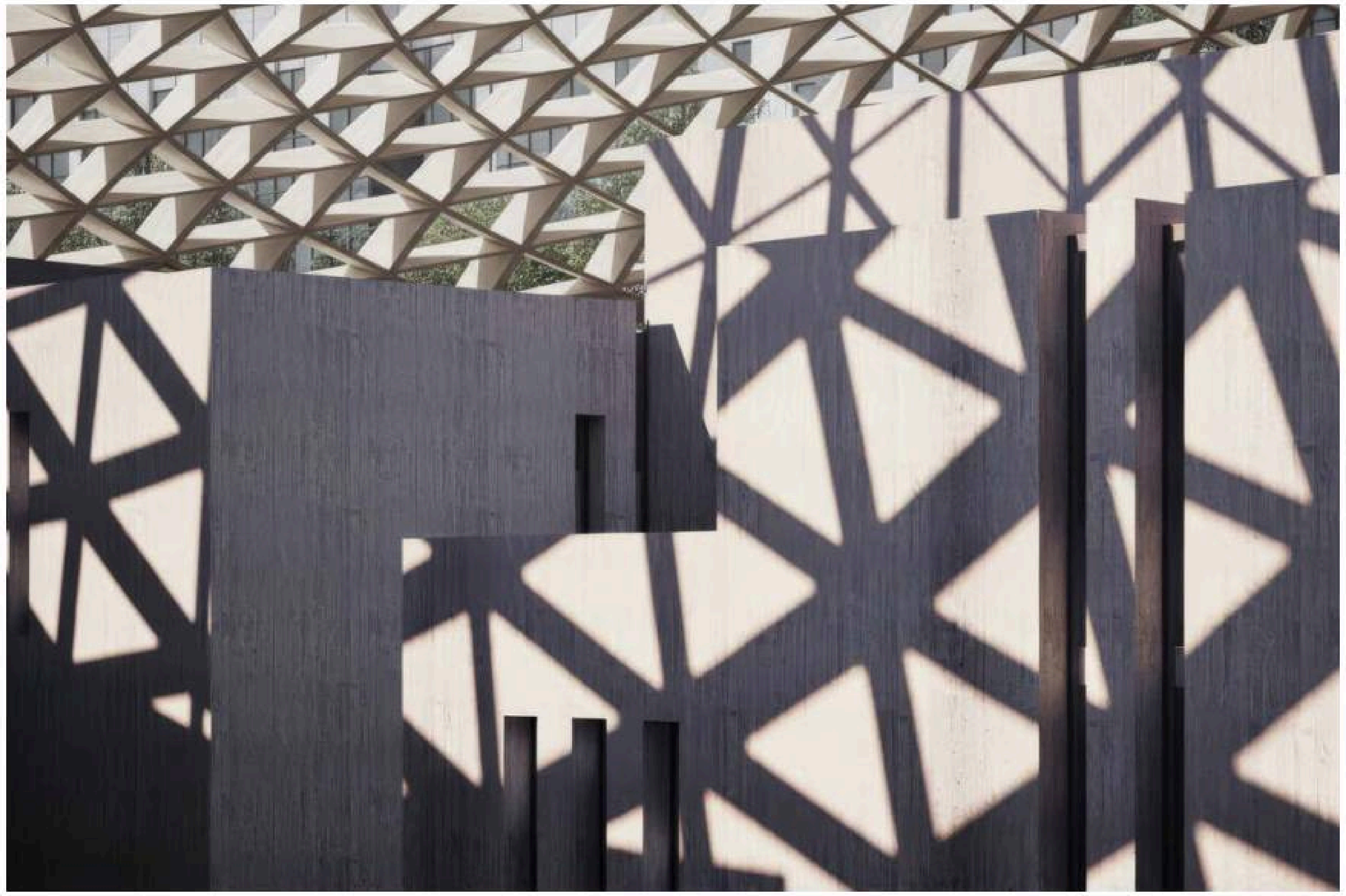


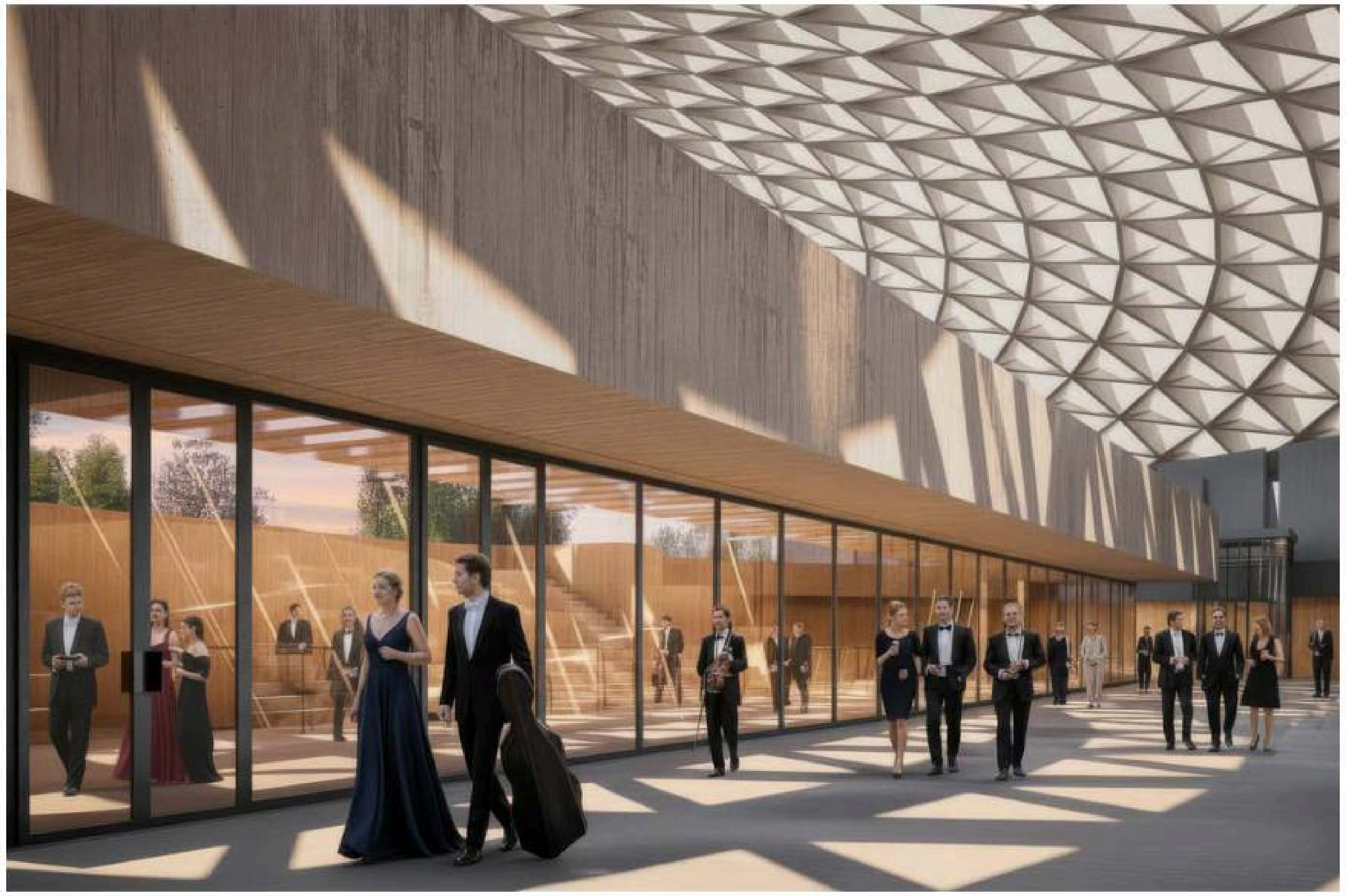
WEST ELEVATION: BUILDING ENTRANCE 1:200



NORTH ELEVATION: VIEW FROM STREET 1:200

4. The Architecture Below





The Auditorium

Architectural and Acoustic Performance

The auditorium forms the spatial and acoustic core of the House of Music. Located at the deepest level of the hypogeal complex, it is positioned to benefit from maximum enclosure and material mass, ensuring acoustic isolation from the surrounding programme and from the landscape above. With a seating capacity of approximately 480 people, the hall is designed to accommodate a range of musical performances while maintaining intimacy, clarity, and spatial focus.

The plan organization is compact and highly legible, with the seating arranged around a clearly defined stage volume. The geometry of the hall prioritises proximity between audience and performers, minimising distance and reinforcing a collective listening condition. Access to the auditorium occurs from multiple hypogeal levels, allowing the audience to enter gradually without disrupting the performance space. Backstage and service functions are positioned laterally and to the rear, ensuring clear separation between public and technical circulation.

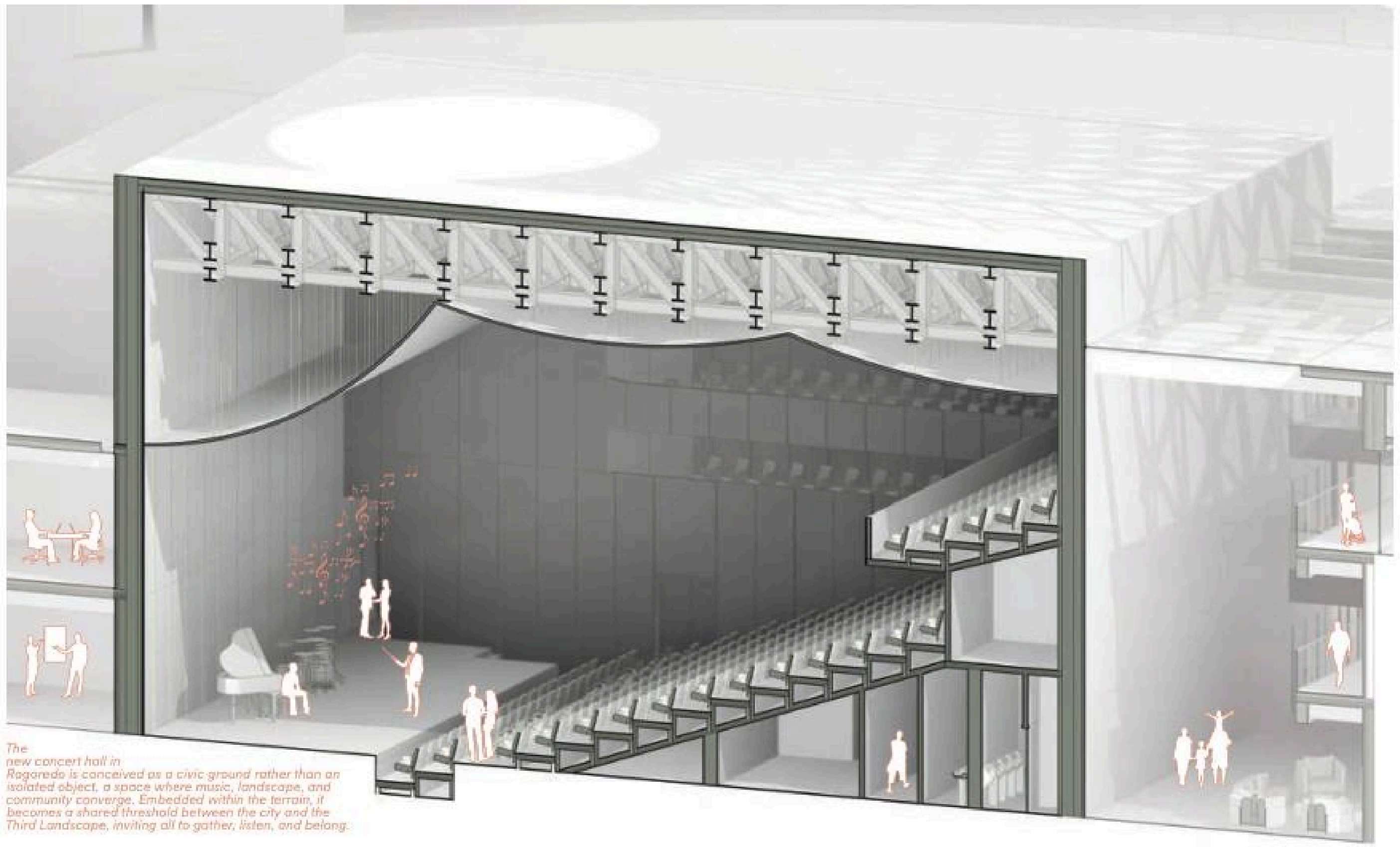
Spatial performance is primarily articulated through section. The stepped seating follows a continuous incline that ensures consistent sightlines across all rows, while reinforcing the downward spatial sequence established throughout the building. The vertical proportions of the hall are calibrated to balance enclosure and openness, allowing sound to develop fully within the space without excessive reverberation. The enclosing walls and ceiling are conceived as continuous surfaces, shaping both acoustic behaviour and visual perception.

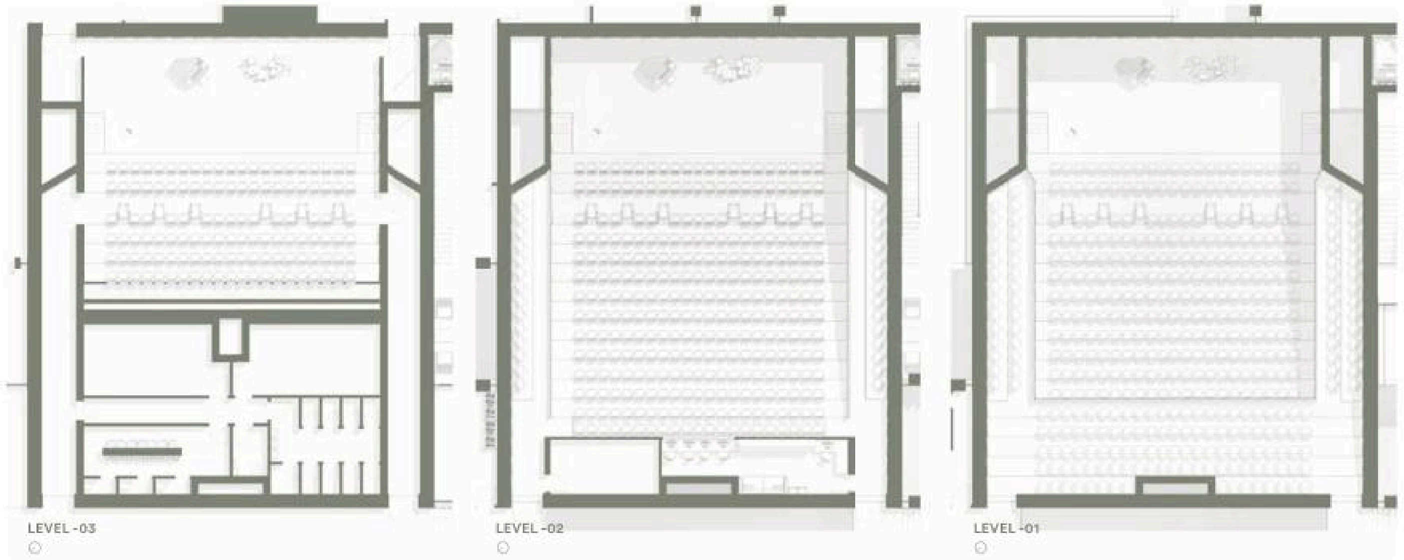
Acoustic performance is achieved through a combination of geometry, material articulation, and surface treatment. Wall panels and ceiling elements are designed to diffuse and reflect sound evenly, avoiding focal echoes while maintaining warmth and clarity. The acoustic studies illustrate how sound propagates from the stage across the seating area, demonstrating controlled reflection and distribution throughout the hall. Material choices are integrated into the architectural language, allowing acoustic elements to read as part of the spatial composition rather than as applied technical devices.

Light within the auditorium is deliberately restrained. Artificial lighting is concealed within architectural elements, reinforcing the sense of enclosure and directing attention toward the stage. This controlled lighting environment supports concentration and reinforces the hall's separation from the external world, aligning with the project's broader emphasis on immersion, resonance, and collective experience.

Together, the plan, section, and acoustic studies demonstrate how the auditorium operates as a precise architectural instrument. Embedded within the ground and shaped by enclosure, the space prioritises listening, focus, and presence. The auditorium does not seek visual spectacle, but instead establishes a concentrated interior condition in which sound, space, and audience are brought into close and deliberate relationship.

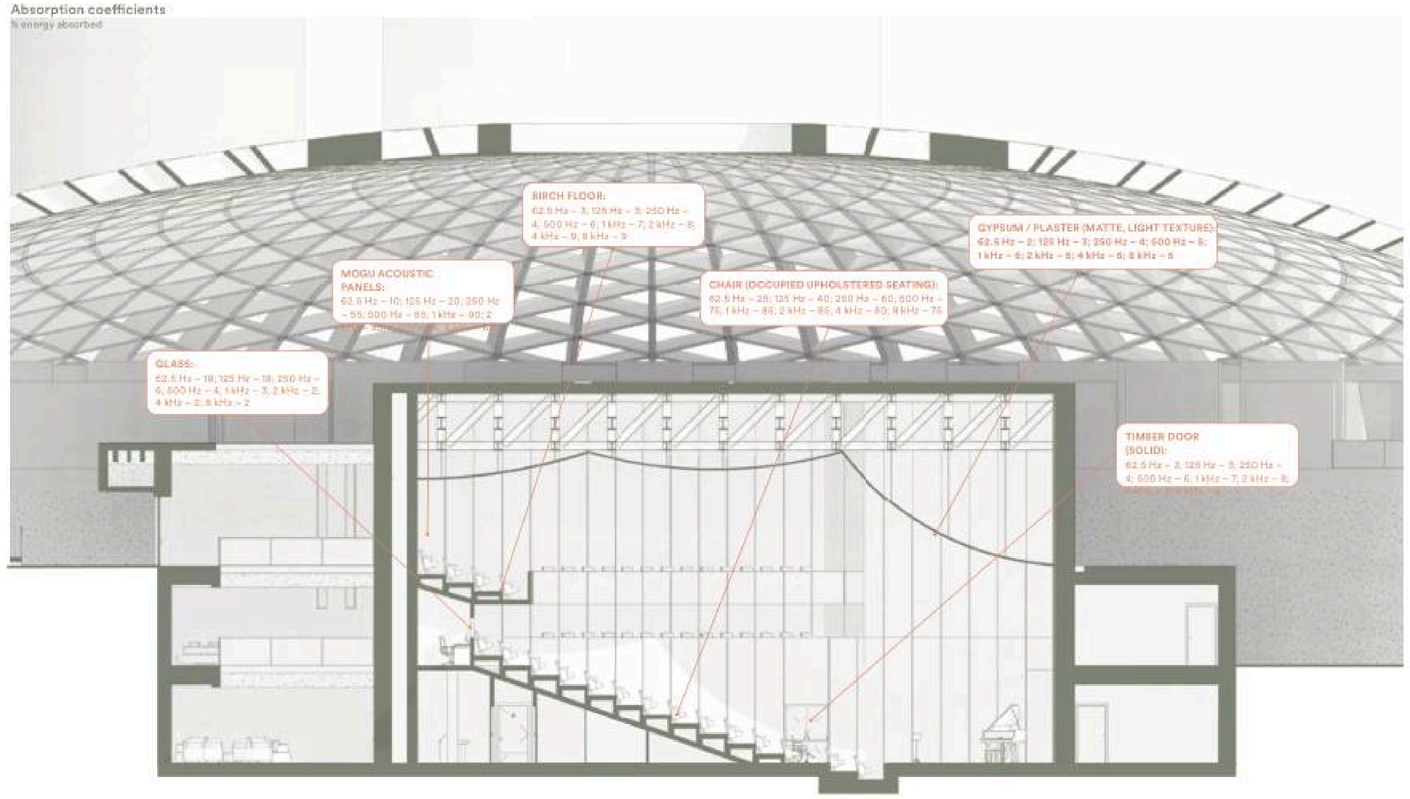
4. The Architecture Below

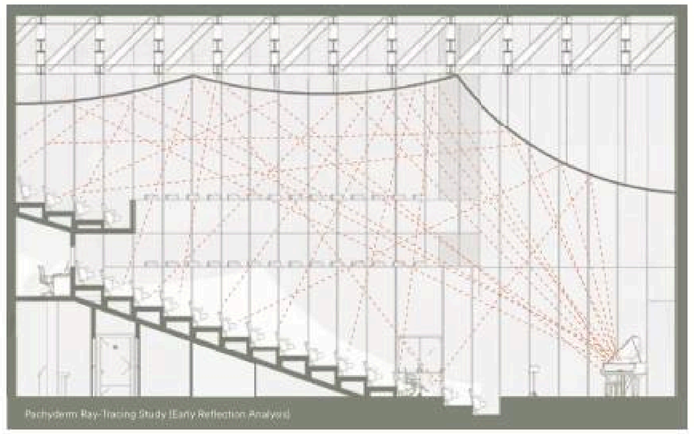


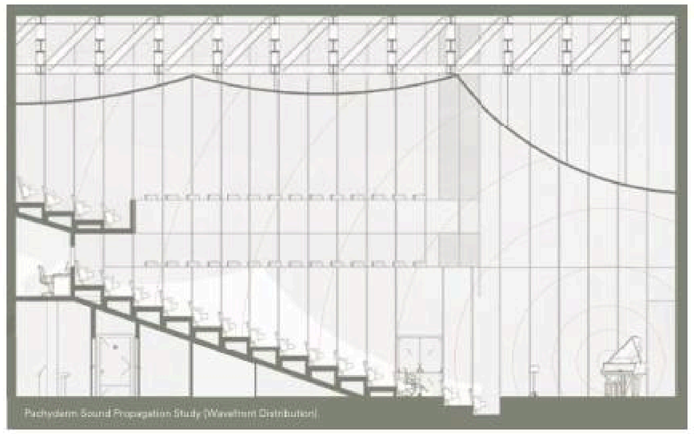


4. The Architecture Below

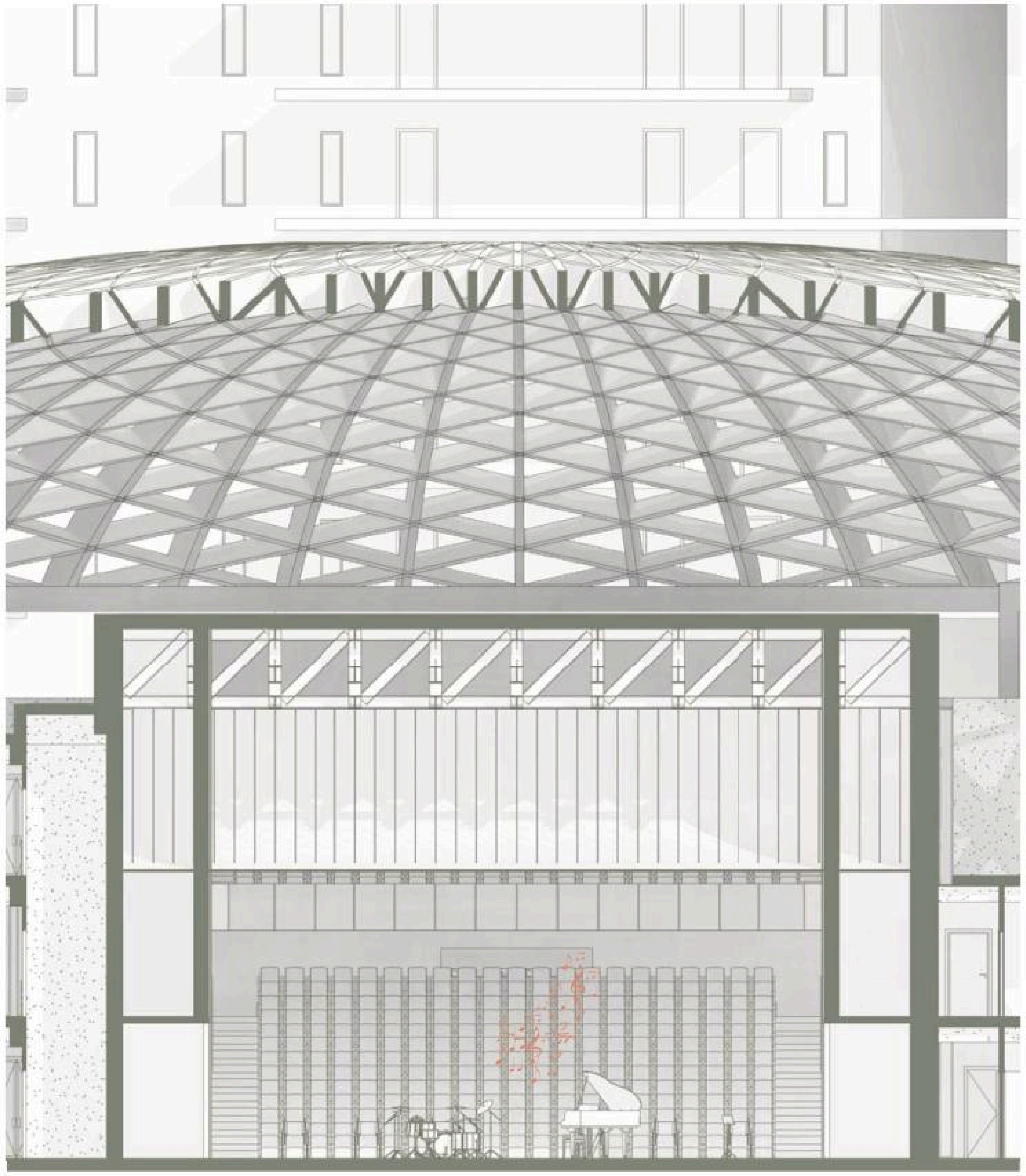
Absorption coefficients
% energy absorbed




Pachyderm Ray-Tracing Study (Early Reflection Analysis)


Pachyderm Sound Propagation Study (Wavefront Distribution)

For an occupied performance, the acoustic strategy balances reflective mass with controlled absorption. The sculpted plaster/gypsum ceiling & panels (2-5%) together with birch timber flooring (3-9%) form a predominantly reflective envelope that preserves early sound energy and spatial warmth. Most wall surfaces remain reflective to maintain lateral envelopment, while Mogu acoustic panels (60–90%) are used selectively at rear and upper zones to control late reflections and prevent flutter echo. Occupied upholstered seating (40-85%) provides the primary mid- and high-frequency absorption once the hall is filled. With a volume of approximately 3,795 m³ & limited absorptive coverage, the hall is calibrated to achieve a mid-frequency reverberation time of roughly 1.8-2.0 seconds (500-1000 Hz), supporting both resonance & clarity.



5. Endurance and Ecology

This section addresses the long-term performance of the project through an integrated consideration of material durability, ecological responsibility, and resource efficiency. If the previous chapters established the spatial, architectural, and landscape strategies of the intervention, this section focuses on how those strategies are sustained over time. Endurance is understood not only as structural longevity, but as the capacity of the project to remain environmentally responsive, materially resilient, and operationally efficient throughout its life cycle.

It includes an in depth investigation on how material choices, construction logic, and circular strategies support durability while reducing environmental impact. Energy, water, and thermal systems are considered as part of a cohesive ecological framework rather than as isolated technical components, ensuring that environmental performance is embedded within the architecture from the outset.

Finally, the section explores time as an active design parameter. Temporal design is understood as the ability of the project to evolve, weather, and adapt to changing environmental and social conditions. Together, these considerations position endurance and ecology not as supplementary concerns, but as foundational principles that support the project's ambition to operate responsibly, efficiently, and sustainably over time.

Circularity

Intentional Design Choices
In an era of accelerated construction cycles, planned obsolescence, and low quality, disposable architecture, this project proposes an ethic of permanence.

Permanence is not rigidity, but responsibility: designing structures that endure physically, adapt socially, and regenerate ecologically. In Italy, where concrete monuments have stood for centuries as civic anchors embedded in the landscape, permanence is understood as cultural continuity rather than excess. Circularity is therefore approached not as a technical checklist, but as a spatial strategy, embedding reuse, reversibility, and material stewardship into the architecture of the ground. The project resists disposability; it settles into the terrain, endures across generations, and evolves without erasure.

The project adopts circular strategies as an extension of its commitment to endurance, seeking to minimise resource consumption while maximising material lifespan and adaptability. Rather than treating circularity as a purely technological add-on, the design integrates circular principles into the architectural logic of construction, use, and long-term transformation. Materials are selected and assembled to allow for repair, reuse, and eventual disassembly, reducing dependence on irreversible systems and short-lived components.

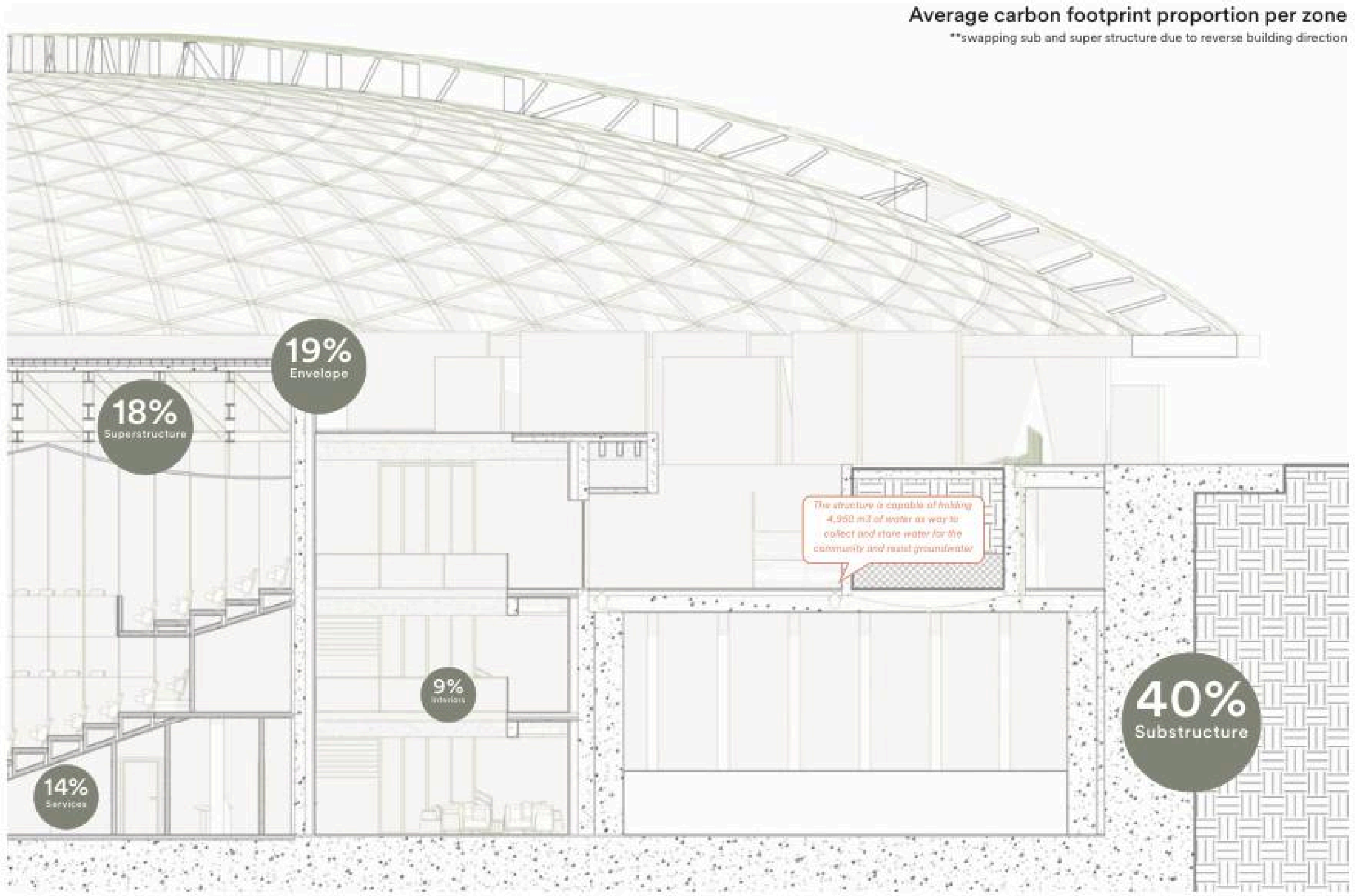
A key circular strategy lies in the reduction of material layers and the consolidation of functions within single elements. Structural concrete walls serve simultaneously as load-bearing elements, acoustic mass, and interior finish, eliminating the need for applied cladding or redundant assemblies. This reduction in material complexity limits waste during construction and simplifies maintenance over time. Where secondary layers are required, they are clearly separated from the primary structure, allowing individual components to be replaced or renewed without compromising the integrity of the building.

Bio-based and regenerative materials play a central role in the project's circular approach. Cork insulation, clay plaster, and mycelium acoustic panels are derived from renewable sources and manufactured through low-impact processes. These materials are selected not only for their environmental performance, but for their capacity to be repaired, composted, or reintegrated into biological cycles at the end of their life. In this way, material obsolescence is replaced by material succession, aligning architectural systems with ecological processes.

