

THE CONFIGURABLE TERMINAL

A design framework for an adaptable airport terminal

GRADUATION REPORT

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I have been fascinated by airports since my childhood when I occasionally visited Schiphol Airport. During the ride, the Schiphol Tower appeared in the distance. Once there, the tower was even larger, you could observe the planes, and inside, I was overwhelmed by the number of people. For me, an airport is a type of building where every aspect of architecture comes together, particularly the combination of functional design and designing for passengers. I am delighted to get the chance to explore my fascination within the Explore Lab graduation studio.

I would like to thank Henri van Bennekom, Rico Heykant and Peter Rieff (from NACO) for their guidance during my graduation project. Their help enabled me to achieve the final result presented in this report.

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01 Introduction

Airports are complex buildings and vary greatly in size, from small regional airports to enormous international hubs. They are multi-functional structures that combine many different functions and are subject to constant change. This is one of the reasons why airports are always evolving. Runways are the only element in airport design that are relatively fixed (Edwards, 2004). All other parts: aircrafts, aprons, piers and passenger terminals, are subject to change because of the always changing passenger and airline demands (Charkas & Needham, 2023), technological aircraft advances and operational demands (Shuchi et al, 2012).

Inflexible terminals

Many passenger terminals or entire airports have been closed since they were unable to adapt to these changing needs. The Trans World Airlines (TWA) terminal at John F. Kennedy International Airport was regarded at the time as the highlight of the golden age of aviation due to its flowing lines and futuristic appearance. However, over time it appeared that the compact and radial design was totally inefficient in comparison to rectangular shaped terminals (Shuchi et al, 2018). Another example was the design of Mirabel International Airport in Montreal, built in 1976 for the Olympic Games. The masterplan intended to carry up to fifty million passengers a year. However, shortly after the Olympic Games were finished, passenger demand decreased heavily. Since then, parts of the terminal became inactive. Today, the airport operates only for cargo with a small part of the original terminal (Kwakkel et al, 2010; Magalhães et al, 2017). A third example relates to the inflexible design of Pittsburgh International Airport that has led to a major redevelopment of the terminal when the airport lost its hub function. US Airways changed its hub location from Pittsburgh to Philadelphia and as a result, passenger demand has shifted completely resulting in an unfriendly terminal layout (De Neufville, 2008).

External factors

It is not only the above factors that call for better implementation of flexibility in airport design. External factors including geopolitical tensions, economic instability, fluctuating fuel prices, shifts in global trade, and ongoing supply chain disruptions also create considerable uncertainty in the aviation industry and require for more flexibility in airport design. These factors could namely negatively impact passenger demand and lead to regional declines in air traffic (Li, 2025b).

Growing number of passengers

Despite the changing demands and all the uncertainties with which the aviation industry is dealing, it has experienced sustained growth over the past decades, reaching a record number of 9.4 billion passengers in 2024. Thereby, it exceeded pre-pandemic levels by almost 3 percent, indicating a strong recovery and renewed growth in aviation traffic (Zhang, 2025). Forecasts indicate that this upward trend will continue with passenger numbers expected to reach around 12 billion in 2030 (Li, 2025b) up to 22 billion in 2053 (Li, 2025a).



fig. 1: TWA terminal at John F. Kennedy International Airport

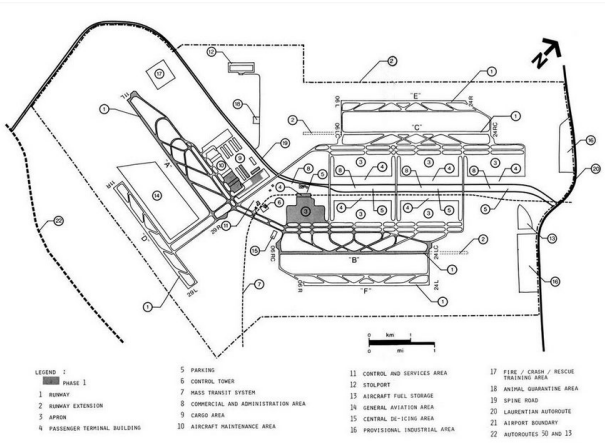


fig. 2: Masterplan of Mirabel International Airport



fig. 3: Pittsburgh International airport during construction work

Problem statement

To respond to the expected increase in passenger numbers, significant investment in airport capacity will be required, including the construction of new airports and the expansion of existing facilities. At the same time, the uncertain and dynamic nature of the aviation industry requires airport designs that are not only suitable for growth, but also flexible enough to accommodate other functions if demand suddenly decreases. This dual challenge highlights the growing importance of adaptive and resilient airport infrastructure as a crucial consideration for the future development of airports and the built environment. Therefore, this research will answer the following research question:

How can an airport terminal be designed as an adaptable framework that can adjust to changing air travel conditions over time?

This question is divided into the following sub-questions:

1. Which terminal typology is most suitable for adaptive design?
2. Which elements of a terminal building need to be flexible, and to what extent?
3. Which architectural design strategies can support long-term adaptability in an airport terminal?

Scope

The outcome of this research has led to the design of a generic concept for an adaptable airport terminal mainly focusing on future growth scenarios. Comprising multiple configurations, thereby enabling maximum flexibility depending on the location of the airport to be built.

02 Methodology

This research is conducted by a combination of different methods. Literature studies are used to find already existing research about adaptive and flexible airport design. The following terms were used in Google Scholar, Researchgate, Academia and the TU Delft Repository to find available publications: adaptive airport, adaptive architecture, adaptive strategic planning airport, flexible airport design, flexibility in airport design and flexible architecture.

Also several books have been used for this research, namely: Airport Systems: planning, design, and management; The Evolution of Airport Design; Airport Development Reference Manual. These sources have been utilised for the theoretical framework of this research. In addition, literature research has also played a role by answering the sub-questions.

For the first sub-question, a combination of literature research, analyses of different terminal typologies and reference projects has resulted in a matrix that shows for each terminal typology the suitability of adaptive design.

Case studies and literature research were methods that have been applied on the second sub-question. A list divided into different categories reveals which elements of an airport terminal need to be flexible and to what extent.

For answering the last sub-question, literature research is used to come up with several design strategies that can be helpful when designing an adaptive airport terminal.

The outcomes of this study, in combination with research by design, drawing and modelling have led to the design of an adaptable framework for an airport terminal. The terminal building can be configurated depending on the location and its future growth predictions.

The framework is primarily focused on accommodating growth, but certain design choices have been made in an attempt to make the spaces as flexible as possible to ensure greater adaptability if demand for air travel significantly decreases in the future. Although no detailed study has been carried out to determine which non-aviation functions could be then housed in the terminal.

03 Theoretical framewrok

The theoretical framework provides the theoretical foundation for this research. First, some basic information about airports and terminals is explained: types of airports, typologies of a terminal building, and different terminal layouts. Then, the definitions of flexibility and adaptability related to airport design are explained. Finally, the theory of Brand's shearing layers is explained. These shearing layers are important for determining a building's level of flexibility and show how a building evolves over time as different elements change at different speeds.

Types of airports

An airport is a physical location that permits aircraft to land and take-off. It is used for (de)boarding passengers, (un)loading cargo, refuelling and maintenance (Roling, 2025a). According to Roling (2025a) there are five different types of airports: airfields, origin & destination (O&D) airports, hubs, military airports and helicopter bases. For this research, only airfields, O&D airports and hubs will be included.

Airfields

According to the Cambridge Dictionary (n.d.) an airfield is 'a level area where aircraft can take off and land, with fewer buildings and services than an airport and used by fewer passengers'. Roling (2025a) adds to this definition that an airfield is only used for general aviation, military flying, flight training and private use with no commercial flights. Examples of airfields in the Netherlands are Lelystad Airport, Breda Airport and Hilversum Airport.

O&D airports

O&D airports are primarily intended for airlines with a focus on point-to-point traffic. Point-to-point traffic is the system that is used for passengers that board a flight at their place of origin and disembark the aircraft at their destination without changing to a second flight (Cook & Goodwin, 2008). O&D airports can have a seasonal function such as summer destinations or can act as feeder for hubs.

Hubs

Hubs are known in the aviation industry as the largest airports and focus mainly on connecting passengers. Most airline traffic is from a single airline that carries passengers from their departure destination via the hub to their final destination on a second flight (Roling, 2025a). Hubs are often the main airport of big cities, e.g. Heathrow Airport in London or Charles De Gaulle Airport in Paris. While O&D airports are more often considered the second, smaller airport of a large city: London Stansted or Paris Orly Airport. Figure 4 illustrates the difference in size between the three different types of airports.

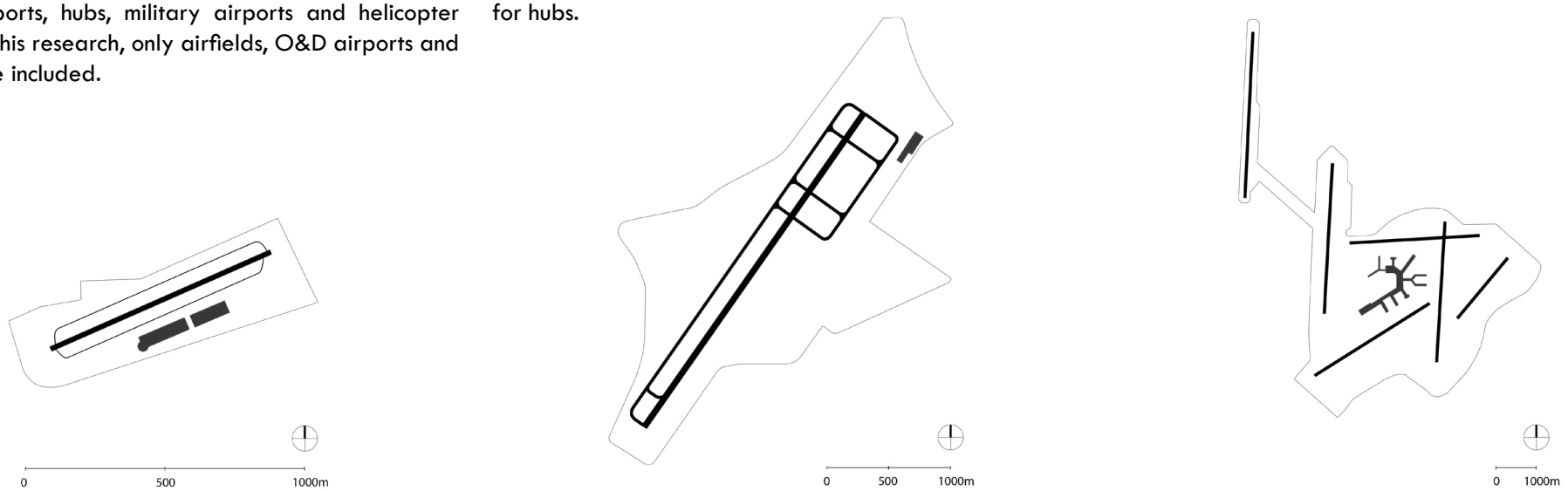


fig. 4: size difference in airports; left: Breda Airport (airfield), middle: Eindhoven Airport (O&D), right: Schiphol Airport (hub)

Terminal configurations

Terminals can have various configurations based on a particular connection between the airplane, passenger processing and the boarding areas (Landrum & Brown, 2010). According to Roling (2025b) and Kazda & Caves (2015) there are five main concepts in which Kazda & Caves (2015) mentions a sixth, very basic typology. Because of the dimensions and manoeuvring characteristics of aircrafts, it is nearly impossible to place them all directly at the main terminal building. Over the years, several concepts have been evolved with pros and cons. An airport can be designed using only one typology or a combination of typologies.

