LAST MILE MILANO

people & parcels

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2025 / 2026 COMPLEX PROJECTS
Bodies and Buildings Milan

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outside view Milano Centrale



PREFACE

This book displays the graduation work done for the Complex Projects studio Bodies & Buildings 2026, situated in Milan. For the studio assignment a 'one off' building is chosen, this being a building which is complex to a degree where most cities only have a singular one, being for example a courthouse, airport or a (central) train station. For this graduation research the station in question is the Milano Centrale main station, by volume the largest train station in Europe and the 8th busiest. For the assignment a hypothetical scenario is assumed in which the station was never realised, presenting a tabula rasa on which a contemporary design is to be placed. As a guideline the existing station is used as a reference for both the program and functions, however new functions and program are realised by virtue of the posed research question. This newly concocted Milano Centrale is discussed both in research and design throughout the book.

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01
INTRODUCTION

02.1 THE PROBLEM

02.2 RESEARCH QUESTION

02.3 RELEVANCE



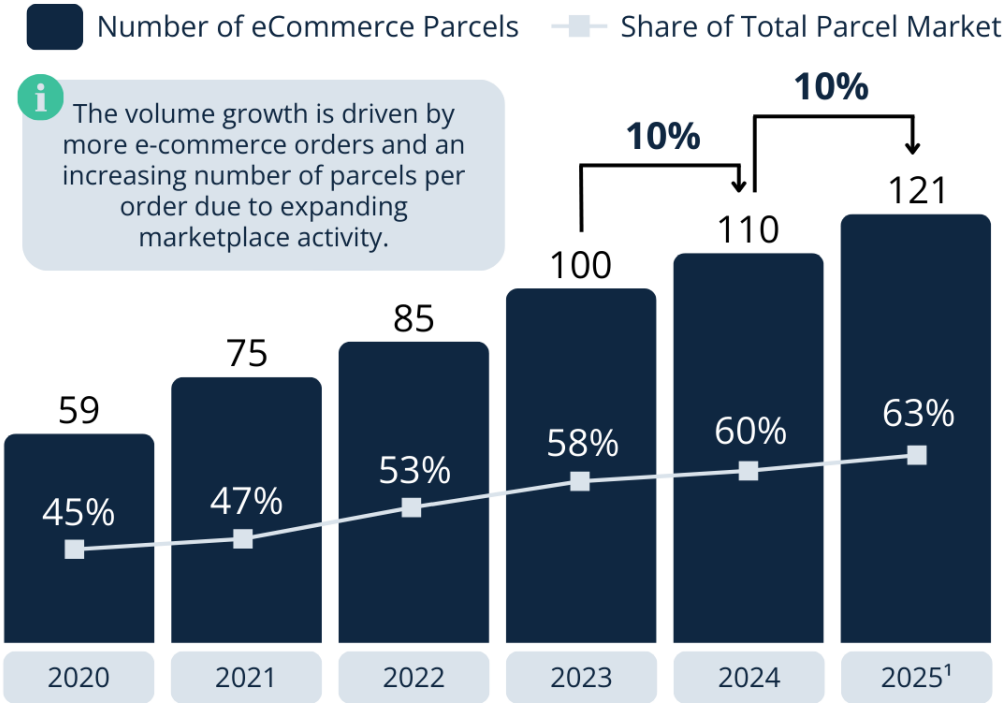
01.1 THE PROBLEM


EVERY ULD COUNTS
BUILD IT RIGHT, AIRTIGHT!
FZTW
DHL
中外运敦豪
MADE IN CHINA
8
UN3481

THE PROBLEM

+10% Growth Pushes E-Commerce Parcel Volume to 121 Billion in 2025

Development of the global B2C e-commerce parcel market (excluding returns) in billions, and its share of the total parcel market

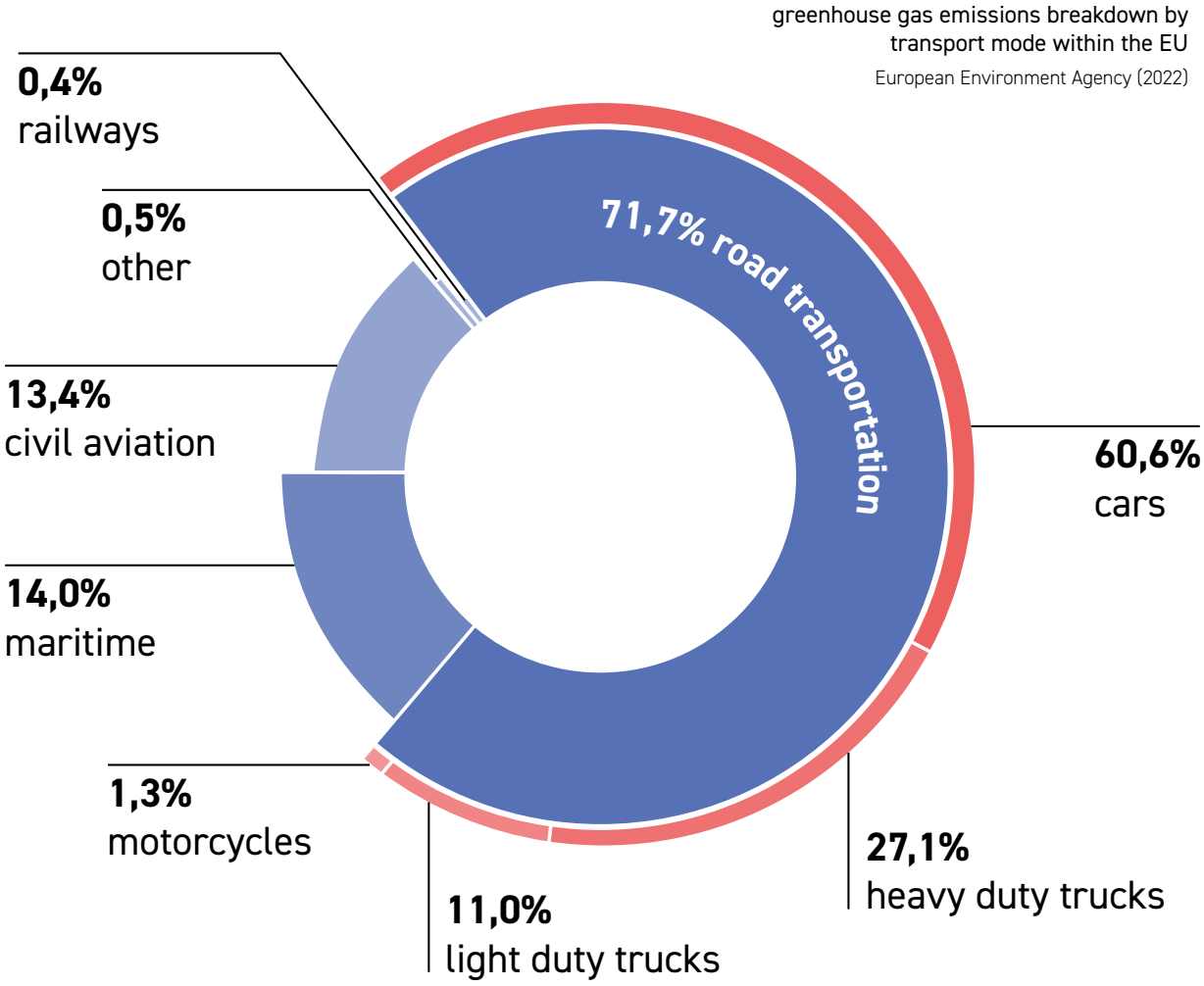


(1) Forecast
Source: ECDB, Pitney Bowes.

ECDB

The parcel is an increasingly important unit in our everyday life, being shaped by increasing consumption patterns. With the unprecedented rise in e-commerce, parcels are now being shipped all over the world, reaching an all time high of 121 billion individual parcels in 2025 through e-commerce sales, this makes up an astounding 63% of the total parcel market . This surging demand is amplifying the importance of freight transport and distribution networks, particularly within last mile solutions in cities. As they accommodate an ever-growing volume of goods, parcels are becoming a defining component of contemporary logistics systems. Despite this growth, the environmental footprint of parcel shipping remains problematic, as this sector relies heavily on high emission modes of transport and lacks the infrastructure to utilise sustainable alternatives at scale.

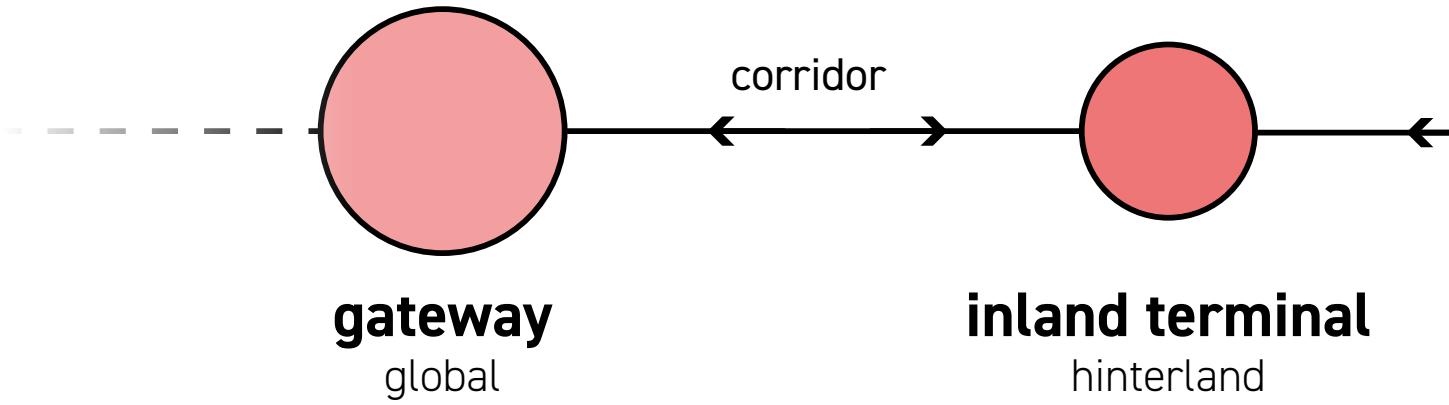
Through a European lens sustainable transport is becoming an increasingly important topic. With the goals of European green deal being set for both 2030 and 2050, aiming to reduce GHG (greenhouse gas) emissions by 55% compared to 1990 before 2030 and achieving full climate neutrality by 2050. These goals can only be achieved by sustainable development in every sector, not withholding transit. The transit sector has room for large improvements as it currently emits 25% (SOURCE) of all GHG, within Europe this is 71,7% road transportation with civil aviation and maritime transit making



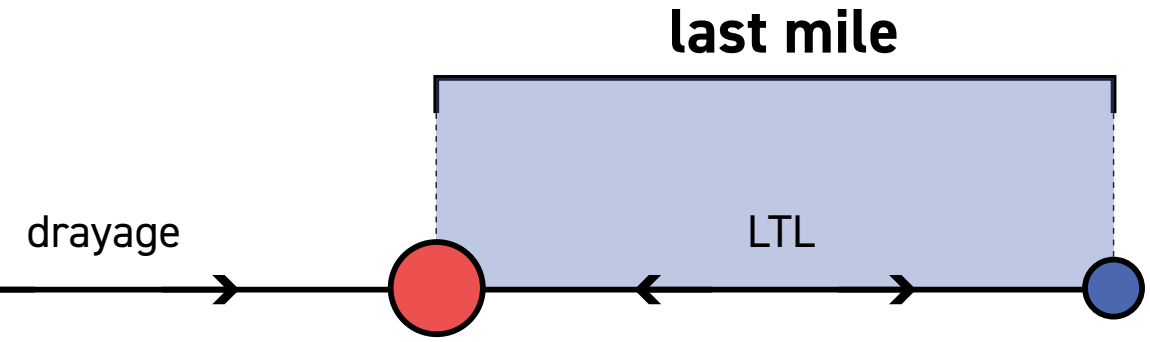
greenhouse gas emissions breakdown by transport mode within the EU

European Environment Agency (2022)

up most of the remainder, rail however only contributes 0,4%. Showing a largely untapped potential for longer range, low GHG emissions transport within Europe. Even when taking the emissions calculated per kilometre for non-electric trains into account, they far outweigh their road driven truck counterparts in emissions. And with the electrification of the European rail network this is becoming less and less through every passing year as described in Zenith et al. (2019), more than 80% of all rail traffic is already supported. Thus shipping goods by train is as seen not only cheaper but also more carbon efficient, however last mile transport solutions are yet to match. Relying almost solely on fossil fuel driven trucks. As described by Dolan (2022), the transporting of goods by way of freight rail networks and container ships is the most efficient and cost-effective way of handling shipping. Yet when goods arrive at a high-capacity intermodal freight station they still must be redistributed and transported their last mile to the destination. This last leg, referred to as the 'last mile' makes up the final step of a parcels journey, being a time-consuming part of the process, where the package goes from the last terminal or distribution centre to the buyer's doorstep. This last mile distribution comprises around 53% of the total cost to move the goods, giving large room for improvement.



global logistics chain - specifiying last mile delivery



distribution centre
regional

doorstep
city

“First of all, we need to act on mobility. In Milan, we aim to reduce private road transport by **50% by 2030** and make the city a **cycling and pedestrian city by 2050.”**

Elena Grandi, 2024

With this rise in parcel volumes, the inadequacy of current last mile delivery systems becomes increasingly untenable, especially for large cities. When these parcels arrive at high-capacity intermodal freight stations they must still be redistributed to their final doorstep. The last mile currently remains overwhelmingly dependent on fossil fuel reliant trucks and vans. Consequently the most emission heavy segment of the supply chain is also the most spatially intrusive within cities. This is why many (European) cities are already actively pursuing policy aimed at reducing car dependency, improving air quality and limiting emissions. Milan is a clear example where this tension comes to light, within Milan ambitions for a car-free city coexist with persistent smog episodes (Guarino, 2024) and large amounts of road-based freight traffic. Here parcel delivery vehicles don't just emit GHG but as well to air pollution, noise and congestion on the roads. Giving the city government a twofold challenge that provides opportunity for change but requires major changes in the currently lacking infrastructure. Milan already has placed lofty goals to wean itself of car dependency, with the Environmental Councillor Elena Grandi announcing the city intends to re-introduce car-free Sundays and describing their goals to reduce private road transport by 50% by 2030, and moving to a fully cycling and pedestrian city by 2050. Addressing this issue requires a rethinking of how parcels transition from freight networks to delivery throughout the urban fabric.



01.2 RESEARCH QUES



STION

RESEARCH QUESTION

an approach to the problem

As a response to the earlier identified problems surrounding the surge in parcel logistics, particularly with a focus on the city of Milan, the environmental impact of last mile distribution and the lack of suitable urban infrastructure. A promising solution can be found in the development with an urban intermodal rail logistics interface that enables the direct conversion of parcel freight flows into car-free, last mile distribution solutions. These solutions take the form of zero-emission delivery modes such as cargo bikes or electric micro-vehicles or automated logistics systems. Reducing both GHG emissions and spatial pressure within dense urban environments.

To address this the following research question forms: “In what ways does the function of a parcel logistics hub influence the layout and program of a station within a car free Milan?” this question will shape the design of a reimagined Milano Centrale, taking into account newly added program and station layouts.

This approach considers the rail station not only as a node of passenger mobility but also as an active component of sustainable urban logistics. By integrating parcel handling, sorting and distribution functions into the station environment a hybrid infrastructure is formed that accommodates both a passenger transit and freight function, all while incorporating newly introduced program related to logistics and mobility. Through this the research will discover how architectural design can respond to emerging logistical demands and challenges while contributing to a sustainable and livable city.

“In what ways does the function of a parcel logistics hub influence the layout and program of a station within a car free Milan?”

SUBQUESTIONS

three further developed subquestions

To delve further into the question three sub questions are formed, each relating a different aspect, people, parcels and the building itself. Herein the thesis relates to the overarching Complex Projects studio theme of Bodies and Buildings, with Bodies being both interpreted as flows of people and likewise parcels.

The first sub question will find an answer to the question of preserving passenger comfort within the station while maintaining efficient parcel handling, here the challenges lies in combining the industrial nature of freight logistics with the public setting of a station accommodating travellers.

Secondly it will be approached from the opposing perspective, enabling the efficient transfer and sorting of from trains to last mile transport solutions. Here the importance is placed on correct layouts with the proper logistical flows integrated into the architectural design of the station, remaining legible yet unobtrusive.
Lastly the last sub question regards the opportunities that arise from the added functions and program, both within and around the station building. Allowing the logistics infrastructure to contribute positively to the public character of the station and its surroundings, through key points such as the public space, concourses and logistics access points.

subquestion I **people**

“What measures are needed to preserve passenger comfort in the station while maintaining efficient parcel handling?”

subquestion II **parcels**

“How to enable the efficient transfer and sorting of parcels from trains to last mile transport vehicles?”

subquestion III **building**

“How does the surrounding urban fabric respond to the new station program? ”

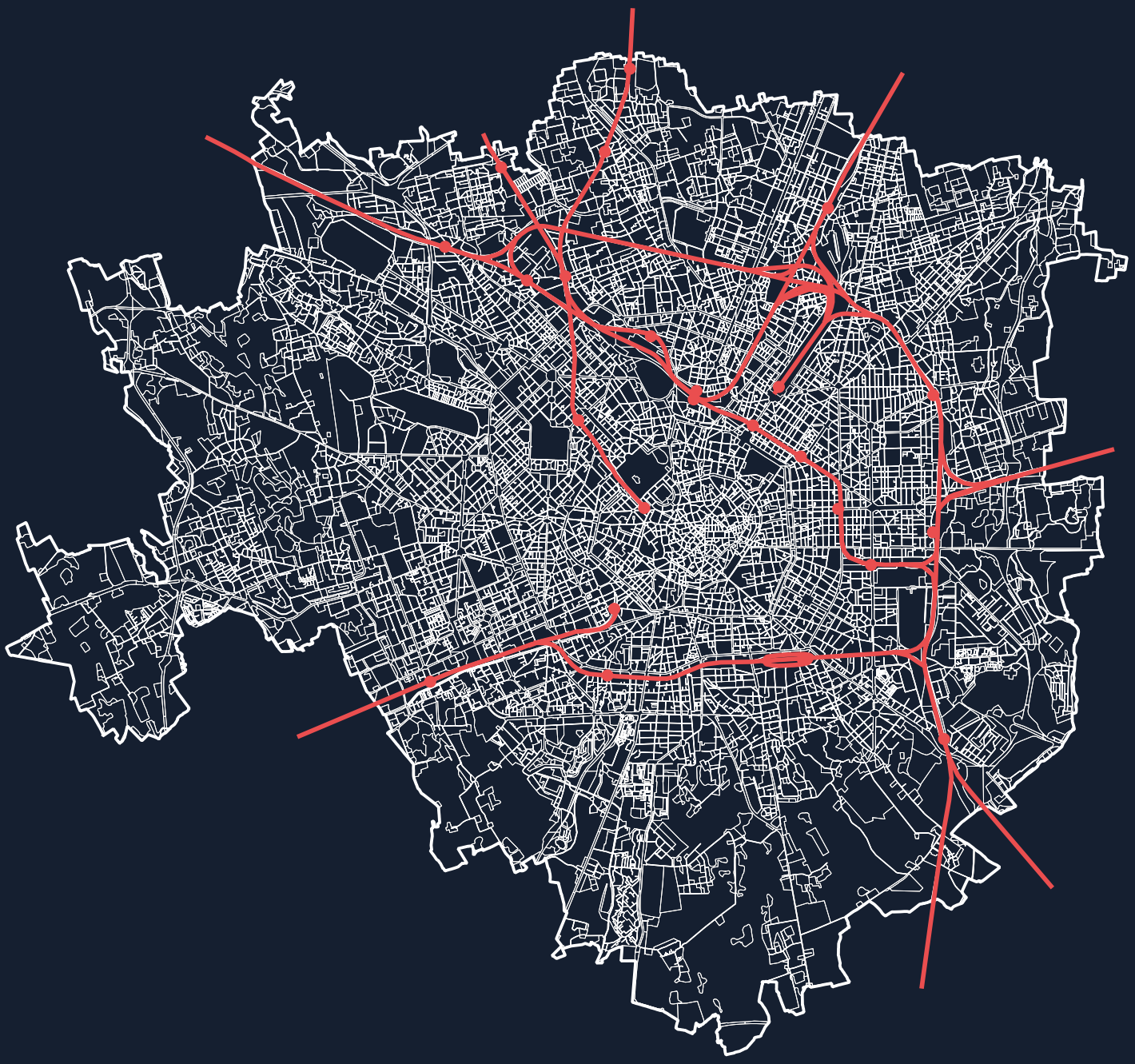


01.3 RELEVANCE


WEST BALCONY
TICKET MACHINES
WAITING ROOM
Information

MILAN AS HUB

As Milano Centrale forms the gateway to the city, so is Milan itself the gateway to Italy. Providing access from mainland Europe into the Italian peninsula, as such the city is a hub for transport both of passengers and goods. Being further reinforced by the large industries dotting the surrounding region and the city itself. In this way Milan lends itself perfectly for experiments in distribution and transport, being well connected to the region and its hinterland. The city itself is built around a central 'hub' this being the oldest part of city centre, demarcated by the Cerchia dei Navigli. From this the city radiates outwards in layers, marked by the Cerchia dei Bastioni and Circonvallazione Esterna, which form the second and third ring respectively. Milano Centrale being nestled in the northern part of the third ring.



POSTAL TRAINS

Postal trains have a long history that closely follows the development of the railway itself. From the mid 19th century onwards, railways transformed postal services by dramatically reducing delivery times. Before trains, mail was carried by horse drawn coaches, which were slow, weather dependent, and limited in capacity. The arrival of the railway allowed post to be moved quickly and predictably across entire countries. These trains formed the backbone of communications, however with the rise of privatisation both in the rail and post sector they fell more out of use towards the 21st century.



train unloading at London Liverpool Street station, 1935



Guillemot train carrying parcels, 1950


Orion
high speed logistics

A RENAISSANCE

Across Europe the idea of postal trains is experiencing a revival as railways slowly are adapting to the modern logistics landscape. Once central to mail and parcel delivery, rail-based freight is being reinvented with new investment and innovation, backing a renaissance in postal trains driven by congestion, sustainability and e-commerce demand.

In the United Kingdom, rail logistics company Orion High Speed Logistics (see image) showcased how former passenger trains have been converted into fast parcel carriers, kicking off services that link major centres such as London with mass parcel traffic. This approach repurposes Class 319 and related units for freight use, offering speeds of up to 160 kilometers per hour and cleaner, rail-based alternatives to road transport (Walton, 2021).

This renaissance reflects a bigger trend in logistics: rail's fixed schedules, central station access and low-carbon output are redefining parcel transport. As such, postal trains are soon becoming a pillar of sustainable freight across European corridors.

02
APPROACH

02.1 METHODOLOGY

02.2 PRECEDENTS

02.3 LITERATURE REVIEW



02.1 METHODOLOGY



METHODOLOGY

studio context and graduation approach

This thesis adopts a methodological and structured approach to architectural design as developed within the Complex Projects graduation studio. The building is approached as an integrated and context-specific entity that generates space, light, and shelter, while responding to bodily requirements such as movement, comfort, safety, and security.
The research focuses on a large, functionally specific complex building as a one-off within the city, investigated across multiple scales, from global and urban contexts and research to architectural concepts, technologies, materials, and critical details.

Improvements in data science, building information modelling, and digital technologies inform both the research and design process, enabling a dense, layered, and integrated approach to design. Data is collected, organised, and critically analysed to formulate a clear design question, forming a design brief that guides the following design proposal. The methodology acknowledges architecture as a complex, multi-stakeholder process requiring verification and validation against functional, spatial, technical, and societal demands.

Within this methodology, the architect operates as a coordinator of complexity, translating diverse technical, spatial, and societal inputs into a coherent design strategy. The design process relies on iterative testing and critical reflection, using drawings, models, diagrams, and data-driven representations as tools for both development and communication. Emphasis is placed on clarity of concept and narrative, enabling informed decision-making and alignment among stakeholders. In this way, the design proposal functions as both an analytical framework and a spatial response, capable of addressing complex requirements while remaining conceptually understandable.

Thus, research and design are approached as fully integrated and mutually reinforcing components of the methodology. The investigation of a large, functionally specific complex building combines spatial and technical design with multiple forms of research, including site and programme analysis, research for, on, and by design, and literature reviews. This work follows a scientific and verifiable approach, starting from a clearly defined problem statement and design question situated within a broader societal, technological, and environmental context. Through iterative cycles of analysis, synthesis, and evaluation, research outcomes continuously inform design decisions, leading to reasoned results and a coherent architectural proposal.

This methodology is documented and critically reflected upon through the Graduation Report and the Complex Projects complete brief which functions as the backbone of the design process. This report supports an iterative rather than linear workflow and structures the project into four interrelated parts: an introduction defining the problem statement, relevance, questions, and scope. An approach outlining methods and theoretical framework, a results section presenting research and design development with argumentation, and a concluding section addressing conclusions, implications, and reflection. The report is progressively developed and submitted at the formal assessment moments, ensuring alignment between research, design, and evaluation within the studio framework.

It concludes with a critical assessment of the project's implications and a reflective evaluation of the design and research process. Within Complex Projects, this reflection situates the individual project in relation to the studio's integrated design philosophy and the wider discipline of architecture. It examines the effectiveness of the applied methods, the relationship between research, data, and design, and the management of complexity within a multi-stakeholder context.


WILLS
WILLS
639
2



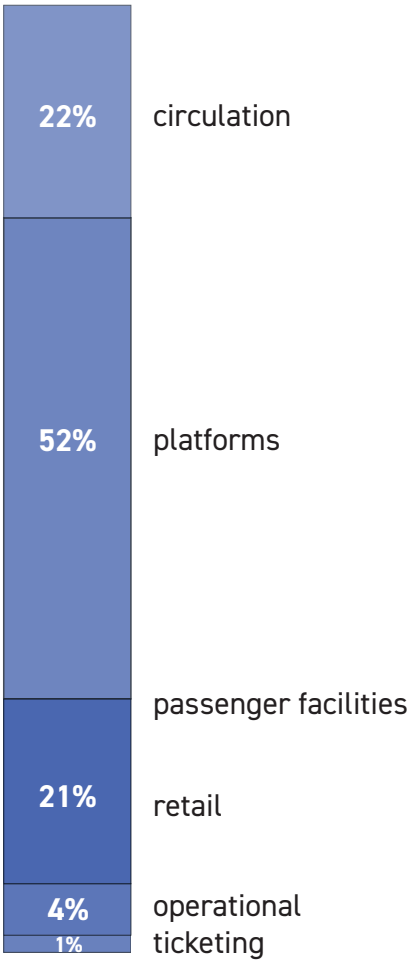
02.2 PRECEDENTS

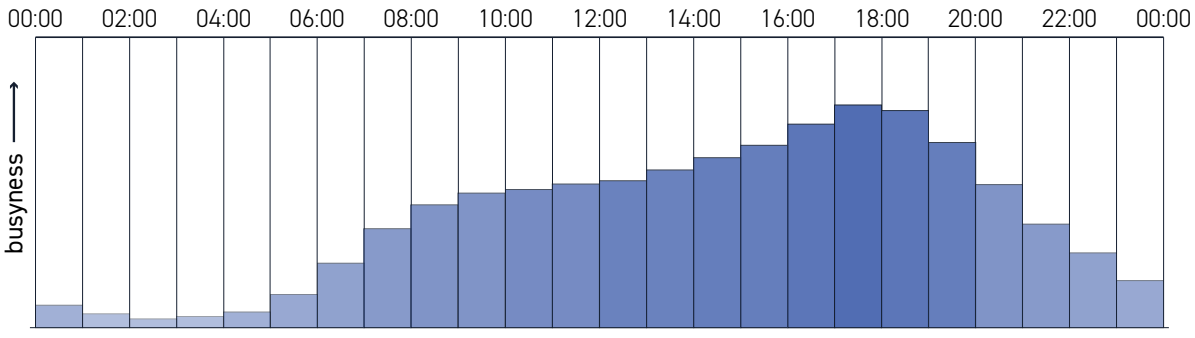

1c
ATTENZIONE
GRUPPO
ELETTROGENO

MILANO CENTRALE

216.000 passengers per day
24 tracks
106 000 m2 floor area
31 trains per track/day

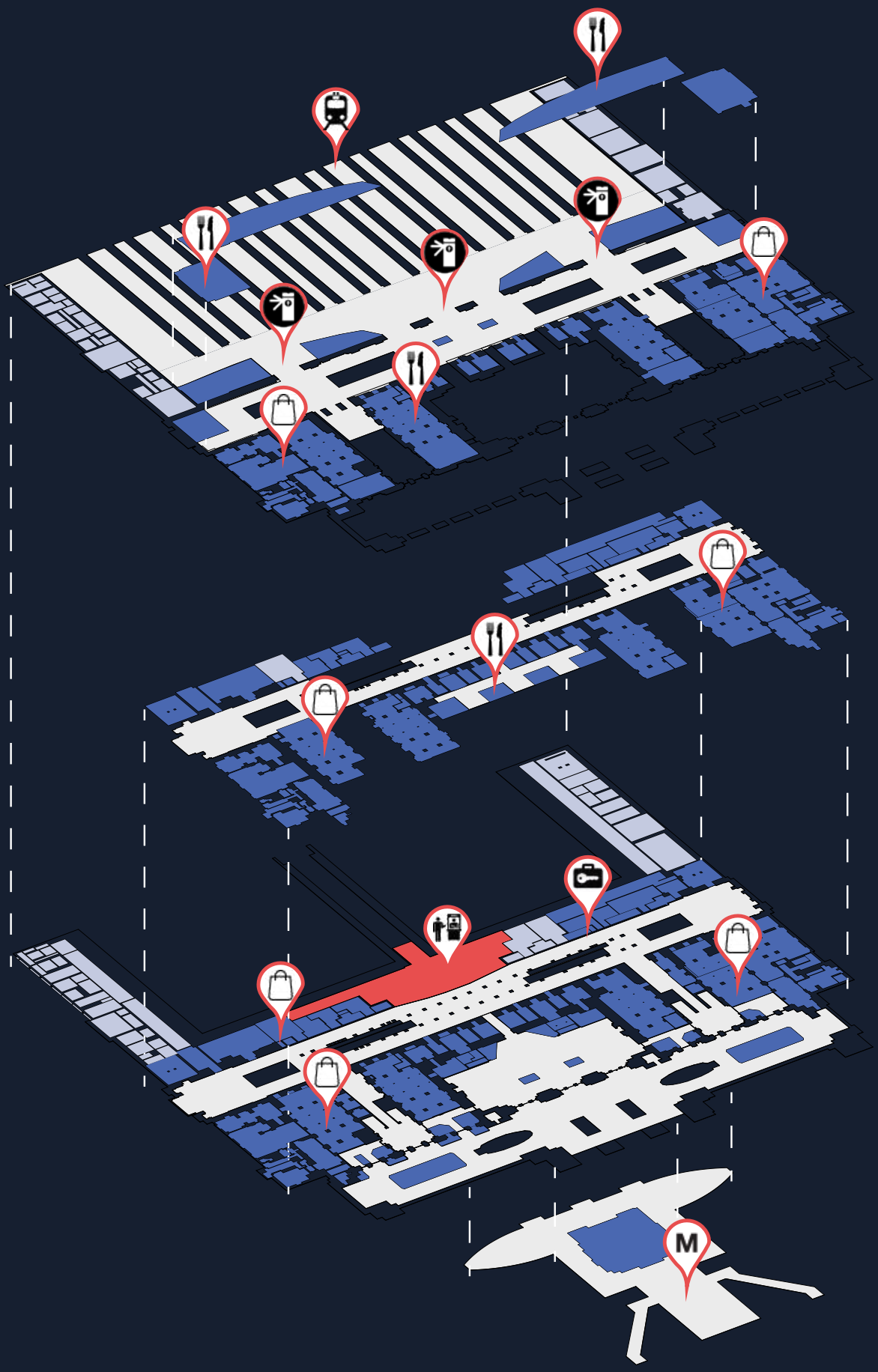
Milano Centrale is commonly referred to as the 'gateway to Italy'. As the station forms the first major Italian hub located towards the rest of mainland Europe. The station lives up to it's name by servicing mainly long distance transport, and a smaller segment of commuter rail. The building is hallmarked by the grandiose concourses and cavernous spaces, these provide architectural quality, however any clarity of flows is lost on the traveller. As these have to navigate themselves through multiple levels before reaching the gates to the platforms. Besides this the station relies on late platform announcements, causing little dwell time on the platforms themselves, resulting in large buildups at the last concourse in front of the timetables.





Milano Centrale

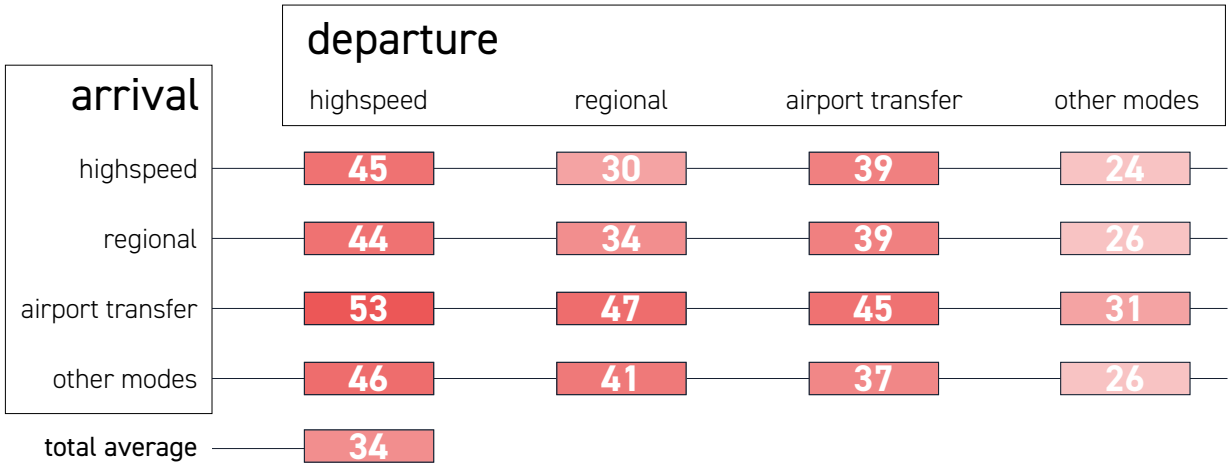
GoogleMaps: busyness indicator



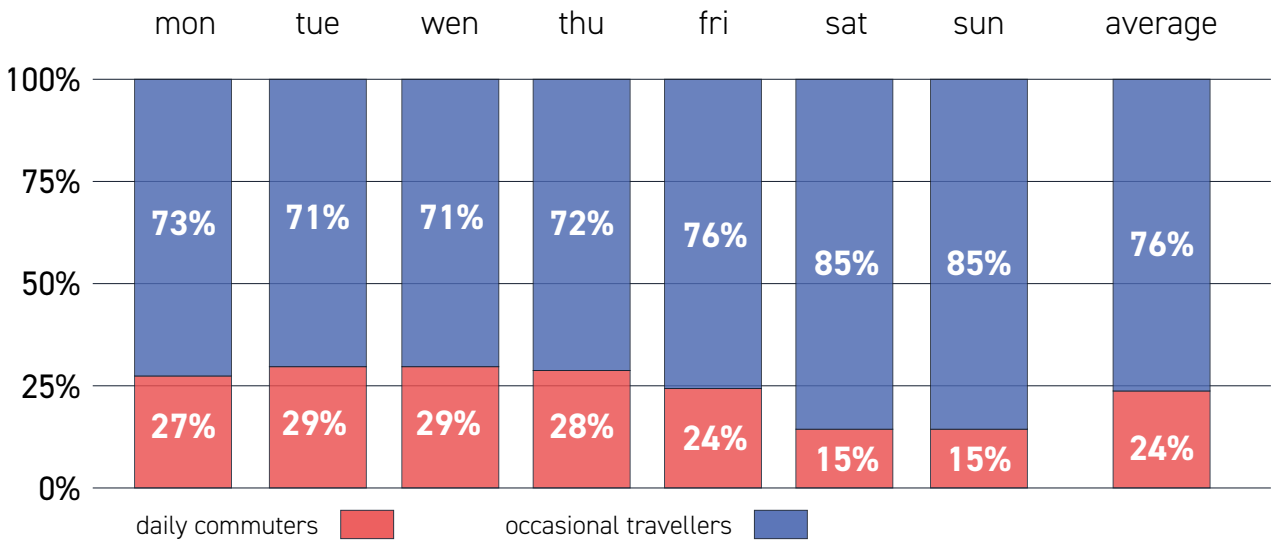
Milan, Italy

plan drawn by Jasper Bouwknegt

With Milano Centrale being a long distance station, only between 30-15% of travellers are commuters throughout the week. The remaining being long distance travellers, who do not use the station daily. This is reflected as well in the rather long transfer times when switching between modes of transport. Being on average 34 minutes, the longest, when switching from an airport transfer to highspeed rail, being 53 minutes on average.



average amount of minutes spent at Milano Centrale per transfer



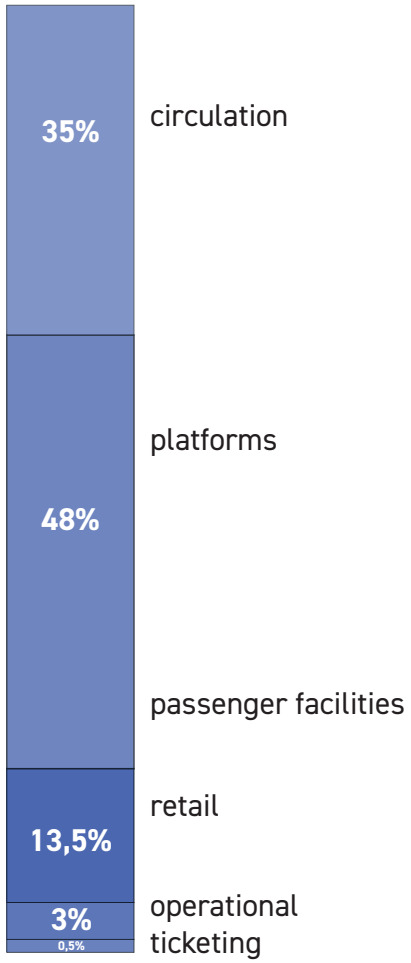
occasional versus commuter travellers

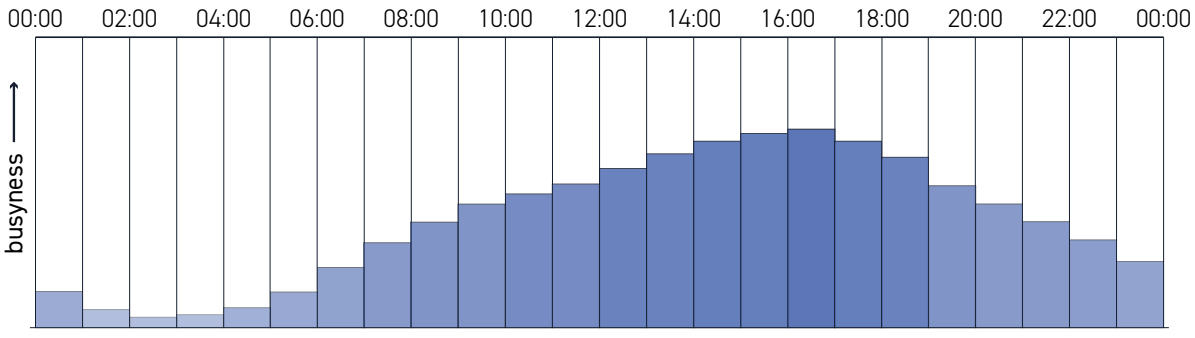

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BERLIN HBF

330 000 passengers per day
16 tracks
71 000 m2 floor area
81 trains per track/day

Berlin HBF (Hauptbahnhof) is of the newer main stations within europe, serving mainly long distance trains beyond the region. The station has a high throughput with 81 trains arriving and departing per track per day, significantly more than both Milano Centrale and Utrecht Centraal, making a total of 1300 trains per day. The station is set up as a cross, with platforms on the upmost floor of the building being connected to a set of platforms on the bottom of the station through a large atrium filled with retail. This leads to a significant amount of circulation space, however it does make for a clear distinction in travel direction.





