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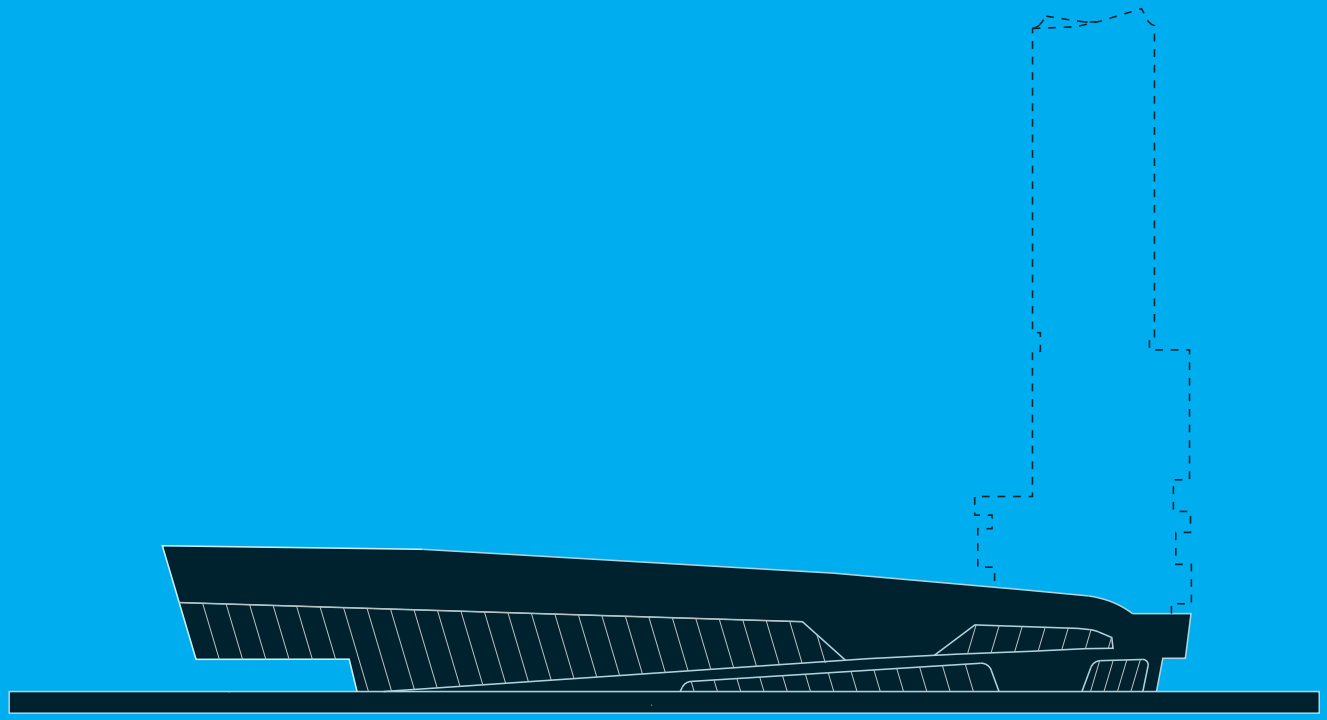
REVIVING THE SILK ROAD
XI'AN TRAIN STATION



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REVIVING THE SILK ROAD
XI'AN TRAIN STATION

DIPLOMARBEIT

ausgeführt zum Zwecke der Erlangung des akademischen Grades einer Diplom-IngenieurIn unter der Leitung von

Associate Professor Dipl. Ing. Dr. Alireza Fadai

und als verantwortlich mitwirkender AssistentIn

Univ.-Ass. Dipl.-Ing. SBA Sigrun Swoboda

am Institut für Tragwerksplanung und Ingenieurholzbau
E259

eingereicht an der Technischen Universität Wien
Fakultät für Architektur und Raumplanung

von

Alexandra Comăniță, BSc.
01125973
Zeltgasse 4/7, 1080 Wien

Wien, am _____ Unterschrift_____

ABSTRACT

EN

With more than 4000 years of traceable history, the Silk Road is known nowadays as the staple of land trading routes of the ancient world. Situated towards the end of this historical imbued passage, the city of Xi'an (China) is a blend of ancient fascination with contemporaneity which evokes a contradictory urban fabric: from stone dragons and pagodas to lively neon lights in narrow streets, and over 8 million inhabitants who populate the concrete towers that watch over the Terracotta Army.

A strong initiative of modernization led by the local authorities aims to establish the city as the new hot-spot of East-meets-West and requires the development of a new rail station capable of resonating with the urban contradictions which give Xi'an its provocative character.

The city authorities have initiated an urbanisation scheme under the name of "Xi'an 2030" whose aim is to enable a sustainable expansion of the city. This project's target is to deliver a feasible solution in this context and integrate the current complexity of the urban situation in the bounds of the design.

DE

Mit mehr als 4000 Jahren nachvollziehbarer Geschichte ist die Seidenstraße heutzutage als Haupthandelsroute der Antike bekannt. Xi'an (China) war der Ausgangspunkt der Seidenstraße und ist heutzutage eine Mischung aus alter Faszination und Zeitgenossenschaft, die ein widersprüchliches städtisches Gefüge hervorruft: von Steindrachen und Pagoden bis zu lebhaften Neonlichtern in engen Gassen und mit über 8 Millionen Einwohner, welche die Betontürme bevölkern und die über die Terrakotta-Armee wachen.

Eine starke Initiative zur Modernisierung die von den lokalen Behörden geleitet wird, zielt darauf ab, die Stadt als neuen Treffpunkt zwischen Osten und Westen zu etablieren und erfordert die Entwicklung eines neuen Bahnterminals, welches mit den städtischen Widersprüchen in Einklang stehen kann.

Die Staatsregierung hat unter dem Namen „Xi'an 2030" ein Urbanisierungsprogramm initiiert, dessen Absicht es ist, eine nachhaltige Erweiterung der Stadt zu ermöglichen. Ziel dieses Projekts ist es, in diesem Zusammenhang eine praktikable Lösung zu liefern und die aktuelle Komplexität der städtischen Situation im Rahmen des Entwurfs zu integrieren.

02

BRIEF

The subject of this diploma was inspired by the brief of a design competition organized by YAC (Young Architects Competition). The competition envisioned the creation of a new rail terminal located at the eastern terminus of the Silk Road in Xi'an (China), which would define the meeting point between East and West.

Since airports and railway stations are not only places of transit, but also gates to contemporary metropolises, the target was to design a station which should represent the staple and the manifesto of a city in constant change. In order to create a new urban landmark for a city which plans to rebrand itself as an international epicenter of production investments and the Hi-Tech market by 2030, the new railway station would have to dialogue with such ecosystem to properly reflect its qualities and meet the expectations of a demanding and international public.

Therefore, the requirement was a redefinition of the way a train station of the 21st century should function, by also integrating a number of features such as hotel, office and retail spaces, while also taking into consideration feasible and consistent technological solutions, energy sustainability and environmental compatibility.

The proposal envisions the functions of train station, hotel, office and retail spaces as separate buildings connected through a landscape. An existing tower incorporates the latter functions. Thus, the train station will be connected to it in order to create a unitary landmark for Xi'an that reflects the city's policy for sustainable development.

DISCLAIMER

This thesis is inspired by an ideas competition organized by YAC in 2019 (“Xi’an Train Station”) and uses the site provided by the organizers as starting point for the project.

The project assumes that the proposal in the thesis ‘Xi’an - An Urban Dynasty’ by Dimitrios Sifakis is existing on the site, hence its occurrence in some figures as faded content for context purposes.

The content contributions in this thesis are credited as follows:
Chapter 4 “The Silk Road” and Chapter 5 “Xi’an” - researched with Dimitrios Sifakis
Chapter 8 “Site Analysis & Concept” - developed with Dimitrios Sifakis
Chapter 11 “Building Physics” - simulation and figures developed by Dimitrios Sifakis
Chapter 9 “34°08’36.5”N 108°45’05.4”E” and Chapter 12 “Design” - developed by Alexandra Comanita with site context (tower and western park) provided by Dimitrios Sifakis

Note: Unreferenced figures outside the chapters mentioned above are developed by Alexandra Comanita

Note: the * symbol makes a referral to collaborative work with Dimitrios Sifakis

02

INTRODUCTION

The focus of this project lies in the investigation of how a public node of transport can enhance the area it is placed in. The interest in this topic arose firstly from the typology of the train station itself as a catalyst for further urban development and the social implications it brings with it and secondly, from the particularities found in the city of Xi'an: a past imperial city with a rich history that currently undergoes a tabula rasa strategy employed on a large part of its masterplan. Transport nodes assume the responsibility of shaping their surroundings and are largely responsible for further changes in the city fabric, the functions they attract in their vicinity and the circulation they dictate.

Regarding the transportation function itself, since train stations aren't only seen as spaces of commute but are also of huge importance in the public aspect, such a building needs to be conceived for the decades to come and it needs to be understood how it can become reactant to sudden changes. Looking back at train stations from the past, with the expectation and needs of today's society it could easily be assumed that this typology of building has had to evolve immensely and the inflexible planning of the older stations does not cater anymore for the growing/changing city and the traveler's expectations. Now more than ever, the need for an appropriate choice in terms of construction materials, sustainability and high internal flexibility obligate the train station as a typology to become a trendsetter for the city. This thesis investigates some of the most encountered problems as well as how a future oriented train station could work, drawing inspiration from three case studies of reference. Certain characteristics are chosen from them and used as guidelines for a newly built rail node.

In other words, the main focus is to determine what design choices influence most the quality of a railway station and how can they be implemented safely in the context of expected-high-density cities?
After providing a brief introduction into the past of the city and its socio-economical and political status quo, the thesis questions the typology of the train station to understand the driving factors of its emergence and evolution. By exploring the site's orientation and environmental conditions the choices in design (and further along the way, structure) are explained.

03

CONTENTS

04

THE SILK ROAD| Historical Background And Development

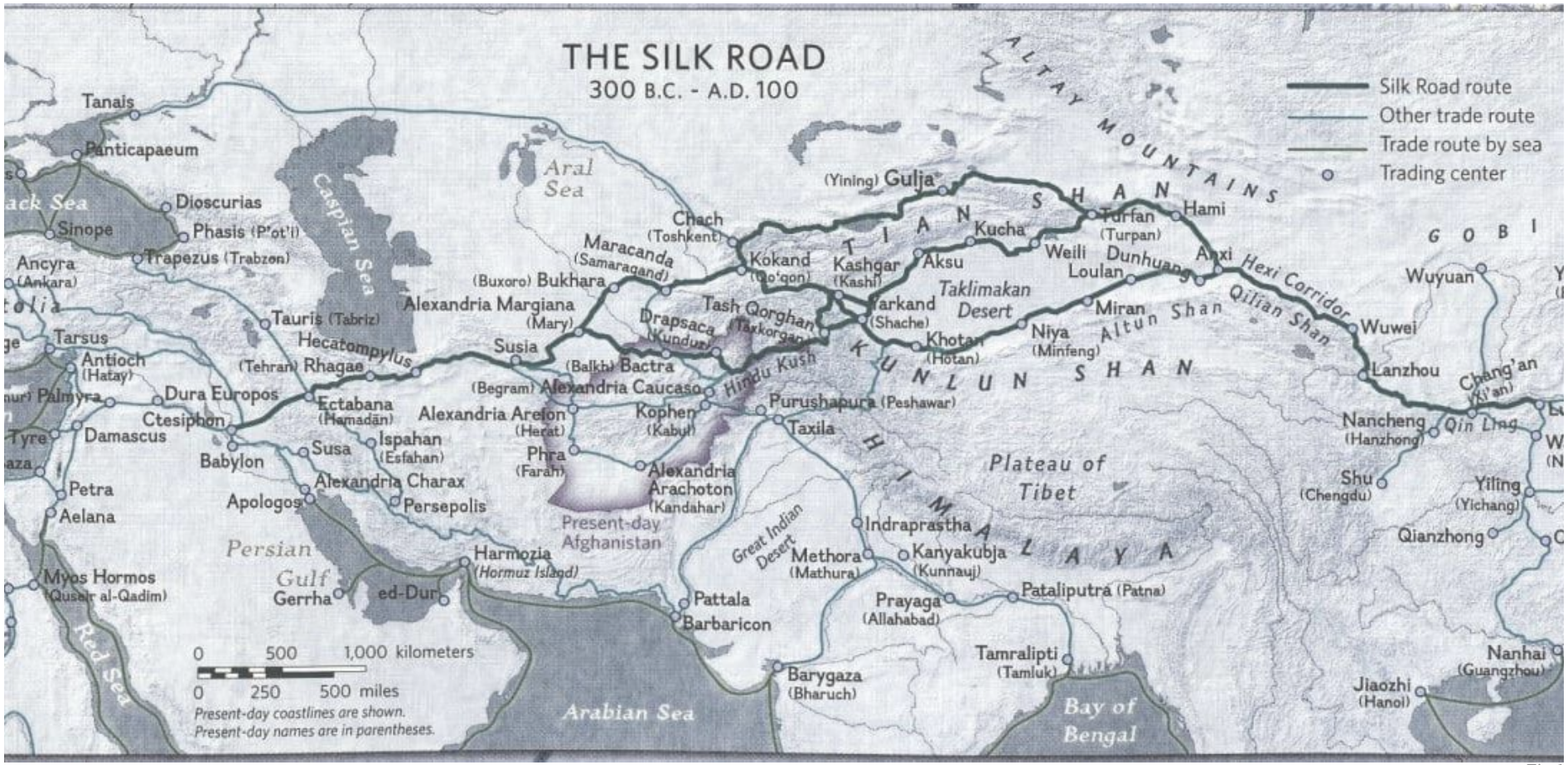


Fig.1

The "Silk Roads" were a vast network of land and maritime trade routes which connected the East and West from the 2nd century BCE to the early 18th century and served as a corridor for economic, political, religious and cultural interactions, paving the way for these relationships across civilizations.(1)

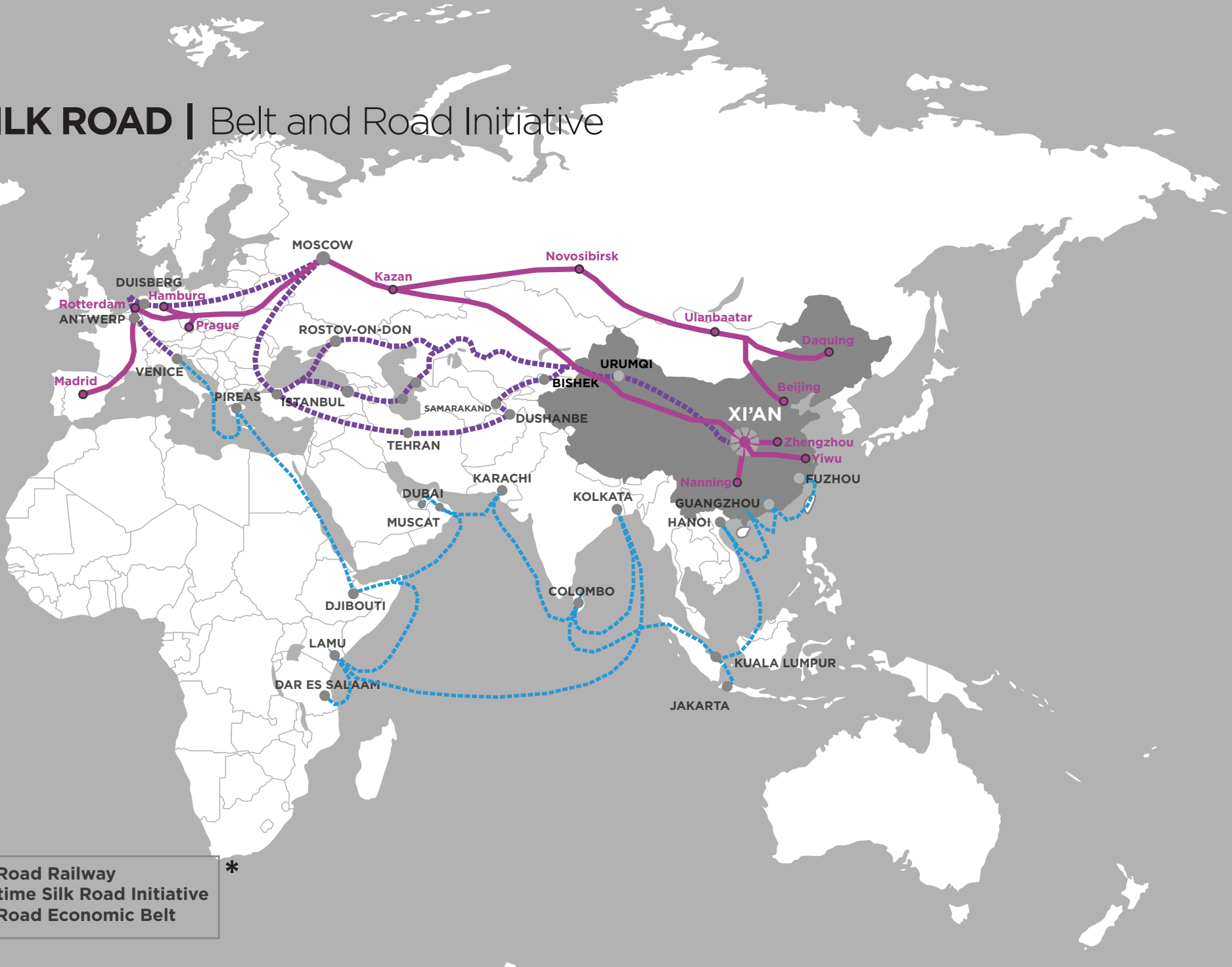
Stretching from Xi'An in China to Antioch in what today is Syria, these land routes connected East Asia and Southeast Asia with South Asia, Persia, the Arabian Peninsula, East Africa and Southern Europe.(2)

During the Middle Ages, these routes served as a fundamental contact between the civilizations of Eurasia. The main trade was made using caravans, which, when heading eastwards carried gold, precious stones, fabrics, ivory and coral, while when heading west, they were loaded with silk, furs, ceramics, cinnamon and bronze weapons. These routes also served the purpose of an exchange of information between countries, serving besides trade also as an dialogue of cultural and intellectual knowledge.

The name derives from the profitable trade in silk which developed during the Han dynasty in China (207 BCE-220CE)(3). Since June 2014 the Chang'An – Tianshan corridor of the Silk Road is recognized by UNESCO as a World Heritage Site.

Nowadays China is planning for 2049 a revival of the ancient trade route through the Belt and Road Initiative (BRI) project which envisions a broader global infrastructure stretching from East Asia to East Africa and Central Europe.

THE SILK ROAD | Belt and Road Initiative



The Belt and Road Initiative (BRI) refers to the creation of the Silk Road Economic Belt and the 21st Century Maritime Silk Road as a foreign policy initiative, which should connect Africa, Asia and Europe along six economic corridors, involving more than 60 countries along its way. The project has been proposed by president XI Jinping as a "revival of China"[4] aiming to strengthen China's trade connections and to revive the ancient Silk Road.

Ever since the BRI was announced in 2013 with a completion date set to 2049, thoughts have been made about a new possible train connection between Europe and Asia, since the only direct regional connective route was through the Trans-Siberian-Railway. The cargo route was the first to be developed with Beijing opening in 2014 the longest rail link in the world - a 13.000 km cargo rail route between the Chinese city of Yiwu and Madrid, involving 12 Chinese and 9 European cities and surpassing in length the previously longest distance by train - the Trans-Siberian-Railway. [5]

Proven to be highly lucrative, the plan seems to be expanding rapidly, with new rail connections being developed yearly. Currently the only passenger train connection along the New Eurasian Land Bridge is between Moscow and Beijing through Kazakhstan.

By 2026 there is a high speed railway planned between Berlin and Beijing through Moscow with a total length of 9.447 km and a trip duration of 2 days. The success of this implementation would ensure a growth by 1% in 2030 of the country's GDP.[6]

05

XI'AN | An Introduction

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> *Xi'An is contaminated by contemporaneity, yet it preserves an ancient fascination thanks to its tall pagodas and mighty bastions, the banks of the Feng River and the smooth peaks of Mount Hua. Xi'An has all the elements to be defined a contemporary city, yet these scenarios evoke a thousand-year old memory. The same screams, the same smells used to rise up towards the same sky when people used to gather around the fire to tell stories about Pan Gu and the 4 mythical beasts before the ascend of the Three Sovereigns and Five Emperors.*
> *(YAC, 2019 on the character of Xi'an)*

Xi'an, the oldest of China's Four Great Ancient Capitals[4] was the imperial capital in the central province of Shaanxi once known as "City of Eternal Peace"[5]. However, Xi'an has evolved beyond the folklore and legends which defined it centuries ago into a constantly changing city defined by innovation and contemporaneity.

Historical city

Xi'an (historically Chang'an) is the capital city of the Shaanxi province in north-central China and is located in the south-central part of the province overlooking the Wei River and the Qin Mountains. It dates back to around 1,000 BC and has witnessed several reigning dynasties along the course of history. Here, the first Emperor of China, Qin Shi Huang has left in 210 BCE his gigantic mausoleum together with a collection of terracotta sculptures – the Terracotta Army a as a legacy for the coming generations and offering the world one of the most renowned symbols of ancient China. Being one of the oldest cities in China, Xi'an has had a long history with a huge number of stability fluctuations. Following the fall of the Tang dynasty (618-907) during which the city placed itself as one of the worlds largest metropolis from ancient times, the city declined but managed to function as a market and trade center. Xi'an has also witnessed the beginning and end of the Ancient Silk Road (130-1453) during the Han Dynasty and played an important role throughout history. Being also the geographical terminus of the ancient trade route, its immense cultural impact could be felt for the coming centuries. [6]

Mount Hua

Mount Hua is located in the outskirts of Xi'an (Huayin City),

Fig.2

about 120 km east of the city, south of the Wei River valley and is the western mountain of the Five Great Mountains of China. Its five peaks are overlooking the city from a maximum height of 2,154 m.

Mount Hua is also an important part in the city's culture for its religious significance dating to the 2nd century BC, when Daoists believed that the mountains were home to the god of the underworld. It was a place of pilgrimage and the temple at the base of the mountains attracted believers and immortality seekers as a medium for contacting god. (7) Reputedly many herbal Chinese medicine and powerful drugs were found there.(8) Nowadays it still attracts thousands of visitors and pilgrims who come yearly to experience one of the most iconic places of traditional China.

Contemporary City

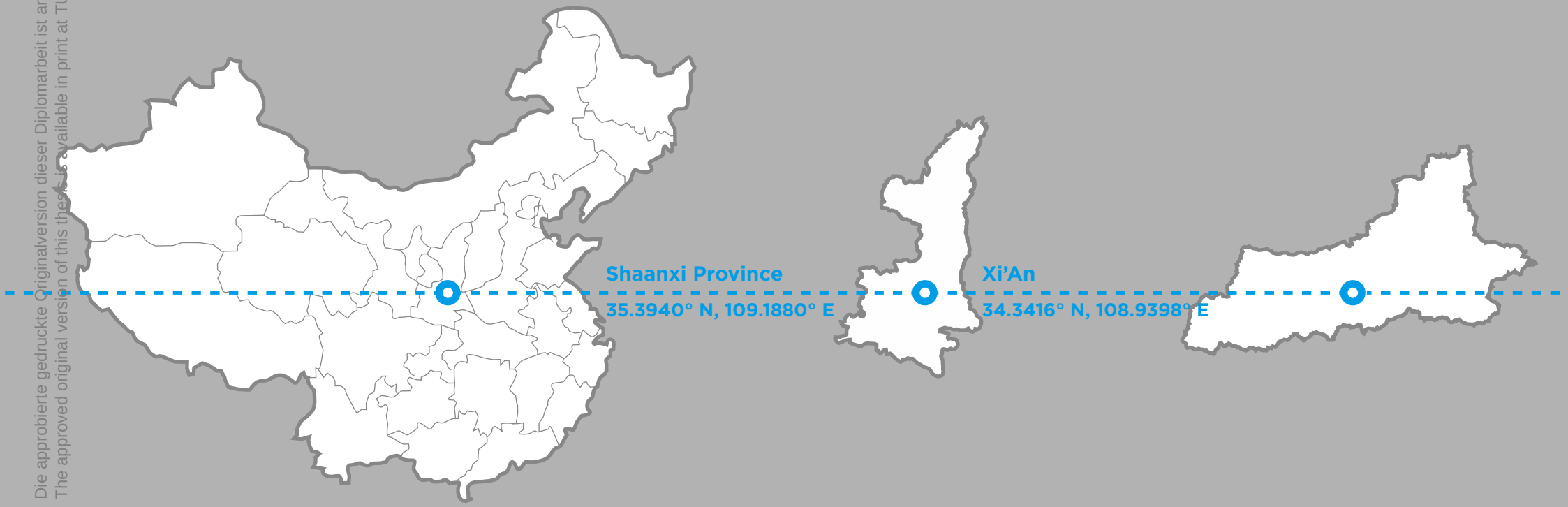
In contemporary times, concomitantly with the reaching of the main east-west rail line in 1935, the city experienced a rather slow industrial development, this changing by the mid 50's when it turned into the primary focus of expenditures from the central government and since then managed to uphold itself as one of China's major industrialized cities. Initial phases of the industrialization foresaw the establishments of factories for metallurgical products, chemicals, precision instruments, construction equipment and processed foods. In later stages the focus directed itself onto the creation of regional centers dedicated to a more specific market such as textile, electrical machinery, the aerospace industry, electronics, agriculture but also as a railway and highway hub, connecting Xi'an to other major cities within Shaanxi and the adjacent provinces. Based on its rich history, the city's tourism has also experienced a boom for its historical monuments, ancient ruins and tombs, making it one of the country's most popular tourist destinations(9). With over 8 Million inhabitants, today's Xi'an is a city of sublime contradictions – a compelling combination between relics from its rich cultural heritage, stone dragons, largely intact city walls, the famous terracotta warrior artefacts and glass and steel skyscrapers. It is rapidly evolving into a prospective epicenter of innovation, the Chinese business and Hi-Tech market.

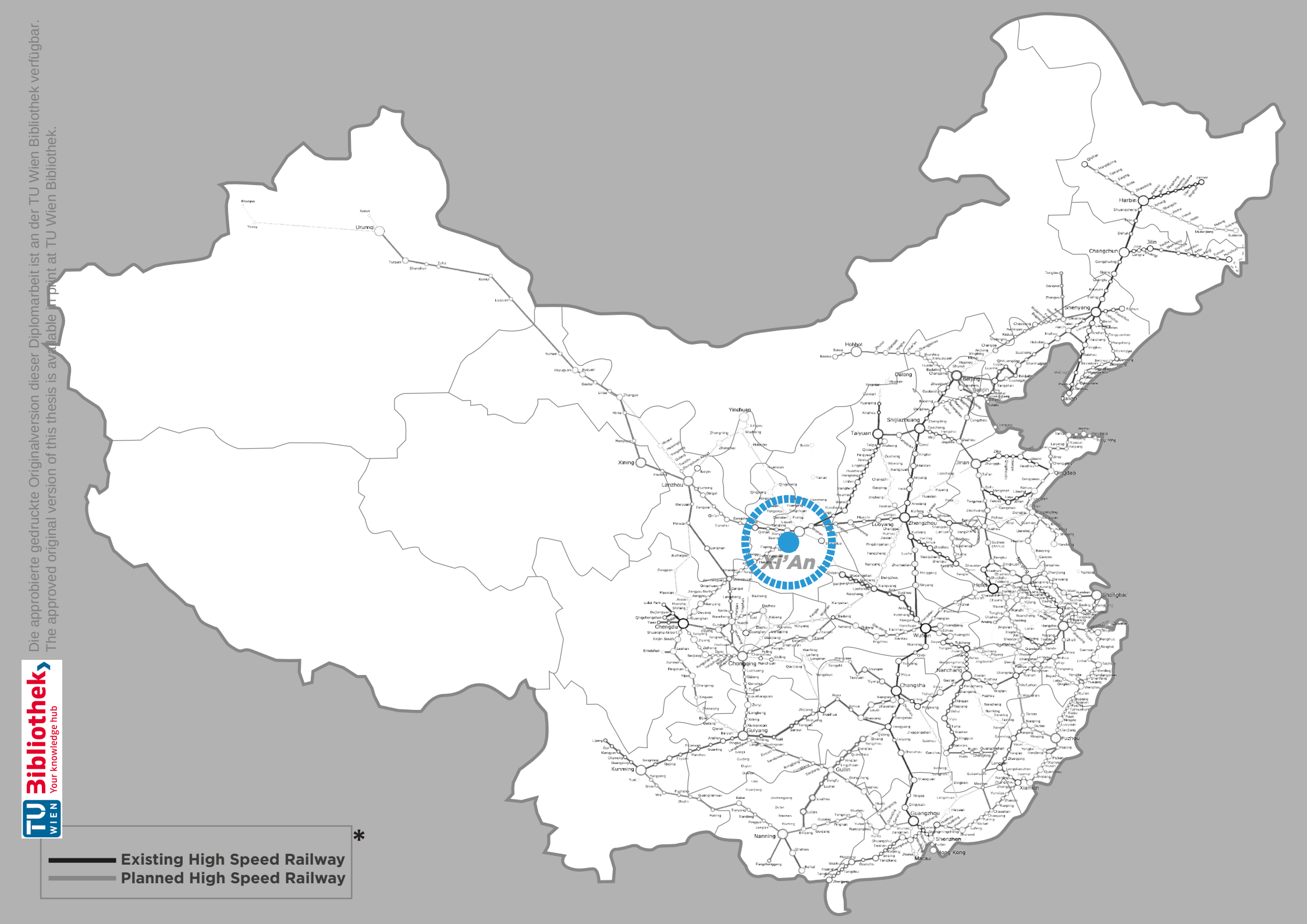
The Terracotta Army

While Mexicans were building the Teotihuacan pyramids, Qin Shi Huang (the 1st Emperor of China) was preparing an army which, according to funerary beliefs, would protect him in the afterlife. More than 8.000 soldiers, chariots and horses were crafted at the foot of Mount Li by government labourers and local craftsmen. Parts of the Army have been touring the world in exhibitions since 1982 (Melbourne) drawing millions of visitors only with its name, most recently seen in Bangkok (2019) (10).

Fig.3

西安 XI'AN | Mapping & Data *





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POPULATION
CHINA

1,135 Bil.
1,439 Bil.

0,50%
YEARLY
GROWTH
RATE

NUMBER

2,22 Mil.
3,79 Mil.
5,53 Mil.
8,0 Mil.
10,43 Mil.

POPULATION
XI'AN

3,75%
YEARLY
GROWTH
RATE

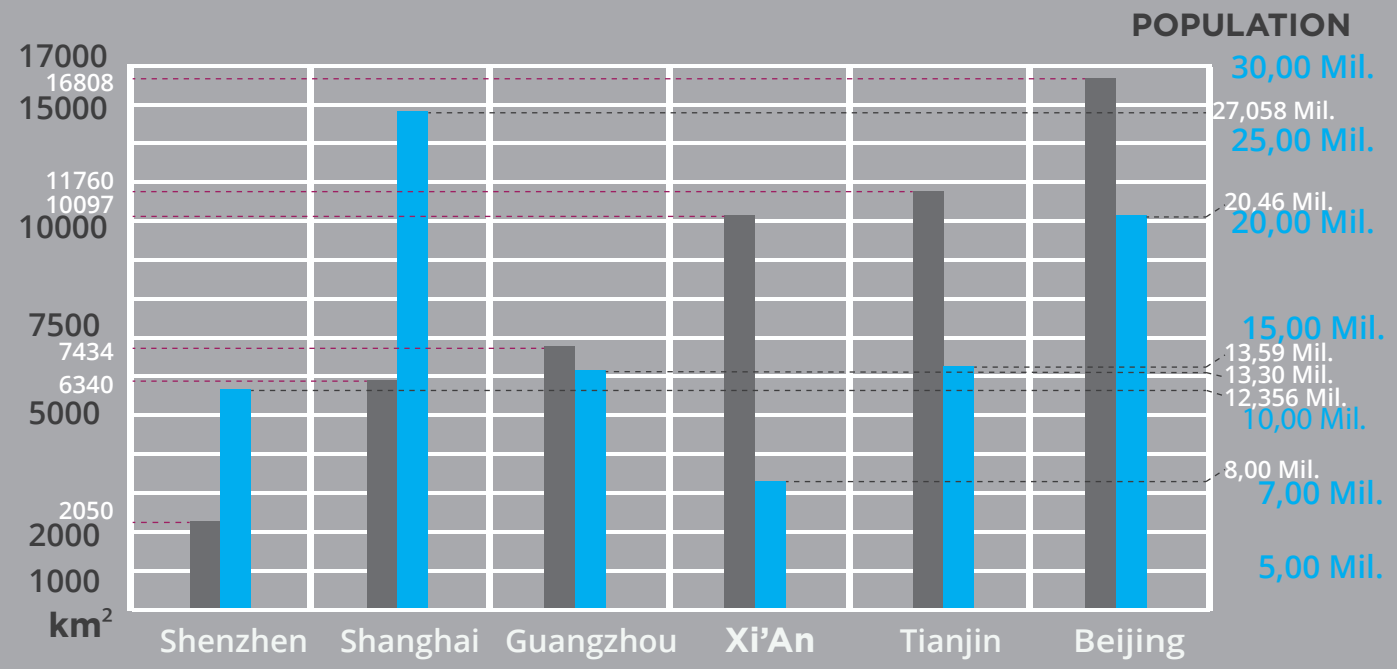
YEAR 1990 2000 2010 2020 2035

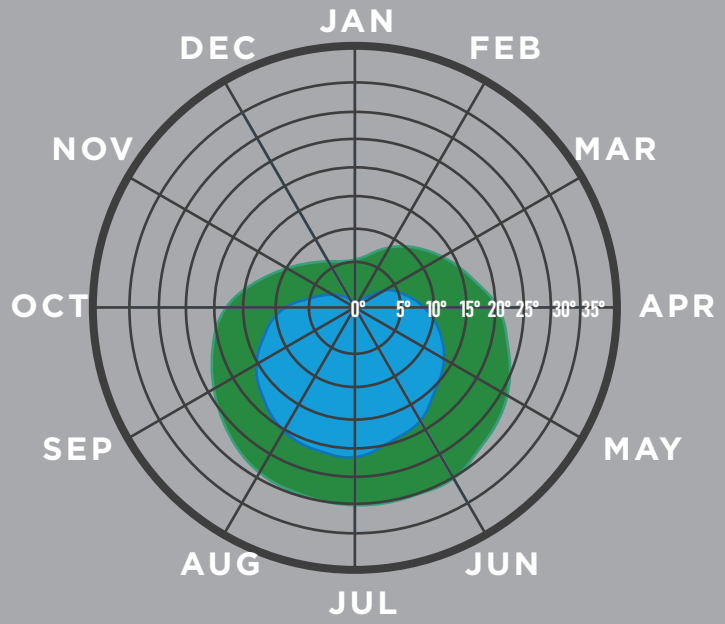
AREA
CHINA

9,597
Mil. km²

AREA
XI'AN

10,097
km²





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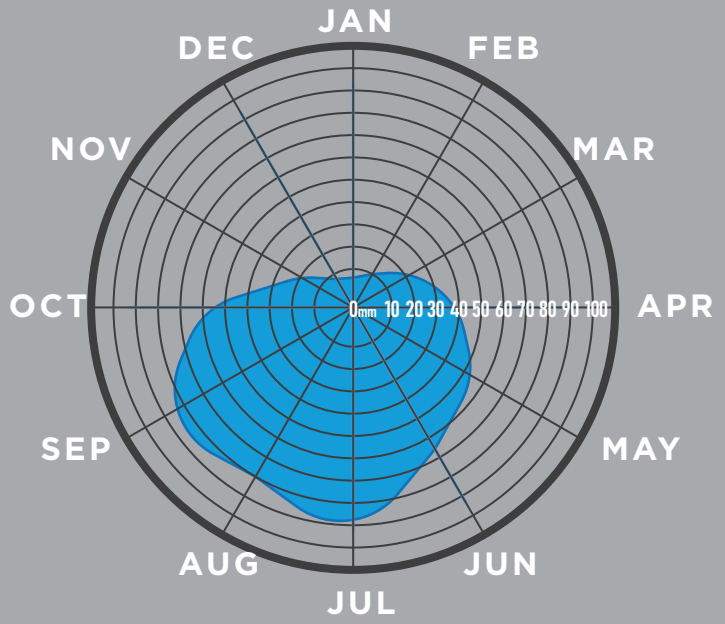

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XI'AN | 2030 Masterplan

> *Xi'An is tireless and adaptable to the needs of the times. By 2030, this city will experience an expansion of more than 17km². This is the outcome of a measure that has been implemented by the central government of Beijing. It aims at maintaining the city as the hub of the relationships between China and the Western world.*
>
> *(YAC, 2019 on the development of Xi'an)*

After arising to power, Xi Jinping called for "the great rejuvenation of the Chinese nation". China's past was to be seen as a guideline towards setting the grounds for a prosperous and powerful future nation. The strategy of drawing inspiration from its rich past has been used in the development of several individual cities in modern China so far.