1. Simple concept

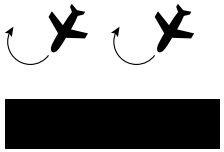
This concept is considered the simplest typology by Kazda & Caves (2015) and is mainly used at airfields and small O&D airports with a couple of commercial flights a day. The parking spots are self-manoeuvring types without being pushed-back by a truck. Aircrafts are normally positioned under an angle to minimise engine jet blast or propwash on the terminal.

2. Transporter

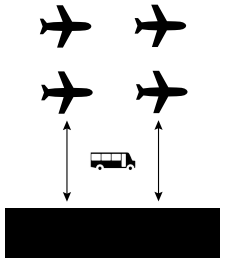
The transporter typology is known for its separation between the terminal building and the aircraft stands. The airplanes are located remotely and often far away from the passenger terminal building. Passengers are transported from the terminal building to the aircraft via buses (Kazda & Caves, 2015).

3. Linear

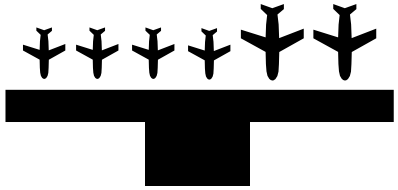
The linear configuration contains a single passenger area in which check-in and security are located, connected to a single waiting hall that is again connected to the aircraft parking spots. Boarding the aircraft is done via a number of gates, located along the terminal building, leading directly to the jet bridge or the aircraft parking area (Landrum & Brown, 2010).



1. simple



2. transporter



3. linear

4. Pier

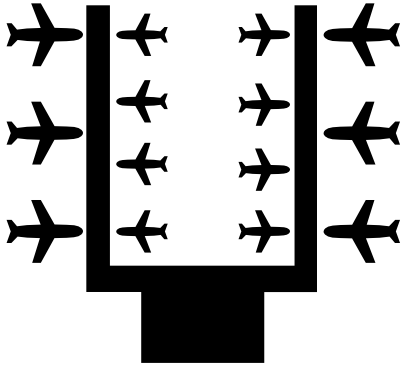
The pier concept consists of one or more concourses that are connected to the main terminal building. When viewed from above, the concourses are similar to fingers that are attached to the palm of a hand. Aircrafts are positioned on both sides of the pier, mostly perpendicular (Landrum & Brown, 2010). The evolution of piers was the best way for capacity growth by increasing the number of gates that are directly connected to the aircraft, all under one roof (Kazda & Caves, 2015).

5. Satellite

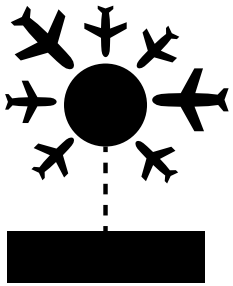
The satellite configuration is a separate building constructed on airside that is fully enclosed by aircraft parking spots, on average between the four and eight spots (Kazda & Caves, 2015). It is connected to the main terminal building, where check-in and security take place, via an above-ground or underground corridor or connector (e.g. Automated People Mover (APM)). The satellite building is used for waiting areas and several services for passengers including restrooms, retail and bars (Landrum & Brown, 2010).

6. Midfield (linear or X-shaped)

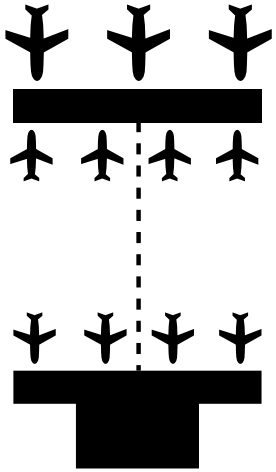
The midfield typology is closely related to the satellite concept. It has the same functional concept, however, the midfield building is larger and has more aircraft stands (easily around the fifty gates) (Neufville & Odoni, 2013). It comes with two different shapes, linear or X-shaped, and is connected via an underground APM (Roling, 2025b).



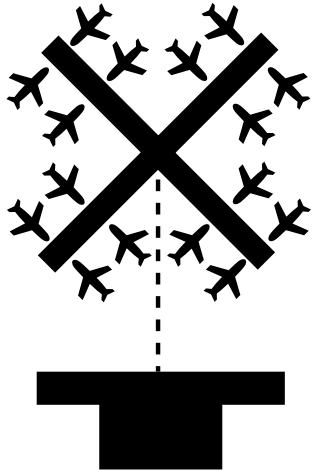
4. pier



5. satellite



6. midfield (linear)



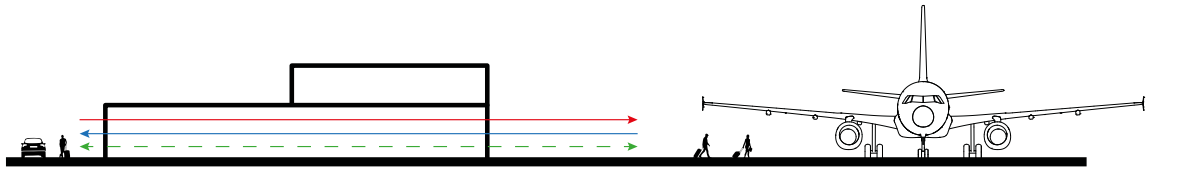
midfield (X-shaped)

Terminal layouts

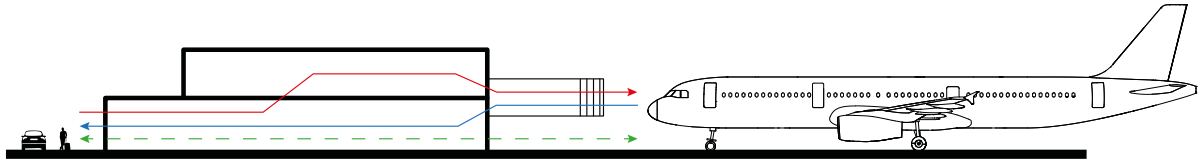
The terminal building serves as the connection between landside and airside. Landside is the area where passengers arrive at the terminal by car, taxi or public transport. This area is freely accessible without any (security) restrictions. The airside is the secure area after security control. It is the area where passengers wait for boarding, but also taxiways and runways are part of the airside.

The terminal building is designed to accommodate all the necessary procedures that a passenger must undergo before taking a flight, and to ensure a physical separation between the departure and arrival flows. This can be achieved in various ways, as shown in figure 5.

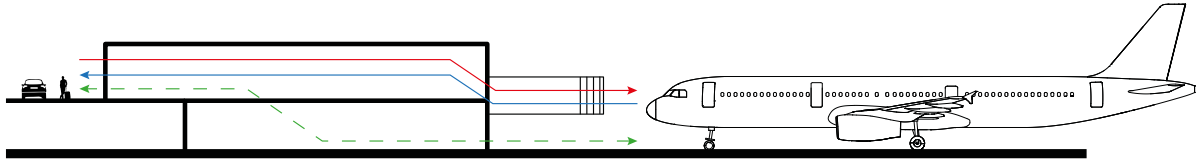
At small airports, arriving and departing passengers are separated on the same floor by horizontal partitions. At larger airports, the two flows are separated vertically across different floors in order to minimise the floor space required. The one and a half level layout is a common design at airports. It is only at larger hubs that a two- or even three-level layout is used, as transfer passengers here add an extra layer of complexity to the separation of arriving and departing passengers.



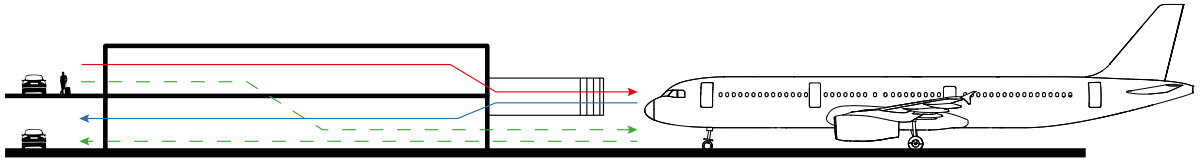
one level layout



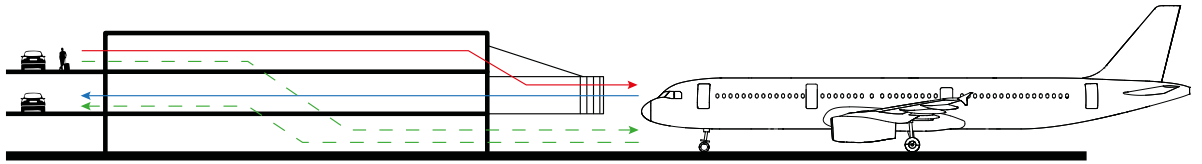
one and half level layout: type A



one and half level layout: type B



two level layout



three level layout

fig. 5: airport terminal layouts with departure flow (red), arrival flow (blue) and baggage transport (green)

Adaptability and flexibility: definitions

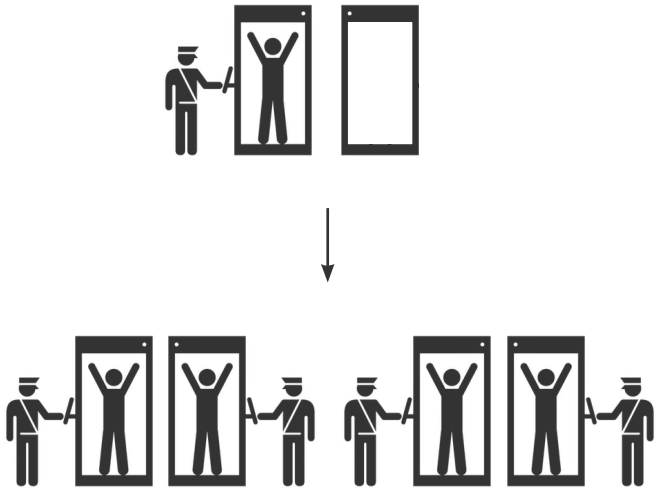
Adaptability is often used interchangeably with flexibility. However, both terms represent two different strategies for managing change and minimising risks in buildings and maintaining economic value (Leaman et al, 1998). According to Groak (1992) adaptability is the capability of: 'different social uses, which means designing a particular space which can be used in a variety of different ways.' Adaptive design is mainly focused on potential larger-scale changes for the mid and long-term future including new user demand, change in services or economic challenges (Leaman et al, 1998).

Flexibility is an important criteria for achieving adaptive design. It is defined as changes that can be realised quickly and with relatively small effort or cost (Leaman et al, 1998). Groak (1992) describes flexibility as the capability of: 'different physical arrangements, which can be achieved by altering the physical fabric, by joining, extending or through sliding or folding walls and furniture.'

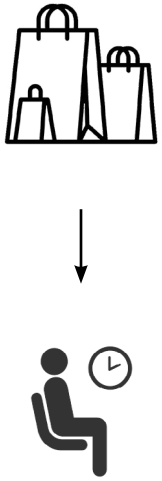
Existing literature about flexibility in airport design contains three levels of flexibility to make airport terminals resilient to future uncertainties for short-, medium- and long-term: operational, tactical and strategic flexibility (Shuchi et al, 2017). Operational flexibility specifies the ability to accommodate rapid changes in an airport terminal that occur daily or weekly, for instance furniture adjustments or the use of extra security counters. Tactical flexibility indicates changes that can happen every two to five years. It is focused on the improvement of specific aspects within a terminal building to improve passenger flows and functionality. Strategic flexibility refers to possible scenarios for the long term that could occur. This level of flexibility effects adjustments in the building structure or building envelope over a longer period of time and asks for more radical changes than operational flexibility (Shuchi et al, 2017). The three different levels of flexibility are illustrated on the following page.