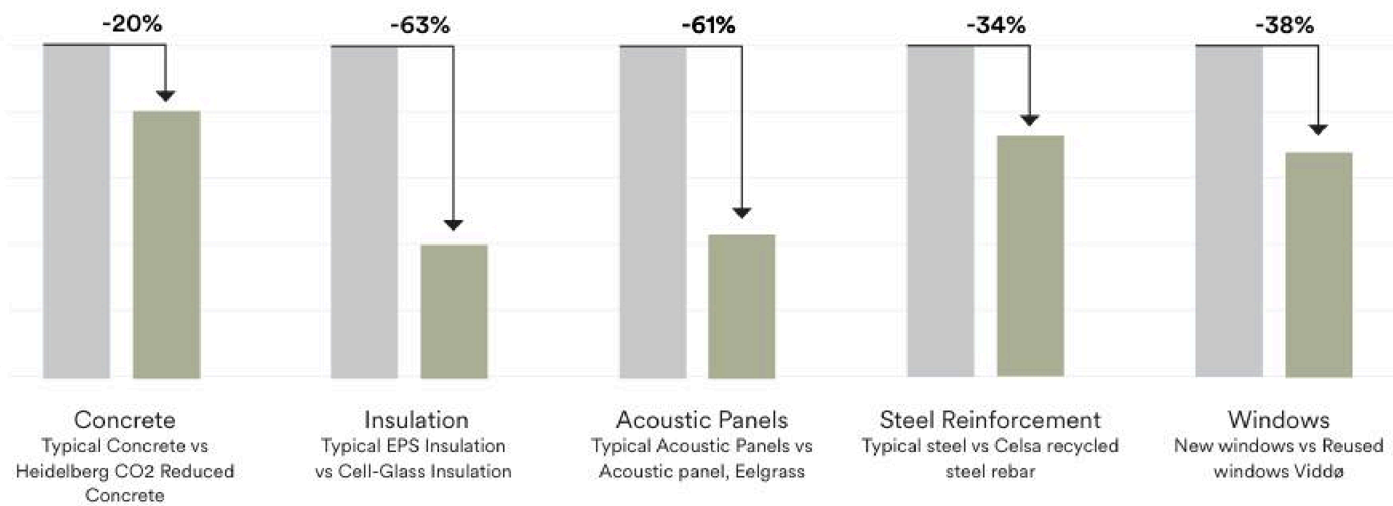
Circular strategies are also reinforced through the project's relationship to the landscape. Excavated soil is reused within the site to shape topography, planting zones, and landscape infrastructure, reducing material export and transportation impacts. The building and landscape are thus understood as part of a single material system, where extraction, reuse, and reintegration occur within a closed territorial loop.

Through these strategies, circularity becomes a spatial and architectural condition rather than a technical checklist. The project prioritises systems that can evolve, be repaired, and be reused, ensuring that endurance is achieved not through over-engineering, but through material intelligence and restraint. Circularity is therefore positioned as a long-term design ethic that supports ecological responsibility, architectural longevity, and adaptive reuse.

Average carbon footprint proportion per zone
**swapping sub and super structure due to reverse building direction



Carbon footprint distribution of elements



Circularity

Project Materiality

Material durability is understood in this project not only as a technical requirement, but as an ethical and ecological position. In a context shaped by long-term neglect and infrastructural abandonment, durability becomes a form of care: a commitment to permanence, reduced maintenance, and extended material life cycles. The architectural choices made for the Rogoredo Music Hall prioritise materials that can withstand time, environmental stress, and intensive use, while remaining legible, repairable, and environmentally responsible.

The primary structural system is composed of exposed concrete shear walls, specified using CarbonCure concrete technology. This system allows the building to retain the structural and acoustic advantages of mass concrete while significantly reducing embodied carbon through the permanent mineralisation of captured CO_2 within the concrete mix.

The use of concrete as both structure and finish reinforces material honesty and eliminates the need for secondary cladding systems, reducing material redundancy and long-term maintenance. Embedded within the earth, these walls benefit from stable thermal conditions, further extending their lifespan and performance.

To complement the structural system, interior insulation is provided by expanded cork panels supplied by Biosughero. Cork is a regenerative, bio-based material harvested without tree felling, aligning durability with ecological renewal. Its resistance to moisture, mould, and pests makes it particularly suited to the building's subterranean condition, while its thermal and acoustic properties enhance long-term comfort and performance. The use of cork strengthens the building envelope without relying on synthetic insulation systems that degrade over time or complicate end-of-life disposal.

Interior finishes further reinforce the project's approach to endurance. Clay plaster is used throughout circulation and public spaces, offering a breathable, repairable, and low-impact surface that improves indoor air quality and regulates humidity. Unlike industrial coatings, clay plaster can be locally repaired and renewed without full replacement, extending the life of interior surfaces while maintaining a tactile connection to the surrounding rewilded landscape.

Openings within the thick concrete envelope are formed using structurally bonded glazing systems, allowing light to penetrate the subterranean spaces without introducing visually dominant framing. These vertical incisions operate as durable, high-performance elements that balance environmental control, acoustic isolation, and spatial clarity. By integrating structure and glazing into a single system, the façade avoids layered complexity and reduces long-term failure points.

Within the auditorium, material durability is paired with acoustic performance through the use of mycelium-based acoustic panels. Produced from fungal structures and upcycled textile waste, these panels combine high sound absorption with low embodied energy and circular production processes. Their lightweight nature allows for replacement or adaptation over time without compromising the primary structure, supporting both functional longevity and environmental responsibility.

Taken together, these material strategies position durability as an active design driver rather than a passive outcome. The building is conceived as a long-term spatial and ecological investment, where materials are selected not only for immediate performance, but for their capacity to age, adapt, and remain relevant within a changing environmental and social context.

5. Endurance and Ecology

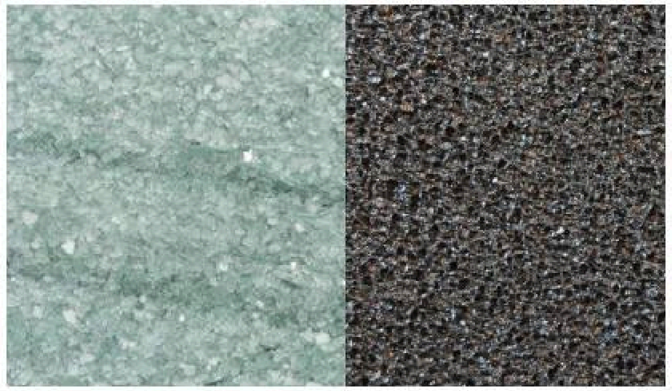
Prioritizing reclaimed, recycled, and bio-based materials within a design framework that enables long-term reuse and material recovery.

Low carbon cement with local recycled crushed aggregates

Recycled steel reinforcement

Clay plaster made from local sourced product

Acoustic panels made from eelgrass



Cell-glass made of recycled glass for slab insulation

Windows made from reused products

Screed made from recycled aggregates

Insulation composed of recycled cork

Circularity

Understanding the impact of each material section

BASEMENT WALLS	GROUND FLOOR SLAB STRUCTURE	GROUND FLOOR SLAB INSULATION	COLUMNS AND BEAMS	WALLS
Concrete C40/50 (452 kgCO2e/m3) + virgin steel rebar (2,29 kgCO2e/kg)	Concrete C30/37 (437,36 kgCO2e/m3) + virgin steel rebar (2,29 kgCO2e/kg)	EPS (132,6 kgCO2e/m3)	Concrete C40/50 (452 kgCO2e/m3) + virgin steel rebar (2,29 kgCO2e/kg)	Concrete C40/50 (452 kgCO2e/m3) + virgin steel rebar (2,29 kgCO2e/kg)
Low carbon concrete C40/50 (325,41 kgCO2e/m3) + recycled steel rebar (1,26 kgCO2e/kg)	Low carbon concrete C30/37 (266,49 kgCO2e/m3) + recycled steel rebar (1,26 kgCO2e/kg)	Cellular glass insulation (1,7 kgCO2e/m3)	Low carbon concrete C40/50 (325,41 kgCO2e/m3) + recycled steel rebar (1,26 kgCO2e/kg)	Low carbon concrete C40/50 (325,41 kgCO2e/m3) + recycled steel rebar (1,26 kgCO2e/kg)

STRUCTURE	INT. CLADDING	GLAZING	ROOF SLAB	ROOF MATERIAL
Concrete C40/50 (452 kgCO2e/m3) + virgin steel rebar (2,29 kgCO2e/kg)	Plaster, primer, and paint (2,3 kgCO2e/m2)	Curtain walls, double glazing tempered glass, alu frame (170,3 kgCO2e/m2)	Concrete C30/37 (437,36 kgCO2e/m3) + virgin steel rebar (2,29 kgCO2e/kg)	Bitumen (6,8 kgCO2e/m2)
Low carbon concrete C40/50 (325,41 kgCO2e/m3) + recycled steel rebar (1,26 kgCO2e/kg)	Clay Plaster (0,031 kgCO2e/m2)	Recycled aluminium frame window (117 kgCO2e/m2)	Hollowcore Deck (0,0894 kgCO2e/kg)	Bitumen tiles made from recycled components (2,67 kgCO2e/m2)

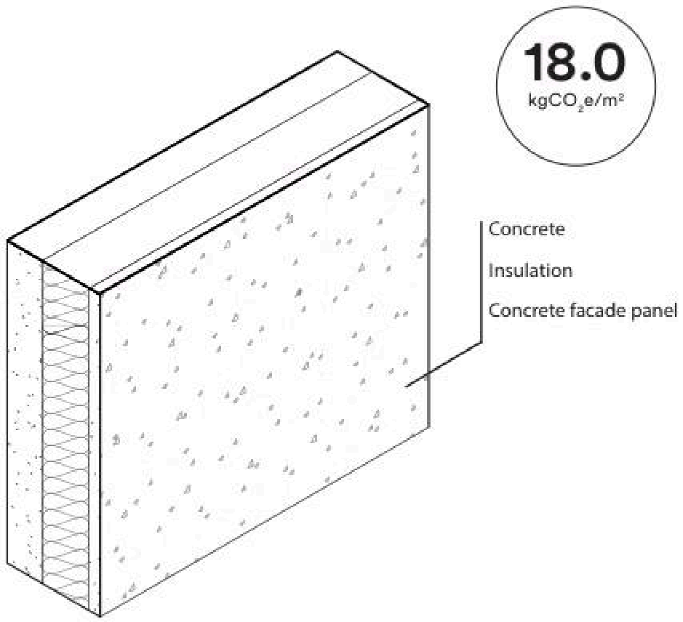
Monolithic concrete substructure

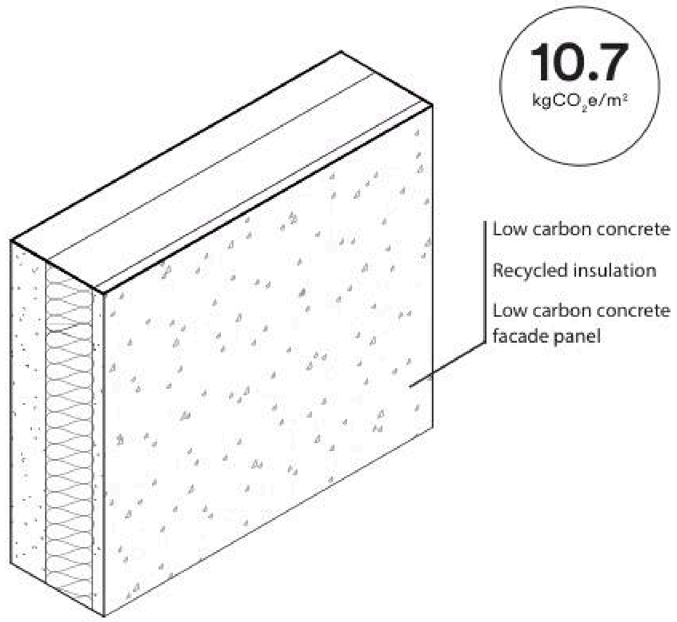
The primary structural system consists of a reinforced concrete substructure embedded within the terrain, forming the long-life civic foundation of the project. The total concrete volume amounts to around 20,000 m³, reflecting the structural demands of the subterranean performance spaces and the project's commitment to long-term durability.

Extended service life

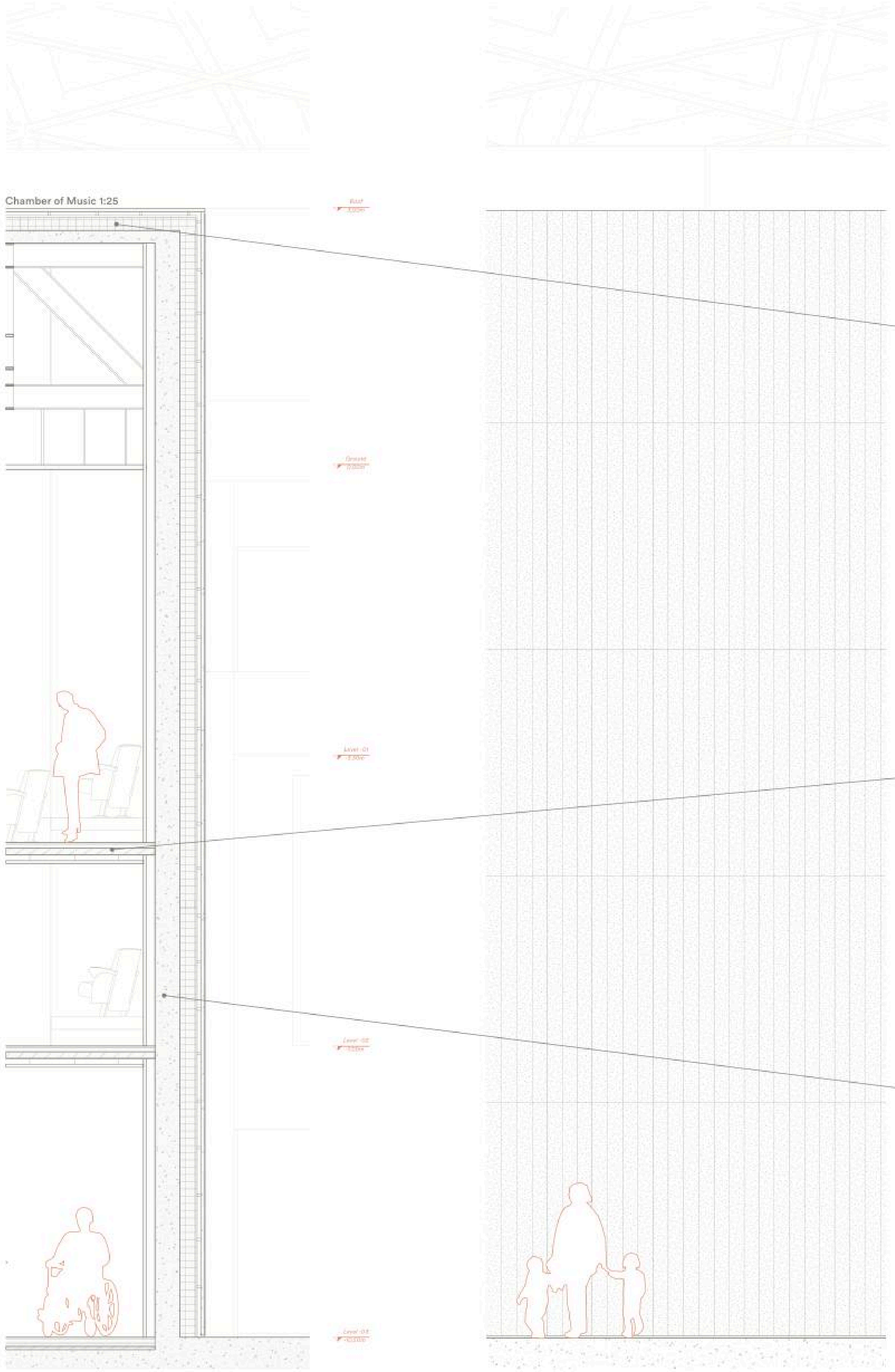
Reduced maintenance requirements

Durability under ground conditions

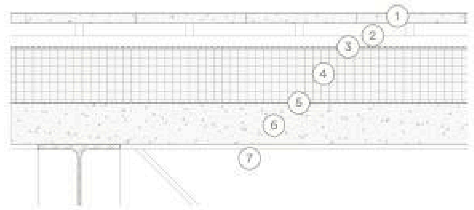




Chamber of Music 1:25

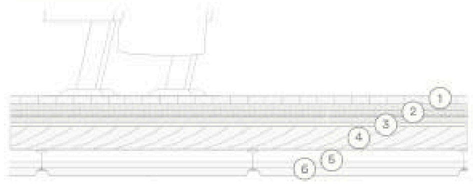


Chamber of Music - Roof
Detailed Section 1:15



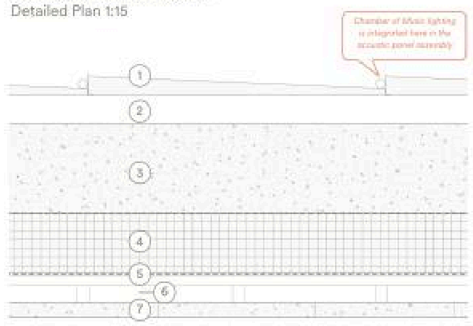
1. 50mm low-carbon precast concrete roof panels sloped (1–2%)
2. 100mm ventilated cavity with aluminium subframe + thermal breaks
3. fully bonded waterproof roofing membrane
4. 200mm recycled cork insulation (continuous, above slab)
5. vapour control layer (fully sealed, airtight)
6. 150mm low carbon concrete slab
7. steel auditorium trusses

Chamber of Music - Balcony Floor
Detailed Section 1:15



1. 20mm reused timber flooring
2. 54mm high-density acoustic floor board (3 layers)
3. 12mm impact sound isolation mat
4. 65mm clt structural deck
5. 15mm søuld eelgrass acoustic mat
6. 25mm mogu acoustic ceiling panel

Chamber of Music - Exterior
Detailed Plan 1:15



1. tilted mogu mycelium acoustic panels
2. 10cm service cavity with secondary support framing for acoustic panels
3. 30cm structural low carbon concrete wall
4. vapour control layer (fully sealed, airtight)
5. 20cm recycled cork insulation
6. vapor-permeable wind barrier membrane
7. 10cm ventilated rainscreen cavity with secondary support framing
8. 5cm low carbon precast facade panels

Material Strategy

Intentional Material Selection Highlights

Exterior Facade & Shear Wall - CarbonCure Conrete
Our building's structural system is defined by thick exposed concrete shear walls, which wrap the perimeter of the volume. To align structural integrity with environmental responsibility, we picked CarbonCure concrete, an innovative, low-carbon alternative to conventional cement-based mixes. CarbonCure technology works by injecting captured industrial CO_2 directly into the concrete mix, where it mineralizes and becomes permanently embedded as calcium carbonate. This process not only reduces the embodied carbon of each cubic meter of concrete by approximately 5–15%, but also enhances compressive strength, enabling high-performance structural elements without compromise.

Figure 5.1: Concrete Construction

Interior Insulation - Cork by Biosughero
To complement the CarbonCure concrete shear walls, expanded cork insulation panels supplied by Biosughero, a local Italian company dedicated to circular, bio-based building materials, were chosen. Harvested without cutting trees, cork is a regenerative, low-impact material with strong ties to regional supply chains, much of it processed in Tuscany and Sardinia. Its natural resistance to moisture, mold, and pests makes it ideal for the below-grade environment of a sunken structure, while its breathable, capillary-active behavior allows for passive regulation of interior humidity levels. Beyond its thermal performance, cork also provides outstanding acoustic insulation, making it a strategic envelope choice for a music hall, where control of sound transmission and reverberation is essential.

Figure 5.2-3: Cork Panel Insulation

Clay Plaster Finishes - Throughout the Building
Throughout the building, we've incorporated clay plaster finishes: an ancient, natural material composed of clay, sand, and mineral aggregates. Locally sourced and produced in Italy, clay plaster supports a low-impact, regional supply chain that aligns with our commitment to sustainable construction. Celebrated for its tactile warmth and subtle tonal variation, clay plaster brings a sense of natural softness to interior spaces. Its organic texture resonates with the surrounding park's rewilding narrative, reinforcing the project's ecological identity and creating a harmonious transition between built and natural environments.

Figure 5.4-5: Clay Plaster

Auditorium Acoustic Panels - Mogu Mycelium Panels
To enhance the acoustic environment of the music hall, we have selected Mogu Acoustic Panels, crafted from mycelium, the root-like structure of fungi, and upcycled textile residues. Produced in Lombardy, Italy, these panels support a local, circular supply chain aligned with our sustainability goals. The panels' organic textures and forms evoke the beauty and complexity of nature, integrating the auditorium's interior with the landscape's regeneration ethos. Acoustically, Mogu panels provide exceptional sound absorption, especially in the critical speech frequency range (250–1000 Hz), ensuring clarity and comfort in the performance space. They are naturally fire-retardant (B-s1-d0 rating) and VOC-free, promoting healthy indoor air quality.

Figure 5.6-7: Cork Panel Insulation

Material Strategy

Thermal protection

U = 0,22 W/(m²K)

GEG 2020/24 Bestand*: U<0,24 W/(m²K)

excellent insufficient

Moisture proofing

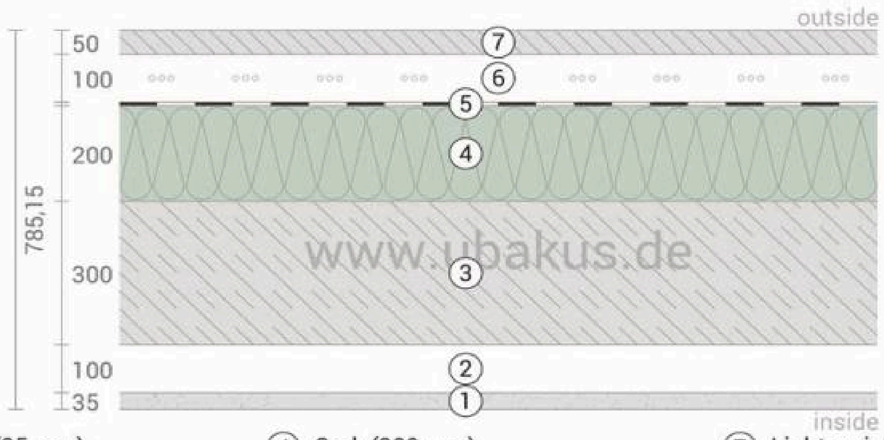
No condensate

excellent insufficient

Heat protection

Temperature amplitude damping: >100
phase shift: non relevant
Thermal capacity inside: 622 kJ/m²K

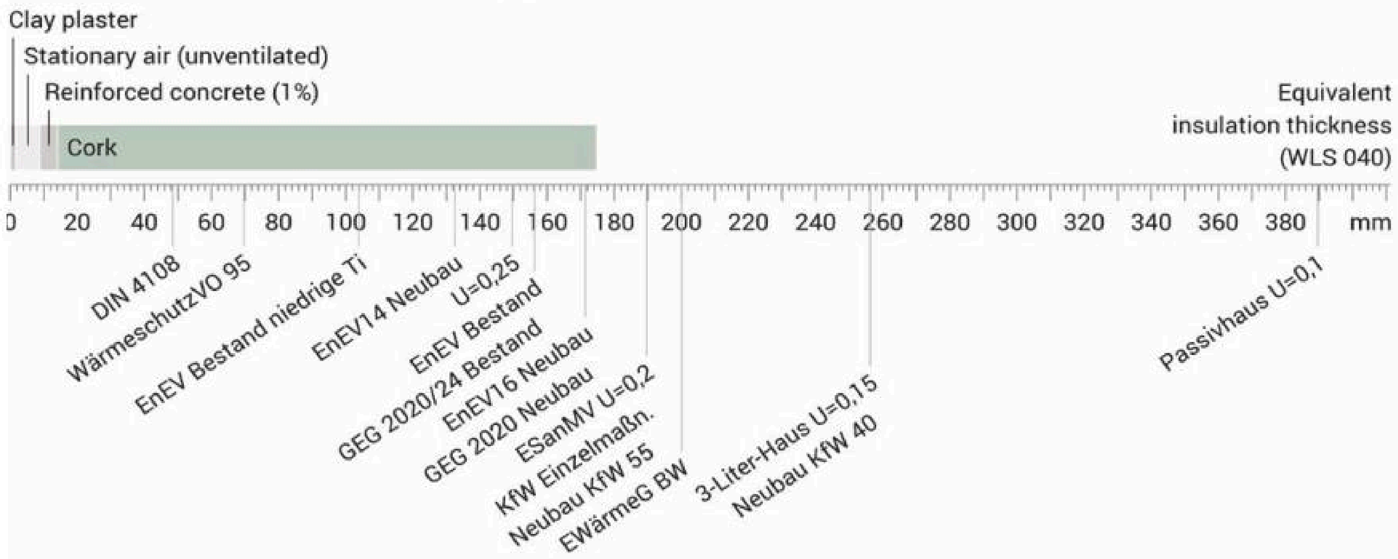
excellent insufficient



1. Clay plaster (35 mm)
2. Stationary air (100 mm)
3. Reinforced concrete (300 mm)
4. Cork (200 mm)
5. Windpapier Ampack
6. Rear ventilated level (100 mm)
7. Light weight concrete (50 mm)

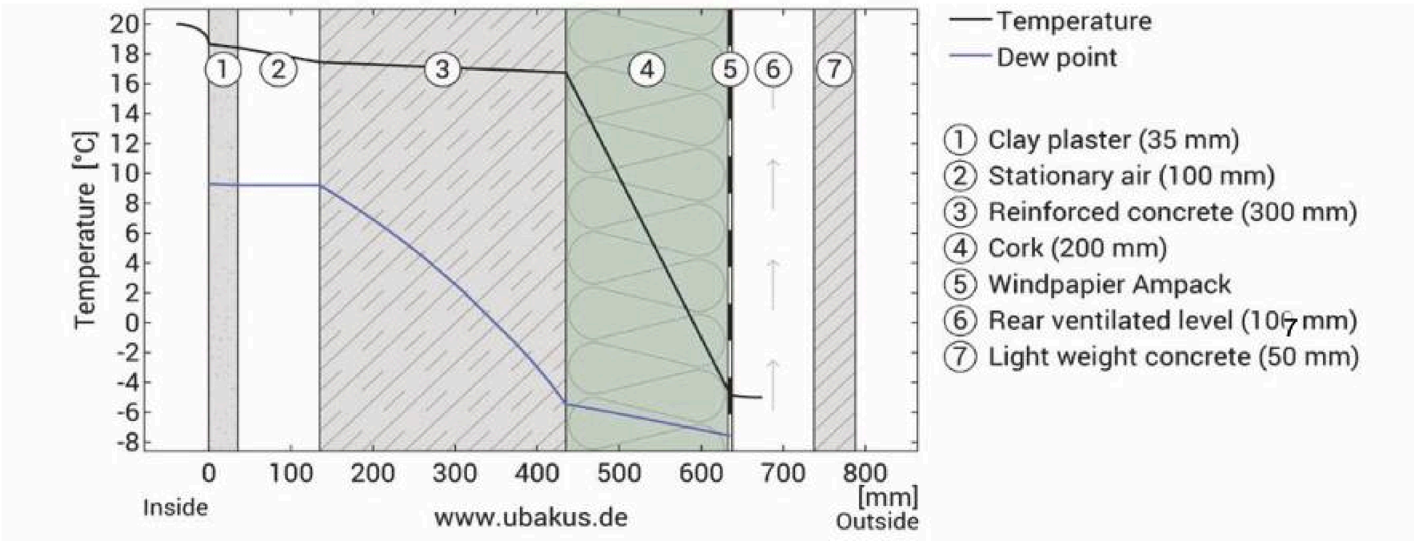
Impact of each layer and comparison to reference values

For the following figure, the thermal resistances of the individual layers were converted in millimeters insulation. The scale refers to an insulation of thermal conductivity 0,040 W/mK.



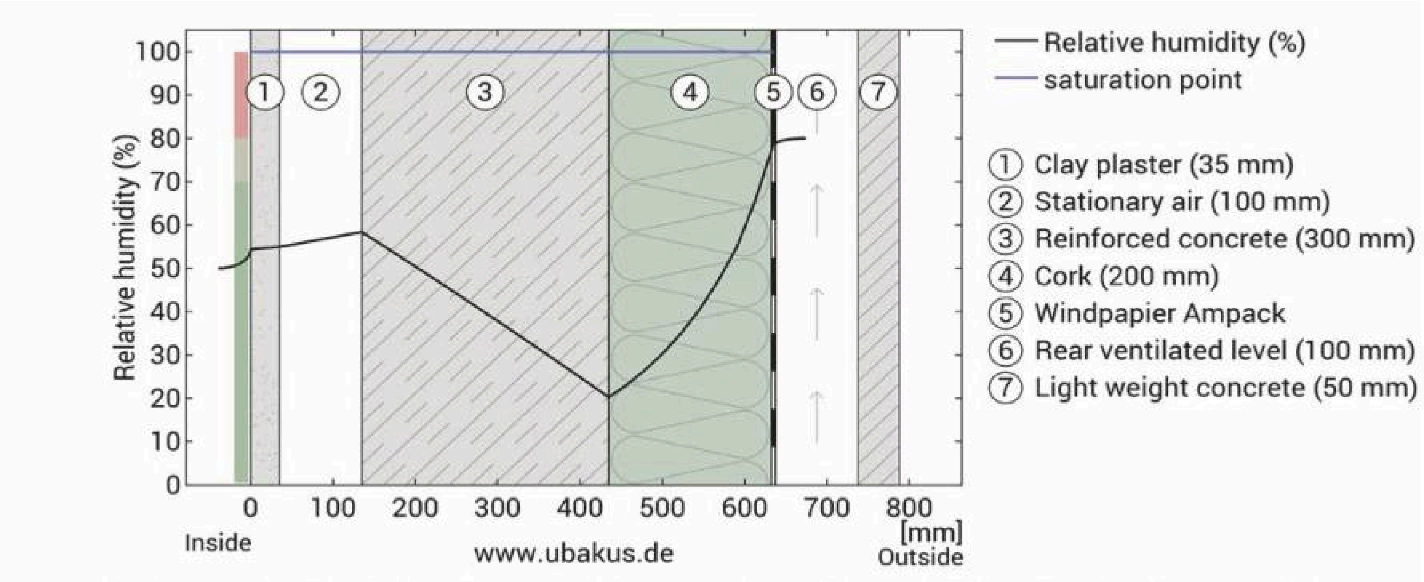
The analysis shows that the temperature line never crosses the dew point line, meaning no condensation forms inside the wall, as the external cork insulation keeps the concrete warm and shifts moisture risk toward the ventilated outer layer.

TEMPERATURE PROFILE



The humidity profile shows that relative humidity remains below the saturation point throughout the wall section, confirming that no moisture accumulation or condensation occurs within the assembly.

HUMIDITY



6. The Functional Systems

While the previous sections establish the architectural, spatial, and environmental logic of the project, this chapter focuses on the systems that allow the building to function as a coherent and enduring building. The functional systems are not approached as secondary technical resolutions, but as integral components that shape how the architecture is formed, inhabited, and maintained over time.

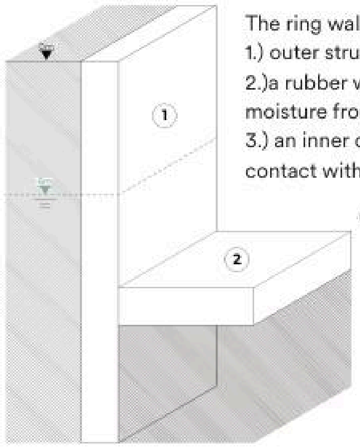
Structure, services, and construction are understood here as active design agents, influencing spatial organisation, material expression, and environmental performance. The structural strategy defines the project's primary framework and relationship to load, span, and ground, while mechanical, lighting, and energy strategies are developed in direct response to the building's spatial depth, enclosure, and climatic behaviour. Rather than relying on concealed or generic solutions, these systems are embedded within the architectural logic, reinforcing clarity, legibility, and robustness.

The section concludes by addressing construction and economic strategies, situating the project within realistic constraints of assembly, material availability, and cost. In doing so, the functional systems are framed not as optimisations of efficiency alone, but as contributors to the project's long-term resilience, adaptability, and architectural integrity.