Xi'an isn't an exception from this strategy either – in common view, in order for the city to have a successful future development, it is mandatory to understand and also maintain a strong connection to its imperial past and prominence.
Needless to say, China has a history of presenting the past based on the country's fluctuations in terms of cultural and political environment. Thus, the construction of collective memory regarding its own history is used not only as a means for the preservation of past values but also for future development. Xi'an is just another case study for grasping China's method of envisioning its present based on its past.

While many sites had already been lost due to events prior to the founding of the PRC (People's Republic of China), there were still many places to be protected in Xi'an in 1949 [11]. The central government of the PRC recognized the value of protecting historical sites, and issued a series of directives in 1951 instructing local governments to protect significant historical landmarks. While the 1953 Overall Plan for Xi'an explicitly preserved some areas of the city based on historic value, the key emphasis of the plan was on industrial development and the intention was to change the historic city of 'consumption' to a city of 'socialist production', according to Ya Ping Wang's article "Planning and conservation in historic Chinese cities".[12]

Despite these preservation efforts, Xi'an lost much of its historic character to development. One stark example of this is Nandajie (South Great Street), which was a thriving

Fig.4a

centrally located street; this area, during the redevelopment process, was winded and the low buildings were replaced with taller modern constructions that altered its character.

Beginning in 1961, the State Council published a list of "key national sites" and issued The Provincial Ordinance of Historic Interests Protection and Management providing guidance to local governments on creating organizations that manage important historic sites. Despite these protections, however, there was a lack of funding available for the preservation efforts outlined in the directives. In Xi'an this meant that the City Wall fell into disrepair and parts of its historic brick structure were removed to make way for roads or building materials were repurposed by residents for the construction of housing.

Perhaps more costly to the historic landscape of Xi'an, however, was the rapid development of the city, which permanently altered the historic skyline and left historic structures almost completely enveloped by modern expansion. Preservation radically shifted with the advent of the Cultural Revolution in 1966 as protecting historic sites was considered "reactionary" and many historic sites were targeted and destroyed by the public [13].

In Xi'an, perceived value in historical preservation surged after the 1974 in the public and government's eyes with the discovery of the Terracotta Warriors, resulting in the direction of more resources toward preservation. Historic sites, however, still lacked formal protection. The 1980 revised city plan envisioned Xi'an as "a city of advanced sciences, culture and education with textile and machinery manufacturing industries as main sectors, and tourist trade based on the protection of the city's historic features." While preservation was written into the vision of the city, the justification for this preservation was not the intrinsic value of the historic sites but rather their value in the promotion of economic development through tourism.

In 1981, the State Bureau of Historic Interests Management proposed new measures and noted damage to historic sites to the State Council, which eventually led to the creation of new policies[14]. The 1980s also brought a shift in approach to historic preservation away from preserving isolated sites toward protecting historic areas that allowed for the designation of "Historic Cities or Towns." This signalled a shift in public understanding of the value of historic sites from isolated pockets to well bound areas[15].

For Xi'an these policies meant that greater attention was paid to how historic sites could be protected, including increases in funding. The City Wall became a focus of this protection and the entire surrounding site was to be rebuilt and used as park land. Additionally, city plans

called for height restrictions on buildings inside the wall within a certain distance [16]. Today, these preservation efforts have rendered the Xi'an City Wall a major tourist attraction and a site of local cultural activity.

However, the aforementioned preservation efforts have not been enough for keeping the Xi'an's historical character intact and consequently, high-rise developments have taken the place of original landmarks.

But perhaps the most drastic of changes came from the Xi'an 2030 Masterplan, which envisions the wipe out of an entire area of the city and a consequent rearrangement of the urban fabric, maintaining only the banks of the river and canals as natural direction and re-envisioning everything, including the existing circulation axes. The new masterplan foresees the development of a Financial District, Cultural District, Fashion District and International Residential Areas, all encompassed within the "Innovation Landscape Ring". The new layout is split into two main sectors along the "Main-Industrial Axis" and the "Eco-Commercial Axis" and divided by a "Theme Park Leisure Area". (Fig. 5)

This "Innovation Landscape Ring" rearranges the urban layout in a NE/E - SW/W direction, perpendicular to the Fenghe River and following the tracks of the new high-speed railway line.

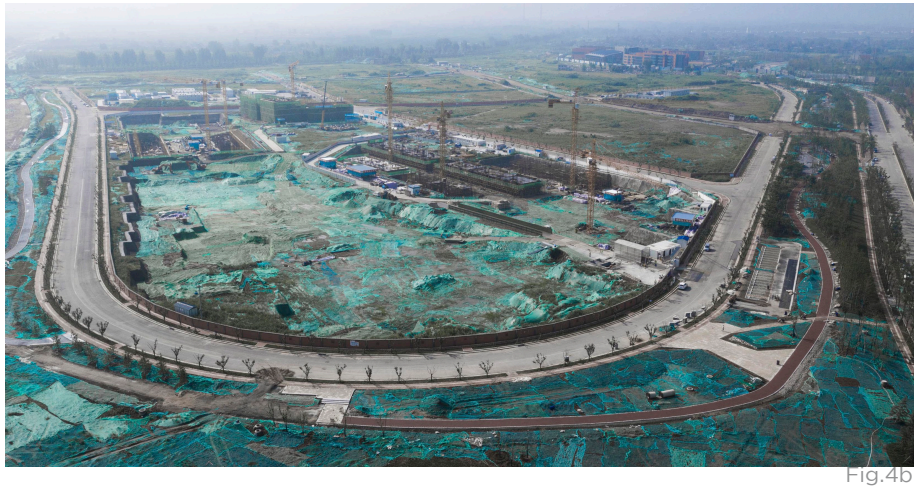


Fig.4b

Fig.4c

XI'AN | Current Situation

XI'AN | Masterplan with project site

*

Fig.6

XI'AN | 2030 Masterplan

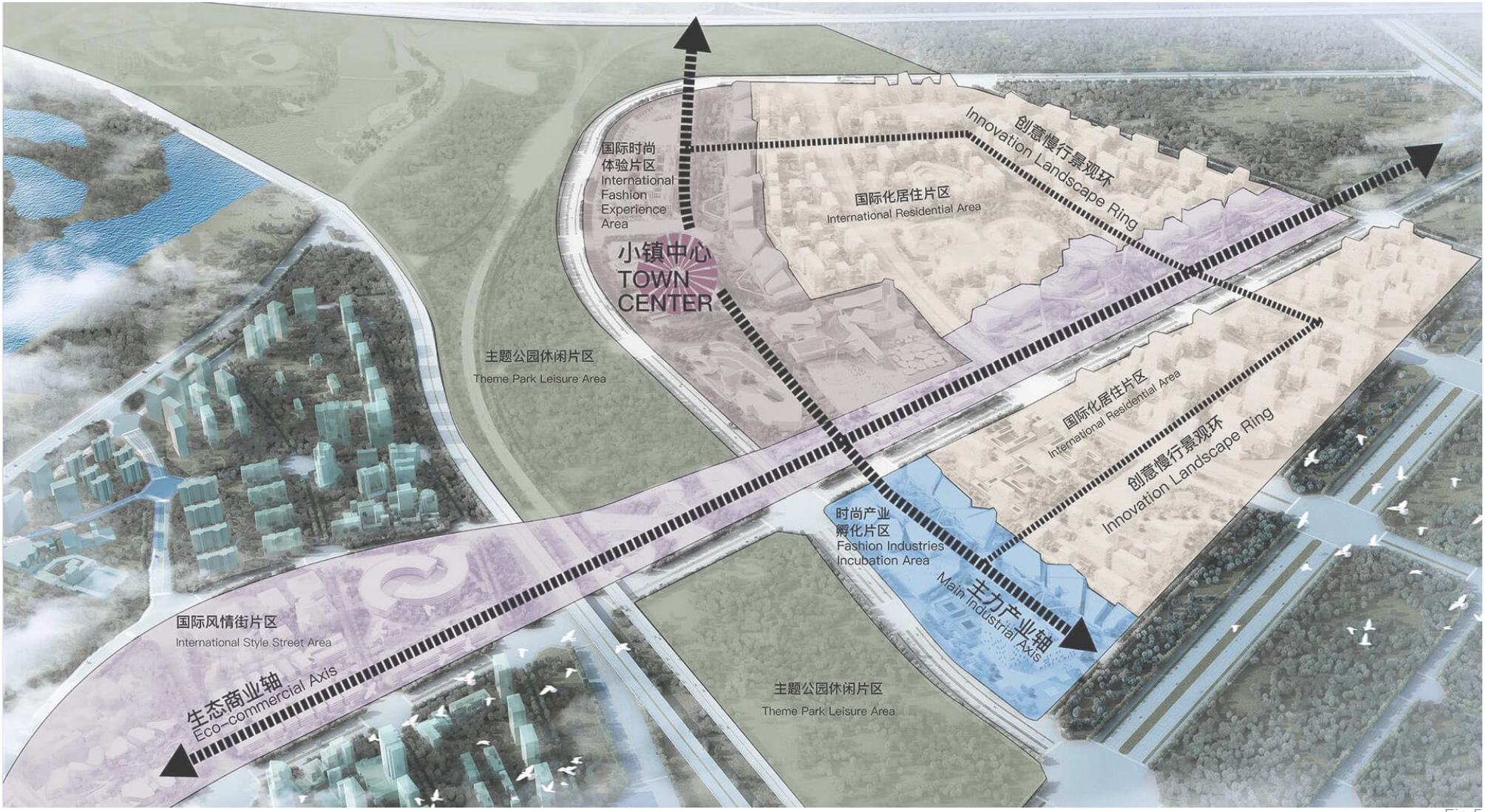


Fig.5

XI'AN | 2030 Masterplan | Zoning Diagram

> *We think of globalisation as a uniquely modern phenomenon; yet 2,000 years ago too, it was a fact of life, one that presented opportunities, created problems and prompted technological advance.*
>
> *Peter Frankopan, The Silk Roads: A New History of the World*

TRAIN STATIONS

The architectural implications of a train station are as complex as spatial theory itself. At the very core of things, a successfully built transportation node manages to integrate functionality, spatial programme, design and structural elements flawlessly, resulting in the balanced materialization of a public landmark.

Historically recorded more than 2.000 years ago (605 BCE, Corinth), trackways and wagonways helped shape entire human settlements (Diolkos, Hohensalzburg Fortress, most of the USA)[17] with the contemporary result of becoming urban landmarks for roaming passengers and goods.

Stations affect the surrounding landscape depending on their functional type: city center terminal, suburban station, interchange, LRT, but in the contemporary context, stations have become increasingly complex, thus fulfilling a plethora of functional roles. The spatial framework requires the intertwining of a main building with concourses, canopies, outdoor environment and consequent functions for travelers.

This complexity is directly proportional to the setting of the station and the amount of passengers expected to interact with it. Here, a dialogue between form and function intervenes in setting up a healthy relationship between the main function - transportation and the required adjacent functions.

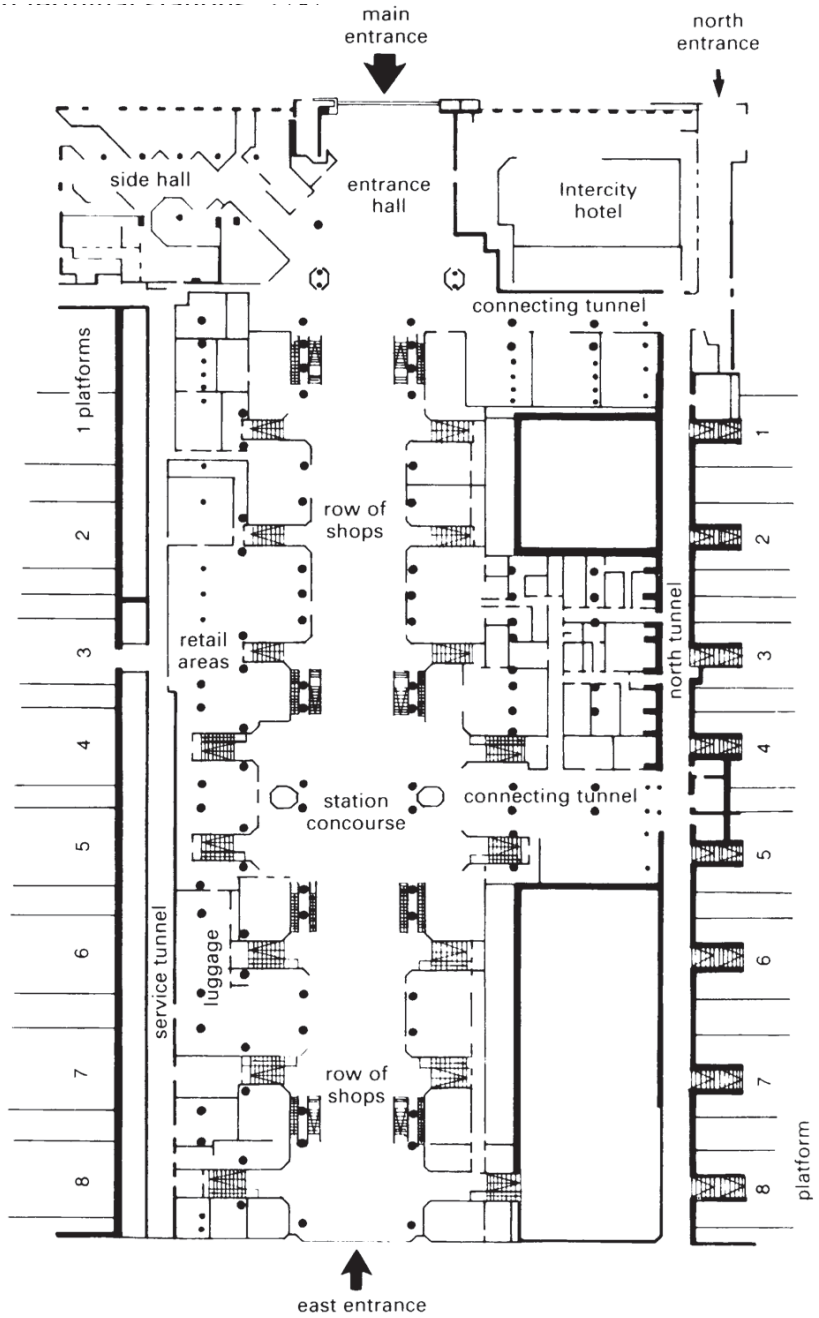
TRAIN STATIONS | Encountered Problems

Given the rapid worldwide urbanization, the most prominent challenge encountered by train stations is integration in the city context. Traffic congestion, accessibility and sustainable design are only the most obvious consequences of shaping a train station into a holistic and unitary architectural environment.

Unlike the West, China displays seasonal fluctuations in railway travel, resulting in overwhelming congestion on the passengers' concourse. It is not only a phenomenon encountered in smaller (local) stations, but also heavily affects some of the mega-stations[18]. This has pushed architects in the more recent years to exaggerate the public areas in order to create enough space to accommodate the potentially massive amount of travelers.

Countrywide, the policy adopted by the Chinese Government pushes for the standardization of design and procedures of infrastructural nodes, as a move meant to facilitate faster construction and delivery of buildings dedicated to HSR nodes (High-Speed Rail)[19]. This of course, involves not only considerable savings in terms of capital and time, but also consequences in terms of urban integration and optimization of the stations for their surroundings. Another persistent issue is security - as a clear priority for the rail transport system, passengers tend to experience a considerably larger amount of ticket checks, bag scans and detection gates compared to Western stations. The scrutiny in terms of checks, might sometimes result in an irritable experience depending on province and type of train.

In terms of facilities, Chinese stations have a greater necessity for additional functions compared to Europe as a result of the 'Railway Experience' phenomenon. At its core, socio-economical factors[20] influence the passengers' perception of the infrastructure hub more than the accessibility to the transport interchange or additional facilities existent within the station.[21]



Pedestrian Arcade Düsseldorf Train Station, Neufert Fig.7

TRAIN STATIONS | The Future Of Train Stations

Globalization and urbanization trends point towards more than 10 billion people inhabiting the planet in 2050, 75% of which will be living in what is nowadays referred to as 'Megacities'. Rail nodes need to adapt to this ever changing infrastructure of cities and provide the adequate facilities needed by potential travelers.

Changes in demographics and urbanization (every 2 seconds another person migrates from a rural settlement to a city) require a decentralized system that embraces a bottom-up attitude towards citizen co-creation and improvements caused by technological advancements. (22) In other words, the urban environment needs to be reorganized in such a manner in which it offers enough opportunities, functions and facilities outside of what is now commonly known as the 'City Centre'. The theoretical solution invoked by the concept of 'Smart Cities' is that urban nodes (whether they are of political, social, infrastructural, public, etc. origins) are to be implemented across the city fabric to create a unitary environment able to cater for all citizens.

Historically, train stations had to simply serve a single purpose: a place where the traveler embarked at point A to disembark in point B. With this approach, there was no need for accommodation, entertainment, workspaces, etc. in the vicinity of stations since the 'City Centre' was an approachable concept.

As Megacities started emerging (the term denotes any urban entity of more than 10 mil. inhabitants), accessing those areas with commodities in the urban centers became increasingly hard. This all saw a shift with the emergence of a new building typology, the airport around the 1920s. Although not the first of its kind, Flughaven Devau (23) was the first commercial airport to embrace the idea of integrating additional functions complementary to travelling, hence employing a tram link to the city.

Train stations are no different, seeing a higher demand in improving the traveling experience. Alongside, came the idea that traveling does not need to be defined as the delivery of goods/people between two points, resulting in a more integrative attitude of additional functions around the needs of the passenger. Not only do stations need to become an urban node, they also require to be adapted to new technologies, provide adequate spatial organization,

Fig.8

be congestion-proof and energy efficient, but also offer all the necessary adjacent functions to traveling, thus demanding for a non-standardized approach. The latter is to be directed by the urban requirements. A mention worthy example is Space X's Hyperloop project. Sparking more than few architectural competitions and independent proposals, the idea behind was to provide a space, not only for traveling, but also capable of enabling the creation of a spatial situation that encompasses all the necessities of a passenger. In consequence, non-traditional technology implemented in a large scale concept results in a redesign and reconceptualization of what a traditional train station means.[24]Although currently concentrating on testing the new technology, the expectations for Hyperloop stations are to transform public transit into a more user-centric service.

PRECEDENTS

The projects below have been analysed and taken into consideration during the design process of this proposal.

Each one of them features a certain characteristic in the way they approached the urban context, integration of uses and construction. As short case studies, the main focus of the ‘Precedents’ is to understand the driving factors in designing a train station and how to adapt its uses according to the needs of the travelers.

Their locations have been chosen strategically in different parts of the world to further ensure that no uses are omitted and to create a comparison between the expectations of the brief versus the real-world conditions in Europe and Asia.

07

Delft city hall and railway station complex | Mecanoo

2006 - 2017 | Delft, Netherlands

Fig.9 a

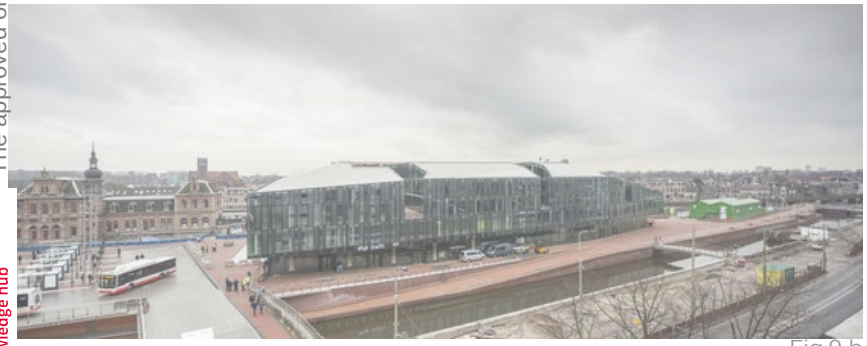


Fig.9 b

The new railway station of Delft opened its doors nine years after the project was commissioned (2015) to Mecanoo Architects at 80% of the planned capacity. By 2017, the remainder of the development has been built with the aim of combining the city hall (including the offices of the Municipality) with the new train tunnel.

The latter has taken the place of a concrete viaduct designed in the '60s which was seen as a dividing element to the urban context. As a main drive for the concept, the City Hall and the station are now directly linked.

Covering over 7.700 m, the terminal's main feature is the undulating ceiling, assembled from a series of aluminium fins printed with a reminiscent image of the regional map of the late 19th century.

Other integrated design and structural elements are covered with Delft's famous blue tiles, while municipal services are enclosed in glass volumes facing the station, providing a sense of integration with the surrounding functions. The commercial area has received a similar treatment in terms of openness and undisruptive lines of sight.

The external finish of the facade (fused glass panels) reacts and reflects the environment and translate the colours of the sky into the dominant colours of the station. Openings are designed in the facade to reference the iconic window designs of the city. This shell is a compact envelope which transitions from high to low (with the aim to slowly be visually integrated into the city). (25)

Fig.9 c

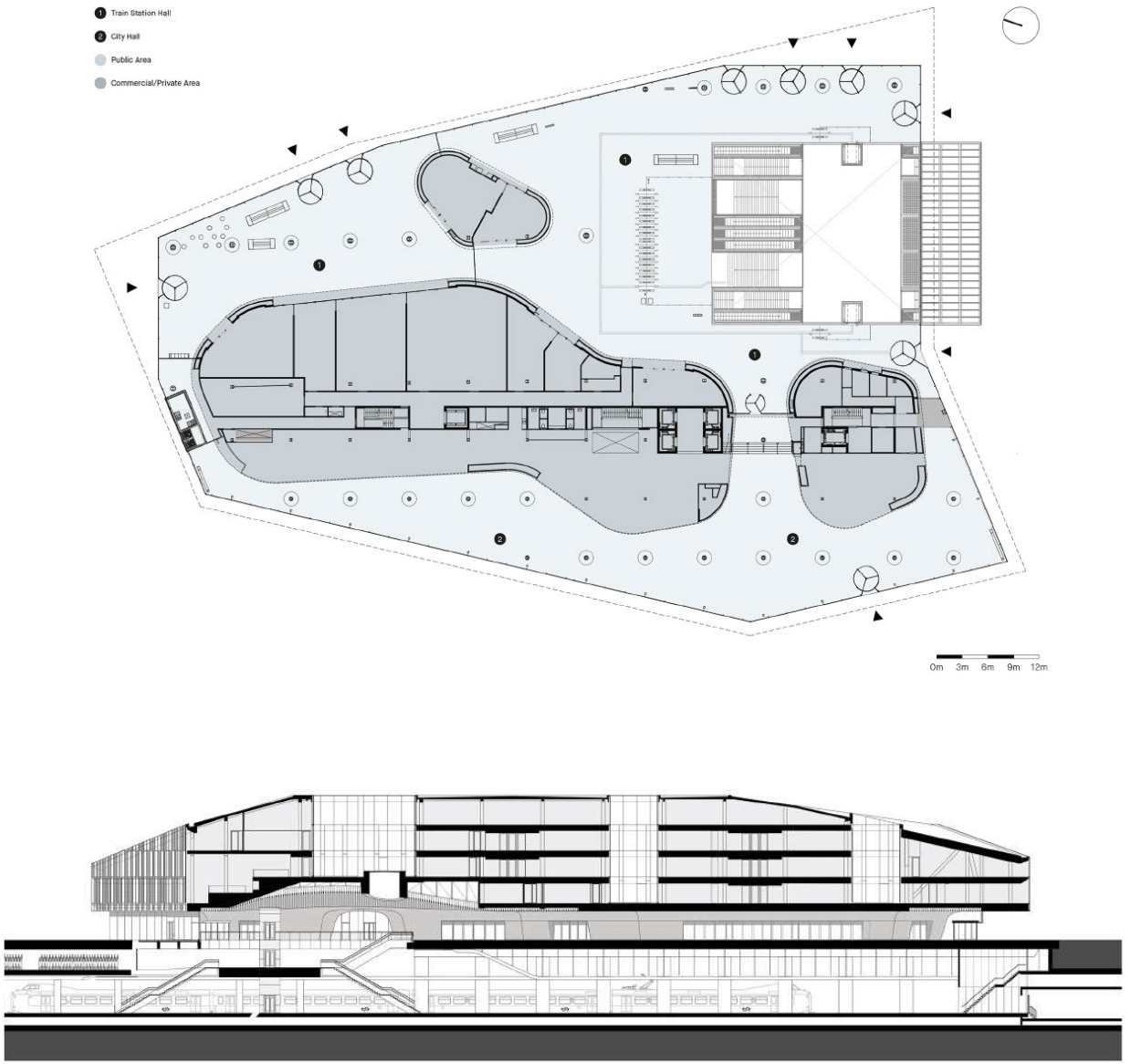
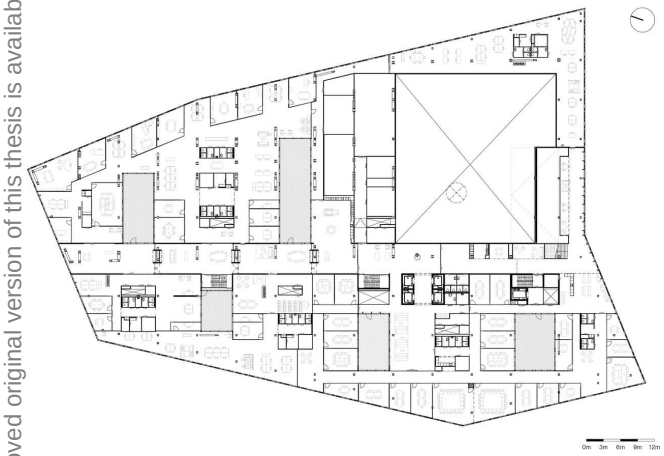
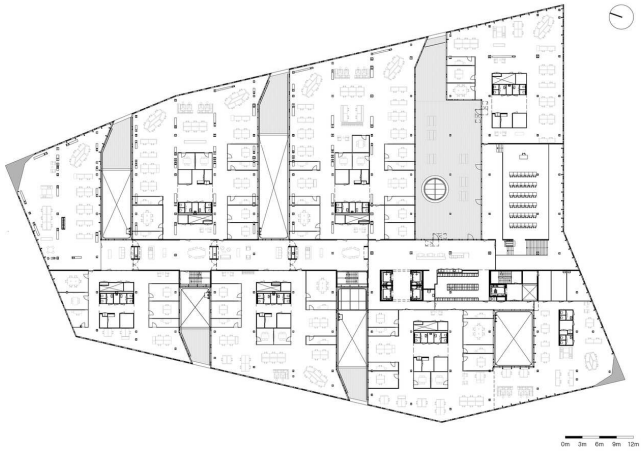


Fig.9 d





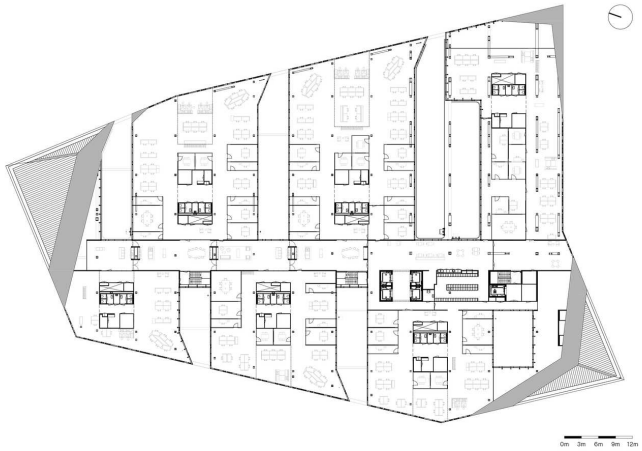


Fig.9 e

The City Hall unfolds on almost 20.000 m and features a public lobby of 2.230 m that links (physically and visually) to the station hall (2.450 m), retail facilities, and food courts. Other functions (bicycle shed, internal patio, archive and loading bays) are discreetly integrated amongst the larger uses.

07

Kaohsiung Station | Mecanoo

2014 - 2024 | Kaohsiung, Taiwan

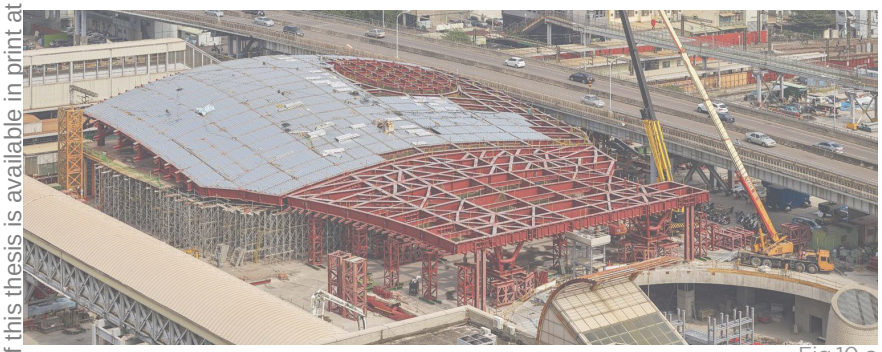


Fig.10 a

Fig.10 b

Kaohsiung Station embraces the idea of exaggerating public space by integrating in its organic (curvilinear) shape a landscaped canopy.

The greenery is used to bring together different modes of public transportation while concomitantly enforcing the city's policies for sustainable future development.

As the metropolitan area unfolds, the proposal becomes a centrepiece to its context and joins together along almost 10km of railway tunnels in seven distinct subterranean stations. From taxis, bicycles, bus services, to metro and rail, the transportation hub is meant to offer a multitude of choices to travelers. As the city is trying to redefine its identity, the station is designed to become the main point of arrival at both ground and underground levels.

The above-ground part is defining for the concept of a greener/more sustainable city, while below (train and metro platforms), the bright ceiling lights envelop a sunken plaza connected to hotels, restaurants, retail outlets and facilities accessible for passengers and members of the community.

The multi-layered landscape houses a bike path as a metaphor for connecting old and new traditions of Kaohsiung, which crosses the site from East to West.

