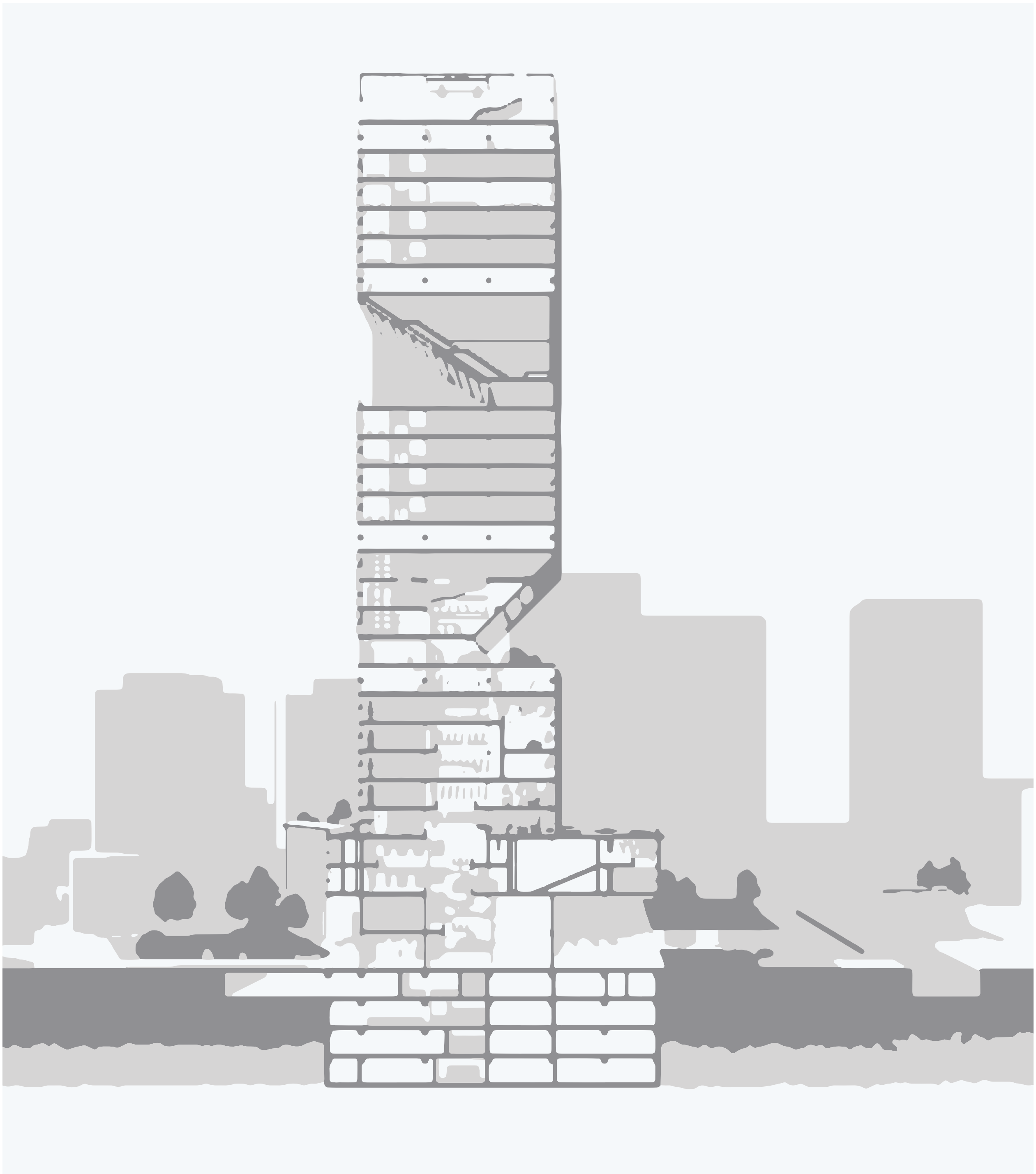
POLITECNICO
MILANO 1863

GIOIA 22, RE-ARTICULATING PORTA NUOVA

A public high-rise proposal in Milan skyline



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Abstract

The hereby presented thesis concerns the design of the reconstruction of Gioia 22 project. The brief called for a new development for the Gioia 22 COIMA building and the neighboring area of Porta Nuova-Gioia, representing a chance to take part to the pressing debate about the impact of the new high-rises on the city scape.

From the perspective of urban scale, the project takes urban sustainability to a new level by gradually transforming mobility into a more sustainable way, thanks to the street network involved in the existing Naviglio Martesana unveiling the project Rearrange. The design team chose to demolish the existing building because its shape and geometry do not match with the surrounding environment and buildings. In addition, the team reopened the Navigli Canal in accordance with Milan's 2030 plan, adding water features to the context.

The building itself was considered as a group of intertwined volumes that establish a visual relationship with the surrounding environment. The two urban assets considered were through via Giovanni Battista Pirelli and via Melchiorre Gioia, the gateway to the region. Special overhangs were designed with suspension steel structural conception, to distinguish them from the main steel column-beam frame.

The volume composition helps to demonstrate the mixed-use nature of the building and aims to expand the scope of activities and spaces that can benefit both regions and cities. Public functions, including an exhibition space, a library, a auditorium and a sky bar are located within the tower, while the remains parts hosts the office floors. Apart from that, there are retails and cinema in the podium, as well as parking and connection to the Gioia metro station (M2) underground.

The design was integrated with a series of building systems, with sustainability and carbon footprint reduction as key values. In addition to HVAC, Water Management, Ventilation system, Eletric system and Renewable Energy systems, a set of photovoltaic systems was introduced, not only because of their impact on livability, but also as part of a greater commitment to pursue sustainability and building language integration.

Estratto

La tesi qui presentata riguarda la progettazione della ricostruzione del progetto Gioia 22. Il bando prevedeva un nuovo sviluppo per l'edificio Gioia 22 COIMA e l'area limitrofa di Porta Nuova-Gioia, rappresentando un'occasione per partecipare al pressante dibattito sull'impatto dei nuovi grattacieli sul paesaggio urbano.

Dal punto di vista della scala urbana, il progetto porta la sostenibilità urbana a un nuovo livello trasformando gradualmente la mobilità in un modo più sostenibile, grazie alla rete stradale coinvolta nell'esistente Naviglio Martesana presentando il progetto Riorganizzare. Il team di progettazione ha scelto di demolire l'edificio esistente perché la sua forma e la sua geometria non corrispondono all'ambiente e agli edifici circostanti. Inoltre, il team ha riaperto il Canale dei Navigli secondo il piano di Milano 2030, inserendo nel contesto giochi d'acqua.

L'edificio stesso è stato considerato come un insieme di volumi intrecciati che stabiliscono un rapporto visivo con l'ambiente circostante. I due beni urbani considerati furono, tramite Giovanni Battista Pirelli e Melchiorre Gioia, la porta di accesso alla regione. Appositi sbalzi sono stati progettati con concezione strutturale in acciaio di sospensione, per distinguerli dal telaio principale a colonna in acciaio.

La composizione del volume aiuta a dimostrare la natura a uso misto dell'edificio e mira ad ampliare la portata delle attività e degli spazi che possono beneficiare sia le regioni che le città. Le funzioni pubbliche, tra cui uno spazio espositivo, una biblioteca, un auditorium e uno sky bar si trovano all'interno della torre, mentre le parti rimanenti ospitano i piani degli uffici. Oltre a ciò, ci sono negozi e cinema sul podio, oltre a parcheggio e collegamento alla metropolitana della stazione della metropolitana di Gioia (M2).

Il progetto è stato integrato con una serie di sistemi costruttivi, con la sostenibilità e la riduzione dell'impronta di carbonio come valori chiave. Oltre ai sistemi HVAC, Water Management, Ventilation system, Electric system e Renewable Energy, è stato introdotto un insieme di impianti fotovoltaici, non solo per il loro impatto sulla vivibilità, ma anche come parte di un maggiore impegno per perseguire la sostenibilità e l'integrazione del linguaggio edilizio .

A problem to be solved

Milan is often referred to as the 'modern city', not only in Italy but also in Europe. Milan has been updating this scene, and in the process of transormation. Milan keeps exploring the relation between modernity and verticality, which is why Milan’s appearance and skyline are constantly changing in the past 100 years.

In the early 20th centry, At the beginning of the 20th century, with the development of the second industrial revolution, building materials gradually shifted from wood, stone and brick to reinforced concrete and steel. In the mid-nineteenth century, a new method of directly producing steel emerged. This discovery allowed architects to mass-produce high-quality steel at a lower cost. The characteristics of metal in buildings are emphasized: standardized components can reduce construction costs; the fireproof properties of the frame structure reduce the risk of fire; the hardness of steel can increase the height of the building.
Technology promotes changed in people's urban aesthetics. People began to admire the modern urban landscape full of super high-rise buildings, hoping to use the high-rise buildings to show the strength of the city. Manhattan, New York is a typical example. During this phase, a large number of super high-rise buildings were built, including Home Insurance Building (1885) and Newyork Tribune Tower (1875).
At this stage, the design of high-rise buildings conforms to the technological boom, and the mainstream urban aesthetic blindly worships the super high-rise buildings led by Manhattan. The more vertical a city develops, the closer it is to the ideal modern metropolis in people's minds.

Black-and-white photograph of the Home Insurance Building, 1885

A problem to be solved

But soon, some American architects (including Louis Sullivan) criticized this new vertical construction: the rising volume of the building prevents natural light from reaching the ground; the floor area ratio of low-rise buildings and super high-rise buildings is torn apart, causing people and traffic. Congestion; new security issues emerge, especially in the area of fire. In the mid-20th century, New York passed a zoning law that required architects to adjust the height of the building to the width of the street. This has directly led to the construction of pyramid-shaped buildings, or high-rise buildings retreating from the street side, leaving a safe distance for the road. For example, the Seagram Building (Ludwig Mies van der Rohe, Philip Johnson, Ely Jacques Kahn, 28 meters from Park Avenue) and Robert Allan Jacobs, 1958).
The city's worship of heights began to slow down. Some architects and urban planners put forward an objective point of view: Modern buildings do not necessarily need to be developed vertically. How to locate super high-rise buildings in cities has become an urban problem that needs to be solved.

New York Tribune Building,
published on March,9 2008

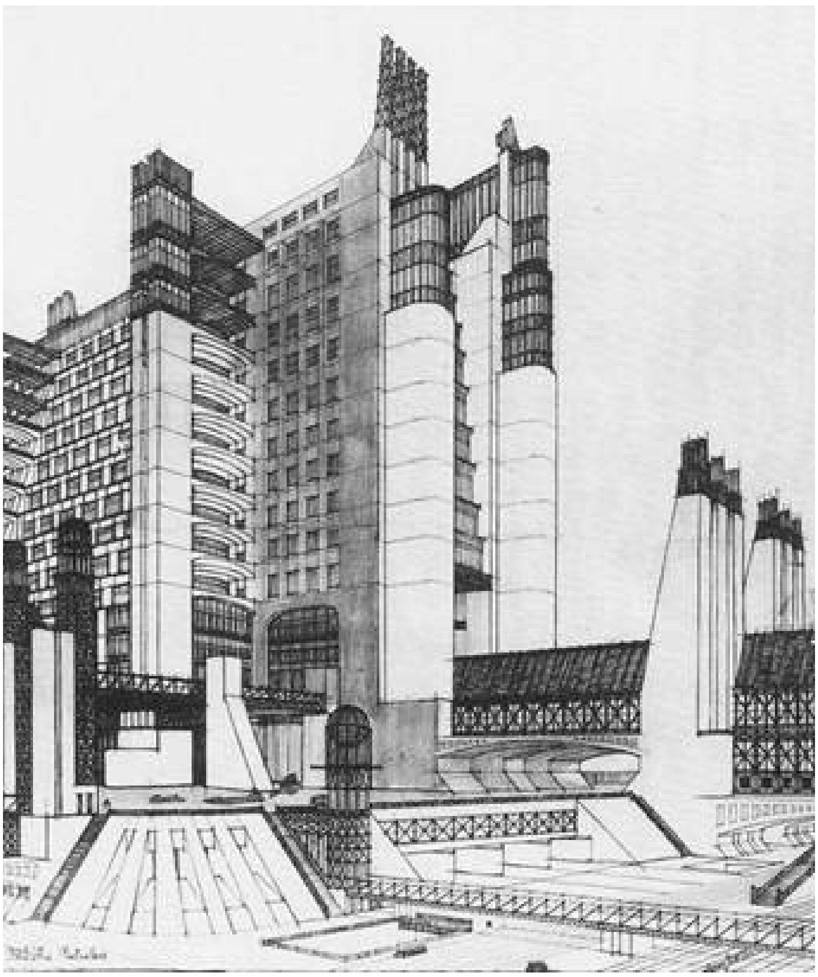
Seagram Building, photography
by *375parkavenue*

Midtown Manhattan 1980s is a
photograph by Gary Eason which
was uploaded on July 4th, 2012.

First hise-rise in Milan

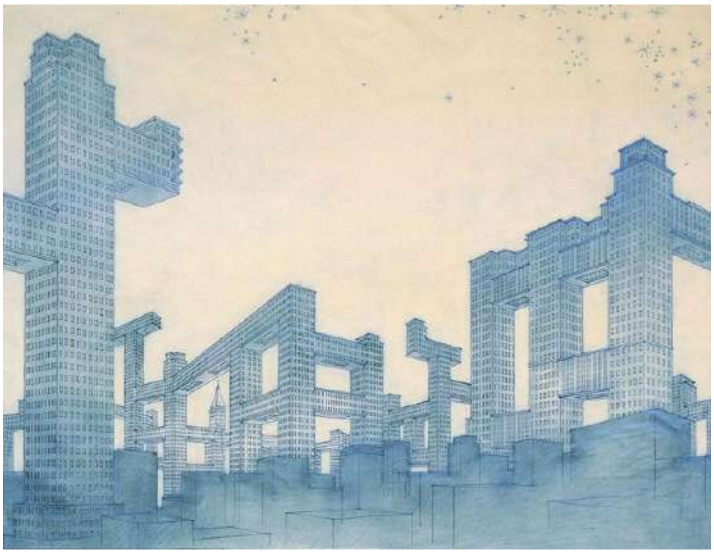
In the 20th century, Milan was known as the flattest city in the world. In terms of topography, Milan is in a plain area, and in terms of architectural form, the urban fabric of Milan mainly retains architectural features from the Gothic and Renaissance periods. In particular, the number of skyscrapers in Milan has never reached the standard of a modern city in people's minds.

The first skyscraper in Milan was designed by a futuristic architect Antonio Sant'Elia. It was an architectural sketch published in newspapers in 1914. The building in Sketch is stepped, the concrete facade is neatly arranged with windows on each floor, and each corner is equipped with a vertical concrete elevator. There are not many details in the sketch, but Antonio's avant-garde giant buildings are enough to satisfy Milan citizens' illusions about building a modern city similar to Manhattan. Milanese with traditional Renaissance thoughts began to accept that Milan also needs skyscrapers that symbolize future technology. Benito Mussolini published an article on Il Popolo d'Italia in 1915 publicly expressing his desire for Milan - the 'flattest city in the world' to have an entire district of skyscrapers.



Antonio Sant'Elia, Milanese skyscraper sketch, 1945

First hise-rise in Milan



Piero Portaluppi, Hellytown sketch, 1926

Milan, the Haussmanian style of the architect Mario Borgato, in piazza Piemonte and surroundings

An example similar to Antonio Sant'Elia also occurred in Piero Portaluppi. His work Hellytown, the city of hell, on the one hand is praised by people for its sense of future, on the other hand it is considered absurd and impractical.
For Milan in the 1920s, the design plan for this type of high-rise building only stayed at the plan stage, and there was no actual construction plan. In fact, these crazy upward-growing structures are more of an architect's imagination of a modern city full of skyscrapers than a service for practicality, just like Manhattan.

Finally in 1925, Mario Borgato's twin towers were completed in Piazza Piemonte, setting a record for the height of Milan, reaching 42 meters. This is an attempt to mature the urban concept of Milan. The new building was not built to break the height record and cater to the architectural aesthetics, but to adapt to local conditions.

Milan hise-rise revolution

During this period, due to the rapid economic growth in Milan, the people's living standards have been unprecedentedly improved, and modern architectural concepts have also been updated. Milan launched a new urban plan in 1953. An important part of this new blueprint is to create the "Centro Direzionale di Milano", which is the so-called center of Milan's service industry. In order to reorganize this large area, Milan began to carry out large-scale land acquisition and demolition, the scope is roughly the area enclosed by today's Stazione Centrale, Porta Nuova and Porta Garibaldi. Encouraged by the Centro Direzionale plan, people no longer insisted on the requirement of "buildings should not be higher than Milan Duomo", and a small number of high-rise buildings began to be constructed experimentally in this area.

Around 1960, the high-rise buildings in the Centro Direzionale area of Milan basically took shape. As the earliest high-rise buildings planned and completed in Europe after the war, they represented European cities of that era (especially those destroyed by war, such as Milan). , Frankfurt, etc.) are slowly trying to build a large number of high-rise buildings.

The business center in 1961, the UTC tower has recently been under construction

Typical skyscraper in Milan - Pirelli skyscraper

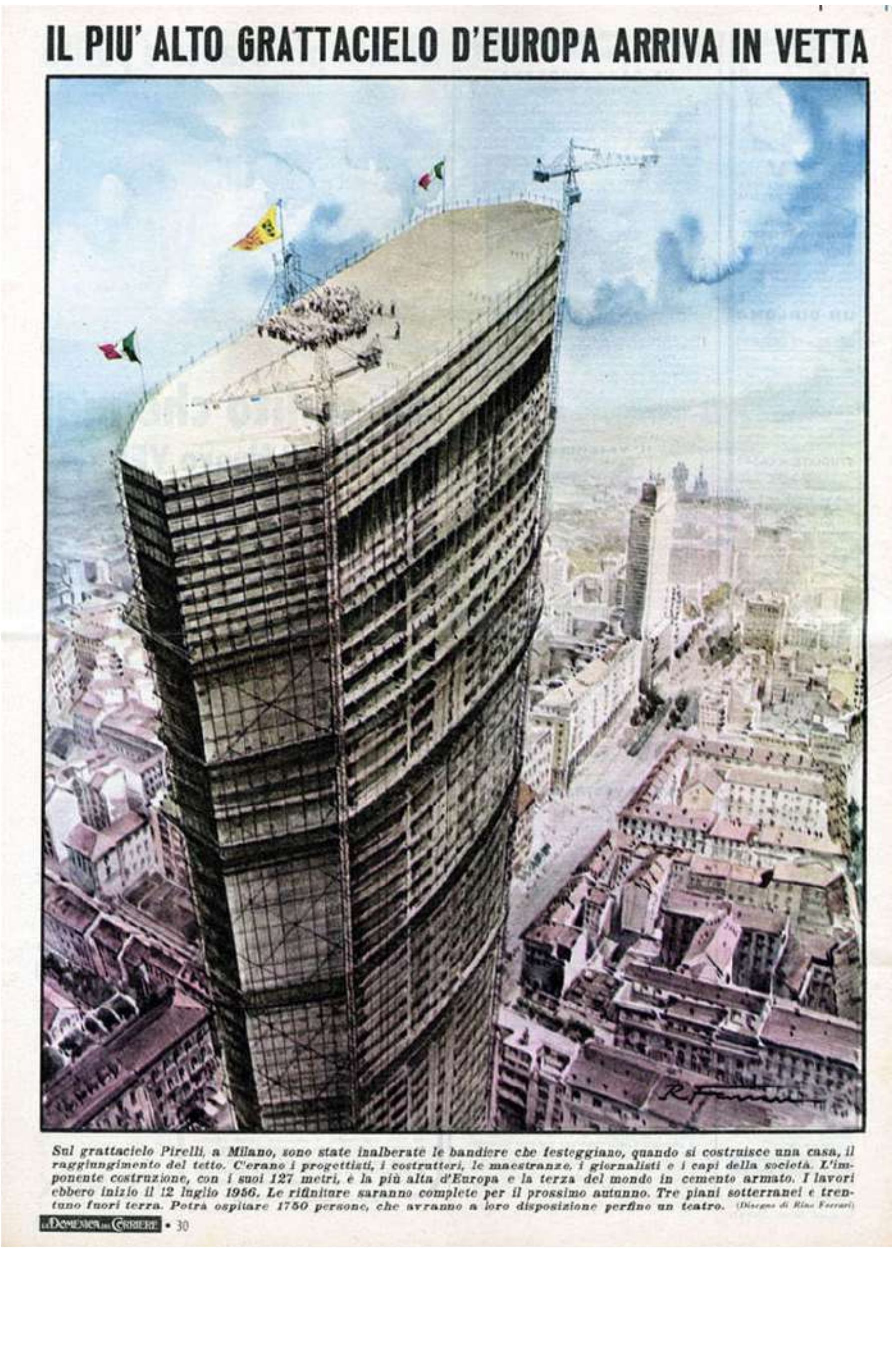
Although 'Centro Direzionale' failed to develop into a fairly complete business district (such as today's La Défense in Paris or Canary Wharf in London), the completed parts still seem to have the confidence that they had in the economic glory days strength.

Undoubtedly the most eye-catching building in the entire area is the Pirelli Building, which was jointly designed by architect Gio Ponti and architect Pier Luigi Nervi. When you walk out of the central station, everyone first sees that the side looks like a sharp sword. The high-rise building facing the sky, this building is so famous that not only the students of architecture departments of universities all over the world know it well, but also many ordinary Italian residents can say something about it. Construction of the Pirelli Building began on July 12, 1956, and was completed and opened on April 4, 1960. It was the tallest building in the European Union from the top of the structure in 1958 to 1966.
The diamond-shaped plane is one of Gio Ponti's design features. This building also broke the internationalist style that swept the world at that time. Instead of adopting a traditional frame building structure, the 30-story floor slab was hung on four rows of vertical concrete wall panels. It was the administrative center of the Pirelli Tire Group until 1978. The location was later due to the high cost of building management. In June 1978, the building was officially sold to the Lombardy Regional Government, which used it as the headquarters of the regional government.

Whether it is official or private, this building and this area have been firmly tied to the glory of the "economic miracle" period, as one of the peaks of economic prosperity (there are also many in the various official introductions of the city of Milan. Mentioned), it is still not outdated until today, and it is still one of the most important symbols of Milan. The classic shape has also attracted the imitating of other high-rise buildings (MetLife Building in New York), Banco Atlantico Building in Barcelona, and Lonza in Basel. Group Building, etc.), the height of 127 meters dominated Milan's highest height for 49 years, and it was only broken by the new headquarters building of Lombardy in 2009 with a height of 161.3 meters.

Typical skyscraper in Milan - Pirelli skyscraper

This is a large poster report of the Sunday Post when the Pirelli building was topped out. The title means: The tallest building in Europe has been topped off. It is mentioned in the following introduction: At 127 meters, it is the tallest reinforced concrete building in Europe and the third tallest in the world. The height of 127 meters and 32 stories was indeed an eye-catching height in 1960, especially in European cities that are relatively conservative in the construction of high-rise buildings. (Except for the three tall buildings in the United States and South America, this height was the undisputed number one in Asia, Africa, Oceania, and Western Europe at the time. Later skyscrapers such as Hong Kong and Shanghai were not as high as the Pirelli skyscraper at the time.)



IL PIU' ALTO GRATTACIELO D'EUROPA ARRIVA IN VETTA

Sul grattacielo Pirelli, a Milano, sono state inalberate le bandiere che festeggiano, quando si costruisce una casa, il raggiungimento del tetto. C'erano i progettisti, i costruttori, le maestranze, i giornalisti e i capi della società. L'imponente costruzione, con i suoi 127 metri, è la più alta d'Europa e la terza del mondo in cemento armato. I lavori ebbero inizio il 12 luglio 1956. Le rifiniture saranno complete per il prossimo autunno. Tre piani sotterranei e trentuno fuori terra. Potrà ospitare 1750 persone, che avranno a loro disposizione perfino un teatro. (Disegno di Rino Ferrari)

La Domenica del Corriere • 30

Pirelli building completion poster, 1960

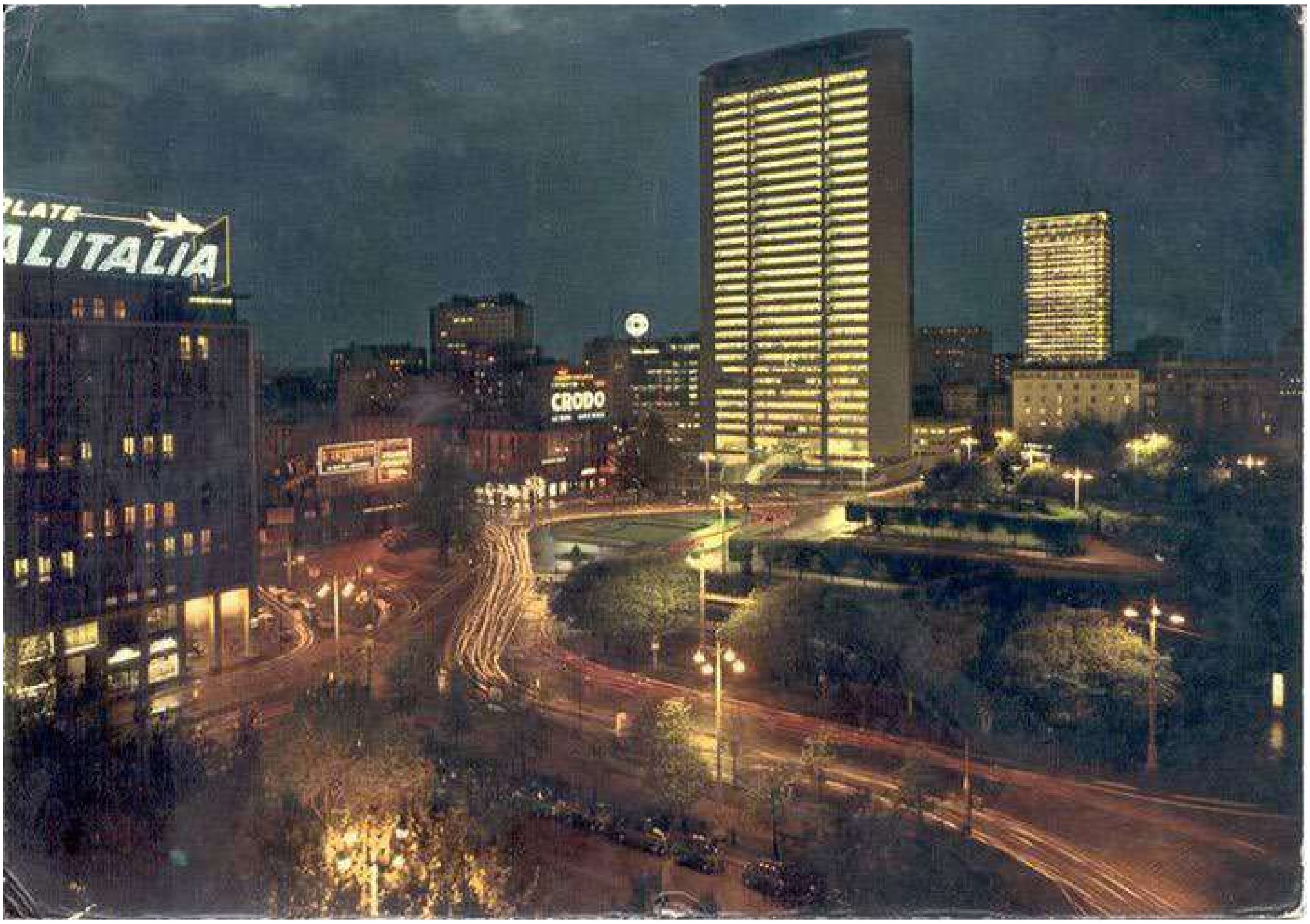
Typical skyscraper in Milan - Torre Breda

Torre Breda, completed in 1954, 117 meters, 30 floors, immediately replaced the Piacentini Tower in Genoa opened in 1940, the highest in Italy, and the highest in the European Union.

The exterior of this building does not seem to be very special. Both the shape and the internal functions are the same as tall buildings in other parts of the world at that time, but it is important because:
It is the first city planning law in Milan to break the fascist era of 1934. (The Albertini plan stipulates that the highest height shall not exceed the golden statue of the Virgin Mary at the top of the Milan Cathedral. The cathedral spire reaches 108.5 meters + the Virgin Mary Ya statue 4.16 meters), of course, this is also the highest traditional height.
Torre Breda, as one of the representative buildings of the Italian revival after the war, broke the rules of the Milan skyline over the centuries. It is also the first residential building in Italy to allow ventilation in the bathroom (previously prohibited by law). The tallest residential building in Europe at that time was equipped with an air pressure transmission device directly connected to the post office in the building, the cast iron bathtub was equipped with heating and thermostatic adjustment functions, the kitchen was equipped with garbage disposal equipment, and all apartments were equipped with energy-saving standards. There are cooling water equipment maintained at 14 degrees), these kinds of things are not unusual at all today, and even look outdated. But today 61 years ago, this is simply a super modern life that many ordinary people could not imagine. The high-rise apartments that people look up to are equipped with all modern facilities. Therefore, this apartment was called "Palazzo per ricchi (rich man's building)" at the time. It is conceivable that the price of each apartment in the tallest residential building at the time was expensive.

Bireda Tower photography by
Tang, in Piazza della Repubblica

Typical skyscraper in Milan - Galfa Tower



The night view of Piazza Duca d'Aosta in the early 1970s. The tall building in front is the Pirelli Building, and the whole body is lit up by the Galfa Building (1956-1959, 102.5 meters, 31 floors, Milan's first high-rise building with all-glass walls). The surrounding area of mid- to high-rise buildings ranging from ten to twenty stories is the Centro Direzionale area.

Fail of Milan hise-rise revolution

However, the fact is that every step of regional construction is very difficult. Although it is the era of rapid economic development after the war, people's perceptions have not changed much. The historical central city has not been completely destroyed like Rome and Florence. The strict laws are kept in order, but development and construction are allowed. Milan citizens still like to live in historical areas, and the core area of the tertiary industry has not moved to the CDM area as expected, but has further accelerated its expansion in the old city.
In the demarcated area, there are large tracts of vacant land that has not been built. The area that has already been constructed is very crowded and chaotic due to the simultaneous construction of high-rise buildings and other facilities, but they are planned separately, so that a kind of separation is finally formed. Realistic environment and the construction of large-scale buildings on narrow streets, and the uneven distribution of density in the area. This pattern lasted until 1978 (at this time some land was still barren and unused). These areas are defined this time as: "Interesse Pubblico" (public interest). Any large-scale construction and development are not allowed in this area. Therefore, the CD plan that began in 53 years has come to an end. Nature was abandoned.

As a result, the plan that once seemed to make people feel that the city of the future is close at hand has come to a close.

In this period, Although Italy is relatively conservative in architecture, it still tries to keep up with world trends in some respects. In addition to meeting some of the actual needs of that era, Milan's high-rise buildings have a part of significance, that is, the symbolic significance of post-war reconstruction. (In other words, people recognize that skyscrapers are a more important sign of economic prosperity).

Historical photos of the Centro Direzionale district in Milan in the 1970s (abandoned plot, now the site of the new Porta Nuova Park), you can see the high-rise buildings of the built area behind.

Milan high-rise roles in the 21st century

In the 21st century, people not only continue to use skyscrapers for economic and material purposes, but also try to give high-rise buildings more non-material meaning.

Among the many completed Milan skyscraper projects, the Vertical Forest designed by Stefano Boeri stands out with its harmonious relationship between the artificial world and the new nature. Because the design began to focus on a relatively new concept, (except for the practicality of the building, the comfortable relationship with the road, and the scale of the human body), that is the relationship with nature.
In addition, Palazzo Lombardia has taken a unique approach in the exploration of super high-rise buildings. It strives to consider the depth of urban space use, emphasizes the connection between the building and the ground, and considers the podium of the building from the urban scale.

Other high-rise buildings in the same period, such as the Generali Tower (Zaha Hadid Architects, 2017) and Libeskind tower (Daniel Libeskind, 2020) in City Life, and the UniCredit Tower in Piazza Gae Aulenti were rated as'the unimaginative implementation of a widespread déjà' by Fulvio Irace vu'. (Milano Verticale, 2021)

The series of environmental and climate problems that occurred at the beginning of this century (21st century) are obvious to all. The urgency of resource and environmental threats, the concern for the quality of urban life, and the reflection on the relationship between nature and the city, all urge Milan to deal with the role of high-rise buildings in the city in a more complex way. Undoubtedly, the verticality of high-rise buildings will always have the symbolic meaning of representing the'modern city'. However, Milanese no longer use height as the only indicator to measure its symbolic significance. The contribution of skyscrapers to the skyline and improving the quality of life of citizens is even more valued.

Model of Tre torri in City Life area

Vertical Forest, by Boeri Studio (Stefano Boeri, Gianandrea Barreca, Giovanni La Varra), with UniCredit Tower in background.

Porta Nuova regional planning

Today, the Porta Nuova district has 350,000 square meters of buildings and 160,000 square meters of landscape and walking paths. It is one of the most attractive neighborhoods in Milan and can be regarded as one of the greatest urban regeneration projects in modern history.

The development of Porta Nuova can be divided into the following areas: Garibaldi-Repubblica, characterized by Cesar Pelli's conceptual plan, based on the construction of a central podium, as a new urban square, pursuing connectivity, pedestrian areas and accessibility Sex; Porta Nuova-Varesine, owns an iconic steel and glass office building Torre Varesina B (Diamante); Porta Nuova-Isola, whose conceptual plan was drafted by Studio Boeri, who is also the designer of two Bosco Verticale residential buildings; Porta Nuova-Gioia, the area around the intersection of via Melchiorre Gioia and via Pirelli.

Although the area around Garibaldi Station has been completed, the Numene district is still undergoing major renovations, mainly due to the synergy between the real estate company Coima and the City of Milan. Through this cooperation, a complete master plan was developed for Xinmen-Jiaoya District, aiming to renovate all the buildings around BAM. The park was designed by Inside Outdoor as a tree library. The master plan is formulated by the company appointed by Coima in accordance with the goals and rules set by PGT2030, involving real estate assets (Gioia20, Gioia22, Pirelli35, Pirelli39) and the surrounding public space.
The vision proposed by Coima covers the impact that the design will have on multiple levels: the new gate area will be completed. Together with the new Scalo Farini, Bovisa and MND (Green Door), create an urban regeneration corridor and ultimately empower the urban network.

Panoramic view taken from Palazzo Lombardia, Nature blender, 2020

▌02 ARCHITECTURE COMPOSITION

Porta Nuova Gioia Masterplan plot, taken from Bando concorso P39-Allegato A

The identity of new Gioia 22 Tower

The construction of Gioia22's tower is part of Porta Nuova's plan. Prior to this, the 21-story INPS tower was built in Gioia 22 in 1961 and was abandoned in 2012.

Now in the Gioia 22 plot is a high-rise Coima tower under construction. Our project is to re-plan and design Gioia 22 so that the Gioia 22 tower can take on the role of rejuvenating Porta Nuova in a form that more respects the urban texture. Compared with the Coima Gioia 22 tower, our design has the following adcantages and identities:

Respect the context. We not only analyzed the surrounding main roads such as Via Gioia and Via Giovanni Battista Pirelli, but also the secondary roads Via Antonio Bordoni and Via Alfredo Campanini: Via Antonio Bordoni connects the Gioia plot and the Diamond Tower, and Via Alfredo Campanini connects Torre Galfa. The influence of the flow of people and vision. Therefore, in our first phase of architectural planning, the extension of these two secondary roads was used as the boundary line of the podium building to conform to the flow of people. The area between this boundary line and the main road Via Gioia is arranged as an event square. The new Gioia 22 considers context better than the existing Coima Gioia 22 Tower, because the latter is located at the end of Via Alfredo Campanini, and the site cannot form a smooth sidewalk with pedestrians in this direction. In addition, the podium of the existing Gioia 22 also cut off the connection from Via Antonio Bordoni.

In addition, when the Coima Tower project started in 2018, the surrounding new buildings had not yet determined the construction plan, so the plan did not consider the surrounding new buildings. In our design, within the scope of context, the new Porta Nuova construction projects announced after 2018 are also included in the scope of investigation, including Gioia 20 and MM spa Tower. The completed buildings will be more integrated into the surrounding environment.

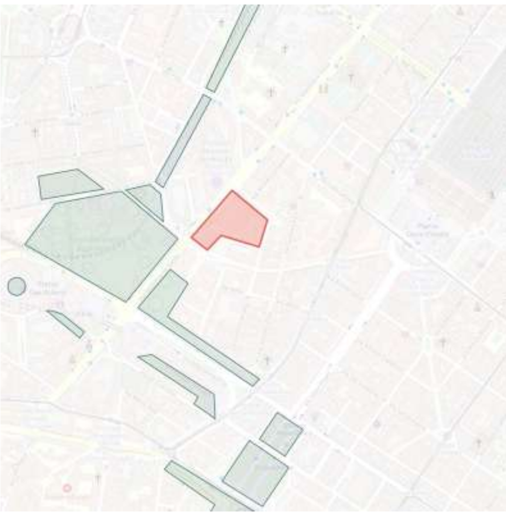
Important road connection in context

The identity of new Gioia 22 Tower

Reopen Navigli. According to Milan's 2030 plan, the Navigli canal in Milan will be reopened. The canal will be refurbished along the direction of via Gioia. Our project uses the reopened Navigli as part of the project plaza, and citizens will have the opportunity to walk directly from the podium to Navigli, experience the Milan canal scenery in the 1800s, and innovate the Gioia 22 project from a cultural perspective.
From the perspective of urban planning, Navigli clearly demarcates the border between the main road and the Gioia 22 project. It serves as a natural barrier between the square and the roadway, distinguishing the noisy main road from the quiet square area.

In addition, according to the "Surrounding park or landscape promenade" of the landscape concept analysis diagram below, it can be seen that the landscape planning of Porta Nuova area did not take via Gioia into consideration. After the opening of Navigli, waterscape treatment along the coast of Navigli will make up for the lack of green landscape planning in this direction.

Location map of Navigli Canal in the scale of whole Milan



Surrounding park or landscape promenade

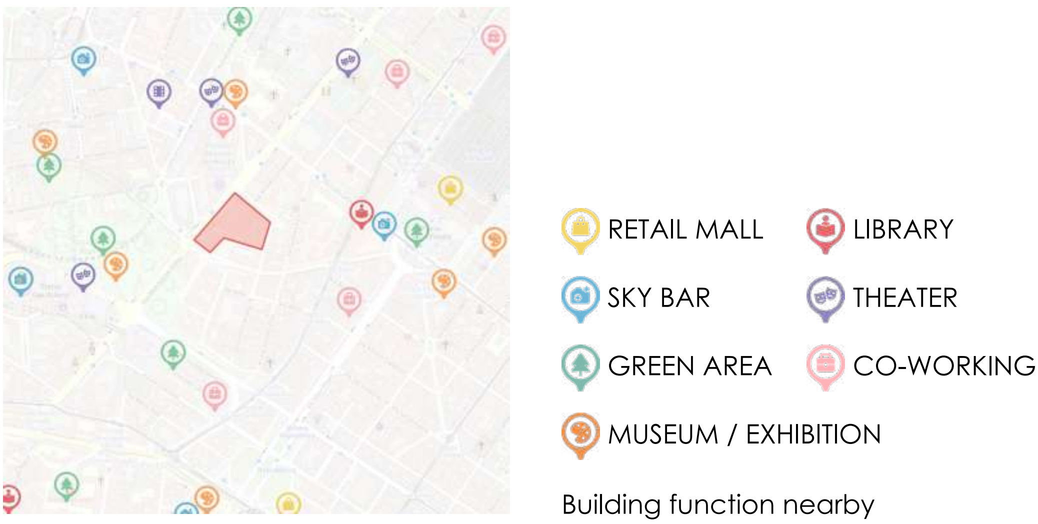
The identity of new Gioia 22 Tower

Public Function. In the previous chapter of 'Milan high-rise roles in the 21st century', we analyzed that now Milan's high-rise buildings no longer blindly pursue height, but care more about whether skyscrapers can have a multi-dimensional positive impact on the city of Milan.
When considering the functions of Gioia 22 Toer, we first did a preliminary research on the building functions in the Porta Nuova area. We found that the surrounding buildings are mainly private offices, and there are few public functions that serve the citizens. So we decided to define the architectural function of the tower as mix-used. In addition to private office and co-working areas, we inserted public service blocks (including Retails, exhibition, library, auditorium and sky bar which has an amazing view towards Garibaldi area and Pirelli skyscraper). We arranged these blocks vertically and separated them with private office floors, trying to construct a vibrant vertical street.

Compared with Coima Gioia Tower, our design is more complete in function, and users are no longer limited to companies and office workers, but are open to all citizens. Skyscraper is no longer a business area that ordinary Milan citizens can only see from a distance but are difficult to enter. The analysis of the public function of Gioia 22 tower is a proof that we are exploring the influence of Milan skyscraper on the city.

Sustainable strategy. Coima Gioia 22 uses photovoltaic panels on the curtain wall to contribute as NZEB. The annual carbon dioxide emission reduction realized in GIOIA 22 is equivalent to the CO_2 absorption of roughly 10 hectares of woods.

The new Gioia 22 Tower will follow the design of the facade photovoltaic panels, absorbing solar energy and converting it into electrical energy for use in the building. At the same time, in the use of water resources, we opened water intake and drainage wells to the underground river, and arranged rainwater collection pipes on all roof terraces. Do your best to use clean energy and re-use resources.



Building function nearby

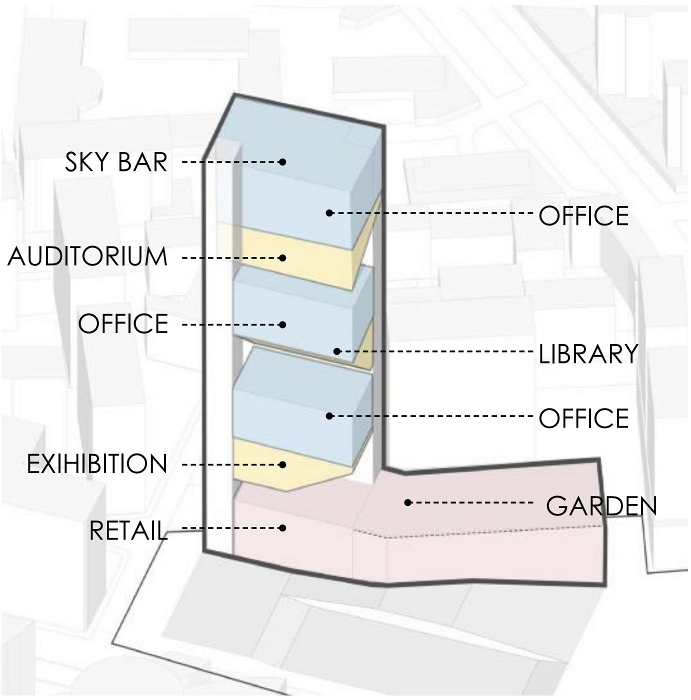
The aim of new Gioia 22 Tower

The transformaThe concept is to re-imagine the new public square connecting main infrastructures i.e. creating a new horizon to Porta Nuova Garibaldi Republica, the new redeveloped urban fabric.

The public square provides controlled movement in a well-organized manner giving it a sense of order to the Square with connections approaching from Garibaldi Station and Centrale station and multiple levels: -1.5m level sinking plaza creats a hydrophilic plaform interacting with Navigli, ±0m ground level enhance the street continuity near our podium provides a clear boundary and top view to the context.

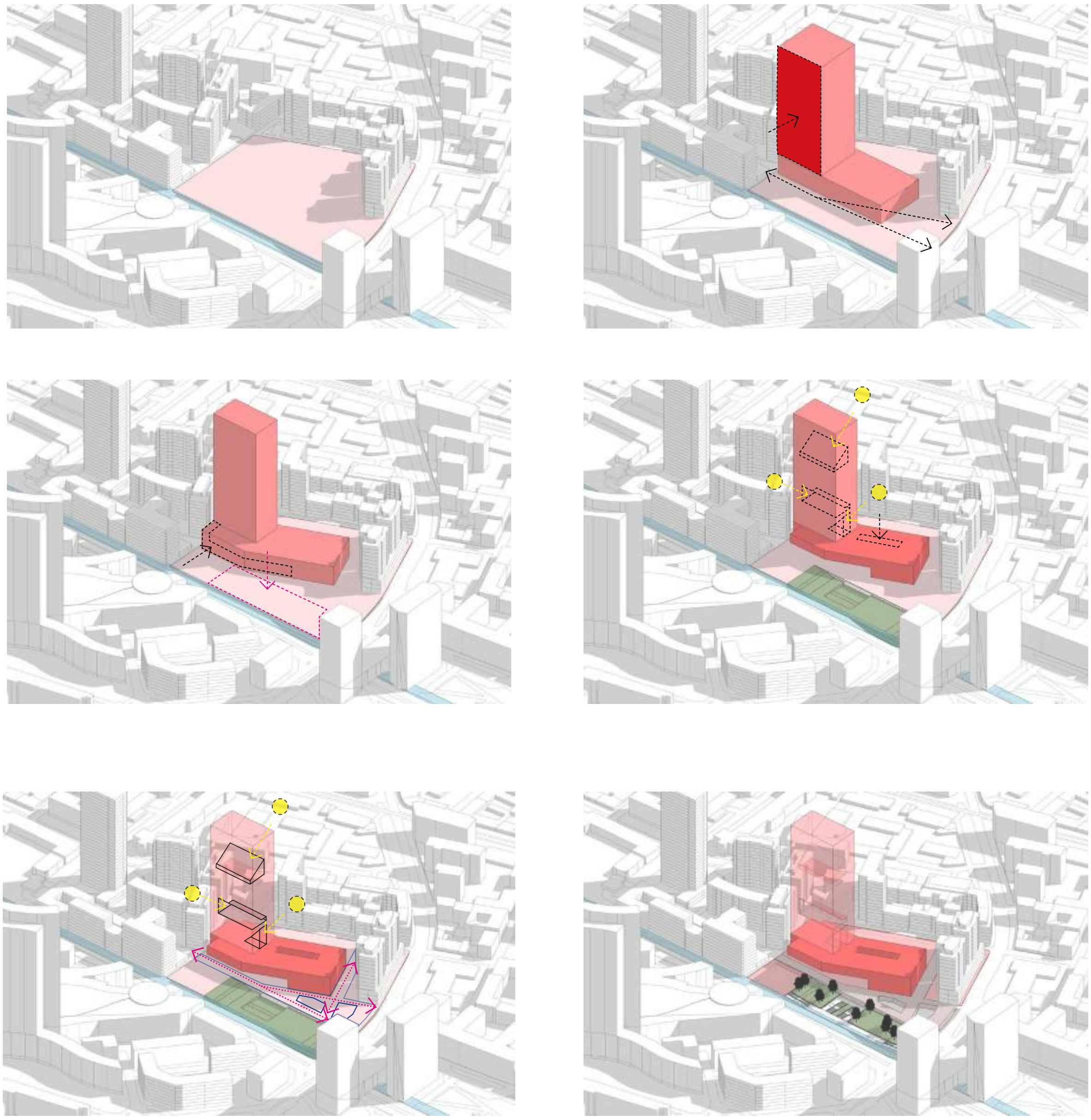
The building is characterized by the control created by the construction and the interaction with pedestrian activities & vehicular movements generated by the design. The base created provides a strong connection between the ground level and the high rise. The tall building gives the area a character as a unique marker & addition to the skyline of Milano.

Position and composition of the designed building are tightly connected. The project is the result of an assembly of volumes on the truss core located in the diagonal corners. Each form has an impact on the way in which the building engages with its closer or farther surroundings, and it is related to the sun path features and solar radio angle of the site.



New Gioia 22 Tower proposal

Volume

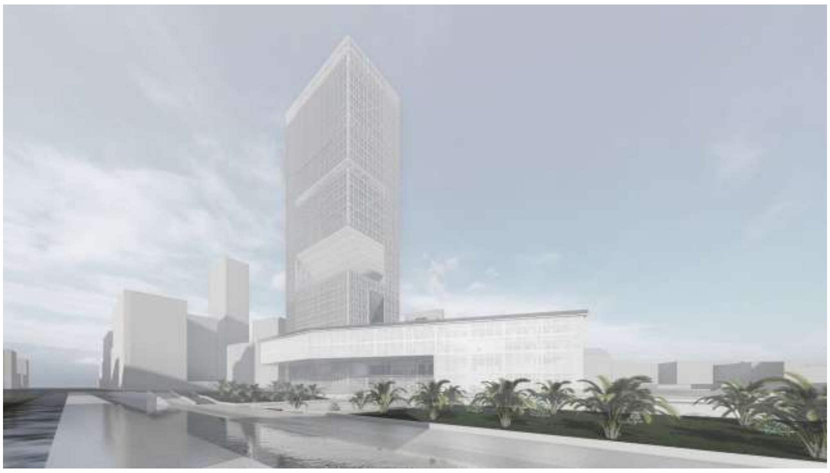


1. Proposed site next to naviglio
2. Building mass (Tower on podium) placed next to naviglio respecting the urban road network
3. Further podium mass angulated to facilitate the road network. Tower narrowed to reduce the bulkiness of the mass
4. Creating voids to reduce bulkiness of the podium. Also proposing a sunken plaza to increase interaction with podium & naviglio. Referring the sun angles further carving proposed in the tower.
5. Voids created referring sun angles carved in the tower. Voids facing towards Centrale / Pirelli Tower & Porta Garibaldi. Defining road connectivity
6. Final configuration of the the Tower - Podium & Piazza - pathways

Programme

At the end, the project is a mix-used tower located in the place of INPS Tower in Milan (Via Gioia, 22), composed of two bodies: the 4-floor podiumwith 4 floors underground, and a 32-floor tower. These two volumes are connected by the podium itself. The podium also connects with the sinking plaza, which provided a wide view to the whole Garlibardi area and the Navigli in the north of our site.

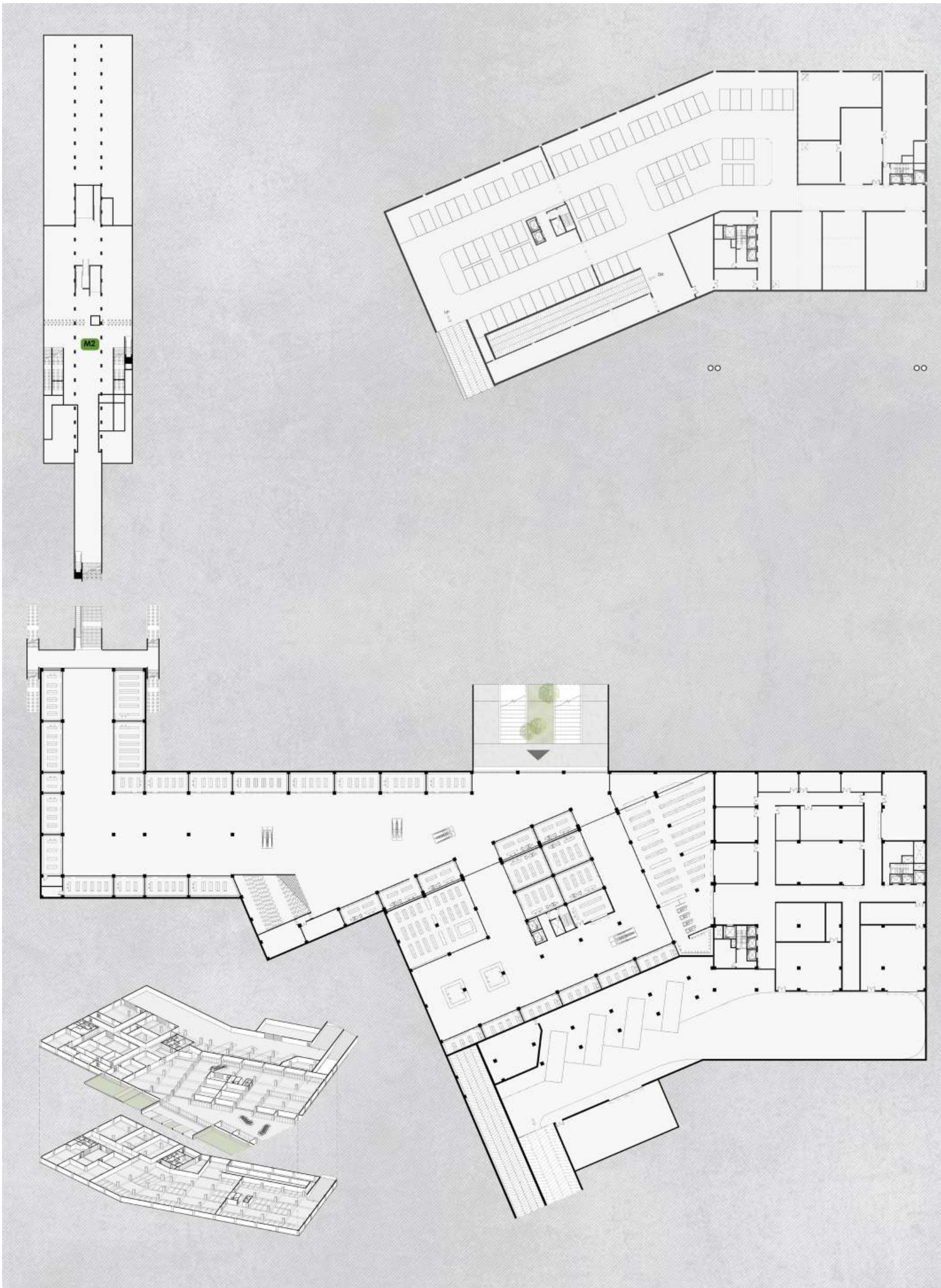
In the podium, there are mainly the commercial areas or retails. While in the tower, we are planning both private office and public use space like exhibition, library, auditorium, sky bar and roof garden.