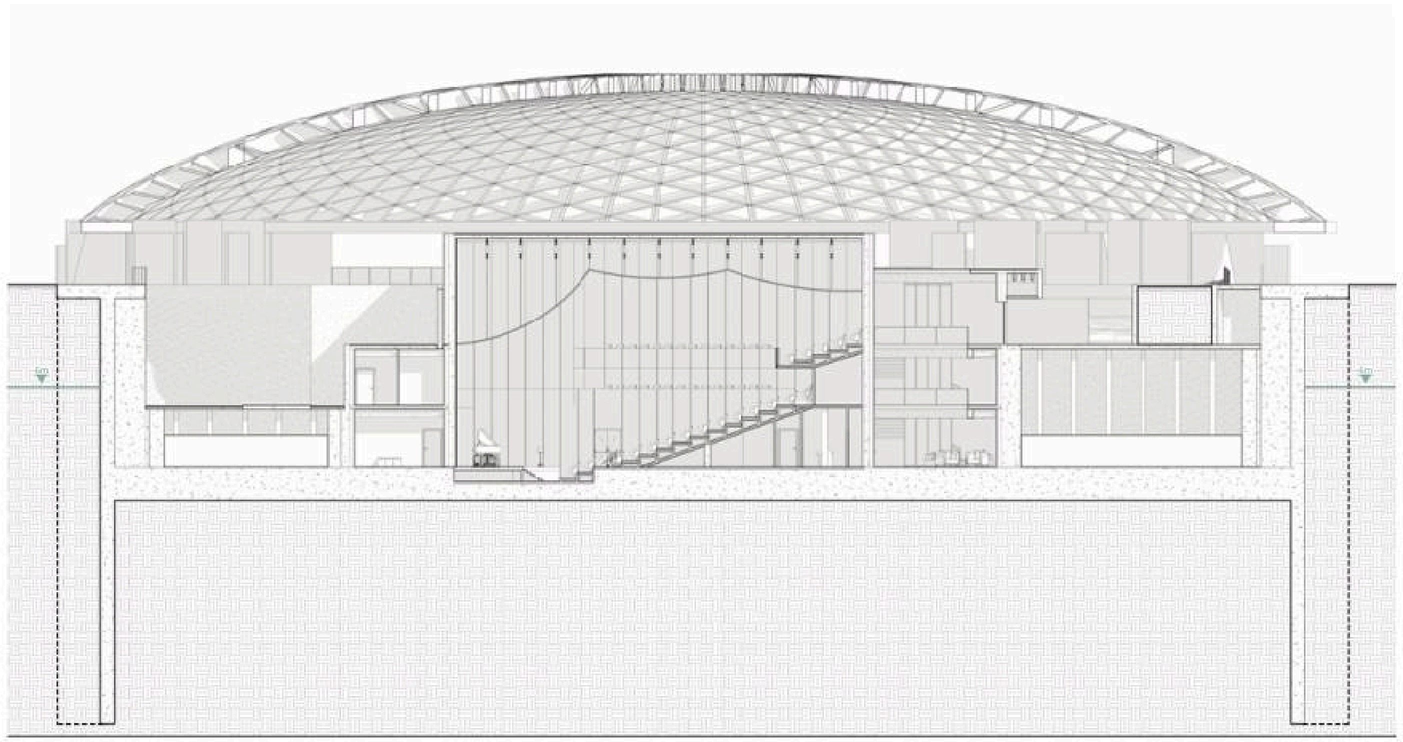
Structural Strategy

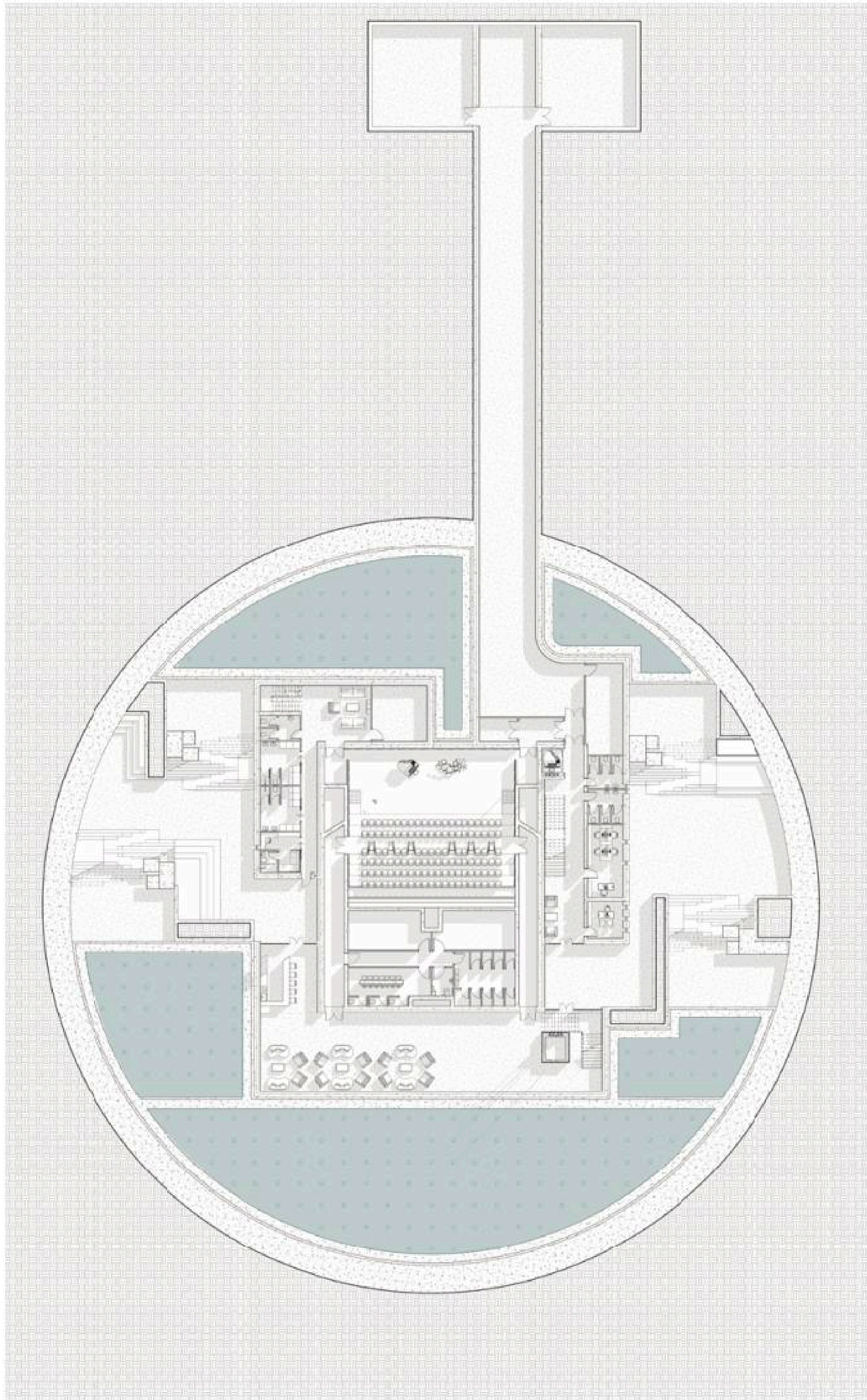
Water Table Challenges

Our site in Rogoredo, Milan, lies above a high water table typical of the Po Valley region, where groundwater sits only 6 meters below the surface due to the area's low elevation and alluvial soil conditions. Because our building is sunken, we had to carefully address the challenges posed by hydrostatic pressure and potential water infiltration. This led us to design a thick foundation and a layered ring wall system to ensure both structural stability and long-term durability. This composition allows the wall to withstand both external groundwater pressure and internal water loads, while maintaining the integrity of the structure over time. To address the permeability of our canopy and promote sustainable water management, our design integrates water storage tanks beneath the sunken levels of the Mineral Garden. Rainwater that filters through the canopy and landscape is collected and directed into these underground tanks, taking advantage of the site's natural drainage while preventing excessive runoff. This stored water is then repurposed for grey water uses such as flushing toilets and irrigating planted areas, reducing reliance on the municipal water supply and reinforcing the project's environmental responsiveness.

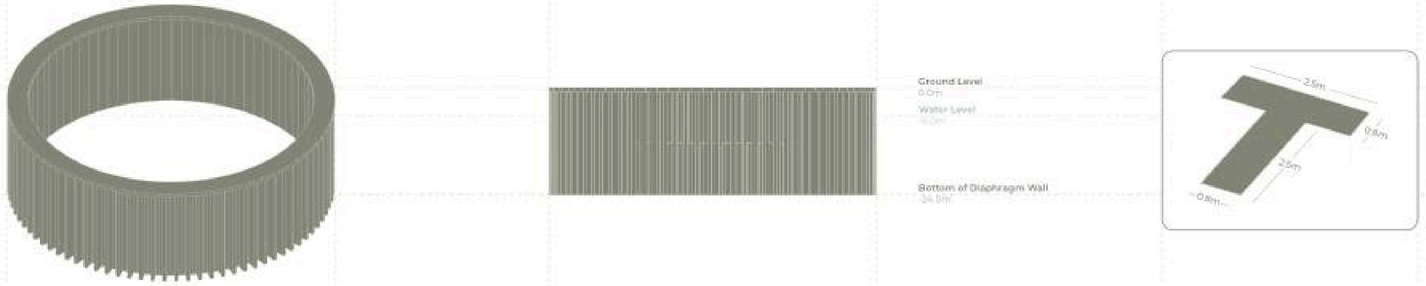


The ring wall is composed of an:
1.) outer structural concrete layer
2.)a rubber water insulant that prevents moisture from degrading the structure
3.) an inner concrete layer that comes into contact with the interior water tank.



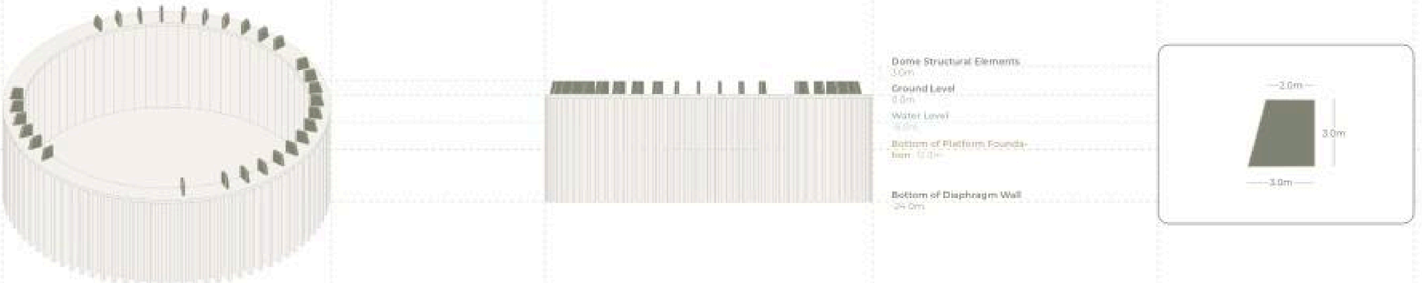


Structural Strategy



DOME RING

PLATFORM FOUNDATION

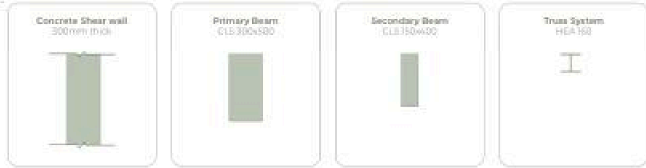


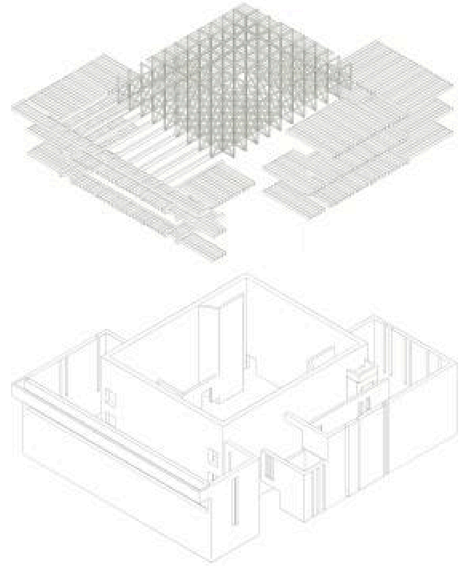
DOME COLUMNS

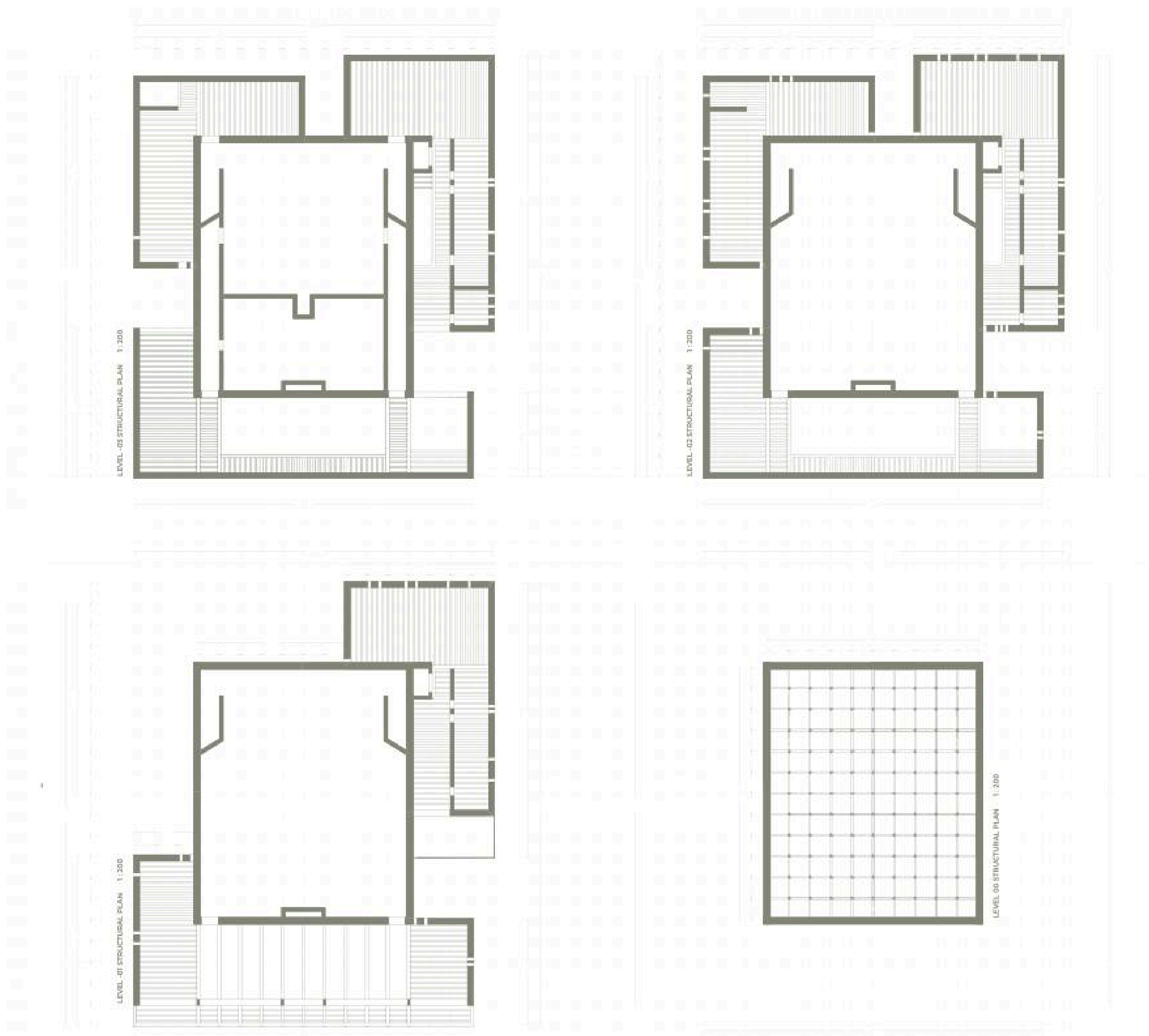
DOME STRUCTURE

The structural system of the Music Hall is based on a reinforced concrete frame, composed of concrete shear walls, beams, and columns. This system ensures overall stability and load transfer, with vertical loads carried through beams and columns to the foundations, while shear walls provide resistance to horizontal actions and contribute to the global stiffness of the building.

Within the main auditorium, the roof and ceiling system is supported by a series of steel trusses spanning above the performance space. This solution allows for a wide, column-free interior while limiting structural depth and controlling deformations. The steel trusses were analytically verified using MIDAS Gen, where dead and live loads were applied and evaluated under both Serviceability and Ultimate Limit States. Different steel profiles were compared under identical conditions to assess displacements and stress utilization, leading to the selection of an optimized solutionThe material heaviness of the structural system was intentionally chosen to resonate with the physical and symbolic weight of the ground. The use of reinforced concrete expresses a direct relationship with the soil, anchoring the Music Hall to the site and reinforcing the idea of the ground as an active, resonant element rather than a neutral base .

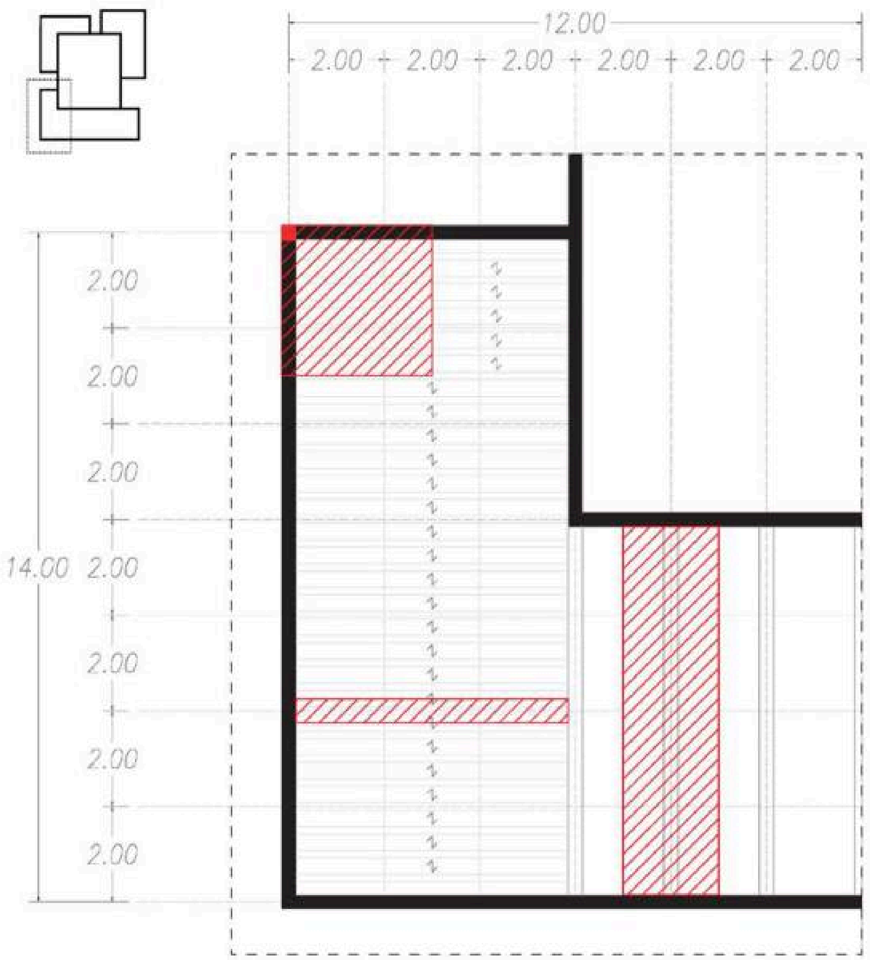




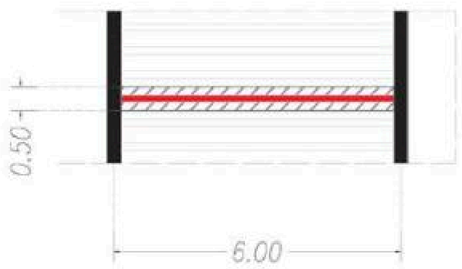


Structural Strategy

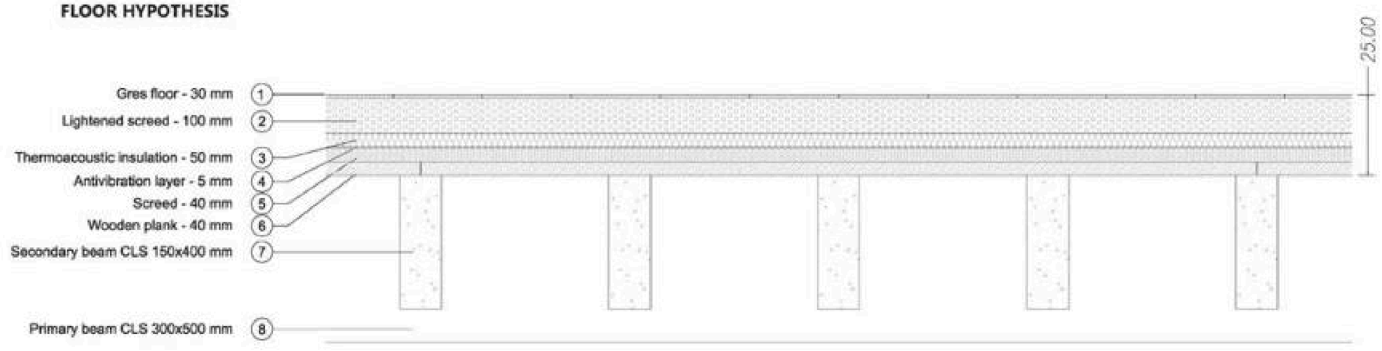
PLAN AND TRIBUTARY AREA



SECONDARY BEAM AND TRIBUTARY AREA



FLOOR HYPOTHESIS



FLOOR WEIGHT

Material		Weight in Kg/m3	Thickness in mm	Thickness in m	Weight in Kg/m3	TOTAL weight in kN/m2
Gres	1	/	10	0.01	24	4.67
Lightened screed	2	1200	100	0.1	120	
Thermoacoustic insulation	3	250	50	0.05	12.5	**Dead Loads**
Antivibration layer	4	/	5	0.01	6	4.67
Screed	5	2000	40	0.04	80	
Wooden plank	6	750	40	0.04	30	**Live Loads**
Primary beams	7	/	500	0.5		NCT 2018 cat. C2 = 4
Secondary beams	8	/	400	0.4		

COMPUTATIONS - SECONDARY BEAMS

DATA

Beam: IPE 220

Span (L) = 6 m

Spacing (l) = 0.5 m

Dead Loads (G) = 4.67 $\frac{kN}{m^2}$

Live Loads (Q) = 4 $\frac{kN}{m^2}$

Safety coefficient – DL (γ_g) = 1.35

Safety coefficient – LL (γ_q) = 1.5

Young's Module (E) = 21000 $\frac{N}{mm^2}$

ULS (Ultimate Limit State)

$q_{ULS} = \gamma_g \times G + \gamma_q \times Q \rightarrow q_{ULS} = 1.35 \times 4.67 \frac{kN}{m^2} + 1.5 \times 4 \frac{kN}{m^2} = 12.31 \frac{kN}{m^2}$

$q_{linear} = q_{ULS} \times l \rightarrow q_{linear} = 12.31 \frac{kN}{m^2} \times 0.5\, m = 6.16 \frac{kN}{m}$

$M_d = \frac{q_{linear} \times L^2}{8} \rightarrow M_d = \frac{6.16 \frac{kN}{m}(6\, m)^2}{8} = 27.72\, kNm$

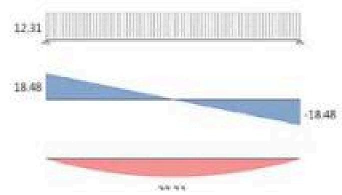
$V_d = \frac{1}{2} \times q_{linear} \times l \rightarrow V_d = \frac{1}{2} \times 6.16 \frac{kN}{m} \times 6\, m = 18.48\, kN$

BENDING MOMENT RESISTANCE CHECK

$M_r = \frac{W_{pl} \times f_{yk}}{\gamma_m} \rightarrow M_r = \frac{285000\, mm^3 \times 235 \frac{N}{mm^2}}{1.05} = 63.79\, kNm$

$\frac{M_d}{M_r} \le 1 = \frac{27.72\, kNm}{63.79\, kNm} = 0.44 \le 1 \rightarrow verified$

INTERNAL ACTION DIAGRAM



SHEAR RESISTANCE CHECK

$V_r = \frac{A_v \times f_{yk}}{\gamma_m \times \sqrt{3}} \rightarrow V_r = \frac{1590\, mm^2 \times 235 \frac{N}{mm^2}}{1.05 \times \sqrt{3}} = 205.45\, kN$

$\frac{V_d}{V_r} \le 1 = \frac{18.48\, kN}{205.45\, kN} = 0.09 \le 1 \rightarrow verified$

ULS (Ultimate Limit State)

DEFLACTION RESISTANCE CHECK (Total load)

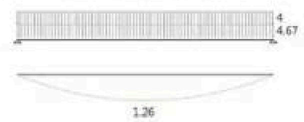
$q_{SLS} = G + Q \rightarrow q_{SLS} = 4.67 \frac{kN}{m^2} + 4 \frac{kN}{m^2} = 8.67 \frac{kN}{m^2}$

$q_{linear} = q_{SLS} \times l \rightarrow q_{linear} = 8.67 \frac{kN}{m^2} \times 0.5\, m = 4.34 \frac{kN}{m}$

$\eta_d = \frac{5qL^4}{384EI} \rightarrow \eta_d = \frac{5}{384} \frac{4.34 \frac{kN}{m} \times (6\, m)^4}{210000000 \frac{kN}{m^2} \times 0.00002772\, m4} = 0.0126\, m = 1.26\, cm$

$\eta_r = \frac{l}{250} \rightarrow \eta_r = \frac{6\, m}{250} = 0.024\, m = 2.4\, cm$

$\eta_d \le \eta_r = 1.26\, cm \le 2.4\, cm \rightarrow verified$



DEFLACTION RESISTANCE CHECK (Live load only)

$q = Q = 2 \frac{kN}{m^2}$

$q_{linear} = Q \times l \rightarrow q_{linear} = 4 \frac{kN}{m^2} \times 0.5\, m = 2 \frac{kN}{m}$

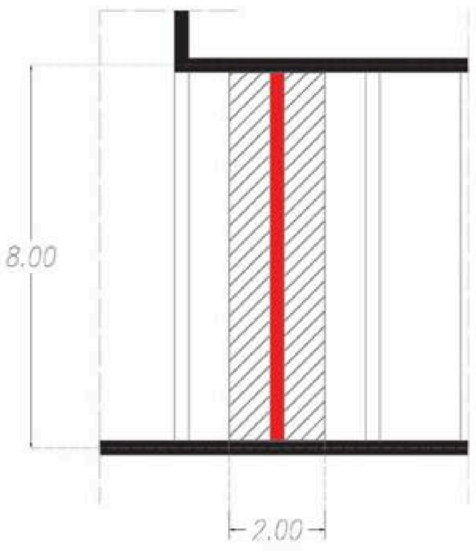
$\eta_d = \frac{5qL^4}{384EI} \rightarrow \eta_d = \frac{5}{384} \frac{2 \frac{kN}{m} \times (6\, m)^4}{210000000 \frac{kN}{m^2} \times 0.00002772\, m4} = 0.006\, m = 0.6\, cm$

$\eta_r = \frac{l}{300} \rightarrow \eta_r = \frac{6\, m}{300} = 0.02\, m = 2\, cm$

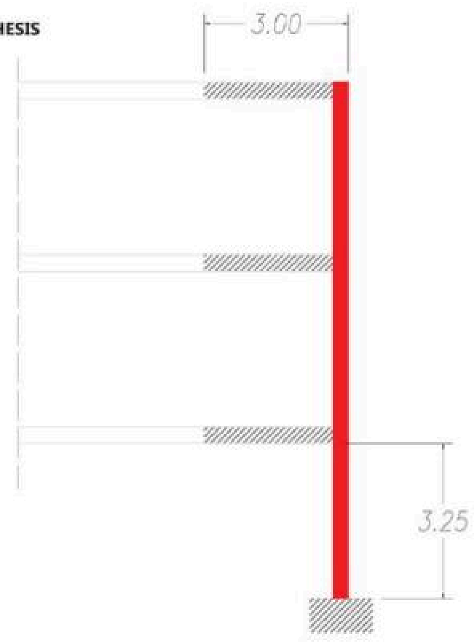
$\eta_d \le \eta_r = 0.6\, cm \le 2\, cm \rightarrow verified$

Structural Strategy

PRIMARY BEAM AND TRIBUTARY AREA



COLUMN HYPOTHESIS



COLUMN HYPOTHESIS

$q_{ULS} = \gamma_g \, x \, G + \gamma_q \, x \, Q \rightarrow q_{ULS} = 1.3 \, x \, 7.73 \frac{kN}{m^2} + 1.5 \, x \, 4 \frac{kN}{m^2} = 16.05 \frac{kN}{m^2}$

Overall axial load acting on the column $N_{sd} = q_{ULS} * A * 3 \rightarrow N_{sd} = 16.05 \frac{kN}{m^2} \, x \, 9 \, m^2 x \, 3 =$

Chosen concrete $\rightarrow C \; 40/50$

Pillar height (H) = $30 \, cm = 0.3 \, m$

Pillar base (B) = $30 \, cm = 0.3 \, m$

Pillar Area (A) = $b \, x \, h = (0.3 \, m)x(0.3 \, m) = 0.09 \, m^2$

Pillar total height (h) = $3.25 \, m$

Inertia radius $i = \frac{h}{\sqrt{12}}$ for rectangular section

Effective slenderness $\lambda_{eff} = \frac{l_0}{i} = \frac{l_0}{\frac{h}{\sqrt{12}}} = \frac{\sqrt{12} \cdot l_0}{h} = \frac{\sqrt{12} \cdot 325}{50} = 22.51$

Limit slenderness $\lambda_{limit} = \frac{20}{n} = \frac{20}{\frac{N_d}{A \cdot fcd}} = \frac{20}{\frac{[illegible] \, daN}{50^2 \cdot 22.67}} = 41.64$

$\lambda_{eff} \leq \lambda_{limit} \rightarrow \omega = 1{,}0$

Acting Stress $\sigma = \frac{N}{\omega \cdot A} = \frac{433.35 \, x \, 100 \, daN}{1 \, x \, 50^2 cm^2} = 17.33 \frac{daN}{cm^2}$

$R_{ck} = 300 \frac{daN}{cm^2}$

Design stress $\sigma_{amm} = 0.7 \cdot \left(60 + \frac{Rck - 150}{4}\right) = 0.7 \cdot \left(60 + \frac{300 - 150}{4}\right) = 68.25 \frac{daN}{cm^2}$

$\sigma \leq \sigma_{amm} \rightarrow 17.33 \frac{daN}{cm^2} \leq 68.25 \frac{daN}{cm^2} \rightarrow verified$

COMPUTATIONS - PRIMARY BEAMS

DATA

Beam: IPE 500

Span (L) = $8 \, m$

Spacing (l) = $6 \, m$

Dead Loads (G) = $4.67 \frac{kN}{m^2}$

Live Loads (Q) = $4 \frac{kN}{m^2}$

Safety coefficient – DL (γ_g) = 1.35

Safety coefficient – LL (γ_q) = 1.5

Young's Module (E) = $21000 \frac{N}{mm^2}$

ULS (Ultimate Limit State)

$q_{ULS} = \gamma_g \times G + \gamma_q \times Q \rightarrow q_{ULS} = 1.35 \times 4.67 \frac{kN}{m^2} + 1.5 \times 4 \frac{kN}{m^2} = 12.31 \frac{kN}{m^2}$

$q_{linear} = q_{ULS} \times l \rightarrow q_{linear} = 12.31 \frac{kN}{m^2} \times 6 \, m = 73.86 \frac{kN}{m}$

$M_d = \frac{q_{linear} \times L^2}{10} \rightarrow M_d = \frac{73.86 \frac{kN}{m} (8 \, m)^2}{10} = 472.04 \, kNm$

$V_d = \frac{1}{2} \times q_{linear} \times l \rightarrow V_d = \frac{1}{2} \times 73.86 \frac{kN}{m} \times 6 \, m = 221.58 \, kN$

BENDING MOMENT RESISTANCE CHECK

$M_r = \frac{W_{pl} \times f_{yk}}{\gamma_m} \rightarrow M_r = \frac{2194000 \, mm^3 \times 235 \frac{N}{mm^2}}{1.05} = 491.03 \, kNm$

$\frac{M_d}{M_r} \leq 1 = \frac{472.04 \, kNm}{491.03 \, kNm} = 0.96 \leq 1 \rightarrow verified$

ULS (Ultimate Limit State)

DEFLACTION RESISTANCE CHECK (Total load)

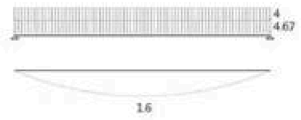
$q_{SLS} = G + Q \rightarrow q_{SLS} = 4.67 \frac{kN}{m^2} + 4 \frac{kN}{m^2} = 8.67 \frac{kN}{m^2}$

$q_{linear} = q_{SLS} \times l \rightarrow q_{linear} = 8.67 \frac{kN}{m^2} \times 6 \, m = 52.02 \frac{kN}{m}$

$\eta_d = \frac{3qL^4}{384EI} \rightarrow \eta_d = \frac{3}{384} \frac{52.02 \frac{kN}{m} \times (8 \, m)^4}{210000000 \frac{kN}{m^2} \times 0.00048200 \, m^4} = 0.016 \, m = 1.6 \, cm$

$\eta_r = \frac{l}{250} \rightarrow \eta_r = \frac{6 \, m}{250} = 0.024 \, m = 2.4 \, cm$

$\eta_d \leq \eta_r = 0.016 \, m \leq 0.024 \, m \rightarrow verified$



DEFLACTION RESISTANCE CHECK (Live load only)

$q = Q = 4 \frac{kN}{m^2}$

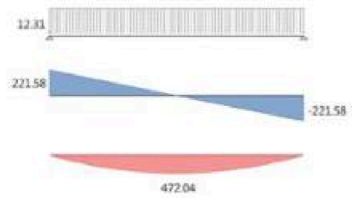
$q_{linear} = Q \times l \rightarrow q_{linear} = 4 \frac{kN}{m^2} \times 6 \, m = 18 \frac{kN}{m}$

$\eta_d = \frac{3qL^4}{384EI} \rightarrow \eta_d = \frac{3}{384} \frac{18 \frac{kN}{m} \times (8 \, m)^4}{210000000 \frac{kN}{m^2} \times 0.00048200 \, m^4} = 0.0057 \, m = 0.57 \, cm$

$\eta_r = \frac{l}{300} \rightarrow \eta_r = \frac{6 \, m}{300} = 0.02 \, m = 2 \, cm$

$\eta_d \leq \eta_r = 0.57 \, cm \leq 2 \, cm \rightarrow verified$

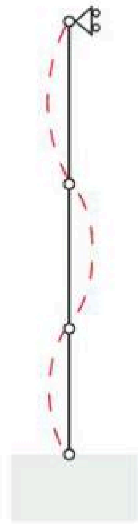
INTERNAL ACTION DIAGRAM



SHEAR RESISTANCE CHECK

$V_r = \frac{A_v \times f_{yk}}{\gamma_m \times \sqrt{3}} \rightarrow V_r = \frac{5090 \, mm^2 \times 235 \frac{N}{mm^2}}{1.05 \times \sqrt{3}} = 657.71 \, kN$

$\frac{V_d}{V_r} \leq 1 = \frac{221.58 \, kN}{657.71 \, kN} = 0.34 \leq 1 \rightarrow verified$



CLASSE DI RESISTENZA	CATEGORIA CALCESTRUZZO	PRESCRIZIONI PARTICOLARI
C 8/10	Non strutturale	Nessuna
C 12/15		
C 16/20	Ordinario	Obbligo Certificazione FPC se prodotto all'esterno del cantiere
C 20/25		
C 25/30		
C 28/35		
C 32/40		
C 35/45		
C 40/50		
C 45/55		
C 50/60	Alte prestazioni	Obbligo sperimentazione preventiva + Certificazione FPC
C 55/67		
C 60/75		
C 70/85	Alta resistenza	Obbligo di sperimentazione e autorizzazione del Consiglio Superiore dei Lavori Pubblici
C 80/95		
C 90/105		

Structural Strategy

Verifying Structure with MIDAS GEN
A finite element structural analysis of the theatre roof trusses was conducted in MIDAS Gen to evaluate the performance of the proposed steel grid under realistic loading conditions. The study assessed global deformation, stress distribution, and code compliance at both Serviceability (SLS) and Ultimate Limit States (ULS).