Kaohsiung's vision for a sustainable city is translated into the curvilinear shaped canopy whose presence is seen as a strong gesture of connecting the city. Not only is the green space enveloping the entire built footprint, it also unifies all functions under one functional roof.(26)

Fig.10 c

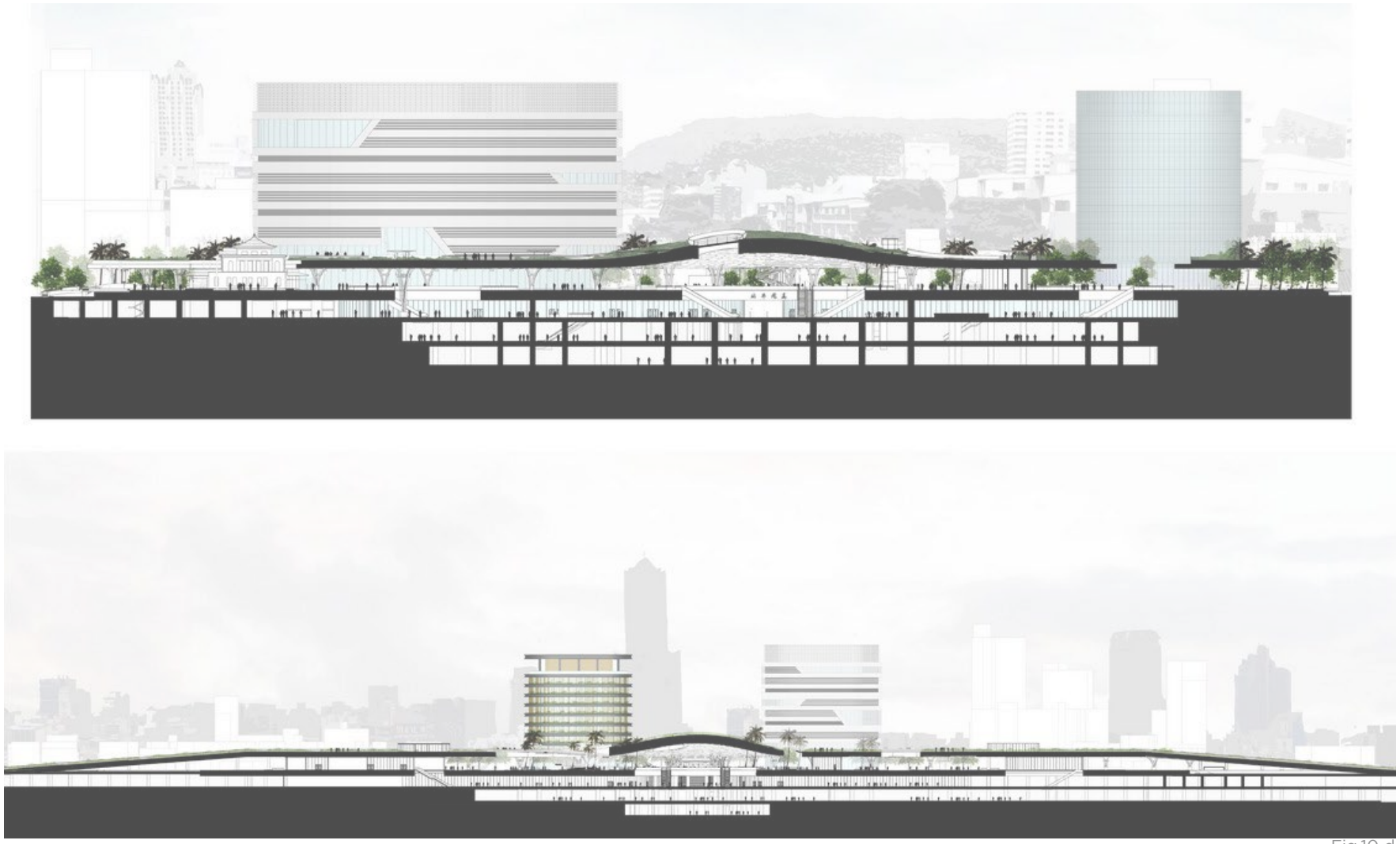


Fig.10 d

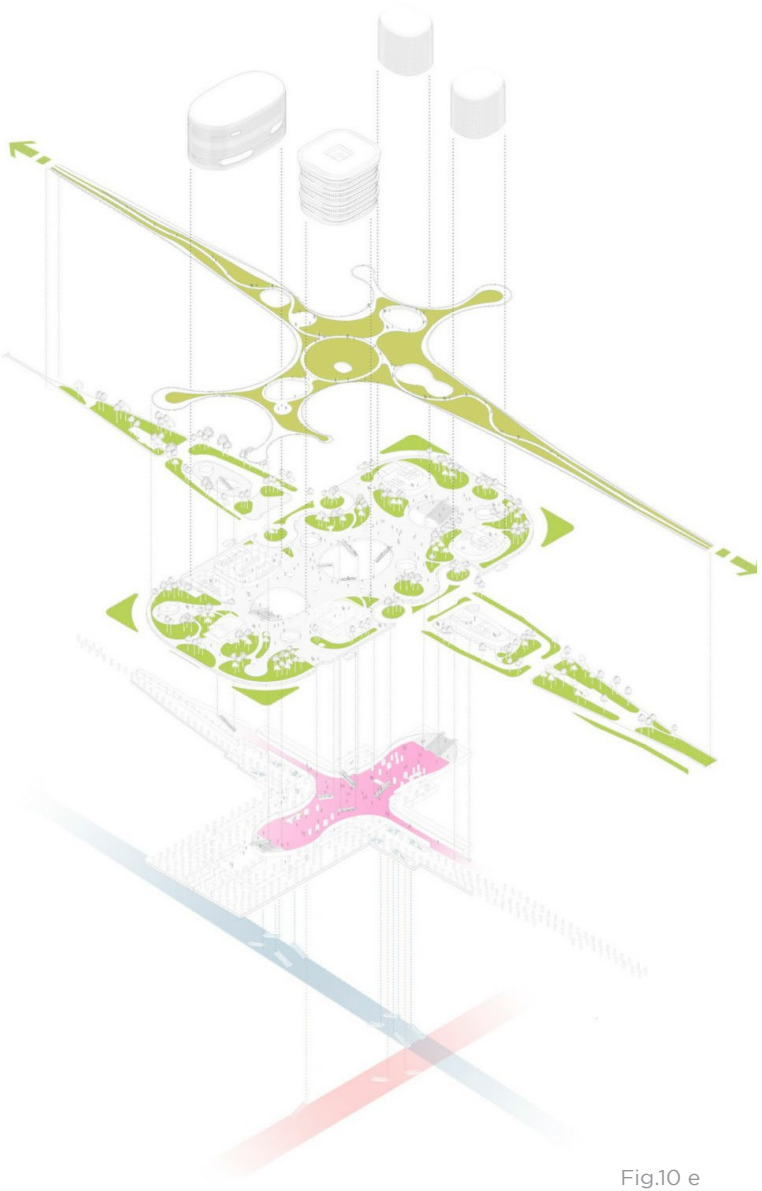


Fig.10 e

The tropical climate played a major role in approaching the design of the station: the canopy (almost 13.000 m) shields the public plaza from external conditions, similarly to how trees would act in a forest. Not only that, but the created micro climate houses a space adequate for social interaction, public events. (26)

07

West Kowloon Station | Aedas

2018 | Kowloon, Hong Kong

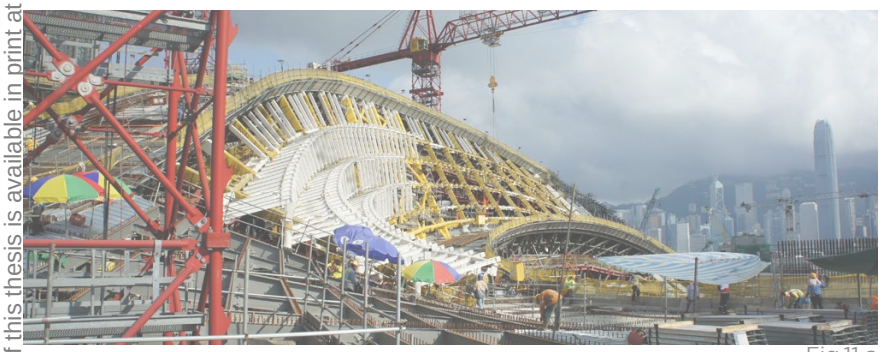


Fig.11 a

Fig.11 b

As the first major project to be completed in the West Kowloon cultural district, the train station is designed to be the new gateway to Mainland China within the new section of the Guangzhou-Shenzhen-Hong Kong High-Speed Rail service. The 142 km of rails is connected all the way to Beijing with the National High-speed Rail network for a total of more than 25.000 km worth of train lines akin to an airport, rather than a local train station, West Kowloon Station handles passengers through border controls and security checks, covering more than 400.000m of usable floor area. The amount of built area however, is optimized for the large influx of passenger and ensures the avoidance of congestion. The brief of the competition required the conception of a landmark-building which created an incontestable sense of 'arrival' that fit the context of Victoria Harbour.

Aedas Architects purposed over 3 hectares of green space, referred to in the context of this project as 'green plazas', into shaping the outside of the station. The shape is a dialogue between the bending area towards the entrance and the roof structure facing upwards. This design gesture results into a 45m tall volume whose directionality is focused on the South facade facing towards the Hong Kong Central skyline and encouraging visitors to walk the length of its roof landscape.

The 430.000m facility features 15 tracks and is the largest below-ground station terminus in the world. The site's prominence is immediately adjacent to the future West Kowloon Cultural District and next to Victoria Harbour required a design that was completely motivated by civic demand.(27)

Fig.11 c

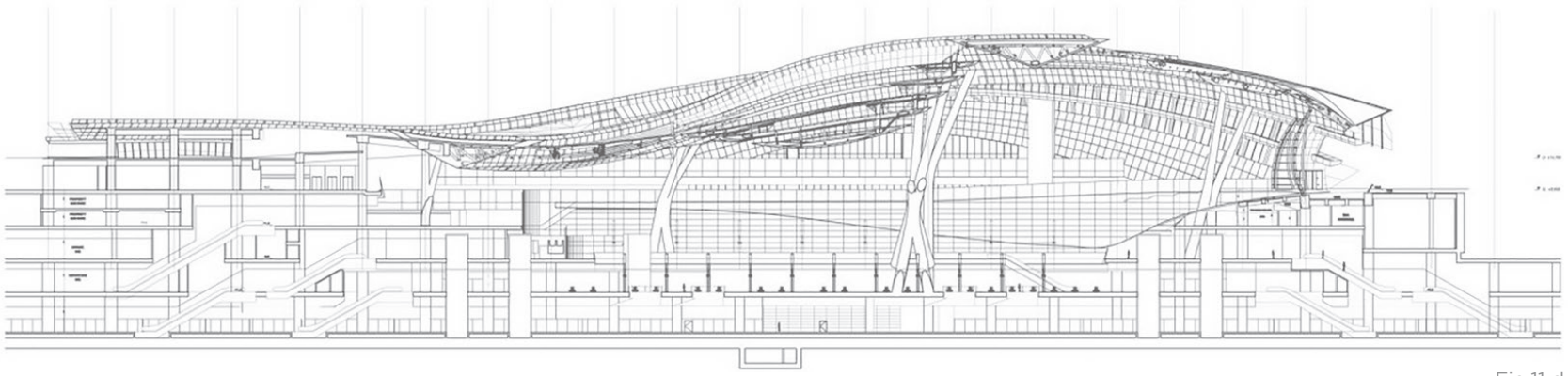


Fig.11 d

The irregular three dimensionally curved geometry of the roof and the significant inclination of the mega-columns introduced relatively large horizontal movements to the roof. The difficulty arose from the gradual movements progressively building up during construction as the roof gravity loads supported by the inclined mega-columns progressively increased. Three-dimensional pre-camber was adopted accordingly to ensure that the as-built roof geometry was achieved within the specified tolerances to maintain the design integrity. (27)

Fig.11 e

RESEARCH CONCLUSIO

The new train station of Xi'An would have to follow certain parameters in order to ensure a future-oriented use of the building that is able to accommodate people's needs and is easily adaptable to the unpredictable changes in the city.

Putting into perspective some of the aforementioned encountered concerns in the current state of train stations, such as traffic congestion, insufficient public space and a non-flexible spatial organisation, a new model for this typology would have to counteract these aspects and adopt a certain amount of measures which tackle these problems, while at the same time prioritizing civic demands and sustainability.

Taking into consideration the discussion of the reference projects, the following aspects will be integrated into this proposal:

1. Greenery - as a means of enforcing sustainable future development (i.e. the translation of the built surface into a green envelope which encloses all the functions under one roof)
2. A comprehensive connectivity between the adjacent lots - the station is perceived as a link in the city, encouraging visitors to experience the area outside the interest of a commute
3. A flexible inner spatial organisation that can be adapted to a potentially changing influx of passengers.

34°08’36.5”N 108°45’05.4”E | Site Analysis

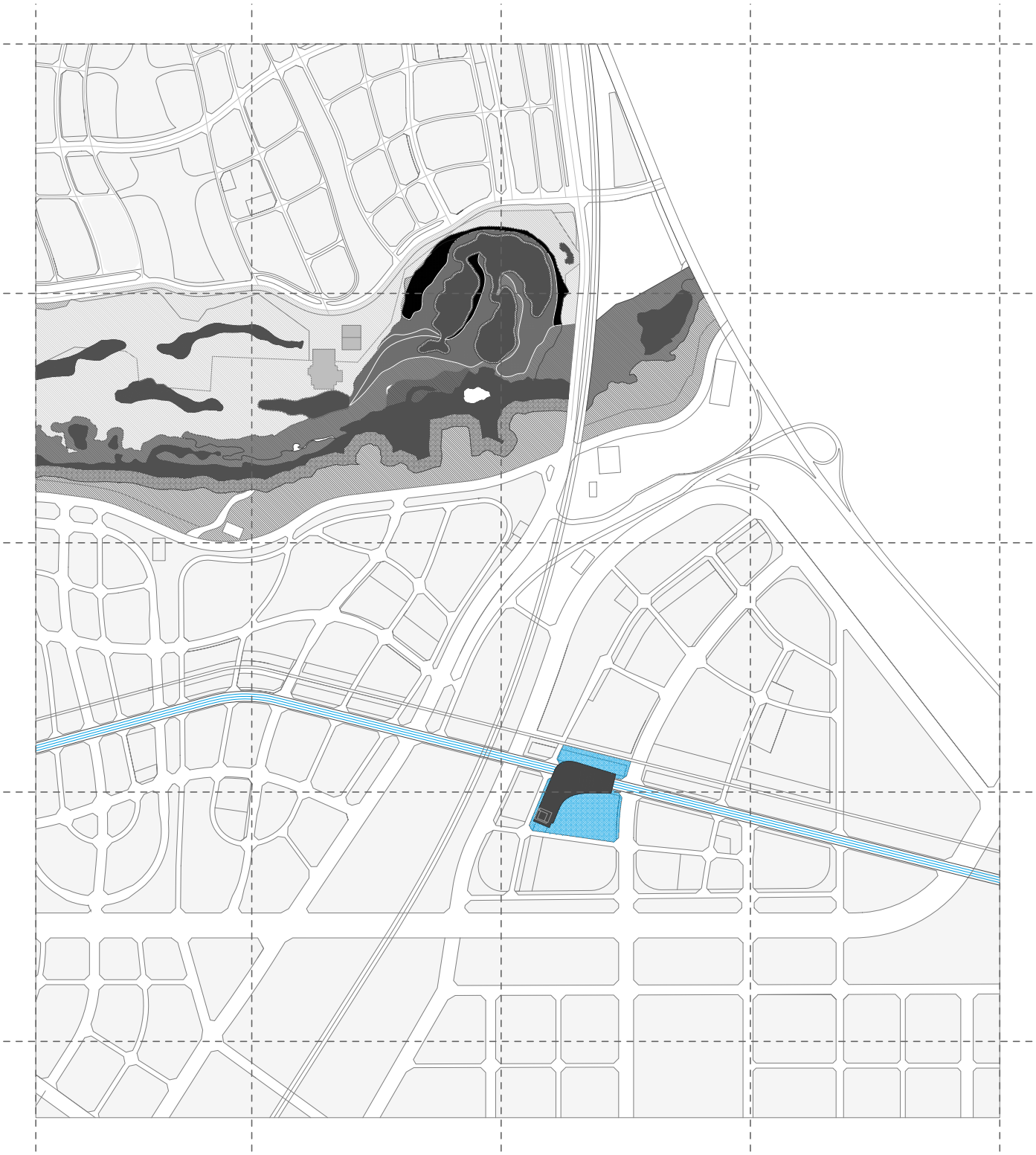
The proposed masterplan of Xi’An reorders the urban structure of the area and orientates it according to the infrastructure nodes and surrounding nature. Having as a main direction the train tracks (NE/E to SW/W), the site is composed of two buildable lots which represent 78%, respectively 22% of the total area.

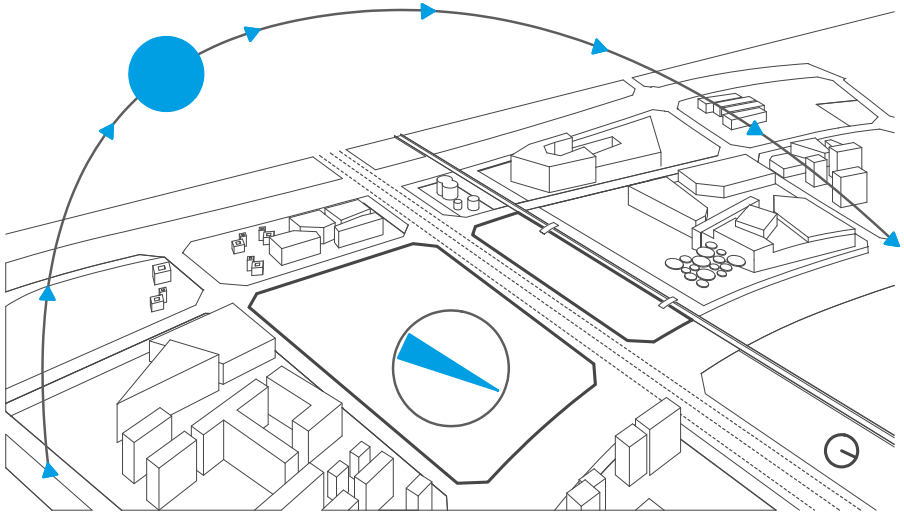
During past decades, the Chinese Government has been taking action in transforming public space into monuments of political achievement where the natural terrain is often desolated and replaced by artificial features and the parks often becomes tourist attractions instead of an integral part of the urban landscape.(28)

A primary purpose of this project is to reclaim the public domain in the context of Xi’an and integrate it seamlessly in the design process. Therefore, one of the main focuses will be to redefine the boundaries between the indoors and outdoors while also maximizing the green footprint of the project.

As previously mentioned, the orientation of the site and lack of high rise surroundings of the master plan, offer the ideal condition for the development of extensive green spaces by taking advantage of the temperate climate and solar radiation. Concomitantly, the new train station will communicate with the existing tower & shopping center but also with the surrounding lots, by optimizing pedestrian routes which allow passengers and visitors to experience the entire footprint of the site.

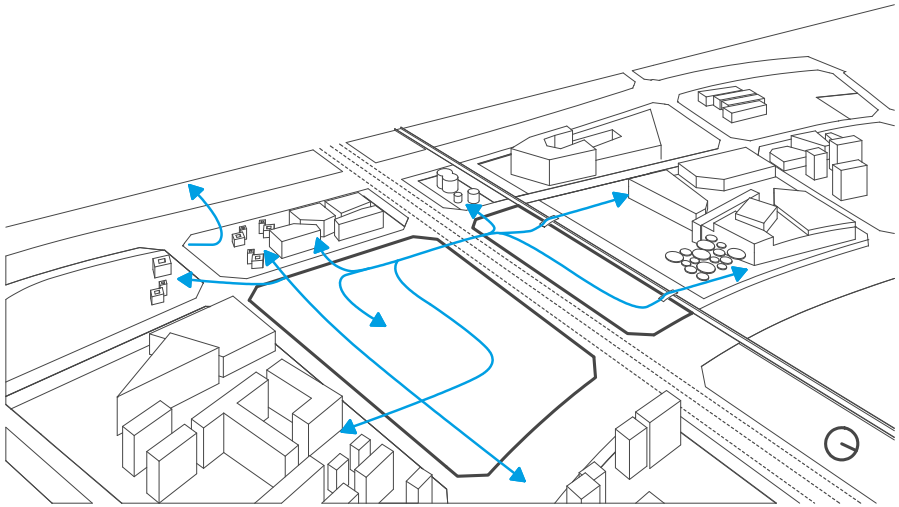
Public transportation will be integrated on the edges of the site as 3 main areas focused around the method of travelling: a bus interchange and taxi drop off with bicycle parking at the pedestrian level (the two are close to each other but on different edges of the site), while personal transportation, deliveries and cars will be directed towards the underground of the building in order to perpetuate the concept that diverse and adequate public transport erases the need to employ a personal vehicle.





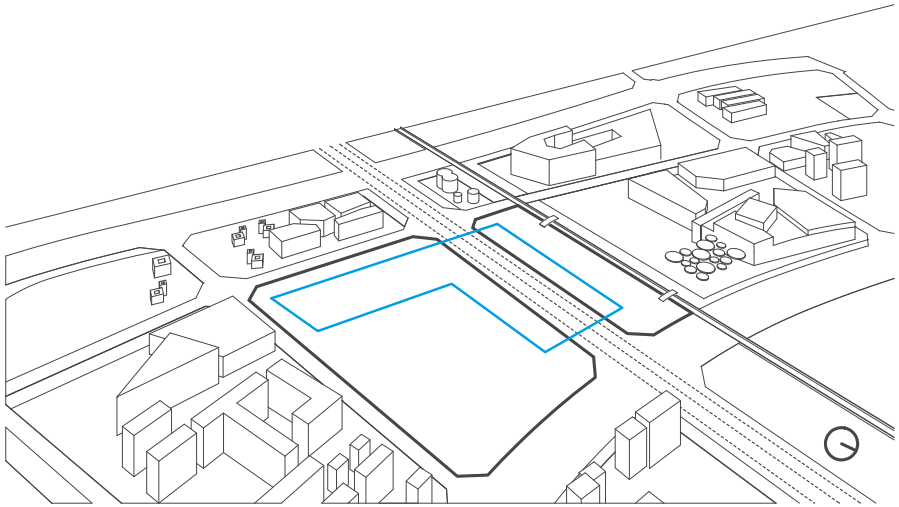
BUILDING ORIENTATION*

Possibility of developing a concept based on extensive green spaces by taking advantage of the temperate climate and solar radiation



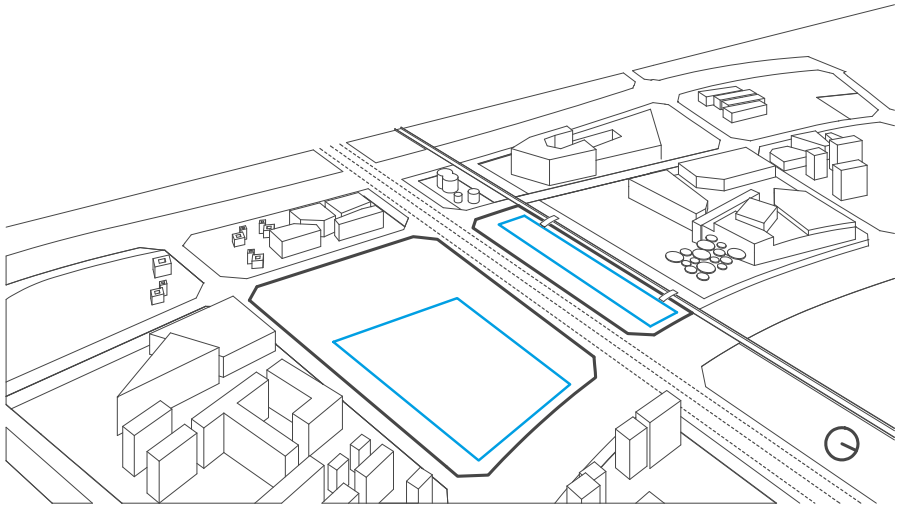
CONNECTIVITY*

Connection of the adjacent sites to the concept lot and creation of walkable routes which allow passengers and visitors to experience the entire footprint of the site.



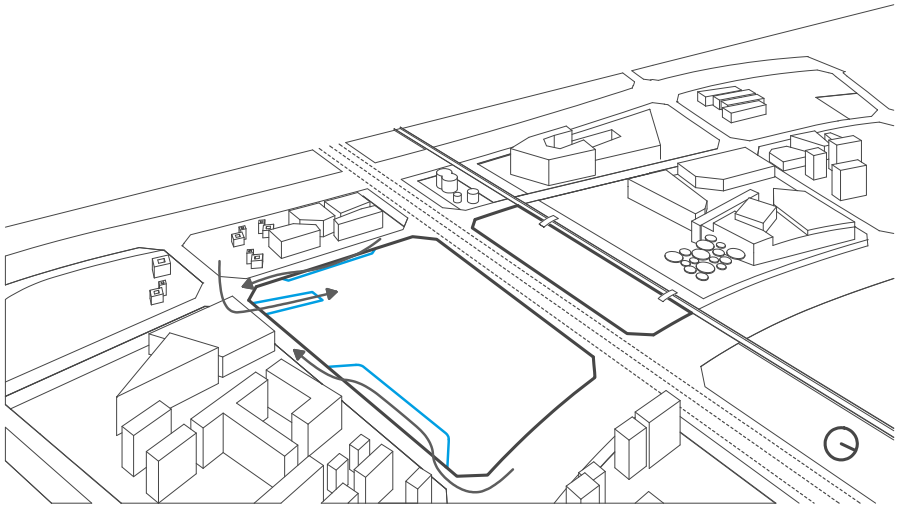
PLACEMENT*

Two lots representing 78% / 22% of the total buildable area.
Placement of the train station above the train tracks



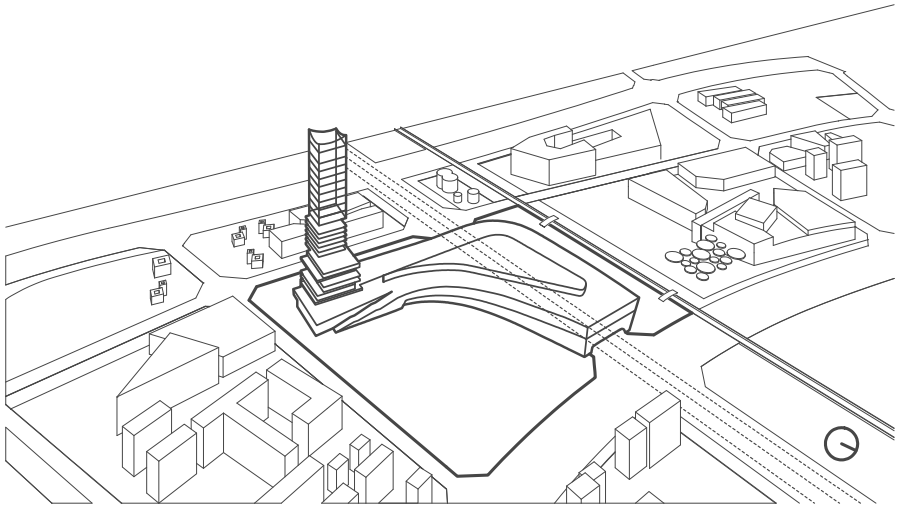
SQUARES*

Redefining the boundaries between the indoors and outdoors while also maximizing the green footprint of the project.



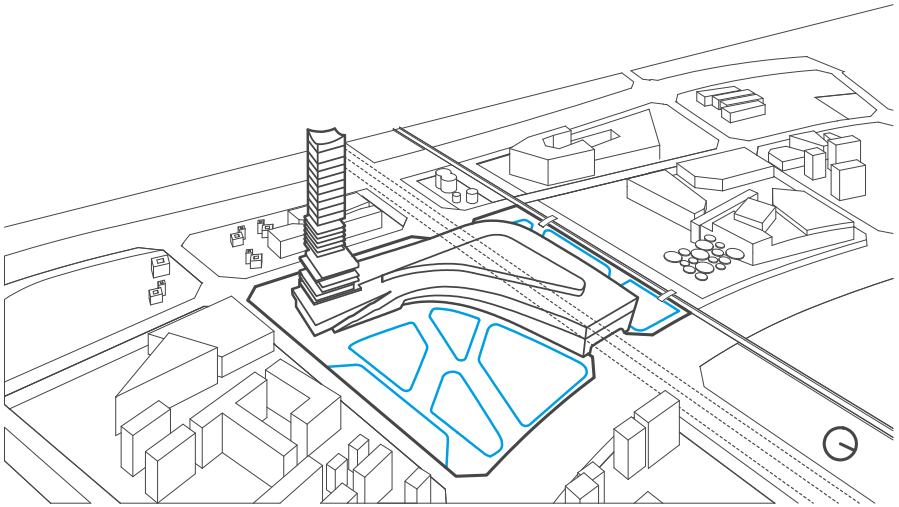
TRANSPORT INTERCONNECTIVITY*

Integration of public transportation on the edges of the site as 3 main areas



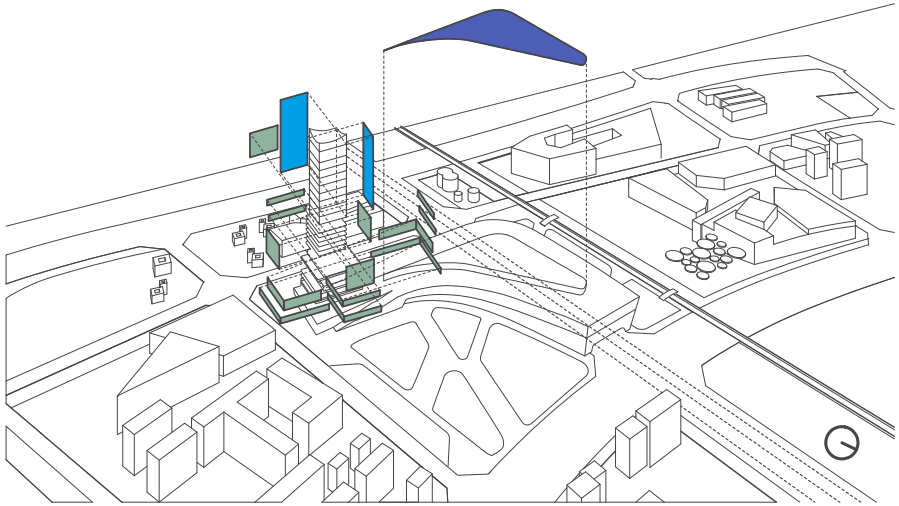
DESIGN*

Train Station connected on the western side with the adjacent Dynasty tower



LANDSCAPE*

The park as an integral part of the urban landscape instead of a tourist attraction



SUSTAINABILITY*

Integration of green-wall-systems, PV-glass, rainwater capture and natural ventilation

09

34°08’36.5”N 108°45’05.4”E | Concept

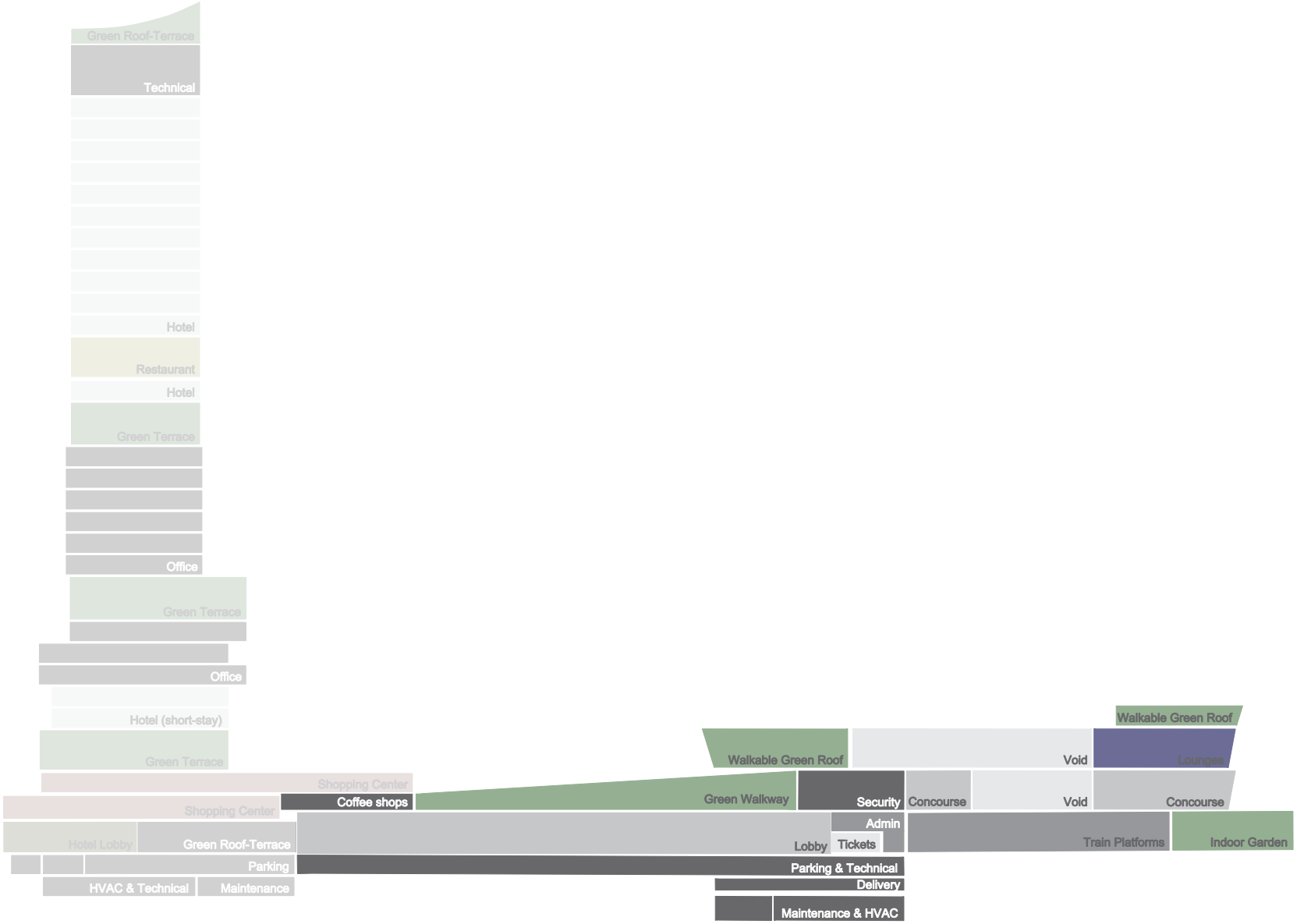
The station is developed as an integrative part of the surroundings with a main focus of communicating with the adjacent existing tower which includes most of the additional functions required for travelers.

The functional program of the station is meant to have an inclusive attitude towards the ephemerality of traveling, consequently enforcing the following: a large lobby which reorients circulation towards all possible directions and functions, an exhibition space which displays the evolution of stations and new technologies integrated within the proposal in question, a small shopping area for passengers (for basic needs), a security entrance which manages passenger circulation to the adequate platforms, the concourse, waiting areas, gastronomy and ticket/information areas.

As external materialization of publicly accessible spaces, the station features a green landscape on the roof that doubles as a promenade, recreational green islands meant to direct pedestrian circulation, connectivity to adjacent lots, public transportation areas for taxis/buses and bikes and a connection to the Dynasty Tower. The building’s orientation is conceived to maximize energy efficiency and follows the main directions of the site. The narrative conducts the paths of the pedestrians towards two dominant approaches to the building: visitors and travellers each one of them featuring a different manner of traversing the built surface of the station.

Hard boundaries within the station are strictly integrated to create a separation between the passengers and visitors, hence the opportunity of a bidirectional circulation in the lobby. The narrative is also split between shopping and adjacent functions areas versus higher security spaces such as station platforms.

Structural elements are arrayed along the building as enforcements of the circulation lines and follow the directionality of the design. The structural elements (V shaped columns) have a constant span (center to center) but variable sizes and blend with the ground floor structure of the connected tower. The intertwining between the existing (tower) and proposed (station) offers consistency to the urban fabric and creates a reciprocal discourse of the two entities.