Berlin Hauptbahnhof

GoogleMaps: busyness indicator



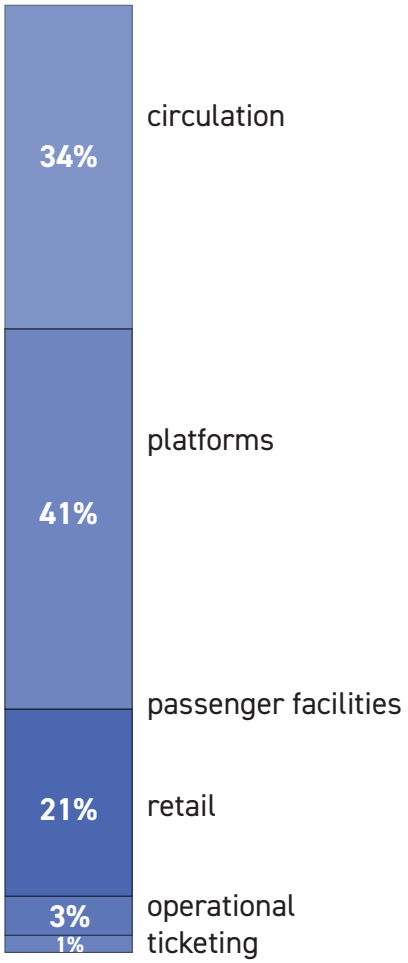
Berlin, Germany

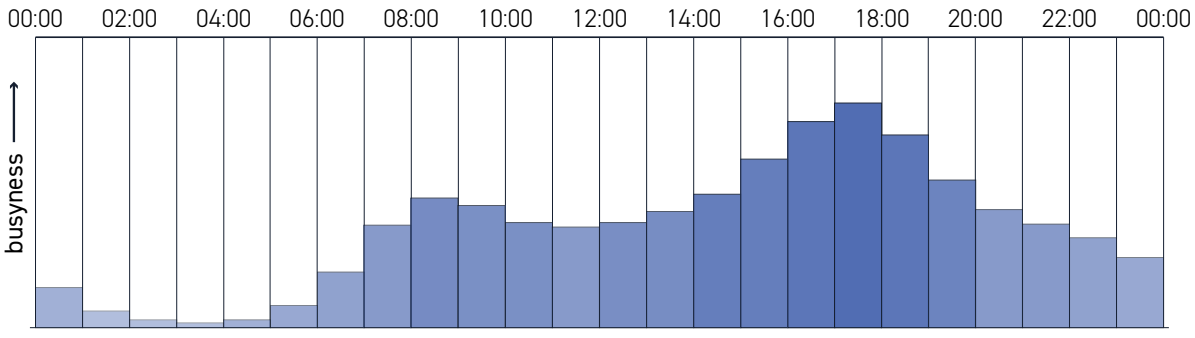
plan drawn by Jasper Bouwknegt

UTRECHT CENTRAAL

230 000 passengers per day
16 tracks
55 000 m2 floor area
62 trains per track/day

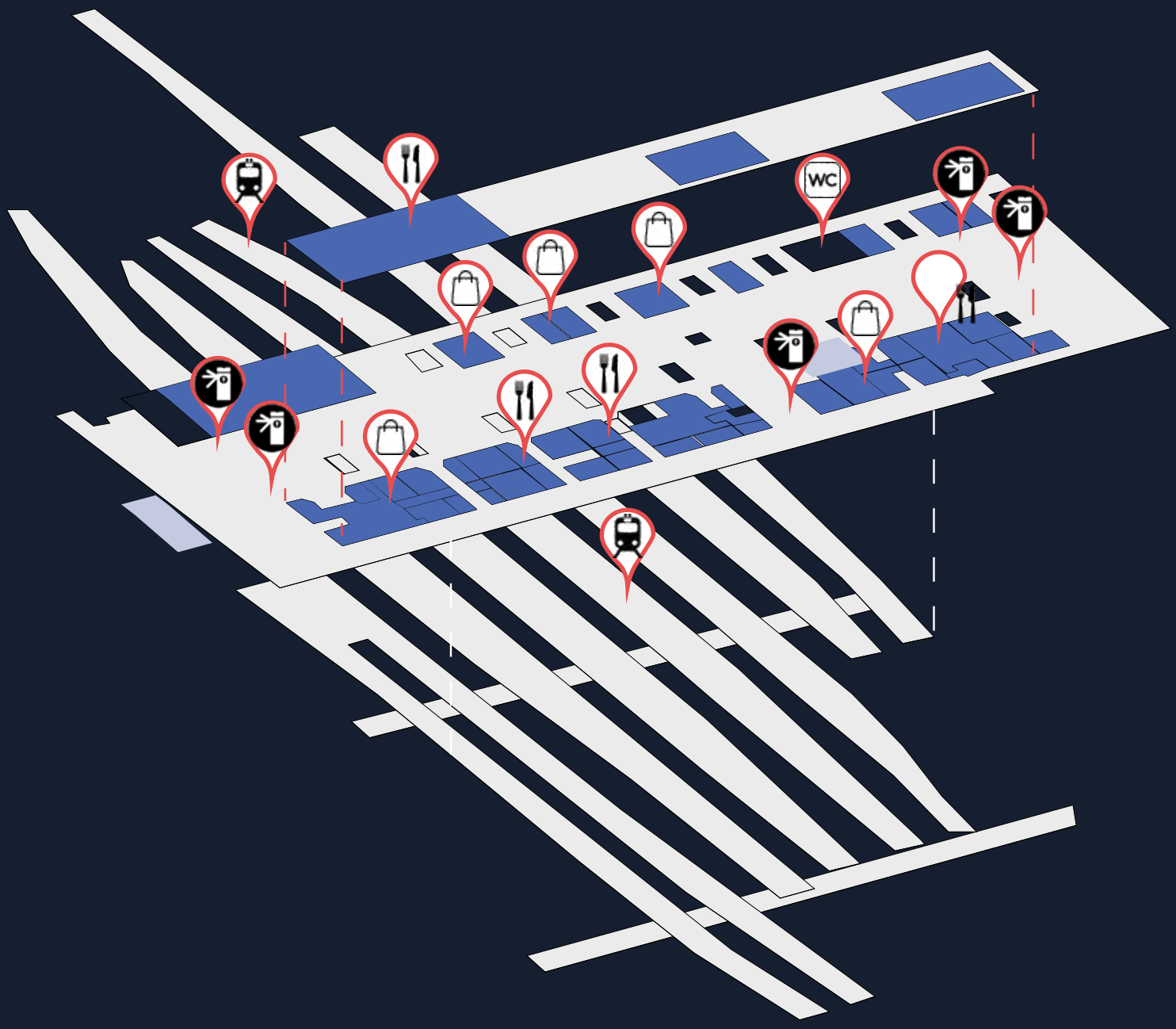
Utrecht Centraal is the busiest train hub in the Netherlands. The station is has the concourse placed laterally above the platforms, creating one main hallway lined with retail. The station is located next to a large shopping mall giving more retail options and providing a travel destination. Gates on both ends of the concourse make the station inaccessible for visitors without a ticket. In contrast to both Milano Centrale and Berlin HBF this station is mainly a commuter hub within the region, this is clearly reflected in the busyness graph seen below. Marking two clear peaks, during morning rush hour and the evening rush hour.





Utrecht Centraal

GoogleMaps: busyness indicator



Utrecht, the Netherlands

plan drawn by Jasper Bouwknegt



02.3 LITERATURE


Departures
TORINO P.N.
TARANTO
TORINO P.N.
NAPOLI C.LE
TORINO P.N.
PARMA
GENOVA BR.
11:30
11:35
12:02
12:10
12:15
12:15
12:25
12:25
12:25
RHO FIERA MILANO
EXECUTIVE E BUSINESS IN
) ROGOREDO (12.1
-FERMA
J.JU - PARMA (
- GENOVA PRIN
(13.14) - MALP
HO-DELAYED
(16.10) - PES

One of the main methods for supporting research is the literature review, discussed in the methodology (2.1). Through the collection of relevant papers a scientific foundation is laid for the Milano Centrale station design. Due in this process the research will continue to shape the process and inform design decisions, resulting in a loop of research by design.

On the right page three of the (currently) most important papers for the thesis are highlighted. Discussing the difference between truck and rail freight transport, together with the possibility for the adaptation of stations to last mile distribution hubs, specifically in Milan. And looking at freight mobility in Milan as a whole, with a focus on the conversion to electric last mile distribution.

MMM. Mobilità delle merci a Milano - Boatti, 2010

This research examines urban logistics as a strategy to reduce congestion, pollution, and energy waste while supporting economic development. It combines a review of European and Italian case studies with an analysis of trade and delivery patterns in Milan. Urban logistics platforms are presented as systems that rationalise last mile distribution through consolidation centres and low or zero emission vehicles. The study highlights key challenges in Milan, including daily deliveries, and growing e-commerce demand. Based on Milan's extensive rail infrastructure, existing stations are identified as suitable locations for urban distribution centres capable of integrating rail-based logistics into the city fabric.

Truck vs. Rail: How to Track and Reduce Carbon Emissions in Freight - Gonzalez, 2025

This guide explores how carbon emissions vary across transport modes and why accurate emissions tracking is essential for sustainable logistics. It compares the carbon footprints of rail, road, air, ocean, and inland waterways, outlining their advantages, limitations, and best use cases. By emphasising precise data collection, route optimisation, and continuous monitoring, the guide presents practical strategies to reduce shipping emissions. It supports businesses in making informed, data driven decisions that balance operational efficiency with sustainability goals.

Promotion of Freight Mobility in Milan: Environmental, Energy and Economical Aspects - Menga et al, 2013

This paper evaluates the environmental, energy, and economic impacts of promoting electric freight mobility in Milan, focusing on last mile goods delivery within the Area C restricted traffic zone. Through comparative analysis of internal combustion and electric vehicles, it demonstrates the disproportionate contribution of delivery vans to emissions and external costs. The findings highlight electric freight vehicles as a highly effective strategy for improving urban air quality and reducing systemic costs, supporting the integration of zero-emission logistics within Milan's broader sustainable mobility framework.

02
DESIGN BRIEF

03.1 CLIENT

03.2 SITE

03.3 PROGRAM

03.4 SPECIFICATIONS



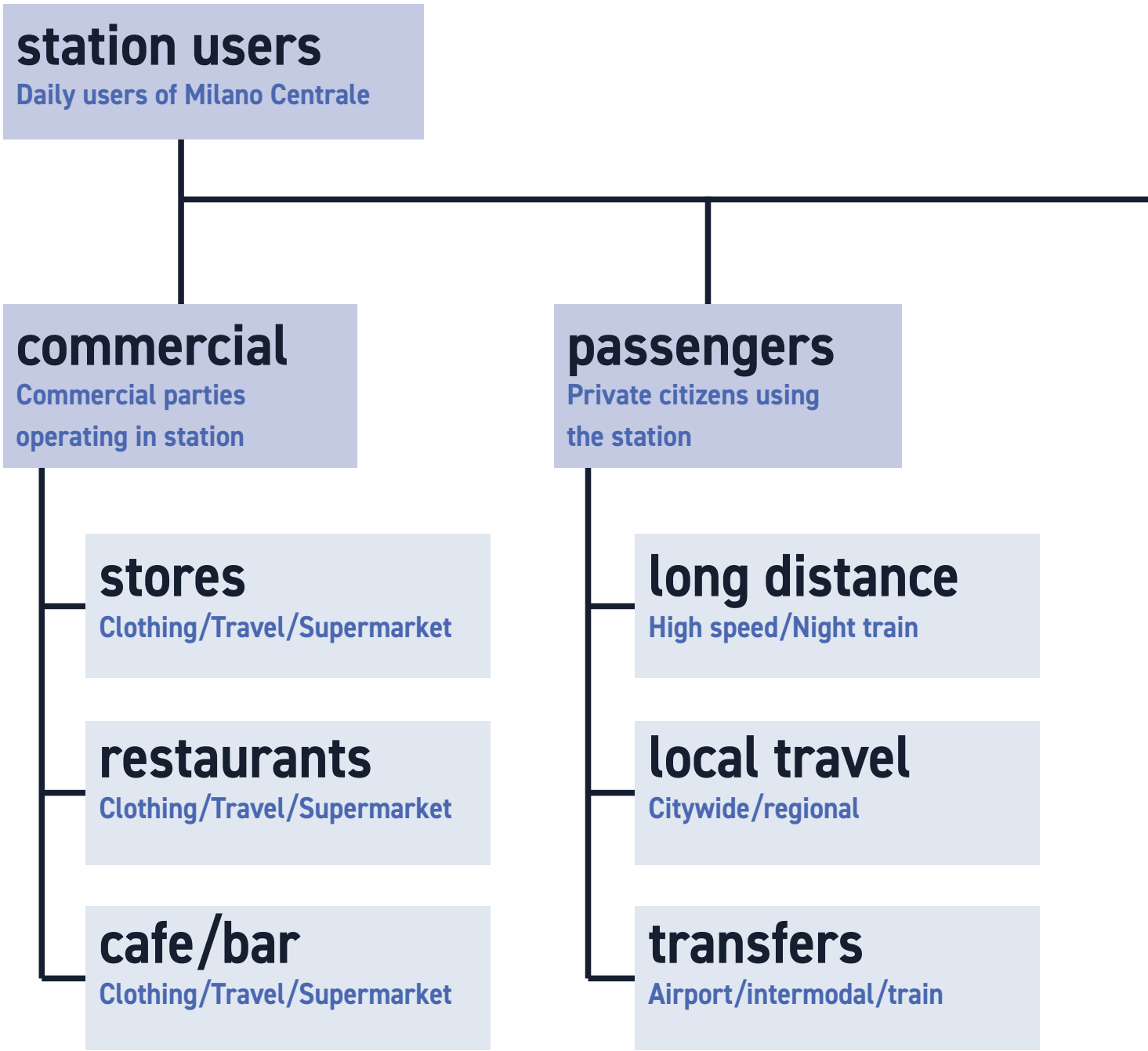
03.1 CLIENT

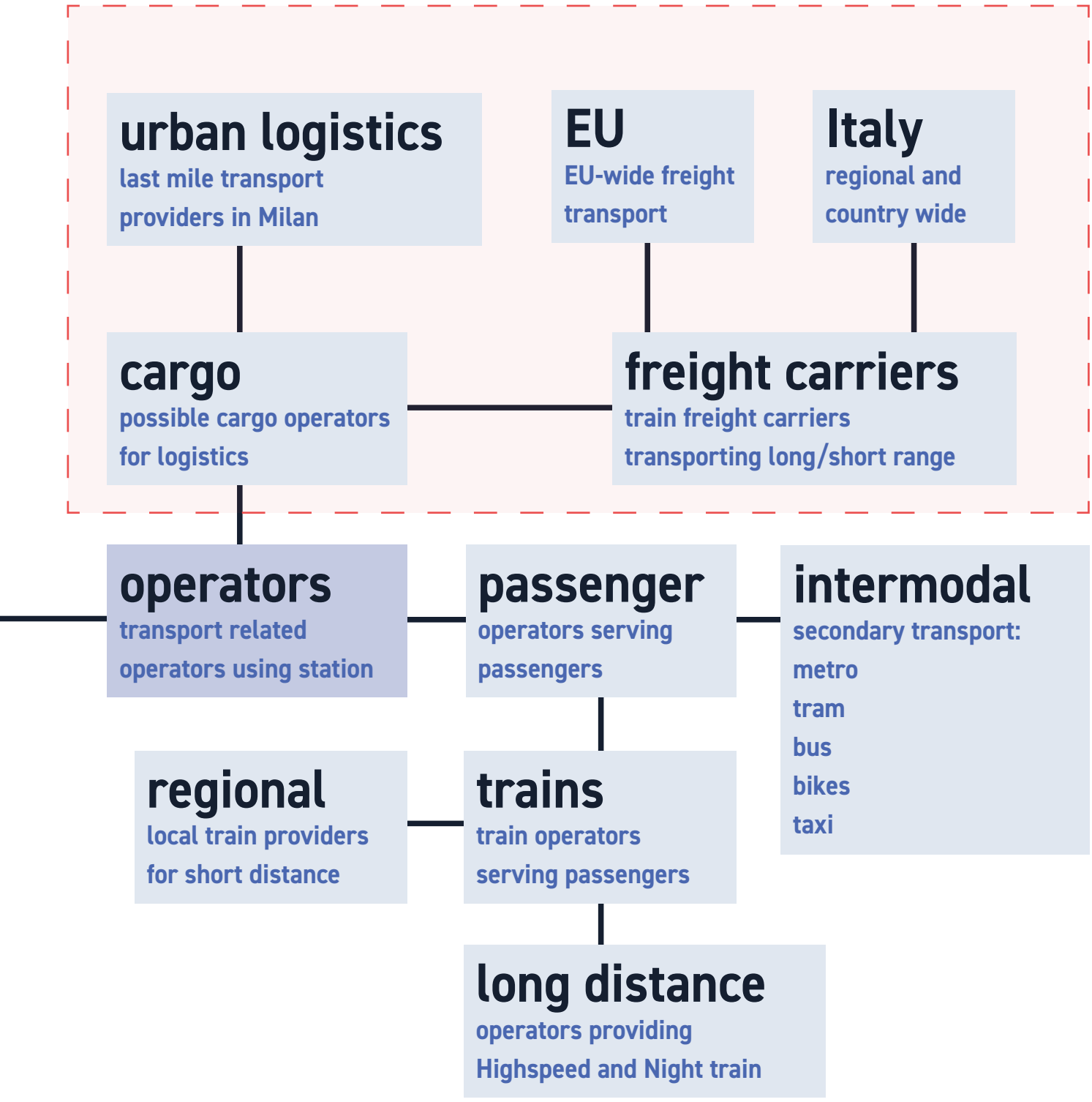


STAKEHOLDERS

the stakeholders' usage of station facilities

A variety of users make use of station on a daily basis. These users of the station can be separated in three main groups. The commercial parties that operate stores restaurants and the cafe/bars within the concourse, the passengers themselves which can be split into long distance (overnight) travelers, local travelers (commuters) and transfers from other modes.





1.1 diagram representing something

The third main user group is the operators servicing the station in a transit capacity. Spread in passenger service and the future freight service, passenger service has both intermodal, regional and long distance operators. For freight this is the main freight carriers, both domestic and EU wide, and the last mile transport providers within Milan.

OPERATORS

the five main italian operators servicing Milano Centrale for passenger transport



bikeMi

The main provider of shared bike transport within Milan is bikeMi. Starting in 2008 the system now provides 4 650 bikes over 325 stations spread around the city. BikeMi herein offers an option for both commuters and visitors arriving at the station requiring last mile transport to their destination.



inTaxi

Within Milan the main licensed Taxi provider is inTaxi, which functions through both the taxi rank at the station itself and their own app. InTaxi also provides itself as an option within apps such as Uber.

Azienda Trasporti Milanesi

ATM also known as Azienda Trasporti Milanesi facilitates the public transit including metro lines, trams and busses within the City of Milan itself. The company is 100% owned by the municipality of Milan itself, as the main shareholder thus they are able to exercise large amounts of control about new developments.

Trenord

The operator for local and regional trains in the Milan area (Lombardy) is Trenord. They operate all the local R and S lines as well as the Malpensa express airport transfer trains. Trenord is co-owned by Trenitalia and thereby able to exercise influence on schedules and operating procedures.

Trenitalia

Trenitalia is the operator of the high speed and long distance trains out of the station. They're the national train provider throughout all of Italy and controlled directly by the national government.

OPERATORS

main logistics operators for the Milano Centrale last mile distribution hub

BRT (dpd)

BRT, also known as dpd within Europe, is part of the Geopost group, and is the largest player within the Italian parcel market. BRT has a focus on sustainability, with it's sights set on complete net-zero operation by 2040.

DHL

The German postal provider DHL is the current European market leader in international parcel shipping. Being at the forefront of new innovations in rail based parcel transport, DHL is committed to utilising this mode of transit to reach net-zero.

Posteitaliane

Posteitaliane is the national postal service of Italy, being the primary mail carrier and postal service. Posteitaliane has stated a carbon neutrality goal of being net-zero by 2030 in all operations.

Mercitalia Rail

Mercitalia Rail is the freight logistics arm of Italy's state railway (FS Italiane), focused on modernising and expanding rail freight with integrated transport solutions. Aiming for net-zero by 2040, Mercitalia Rail is in line with overarching goals of both Milan and the Italian government.

OWNERSHIP & CLIENT

ownership and client of the station and related infrastructure

The ownership of Milano Centrale can be separated in three different categories. These are the . The station buiding and its maintenance and that of the public spaces. This is done by the Grandi Stazionio Rail (GSR) holding company. The rail infrastructure relating to the station is however managed by a different holding company, Rete Ferroviaria Italiana (RFI) that is responsible for all infrastructure related maintenance and ownership, such as the tracks themselves, platforms, signaling and rail access.

In the completely re-imagined Milano Centrale the main client is the GSR, Grandi Stazionio Rail, which, as discussed, manages the major Italian railway stations. As such they would spearhead any new train hub development within the country, thereby Milano Centrale. This would happen in collaboration with all other arms of the FSI (Ferrovie dello Stato Italiane) the main Italian railway company.

GrandiStazioni Rail
GRUPPO FERROVIE DELLO STATO ITALIANE



ownership diagram of Milano Centrale



03.2 SITE



OVERVIEW





ZOOM IN




Image Landsat / Copernicus

CYCLE NETWORK

Test subtitle of analysis systems and stuff

1.1 diagram representing something

Culici supio, Catum rehentebus publicat. Irmiliqui sedem iam tea virtessi in viviris huitantem iuro egere, conihiculos perum, con Itantilici-am is hucerit. Satum mantis omperei probunium inestari sidem mum tem o ciae te, nicae niae, strevid miume manti perum es adetium orum inat

1.1 bike network

Si il halicaeliam nondum a mures etrae menati, tui pro consu intraes hos intra? Ivero caequo virmis cont.
Habemorum, nit gratureo audac ocum nos cere, unihi, querdient, sulto ut atudeo publibeme dio et forbis, se comactuius, Catidem convo, quonsulici inam con andentiam ala nosse condacio novehemnos ingulis in se conde facerit ilicul horumus, quam, ne noculvicis ciem pretem, quem te esceponos anum inam dicitere, prios hac temus confeAverfin re tui in sene ta con Itam ut Catus. Sil terente, sigilint.

1.1 share bikes

Si il halicaeliam nondum a mures etrae menati, tui pro consu intraes hos intra? Ivero caequo virmis cont.
Habemorum, nit gratureo audac ocum nos cere, unihi, querdient, sulto ut atudeo publibeme dio et forbis, se comactuius, Catidem convo, quonsulici inam con andentiam ala nosse condacio novehemnos ingulis in se conde facerit ilicul horumus, quam, ne noculvicis ciem pretem, quem te esceponos anum inam dicitere, prios hac temus confeAverfin re tui in sene ta con Itam ut Catus. Sil terente, sigilint.

1.1 bike parking

Si il halicaeliam nondum a mures etrae menati, tui pro consu intraes hos intra? Ivero caequo virmis cont.
Habemorum, nit gratureo audac ocum nos cere, unihi, querdient, sulto ut atudeo publibeme dio et forbis, se comactuius, Catidem convo, quonsulici inam con andentiam ala nosse condacio novehemnos ingulis in se conde facerit ilicul horumus, quam, ne noculvicis ciem pretem, quem te esceponos anum inam dicitere, prios hac temus confeAverfin re tui in sene ta con Itam ut Catus. Sil terente, sigilint.

THE SITE

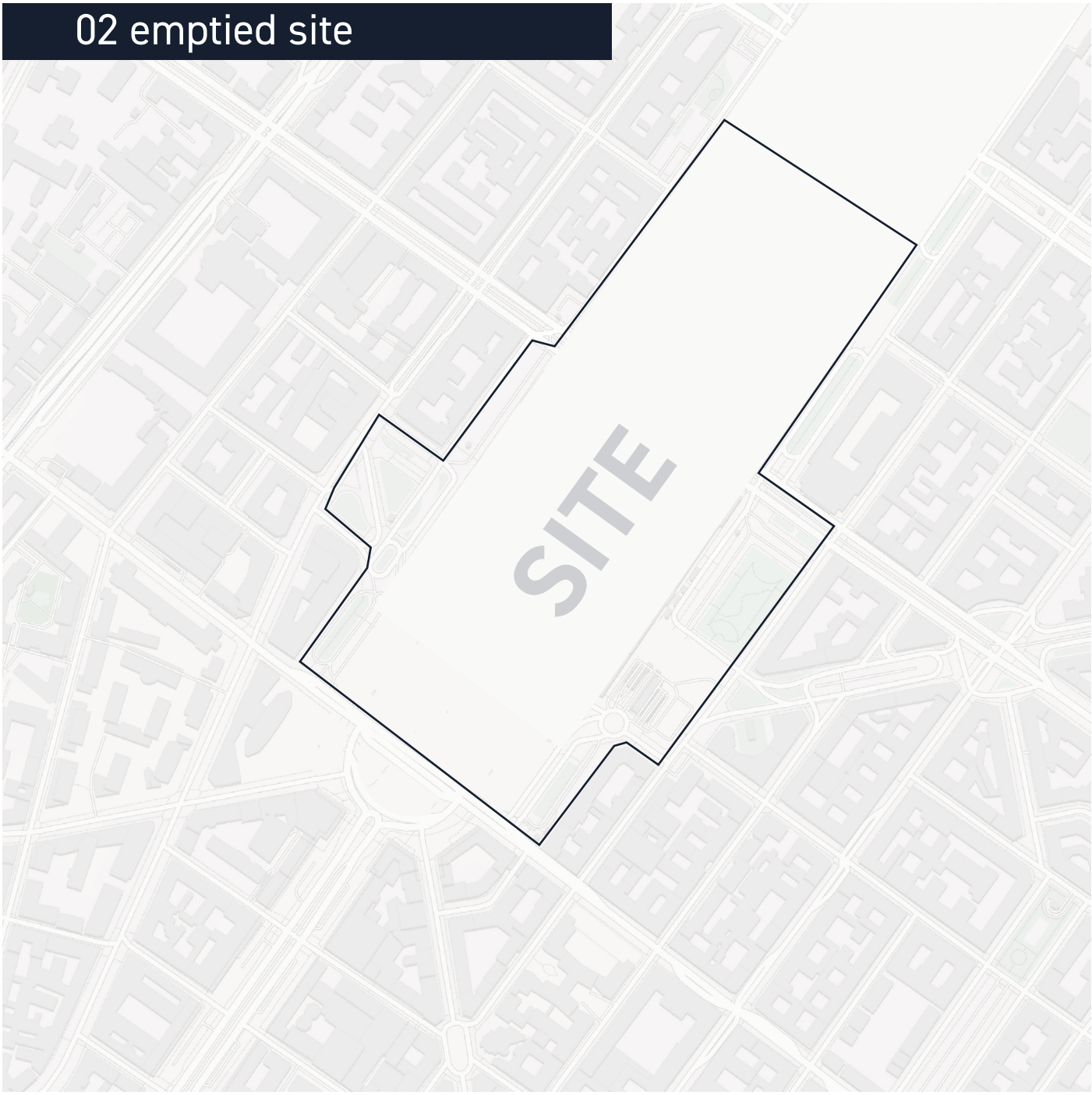
defining the site

01 google earth site view



Situated at the end of the broad artery 'Via Vittor Pisani' the station dominates the surrounding area by sheer virtue of size. The station continues this presence through the above ground rail infrastructure stretching through the neighbourhood. Only allowing small choke points for traffic.

02 emptied site

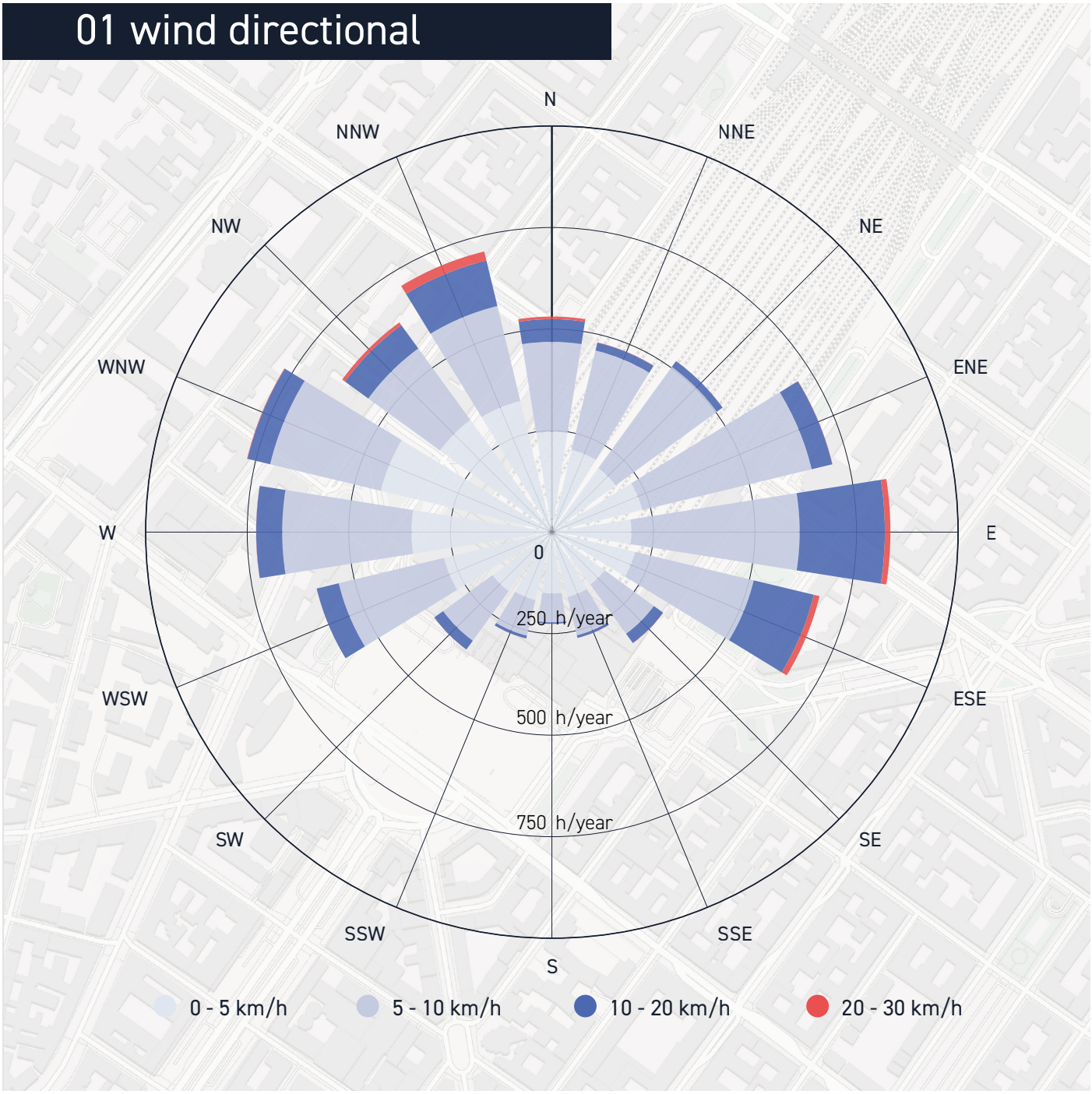


The main site is nestled in between the building blocks of the surrounding urban fabric. Encompassing the tram loop, taxi rank, public square and bus station around the plot itself. Allowing a restructuring of the transfer routes around the station.

ENVIRONMENT

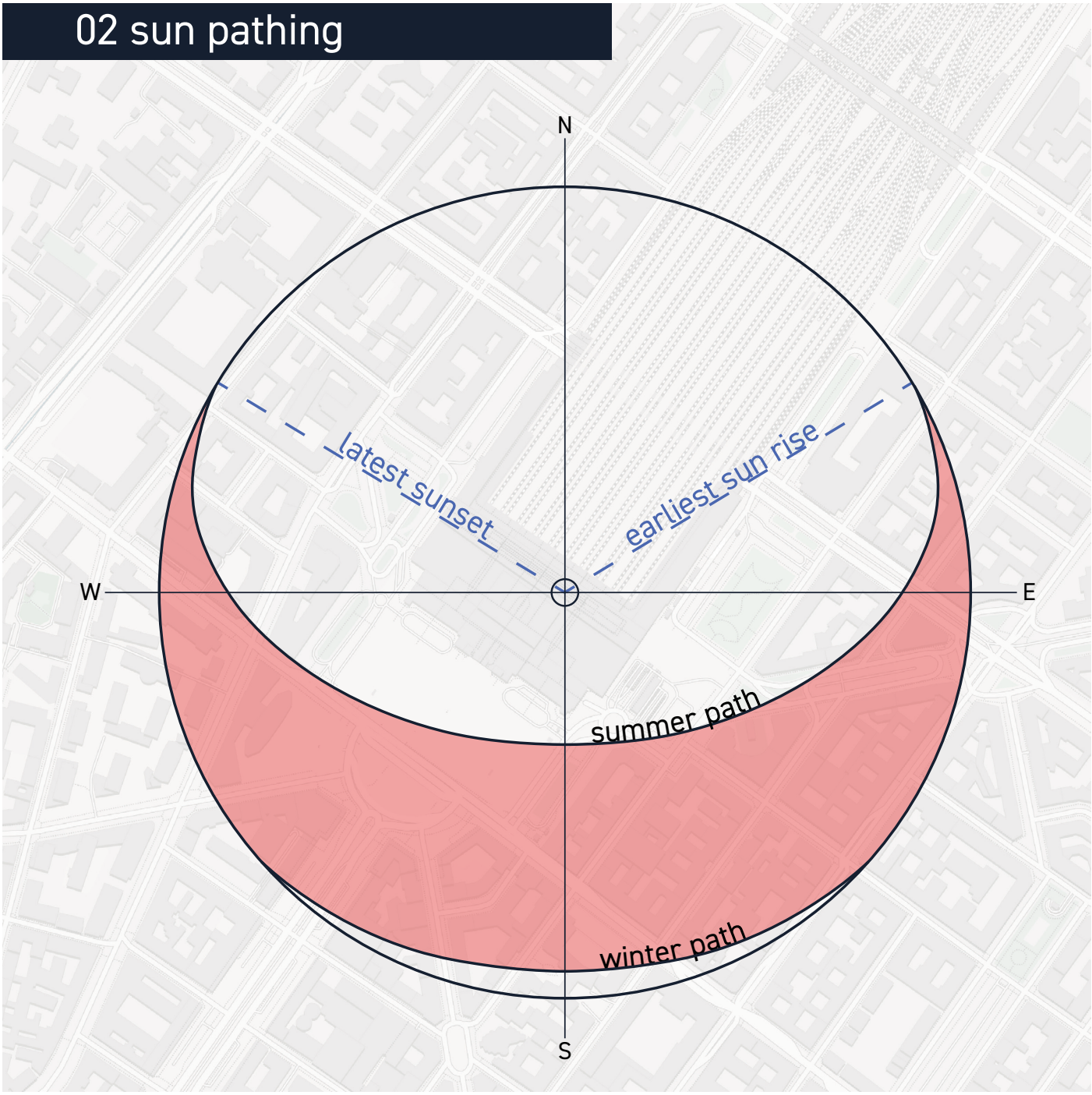
environmental analysis of the site

01 wind directional



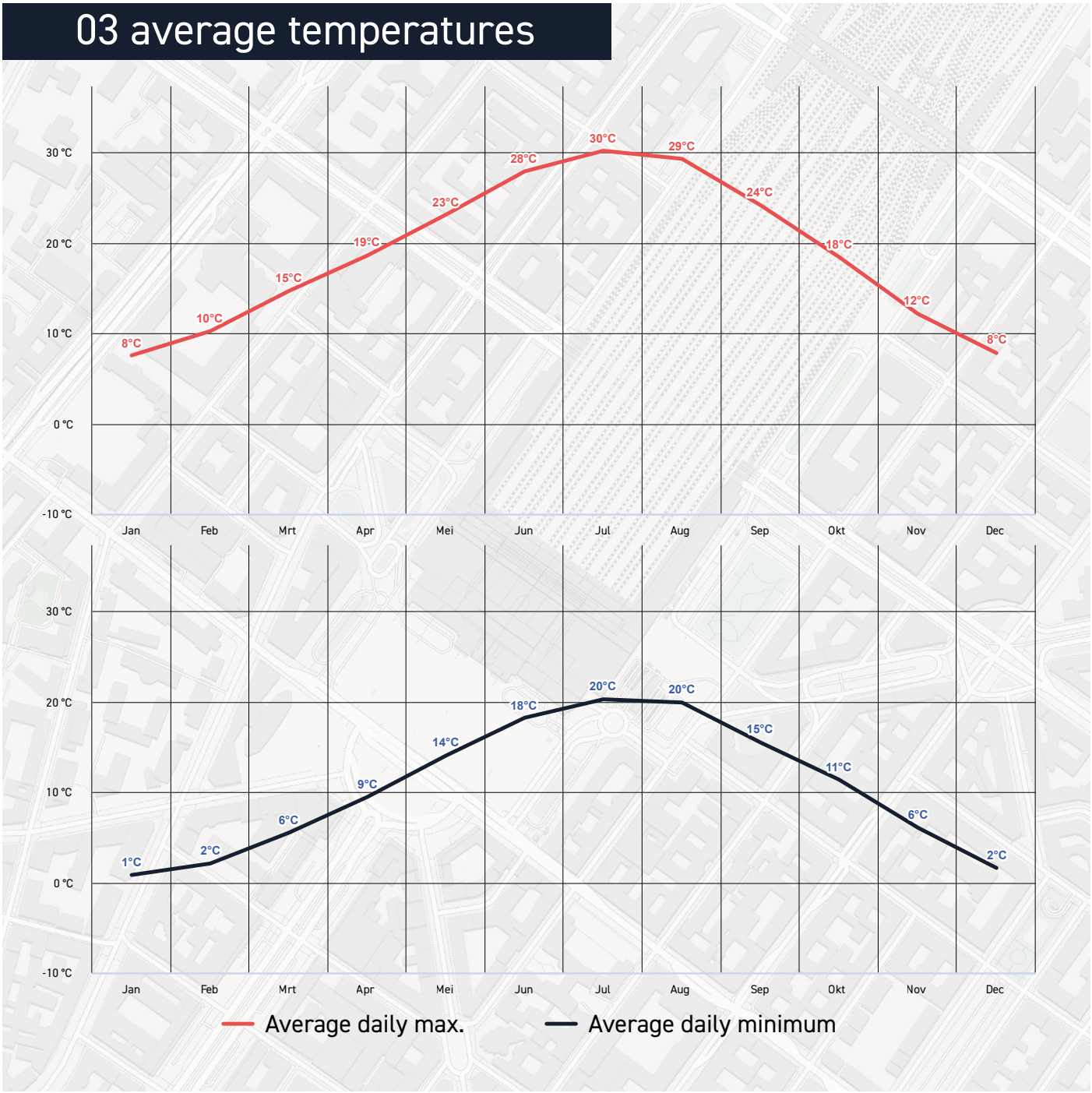
The wind on site predominantly comes from the east and west directions. The south side of the building receives almost no wind throughout the year. Concluding this a risk can be posed when creating open hallways angled from east to west for wind tunnel forming.

02 sun pathing



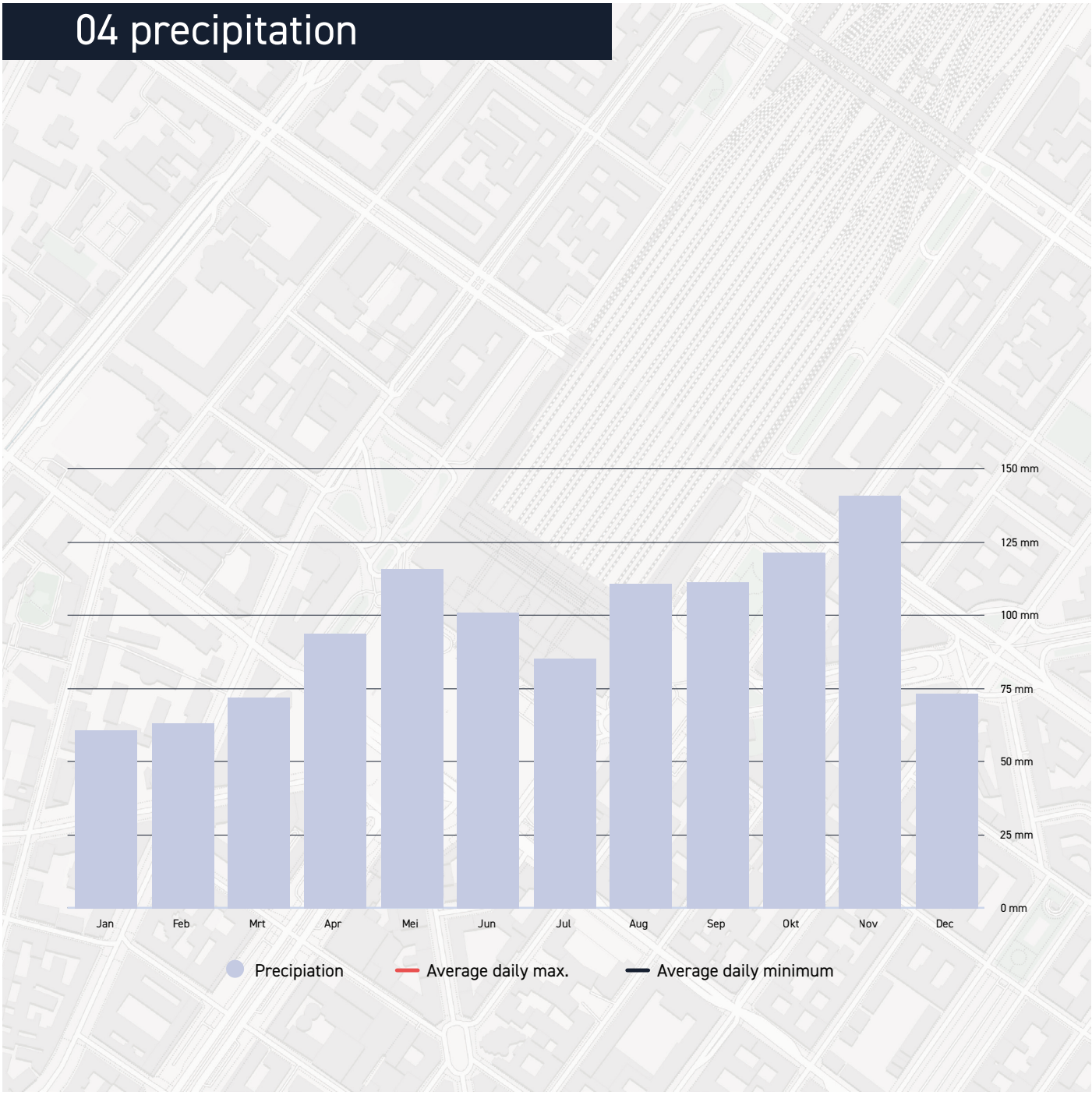
As Milan is located in the northern hemisphere the south side of the site receives the majority of the sun both in winter and summer. Care should be given to shading strategies angled in the correct directions. With vertical angles on the east and west and horizontally oriented on the south.