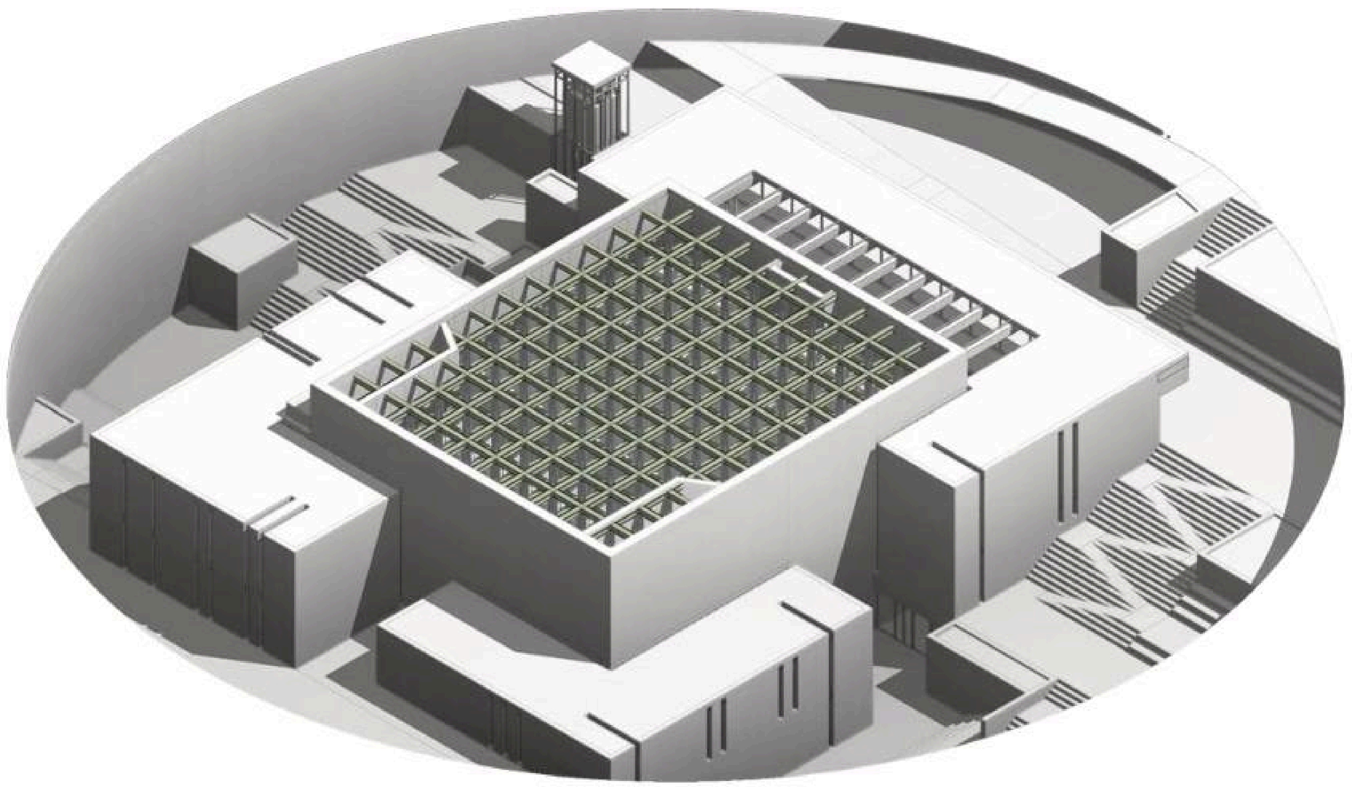
To evaluate material efficiency and structural performance of the auditorium roof structure, three separate analyses were performed under identical geometry, loading conditions, and boundary constraints while varying the steel beam profiles.

-HEB 300: Very low stress ratios and minimal deflection, structurally safe but significantly oversized and materially inefficient.

-IPE 160: High stress ratios approaching 1.0 at ULS and excessive deflection at SLS, structurally critical and insufficient.

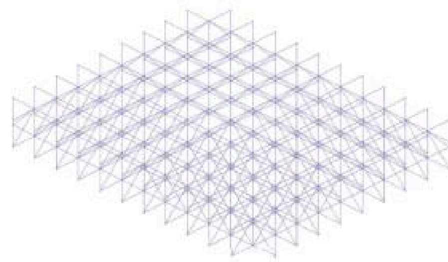
-HEA 160: Best beam option with balanced performance with acceptable SLS deflections and safe ULS stress utilization.

The HEA 160 profile was therefore selected as the optimal compromise between structural safety and material

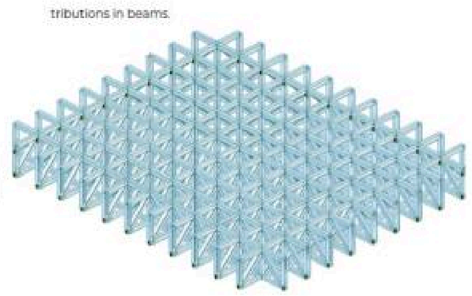


This study focuses on the theater roof beams as the main structural components under investigation. To develop the analytical model, the roof beam geometry was exported from Revit to AutoCAD and then simplified to better align with the requirements of MIDAS. Beams were modeled as linear elements, while wall components were defined using surface or region elements, allowing MIDAS to clearly distinguish between beam and plate/wall behavior.

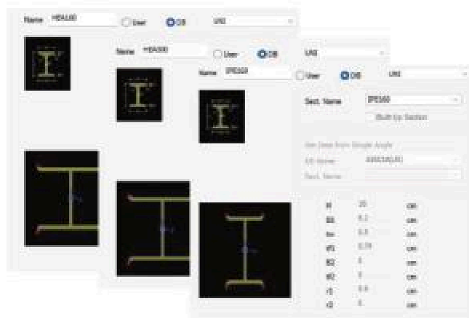
1. Importing Elements Into Midas



2. Selecting Boundary Conditions



3. Defining Materials And Sections



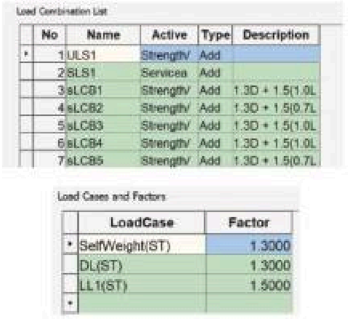
4. Defining Loads In MIDAS

Layer	Spessore	Densità (kg/m³)	γ (kN/m³)	Carico q (kN/m²)
Gravel	0,020 m	2000	19,62	0,392
Asphalt	0,010 m	2400	23,54	0,235
thermal layer	0,040 m	30	0,294	0,012
Substrate concrete/sabbia	0,030 m	2500	25	0,75
Pannelli fonoassorbenti	x			0,196
Impianti / luci (allowance)	x			0,5
			DL totale	2,085

Carichi nodali su maglia 2,00 × 2,00 m
DEAD LOADS
Nodo interno (area trib. = 4,0 m²)
F interno=−4,0·2,085=−8,34 kN
Nodo bordo (area trib. = 2,0 m²)
F bordo=−2,0·2,085=−4,17 kN

LIVE LOADS
LL1-manutenzione- q=0,50 kN/m²
F interno=−4,0·0,50=−2,00 kN
F bordo=−2,0·0,50=−1,00 kN
LL2-carico temporaneo pesante - q=1,50 kN/m²
F interno=−4,0·1,50=−6,00 kN
F bordo=−2,0·1,50=−3,00 kN

5. Defining Load Combinations



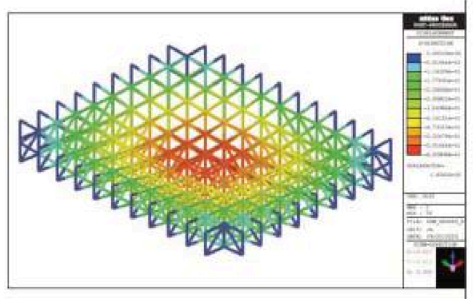
Load Combination List

No	Name	Active	Type	Description
1	ULS1	Strength/	Add	
2	SLS1	Services	Add	
3	sLCB1	Strength/	Add	1.3D + 1.5(1.0L
4	sLCB2	Strength/	Add	1.3D + 1.5(0.7L
5	sLCB3	Strength/	Add	1.3D + 1.5(1.0L
6	sLCB4	Strength/	Add	1.3D + 1.5(1.0L
7	sLCB5	Strength/	Add	1.3D + 1.5(0.7L

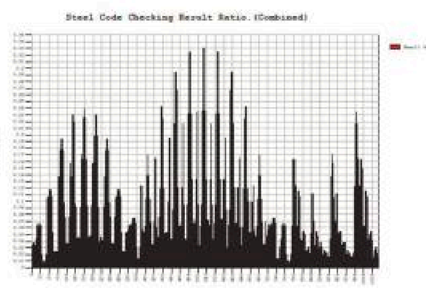
Load Cases and Factors

LoadCase	Factor
SelfWeight(ST)	1.3000
DL(ST)	1.3000
LL1(ST)	1.5000

6. Completing Structural Analysis



7. Verifying Within Steel Code



8. Results Analysis

SECTION	HEIGHT (mm)	TOTAL WEIGHT (kN)	MAX DISPLACEMENT SLS (mm)	STRESS RATIO (ULS)	EFFICIENCY	ASSESSMENT
HEB300	300	1500,6	3,5	0,137	Very low	Oversized
HEA160	160	997,4	6,5	0,32	Balanced	Optimal
IPE160	160	273,4	10,5	0,99	Critical	Unsafe

Mechanical Strategy

HVAC Strategy for the Muisc Hall
Air distribution system for the main performance space adopts displacement ventilation strategy integrating under-seat air supply diffusers with high-level ceiling returns. Conditioned air is supplied directly into the occupied zone from the under-seat diffusers. Buoyant warm and contaminated air generated by the audience and operating equipment rises and is mechanically extracted through concealed ducts at the ceiling level.

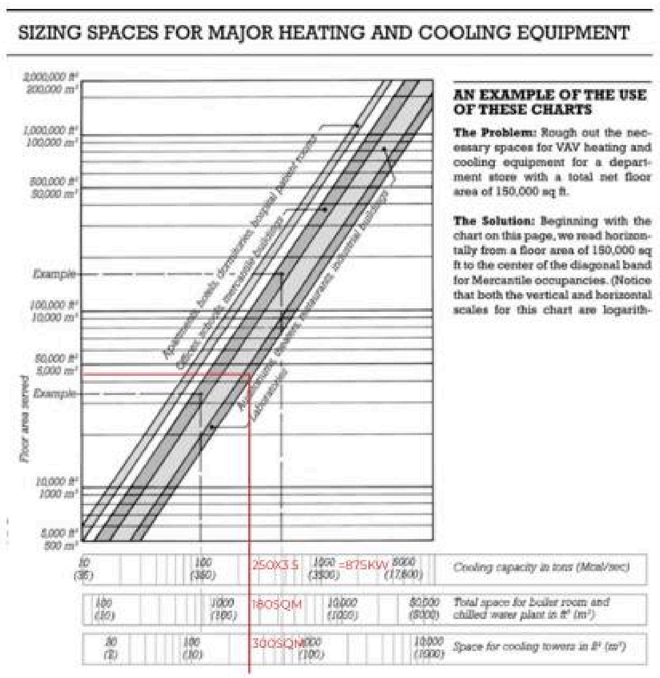
Designed for auditoria and concert halls, the configuration maximizes thermal and acoustic comfort while minimizing the visibility of the system. The components of the system control high-velocity overhead stream mixing by stratifying the air and introducing cooled air directly to the occupants in the seating zone.

After sizing the ducts via rule of thumb, it was determined that the following systems are needed:

- 6sqm of area in main supply/return ducts | 4 main ducts (2 supply 2 return underground) | 1m wide by 2m high | V = 12.0 m/s = 25/12.0 = 2.08m. The selected system might be a bit noisy but it will be underground which means more sound insulation.
- 10sqm of area in branch supply/return ducts | V = 6.0 m/s: 50 / 0.48(area*6)) ≈ 100 trunks | 40cm wide by 20cm high
- MECHANICAL SPACE = 468SQM which is just above the rule of thumb

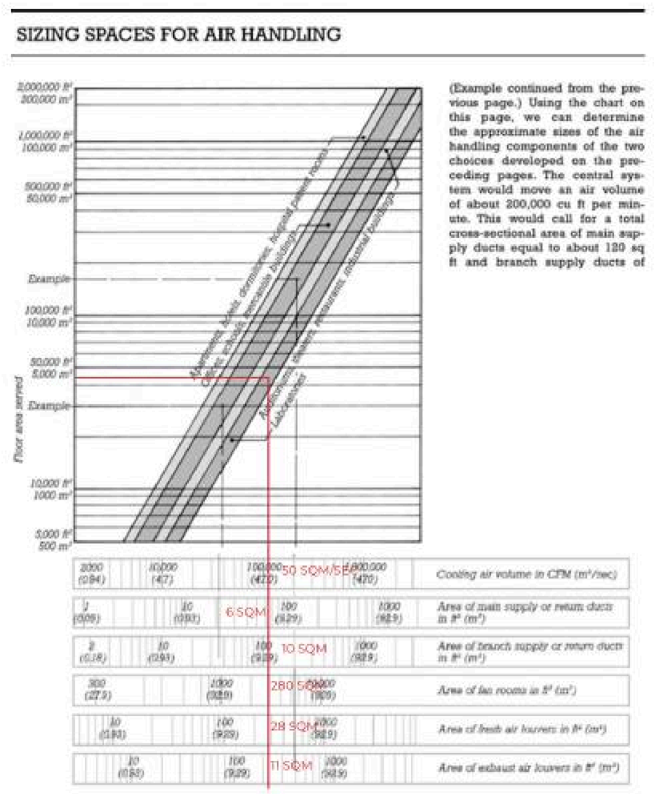
Benefits of the System
1. Temperature control: Layering of warm air is not allowed in audience seating areas as air is directly supplied under the seats. With this design, drafts and under-seat cold air are eliminated, and the warmer air layers are allowed to rise above head level.
2. Energy saving: Heating and cooling are only provided to the lower occupied zone instead of the entire hall volume, which lowers the operational energy use by the system.
3. Acoustic comfort: The performance of the hall and the system are not compromised by air movement as low-velocity delivery minimizes movement noise and maintains the cabin quiet.
4. Discreet integration: All seating and ceiling orthogonal surfaces incorporate the system, thus preserving Architectural Expression and Sightline Intactness.
5. Improved air quality: Audience-related contaminants and heat are removed and discharged at the ceiling level, preserving air quality and comfort during extended bouts.

6. The Functional Systems



We began investigating the MEP systems by estimating the sizing of the elements through a Rule of Thumb document provided by Professor Sarto. Through this, it was determined that a building of our size and use will need 875kW of cooling capacity, 180sqm of space for a boiler and chiller room, and 300sqm for a cooling tower if needed. We used this information to guide our decision making process regarding functions and space assignment in the floor plans.

From these studies we determined that we need 180 + 280 = 460sqm in technical spaces in our building which we integrated into the lowest level of our building and the separate mechanical building.



Regarding the sizing of spaces for Air Handling, this tool estimates that we will need 50sqm/sec of cooling air volume, 6sqm of area in main supply/return ducts, 10sqm of area in branch supply/return ducts, 280 sqm of area for a fan room, 28sqm of area of fresh air louvers, and 11sqm of area in exhaust air louvers. We took all of this information into consideration when we planned the mechanical systems in our building.

Mechanical Strategy

Aermec NXP Series Heat Pumps

The Aermec NXP series comprises multipurpose water-to-water heat pumps designed for indoor installation, capable of simultaneously and independently producing hot and chilled water. These units are ideal for 2-pipe or 4-pipe systems, making them suitable for applications requiring both heating and cooling throughout the year. (Aermec, 2024)

Key Features:
- Cooling Capacity: Approximately 109 to 502 kW per unit.
- Heating Capacity: Approximately 123 to 560 kW per unit.
- Refrigerant: R410A.
- Compressor Type: High-efficiency scroll compressors.
- Heat Exchangers: Optimized plate exchangers for efficient heat transfer.

Sizing for the Project:
Given the building's estimated cooling demand of 875 kW, we need
- two units of NXP 0500 (each ~250 kW)
- one unit of NXP 0400 (each ~200 kW)
- one unit of NXP 0175 (~175 kW)

to total approximately 875 kW.

Figure 7.3: Aermec NXP Series Heat Pumps

Air Handling Units (AHU)

We propose using two custom-built Air Handling Units (AHUs) is designed to process about 25 cubic meters of air per second, which translates to roughly 90,000 cubic meters per hour. To handle this volume efficiently, each AHU typically occupies a footprint of approximately 10 meters in length by 3 meters in width, resulting in about 30 square meters of floor space. The height of these units usually ranges between 2.5 and 3 meters to accommodate essential components such as fans, filters, and hydronic heating and cooling coils.

To ensure proper maintenance access, it is essential to provide a clearance of at least 1 meter on all sides of each AHU. This clearance allows technicians to perform routine inspections, repairs, and service tasks safely and comfortably. Factoring in this required space, the effective footprint per AHU increases to approximately 12 meters by 5 meters, or 60 square meters. Since there are two AHUs planned for your design, the combined space requirement, including clearance, totals around 120 square meters. These AHUs are integrated with the Aermec NXP heat pump units via hydronic coils, which circulate hot or chilled water to provide heating and cooling to the air passing through the units. The AHU fans then distribute the conditioned air throughout the building's duct system to maintain comfort within occupied spaces. The proposed total AHU space of about 120 square meters fits well within the 280 square meters allocated for the fan room, allowing room for additional equipment and safe technician movement. (Tangra, 2024)

Parameter	Per AHU	Two AHUs Total
Airflow capacity	25 m³/s	50 m³/s
Footprint (Length × Width)	10 m × 3 m (30 m²)	60 m² (without clearance)
Clearance for maintenance	1 m all sides	2 m length & width total

Figure 7.4: AHUs

Mechanical Strategy

TROX TA-Silenzio VAV Terminal Units

To address the diverse HVAC needs of our music hall, we have selected two distinct Variable Air Volume (VAV) systems, each tailored to the acoustic and thermal demands of specific building zones. For the theater spaces, where acoustic performance is paramount, we specified the TROX TA-Silenzio VAV Terminal Units. These are engineered for high-performance airflow management with minimal sound emission. The TA-Silenzio features advanced volume flow control across a wide range (up to 28,836 m³/h), making it ideal for high-capacity environments like performance halls. Its design incorporates precision airflow regulation and optional acoustic cladding, ensuring that system noise is kept to a minimum, an essential requirement in performance settings. The unit's compliance with EN 1751 standards for air and casing leakage further ensures efficiency. (TROX, 2024)

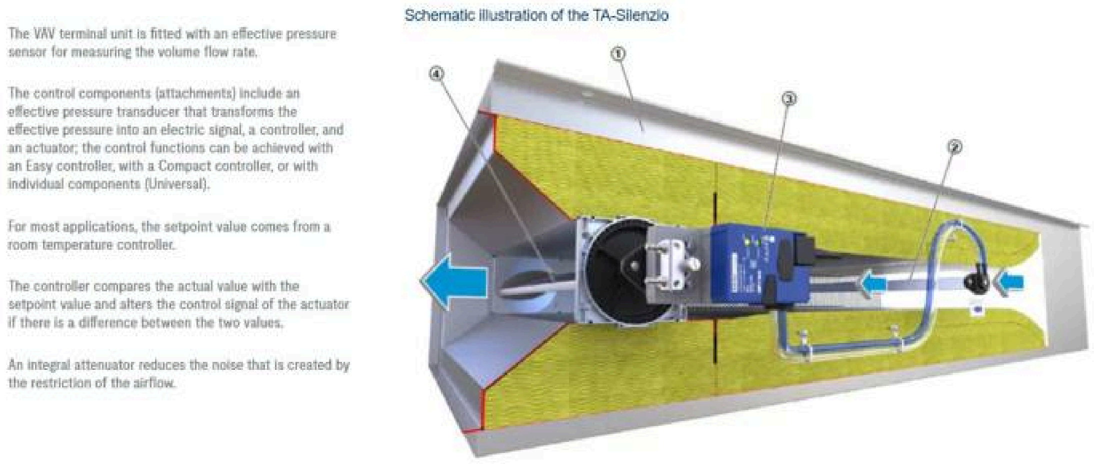


Figure 7.5-6: TROX TA-Silenzio VAV Terminal Units

Thermaduct Thermaround Architectural Duct System

To meet the airflow requirements outlined in our mechanical sizing - 50 m³/s of cooling air volume and 6 m² of main duct cross-sectional area,we specified the Thermaduct Thermaround Architectural Duct System for all exposed ductwork in the theater zones. This system meets both performance and aesthetic demands, offering factory-fabricated, pre-insulated round ducts with R-12 continuous insulation that reduces thermal losses and eliminates the need for externallagging, streamlining installation on exposed concrete ceilings.

At the core of the system is Kingspan KoolDuct®, a closed-cell phenolic foam with UL 181 Class 1 flame resistance and antimicrobial properties, ideal for maintaining air quality in large performance spaces. The round profile supports efficient airflow with reduced pressure drop, and double-gasketed, factory-sealed joints ensure Class 3 or better leakage ratings, making it a robust solution for high-volume, energy-efficient delivery.

Visually, the smooth, curved design integrates seamlessly into the architectural language of our semi-subterranean music hall. The ducts act not only as HVAC components but also as visible infrastructure, reinforcing the building's functional expression while delivering comfort and efficiency in high-density spaces. (Thermaduct, 2024)

Figure 7.7: Thermaduct Thermaround Architectural Duct System

Mechanical Strategy

Based on rule-of-thumb sizing, the main supply and return ductwork requires 6 m² of total area. This is provided by four underground ducts (two supply, two return), each measuring 1.0 m × 2.0 m, operating at an air velocity of approximately 12.0 m/s. While this velocity is relatively high, placing the ducts underground allows for improved acoustic insulation and limits noise transmission into the performance spaces. The branch supply and return system accounts for an additional 10 m² of duct area. Air is distributed through approximately 100 smaller ducts measuring 40 cm × 20 cm, operating at a reduced velocity of 6.0 m/s to maintain acoustic comfort within occupied areas. The total mechanical space amounts to 468 m², slightly exceeding rule-of-thumb estimates, reflecting allowances for acoustic performance and spatial integration.

Air distribution in the main performance hall uses a displacement ventilation strategy, supplying conditioned air through under-seat diffusers and extracting warm air at ceiling level. Heat and contaminants generated by occupants rise naturally and are removed through concealed high-level returns, supporting thermal comfort, acoustic control, and minimal visual impact.

Benefits of the System:

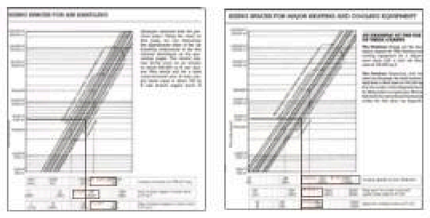
1. Temperature control:
In audience seating areas as air is directly supplied under the seats. With this design, drafts and under-seat cold air are eliminated, and the warmer air layers are allowed to rise above head level.

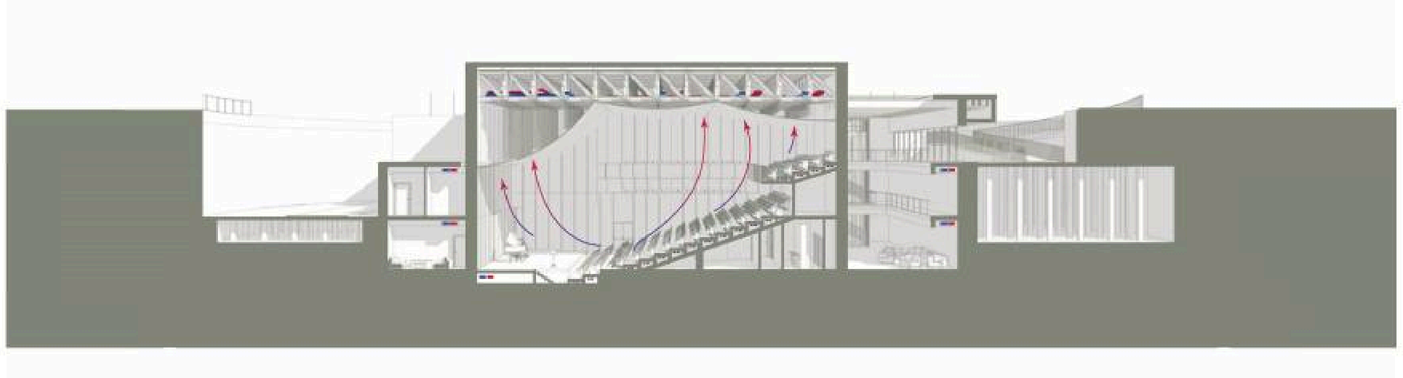
2. Energy saving:
Heating and cooling are only provided to the lower occupied zone instead of the entire hall volume, which lowers the operational energy use by the system.

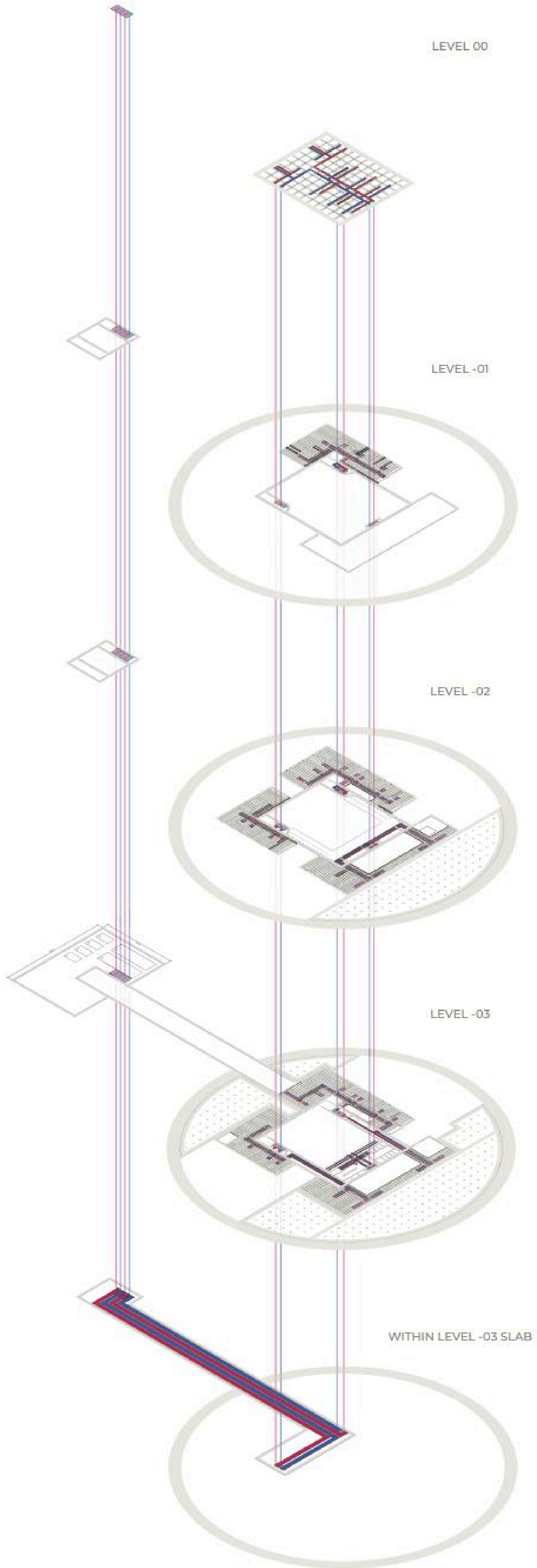
3. Acoustic comfort:
The performance of the hall and the system are not compromised by air movement as low-velocity delivery minimizes movement noise and maintains the cabin quiet.