Another key factor for ensuring adaptability in airport design is the ability to adjust to the changing type, needs and location of traffic. Due to the rise of low-cost carriers (e.g. Ryanair, easyJet, Southwest Airlines and IndiGo), the uncertainty in airport planning has significantly increased. Low-cost airlines use a different business model than legacy airlines (e.g. KLM, Lufthansa, American Airlines and Emirates) and therefore ask for different facilities within an airport terminal than full-service carriers. Low-cost airlines focus on point-to-point traffic, thereby avoiding centralised major hubs, and prioritise profitability through operational efficiency and minimal extras (De Neufville, 2008). For this reason, an airport design should be adaptable to both business models, functioning either as O&D or hub.

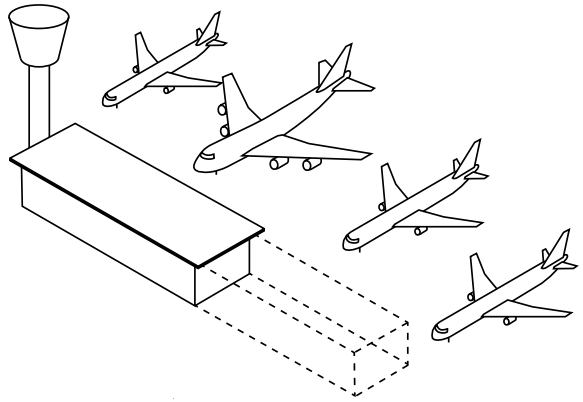
The third and last criteria for adaptive design included in this research, is the potential for a change in the function of the airport terminal, and then specifically a non-aviation function. Since described earlier, adaptability is the ability to design a space for a variety of functions. And together with the future scenario in mind that air travel demand may decline, it is worth noting to explore the potential for a terminal building to accommodate alternative functions.



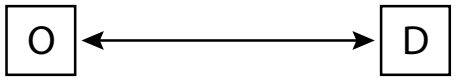
1. operational flexibility



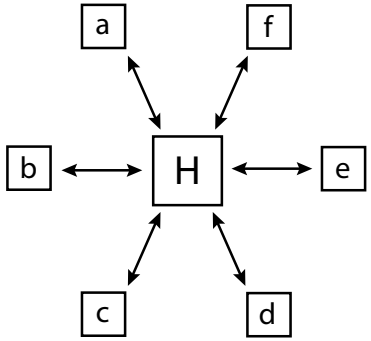
2. tactical flexibility



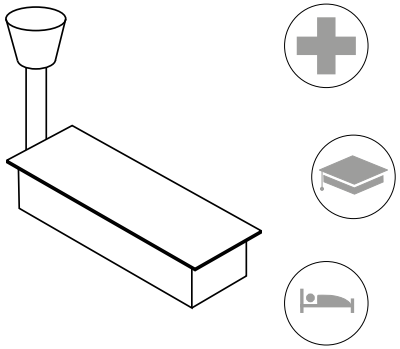
3. strategic flexibility



4. suitable as O&D airport



5. suitable as hub airport



6. potential for non-aviation reuse

Shearing layers of Brand

The Shearing Layers concept, developed by Stewart Brand, explains how buildings evolve over time. The framework identifies six hierarchical layers, namely: site, structure, skin, services, space plan, and stuff, each with its own lifespan (Brand, 1994). Understanding these layers helps designers create buildings that can adapt rather than become obsolete.

The most permanent layer is the site, which refers to the building's geographic location, orientation, and legal boundaries. It typically endures for centuries. Next is the structure, including foundations, load-bearing walls, columns, and floors; this skeleton often lasts 30–300 years, but only a few buildings pass the 60 years. The skin comprises the exterior envelope such as facades, roofs, and windows, which protects the interior and is usually replaced every few decades due to weathering or performance upgrades. More rapidly changing are the services, for instance heating, ventilation, plumbing, electrical systems and elevators. These technological systems often require replacement every 7–15 years. The space plan refers to the interior layout: partitions, room arrangements, and circulation paths, which can change as occupants' needs evolve. Finally, stuff includes movable objects such as furniture, equipment, decorations, and personal belongings; this layer can change daily to weekly.

Brand argues that buildings remain useful when these layers can shift relative to one another; meaning that faster layers can change without disrupting slower ones. Designing with this principle supports adaptability, sustainability, and long-term value by allowing buildings to accommodate new uses over time instead of requiring demolition.

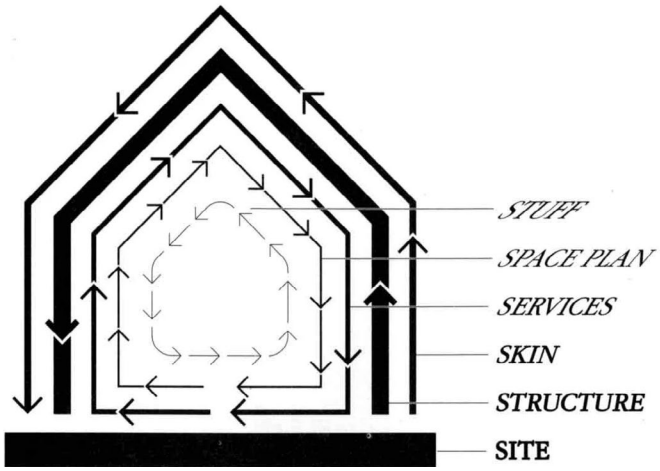


fig. 6: shearing layers by Brand (1994)

04 Results

Research findings

Literature studies, combined with an analysis of various terminal configurations, have shown that the transporter configuration is the most suitable for adaptive design based on the criteria assessed in this study. In this configuration, passengers are transported by bus from the terminal to the aircraft and vice versa. The transporter configuration is respectively followed by the linear and pier configurations. The full results can be found in Appendix I.

Next, various spatial and functional elements of three airport terminals were analysed, after which they were linked to Brand's shearing layers. The most important consideration for the design of an adaptable terminal concept is the separation of the structure and skin layers, the positions of the service layer, and the degree of flexibility of the space plan layer. A complete overview of the layers with their elements and the analysis of the three airports can be found in Appendix II.

Finally, research was conducted into design strategies that support adaptability in airport design. Five design strategies have been identified that can influence the long-term adaptability of a building. The first, 'design with layers', refers to Brand's shearing layers and has already been explained earlier.

An open-plan layout is a second design strategy in which an straightforward floorplan without walls or service blocks provides a lot of flexibility in the layout and for future modifications.

A third strategy is modularity, it can be applied in various ways, including a modular approach to the structural grid, but also the use of small modules for the internal layout. It can even be extended to a 'kit of parts' principle, whereby the building consists of small components that are assembled on site.

Geometric simplicity is another strategy that contributes to an adaptable design. A simple geometric building offers greater flexibility. Furthermore, a simple form also ensures more efficient passenger flows, an important aspect of terminal design.

The fifth and final design strategy is designing with buffer spaces. Designing the building to be larger than necessary or creating neutral spaces increases flexibility.

A full and more detailed description of the design strategies, including some example buildings, can be found in Appendix III.

Design brief

The knowledge acquired from the research has been translated into a design framework for an adaptable airport terminal. Prior to explaining this design, it is important to define the design brief and the constraints. An airport is an enormously complex building typology with a wide range of stakeholders and other factors which could not all be included, due to the given timeframe of this graduation project.

Design aim

The aim is to design an adaptive airport terminal that functions as a framework, and that is configurable to suit the building region. The main focus is on exploring how to make this design adaptable, scalable and configurable. It is important to note that the design is not related to a specific location, but could be implemented in various locations around the world.

Design scope

This design project focuses only on the passenger terminal building of an airport. Excluded from this design are additional buildings, hangars and the air traffic control tower. The terminal building is designed only for point-to-point traffic. It does not cater for airports with transfer passangers, as this would result in additional movements and other logistic challenges. Given the time available, this is not feasible.

The design's starting point is the transporter configuration. As explained earlier, this configuration appeared as the best suited for designing an adaptable terminal. The configurator will also include options for the linear configuration, as this type was ranked second. In addition, the design is based on the one and half terminal layout. This layout provides vertical separation between departing and arriving passengers and offers sufficient capacity for growth in line with future expansion phases. These expansion phases will be explained in more detail on the following page.

The main research question refers to changing conditions within the aviation sector. This research and design project has mainly focused only on growth scenarios. It is difficult to investigate all the factors that influence a terminal building over time and that was not the primary focus of this project.

Functional requirements

The aim is to design the terminal as accurately as possible so that it truly functions effectively as a terminal. Therefore, an overview of the functions being considered in the design process is provived. A distinction is made between aviation functions, non-aviation functions, operational functions and building services. Table 1 provides an overview of the programme, broken down into these four categories.

	aviation functions	**non-aviation functions**	**operational functions**	**building services**
elements	departure hall self check-in kiosks self baggage drop security control border control departure lounge waiting area boarding area baggage claim customs arrival hall	retail landside retail airside bars/restaurants information desks lost and found car rental restrooms	staff offices security offices border control offices	technical install. room storage room logistics room

table 1: overview of functions included in the terminal design

Expansion phases

One component of the final design is to ensure that the terminal is future-proof and designed to accommodate growth. To make these growth phases more tangible and realistic, Table 2 on the right provides a general overview of the various growth phases, along with the corresponding sizes and numbers of specific functions and elements. This information has been provided by NACO and is based on reference projects of a similar scale. Therefore, this overview serves as a guideline for the terminal's design in terms of dimensions and floor areas.

phase	**1**	**2**	**3**	**4**	**5**	**6 (vision)**
year	0	+5	+10	+15	+25	+?
total passengers	500 000	800 000	1 300 000	2 500 000	4 000 000	15 000 000
total GFA	7 000 m²	11 000 m²	19 000 m²	30 000 m²	49 000 m²	155 000 m²
check-in desks	15	20	26	37	44	96
security lanes	3	3	4	5	6	13
outbound passport control	6	8	10	13	17	36
inbound passport control	7	9	11	15	20	42
reclaim belts	2	2	3	5	7	10
make-up carrousel	1	2	2	3	4	8
gates (bus)	3	3	3	3	5	7
gates (contact)	0	2	6	8	11	18
check-in queuing area	200 m²	250 m²	330 m²	475 m²	570 m²	1240 m²
security queuing area	200 m²	230 m²	270 m²	350 m²	430 m²	840 m²
departure hall	200 m²	250 m²	350 m²	500 m²	660 m²	1430 m²
arrival hall	350 m²	450 m²	550 m²	800 m²	1060 m²	2490 m²
concessions landside	60 m²	100 m²	190 m²	360 m²	700 m²	2620 m²
concessions airside	200 m²	400 m²	640 m²	1200 m²	2340 m²	8810 m²

table 2: overview of growth phases with specifications

04.1 Explanation of terminal concept

Flow diagram

Designing an airport terminal requires a lot of preliminary research, particularly regarding the various passenger flows. Every passenger is unique, moving at different speeds and in different directions through the terminal. Departing passengers go through a series of checkpoints before entering the aircraft. Even after landing, passengers must still go through a number of processes before returning to the public area.

Figure 7 on the right shows a flow diagram of the most important steps that departing and arriving passengers must pass through. These steps are divided into three sections: the landside concourse, the processing area and the airside concourse. The landside concourse is open to the public and consists mainly of the departure and arrival hall and related functions. The processing area is accessible only to passengers and consists primarily of the security control, passport control and the baggage hall for arriving passengers. The airside concourse includes waiting areas, lounges, gates and a few concessions.