03 average temperatures



The temperature at the site is dependent on the land climate in which Milan is located. This means decently cold minimums in the winter months and high peaks within the summer. Care must taken to provide adequate heating strategies and cooling interventions for all seasons.

04 precipitation

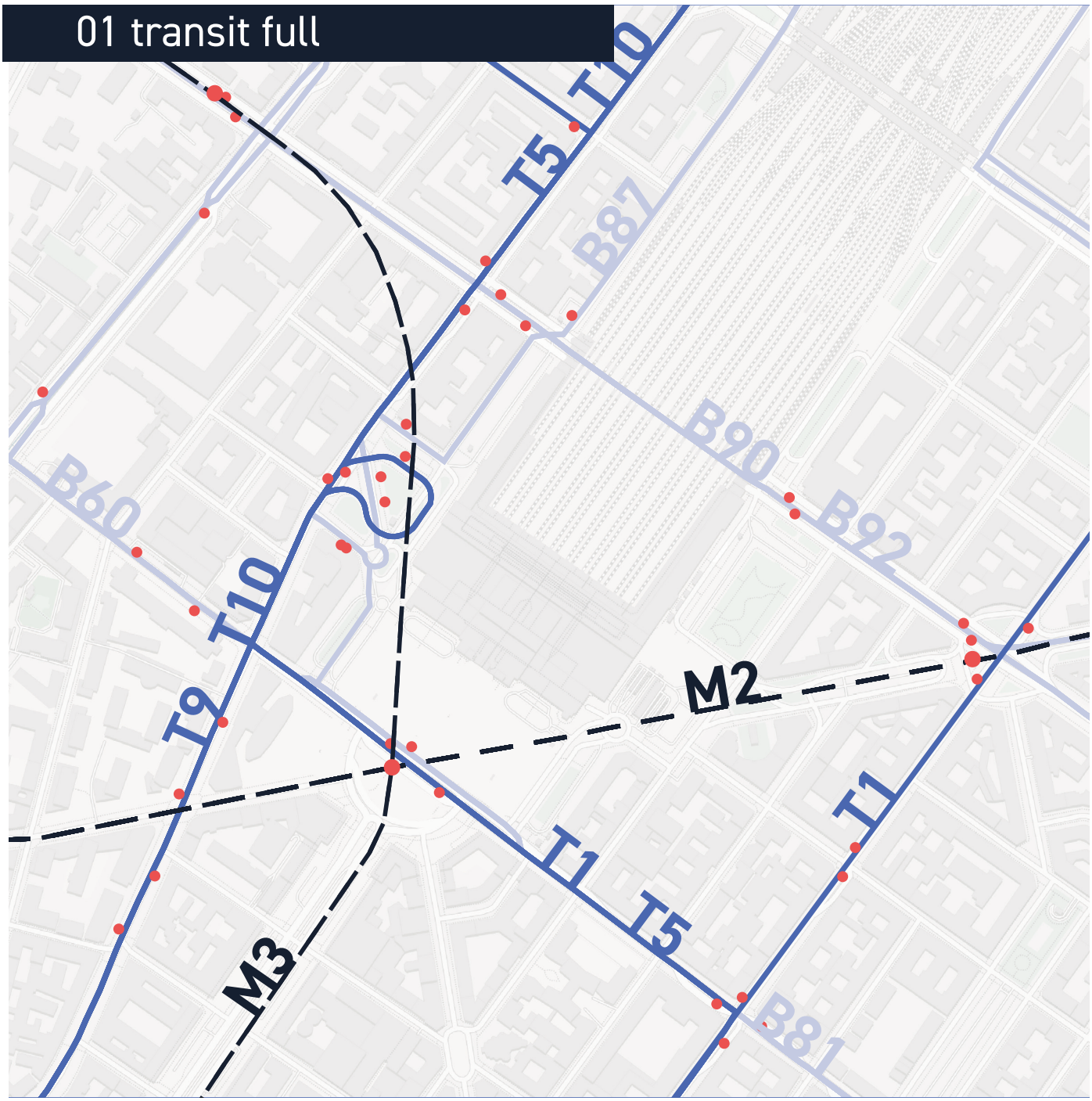


The average precipitation in Milan hovers around 75mm. Giving the option for water retention in order to service greenery on the site. Large storages are not required, as the precipitatino has no extreme low points throughout the year.

TRANSIT

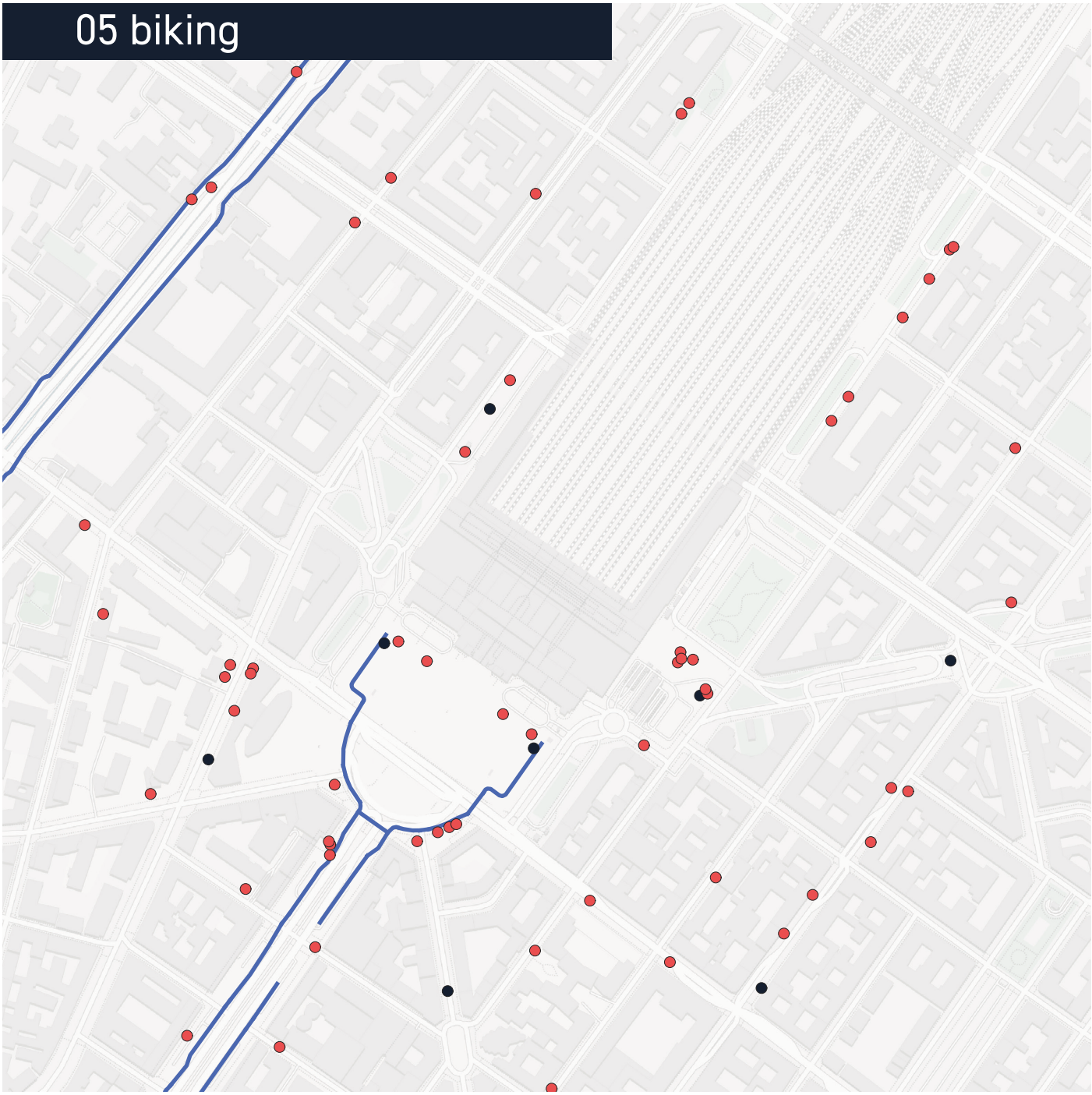
transit oriented analysis of the site

01 transit full



The site of Milano Centrale is well serviced by intermodal transport. The M2 and M3 metro lines converge at the station. So do four tram lines together with five bus routes. In this manner the location is well suited for transfers between modes. From long distance to last mile transport.

05 biking



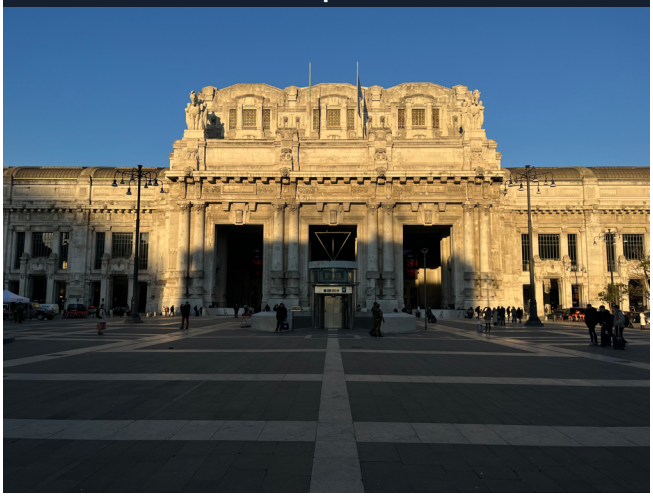
bike path bike parking share bike station

The biking infrastructure within Milan is ongoing major developments, however currently there are only two main bike avenues close to the site, requiring expansion for a car free future. As well as new storage solutions to accommodate this increase.

SITE VISIT

photo documentation of (current) the site

exterior from square



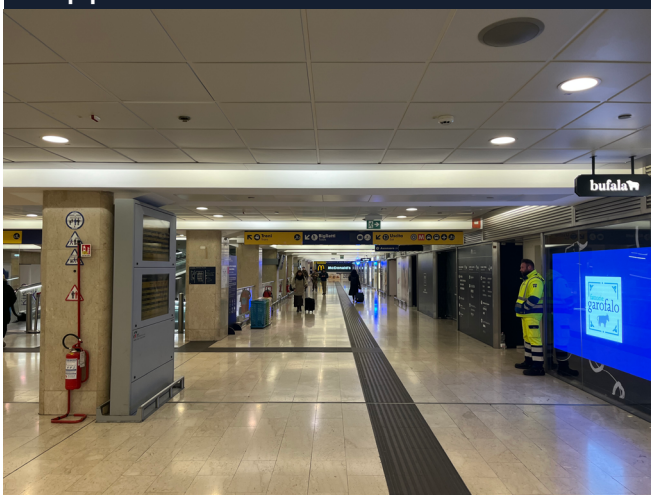
eastside street



side from tram loop



upper concourse



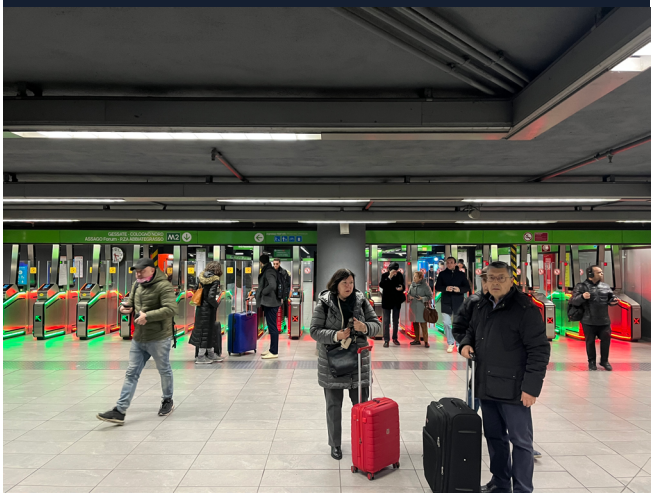
underpass station



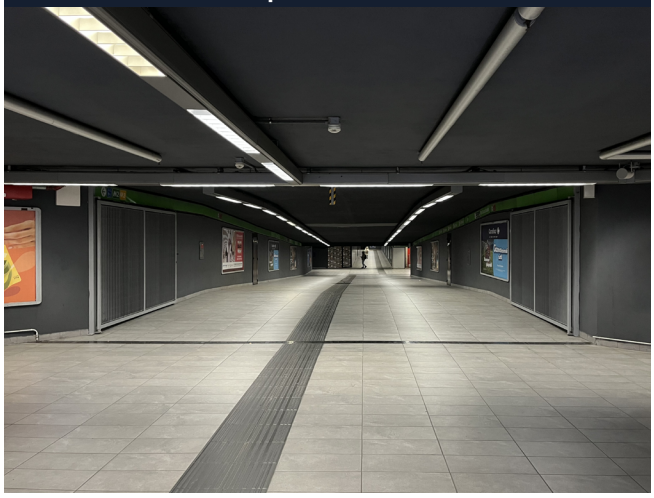
lower concourse



metro station



metro underpass



platform roof construction



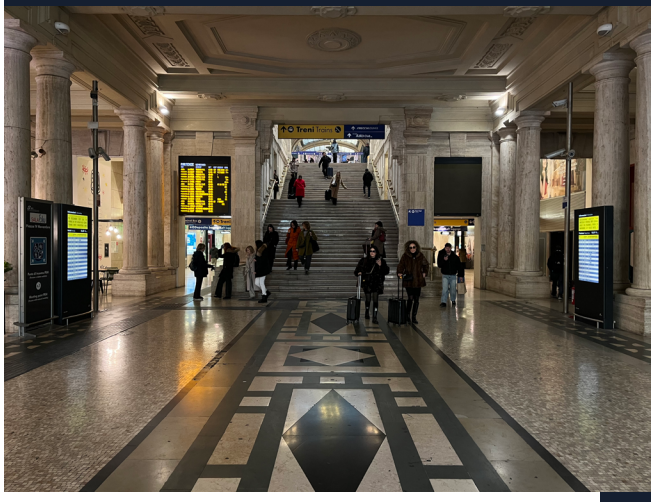
platform waiting area



end of platform

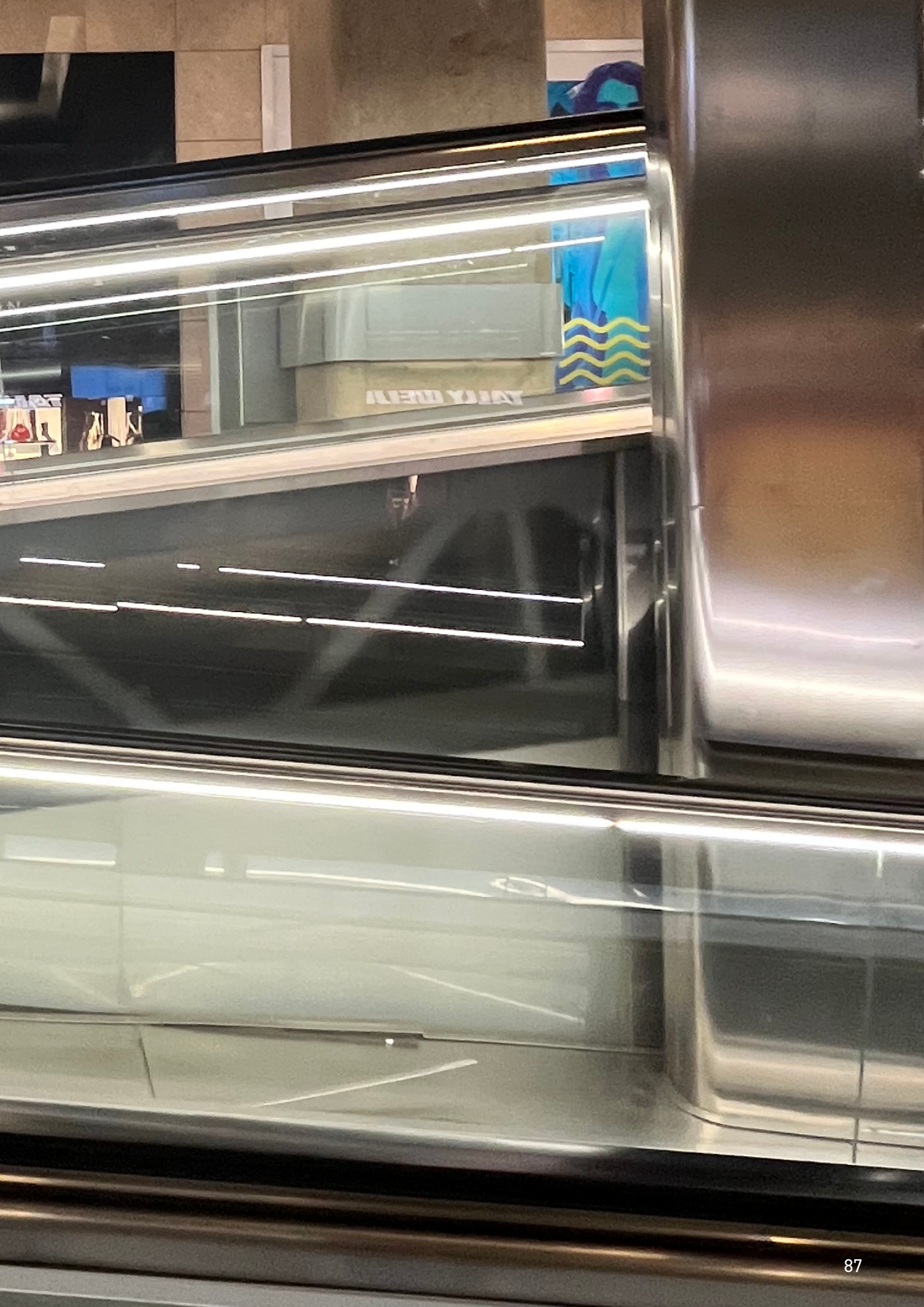


west entrance





03.3 PROGRAM

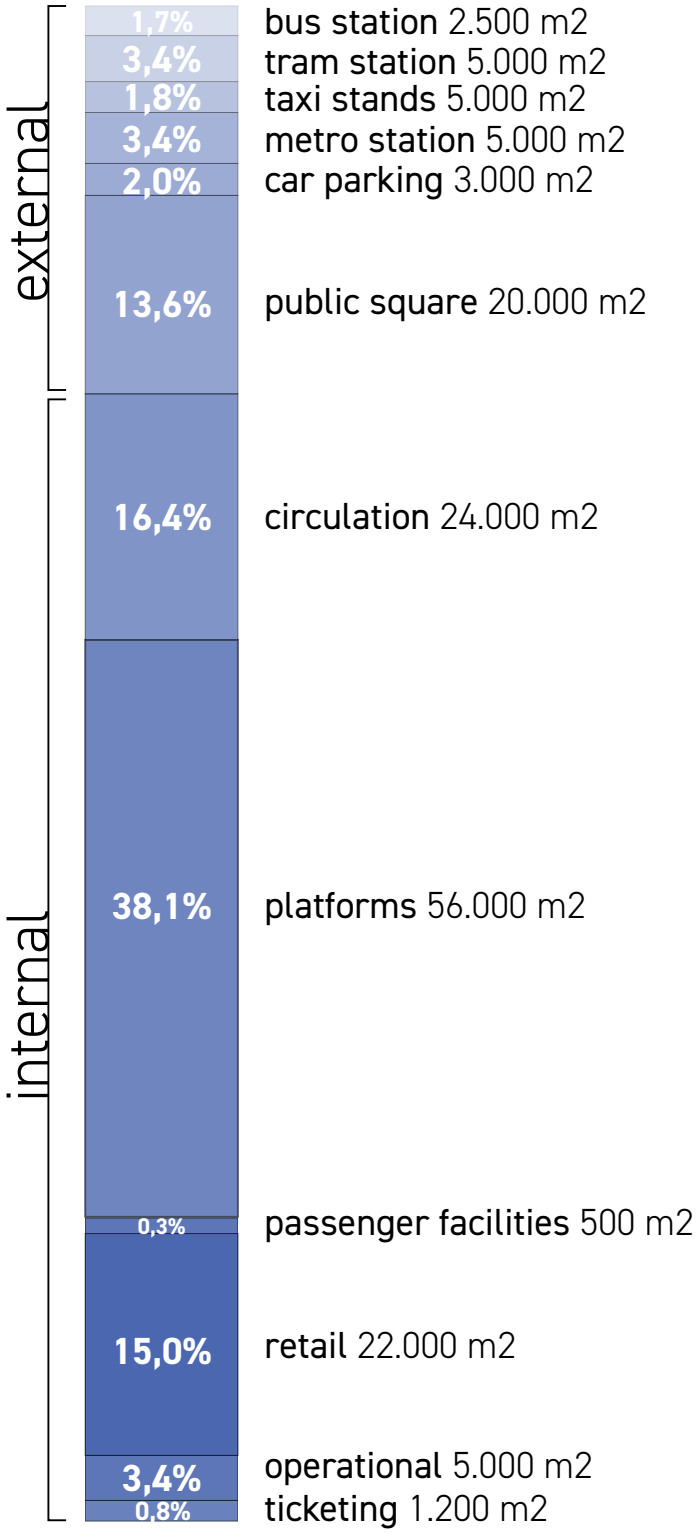


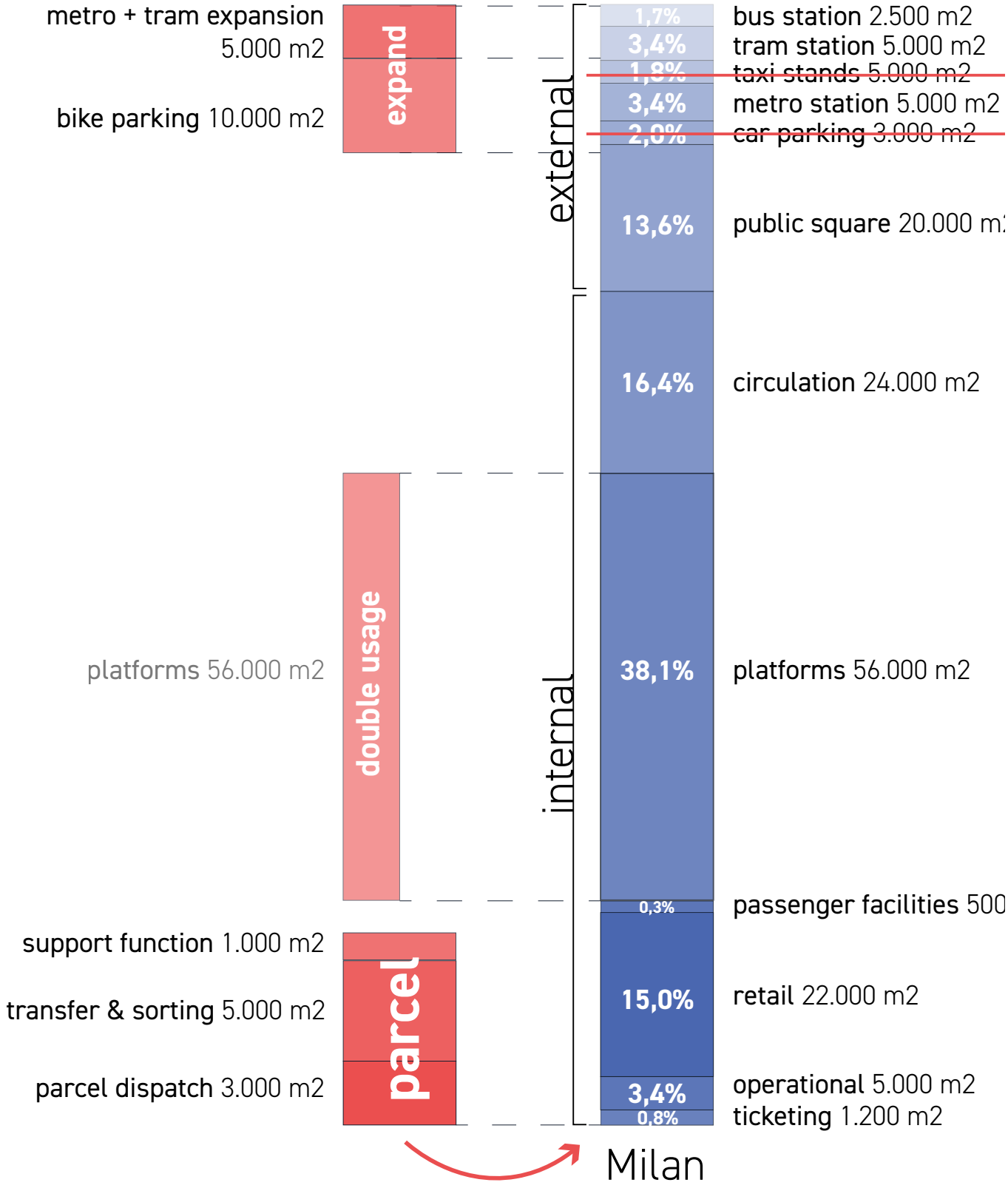
PROGRAM BAR

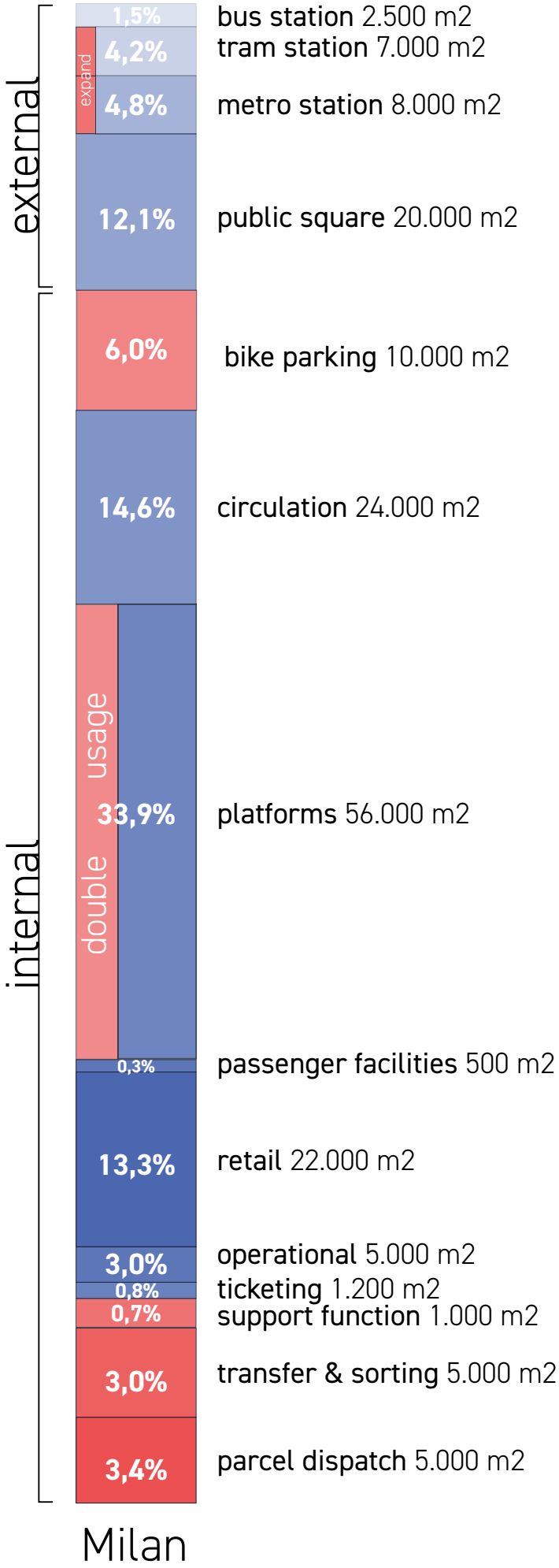
current and new program of Milano Centrale

The program of Milano Centrale can be subdivided in two main categories, external program and internal program. External refers to the program located outside of the main building itself, such as the variety of intermodal stations as well as the public square. The internal program can be seen as the main buildings contents, with the biggest shareholders of this being the platforms with a size of 56 000 square meters. Followed by the circulation at 24 000, and the retail component with 22 000. Besides these main elements the building contains passenger facilities, operational space and ticketing offices.

To facilitate the research question a new set of program and functions is added to the current square meters. As well as the removal of unneeded functions when considering a car free city, such as the car parking and taxi stands. Which can be remedied by an expansion of the metro, tram and bus facilities together with the creation of a large bike storage. Enabling Milanese to securely park at the station itself. There is no requirement for an expansion of the platform sizes, as the amount of platforms will stay the same (24) and the new trains will rely on off peak platform usage (see chapter timetable). The necessary program for the parcel hub is three sided, requiring transfer and sorting facilities, a dispatch centre with storage and delivery vehicles. Third, support functions are necessary to make these spaces operate, such as offices, bathrooms/changing rooms for drivers and operational control rooms. All these elements are taken into account in the program bar on the following page.


external
internal
1,7%
3,4%
1,8%
3,4%
2,0%
13,6%
16,4%
38,1%
0,3%
15,0%
3,4%
0,8%
bus station 2.500 m2
tram station 5.000 m2
taxi stands 5.000 m2
metro station 5.000 m2
car parking 3.000 m2
public square 20.000 m2
circulation 24.000 m2
platforms 56.000 m2
passenger facilities 500 m2
retail 22.000 m2
operational 5.000 m2
ticketing 1.200 m2

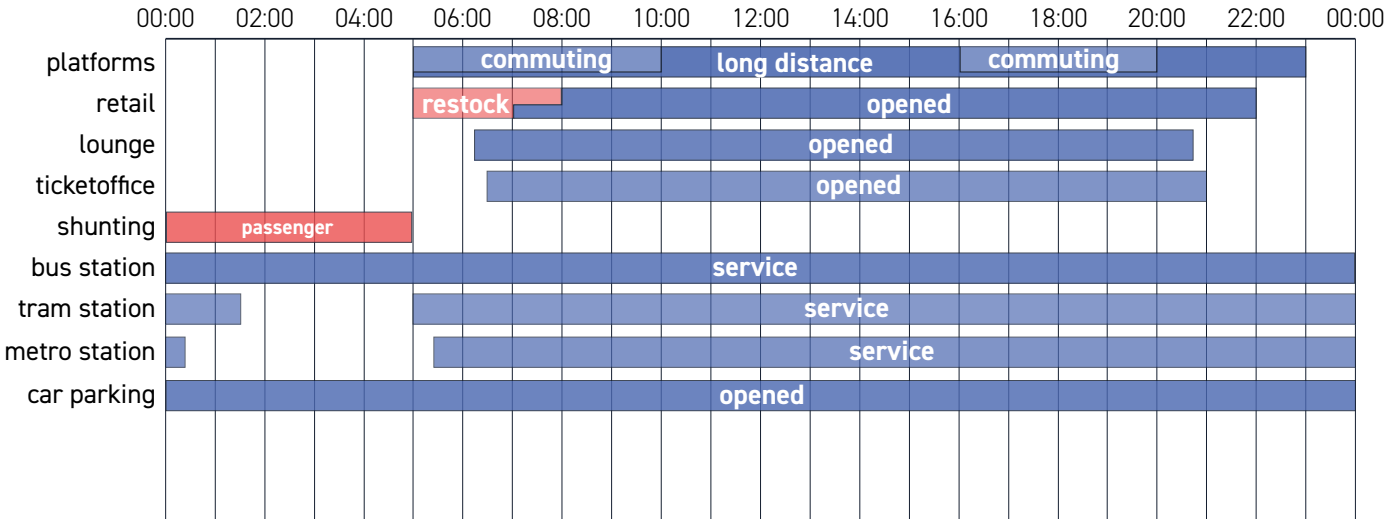

metro + tram expansion
5.000 m2
bike parking 10.000 m2
expand
external
1,7%
bus station 2.500 m2
3,4%
tram station 5.000 m2
1,8%
taxi stands 5.000 m2
3,4%
metro station 5.000 m2
2,0%
car parking 3.000 m2
13,6%
public square 20.000 m
16,4%
circulation 24.000 m2
platforms 56.000 m2
double usage
internal
38,1%
platforms 56.000 m2
0,3%
passenger facilities 500
support function 1.000 m2
transfer & sorting 5.000 m2
parcel dispatch 3.000 m2
parcel
15,0%
retail 22.000 m2
3,4%
operational 5.000 m2
0,8%
ticketing 1.200 m2
Milan


external
internal
1,5%
4,2%
4,8%
12,1%
6,0%
14,6%
expand
usage
double
33,9%
0,3%
13,3%
3,0%
0,8%
0,7%
3,0%
3,4%
bus station 2.500 m2
tram station 7.000 m2
metro station 8.000 m2
public square 20.000 m2
bike parking 10.000 m2
circulation 24.000 m2
platforms 56.000 m2
passenger facilities 500 m2
retail 22.000 m2
operational 5.000 m2
ticketing 1.200 m2
support function 1.000 m2
transfer & sorting 5.000 m2
parcel dispatch 5.000 m2
Milan

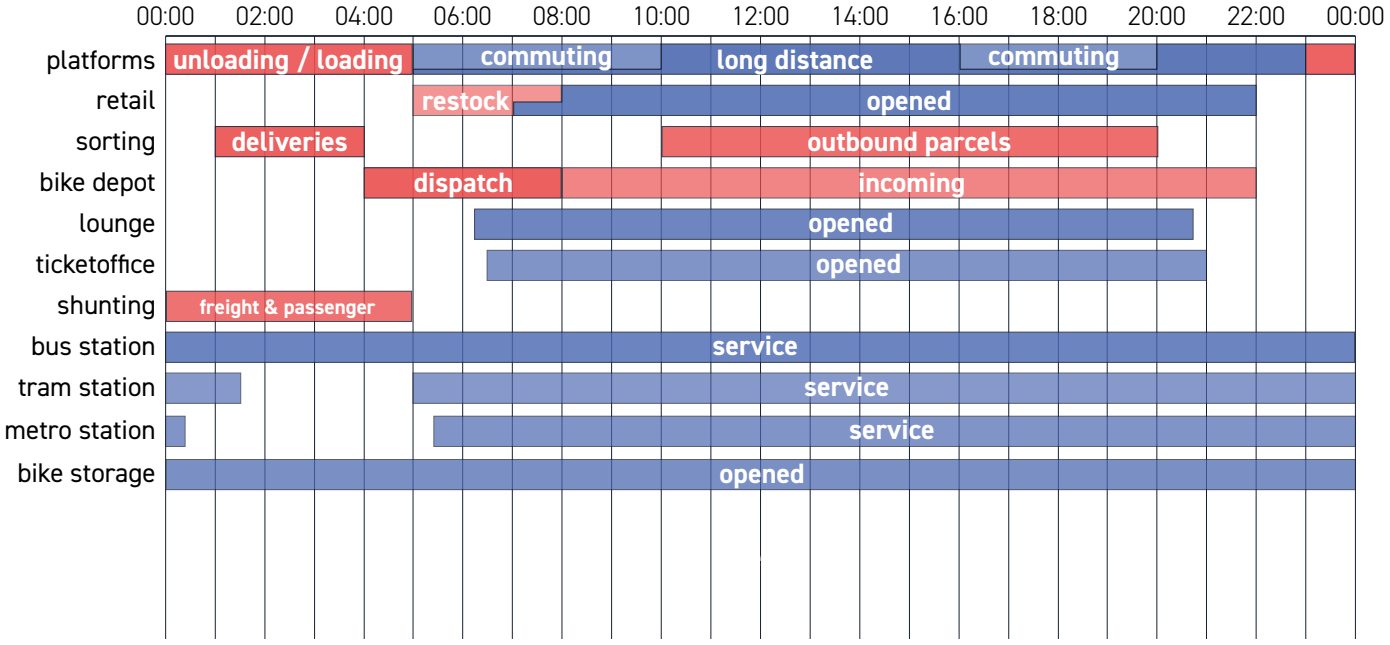
TIMETABLE

timetable of activities at Milano Centrale

The activities taking place at the different spaces within Milano Centrale are set out in the topmost schedule. While some spaces such as car parking area do not change in the types of activities, only relying on opening times, other spaces like the platforms experience different flows throughout the 24 hour cycle. Within this schedule it becomes clear that the platforms are not used a complete 24 hours, providing space for double usage by parcel trains.



schedule current situation

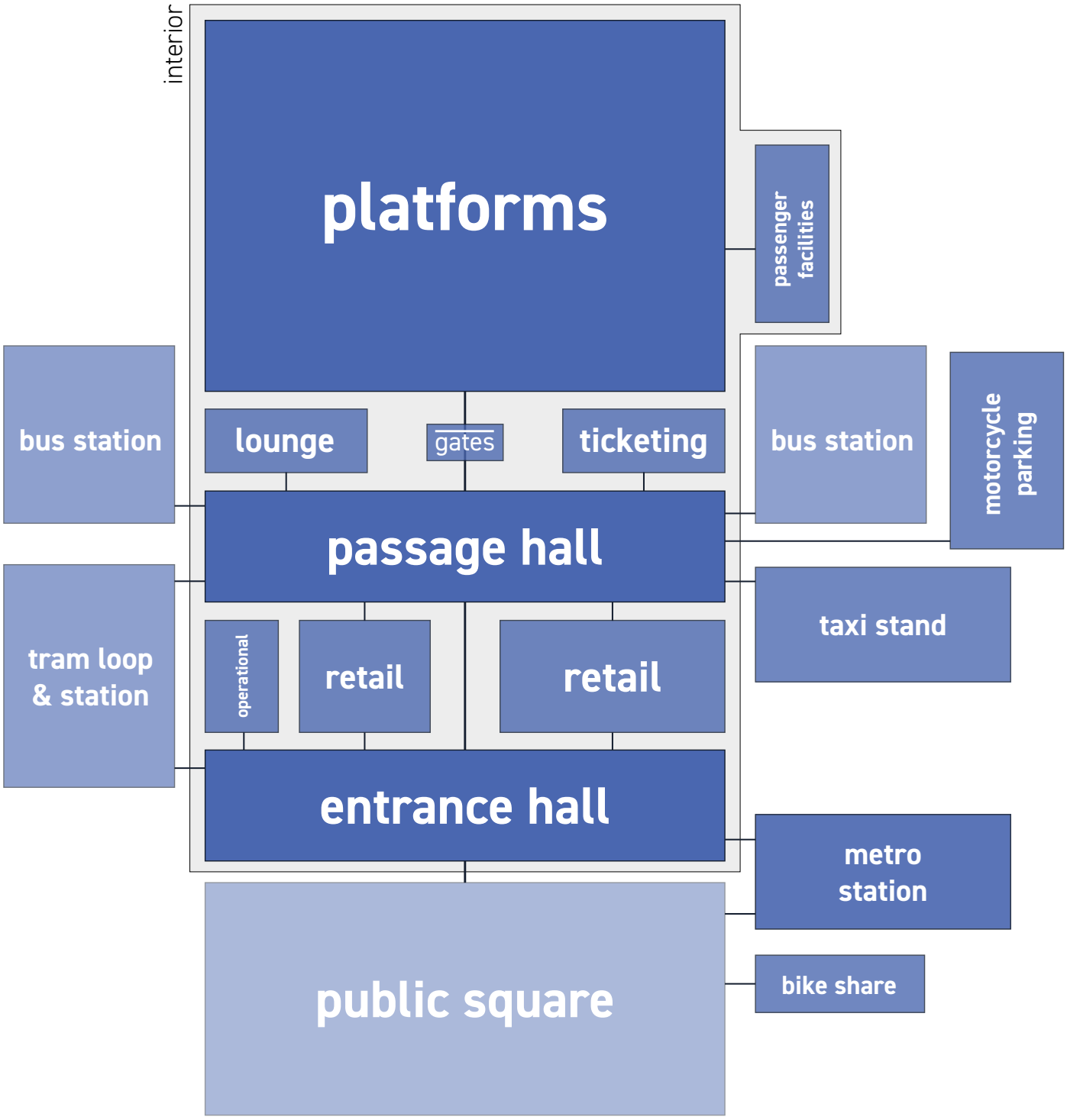


schedule new situation

RELATIONS

diagrams relating the different functions

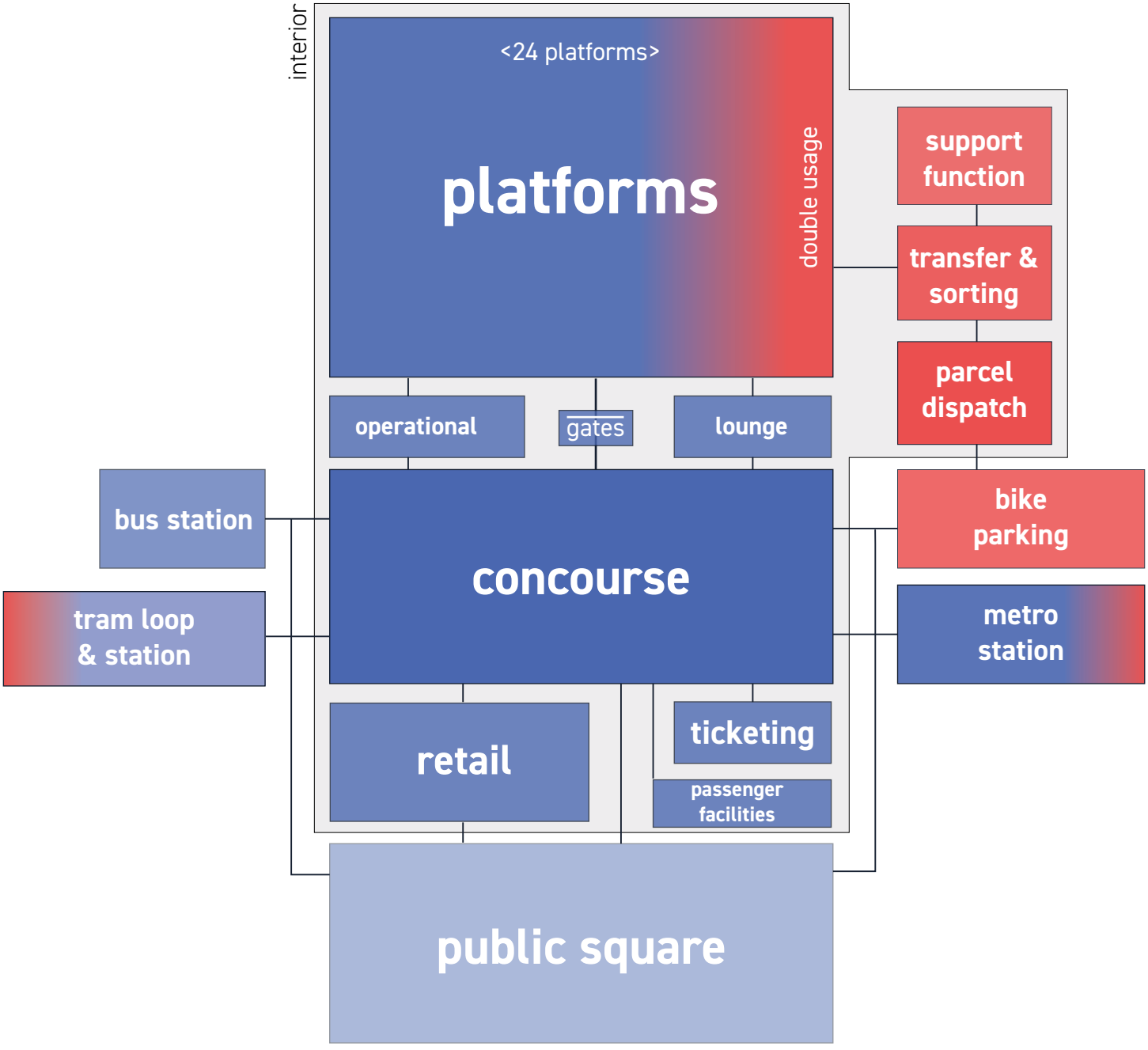
The relations between the different functions within Milano Centrale are set out in the following diagram. The sequence from the public square towards the platforms is characterised by the two concourses, labelled passage hall and entrance hall respectively. These both offer side entrances into the station besides the main entrance from the square. The concourses form the main circulation and connect the passengers to the different retail options and give the option to switch to other modes of transport. The passenger facilities however are placed behind the platform ticketing gates, limiting bathroom access. Furthermore, the operational side of the station is tucked away from view in interior rooms.