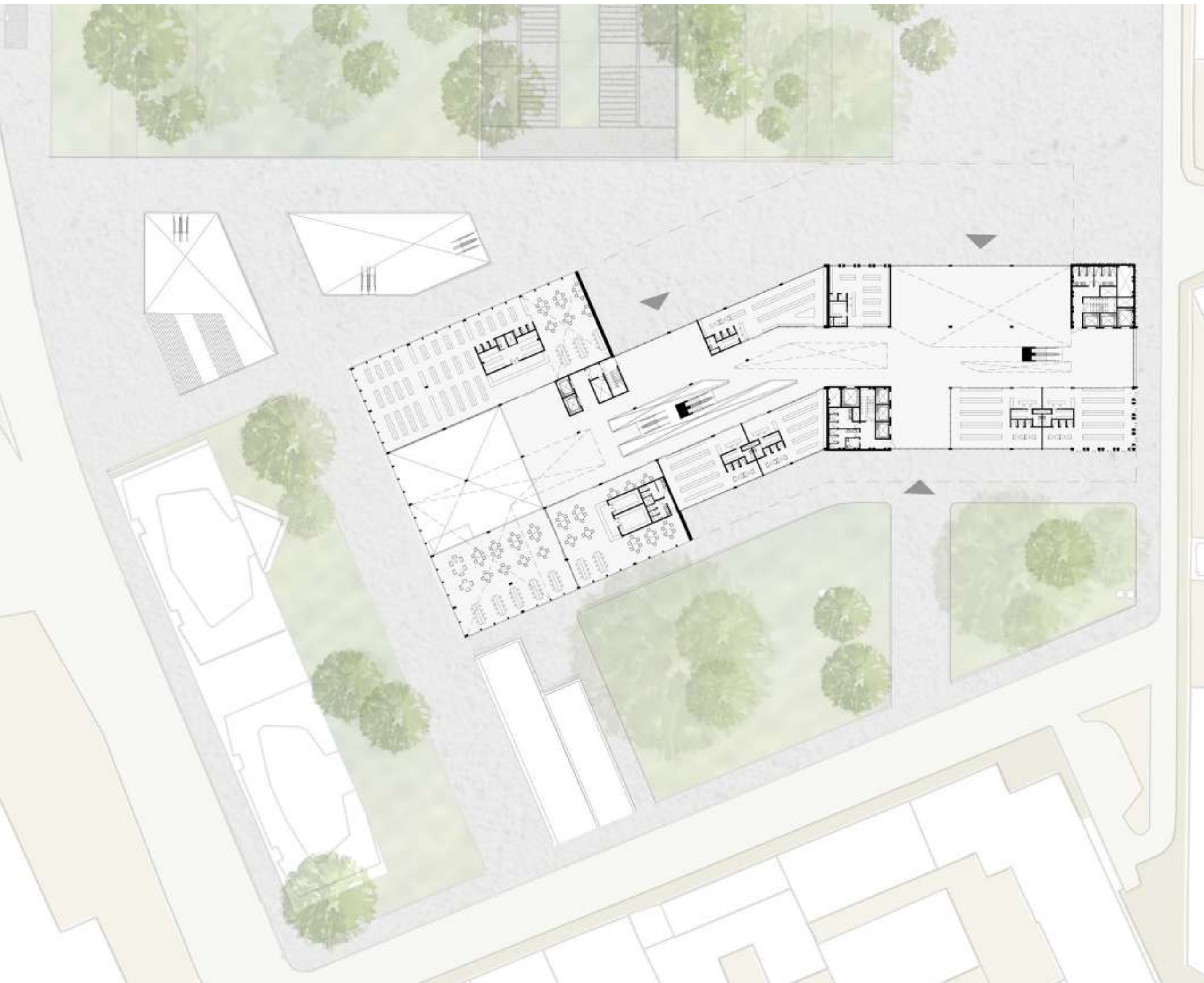
▌02 ARCHITECTURE COMPOSITION

Masterplan 1:4000

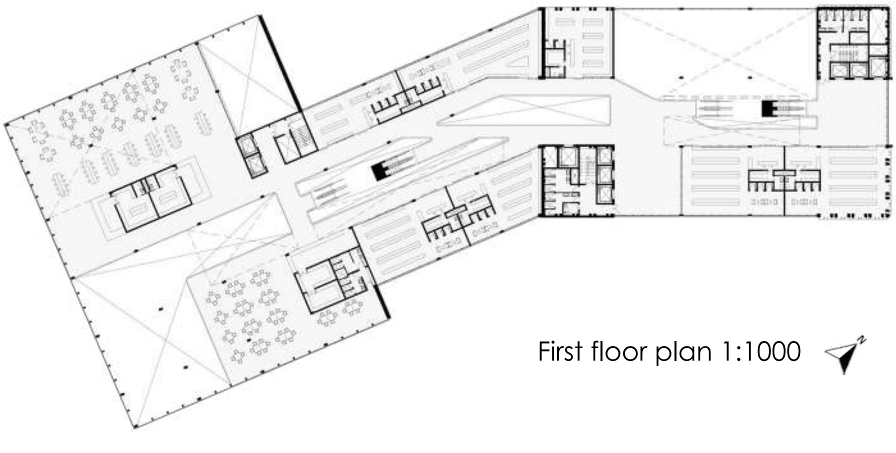
02 ARCHITECTURE COMPOSITION



Underground floor plan 1:1000

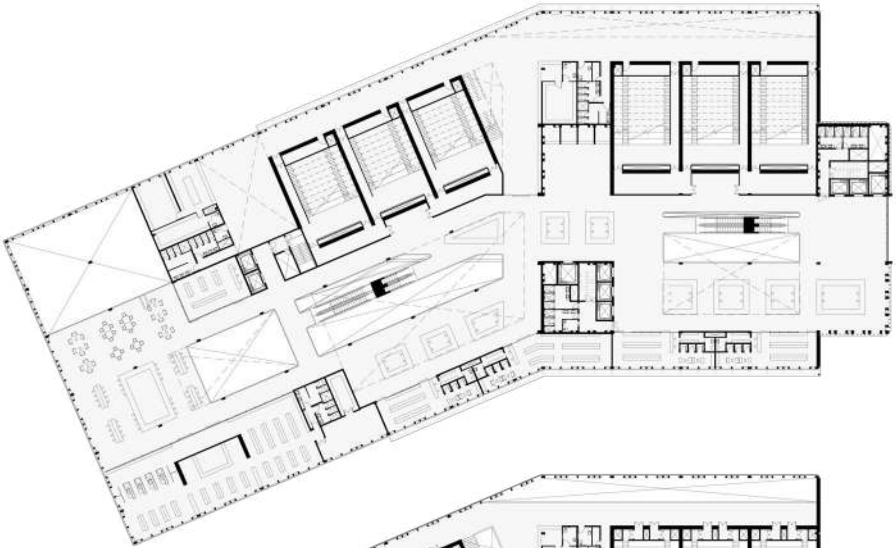


Ground floor plan 1:1000

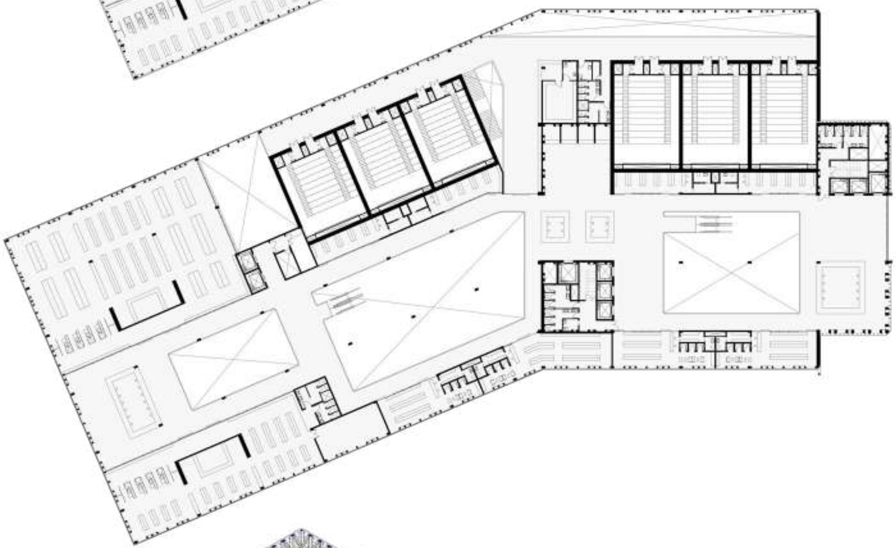


First floor plan 1:1000

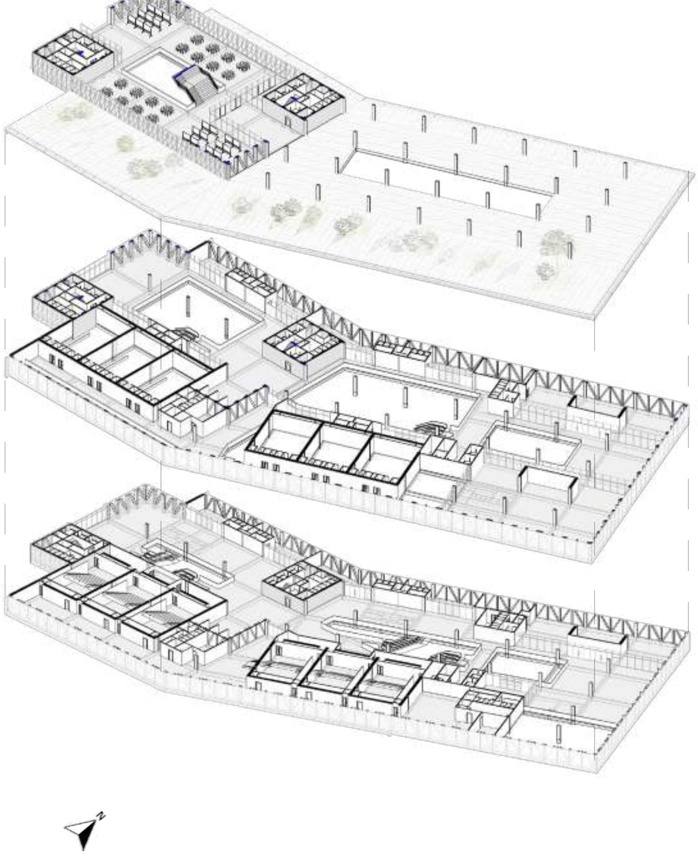
▌02 ARCHITECTURE COMPOSITION



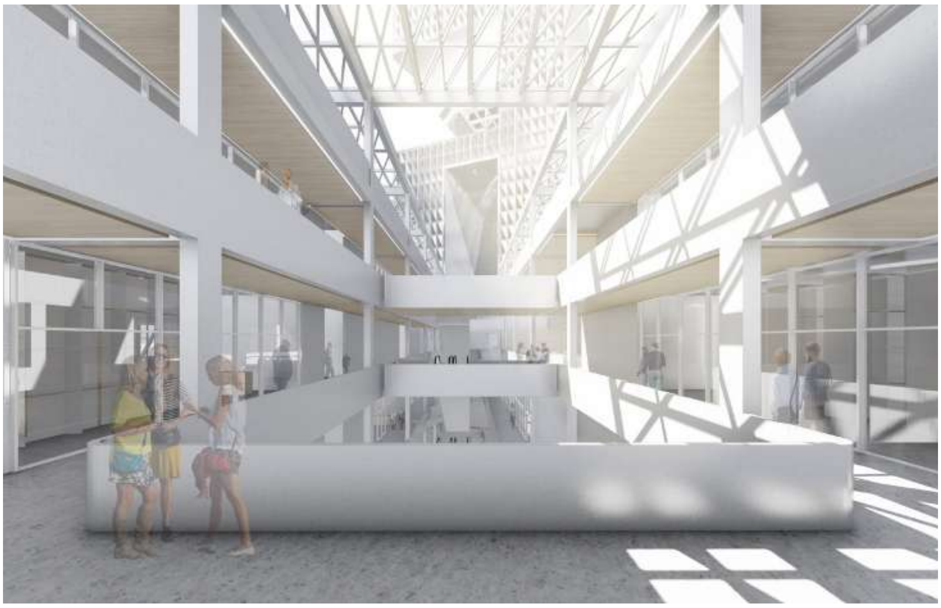
① LEVEL 2 : +12M
1:250

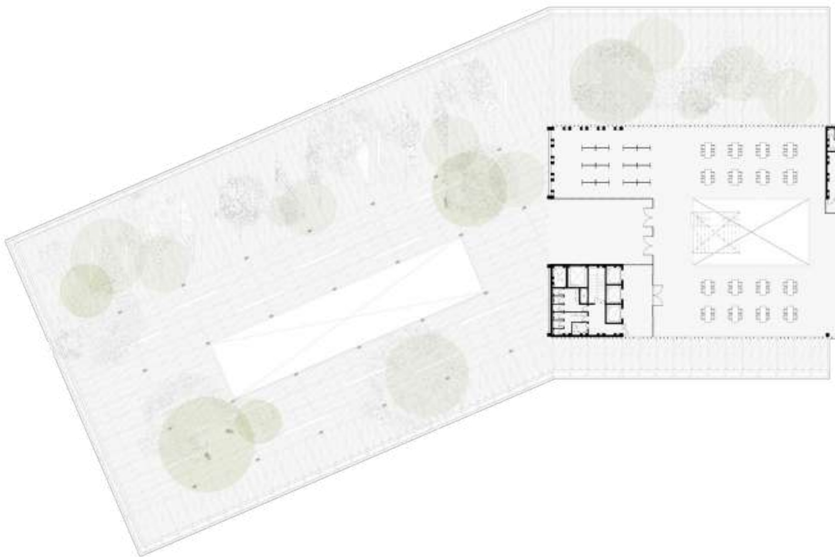


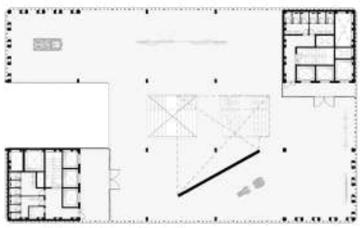
② LEVEL 3 : +16.5M
1:250



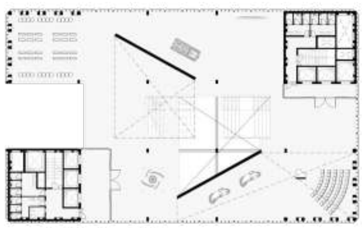
Podium plan 1:1000



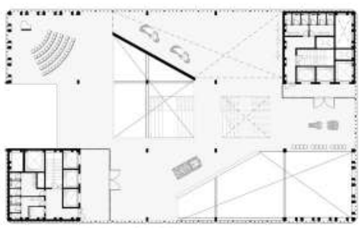




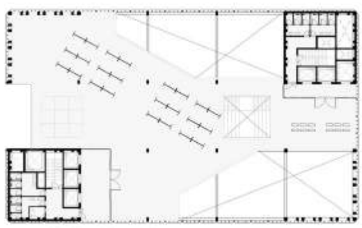
② LEVEL 5 : +25.5M
1:250



③ LEVEL 6 : +30M
1:250

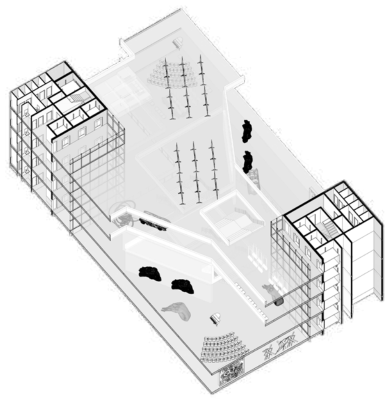


④ LEVEL 7 : +34.5M
1:250

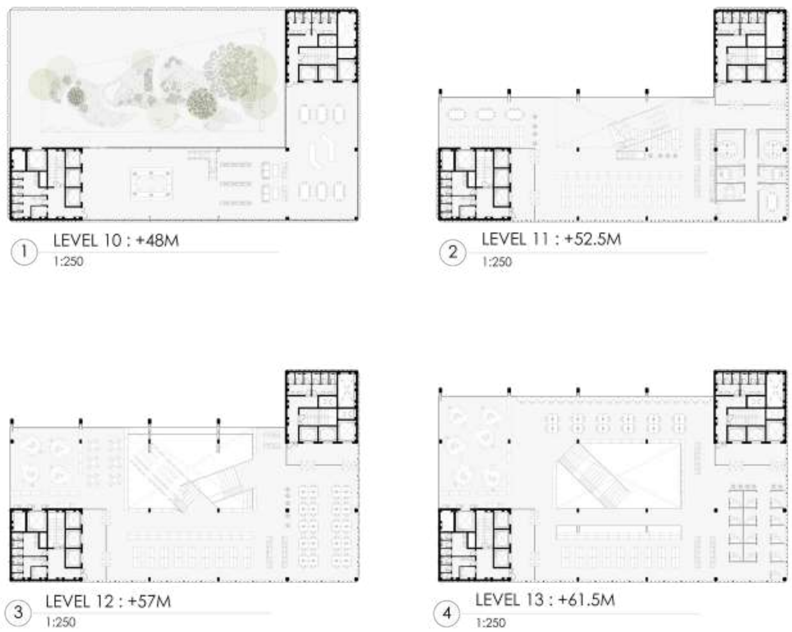


⑤ LEVEL 12 : +57M
1:250

Exhibition plan 1:1000

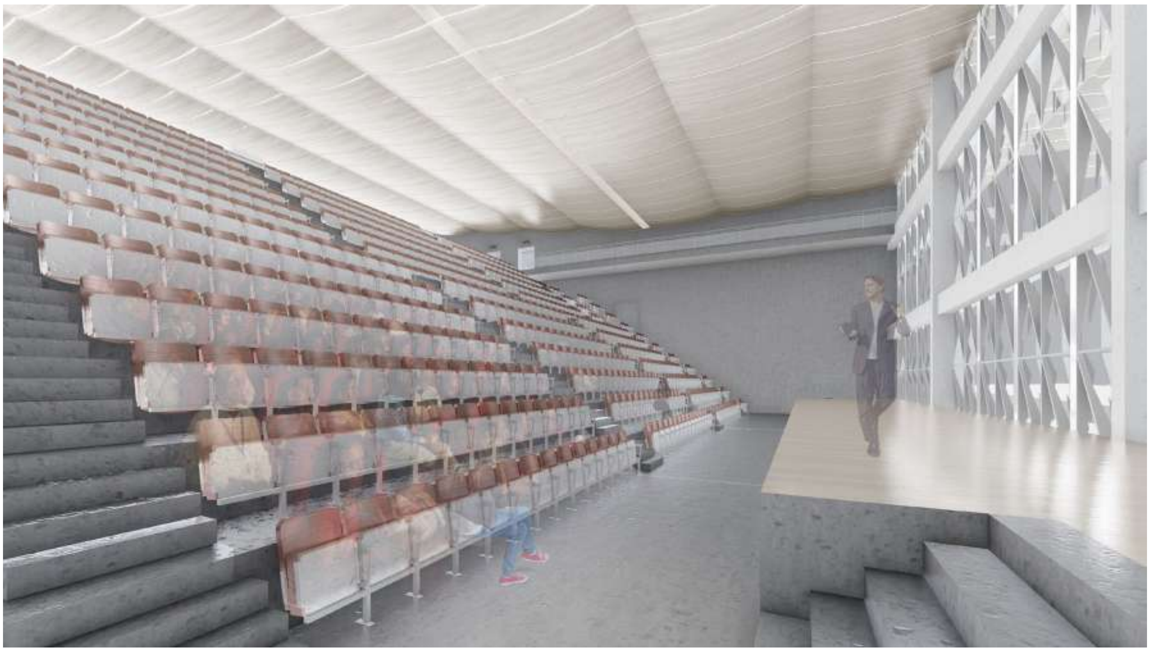



PARKS AREA
5-30-40

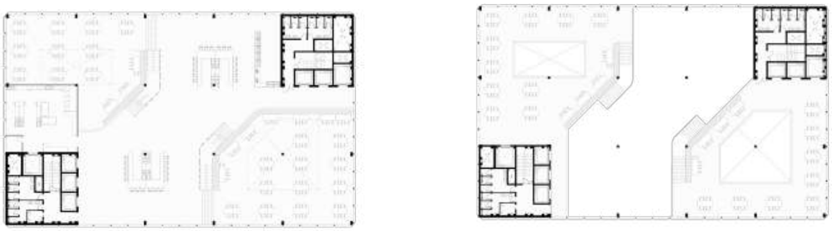


Library plan 1:1000

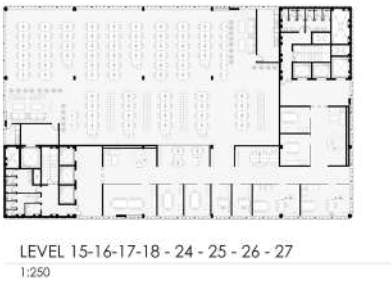
Auditorium plan 1:1000



▌02 ARCHITECTURE COMPOSITION

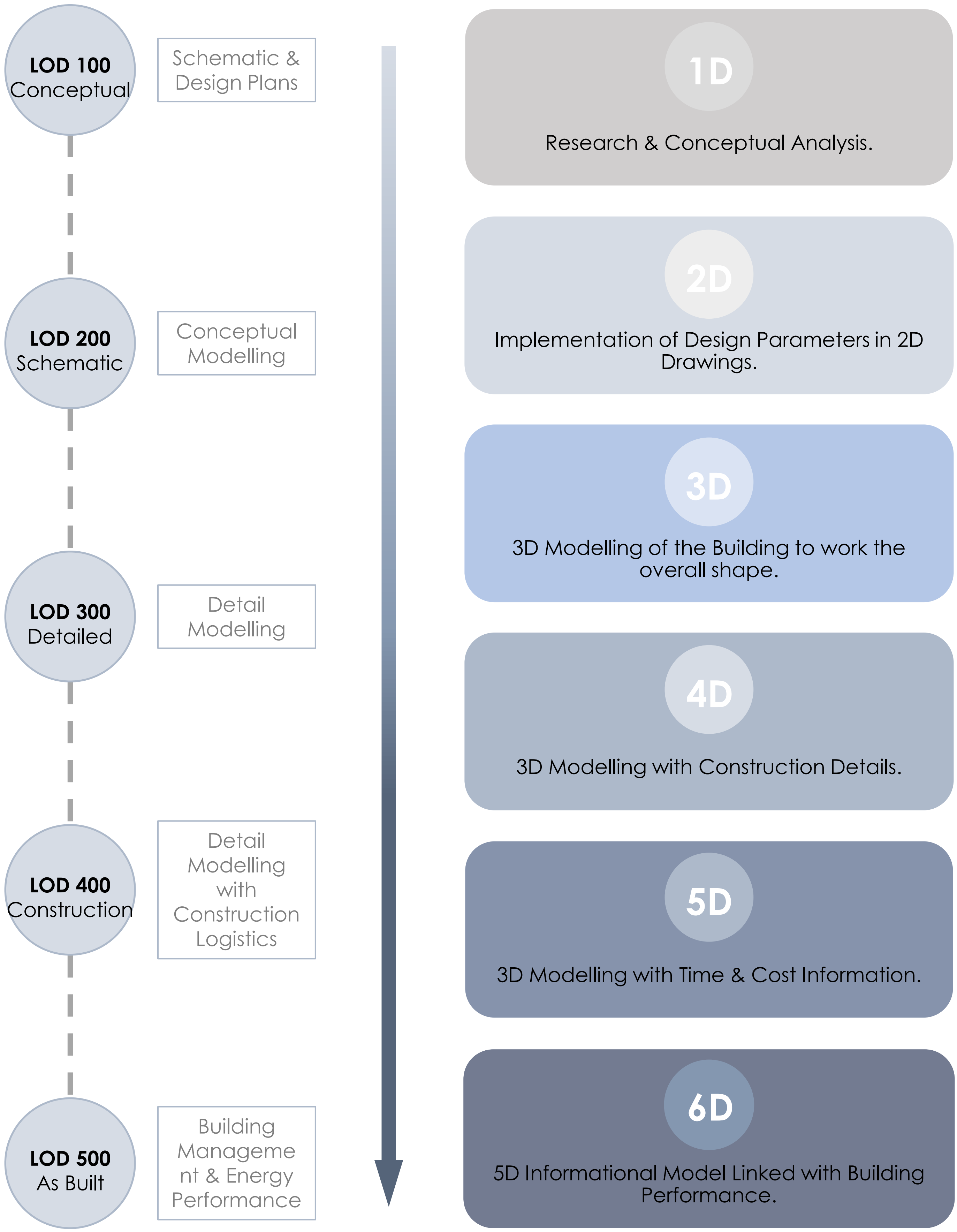


Skybar plan 1:1000



Office plan 1:1000

LOD table and BIM dimension



BIM workflow

SITE ANALYSIS — AutoCAD

LOD 100

DAYLIGHT — VELUX Daylight Visualizer

CONCEPT MODEL — Rhinoceros

LOD 200

SITE ANALYSIS

RADIATION

PACHYDERM

DETAIL MOELLING — AUTODESK® REVIT®

LOD 300

MODELING

MATERIAL

STRUCTURE

ENERGY — activehouse

FAÇADE DEEPENING — Rhinoceros

LOD 400

MEP DESIGN — AUTODESK® REVIT®

WIND ANALYSIS — SIMSCALE

SCHEDULE — SYNCHRO PRO

LOD 500

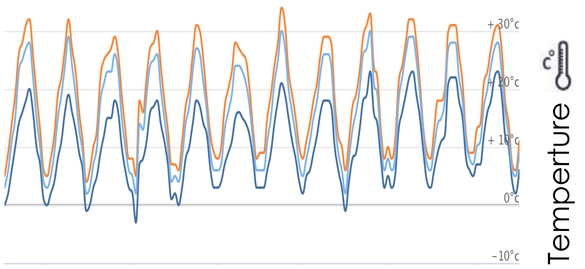
ACCURATE SOLUTION — IES INTEGRATED ENVIRONMENTAL SOLUTIONS

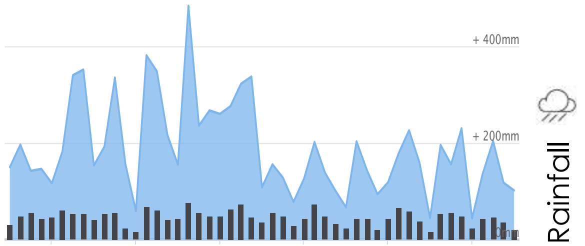
DETAILS — Tekla

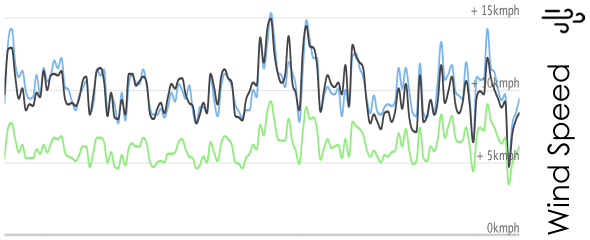
COMMUNICATION & DATA SHARING TOOLS — OneDrive

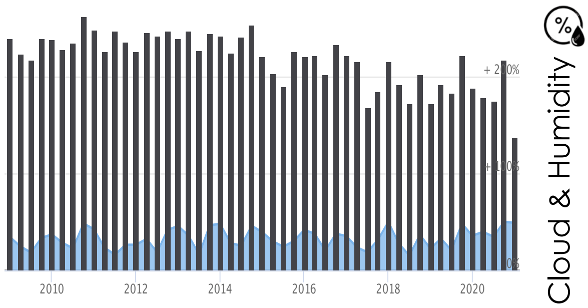
FINAL PRESENTATION — UNREAL ENGINE, LUMION, Ps, Ai, Id

Milan weather data

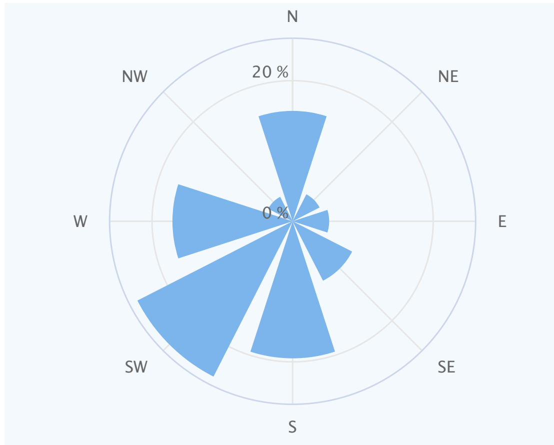






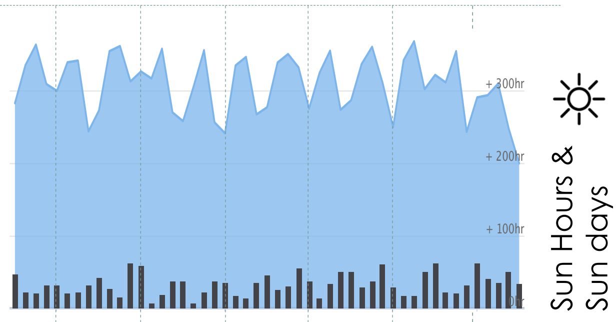


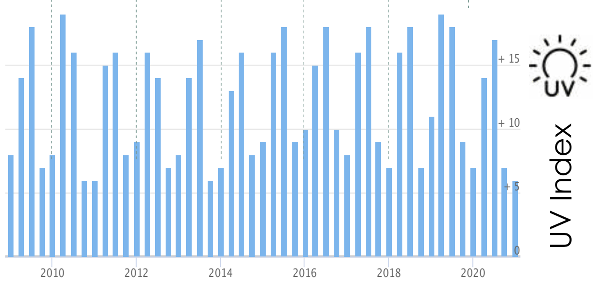
Annual Wind Direction Distribution



N Northern	NE Northeastern	E Eeastern	SE Southeastern
15.7%	**4.3%**	**5.2%**	**9.5%**

S Southern	SW Southwestern	W Western	NW Northwestern
19.5%	**24.8%**	**17.1%**	**3.9%**



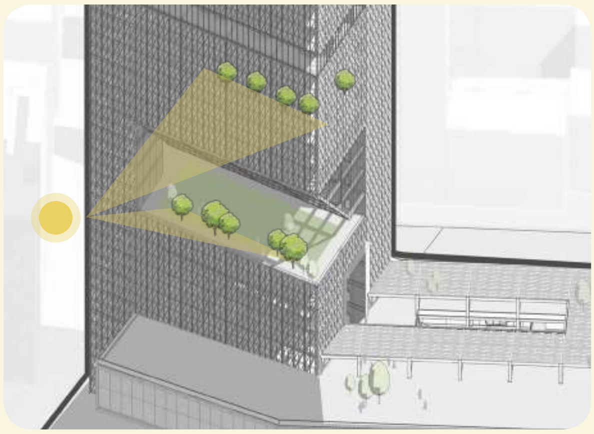


Nearly zero energy buildin(NZEB) stretegies

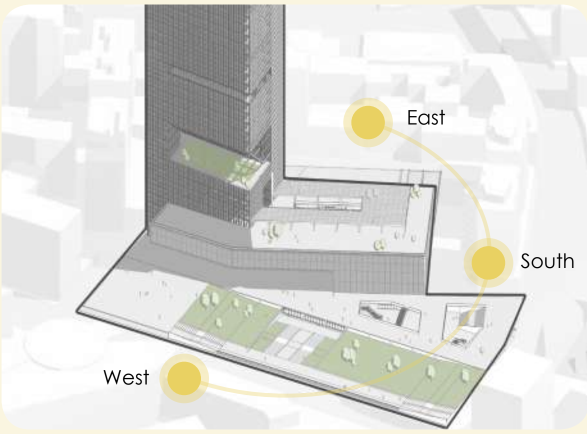
PASSIVE STRATEGIES

SOLAR & THERMAL CONTROL

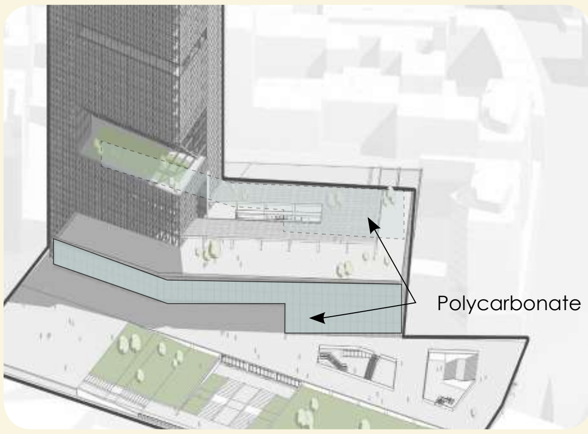
Natural solar protection - plaza



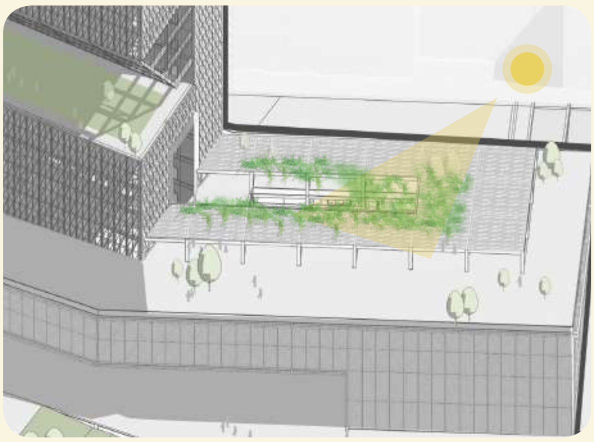
Natural solar protection - tower



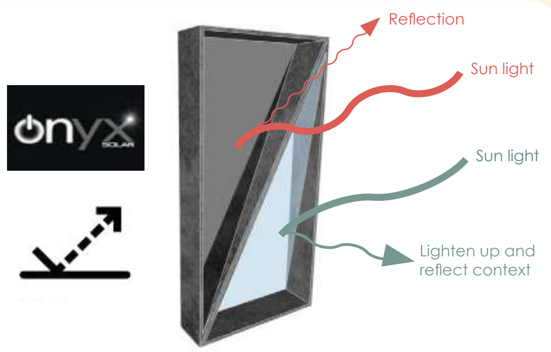
Orientation



Thermal mass



Artificial solar protection

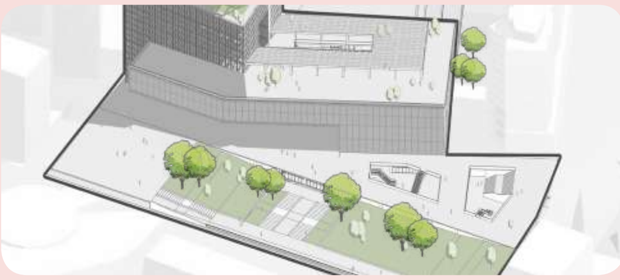


Reduces the transmission of infrared radiation by up to 95%
Filters out 99% of the ultraviolet radiation (UV)

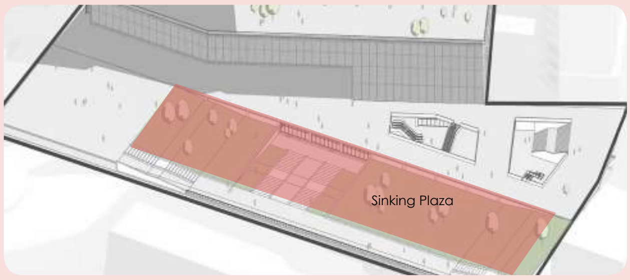
Reflectance of the glass

PASSIVE STRATEGIES

THERMAL ZONING

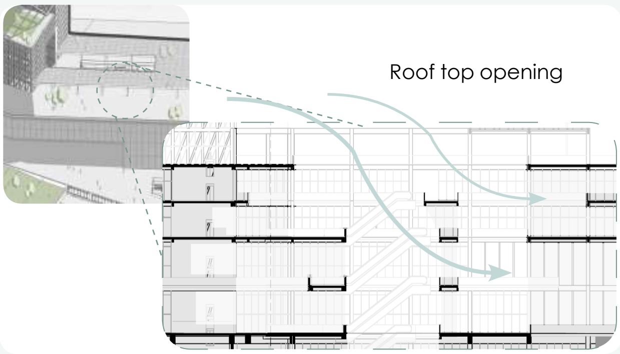


Courtyard design

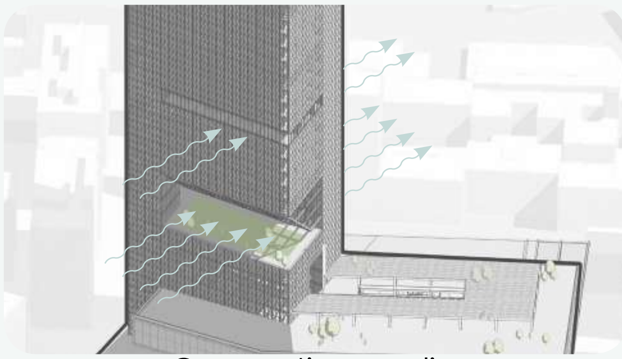


Earth sheltered

PASSIVE COOLING



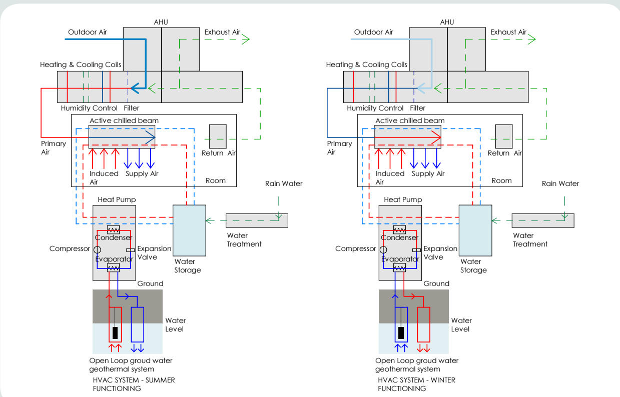
Natural ventilation



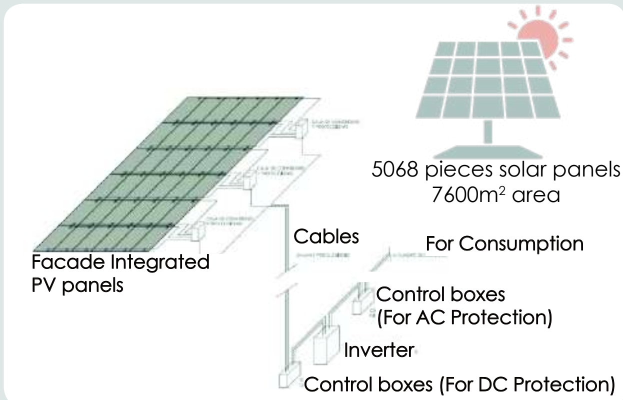
Convective cooling

ACTIVE STRATEGIES

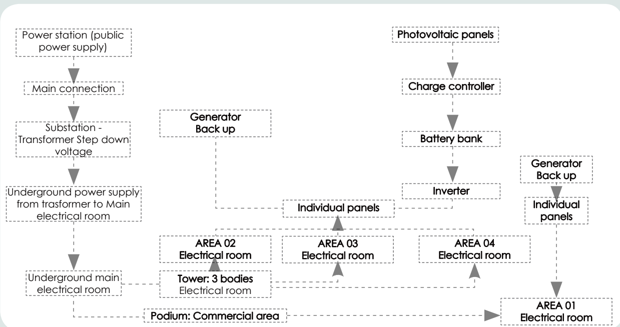
ACTIVE SERVICE



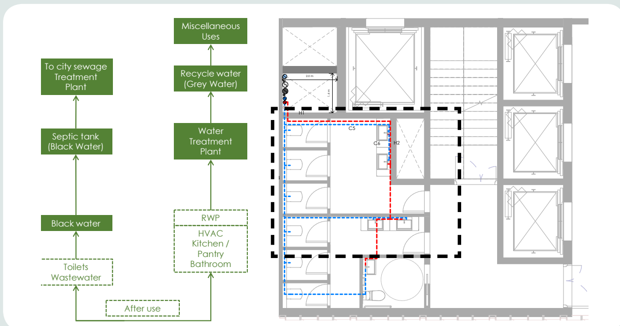
Mechanical ventilation - HVAC systerm



Photovoltaic generation



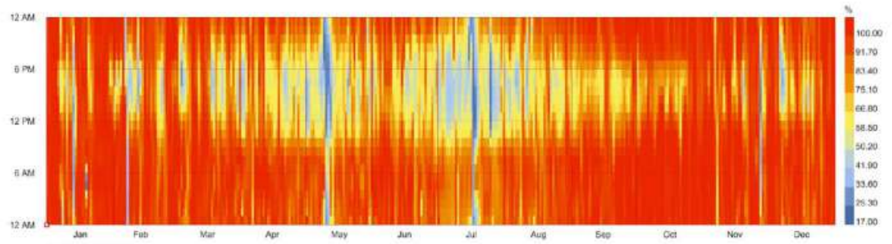
Eletric generation - Electrical system



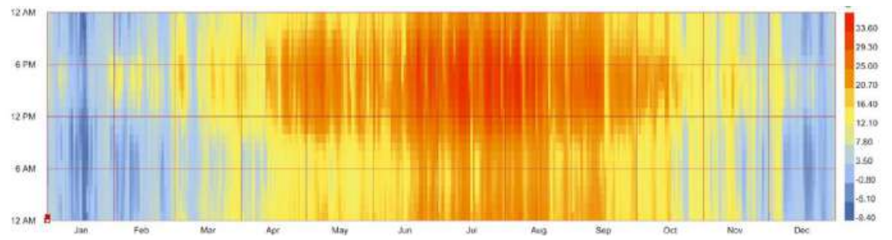
Domestic water service - Water supply

Site analysis - Ladybug

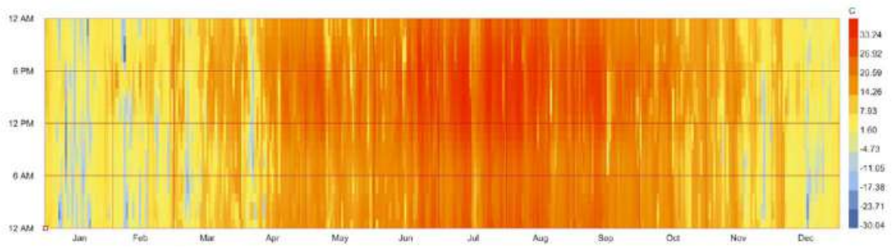
Environmental factors such as solar radiation, wind, temperature, sun path, humidity analyses are procured with grasshopper-ladybug plugin. Epw file is selected for Milan and applied on simplified simulation geometry. The results affected the design of the sun shading for windows in facade, the materials for facade, form and orientation of the building. The data of wind affected the building shape and orientation in the site.



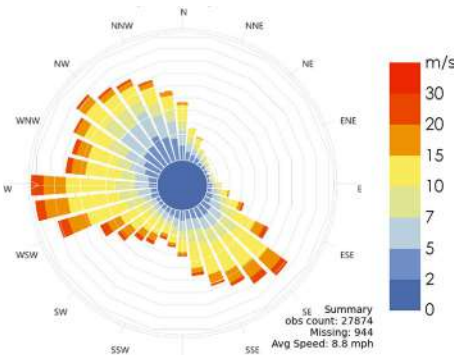
RELATIVE HUMIDITY CHART



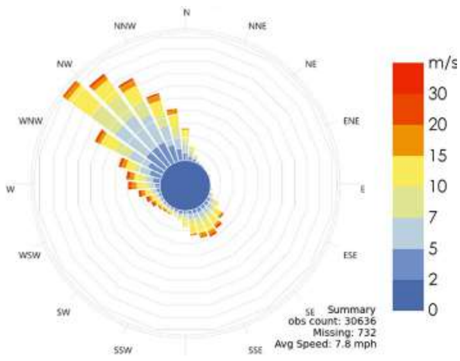
DRY-BULB TEMPERATURE CHART



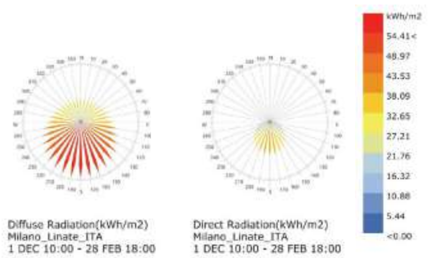
UNIVERSAL TERMAL CLIMAT CHART



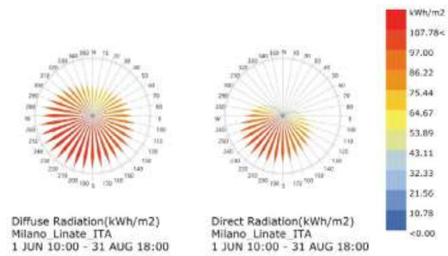
WIND ROSE - SUMMER



WIND ROSE - WINTER

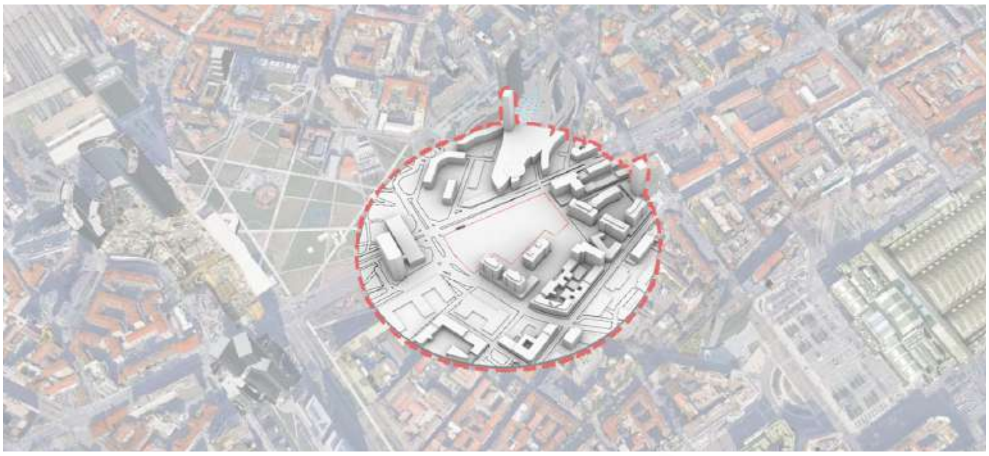


RADIATION - SUMMER

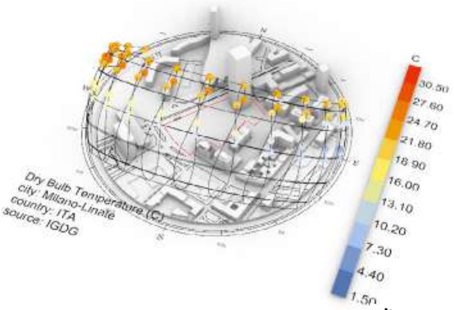


RADIATION - WINTER

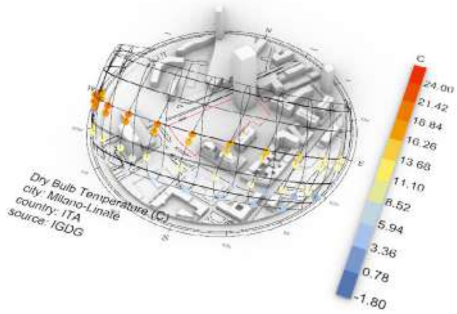
Building radiation analysis - Ladybug



CHOOSING AREA

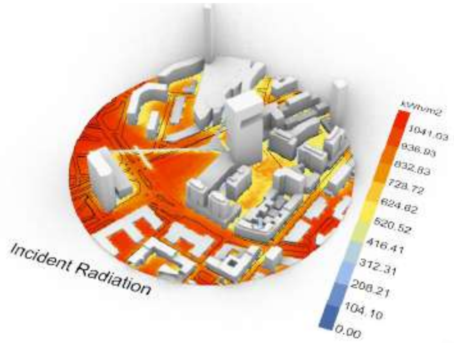


SUN PATH - SUMMER

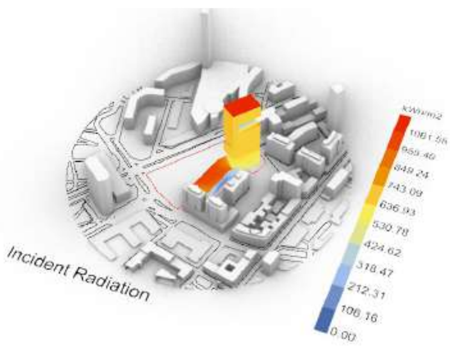


SUN PATH - WINTER

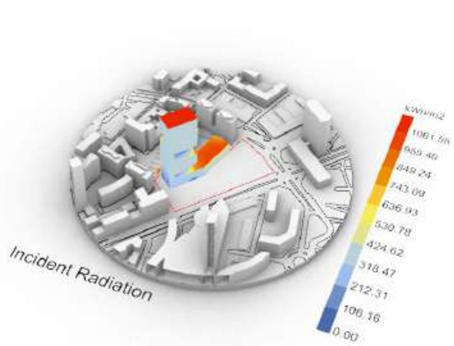
ORIGINAL CONTEXT



CONTEXT AFTER DEVELOPMENT



SOUTH - EAST



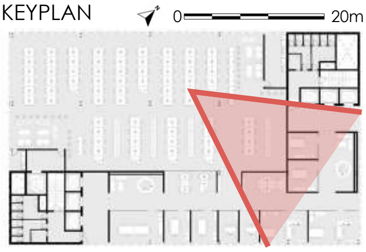
NORTH - WEST

Daylight analysis - Velux

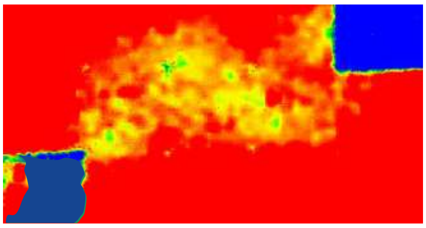
VELUX Daylight Visualizer is a professional lighting simulation tool for the analysis of daylight conditions in buildings. It is intended to promote the use of daylight and to aid professionals by predicting and documenting daylight levels and appearance of a space prior to realization of the building design.

To behold and predict daylight levels and appearance of the interior spaces prior to the realization of the building, we took the merits of VELUX-Daylight Visualizer. To fulfill the lighting simulations along the "BIM" process, we decided firstly to analyze two very different spatial configurations: the typical office floor with solar panel facade (showing below), and the lobby of the tower (next page).

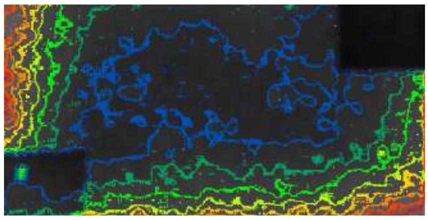
KEYPLAN



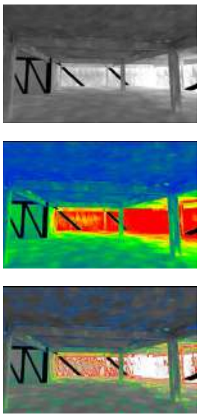
OFFICE - MARCH, FALSE COLOR



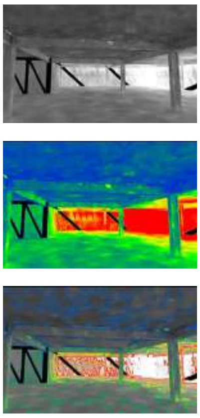
OFFICE - MARCH, IOS COLOR



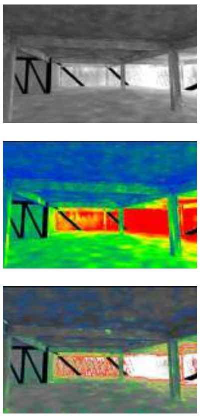
JANUARY



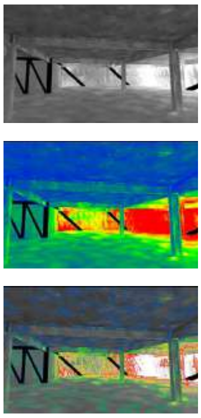
FEBRUARY



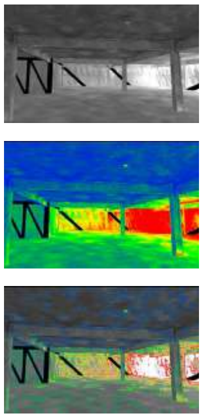
MARCH



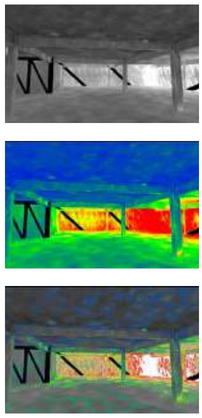
APRIL



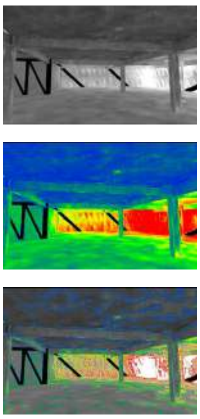
MAY



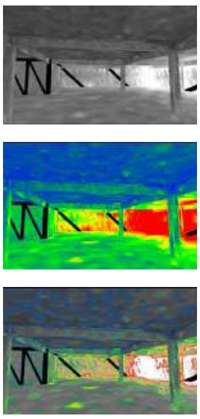
JUNE



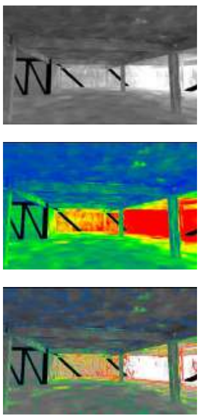
JULY



AUGUST



SEPTEMBER



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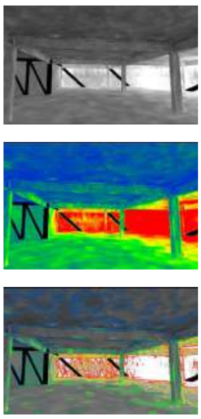

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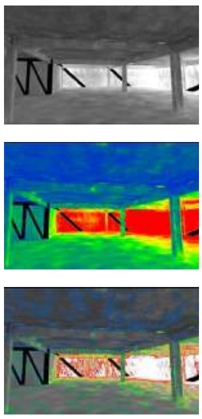

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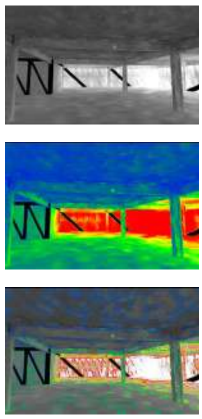
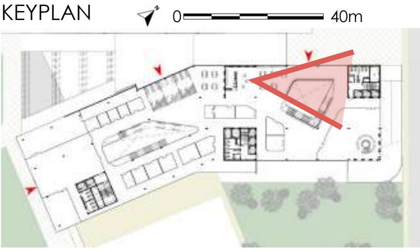
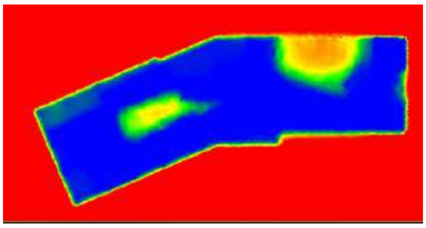


Daylight analysis - Velux

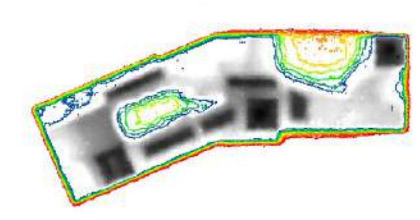
KEYPLAN 0 40m



LOBBY - MARCH, FALSE COLOR



LOBBY - MARCH, IOS COLOR



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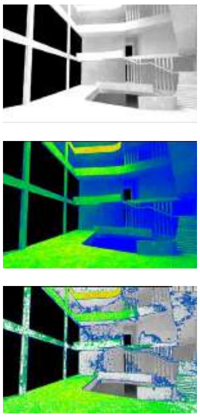

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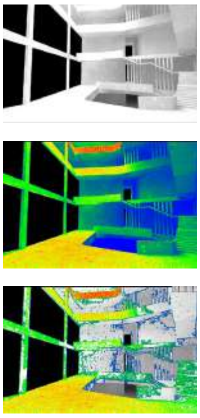
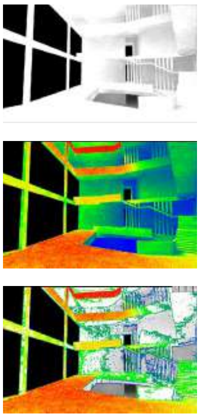
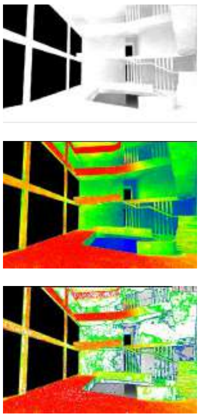


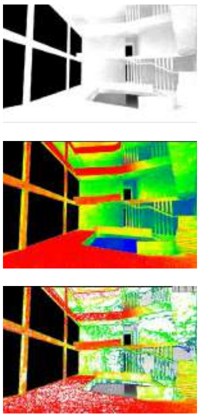
MARCH



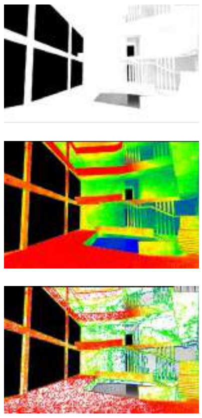
APRIL



MAY



JUNE



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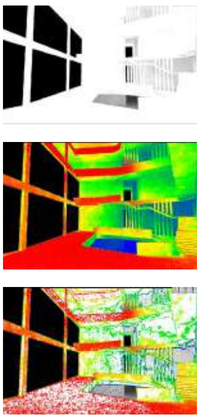
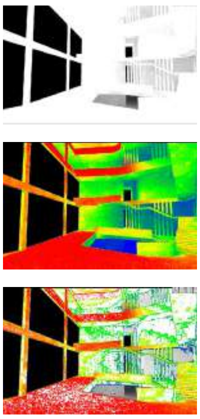
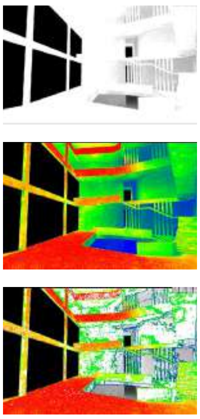


AUGUST



SEPTEMBER



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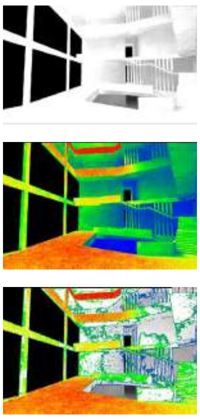

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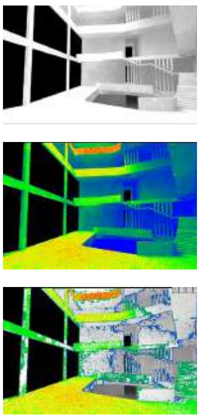

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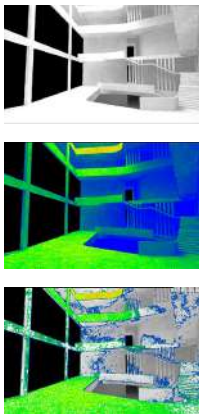
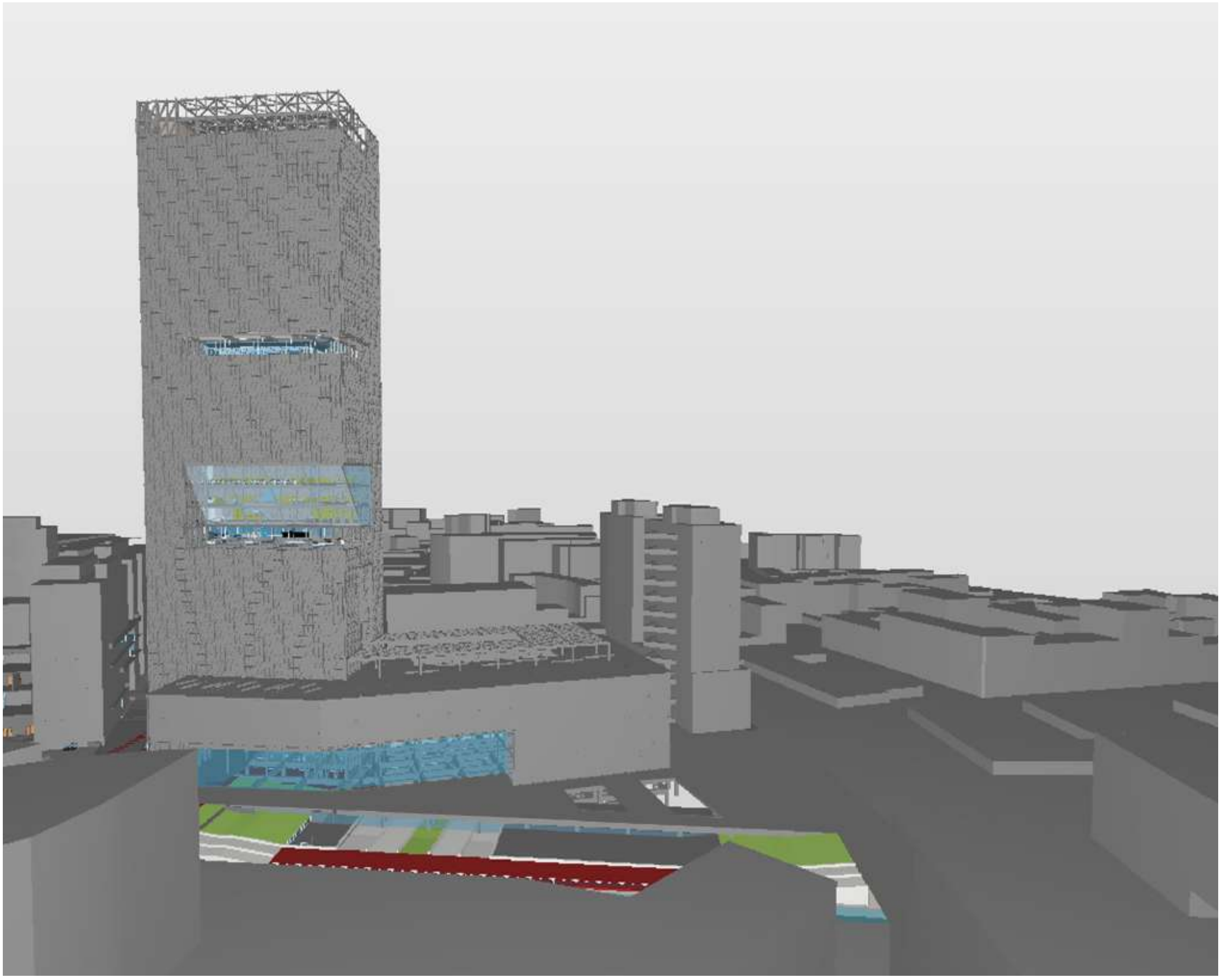


Model checking - Solibri office

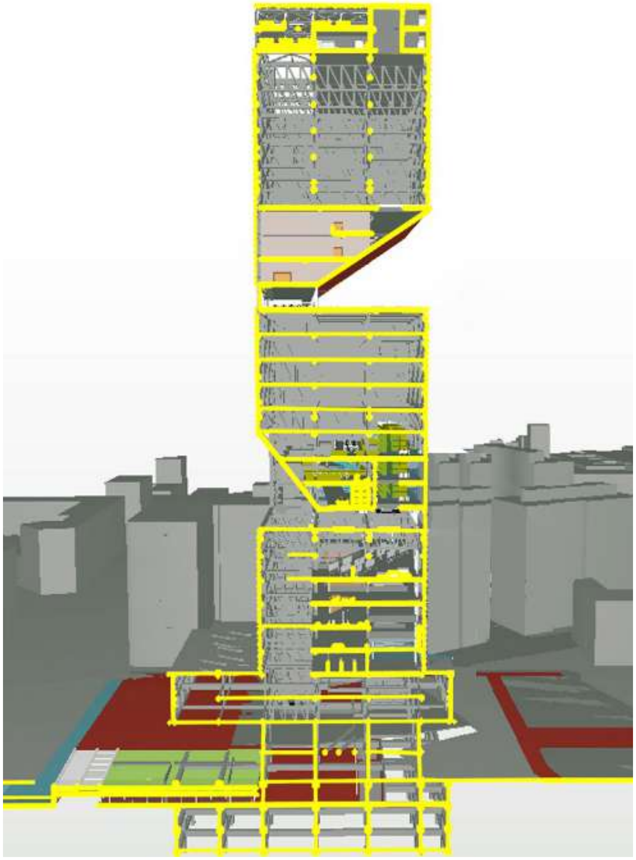
Solibri is founded on the concept of Open BIM. Solibri Office can import building models from all major BIM software products by using the standardized IFC interface. Solibri finds the problems and helps to solve them so they don't become issues later on. It doesn't only point out the problems that could appear at the construction phase, also point out the other areas that can become a problem once the building is at use.