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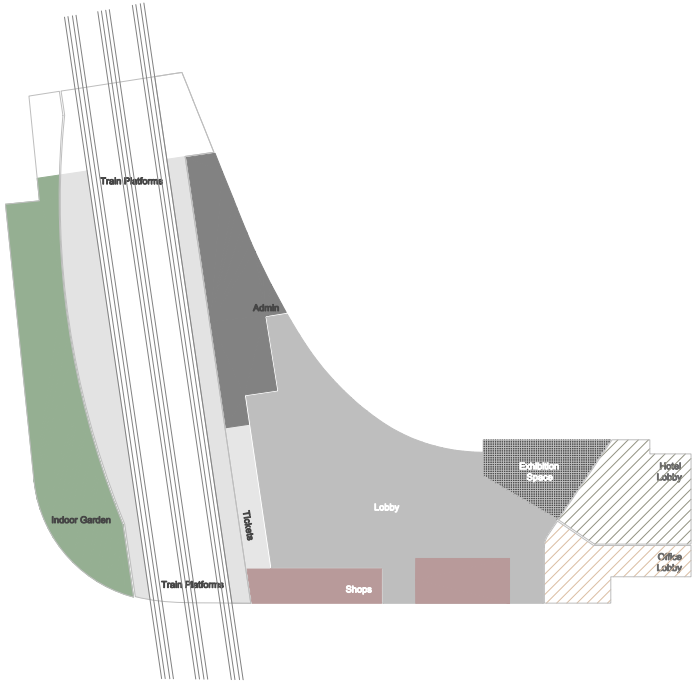
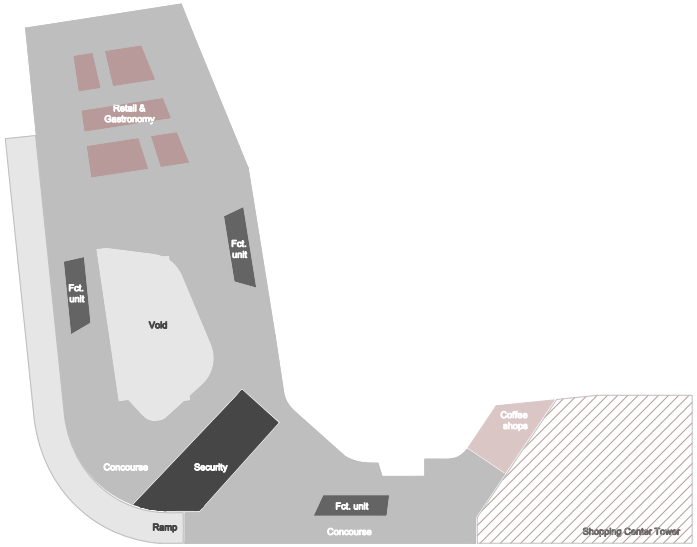


GROUND FLOOR PROGRAM

The lobby offers a bidirectional circulation towards the adjacent tower's lobbies and at the opposite direction, to the first floor connection leading to the train platforms. Administration, information desk and ticket offices form a barrier between the lobby and the platforms.

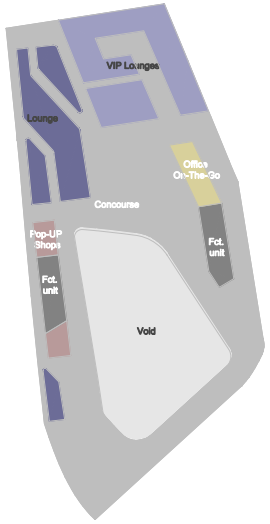
Lobby	9620 m²
Administration	2580 m²
Tickets/Information	635 m²
Shops	1700 m²
Indoor Garden	4460 m²



FIRST FLOOR PROGRAM

The passenger concourse is scaled appropriately to accommodate a large influx of travelers. The void ensures a sense of arrival for the passengers, replacing the need for a canopy. Shops are discreetly integrated into the main waiting area, also serving as boundaries for various areas of the concourse (quiet area/open area).

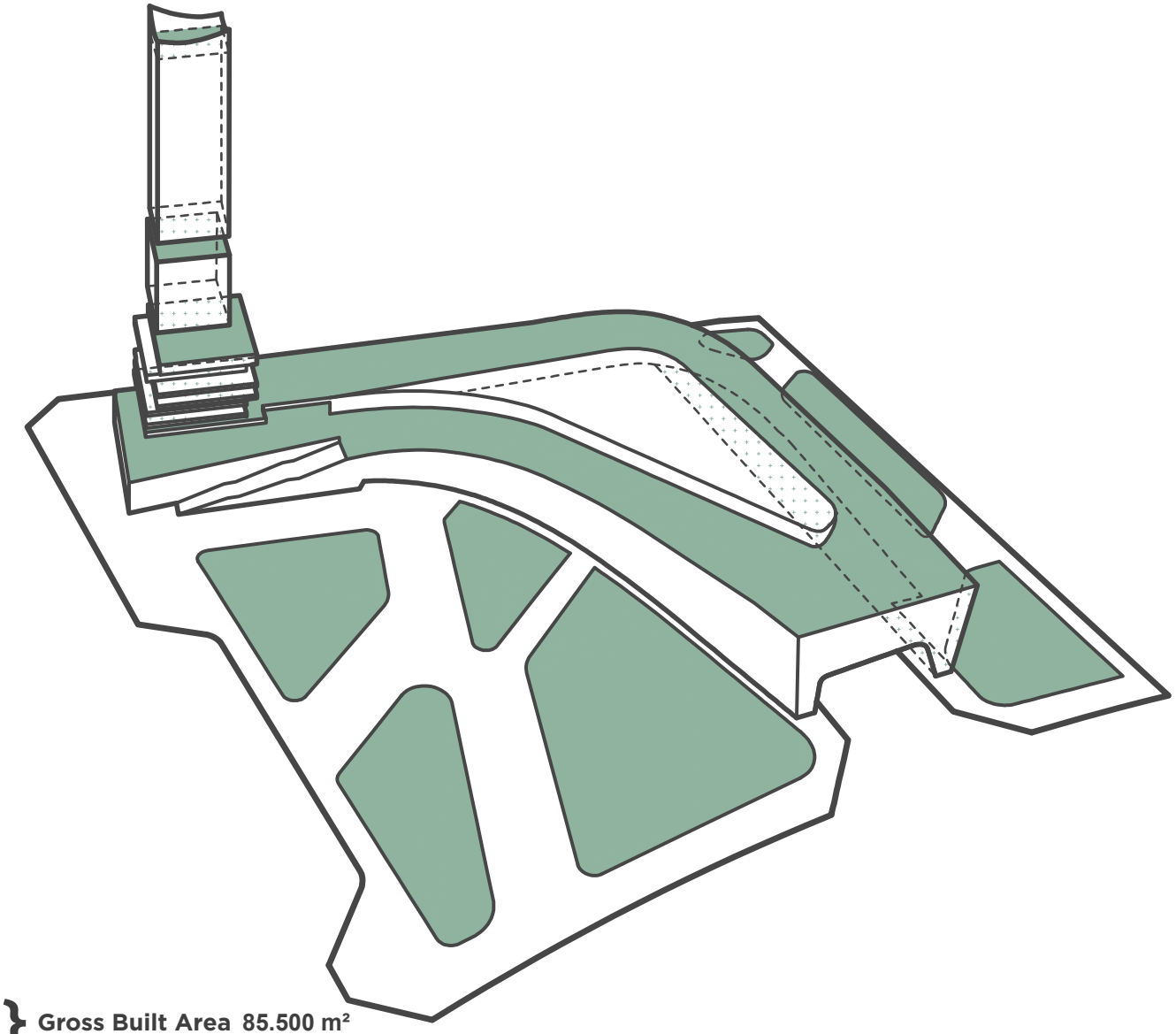
Passenger Concourse	17000 m²
Functional Units	905 m²
Retail/Gastronomy	1975 m²
Security	1370 m²



SECOND FLOOR PROGRAM

Lounges and short-term offices are placed on the higher floor to provide a more private experience for the traveler. The enlarged void offers unobstructed views towards the platforms and the first floor, thus visually encompassing the entire building.

Passenger Concourse	9320 m²
Functional Units	660 m²
VIP Lounge	1795 m²
Lounge	1420 m²
Office On-The-Go	295 m²



SURFACE

SITE AREA 93.645 m²

32% BUILT AREA

Building Footprint	30.000m²
Gross Floor Area	64.750 m²
Walkable Roof	20.750 m²

} **Gross Built Area 85.500 m²**

*

09

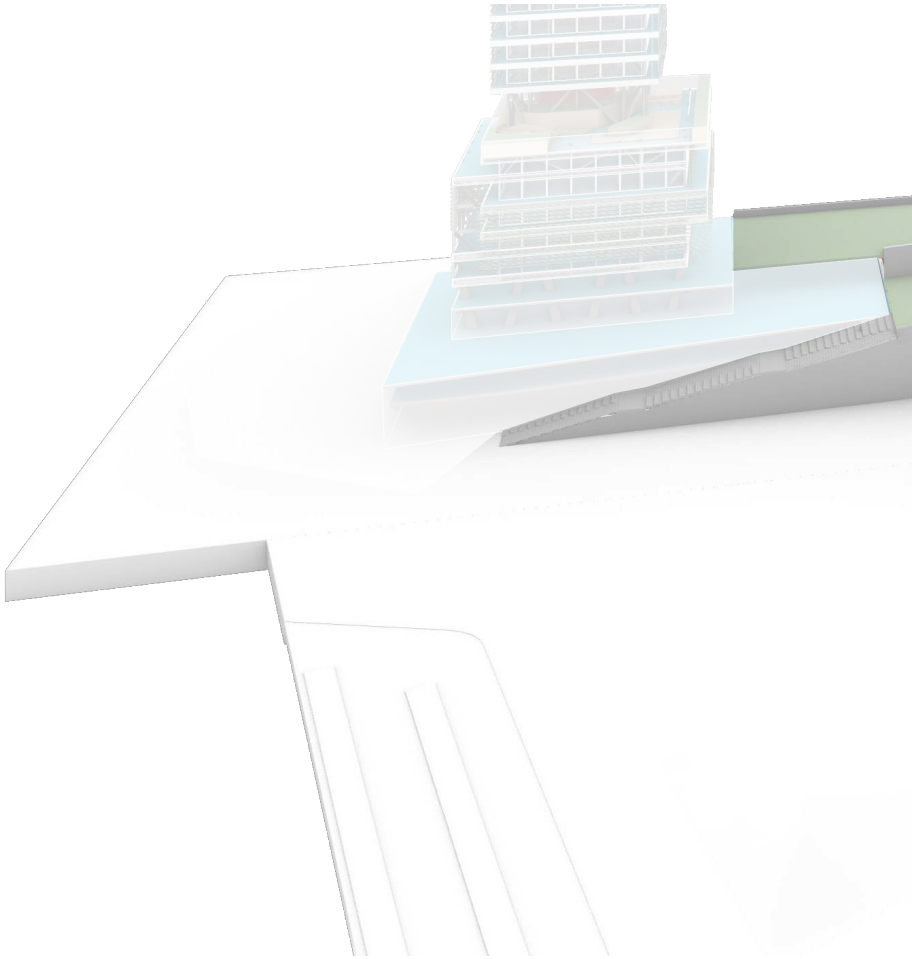
34°08’36.5”N 108°45’05.4”E | Design and Digitalization

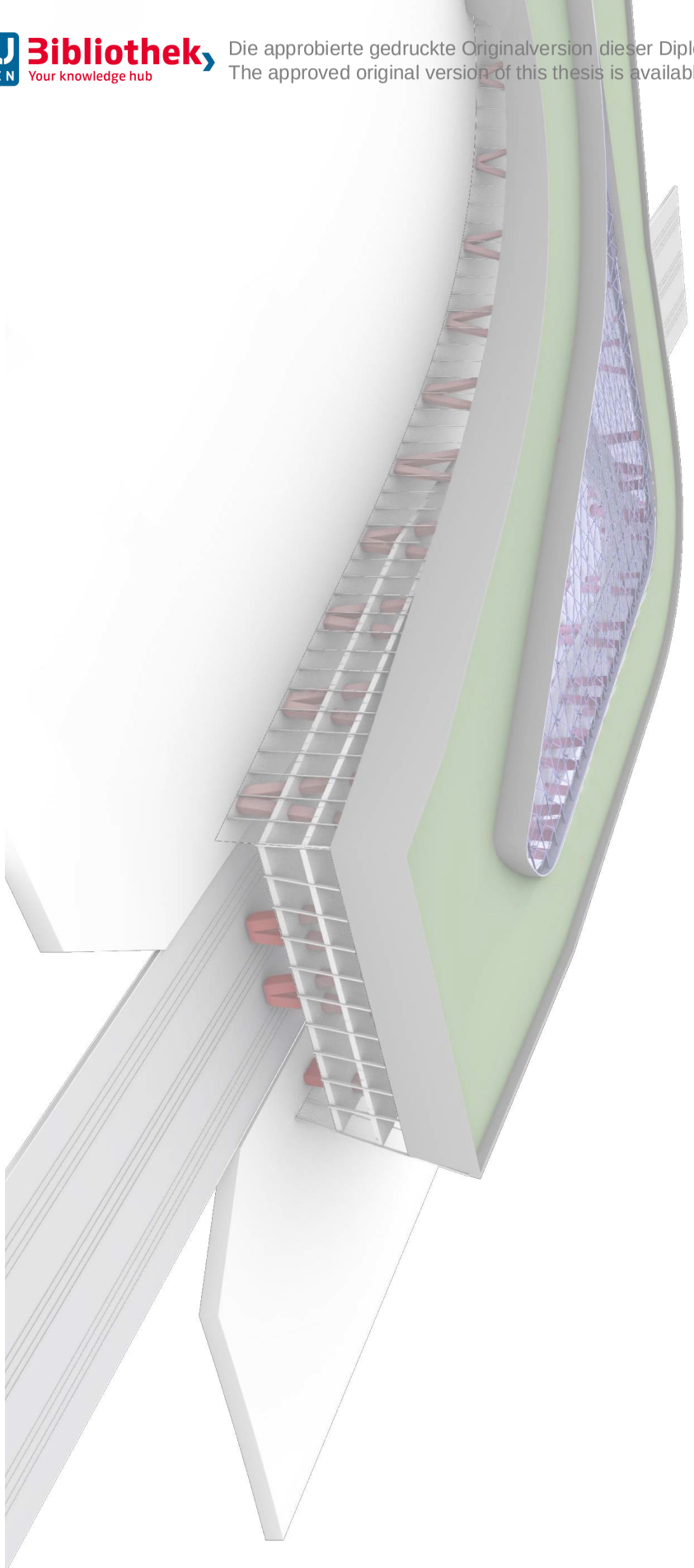
The backbone concept of the building was to follow the direction of the site, hence the placement. The curvature of the building was dictated by the vector of the train tracks and its intersection with the southern border of the site.

As a consequence, the building is supported by four rows of columns with a 25m maximum offset from each other and a 4m maximum overhang of the floors. The central area of the building (the glass void) is resting on a spatial framework in order for natural light to reach the ground level without any inhibition from the columns. The framework expands underneath the walkable floors and is attached in the end to the main V supports.

The building features two upper floor levels with a minimum height of 7 meters (clear) which, together with the ground floor and roof offer 85.500m of usable area (footprint 30.000m) for the passengers and employees of the station.

The station’s main lobby is accessed through the main entrance adjacent to the landscape steps and a secondary access point follow the shape of the building with a ramp on the western side taking visitors and travellers to the first floor of the station. On both sides, two landscaped areas have been designed for both leisure purposes and temperature regulation from season to season.





STRUCTURE | Description

LIGHTWEIGHT STRUCTURES

Under the current trends of material rationalization during the construction process, one of the project's aims is to minimize the amount of structural supports and achieve larger spans capable of offering uninhibited sight lines inside the building.

In tone with Möller's structural principles for lightweight constructions, the structural design follows the dominant directions of the building in order to achieve the following [29]:

- Avoidance of bending stresses
- Be able to avoid stability problems by carrying compression forces over short distances
- Design planar components in compression adequately to secure them against stability failures
- Use self-stabilizing systems when compression forces must be carried on longer distances
- Simplify foundations by adequately orienting the forces within the load-bearing system

STRUCTURAL MATERIAL CHOICE

Composite members refer to structural elements made up of two or more different materials whose properties are combined to form a better performing unit. Such properties in the context of the project are the large resistance to compression for concrete and the tensile strength of steel. As one of the most common composite forms, the advantages of combining steel and concrete result in a highly efficient lightweight unit which bears the structural application characteristics for massive buildings, high rises, bridges, etc.

Forms of the above composite are being applied throughout the building in the main supporting columns and the floors. While the V shaped supports are concrete reinforced steel columns, the composite floors are constructed from concrete cast on top of profiled steel decking. The main role of the decking is to act as a formwork during the construction stage, as well as external reinforcement during the composite stage. The standard trapezoidal decking (80 mm deep) can span around 4.5 m unsupported, while other variations can reach longer spans with a higher depth (deep decking measures 200 mm thickness) in order to reach a larger span of up to 6.5 m unsupported.

CARBON FOOTPRINT

As a means to keep the carbon footprint of the proposal as low as possible, the project employs shallow trapezoidal decking (80 mm) and a series of secondary supporting steel trusses for the floors in order to achieve larger spans without additional columns. The Pratt truss system reaches between main columns and connects back to the main structural elements, enabling spans of up to 8 m without employing heavyweight beams.

The advantages of this shape (N) is its ability to use the vertical members for compression and horizontal members for tension. This configuration is able to achieve long spans (up to 100 m when adequately scaled) under the principle that longer diagonal members are only in tension for gravity load effects, therefore being used more efficiently.

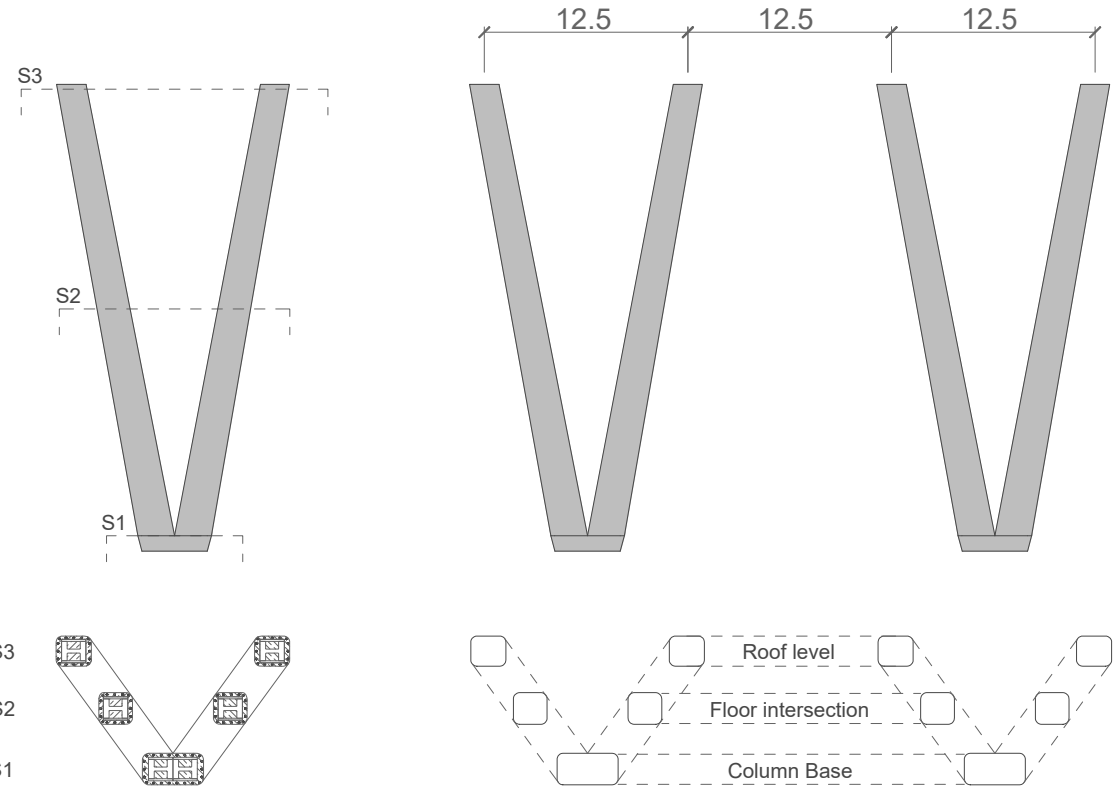
The same truss design is used to support the walkable green roof. The ramps serve multiple purposes, notable being as viewpoints towards the city, public space, park, jogging area and more, but the greening process is semi intensive, with plant sizes no larger than 2 meters and soil depth of 120 mm, amounting to less than 100 kg/sqm.

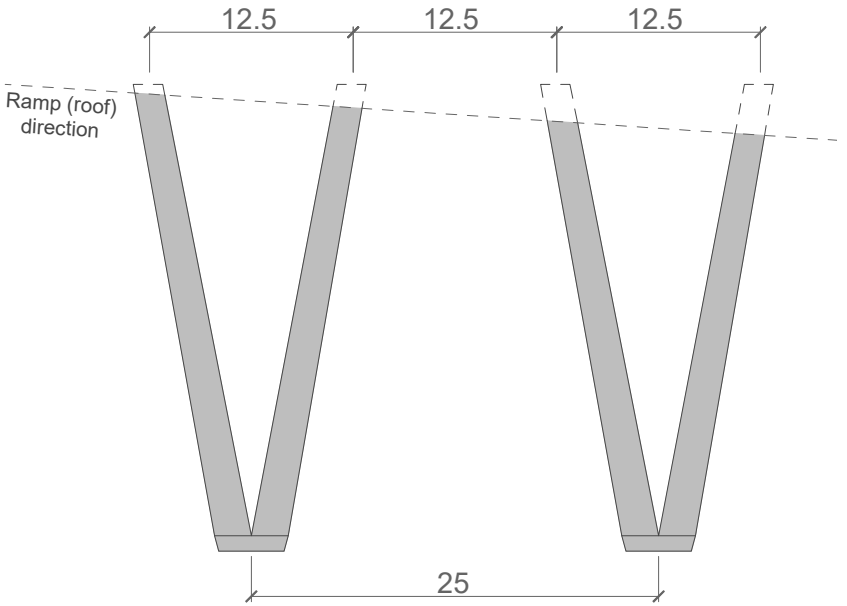
VOID SOLAR PANELS

The central void solar panels (3 x 3 m each) are supported by a spatial framework which arches along this design element and carries its load onto the secondary columns.

Arching is used as a strategy to maximize the span, allowing for the framework to carry the load of the panels to reach the columns of the secondary directions through a series of beams. It is worth noting that employing some soft connections offers the flexibility to deal with snow loads during winter.

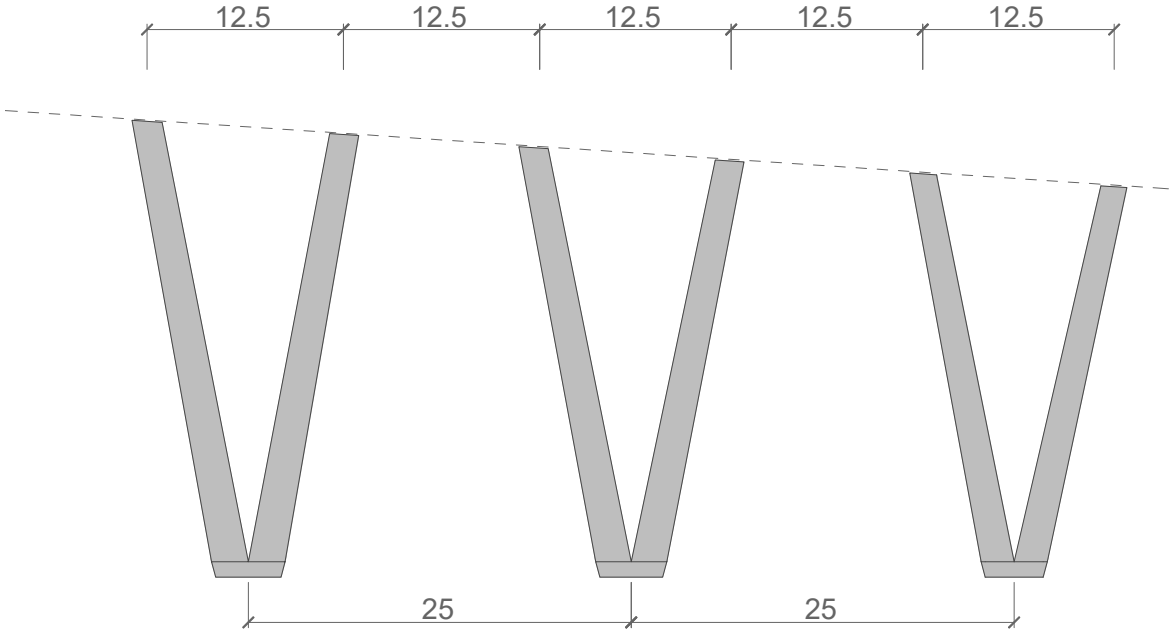
STRUCTURE | Concept and Layout



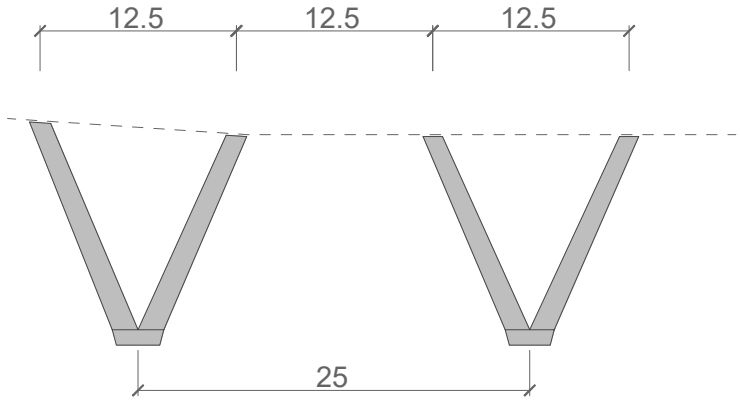


Trimmed tops with with plane of inclined green rooftop

Composite Column: 2x Histar HD-Profiles mirrored on the short axis, encased in reinforced concrete, with a cladding finish.

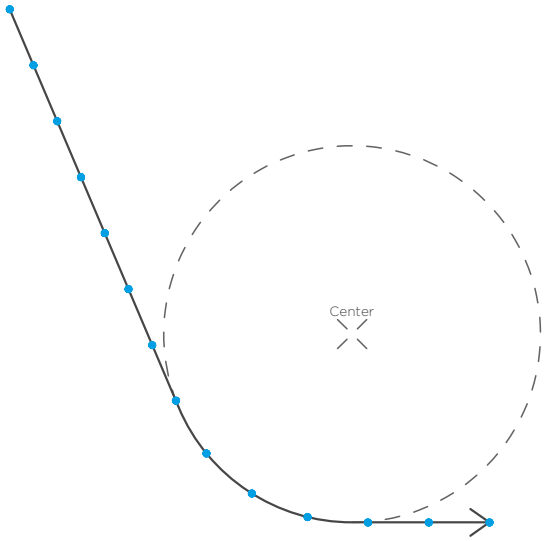


Constant distance between columns
situated on the same direction

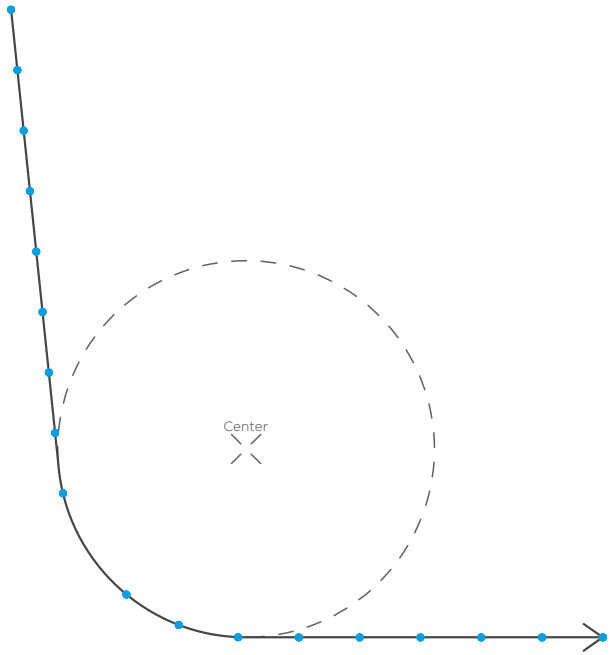


Thinner columns
as height of building decreases & load
reduces

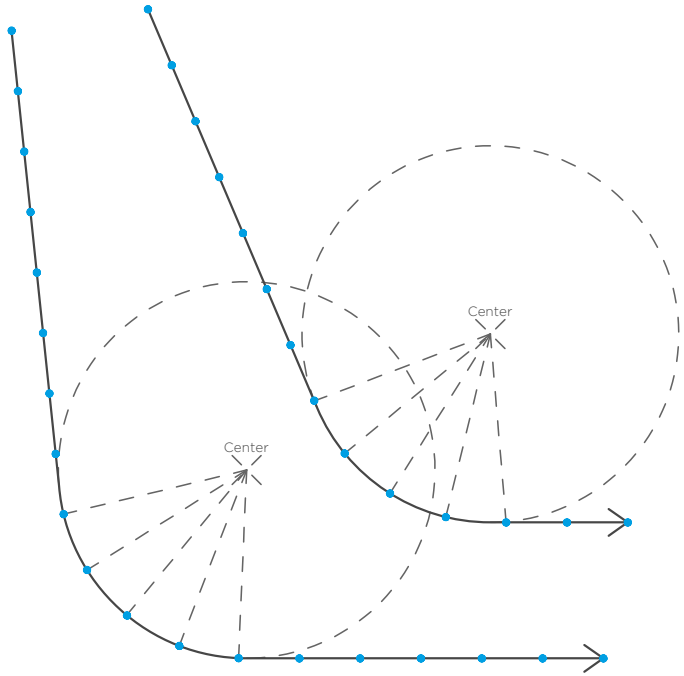
Dominant Direction I



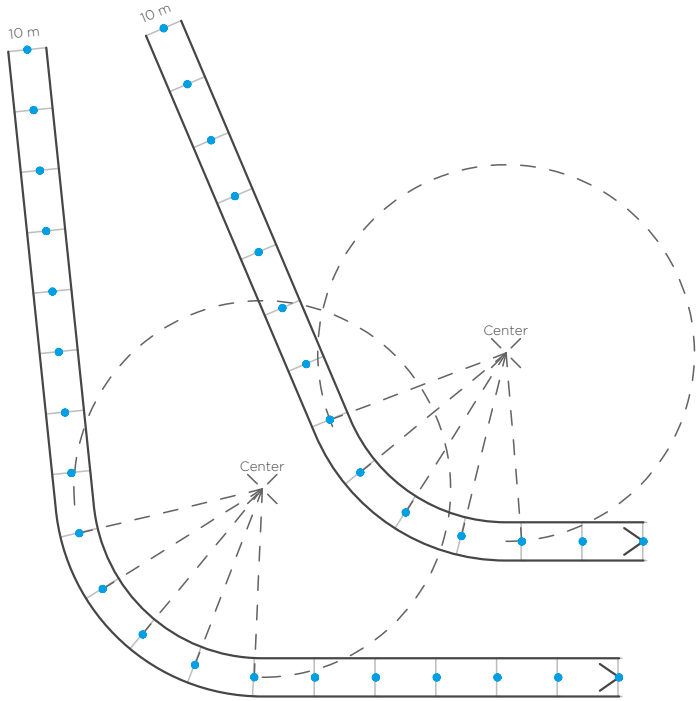
Dominant Direction II



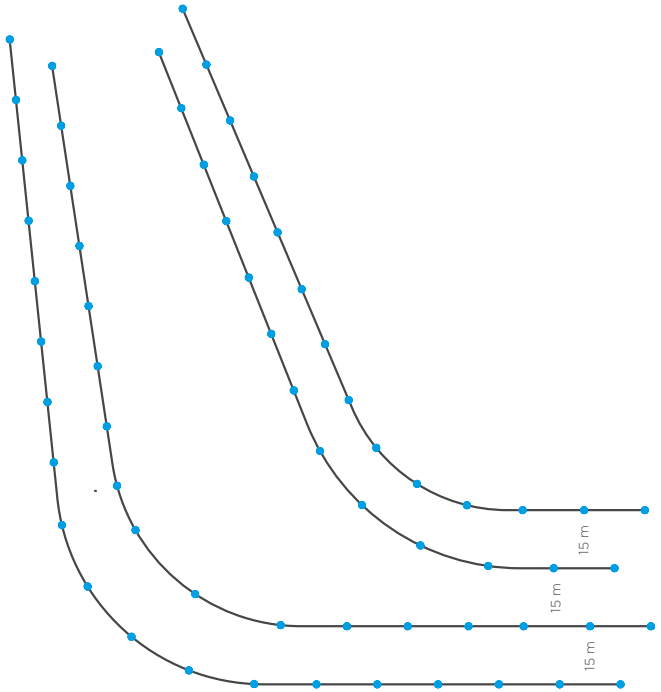
Construction of
geometry curve



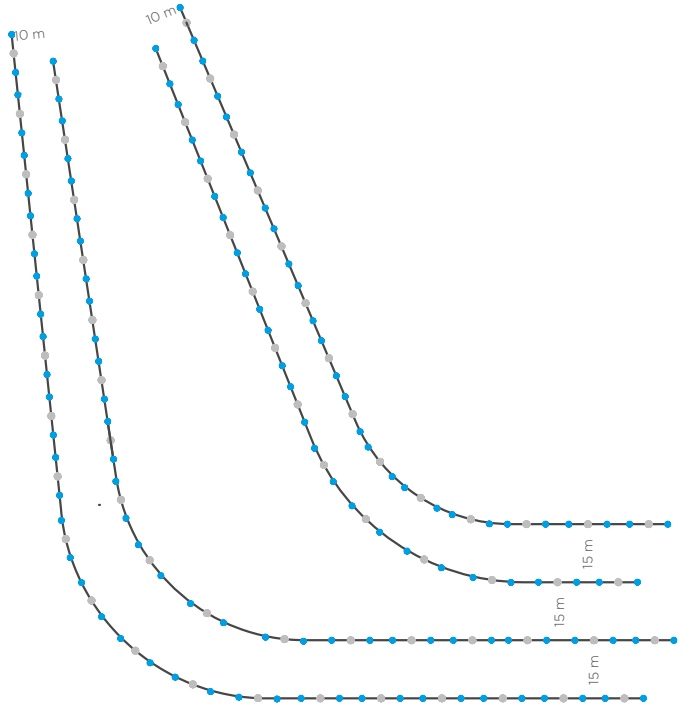
Offsetting the columns
& secondary directions



Adapting to building width

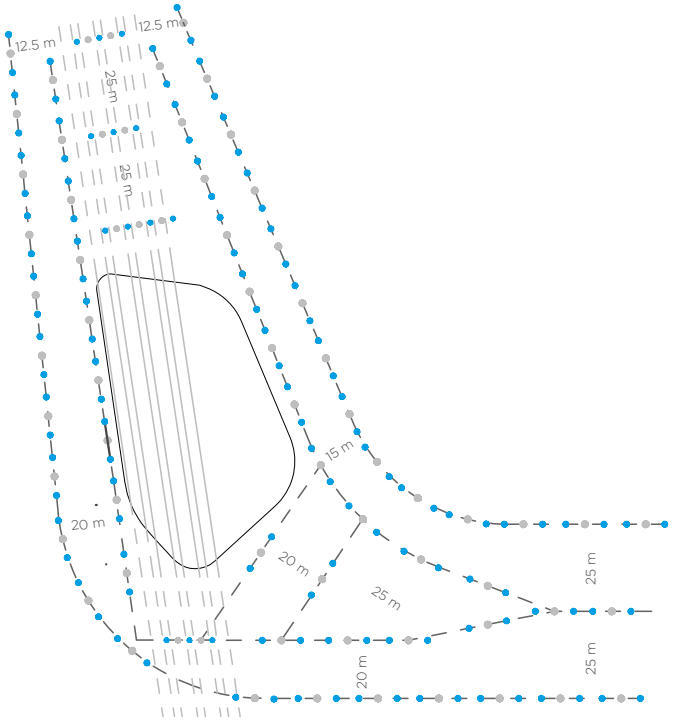


V-Split (plan)

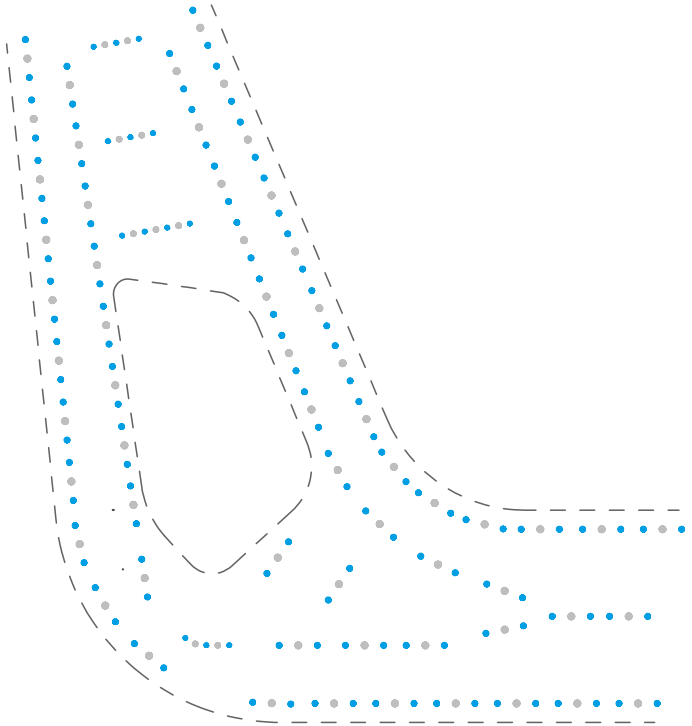


The parametric design of the building allows for its shape to be adapted for any variable. The constants are represented by the distance between the columns, maximum thickness of the column and direction of the 4 main curves that give the outline of the building. All included construction elements (joints of the spatial framework, walls, facade panels, column width, etc.) are proportional to the constants.