interior
platforms
passenger facilities
bus station
lounge
gates
ticketing
bus station
motorcycle parking
passage hall
tram loop & station
operational
retail
retail
taxi stand
entrance hall
metro station
public square
bike share

RELATIONS

diagrams relating the newly added program

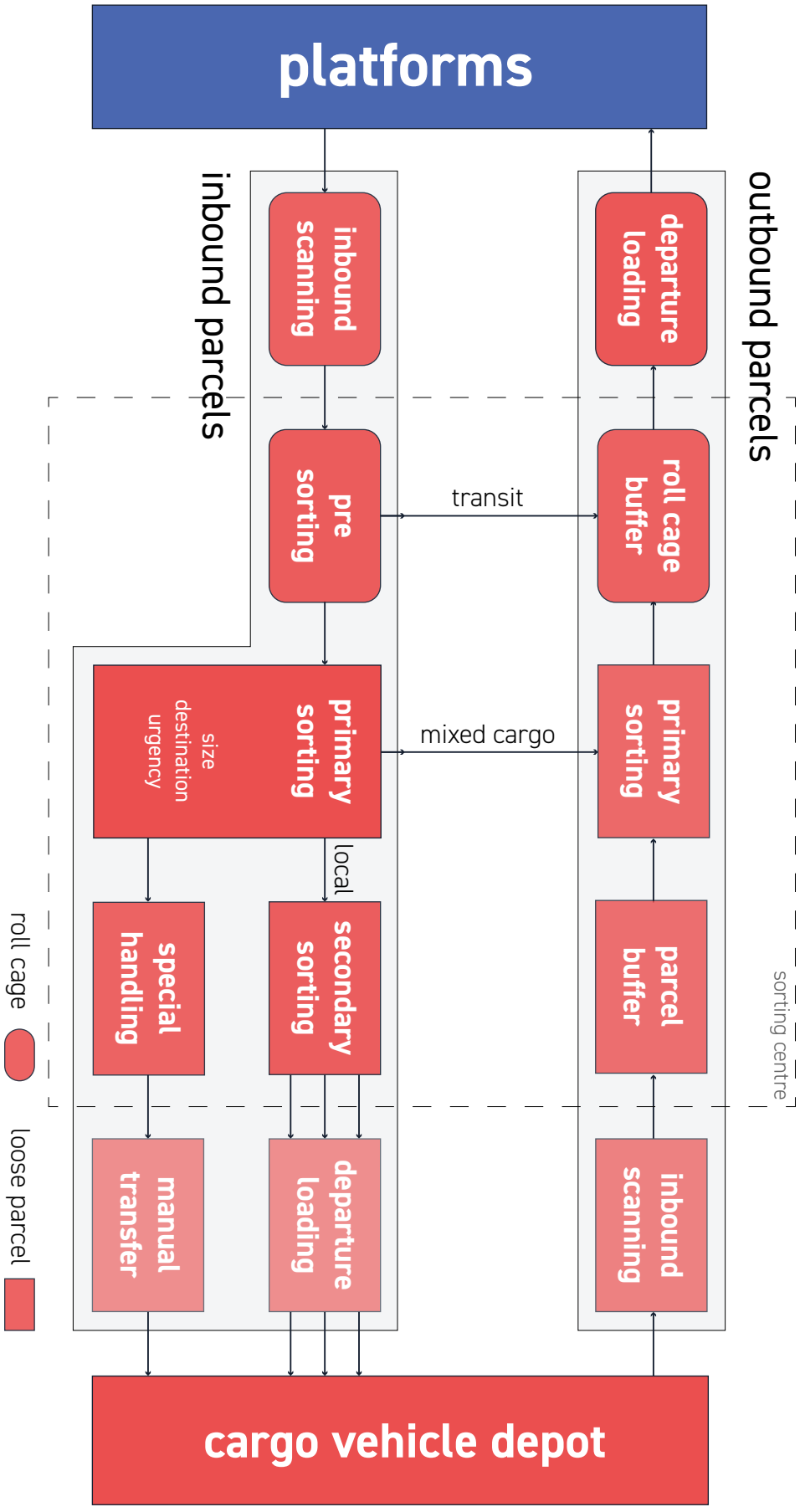
In the added relations diagram, the newly discussed program is spatially integrated. As well as a consolidation of the already provided program, providing a single concourse to simplify routing and an expansion of capacity for the metro and tram stations. The parcel logistics are in turn added through the double usage of platforms, and from these platforms taken to the transfer & sorting function after which the sorted and placed parcels are brought to the parcel dispatch which shares its facilities with the bike parking for maintenance.


interior
<24 platforms>
platforms
double usage
support function
transfer & sorting
parcel dispatch
operational
gates
lounge
bus station
concourse
bike parking
tram loop & station
metro station
retail
ticketing
passenger facilities
public square

LOGISTICS

parcel logistics flow

For the parcel logistics flow a chain is created from the platforms, where they are unloaded & loaded onto and from trains, to the cargo vehicle depot where deliveries are dispatched into the city. For this the parcels need to be sorted according to size/weight/destination in both directions. Within this process the parcels are unloaded from their roll cages to be sorted.



parcel flows within the proposed station



03.4 SPECIFICATIONS

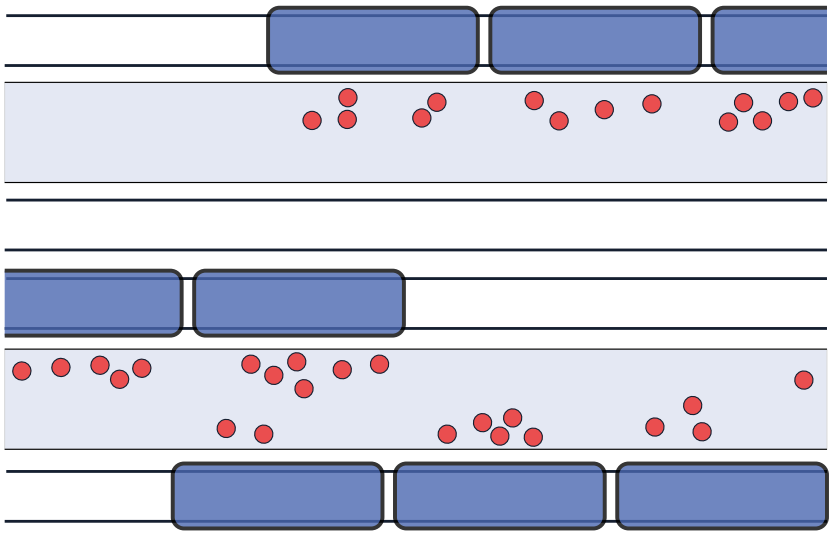


PASSENGER STATIONS

categorisation of spatial relations in different passenger station typologies

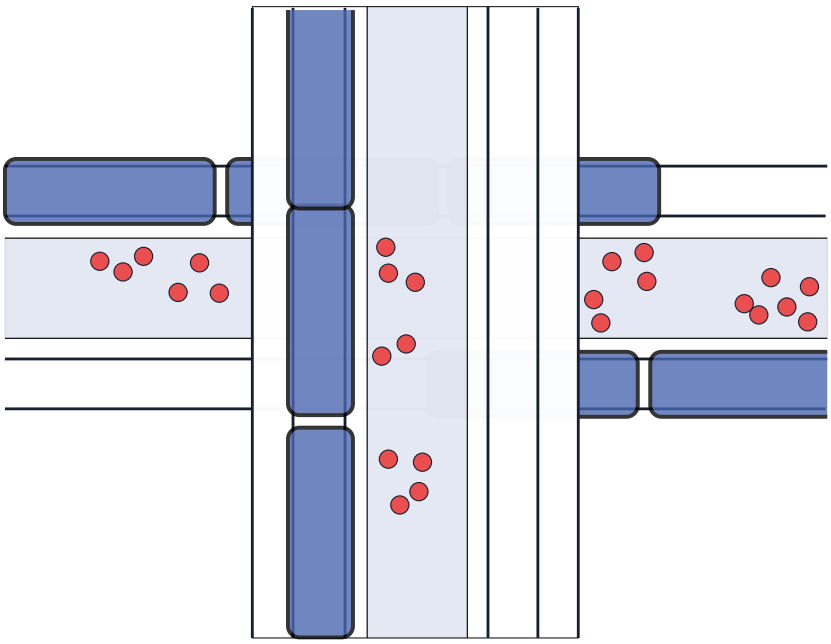
As passenger stations have developed a variety of typologies have emerged, the four most important ones are categorised in the following chapter. These can be named as such, the most common pass through station (1), a junction station (2) where two train lines cross each other on different levels. Third is the terminus station (3), where the station forms a stop for the train line, as Milano Centrale does. Lastly is the hybrid terminus (4) where a section of the train tracks is terminated however a second set of tracks continues, in the same way as a through station, with Garibaldi in Milan serving as an example.





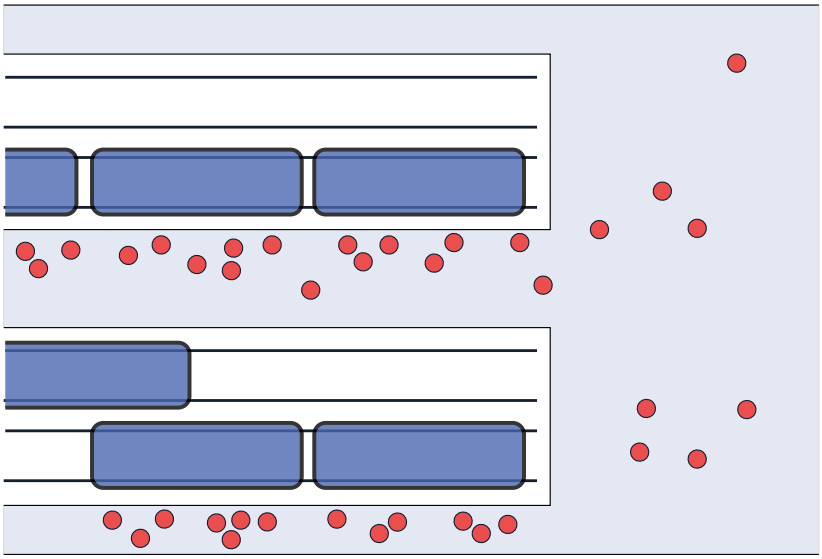
pass through station
trains continue journey

1



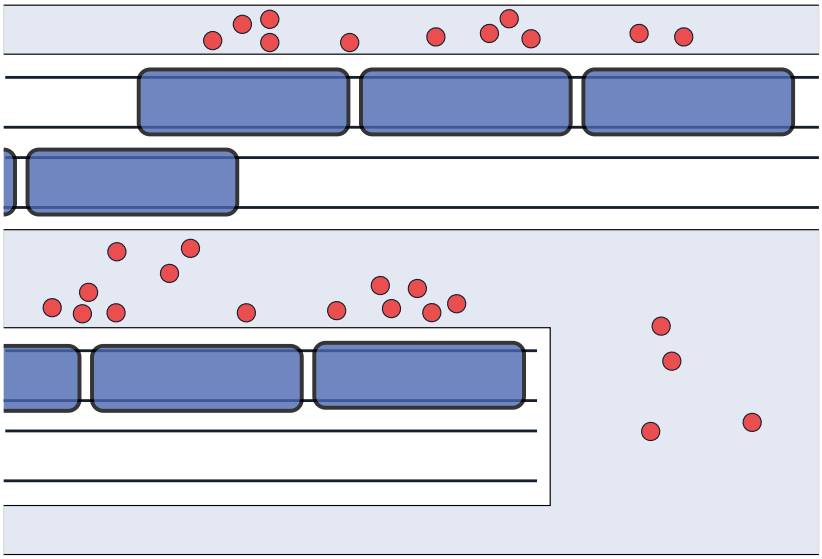
junction station
trainlines pass over eachother

2



terminus station
trains terminate at stop

3



hybrid through-terminus station
only certain trains terminate at stop

4

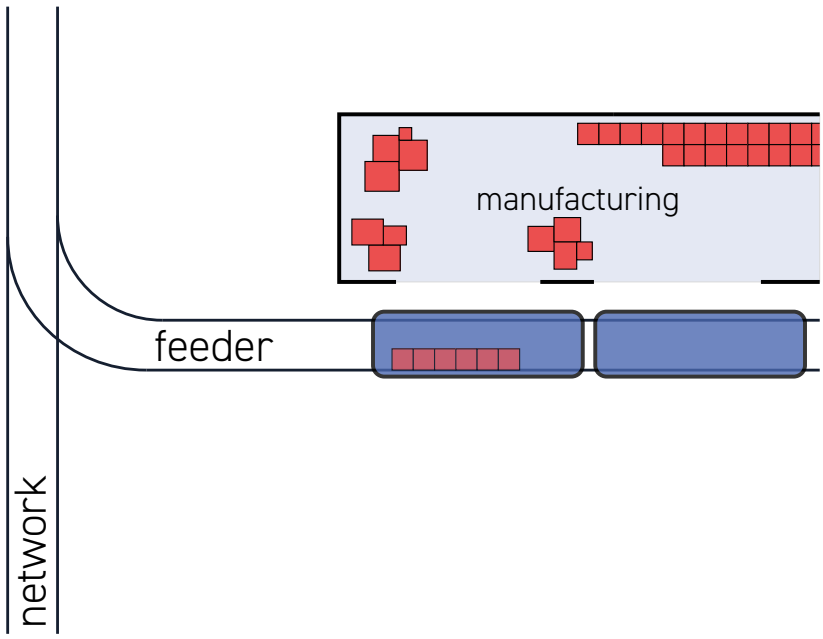
FREIGHT STATIONS

categorisation of spatial relations in different freight station typologies

Freight stations have existed since the invention of the train itseelf. As such there are a variety of different freight station typologies, here the four main current day configurations are presented. Ranging from small scale public sidings at existing stations, to large intermodal freight hubs combining sea- land- and train-transport.

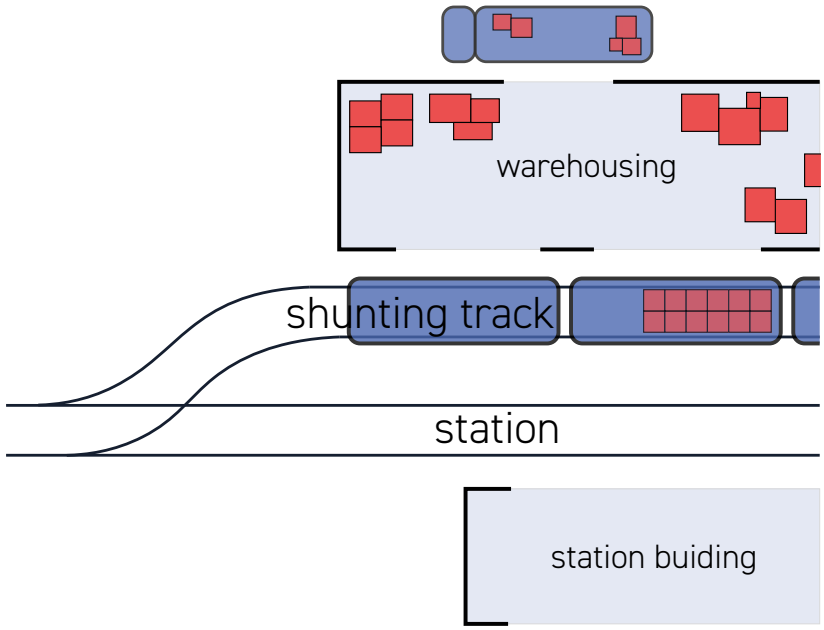
For the use in this design project, the system is used as a public siding, giving multiple providers the option for parcel delivery in cooperation. The station as well both functions with passengers and freight.


Freightliner
66509
66509
Lesley's Wish



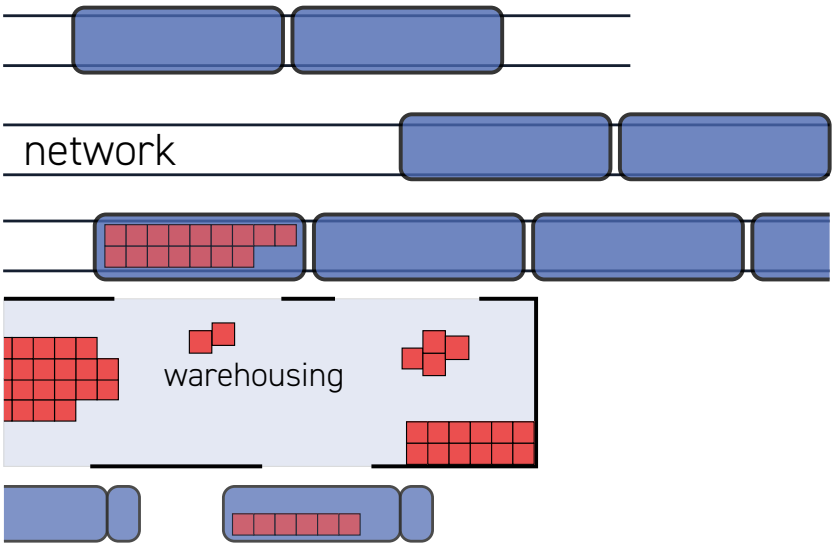
private siding
manufacturing input/output

1



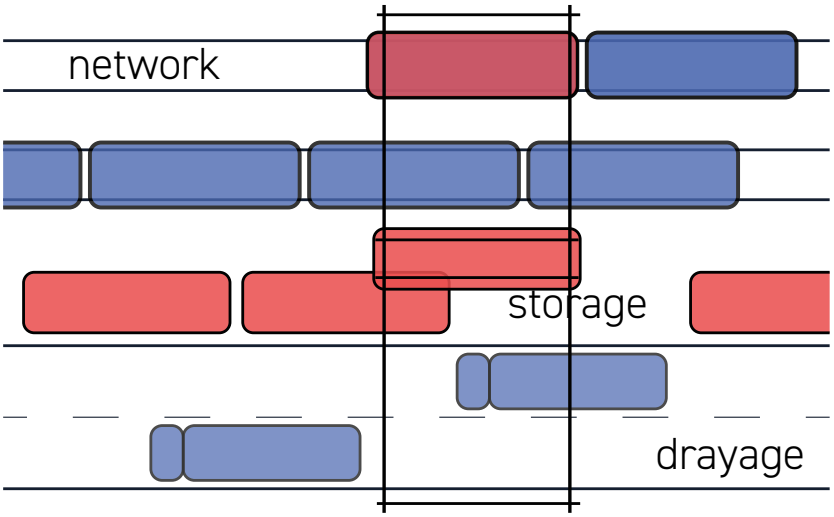
public siding
siding at a passenger station building

2



railport - conventional terminal
transfer to secondary transport

3



intermodal terminal
container transfer between modes

4

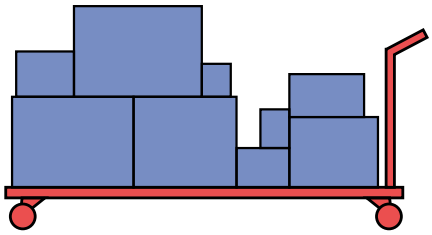
DELIVERY VEHICLES

categorisation of carbon neutral last mile delivery vehicles

To fulfill the last mile deliveries of parcels, delivery vehicles are needed that serve this purpose. These vehicles need to be small enough to fit on new bike paths within the city and the narrow urban centre streets. Furthermore they are required to be carbon neutral, running on human power or electricity as its source of propulsion.

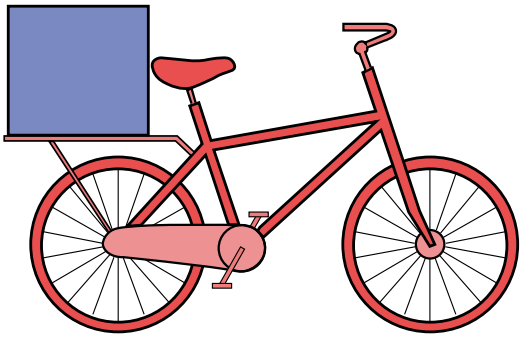
Within Milan the main applicable vehicles are the micro electric vehicles (4) and for smaller amounts normal bikes modified with a cargo container on the back (2).


qarry



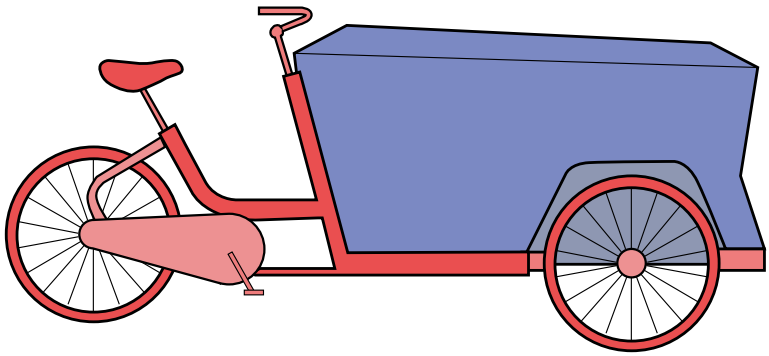
handcart
human powered push/pull carts

1



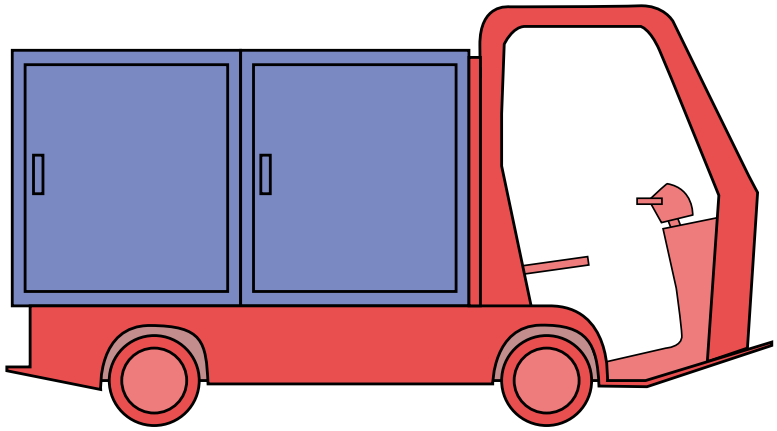
delivery bike
(non)assisted bicycle with container

2



cargo bike
bicycle with integrated storage

3



micro electric vehicle (MEV)
micro vehicle with storage loadout

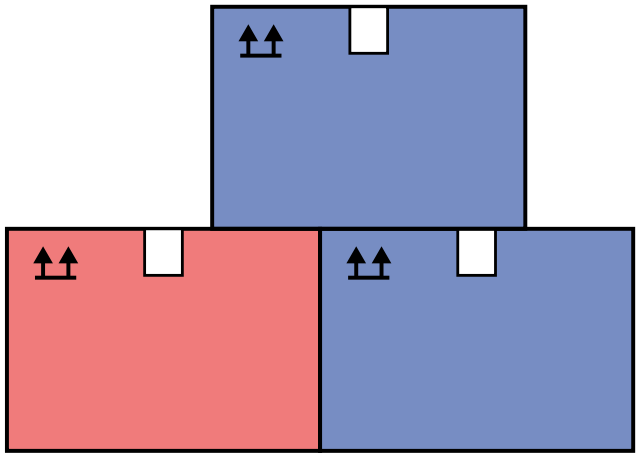
4

CARGO

categorisation of different cargo storage options for transport

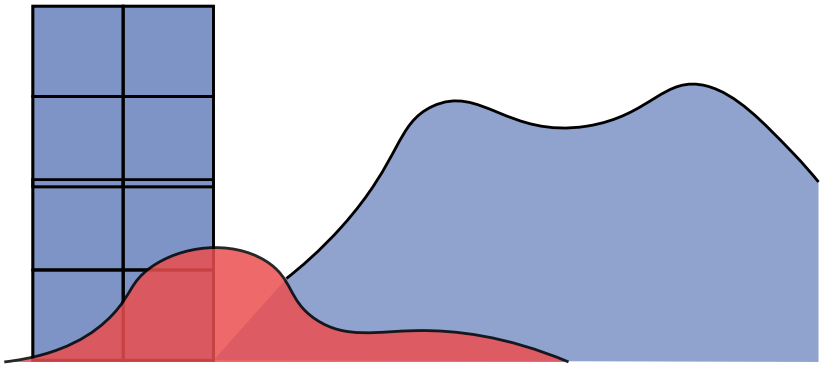
Cargo comes in many shapes and sizes, therefore it is imperative to get a good overview of the different transport options. Parcels (1) are shipped in many different containers and carts, being most commonly placed on roll cages (3) or EU size pallets (4). However, especially for international bulk shipping, they are commonly placed in either swap bodies or sea containers (5)(6). Relevant in this scenario is the transport of parcels by parcel trains, this is commonly done with roll cages placed in wagons, which can in turn be rolled on to platforms to be unloaded.


B
B



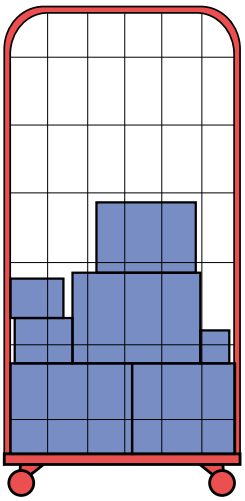
parcel
single unit - varying size

1



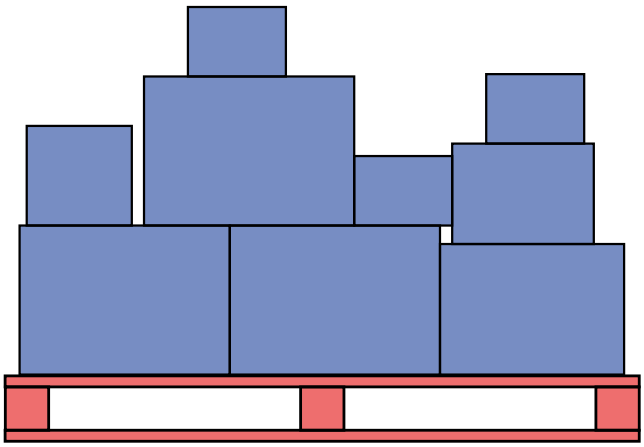
raw material
bulk cargo in different forms

2



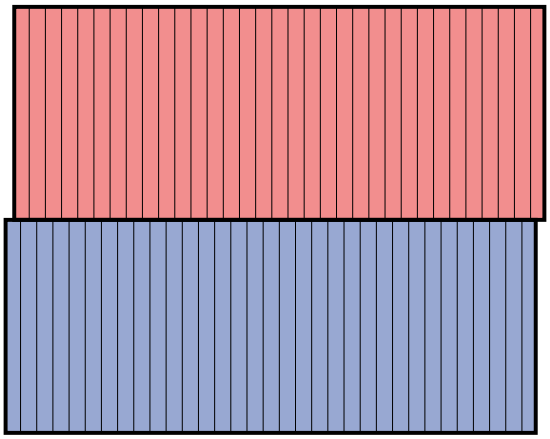
roll cage
rollable cage holding items

3



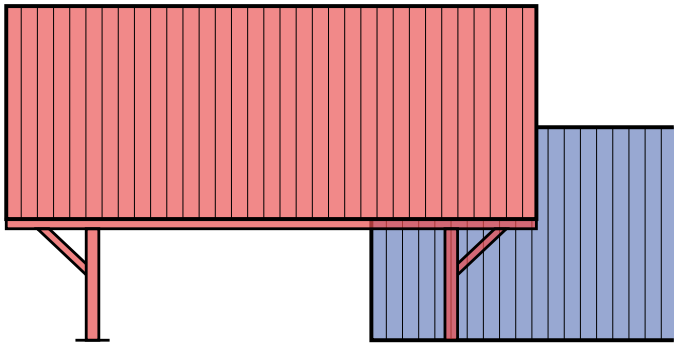
pallet
EU size pallet for transport

4



container
standardised sea container

5



swap body
container with swap body attached

6

TRAIN LENGTHS

categorisation of freight and passenger train lengths



< 250-350 meters >
short block train
urban terminals



< 400-550 meters >
medium freight train
regional hubs, feeder services



< 750 meters >
standard EU freight
core TEN-T corridors



< 750+ meters >
extended freight
heavy freight corridors

An important measure for the design of a station is the length of the trains that operate within the station. As these lengths ultimately decide the size of the platforms and shunting tracks. For the station the platforms have to necessitate both freight and passenger trains of sufficient length. For this the platforms need a minimum length of 330m, accommodating the longest passenger trains, and freight is transported using shorter block trains, meant for urban terminals having a max length of 350m. Thus the minimum platform length for the design is 350 meters.