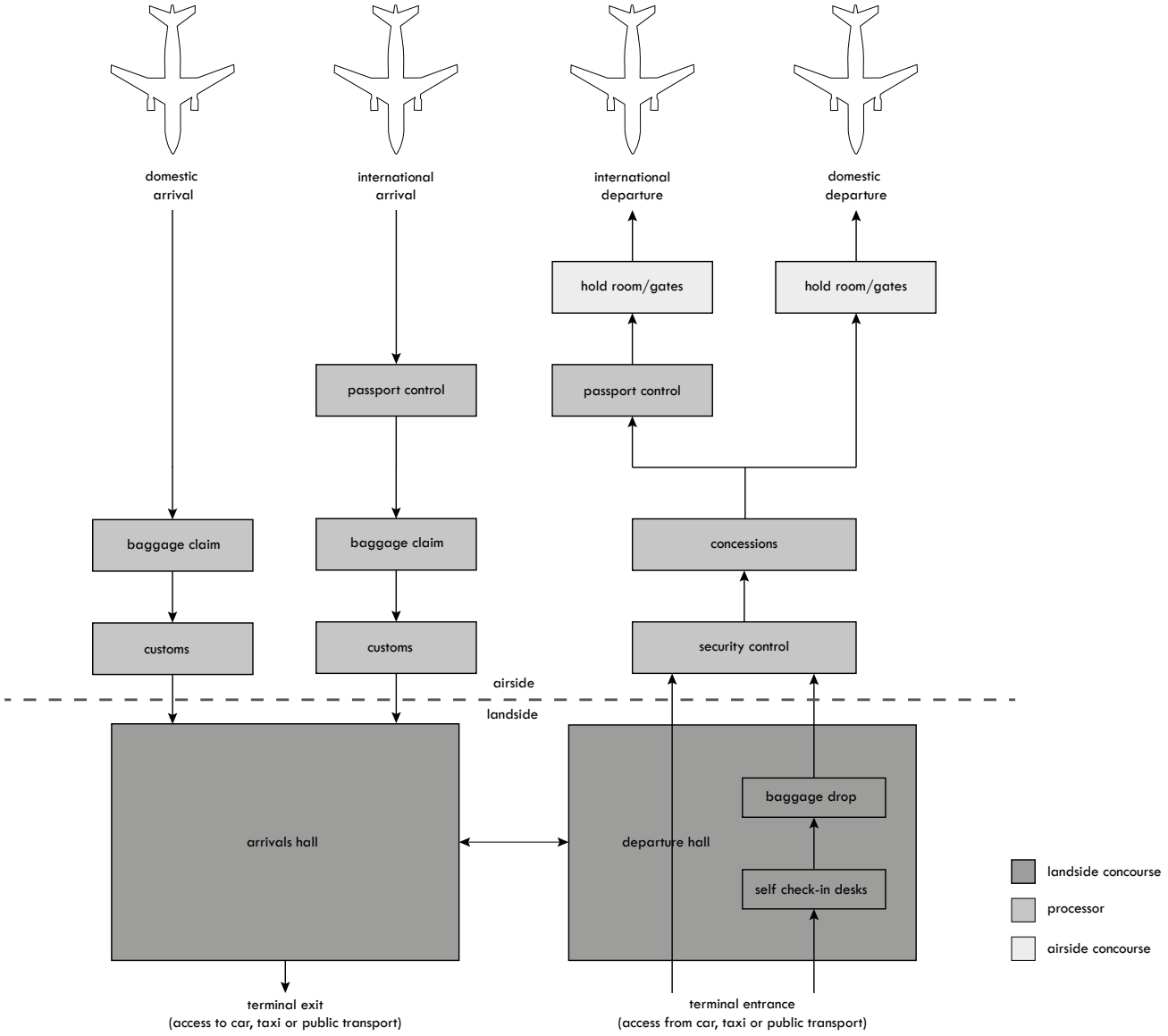


fig. 7: flow diagram

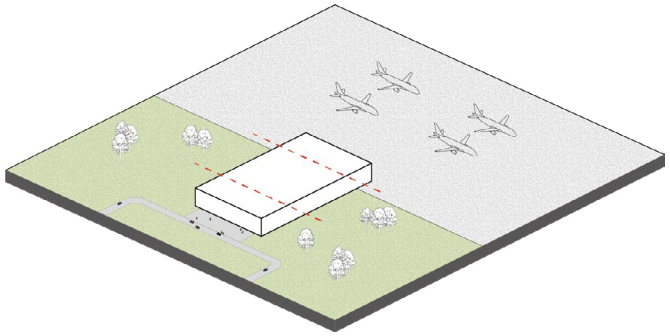
Terminal design concept

Figure 8 illustrates the conceptual foundation for the terminal design in four stages. In the first stage, the terminal is illustrated as a simple, rectangular block based on the required dimensions.

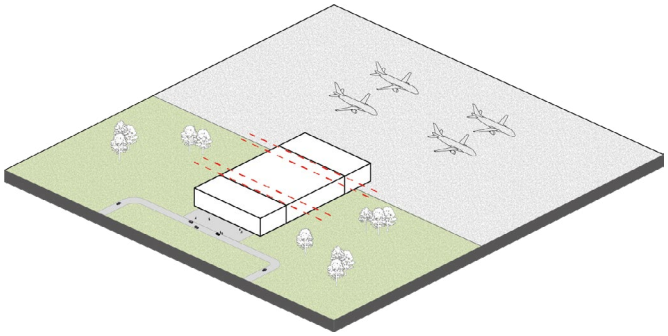
The rectangular block is then divided into three sections: the landside concourse, the processing area, and the airside concourse.

In the third step, two service zones are added between the three sections, so that fixed facilities such as shafts, restrooms and technical rooms are designed in an orderly manner within the corridor. Thereby, an open plan layout can be created in the three sections.

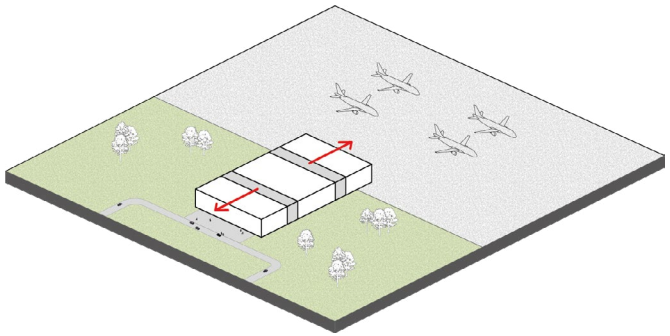
Finally, these three sections are physically separated from one another to create space for green zones. These green zones not only enhance the passenger experience but also serve as a physical transition from one section to the next. This would make it easier for passengers to find their way around and make the entire process more clear. The green areas can be made larger or smaller depending on the space available within the building site.



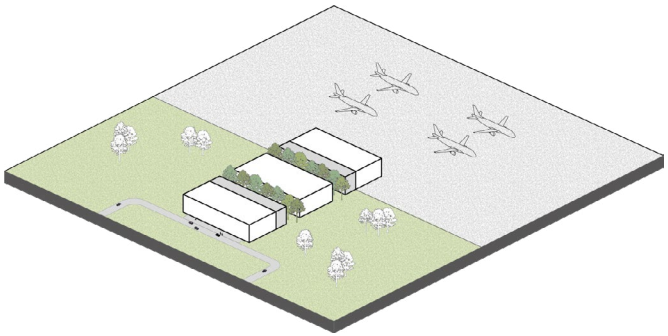
1. simple geomatrical shape, divided into three areas: landside concourse, processor & airside concourse



2. addition of two service zones between the three different areas



3. physical division of building to create openings



4. the created openings become green zones

fig. 8: conceptual drawings of terminal design

Internal modules

A considerable amount of effort has been devoted to making the design as adaptable as possible, and one of the possible design strategies to achieve this, is the use of modularity. One way of making the design modular is to use individual modules, in this case internal modules. The interior spaces are designed to fit within the structural grid, allowing the interior to be assembled and configured like building blocks.

The degree of modularity increases if these modules are also made up of smaller components that are manufactured off-site and then only need to be assembled on the construction site. The intention is that the modules consist of individual components that can be transported separately and then joined together on site. This applies particularly to walls, floors and ceilings. Modules for baggage conveyor belts and the Baggage Handling System (BHS) are somewhat more specialised, but these components should also be produced with a modular approach.

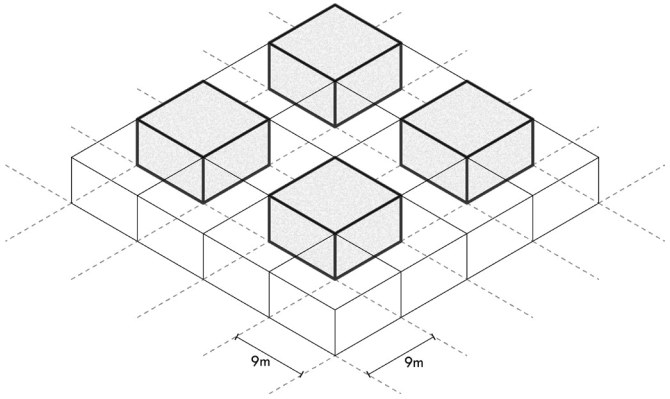


fig. 9a: modules for ancillary facilities (9x9m): offices, restrooms, technical installation rooms and vertical circulation

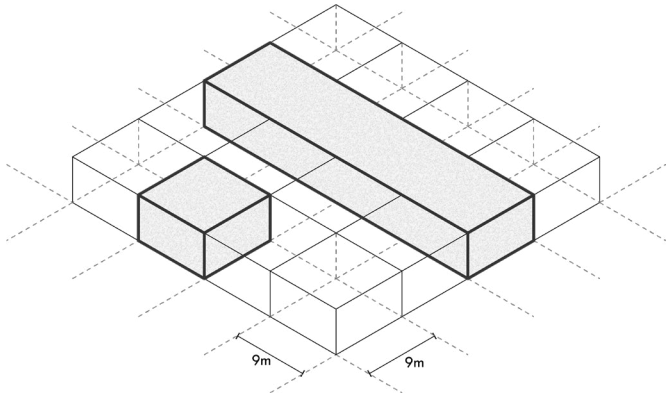


fig. 9b: modules for the processing area: security control (9x36m) and e-passport control (9x9m)

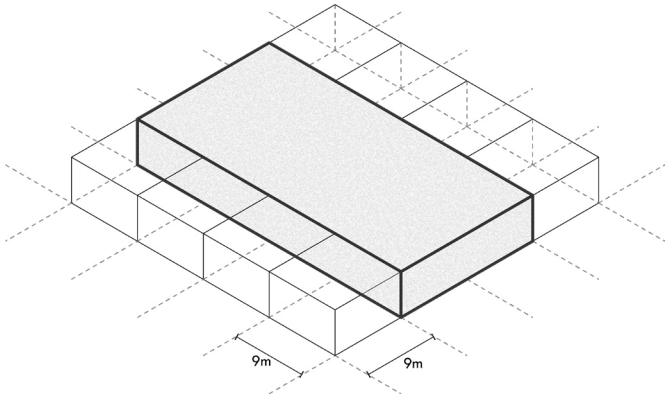


fig. 9c: module for baggage conveyor belt (18x36m)

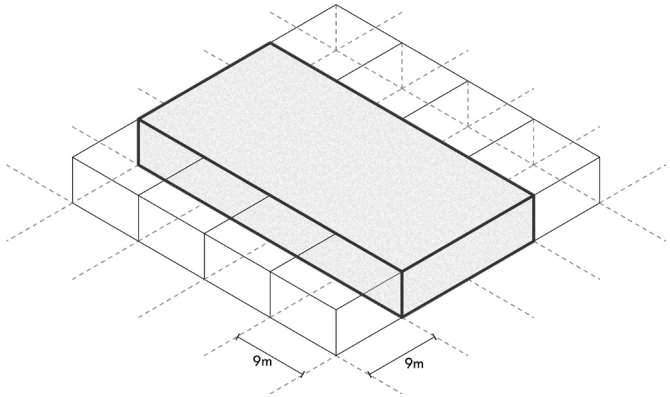


fig. 9d: BHS module for one make-up carousel (18x36m)

Modular construction grid

In addition to the use of internal modules, the construction of the terminal is also modular. The structural grid is based on a 9 by 9 metre grid, but many spaces require larger clear spans, meaning that most columns are placed at 18 by 9 metres or even 18 by 27 metres. The structure consists of steel columns and steel beams with a steel spaceframe roof structure. This frame comprises triangular-shaped steel bars connected to one another at the joints. This system makes it easy to expand, as new bars can be connected to the joints of the existing structure. The space frame also makes it easy to create large, unobstructed spans due to the high degree of stiffness provided by all the triangular connections. A schematic drawing is shown in figure 11.