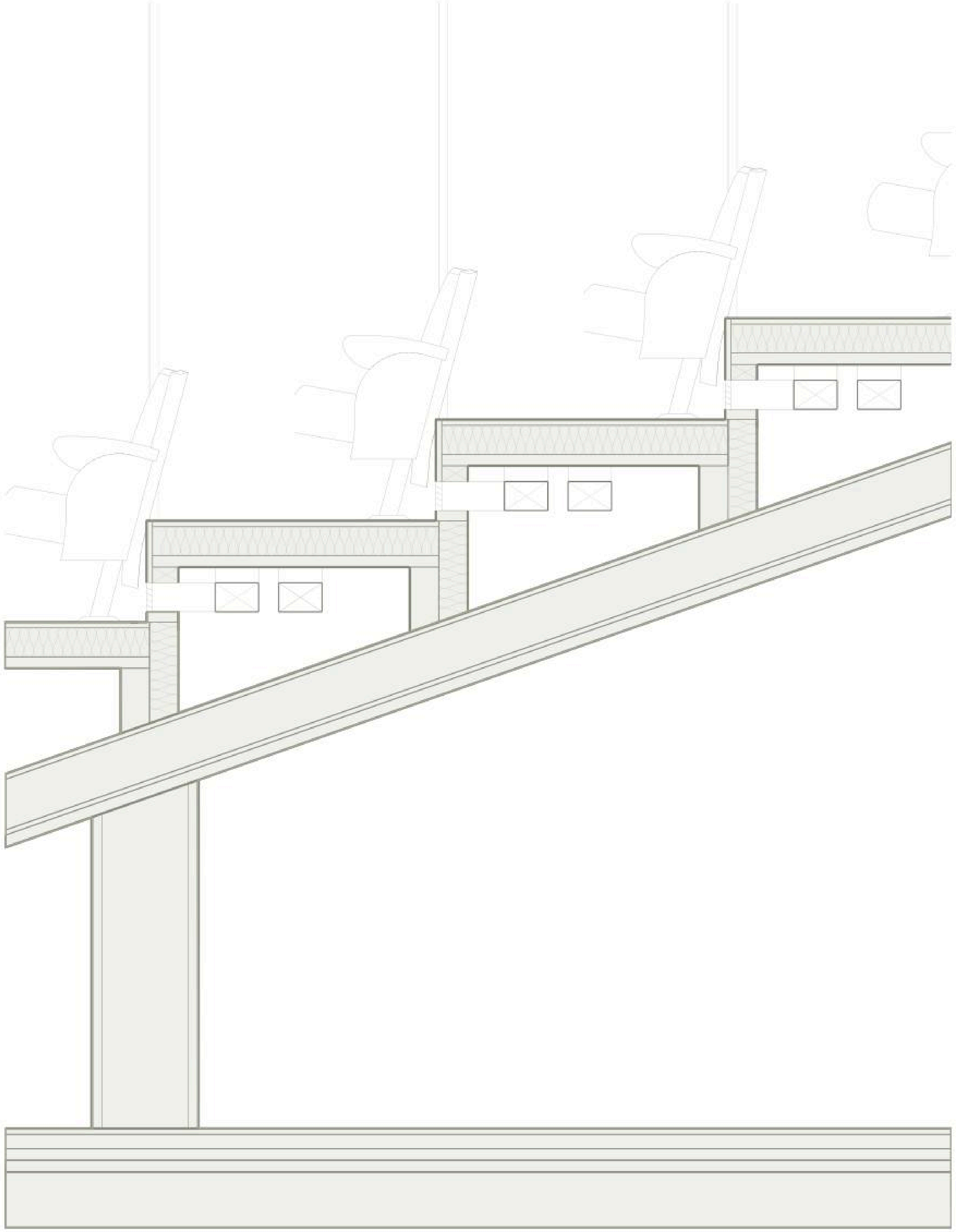
4. Discreet integration:
All seating and ceiling orthogonal surfaces incorporate the system, thus preserving Architectural Expression and Sightline Intactness.

5. Improved air quality:
Audience-related contaminants and heat are removed and discharged at the ceiling level, preserving air quality and comfort during extended bouts.





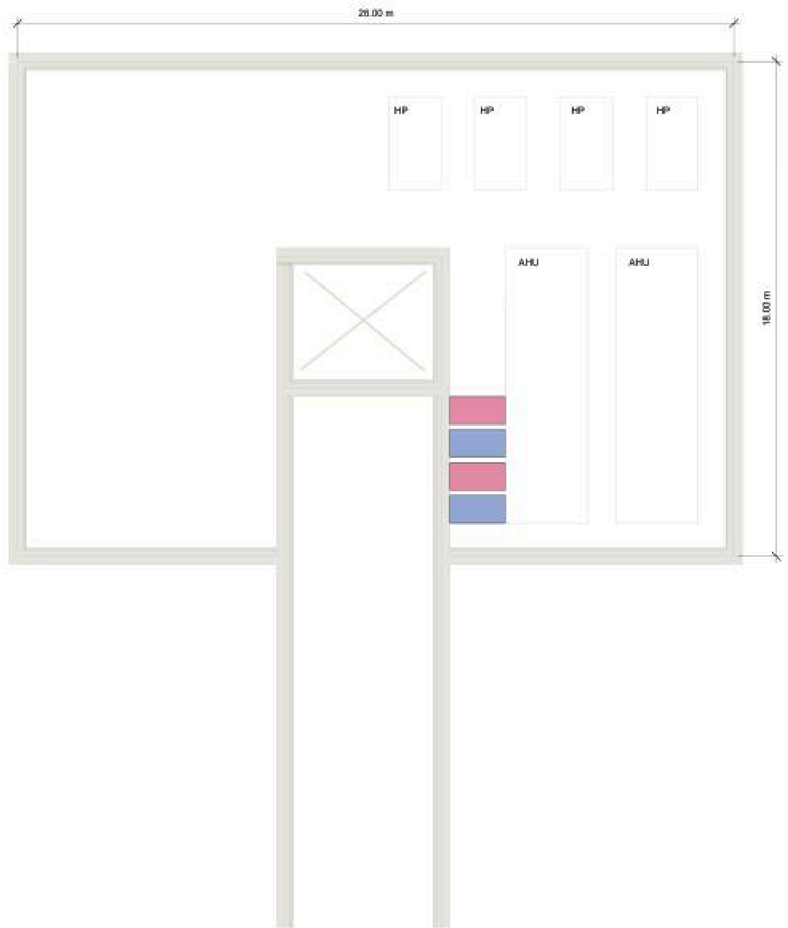




The total mech. space amounts to 468 m², slightly exceeding rule-of-thumb estimates, reflecting allowances for acoustic performance and spatial integration. It includes 2 air handling units and 4 heat pumps.

Model	Cooling Capacity	Length (mm)	Width (mm)	Height (mm)	Approx. Weight
NXP 0175	~175 kW	2,120	1,250	1,976	~1,000 kg
NXP 0400	~400 kW	2,120	1,250	1,976	~1,100 kg
NXP 0500	~500 kW	2,600	1,250	2,000	~2,000 kg

Parameter	Per AHU	Two AHUs Total
Airflow capacity	25 m^3/s	50 m^3/s
Footprint (Length × Width)	10 m × 3 m (30 m^2)	60 m^2 (without clearance)
Clearance for maintenance	1 m all sides	2 m length & width total



Environmental Strategy

The environmental strategy for the project is informed by a series of climate and environmental analyses examining local climatic conditions, solar exposure, wind behaviour, and daylight availability. These studies were undertaken to establish a clear understanding of the site's environmental context in Milan and to guide key architectural decisions related to form, section, orientation, and envelope design. Detailed outputs, diagrams, and simulation results are presented in the appendix, while this chapter summarises the main findings and their design implications.

Climate Conditions
Milan's climate is characterised by hot, humid summers and cold, damp winters, with significant seasonal variation in temperature, solar radiation, and humidity. Summer daytime temperatures frequently exceed comfort thresholds, while winter conditions are marked by low temperatures, high moisture levels, and limited solar angles. The city also experiences relatively low average wind speeds due to its location in the Po Valley, with occasional stronger winds associated with passing weather fronts. These climatic characteristics informed an early design emphasis on thermal stability, solar control, and protection from summer overheating, while recognising the limited potential for wind-driven cooling and the importance of controlled daylight access. Climate data visualisations, including temperature, humidity, wind, and comfort charts, are provided in the appendix.

Sunlight Hours and Solar Exposure
Sunlight hours and solar access studies were used to assess how direct sunlight interacts with the site and surrounding urban fabric across seasonal conditions. The analysis confirmed that the open park area receives substantial daylight throughout the year, supporting its role as an active and safe public space. The placement of the music hall at the northern edge of the site and the stepped massing of adjacent buildings minimise obstruction of sunlight reaching the park. Seasonal solar studies demonstrate that while summer months receive extended periods of direct sunlight, winter solar angles are lower and more directional. This informed the incorporation of a large canopy structure, which moderates excessive solar gain during summer while still allowing controlled daylight penetration during spring, autumn, and parts of the winter season. Seasonal solar diagrams illustrating solstice and equinox conditions are included in the appendix.

Solar Radiation Analysis
Solar radiation analysis further clarified the intensity and distribution of solar gain across building surfaces and public spaces. Results indicate high levels of solar radiation during summer months, particularly between May and September, reinforcing the need for shading strategies to reduce heat gain and improve thermal comfort. The partially sunken nature of the building inherently limits direct solar exposure, benefiting from the insulating properties of the surrounding ground. The canopy complements this strategy by shading exposed surfaces and circulation areas, reducing reliance on mechanical cooling and mitigating urban heat island effects. At the same time, the analysis highlights the trade-off between shading and daylight access, particularly in winter, where reduced solar penetration requires careful integration of artificial lighting strategies. Full radiation maps and directional diagrams are provided in the appendix.

Wind Analysis and Microclimate
Monthly wind analyses were conducted to understand prevailing wind directions, seasonal variations, and potential microclimatic effects at pedestrian level. The results confirm generally low to moderate wind speeds throughout the year, with slightly increased activity during transitional seasons. This informed a design approach that prioritises shelter and controlled airflow rather than reliance on natural ventilation driven by wind. Landscape elements, building edges, and the sunken plaza geometry are used to moderate wind conditions, ensuring outdoor comfort while avoiding wind acceleration effects. Detailed wind roses and velocity diagrams for each month are included in the appendix.

Daylighting Studies
Daylighting studies were undertaken to evaluate the availability and quality of natural light within the building, particularly in underground and recessed spaces affected by the canopy. Comparative analyses with and without skylights demonstrate that daylight levels are significantly improved through the introduction of controlled top-lighting elements. While the studies confirm that artificial lighting remains necessary in many interior spaces, especially in deep-plan and transitional areas, daylight contributes meaningfully to visual comfort and spatial quality. The analysis also identified areas requiring further architectural refinement, such as the introduction of slit windows in rehearsal spaces lacking adequate natural light. Detailed illuminance maps and comparative simulations are provided in the appendix.

Summary
Collectively, the environmental analyses support a design strategy that responds directly to Milan's climatic conditions through sectional depth, solar control, and moderated exposure, rather than relying on environmental optimisation alone. By situating detailed simulation outputs in the appendix, the main body of the thesis focuses on how environmental analysis informed architectural decisions, reinforcing the project's climate-responsive approach without overloading the narrative with technical data.

Energy Strategy

Italian Electricity Use and Carbon Intensity
Italy's electricity system is characterised by a mixed energy profile combining a growing renewable share with continued dependence on fossil fuels. As of 2026, the national electricity mix has an average carbon intensity of approximately 348 gCO_2eq/kWh, placing Italy in the mid-range of European performance. While this represents a lower carbon intensity than coal-dependent countries in Eastern Europe, it remains significantly higher than systems supported by extensive nuclear or large-scale hydropower generation.

Carbon-free electricity accounts for roughly 40% of total production, with renewables contributing approximately 34%. Renewable generation is primarily derived from hydropower, solar, and wind, supplemented by smaller contributions from geothermal and biomass sources. Despite this progress, natural gas remains the dominant balancing energy source, particularly during periods of peak demand and reduced renewable output. This structural reliance limits further reductions in grid carbon intensity.

Analysis of electricity data from 2021 to 2026 shows only modest variation in carbon intensity, indicating a relatively stable emissions profile rather than a sustained downward trend. Reductions in coal use over this period align with national and European decarbonisation objectives; however, these reductions have largely been offset by continued gas use rather than replaced by equivalent increases in renewable capacity. Italy's electricity system also exhibits a net reliance on imports, reflecting both seasonal demand fluctuations and constraints in domestic generation capacity. While cross-border electricity exchange supports grid stability, it introduces additional exposure to external energy markets and limits overall energy autonomy. (Electricity Maps, Italy Electricity Data, 2026)

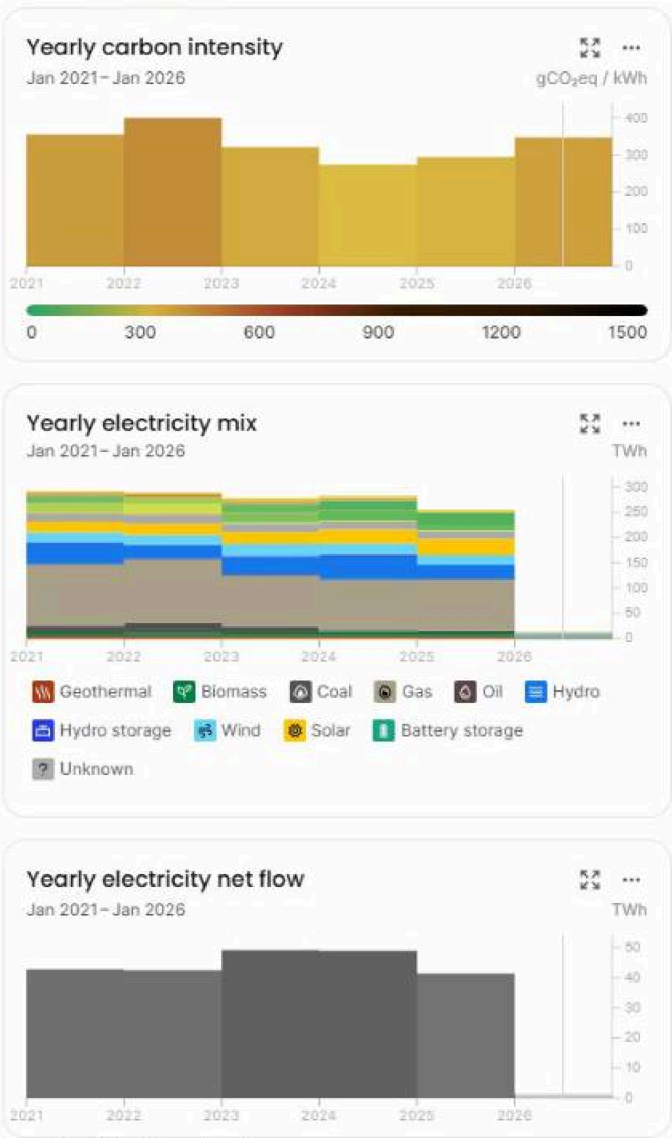


Figure 7.8-10: Italian Energy Statistics

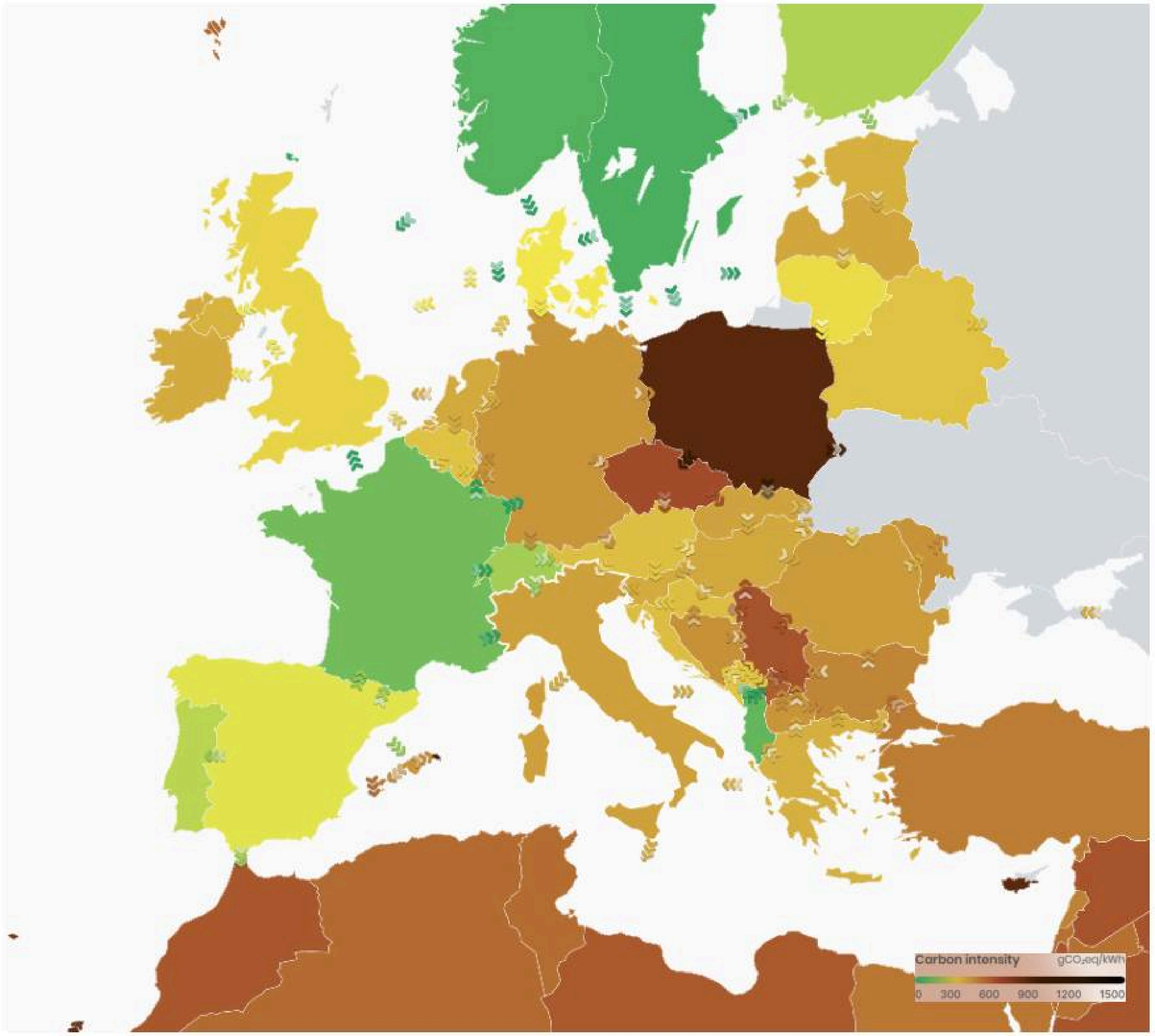


Figure 7.11: Electricity Map of Europe showing Carbon Intensity of energy being used

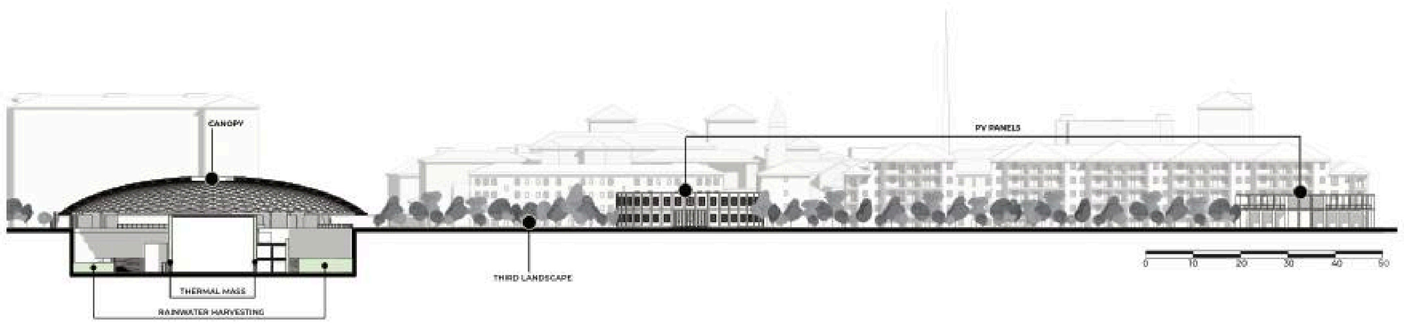
Energy Strategy

Strategic Implications
Within this context, reductions in operational energy demand play a critical role in lowering effective carbon emissions. As the electricity grid remains partially dependent on fossil fuels, energy efficiency, peak load reduction, and on-site renewable generation become essential mechanisms for mitigating carbon impact. At both the building and urban scale, strategies that reduce demand intensity directly limit reliance on a grid that has not yet fully transitioned to low-carbon supply. This approach is particularly relevant in energy-intensive cultural buildings, where occupancy patterns and internal gains can otherwise drive disproportionate peak loads. Furthermore, stabilising demand profiles enhances compatibility with renewable energy production, which is inherently variable.

Consequently, the building's energy strategy prioritises passive environmental control alongside high-efficiency active systems, significantly reducing operational energy demand while remaining aligned with Italy's partially decarbonised electricity mix. By addressing energy demand first, renewable generation and mechanical systems can operate at a reduced scale, improving overall efficiency and long-term resilience.

Passive Energy Systems
1) Thermal Mass: *The underground concrete envelope acts as a huge thermal buffer. Even if it's cold in winter, temperature swings are minimal, so heating/cooling loads are stable and reduced. During summer this space becomes a refuge from the heat.*
2) Canopy: *The lattice canopy reduces any incidental solar gain and acts as shading.*
3) Third Landscape: *The rewilded landscape helps evapotranspiration cooling, reduces urban heat island effect, and increases water permeability which is an indirect energy-saving benefit for HVAC.*
4) Rainwater Harvesting: *The tanks in the sunken plaza reduce the need for potable water and can be part of passive cooling strategies (like using water features to cool air or pre-cool ventilation intake)*

Active Energy Systems
1) PV Panels: Area: *1,000 m^2, Efficiency: 20% (average modern PV panel), Tilted south (~30°), Solar irradiation: Milan ~1,400 kWh/m^2/year. PV Energy=Area×Irradiation ×Efficiency 1000 m^2×1400 kWh/m^2/year×0.20=280,000 kWh/year*



Energy Performance
Assumptions
- Building: Area: 4,000 m^2
- Underground sunken theater tends to have stable, cool temperatures so we need to set typical theater setpoints: Heating: 20 °C // Cooling: 24 °C
- Baseline Energy Demand (typical kWh/m^2/year): Underground/thermally massive theater: Heating: ~50 kWh/m^2/year (lower than typical building because of thermal mass) Cooling: ~60 kWh/m^2/year (needs dehumidification + cooling for occupancy)
  Total: ~110 kWh/m^2/year Multiply by 4,000 m^2 → 440,000 kWh/year baseline demand
- Heat Pumps: 4 heat pumps, Average COP (Coefficient of Performance): Heating: 4.0 // Cooling: 3.5
- AHUs / Ventilation: Assume standard: 2 AHUs providing 50% of ventilation demand, Energy recovery: 60%
- PV Panels: Area: 1,000 m^2, Efficiency: 20% (average modern PV panel), Tilted south (~30°), Solar irradiation: Milan ~1,400 kWh/m^2/year

Calculations
PV Energy Production:
PV Energy=Area×Irradiation×Efficiency kWh/year}1000 m^2×1400 kWh/m^2/year×0.20
PV Energy = 280,000 kWh/year
PV can cover ~64% of baseline energy demand (280,000 ÷ 440,000).

Heat Pump Energy Use:
Heating demand: 50 kWh/m^2/year × 4,000 m^2 = 200,000 kWh/year
Cooling demand: 60 kWh/m^2/year × 4,000 m^2 = 240,000 kWh/year

Electrical consumption of heat pumps:
Electricity=Thermal demand
Heating: 200,000 ÷ 4.0 = 50,000 kWh/year
Cooling: 240,000 ÷ 3.5 ≈ 68,600 kWh/year
Total HVAC electricity demand: ~118,600 kWh/year

Passive design reduces energy demand, efficient heat pumps limit electricity consumption, and on-site photovoltaics offset approximately 64% of the building's annual energy use.

Construction Strategy

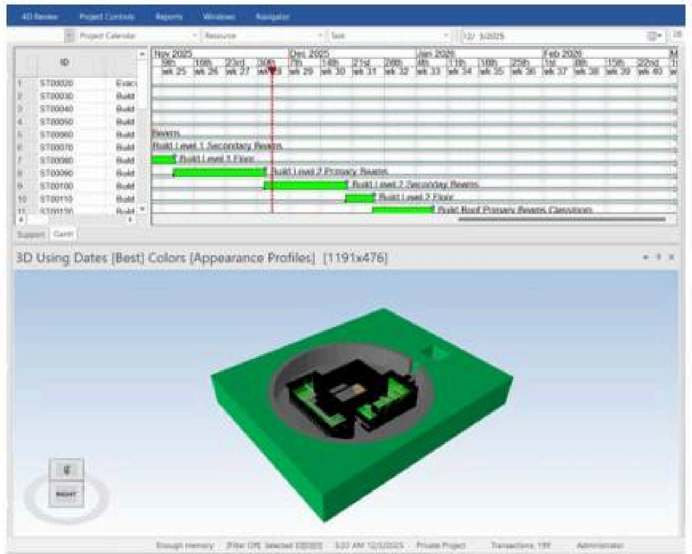
Phased Assembly and Construction Sequencing

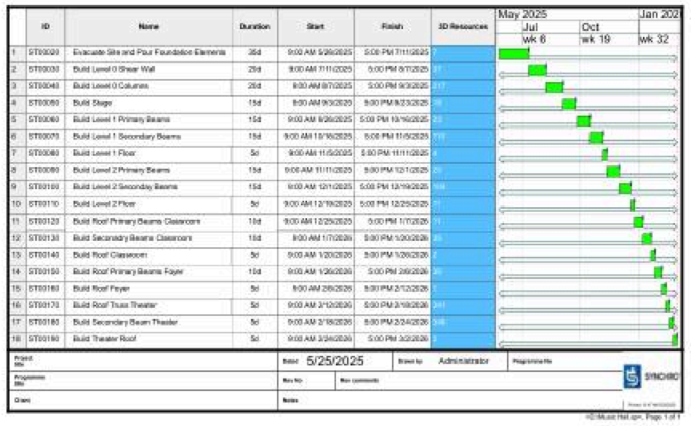
The construction strategy addresses the building's sunken condition and structural complexity through a phased and highly coordinated assembly process. To manage this, a 4D construction sequencing approach is used using SYNCHRO, integrating three-dimensional structural modelling with time-based scheduling to test buildability and clarify the order of construction.

The structural system is first modelled in Revit, defining the primary load-bearing elements, including shear walls, columns, beams, and trusses. This model is then imported into a 4D environment, where construction phases are sequenced and visualised over time, establishing a clear relationship between structural logic and construction methodology.

Construction begins with site preparation and excavation, creating a stable base for the sunken theatre volume. This is followed by the foundation and retaining wall phase, including slab-on-grade foundations, deep footings, waterproofing, and reinforced concrete walls, which together form the primary load-bearing and retaining structure. Subsequently, vertical structural elements such as shear walls and cores are constructed to provide lateral stability, followed by the installation of horizontal elements, including floor beams and slabs, assembled level by level. The primary structure is completed with the installation of roof beams and trusses, allowing for the integration of mechanical and service zones above the theatre space.

The overall construction sequence spans approximately ten months, from late May 2025 to early March 2026. By linking structural elements directly to scheduled tasks, the 4D model enables the construction process to be simulated over time, supporting coordination between trades and providing a clear visual narrative of how the building is assembled.



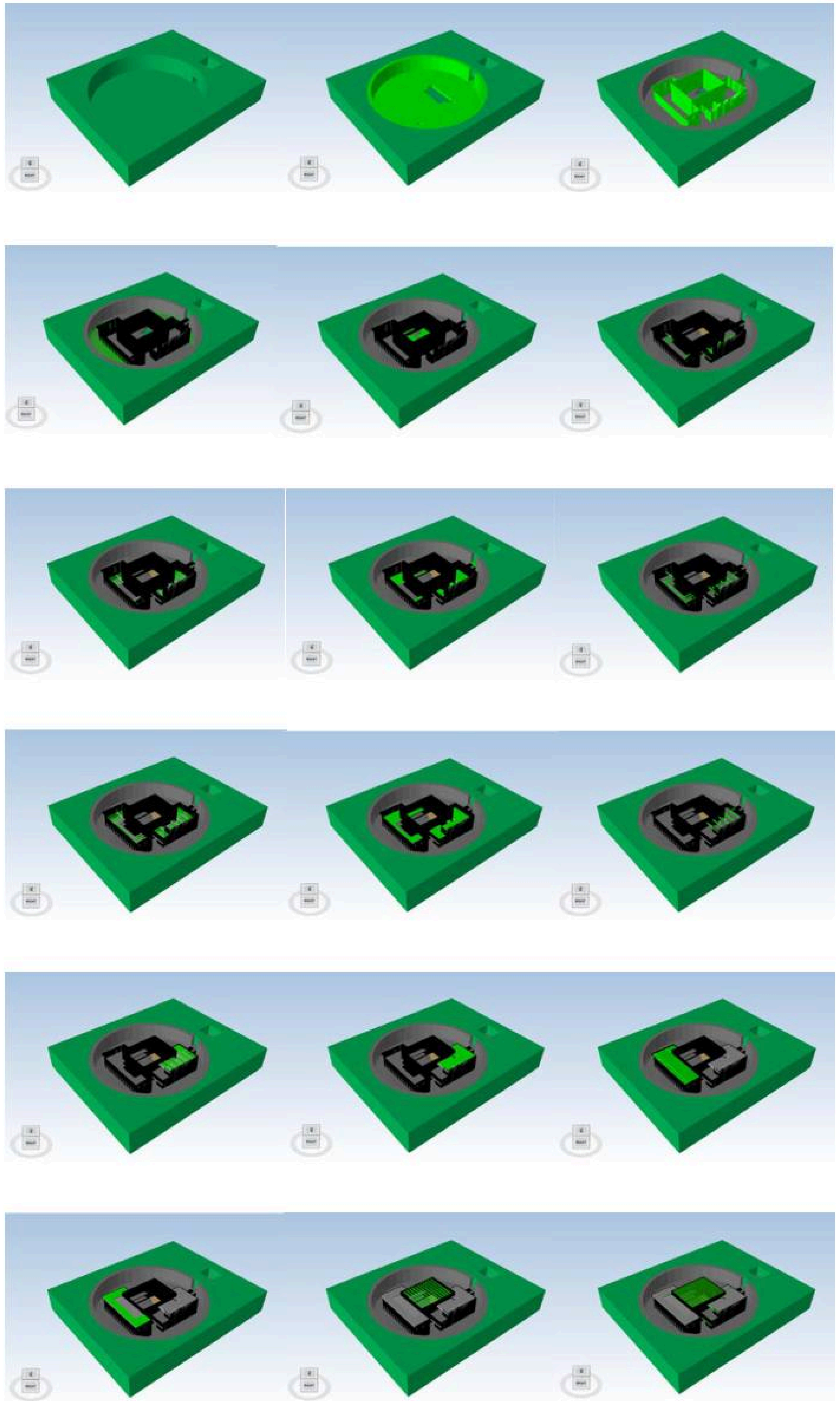


	ID	Name	Duration	Start	Finish	3D Resources
1	ST00020	Evacuate Site and Pour Foundation Elements	35d	9:00 AM 5/26/2025	5:00 PM 7/11/2025	[illegible]
2	ST00030	Build Level 0 Shear Wall	20d	9:00 AM 7/11/2025	5:00 PM 8/7/2025	[illegible]
3	ST00040	Build Level 0 Columns	20d	9:00 AM 8/7/2025	5:00 PM 9/3/2025	[illegible]
4	ST00050	Build Stage	15d	9:00 AM 9/3/2025	5:00 PM 9/23/2025	[illegible]
5	ST00060	Build Level 1 Primary Beams	15d	9:00 AM 9/26/2025	5:00 PM 10/16/2025	[illegible]
6	ST00070	Build Level 1 Secondary Beams	15d	9:00 AM 10/16/2025	5:00 PM 11/5/2025	[illegible]
7	ST00080	Build Level 1 Floor	5d	9:00 AM 11/5/2025	5:00 PM 11/11/2025	[illegible]
8	ST00090	Build Level 2 Primary Beams	15d	9:00 AM 11/11/2025	5:00 PM 12/1/2025	[illegible]
9	ST00100	Build Level 2 Seconday Beams	15d	9:00 AM 12/1/2025	5:00 PM 12/19/2025	[illegible]
10	ST00110	Build Level 2 Floor	5d	9:00 AM 12/19/2025	5:00 PM 12/25/2025	[illegible]
11	ST00120	Build Roof Primary Beams Classroom	10d	9:00 AM 12/25/2025	5:00 PM 1/7/2026	[illegible]
12	ST00130	Build Secondary Beams Classroom	10d	9:00 AM 1/7/2026	5:00 PM 1/20/2026	[illegible]
13	ST00140	Build Roof Classroom	5d	9:00 AM 1/20/2026	5:00 PM 1/26/2026	[illegible]
14	ST00150	Build Roof Primary Beams Foyer	10d	9:00 AM 1/26/2026	5:00 PM 2/6/2026	[illegible]
15	ST00160	Build Roof Foyer	5d	9:00 AM 2/6/2026	5:00 PM 2/12/2026	[illegible]
16	ST00170	Build Roof Truss Theater	5d	9:00 AM 2/12/2026	5:00 PM 2/18/2026	[illegible]
17	ST00180	Build Secondary Beam Theater	5d	9:00 AM 2/18/2026	5:00 PM 2/24/2026	[illegible]
18	ST00190	Build Theater Roof	5d	9:00 AM 2/24/2026	5:00 PM 3/2/2026	[illegible]

May 2025 | Jul | wk 6 | Oct | wk 19 | Jan 2026 | wk 32

Dated 5/25/2025 | Drawn by Administrator

SYNCHRO



Economic Strategy

This section evaluates the economic and environmental implications of material selection through a comparative study of a 30 cm structural/cladding concrete wall, assessing the use of CarbonCure concrete against conventional reinforced concrete. The analysis is based on a Milan context, a total wall area of 1,311 m², and a 30-year study period, considering technical performance, aesthetic requirements, sustainability impact, and financial investment. Rather than treating sustainability as a cost-driven constraint, the strategy examines whether a lower-carbon material choice can be justified within realistic construction and lifecycle cost parameters, while maintaining architectural and structural intent.