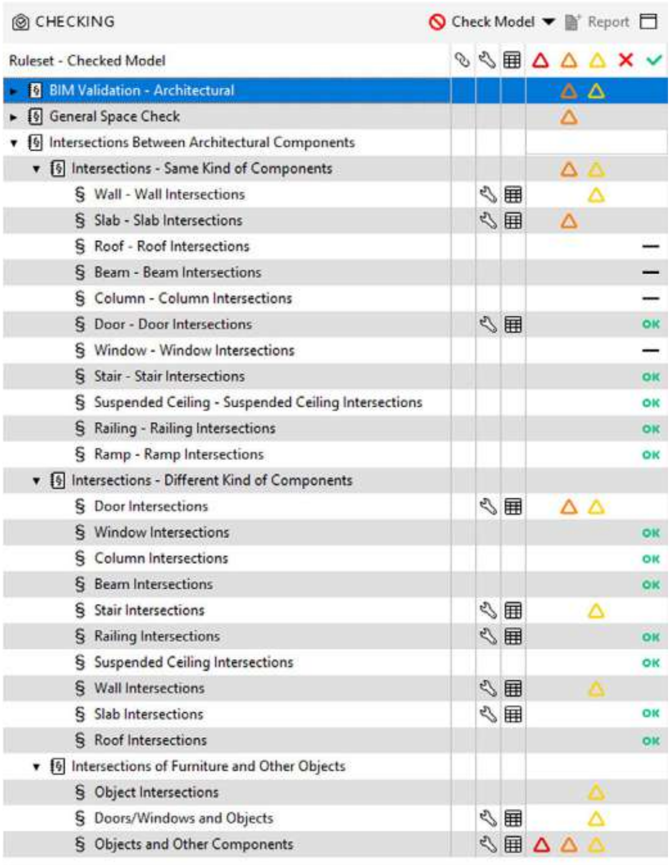
Solibri's quality checking is based on both pre-defined and customizable rules, out of which you select which ones to use. We offer the best pre-defined rules on the market for checking not only model quality, but much more – imagine the ability to consider everything regarding, for example, the comfort of use in your newly constructed building, including details like thoroughly planned accessibility or perfectly sized and angled parking spaces.

In our project, we applied Solibri office right after the 3D modelling finished, to make sure the model was without intersection. According to the result reports, we kept updating and modifying our Revit model, and arriving to the final version.



Model checking - Solibri office





BIM Validation - Architectural	Acc	Rej	Maj	Nor	Min
Model Structure Check			x	x	x
Model Hierarchy	OK				
Building Floors	OK				
Doors and Windows				x	
Door Opening Direction Definition					x
Unique GUID values			x		
Amount of Site Instances	OK				
Amount of Doors or Windows in Openings	OK				
If Decomposed Object has Geometry Defined, Its Parts Should Not Have Geometry	-				
If Parts of Decomposed Object have Geometry Defined, the Decomposed Object Itself Should Not Have Geometry	OK				
Material of Decomposed Objects Should Only Be defined in Part Level	OK				
Openings in Complex Walls Shouls be Related to Wall, Not Parts	-				
Component Check			x	x	x
Component Dimensions			x	x	x
Wall Dimensions Should Be Sensible			x	x	x
Wall Height			x		x
Wall Thickness	OK				
Wall Length				x	
Wall Opening Distances				x	
Door And Window Openings Must Have at Least Minimal Size	OK				
Window Width	-				
Window Height	-				
Door Width	OK				
Door Height	OK				
Slab Dimensions Should Be Sensible				x	
Slab Thickness				x	
Slab Area	OK				
Roof Dimensions Should Be Sensible	-				
Roof Thickness	-				
Roof Area	-				

Column and Beam Dimensions Must Be Within Sensible Bounds	-				
Column Profile	-				
Beam Profile	-				
Column Length	-				
Beam Length	-				
Floor Heights				x	
Clearance			x		x
Clearance in Front of Windows	-				
Clearance in Front of Doors			x		x
Clearance Above Suspended Ceilings	OK				
Free Area in Front of Fixed Furnishing			x		
Deficiency Detection			x	x	x
Required Components				x	
Unallocated Areas	-				
Components Below and Above			x	x	x
Components Above Columns	-				
Components Below Columns	-				
Components Above Beams	-				
Components Below Beams	-				
Components Above Walls			x	x	x
Components Below Walls			x	x	x
Revolving Doors Must Have Swinging Door Next to It	-				
Slabs must be Guarded against Falling				x	
General Space Check	**Acc**	**Rej**	**Maj**	**Nor**	**Min**
The Model Should Have Spaces				x	
Space Properties	-				
Spaces Must Have Name	-				
Spaces Must Have Number	-				
Space Dimensions Must Be Within Sensible Bounds	-				
Spaces Must Have Doors	-				
Space Location	-				
Space Intersections	-				
Space Validation	-				
Spaces in Same Building Storey Must Have Same Bottom Elevation	-				

Intersections Between Architectural Components	Acc	Rej	Maj	Nor	Min
Intersections - Same Kind of Components		X	x	x	x
Wall - Wall Intersections		X	x		x
Slab - Slab Intersections		X	x	x	
Roof - Roof Intersections	-				
Beam - Beam Intersections	-				
Column - Column Intersections	-				
Door - Door Intersections			x		
Window - Window Intersections	-				
Stair - Stair Intersections	OK				
Suspended Ceiling - Suspended Ceiling Intersections	OK				
Railing - Railing Intersections	OK				
Ramp - Ramp Intersections	OK				
Intersections - Different Kind of Components			x	x	x
Door Intersections			x	x	x
Window Intersections	OK				
Column Intersections	OK				
Beam Intersections	OK				
Stair Intersections			x	x	x
Railing Intersections			x		
Suspended Ceiling Intersections	OK				
Wall Intersections				x	x
Slab Intersections			x		
Roof Intersections	OK				
Intersections of Furniture and Other Objects		X	x	x	x
Object Intersections		X	x	x	x
Doors/Windows and Objects			x	x	x
Objects and Other Components			x	x	x

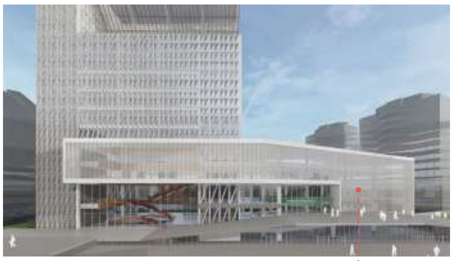
Material definition - Ces edupack

CES Edupack is a software selection of materials, including processes, joining and finishing.

EduPack includes a database of materials and process information, materials selection tools and a range of supporting resources. Apart from seeing the material properties in this soft ware, we can also get the embodied energy of the chosen material.

When the general shapes of the project are defined, we use this software to acquire information of material we use.

With this, we can better choose which material has suitable characteristic.



POLYCARBONATED

Polymers and elastomers > Polymers > Thermoplastics >

Description

Illustration

Figure caption

Polycarbonate is tough and impact-resistant: hence its use here in the construction of a bicycle shed.

The material

PC is one of the 'engineering' thermoplastics, meaning that they have better mechanical properties than the cheaper 'commodity' polymers. The family includes the plastics polyamide (PA), polyoxymethylene (POM) and polytetrafluorethylene (PTFE). The benzene ring and the -OCOO- carbonate group combine in pure PC to give it its unique characteristics of optical transparency and good toughness and rigidity, even at relatively high temperatures. These properties make PC a good choice for applications such as compact disks, safety hard hats and housings for power tools. To enhance the properties of PC even further, it is possible to co-polymerize the molecule with other monomers (improves the flame retardancy, refractive index and resistance to softening), or to reinforce the PC with glass fibers (giving better mechanical properties at high temperatures).

Compositional summary

(O-(C6H4)-C(CH3)2-(C6H4)-CO)n

General properties				
Density	1.19e3	-	1.21e3	kg/m^3
Price	* 16.6	-	18.9	CNY/kg
Material form that data applies to				
Bulk	✓			
Sheet	✓			
Building system				
Superstructure	✗			
Enclosure	✓			
Interiors	✓			
Services	✗			
Mechanical properties				
Young's modulus	2.32	-	2.44	GPa
Shear modulus	* 0.829	-	0.872	GPa
Bulk modulus	* 3.83	-	4.03	GPa
Bending modulus	* 2.1	-	2.56	GPa
Poisson's ratio	* 0.391	-	0.407	
Yield strength (elastic limit)	59.1	-	65.2	MPa
Tensile strength	62.7	-	72.4	MPa
Compressive strength	* 69	-	86.2	MPa
Bending strength	* 62	-	73.5	MPa
Elongation	110	-	150	% strain
Hardness - Vickers	* 18	-	20	HV
Fatigue strength at 10^7 cycles	* 23.7	-	30.8	MPa
Fracture toughness	2.1	-	2.3	MPa.m^0.5
Mechanical loss coefficient (tan delta)	* 0.0164	-	0.0172	
Thermal and combustion properties				
Thermal conductor or insulator?	Good insulator			
Thermal resistivity	4.59	-	5.18	m.°C/W
Thermal expansion coefficient	120	-	125	µstrain/°C
Specific heat capacity	1.15e3	-	1.25e3	J/kg.°C
Glass temperature	142	-	158	°C
Maximum service temperature	* 101	-	116	°C

GLASS FIBER REINFORCE PANEL

Composites > Polymer >

Description

Illustration

Figure caption

Glass fiber reinforced panels joined together to form the primary walls of a single family detached house.

The material

Composites are one of the great material developments of the 20th century. Those with the highest stiffness and strength are made of continuous fibers (glass, carbon or Kevlar, an aramid) embedded in a thermosetting resin (polyester or epoxy). The fibers carry the mechanical loads, while the matrix material transmits loads to the fibers and provides ductility and toughness as well as protecting the fibers from damage caused by handling or the environment. It is the matrix material that limits the service temperature and processing conditions. Polyester-glass composites (GFRPs) are the cheapest and by far the most widely used. A recent innovation is the use of thermoplastics at the matrix material, either in the form of a co-weave of cheap polypropylene and glass fibers that is thermoformed, melting the PP, or as expensive high-temperature thermoplastic resins such as PEEK that allow composites with higher temperature and impact resistance. High performance GFRP uses continuous fibers. Those with chopped glass fibers are cheaper and are used in far larger quantities. GFRP products range from tiny electronic circuit boards to large boat hulls, body and interior panels of cars, household appliances, furniture and fittings. Fiberglass and pultrusions are commonly used in architectural applications as stiff and strong panels and standard structural sections.

Compositional summary

Epoxy + continuous E-glass fiber reinforcement (0, +-45, 90), quasi-isotropic layup.

General properties				
Density	1.75e3	-	1.97e3	kg/m^3
Price	* 227	-	250	CNY/kg
Material form that data applies to				
Bulk	✓			
Sheet	✓			
Building system				
Superstructure	✓			
Enclosure	✓			
Interiors	✓			
Services	✓			
Mechanical properties				
Young's modulus	* 15	-	28	GPa
Shear modulus	* 7.99	-	8.29	GPa
Bulk modulus	* 6.8	-	7.85	GPa
Bending modulus	13.8	-	20.6	GPa
Poisson's ratio	* 0.314	-	0.315	
Yield strength (elastic limit)	* 207	-	304	MPa
Tensile strength	* 207	-	304	MPa
Compressive strength	* 207	-	257	MPa
Bending strength	345	-	483	MPa
Elongation	* 0.85	-	0.95	% strain
Hardness - Vickers	* 10.8	-	21.5	HV
Fatigue strength at 10^7 cycles	* 41.3	-	91.1	MPa
Fracture toughness	* 19.3	-	31	MPa.m^0.5
Mechanical loss coefficient (tan delta)	* 0.0028	-	0.0029	
Thermal and combustion properties				
Thermal conductor or insulator?	Poor insulator			
Thermal resistivity	* 1.82	-	2.5	m.°C/W
Thermal expansion coefficient	* 8.64	-	33	µstrain/°C
Specific heat capacity	* 1.02e3	-	1.12e3	J/kg.°C
Glass temperature	99.9	-	180	°C
Maximum service temperature	* 140	-	220	°C
Flammability	Self-extinguishing			
Emissivity	0.75			

POLYWOOD

Wood, plywood, glulam, bamboo, straw and cork > Wood panel composites > Plywood >

Description

Illustration

Figure caption

Plywood dominates the planar substrate market for both wood and steel stud construction.

The material

Plywood is laminated wood, the layers glued together such that the grain in successive layers are at right angles, giving stiffness and strength in both directions. The number of layers varies, but is always odd (3, 5, 7 ...) to give symmetry about the core ply - if it is unsymmetric it warps when wet or hot. Those with few plies (3,5) are significantly stronger and stiffer in the direction of the outermost layers; with increasing number of plies the properties become more uniform. High quality plywood is bonded with synthetic resin.

Compositional summary

Cellulose/Hemicellulose/Lignin/12%H2O/Adhesive

General properties				
Density	700	-	800	kg/m^3
Price	* 3.7	-	4.1	CNY/kg
Material form that data applies to				
Bulk	✓			
Sheet	✓			
Building system				
Superstructure	✓			
Enclosure	✓			
Interiors	✓			
Services	✗			
Mechanical properties				
Young's modulus	6.9	-	13	GPa
Shear modulus	0.14	-	0.21	GPa
Bulk modulus	* 1.63	-	2.45	GPa
Poisson's ratio	0.2	-	0.3	
Yield strength (elastic limit)	9	-	22	MPa
Tensile strength	10	-	28	MPa
Compressive strength	27	-	34	MPa
Elongation	* 2.43	-	2.97	% strain
Hardness - Vickers	9	-	11.3	HV
Fatigue strength at 10^7 cycles	* 5.7	-	12.7	MPa
Fracture toughness	* 1	-	1.8	MPa.m^0.5
Mechanical loss coefficient (tan delta)	0.0077	-	0.0104	
Thermal and combustion properties				
Thermal conductor or insulator?	Good insulator			
Thermal resistivity	2.86	-	3.33	m.°C/W
Thermal expansion coefficient	6	-	8	µstrain/°C
Specific heat capacity	1.66e3	-	1.71e3	J/kg.°C
Maximum service temperature	117	-	137	°C
Flammability	Flammable			
Emissivity	* 0.81	-	0.9	

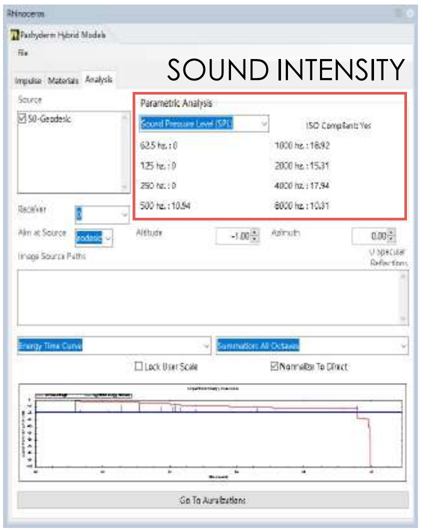
Acoustic design - Pachyderm

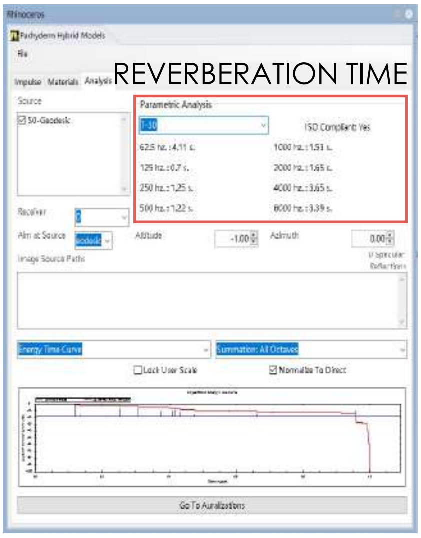
For the acoustic design of the auditorium, we adopted rhino and pachyderm plug-ins. This software helps us to better define the materials of the walls and acoustic board inside the auditorium.

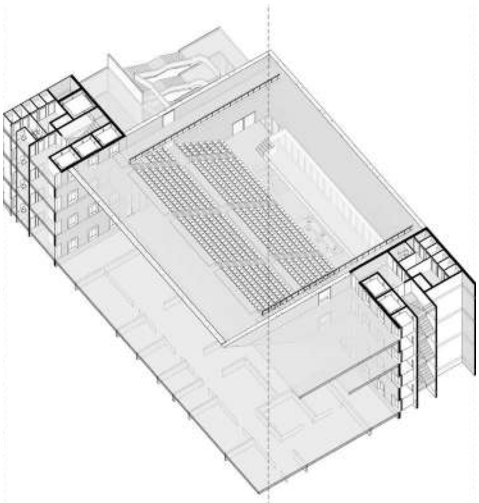
For this spcae, we placed the sound source in the center of the stage, and each took the farest audience position: the last row of seats in the second floor to test the reverberation and sound intensity of the sound.

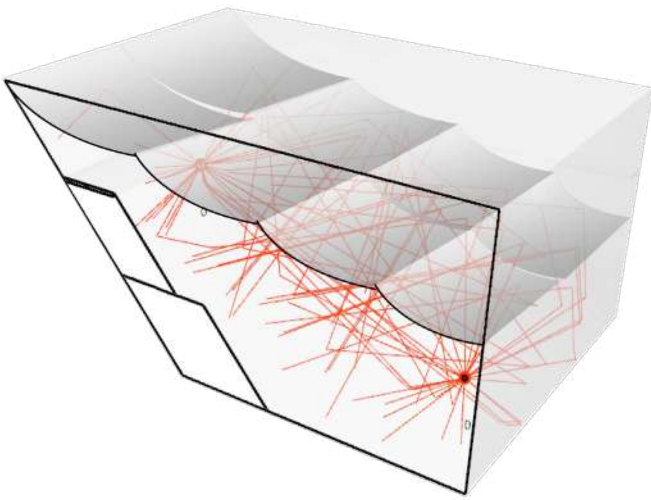
Below, you can see the sound propagation path from the sound source to this typical locations in the auditorium.

Activity and Type of Area	Noise Rating NR value	L_p (dB_A)
Kindergartens	30	35
Auditorium	25	30
Library	30	35
Cinema	30	35
Concert hall	20	25
Court room	25	30
Theater	25	30
Store, retail	35	40
Supermarkets	40	45
Hospital, corridor	30	35
Hospital, operating theater	25	30
Hospital, private room	20	25
Hotel, lobby	35	40
Hotel, restaurant	40	45
Hotel, ballroom	30	35
Church	25	30
Office	30	35
School, lecture room	25	30
School, corridor	30	35
School, gymnasium	30	35
Swimming pool	35	40
Studio, record	20	25
Studio, radio	15	20
Studio, television with audience	25	30
Studio, television without audience	20	25









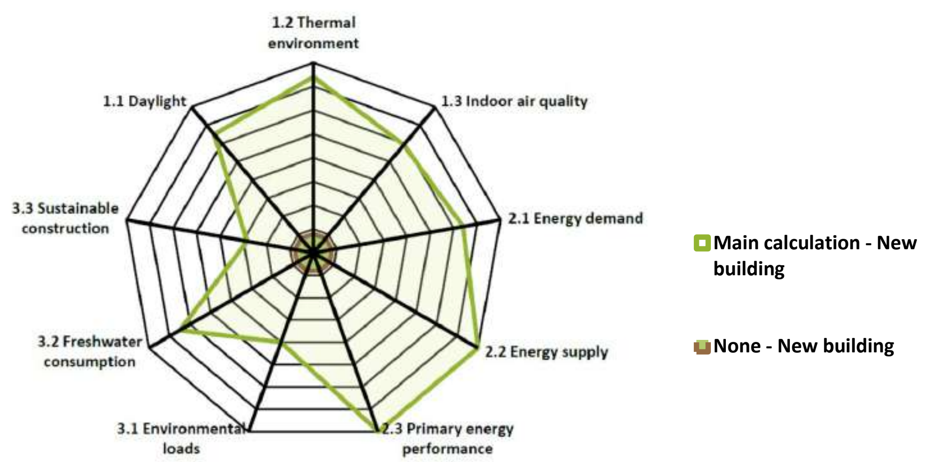
Energy performance - Active house

The Active House Specifications explain the vision that is Active House and outline the technical specifications that determine the quality and performance of an Active House. This definition and description of an Active House is intended as a guideline at an international level. It seeks innovative technical approaches whilst introducing goals of architectural quality and environmental design, at the same time as providing energy efficiency.

Active House is a vision of how to create sustainable buildings anywhere in the world. These Specifications offer insight and knowledge needed to draw up the required technical specifications and design concept for an Active House. They include important issues to consider when creating an Active House. These issues can be qualitative or quantitative. The qualitative aspects describe aspects that influence the quality of a building or how it is being experienced by the user, but difficult to put a number on, such as having a view. The quantitative aspects form the basis for the Active House radar, that can be used as a communication instrument to display the quality of an Active House in an instant.

activehouse.INFO
NETWORK AND KNOWLEDGE SHARING

Main calculation - New building		
Comfort	Value	Category
1.1 Daylight:	3.7 %	1.8
1.2 Thermal environment:	Better level	1.3
1.3 Indoor air quality:	≤ 1000 ppm	2.0
Classification		
Energy	Value	Category
2.1 Energy demand:	56.0 kWh/m²	1.8
2.2 Energy supply:	153.0 kWh/m²	1.0
2.3 Primary energy:	-90.0 kWh/m²	1.0
Classification		
Environment	Value	Category
3.1 Environmental loads:	Good level	3.0
3.2 Freshwater:	35 % savings	1.8
3.3 Sustainable construction:	Better level	3.6
Classification		

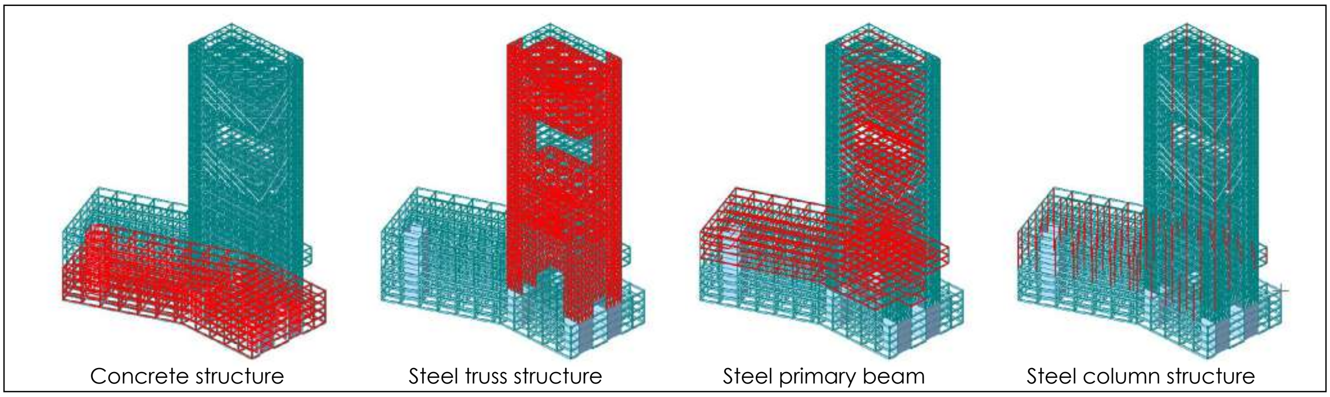


Structure - Midas

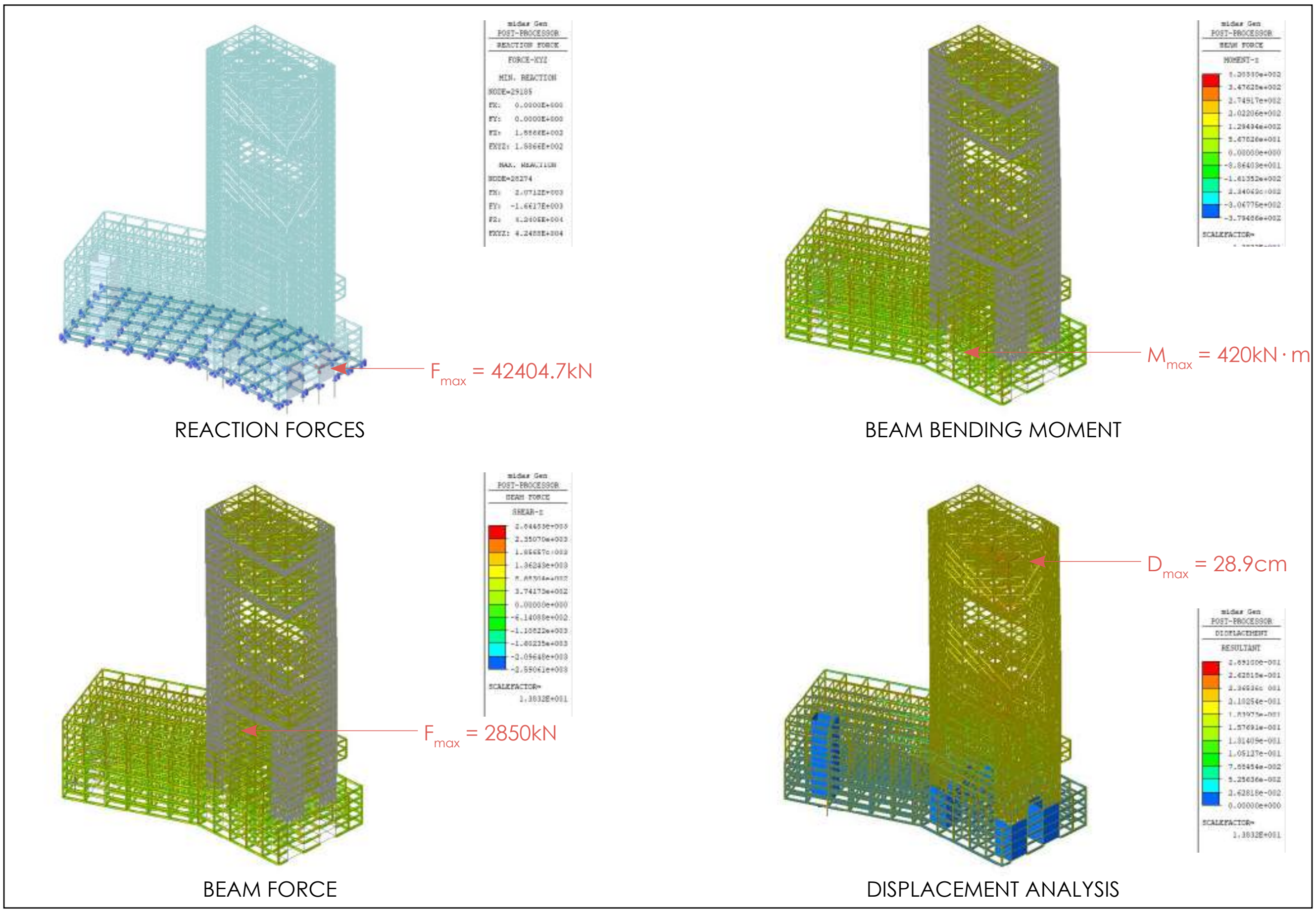
With its intuitive user interface, contemporary computer graphics and powerful solver, midas Gen enables practicing engineers to readily perform structural analysis and design for conventional and complex structures.

Midas Gen utilizes a diverse range of specialty finite element analysis functions as well as modern theories of structural analysis to render accurate and practical results. These features contribute to higher and unprecedented standards of convenience, efficiency, versatility and productivity for structural design.

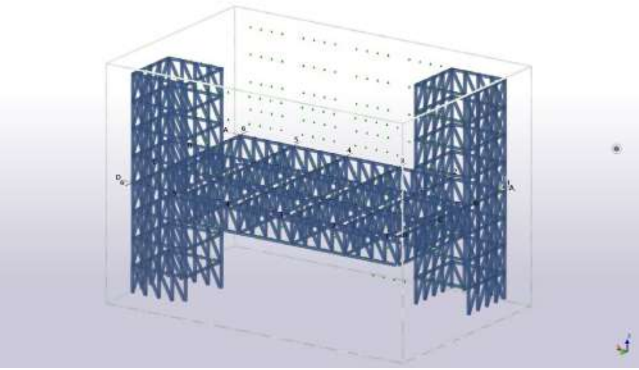
ASSIGN STRUCTURAL ELEMENTS



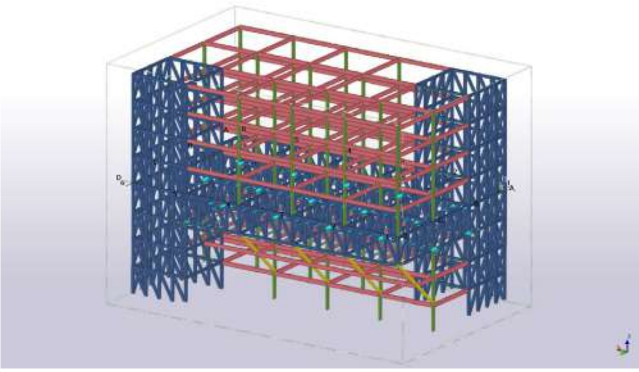
OVERALL ANALYSIS RESULT



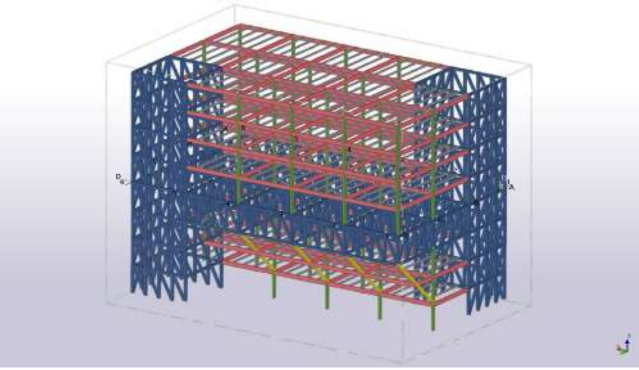
Structure - Tekla



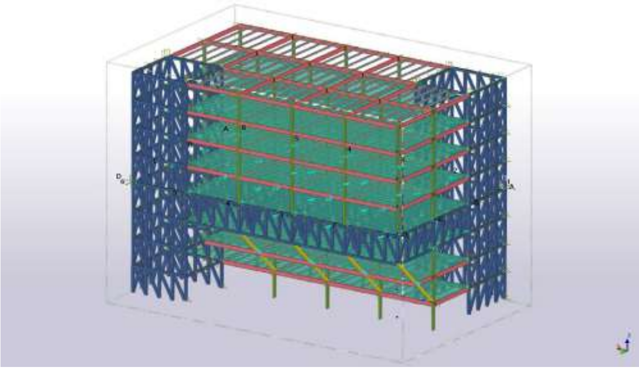
PHRASH 1 - TRUSS



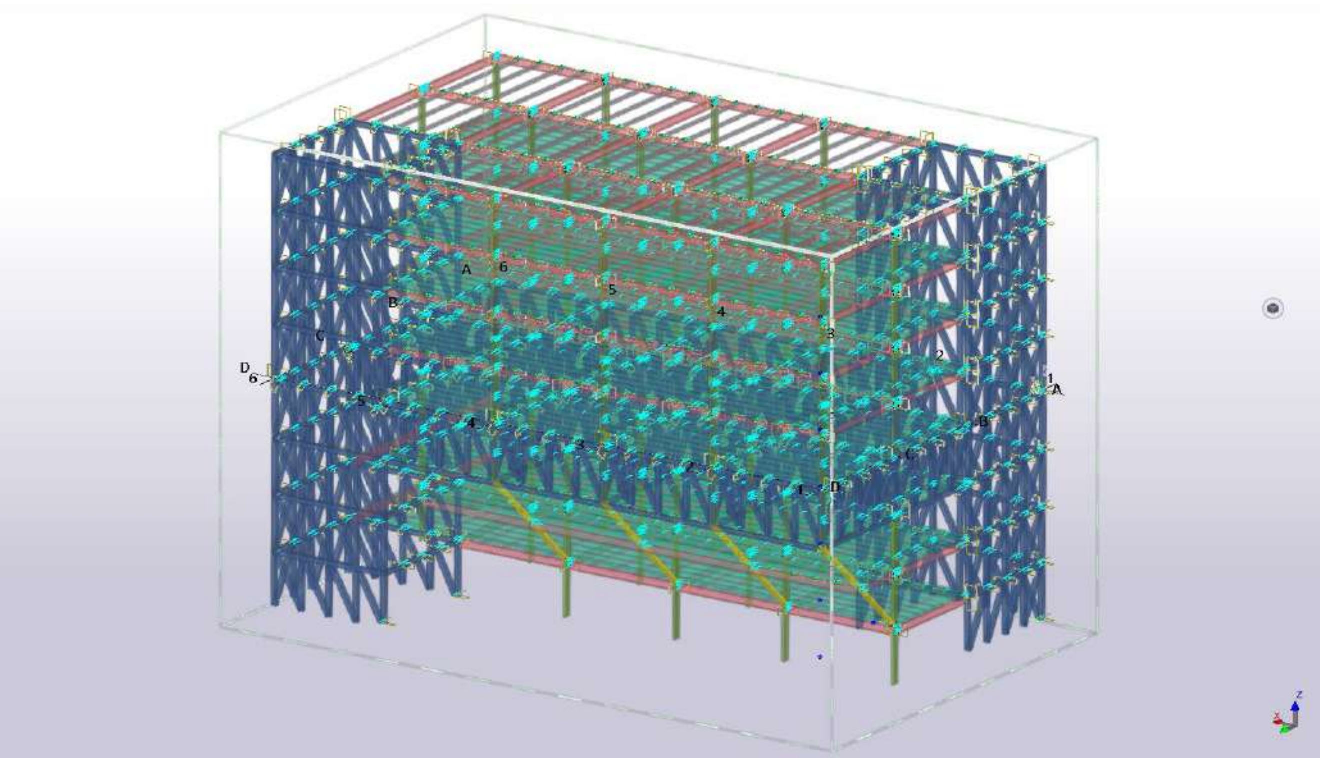
PHRASH 2 - PRIMARYBEAM



PHRASH 3 - SECONDARY BEAM



PHRASH 4 - METAL DECK

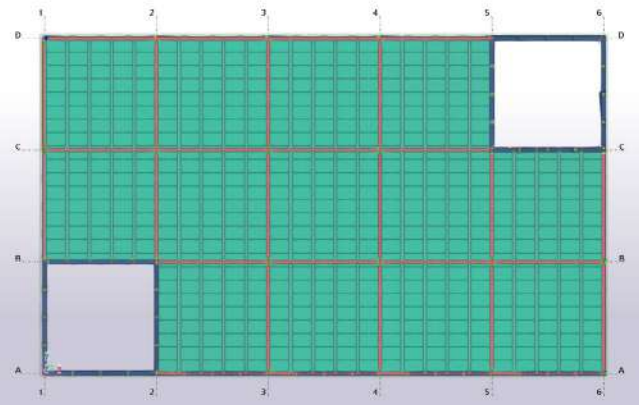


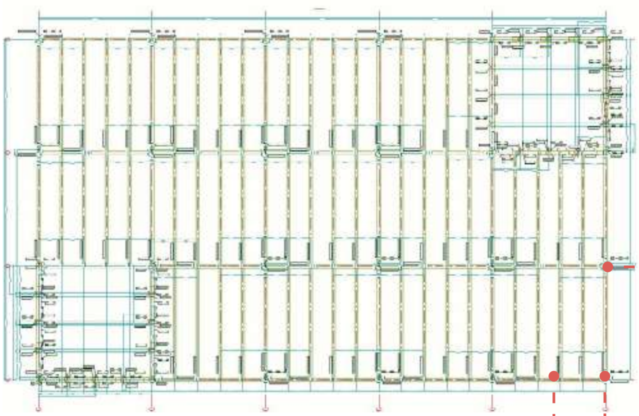
OVERALL VIEW

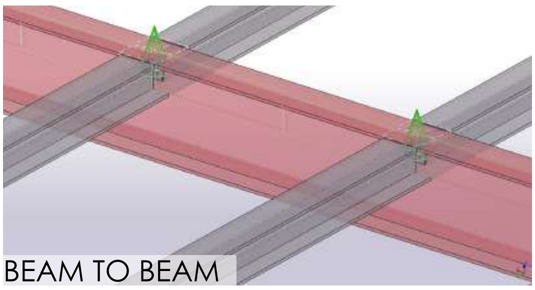
Structure - Tekla

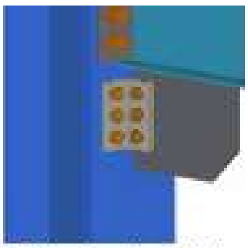
Tekla Structures is a building information modeling software able to model structures that incorporate different kinds of building materials, including steel, concrete, timber and glass. Tekla allows structural drafters and engineers to design a building structure and its components using 3D modeling, generate 2D drawings and access building information. Tekla Structures was formerly known as Xsteel (X as in X Window System, the foundation of the Unix GUI).

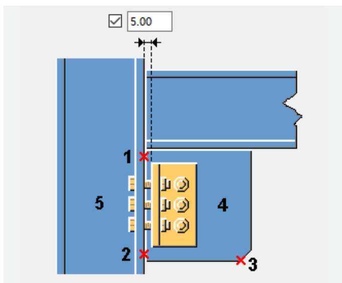
We use Tekla to define the joints of structural elements, which helps us to further define the details of the structure and understand the combination mode between the elements.

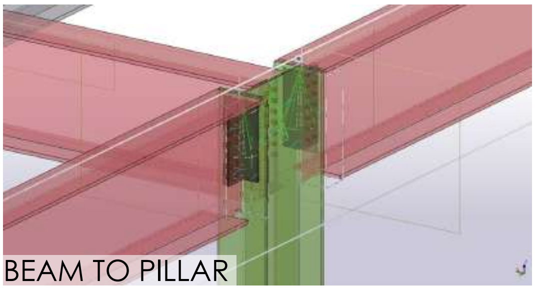

PLAN VIEW

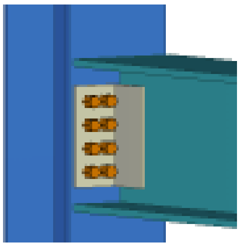

PLAN DETAIL

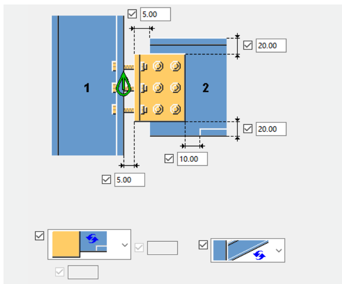

BEAM TO BEAM

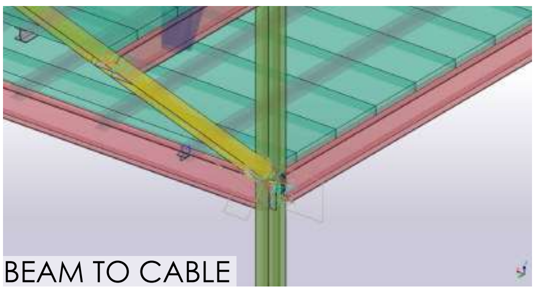

Clip Angles (44)

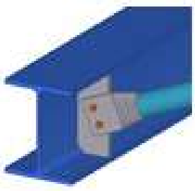


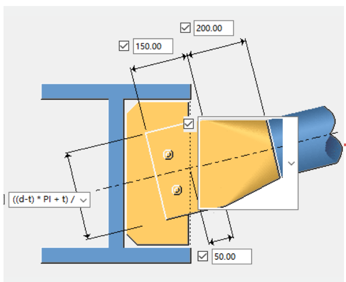

BEAM TO PILLAR


Clip angle (141)




BEAM TO CABLE


Squeezed tube bolted (102)



Project management - Synchro

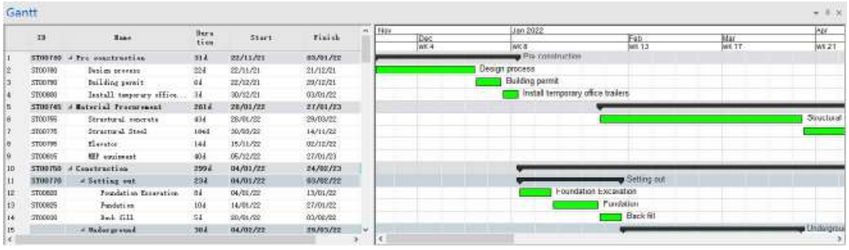
SYNCHRO 4D is designed for construction modeling, planning and scheduling, visualization, simulation, and project controls. All construction team members can build digital projects on the screen and extend the value of 3D models by adding time, the fourth dimension. Serving as the real-time source of truth, SYNCHRO 4D can help solve the time-cost conundrum, increase safety, and reduce both employee and project risks.

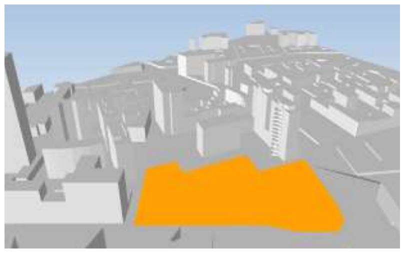
SYNCHRO 4D provides a wholistic and purpose-built construction solution, enabling projects to construct, plan, and track projects based on a construction model. Users can easily communicate and present the construction plan and schedule, allowing for trade partner collaboration and commitment with confidence, on-time execution and delivery, and quicker approval for payment. The web and mobile applications extend the value of the 4D construction model by exchanging and managing 2D, 3D, and 4D models with geolocated, rich data in the project context. Teams can efficiently access and author data to make more informed decisions.

Slice and dice your design into a construction model with auto-populated quantities while keeping original design intent. Display both 3D models and the schedule in one environment to perform model-based scheduling. Add construction equipment and paths to schedule activities to visualize conflicts and resolve them before construction. Perform "what-if" analysis to reduce risks and delays by reviewing time-lapsed construction sequences. Identify areas that are ahead or behind schedule through a planned-versus-actual visualization.

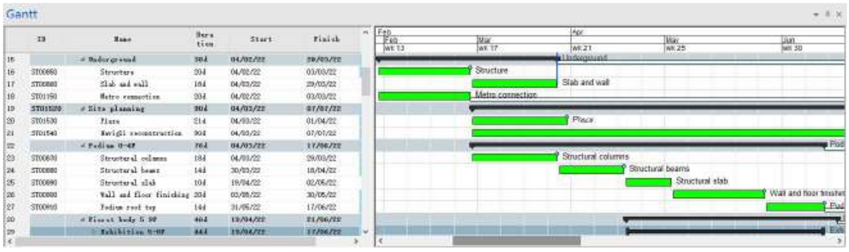
In the LOD500 stage, we use Synchro to evaluate the construction cycle of the project and seek a construction management plan that is faster and saves manpower, money, material resources and financial resources. According to the planning, the project will take 352 days to complete. Including 31 days for pre construction, 263 days for construction, and 42 days for project completion. In the construction phase, we build the structural parts from bottom to top, and when the structural part of each block is completed, we continue to build the structure upwards while constructing the curtain wall, indoor floor and partition wall of the completed block, in case to reduce the total construction time.

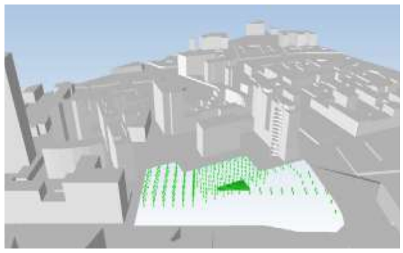
Project management - Synchro



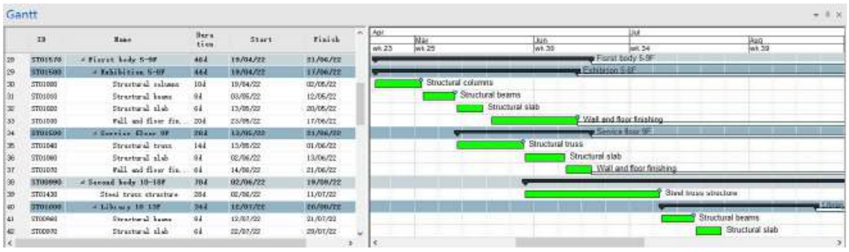


week1 - week12 pre construction, setting out

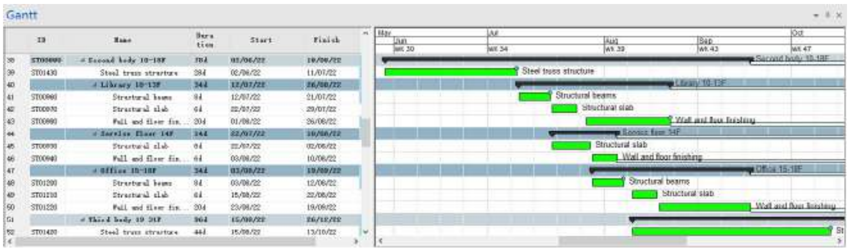


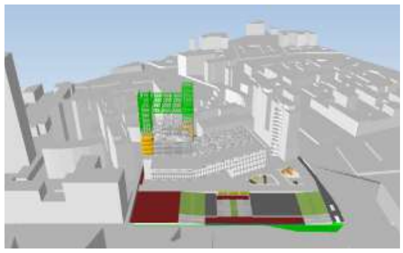


week13 - week31 site planning, parking, podium

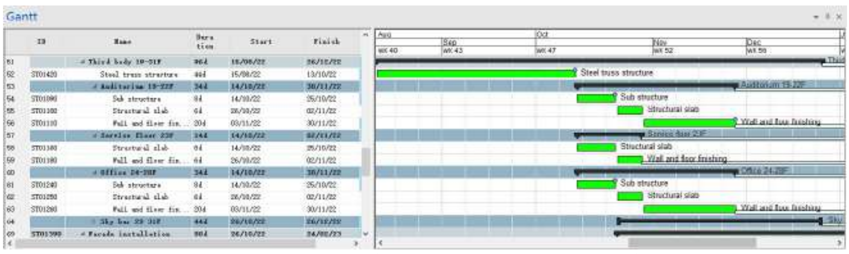


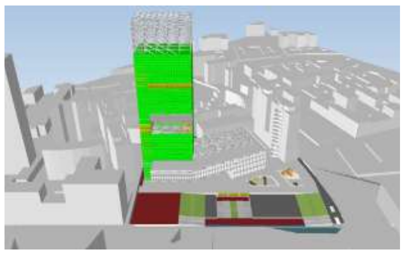
week26 - week32 tower first body construction



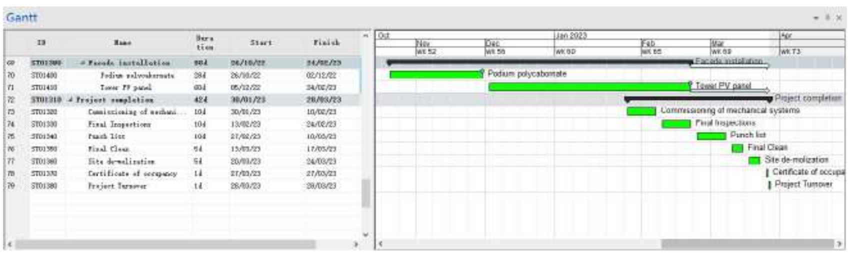


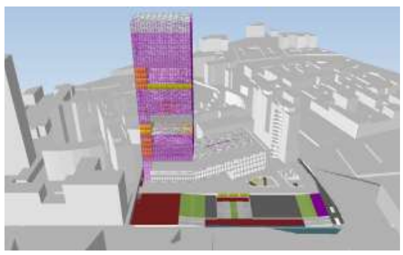
week30 - week45 tower second body construction





week40 - week58 tower third body construction





week49 - week71 facade installation, project completion

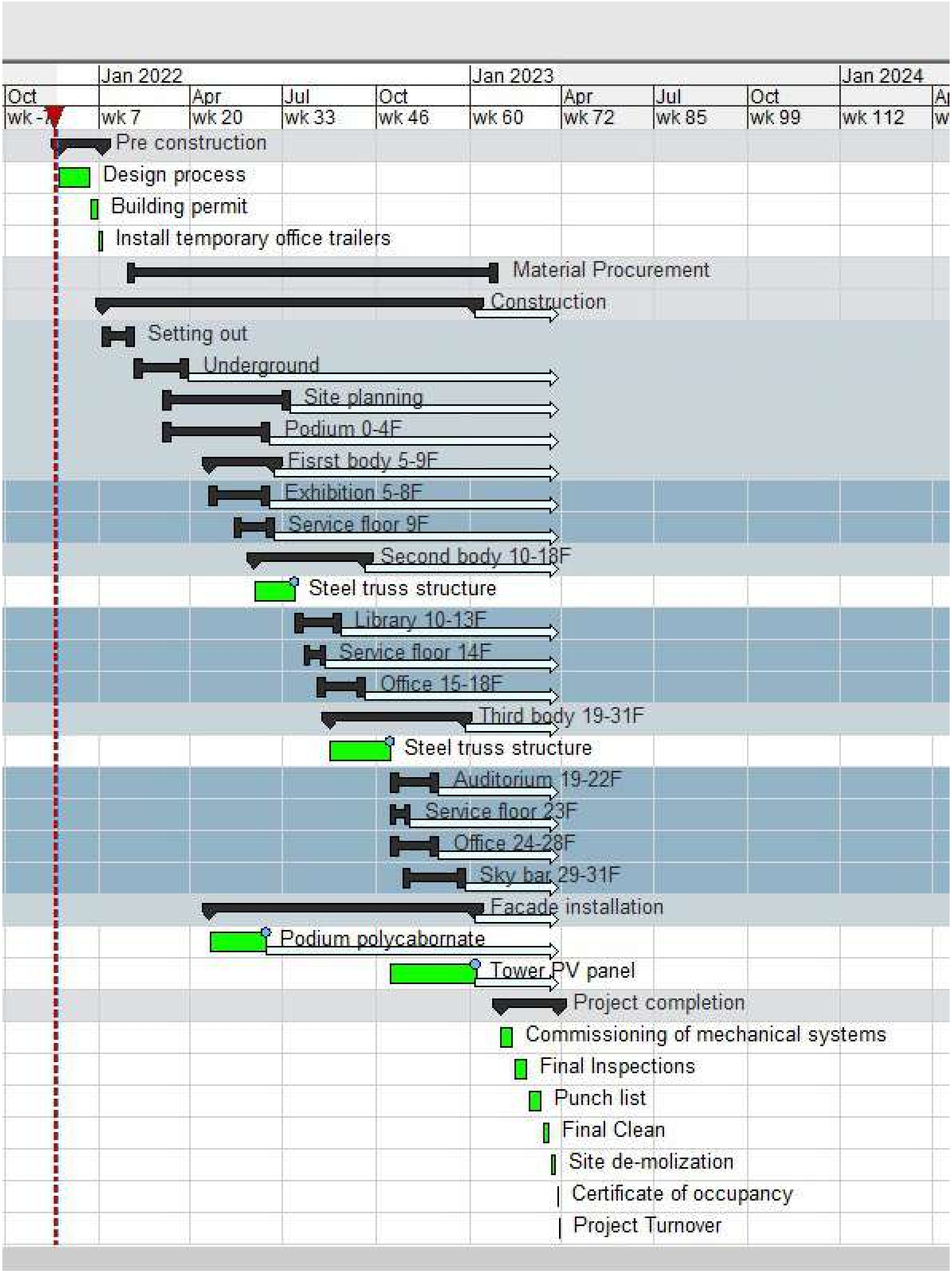
Project management - Synchro

Gantt

	ID	Name	Duration	Start	Finish
1	ST00740	**Pre construction**	31d	22/11/21	03/01/22
2	ST00780	Design process	22d	22/11/21	21/12/21
3	ST00790	Building permit	6d	22/12/21	29/12/21
4	ST00800	Install temporary office...	3d	30/12/21	03/01/22
5	ST00745	**Material Procurement**	261d	28/01/22	27/01/23
10	ST00750	**Construction**	263d	04/01/22	05/01/23
11	ST00770	**Setting out**	23d	04/01/22	03/02/22
15	ST01550	**Underground**	38d	04/02/22	29/03/22
19	ST01520	**Site planning**	90d	04/03/22	07/07/22
22	ST01560	**Podium 0-4F**	76d	04/03/22	17/06/22
28	ST01570	**Fisrst body 5-9F**	46d	19/04/22	21/06/22
29	ST01580	**Exhibition 5-8F**	44d	19/04/22	17/06/22
34	ST01590	**Service floor 9F**	28d	13/05/22	21/06/22
38	ST00990	**Second body 10-18F**	78d	02/06/22	19/09/22
39	ST01430	Steel truss structure	28d	02/06/22	11/07/22
40	ST01600	**Library 10-13F**	34d	12/07/22	26/08/22
44	ST01610	**Service floor 14F**	14d	22/07/22	10/08/22
47	ST01620	**Office 15-18F**	34d	03/08/22	19/09/22
51	ST01630	**Third body 19-31F**	96d	15/08/22	26/12/22
52	ST01420	Steel truss structure	44d	15/08/22	13/10/22
53	ST01640	**Auditorium 19-22F**	34d	14/10/22	30/11/22
57	ST01650	**Service floor 23F**	14d	14/10/22	02/11/22
60	ST01660	**Office 24-28F**	34d	14/10/22	30/11/22
64	ST01670	**Sky bar 29-31F**	44d	26/10/22	26/12/22
69	ST01390	**Facade installation**	188d	19/04/22	05/01/23
70	ST01400	Podium polycabornate	40d	19/04/22	13/06/22
71	ST01410	Tower PV panel	60d	14/10/22	05/01/23
72	ST01310	**Project completion**	42d	30/01/23	28/03/23
73	ST01320	Commissioning of mechani...	10d	30/01/23	10/02/23
74	ST01330	Final Inspections	10d	13/02/23	24/02/23
75	ST01340	Punch list	10d	27/02/23	10/03/23
76	ST01350	Final Clean	5d	13/03/23	17/03/23
77	ST01360	Site de-molization	5d	20/03/23	24/03/23
78	ST01370	Certificate of occupancy	1d	27/03/23	27/03/23
79	ST01380	Project Turnover	1d	28/03/23	28/03/23

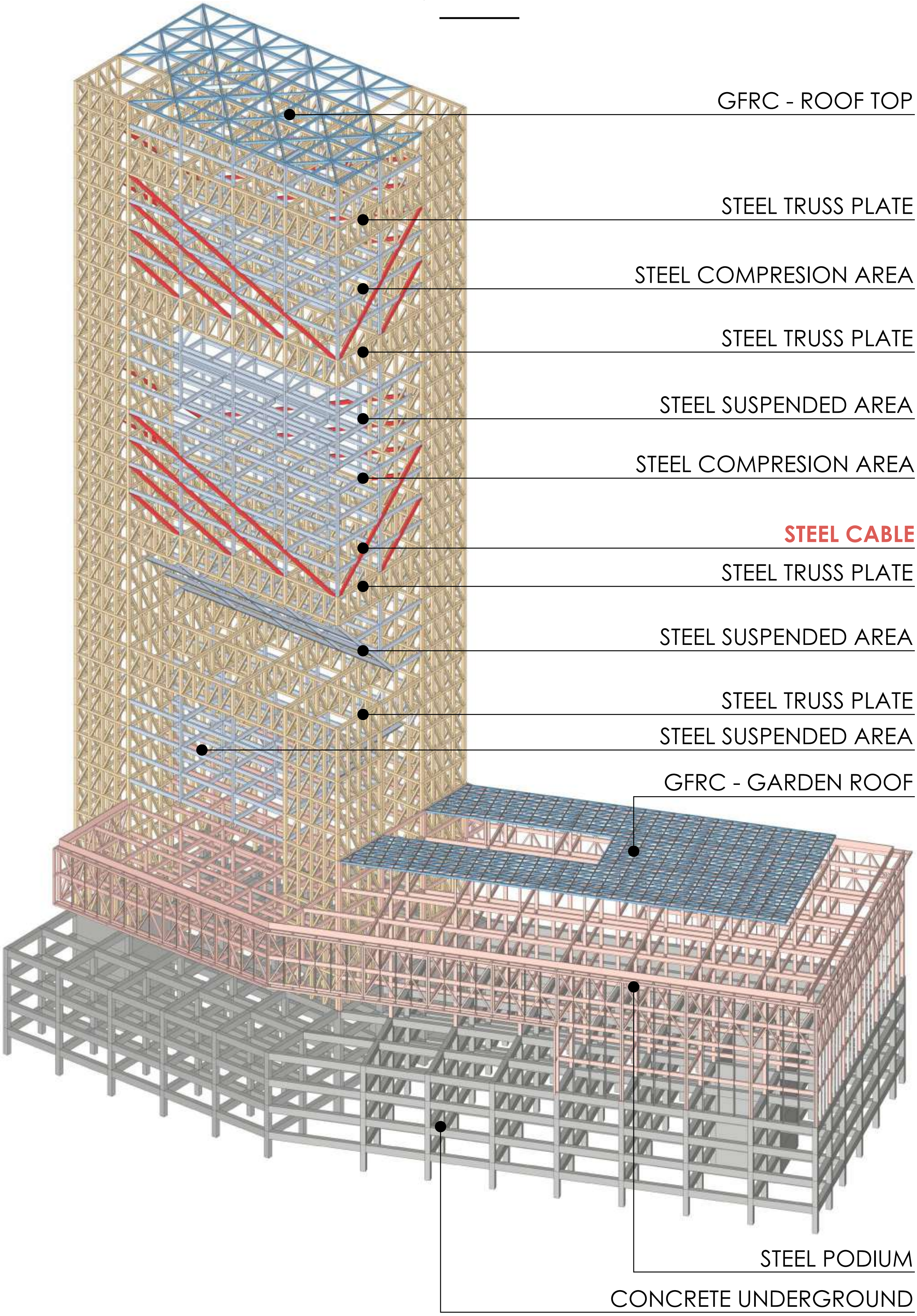
Gantt chart for construction of the whole process

Project management - Synchro



Gantt chart for construction of the whole process

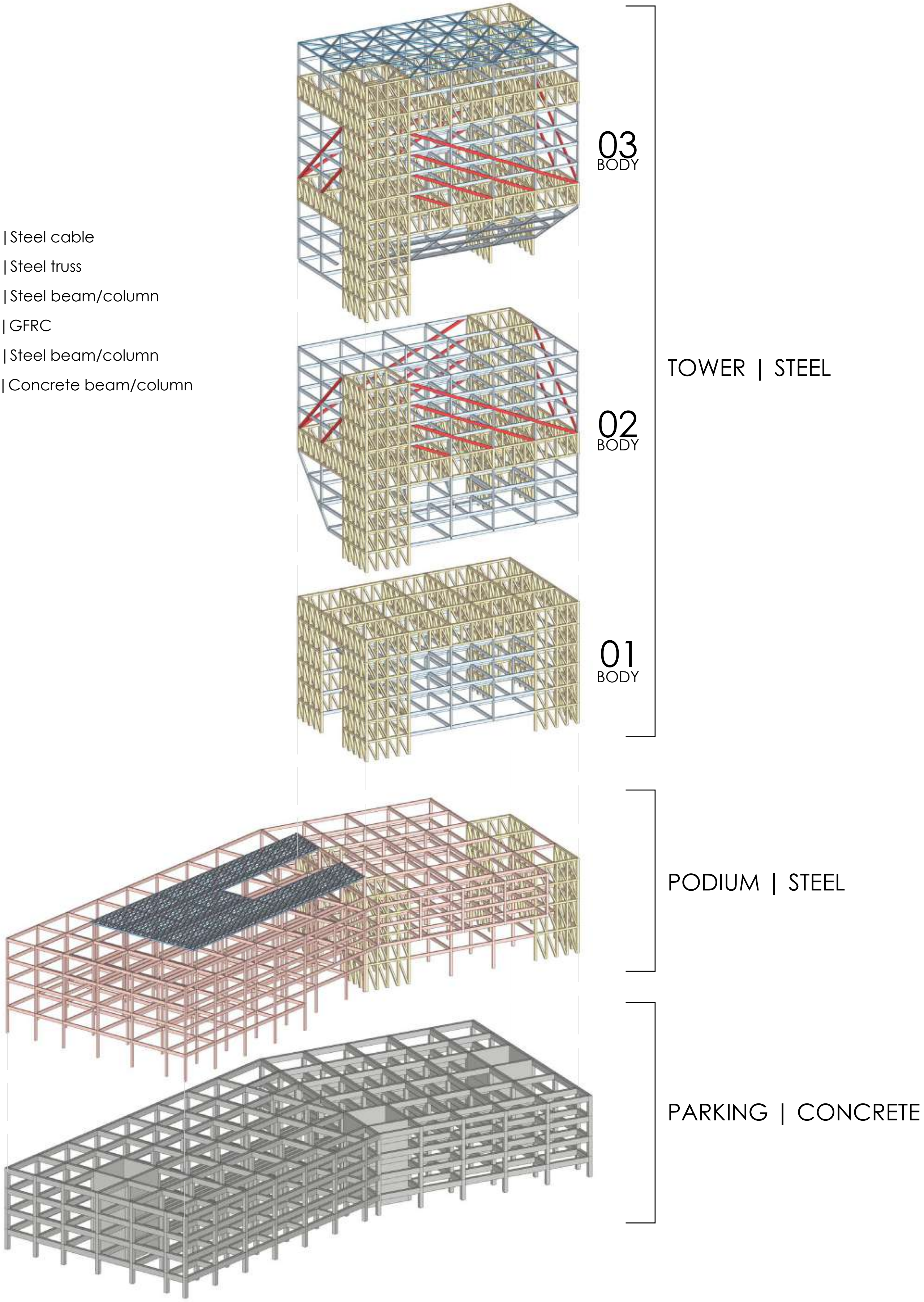
3D behavior


GFRC - ROOF TOP
STEEL TRUSS PLATE
STEEL COMPRESION AREA
STEEL TRUSS PLATE
STEEL SUSPENDED AREA
STEEL COMPRESION AREA
STEEL CABLE
STEEL TRUSS PLATE
STEEL SUSPENDED AREA
STEEL TRUSS PLATE
STEEL SUSPENDED AREA
GFRC - GARDEN ROOF
STEEL PODIUM
CONCRETE UNDERGROUND

▌04 STRUCTURAL DETAILS

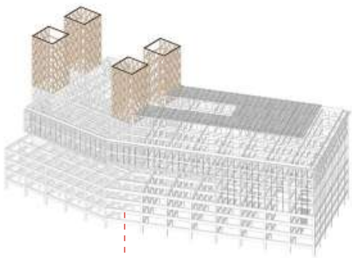
Explosion structural scheme

- Tower | Steel cable
- Tower | Steel truss
- Tower | Steel beam/column
- Roof | GFRC
- Podium | Steel beam/column
- Parking | Concrete beam/column

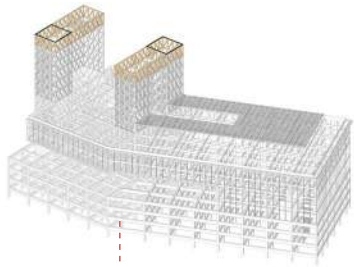


Construction scenquence - the first body

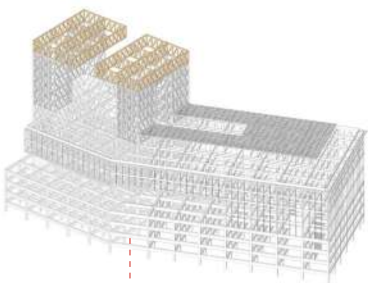
01
BODY



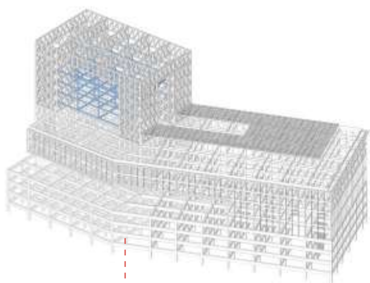
First body step 1



First body step 2



First body step 3



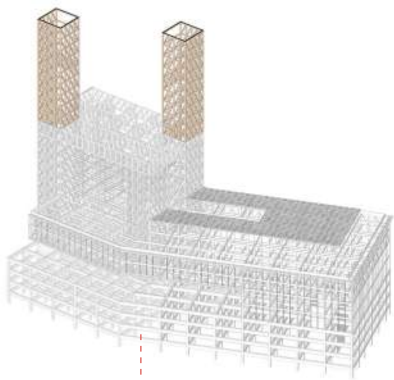
First body step 4

The bottom part of the project is the podium. Starting from the 4th floor, the first body of the tower grows upwards. This volume is supported by four truss-structure cores at the same time, and its function is an exhibition space.