For the floor levels, the Holcon floor system is used, which is a modular floor system. It consists of an upper and lower concrete slab with a hollow space in between, where reinforced steel connects the two slabs. The slabs are dry-laid on the steel beam and rest on it. The void between the upper and lower slabs can be used for pipes and air ducts. A schematic drawing of the connection to the steel beam and column is shown in figure 10.

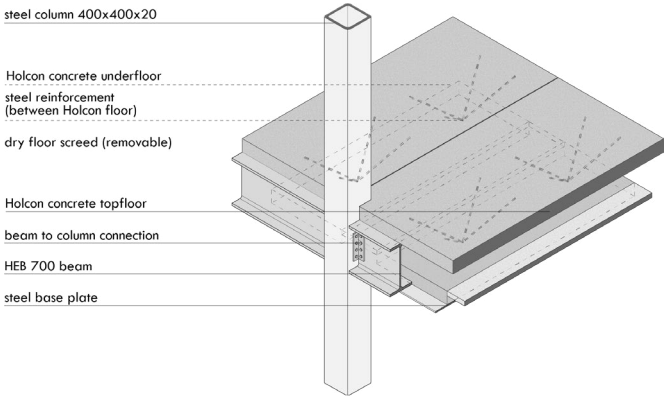


fig. 10: detailed drawing of structural connection

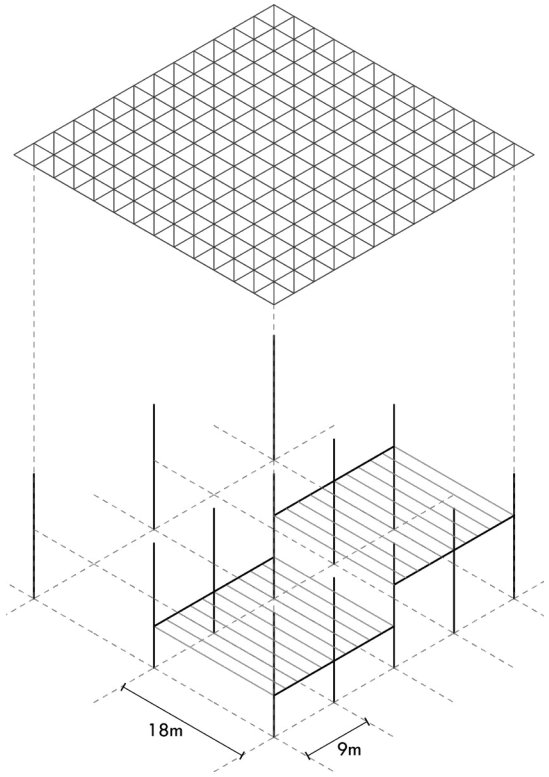


fig. 11: conceptual drawing of the construction

Expansion phases

Phase 1, or rather the starting point for this adaptive terminal, is designed to accommodate around half a million passengers a year and follows the transporter typology. As the terminal is primarily designed with future growth in mind, the floor area for this phase has been slightly oversized. However, oversizing – or the design of buffer spaces – is a design strategy intended to encourage adaptive design and is therefore a useful tool to employ.

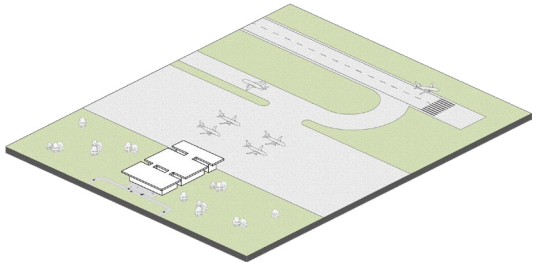
Phase 2 is essentially an interim phase designed to demonstrate that passenger boarding bridges can already be used with a minor extension of the airside concourse. Some airports prefer a transporter typology, whilst others favour a linear typology with passenger boarding bridges.

Phase 3 accommodates approximately 1.3 million passengers per year, which is primarily visible in the expansion of the airside concourse. The landside concourse and processing area have also been extended by 18 metres on both sides. This is the minimum distance required to add an extra module of a baggage conveyor belt and make-up carousel.

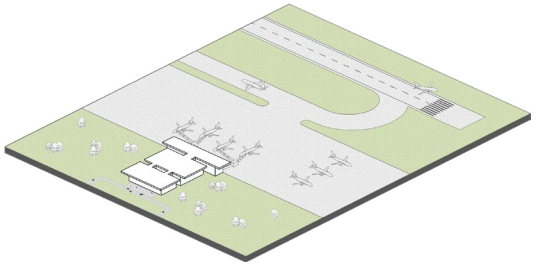
Phase 4 is another size larger and can handle around 2.5 million passengers. With a floor area of 30,000 m², it is approximately 1.5 times the size of the third phase.

Phase 5 has seen the terminal expand to over 30,000 m² compared to the original design. Large wide-body aircraft are now deployed as the number of passengers handled a year is sufficient. The passenger boarding bridges are designed to accommodate either two narrow-body aircraft or one wide-body aircraft to allow for extra flexibility.

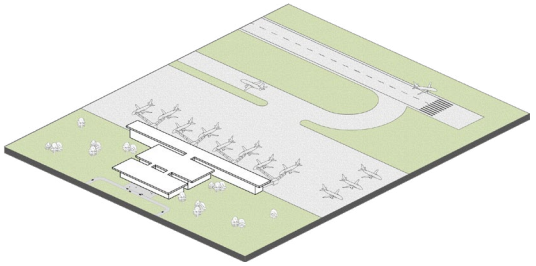
The final phase is characterised as a vision, and so it is not known how many years it might take for the terminal to look like this. The landside concourse and processing area have now become 4.5 times as wide as the original terminal width (324 metres wide). The building can now be described as a medium-sized terminal, currently handling only point-to-point traffic. The second floor of the building can now also be used for additional concessions, lounges and other waiting areas instead of offices.



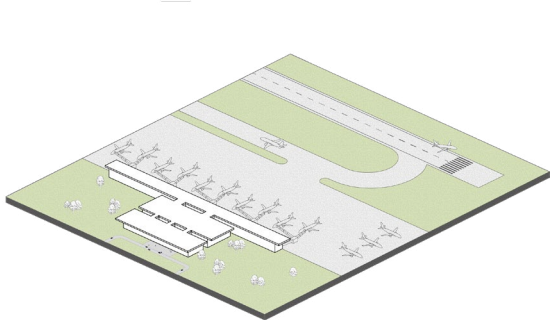
phase 1: ca. 500 000 passengers/year & terminal size 12 000 m²



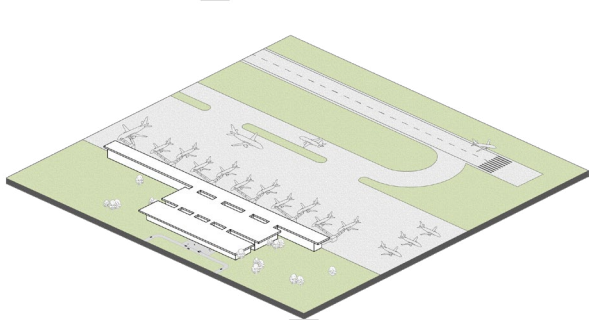
phase 2 (+5 years): ca. 800 000 passengers/year & terminal size 13 000 m²



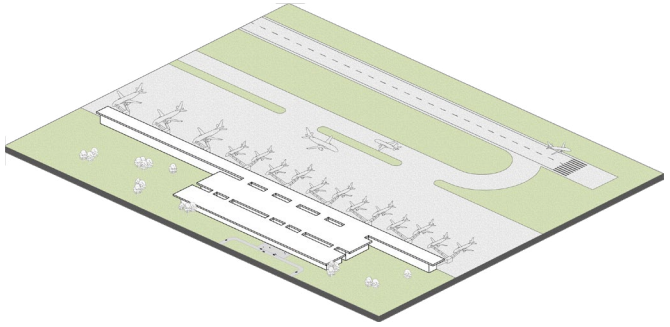
phase 3 (+10 years): ca. 1 300 000 passengers/year & terminal size 19 000 m²



phase 4 (+15 years): ca. 2 500 000 passengers/year & terminal size 30 000 m²



phase 5 (+25 years): ca. 4 000 000 passengers/year & terminal size 45 000 m²



phase 6 (+ ? years): >10 000 000 passengers/year & terminal size 120 000 m²

fig. 13: conceptual drawings of expansions phases

Rotatable terminal

No two airports are the same, and neither are their locations and site plans. As a result, the terminal should also be able to be repositioned depending on the available space. Because this aspect is highly dependent on the specific location, it is impossible to explore every possibility. A simple illustration has therefore been provided to show how the terminal could be oriented in a different way. This illustration can be seen in figure 14.

In both examples, the runway has remained in the same place; only the terminal building is positioned differently. In the example above, the terminal is positioned parallel to the runway, whilst in the example below, the terminal is positioned perpendicular to the runway. In other words, the aircraft parking areas (known as aprons) are perpendicular to the runway. This will also change the way the airport is expanded. The growth phases could be limited due to the expansion direction towards the taxiways and runway leading to safety restrictions.