Technical and Aesthetic Performance

From a technical standpoint, CarbonCure concrete performs equivalently to standard reinforced concrete. Structural capacity, durability, and service life remain unchanged, with an expected lifespan of 80–100 years for both systems. Constructability is also comparable, relying on standard construction methods with only minor adjustments related to CO_2 injection during concrete production. Aesthetically, CarbonCure concrete does not impose limitations on surface finish or visual quality. The material can achieve the same smooth, flat finishes required for a combined structural and cladding wall, ensuring that architectural expression and material intent are preserved. As a result, the substitution does not introduce compromises in either performance or appearance.

Embodied Carbon Reduction

The primary benefit of CarbonCure concrete lies in its reduction of embodied carbon. Typical reinforced concrete is estimated at approximately 130 kg CO_2e/m², while CarbonCure concrete reduces this figure to approximately 123.5 kg CO_2e/m². Across the full wall area, this results in a total carbon saving of approximately 8.5 tonnes of CO_2e, representing a 5% reduction for this element alone. While modest at the scale of a single building component, this reduction is significant when considered cumulatively and in relation to material permanence. The wall represents a long-life element with no anticipated replacement within the study period, meaning the embodied carbon reduction is locked in for the lifespan of the building.

Economic Evaluation

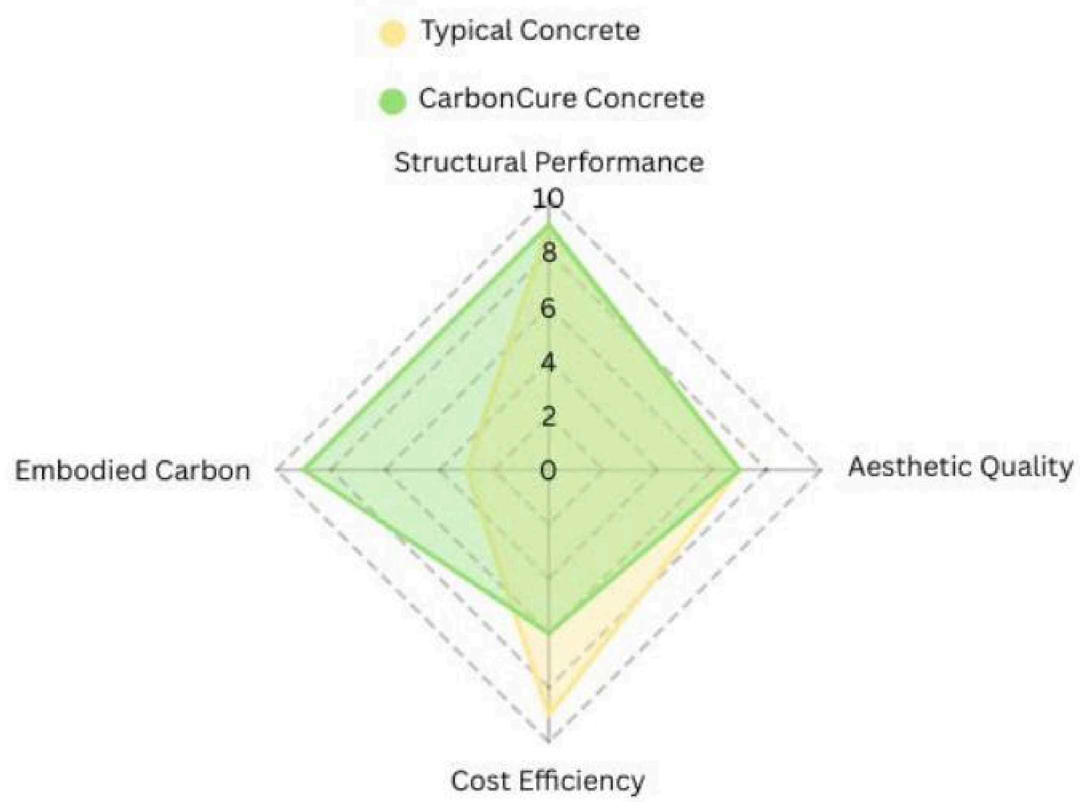
In the Milan construction context, typical reinforced concrete is estimated to cost €140–180/m², while CarbonCure concrete ranges from €150–190/m², reflecting a slight premium associated with CO_2 injection processes and licensing. For the total wall area, this results in an incremental upfront cost of approximately €13,000–20,000. Over a 30-year lifecycle, maintenance and replacement costs are assumed to be identical for both systems, and no operational cost differences are introduced. When annualised, the additional cost is minor relative to overall project value and construction budgets. From a financial perspective, the material substitution represents a limited and predictable investment rather than a significant economic risk.

Multi-Criteria Assessment

To evaluate the material choice holistically, a multi-criteria decision analysis was undertaken, weighting structural performance, aesthetics, cost, and sustainability equally. CarbonCure concrete scores highly across all categories, matching conventional reinforced concrete in technical and aesthetic criteria, scoring slightly lower in cost, and significantly higher in carbon reduction. The resulting assessment demonstrates that CarbonCure achieves the strongest overall balance between environmental performance and financial investment, outperforming conventional reinforced concrete when sustainability is considered alongside traditional design priorities.

Conclusion

The adoption of CarbonCure concrete for the structural/cladding wall demonstrates that meaningful embodied carbon reductions can be achieved without compromising performance, appearance, or buildability. While the upfront cost is marginally higher, the financial premium is small relative to total project value and is offset by long-term environmental benefits. From a 30-year perspective, CarbonCure concrete represents a cost-effective and low-risk sustainability upgrade, aligning environmental responsibility with architectural intent and structural performance. This approach supports a broader project strategy in which carbon reduction is achieved through informed material choices rather than fundamental design compromise.



7. Conclusion

This thesis has explored how architecture can operate as a condition of resonance rather than as an isolated object, responding to urban fragmentation through depth, continuity, and long-term presence. Set within the marginal and often overlooked context of Rogoredo, the project reframes a site defined by absence, stigma, and infrastructural separation as a place of collective experience grounded in landscape and sound.

The project began with an investigation into the ground as both physical and cultural territory. By understanding Rogoredo not as an empty site but as a fragmented urban condition shaped by neglect and deferred investment, the thesis established the need for an intervention capable of addressing absence without erasure. The architectural response rejected monumentality and surface assertion, instead proposing descent, embedding, and continuity as spatial strategies through which belonging and presence could gradually emerge.

Through the conceptual descent, architecture was defined as a resonant medium, capable of engaging sound, memory, and collective experience without relying on visibility or spectacle. The subterranean music hall operates not as an iconic landmark, but as a stabilising core, anchored within the ground and supported by material mass, permanence, and enclosure. Sound becomes both programme and generator, shaping space through resonance rather than through form alone.

Landscape was positioned as the primary agent of urban repair. Drawing from the principles of the Third Landscape, the project reinterprets rewilding as a strategic act rather than an aesthetic gesture. By recomposing two fragmented plots into a continuous green belt, the intervention restores spatial and ecological continuity across infrastructural barriers. The landscape absorbs uncertainty, accommodates change, and supports long-term stewardship, establishing the conditions for both ecological regeneration and social reoccupation.

Material and environmental strategies reinforced this ethic of endurance. Durability, circularity, and thermal performance were addressed through architectural restraint, material intelligence, and envelope-based performance rather than through technological excess. The building's longevity is ensured not through redundancy or over-engineering, but through clarity of construction, repairability, and alignment with long-term environmental processes.

Finally, the project examined social resonance as an emergent condition. Accessibility, user journeys, and shared spaces were designed to encourage gradual activation, familiarity, and collective ownership. Rather than imposing programmed activity, the project creates spatial conditions that support everyday use, lingering, and informal encounter, allowing social meaning to accumulate over time.

Together, these strategies propose an alternative model for intervention within marginal urban contexts. Architecture is not deployed as a solution imposed upon the city, but as a framework capable of supporting resonance across spatial, ecological, and social dimensions. By working through the ground, through landscape, and through time, the project demonstrates how architectural presence can be reintroduced without domination, allowing places defined by absence to regain continuity, depth, and collective life.

Future Evolution of the Site

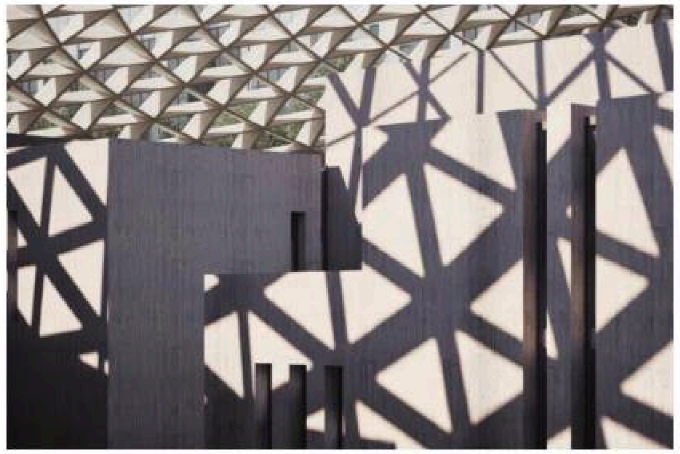
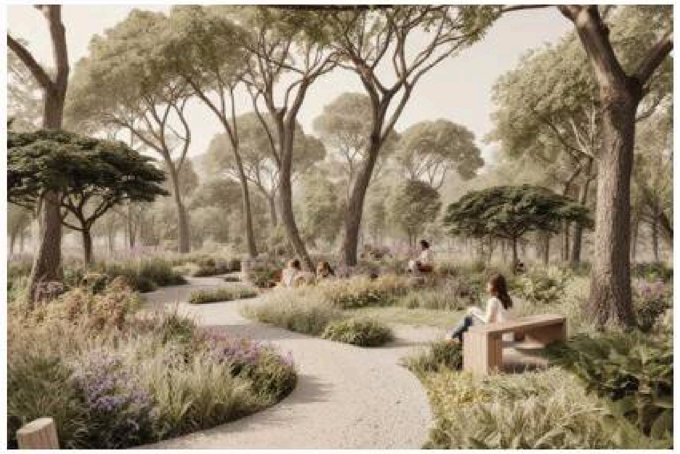
The project is conceived as an unfinished condition, one that only becomes complete through time. Rather than fixing the site into a final image, the intervention establishes a framework within which landscape, use, and collective memory can slowly accumulate. Growth, weathering, and repetition are not side effects of the project, but its intended outcome.

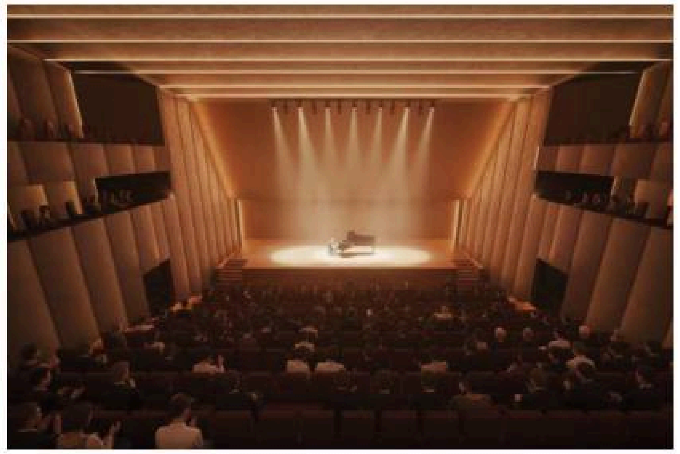
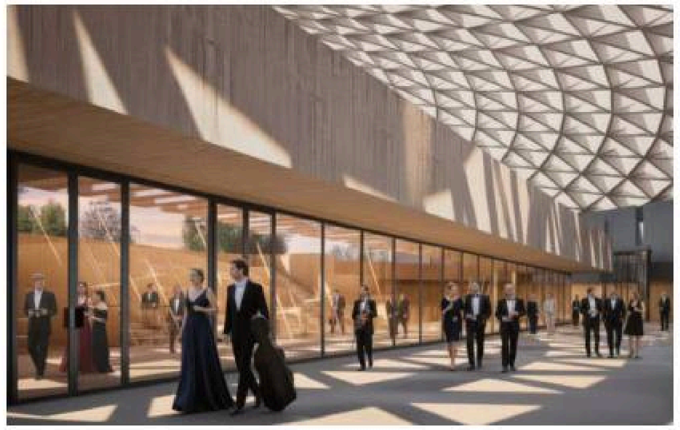
At the moment of completion, the landscape appears open and tentative. Young vegetation outlines paths and clearings, while the architecture remains largely withdrawn, embedded within the ground and legible only through subtle markers. The site reads as a quiet field of possibility, defined more by continuity than by form, inviting exploration without instruction.

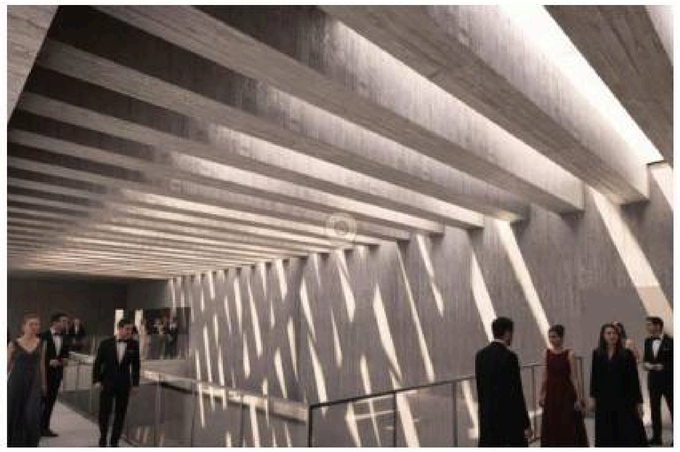
As years pass, the landscape thickens. Trees extend their canopies, paths soften at their edges, and shaded pockets begin to form where people naturally linger. Seasonal rhythms become visible: light filtered through leaves, sound absorbed by growth, heat moderated by shade and soil. The presence of the music hall, constant and stable, anchors these changes without directing them, allowing use to emerge organically through familiarity and repetition.

Over decades, the site becomes inseparable from its surroundings. What was once perceived as an intervention dissolves into the everyday life of the city. The park functions as a corridor, a refuge, and a meeting ground, while the architecture below continues to host sound, gathering, and shared experience. The distinction between designed space and natural growth fades, replaced by a layered environment shaped equally by ecology, time, and human presence.

In this long-term condition, the project no longer seeks attention. Its success is measured by disappearance into use, by the quiet persistence of paths, trees, and routines, and by the continued resonance of sound beneath a living landscape. The site endures not because it resists change, but because it was designed to accept it.

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1.7 AI Aino Maps

1.8-1.10 Google Map Images

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Appendix

Appendix A: Digital Tools and Design Process

During the development of this thesis, the design process was used as an opportunity to reflect on the evolving role of digital tools within contemporary architectural practice. Alongside traditional methods of drawing, modelling, and physical testing, a range of digital platforms were explored as part of a broader investigative workflow.

Image-based tools such as Krea were used experimentally during early conceptual phases to test atmospheres, material sensibilities, and abstract spatial qualities. Mapping and analytical tools, including Aino AI, supported the organisation and visualisation of territorial data during preliminary site studies. These tools were employed to assist interpretation rather than to generate definitive analytical outcomes. Language-based digital tools were used selectively to support the editing and organisation of written material, assisting with clarity, structure, and revision during the drafting process. All architectural concepts, arguments, drawings, and critical interpretations presented in this thesis were independently developed by the author and remain the result of personal design research and decision-making.

The use of these tools reflects current professional practice, in which digital platforms increasingly support iterative thinking, testing, and communication without replacing authorship or critical judgement. Their inclusion in the thesis process is intended as a methodological acknowledgement rather than a source of content generation.

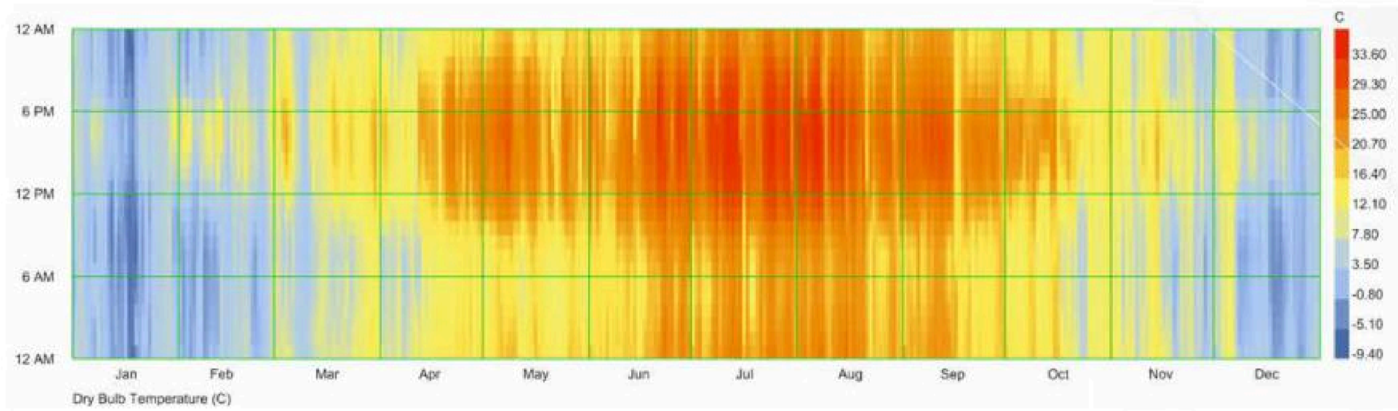
Appendix B: Environmental Studies

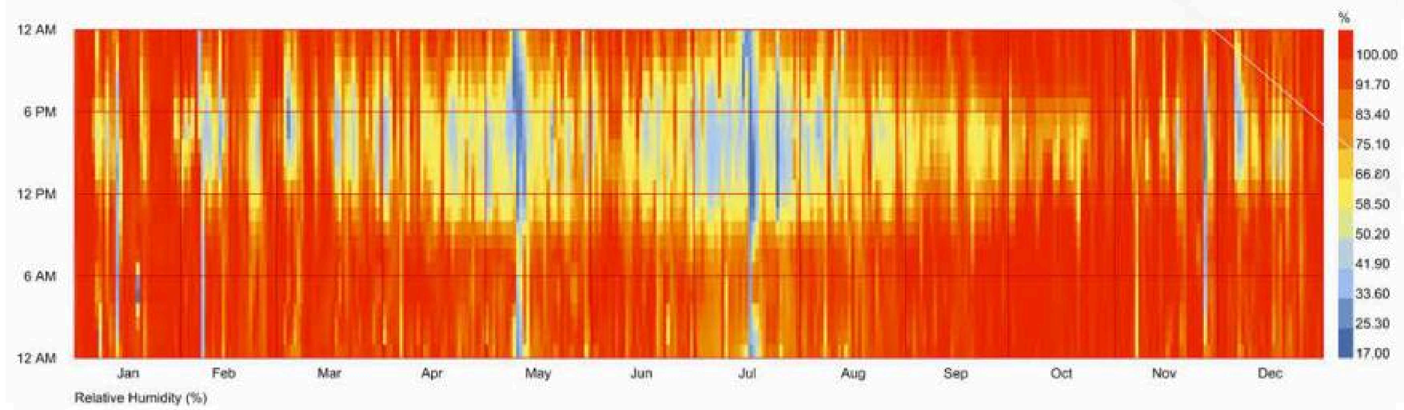
Milan, located in northern Italy, has a humid subtropical climate (Köppen climate classification Cfa) with some influences from the continental climate due to its inland position. This climate is characterized by hot, humid summers and cold, damp winters. Here's an in-depth look at the climate in Milan:

Notable Elements:
Average daytime temperatures in summer range from 28°C to 33°C, but heatwaves can push temperatures above 35°C. Nighttime temperatures usually stay between 18°C to 22°C. Summers are quite humid, which can make the heat feel more intense.Winters are cold, with average temperatures ranging from 0°C to 7°C. Frosts are common, and nighttime temperatures can occasionally drop below freezing. Winter also sees a moderate amount of rainfall, and snow is possible but not frequent. When it does snow, it tends to melt quickly.

Milan receives an average of about 1000 mm of precipitation annually with rainy seasons in the Spring and Autumn.

Milan experiences light winds due to its location in the Po Valley, which is shielded by the Alps to the north. However, occasional strong winds can occur, especially when weather fronts pass through the region. Additionally, like many large urban areas, Milan faces air pollution issues, especially in winter when thermal inversions trap pollutants close to the ground.





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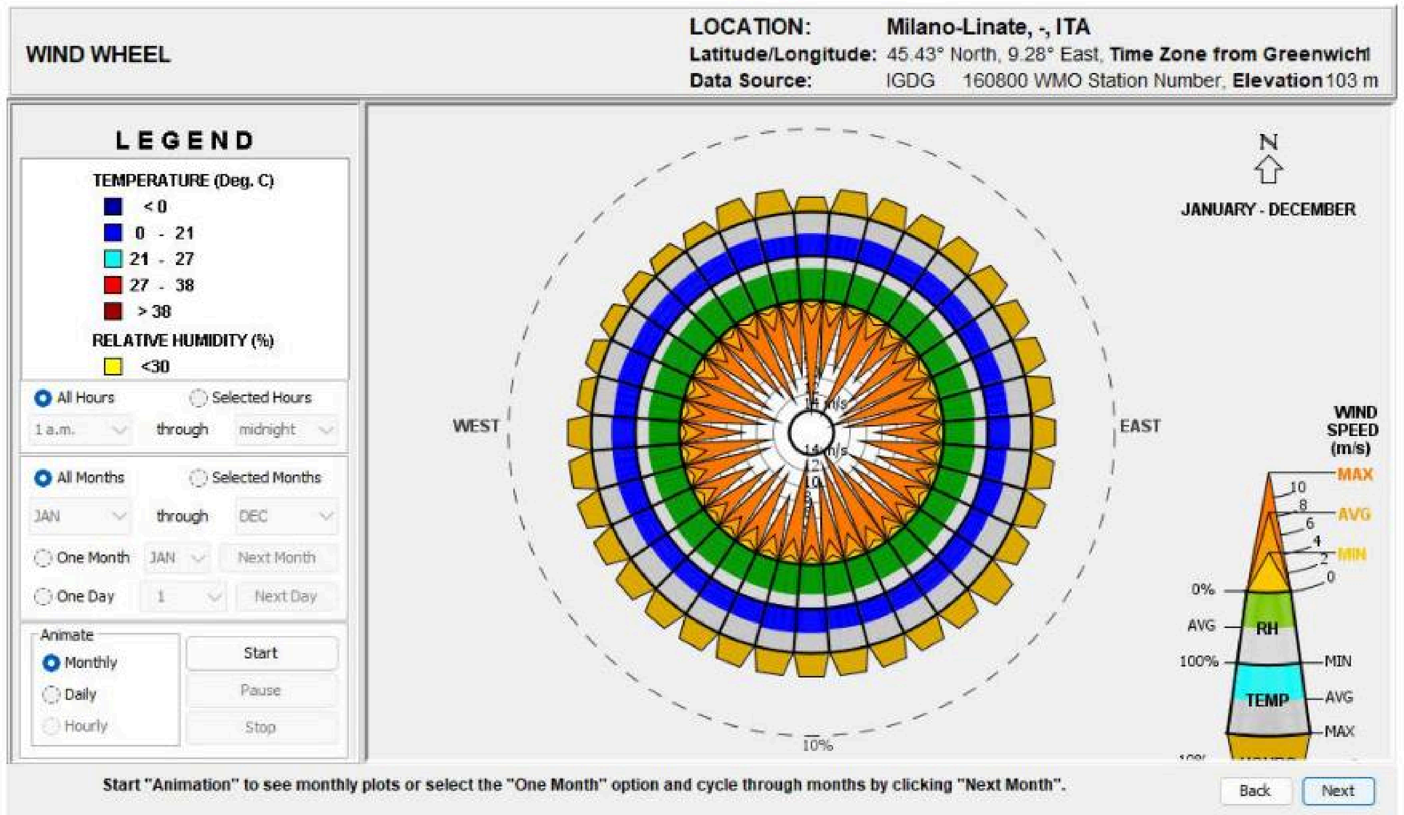
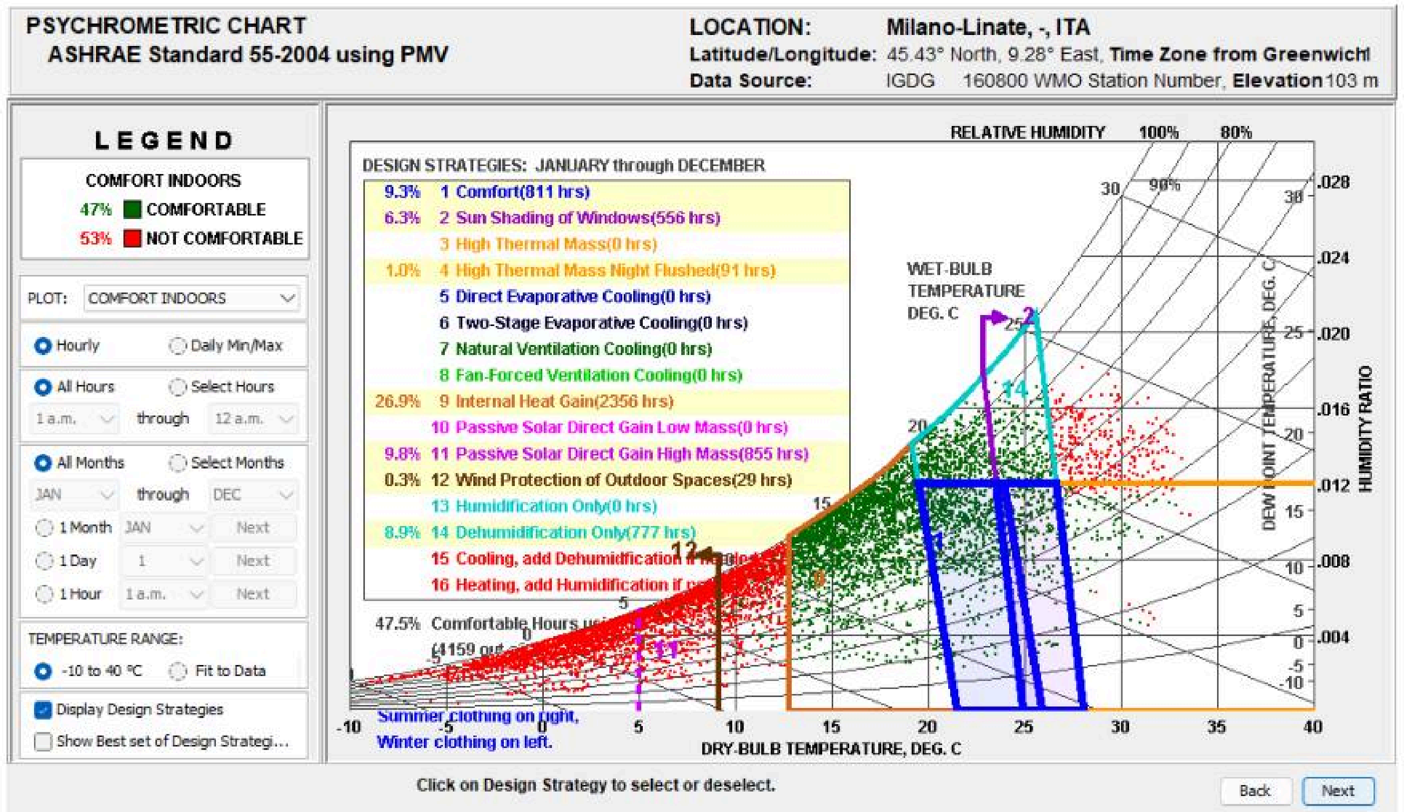
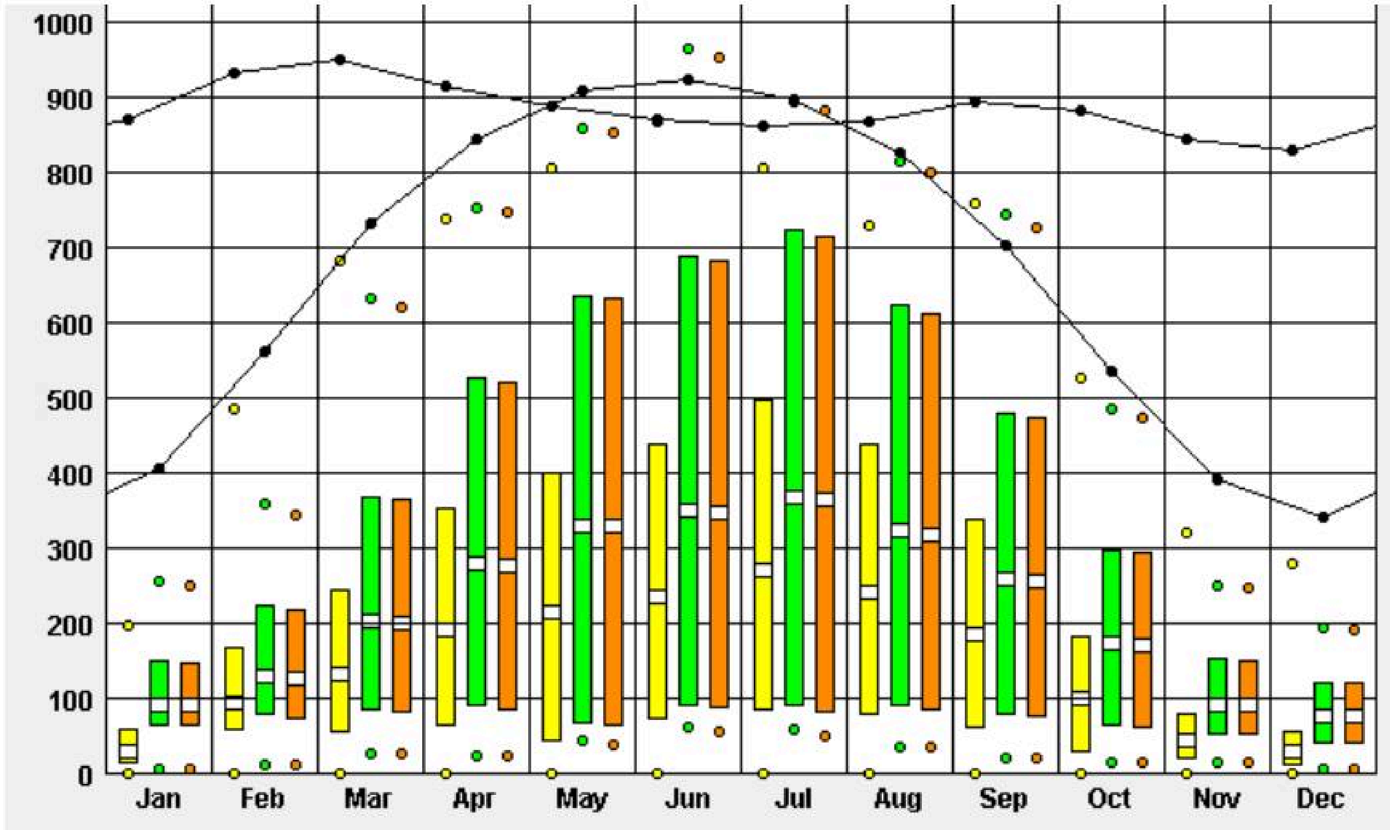
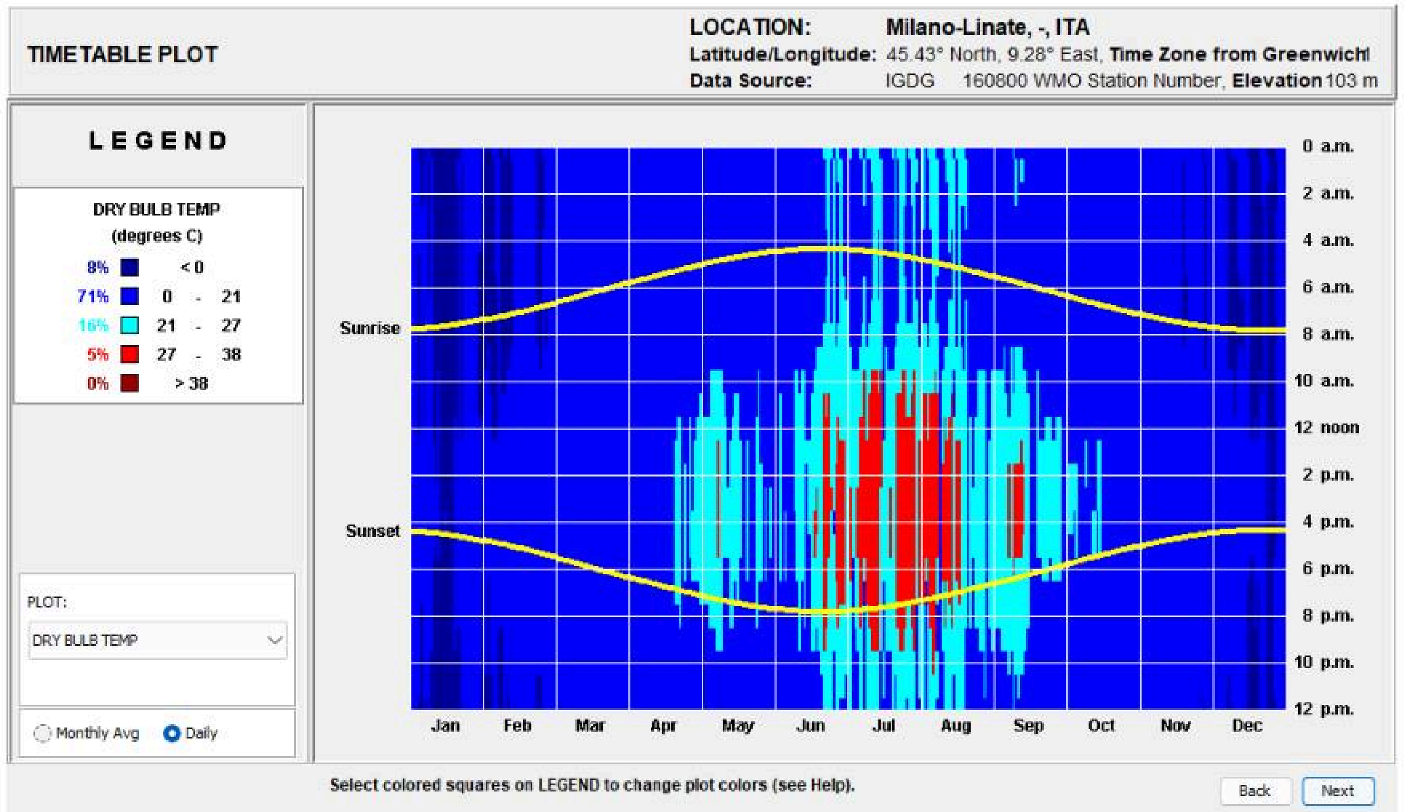




We began our climate analysis with the study of the direct sunlight hours on the project site and building form. It was important for us to design a building that is oriented in a proper direction to create thermal comfort and natural lighting for it's occupants. We did not want to design buildings that blocked the sunlight from entering the park which is one of the reasons why the gate building is tiered and low and why the music hall is on the north end of the site. Additionally, from this analysis, we discovered the largest park of the park recieves a lot of daylight which is optimal for safety and viability of park spaces.