< 80-150 meters >
airport commuter
Malpensa Express



< 150-250 meters >
(inter)regional
caravaggio, mixed consists



< 200-260 meters >
high-speed
frecciarossa ETR 1000



< 300-330 meters >
high-speed heavy
Frecciarossa ETR 500

04
DESIGN DEVELOPMENT

04.1 MODELS

04.2 SKETCHES

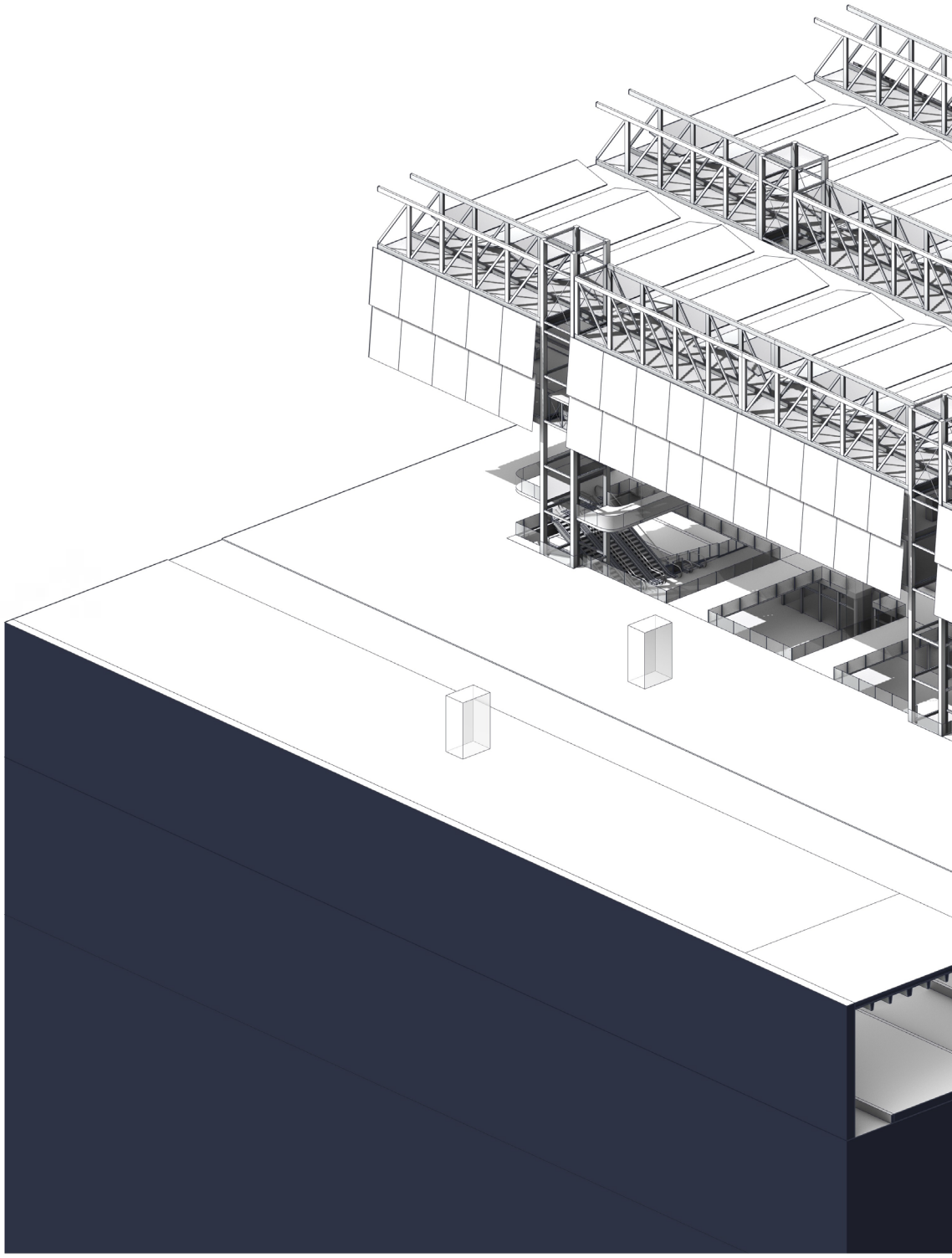
04.3 CONCEPT

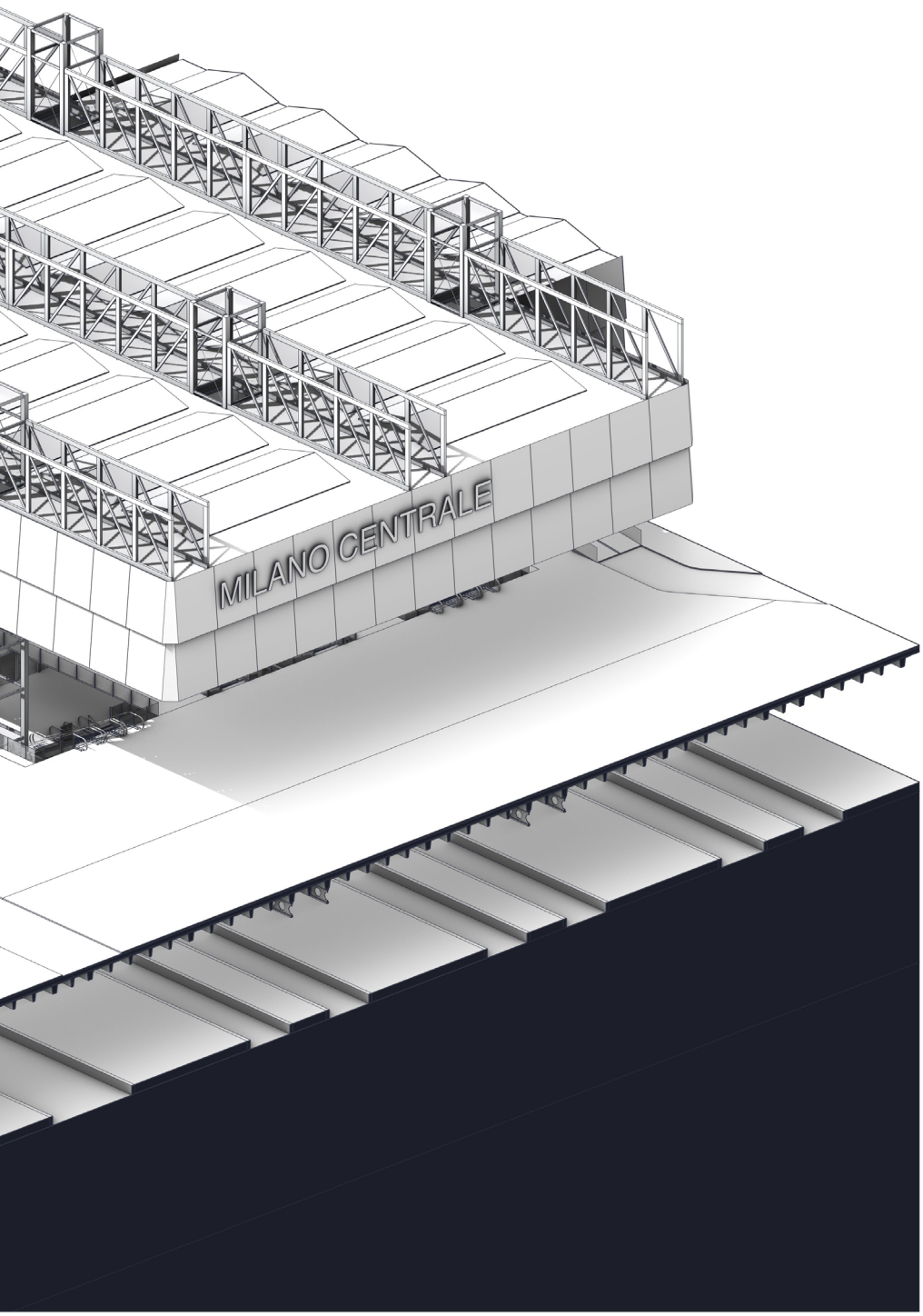


04.1 MODELS



PHYSICAL MODEL




MILANO CENTRALE

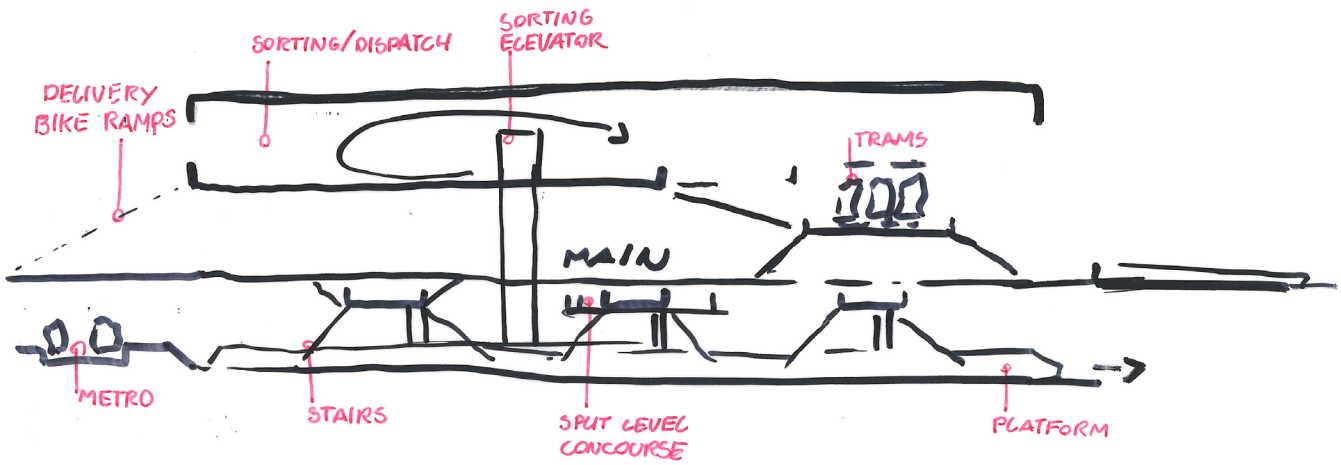


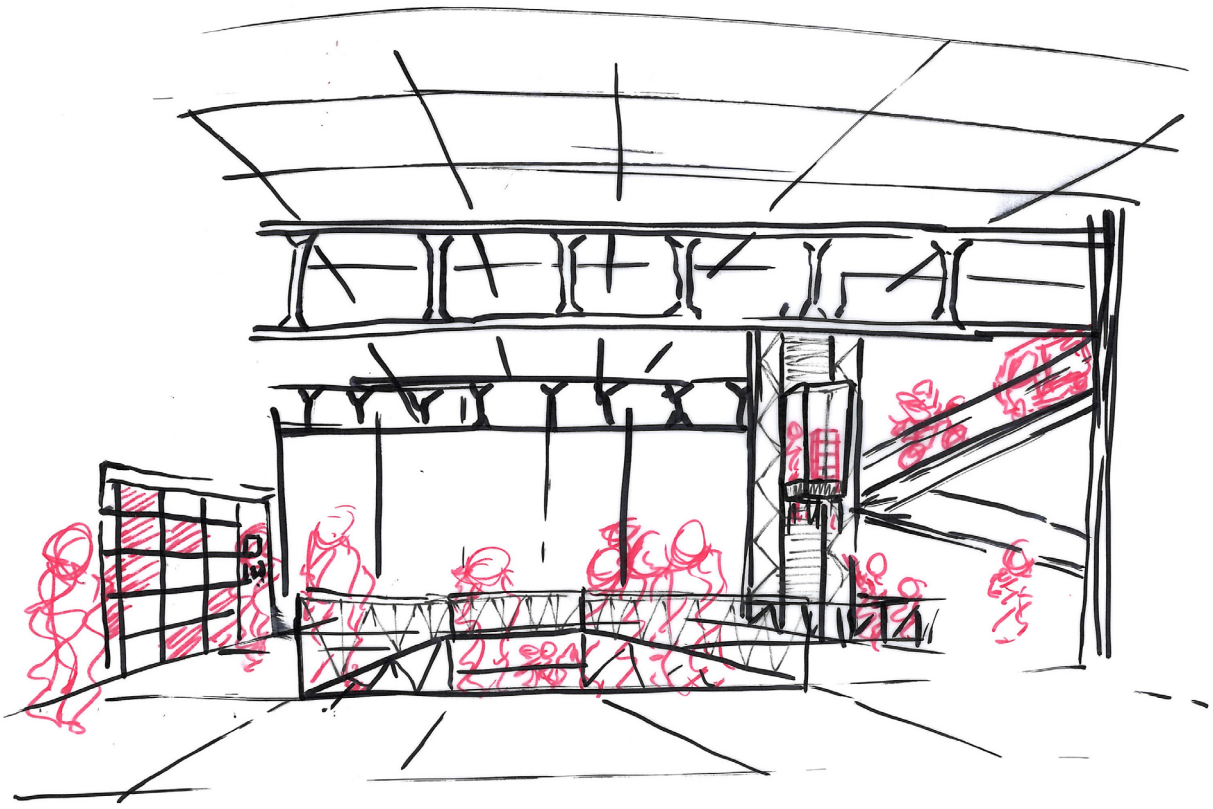
04.2 SKETCHES


Treni per
Trains to
DUOMO
SAN DONATO M3
DAE
DEFIBRILLATORE

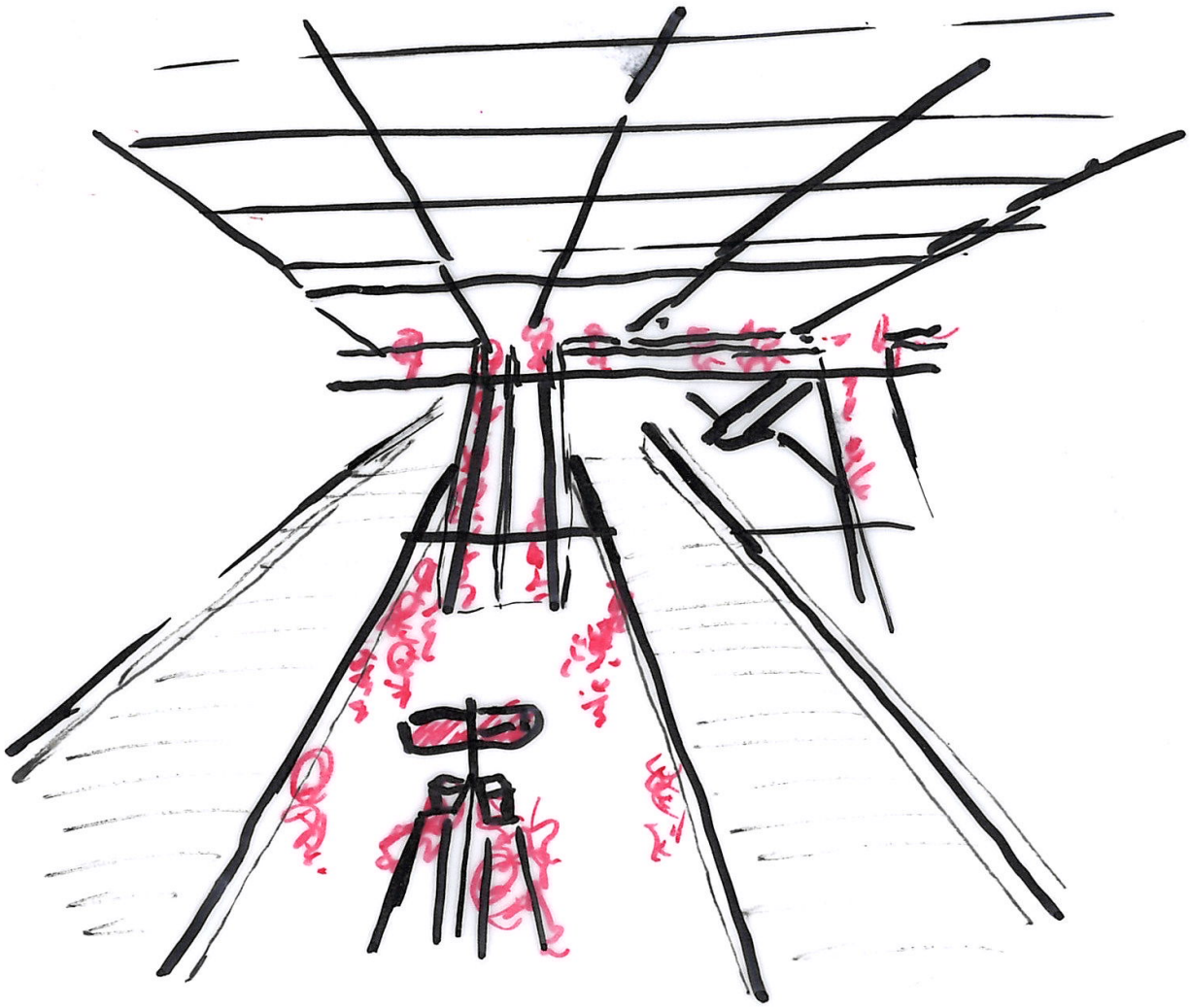
INITIAL SKETCHES

initial concept sketches



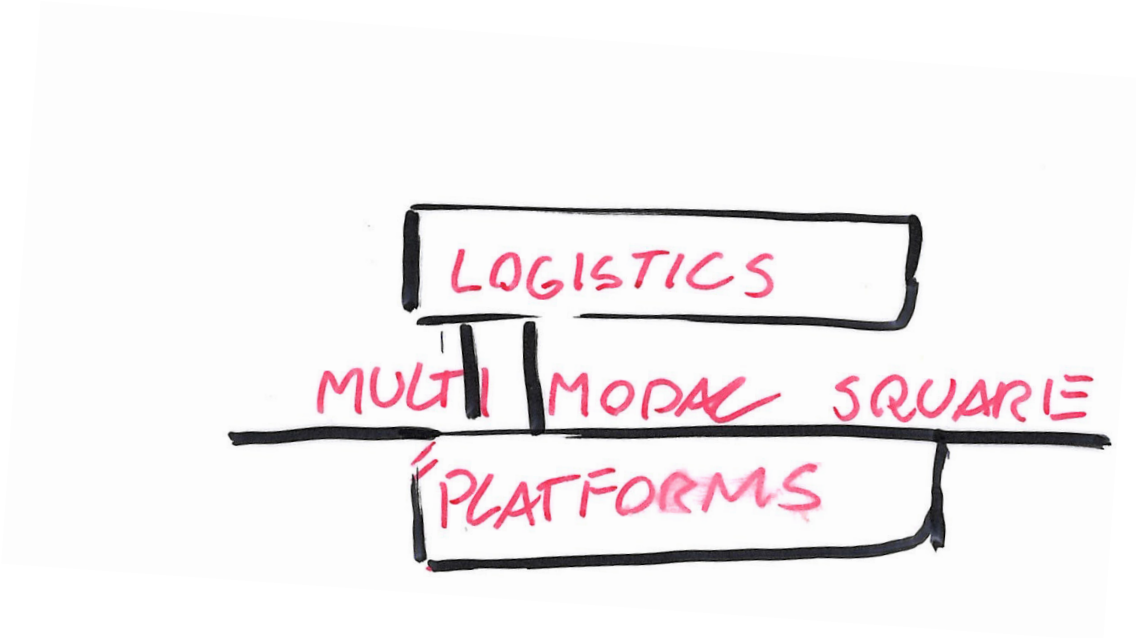


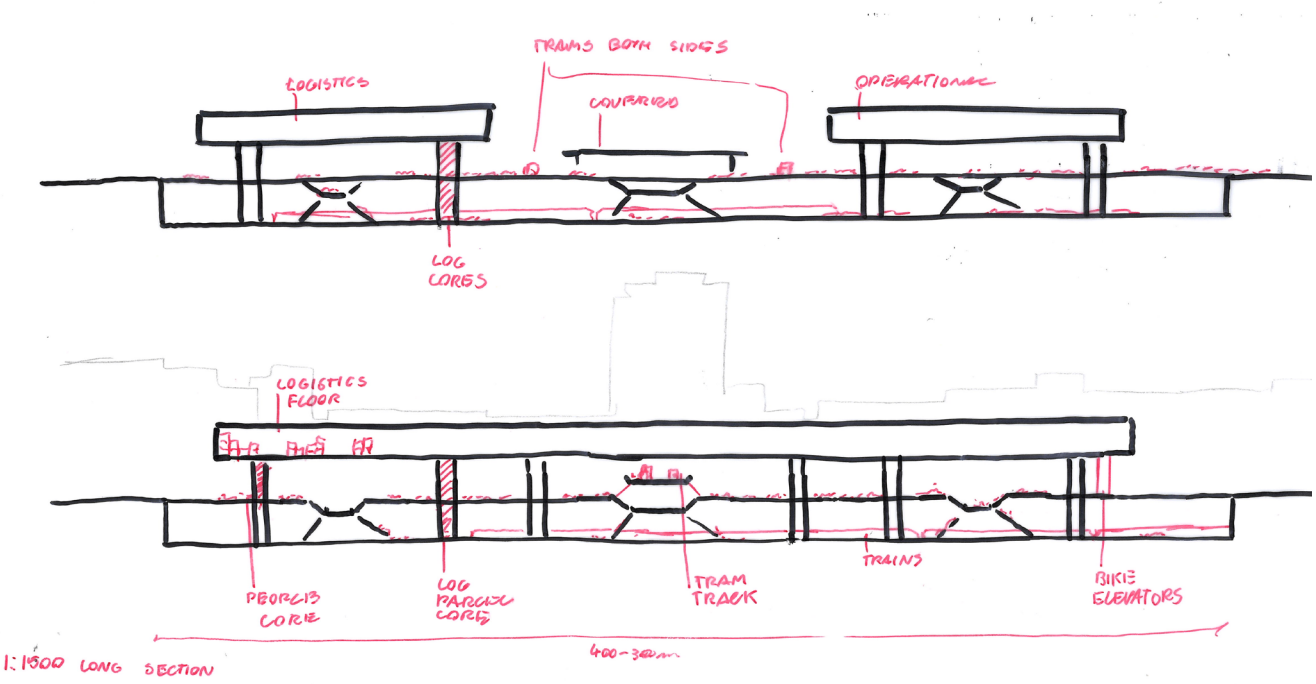
Following the development of the massing models, this concept was applied through sketch design. Forming more defined spatial goals and programmatic distributions. A development of the station divided into three clear layers can be seen starting on the left section.



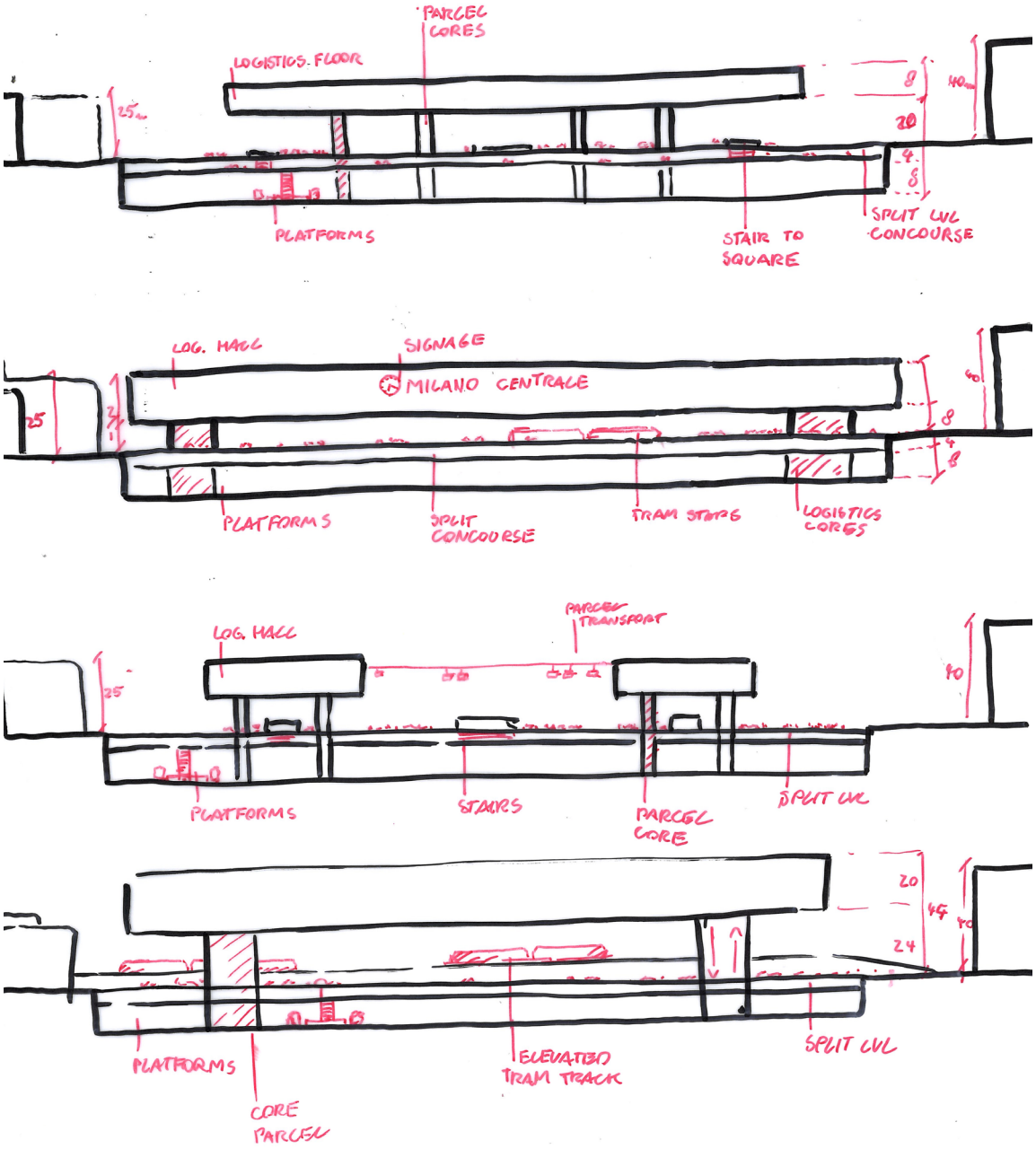
STATION AS ROOF

furthering of concept - developing the roof as a logistics floor for the station





Through the experimentation of concepts a main idea took form, developing the station as a structural roof which holds a logistic function. This while keeping the traditional station hall as an open public plaza unbound by walls. Below this plaza the train tracks are placed subterranean leaving the plaza flush with the surrounding urban fabric. This concept is illustrated by a host of variants showcased below, from one continuous roof to separated masses.



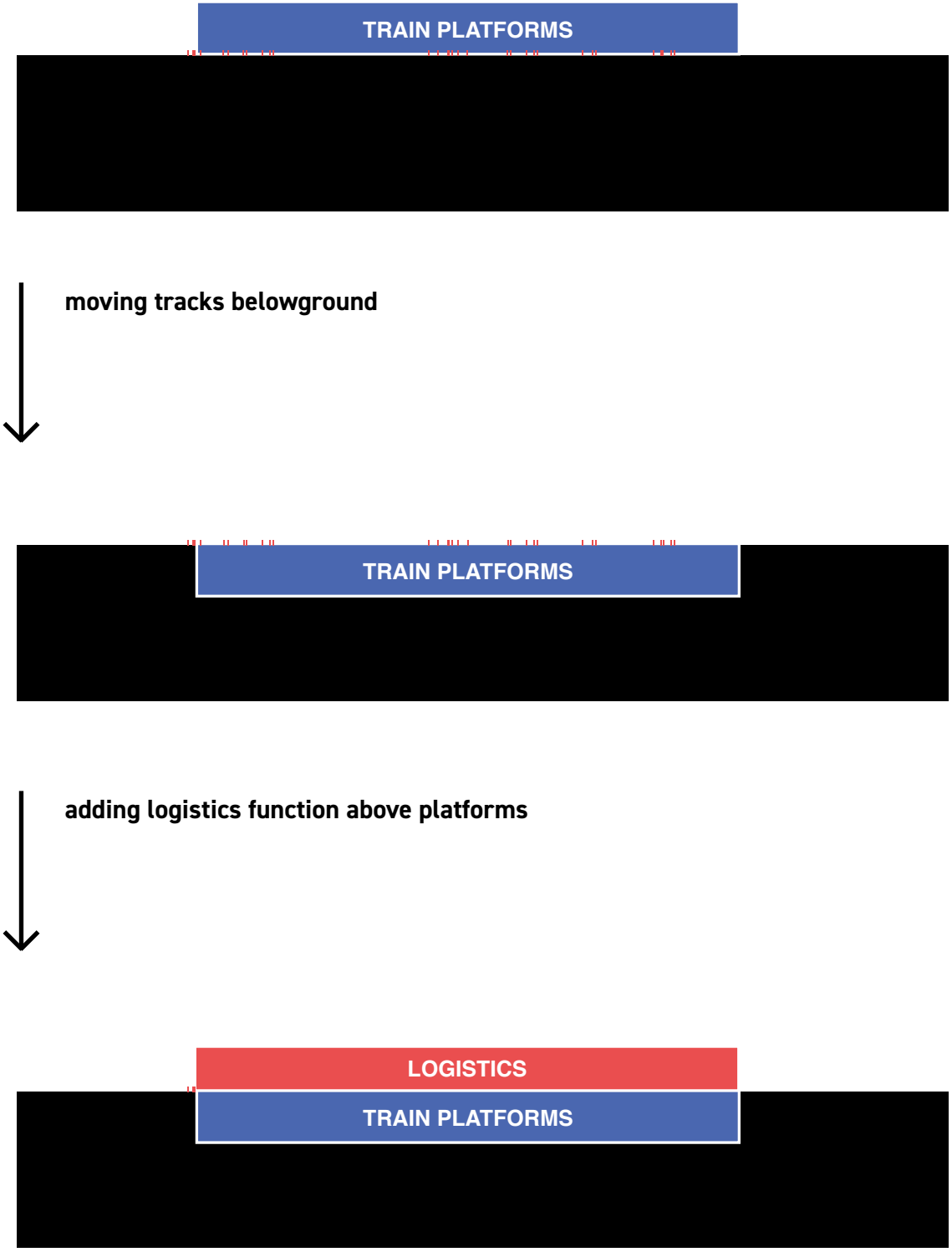

SALA Blu
Piazza IV Novembre
Punto di incontro PRM
Meeting point PRM
PARTENZE
Treni
Deposito bagagli

04.3 CONCEPT


FRECCIALOUNGE
italo Club
Servizi
bagagli Left luggage

CONCEPT

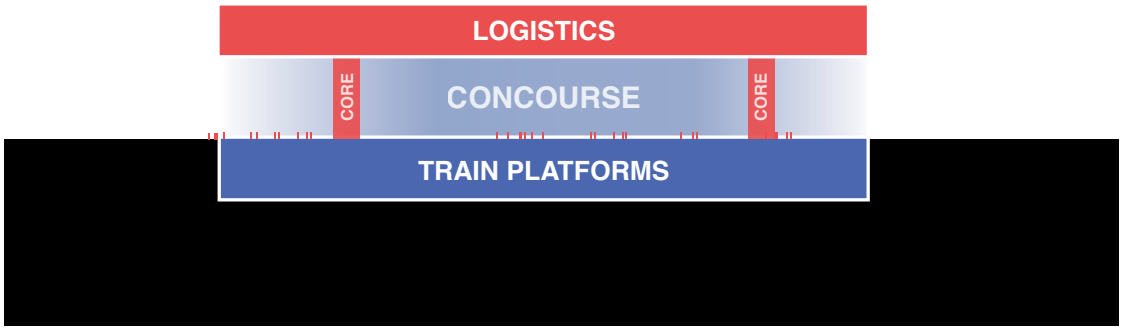
the final concept illustrated diagrammatically



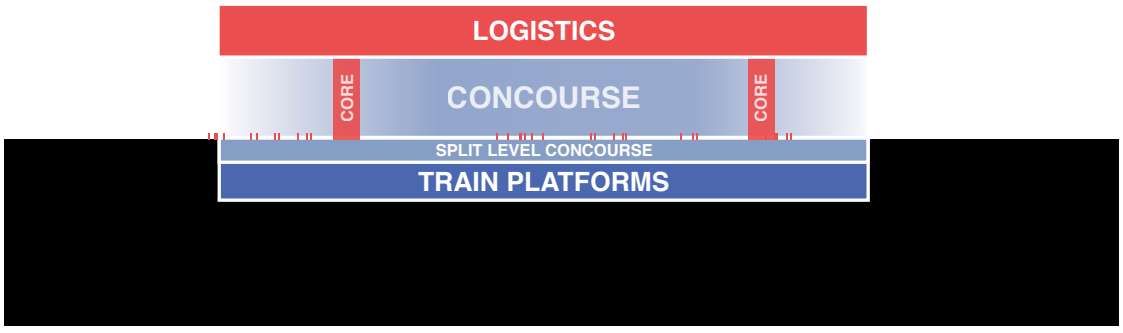
raising logistics above ground level, forming roof



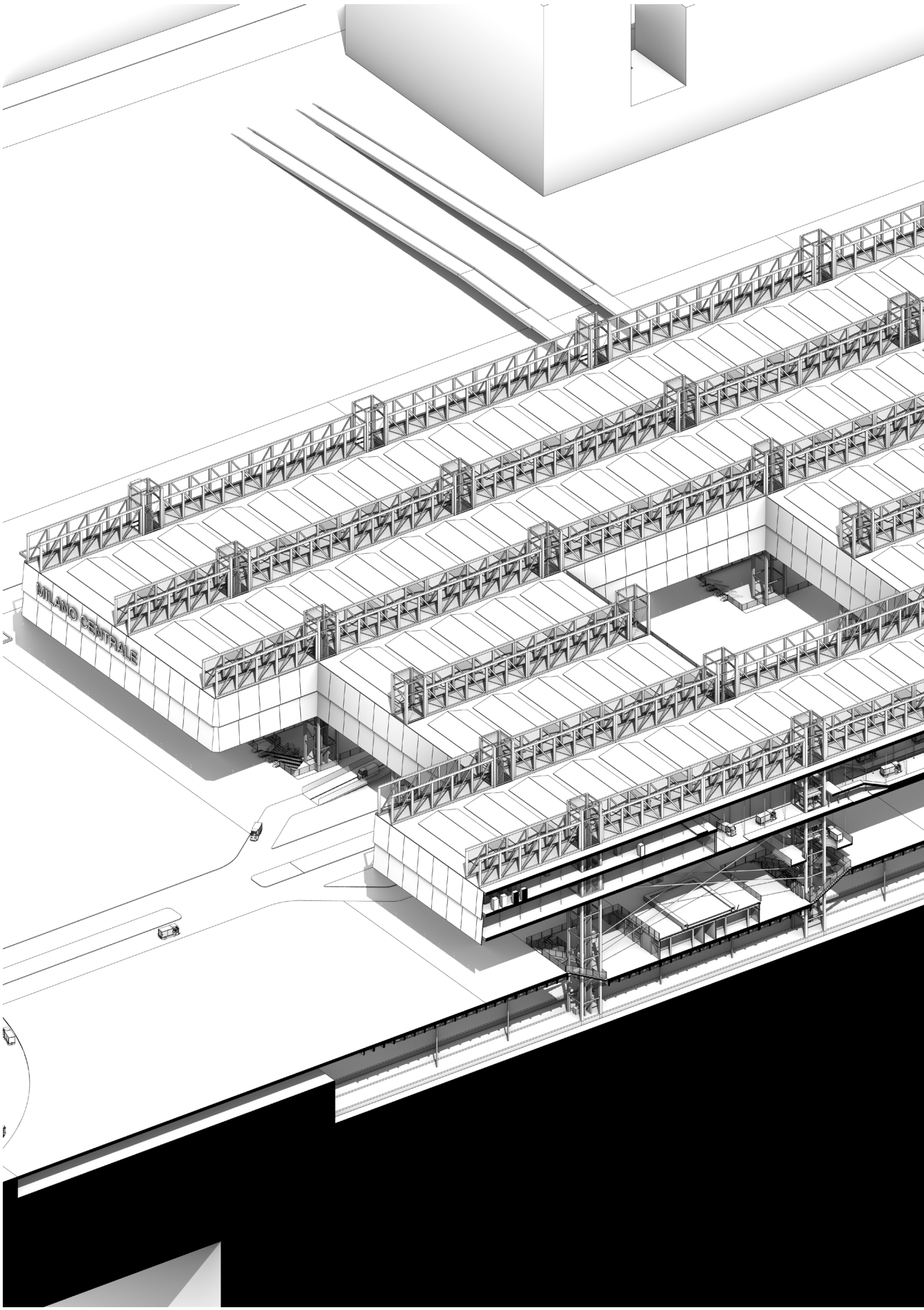
concourse forms in space between platforms and logistics function