Adapting for voids
& train tracks



Column layout



The main structure support is comprised of a double series of V-Columns made of two Histar HD-Profiles following the shape of the building. In an attempt to maximize efficiency and reduce the amount of materials used, these columns vary in height and width according to the support necessities of the levels - for example towards the northern side of the building these columns measure 35m in height with a profile of 2,6 x 2,6 m. Heading to the lobby, since the height of the roof decreases to 20m, the columns become thinner and the profile measures 1,60 x 1,60 m.

SPATIAL FRAMEWORK | Void Panels Truss System
Precedent Analysis | Hauptbahnhof Wien

As structural design precedent, the canopies of Vienna Haupbahnhof use a similar truss principle. The loads of the self supporting canopy construction are transferred onto a series of columns. In cross-section, the slightly inclined supports with the trusses connected above create a rigid frame, which takes over the bearing in the transverse direction, with the beam also rigidly attached to this frame.

A similar approach is taken in the proposed train station to achieve larger spans between columns. The floor thickness allows for the implementation of a similar spatial framework to the one used in Hauptbahnhof, that rigidly connects to the columns, but partially employs soft joints to self adjust for a potential increase in weight.

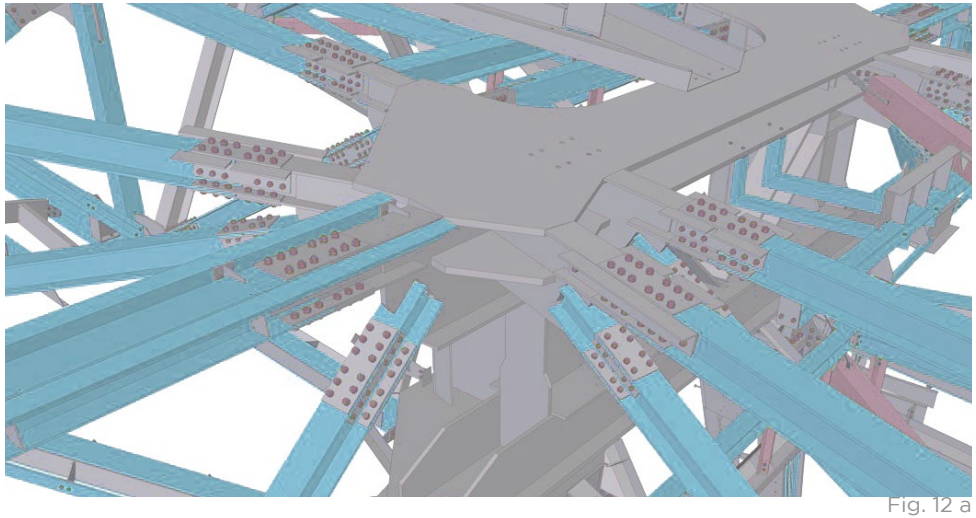


Fig. 12 a

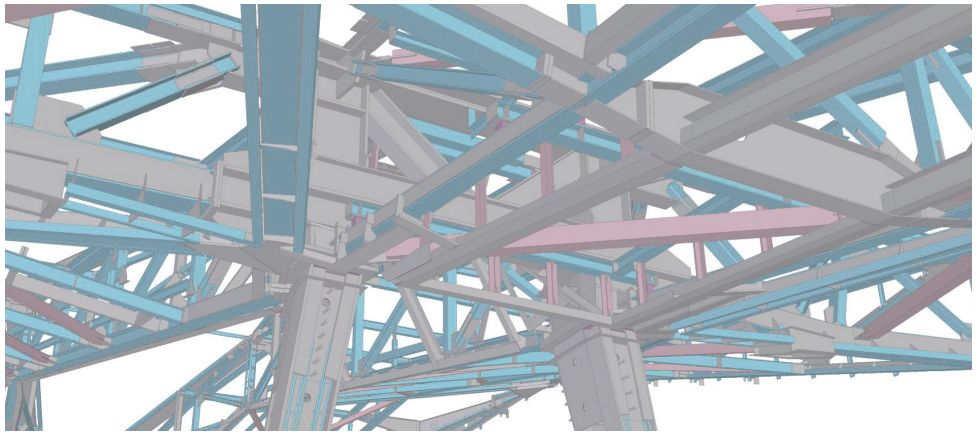


Fig. 12 b

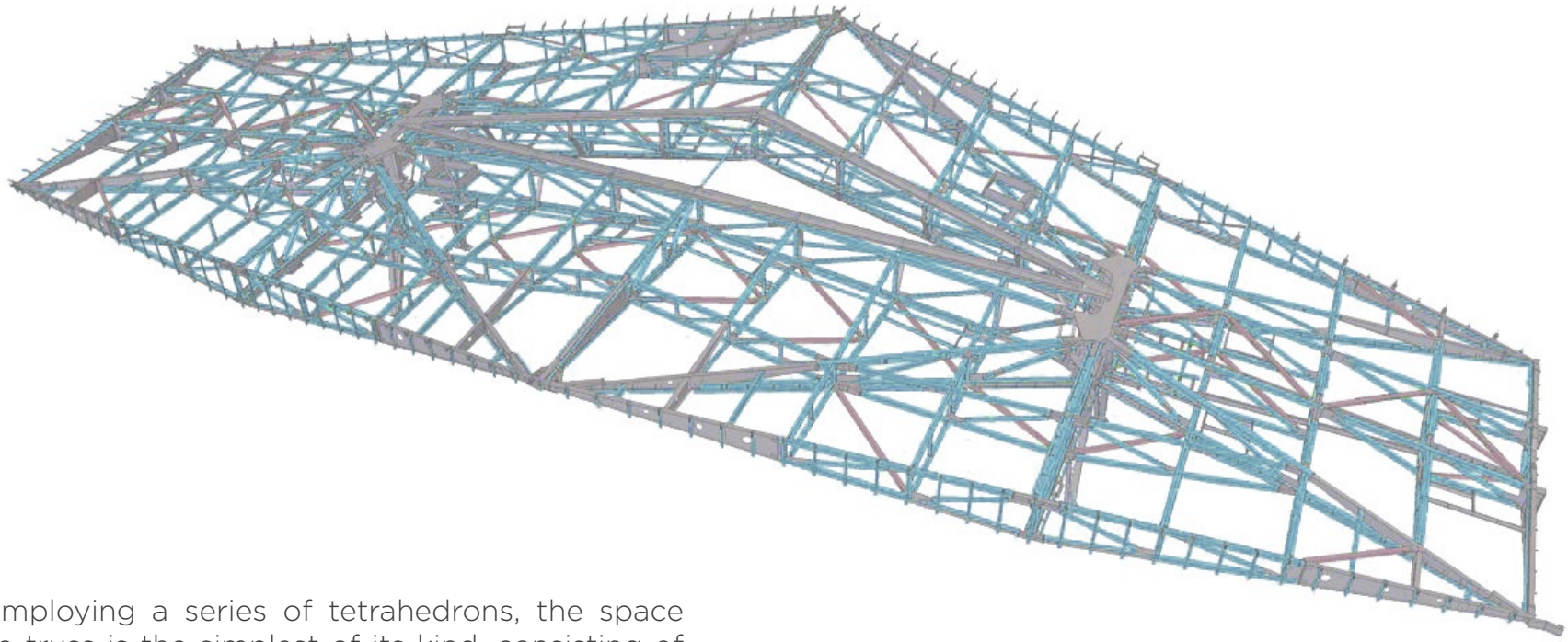
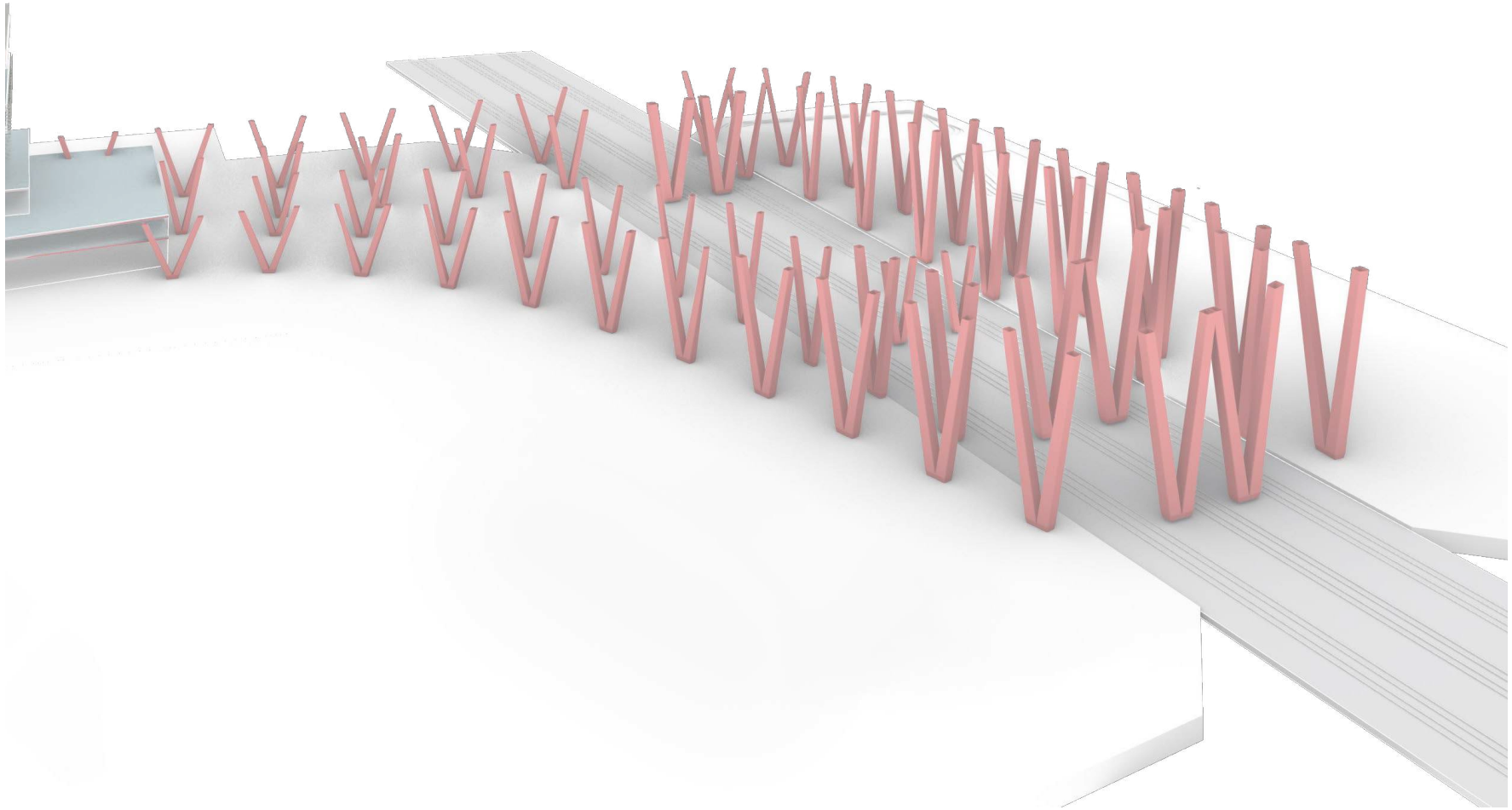


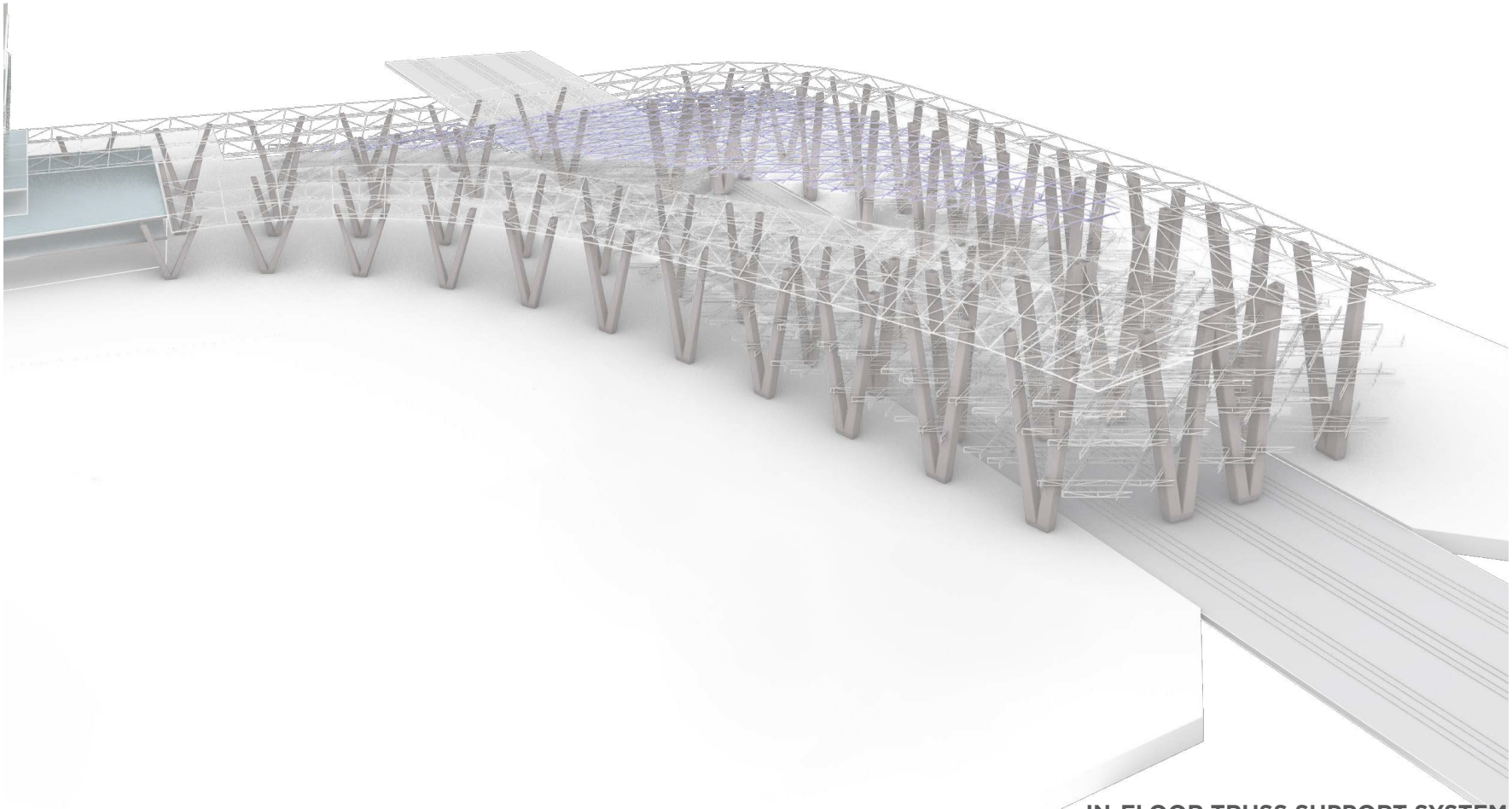
Fig. 13

By employing a series of tetrahedrons, the space frame truss is the simplest of its kind, consisting of four joints formed by six members. The common edges are present on the horizontal plane and the overall volume of the tetrahedron increases the closer it gets to the column. This enables the transfer of forces towards the rigid joints decreasing any potential rotation at the end of the beams and enabling the transfer of moment.