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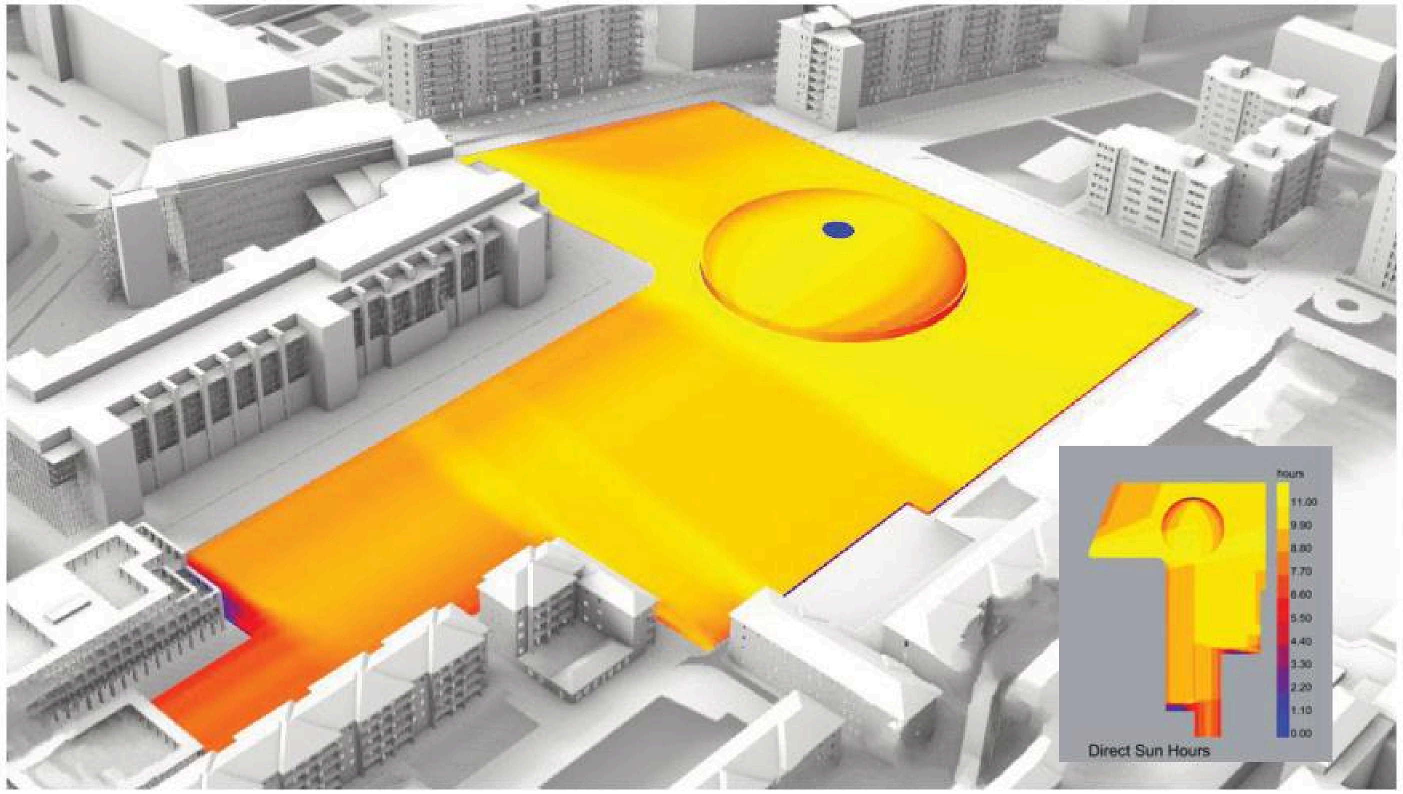
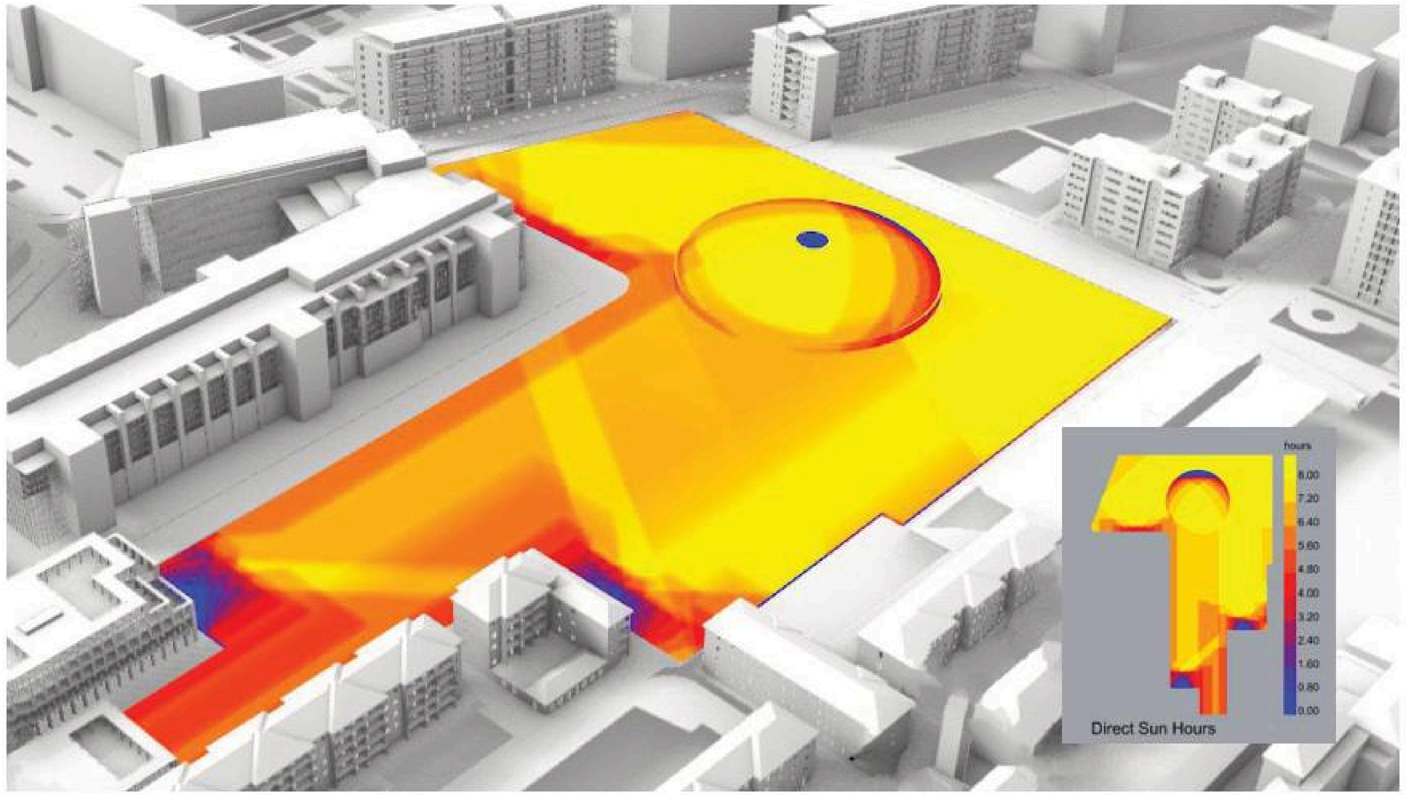


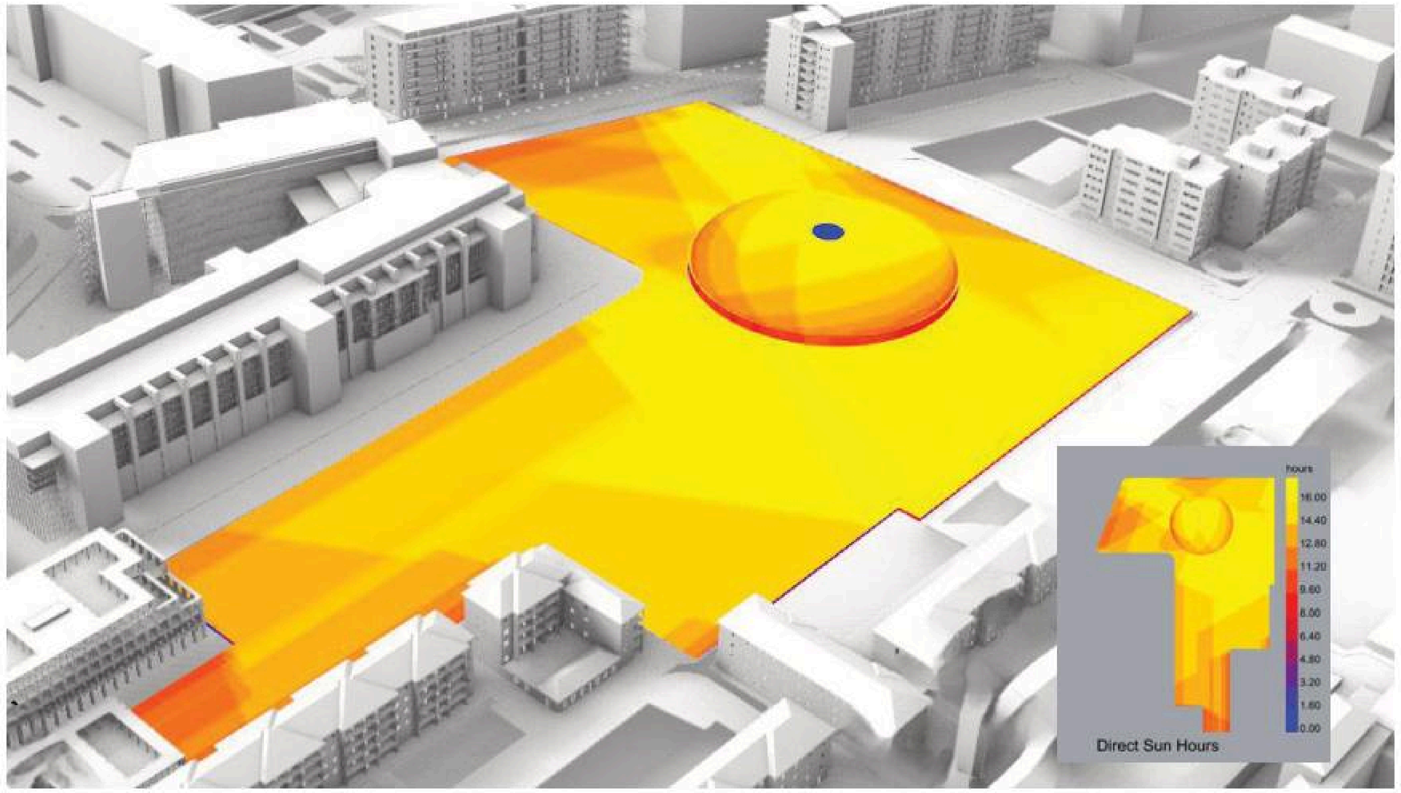
SPRING/FALL EQUINOX

During the spring and the autumn, the canopy gets exposed to a good amount of sunlight guaranteeing that the spaces underneath have enough light.



WINTER SOLSTICE

The N facade receives very little direct sunlight, but the southern facade and most of the park still have the potential to receive 7-8 hours. The south facing part of the canopy still recieves lots of light in the winter which is good news for the space inside



SUMMER SOLSTICE

The entire building is exposed to 8-16 hours of direct sunlight a day proving that during the summer months the canopy is needed to recude the heat level and provide relief.

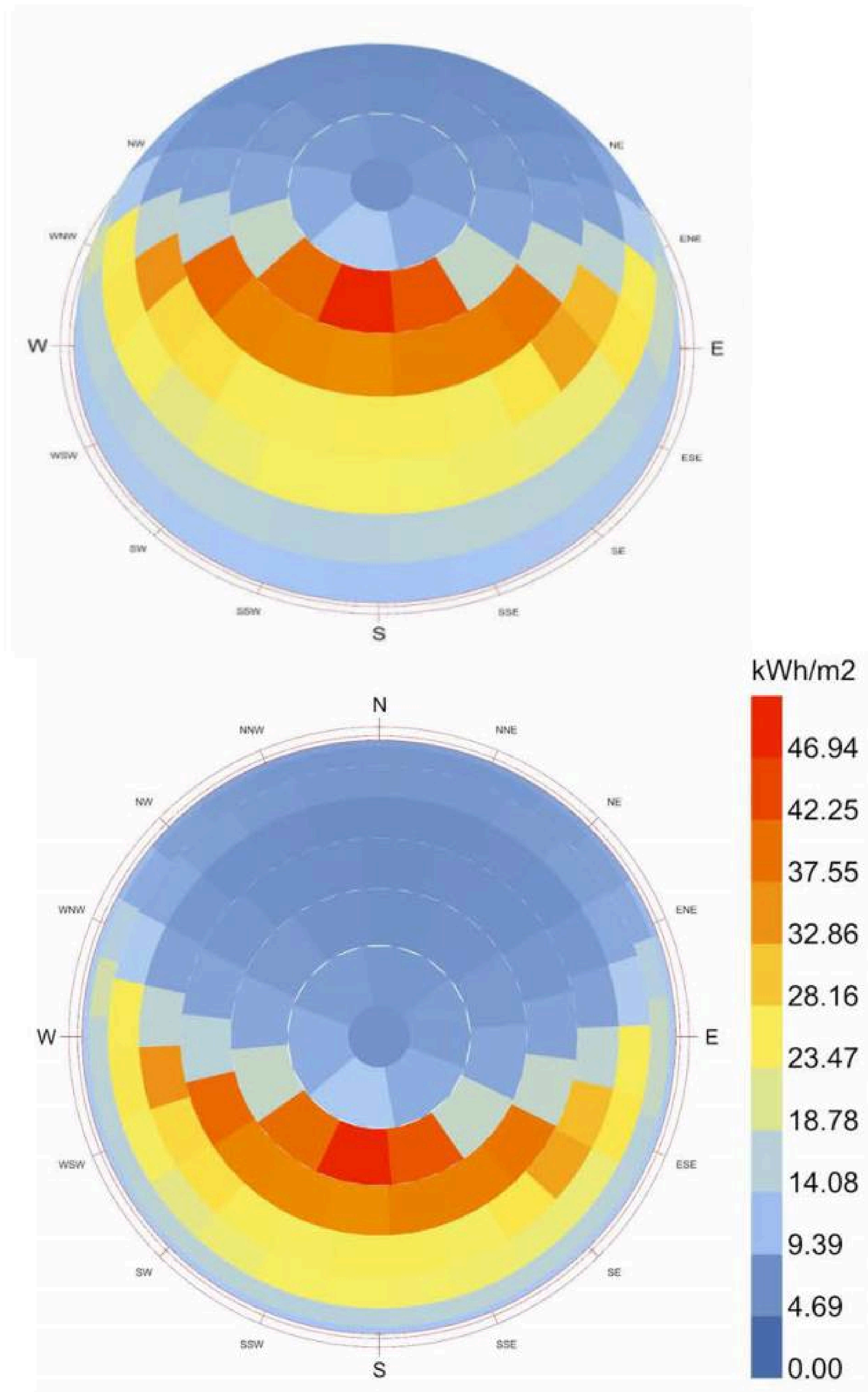
Appendix B: Environmental Studies

Solar radiation studies in Milan reveal a distinct pattern typical of northern Italy's continental climate: high solar angles and strong radiation in summer, especially between May and September, and lower, softer light in winter. The city experiences significant seasonal variation, with long daylight hours and high solar gain during the warmer months. In urban contexts, this radiation is often both a resource and a design challenge - balancing passive solar gain for winter comfort with the need to prevent overheating and glare in summer.

In our project, where the music hall is partially sunken below ground and covered by a large overhanging canopy, the design inherently limits direct solar exposure. From a thermal standpoint, this is largely advantageous. The underground volume benefits from the earth's natural insulation, providing a more stable interior temperature year-round and reducing the need for mechanical cooling during Milan's hot summers. The canopy further reduces solar gain by shading the plaza and building envelope, protecting glazed or exposed surfaces from intense summer sun and mitigating urban heat island effects.

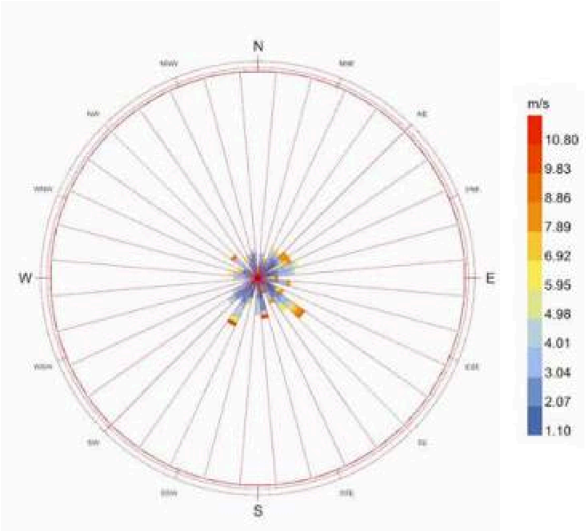
However, this strategy also introduces some drawbacks. The deep canopy and underground design restrict access to direct daylight, which can affect the quality of natural illumination in interior and semi-public spaces. This may increase reliance on artificial lighting, especially in transitional areas like entrances, lobbies, or circulation paths. Additionally, during the winter months, when some passive solar heating would be beneficial, the canopy may block low-angle sunlight that could otherwise help warm the building naturally.

Overall, the reduced solar exposure is beneficial from an energy-efficiency and thermal comfort perspective, particularly given Milan's hot summers. But it requires careful design of lighting and ventilation systems to ensure interior comfort and avoid overly dim or stagnant spaces. Further simulation can help fine-tune the canopy geometry,perhaps incorporating openings, reflective surfaces, or selective transparency,to strike a better balance between shading and daylight access, while leveraging the underground design for passive thermal performance.

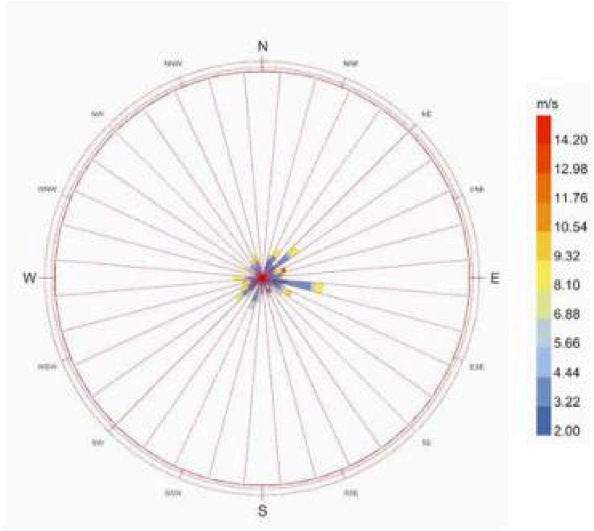


Total Radiation

Appendix B: Environmental Studies

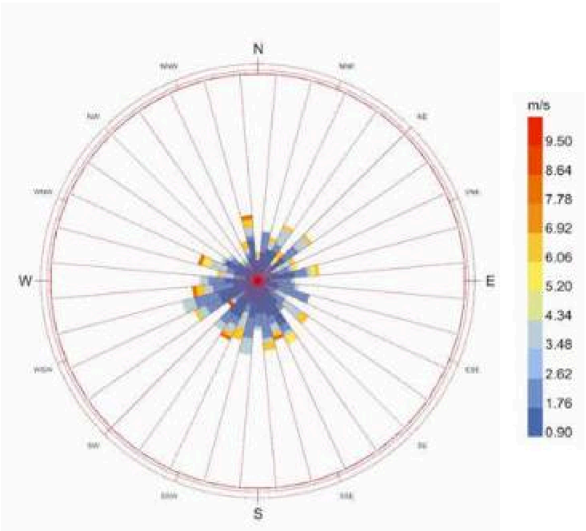


JANUARY



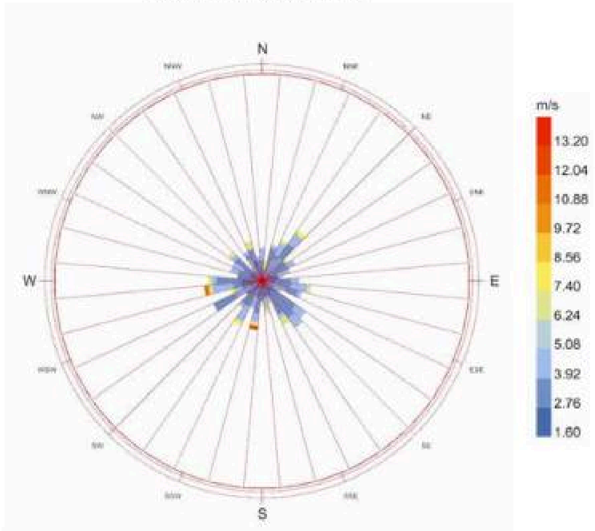
FEBRUARY

Strong gusts of wind

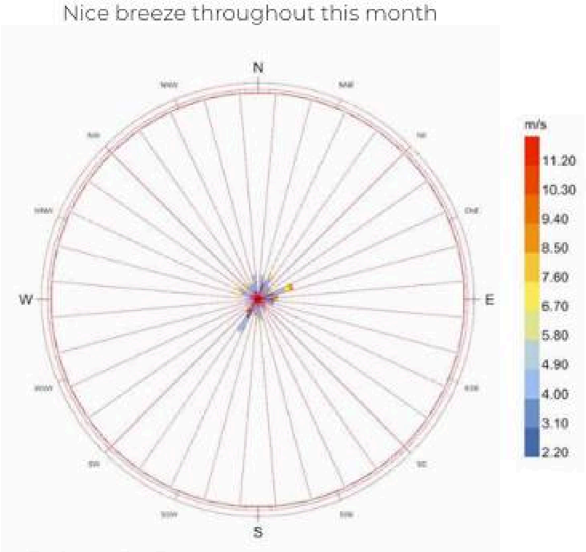


MAY

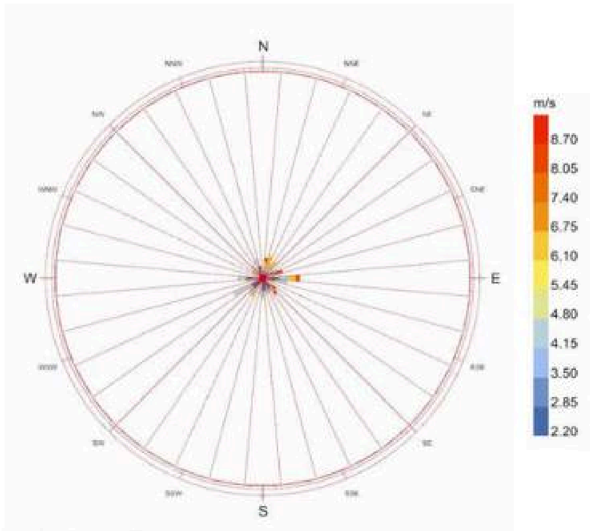
Nice breeze throughout this month



JUNE

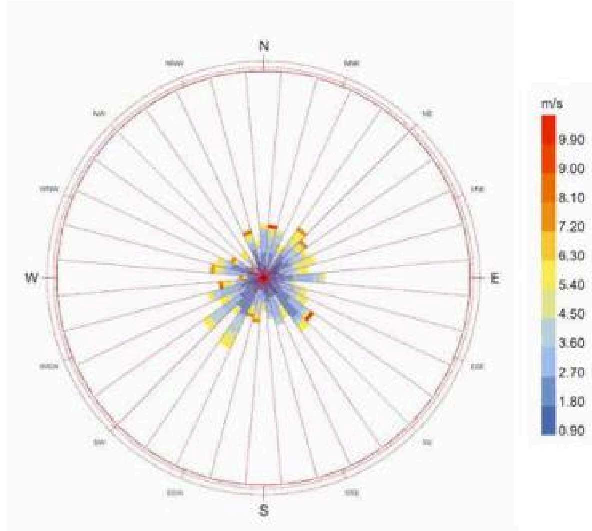


SEPTEMBER



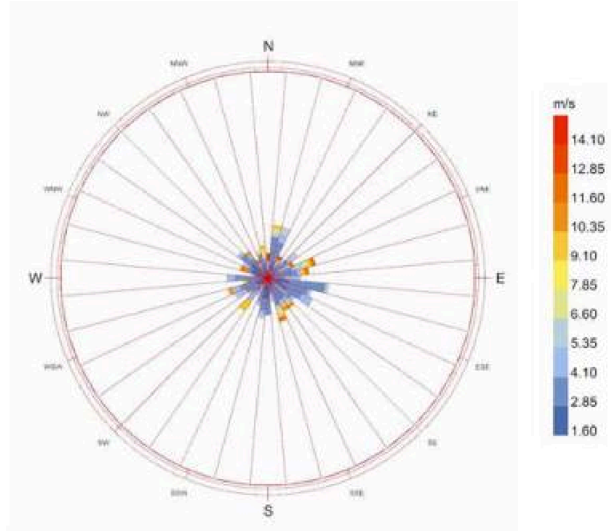
OCTOBER

Least windy month

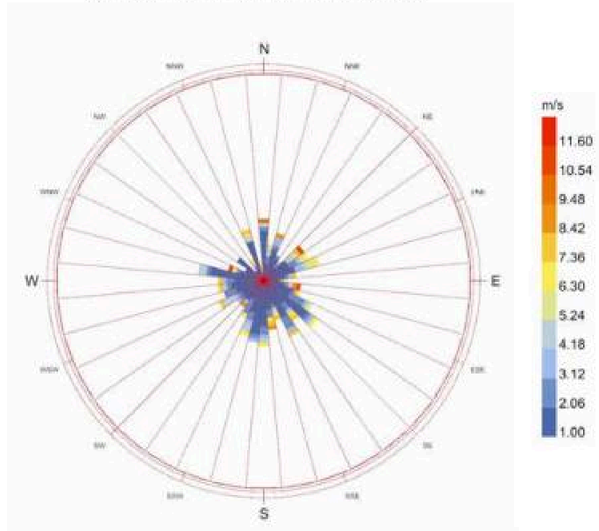


MARCH

Windy month from all directions

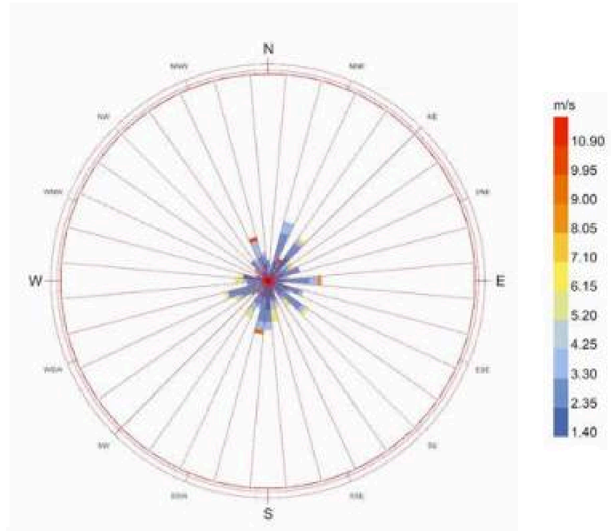


APRIL

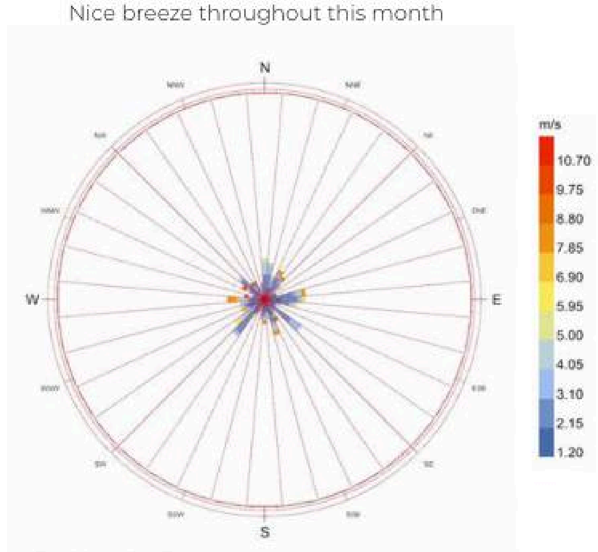


JULY

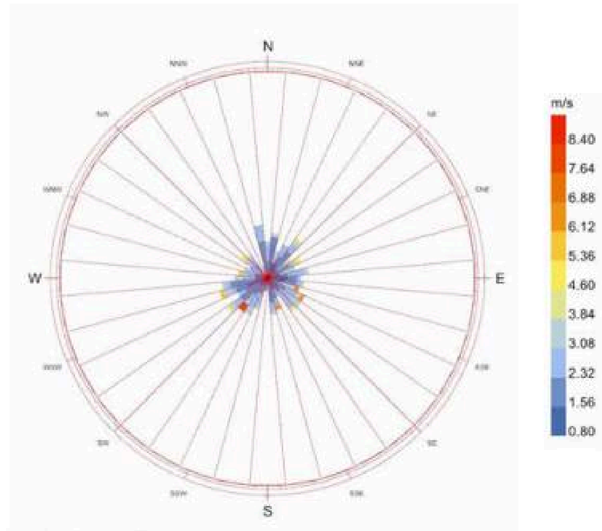
Nice breeze throughout this month



AUGUST



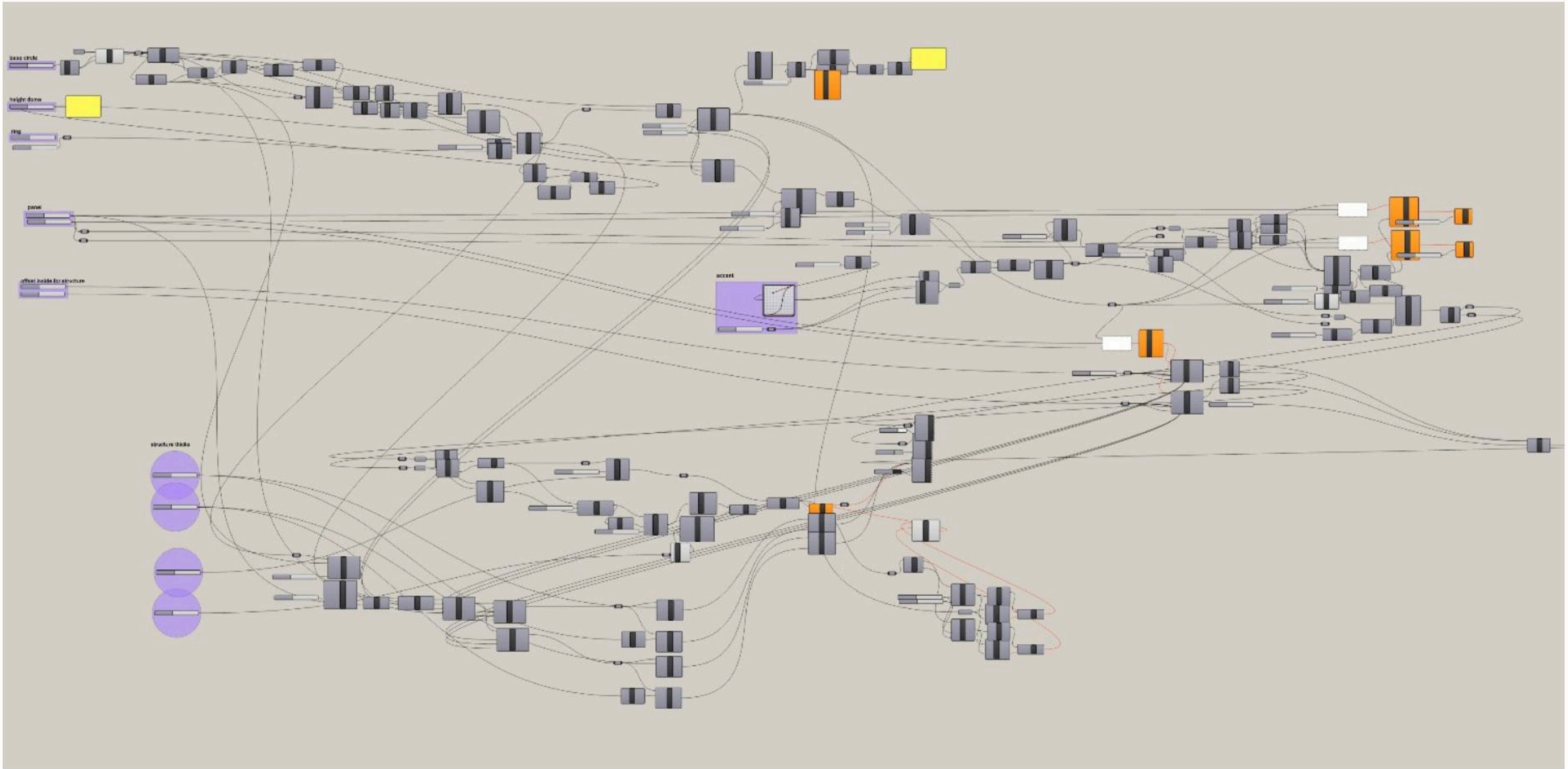
NOVEMBER



DECEMBER

Appendix B: Environmental Studies

The dome canopy was developed parametrically in Grasshopper as a 66-meter-span rounded canopy composed of intertwining elements. Designed as a flexible system, every aspect of the geometry, from the overall span and curvature to the density and weaving pattern of the structural elements,was made fully adjustable. This high level of parametric control allowed for real-time experimentation and optimization, enabling the design to adapt seamlessly to structural, environmental, and aesthetic requirements. The intertwining logic was achieved through custom algorithms that generate a dynamic, woven effect, resulting in a form that is both visually expressive and structurally coherent.