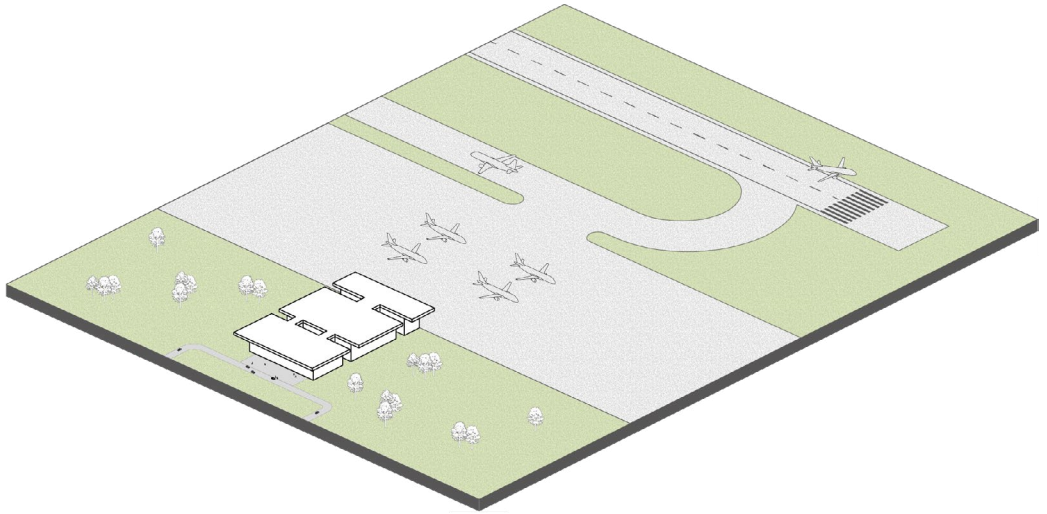


fig. 14a: example of the terminal building's orientation relative to the runway

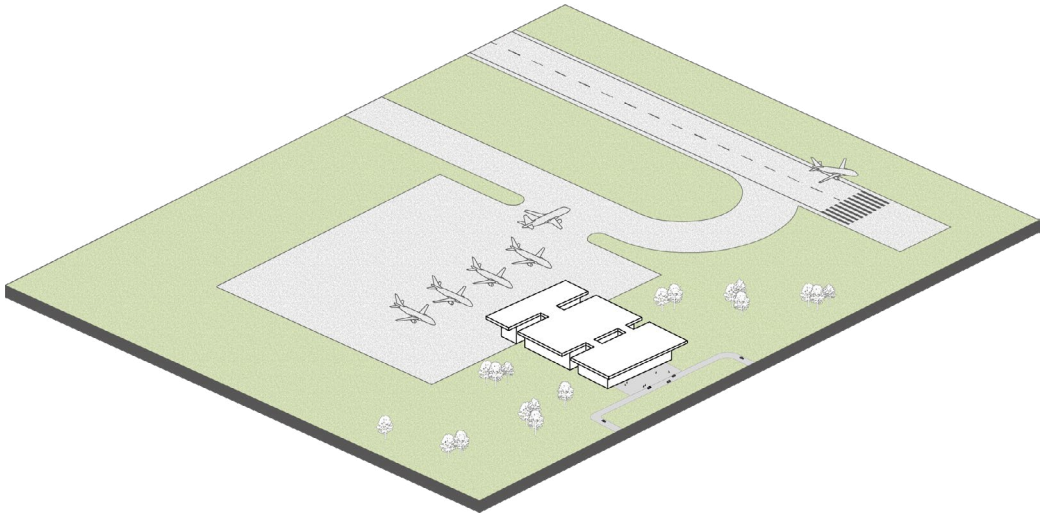


fig. 14b: a different example of the terminal building's orientation relative to the runway

04.2 Configurator

This configurator has been created to add further depth to the design and to demonstrate how the terminal can be customised to a specific region. The terminal can be composed in various steps based on different design aspects. These design aspects allow the terminal to be tailored more specifically to the programme, facades, interior space and indoor climate.

As it is impossible to create the configurator for all countries/continents within the timeframe of this project, three example locations have been selected to demonstrate how the configurator works. These locations have been chosen on the basis of different climates and cultures.

Step 1: determine the basic features of the terminal
The first step is to determine a number of basic characteristics for the terminal. It can be designed with either two or three storeys. The third storey will primarily be used as office space, but could, in the future, serve as additional space for lounges, waiting areas and concessions (retail and bars/restaurants) to enhance the passenger experience.

In addition, the capacity of the basic terminal must be determined. Depending on the required capacity and growth forecasts, a choice can be made between the smallest variant (12 000 m², fig. 15) or a slightly larger one (15 000 m², fig. 16). In the following steps, a few adjustments can still be made to increase or decrease the total floor area.

Finally, a choice has to be made regarding the terminal typology. The standard design is based on the transporter typology, in which passengers are transported by bus from the terminal to the aircraft and vice versa. However, should it be decided to use passenger boarding bridges from the start, the standard terminal will be slightly larger (13 000 m², fig. 17).

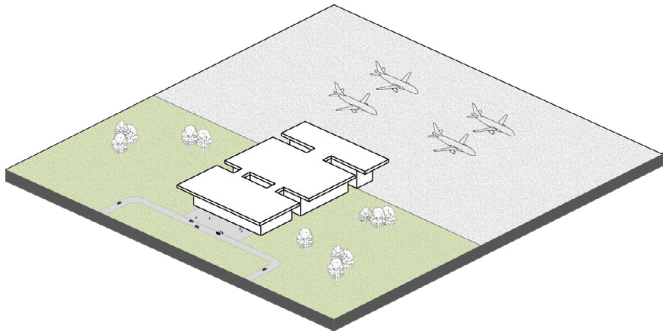


fig. 15: conceptual drawing terminal size 12 000 m² (transporter typology)

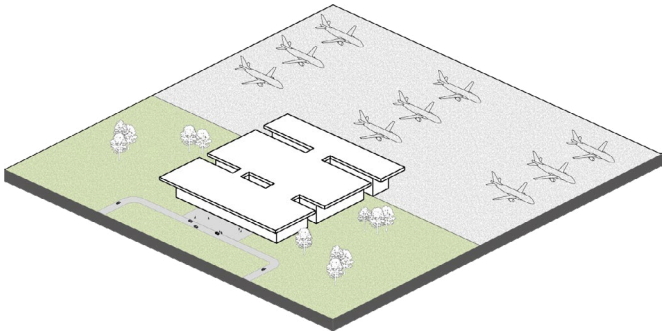


fig. 16: conceptual drawing terminal size 15 000 m² (transporter typology)

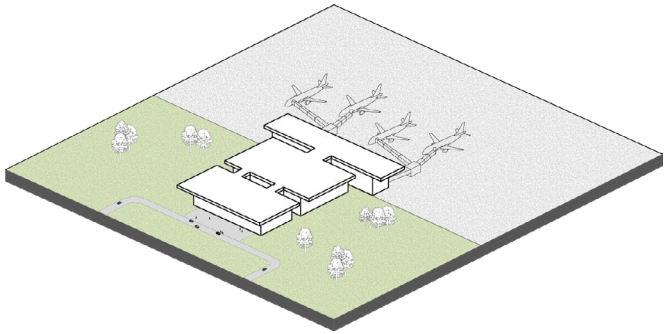


fig. 17: conceptual drawing terminal size 13 000 m² (linear typology with jet bridges)

Step 2: determine size of departure hall

Due to the basic grid and modular construction, it is possible to adjust the size of the departure hall. The preferred size of this space varies by country or region.

The standard terminal has a depth of 27 metres for the arrivals and departures hall. This depth could be reduced to 18 metres, bringing the facade back by 9 metres. This may be attractive for airports in Scandinavia, as the landside area is often somewhat more sober because fewer large family groups travel to the terminal and the focus is on rapid passage through security.

For countries in South Asia such as India, it may, on the other hand, be attractive to extend the departure hall by 9 metres or more to at least 36 metres, as many travellers arrive early and travel with large family groups, or come to say goodbye. But also the addition of many concessions can increase the demand for a more spacious landside concourse.

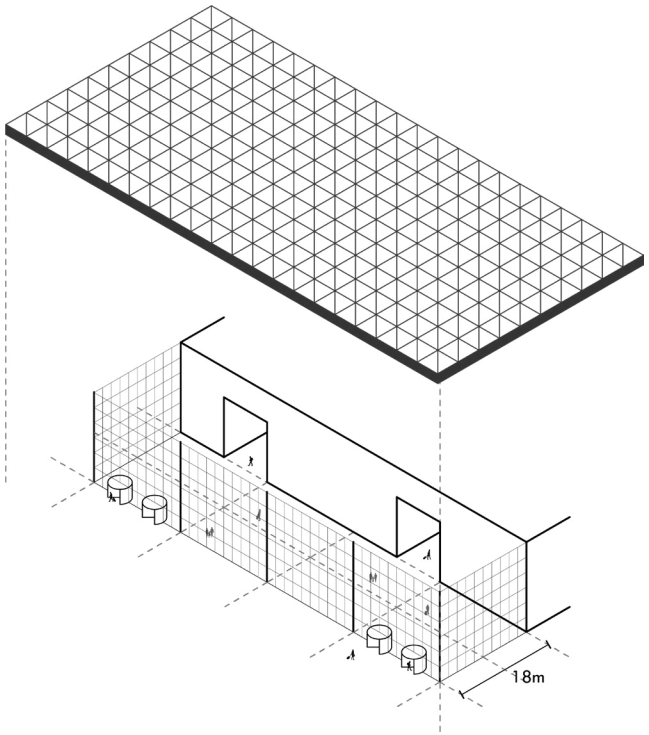


fig. 18a: conceptual drawing of reduced departure hall

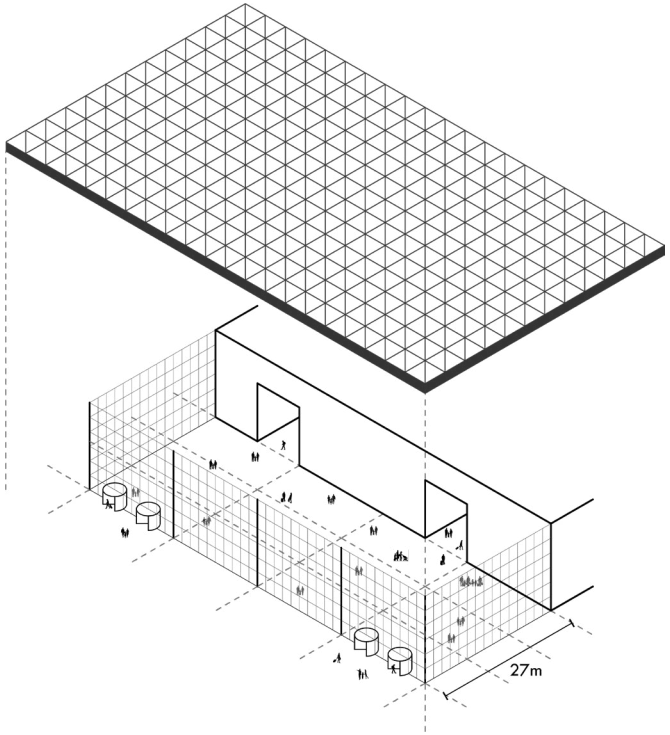


fig. 18b: conceptual drawing of standard departure hall

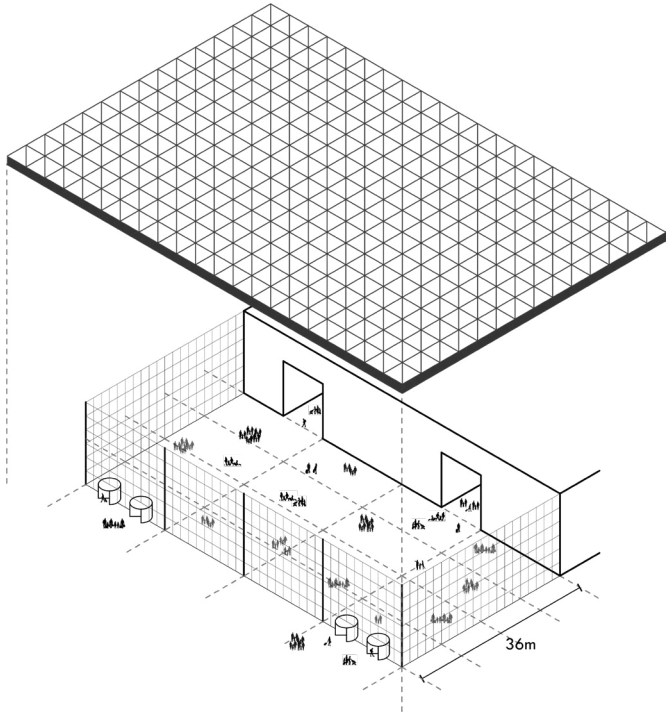


fig. 18c: conceptual drawing of extended departure hall

Step 3: customise facade

The facade has also been designed to be completely modular and demountable. As a result, the facade can be disassembled if an extension is built, parts of the facade can be replaced with minimal disruption, and the facade can be customised to fit the local culture and climate.