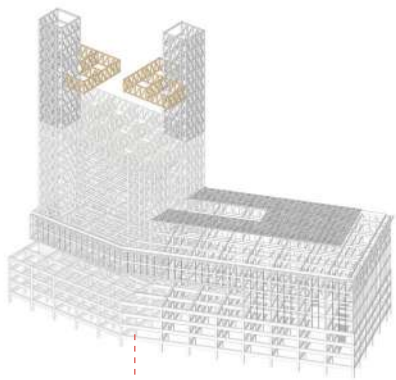
At the top of the first body is the first steel truss plate, which is built from the four cores to the middle. This truss plate is the foundation that supports the whole first body. The columns in this area are suspended from the plate, supporting the floor below it in the form of tension.

Construction scenquence - the second body

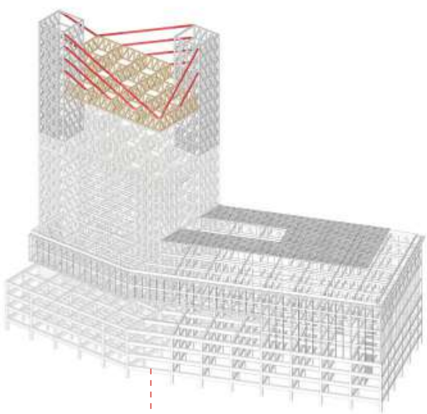
02
BODY



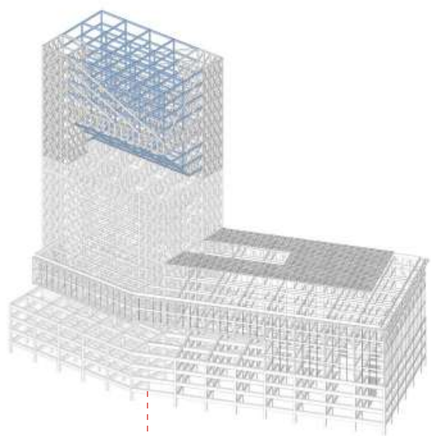
Second body step 1



Second body step 2



Second body step 3



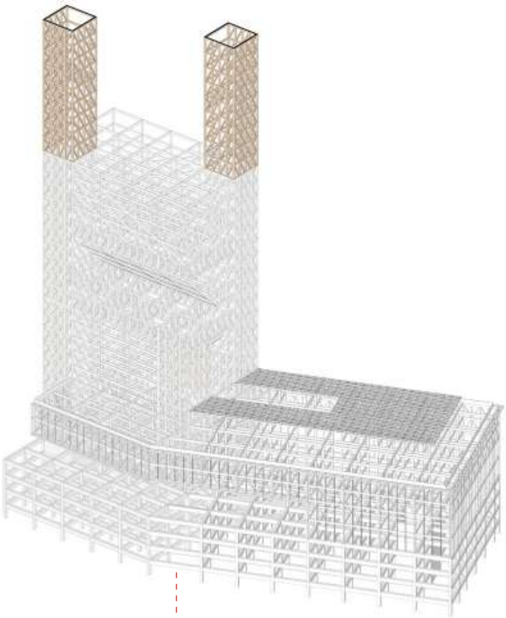
Second body step 4

For the second body, only the two truss cores in the north and south direction continue rising up. The truss plate of the volume is in the middle of the volume. For the volume below that, we have arranged a 3-story library inside, and its columns work with tension. Inside the truss plate is the service floor. Above the truss is the office space, the pillars work with compression, and the load is transmitted to the cores through the truss plate.

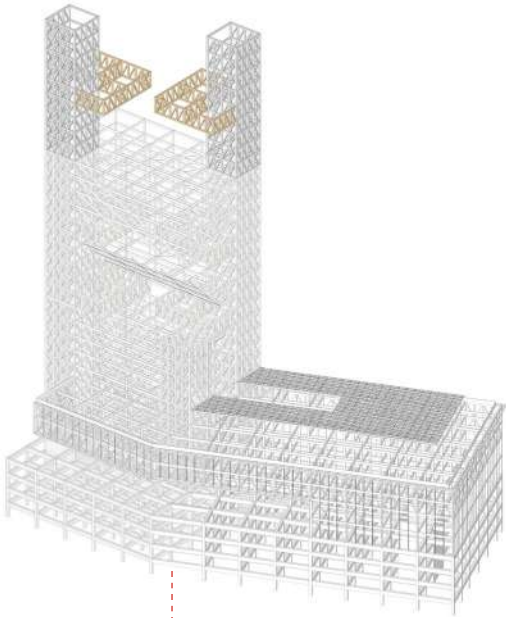
In step 3, we can see that we have placed 10 steel cables on the facade of the building in order to correct the torsion of the truss plate, keeping the truss plate horizontal.

Construction scenquence - the third body

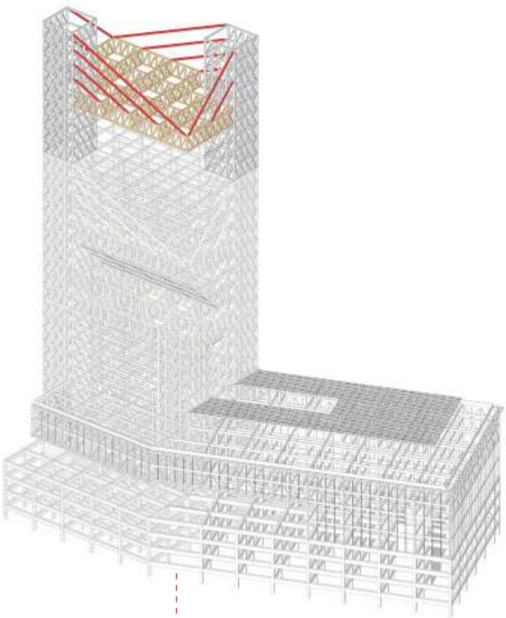
03
BODY



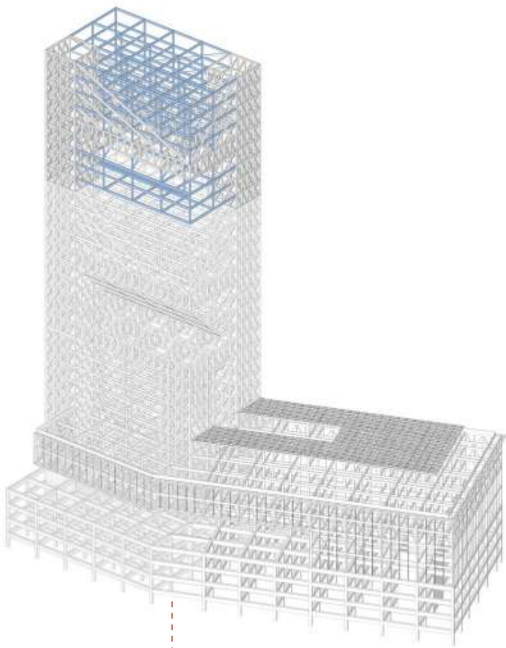
Third body step 1



Third body step 2



Third body step 3

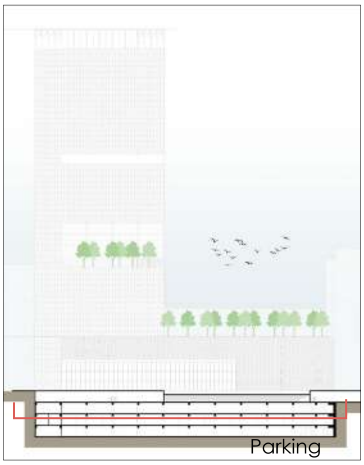


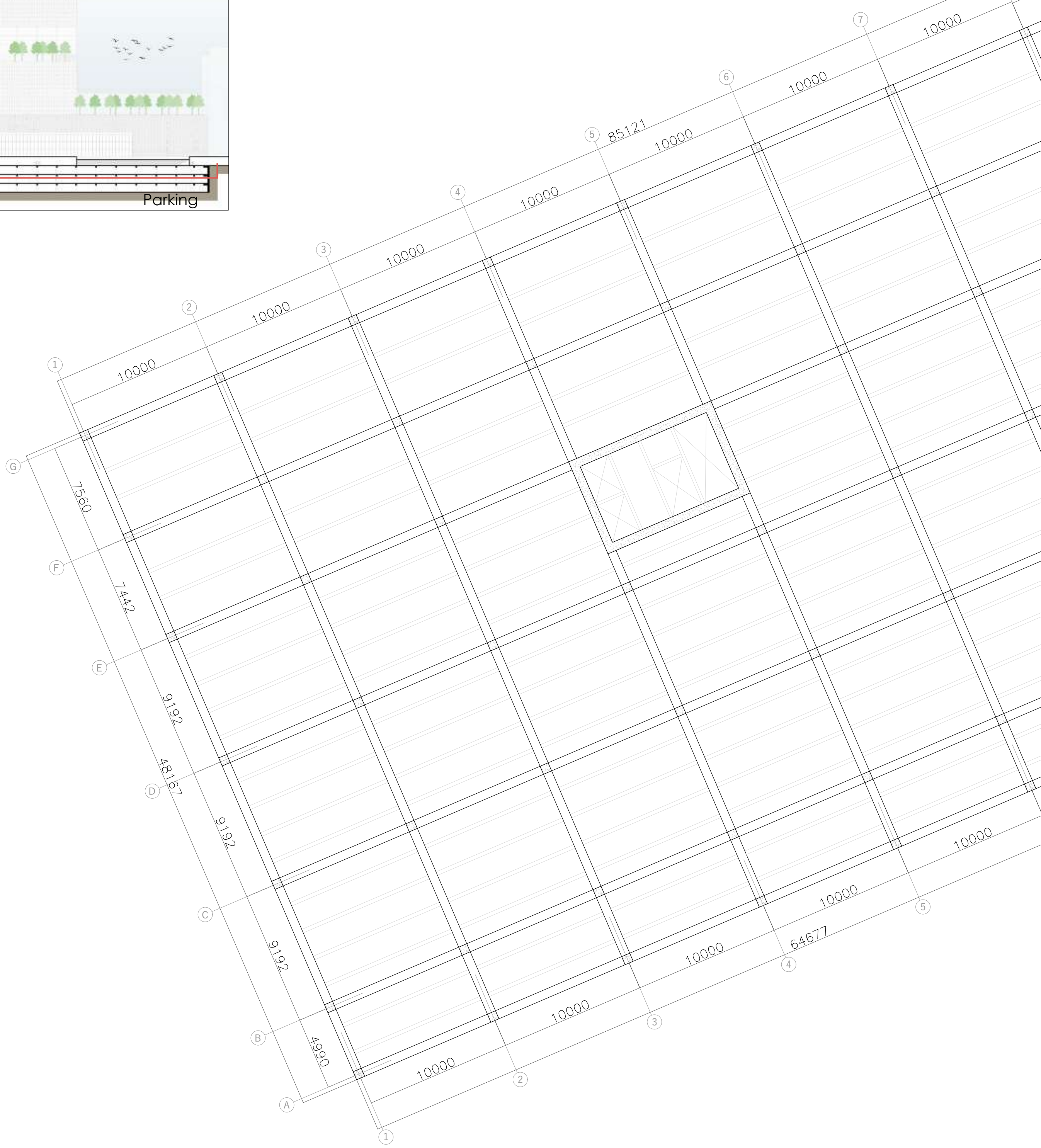
Third body step 4

The third body works similar as the second one. The hanging part of this part is used as a lecture hall.

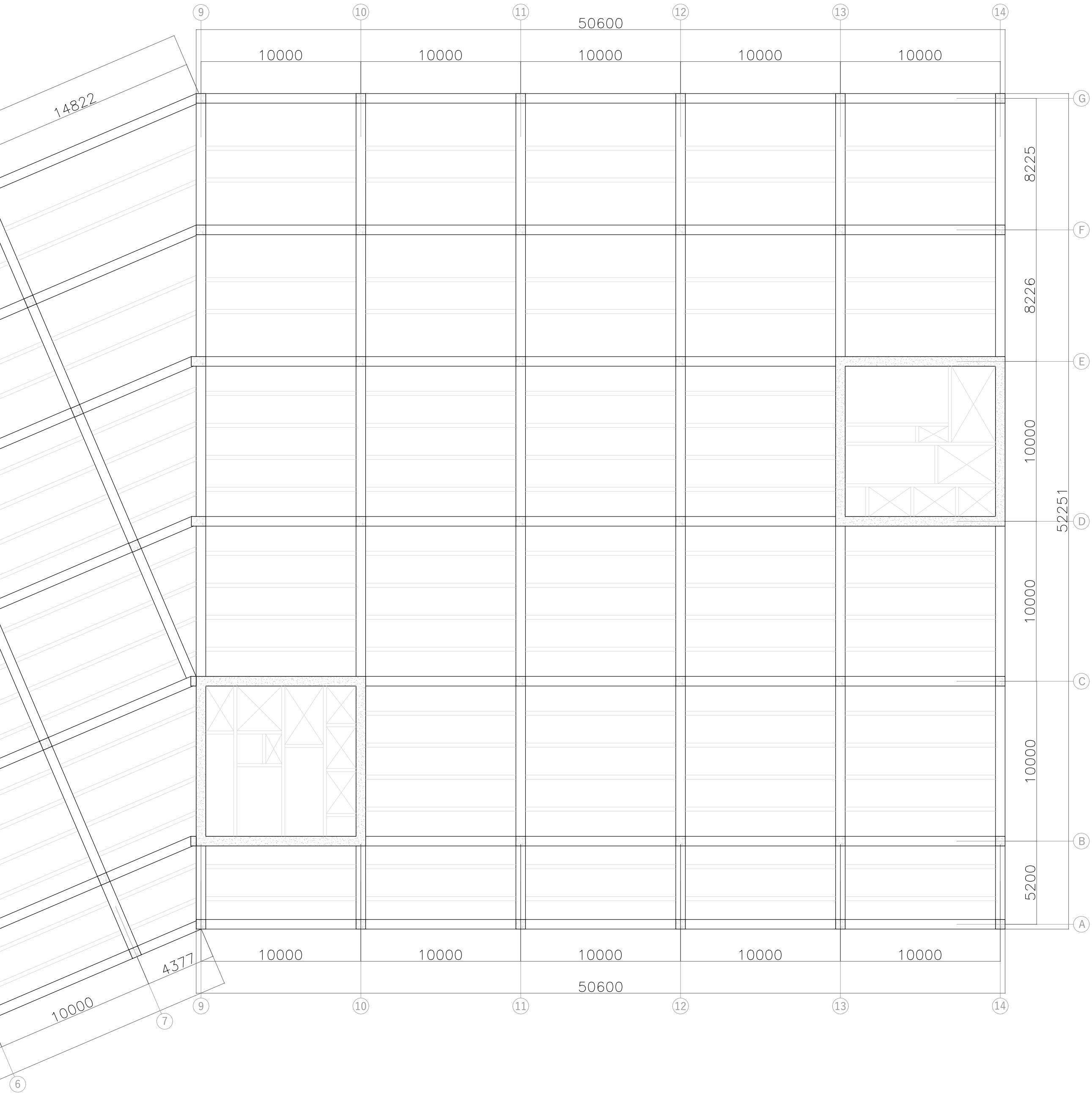
In addition to the truss plate in the middle of the third body, a truss plate is also arranged on the top, which is used to connect the two core tubes and also serves as a support structure for the sky bar at the top.

▌04 STRUCTURAL DETAILS





UNDERGROUND STRU



Concrete column
600*600mm

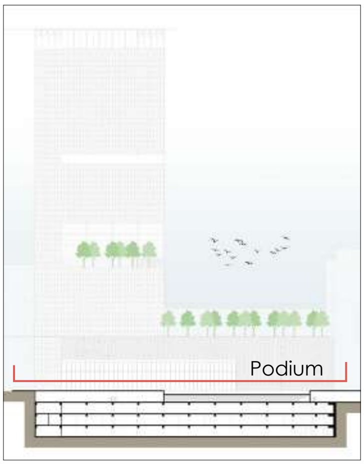
Steel beam
HE260B

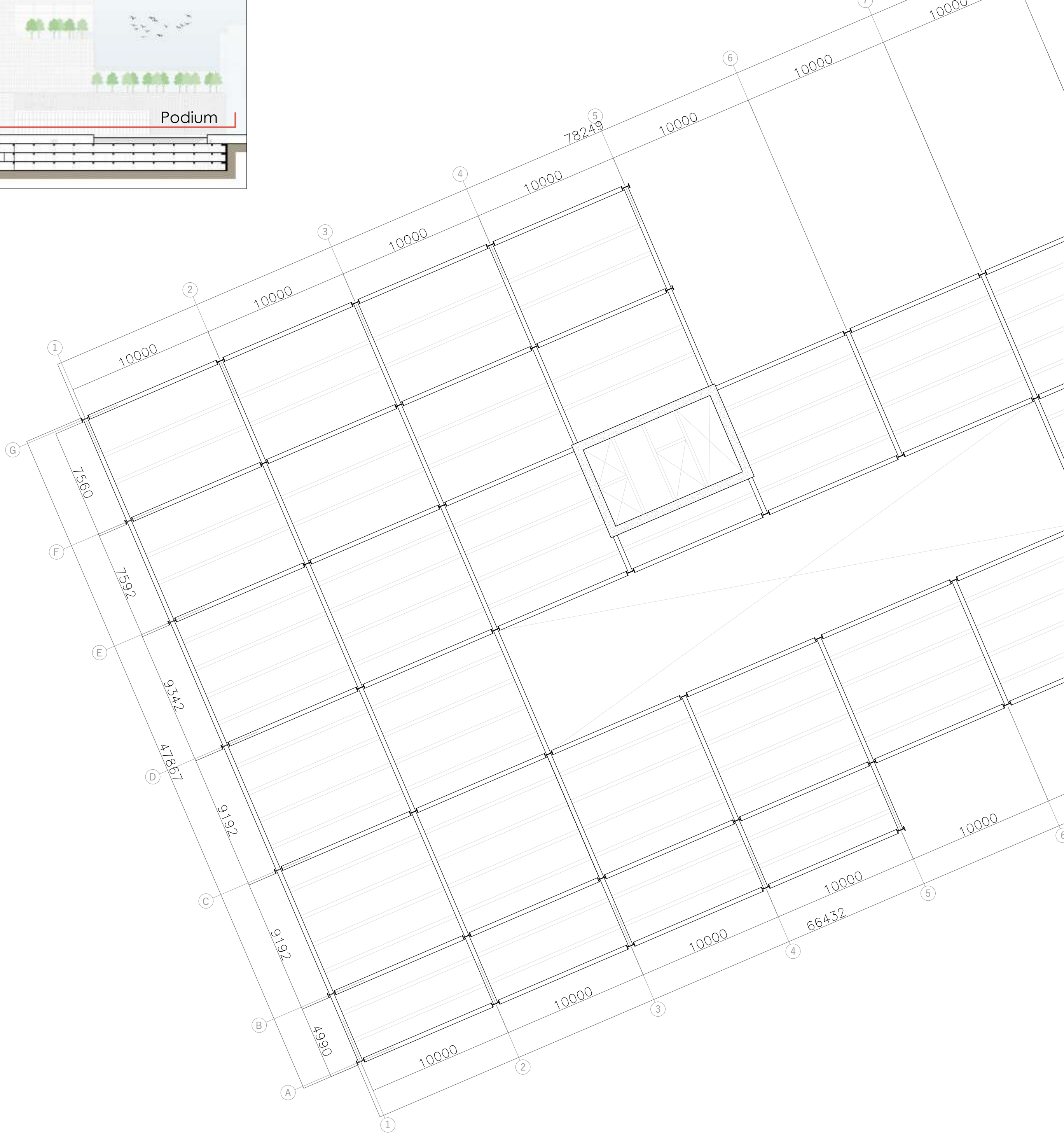
Concrete beam
1200*600mm

Concrete shear wall
600mm thickness

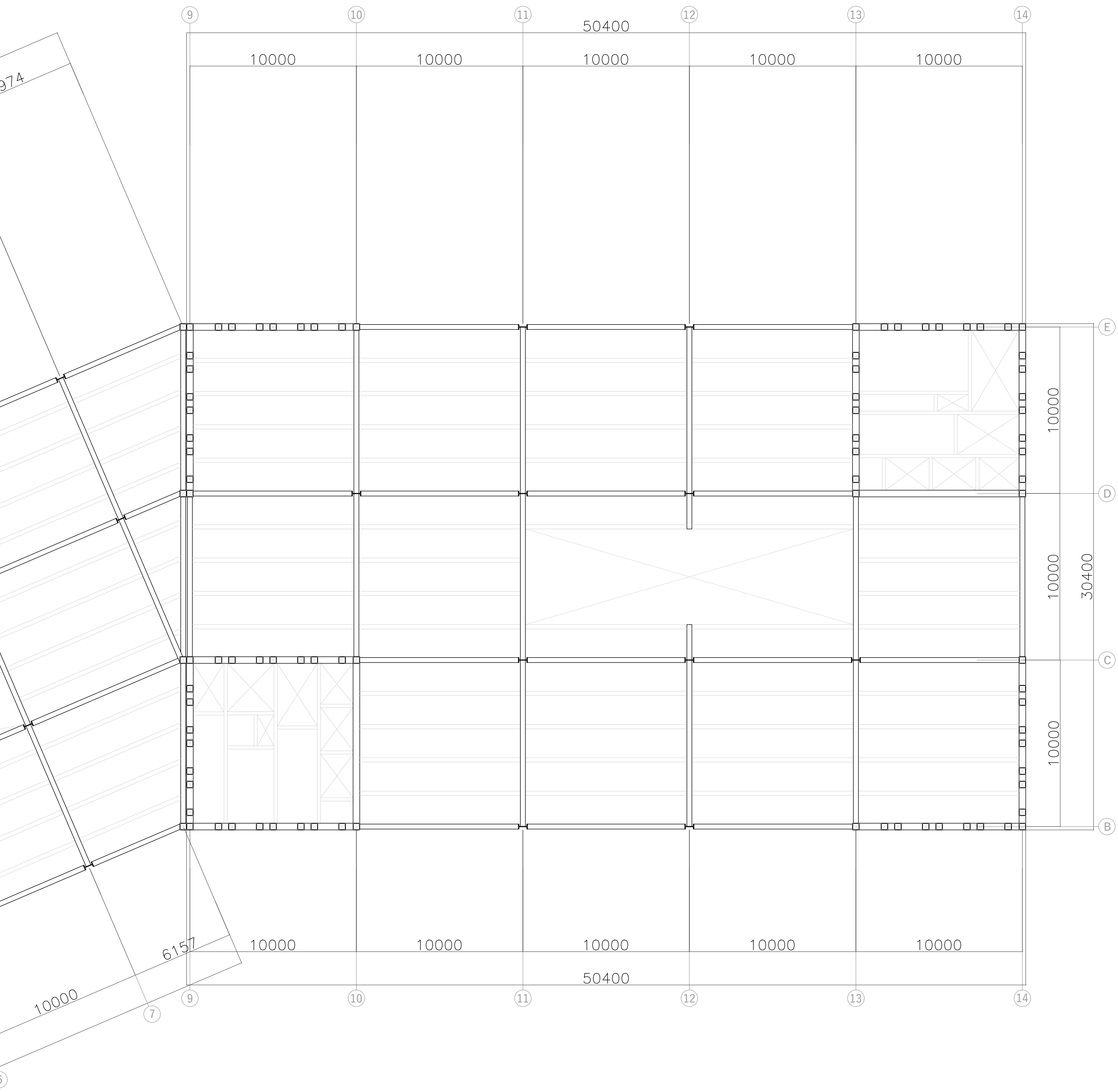
CTURAL LAYOUT 1:400

▌04 STRUCTURAL DETAILS





PODIUM STRUCTU



Steel column
HE550B

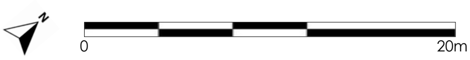
Concrete shear wall
600mm thickness

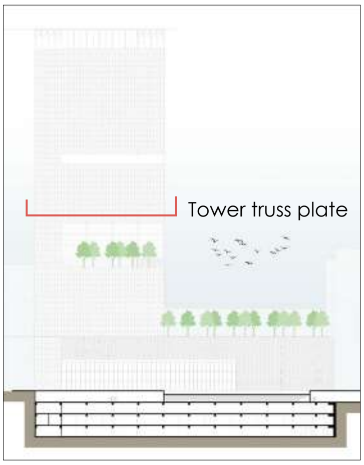
Steel box truss
400*400mm

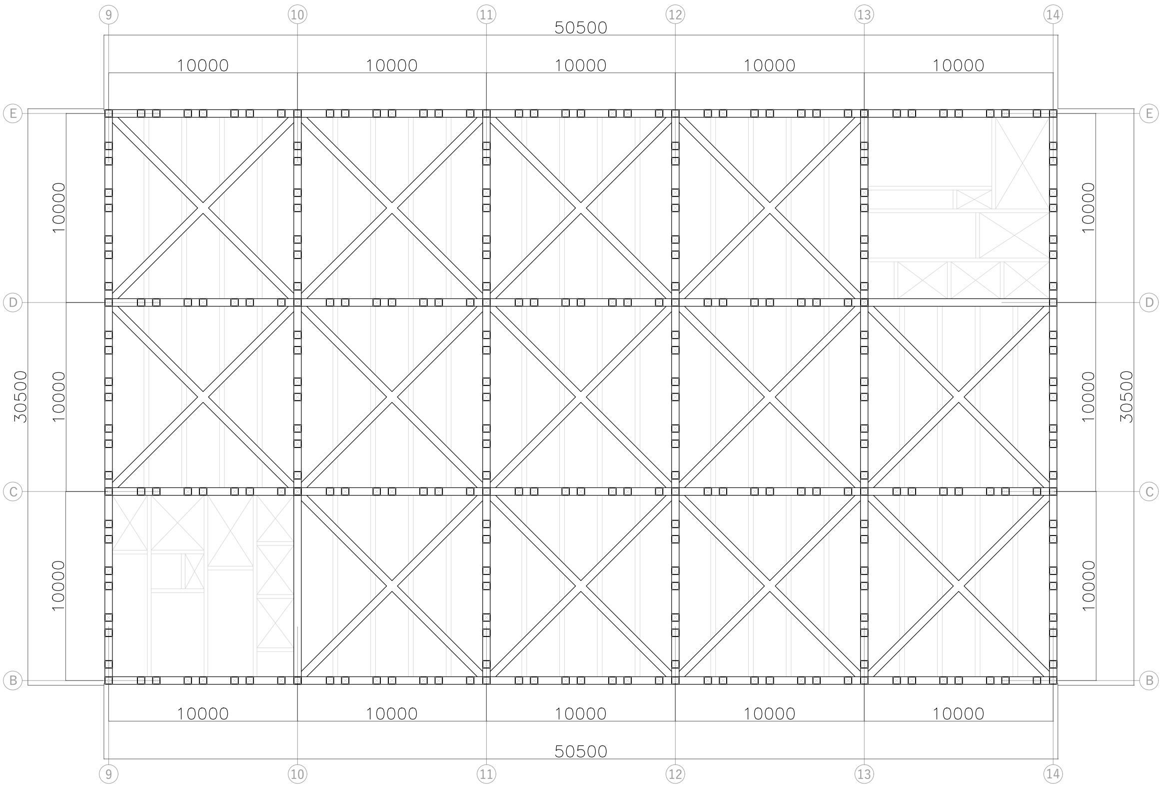
Steel beam
HE650B

Steel beam
HE260B

RAL LAYOUT 1:400







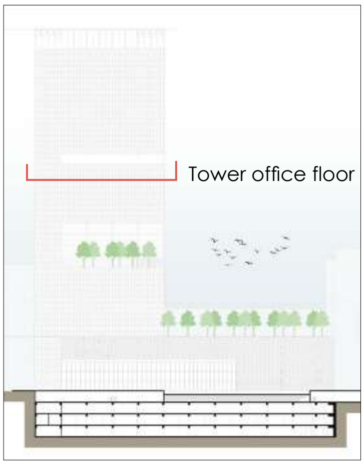
Steel beam HE260B

Steel box truss 400*400mm

Steel beam HE650B

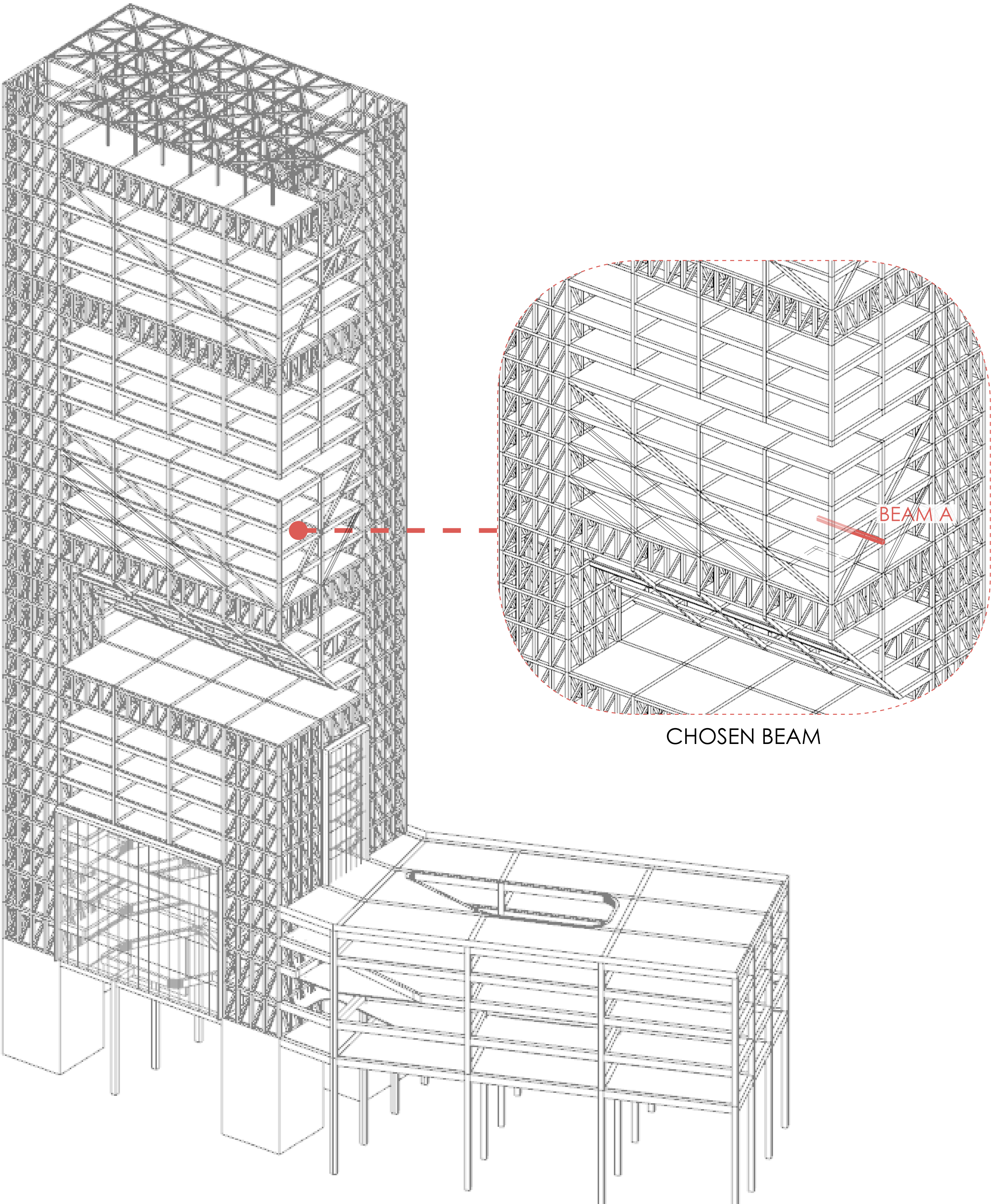
TOWER TRUSS PLATE STRUCTURAL LAYOUT 1:400

0 20m



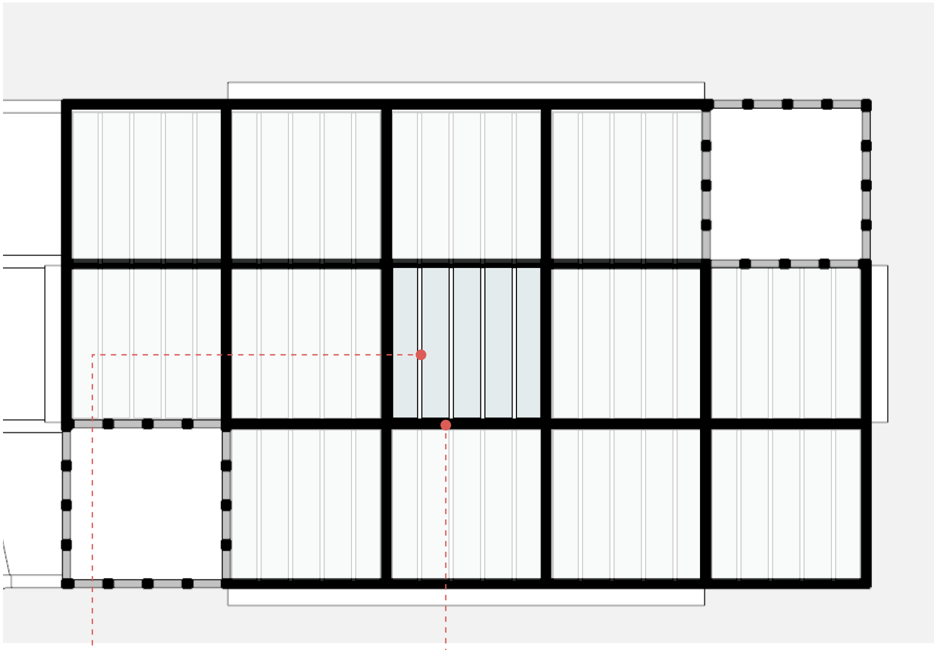
TOWER OFFICE FLOOR STRUCTURAL LAYOUT 1:400

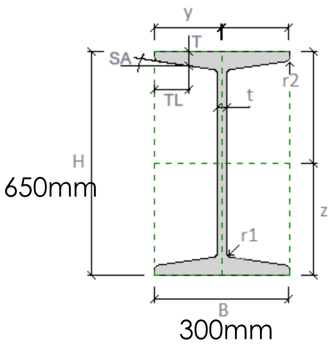
Beam location



ELEMENTS LOCATION

Beam load



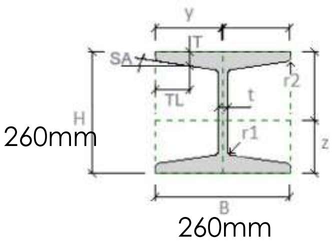


PRIMARY BEAM

B	30	cm	0.3	m
H	65	cm	0.65	m
Linear weight	225	kg/m	2.25	kN/m
Linear load G1			**2.3**	**kN/m**

BEAM TYPE: HE 650 B

BEAM LINEAR LOAD: G1=2.3kN/m



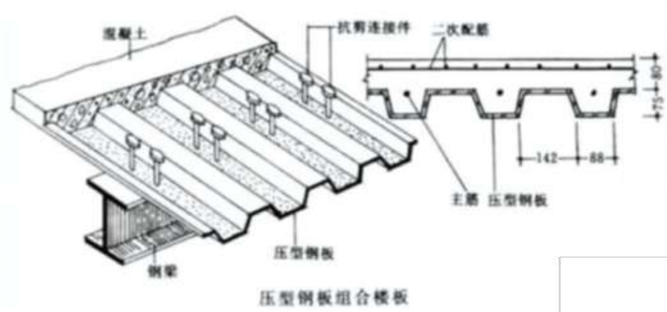
SECONDARY BEAM

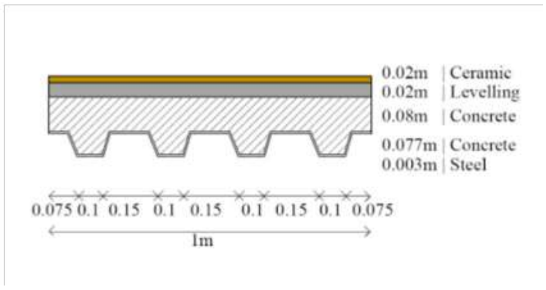
B	26	cm	0.26	m
H	26	cm	0.26	m
Linear weight	93	kg/m	0.93	kN/m
Linear load G1			**0.9**	**kN/m**

BEAM TYPE: HE 260 B

BEAM LINEAR LOAD: g1=0.9kN/m

Slab weight





Layer	Length		Width		Height		Volumetric weight		Weight	
Ceramic	1.0	m	1.0	m	0.02	m	20	kN/m3	0.4	kN/m2
Levelling	1.0	m	1.0	m	0.02	m	20	kN/m3	0.4	kN/m2
Concrete layer	1.0	m	1.0	m	0.08	m	25	kN/m3	2.0	kN/m2
Concrete ribs	1.0	m	0.4	m	0.077	m	25	kN/m3	0.8	kN/m2
Steel	1.0	m	1.0	m	0.003	m	78.5	kN/m3	0.2	kN/m2
Area load G2					**0.2**	**m**			**3.8**	**kN/m2**

SLAB COMBINATION: Pressed steel plate

FLOOR SELF WEIGHT: G2=3.8kN/m^2

Live load

STANDARD: EN1991-1-1

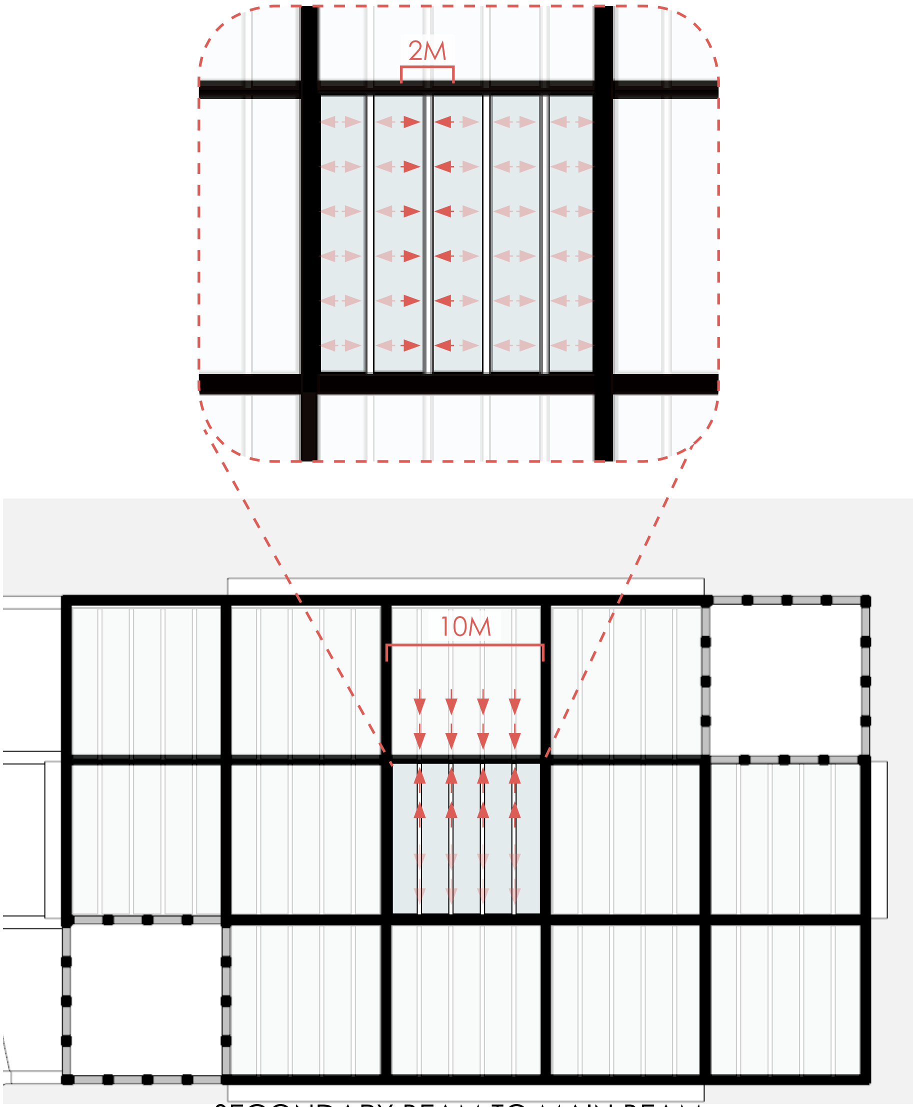
FLOOR TYPE: Office use

LIVE LOAD: Q=3.0kN/m^2

Category	Specific Use	q_k		Q_k		q_k	
A	Areas for domestiv and residential activities	1.5 to 2.0	kN/m2	2.0 to 3.0	kN	0.2-1.0 (0.5)	kN/m
B	Office areas	2.0 to 3.0	kN/m2	1.5 to 4.5	kN		kN/m
C	Areas where people may congregate	…	kN/m2	…	kN	…	kN/m

Linear load

DECK TO SECONDARY BEAM



SECONDARY BEAM TO MAIN BEAM

Influence area width I	2.0	m
Linear load G1	**0.9**	**kN/m**
Area load G2	3.8	kN/m2
Linear load G2	**7.6**	**kN/m**
Area load Q1	3.0	kN/m2
Linear load Q1	**6.0**	**kN/m**

SECONDARY BEAM LINEAR LOAD

BEAM LOAD: g1=0.9kN/m
FLOOR LOAD: g2=7.6kN/m
LIVE LOAD: q=6.0kN/m

Influence area width I	10.0	m
Linear load G1	**2.3**	**kN/m**
Area load G2	3.8	kN/m2
Linear load G2	**41.8**	**kN/m**
Area load Q1	3.0	kN/m2
Linear load Q1	**30.0**	**kN/m**

PRIMARY BEAM LINEAR LOAD

BEAM LOAD: G1=2.3kN/m
FLOOR LOAD: G2=41.8kN/m
LIVE LOAD: Q=30.0kN/m

Secondary beam check - ULS

ULS-Ultimate limit state

	Permanent actions (γ_G) (see note)	Variable actions (γ_Q) One with its characteristic value	Variable actions (γ_Q) Others with their combination value	Prestressing (γ_p)
Favourable effect	1,0	0	0	0,9
Unfavourable effect	1,35	1,5	1,35	1,2

Basic load combination: (ULS)

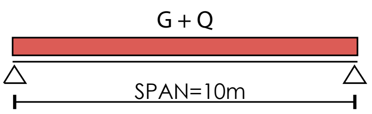
$$1.35G_{1,k} + 1.5G_{2,k} + 1.5\,Q_k$$

Linear load G1	**0.9**	**kN/m**	**Dead load: Beam self weight**
Linear load G2	**7.6**	**kN/m**	**Dead load: Floor Self weight**
Linear load Q1	**6.0**	**kN/m**	**Live load: Office**
Coefficient for G1	**1.35**	-	
Coefficient for G2	**1.35**	-	
Coefficient for Q1	**1.50**	-	
TOTAL BEAM LOAD Quls	**20.5**	**kN/m**	

SECONDARY BEAM LOAD ULS = 20.5kN/m

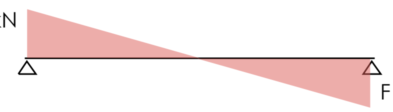
SCONDARY BEAM LOAD CHECK

ULS-Ultimate limit state



1. EXTERNAL BENDING MOMENT
   BEAM LENGHT: L=10m
   LOAD COMBINATION ULS = 20.5kN/m
   $M_{ed} = Q_{uls} L^2/8 = 256.6kNm$

2. SHEAR FORCE
   $F = Q_{uls} L/2 = 102.7kN$



3. CHOOSE STEEL CLASS: S235

4. STEEL CLASS *fyd* CALCULATION
   γs = 1.15
   fyd = 204MPa

5. W_{pl} CALCULATION
   $W_{pl} = M_{ed}/fdy = 1256 \cdot 10^3\,mm^3$

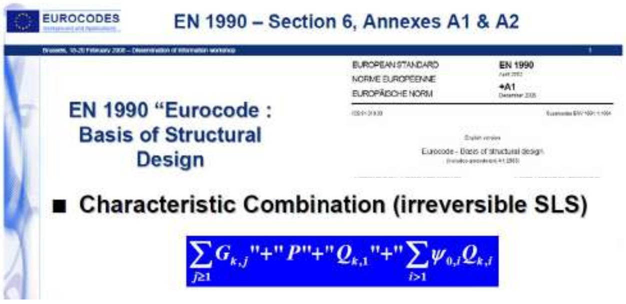
6. CROSS SECTION OF CHOSEN BEAM
   CHOSEN BEAM TYPE: HE260 B
   CHOSEN BEAM *fdy* = $1383 \cdot 10^3\,mm^3$

	G kg/m	I_y mm⁴ x 10⁴	$W_{el.y}$ mm³ x 10³	$W_{pl.y}$ mm³ x 10³	i_y mm x 10	A_{vz} mm² x 10²
HE 260 AA	54,10	7 981	654,10	714,50	10,76	24,75
HE 260 A	68,20	10 450	836,40	919,80	10,97	28,76
HE 260 B	93	14 920	1 148	1 283	11,22	37,59
HE 260 M	172	31 310	2 159	2 524	11,94	66,89

7. COMPARASION
   $W_{pl} = 1256 \cdot 10^3\,mm^3 < W_{max} = 1383 \cdot 10^3\,mm^3$
   VERIFIED

Secondary beam check - SLS

SLS-Serviceability limit state



Characteristic load combination: (SLS)

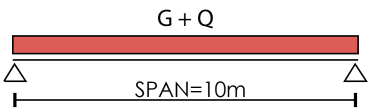
$$G_{1,k} + G_{2,k} + Q_k$$

Linear load G1	0.9	kN/m	Dead load: Beam self weight
Linear load G2	7.6	kN/m	Dead load: Floor Self weight
Linear load Q1	6.0	kN/m	Live load: Office
Coefficient for G1	1.0	-	
Coefficient for G2	1.0	-	
Coefficient for Q1	1.0	-	
TOTAL BEAM LOAD Quls	14.5	kN/m	

SECONDARY BEAM LOAD SLS = 14.5kN/m

SCONDARY BEAM LOAD CHECK

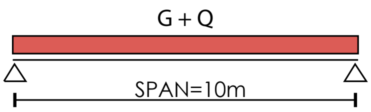
SLS-Serviceability limit state - Total load



1. ELASTIC MODULUS OF STEEL
   $E = 21 \cdot 10^4$MPa
2. DEFORMATION CALCULATION
   BEAM LENGHT: L=10m
   TOTAL LOAD SLS = 14.5kN/m
   $I = 123.8 \cdot 10^4 mm^4$
   Deformation: $\Delta_{TOT} = 5 \cdot Q_{sls} L^4/(384 \cdot E \cdot I)$
   Δ_{TOT} = 7mm
3. MAXIMUM DEFORMATION
   $\Delta_{TOT}max$ = L/250 = 40mm
4. DEFORMATION CHECK
   Δ_{TOT} = 7mm < $\Delta_{TOT}max$ = 40mm
   VERIFIED

Δ_{TOT} = 7mm

SLS-Serviceability limit state - Live load



1. ELASTIC MODULUS OF STEEL
   $E = 21 \cdot 10^4$MPa
2. DEFORMATION CALCULATION
   BEAM LENGHT: L=10m
   LIVE LOAD SLS = 6kN/m
   $I = 123.8 \cdot 10^4 mm^4$
   Deformation: $\Delta_{LIVE} = 5 \cdot Q_{LIVE} L^4/(384 \cdot E \cdot I)$
   Δ_{LIVE} = 3mm
3. MAXIMUM DEFORMATION
   $\Delta_{LIVE}max$ = L/300 = 33mm
4. DEFORMATION CHECK
   Δ_{LIVE} = 3mm < $\Delta_{LIVE}max$ = 33mm
   VERIFIED

Δ_{LIVE} = 3mm

Primary beam check - ULS

ULS-Ultimate limit state

	Permanent actions (γ_G) (see note)	Variable actions (γ_Q)		Prestressing (γ_p)
		One with its characteristic value	Others with their combination value	
Favourable effect	1,0	0	0	0,9
Unfavourable effect	1,35	1,5	1,35	1,2

Basic load combination: (ULS)

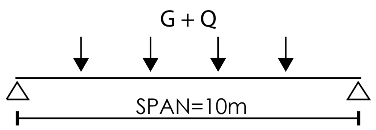
$$1.35G_{1,k} + 1.5G_{2,k} + 1.5\,Q_k$$

Linear load G1	2.3	kN/m	Dead load: Beam self weight
Linear load G2	41.8	kN/m	Dead load: Floor Self weight
Linear load Q1	30.0	kN/m	Live load: Office
Coefficient for G1	1.35	-	
Coefficient for G2	1.35	-	
Coefficient for Q1	1.50	-	
TOTAL BEAM LOAD Quls	104.4	kN/m	

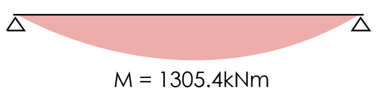
PRIMARY BEAM LOAD ULS = 104.4kN/m

PRIMARY BEAM LOAD CHECK

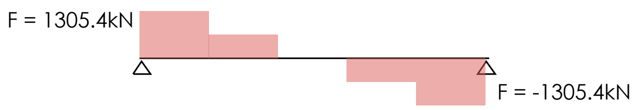
ULS-Ultimate limit state



1. EXTERNAL BENDING MOMENT
   BEAM LENGHT: L=10m
   LOAD COMBINATION ULS = 104.4kN/m
   $M_{ed} = Q_{uls}\,L^2/8 = 1305.4kNm$



2. SHEAR FORCE
   $F = Q_{uls}\,L/2 = 522.2kN$



3. CHOOSE STEEL CLASS: S235

4. STEEL CLASS *fyd* CALCULATION
   γs = 1.15
   fyd = 204MPa

5. W_{pl} CALCULATION
   $W_{pl} = M_{ed}/fdy = 6388 \cdot 10^3\ mm^3$

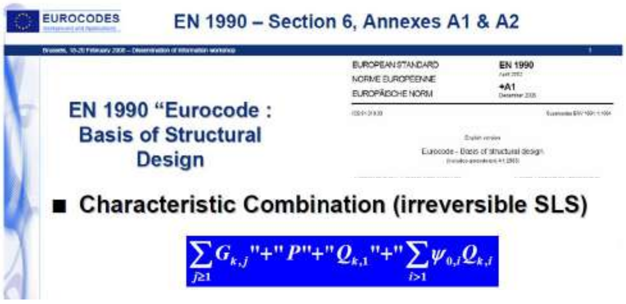
6. CROSS SECTION OF CHOSEN BEAM
   CHOSEN BEAM TYPE: HE650 B
   CHOSEN BEAM *fdy* = $7320 \cdot 10^3\ mm^3$

	G kg/m	I_y mm⁴	$W_{el.y}$ mm³	$W_{pl.y}$ © mm³	i_y mm	A_{vz} mm²
		x 10⁴	x 10³	x 10³	x 10	x 10²
HE 600 AA	129	91 900	3 218	3 623	23,66	81,29
HE 600 A	178	141 200	4 787	5 350	24,97	93,21
HE 600 B	212	171 000	5 701	6 425	25,17	110,80
HE 600 M	285	237 400	7 660	8 772	25,55	149,70

7. COMPARASION
   $W_{pl} = 6388 \cdot 10^3\ mm^3 < W_{max} = 7320 \cdot 10^3\ mm^3$
   VERIFIED

Primary beam check - SLS

SLS-Serviceability limit state



Characteristic load combination: (SLS)

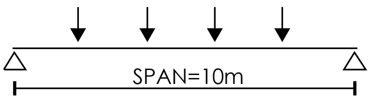
$$G_{1,k} + G_{2,k} + Q_k$$

Linear load G1	2.3	kN/m	Dead load: Beam self weight
Linear load G2	41.8	kN/m	Dead load: Floor Self weight
Linear load Q1	30.0	kN/m	Live load: Office
Coefficient for G1	1.0	-	
Coefficient for G2	1.0	-	
Coefficient for Q1	1.0	-	
TOTAL BEAM LOAD Quls	74.0	kN/m	

PRIMARY BEAM LOAD SLS = 74.0kN/m

PRIMARY BEAM LOAD CHECK

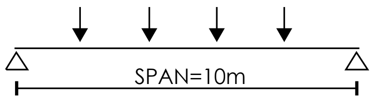
SLS-Serviceability limit state - Total load



1. ELASTIC MODULUS OF STEEL
   $E = 21 \cdot 10^4$MPa
2. DEFORMATION CALCULATION
   BEAM LENGHT: L=10m
   LOAD COMBINATION SLS = 74.0kN/m
   $I = 739.2 \cdot 10^4 mm^4$
   Deformation: $\Delta_{TOT} = 5 \cdot Q_{sls} L^4/(384 \cdot E \cdot I)$
   $\Delta_{TOT} = 6mm$
3. MAXIMUM DEFORMATION
   $\Delta_{TOT}max = L/250 = 40mm$
4. DEFORMATION CHECK
   $\Delta_{TOT} = 6mm \quad < \quad \Delta_{TOT}max = 40mm$
   VERIFIED