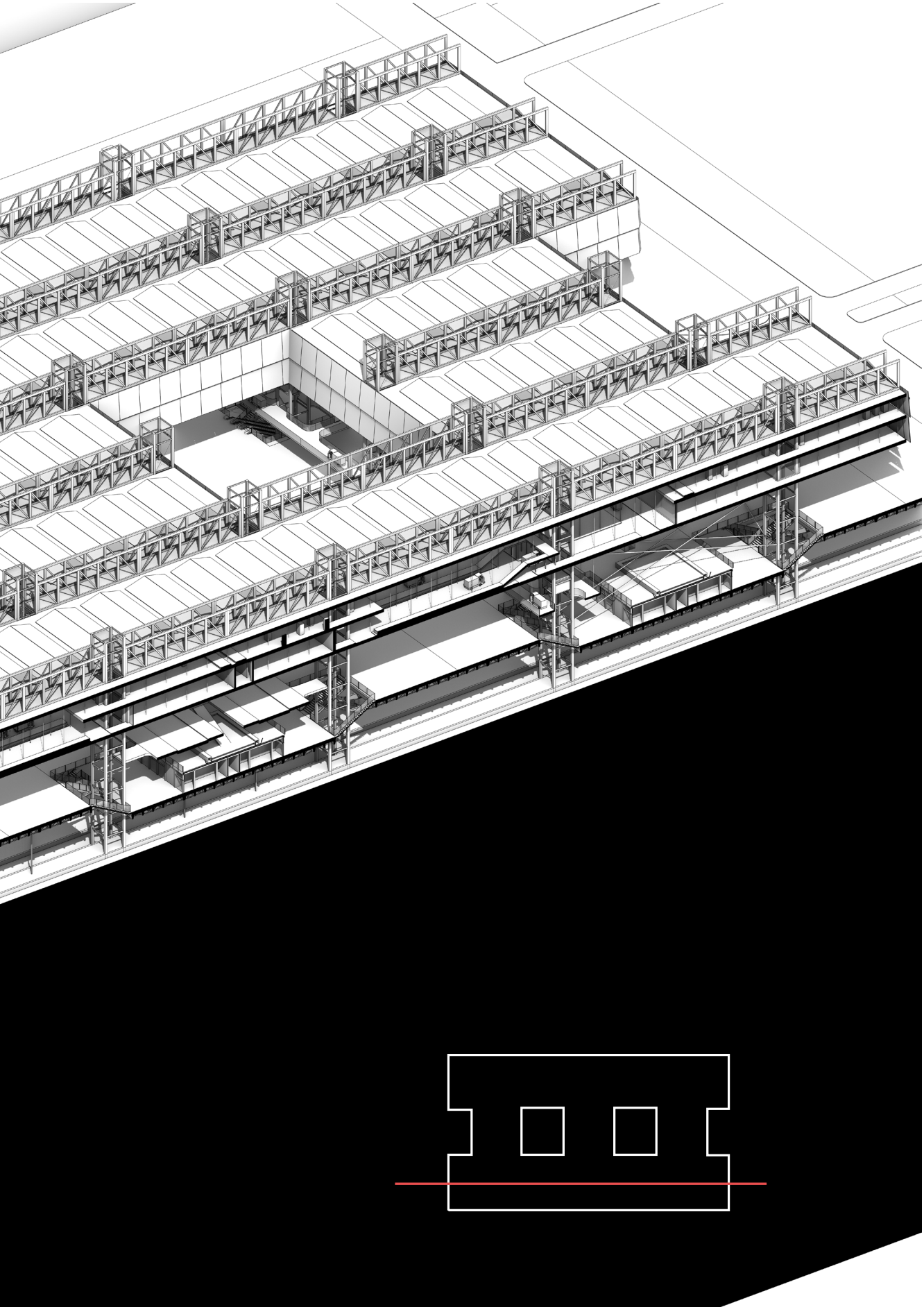
splitting the concourse

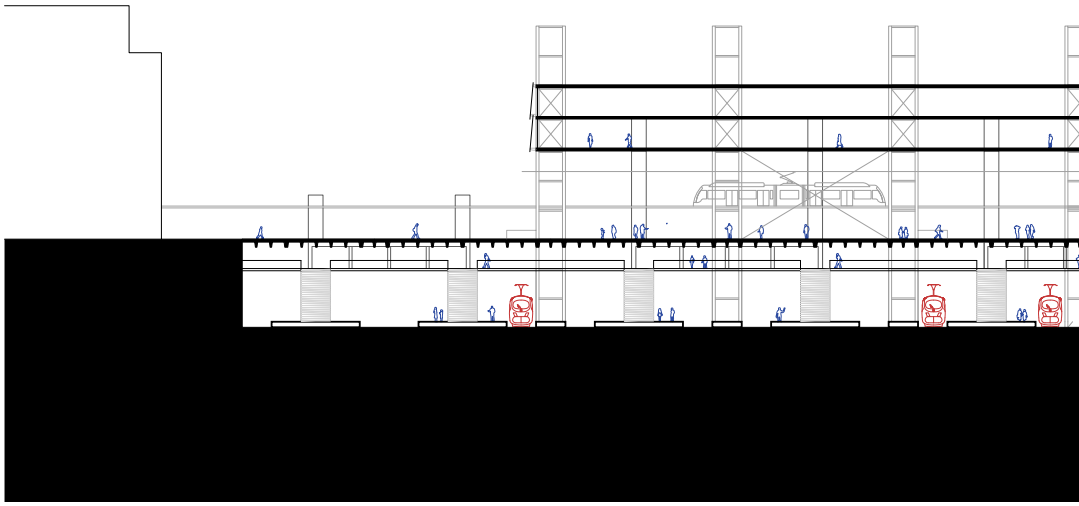


05
DRAWING SET



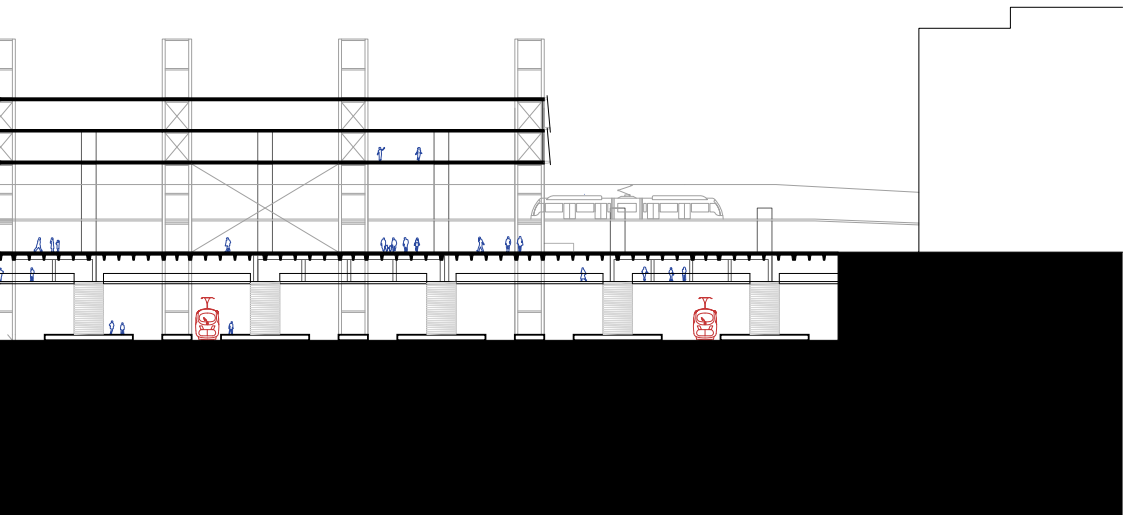
sectional axonometric

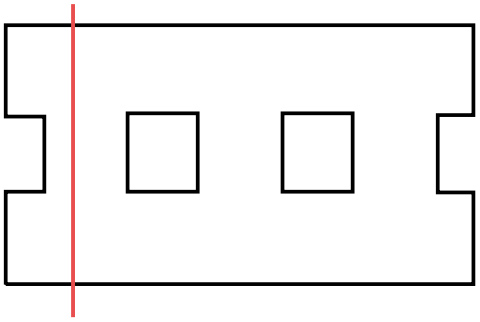




short section
NW - SE

1:1000

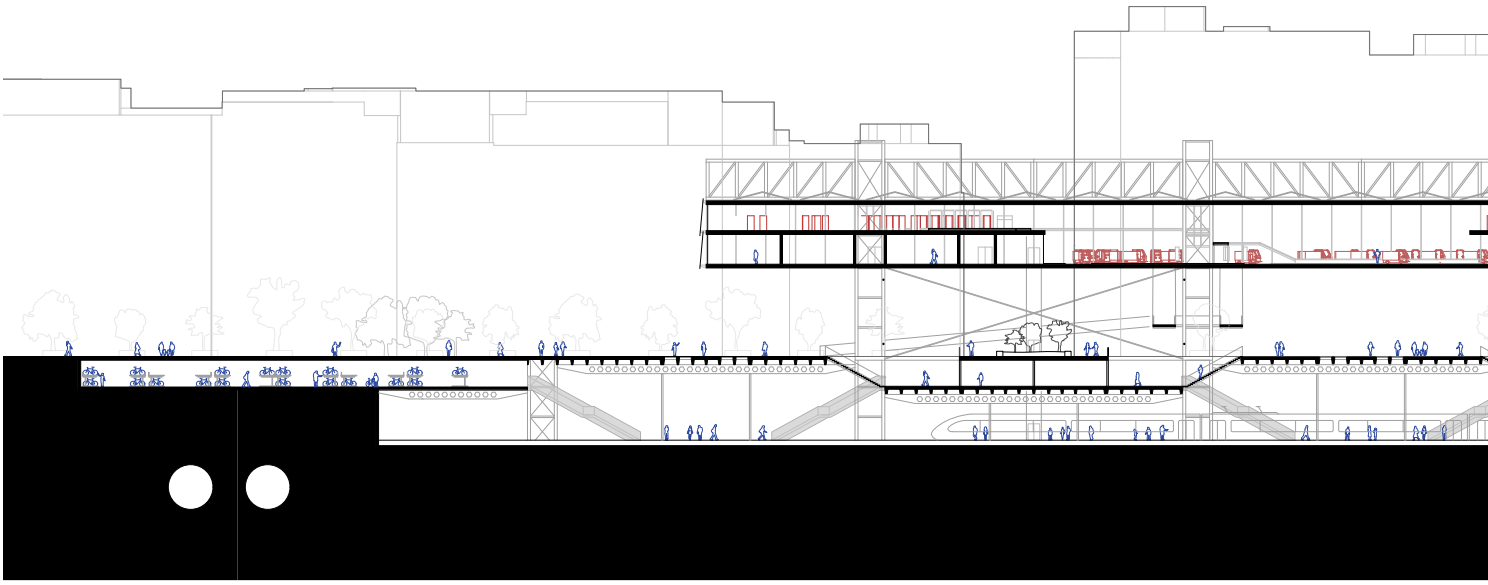






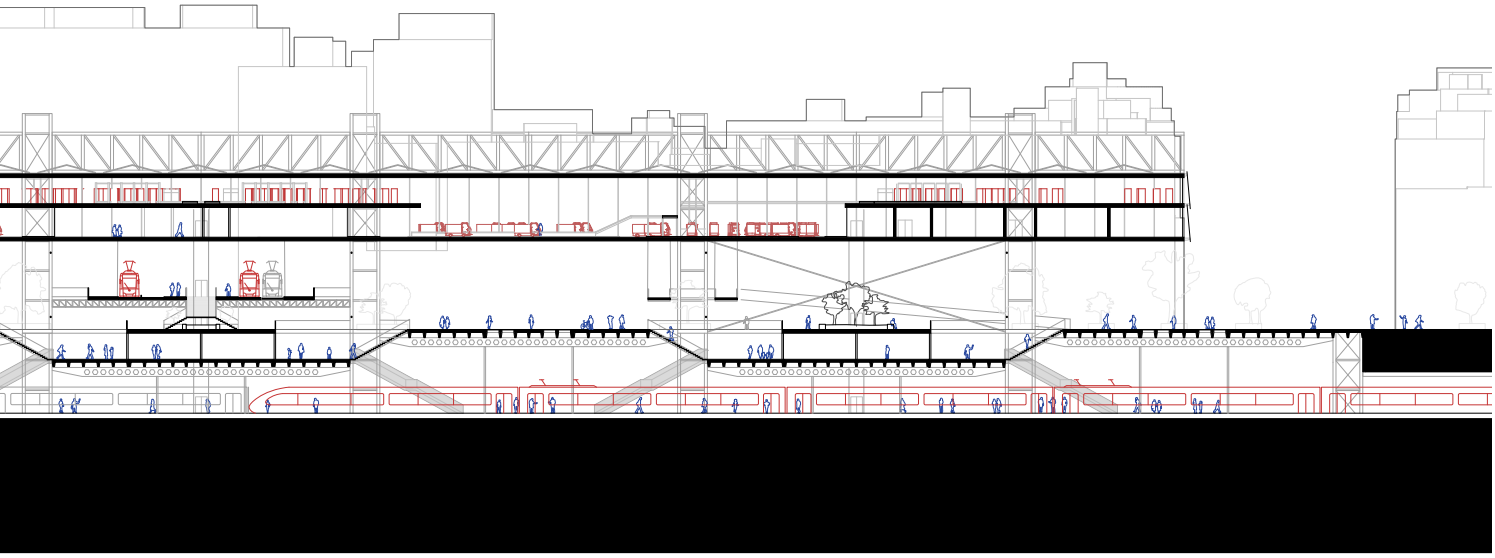
NW - SE elevation at night

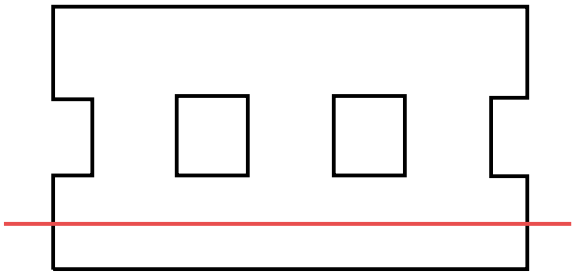

NO CENTRALE

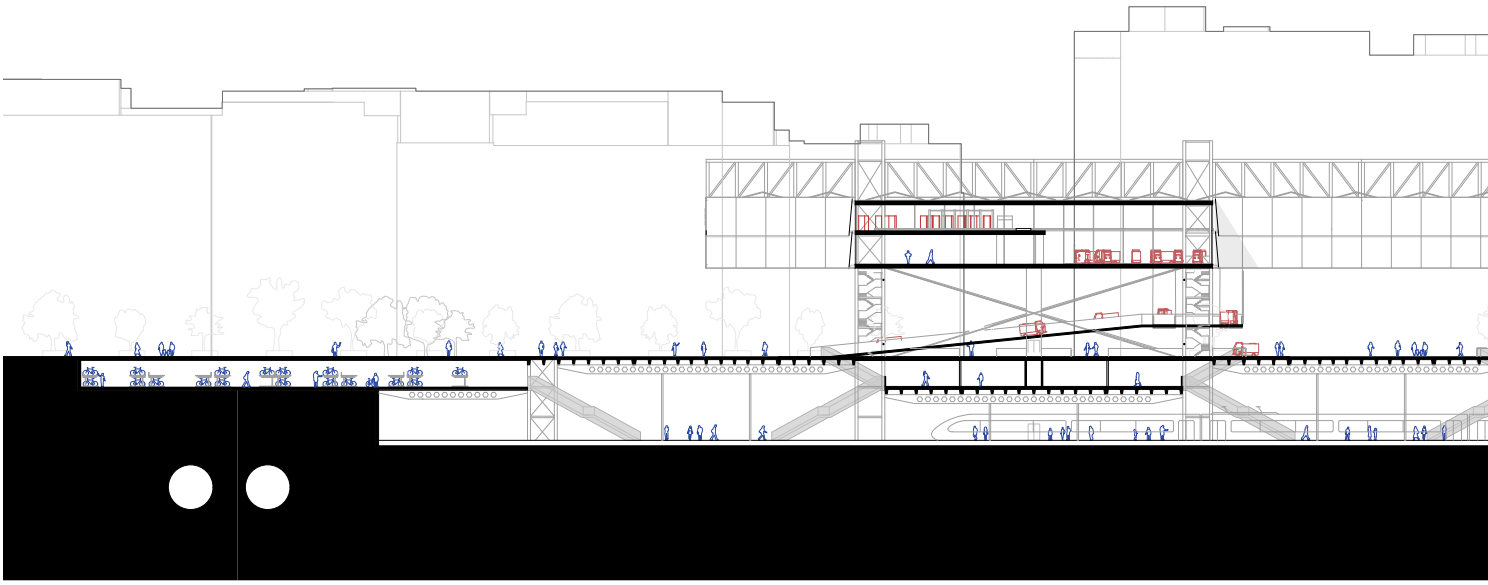


long section
SW - NE

1:1000

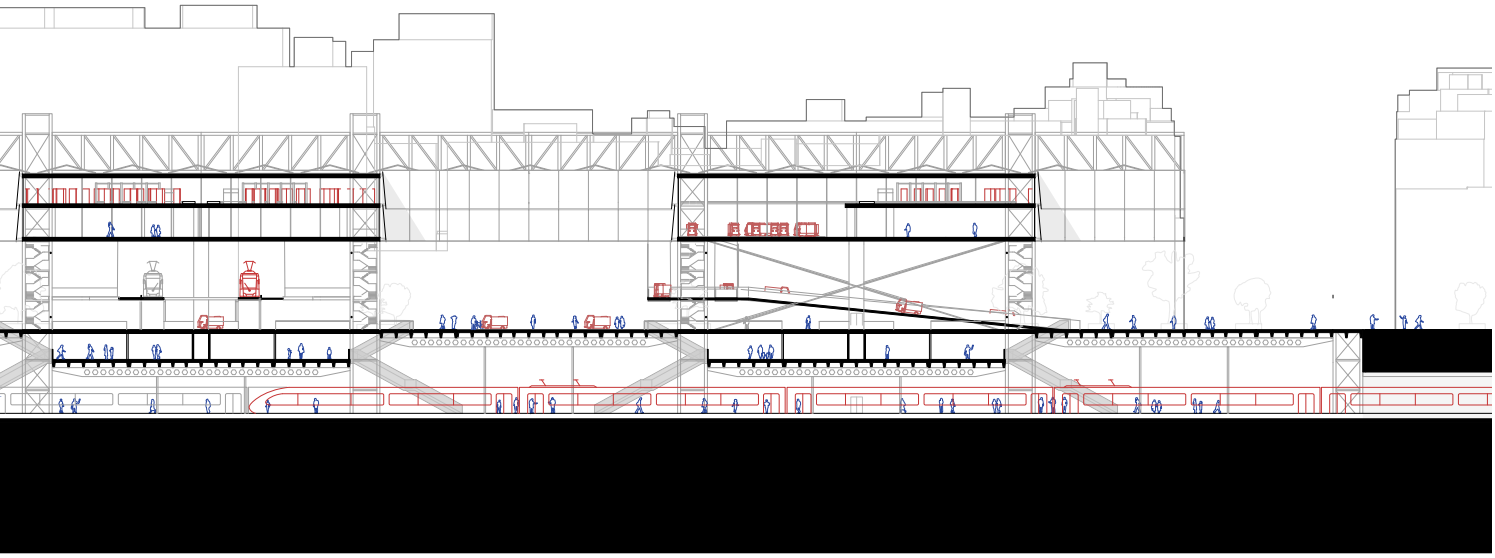


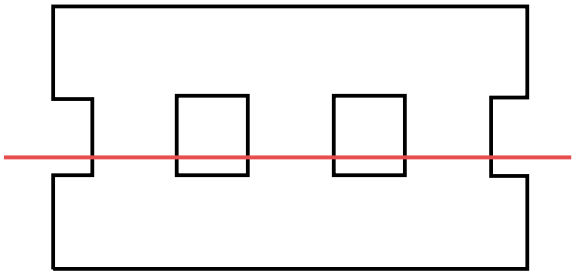




long section
SW - NE

1:1000

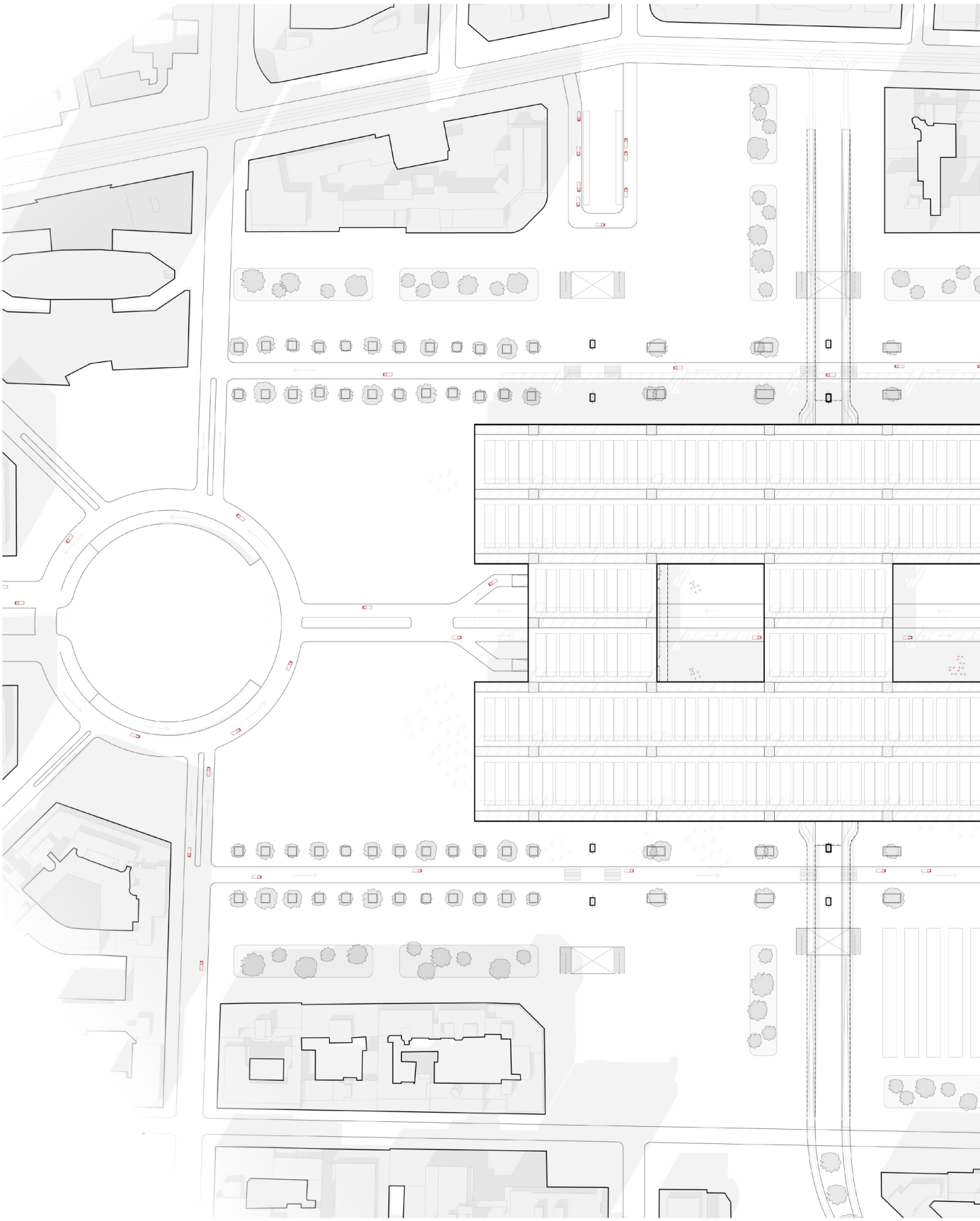






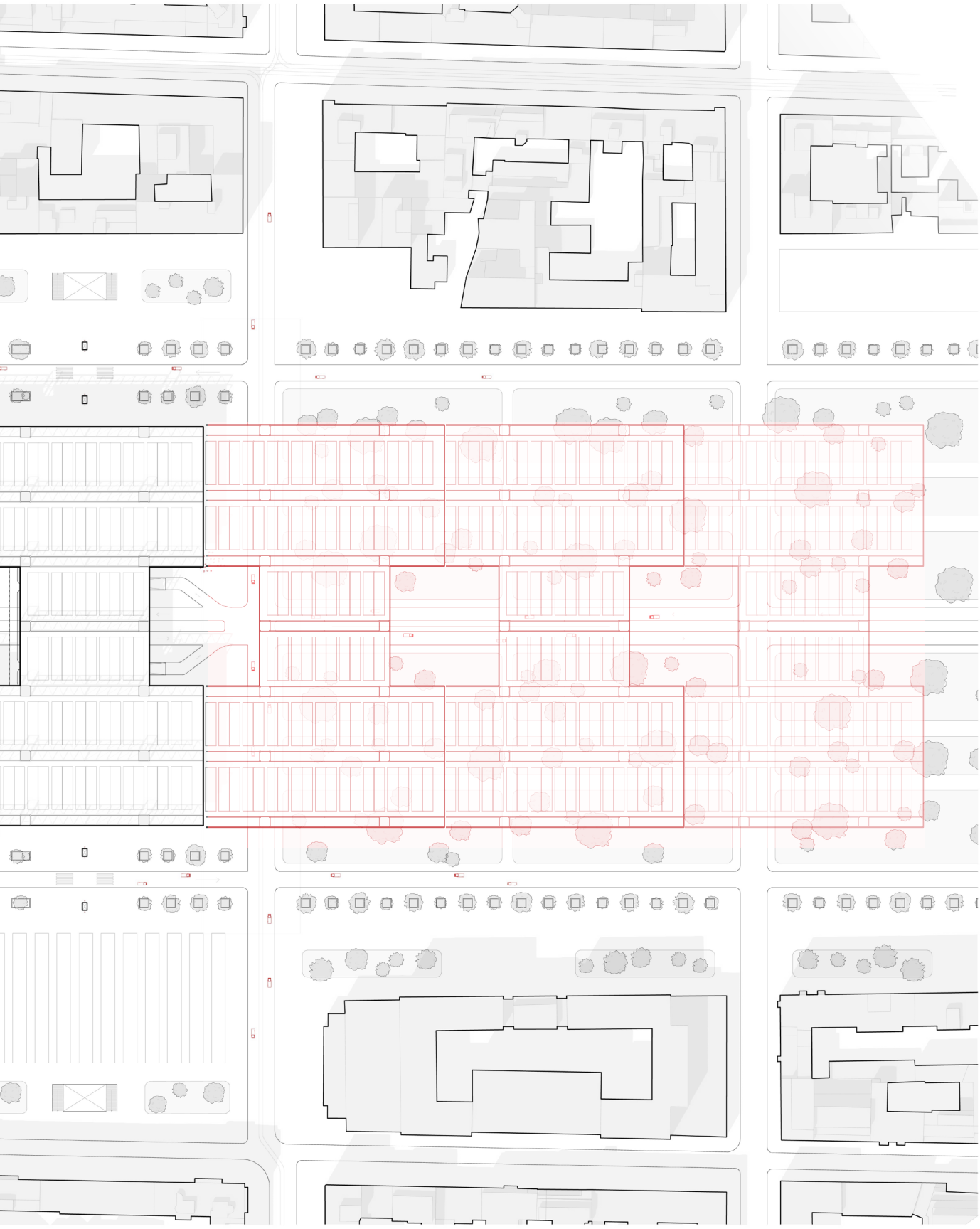
station roof edge

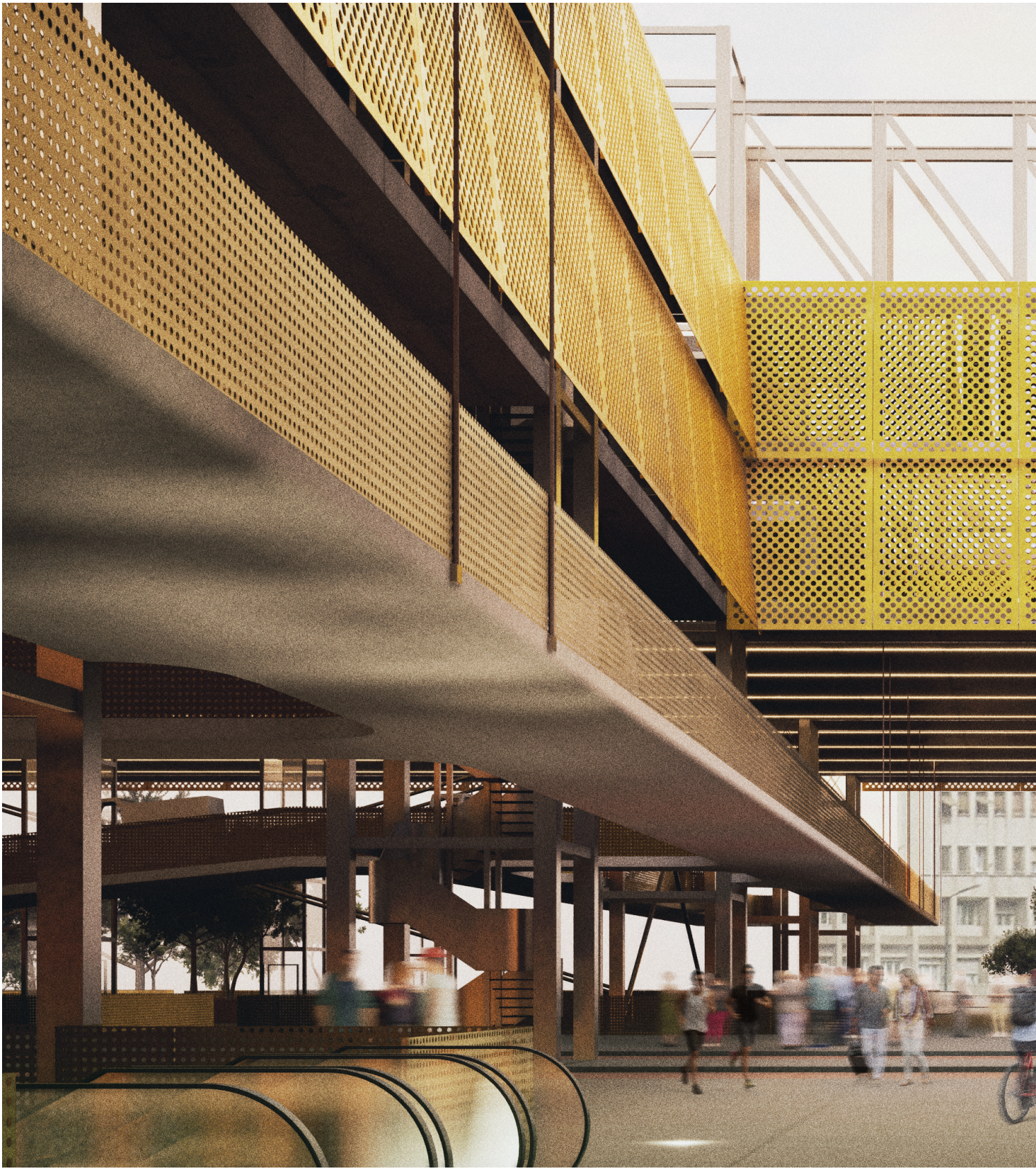

ALE



site plan
zoomed out gf

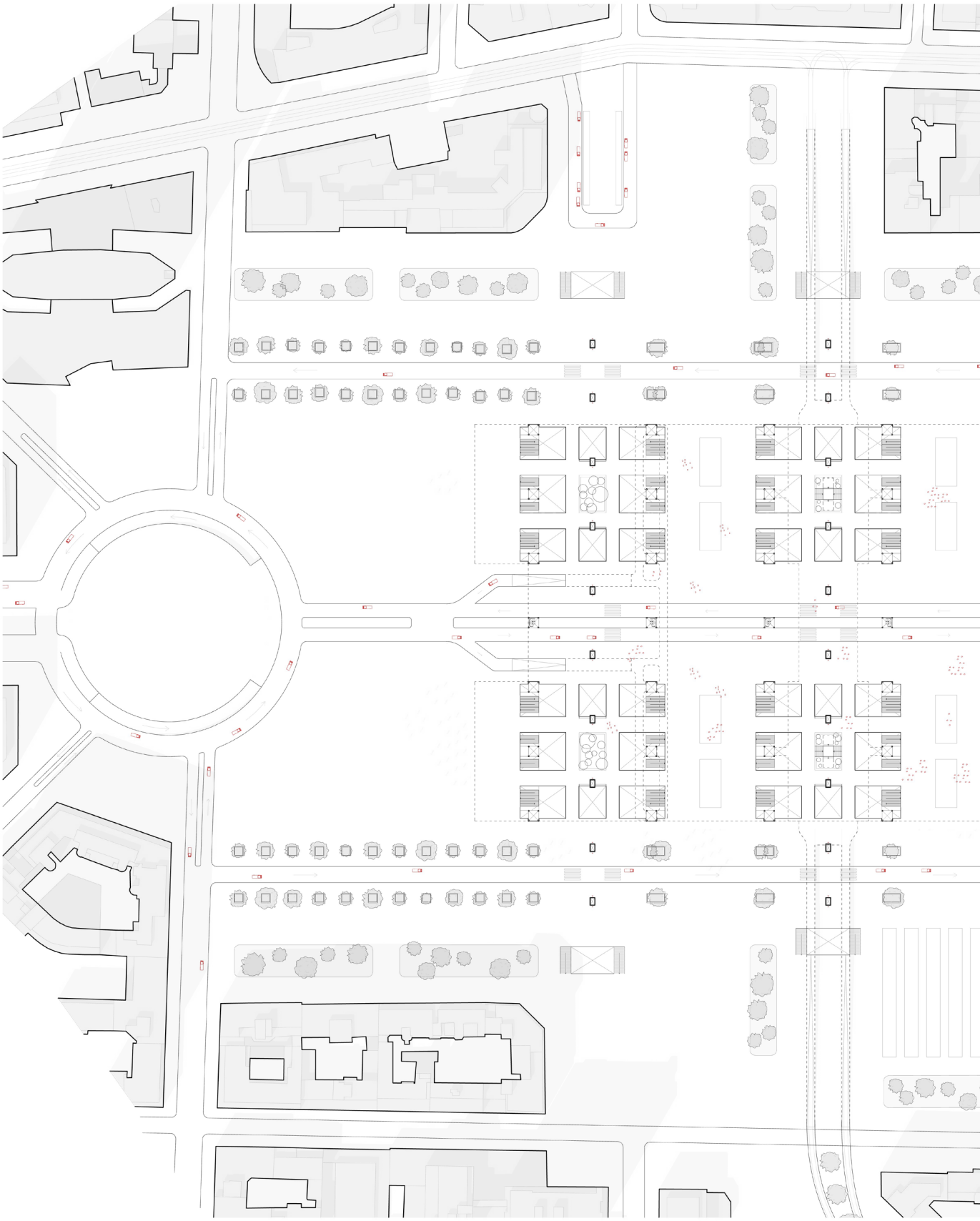
1:1800





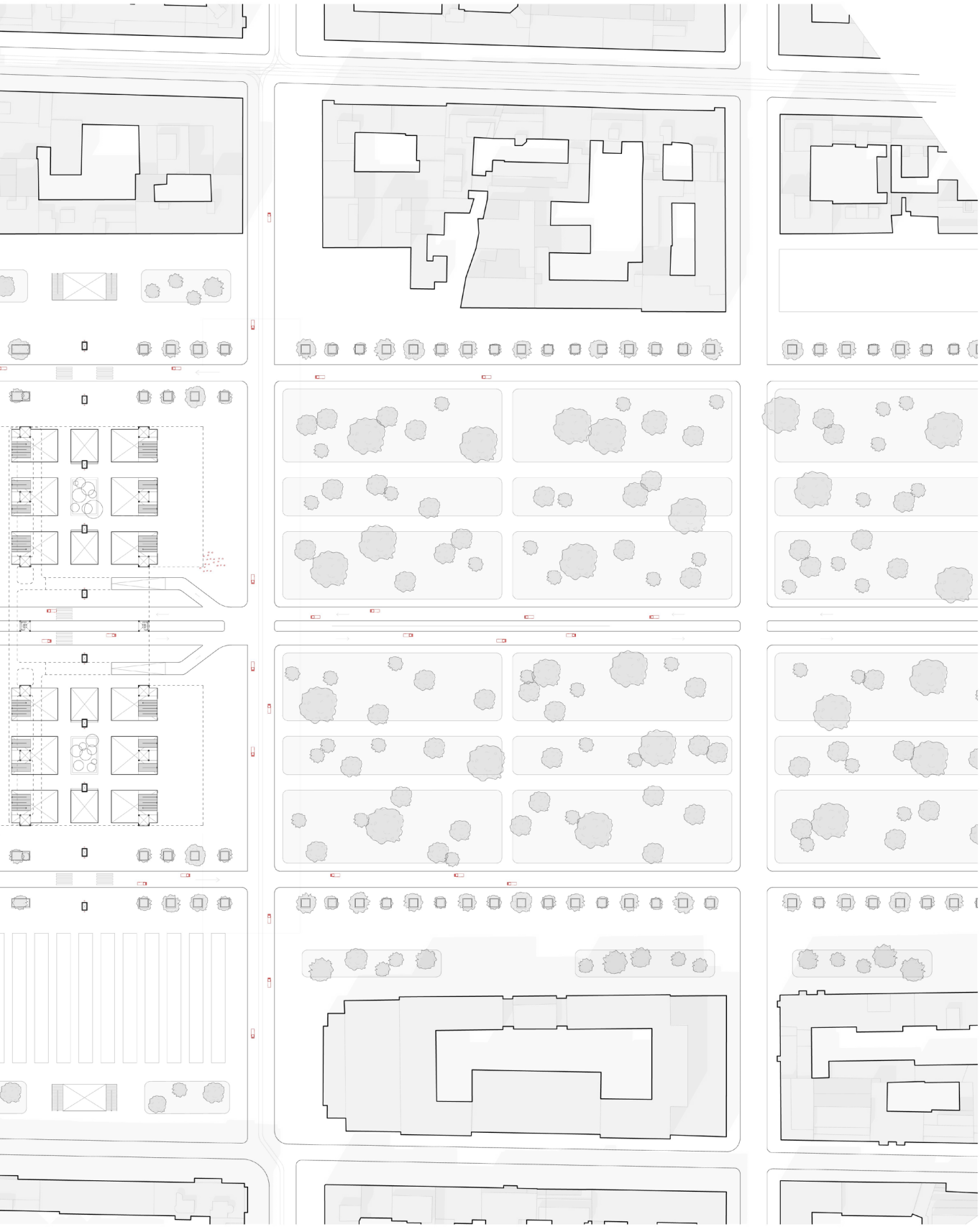
station roof edge

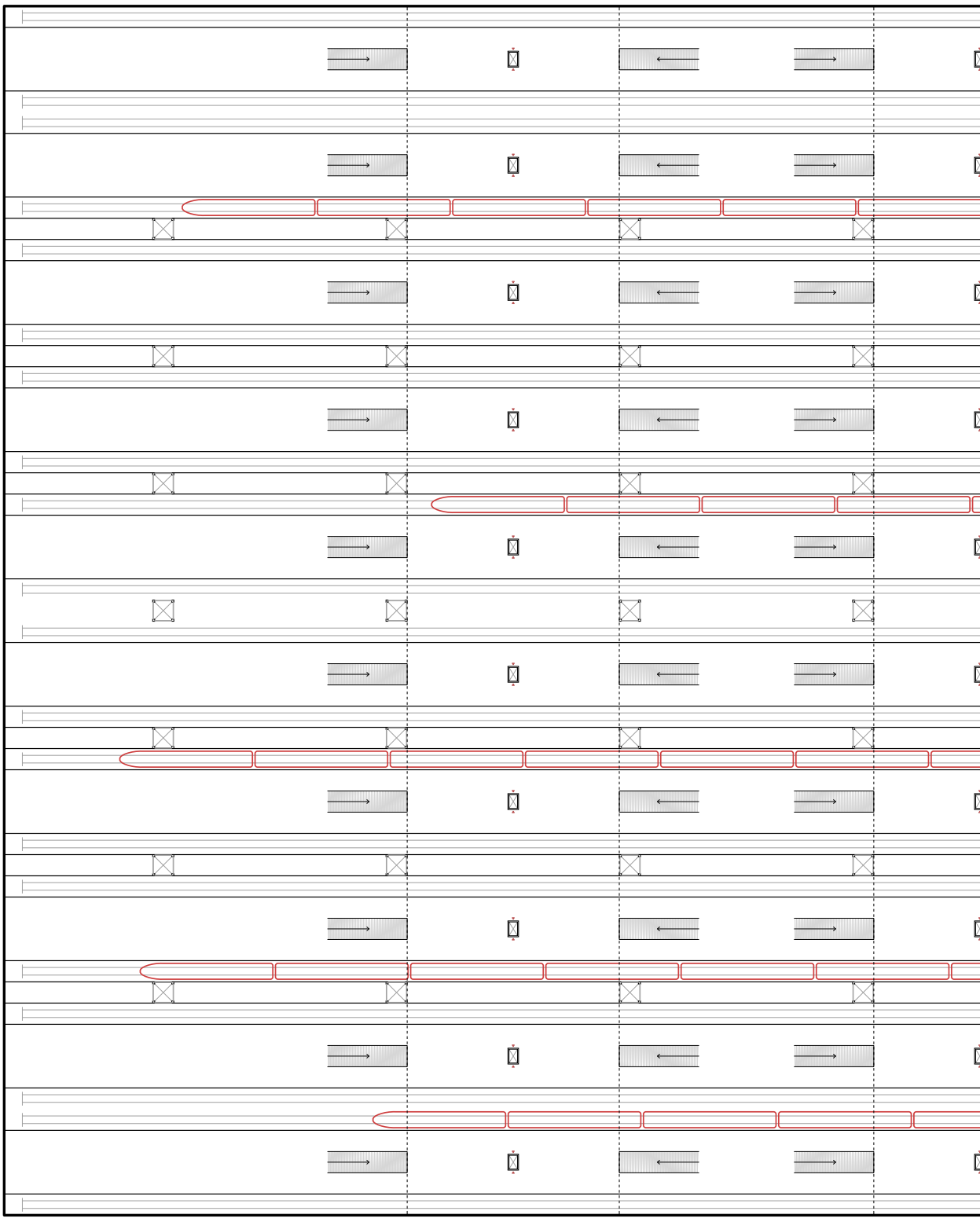

CHICKEN
RAVIOLI
Bar della Stazione



site plan
zoomed out gf

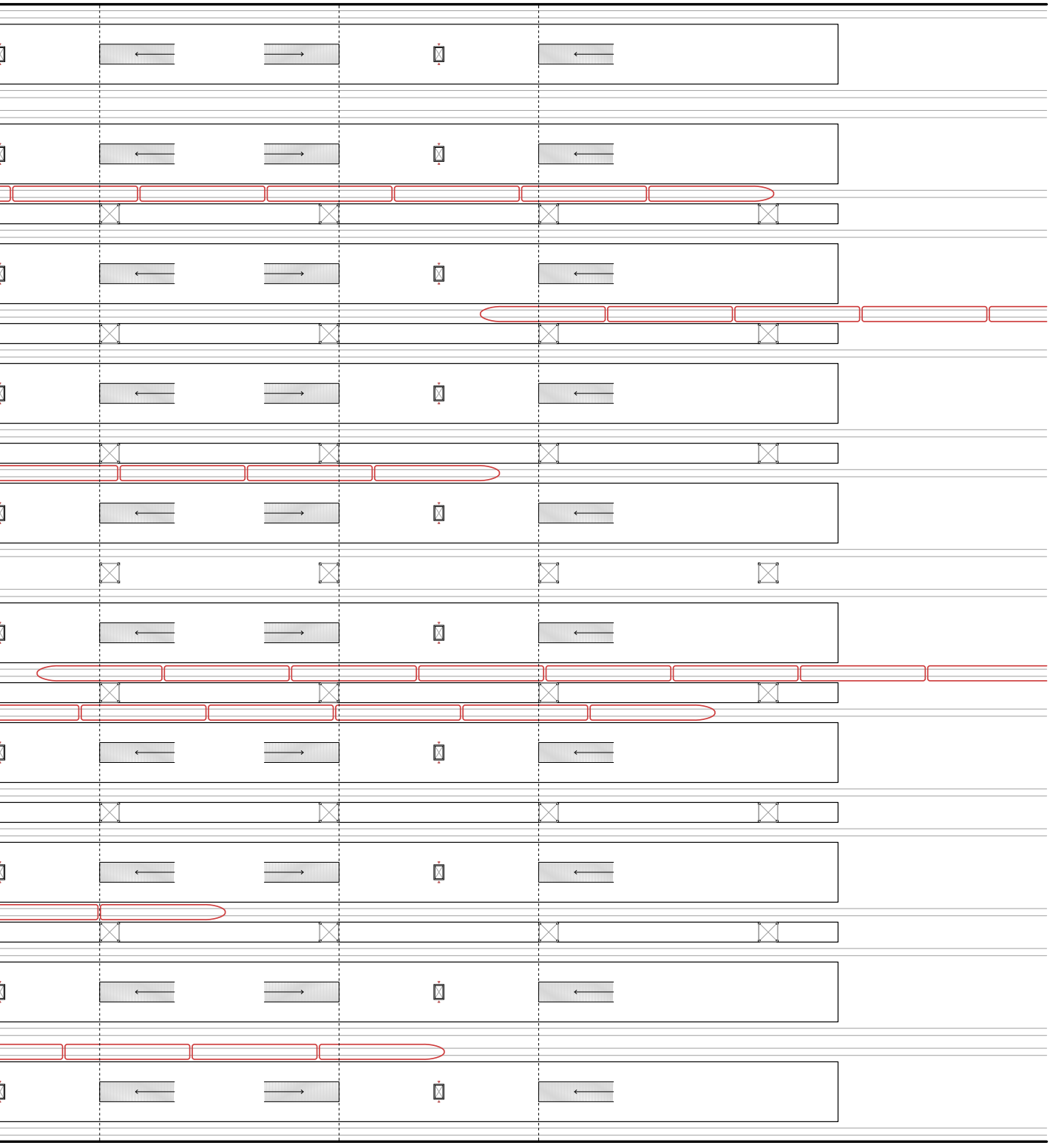
1:1800





-2
platforms

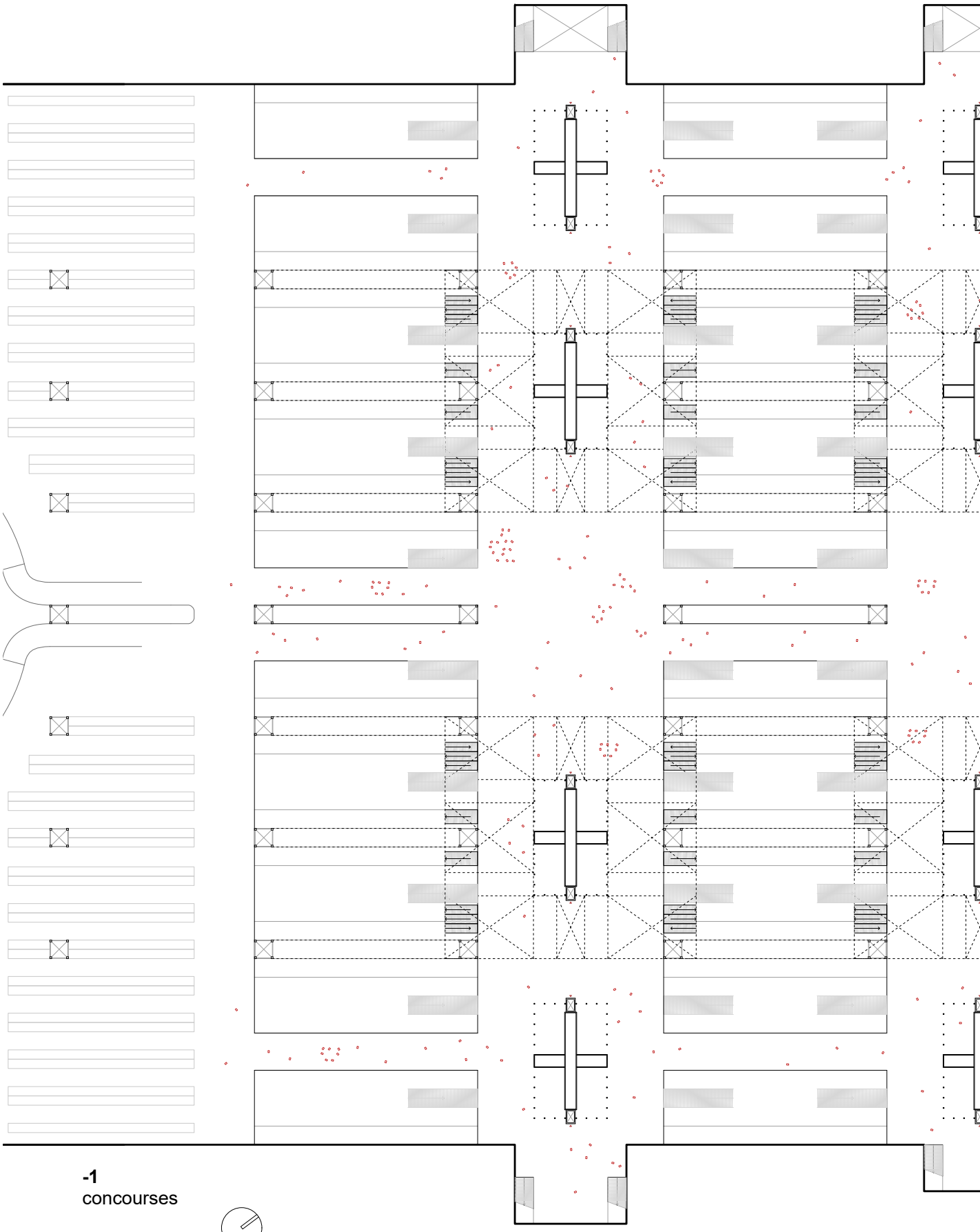
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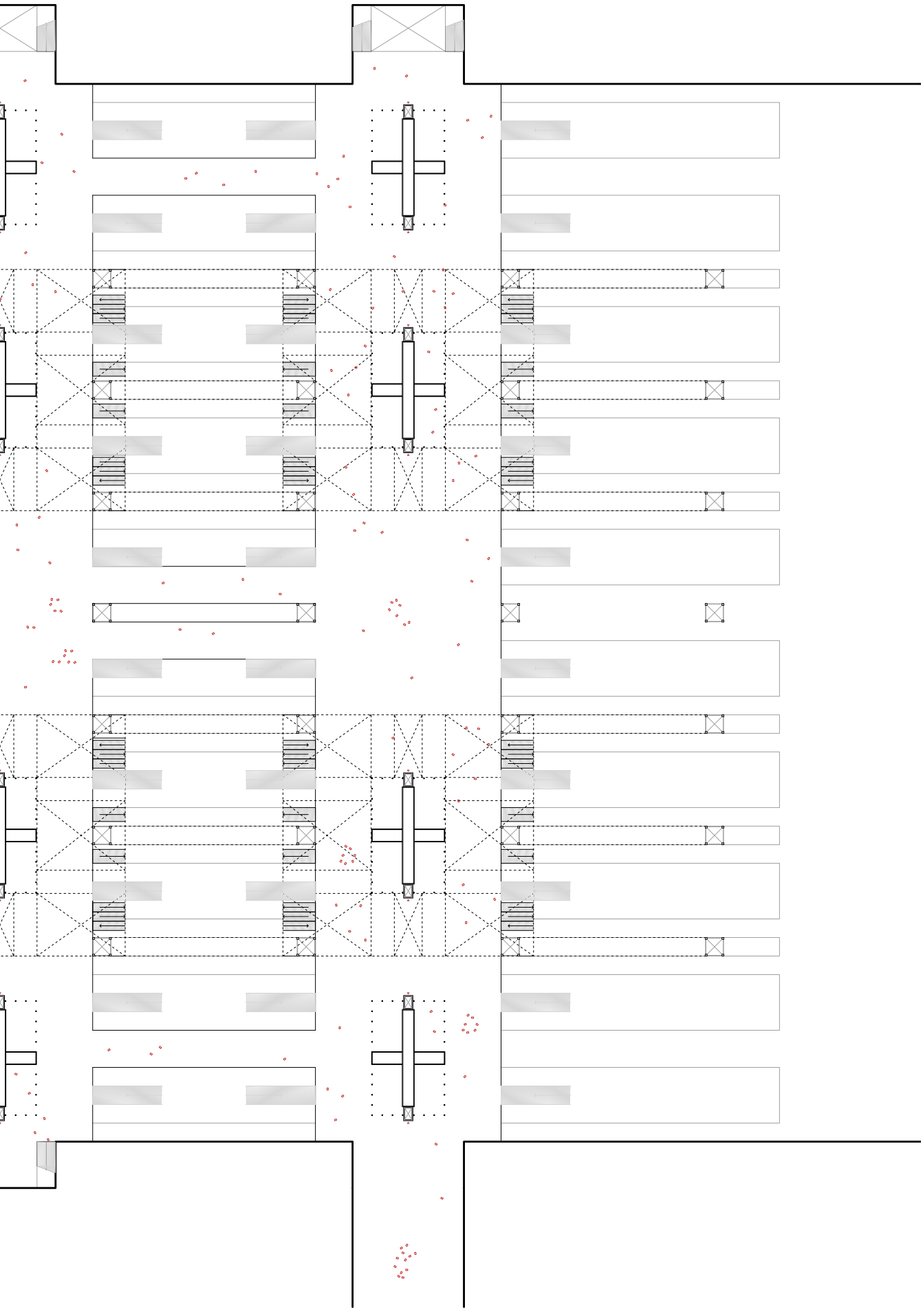
underground platforms arrival