The standard terminal consists primarily of glass. To prevent the building from overheating due to the amount of glass, a 'second' facade of perforated panels is situated in front of the glazing. These panels are inspired by mashrabiya. Mashrabiya is a form of vernacular architecture from the Middle East in which a windowsill or balcony is enclosed by wooden latticework with perforations. It blocks direct sunlight but allows daylight to pass through. In addition, the small perforations accelerate the wind, creating a passive cooling effect.

The principle behind mashrabiya has been translated into modern, perforated aluminium panels. These panels function mainly as shading system as the passive cooling effect is not generated by the thin panels. The degree of perforation can be altered to create subtle patterns.

In the Netherlands, the panels serve as sunshades for the east and west facades. The perforations are neutral and can vary in density to create a varied appearance. In Dubai, the perforated panels could instead feature a more distinctive perforation pattern that is more closely linked to the local culture. While in Scandinavia, this 'second' facade is not functional due to the cold. The amount of glass can be replaced with solid wooden panels, since timber is a common material in these countries.

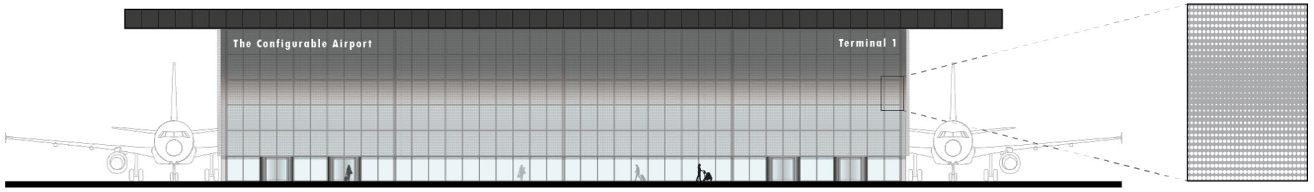


fig. 19a: exemplary design of a possible facade for the Netherlands

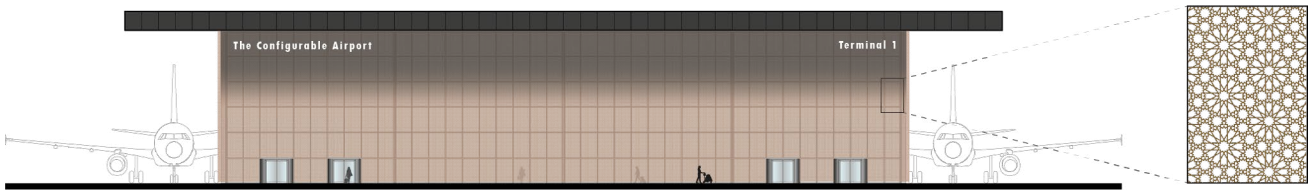


fig. 19b: exemplary design of a possible facade for Dubai

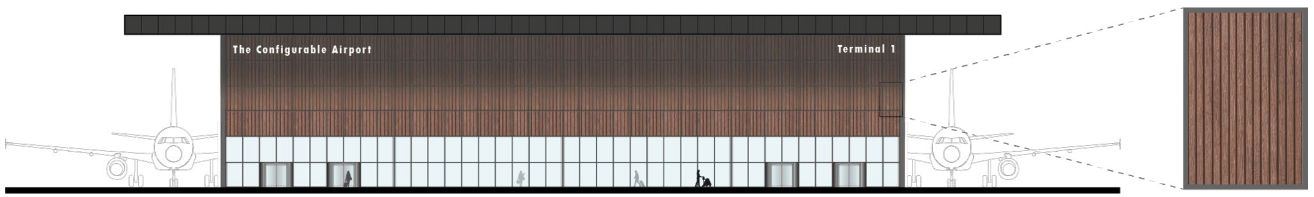


fig. 19c: exemplary design of a possible facade for Scandanavia

Step 4: customise roof

In addition to the facade, also the roof can be customised, as the modular design approach has been applied here as well. The roof is divided into modules of 3x3 metre, matching the dimensions of the space frame structure.

The roof can be constructed from one or more different modules. A first module has been created that combines a green roof with solar panels (fig. 21). Another module is designed as a horizontally positioned skylight including two parts that can be opened (fig. 22). And one module has been designed that serves for technical installations, with the focus on air handling and ventilation (fig. 23). An example of a possible roof composition is shown in figure 24.

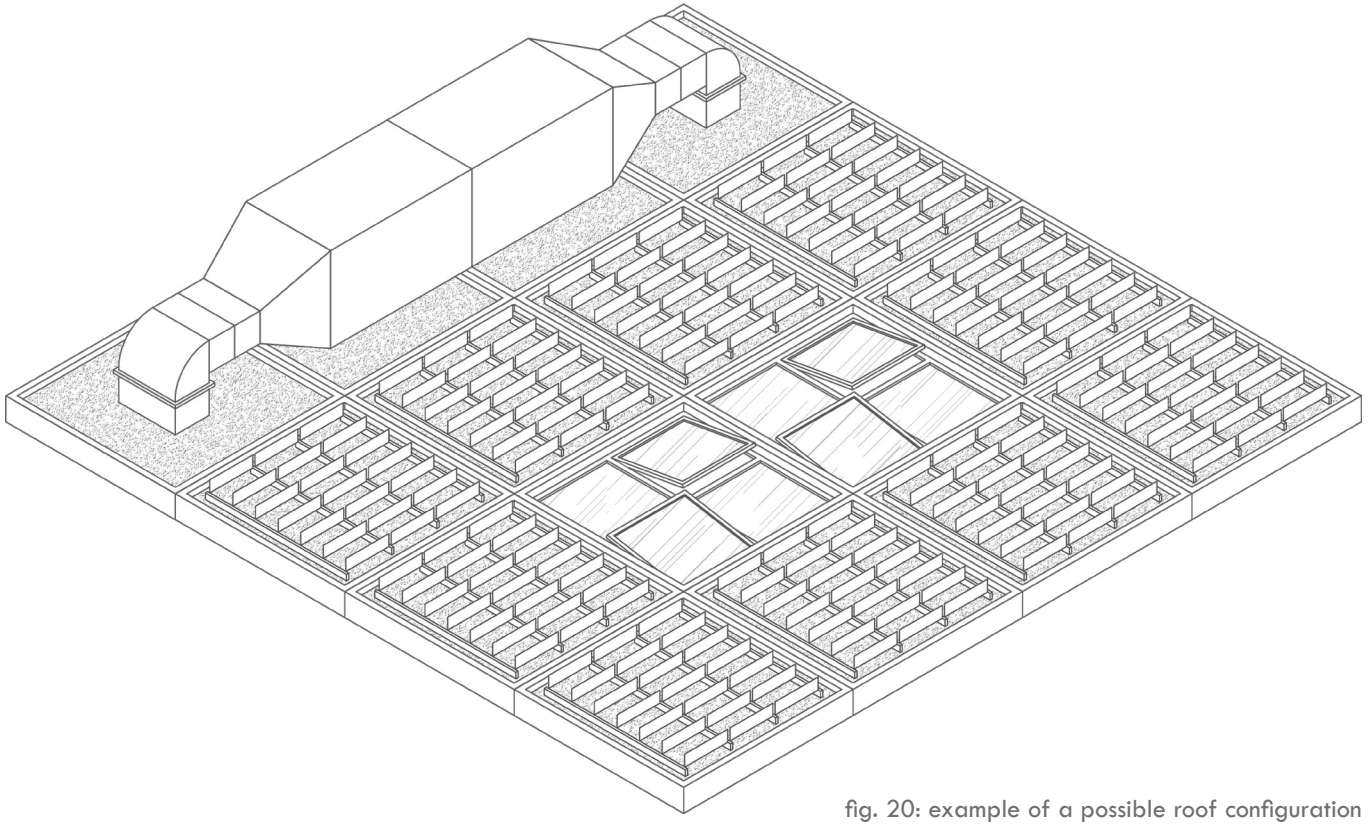


fig. 20: example of a possible roof configuration

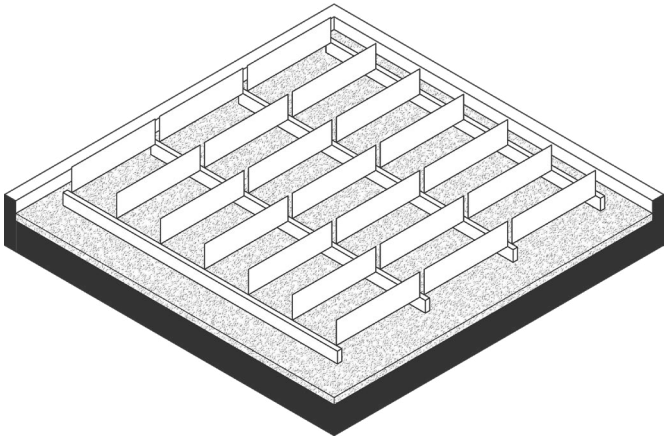


fig. 21: conceptual drawing of green roof module with vertical solar panels (Solargreen Bificial)

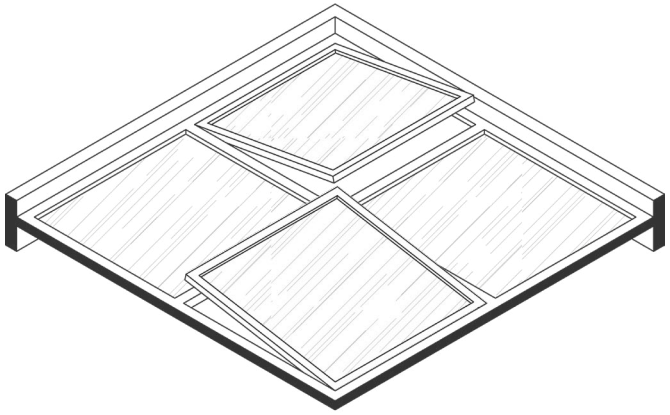


fig. 22: conceptual drawing of horizontal skylight module

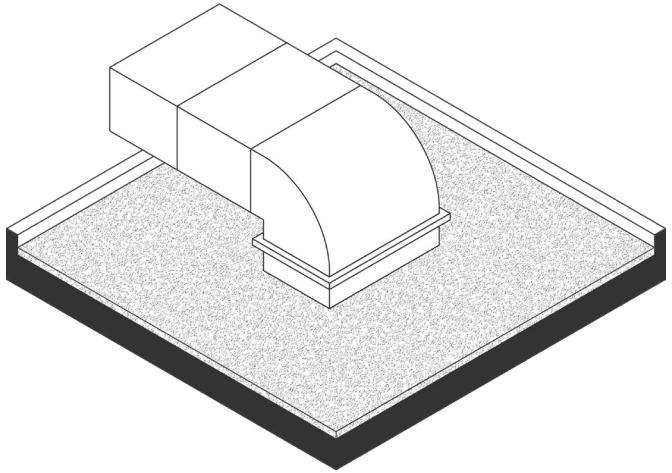


fig. 23: conceptual drawing of installation module (for air handling units and air ducts)

Step 5: adding green zones

The final step is to include a series of green zones. This feature sets this design apart from other airport terminals. The green zones create a more pleasant atmosphere for passengers, reduce stress levels and enhance the passenger experience. In addition, the green zones also serve as a physical separation between the landside concourse, processing area and the airside concourse. This makes the process more transparent for passengers. A third reason to add green areas is the increase in the amount of natural light that enters the building. Terminals are often enormous boxes, meaning that the inner spaces receive no natural light. By dividing the terminal into three sections, extra space is created to allow natural light to enter the building.