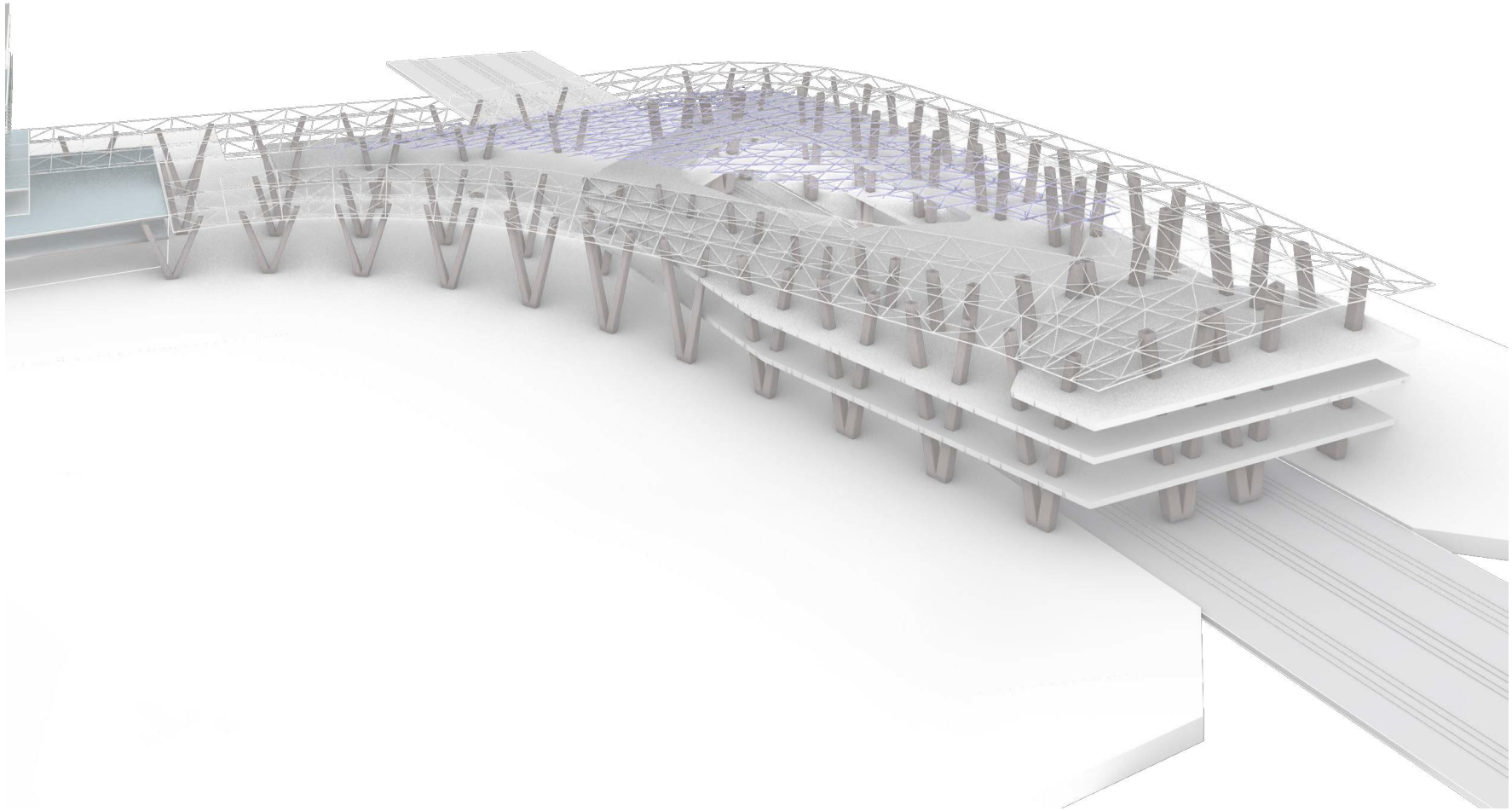
STRUCTURE | Overview



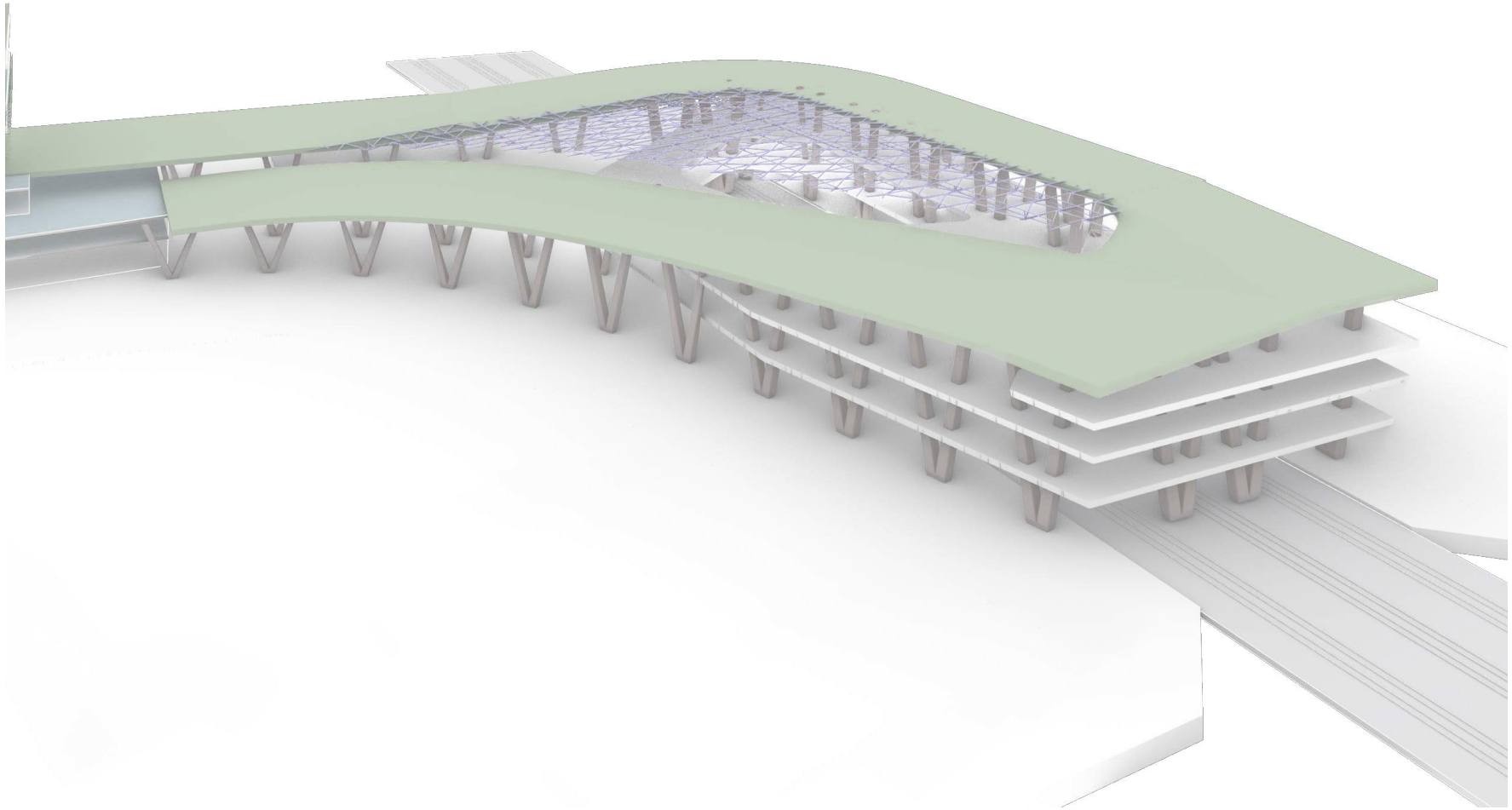
COLUMN LAYOUT



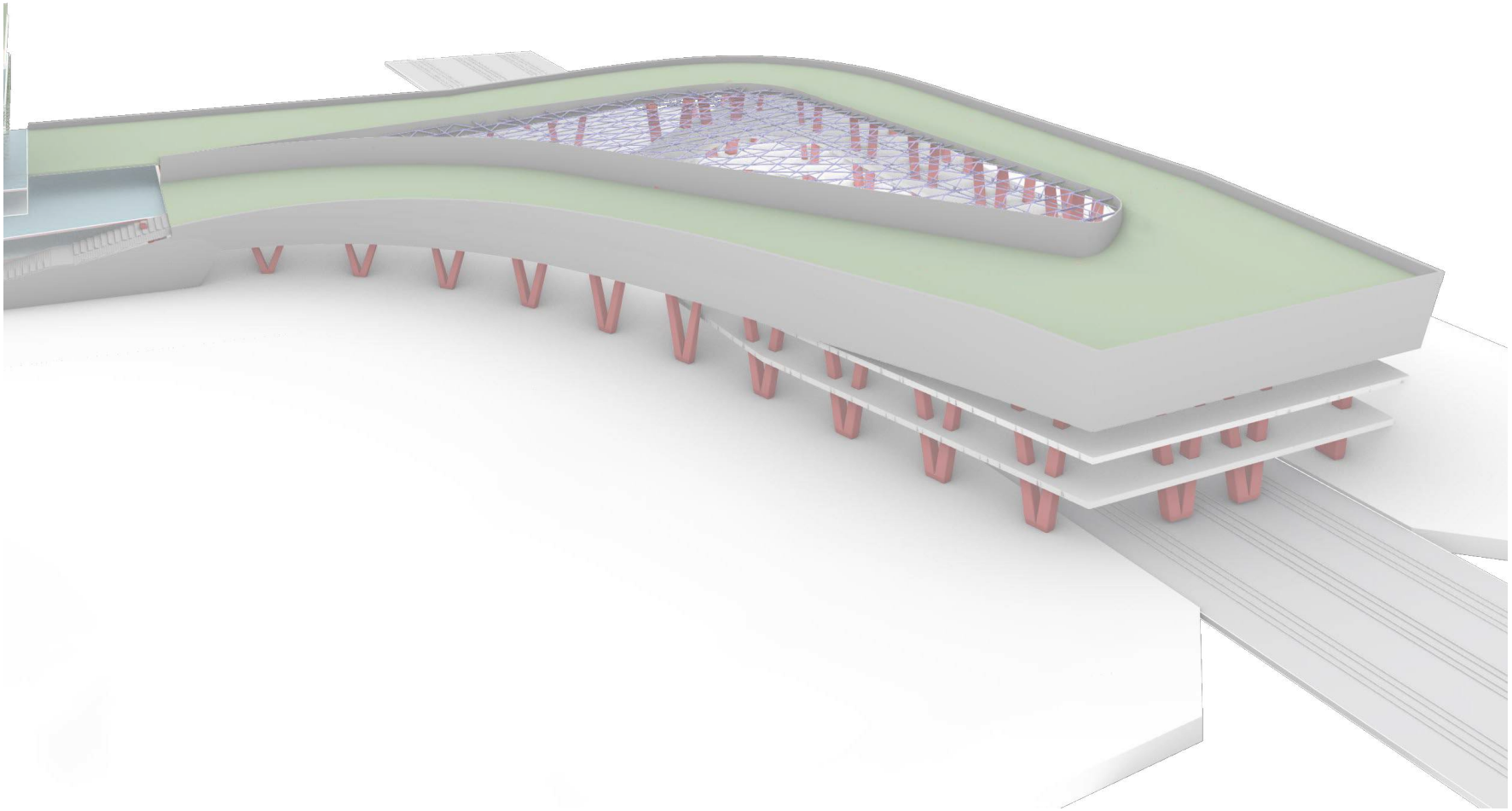
IN-FLOOR TRUSS SUPPORT SYSTEM
AND ROOF SPATIAL FRAMEWORK



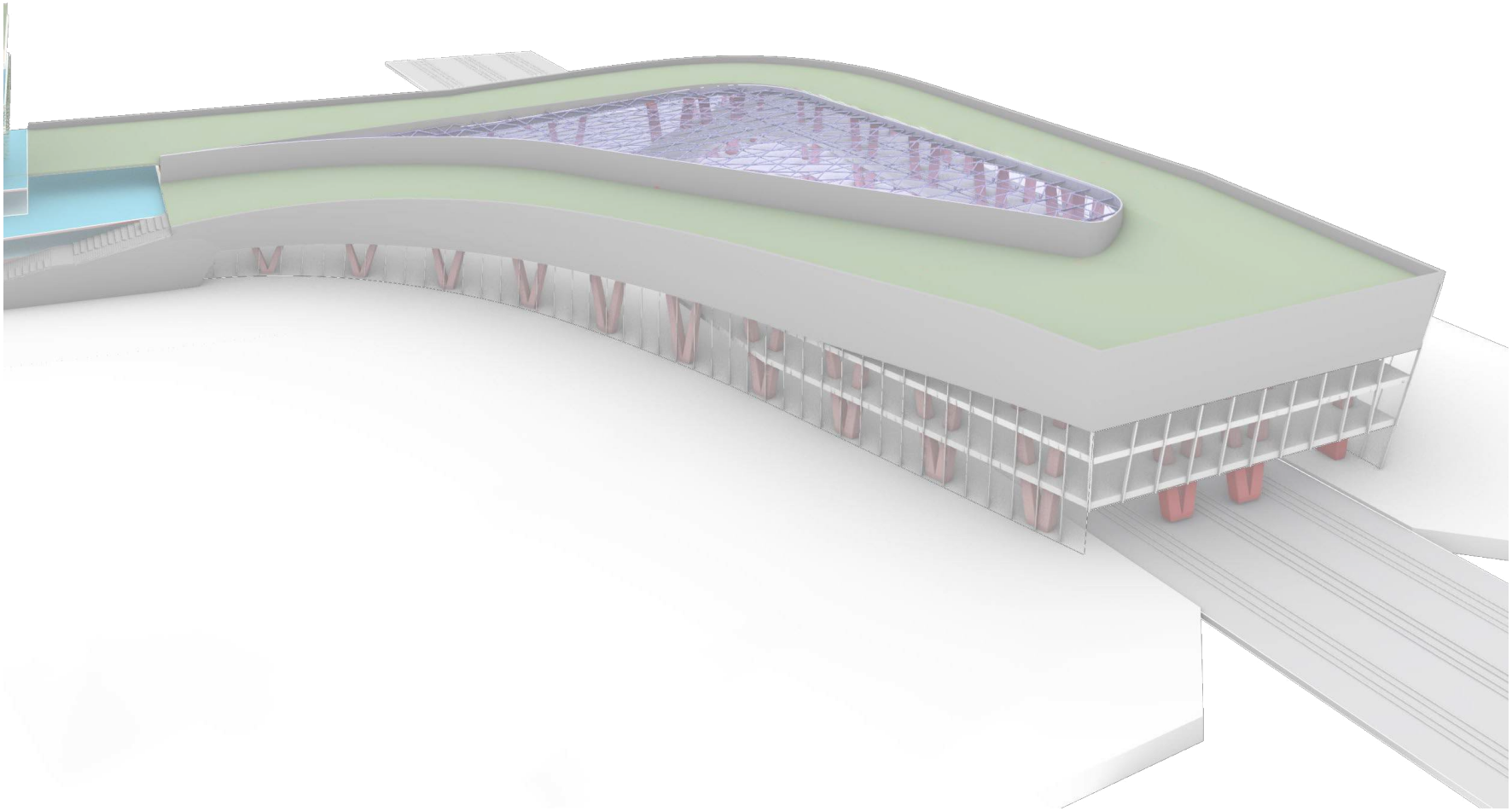
STRUCTURAL ASSEMBLY



ADDITION OF WALKABLE GREEN ROOF

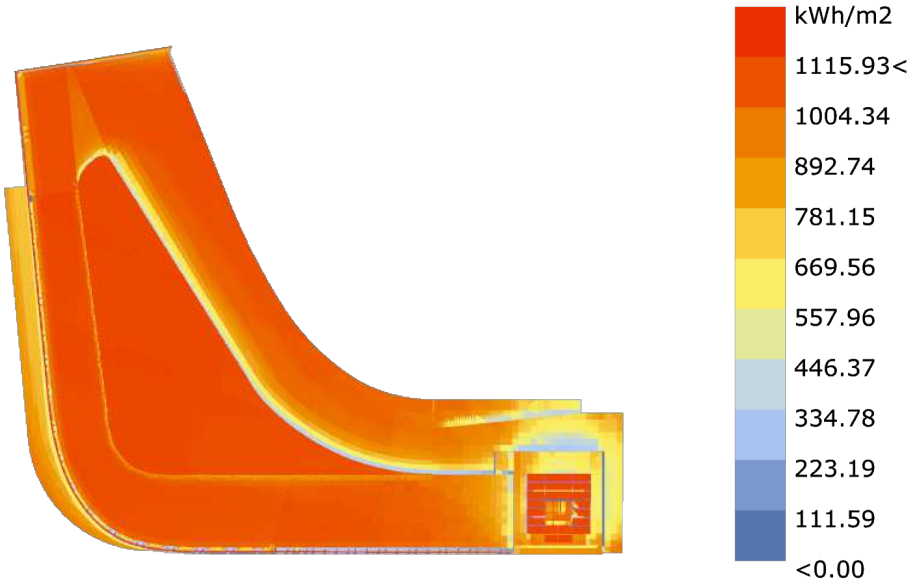


FACADE PANELLING



OVERVIEW TRAIN STATION

BUILDING PHYSICS | Environmental Analysis*

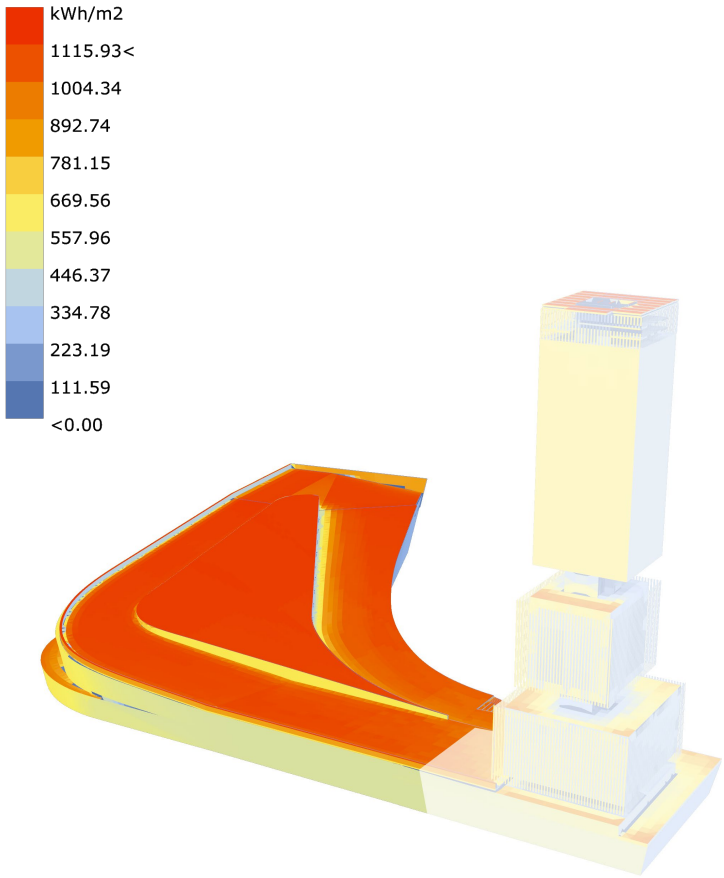


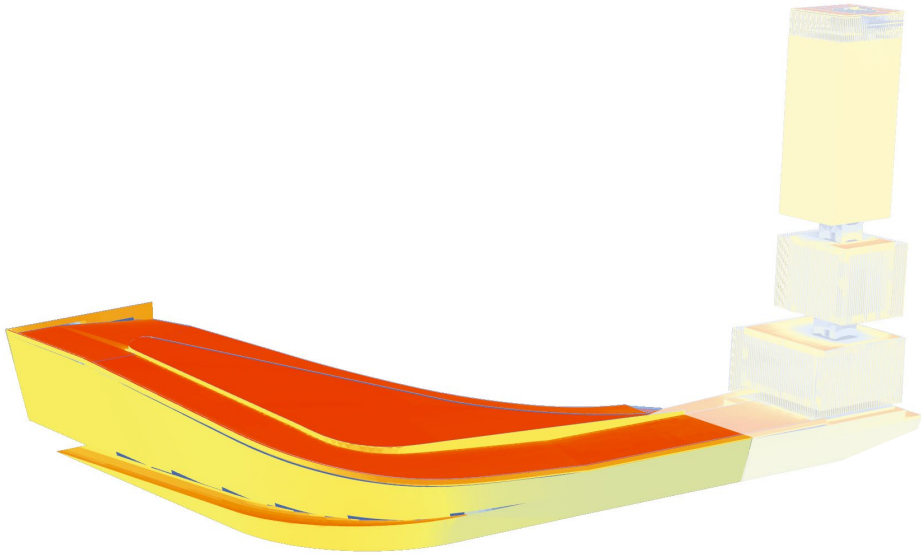
Radiation Analysis
Rotation Angle: 360.0 Degrees
Xian_Shaanxi_CHN_2005
1 JAN 6:00 - 31 DEC 18:00

The solar radiation analysis was employed to determine which areas of the building have the potential to be activated with sustainable solar technologies. The red areas suggest a high amount of solar radiation being received by a surface and are either covered by low opacity solar panels or intensive greening. Featuring a temperate-continental climate, the area of Xi'an has dry cold winters and humid hot summers.

An unfortunate environmental situation is that Xi'an carries the "tradition" of using coal for energy production and heating. The surrounding mountains shelter the city from heavy rains or strong winds. As a consequence the pollutant particulates (PM2.5 and PM10) stagnate in the atmosphere.

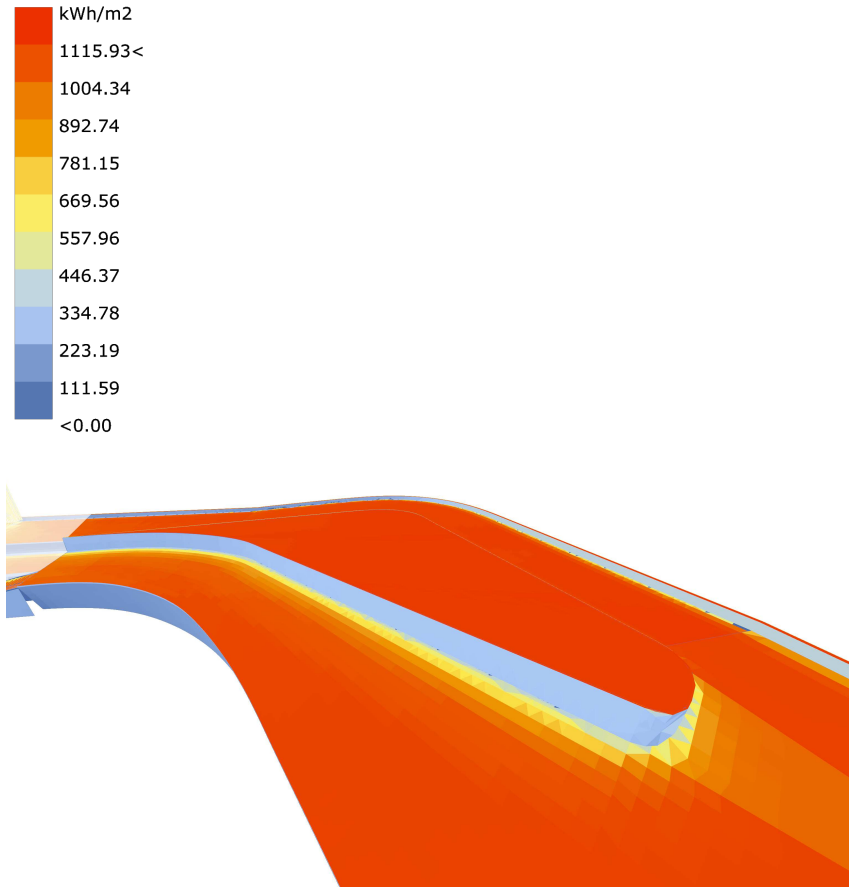
Although the project does not seek to tackle all the city's problems in terms of pollution, the approach is to try and ameliorate the conditions as much as possible within the site. Henceforth, the approach is to use the advantages of green spaces and shape the urban environment in a manner that could be seen as beneficial to the community and visitors.(30)

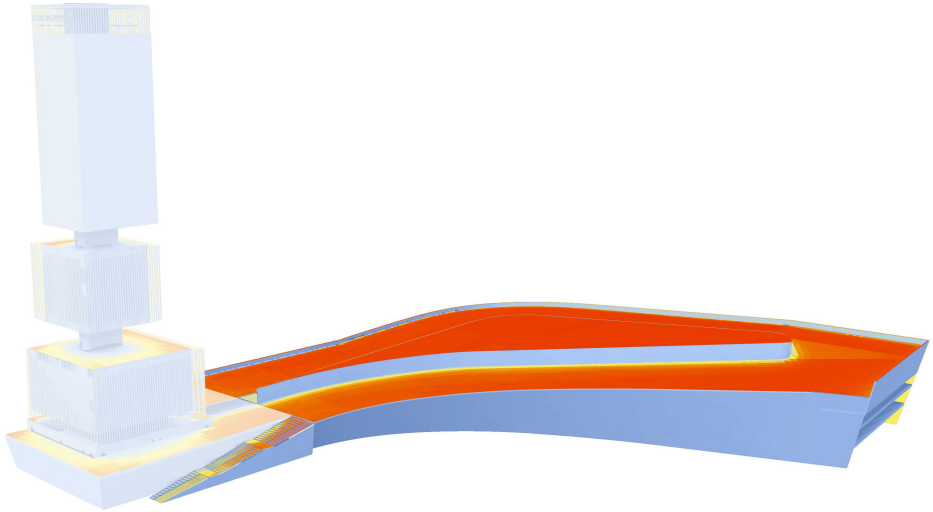




The geographical orientation of the site dictated the placement of the building. The concept implemented was to enable as much natural light to penetrate the facade throughout the day, and also, with PV panels to avoid overheating and produce renewable energy. The latter is achieved by employing the two strategies.

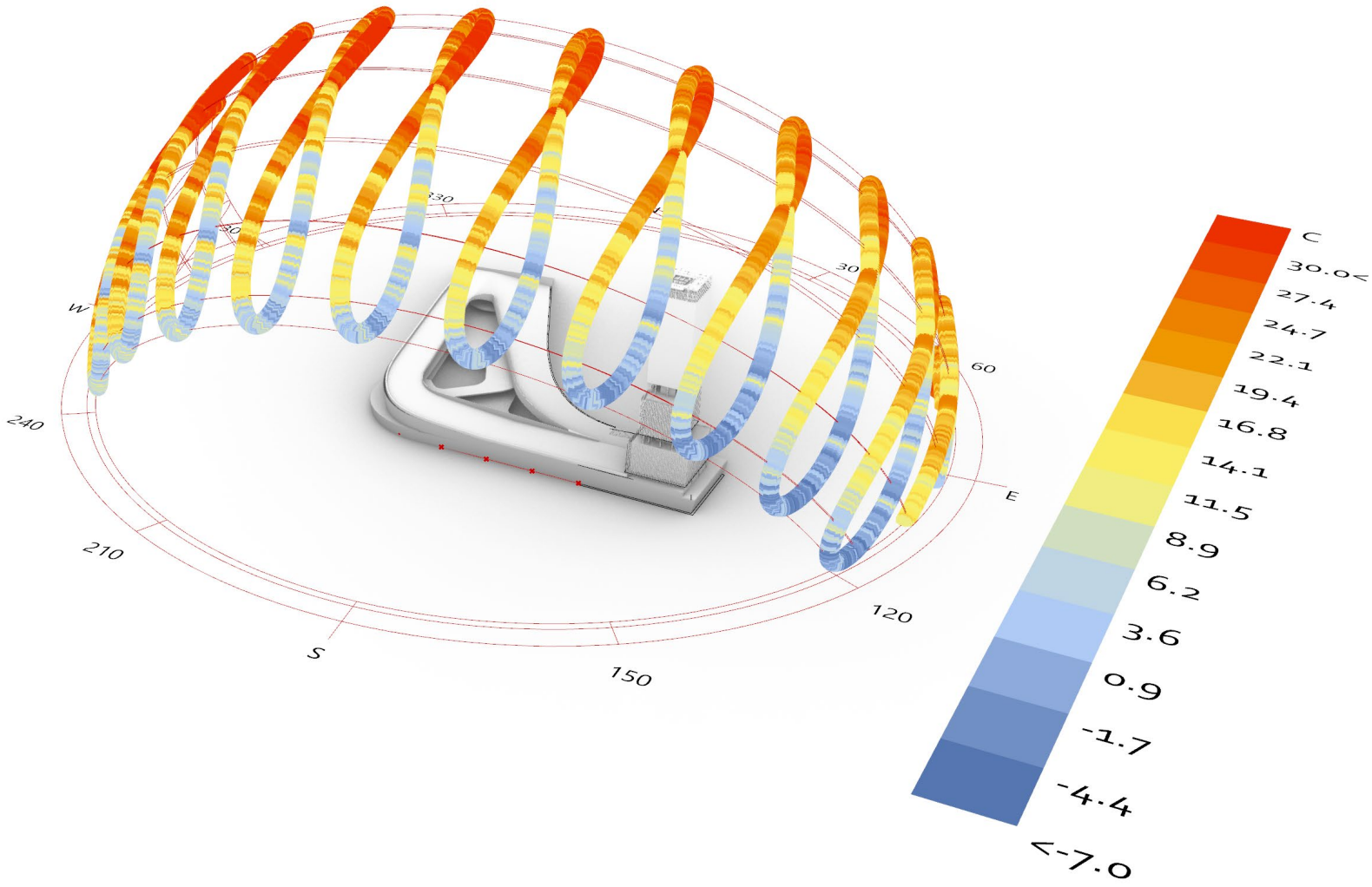
Firstly, the central void of the station is used to light the building, but also harvest solar energy. Since this particular area of the building is strongly lit throughout the entire day, 30% opacity solar panels are used in its construction to provide both an adequate amount of indoor lighting and a source of green energy.



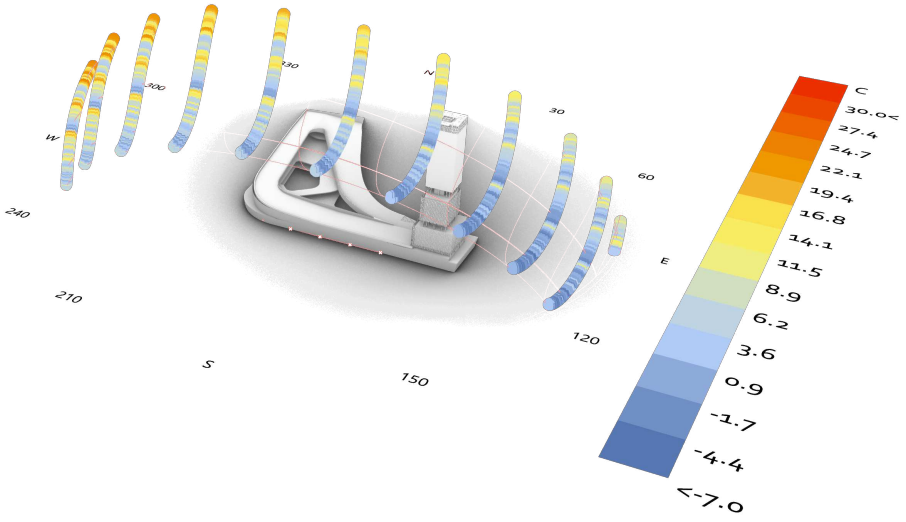


Secondly, the same PV panels are used in the openings of the southern facade for the same reasons (lighting and energy). The solar analysis shows the distribution of radiation onto the building throughout the year and its concentration on the roof.

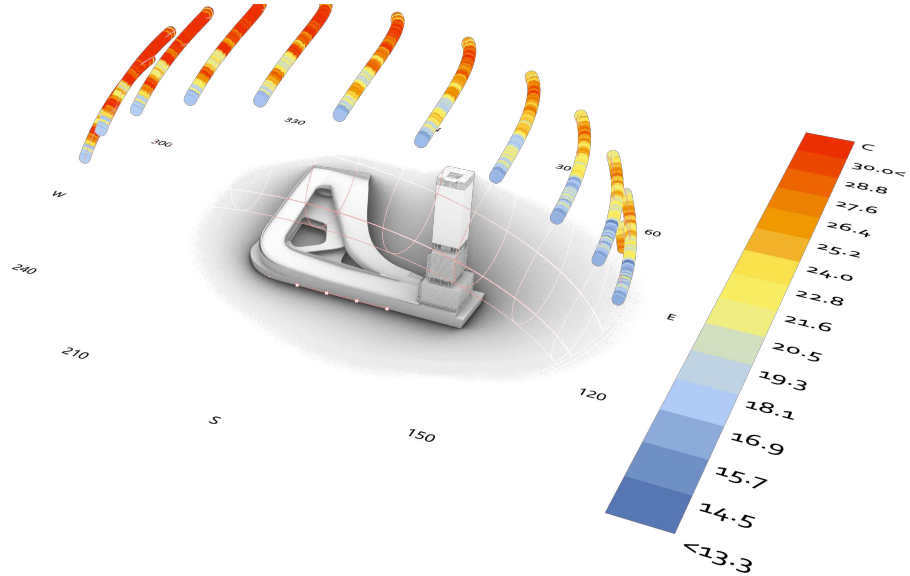
Consequently, the ramps surrounding the void have also been activated as a semi intensive green roof in order to help with heat regulation during summer and take advantage of the sun.



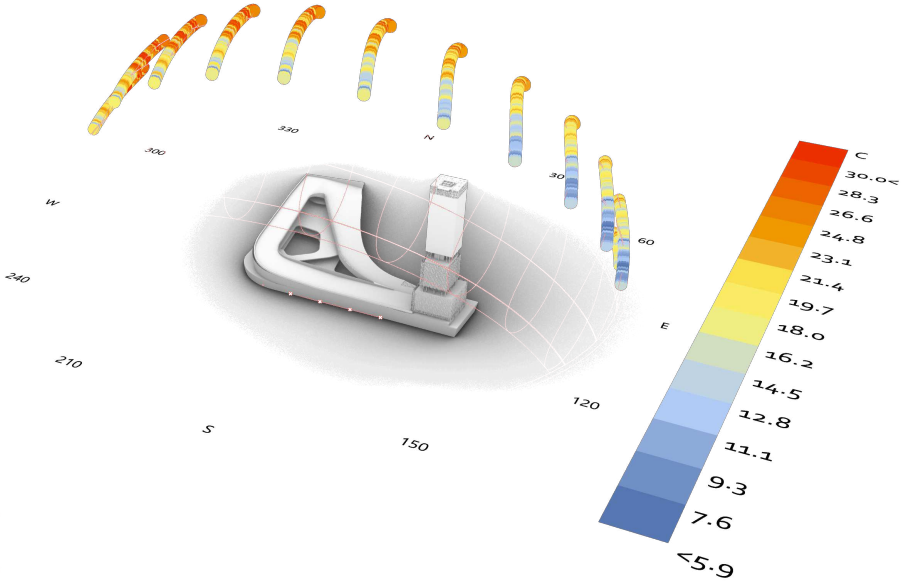
1 YEAR SUNPATH



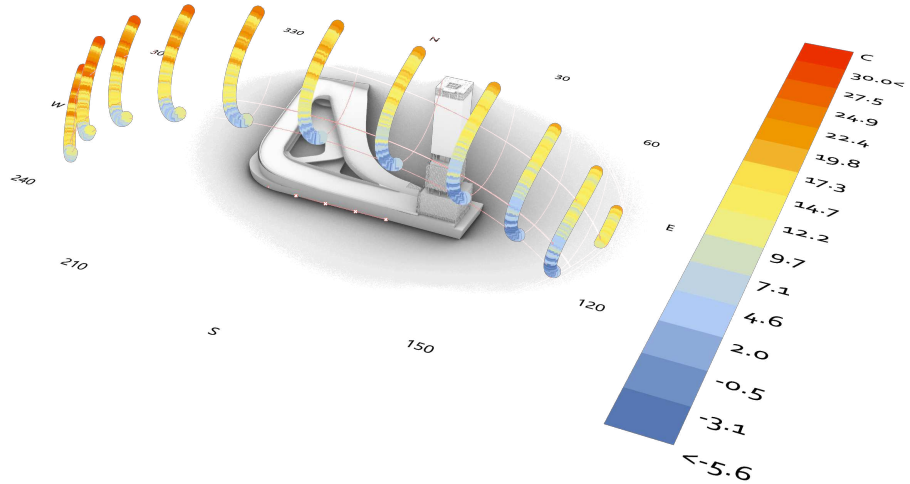
JAN-MAR SUNPATH*



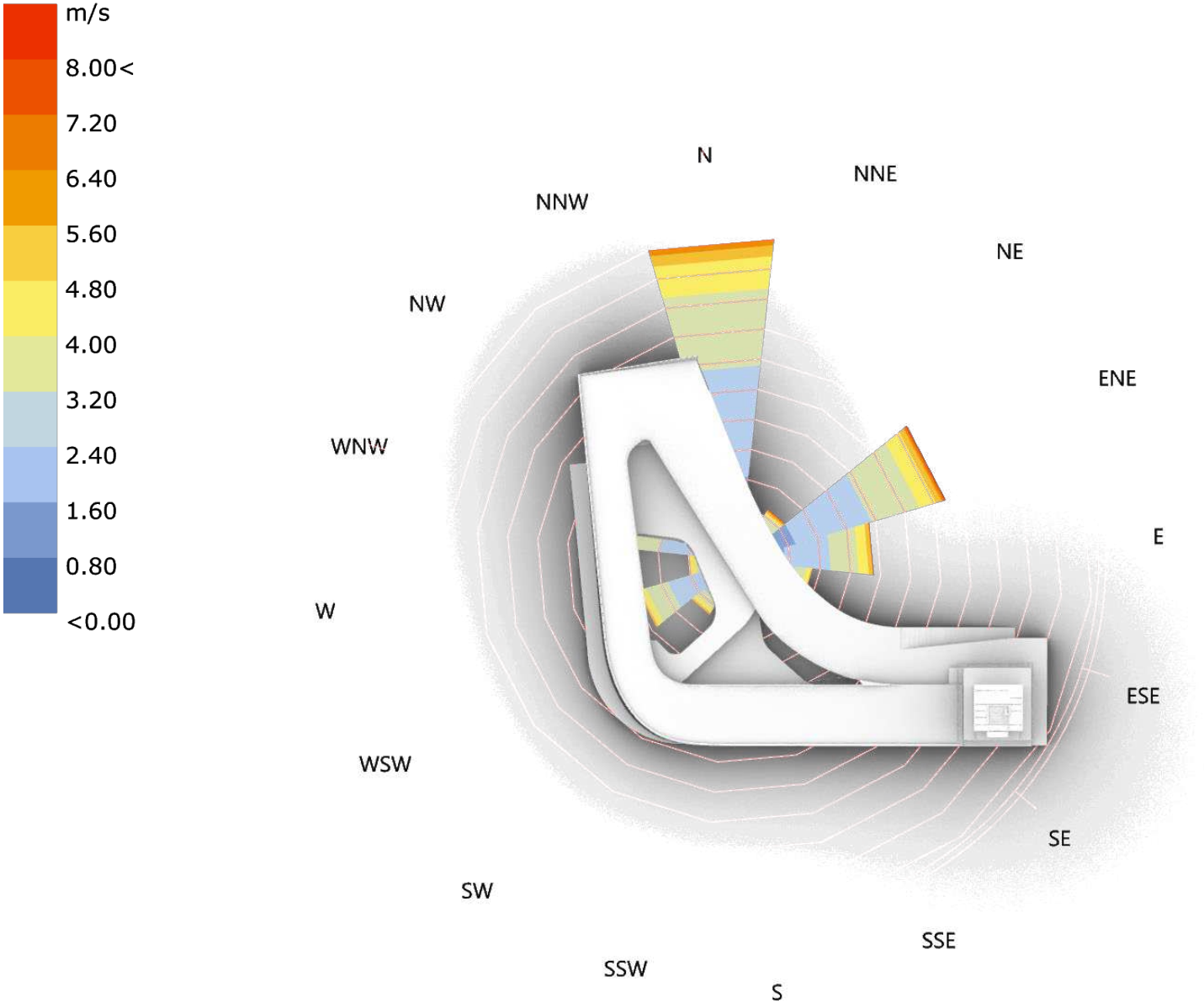
APR-JUN SUNPATH*



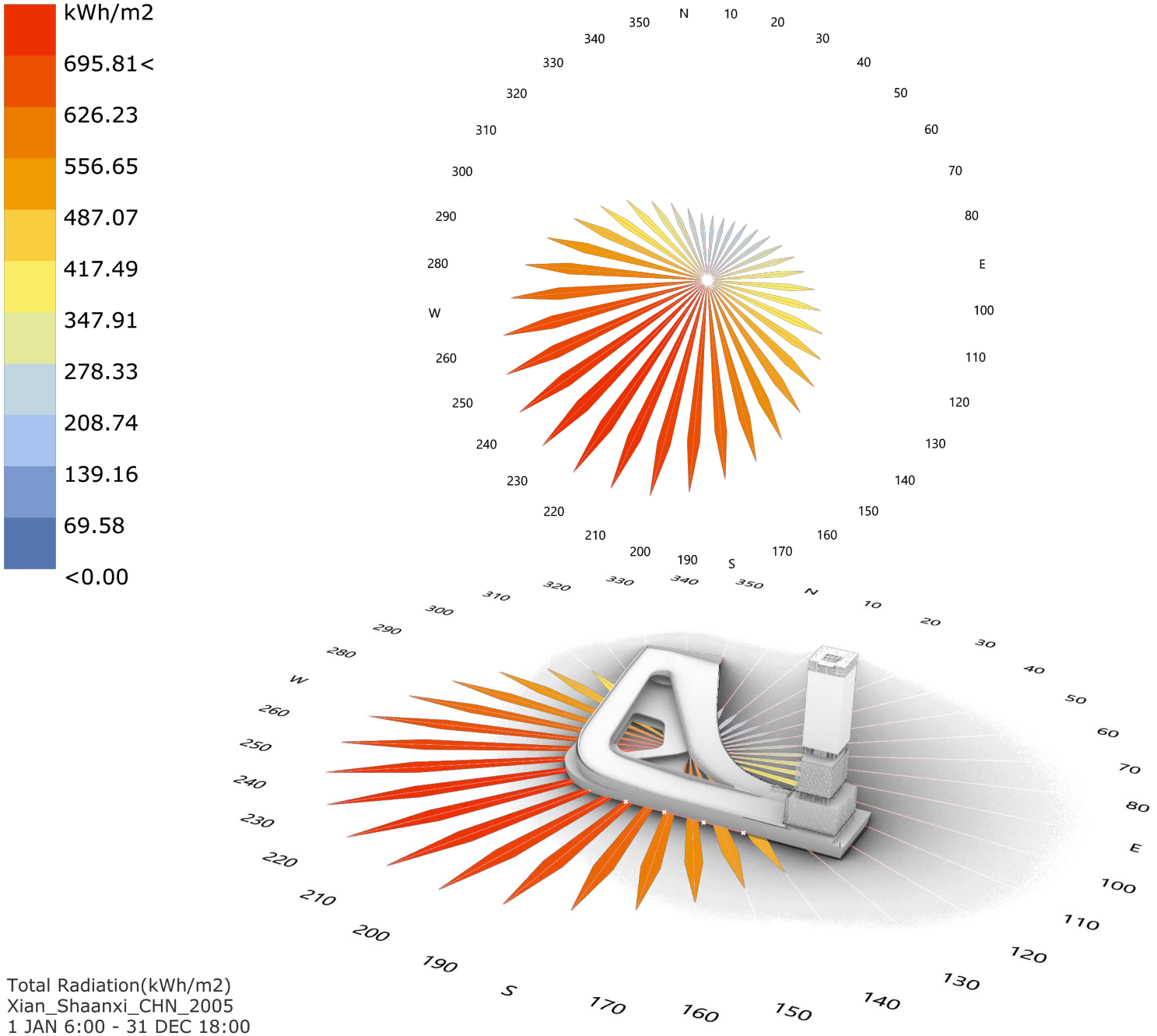
JUL-SEP SUNPATH*

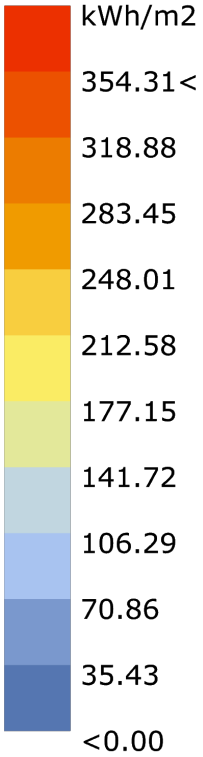


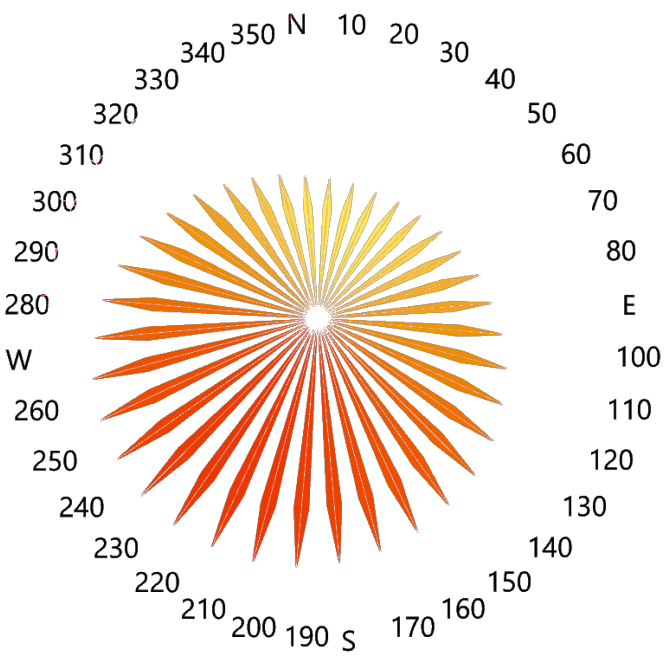
OCT-DEC SUNPATH*

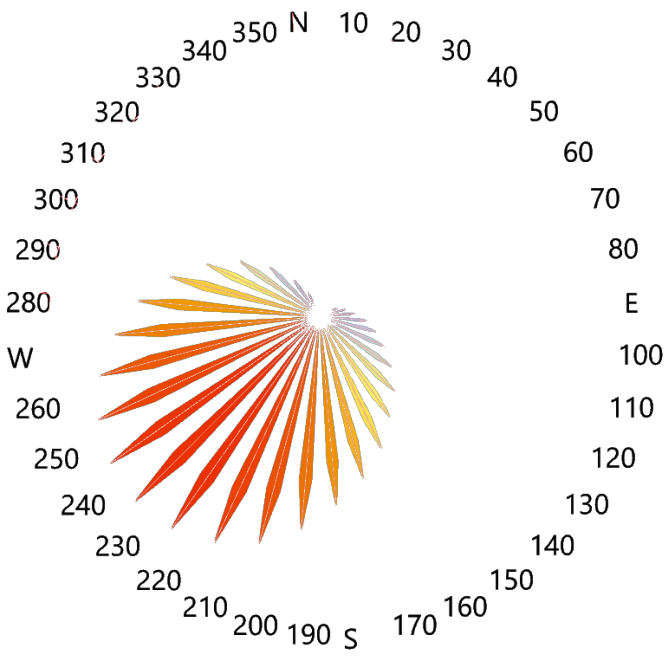


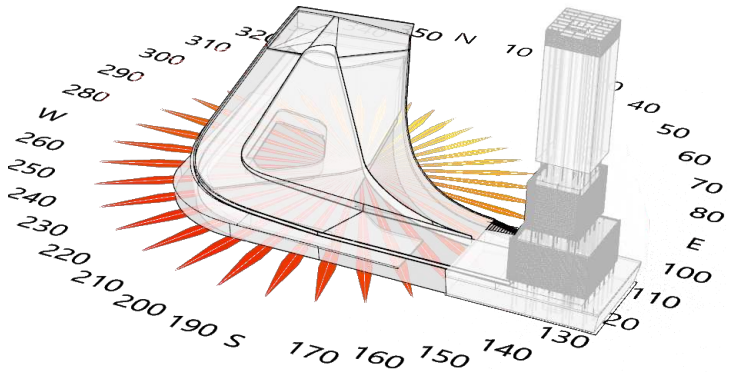
Wind-Rose
Xian_Shaanxi_CHN
1 JAN 6:00 - 31 DEC 18:00
Hourly Data: Wind Speed (m/s)
Calm for 12.60% of the time = 1102 hours.
Each closed polyline shows frequency of 1.1%. = 99 hours.