$\Delta_{TOT} = 6mm$

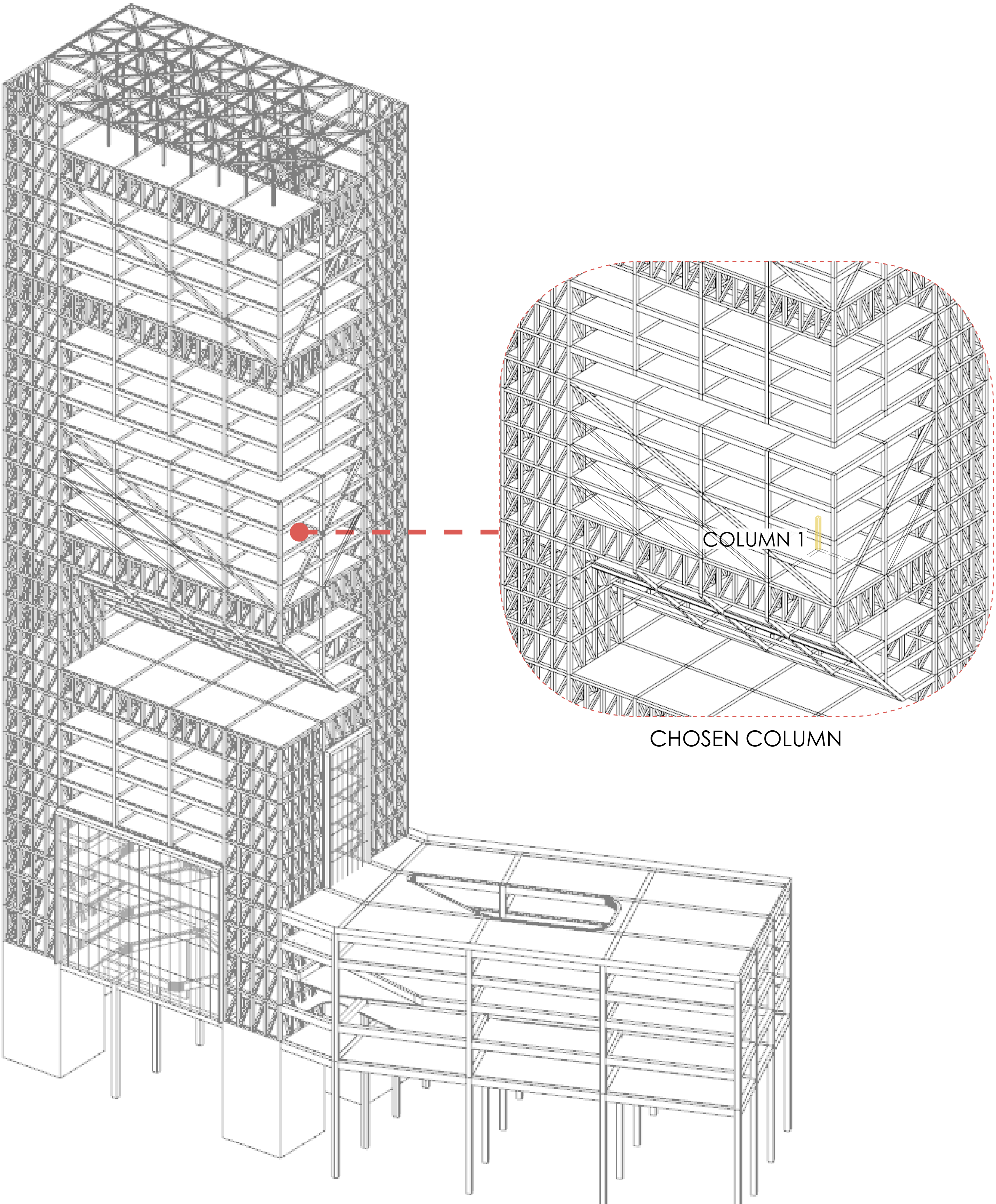
SLS-Serviceability limit state - Live load



1. ELASTIC MODULUS OF STEEL
   $E = 21 \cdot 10^4$MPa
2. DEFORMATION CALCULATION
   BEAM LENGHT: L=10m
   LIVE LOAD SLS = 30kN/m
   $I = 739.2 \cdot 10^4 mm^4$
   Deformation: $\Delta_{LIVE} = 5 \cdot Q_{LIVE} L^4/(384 \cdot E \cdot I)$
   $\Delta_{LIVE} = 2mm$
3. MAXIMUM DEFORMATION
   $\Delta_{LIVE}max = L/300 = 33mm$
4. DEFORMATION CHECK
   $\Delta_{LIVE} = 2mm \quad < \quad \Delta_{LIVE}max = 33mm$
   VERIFIED

$\Delta_{LIVE} = 2mm$

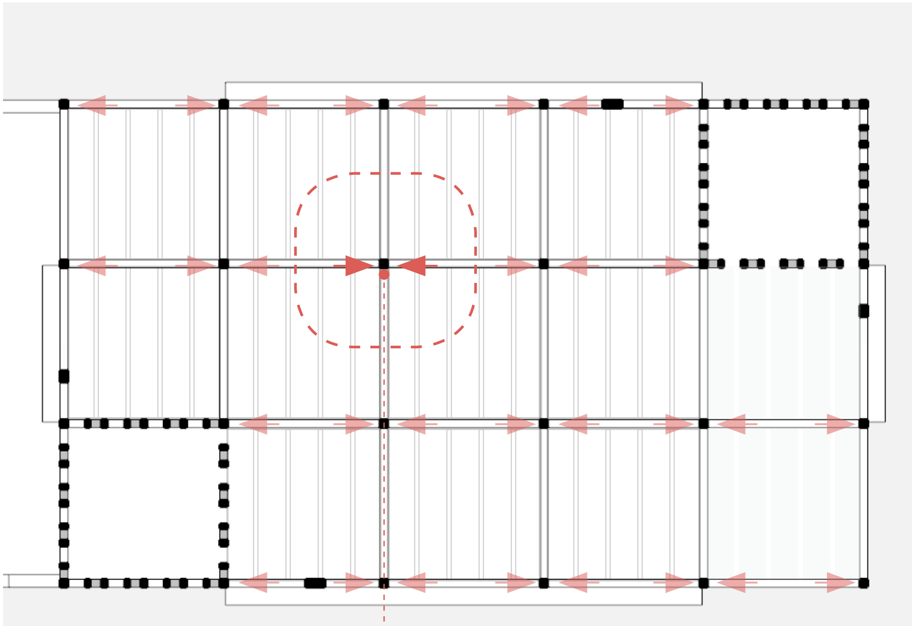
Column location

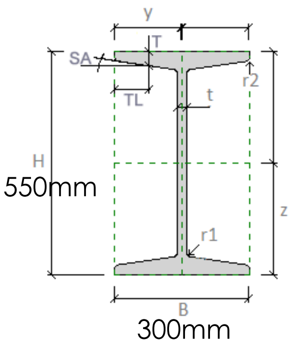


CHOSEN COLUMN

ELEMENTS LOCATION

Column load





Column 1

Pillar Base dimension a	0.55	m
Pillar Base dimension b	0.30	m
Pillar Height H	4.50	m
PILLAR SELF-WEIGHT Puls,self	**9.0**	**kN**
Number of pillars	**4**	
Total load self weigth pillars	**35.8**	**kN**

PILLAR TYPE: HE 550 B

TOTAL PILLAR SELF WEIGHT: G = 35.8kN/m

Désignation		Dimensions					
	G kg/ m	h mm	b mm	t_w mm	t_f mm	r mm	A mm^2 x 10^2
HE 550 AA	120	522	300	11,5	15	27	152,8
HE 550 A	166	540	300	12,5	24	27	211,8
HE 550 B	199	550	300	15	29	27	254,1
HE 550 M	278	572	306	21	40	27	354,4

Load on upper Pillar 1	**1044.3**	**kN**	**Compression floor**
Load on upper Pillar 2	**1044.3**	**kN**	
Load on upper Pillar 3	**1044.3**	**kN**	
Load on upper Pillar 4	**1044.3**	**kN**	
TOTAL PILLAR LOAD Puls	**4213.2**	**kN**	

Puls FOR ULS=4213.2kN

Column check

1. AREA OF SELECTED PROFILE

CHOSEN PROFILE: HE 550B

AREA: $A=25410mm^2$

$i_{min} = 71.7mm$

2. CHOOSE STEEL CLASS: S235

3. STEEL CLASS *fyd* CALCULATION

fyk = 235MPa

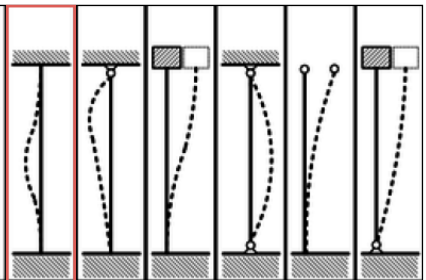
$\gamma s = 1.15$

fdy = *fyk*/γs = 204MPa

4. λ CALCULATION

PILLAR LENGTH: l = 4.5m

LENGTH REDUCTION FACTOR: k = 0.65



Buckled shape of column shown by dashed line						
Theoretical K value	0.5	0.7	1.0	1.0	2.0	2.0
Recommended design value K	0.65	0.80	1.2	1.0	2.10	2.0
End condition key		Rotation fixed and translation fixed				
		Rotation free and translation fixed				
		Rotation fixed and translation free				
		Rotation free and translation free				

$l_0 = l/k = 2925mm$

$\lambda = l_0 / i_{min} = 40.8 < 150$, VERIFIED

- λ_{max} for principal steel bars is 150
- λ_{max} for secondary steel bars is 200
- λ_{max} for reinforced concrete columns is 100

5. $\bar{\lambda}$ CALCULATION

$\lambda_1 = 93.9$ (for S235)

$\bar{\lambda} = \lambda / \lambda_1 = 0.43$

$\lambda_1 = 93.9$ for S 235

$\lambda_1 = 86.8$ for S275

$\lambda_1 = 76.4$ for S355

6. CROSS SECTION CALCULATION

$\bar{\lambda}$	a	b (IPE)	C (HE)	d
0,2	1,0000	1,0000	1,0000	1,0000
0,3	0,9775	0,9641	0,9491	0,9235
0,4	0,9528	0,9261	0,8973	0,8504
0,5	0,9243	0,8842	0,8430	0,7793
0,6	0,8900	0,8371	0,7854	0,7100
0,7	0,8477	0,7837	0,7247	0,6431
0,8	0,7957	0,7245	0,6622	0,5797
0,9	0,7339	0,6612	0,5998	0,5208

$\chi = 0.896$

DESIGN BUCKLING RESISTANCE:

$N_{rd} = A \cdot fyd \cdot \chi = 4652kN$

7. BUCKLING CURVE CALCULATION

$\alpha = b = 0.34$

$\Phi = 0.5[1+\alpha \cdot (\bar{\lambda}-0.2)+\bar{\lambda}^2] = 0.63$

$\chi = \frac{1}{\sqrt{\Phi + \sqrt{\Phi^2 + \bar{\lambda}^2}}} = 0.844$

$$\Phi = 0.5\left[1+\alpha\left(\bar{\lambda}-0.2\right)+\bar{\lambda}^2\right]$$

$$\chi = \frac{1}{\Phi + \sqrt{\Phi^2 - \bar{\lambda}^2}} \quad \text{but } \chi \leq 1.0$$

8. DESIGN VALUE OF COMPRESSION FORCE N_{ed}

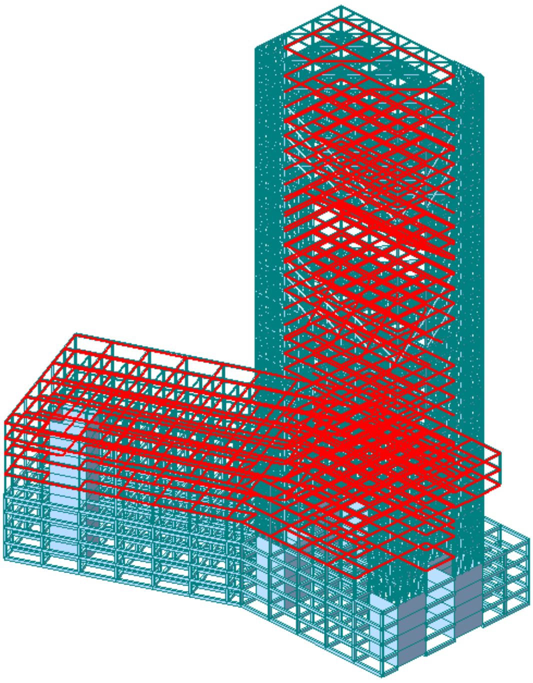
$N_{ed} = 4213.2kN$

9. COMPARISON

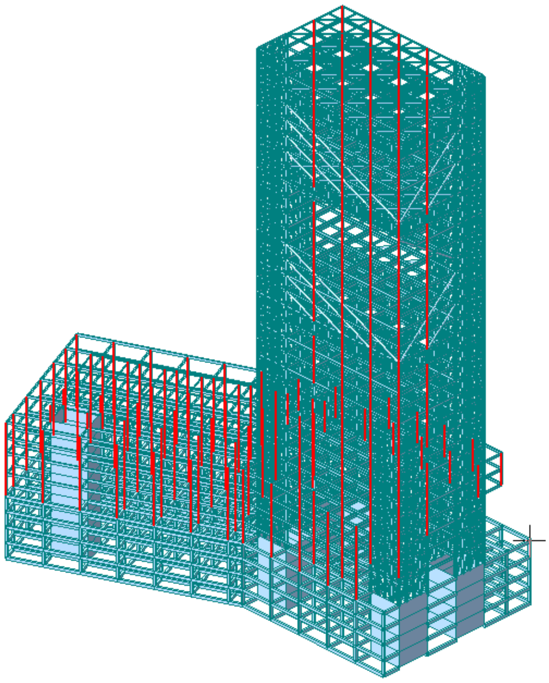
$N_{ed} = 4213.2kN$ < $N_{rd} = 4652kN$

BUCKLING VERIFIED

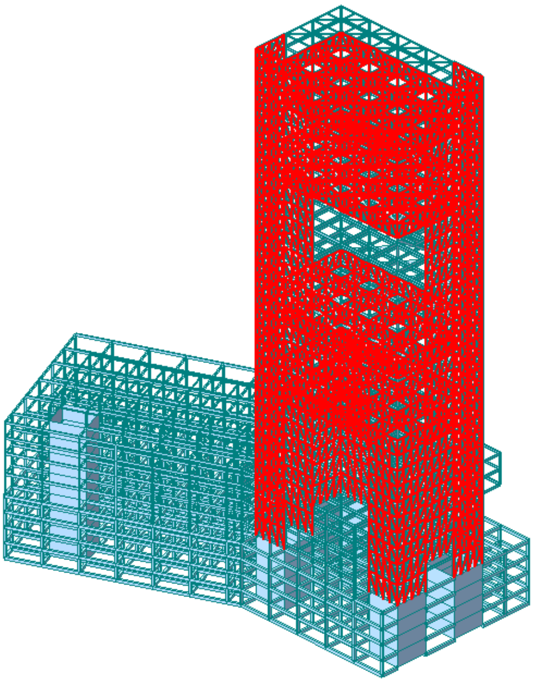
Midas modelling



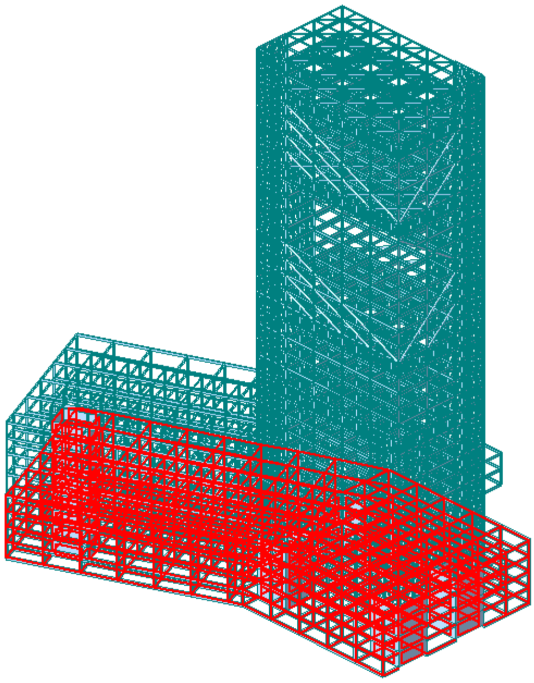
STEEL PRIMARY BEAM



STEEL COLUMN STRUCTURE

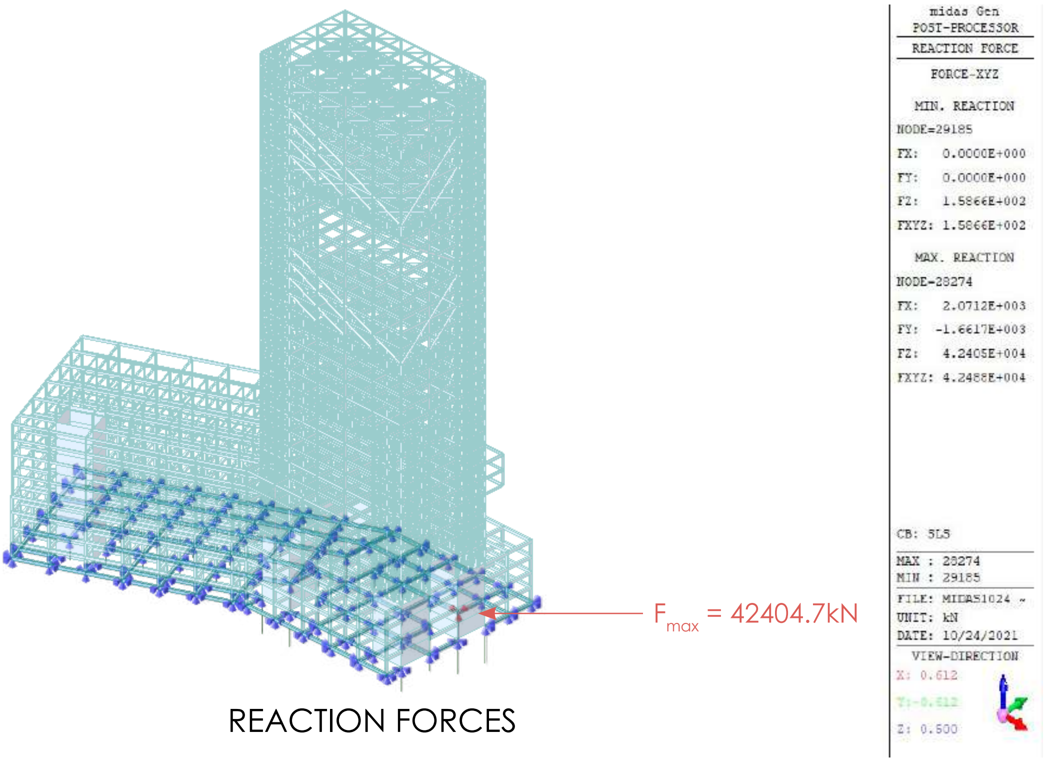


STEEL TRUSS STRUCTURE

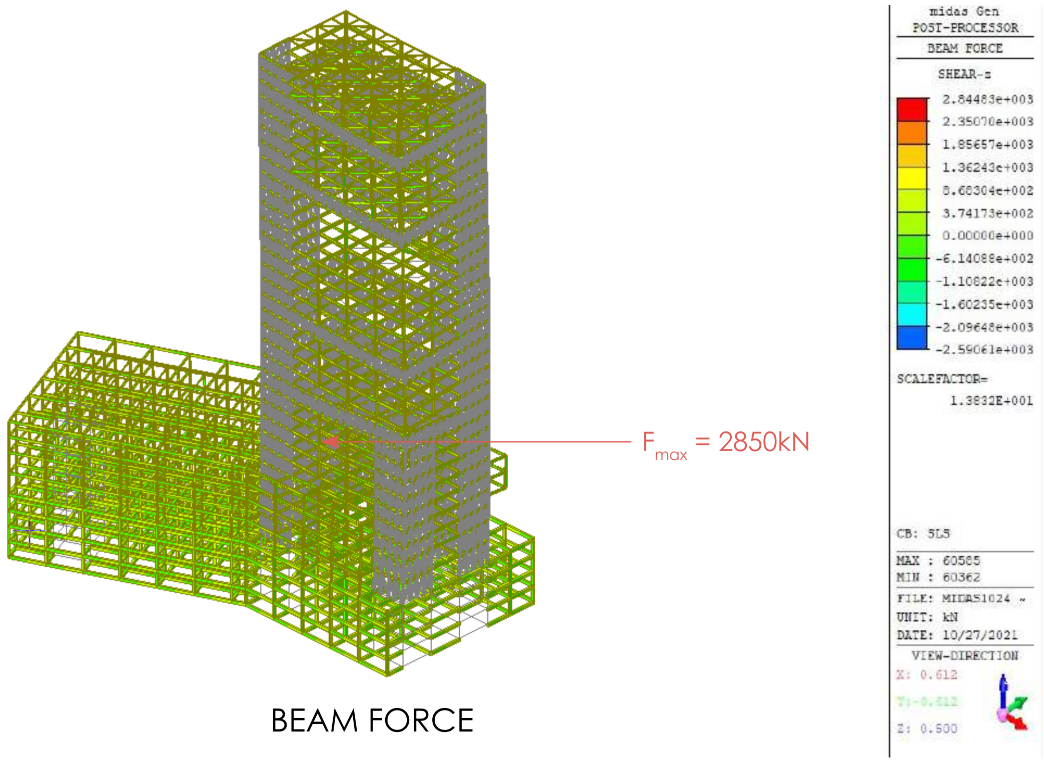


CONCRETE STRUCTURE

Overall midas result

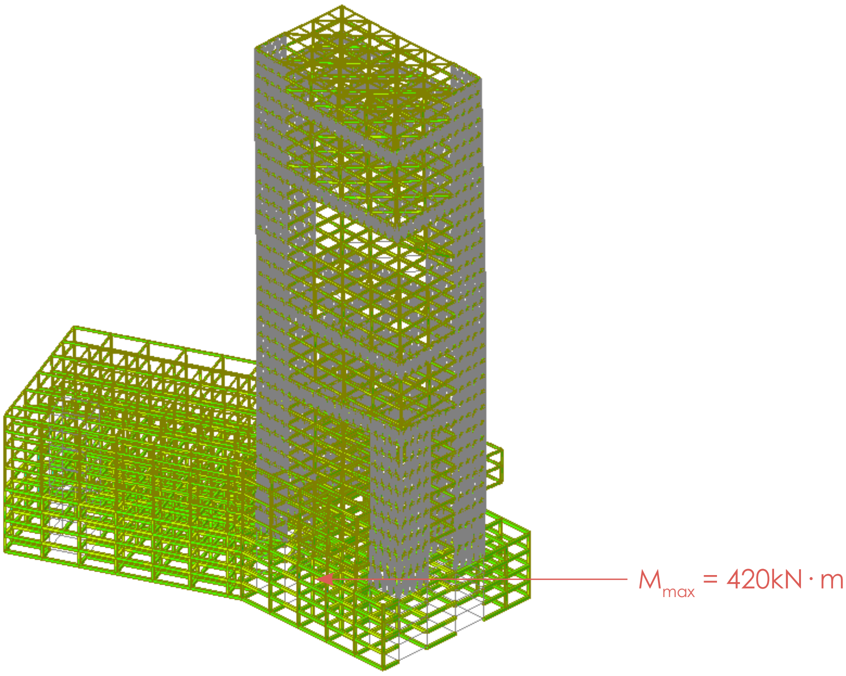


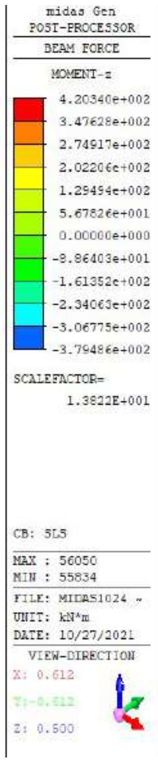
REACTION FORCES



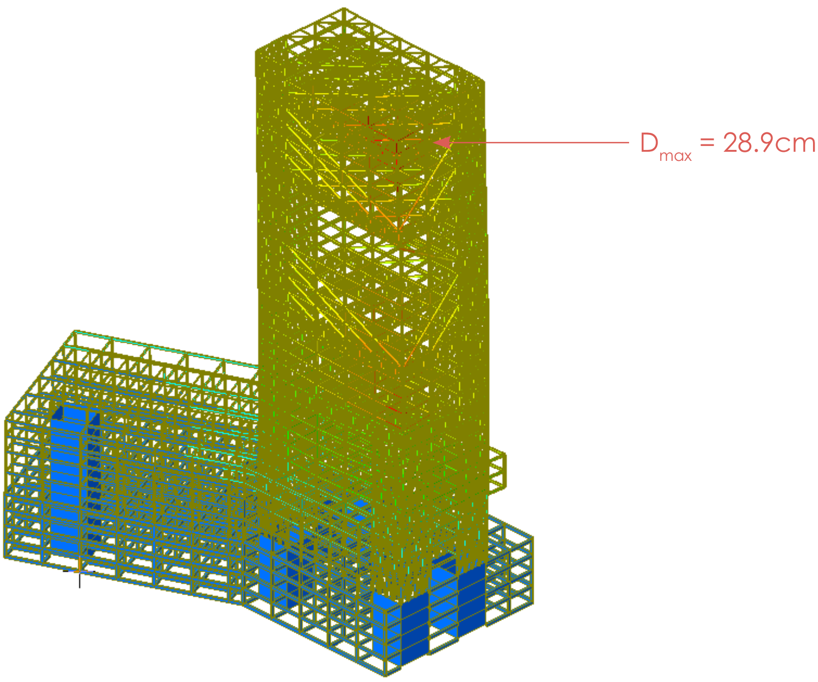
BEAM FORCE

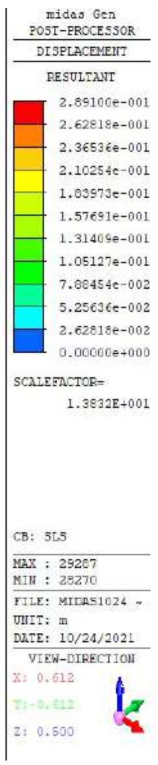
Overall midas result





BEAM BENDING MOMENT

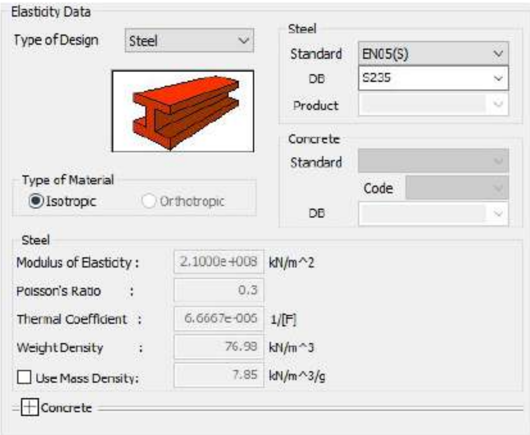




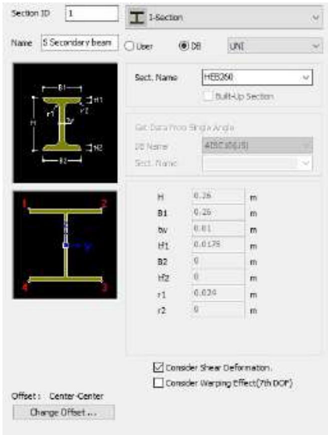
DISPLACEMENT ANALYSIS

Midas elements check

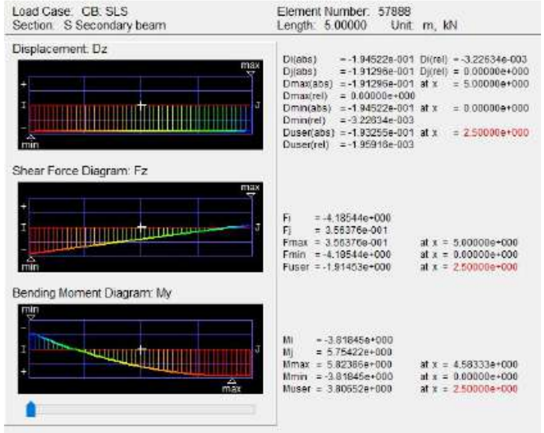
SECONDARY BEAM: HE 260B



Material: Steel S235

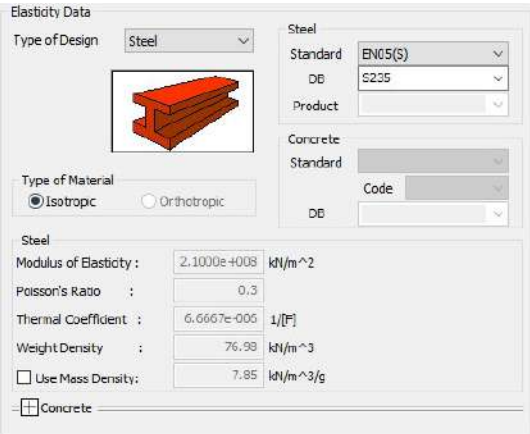


Section: HE 250B

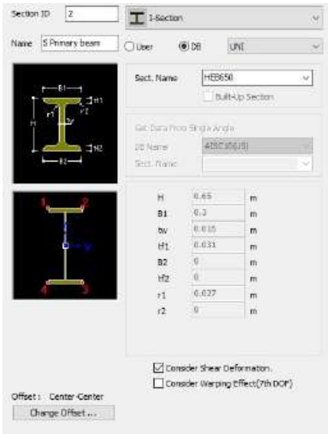


ELEMENT ANALYSIS DIAGRAM

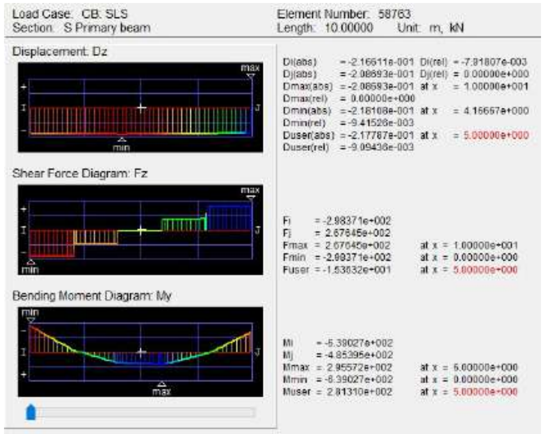
PRIMARY BEAM: HE 650B



Material: Steel S235

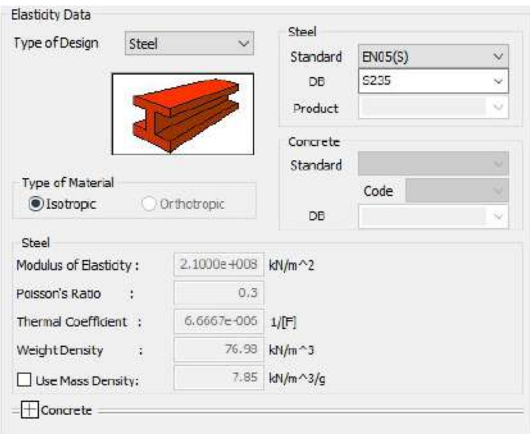


Section: HE 650B

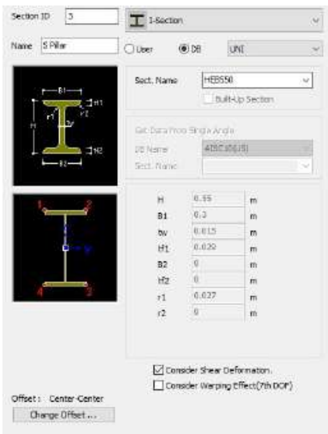


ELEMENT ANALYSIS DIAGRAM

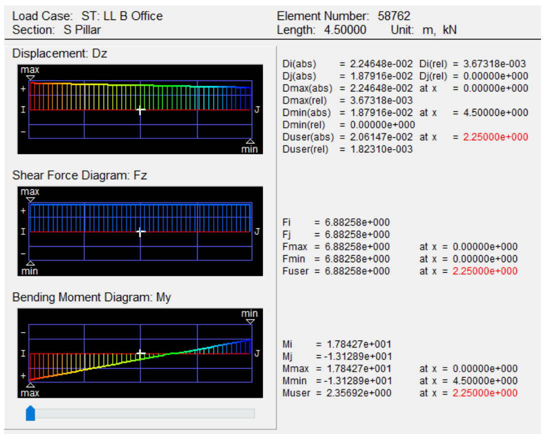
STEEL COLUMN: HE 550B



Material: Steel S235



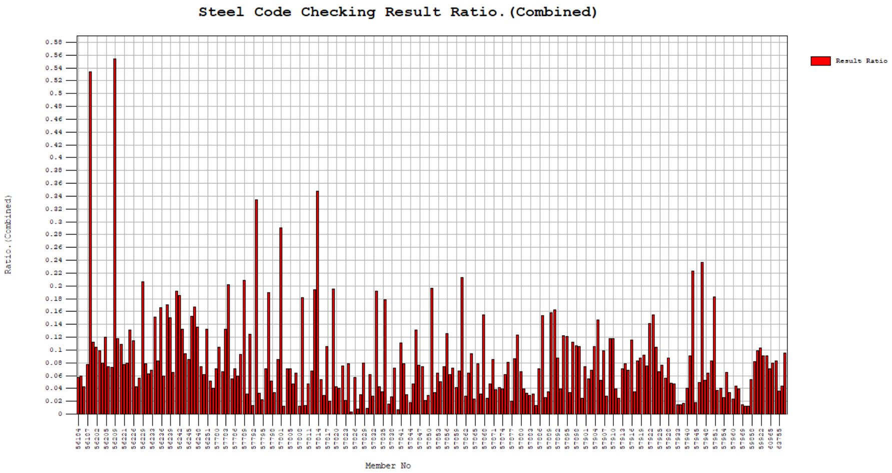
Section: HE 550B



ELEMENT ANALYSIS DIAGRAM

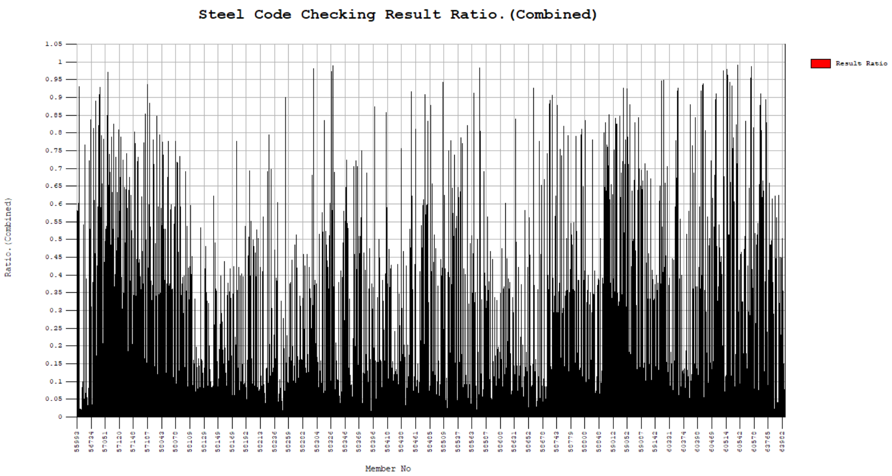
Midas steel code check

SECONDARY BEAM: HE 260B



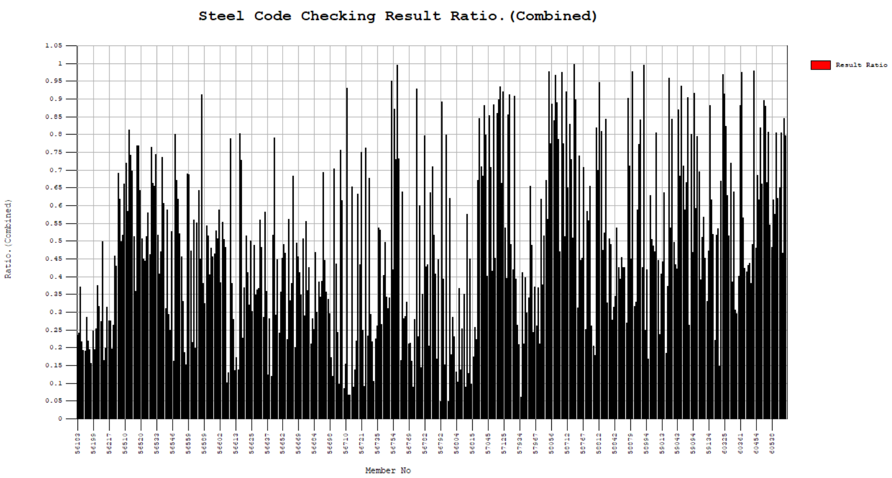
STEEL CODE CHECK RESULT

PRIMARY BEAM: HE 650B



STEEL CODE CHECK RESULT

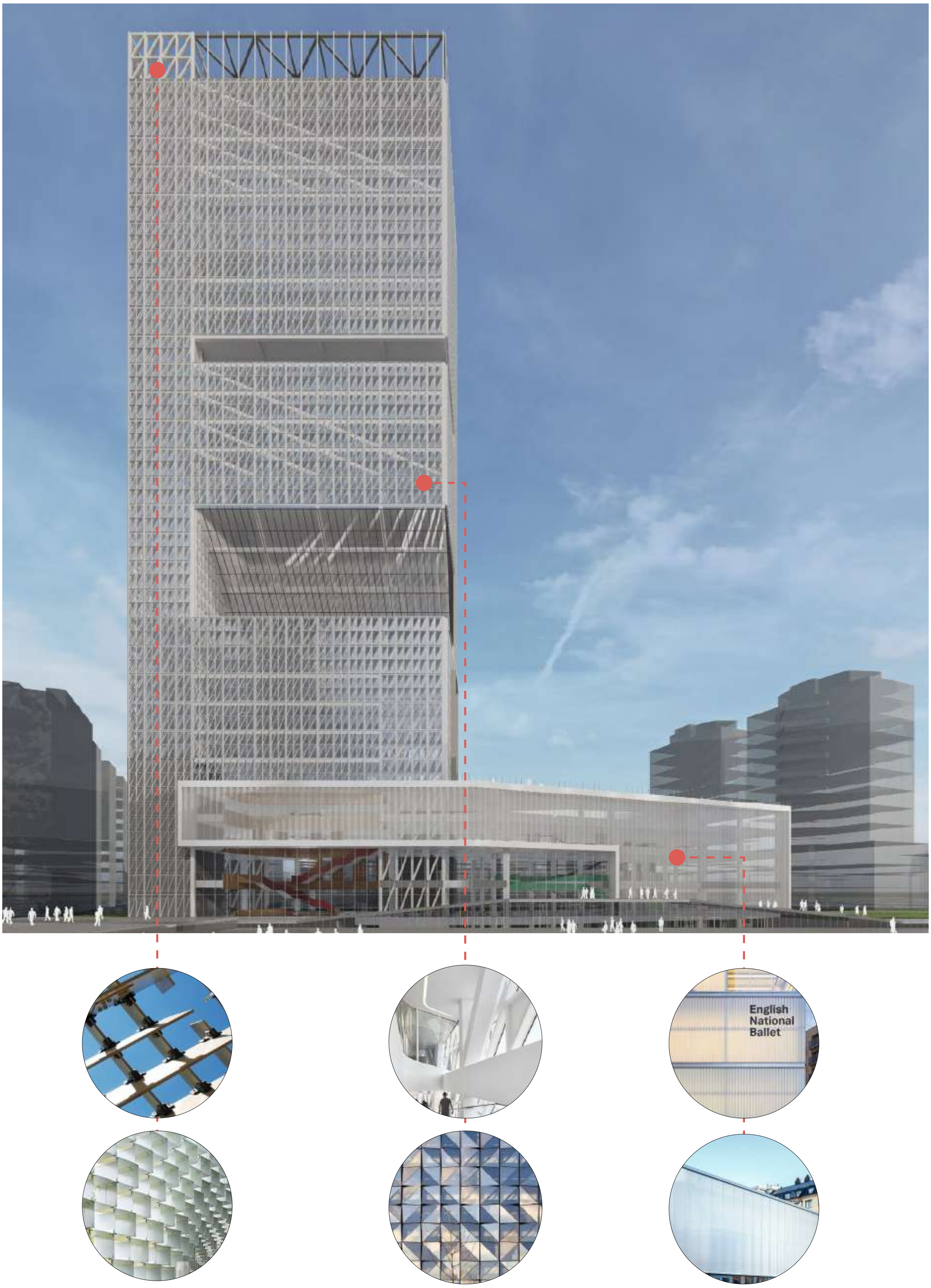
STEEL COLUMN: HE 550B



STEEL CODE CHECK RESULT

▌05 INNOVATION MATERIALS

Exterial material overview



SKY BAR
GLASS FIBER REINFORCED CONCRETE

TOWER FACADE
GLASS AND SOLAR PANEL

PODIUM FACADE
POLYCARBONATE

Podium facade material - Polycarbonate

dott.gallina

Manufacturer - Polycarbonate panel
DOTT. GALLINA

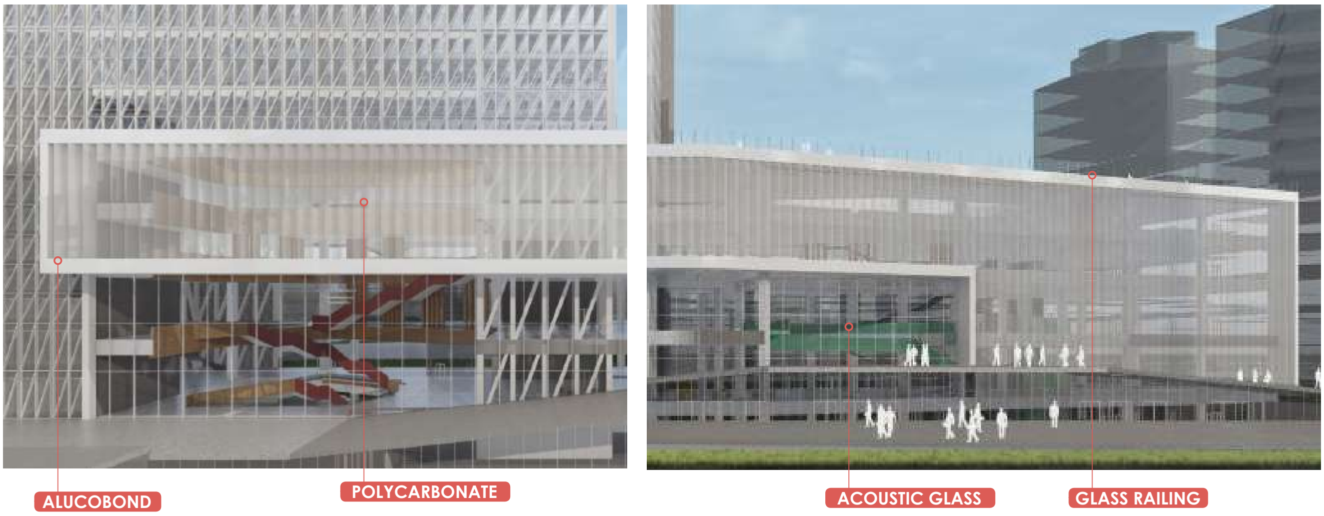
In terms of material selection, we tend to use environmentally friendly and energy-saving materials. Among them, polycarbonate was applied to the facade of the podium. Polycarbonate curtain wall has the characteristics of strong light transmission, high rigidity and low maintenance cost. It is not only practical but also meets the need of aesthetics when used in the facade of the podium.

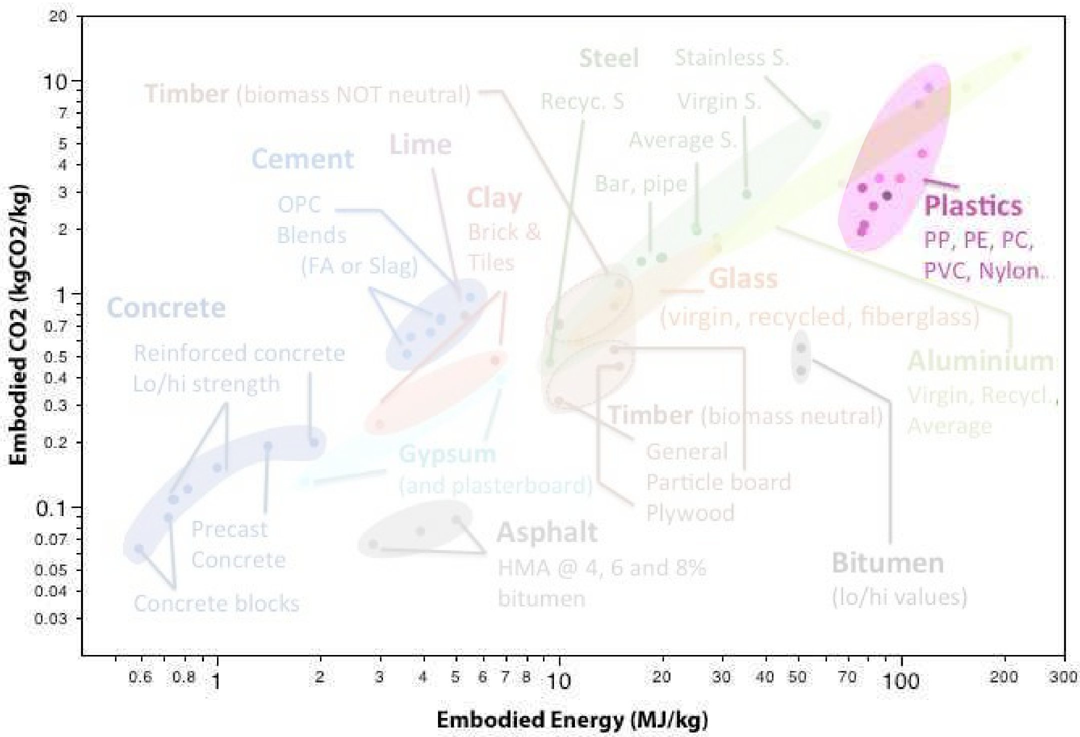
In the selection of the transparency of polycarbonate curtain wall panels, we use frosted materials, so that light and shadow can pass through the curtain wall panels, but the definition is not high. When night falls, the podium is lit by lights from the inside out, and the silhouette of the figure jumps on the polycarbonate curtain wall, increasing vitality to the retails area.

When choosing a polycarbonate manufacturer, we found Dott.Gallina Srl which is located in Italy. The Dott.Gallina Srl was founded in 1960 in La Loggia, a town nearby Torino, thanks to the Dr. Pier Aulo Gallina entrepreneurial spirit, whose dynamism has provided an impetus to the profiles production for the automotive industry. It gived the solid foundation of a constant growth that has achieved the current business reality.

Today the company is a renowned player in the Italian market about the production of sheets and polycarbonate systems, used to build windows-roofing-façades for the construction industry; the Dott.Gallina represent also an excellence in the extrusion of technical profiles designed for industrial and automotive fields. With the guidance of three brothers David, Daniel and Dario, the group employs 220 people and has an annual turnover of over 60 million euro, presenting also a strong internationalization orientation.

Podium facade material - Polycarbonate





Embodied energy is the energy associated with the manufacturing of a product or services. This includes energy used for extracting and processing of raw materials, manufacturing of construction materials, transportation and distribution, and assembly and construction.

Polycarbonate is belong to the highest embodied energy group - Plastic. This represents high energy consumption for the production of polycarbonate curtain wall panels. But on the other hand, it has a long service life cycle and low maintenance cost, so that it is a worthing material for facade curtain wall.

Podium facade material - Polycarbonate

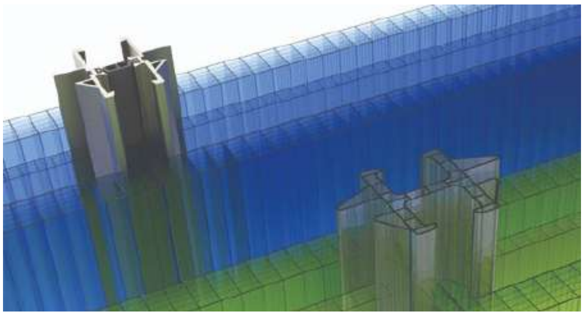
Production standards

arcoPlus®	626	9287	9327	5410
Panel thickness (mm)	20	20	32	40
System thickness (mm)	90	90	114	130
Module width (mm)	600	900	900	600
Structure (walls)	6	7	7	10
Thermal transmittance	0.62	0.64	0.51	0.40
Acoustic insulation	26	26	27	-
Light transmission	39	34	31	20

Special treatments

Features

Linear thermal expansion	0,065mm/m°C
Temperature range	-40°C +120 °C
U.V. rays protection	Coextrusion su 2 lati
Fire reaction EN 13501-1	EuroClass B-s1,d0



1 AESTHETIC DESIGN SOLUTION: The special multi-joints profile "double connector" allows to build a unique wall consisting of 3 layers of paneling, which can be customized by choosing the most suitable arcoPlus® panel in order to give the most suitable coloring or to apply the appropriate surface treatment.

2 EASY AND LOW-COST INSTALLATION: The hollow spaces between the three vertical layers allow a complete natural recirculation of air throughout all seasons, bringing benefits for the health of the environments and for reducing heating/cooling costs.

3 THERMAL INSULATION: ArcoPlus® DB connect system has been developed to offer, thanks to its triple layer composition, the highest performance in terms of thermal insulation and energy sustainability with the purpose of carry out imposing translucent continuous facades

4 RESISTANCE TO UV RAYS AND TO HAIL: Special connector system made with polycarbonate multiwall panels UV protected.

Manufacturer previous projects

Pavilion Arena - Svezia

Place: Stoccolma - Svezia

Scope: cultural

Year: 2011

Application:
continuous façade

Product: arcoPlus®347/547/549


Scuola di Saint Plourin - Francia

Place: Saint Plourin - Francia

Scope: educational

Year: 2016

Application:
ventilated façade

Product: arcoPlus®626


Protoshop Lamborghini -
Sant'Agata Bolognese

Place: Oklahoma City, OK, USA

Customer:
Chesapeake Energy Corporation

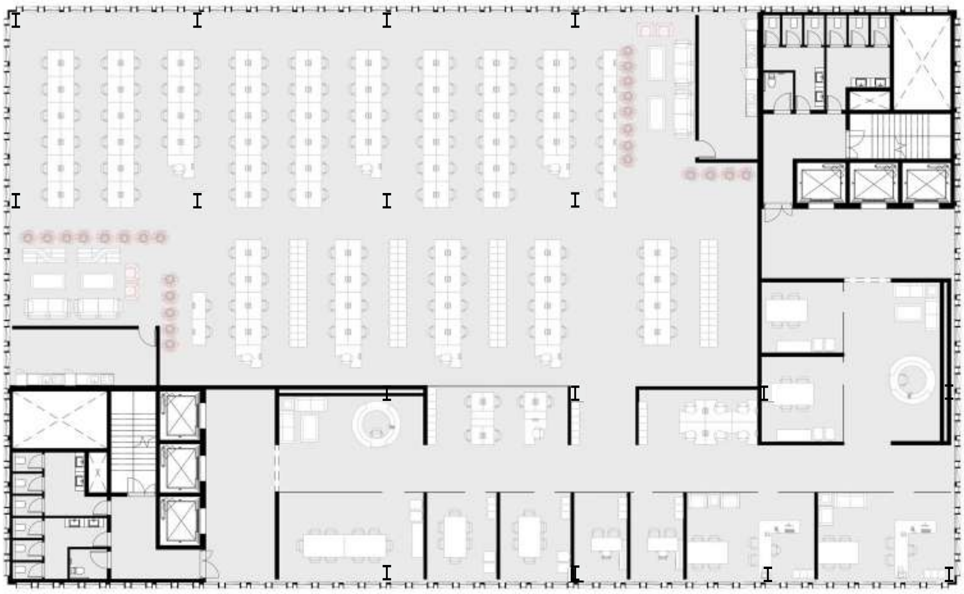
Scope: infrastructural

Year: 2015

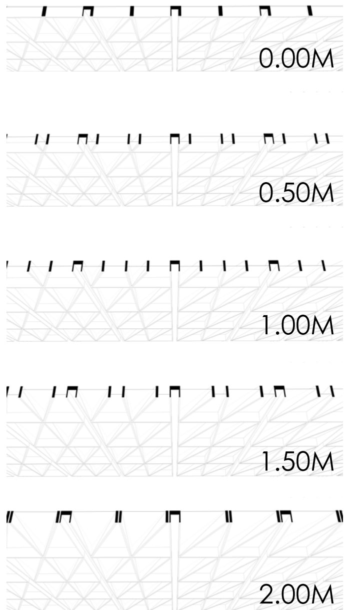
Application:
continuous façade,
Translucent building
envelopes, Traslucent
façade insert, External
curtain wall

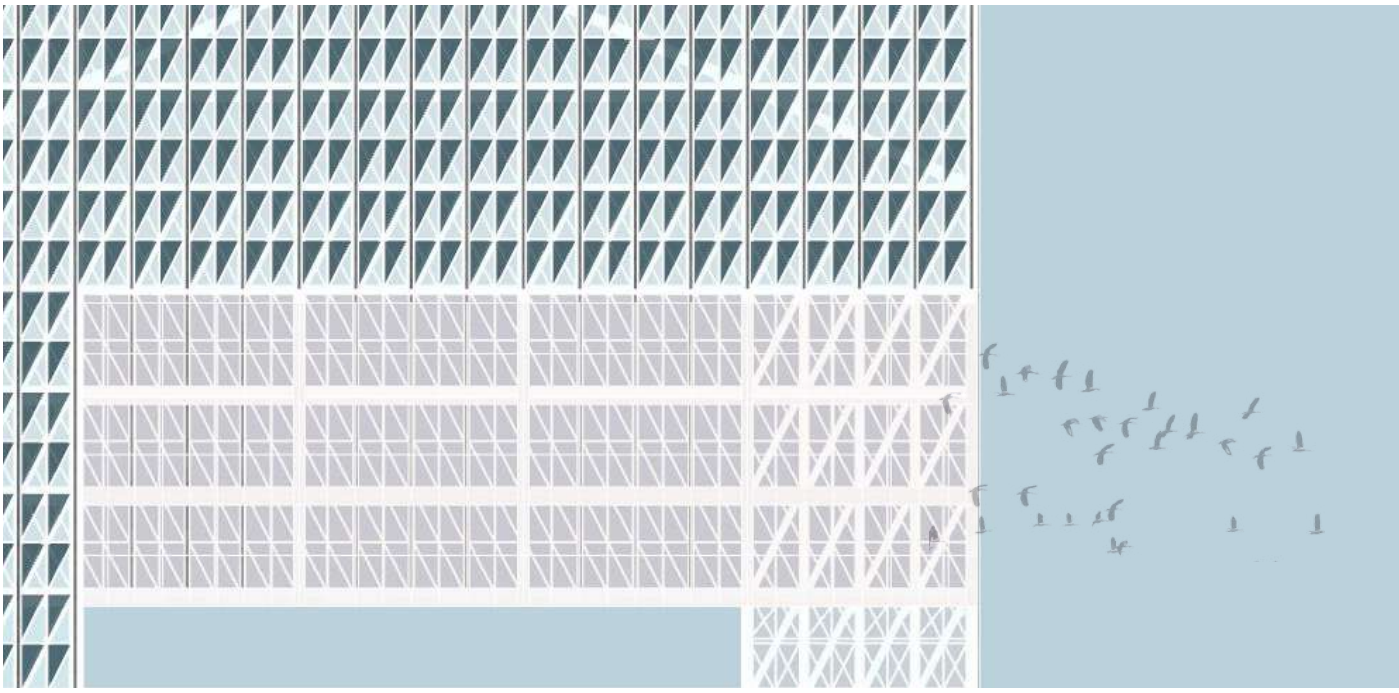
Product: Multiwall Sheets -
PoliCarb®

Tower facade material - PV Panel



TOWER PLAN 1:200

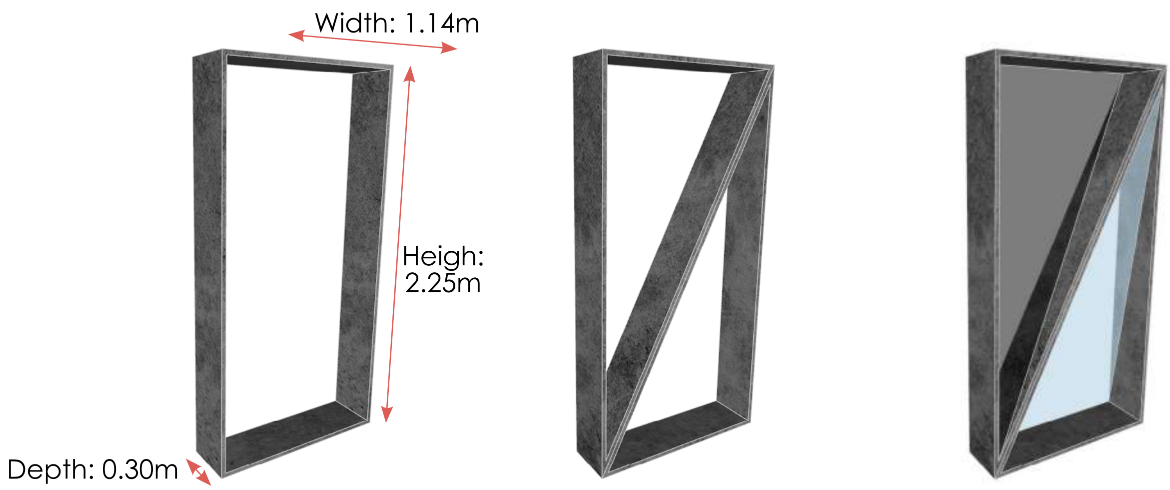




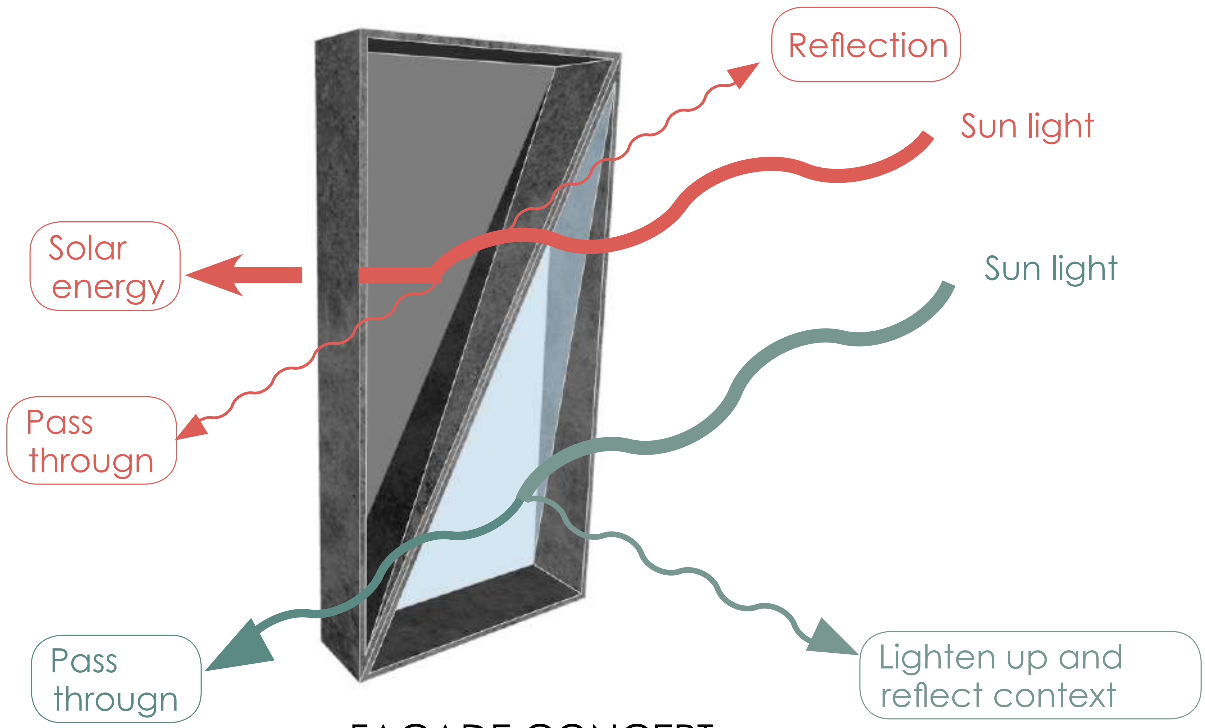
GEOMETRY DETAILS

Tower facade material - PV Panel

In the design, we attached photovoltaic panels to the tower to absorb solar energy in order to power the project system. We divided the entire facade into rectangles curtain frames of equal size and divided the rectangle into two triangles. In order to better absorb solar energy, half of the triangles are set as photovoltaic panels with a slightly upward angle and are directly exposed to sunlight; the other half of the triangles are set as double-glazed with a slightly downward angle to add rhythmic rhythm to the facade design feel.