Appendix B: Environmental Studies

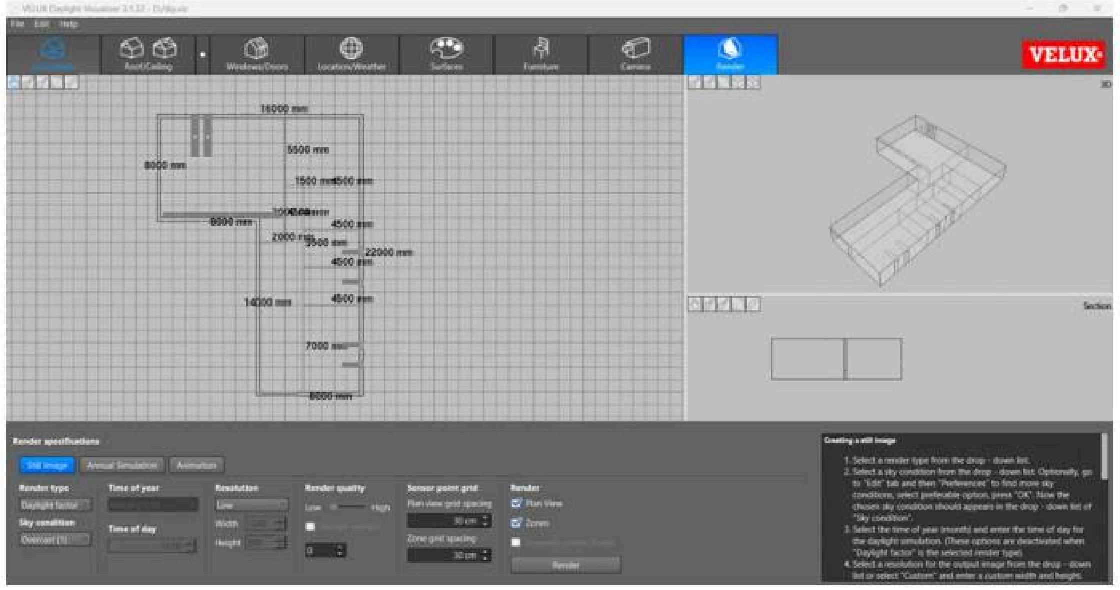
Natural daylighting analysis in a building offers numerous benefits that enhance both the environment and occupant well-being. By optimizing the use of natural light, energy consumption is significantly reduced, leading to lower electricity bills and a smaller carbon footprint. Proper daylighting can reduce the need for artificial lighting, minimizing glare and improving visual comfort.

For our Music Hall, we know that lighting will be an issue because not only is it carved out of the ground and recessed levels, it is also covered by a canopy. There is a deep heavyness to the walls so balancing this out with lighting is very important. It is assumed that we will have to use artifical lighting due to the conditions we are working with, but first we wanted to see what (if any) daylighting is available.

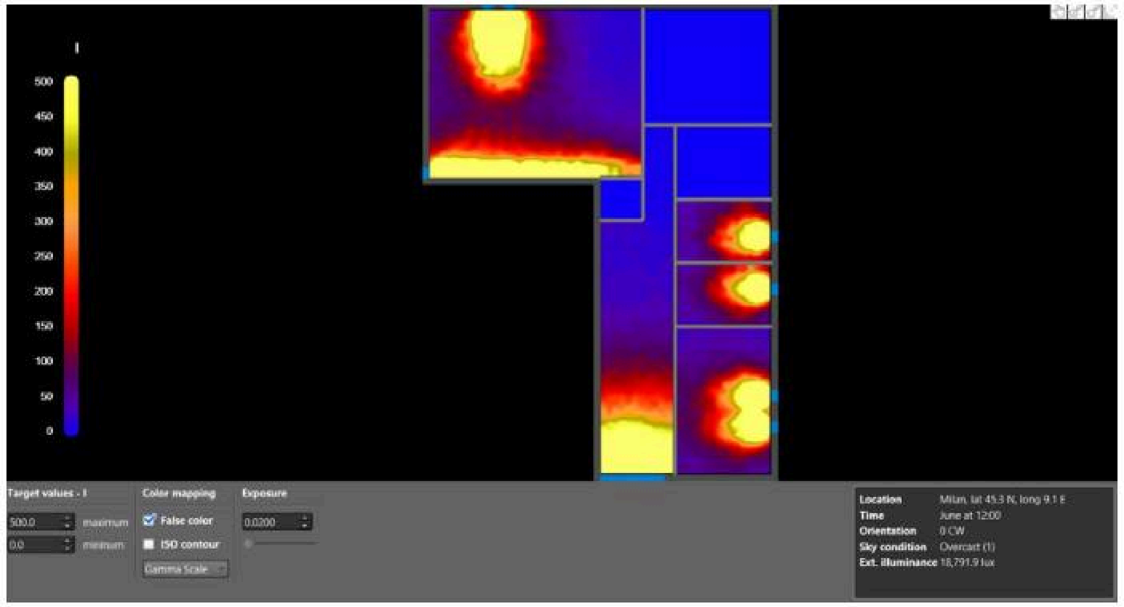
For this study, we have decided to study the lighting and subsequent comfort in the highest level of classroom spaces. We will always use the assumption of overcast skys for the analysis due to the recessed level and canopy cover.

This study found that in summer and winter the skylights and glazing does illuminate the space significantly more than we assumed. However these are not adequate results. We will need to make intentional decisions for artifical ligting in these spaces.Additionally, the skylights ended up playing a large role because we did a study without them and there is a noticable difference.

In addition this study called to our attention that one of the rehearsal rooms has no windows and is therefore not a comfortable space. We need to add slit windows in that area.

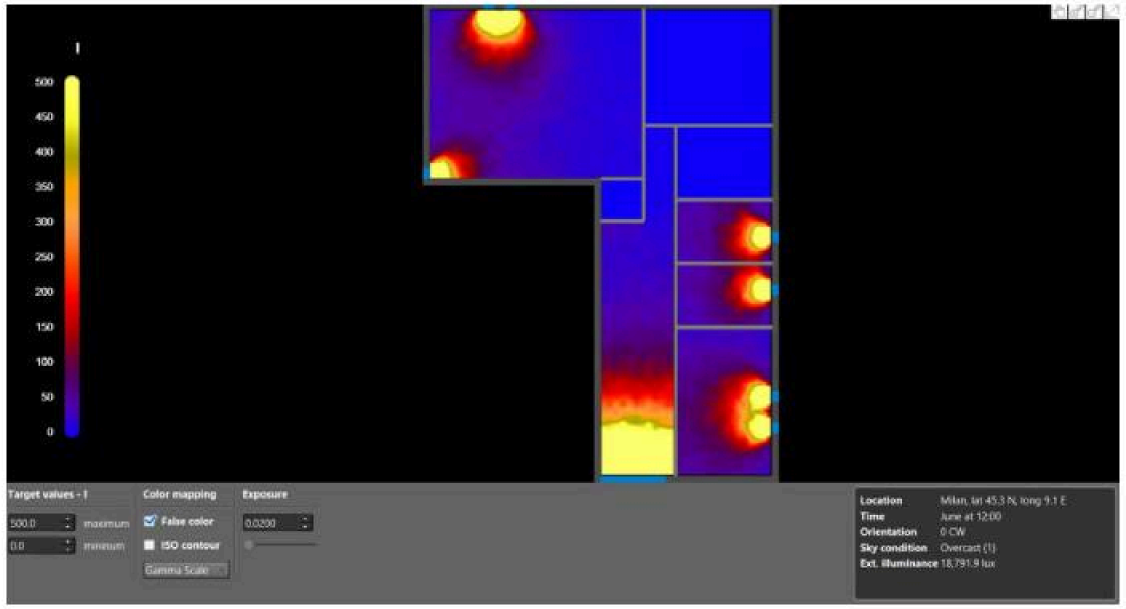


We studied an analysis of lighting with and without having skylights. As expected, adding skylights directly improves the quality of the interior space.



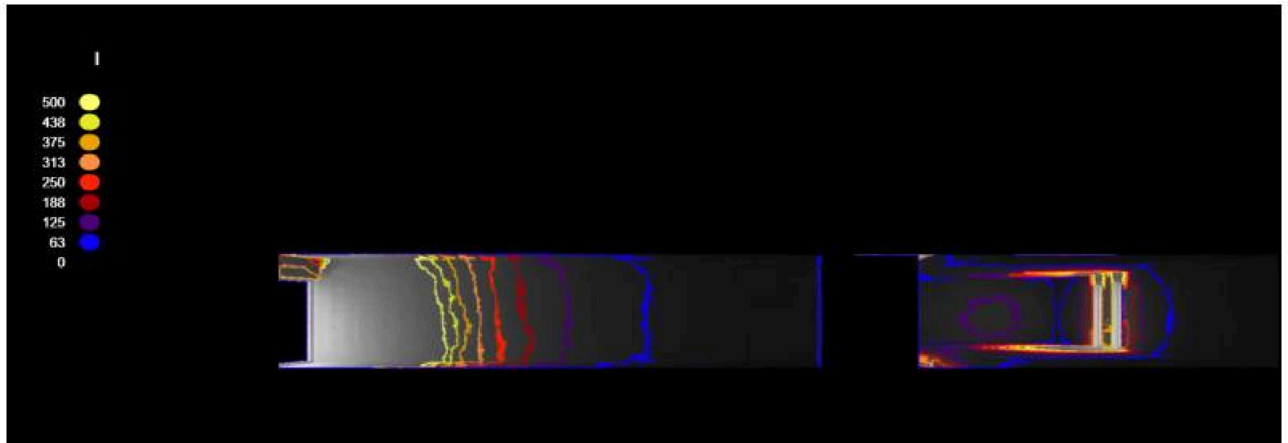
ILLUMINANCE STUDY WITH SKYLIGHTS - SUMMER

VS

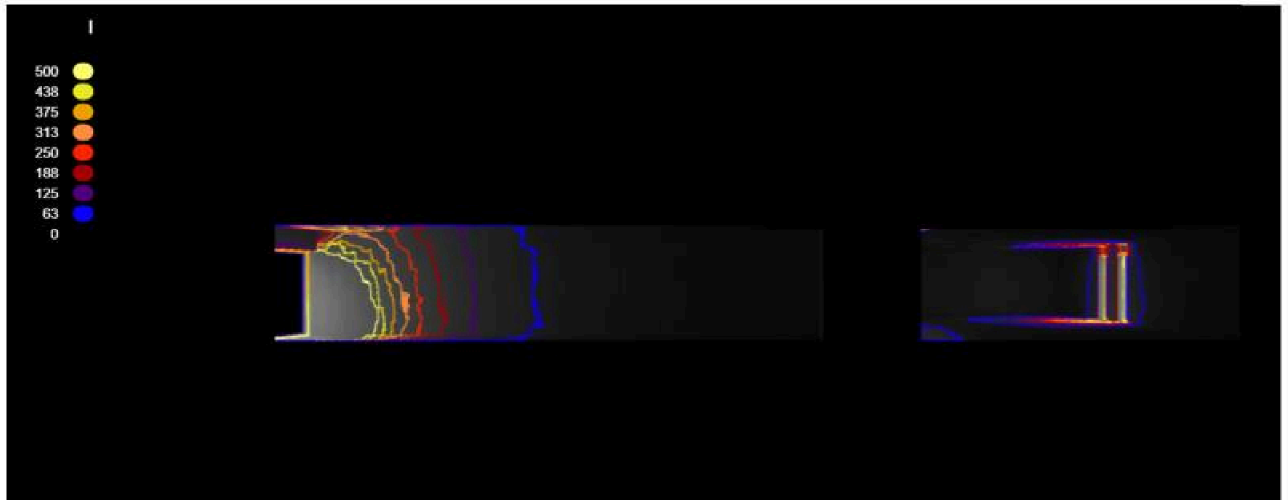


ILLUMINANCE STUDY WITHOUT SKYLIGHTS - SUMMER

Appendix B: Environmental Studies

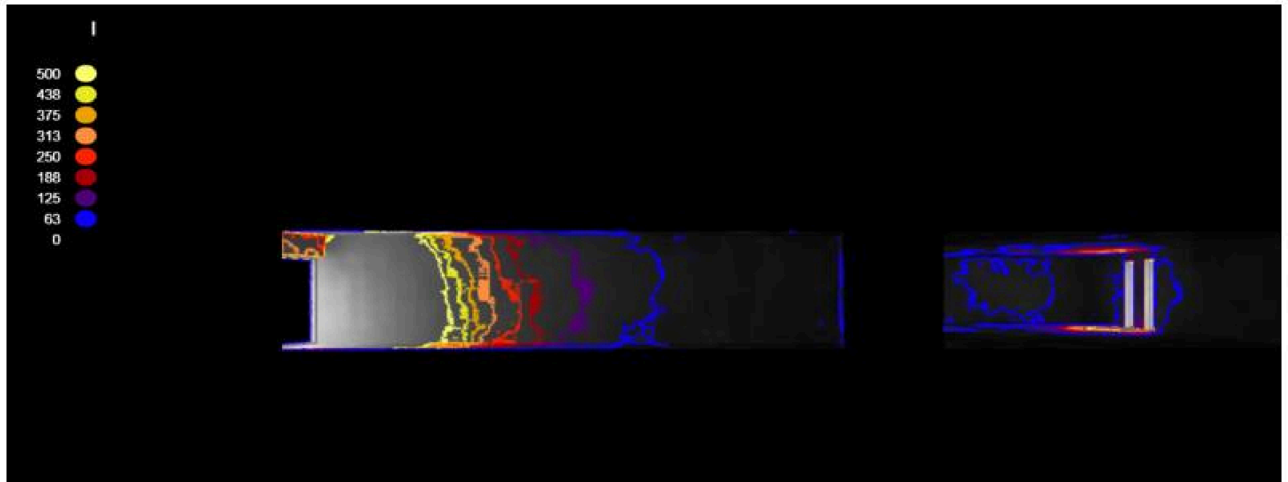


ILLUMINANCE STUDY WITH SKYLIGHTS - SUMMER

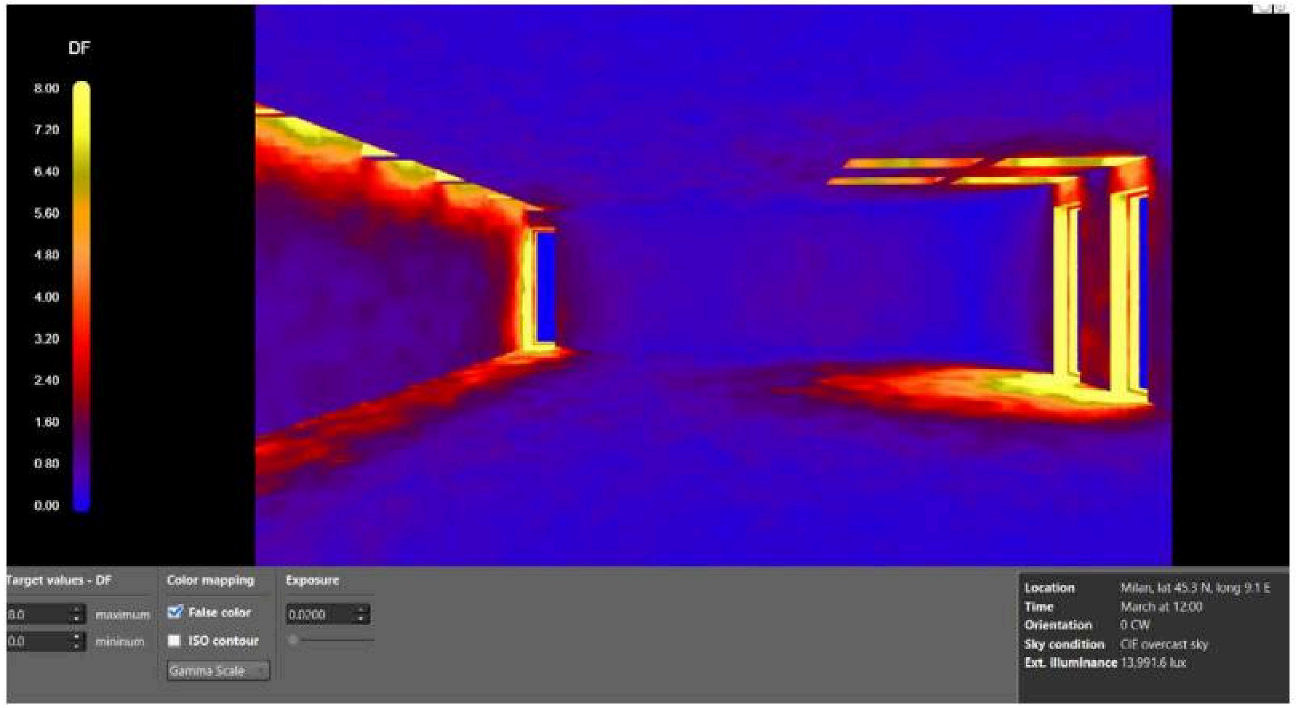


ILLUMINANCE STUDY WITH SKYLIGHTS - WINTER

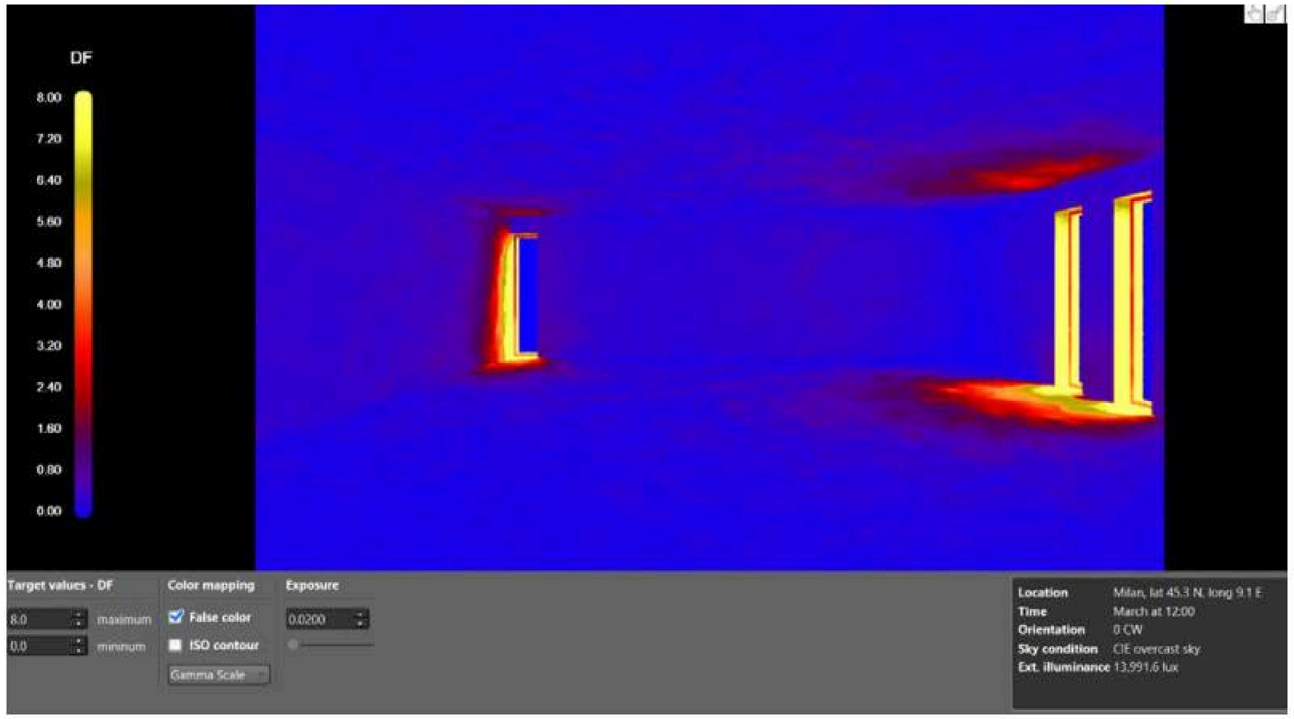
VS



ILLUMINANCE STUDY WITHOUT SKYLIGHTS - SUMMER



DAYLIGHTING STUDY WITH SKYLIGHTS - THE SKYLIGHTS DRAMATICALLY INCREASE THE AMOUNT OF NATURAL LIGHTING IN THE SPACE AND HUMAN COMFORT WHICH DRAMATICALLY REDUCES THE NEED FOR ARTIFICAL LIGHTING AND THE SUBSEQUENT ENGERGY USAGE THAT BRINGS.



DAYLIGHTING STUDY WITHOUT SKYLIGHTS - THIS STUDY SPECIFICALLY SHOWS THE SIGNIFICANT LACK OF DAYLIGHTING WITHOUT THE SKYLIGHTS. THIS IS A MAJOR PROBLEM FOR THE CLASSROOM SPACES ON THE LEVEL BELOW THIS BECAUSE THEY DON'T HAVE SKYLIGHTS. WE NEED TO FIND A WAY TO ADDRESS THIS EITHER BY ADDING MORE WINDOWS OR SPECIFYING AN EXCELLENT ARTIFICIAL LIGHTING SCHEME.

Appendix C: BIM Process

Building Information Modeling (BIM) is a smart digital approach that leverages 3D modeling to aid professionals in architecture, engineering, and construction. It helps them more efficiently plan, design, build, manage, and operate projects. Unlike traditional models, these 3D models carry detailed information about each building component, turning them into a comprehensive resource of project data that is accessible to the entire team. For architects, BIM offers the chance to make more informed design choices, boost building performance, and collaborate more seamlessly. It enhances the design process, supports better decision-making, and makes it easier to implement changes throughout the project. Historically, construction projects have been disjointed, with different teams working independently on separate aspects. BIM addresses this issue by allowing all parties to collaborate in real-time, ensuring everyone has the latest information. This coordinated approach improves the efficiency of project management and the construction process as a whole.

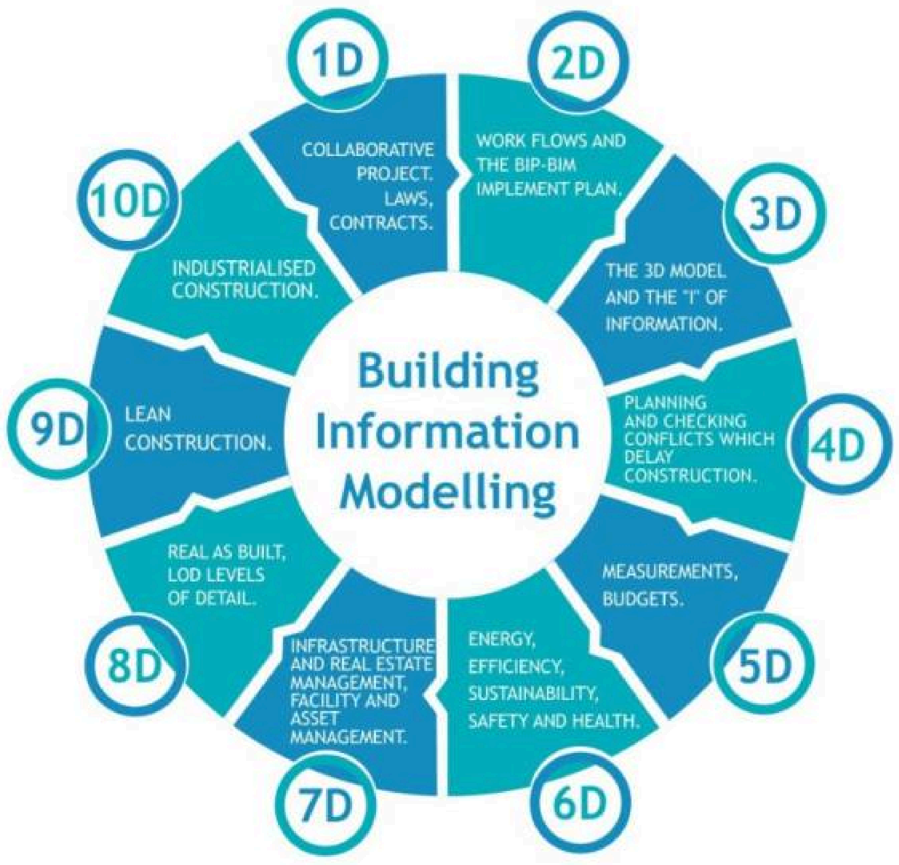
The Levels of Development (LOD) in BIM is an industry standard that serves as a reference tool to enhance communication quality throughout every project phase. LOD focuses on the characteristics of elements in models, indicating the degree of refinement in the 3D geometry of a building. It specifies the amount of information modeled in the 3D file and what data is accessible, thereby conveying the content and reliability of BIMs at various stages of the design and construction process.

LOD 100: Conceptual Design (Pre-Design) At this initial stage, the focus is on site discovery and analysis, understanding the site's needs, benefits, and constraints, and developing a conceptual design. The model primarily consists of 2D symbols and basic masses to represent the elements' existence. This phase includes site analysis and conceptual proposals, often using tools like Rhino, AutoCAD, and SketchUp for preliminary modeling and the Adobe suite for presentations.

LOD 200: Schematic Design In this phase, the building's shape and design are refined, defining different spaces according to the program, and initial facade, structural, and circulation strategies are developed. The elements are outlined with approximate quantities, sizes, shapes, and locations. Tools like Revit and Rhino are used for more detailed design work, while plugins like Ladybug for Grasshopper help with solar radiation and sun path analysis, and VELUX Daylight Visualizer assists with daylight conditions analysis.

LOD 300: Detailed Design This stage involves precise development of the building's design, including the facade, using parametric tools for efficiency and coherence. Sun and daylight analyses guide the design of comfortable, sustainable spaces. Elements are defined with exact dimensions and relative positions. Tools such as Midas, Tekla, Revit, and Solibri Model Checker are employed for structural analysis, construction scheduling, simulation, and quality assurance, ensuring zero design errors and cost savings.

LOD 400: Construction (Fabrication and Assembly) The final design phase involves using building performance software to define the exact structure and construction phases based on a Work Breakdown Schedule. The model elements are detailed as specific assemblies, complete with fabrication, assembly, and detailed information including precise quantities, sizes, shapes, locations, and orientations. Environmental performance is evaluated using tools like the Active House radar. Coordination between BIM software ensures that architectural and technical solutions align with the initial project goals.



BIM Model Uses refer to the various ways Building Information Modeling can be applied throughout the lifecycle of a building project. These uses help stakeholders achieve specific objectives by leveraging the data-rich 3D models.

General Model Uses:
Applicable across various industries, information systems, and knowledge domains.
Typically include the term 'modelling' in their name.
Measured using granularity metrics such as Level of Definition (LOD), Level of Development, and Granularity Level at the component or item level.
Examples: Coordination Modelling, Cost Estimation, and Facility Management.

Domain Model Uses:
Specific to particular industries, such as construction.
Referred to as Construction Domain Model Uses or BIM Uses
Named as either a noun & adjective or just an adjective.
Examples: Design Authoring, Structural Analysis, Energy Analysis, and Construction Scheduling.

Custom Model Uses:
A blend of General and Domain Model Uses.
Tailored to meet the unique modeling requirements of specific projects, clients, employers, or markets.
Adapted to suit particular project needs and goals.
Examples: Custom clash detection for a specific project, and tailored asset management models.

We initially aimed to explore the full breadth of Building Information Modeling (BIM) model uses across design, planning, simulation, and systems coordination. The original scope encompassed over 40 specific uses including advanced analytical processes such as generative design, life cycle assessment, and augmented reality simulation. We also planned to address diverse system-level modeling from fire and HVAC systems to transportation and subterranean infrastructure. This ambition reflected the true potential of BIM to serve as a holistic digital twin across every stage of the built environment lifecycle—from early design to post-occupancy analysis. However, the scale of this exploration proved too expansive for a single volume.

We narrowed our focus to a selection of model uses that best demonstrate BIM's ability to support sustainable, performance-driven, and integrated design. These include foundational tools like 2D documentation and conceptualization, broader applications like urban planning, and targeted analyses such as acoustic, lighting, thermal, wind, site, spatial, structural, and sustainability studies. We also explore key technical systems—construction logistics, facade systems, HVAC—and include parametric modeling to emphasize BIM's capacity for responsive and iterative design processes.

CATEGORY I: GENERAL

1120	Facade Systems Modelling | Glazing/Cladding/Curtain Systems Modelling
1190	HVAC Systems Modelling | Heating/Ventilation/Air-conditioning Systems Modelling
1310	Parametric Modelling

CATEGORY II: DOMAIN

Capturing and Representing	
2010	2D Documentation
Planning and Designing	
3010	Conceptualization
3110	Urban Planning
Simulating and Quantifying	
4020	Acoustic Analysis
4120	Lighting Analysis
4180	Site Analysis
4190	Solar Analysis
4200	Spatial Analysis
4210	Structural Analysis
4220	Sustainability Analysis
4230	Thermal Analysis
4260	Wind Studies
Construction and Fabrication	
5050	Construction Logistics

Appendix C: BIM Process

There are a plethora of BIM software options available that can be utilized during the planning, design, construction, and management stages of a project. These software tools range from those used for initial conceptual design to those focused on detailed architectural modeling, structural analysis, and MEP (mechanical, electrical, plumbing) system integration. Additionally, there are tools for construction scheduling, cost estimation, and facility management.

The workflow on the right illustrates the interconnectedness of these various applications, demonstrating how each one supports a smooth and coordinated design process. For example, architectural design software can integrate seamlessly with structural and MEP design tools, allowing for real-time collaboration and clash detection. Construction planning software can pull data directly from design models to create accurate schedules and cost estimates. During the construction phase, on-site teams can access updated models to ensure precise implementation and track progress. Finally, facility management tools can use the as-built BIM models to maintain and operate the building efficiently.

This interconnected approach ensures that all stakeholders, from architects and engineers to contractors and facility managers, have access to accurate and up-to-date information, enhancing collaboration, reducing errors, and ultimately leading to a more efficient and successful project outcome. Moreover, the continuous feedback loop between the stages facilitates ongoing improvements and adaptations throughout the building's lifecycle.