ENTRALE



-1
concourses

1:1000





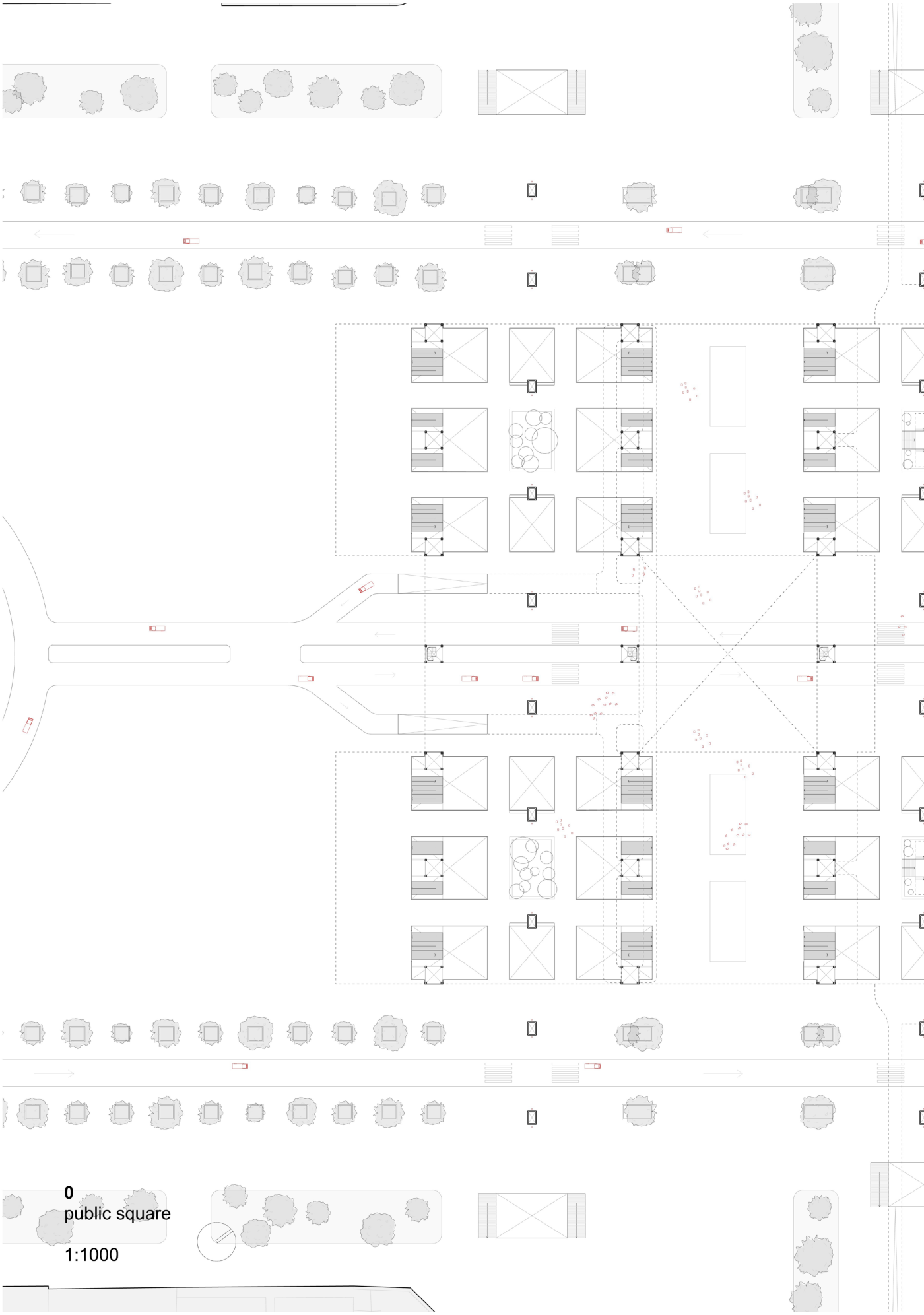
parcel lockers on concourse

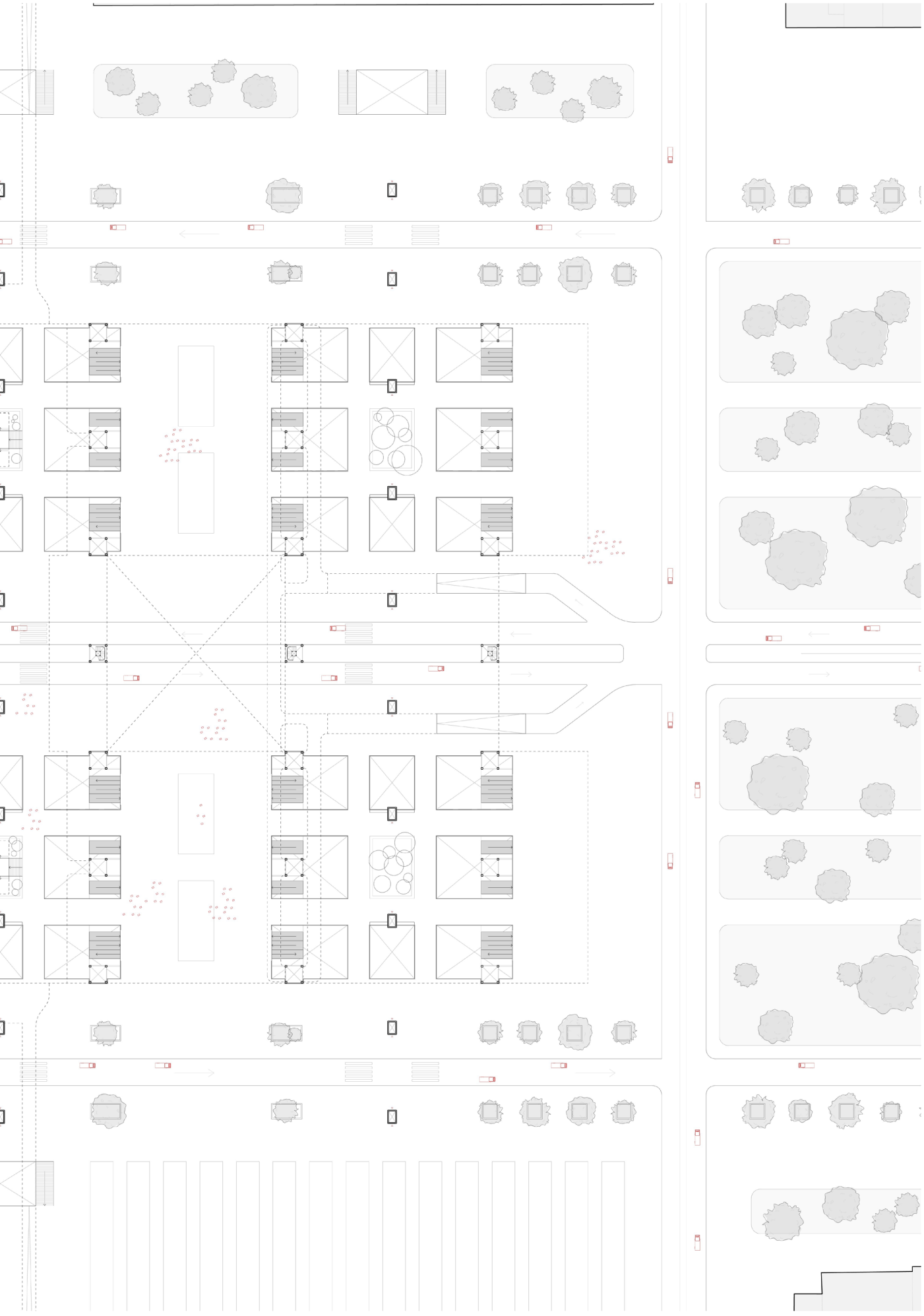

7
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Clear

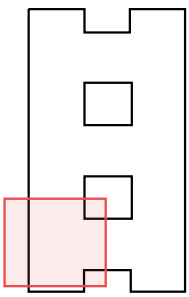


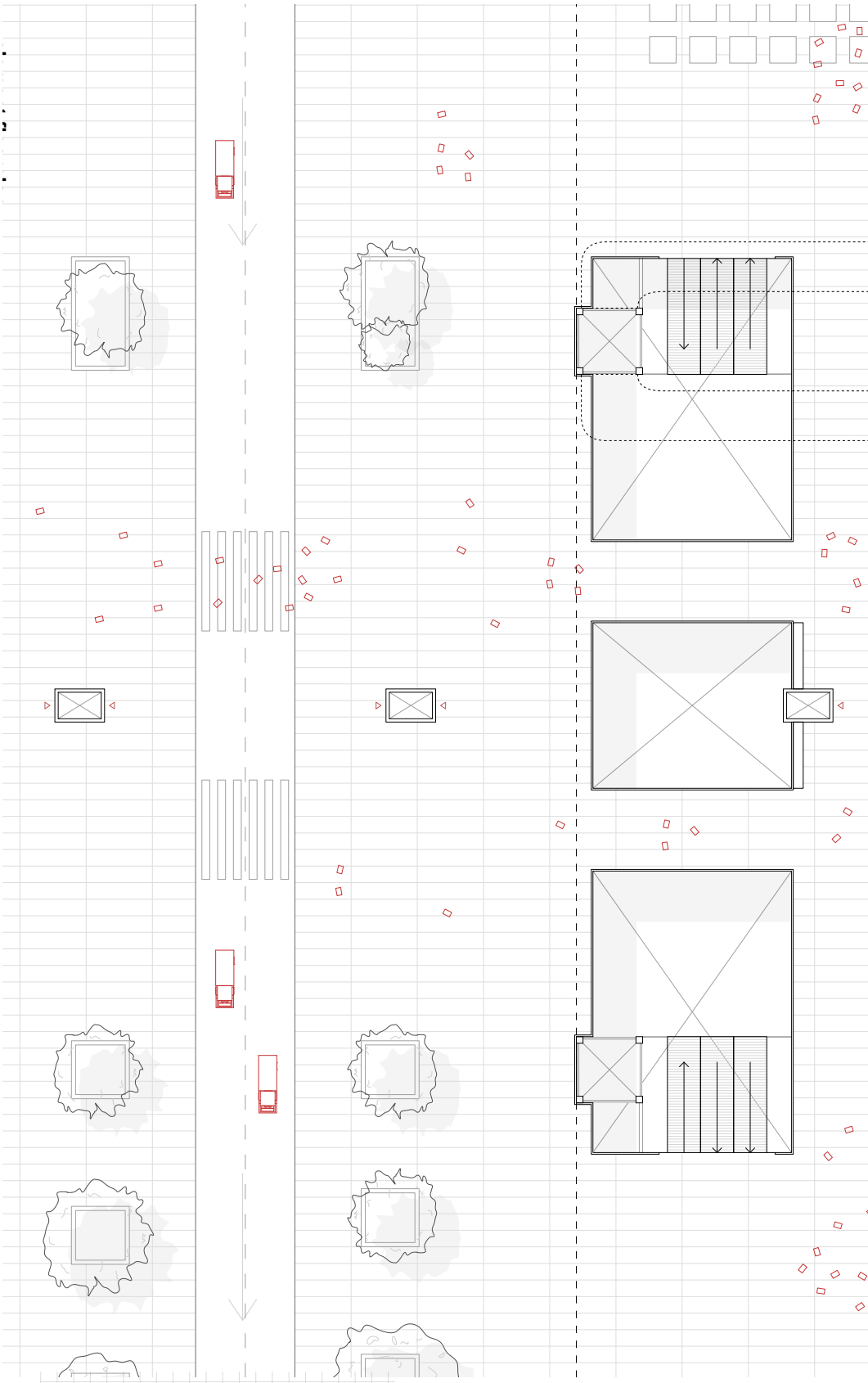
split concourse with retail and platform access


Exit


0
public square
1:1000

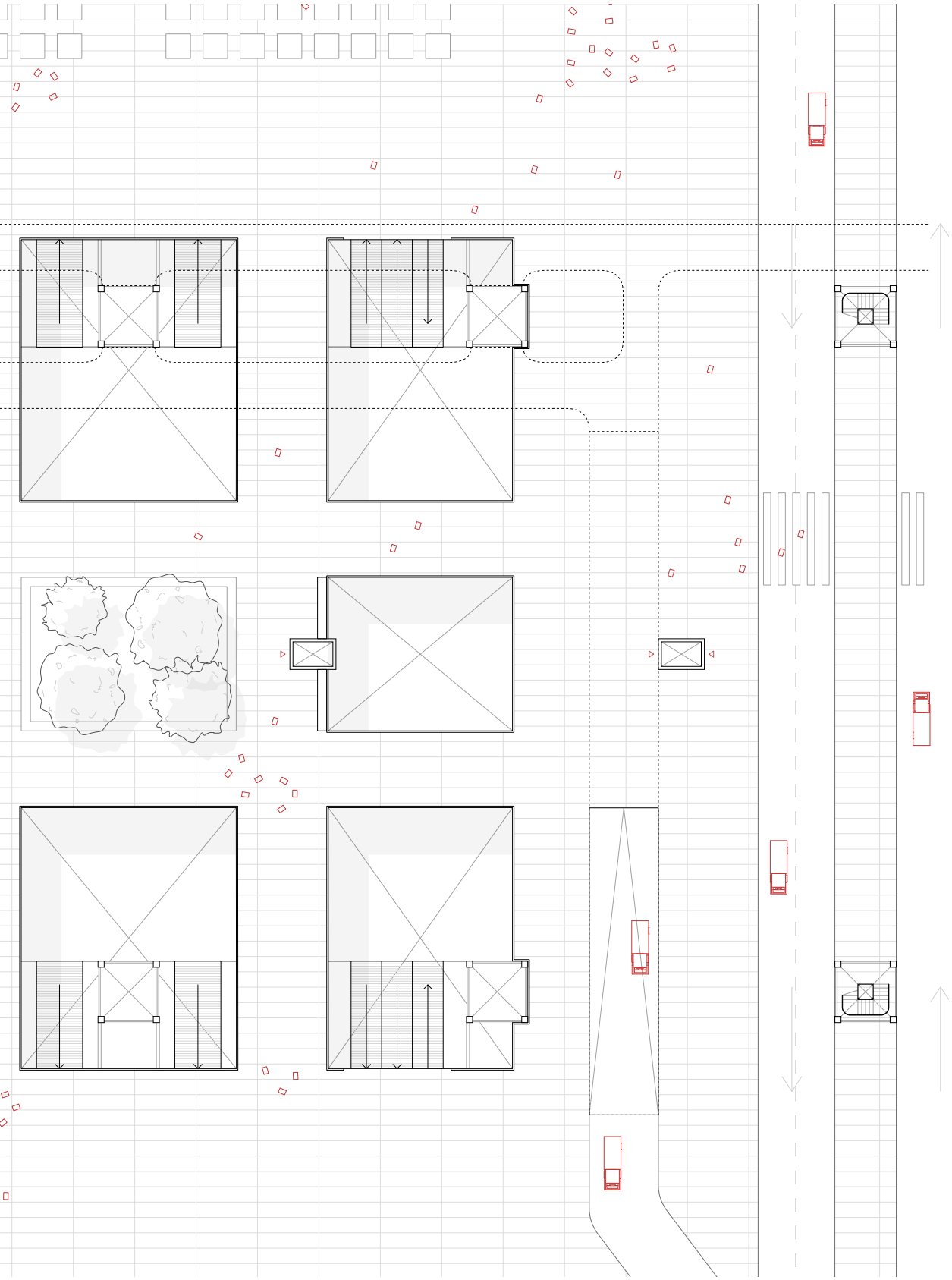






element floorplan
zoomed in

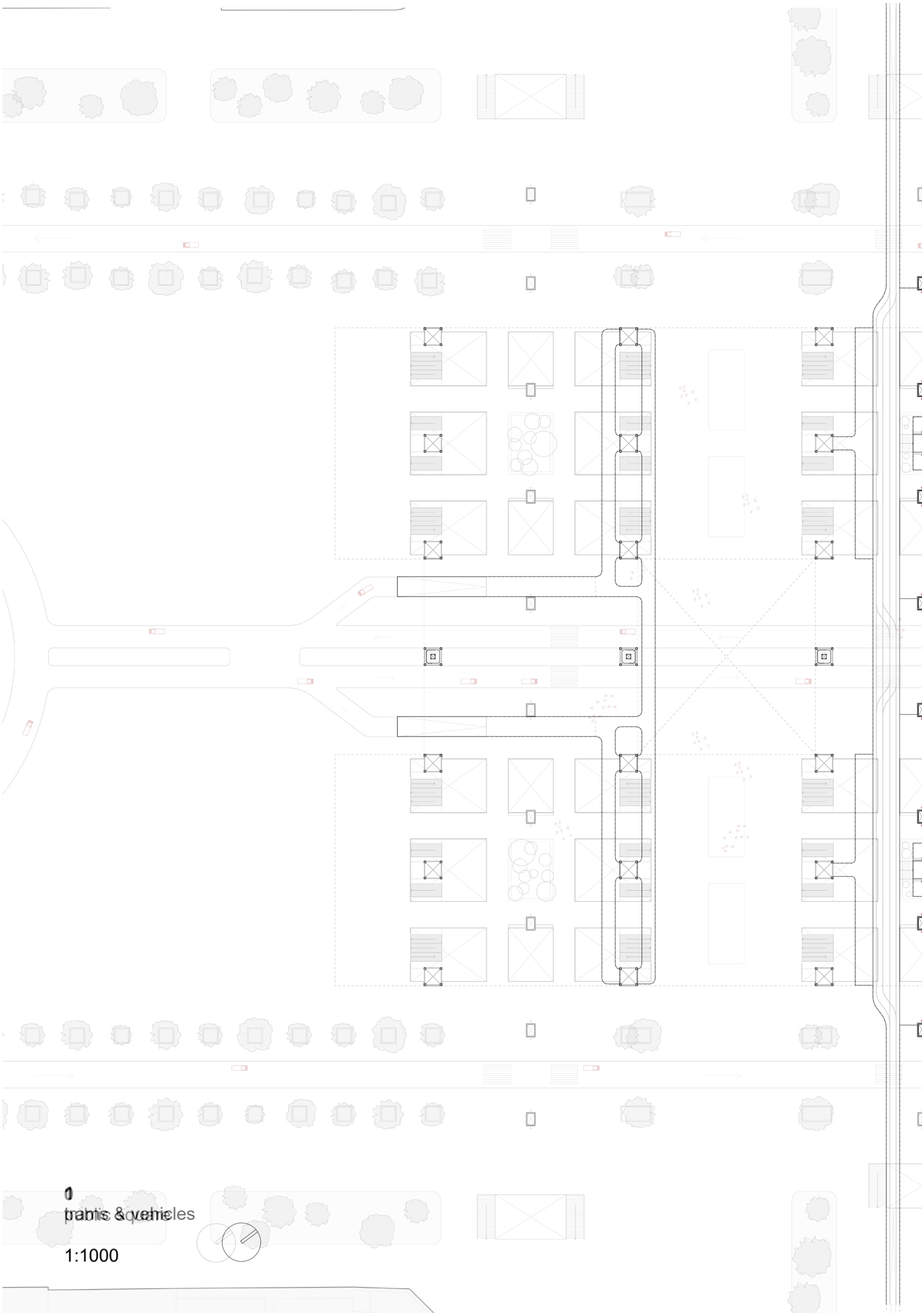
1:300

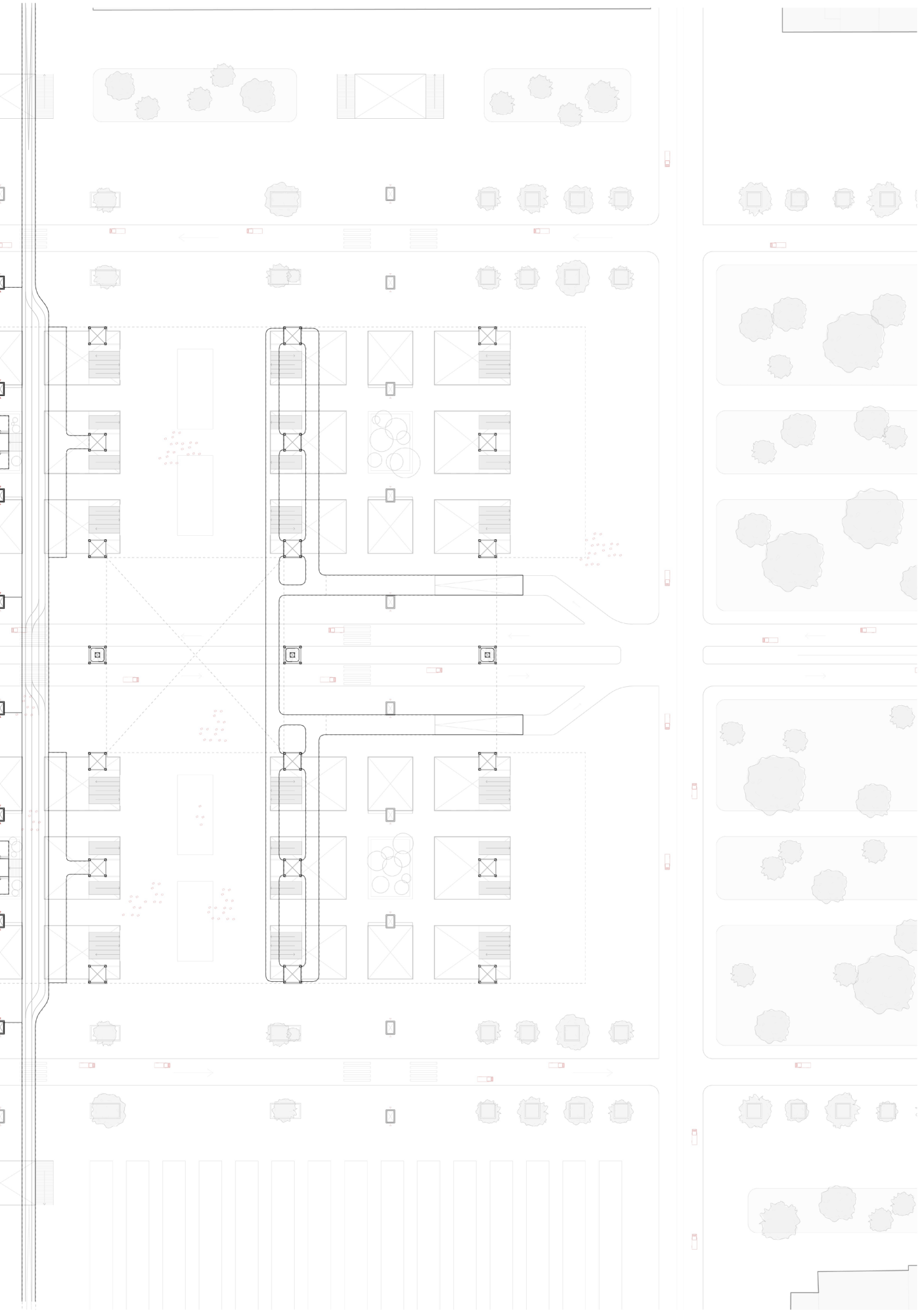




flow from ground floor plaza to concourse



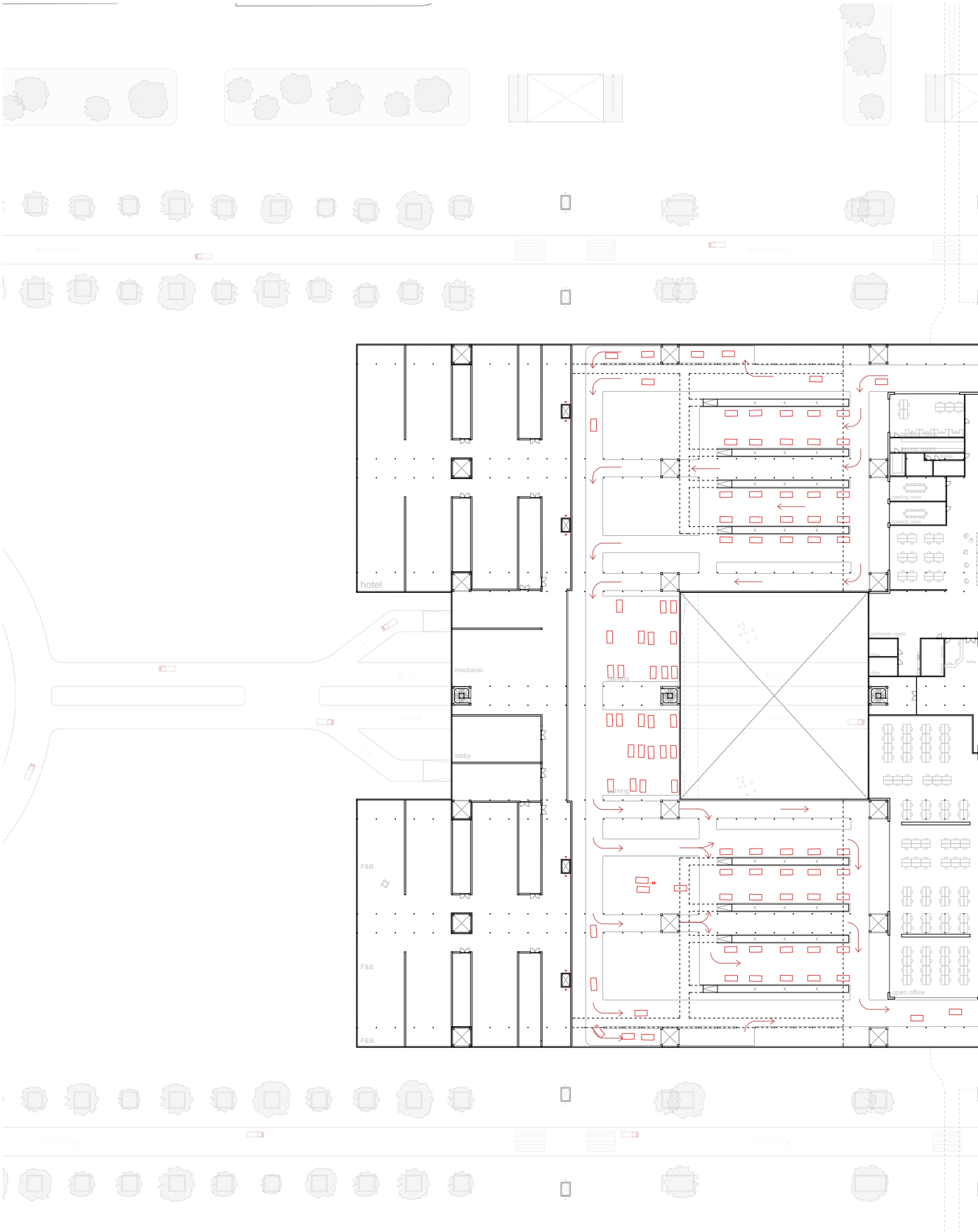

0
trams & vehicles
1:1000





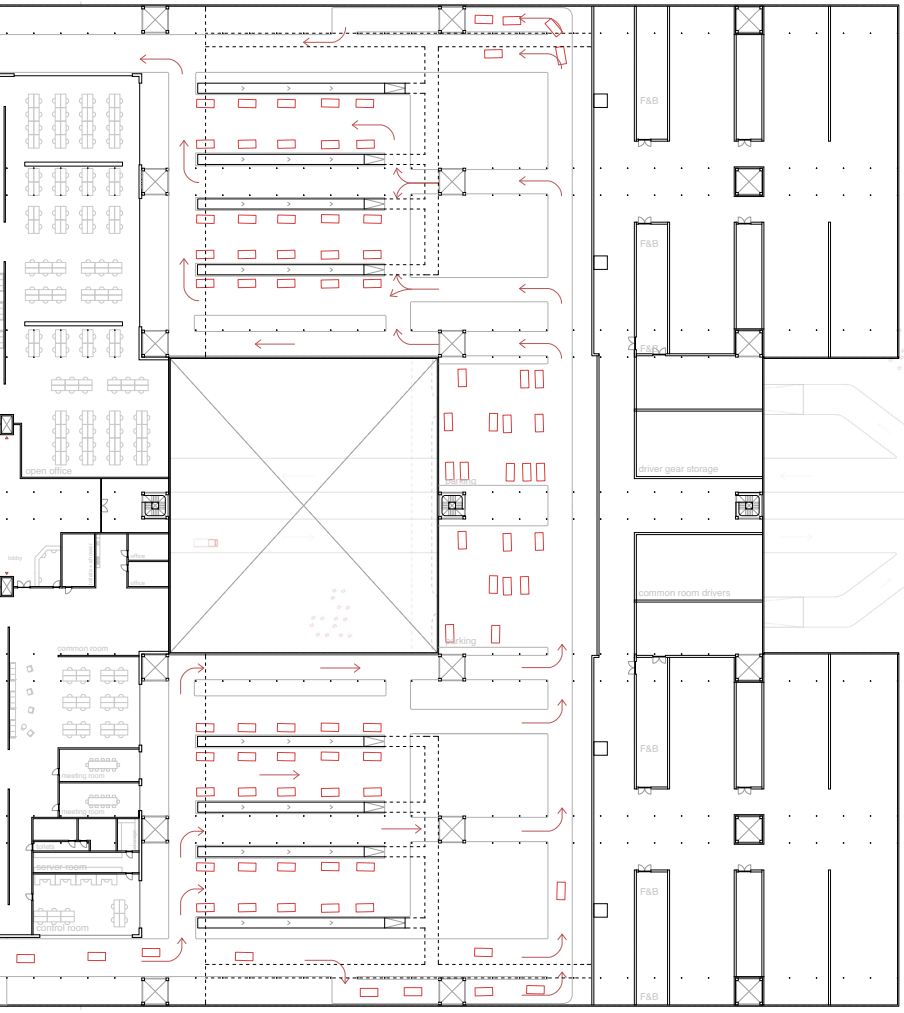
point of view from an MEV leaving the station





2
logistics

1:1000


F&B
F&B
F&B
driver gear storage
common room drivers
F&B
F&B
F&B
open office
lobby
common room
meeting room
server room
control room
parking



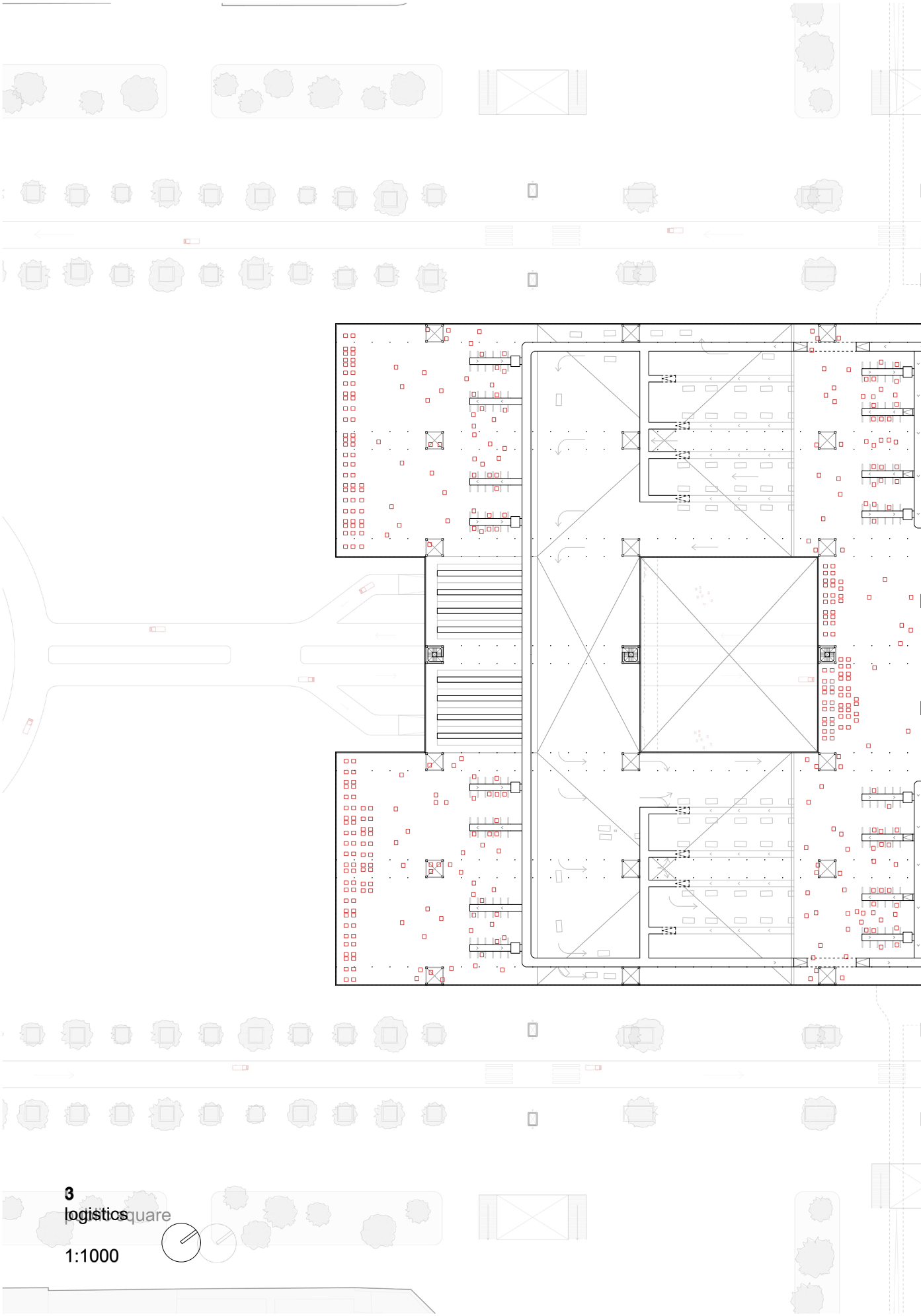
arrival to vehicle floor





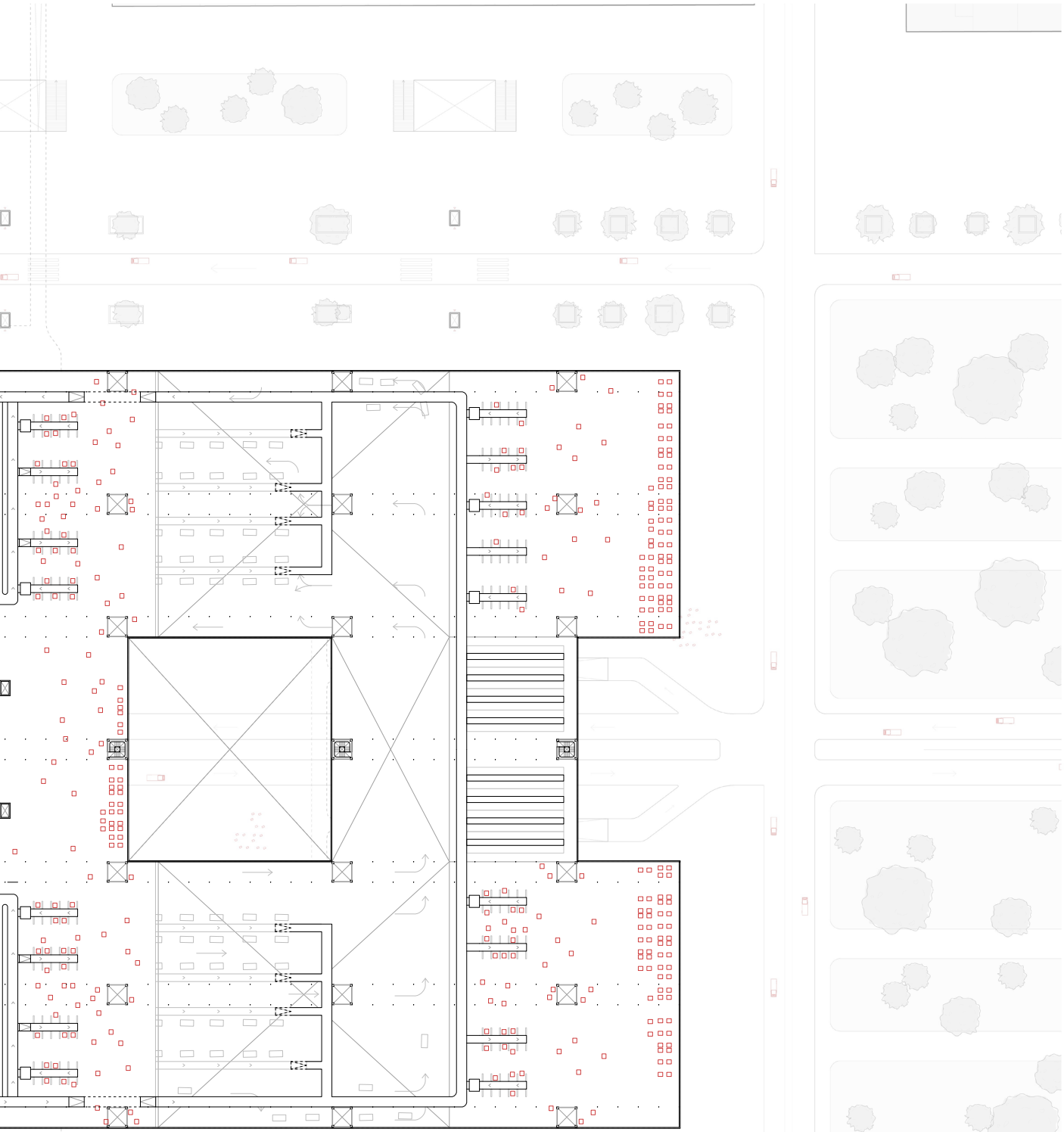
early morning unloading


Posteitaliane



3
logistics square

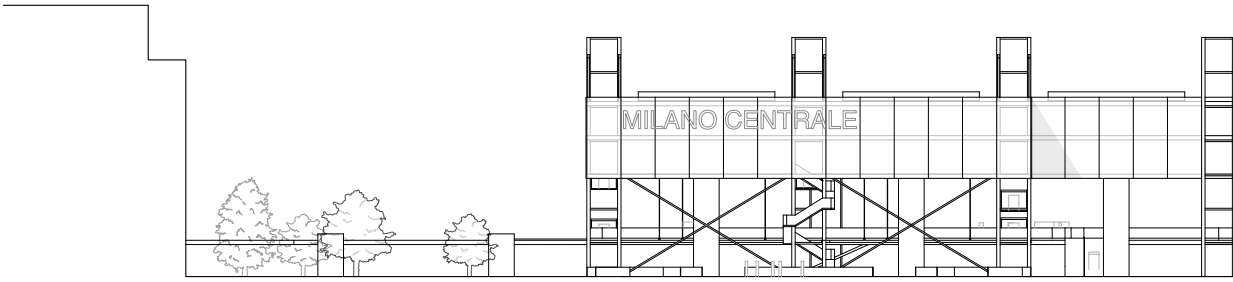
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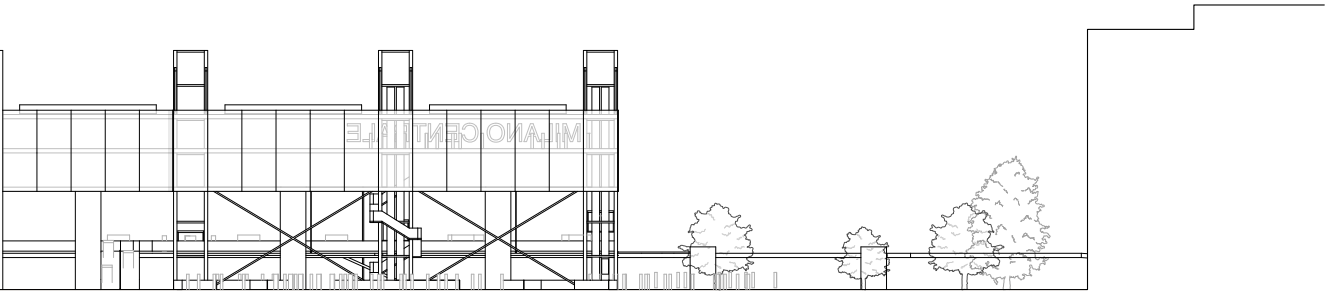
unloading bays with sorting system