Steel frame   Diagonal seperation   Glass pannel installation



FACADE CONCEPT

Tower facade material - PV Panel

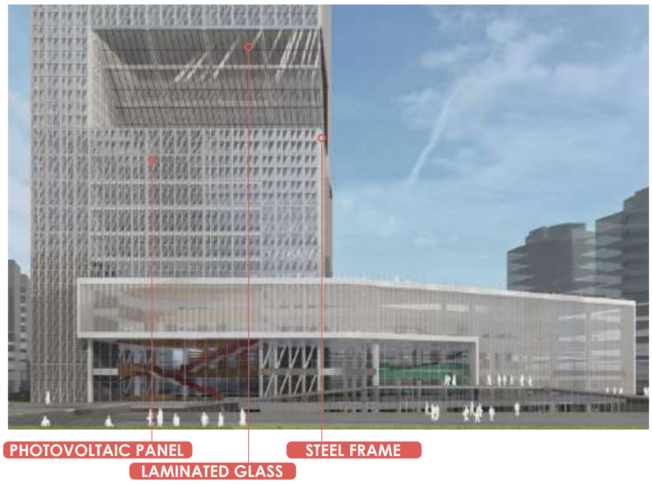
Manufacturer - PV Panel
ONYX SOLAR GLASS

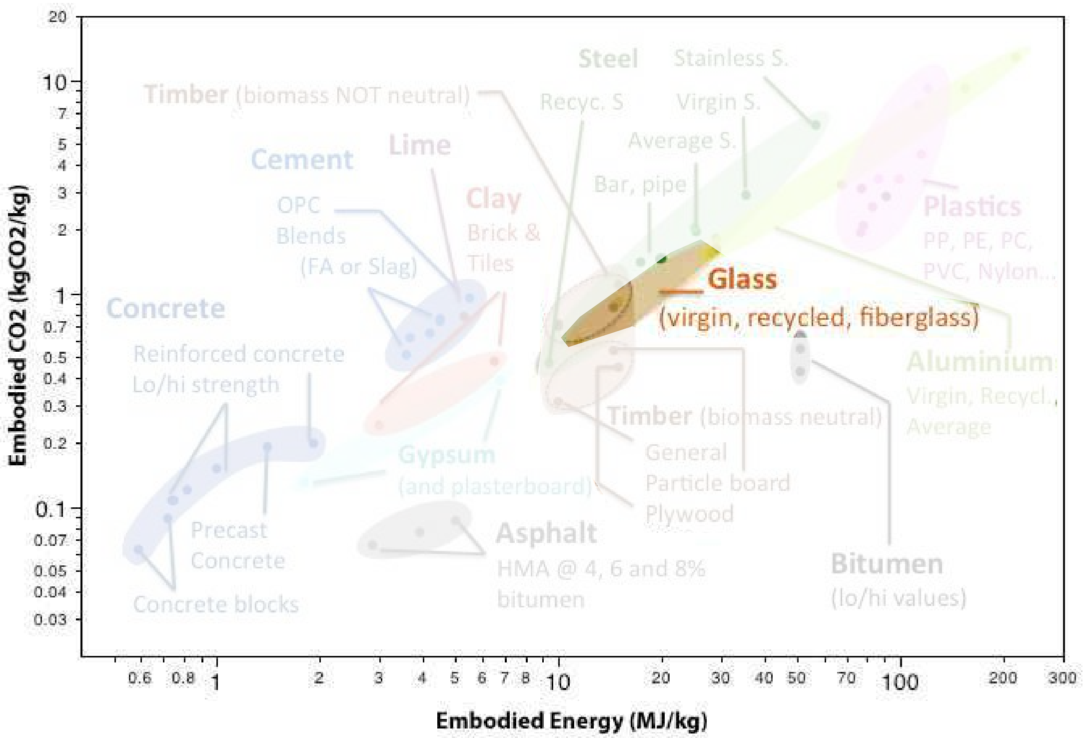
For photovoltaic panels, we chose Onyx Solar.

Onyx Solar is the world's leading manufacturer of transparent photovoltaic (PV) glass for buildings. Onyx Solar uses photovoltaic glass as a material for building purposes as well as an electricity-generating material, with the aim of capturing the sunlight and turn it into electricity. The panes are made of layers of heat-treated safety glass which can provide the same thermal and sound insulation as conventional architectural glass, not to mention the fact that they also let natural light go through in the same way as conventional glass. Thus the photovoltaic glass glass panes could be installed replacing conventional glass on building facades, curtain walls, atriums, canopies and terrace floors, among other architectural applications. These glass panes could additionally be installed on a wide variety of existing buildings and facilities, therefore contributing to their enhacement both from an aesthetic and energetic point of view.

By providing the same thermal insulation as conventional glass, along with the capacity to generate free clean electricity from the sun, it enables buildings to drastically improve their energy efficiency, decrease operation and maintenance costs, and reduce their carbon footprint.

Tower facade material - PV Panel

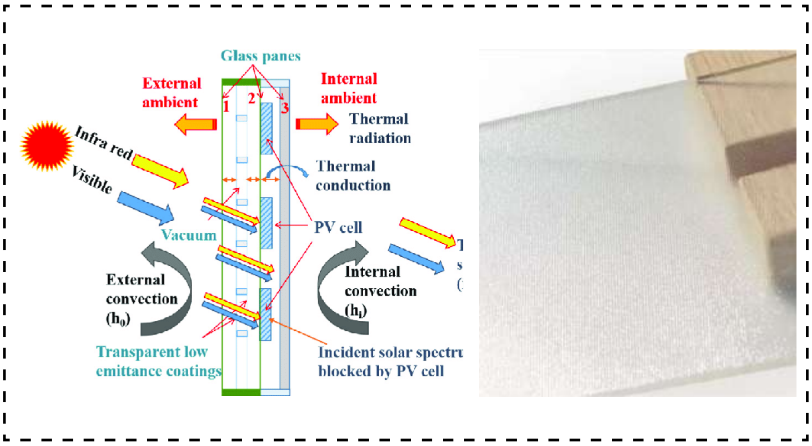




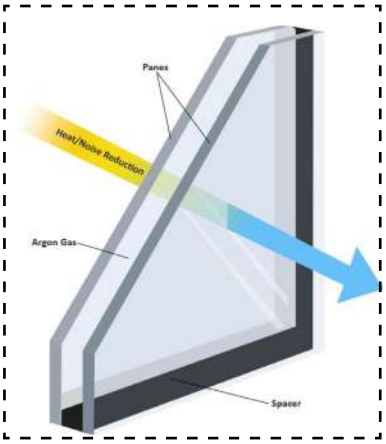
Embodied energy is the energy associated with the manufacturing of a product or services. This includes energy used for extracting and processing of raw materials, manufacturing of construction materials, transportation and distribution, and assembly and construction.

PV panels belong to the medium to high energy group-glass. This means that its production energy consumption and carbon dioxide emissions are both at a moderate level.

Tower facade material - PV Panel



Half transparent solar pannel



Double glazing

Glass with Photovoltaic panels

1 TRANSMITTANCE: Transparent- efficiency 5%
Half transparent - efficiency 7.5%
Opaque - efficiency 15%

2 EFFICIENT: Choice with the added benefit of minimising noise. The sealed air gap between the two panes acts as an added layer of insulation.

1 INSULATION PROPERTIES: The "U-value" measures the amount of heat that passes through the glazing when there is a difference in temperature between its two sides. The lower this value is, the higher the thermal insulation. Onyx Solar's PV glass offers values up to 0.18 BTU/SqFtK, which ties to the highest performing glass products in the market.

2 OPTIMIZED SOLAR FACTOR: Onyx Solar's glass offers a solar factor between 10% to 40%, which makes it an ideal element to improve indoor comfort.

3 HARMFUL RADIATION FILTER: The architectural PV glass developed by Onyx Solar reduces the transmission of infrared radiation by up to 95% compared to a conventional laminated glass; it also filters out 99% of the ultraviolet radiation (UV), which accelerates interior ageing.

4 NATURAL LIGHT: Onyx Solar's PV Glass has been designed to provide natural light in a diffuse manner. Rather than having your windows covered with blinds, PV Glass allows for you to enjoy unobstructed views, enjoy natural light and to avoid glare.

Manufacturer previous projects

Gioia 22 - Milan

Gioia 22 is a new, landmark office tower developed by COIMA and designed by international architectural firm Pelli Clark Pelli Architects.

The building has become one of the most iconic skyscrapers in Italy and a world benchmark in terms of energy efficiency, thanks to its innovative design that incorporates unprecedented standards of technological innovation and environmental sustainability, such as Onyx Solar's Photovoltaic Glass.

Dubai frame - Duabi

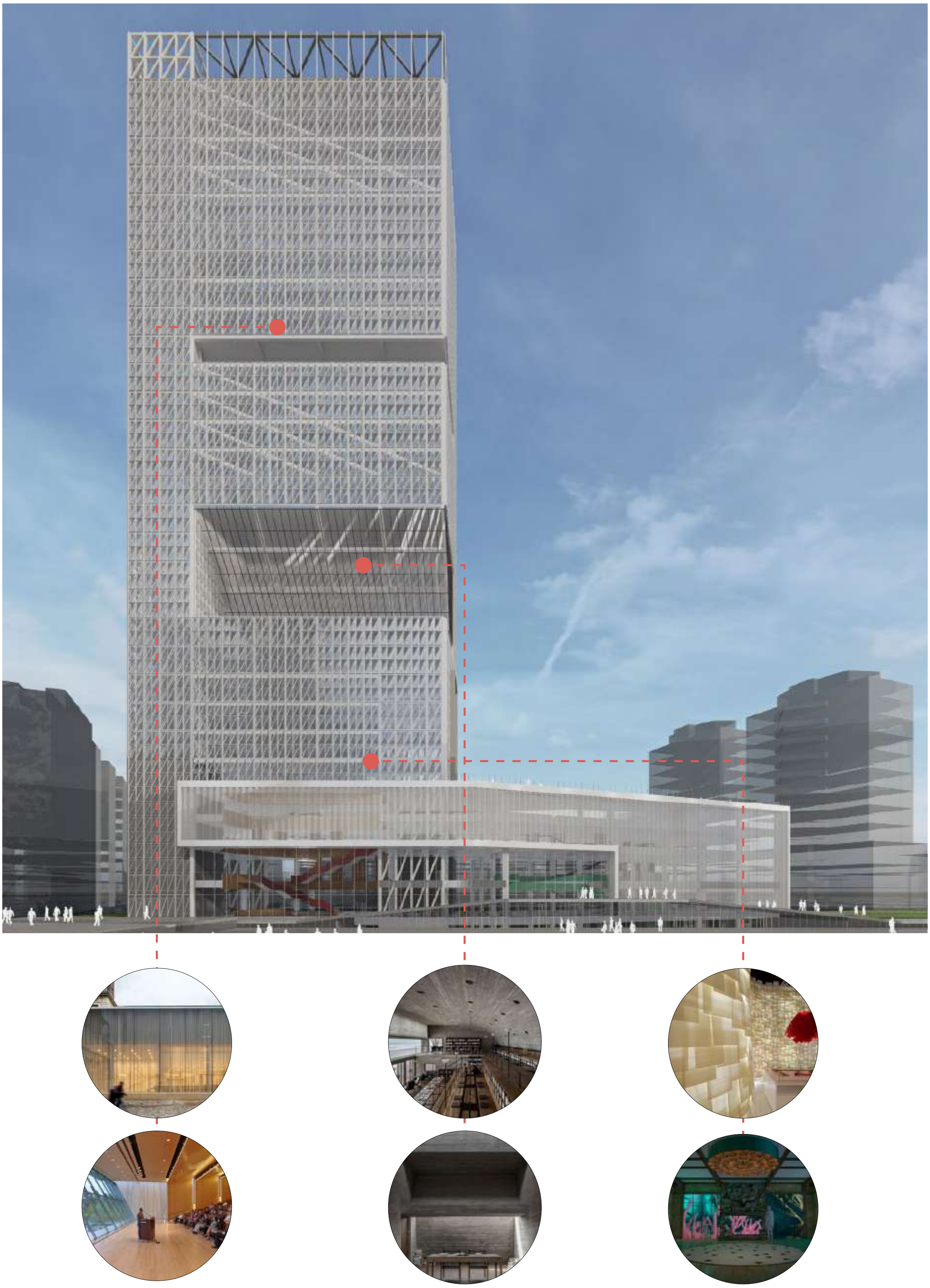
The Dubai Frame is an eye-catching impressive rectangular picture frame-shaped building rising 150 meters (492 Ft) from Dubai's Zabeel Park, spanning 105 meters (344 Ft) horizontally. It attracted a million visitors from around the world during its first year of opening in 2018 and offered them stunning views of the city's past and present. This iconic skycraper is considered one of the world´s most popular tourist attractions nowadays. Onyx Solar, the world's leading manufacturer of photovoltaic (PV) glass, supplied gold color photovoltaic glass for its rainscreen cladding system.

University of Washington - Washington D.C.

The College of Arts and Sciences at University of Washington is getting ready to soon open a spectacular, modern research and instructional space called the Life Sciences Building (LSB), which will provide students with over 170,000 square foot of open and flexible lab space, to boost a collaborative and interdisciplinary approach to research in the field of Biology.

The building has been designed by architects Perkins + Will, and it is a seven-story construction – including two stories below ground, which has been envisioned as a benchmark project in terms of energy efficiency, innovation, and onsite renewable energy.

Internal material overview



AUDITORIUM
ACOUSTIC GLASS

LIBRARY
STAMPED CONCRETE

EXHIBITION
TRANSLUCENT WOOD

Exhibition material - Translucent wood

WOODOO
augmented wood

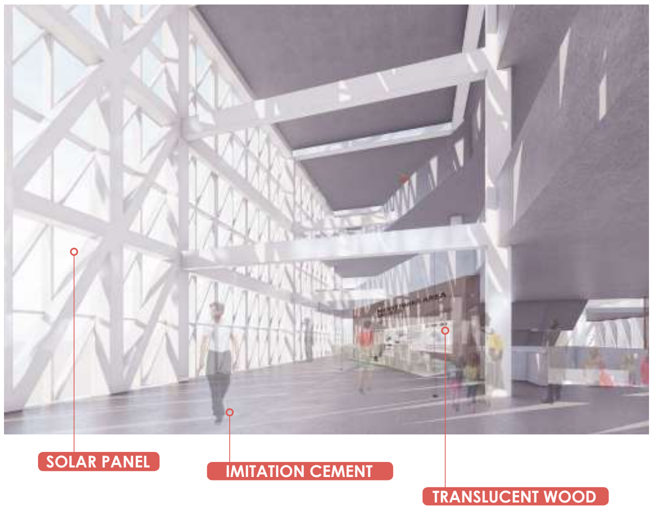
Manufacturer - Translucent Wood
WOODOO

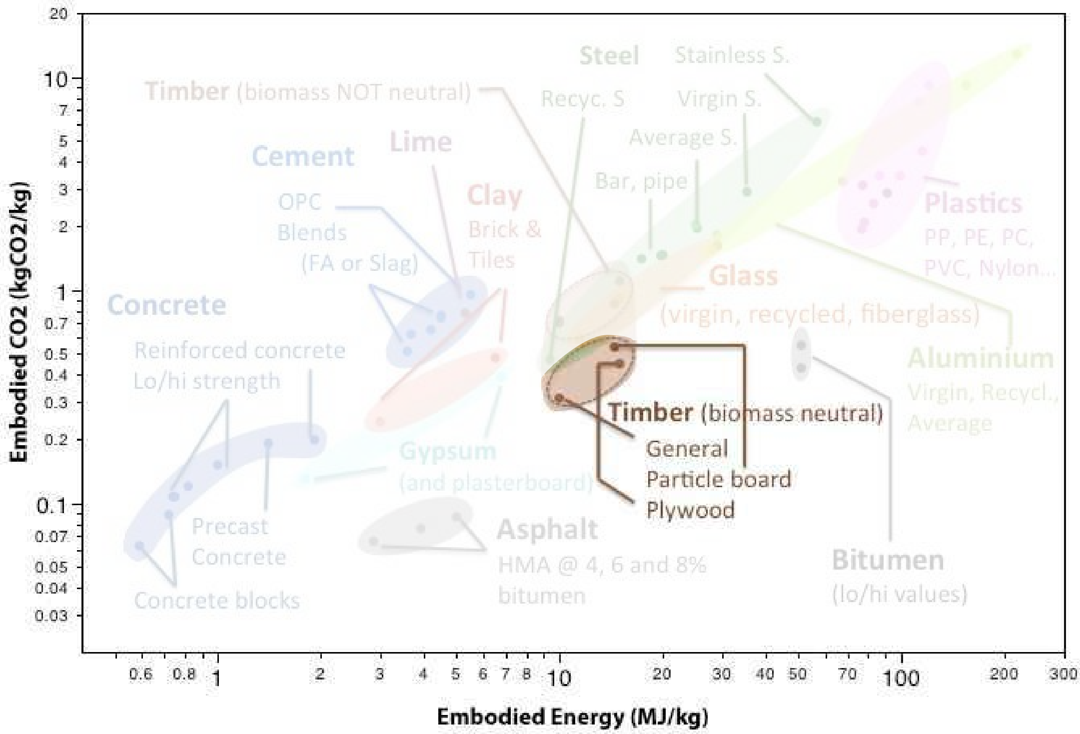
For photovoltaic panels, we chose WOODOO. This is a new type of wood, which is made by soaking logs with a series of chemical materials and then drying them. The finished product is translucent, and the internal wood texture is faintly visible.

Woodoo is a carbon-efficient materials company. We strive to change the world by enabling its transition to sustainable solutions, to win the fight for decarbonization and against climate change. As regenerative materials will play a leading role, we have chosen to mold and shape natural wood from regenerative forestry into materials with extraordinary performance, to help industries and corporations meet their carbon neutrality commitments.

Wood paneling is a LED display unit covered with SLIM translucent wood. It is ideal to assemble custom screen walls or to make partitions with integrated screens. Woodoo believes that, in the future, making products should not be an emissions challenge but an opportunity to capture carbon in durable goods. Since trees are the best carbon trap on the planet, they will be instrumental in bringing about this change.

Exhibition material - Translucent wood

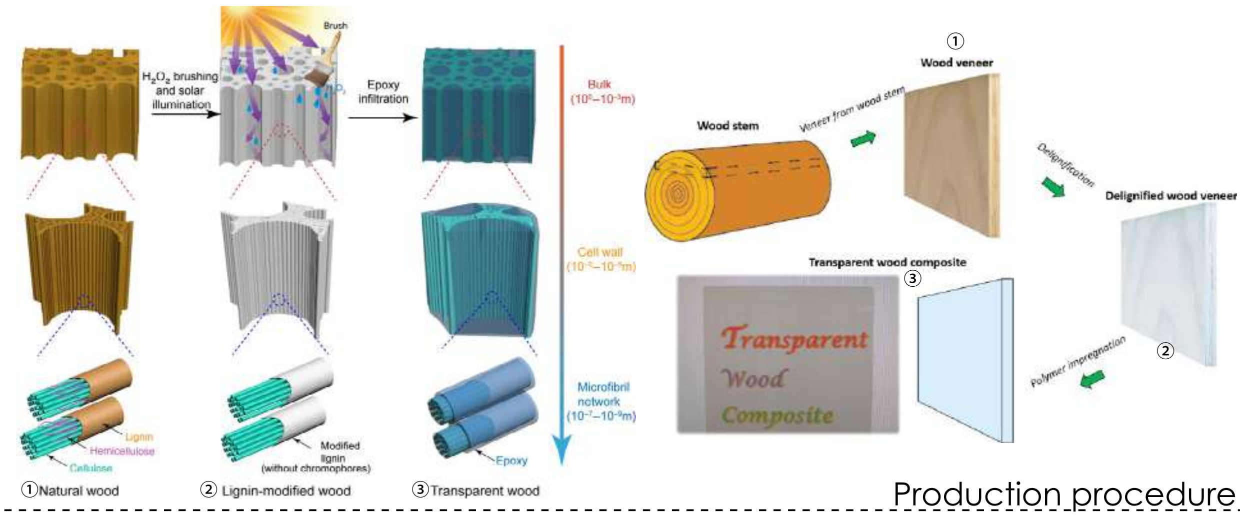




Embodied energy is the energy associated with the manufacturing of a product or services. This includes energy used for extracting and processing of raw materials, manufacturing of construction materials, transportation and distribution, and assembly and construction.

Because Translucent woood is a new type of material, there is no data on energy consumption and emissions, so it is classified into the plywood group here. Translucent wood belongs to the medium energy group-Timber. This means that its production energy consumption and carbon dioxide emissions are both at a moderate level.

Exhibition material - Translucent wood



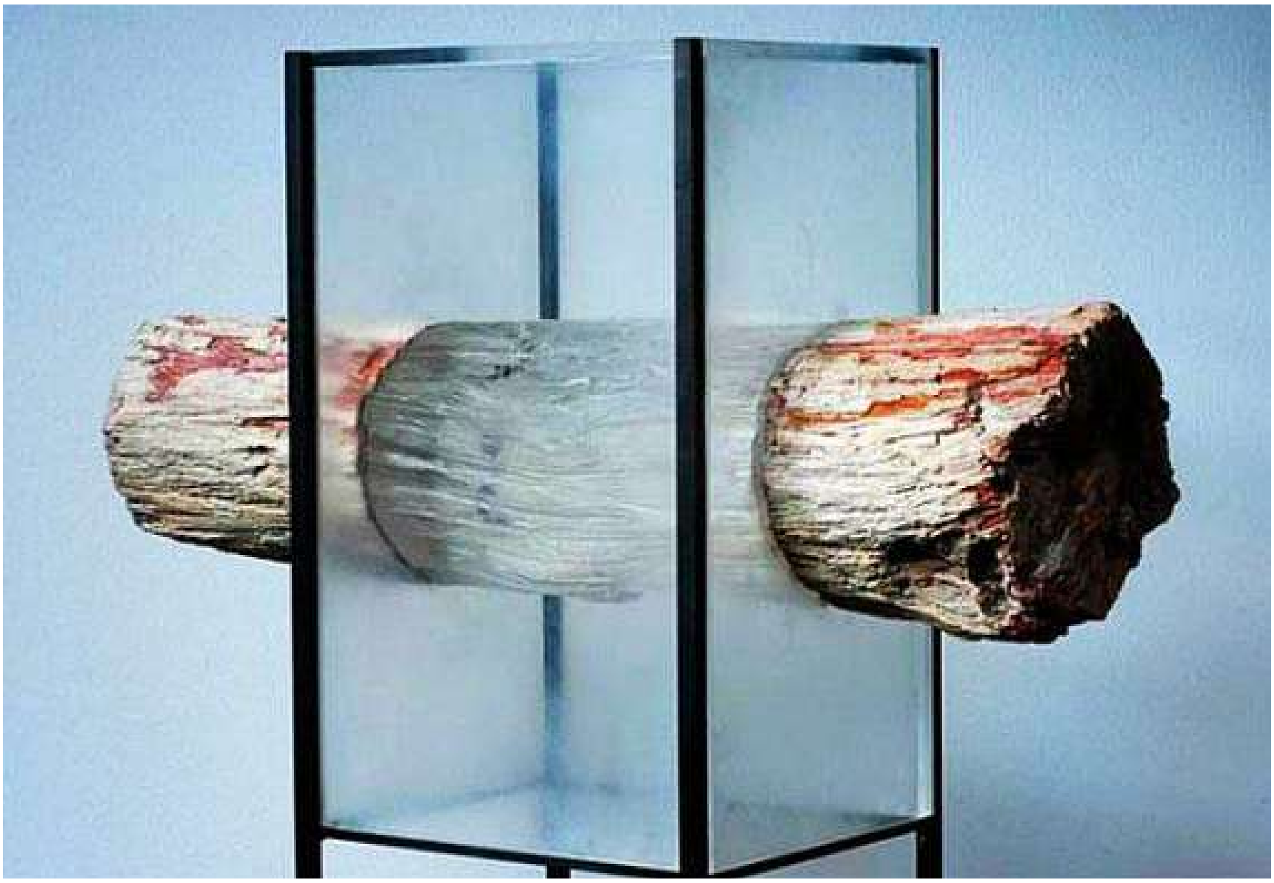
Production procedure

In its natural state, wood is not a transparent material because of its scattering and absorption of light. The tannish color in wood is due to its chemical polymer composition of cellulose, hemicellulose, and lignin. The wood's lignin is mostly responsible for the wood's distinctive color. Consequently, the amount of lignin determines the levels of visibility in the wood, around 80–95%. To make wood a visible and transparent material, both absorption and scattering need to be reduced in its production. The manufacturing process of transparent wood is based on removing all of the lignin called the delignification process.

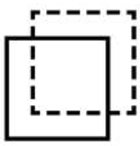
The production of transparent wood from the delignification process vary study by study. However, the basics behind it are as follows: a wood sample is drenched in heated (80 °C–100 °C) solutions containing sodium chloride, sodium hypochlorite, or sodium hydroxide/sulfite for about 3–12 hours followed by immersion in boiling hydrogen peroxide. Then, the lignin is separated from the cellulose and hemicellulose structure, turning the wood white and allowing the resin penetration to start. Finally, the sample is immersed in a matching resin, usually PMMA, under high temperatures (85 °C) and a vacuum for 12 hours. This process fills the space previously occupied by the lignin and the open wood cellular structure resulting in the final transparent wood composite.

While the delignification process is a successful method of production, it is limited to its laboratory and experimental production of a small, and low-thickness material that is unable to meet its practical application requirements. However, at Jiangsu Co-Innovation Center for Efficient Processing and Utilization of Forest Resources in 2018, Xuan Wang and his colleagues developed a new production method of infiltrating a prepolymerized methyl methacrylate (MMA) solution into delignified wood fibers. By utilizing this new technique, large-size transparent wood with any thickness or any measure can be easily made. Yet in spite of this success in the manufacture, challenges still exist with regard to mechanical stability and adjustable optical performance.

Exhibition material - Translucent wood



1 LOW DENSITY COMPARED TO GLASS: From 1200 kg/m3



2 HIGH OPTICAL TRANSMITTANCE: Transparent wood (thickness about 1mm) shows high light transmittance (> 90%), high haze (> 60%) and excellent light guiding effect in the visible wavelength range.

3 LOW THERMAL CONDUCTIVITY: Excellent UV blocking ability and low thermal conductivity (0.24 W $m^{-1}K^{-1}$)

4 OUTSTANDING TOUGHNESS: The rapid manufacturing process and mechanical strength of translucent wood (high longitudinal tensile strength of 91.95 MPa and toughness of 2.73 MJ m^{-3}) are conducive to the enlargement of the production scale (320mm×170mm×0.6mm) while saving a lot of time and energy.

5 ENVIRONMENTAL FRIEDNLY: Translucent wood can reduce energy cost by lowering the usage of artificial lights inside homes and other buildings. Nowadays, urban architecture depends heavily on the use of glass and steel.

Manufacturer previous projects

Cabrini Hospital - Australia

"Our goal was to maximize the space with interactive experiences that children could intuitively use," said Andrea Rindt, Nurse Director for Women and Children at Cabrini Hospital.

Next, ENESS hopes to expand LUMES, spreading its interactive whimsy to other programmatic spaces, such as hospitality and retail. By leveraging its specialties in lighting, software, interactive media, product design, sculpture, and architecture, ENESS intends to collaborate with interior designers to broaden LUMES's material palette and integrate LUMES into new architectural concepts.

Digital Wood Panel - France

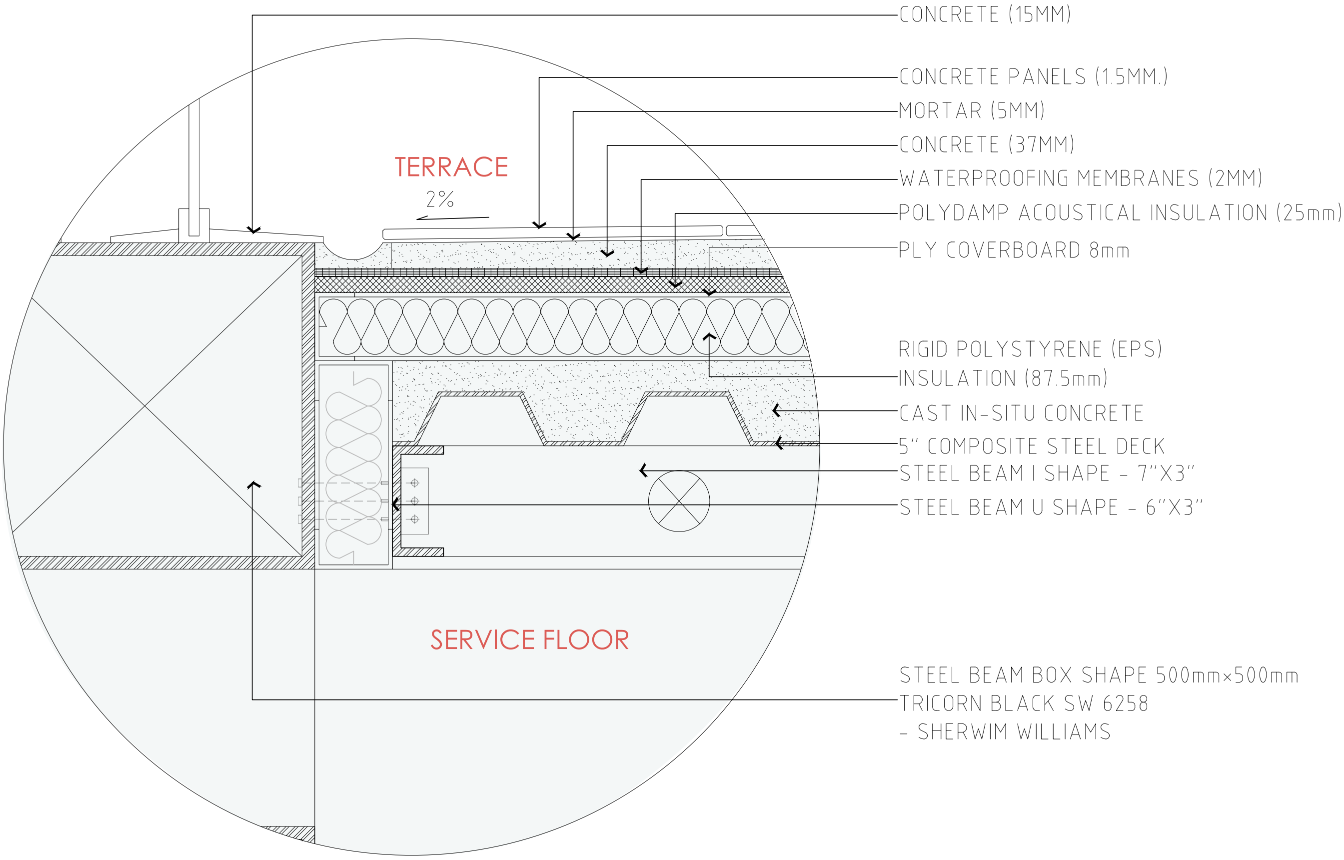
In 2016, Boitouzet founded material science company Woodoo in Paris, France, which retrofits timber to give it new properties. His focus is on transforming the construction industry through replacing steel with wood, for example. Unlike other construction materials, such as stone or concrete which contains sand, wood is a renewable resource, making it an attractive sustainable building material, Boitouzet said.

Building more with trees could also help curb the construction industry's large carbon footprint, which is accelerating climate change. A recent report by the World Green Building Council estimates that 11% of global carbon emissions come from materials and construction processes throughout the building lifecycle. As trees contain carbon, using wood in buildings is a way of storing carbon.

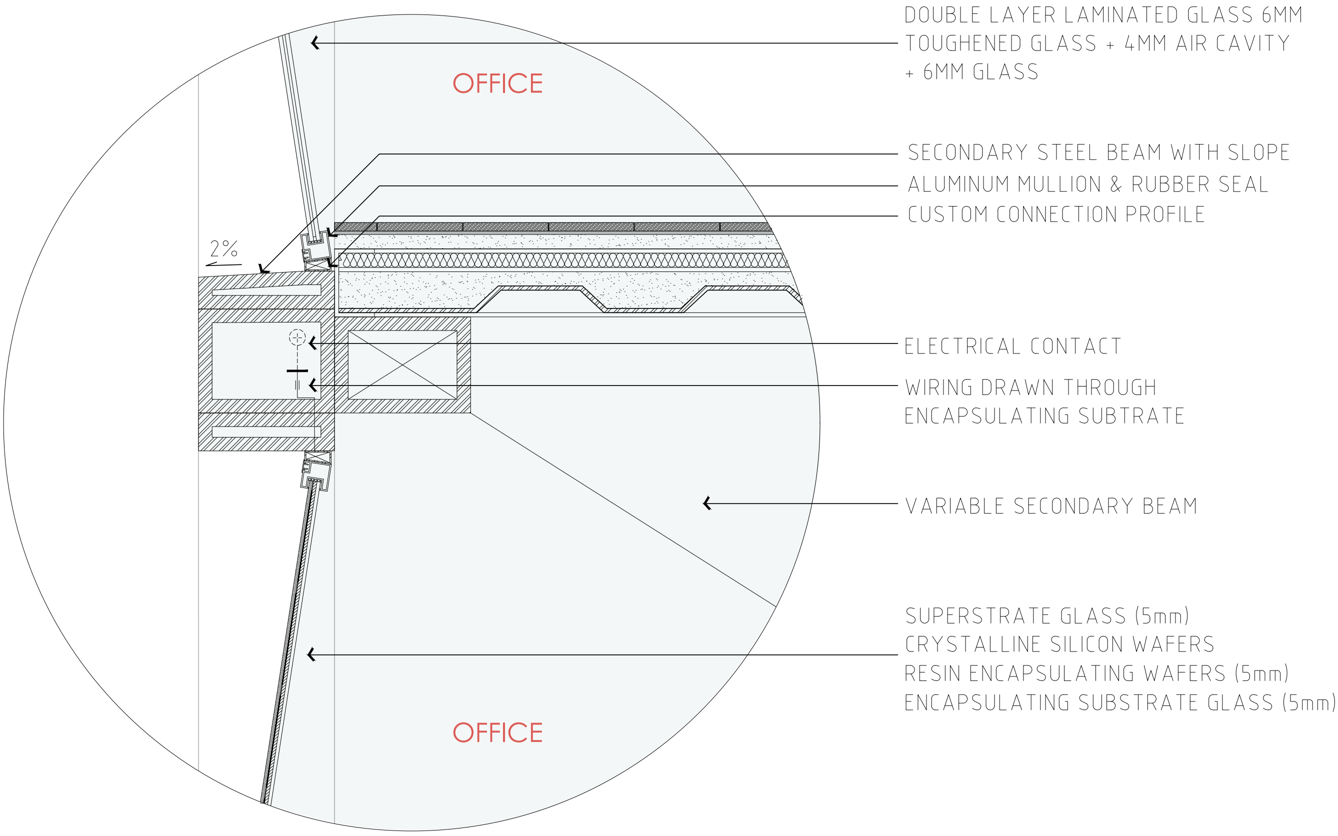
Table Design - Japan

Lars Berglund, a professor at KTH Wallenberg Wood Science Center, says that these translucent panels could not only be used in windows and facades to let in sunlight while preserving the occupant's privacy, but also would be an effective material for the surfaces of solar cells - particularly when covering large expanses of cells, where the wood's cheap production costs would offer a significant cost benefit.

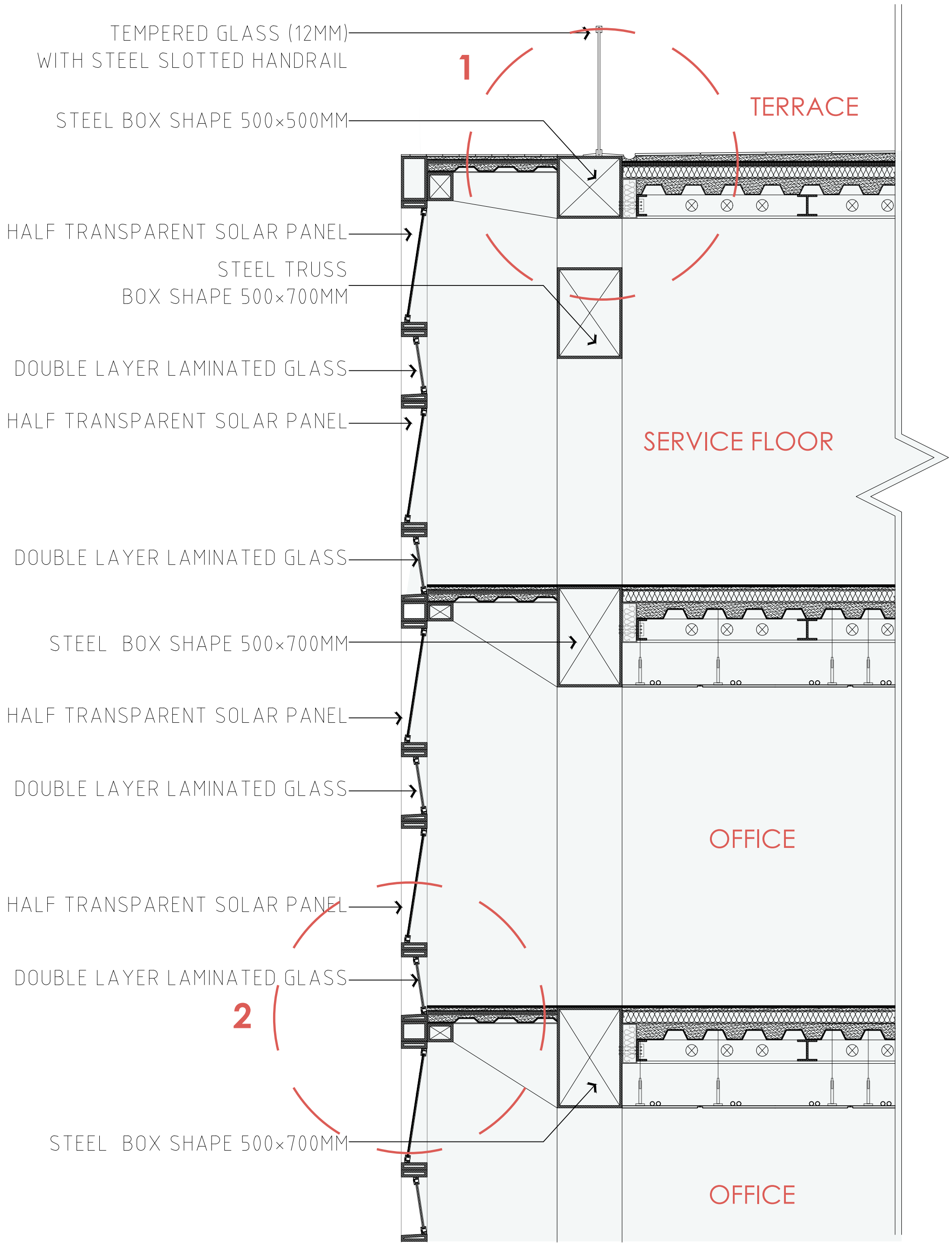
▌05 INNOVATION MATERIALS



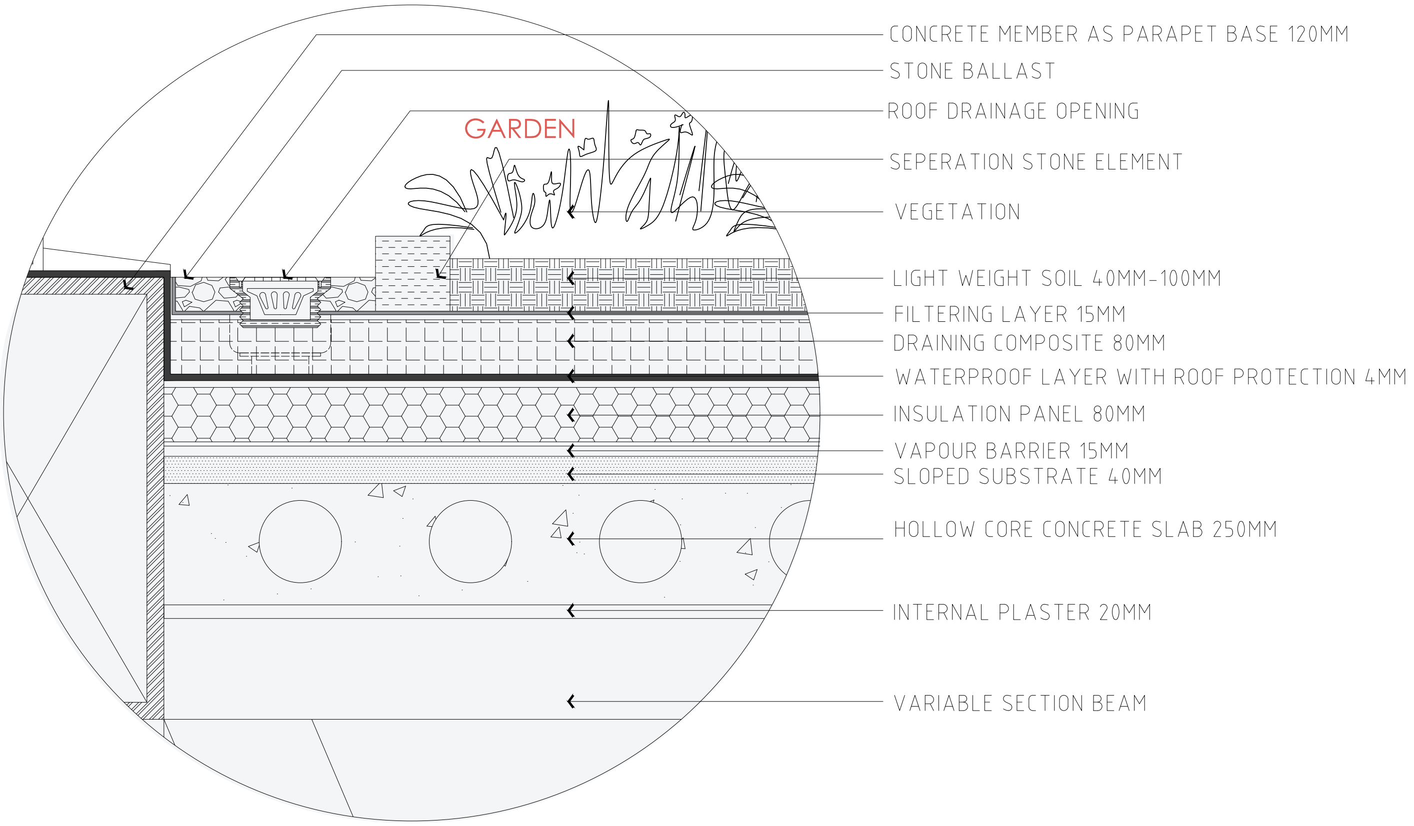
1 TOWER TERRACE DETAIL 1:10



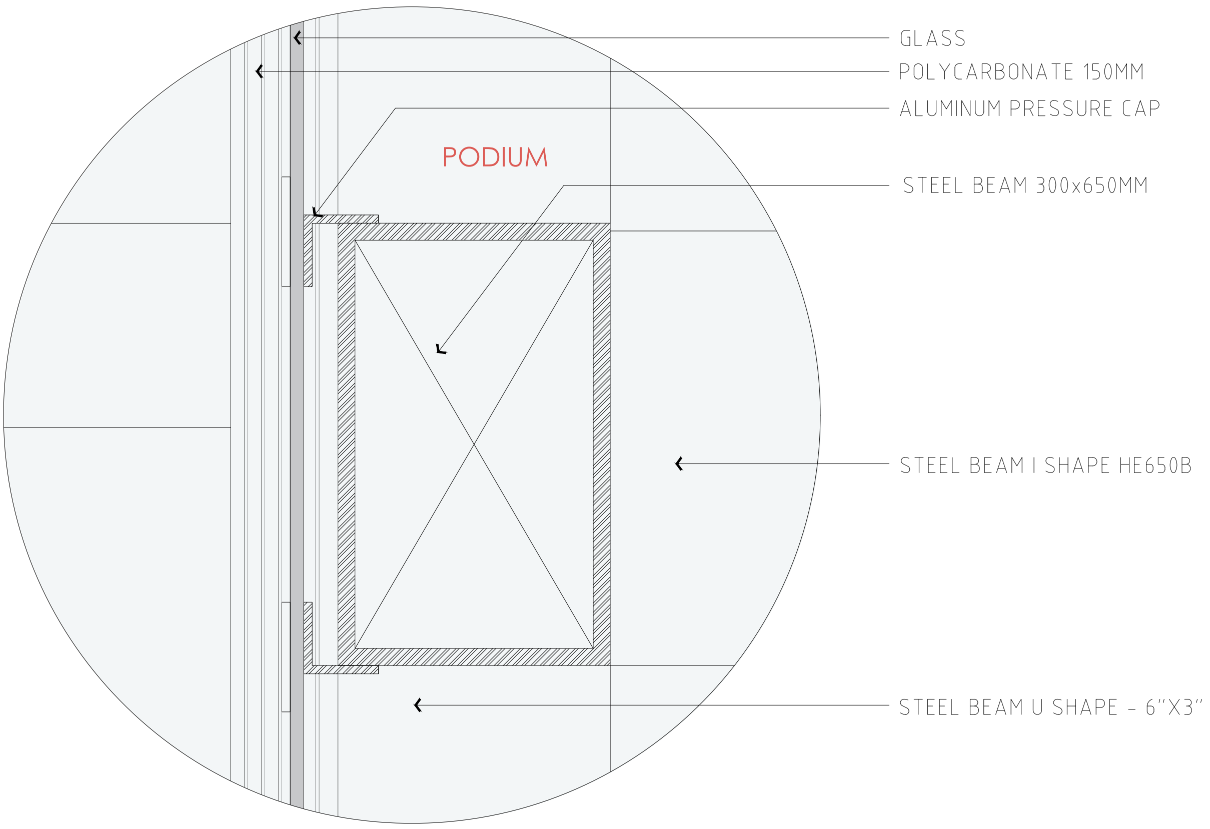
2 TOWER FACADE DETAIL 1:10



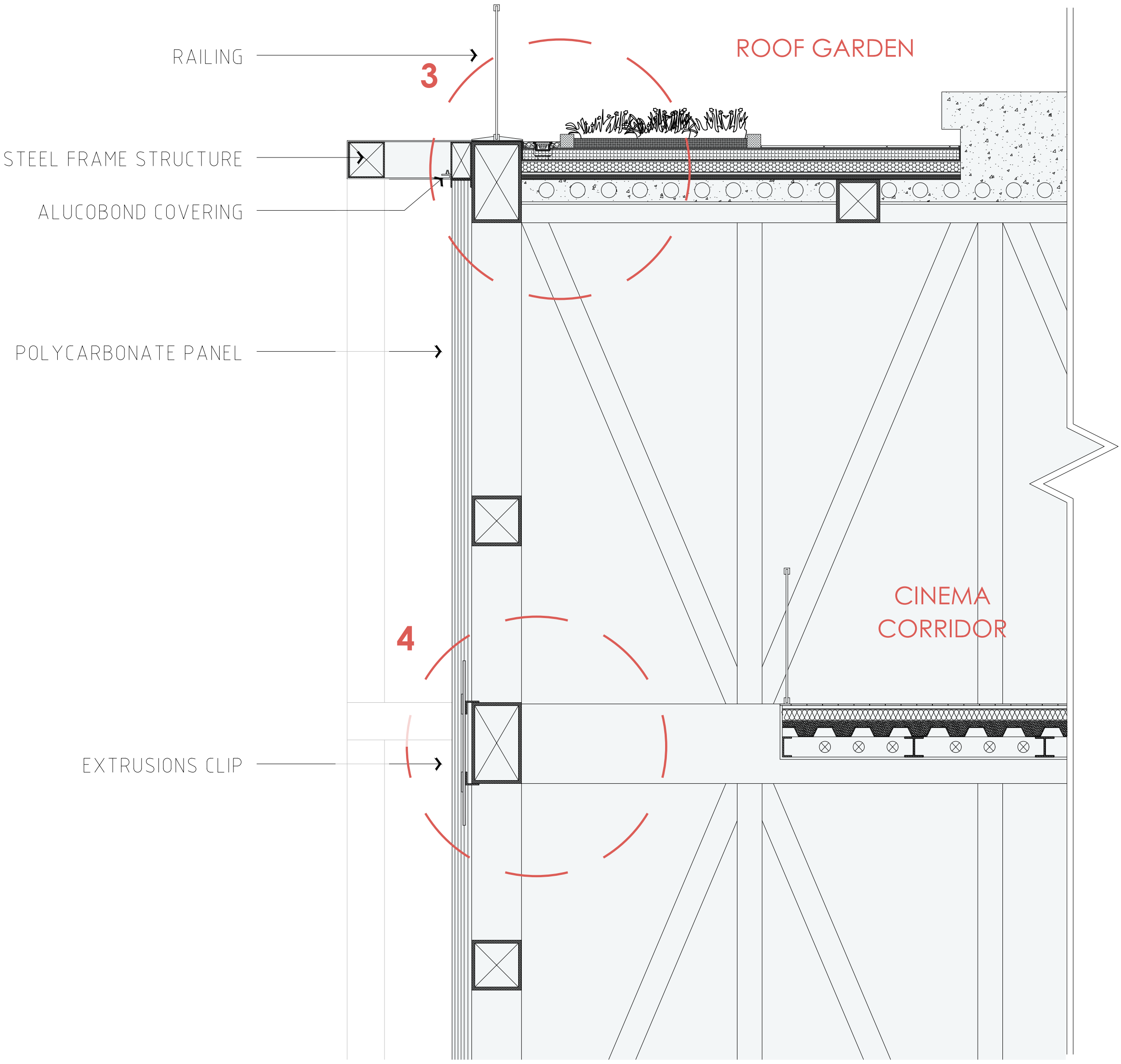
TOWER FACADE DETAIL 1:50



3 ROOF GARDEN DETAIL 1:10



4 PODIUM FACADE DETAIL 1:10



PODIUM FACADE DETAIL 1:50

Public & Service Accessibility & Details

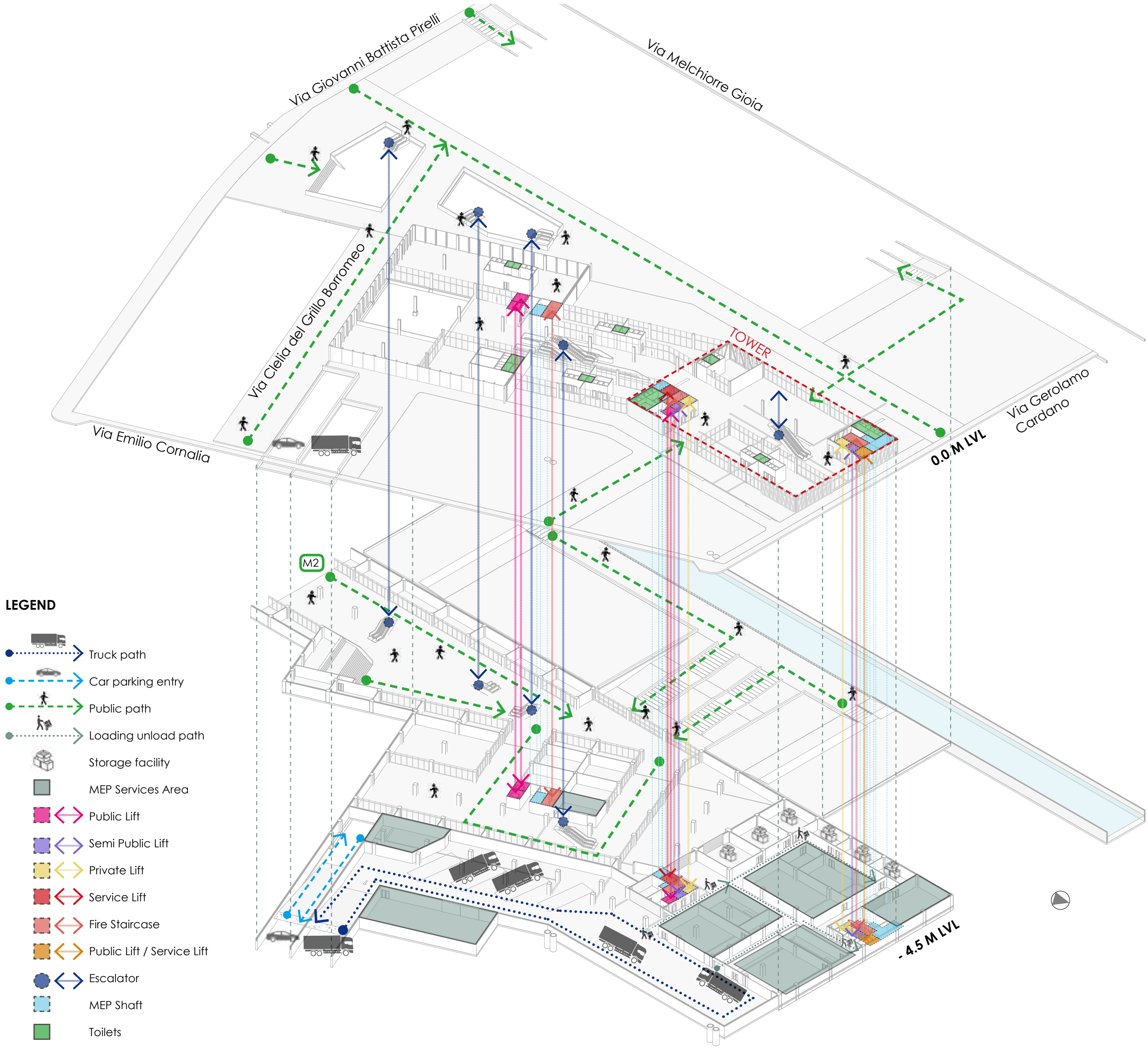
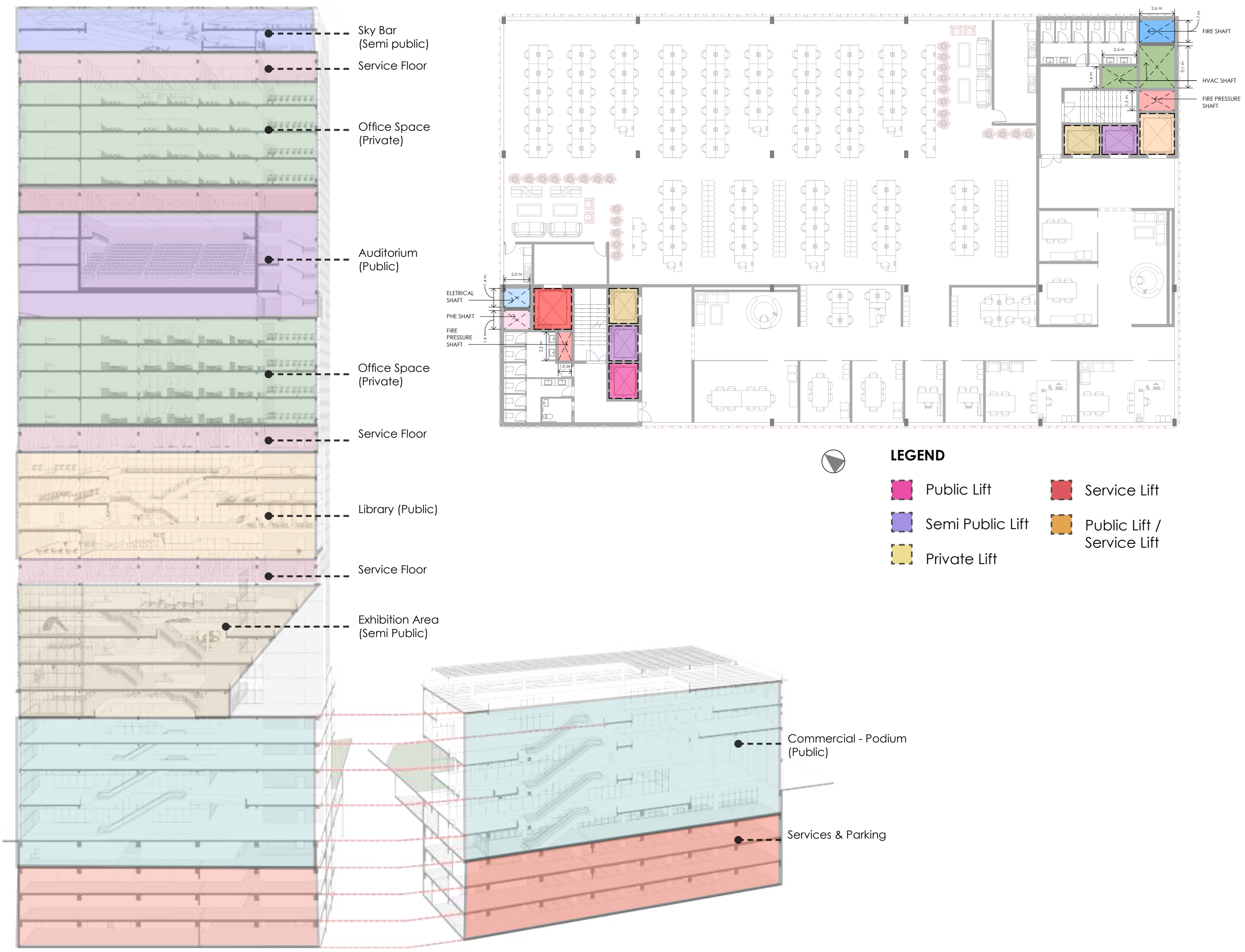


Diagram indicates the strategy of accessibility for the pedestrian and the service entry to the building & movement (Vertical and horizontal).The pedestrian movement at the ground floor is getting access from all 4 directions and the entrance to the building is through the tower from the front (Via Melchiorre Gioia) and from the back (Via Emilio Cornelia) additionally aiding entrances from the Gioia metro station side (Via Giovanni Battista Pirelli). 3 cores serve the podium and 2 cores that serve the tower. The lifts are divided into 4 categories public lift, semi-public lift, private lift, and a service lift. The escalators are connected from outside to the lower ground floor and inside to the rest of the floors of the podium. The escalator is serving the rest of the volume of the podium and the tower is been served by the lifts for vertical connectivity. The east side of the building (Via Emilio Cornelia) accommodates 2 ramps, one catering the car parking entry for the public and one entry for truck parking and loading and unloading area on the lower ground floor. The lower ground floor holds the direct connection to the Gioia metro station. The direct connection to the piazza in front of the building alongside the Naviglio (Via Melchiorre Gioia) and the backside of the lower ground floor are accommodating the parking for the trucks for the loading and unloading area, mechanical service rooms, and storage facility.