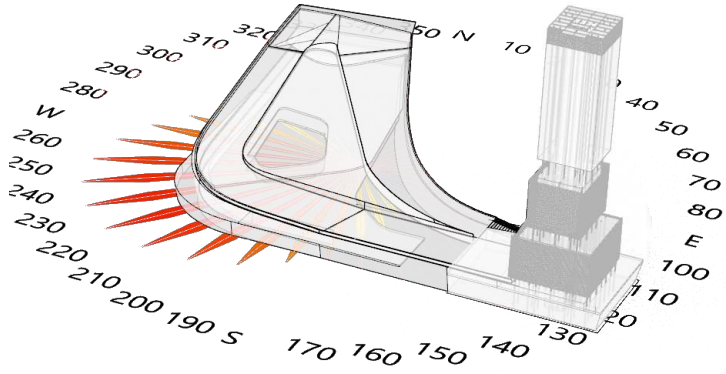








Diffuse Radiation(kWh/m2)
Xian_Shaanxi_CHN_2005
1 JAN 6:00 - 31 DEC 18:00



Direct Radiation(kWh/m2)
Xian_Shaanxi_CHN_2005
1 JAN 6:00 - 31 DEC 18:00

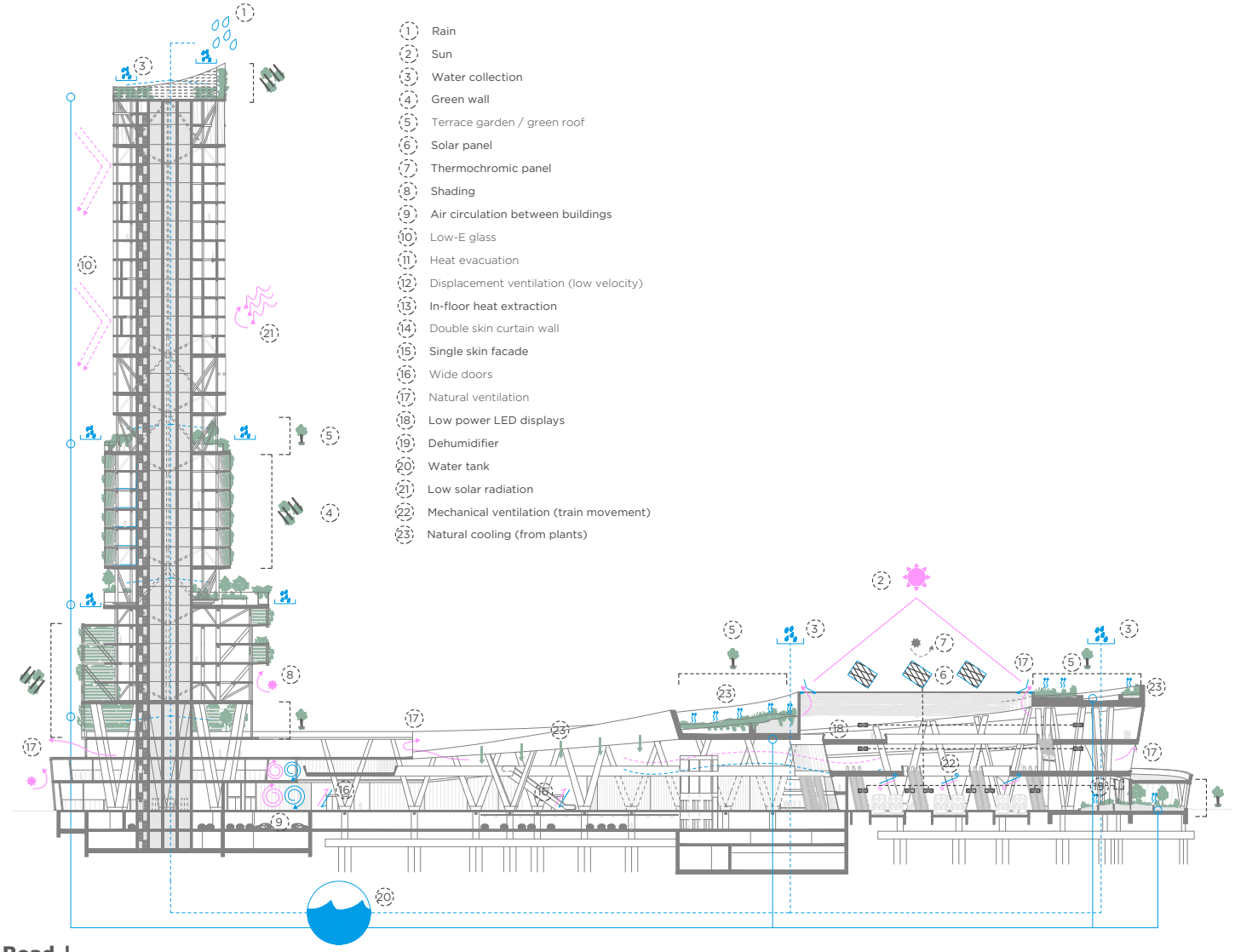
FINDINGS AND DISCUSSION

The purpose of the analysis above is to provide an overview of the climate and weather condition averages on an annual basis in order to understand if any special conditions need to be taken into account for the construction.

Using Vienna as term for comparison, Xi'an average temperature is slightly higher (2-3 degrees Celsius) but most importantly in this case would perhaps be the solar radiation. Although the city has a continental climate (dry cold winters and humid hot summers), the amount of sunshine hours is slightly higher than in Vienna (830 hours) at approximately 950 hours. This means that plants are able to grow without supplemental lighting for 9 out of 12 months, further enabling the creation of large green spaces and parks. As a sustainable strategy, the solar radiation is also put to use through the installation of solar panels on the void of the station and on the southern and eastern facade. The panels cover an area of about 8000 sqm and their design (low energy production but high light transmissibility with 70% transparency) reduces overheating and regulates the amount of direct sunlight that reaches the interior.

Another beneficial factor is the prevailing wind (north to south) which proves advantageous in naturally ventilating the platform area. Although the train tracks are covered and train movement provides passive ventilation, the weather conditions could almost triple the ACH (Air Change Rate) under normal circumstances and increase it 5 fold during windier conditions.

BUILDING PHYSICS | Environmental Diagram



1. Rain
2. Sun
3. Water collection
4. Green wall
5. Terrace garden / green roof
6. Solar panel
7. Thermochromic panel
8. Shading
9. Air circulation between buildings
10. Low-E glass
11. Heat evacuation
12. Displacement ventilation (low velocity)
13. In-floor heat extraction
14. Double skin curtain wall
15. Single skin facade
16. Wide doors
17. Natural ventilation
18. Low power LED displays
19. Dehumidifier
20. Water tank
21. Low solar radiation
22. Mechanical ventilation (train movement)
23. Natural cooling (from plants)

1. Rain
2. Sun
3. Water collection
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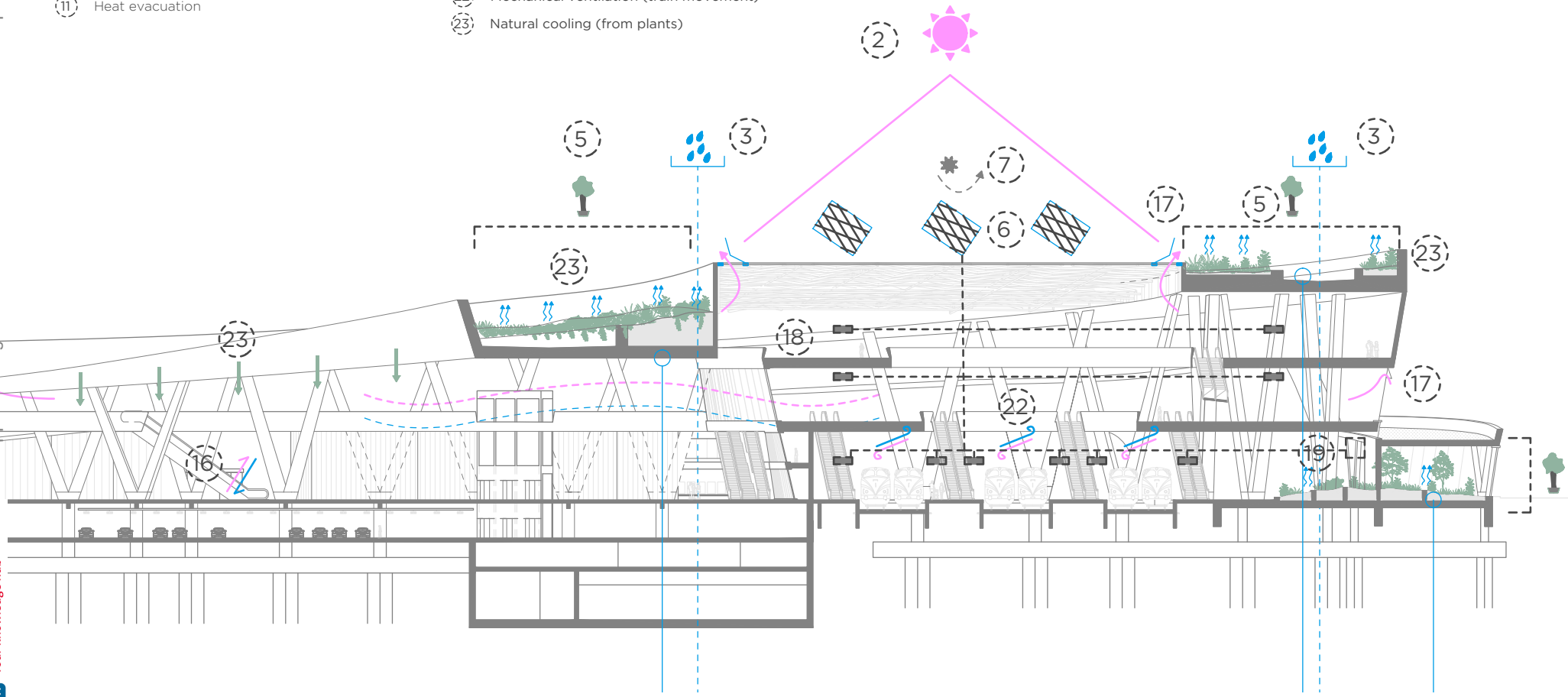

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12

DESIGN | Plans | Sections | Elevations

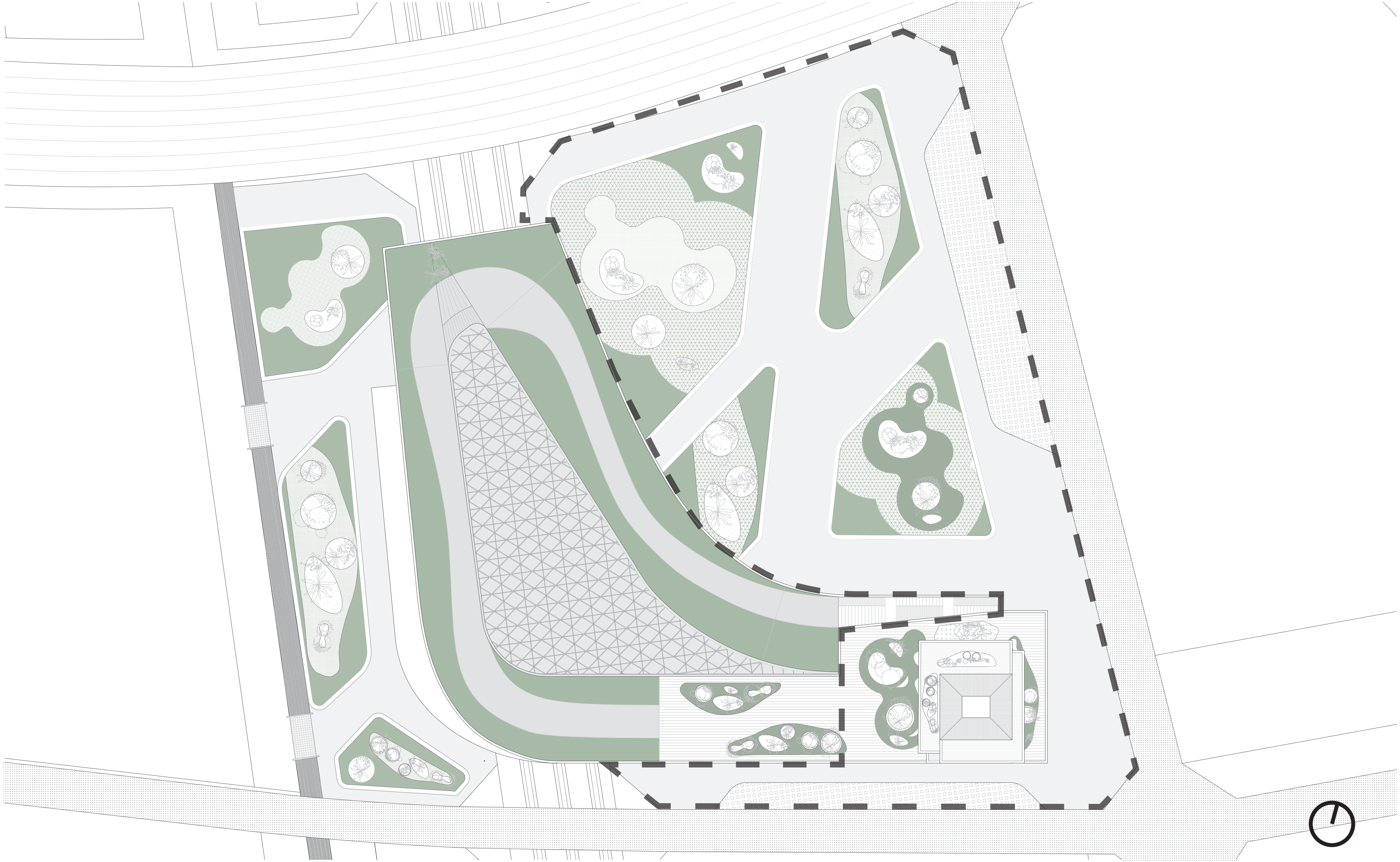
Following the narrative of the site and passing the green space in front of the station, the visitor is met with the entrance to the lobby. Offering an overview of the station's interior, this space opens towards the information desk, ticket counters, exhibition space, essential retail areas and is communicating with the adjacent tower's hotel lobby and shopping center.

Climbing up at the first floor, the visitor is given the choice of becoming a passenger after meeting the boundary set by the security gates. From that point, the station opens up towards a massive concourse with varied functions for all needs and choices (restaurants, indoor gardens, workspaces, waiting areas, working rooms, VIP lounge and other small utilities) all of this happening while maintaining the circularity of the central void. A secondary entrance on the western side directs people above the river canal and straight to the first floor to avoid congestion.

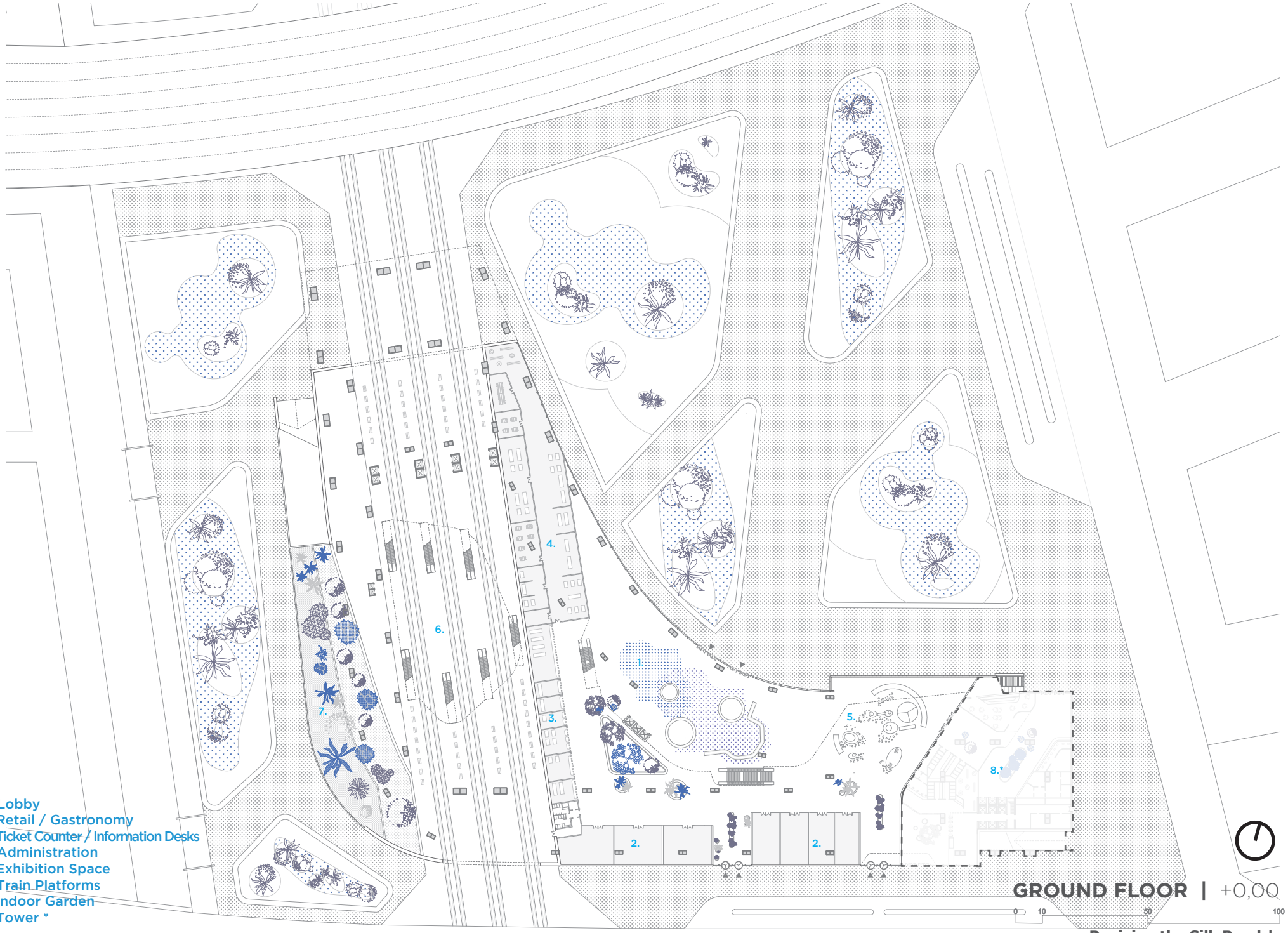
Last but not least, the roof features a promenade that circles the building and creates different points of view towards the city and the adjacent lots. The concept of the internal layout is to create an optimized environment for a fast paced travel experience without disconsidering some passenger's need to enjoy the experience within the station. As a set purpose, the ability to walk through the station without any boundaries is considered an advantage both in terms of experience and spatial adequacy.

Most of the trivial functions (cleaner's space, storages, rest rooms and smoking areas) are hidden within functional volumes along the concourse as a single standardized unit which is otherwise an exception to the rule from the rest of the design approach since most areas don't have a delimitation created by hard boundaries.

All in all, the station aims to become an iconic spot in Xi'an by befriending its surrounding and creating spatial opportunities for anyone who visits, be it simply shoppers, travelers or people seeking leisure related facilities.



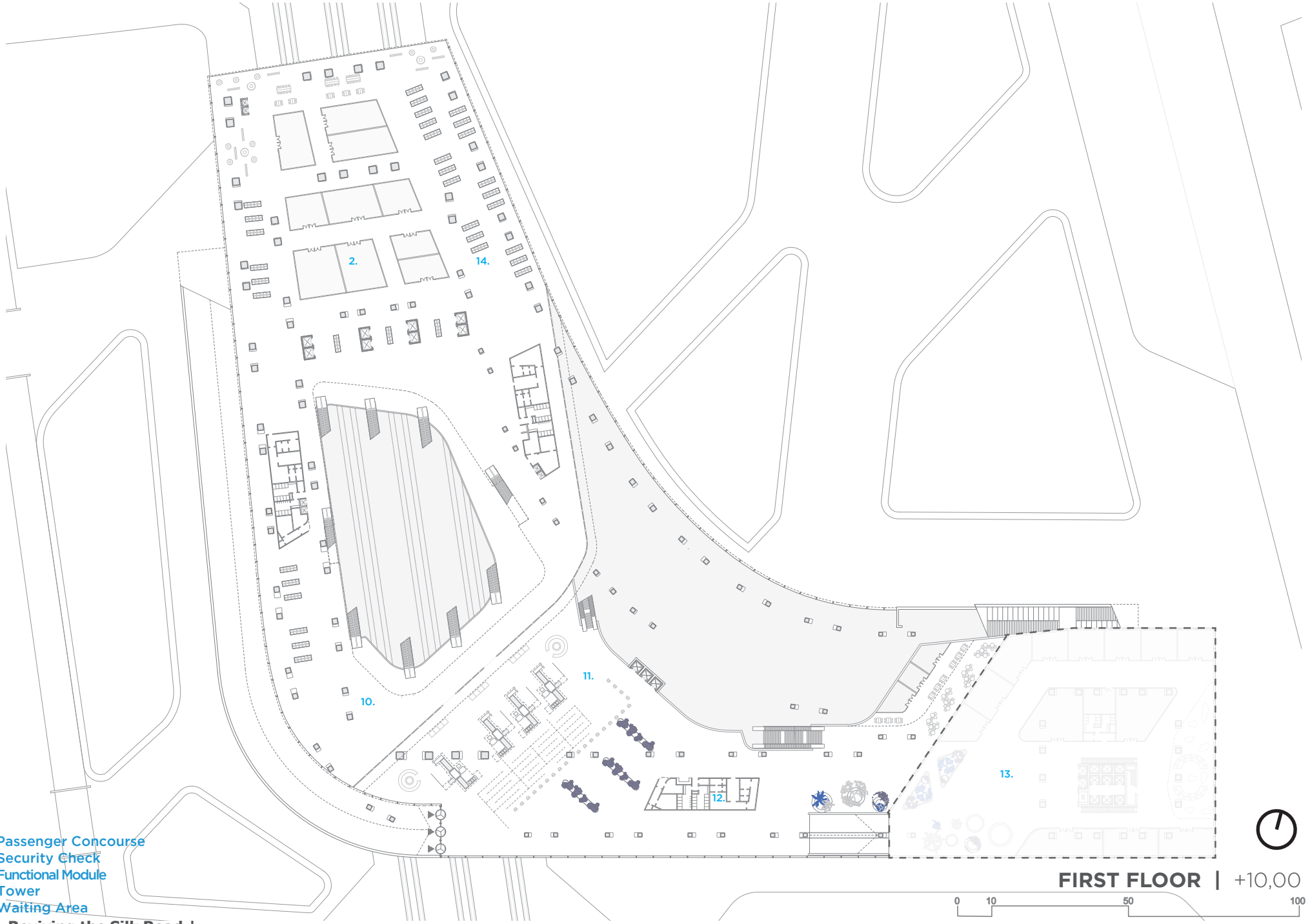
SITE AND ROOF PLAN | 1 : 2500



1. Lobby
2. Retail / Gastronomy
3. Ticket Counter / Information Desks
4. Administration
5. Exhibition Space
6. Train Platforms
7. Indoor Garden
8. Tower *

GROUND FLOOR | +0,00 *

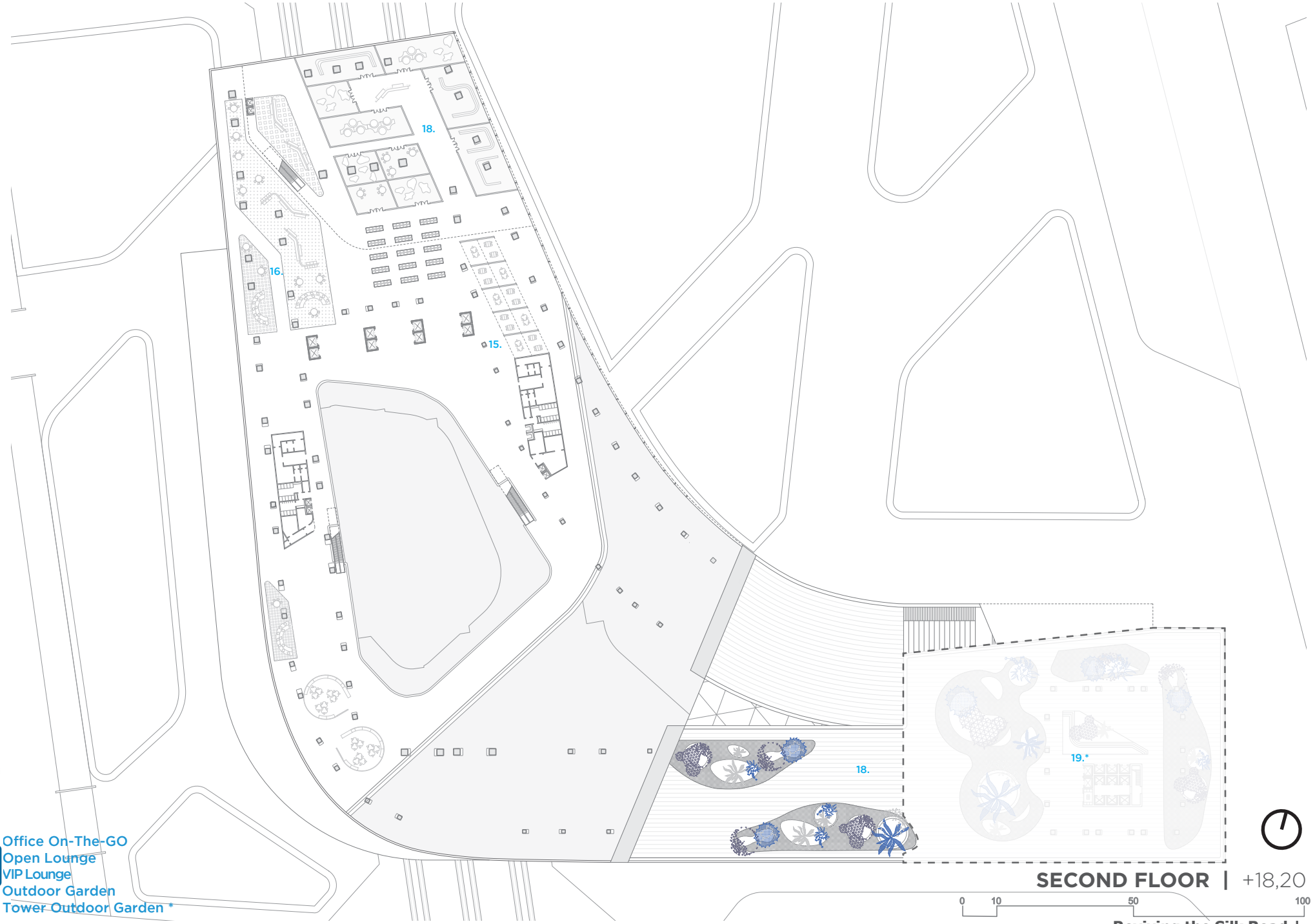
0 10 50 100



2. Passenger Concourse
10. Security Check
11. Functional Module
13. Tower
14. Waiting Area

FIRST FLOOR | +10,00 *

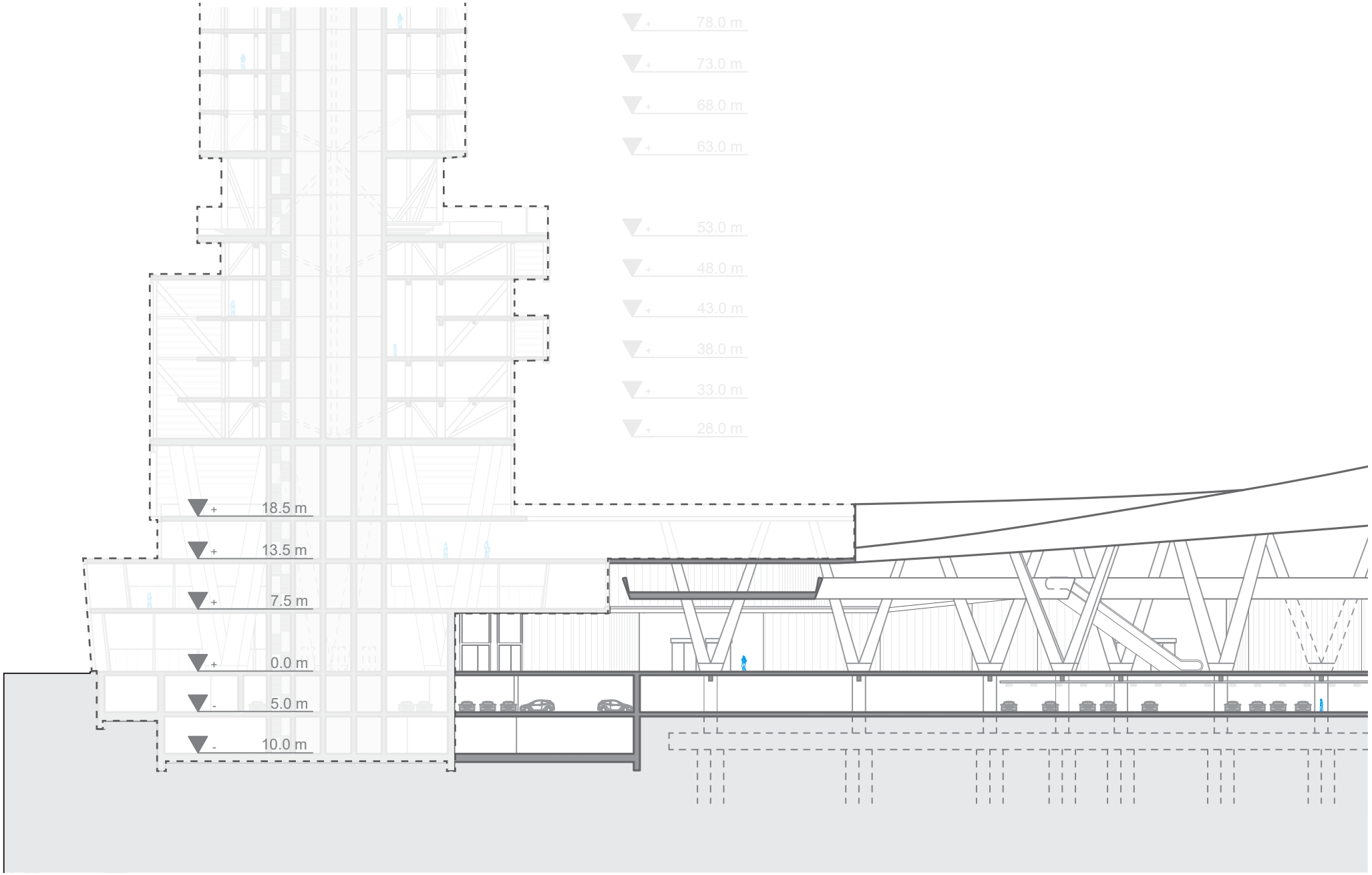
0 10 50 100

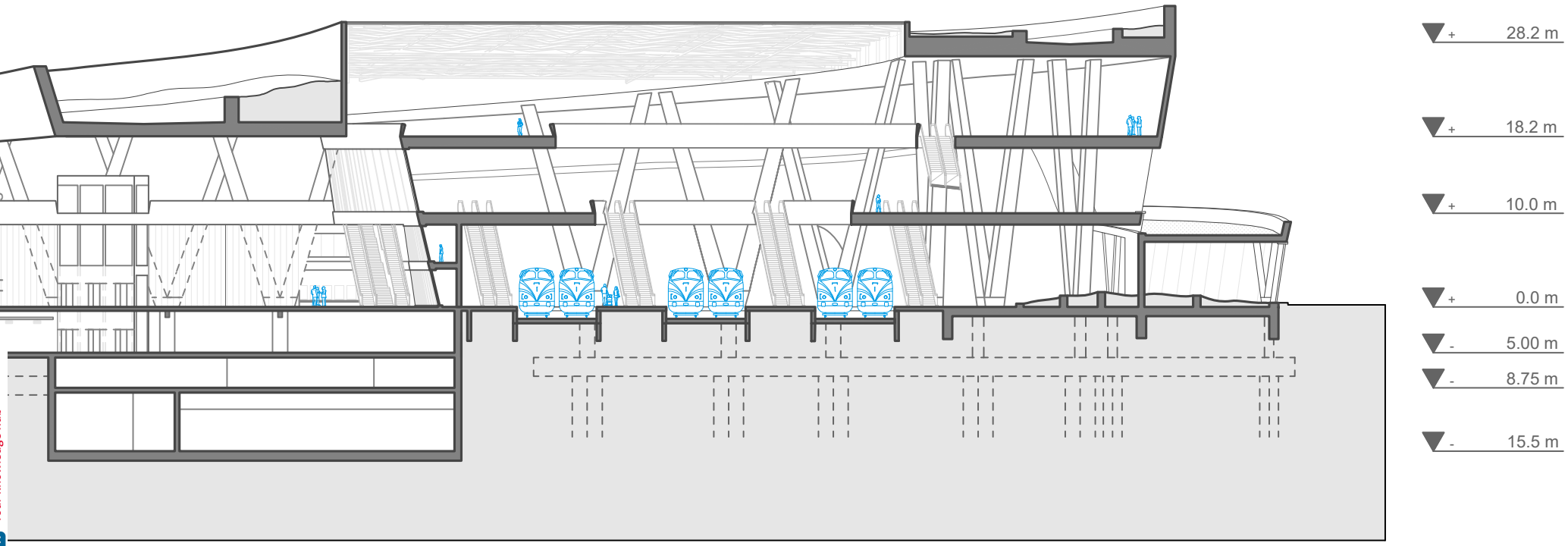


Office On-The-GO
Open Lounge
VIP Lounge
18. Outdoor Garden
19. Tower Outdoor Garden *