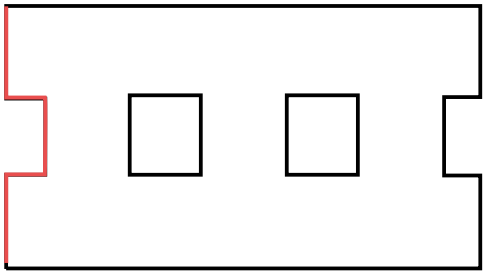

DHL
Posteitaliane



elevation
SW

1:1000

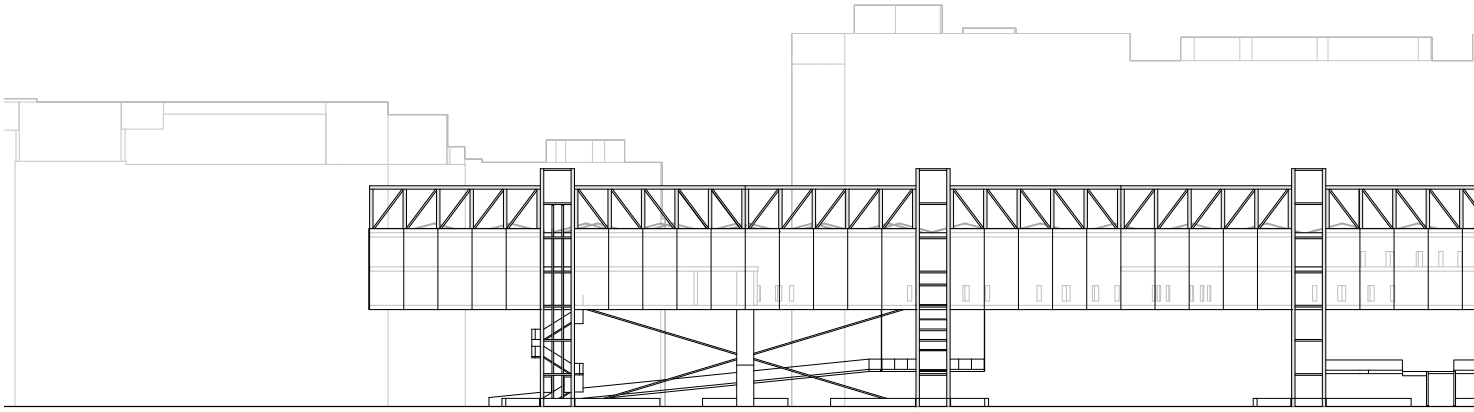






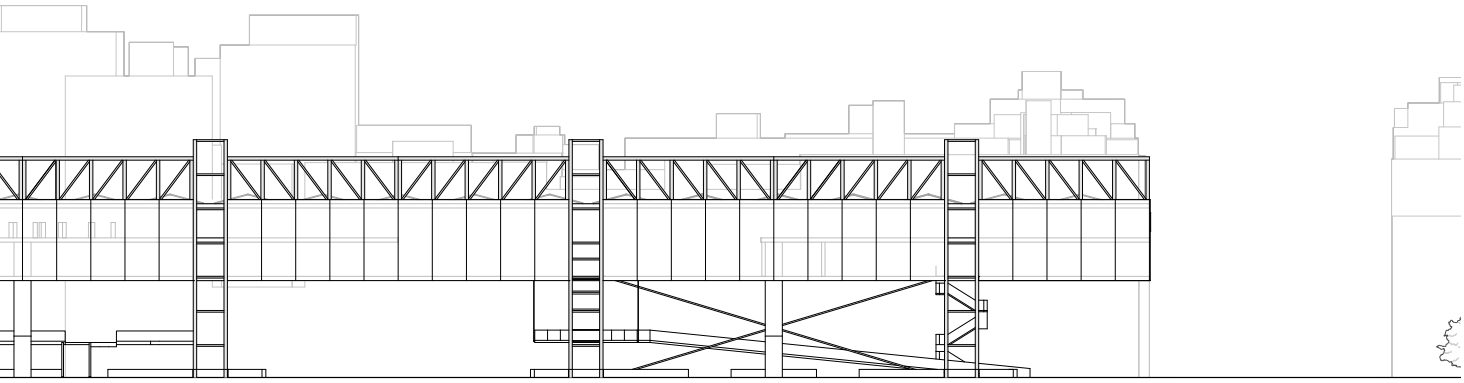
building as seen from plaza

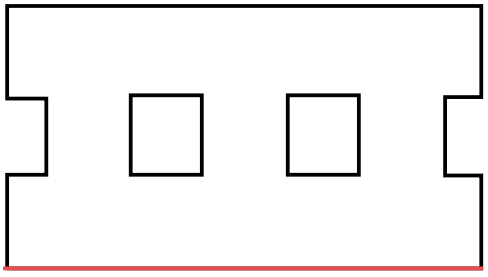




elevation
SE

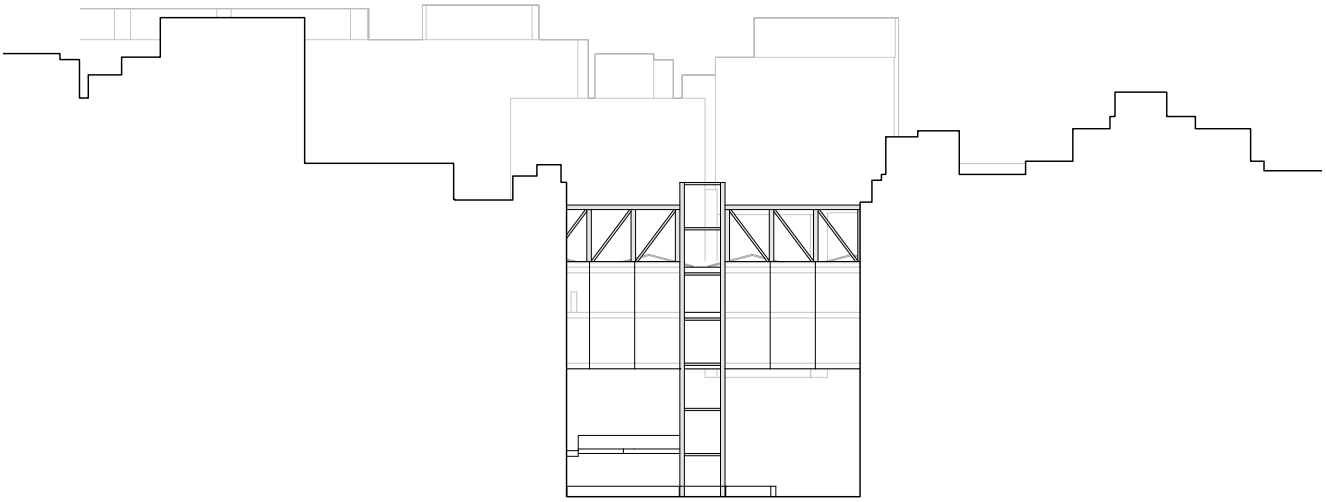
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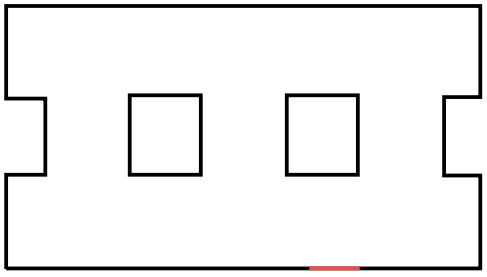


approach to corner of station



elevation from street
SE

1:1000

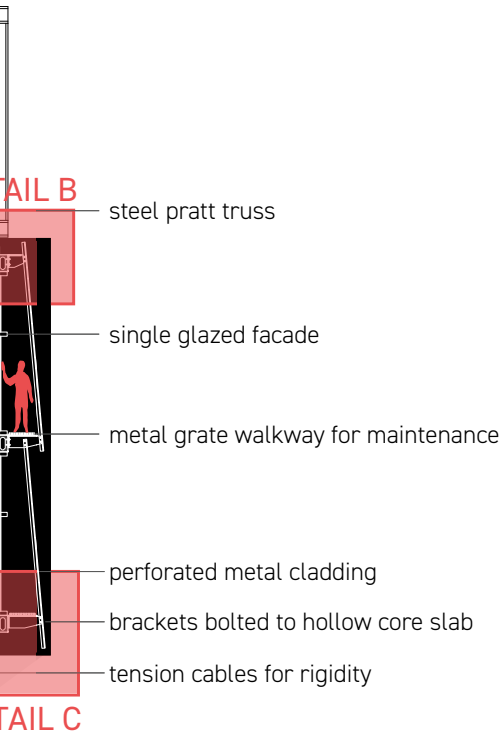


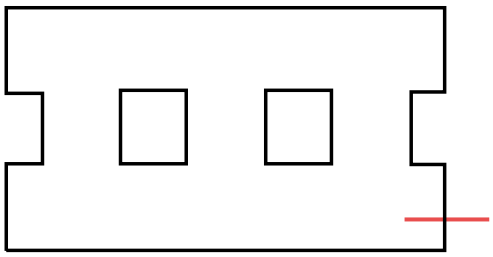


approach from side street

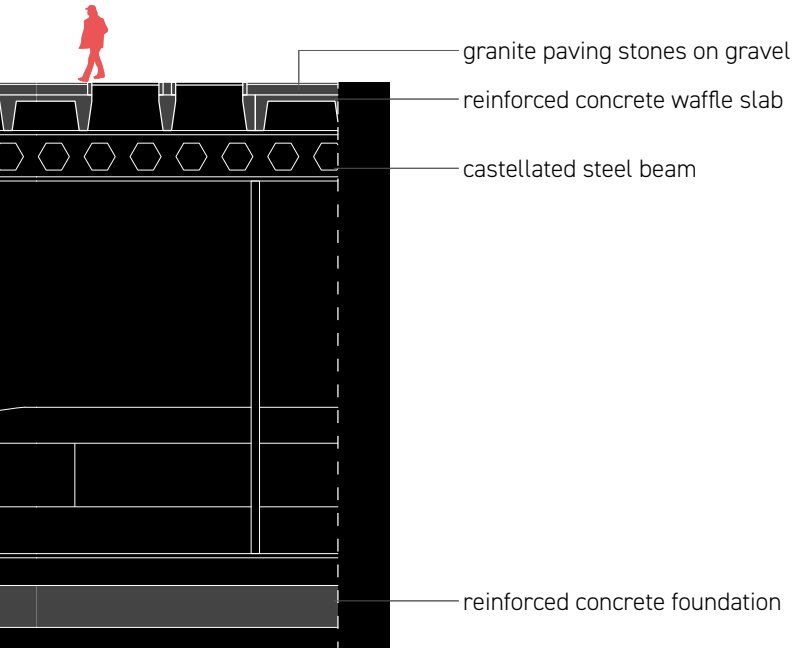


TRUSS
LOGISTICS
CONCOURSE
PLATFORMS
DETAIL A
DETAIL D
DET
DET



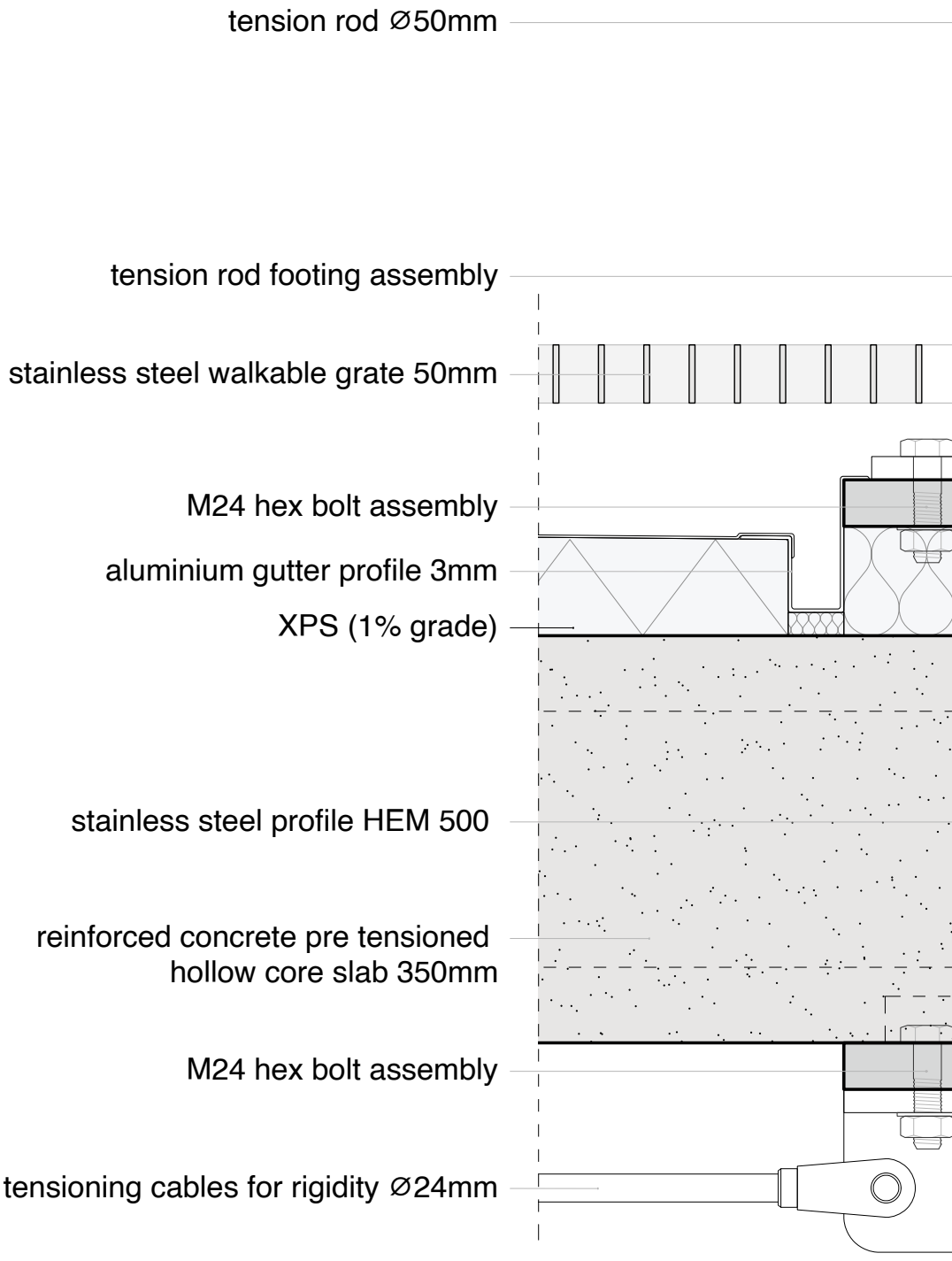


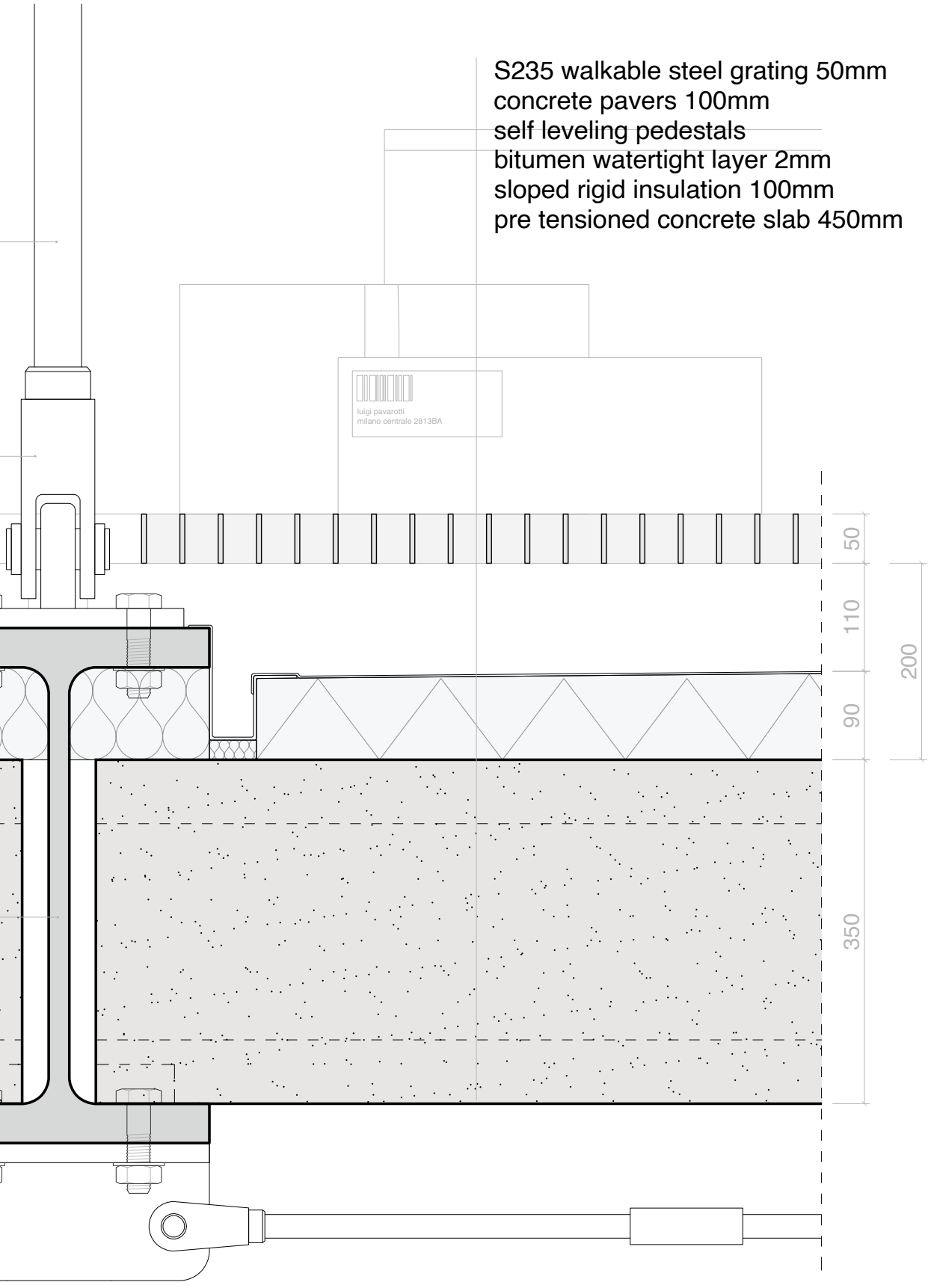
fragment location



detail A
floor suspension connection

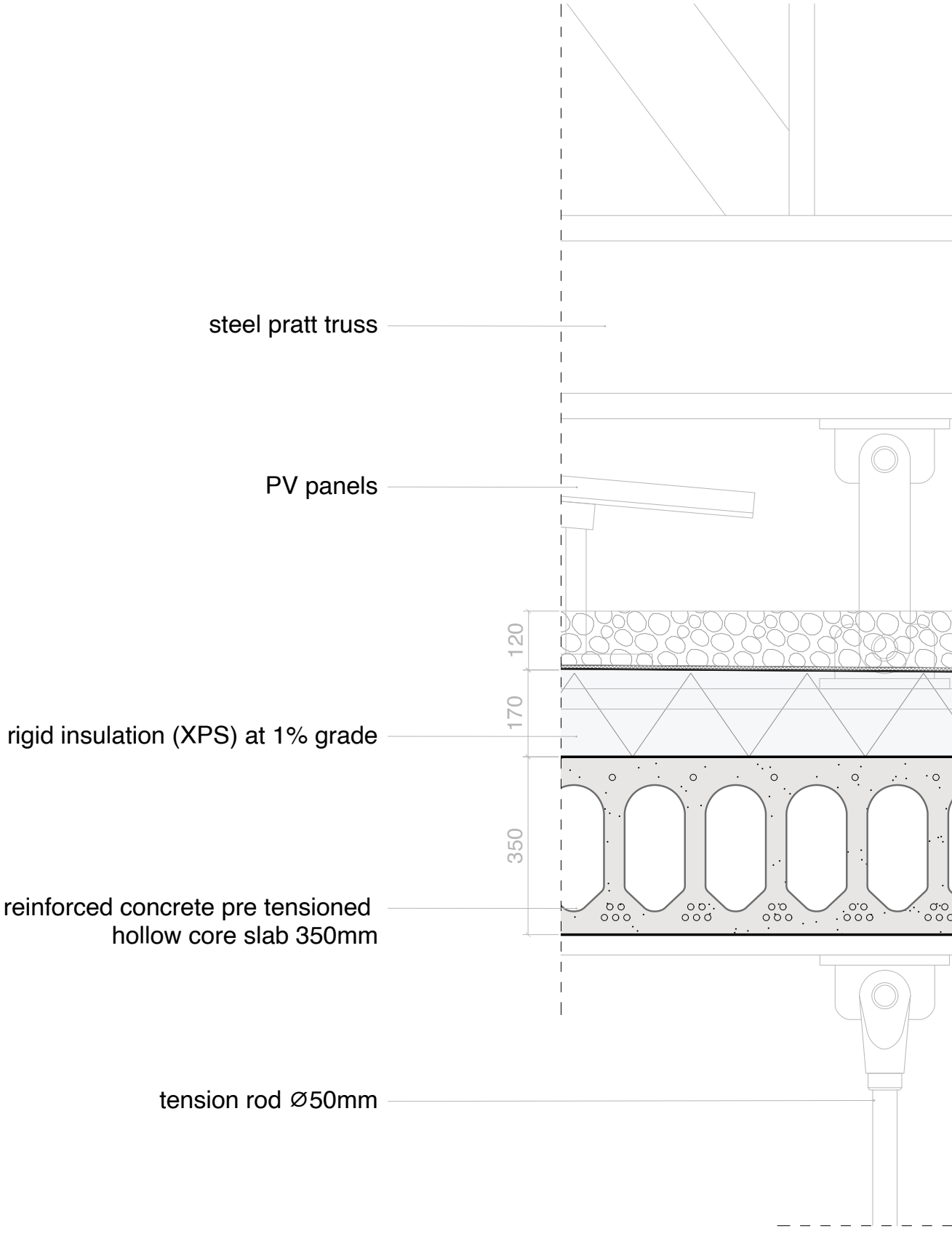
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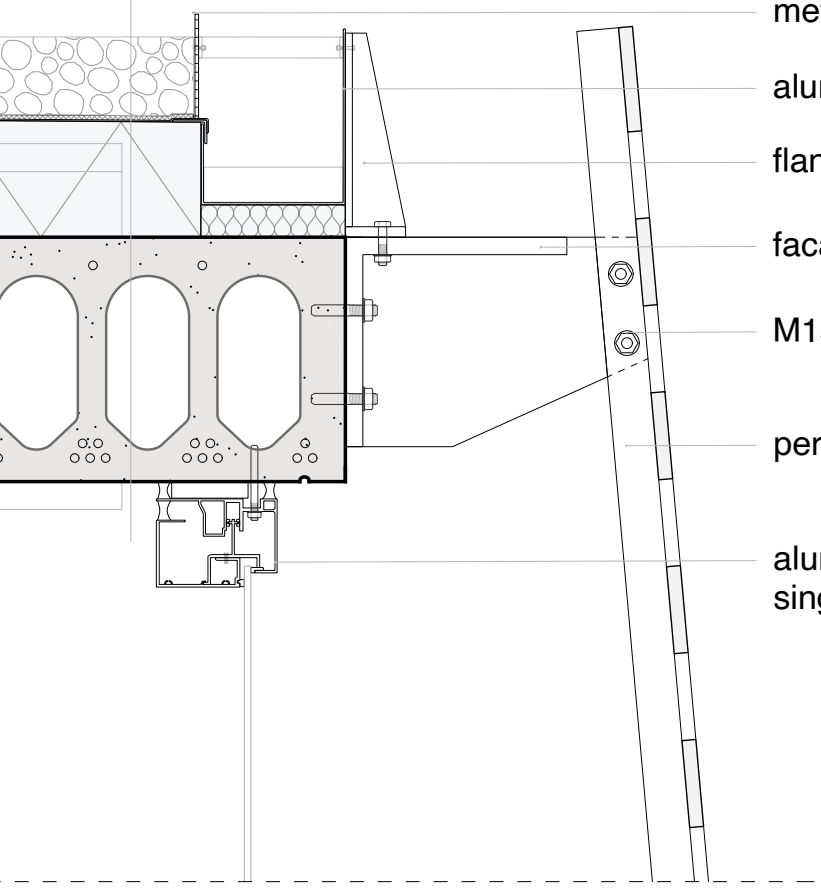

S235 walkable steel grating 50mm
concrete pavers 100mm
self leveling pedestals
bitumen watertight layer 2mm
sloped rigid insulation 100mm
pre tensioned concrete slab 450mm
luigi pavarotti
milano centrale 2813BA
50
110
90
200
350

detail B
roof parapet

1:10



gravel layer 120mm
protective membrane 8mm
bitumen watertight layer 2mm
sloped rigid insulation 170mm
pre tensioned concrete slab 450mm



metal grate holding gravel

aluminium gutter profile 3mm

flange stabilising gutter

facade bracket

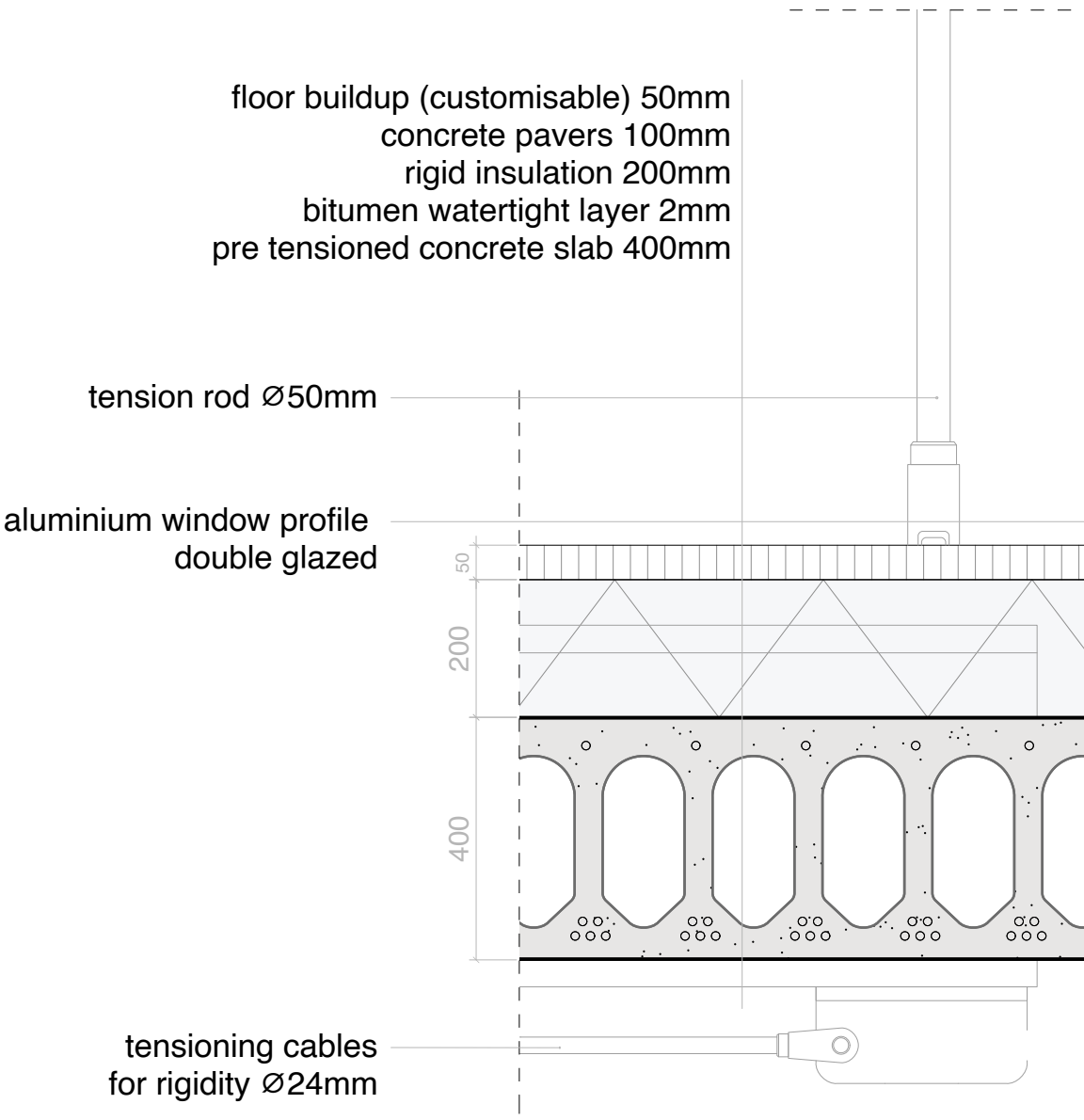
M15 hex bolt to bracket

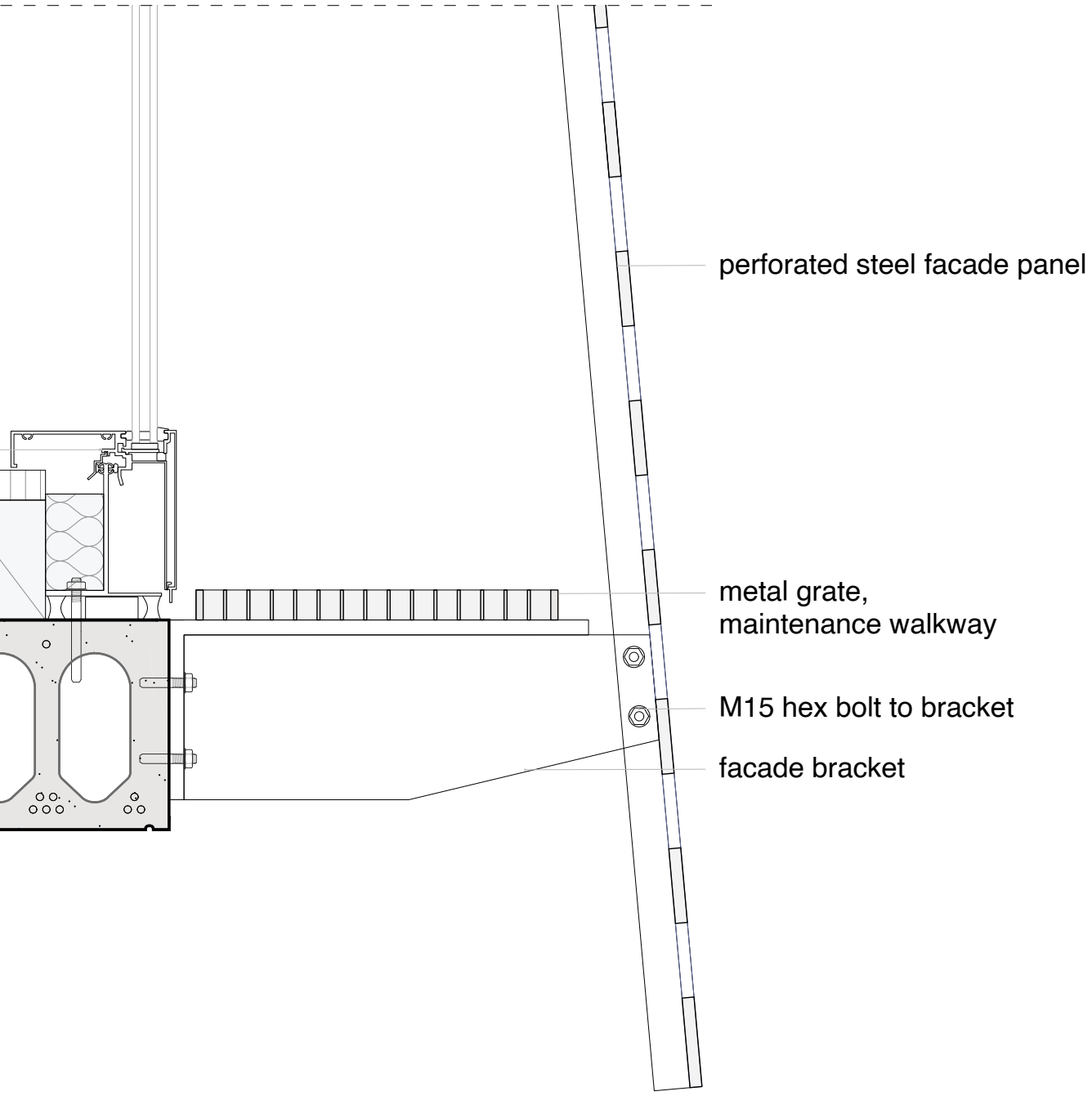
perforated steel facade panel

aluminium window profile
single glazed

detail B
underside facade insulated

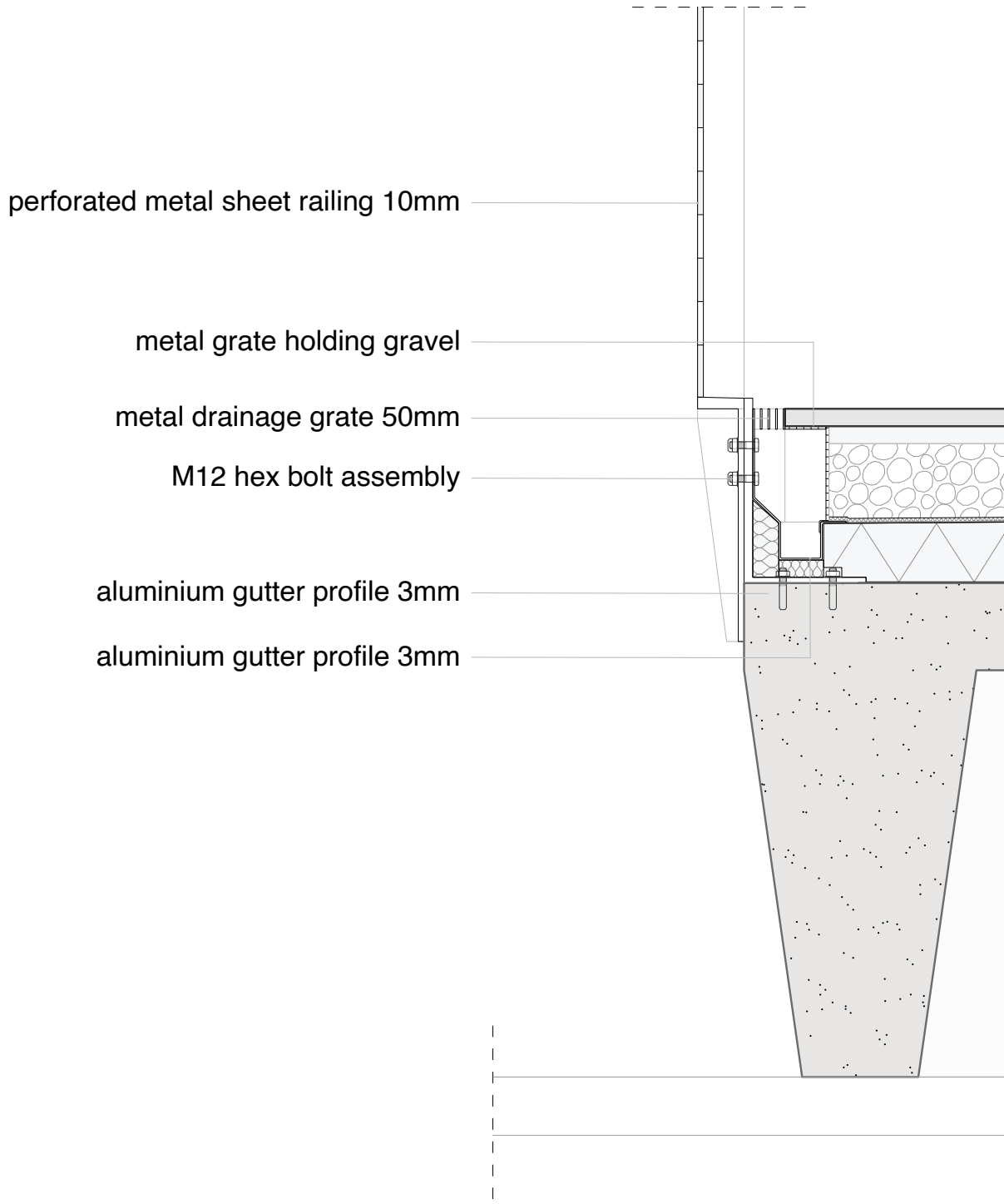
1:10



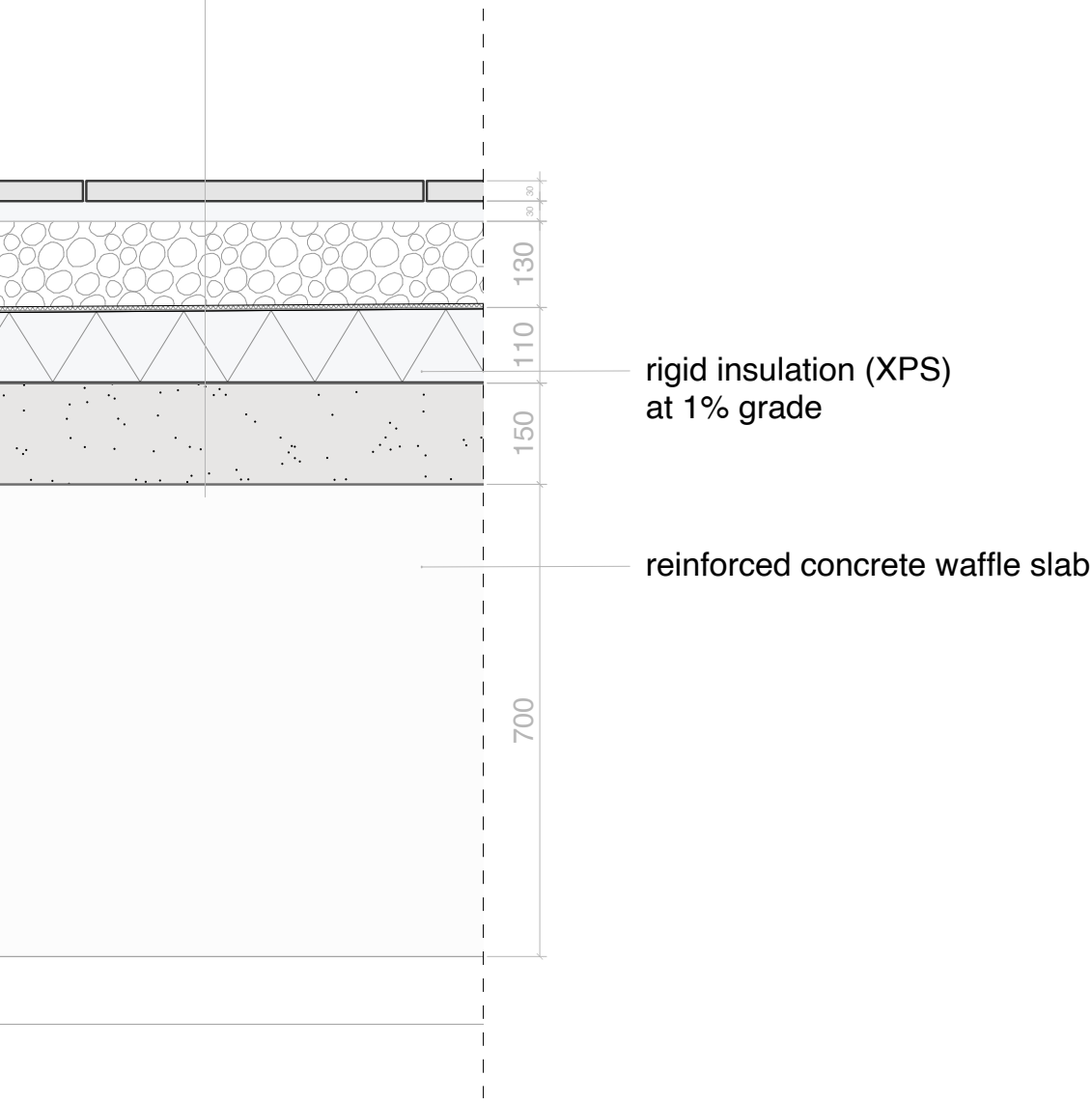

perforated steel facade panel
metal grate,
maintenance walkway
M15 hex bolt to bracket
facade bracket

detail D
platforms roof

1:10



granite (beola) paving stones 30mm
sand screed layer 30mm
gravel leveling 130mm
protective membrane 8mm
bitumen watertight layer 2mm
sloped rigid insulation 110mm
reinforced concrete waffle slab 150mm



06
REFLECTION

RESEARCH QUESTIONS

a reflection of the posed research questions

At the start of the process a main research question was constituted, as follows: "**In what ways does the function of a parcel logistics hub influence the layout and program of a station within a car free Milan?**"

This question is too large to give a direct answer which is why it was split into three subquestions, regarding **people**, **parcels** and the **building**.

Starting of with the question: "**What measures are needed to preserve passenger comfort in the station while maintaining efficient parcel handling?**", throughout the design passenger comfort was to be realised through short dwell times and direct circulation. This circulation principles is well applied through the three parallel concourses and the direct access to elevators on each platform together with direct access to secondary modes of transport such as large bike parking sections, trams and taxi stands. Besides the circulation however, there have been compromises regarding the waiting areas and food and beverage stops, as a significant part of the food amenities are located in the roof structure passengers first need to use the elevators in order to gain access. Forming a potential hurdle, this increased barrier of entry is to be weighed against the potential of good views and the visual interaction with the logistics hub of visitors. This is not the case for the majority of retail, which is located on the concourses itself, having large passenger flows. As such part of the passenger comfort and experience has regrettably been compromised in favour of efficient logistical handling.

Secondly the question regarding parcels: "**How to enable the efficient transfer and sorting of parcels from trains to last mile transport vehicles?**". Here a direct approach was taken, as the majority of the concept depended on strong logistical flows. These flows focus on bringing parcels from delivery vehicles, parcel trains, parcel trams and people to the logistics floor. After which these parcels are sorted and once again distributed to the aforementioned four flows. Throughout the design these flows formed the basis around which the structure, and thereby the building, took shape. In this efficiency was kept wherever possible, the only major efficiency challenge is

the gained travel time of having the delivery vehicles travel to the roof volume in order to load and unload. However this was made necessary in order to free up the ground floor as the station concourse, maintaining clear physical separation of flows while allowing visual connection.

Lastly the third question takes on the role of the building in the urban fabric as follows: "**How does the surrounding urban fabric respond to the new station program?**". This question was the first to be get an answer, as the building development was reliant on the urban strategy, as discussed the station functions as an infrastructure consisting of repeatable modules. This means the urban space freed up by moving the train tracks underground can be utilised for future station expansion. As demand grows for parcel delivery by train and passenger flows increase, the station is able to be expanded following the same structural and programmatic logic. While the plot still sits empty, waiting for any station expansion, it functions as public green. This public amenity is however not lost when the station expands, the land is then converted to plaza space covered by the logistics roof. Providing necessary amenities to the surrounding area. A critique of this approach is the difficulty of foresight, as urban conditions might be entirely different when expansion is required. Due to shifting populations and priorities, thus the currently designed modules are self sustaining and do not rely on the promise of future expansion in order to function.

Concluding this, the main question is answered, showcasing how the program of the station, through the addition of parcel platforms, sorting hubs and vehicle bays in combination with passenger facilities creates an infrastructural system. The layout, largely defined by the urban strategy in combination with the structure shapes the building into a repeatable concept.

07
APPENDIX

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