▌06 MEP DESIGN

Public & Service Accessibility & Details

Since the building is a mixed-use building we have multiple functions accomodating in the proposal starting from the bottom 3 basement belong to service and car parking. From the lower ground floor to the 4th floor of the podium is holds the commercial retail shops which are for public use. Above that are the exhibition space for semi-public use, the library for public use, office space being completely private use, an auditorium for public use, and a sky bar for semi-public use at the top. The tower holds the MEP shafts categorizing electrical, PHE, Fire protection system, and HVAC system.



Envelope material properties

1. External facade - Transparent

Onyx Solar, Solar Energy Company, Italy
Amorphous Silicon Photovoltaic Solar Glass

medium transparency (16.3 - 17.3%)	3.2+4	34%	5.70	1.00	7.1%
	6T+3.2+6T	32%	5.20	0.92	7.0%
	6T+3.2+6T/12Air/6T	14%	2.70	0.48	7.0%
	6T+3.2+6T/12Air/6T low-e	12%	1.60	0.28	7.0%
	6T+3.2+6T/12Argon/6T low-e	12%	1.20	0.21	7.0%
	6T+3.2+6T/12Argon/4/12Argon/6T low-e	12%	1.00	0.18	7.0%

Saint Gobain Glass, Italy

COOL-LITE® SKN 183 (II) is the latest innovation from Saint-Gobain Glass for the range of selective glasses with the highest light transmission. It is an ideal product for facades (curtain walls, windows), in commercial and residential areas and in buildings that need a lot of natural light without compromising on performance.

Saint Gobain Glass, Italy COOL-LITE® SKN 183 (II)

Tipo / Colore	Ug* [W/m2K]	Trasmissione Luminosa TL** [%]	Fattore Solare** [%]	Riflessione esterna** [%]	Riflessione interna** [%]
Composizione standard CLIMAPLUS® 6/16/4 – coating in faccia 2, 90% Argon					
COOL-LITE® SKN 183 e 183 II on PLANICLEAR	1.0	75	40	12	13
COOL-LITE® SKN 083 e 083 II on DIAMANT	1.0	76	41	12	13
Composizione standard CLIMATOP® 6/12/4/12/4 – coating in faccia 2 + PLANITHERM® XN in faccia 5, 90% Argon					
COOL-LITE® SKN 183 and 183 II on PLANICLEAR	0.7	68	37	14	16
COOL-LITE® SKN 083 and 083 II on DIAMANT	0.7	69	38	15	16
Composizione standard CLIMATOP® 6/12/4/12/4 – coating in faccia 2 + ECLAZ® in faccia 5, 90% Argon					
COOL-LITE® SKN 183 and 183 II on PLANICLEAR	0.7	69	37	14	16
COOL-LITE® SKN 083 and 083 II on DIAMANT	0.7	71	38	15	16

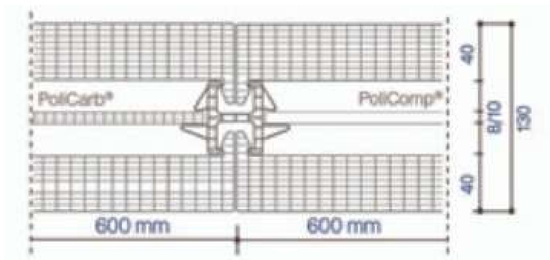
2. External facade - Opaque/ Translucent

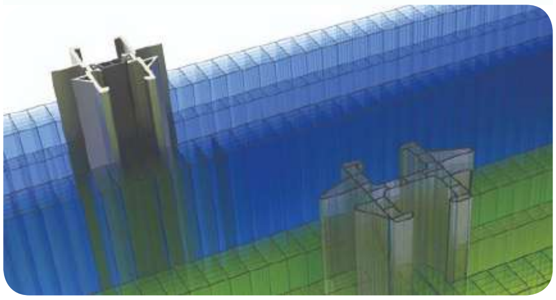
Production standards

arcoPlus®	626	9287	9327	5410
Panel thickness (mm)	20	20	32	40
System thickness (mm)	90	90	114	130
Module width (mm)	600	900	900	600
Structure (walls)	6	7	7	10
Thermal transmittance	0.62	0.64	0.51	0.40
Acoustic insulation	26	26	27	-
Light transmission	39	34	31	26

Features

Linear thermal expansion	0,065mm/m°C
Temperature range	-40°C +120 °C
U.V. rays protection	Coextrusion su 2 lati
Fire reaction EN 13501-1	EuroClass B-s1,d0





Note: The external facade is not air-tight and the shadow determined by the BIPV is negligible, thus it will not be taken into account in the following calculations.

HVAC System - Ventilation & Internal loads

Areas description	Area (m²)	Floors	Total Area (m²)	Ns (people/m²)	Total people	Air supply (l/s/person)	Simultaineity (%)	Total (m³/h)
Commercial Retails	17851.37	1	17851.37	0.25	4462.8425	6	40%	38,559
Exhibition Space	3681.85	1	3681.85	0.3	1104.555	9	35%	12,526
Offices	1251.13	8	10009.04	0.12	1201.0848	7	100%	30,267
Auditorium	3226.42	1	3226.42	1	720	6	100%	15,552
Library	3552.97	1	3552.97	0.3	1065.891	9	45%	15,541
Sky Bar	1666.97	1	1666.97	0.8	1333.576	5	50%	12,002
Toilets (Cores)	92.74	28	2735.83		Extraction		80%	0
Total								1,24,447

Reference Table - UNI 10339 - for Ventilation loads

Prospetto VIII - Indici di affollamento n_s per ogni metro quadrato di superficie

Classificazione degli edifici per categorie	n_s
EDIFICI ADIBITI A RESIDENZA E ASSIMILABILI	
- abitazioni civili:	
soggiorni, camere letto	0,04
- collegi, luoghi di ricovero, case di pena, caserme, conventi:	
• soggiorni	0,20
• sale riunioni	0,60
• dormitori	0,10
• camere letto	0,05
- alberghi, pensioni:	
• ingresso, soggiorni	0,20
• sale conferenze (piccole)	0,60
• camere letto	0,05
EDIFICI PER UFFICI E ASSIMILABILI	
• uffici singoli	0,06
• uffici open space	0,12
• locali riunione	0,60
• centri elaborazione dati	0,08
OSPEDALI, CLINICHE, CASE DI CURA E ASSIMILABILI	
• degenze (2-3 letti)	0,08
• corsie	0,12
• camere sterili e infettive	0,08
• visita medica	0,05
• soggiorni, terapie fisiche	0,20
EDIFICI ADIBITI AD ATTIVITÀ RICREATIVE, ASSOCIATIVE, DI CULTO	
- cinematografi, teatri, sale congressi	
• sale in genere	1,50
• biglietterie, ingressi	0,20 (medio)
• borse titoli e simili	0,50
• sale attesa stazioni e metropolitane, ecc.	1,00

(segue prospetto)

(seguito del prospetto)

Classificazione degli edifici per categorie	n_s
EDIFICI ADIBITI AD ATTIVITÀ RICREATIVE, ASSOCIATIVE, DI CULTO (segue)	
- musei, biblioteche, luoghi di culto	
• sale in genere	0,30
• luoghi culto	0,80
- bar, ristoranti, sale da ballo	
• bar in genere	0,80
• sale pranzo ristoranti	0,60
• sale da ballo	1,00
ATTIVITÀ COMMERCIALI E ASSIMILABILI	
- grandi magazzini	0,25
- negozi o reparti di grandi magazzini:	
• alimentari, abbigliamento, calzature, mobili, ottici, fioristi, fotografi	0,10
• barbieri, saloni di bellezza, lavasecco, farmacie, zona pubblico banche	0,20
- quartieri fieristici	0,20
EDIFICI ADIBITI AD ATTIVITÀ SPORTIVA	
- piscine, saune e assimilabili	
• piscine (sala vasca)	0,30
• saune	0,50
• ingressi	0,20
- palestre e assimilabili	
• campi gioco	0,20
• zone spettatori	1,50
• bowling	0,60
• ingressi	0,20
EDIFICI ADIBITI AD ATTIVITÀ SCOLASTICHE	
- asili nido e scuole materne	0,40
- aule scuole elementari, medie inferiori e superiori	0,45
- aule universitarie	0,60
- altri locali:	
• aule musica e lingue	0,50
• laboratori	0,30
• sale insegnanti	0,30

Prospetto VI - Classi di filtri e efficienza di filtrazione richieste per varie categorie di edifici

Classificazione degli edifici per categorie	Classe ** di filtri min.	Classe ** di filtri max.	Efficienza di filtrazione**
EDIFICI ADIBITI A RESIDENZA E ASSIMILABILI			
- abitazioni civili	4	7	M* , M + A
- collegi, luoghi di ricovero, case di pena, caserme, conventi	4	7	M* , M + A
- alberghi, pensioni	5	7	M + A
EDIFICI PER UFFICI E ASSIMILABILI			
• uffici in genere	5	7	M + A
• locali riunione	5	7	M + A
• centri elaborazione dati	6	9	M + A
OSPEDALI, CLINICHE, CASE DI CURA E ASSIMILABILI			
• degenze (2-3 letti)	6	8	M + A
• corsie	6	8	M + A
• camere sterili e infettivi	10	11	M + A + AS
• maternità, anestesia, radiazioni	10	11	M + A + AS
• prematuri, sale operatorie	11	12	M + A + AS
• visita medica	6	8	M + A
• soggiorni, terapie fisiche	6	8	M + A

EDIFICI ADIBITI AD ATTIVITÀ RICREATIVE, ASSOCIATIVE, DI CULTO			
- cinematografi, teatri, sale congressi	5	6	M + A
- musei, biblioteche	7	9	M + A
- luoghi di culto	4	6	M*, M + A
- bar, ristoranti, sale da ballo			
• bar in genere	3	5	M*, M + A
• sale pranzo ristoranti	5	6	M + A
• sale da ballo	3	5	M*, M + A
• cucine	2	4	M
ATTIVITÀ COMMERCIALI E ASSIMILABILI			
- grandi magazzini	4	6	M*, M + A
- negozi in genere	4	6	M*, M + A
- negozi particolari:			
• alimentari	5	6	M + A
• fotografi	5	6	M + A
• farmacie	5	6	M + A
- zona pubblico banche	4	6	M*, M + A
- quartieri fieristici	2	3	M

(segue prospetto)

HVAC System - Ventilation & Internal loads

			Internal Loads			
Areas description	**Total people**	**Qint,S,pp (W)**	**Total int,S (kW)**	**Qint,L,pp (W)**	**Total int,L (kW)**	**Total int (kW)**
Commercial Retails	4462.8425	75	334.7	80	357.0	
Exhibition Space	1104.555	90	99.4	230	254.0	
Offices	1201.0848	75	90.1	65	78.1	
Auditorium	720	65	46.8	45	32.4	
Library	1065.891	65	69.3	45	48.0	
Sky Bar	1333.576	80	106.7	115	153.4	
Basement Parking	2921.388	0	0.0	0	0.0	
Toilets (Cores)	0	0	0.0	0	0.0	
Total			747.0		922.9	**1669.8**
Equipament	Qint,S,app neglegible	Qint,L,app neglegible				

Reference for Internal loads

Sensile heat load – Internal loads

$$Q_{INT,S} = Q_{INT,S,pp}\, n^{\circ}_{pp} + \sum Q_{INT,S,app}$$

Internal loads (People). They must be estimated in fuction of personal activity and occupational profile [W/pp]:

Attività	applicazioni	$Q_{INT,S,pp}$
Seduto a riposo	teatro	65
Seduto in attività leggera	ufficio, appartamento	70
Seduto in attività media	ufficio, appartamento	75
Seduto al ristorante	ristorante	80
In piedi, lavoro leggero	negozio	75
In piedi, lavoro medio	officina	80
In piedi, lavoro pesante	officina, cantiere	145
In movimento	banca	75
Danza moderata	sala da ballo	90
In cammino a 1,3 m/s	corridoi	110
Attività atletica	palestra, discoteca	210

Internal loads (Equipment). They must be estimated in fuction of the equipment installed and temporal profile of usage [W]:

Apparecchiatura	P_{max}	$Q_{INT,S,app}$
Apparecchiature per ufficio		
Personal computers	100÷600	90÷550
Minicalcolatori	2000÷6500	2000÷6500
Stampanti laser	850	350
Copiatrici eliografiche	1100÷12500	1100÷12500
Fotocopiatrici	450÷6600	450÷6600
Scanner	1700	1500
Imbustatrici ed etichettatrici	600÷6000	400÷4000
Distributori di acqua refrigerata	700	175
Distributori di bevande fredde	1200-1900	550-900
Macchine del caffè	1500	1000
Forni a microonde	600	400
Distruttori di documenti	250÷3000	200÷2400

Latent heat load- Internal loads

$$Q_{INT,L} = Q_{INT,L,pp}\, n^{\circ}_{pp} + \sum Q_{INT,L,app}$$

Internal loads (People). They must be estimated in fuction of personal activity and occupational profile [W/pp]:

Attività	applicazioni	$Q_{INT,V,pp}$
Seduto a riposo	teatro	45
Seduto in attività leggera	ufficio, appartamento	65
Seduto in attività media	ufficio, appartamento	80
Seduto al ristorante	ristorante	115
In piedi, lavoro leggero	negozio	80
In piedi, lavoro medio	officina	200
In piedi, lavoro pesante	officina, cantiere	410
In movimento	banca	100
Danza moderata	sala da ballo	230
In cammino a 1,3 m/s	corridoi	265
Attività atletica	palestra, discoteca	450

Internal loads (Equipment). They must be estimated in fuction of the equipment installed and temporal profile of usage [W]:

Apparecchiatura	$Q_{INT,V,app}$
Apparecchiature per ufficio	
Personal computers	0
Minicalcolatori	0
Stampanti laser	0
Copiatrici eliografiche	0
Fotocopiatrici	0
Scanner	0
Imbustatrici ed etichettatrici	0
Distributori di acqua refrigerata	0
Distributori di bevande fredde	650
Macchine del caffè	0
Forni a microonde	0
Distruttori di documenti	

HVAC System - Heating & Cooling Loads

Summer Heating Load Calculations -
The tower facade surfaces, considered for heating and cooling loads, are varying due to its mass and void typology. Similarly the podium facade surface is also varying with respect to configuaration of multiple cantilevers that constitutes the building.

- The tower facade is being considered in Transparent surface i.e. -
PV& Double Glazed Unit with U value as 1.00 W/(mq K) & 1.00 W/(mq K) respectively. the proportion of th panel is PV - 50% & DGU - 50%.

Area of Panel = 2.59
Area of DGU = 1.14
Area of PV Panel = 1.14
Area of Frame = 0.31
f = Area of glass/(Area of glass+Area of frame) = **0.88**

- The podium facade is being considered in Opaque surface i.e. -
Polycarbonate with U value as 0.4 W/(mq K)

Dati Generali				Note
Località		Milano	-	
Temperatura esterna progetto	T_e	32	°C	*Valore compreso fra 5 e 17 °C
Escursione termica giornaliera*	ΔT_e	12	°C	**Valore compreso fra:
Umidità assoluta esterna massima	X_e	14.4	g/kg	pareti verticali: 100 e 700 kg/mq
Latitudine		45	°	orizzontale sole: 50 e 400 kg/mq
		27	'	orizzontale ombra: 100 e 300 kg/mq
Temperatura ambiente progetto	T_a	27	°C	***Valore compreso fra 150 e 730 kg/mq
Umidità ambiente progetto	X_a	12.7	g/kg	
Massa in pianta***	M_a	158.6	kg/mq	RIEMPIRE CAMPI CON BORDO ARANCIONE
Portata aria esterna di rinnovo	V	124446.8	mc/h	

Dati Involucro

	Superfici Opache			Finestre			
Esposizione	U_p	$M_{f,p}$**	S_p	U_F	f	F=SC F_{vs}	S_F
	W/(mq K)	kg/mq	mq	W/(mq K)	-	-	mq
NORD	0	150	0.0	1.00	0.88	0.82	4258.19
EST	0.4	150	1131.7	1.00	0.88	0.82	7195.67
OVEST	0.4	150	1503.2	1.00	0.88	0.82	6667.92
SUD	0.4	150	684.5	1.00	0.88	0.82	3723.82
ORIZZONTALE OMBRA	0.14	168.8	1601.0				
ORIZZONTALE SOLE	0.27	158.6	3605.1				

Carichi Interni

Carico interno sensibile costante	$Q_{int,s,cost}$	746973	W
Carico interno latente costante	$Q_{int,l,cost}$	922872	W

Carichi interni totali	Ora	Costante	Variabile	Costante	Variabile
	H	$Q_{int,s,cost}$	$Q_{int,s,var}$	$Q_{int,l,cost}$	$Q_{int,l,var}$
	h	W	W	W	W
	8	746973.5	0.0	922871.9	0.0
	9	746973.5	0.0	922871.9	0.0
	10	746973.5	0.0	922871.9	0.0
	11	746973.5	0.0	922871.9	0.0
	12	746973.5	0.0	922871.9	0.0
	13	746973.5	0.0	922871.9	0.0
	14	746973.5	0.0	922871.9	0.0
	15	746973.5	0.0	922871.9	0.0
	16	746973.5	0.0	922871.9	0.0
	17	746973.5	0.0	922871.9	0.0
	18	746973.5	746973.5	922871.9	922871.9
	19	746973.5	746973.5	922871.9	922871.9
	20	746973.5	746973.5	922871.9	922871.9
	21	746973.5	746973.5	922871.9	922871.9
	22	746973.5	746973.5	922871.9	922871.9
	23	746973.5	0.0	922871.9	0.0
	24	746973.5	0.0	922871.9	0.0

HVAC System - Heating & Cooling Loads

CARICO SENSIBILE (POTENZA IN W)

Ora del giorno			4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
NORD	Pareti	Trasm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Finestre	Trasm	21,291.0	21,291.0	21,291.0	21,291.0	21,291.0	21,291.0	21,291.0	21,291.0	21,291.0	21,291.0	21,291.0	21,291.0	21,291.0	21,291.0	21,291.0	21,291.0	21,291.0
	Finestre	Irragg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EST	Pareti	Trasm	3,621.5	4,074.2	4,526.9	4,979.6	5,432.3	5,884.9	6,337.6	6,790.3	7,243.0	7,695.7	8,148.4	8,601.1	9,053.8	9,506.4	9,959.1	10,411.8	10,864.5
	Finestre	Trasm	35,978.4	35,978.4	35,978.4	35,978.4	35,978.4	35,978.4	35,978.4	35,978.4	35,978.4	35,978.4	35,978.4	35,978.4	35,978.4	35,978.4	35,978.4	35,978.4	35,978.4
	Finestre	Irragg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OVEST	Pareti	Trasm	4,810.1	5,411.3	6,012.6	6,613.9	7,215.1	7,816.4	8,417.6	9,018.9	9,620.2	10,221.4	10,822.7	11,423.9	12,025.2	12,626.5	13,227.7	13,829.0	14,430.2
	Finestre	Trasm	33,339.6	33,339.6	33,339.6	33,339.6	33,339.6	33,339.6	33,339.6	33,339.6	33,339.6	33,339.6	33,339.6	33,339.6	33,339.6	33,339.6	33,339.6	33,339.6	33,339.6
	Finestre	Irragg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUD	Pareti	Trasm	2,190.3	2,464.1	2,737.9	3,011.7	3,285.5	3,559.2	3,833.0	4,106.8	4,380.6	4,654.4	4,928.2	5,202.0	5,475.8	5,749.5	6,023.3	6,297.1	6,570.9
	Finestre	Trasm	18,619.1	18,619.1	18,619.1	18,619.1	18,619.1	18,619.1	18,619.1	18,619.1	18,619.1	18,619.1	18,619.1	18,619.1	18,619.1	18,619.1	18,619.1	18,619.1	18,619.1
	Finestre	Irragg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OR. OMBRA	Pareti	Trasm	1,793.1	2,017.3	2,241.4	2,465.5	2,689.7	2,913.8	3,138.0	3,362.1	3,586.2	3,810.4	4,034.5	4,258.7	4,482.8	4,706.9	4,931.1	5,155.2	5,379.4
OR. SOLE	Pareti	Trasm	7,786.9	8,760.3	9,733.6	10,707.0	11,680.4	12,653.7	13,627.1	14,600.5	15,573.8	16,547.2	17,520.5	18,493.9	19,467.3	20,440.6	21,414.0	22,387.4	23,360.7
INFILTRAZIONI			2,08,448.4	2,08,448.4	2,08,448.4	2,08,448.4	2,08,448.4	2,08,448.4	2,08,448.4	2,08,448.4	2,08,448.4	2,08,448.4	2,08,448.4	2,08,448.4	2,08,448.4	2,08,448.4	2,08,448.4	2,08,448.4	2,08,448.4
CARICHI INTERNI		Costc Qint,s,cost W			7,46,973.5	7,46,973.5	7,46,973.5	7,46,973.5	7,46,973.5	7,46,973.5	7,46,973.5	7,46,973.5	7,46,973.5	7,46,973.5	7,46,973.5	7,46,973.5	7,46,973.5	7,46,973.5	7,46,973.5
		Varia Qint,s,var W			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7,46,973.5	7,46,973.5	7,46,973.5	7,46,973.5	7,46,973.5
Totale			**3,37,878**	**3,40,404**	**10,89,902**	**10,92,428**	**10,94,953**	**10,97,478**	**11,00,003**	**11,02,529**	**11,05,054**	**11,07,579**	**11,10,104**	**11,12,629**	**18,62,128**	**18,64,653**	**18,67,179**	**18,69,704**	**18,72,229**
MASSIMO CARICO SENSIBILE			**1872229.16 W**																

CARICO LATENTE (POTENZA IN W)

Ora del giorno		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
INFILTRAZIONI		52.9	52.9	52.9	52.9	52.9	52.9	52.9	52.9	52.9	52.9	52.9	52.9	52.9	52.9	52.9	52.9	52.9
CARICHI INTERNI	Costc	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Varia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	922871.9	922871.9	922871.9	922871.9	0.0	0.0
Totale		**52.9**	**52.9**	**52.9**	**52.9**	**52.9**	**52.9**	**52.9**	**52.9**	**52.9**	**52.9**	**52.9**	**922924.8**	**922924.8**	**922924.8**	**922924.8**	**52.9**	**52.9**
MASSIMO CARICO LATENTE		**922924.83 W**																

Maximum sensitive load - **1872229.16 W**
Maximum latent load - **922924.83 W**

Winter Heating Load Calculations -

Winter heat load Calculations
QHL,i = QT,i+ QV,i +Qhu,i

Design external Temperature	-5 °C
Average seasonal external temperature **Tavg,e**	13.7 °C
Design internal temperature	20 °C

Thermal dispersion by transmission
QT = QT,ie +QT,iae + QT,ia + QTi,g

Thermal dispersion for transmision towards external
QT,e= ∑ [ei Ai Ui (Tint,i– Te)] + ∑ [ei LiΨ (Tint,i – Te)] +∑ [Φ ei (Tint,i – Te)]

Note:Considering thermal bridge as zero

Polycarbonate Façade	ei (From table)	Area (m^2)	U (W/m^2K)	T_{int}	T_{ext}	QT,e (W)
North-East	1.2	0	0	20	-5	0
South-East	1.1	1131.72	0.4	20	-5	12448.92
South-West	1.05	684.47	0.4	20	-5	7186.935
North-West	1.15	1503.15	0.4	20	-5	17286.225

'V- DGU-Transparent Façade	ei (From table)	Area (m^2)	U (W/m^2K)	T_{int}	T_{ext}	QT,e (W)
North-East	1.2	4258.19	1.00	20	-5	127745.7
South-East	1.1	7195.67	1.00	20	-5	197880.925
South-West	1.05	3723.82	1.00	20	-5	97750.275
North-West	1.15	6667.92	1.00	20	-5	191702.7

Roof	ei (From table)	Area (m^2)	U (W/m^2K)	T_{int}	T_{ext}	QT,e (W)
Polycarbonate roof North-Ea	1.2	1540.25	0.4	20	-5	18483
Opaque (Green) roof South-	1.05	2064.8	0.14	20	-5	7588.14
					TOTAL	**678072.82**

Thermal dispersion for transmisiion towards Unheated spaces
QT,iae= ∑ [bu,i Ai Ui (Tint,i– Te)] + ∑ [bu.i LiΨ (Tint,i – Te)]

Note:Considering thermal bridge as negligibe

Roof	bu (From table)	Area (m^2)	U (W/m^2K)	T_{int}	T_{ext}	QT,e (W)
Polycarbonate roof North-Ea	0.7	1540.25	0.4	20	-5	10781.75
Opaque (Green) roof South-	0.7	2064.8	0.14	20	-5	5058.76

Basement	bu (From table)	Area (m^2)	U (W/m^2K)	T_{int}	T_{ext}	QT,e (W)
without external door	0.5	1450.035	0.7	20	-5	12687.81
					TOTAL	**28528.32**

HVAC System - Heating & Cooling Loads

Winter Heating Load Calculations -

Reference table EN 12831: 2017

Unheated space			f_i
Room or group of adjoining rooms/spaces	1 external wall		0,4
	2 external walls	without external doors	0,5
		with external doors	0,6
	3 or more external walls; e.g. external (heated) staircase		0,8
Basement [a]	without external doors/windows		0,5
	with external doors/windows		0,8
Roof space	high ventilation rate of the roof space; e.g. roofs with discontinuous covers (tiles, etc.) and without a sealing sarking layer		1,0
	other non-insulated roofs		0,9
	insulated roofs		0,7
Circulation area	internal space (no external walls) with low ventilation ($\leq 0,5\ h^{-1}$)		0,0
	freely ventilated $\left(\frac{A_{openings}}{V} > 0.005 \cdot \left[\frac{m^2}{m^3}\right]\right)$		1,0
Floor	suspended (floor above crawl space)		0,8

[a] A room can be considered as a basement if more than 70 % of the external wall area is in contact with the ground.

Exposure factor (e_i)

	e_i [-]
North	1.20
East	1.15
West	1.10
South	1.00

Ventilation is handled by AHU

Polycarbonate Façade	**φ (from table)**	**Area (m^2)**	**Qhu.i (W)**
North-East	94	0	0
South-East	94	1131.72	106381.68
South-West	94	684.47	64340.18
North-West	94	1503.15	141296.1

'V- DGU-Transparent Façade	**φ (from table)**	**Area (m^2)**	**Qhu.i (W)**
North-East	94	4258.19	400269.86
South-East	94	7195.67	676392.98
South-West	94	3723.82	350039.08
North-West	94	6667.92	626784.48

Roof	**φ (from table)**	**Area (m^2)**	**Qhu.i (W)**
North	94	3605.05	338874.7
		Total	**2704379.06**

Total Winter heat load	kW	**3411.0**
Total Summer heat load	kW	**2795.2**
Total heat load	W	**6206134.2**
Heat load converted to BTU/Hr	1W = 3.412142 BTU/hr	**21176211.15**
Total BTU/Hr divieded 12000 to find system tonage	TR	**1764.68**

Cross Section Calculations -

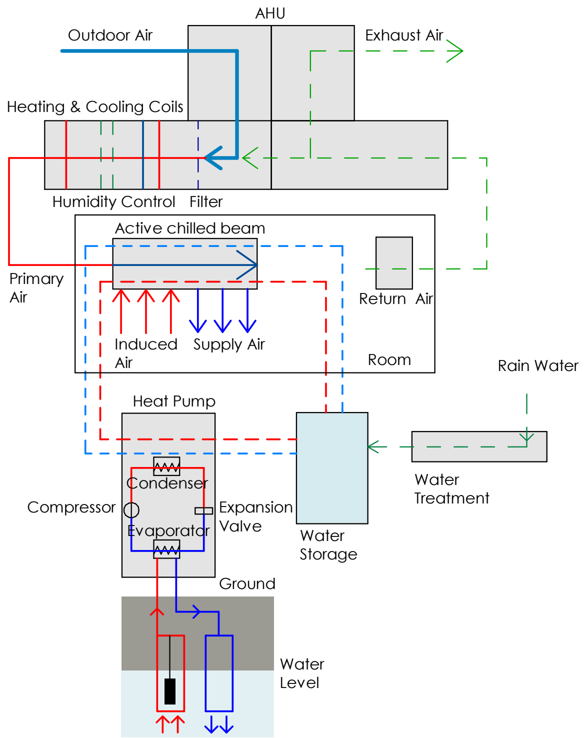
Qsensible (W)	m air (kg/s)	Airflow rate (m^3/s)	c p,air	T air,amb,sp	T air,in	Air speed (m/s)	Cross section (m^2)
18,72,229	41	34.6	1000	27	40.7	3.5	9.88

Size of ducts	**1.2m X 1m**	**Cross section of required duct / no. of ducts in AHU - 8 units**	**1.2**

HVAC System

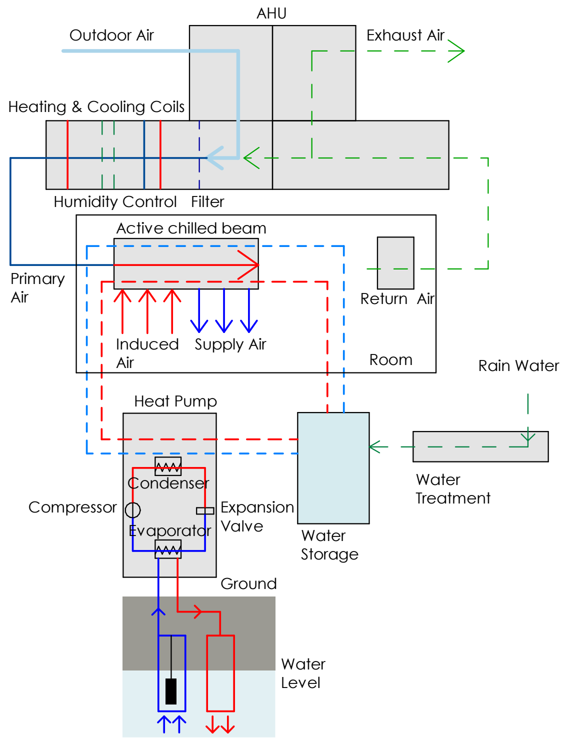
The chiller plant room and Air handler rooms are located on the lower ground floor that is -4.5 level for easy access for maintenance. The chiller system is water-based catered by a geothermal system - groundwater wells - open loop. The location of the wells is towards the east side of the building. The AHU used in the building is air & water-based primary air.

HVAC SCHEME



Open Loop groud water geothermal system

HVAC SYSTEM - SUMMER FUNCTIONING

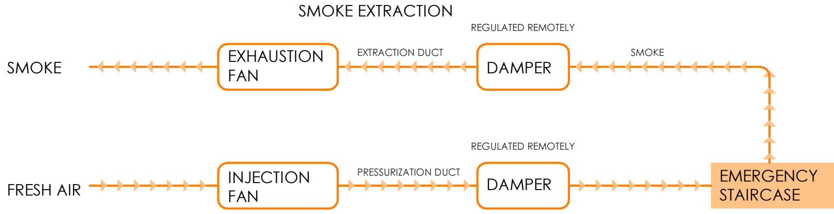


Open Loop groud water geothermal system

HVAC SYSTEM - WINTER FUNCTIONING

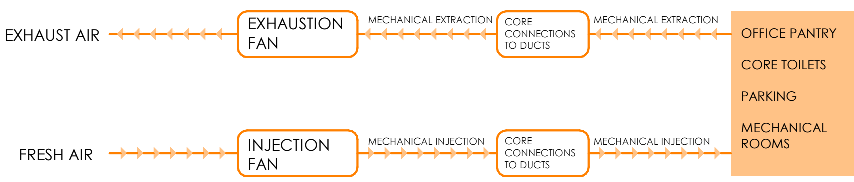
VENTILATION SCHEME

SMOKE EXTRACTION



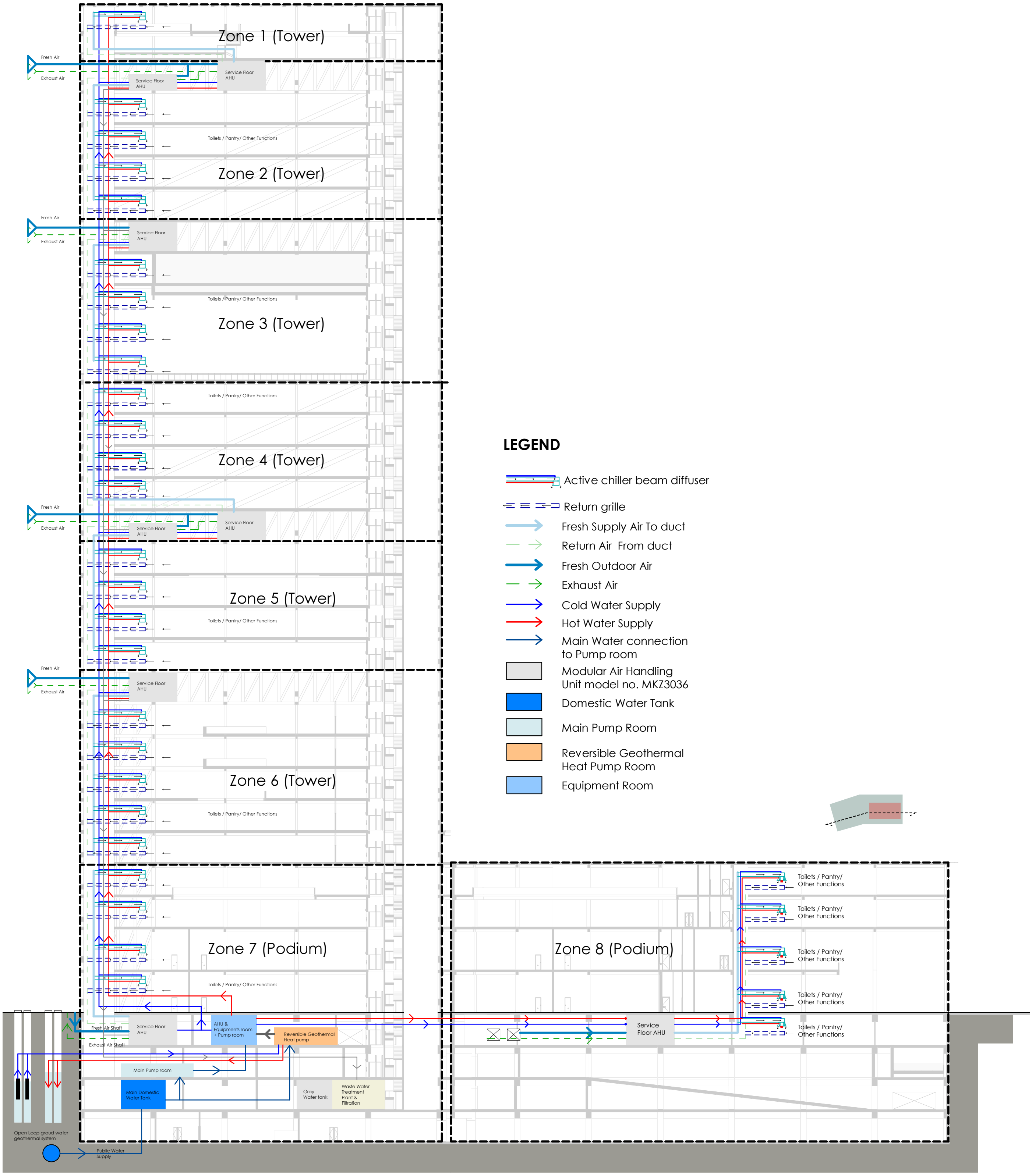
EMERGENCY PRESSURIZATION

SERVICE VENTILATION



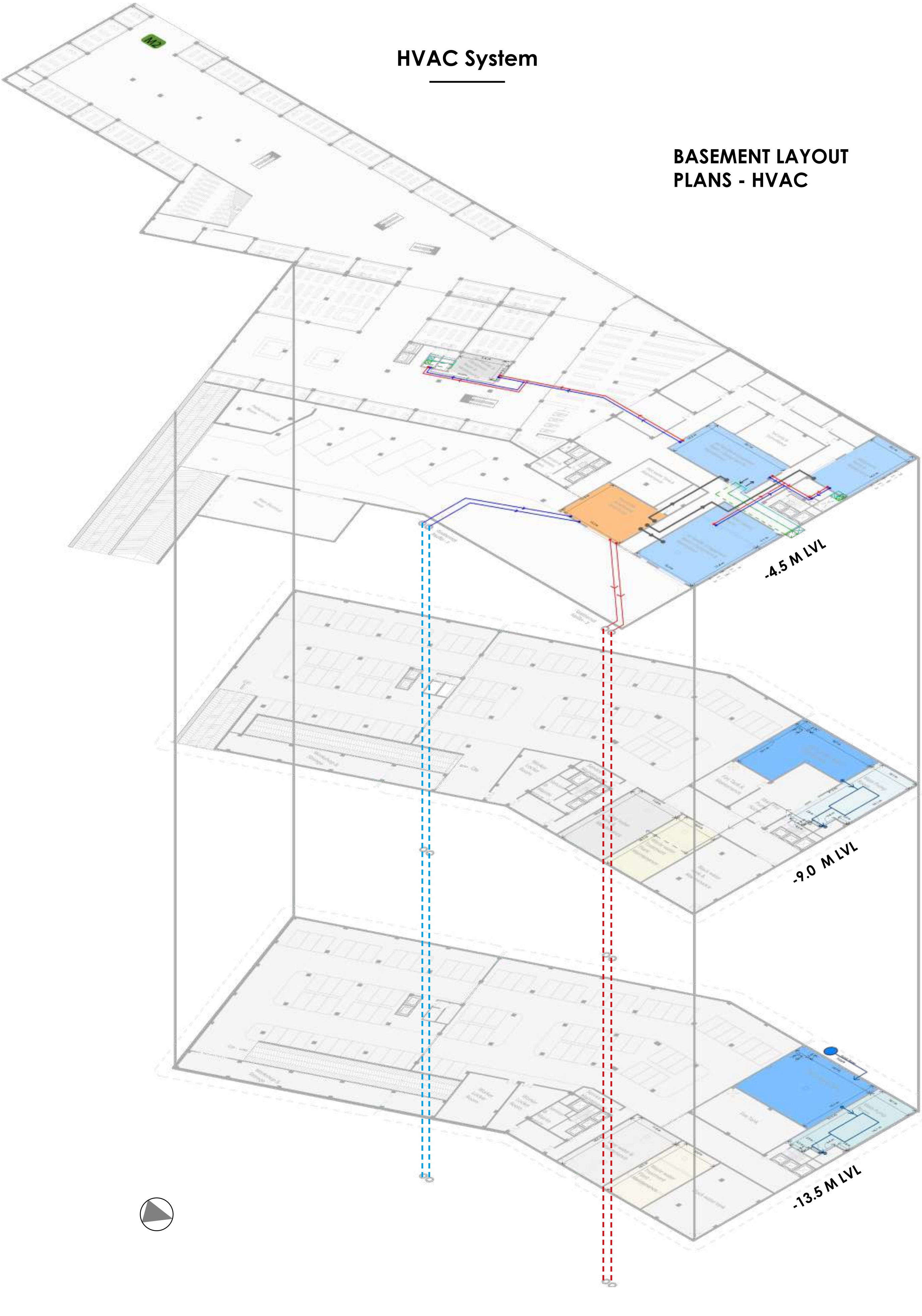
HVAC System

HVAC SCHEME SECTION

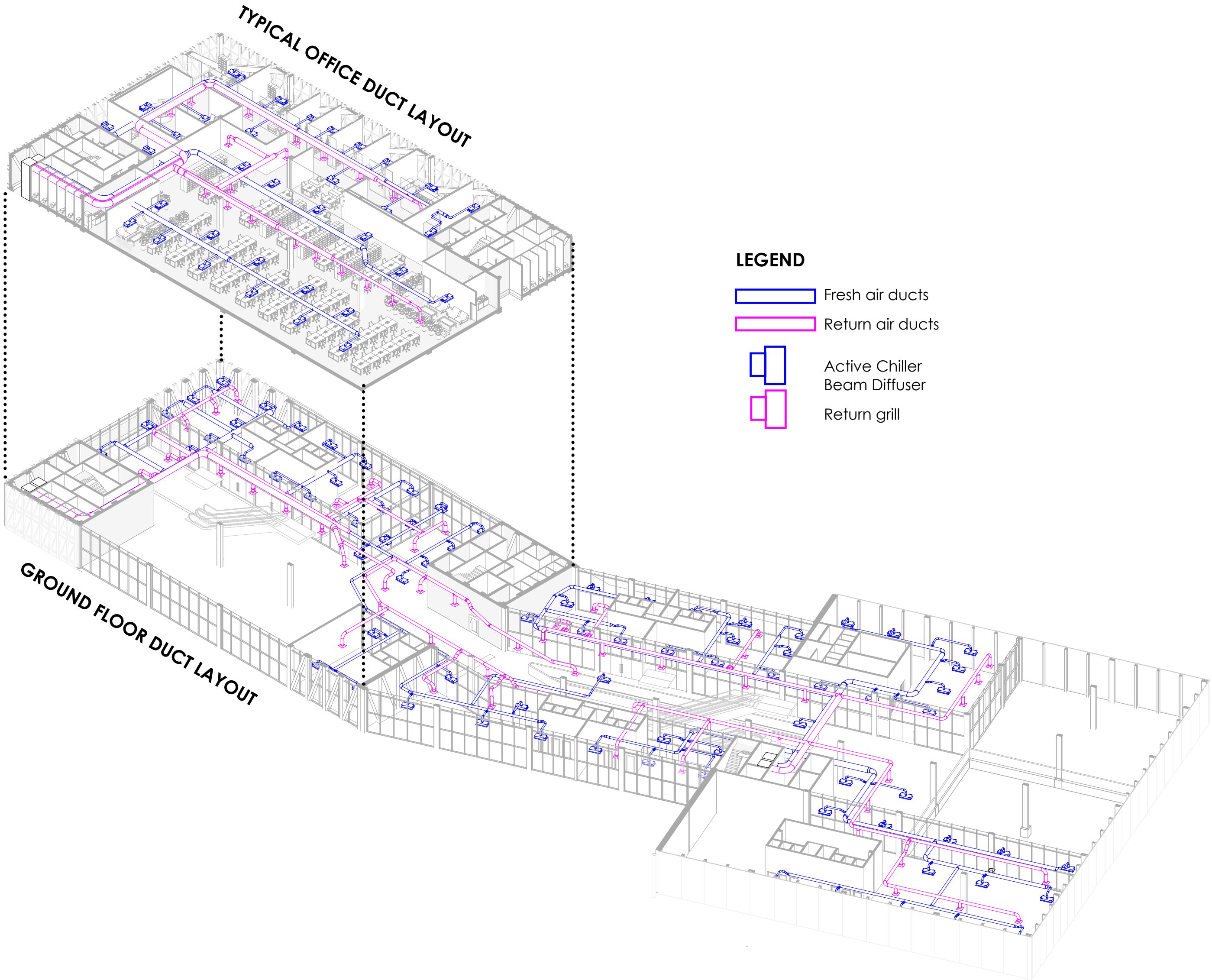


HVAC System

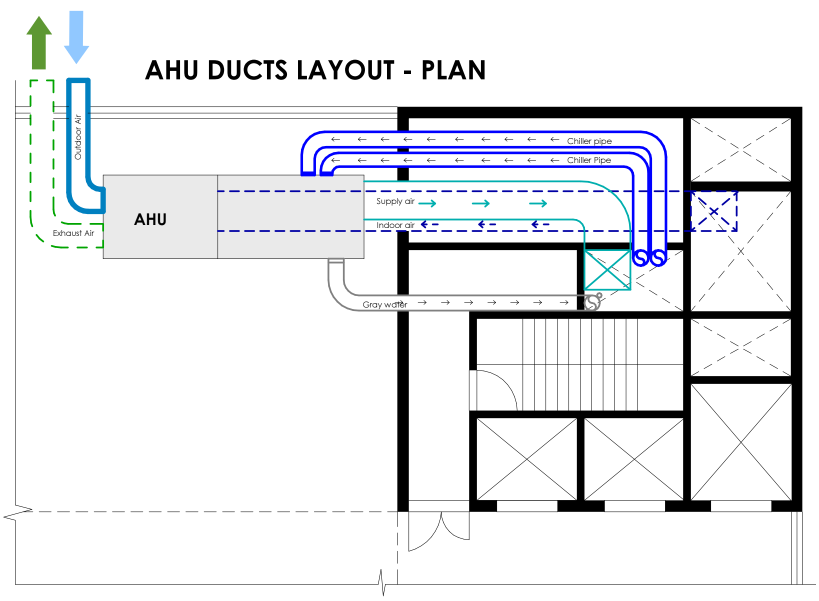
BASEMENT LAYOUT PLANS - HVAC



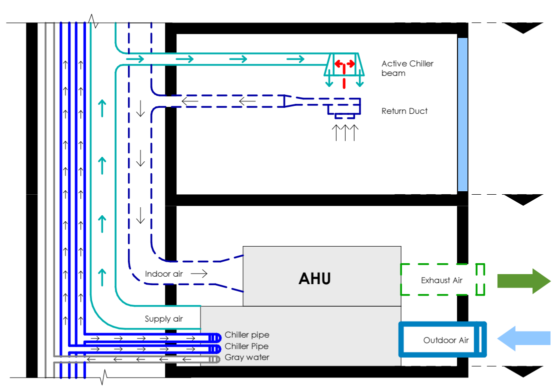
HVAC System



AHU DUCTS LAYOUT - PLAN

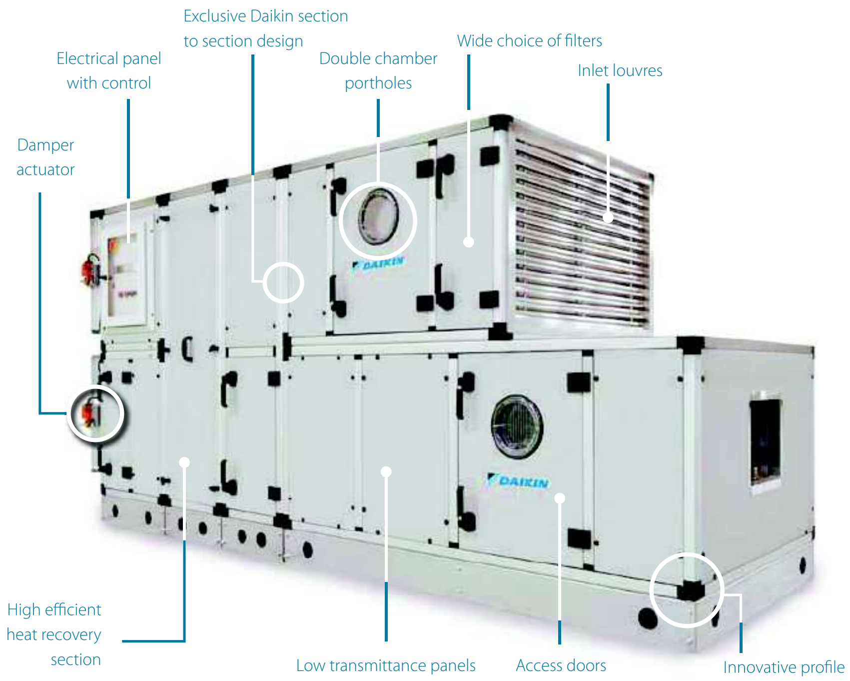


AHU DUCTS LAYOUT - SECTION



HVAC System - Equipment Details

Air Handling Unit D-AHU Professional



Flexible design Daikin Professional air handlers are tailored to your needs, optimizing always the unit for the most cost-effective selection and manufacturing standardization.

» Air flow from 500 m³/h up to 144,000 m³/h.

» All the units can be modularly designed to facilitate the transport and the assembly on site.

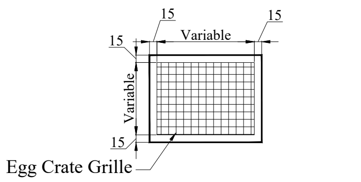
Airflow	Airflow per zone	Unit Size	Height	Width	Face Velocity
(m3/h)	(m3/h)	(m)	(mm)	(mm)	(m/s)
1,24,447	15555.85	1.57 X 2.19	1570	2190	3.5

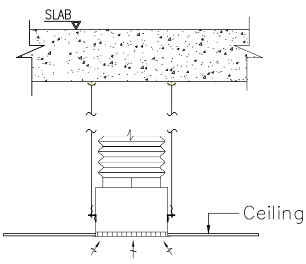
REFERENCE - Active chilled beam Unit - ACB20 - Dadanco catalogue

» An ACB20 is a twin vertical coil Active Chilled Beam with drain pans suitable for use in low temperature chilled water applications.

» In sensible cooling only (dry coil) designs, the ACB20 can be used as a safeguard against unanticipated condensation.

RETURN AIR GRILLE DETAIL

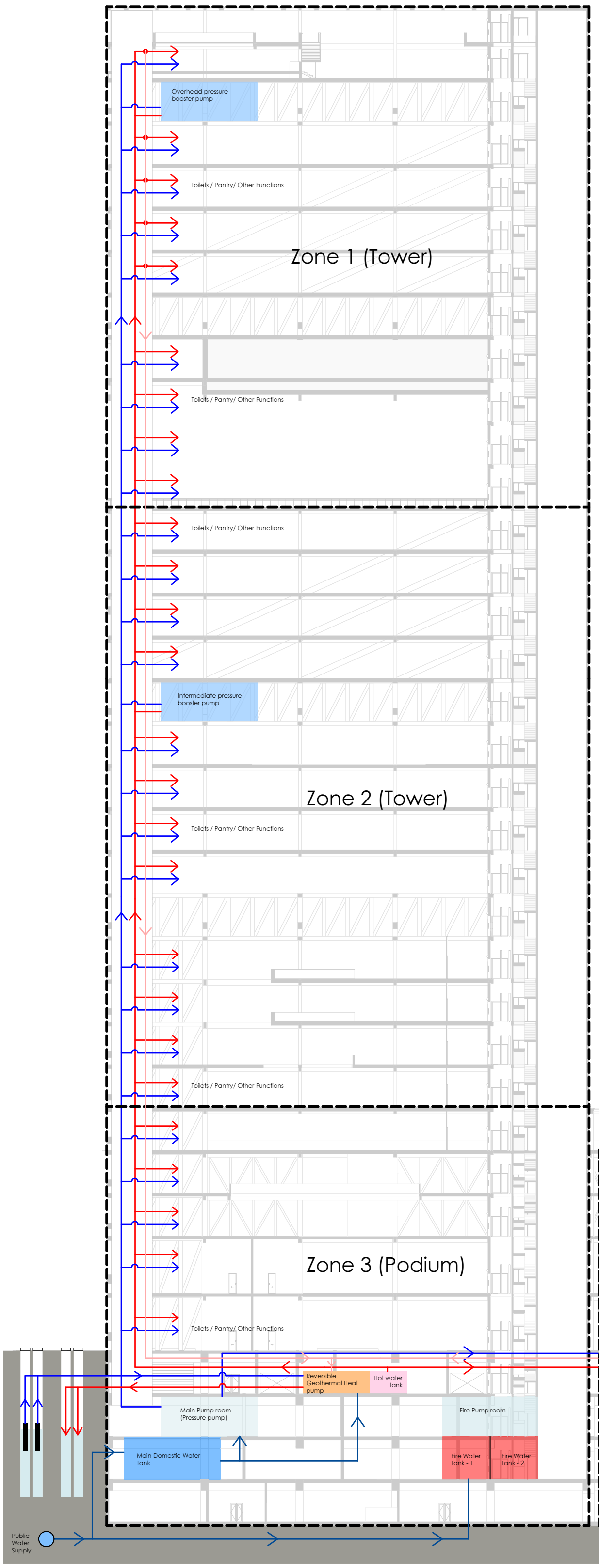




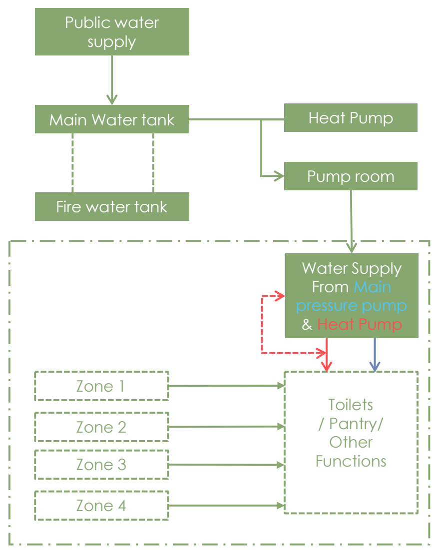
EGG CRATE GRILLE

Water Supply System

The water tank is positioned at -13.5m level with a public water supply. Further connected to pressure pump room at -9.0 m level. The water tank is also connected to a reversible geothermal heat pump for hot water connection. Water is carried all throughout the height of the building, pressure being maintained by the intermediate booster pumps located in service floors



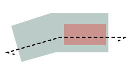
WATER SUPPLY SCHEME

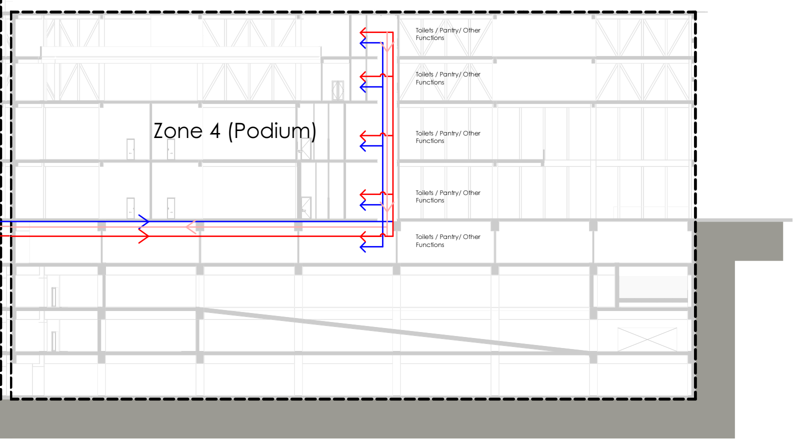


LEGEND

- Main Water Supply
- Hot Water Supply
- Cold Water Supply
- Hot water recirculation
- Fire Water Tank
- Domestic Water Tank
- Hot Water Tank
- Main Pump Room
- Reversiable Geothermal Heat Pump
- Pressure Booter Pump

WATER SUPPLY SCHEME SECTION





Water Supply System

General Calculations

Cold Water					
	Units	Loading Units	Max. LU	Pipe Sizes	
Pantry Sink	4	8	32	32 X 3	
WC	14	1	14	26 X 3	**40 X 3.5**
Washbasin	10	1	10	20 X 2.5	
Total Units	28	10	56		

Hot Water					
	Units	Loading Units	Max. LU	Pipe Sizes	
Pantry Sink	4	8	32	32 X 3	
WC	14	1	14	26 X 3	**40 X 3.5**
Washbasin	10	1	10	20 X 2.5	
Total Units	28	10	56		

Reference for Water Supply System

Table 1 —Draw-off flow-rates Q_A , minimum flow-rates at draw-off points Q_{min} and loading units for draw-off points, from EN UNI 806-3.

Draw-off point	Q_A	Q_{min}	Loading units
	l/s	l/s	
Washbasin, handbasin, bidet, WC-cistern	0,1	0,1	1
Domestic kitchen sink, washing machine [a], dish washing machine, sink, shower head	0,2	0,15	2
Urinal flush valve	0,3	0,15	3
Bath domestic	0,4	0,3	4
Taps (garden/garage)	0,5	0,4	5
Non domestic kitchen sink DN 20, bath non domestic	0,8	0,8	8
Flush valve DN 20	1,5	1,0	15

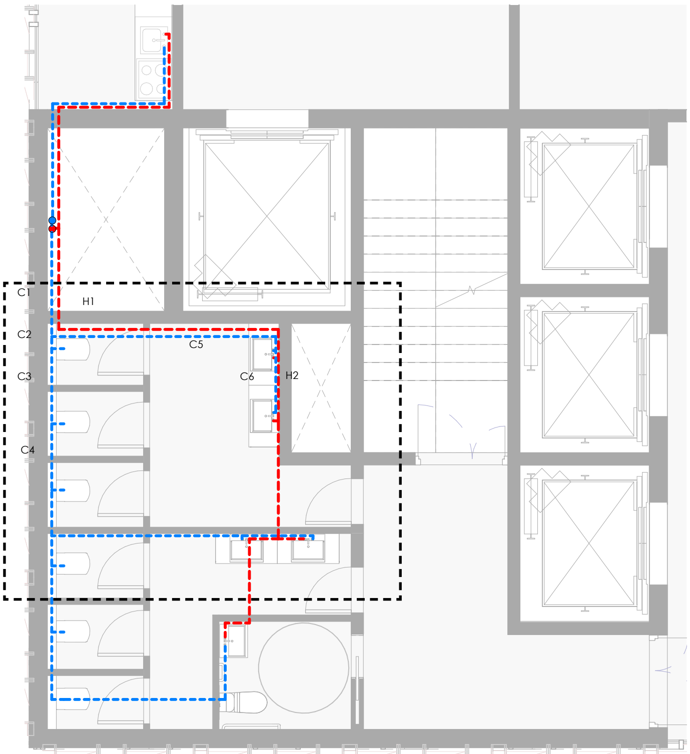
[a] For non domestic appliances check with manufacturer.

Table 2— Loading units for determination of pipe diameters from EN UNI 806-3.

Table 3.8 — PEX/AL/PE-HD resp. PE-MD/AL/PE-HD											
Max. load	**LU**	**3**	**4**	**5**	**6**	**10**	**20**	**55**	**180**	**540**	**1 300**
Highest value	LU			4	5	5	8				
$d_a \times s$	mm	16 x 2,25/16 x 2,0			18 x 2	20 x 2,5	26 x 3	32 x 3	40 x 3,5	50 x 4	63 x 4,5
d_i	mm	11,5/12,0			14	15	20	26	33	42	54
Max length of pipe	m	9	5	4							

Water Supply System

Water Supply Pipe Plan



Legend

- Cold Water Supply riser
- Hot Water Supply riser
- Cold Water Supply pipeline
- Hot Water Supply pipeline

Detailed Calculations

Cold Water

C1	Units	Loading Units	Max. LU
WC	3	1	3
Washbasin	2	1	2
Total Units	5	2	5
Pipe Size			18 X2.0

C2	Units	Loading Units	Max. LU
WC	3	1	3
Washbasin	0	1	0
Total Units	3	2	3
Pipe Size			16 X2.25

C3	Units	Loading Units	Max. LU
WC	2	1	2
Washbasin	0	1	0
Total Units	2	2	2
Pipe Size			16 X2.25

C4	Units	Loading Units	Max. LU
WC	1	1	1
Washbasin	0	1	0
Total Units	1	2	1
Pipe Size			16 X2.25

C5	Units	Loading Units	Max. LU
WC	0	1	0
Washbasin	2	1	2
Total Units	2	2	2
Pipe Size			16 X2.25

C6	Units	Loading Units	Max. LU
WC	0	1	0
Washbasin	1	1	1
Total Units	1	2	1
Pipe Size			16 X2.25

Hot Water

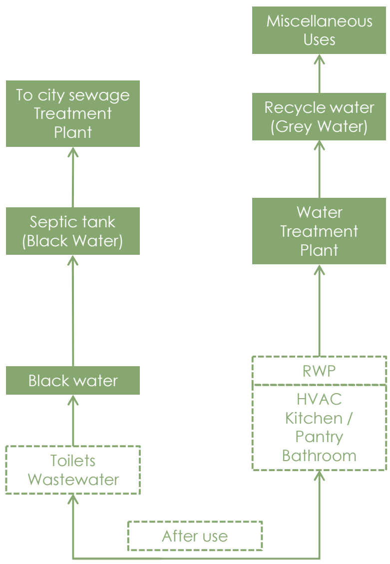
H1	Units	Loading Units	Max. LU
WC	0	1	0
Washbasin	2	1	2
Total Units	2	2	2
Pipe Size			16 X2.25

H2	Units	Loading Units	Max. LU
WC	0	1	0
Washbasin	1	1	1
Total Units	1	2	1
Pipe Size			16 X2.25

Drainage System

The used water - Black and grey carried by PVC pipe from toilets and other locations. The pressure created by the height of the content in the pipes has been breaking every 5 floors for pipes safety and maintenance. Along with rainwater pipes collection storms water on the exposed surface. The collected blackwater is sent to Blackwater tank & greywater - stormwater is sent to water treatment plant and greywater for further miscellaneous use.