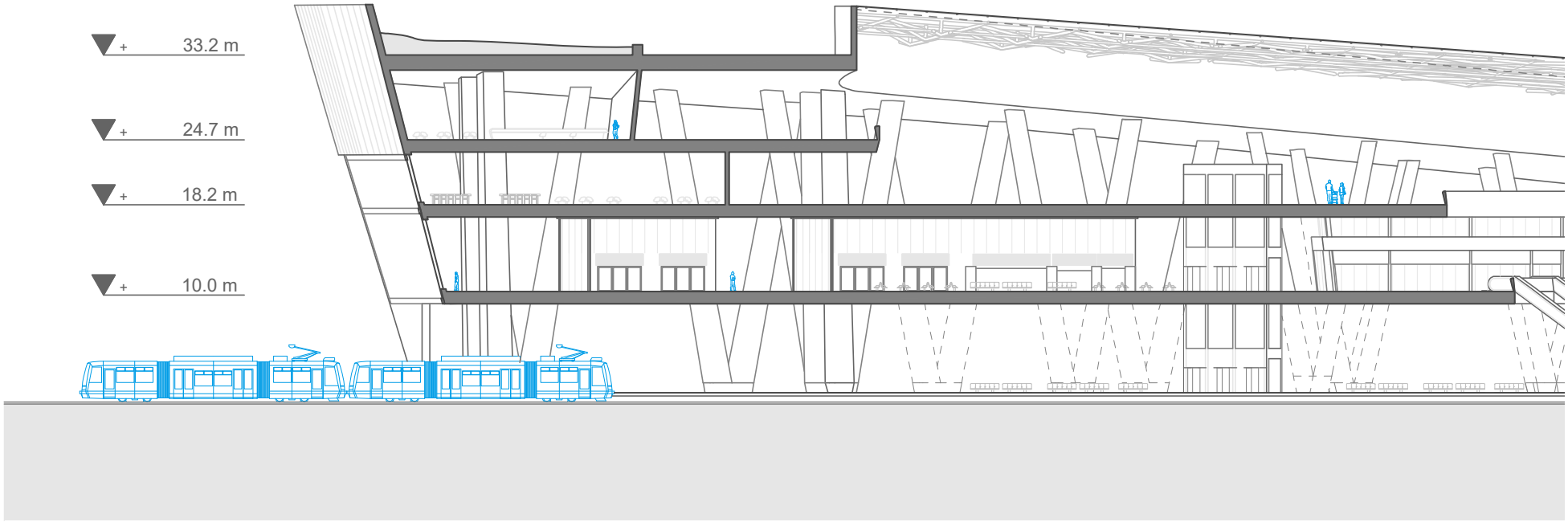
SECOND FLOOR | +18,20 *

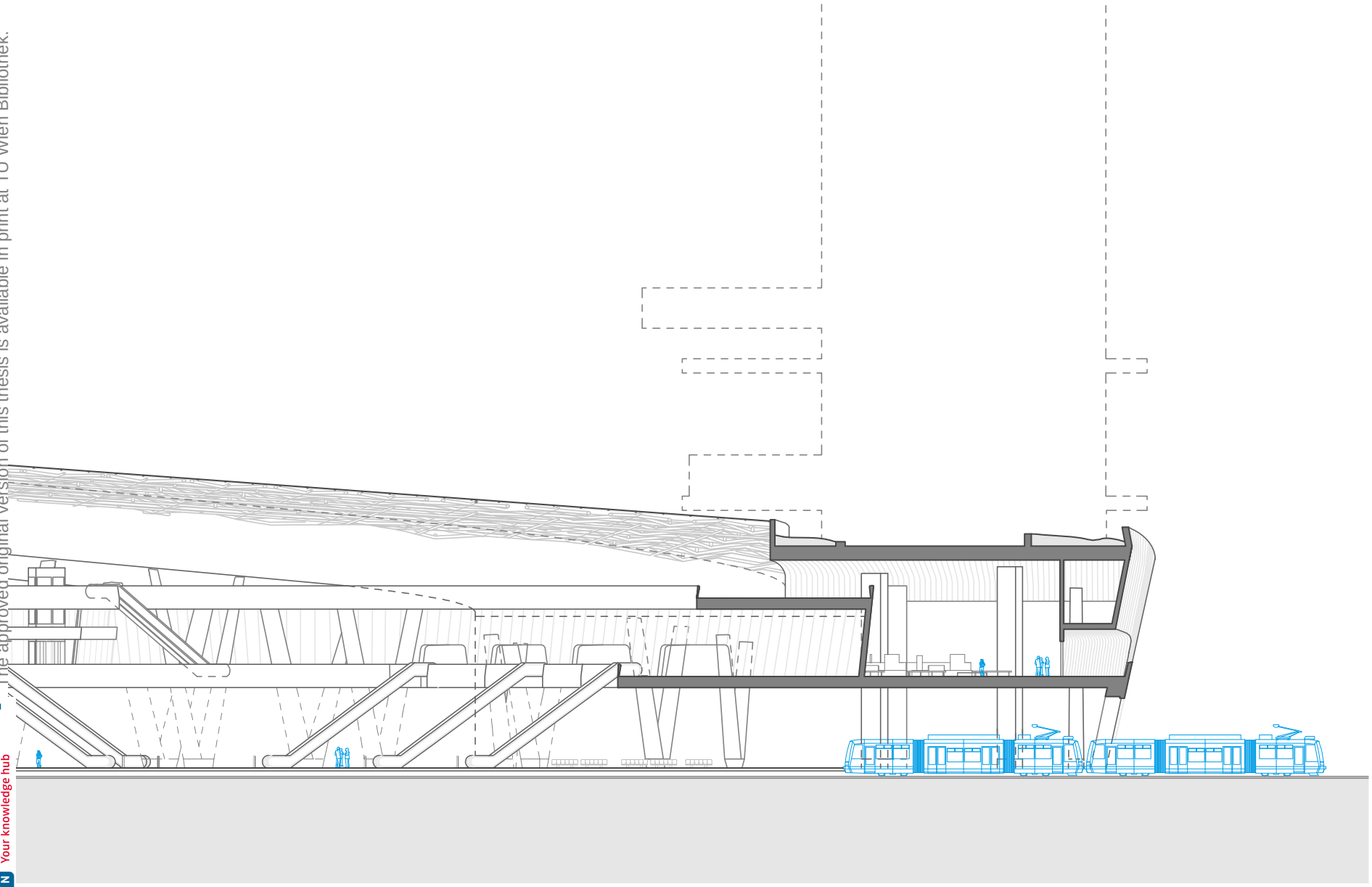
0 10 50 100





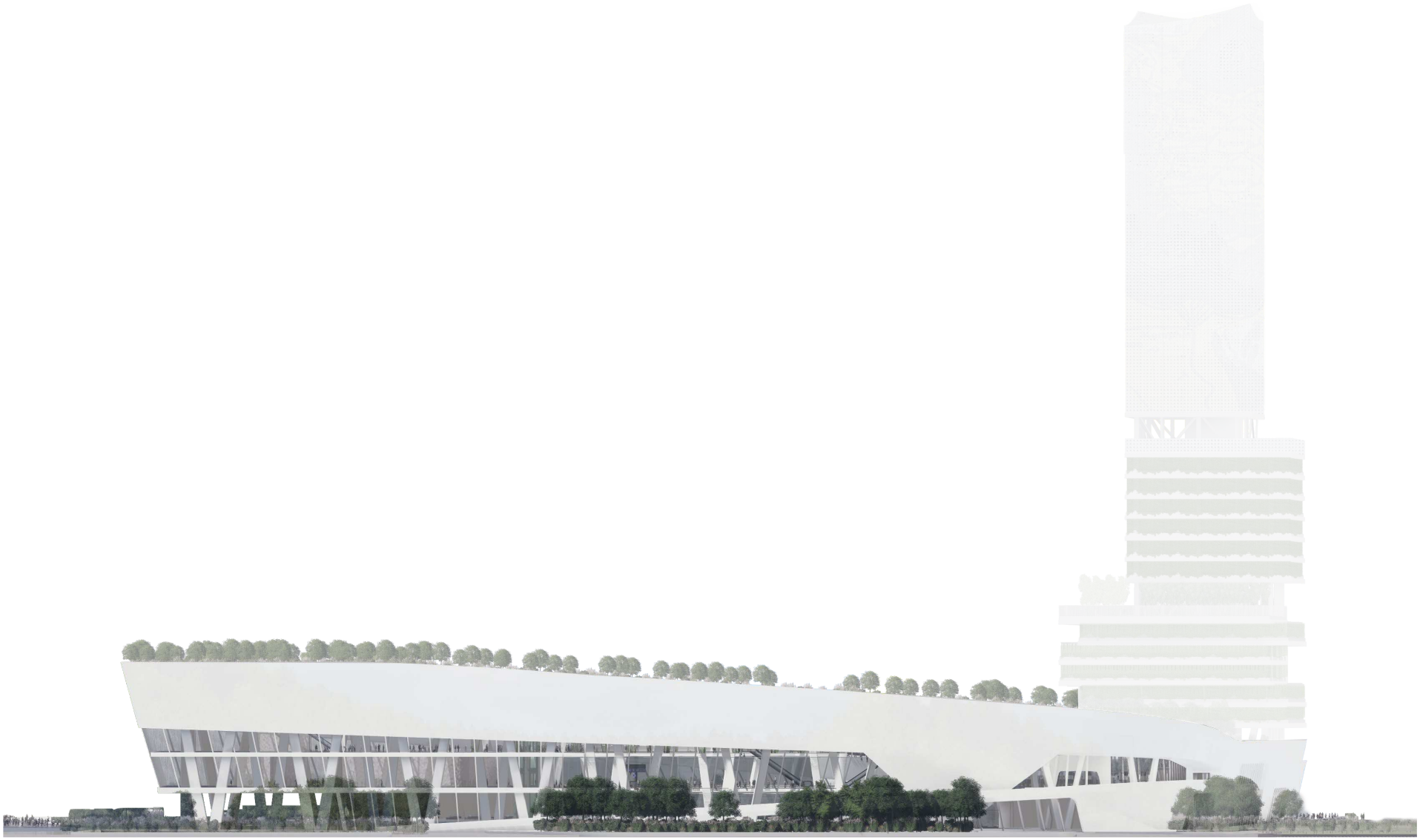
SECTION A-A *



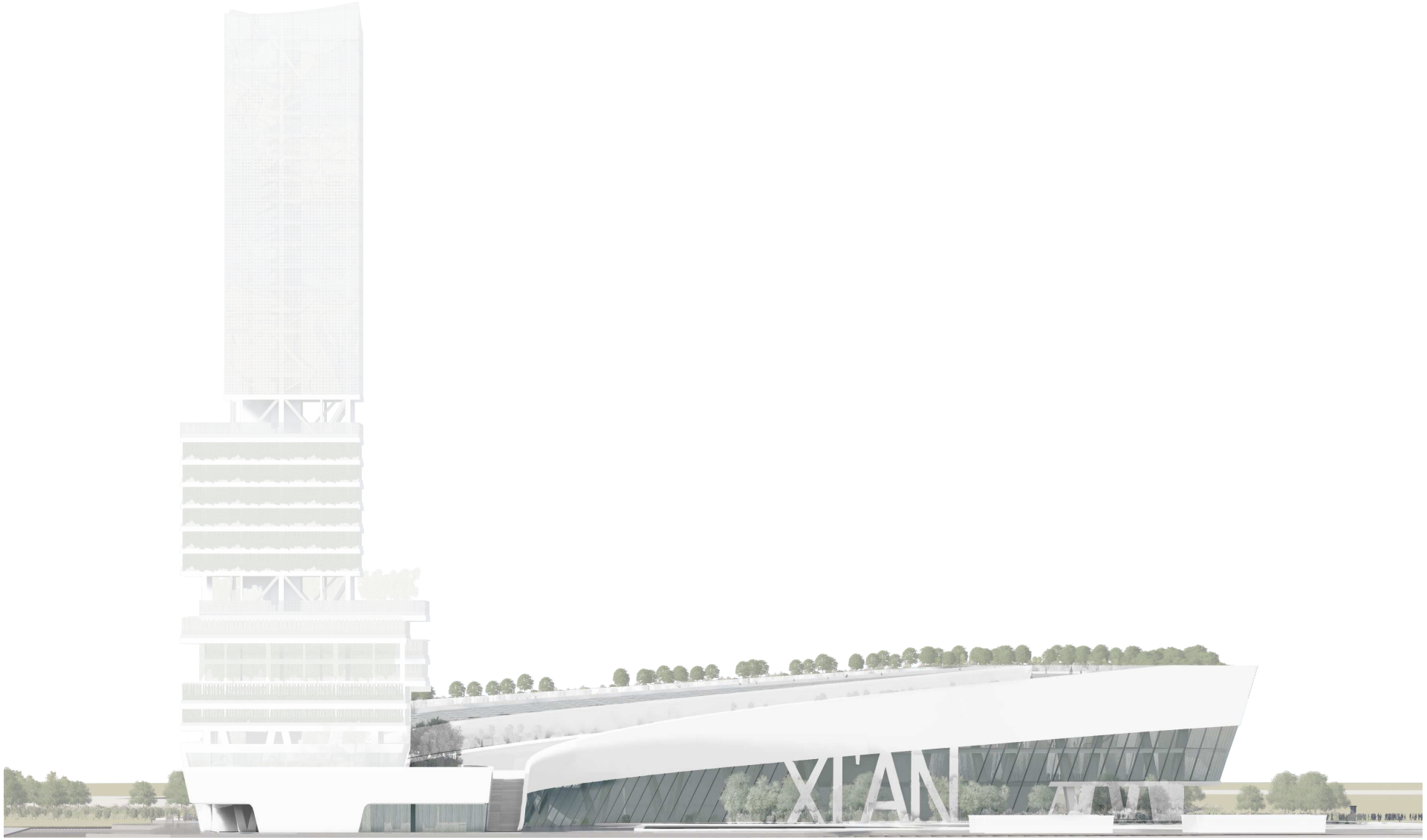


0 10 50

SECTION B-B *

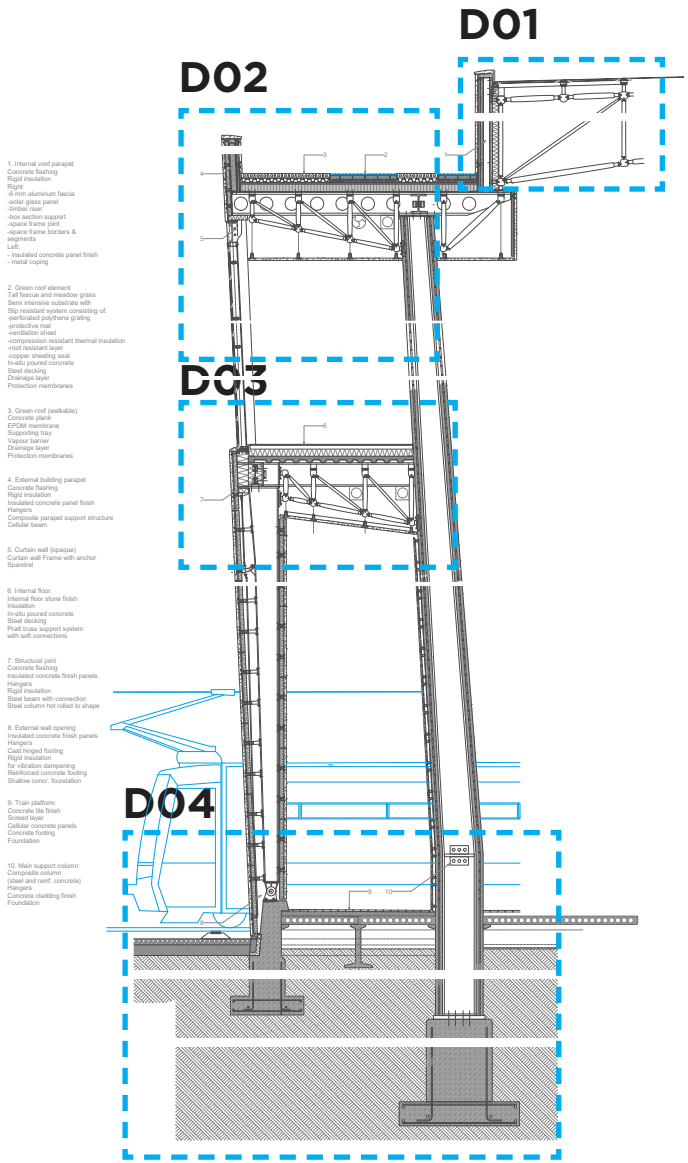


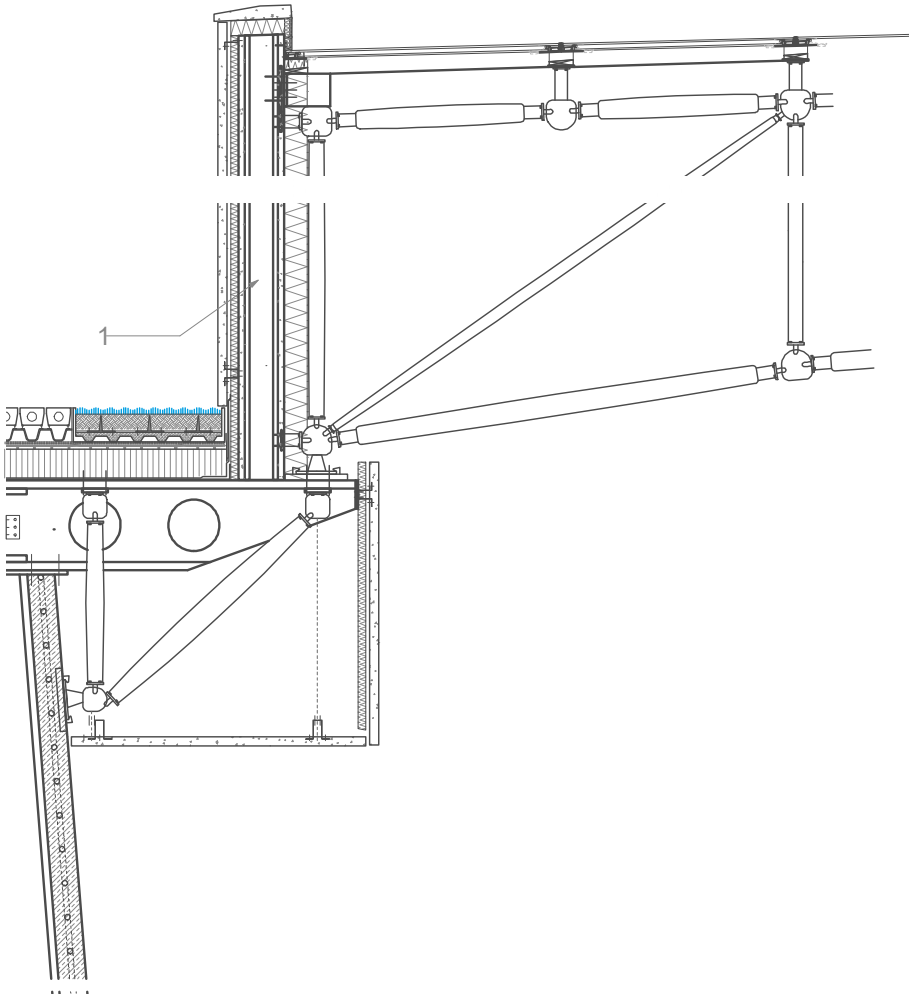
ELEVATION WEST | 1 : 1250*



ELEVATION EAST | 1 : 1250*

DESIGN | Details





1. Internal void parapet
Concrete flashing
Rigid insulation
Right:
-6 mm aluminum fascia
-solar glass panel
-timber riser
-box section support
-space frame joint
-space frame borders & segments
Left:
- insulated concrete panel finish
- metal coping

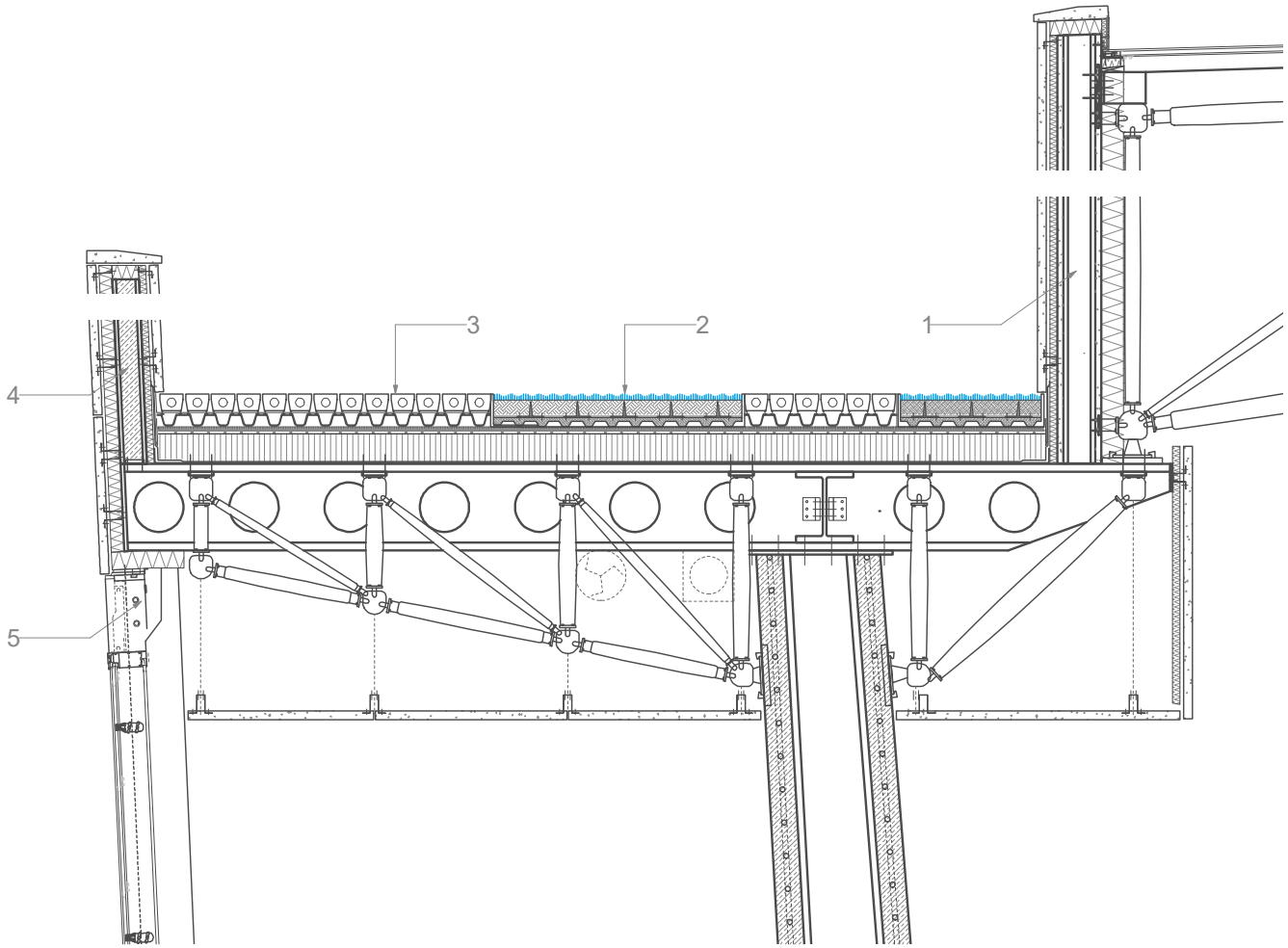
DETAIL | D01 | 1 : 40

2. Green roof element
Tall fescue and meadow grass
Semi intensive substrate with
Slip resistant system consisting of:
-perforated polythene grating
-protective mat
-ventilation sheet
-compression resistant thermal insulation
-root resistant layer
-copper sheeting seal
In-situ poured concrete
Steel decking
Drainage layer
Protection membranes

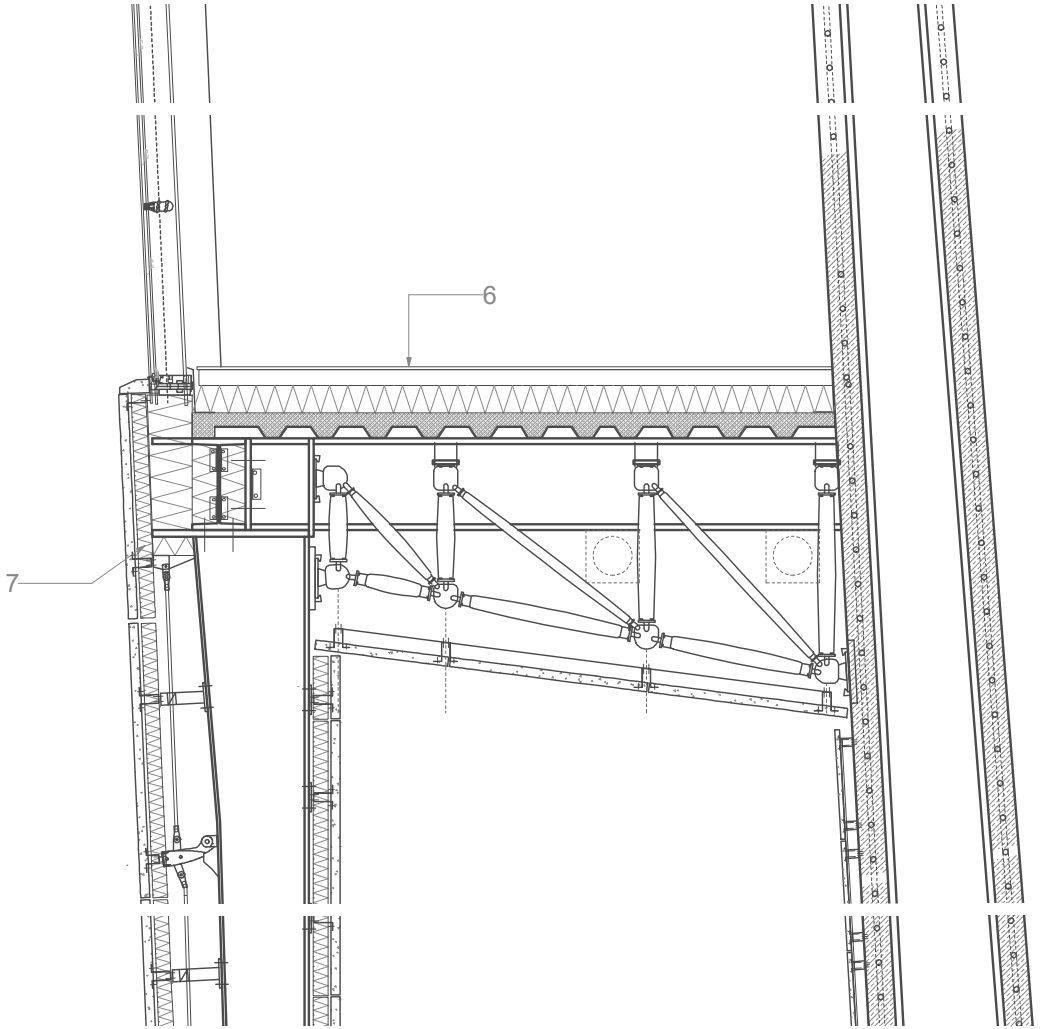
3. Green roof (walkable)
Concrete plank
EPDM membrane
Supporting tray
Vapour barrier
Drainage layer
Protection membranes

4. External building parapet
Concrete flashing
Rigid insulation
Insulated concrete panel finish
Hangers
Composite parapet support structure
Cellular beam

5. Curtain wall (opaque)
Curtain wall Frame with anchor
Spandrel



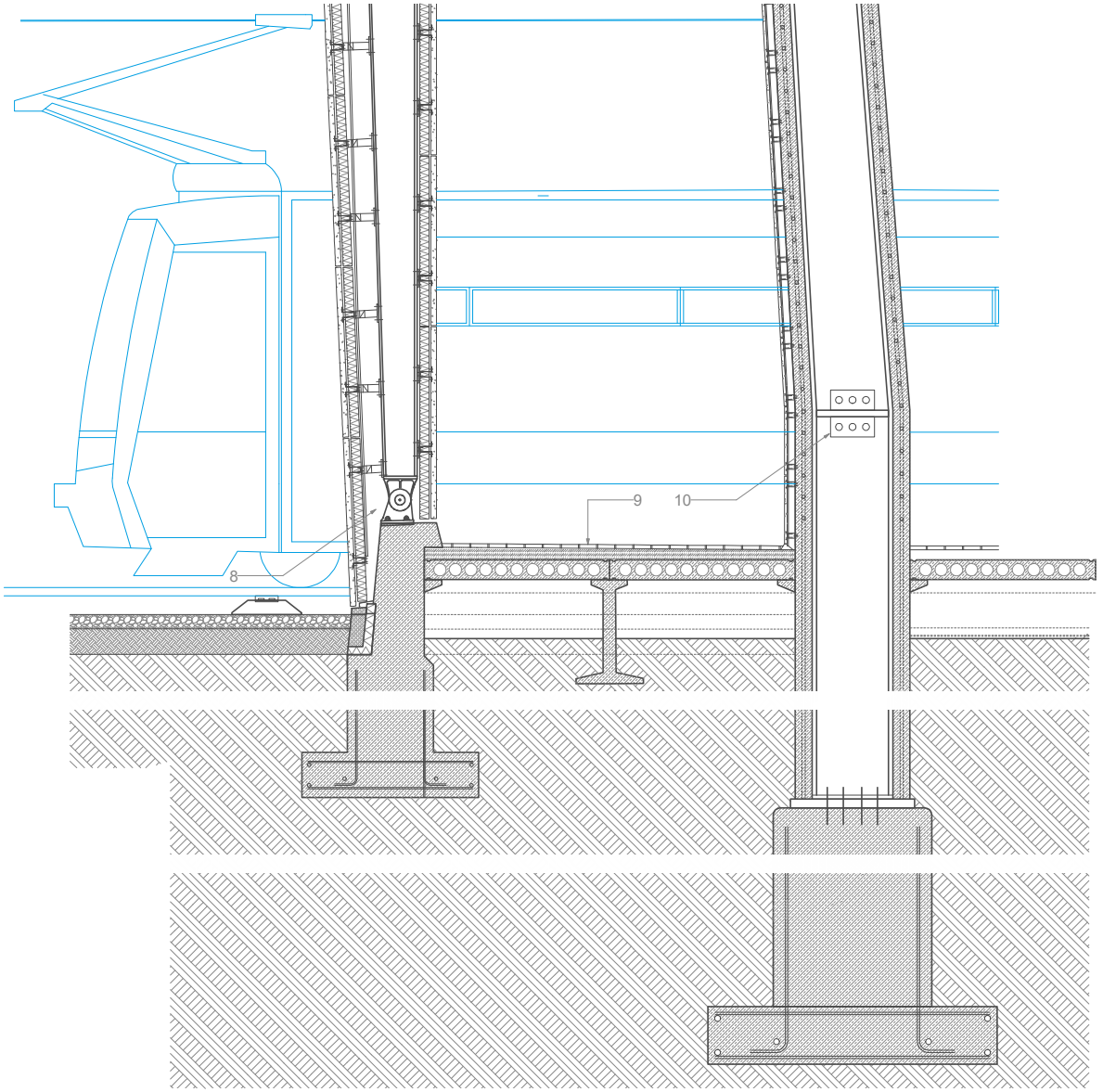
DETAIL | D02 | 1 : 40



6. Internal floor
Internal floor stone finish
Insulation
In-situ poured concrete
Steel decking
Pratt truss support system
with soft connections

7. Structural joint
Concrete flashing
Insulated concrete finish panels
Hangers
Rigid insulation
Steel beam with connection
Steel column hot rolled to shape

DETAIL | D03 | 1 : 40



8. External wall opening
Insulated concrete finish panels
Hangers
Cast hinged footing
Rigid insulation
for vibration dampening
Reinforced concrete footing
Shallow concr. foundation

9. Train platform
Concrete tile finish
Screed layer
Cellular concrete panels
Concrete footing
Foundation

10. Main support column:
Composite column
(steel and reinf. concrete)
Hangers
Concrete cladding finish
Foundation

DETAIL | D04 | 1 : 50

*

DESIGN | Visualisations

THESIS CONCLUSIO

The new train station of Xi'an envisions the perimeter of the train station as a mostly publicly designated space, prioritizing green spaces and the openness of the area for the citizens over built surface.

Since the general scarce allocation of public space was pointed out in an earlier chapter of the thesis, the proposal opts against the idea of a unitary building with a monolithic aspect approach that would occupy the whole site, and aims towards an "economic" use of the site's surface. This is achieved through two strategies: firstly, by taking advantage of the programme present in the tower (shopping center, office and hotel) and choosing to direct the circulation of passengers or visitors in need of those uses towards the high rise development, leaving more space for concourse and decongestion strategies in the station. As such, the footprint of the station amounts to a little over a third of the lot size. Secondly, by allocating the roof of the station for public use and semi-intensive greening, the built surface is converted into a interconnected, public promenade, transforming the entirety of the lot into a place for open activities.

Another aspect which has been prioritized in this proposal was sustainability. Since Xi'an's air pollution problem is a widespread subject, intending to tackle this issue would be unrealistic and could singlehandedly produce another thesis, however buildings should adopt certain strategies that attempt to at least improve the current conditions - this proposal focuses on greenery, minimizing the use of heavy structural elements (use of composites), simulation of local conditions to identify potential culprits that could influence the design negatively, use of rainwater, solar panels, natural lighting through the void, the

avoidance of overheating though the placement and other strategies employed such as use of double skin facade on the southern side, etc. Indeed, there are probably more efficient or newer technologies available at the moment, but the choices made in this case are also based on how widespread certain practices are and they could contribute to ameliorating the situation.

The interior layout also aims at opening up the space and avoiding fixed elements and hard boundaries. Large spaces are able to offer visitors an overview of the building, where they are, where they should go, where is a certain amenity they might need and more. For this reason it is safe to say that a strategy to avoid congestion is people knowing what their target is. Apart from that, the concourse area is highly adaptable for busier times of the year (often the case during holidays in China) by offering ample space for supplemental seating or functional standardized modules that can be arrayed across the currently proposed narrative.

Considerations have also been made for future extensions of the building if needed - if an addition of train tracks would be required, the building can be extended towards the western side of the site , the access ramp can become an internal circulation feature and the indoor garden could be transferred to the roof provided that the same greening system is used. All in all, although the project cannot solve all the issues that the evolving typology of the ‘train station’ is currently facing, it does account for potential changes that might occur in the future and aims to set an early example of what might be expected of HSR nodes.

14

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* = Information marked with this symbol has been developed in collaboration with Dimitrios Sifakis for the thesis 'Xi'an - An Urban Dynasty' ||
For further details, consult the paper written by Sifakis, D. 2020, 'Xi'an - An Urban Dynasty', Masters Thesis, Vienna University of Technology, Vienna

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Fig.1 Ancient Silk Road Route - Daily Outlook Afghanistan - https://menafn.com/updates/pr/2020-02/11/DOA_b2ded606-8image_story.jpg

Fig.2 Xi'an City wall Lantern Festival - Dawn.com - https://i.dawn.com/primary/2019/03/5c9d8d9cd1586.jpg

Fig.3 Terracotta Army - Smithsonian Magazine - https://www.smithsonianmag.com/smart-news/200-more-terracotta-warriors-excavated-china-180973900/

Fig.4 a-c Site images - YAC Xi'an Train Station competition brief - https://www.youngarchitectscompetitions.com/competition/xi-an-train-station

Fig.5 Extended Site Zoning - Chic Italia - https://chicitalia.it/wp-content/uploads/2020/03/sinoita2-600x357.jpg

Fig.6 Extended Site Birdseye rendering - DY163 - http://dingyue.ws.126.net/2020/0514/b8e985c0p00qaanb0008gd200dw0089g00dw0089.png

Fig.7 Pedestrian Arcade Düsseldorf Train Station - Neufert E. and Neufert P., Architect's Data, 2000, Blackwell Science, p. 429

Fig.8 Tessellated Hyperloop Station - Archdaily - https://images.adsttc.com/media/images/5b9a/7cf8/f197/cc3a/da00/02f0/slideshow/cPlompmozes_Hardt_Hyperloop_-_Hyperloop_Station_-_Waves.jpg?1536851171

Fig.9 a,b Delft Station and City Hall construction - Design Boom - https://www.designboom.com/architecture/mecanoo-new-train-station-delft-netherlands-03-02-2015/

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Fig.10 a-c Kaohsiung Train station construction and renderings - Design Boom - https://www.designboom.com/architecture/mecanoo-kaohsiung-station-taiwan-railway-project-06-08-2016/

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Fig.11 a-d West Kowloon Station - Archdaily - https://www.archdaily.com/911930/hong-kong-west-kowloon-station-aedas?ad_medium=gallery

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西安