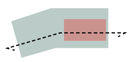
DRAINAGE SCHEME

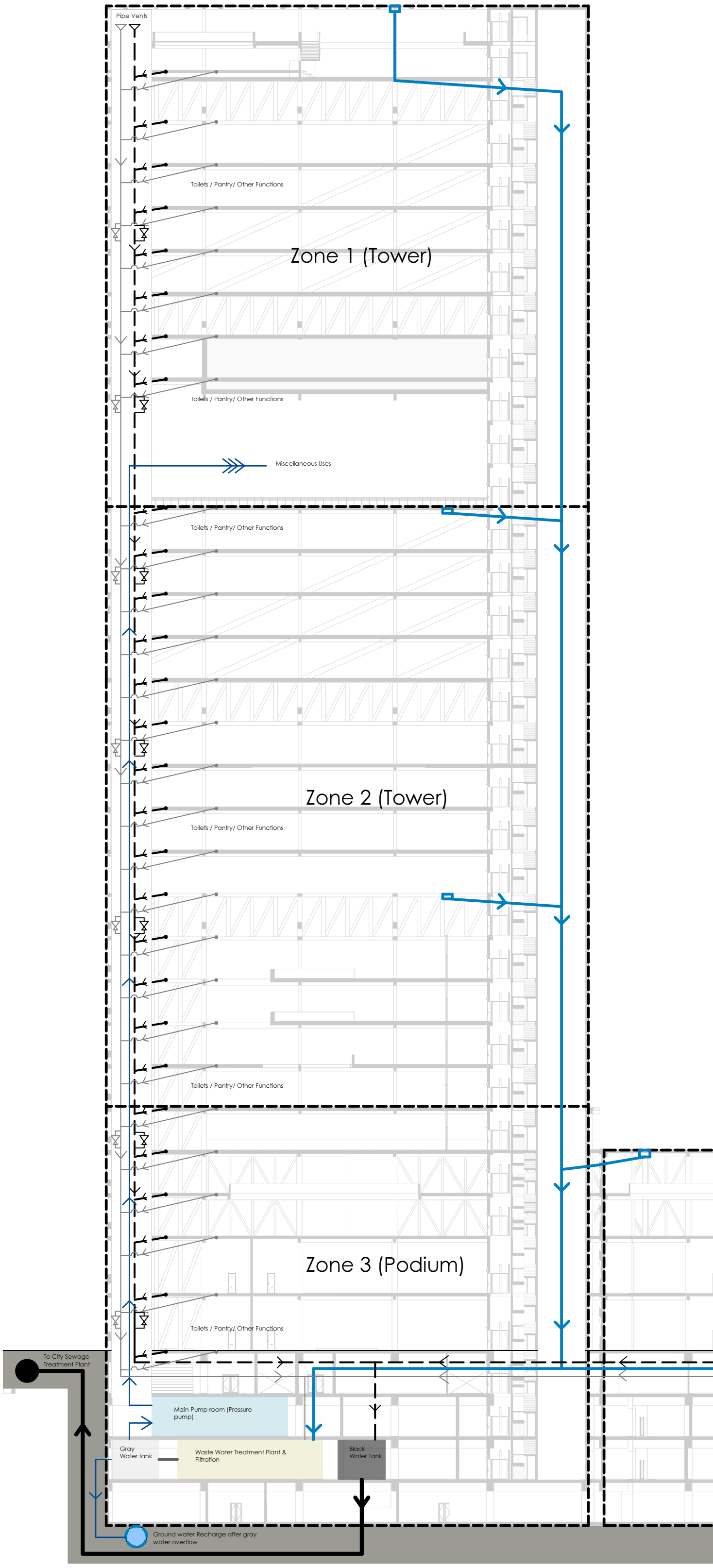


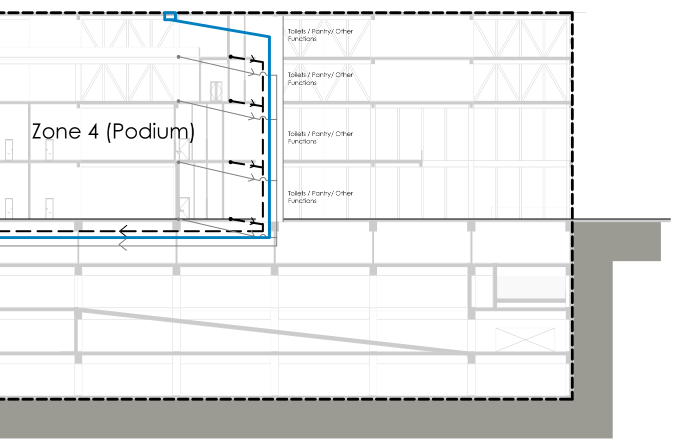
LEGEND

- Miscellaneous Uses
- To City Sewage Treatment Plant
- Gray Water Pipe
- Black Water Pipe
- Rain Water Pipe
- Sewage Treatment Plant line
- Ground Water recharge
- WWTP & Filteration Room
- Main Pump Room
- Black Water Tank
- Gray Water Tank

DRAINAGE SCHEME SECTION







Drainage System

Discharge Branches - General Calculations

Grey Water - Drainage					
	Units	**Discharge Units**	**Max. DU**	**Frequency factor (K)**	**Qmax**
Pantry Sink	3	0.5	1.5	0.5	0.61
Washbasin	10	0.3	3	0.5	0.87
Total Units	13	0.8	4.5	0.5	1.06
DN					**60**

Black Water - Drainage					
	Units	**Discharge Units**	**Max. DU**	**Frequency factor (K)**	**Qmax**
WC	14	2	28	0.5	2.65
Total Units	14	2	28	0.5	2.65
DN					**100**

Reference for Drainage

Table 3: Discharge units (DU) from EN UNI 12056-2.

Appliance	System I	System II	System III	System IV
	DU	DU	DU	DU
	l/s	l/s	l/s	l/s
Wash Basin, Bidet	0,5	0,3	0,3	0,3
Shower without Plug	0,6	0,4	0,4	0,4
Shower with Plug	0,8	0,5	1,3	0,5
Single Urinal with Cistern	0,8	0,5	0,4	0,5
Urinal with Flushing Valve	0,5	0,3	-	0,3
Slab Urinal	0,2*	0,2*	0,2*	0,2*
Bath	0,8	0,6	1,3	0,5
Kitchen Sink	0,8	0,6	1,3	0,5
Dishwasher (Household)	0,8	0,6	0,2	0,5
Washing Machine up to 6 kg	0,8	0,6	0,6	0,5
Washing Machine up to 12 kg	1,5	1,2	1,2	1,0
WC with 4,0 l Cistern	**	1,8	**	**
WC with 6,0 l Cistern	2,0	1,8	1,2 to 1,7***	2,0
WC with 7,5 l Cistern	2,0	1,8	1,4 to 1,8***	2,0
WC with 9,0 l Cistern	2,5	2,0	1,6 to 2,0***	2,5
Floor Gully DN 50	0,8	0,9	-	0,6
Floor Gully DN 70	1,5	0,9	-	1,0
Floor Gully DN 100	2,0	1,2	-	1,3

* per person
** not permitted
*** depending upon type (valid for WC's with siphon flush cistern only)
\- not used or no data

Table 4: Typical frequency factor (K) from EN UNI 12056-2.

Usage of appliances	K
intermittent use e.g. in Dwelling, Guesthouse, Office	0,5
frequent use e.g. in Hospital, School, Restaurant, Hotel	0,7
congested use e.g. in Toilets and/or Showers open to Public	1,0
special use e.g. Laboratory	1,2

Drainage System

Reference - Layout of Branch

Table 5: Hydraulic capacity (Qmax) and Nominal Diameter (DN) from EN UNI 12056-2.

Q_{max}	System I	System II	System III	System IV
l/s	DN	DN	DN	DN
0,40	*	30	see table 6	30
0,50	40	40		40
0,80	50	*		*
1,00	60	50		50
1,50	70	60		60
2,00	80**	70**		70**
2,25	90***	80****		80****
2,50	100	90		100

* not permitted *** not more than two WC's and a total change in directions of not more than 90°
** no WC's **** not more than one WC

DISCHARGE STACKS

Table 7: Hydraulic capacity (Q_{max}) and Nominal Diameter (DN) from EN UNI 12056-2.

Stack and stack vent	System I, II, III, IV Q_{max} (l/s)	
DN	Square entries	Swept entries
60	0,5	0,7
70	1,5	2,0
80*	2,0	2,6
90	2,7	3,5
100**	4,0	5,2
125	5,8	7,6
150	9,5	12,4
200	16,0	21,0

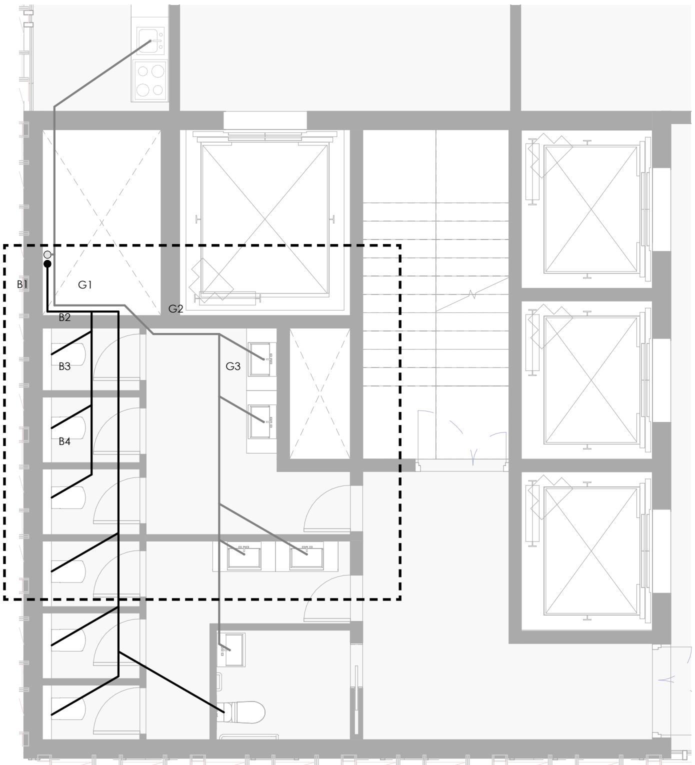
* minimum size where WC's are connected in system II
** minimum size where WC's are connected in system I, III, IV

Table 6: limitations from EN UNI 12056-2.

Limitations	System I	System II	System III	System IV
maximum length (*L*) of pipe	4,0 m	10,0 m	see table 6	10,0 m
maximum number of 90° bends	3*	1*		3*
maximum drop (*H*) (45° or more inclination)	1,0 m	**6,0 m DN>70 **3,0 m DN=70		1,0 m
minimum gradient	1%	1,5%		1%

* Connection bend not included
** If DN < 100 mm and a WC is connected to the branch no other appliances can be connected more than 1 m above the connection to a ventilated system.

Drainage pipe Plan



Legend

- Gray water pipe riser
- Black water pipe riser
- Gray water pipeline
- Black water pipeline

Detailed Calculations

Gray Water

G1	Units	Discharge Units	Max. DU	Frequency factor (K)	Qmax
Washbasin	2	0.3	0.6	0.5	0.39
Total Units	2	0.3	0.6	0.5	0.39
DN					**30**

G2	Units	Discharge Units	Max. DU	Frequency factor (K)	Qmax
Washbasin	2	0.3	0.6	0.5	0.39
Total Units	2	0.3	0.6	0.5	0.39
DN					**30**

G3	Units	Discharge Units	Max. DU	Frequency factor (K)	Qmax
Washbasin	1	0.3	0.3	0.5	0.27
Total Units	1	0.3	0.3	0.5	0.27
DN					**30**

Black Water

B1	Units	Discharge Units	Max. DU	Frequency factor (K)	Qmax
WC	3	2	6	0.5	1.22
Total Units	3	2	6	0.5	1.22
DN					**60**

B2	Units	Discharge Units	Max. DU	Frequency factor (K)	Qmax
WC	3	2	6	0.5	1.22
Total Units	3	2	6	0.5	1.22
DN					**60**

B3	Units	Discharge Units	Max. DU	Frequency factor (K)	Qmax
WC	2	2	4	0.5	1.00
Total Units	2	2	4	0.5	1.00
DN					**50**

B4	Units	Discharge Units	Max. DU	Frequency factor (K)	Qmax
WC	1	2	2	0.5	0.71
Total Units	1	2	2	0.5	0.71
DN					**50**

Drainage System

Discharge Pipe Stacking

Grey Water - Stacking					
	Units	Discharge Units	Max. DU	Frequency factor (K)	Qmax
Pantry Sink	3	0.5	1.5	0.5	0.61
Washbasin	10	0.3	3	0.5	0.87
Total Units	13	0.8	4.5	0.5	1.06
DN	Considering the above floor requirements for stacking - Lvl 30			1.1	DN 70

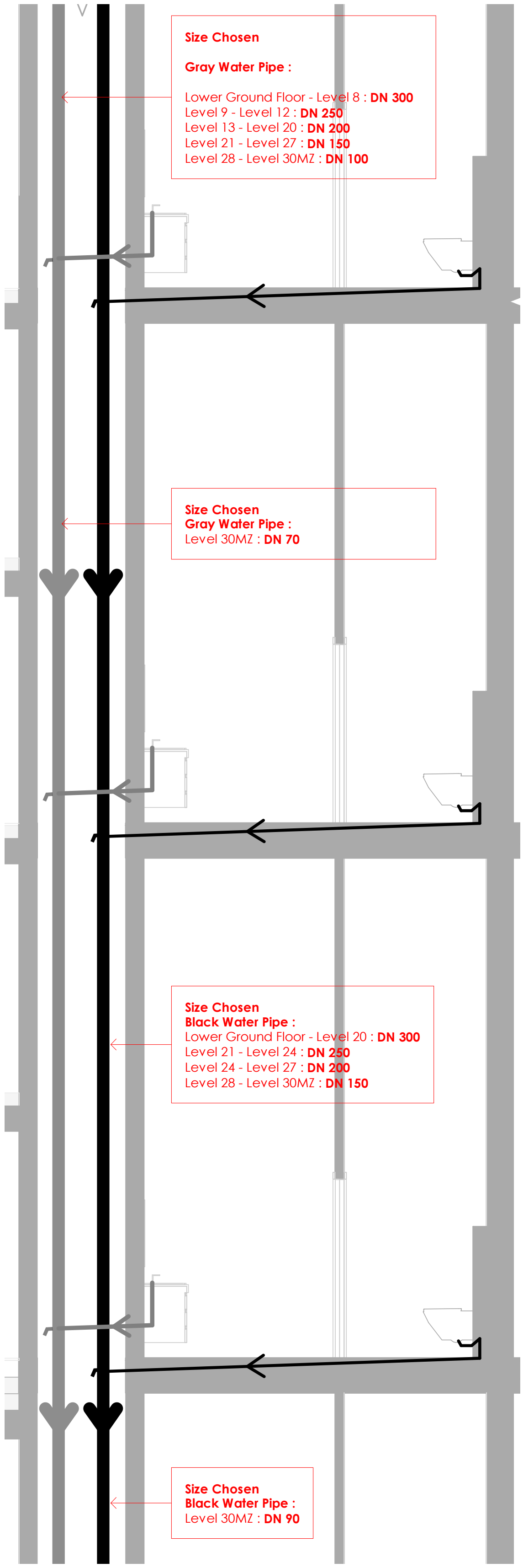
Black Water - Stacking					
	Units	Discharge Units	Max. DU	Frequency factor (K)	Qmax
WC	14	2	28	0.5	2.65
Total Units	14	2	28	0.5	2.65
DN	Considering the above floor requirements for stacking - Lvl 30			2.6	DN 90

Discharge Pipe sizes Stacking as per Levels

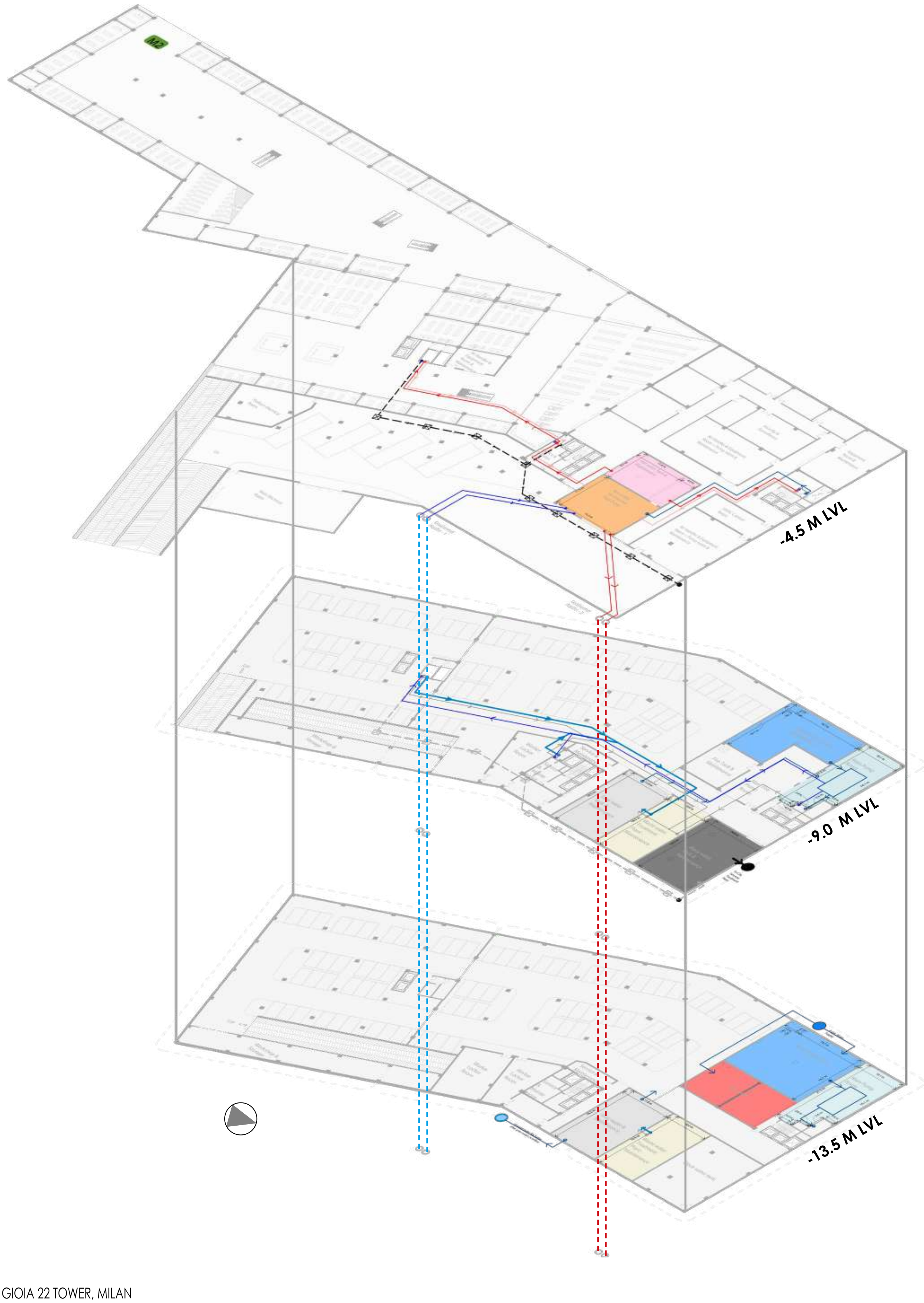
Gray Water Stacking & Vent		
Level	DN	Pipe Dia
LG	35.00	DN 300
GF	33.94	DN 300
L1	32.88	DN 300
L2	31.82	DN 300
L3	30.76	DN 300
L4	29.70	DN 300
L5	28.64	DN 300
L6	27.58	DN 300
L7	26.52	DN 300
L8	25.46	DN 300
L9	24.40	DN 250
L10	23.33	DN 250
L11	22.27	DN 250
L12	21.21	DN 250
L13	20.15	DN 200
L14	19.09	DN 200
L15	18.03	DN 200
L16	16.97	DN 200
L17	15.91	DN 200
L18	14.85	DN 200
L19	13.79	DN 200
L20	12.73	DN 200
L21	11.67	DN 150
L22	10.61	DN 150
L23	9.55	DN 150
L24	8.49	DN 150
L25	7.42	DN 150
L26	6.36	DN 150
L27	5.30	DN 150
L28	4.24	DN 100
L29	3.18	DN 100
L30	2.12	DN 100
L30 MZ	1.06	DN 100

Black Water Stacking & Vent		
Level	DN	Pipe Dia
LG	87.31	DN 300
GF	84.66	DN 300
L1	82.02	DN 300
L2	79.37	DN 300
L3	76.73	DN 300
L4	74.08	DN 300
L5	71.44	DN 300
L6	68.79	DN 300
L7	66.14	DN 300
L8	63.50	DN 300
L9	60.85	DN 300
L10	58.21	DN 300
L11	55.56	DN 300
L12	52.92	DN 300
L13	50.27	DN 300
L14	47.62	DN 300
L15	44.98	DN 300
L16	42.33	DN 300
L17	39.69	DN 300
L18	37.04	DN 300
L19	34.39	DN 300
L20	31.75	DN 300
L21	29.10	DN 250
L22	26.46	DN 250
L23	23.81	DN 250
L24	21.17	DN 250
L25	18.52	DN 200
L26	15.87	DN 200
L27	13.23	DN 200
L28	10.58	DN 150
L29	7.94	DN 150
L30	5.29	DN 150
L30 MZ	2.65	DN 150

Discharge Pipe - Section



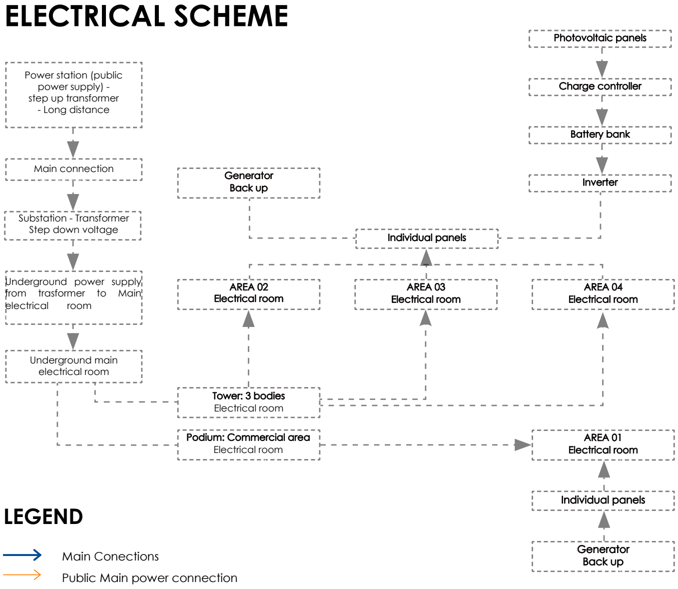
Drainage System & Water Supply Basement layout



Electrical System

The electrical room is positioned at -4.5 Level having the main electrical room holding transformers & two separate electrical rooms for the podium and tower. It has high voltage, low voltage equipment, and distribution panels. Further connecting it to the electrical cables going all the way to the top to other service floors.

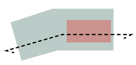
ELECTRICAL SCHEME

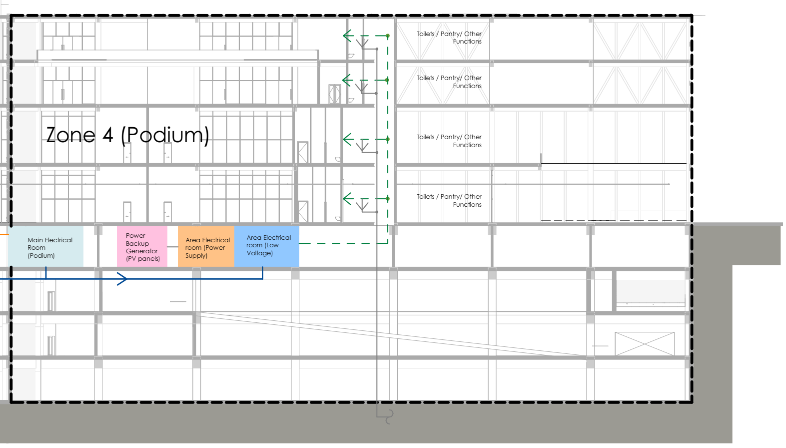


LEGEND

- Main Conections
- Public Main power connection
- Earthing lines
- Electrical lines
- LV Lines
- Lightning Arrester
- Area electrical room (Power Supply)
- Area electrical room (low voltage)
- Power Backup Generator (PV panels)
- Main electrical room (tower/ podium)
- Main Electrical Room
- Substation - Transformer Step down voltage
- Public Power Supply
- Data point
- Ceiling Light Fixture
- Power cable tray
- Data cable tray (LV)
- Data Connection
- Wire connection
- Switch board

ELECTRICAL SCHEME SECTION



Electrical System

LOWER GROUND FLOOR LAYOUT (-4.5 M LVL) : ELECTRICAL

LEGEND

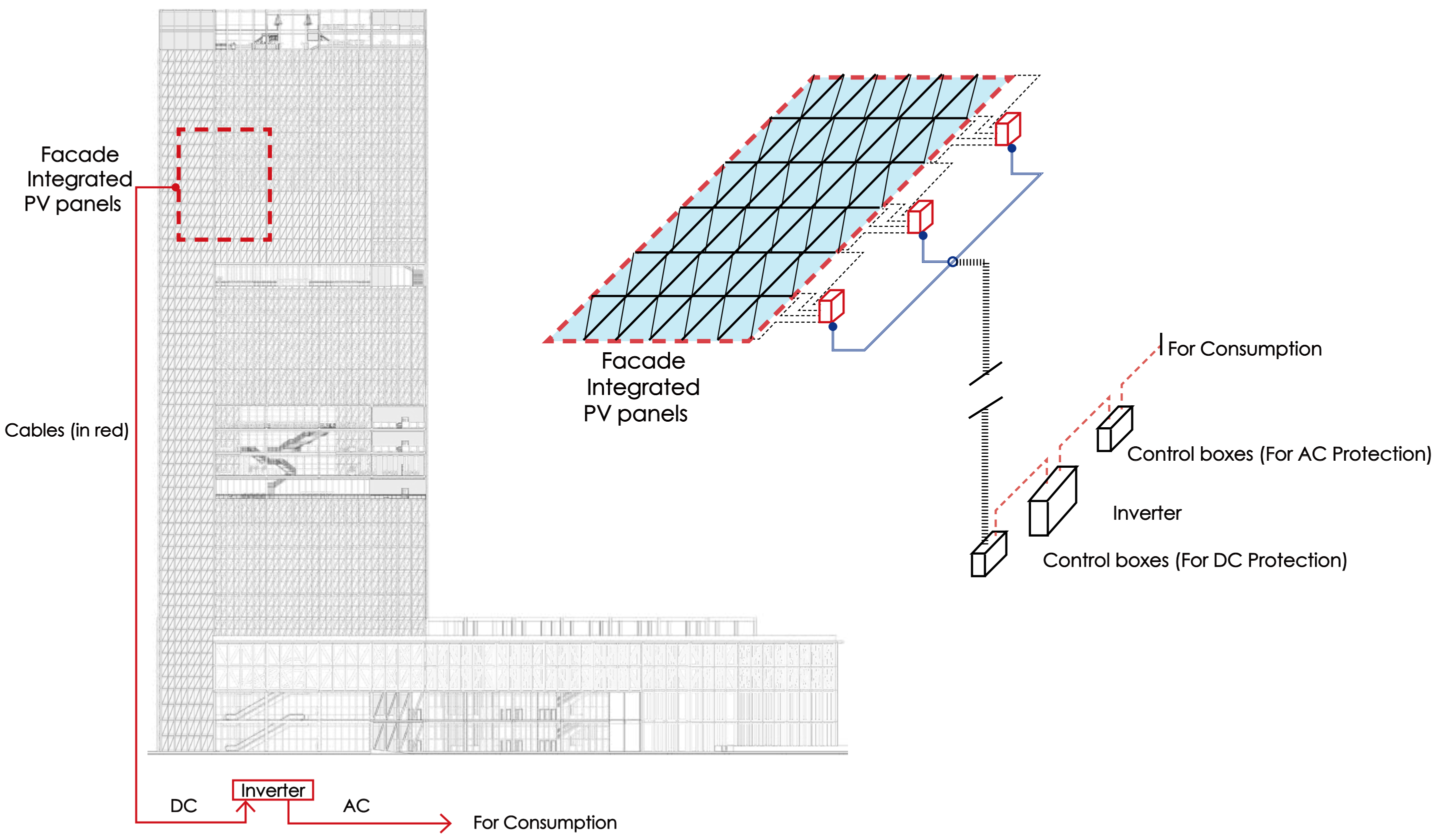
- Main Conections
- Public Main power connection
- Earthing lines
- Electrical lines
- LV Lines
- Lightning Arrester
- Area electrical room (Power Supply)
- Area electrical room (low voltage)
- Power Backup Generator (PV panels)
- Main electrical room (tower/ podium)
- Main Electrical Room
- Substation - Transformer Step down voltage
- Public Power Supply
- Data point
- Ceiling Light Fixture
- Power cable tray
- Data cable tray (LV)
- Data Connection
- Wire connection
- Switch board

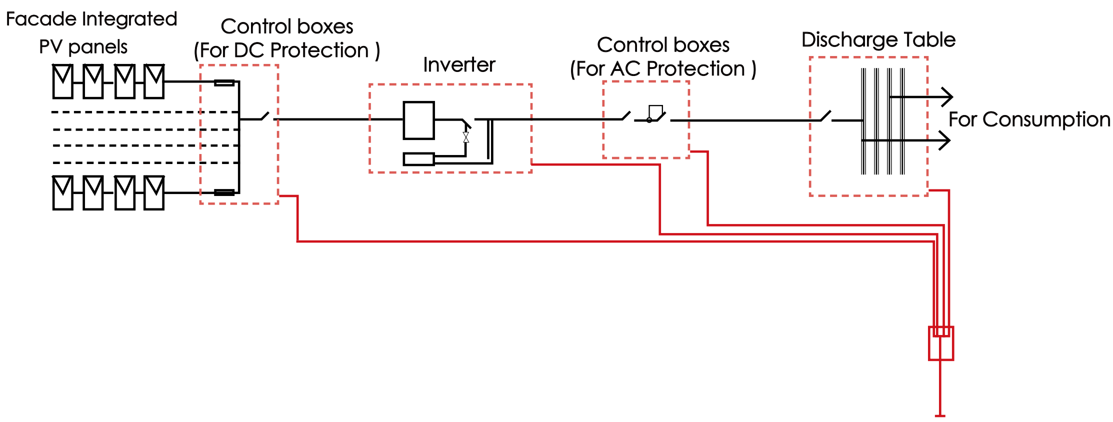
ELECTRICAL LAYOUT TYPICAL OFFICE

Electrical System

The sustainability system with respect to solar radiation in the façade is integrated with over 5000 photovoltaic panels that collect energy from solar radiation that is direct current (DC) and is sent to the inverter placed in service rooms. Further, the stored energy is used for consumption (AC).

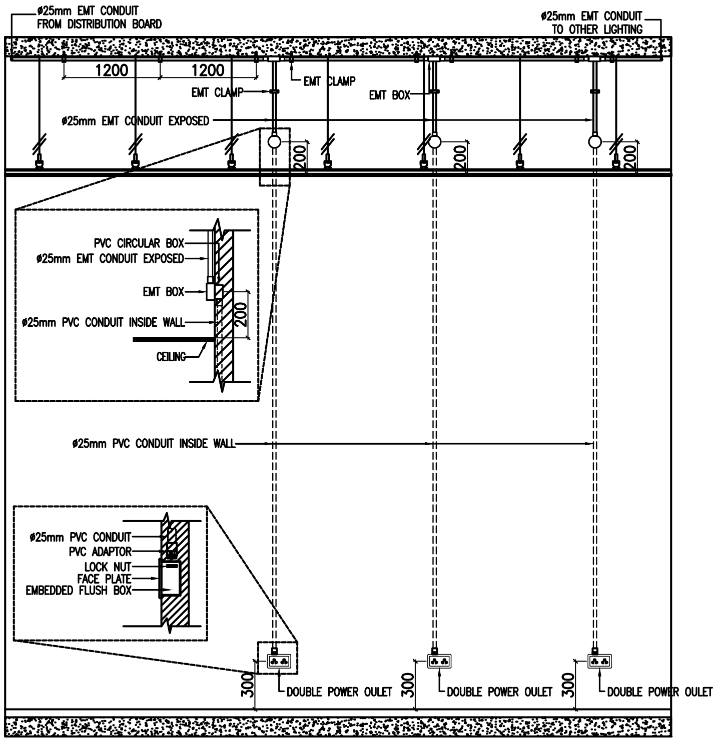
FACADE INTEGRATED WITH PHOTOVOLTIC PANEL



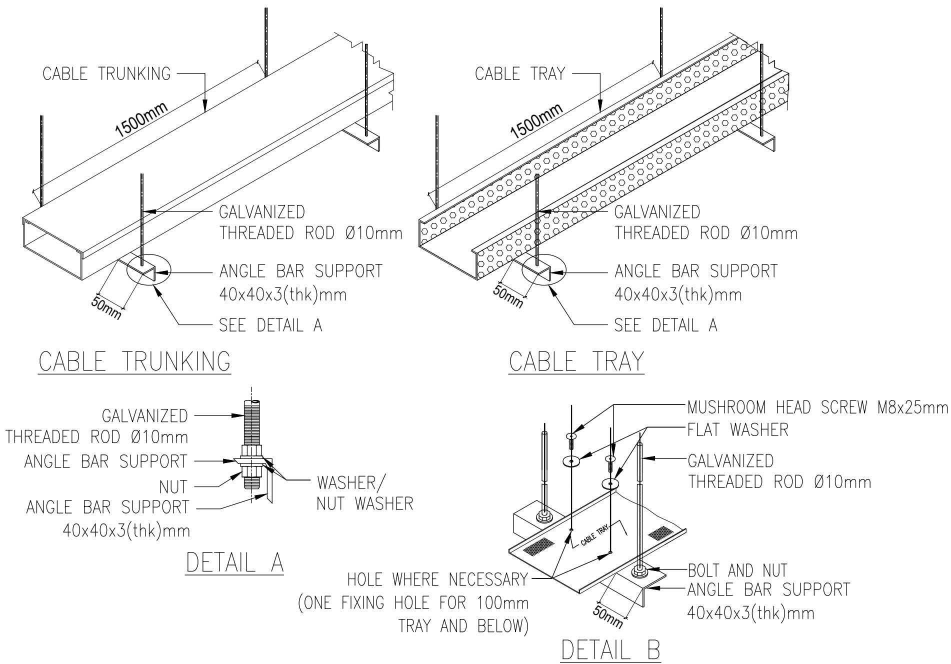


Electrical System - Details

TYPICAL INSTALLATION DETAIL FOR POWER OUTLET (CEILING AREA)

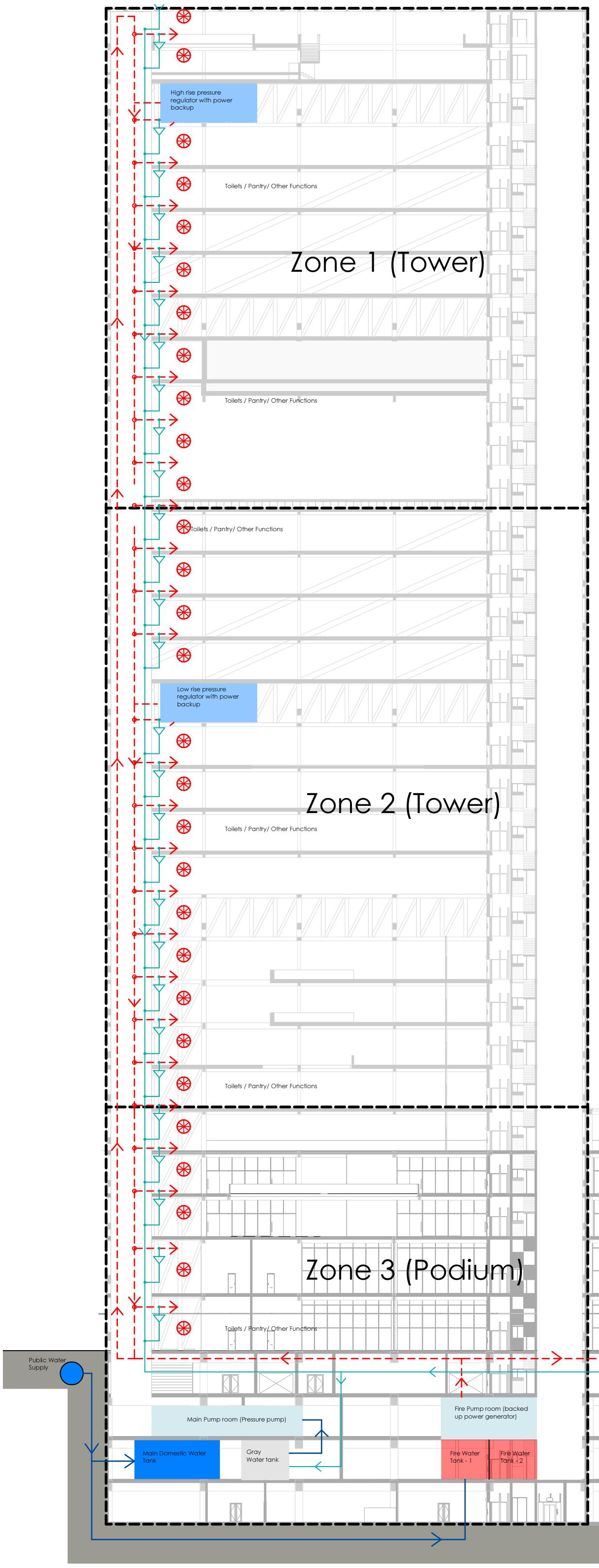
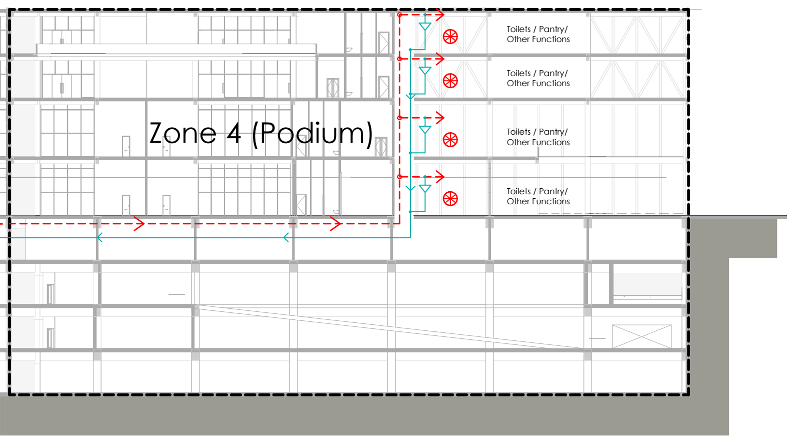


INSTALLATION OF CABLE TRAY/TRUNKING AND HANGER, SUPPORT

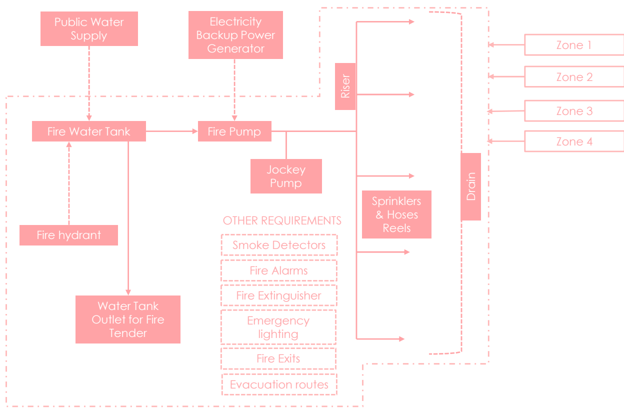


Fire Protection System

The firewater tank is placed at -13.5m level connected to the fire pump room above it at -9.0m level. The water is further circulated to fire hose reels & fire sprinklers on every floor. The pressure in sprinkler pipes is maintained by the intermediate booster pumps backup by a power generator in case of a power outage.

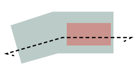
FIRE PROTECTION SYSTEM SCHEME



LEGEND

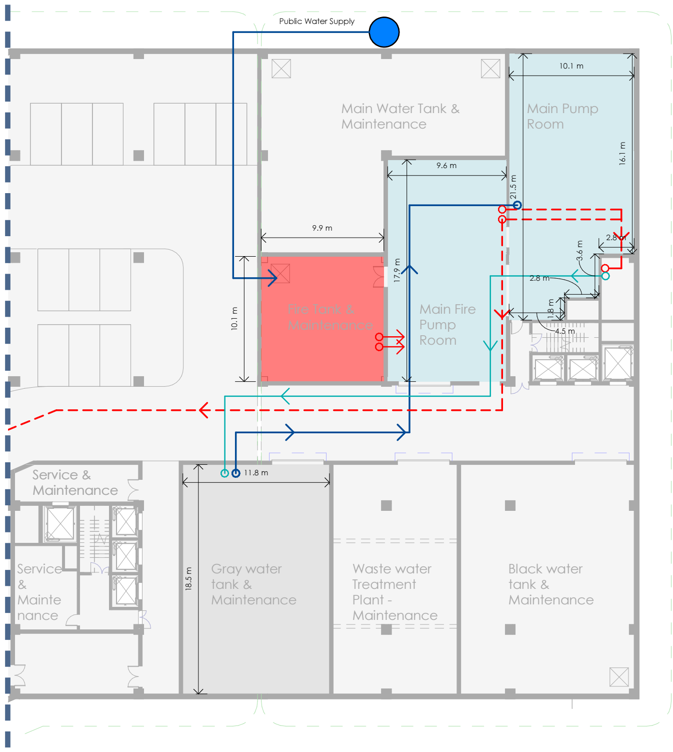
- Main water Connections
- Hose reel
- Sprinkler line riser
- Sprinkler line drain
- Fire Water Tank
- Domestic Water Tank
- Main Pump Room / Fire Pump Room
- Gray Water tank

FIRE PROTECTION SCHEME SECTION



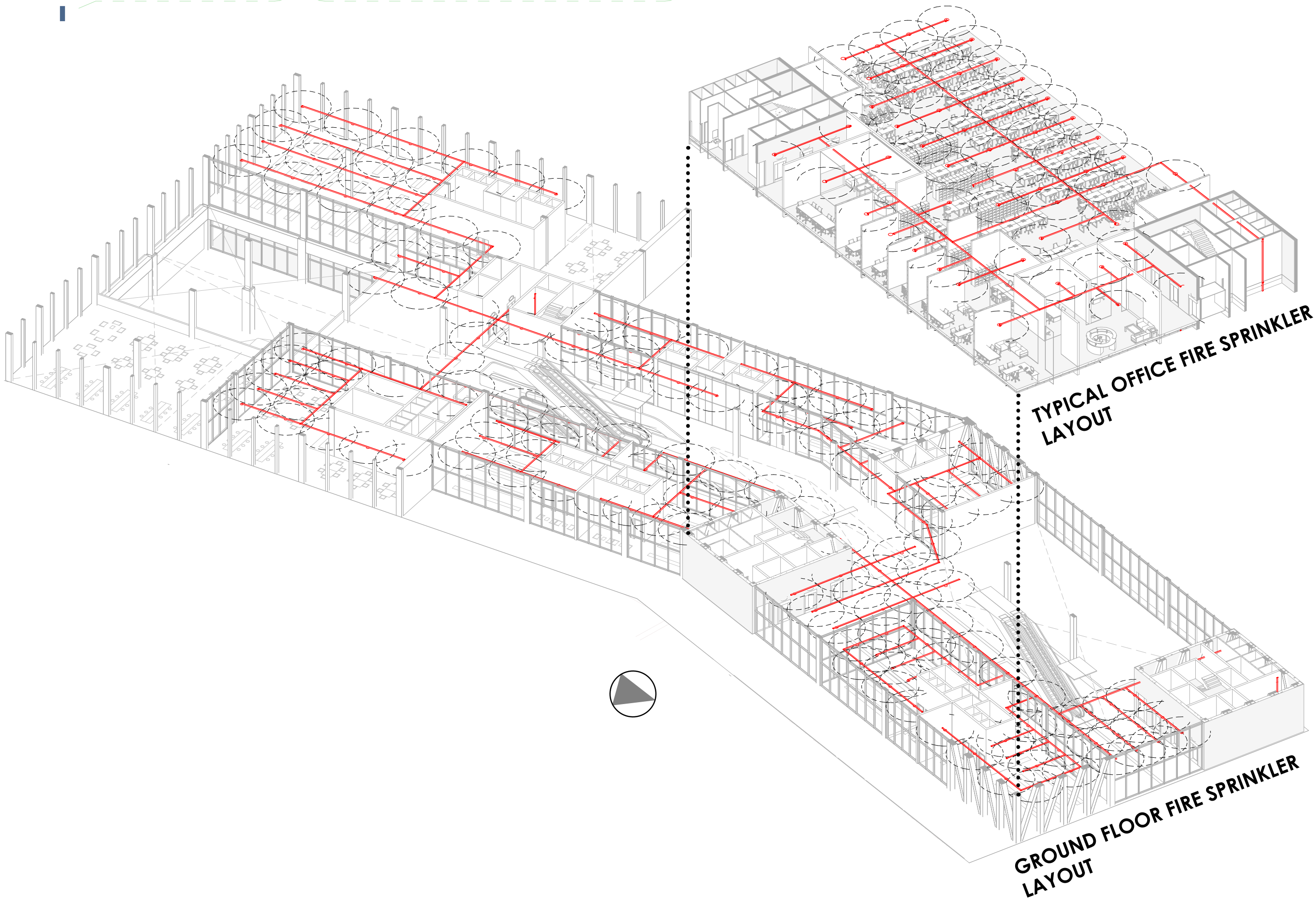
Fire Protection System

BASEMENT LAYOUT - FPS (-9.0 M LVL)

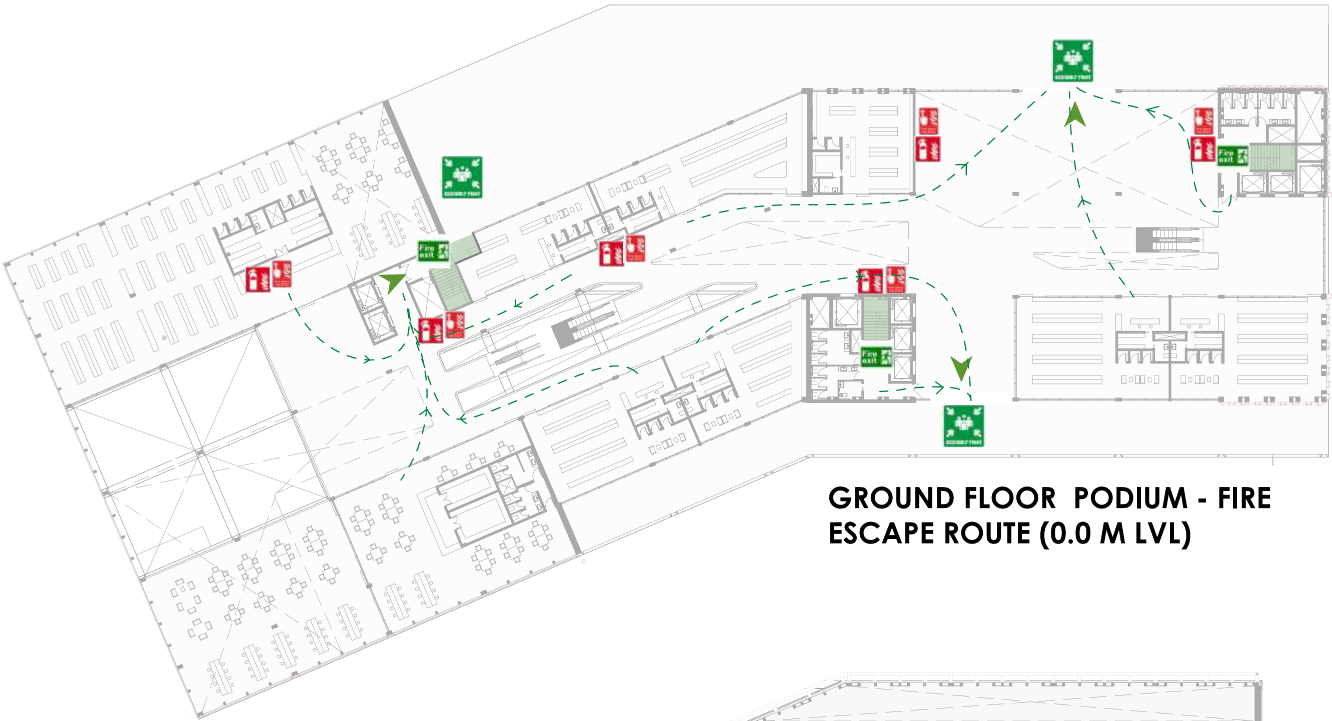


LEGEND

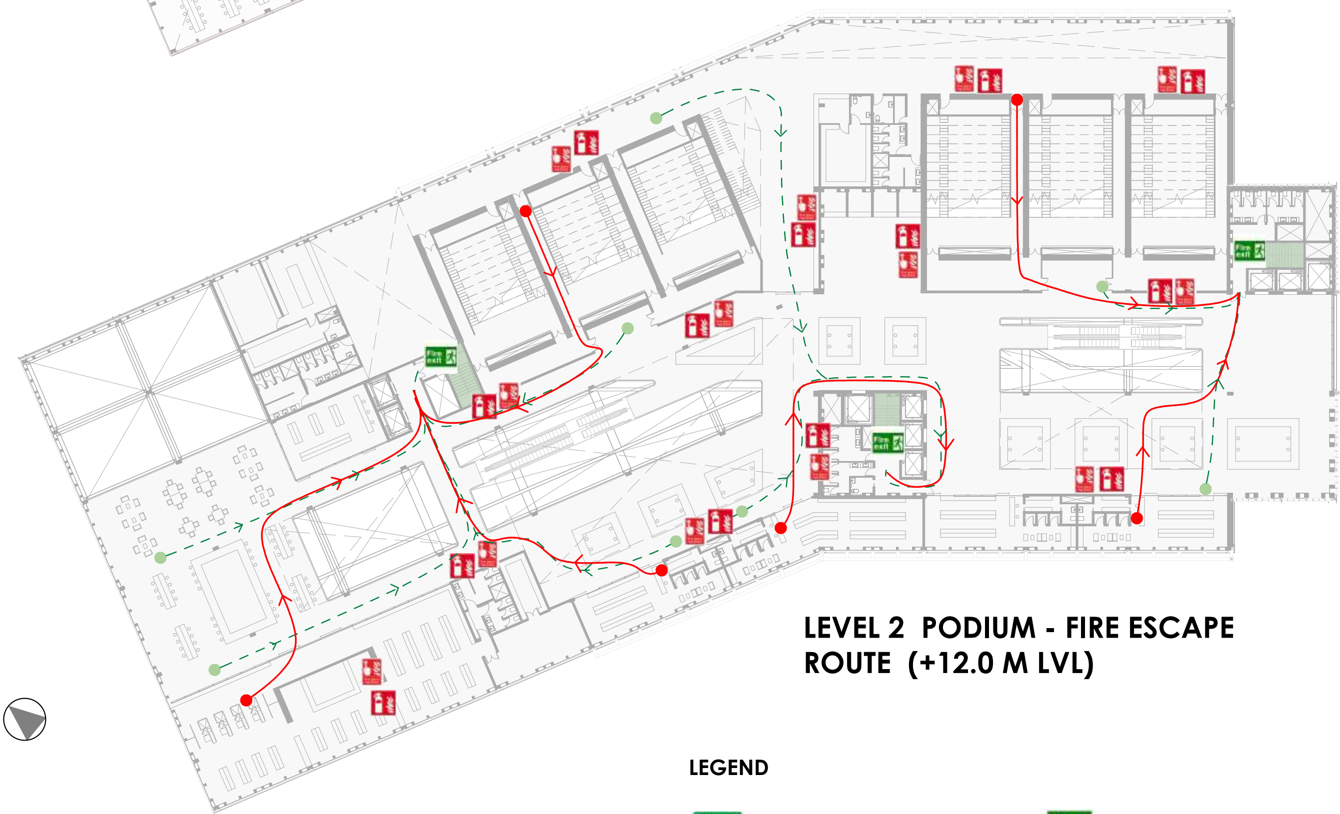
- Main water Connections
- Hose reel
- Sprinkler line riser
- Sprinkler line drain
- Fire Water Tank
- Domestic Water Tank
- Main Pump Room / Fire Pump Room
- Gray Water tank
- Pendent Sprinkler



Fire Protection System



GROUND FLOOR PODIUM - FIRE ESCAPE ROUTE (0.0 M LVL)



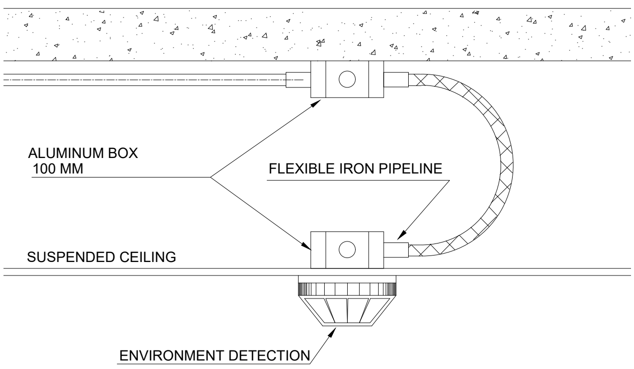
LEVEL 2 PODIUM - FIRE ESCAPE ROUTE (+12.0 M LVL)

LEGEND

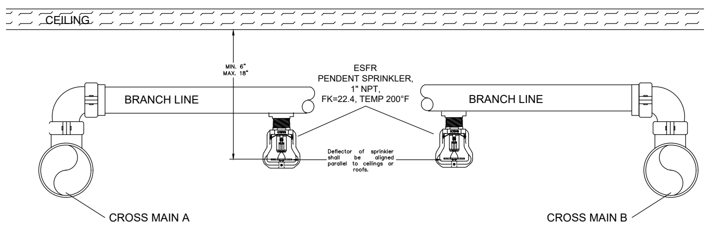
- Assembly Point
- Fire Extinguiser (each 30m)
- Fire alarm call point
- Fire exit (each 40m)
- Staff escape route (max. 30 m)
- Public escape route (max. 30 m)
- Ground floor exit point

Fire Protection System - Typical Details

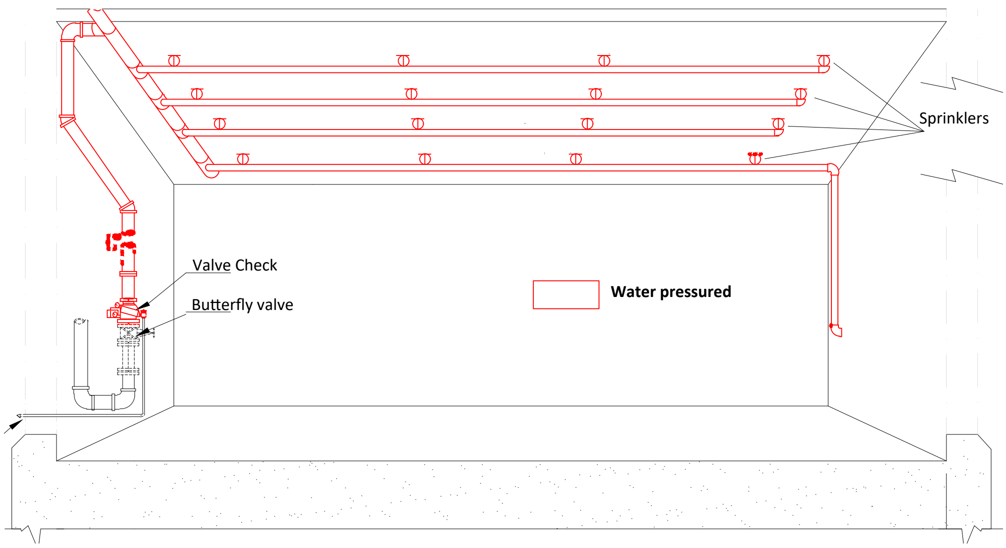
SMOKE DETECTOR INSTALLATION DETAILS



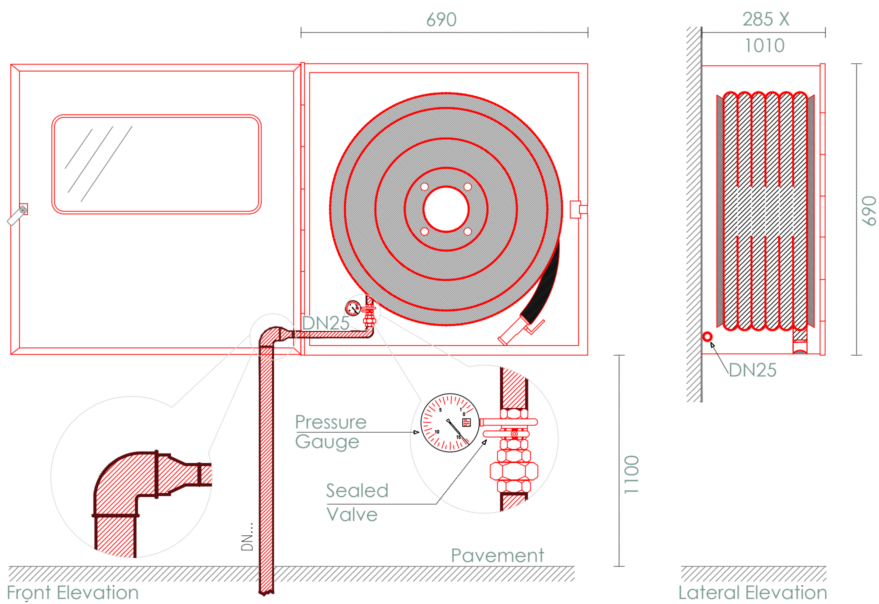
TYPICAL SPRINKLER DETAIL



TYPICAL SPRINKLER LINE DISTRIBUTION



TYPICAL DETAIL FIRE HOSE REEL



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