The green elements can also be extended inside the building by creating an additional green zone in the landside concourse. This ensures that passengers can truly experience the greenery.

If the building site does not allow for the addition of all green zones, savings could be made on the internal green area. The other corridors provide a genuine physical separation and are therefore expected to play a more significant role in helping travellers relax.

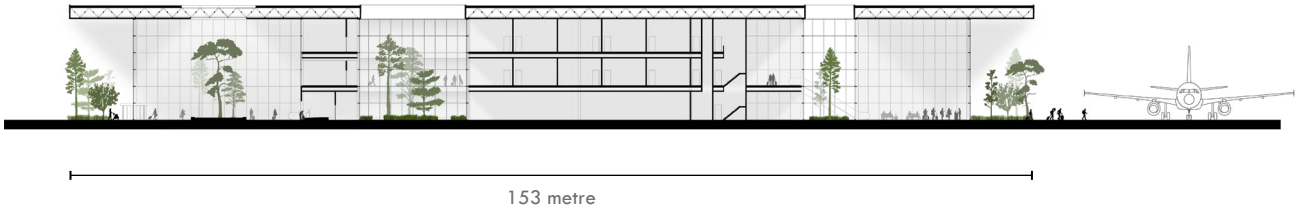


fig. 24a: cross section including all green zones

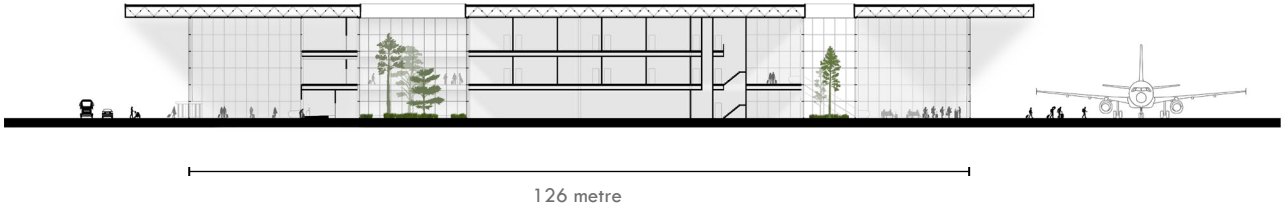


fig. 24b: cross section including only two green zones

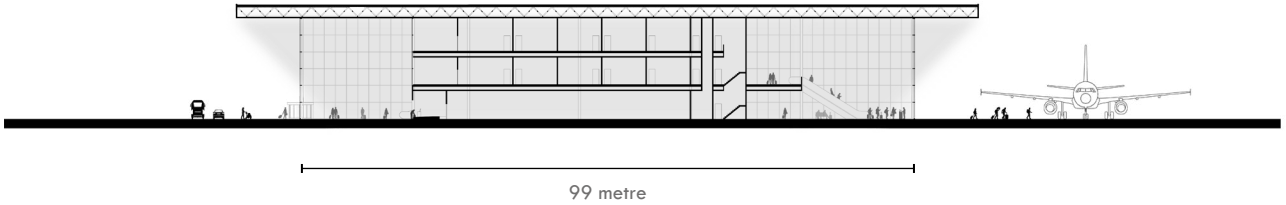


fig. 24c: cross section without green zones

04.3 Elaborated design

The configurator leads to the design of a customised terminal. In this research and design project one specific configuration has been elaborated in detail. In this way, you can see how the modules are integrated into the floor plans, what the facades could look like, how the atmosphere of the interior spaces look like, and how the building's design details have been crafted. The terminal is designed according the transporter typology with a floor area of approximately 12 000 m².

Figure 25 on the right shows a site plan of a virtual greenfield site for a new airport to be built. Assuming there are no restrictions on the building site, a terminal has been designed that includes four green zones. The first green area is located just before the airport entrance to help passengers feel at ease. The second green zone is situated between the landside concourse and the processing area. After the security check, passengers pass through a third green area, which then takes them to the airside concourse to wait for their flight to depart. To make their wait more pleasant, a fourth green zone has been created between the airside concourse and the aircraft. This zone is accessible from the terminal, allowing passengers to wait for their flight outdoors surrounded by greenery.

The following pages provide a more detailed explanation of the terminal's elaborated design, based on the steps that departing and arriving passengers go through within the terminal building.

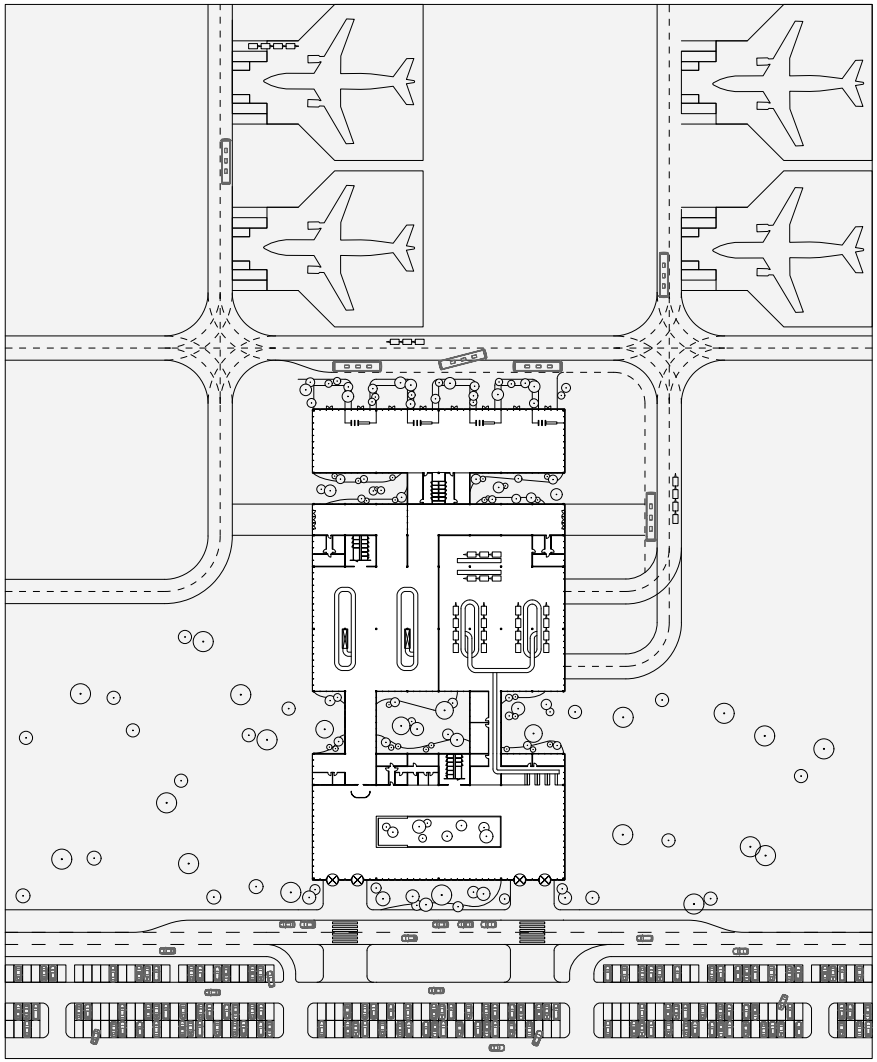


fig. 25: site plan


TERMINAL 1
TERMINAL 1

Step 1: arrival at terminal

The first view that passengers experience upon arriving at the terminal is a corridor of trees and plants, through which the facade becomes visible (see figure 27). This facade has a clean, transparent design, featuring four revolving doors for entering and exiting the terminal. Figures 26 & 28 show, in plan and section view, where you are positioned as a passenger, making it clear how you move through the building.

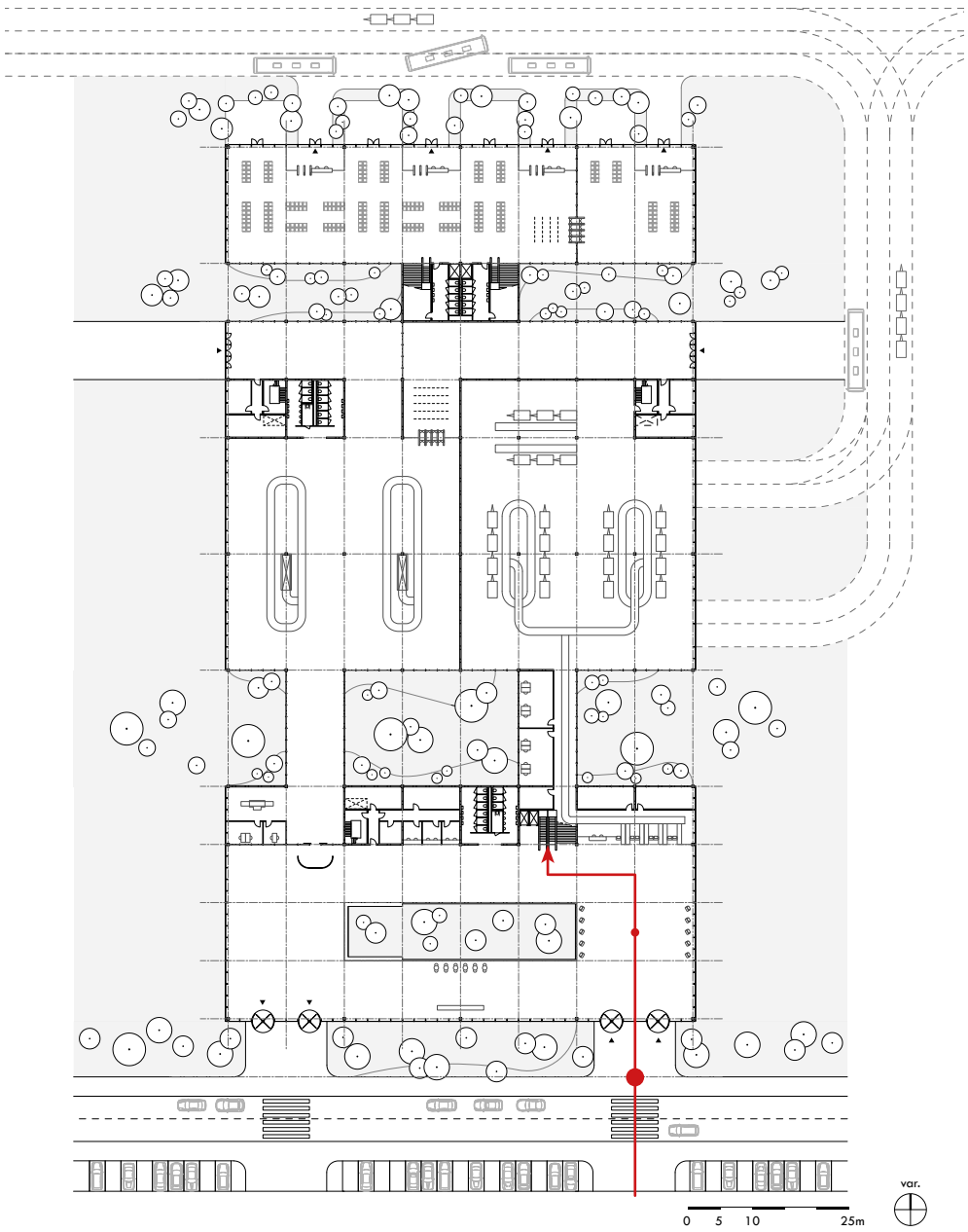


fig. 26: ground floor plan

fig. 27: illustration of the entrance area

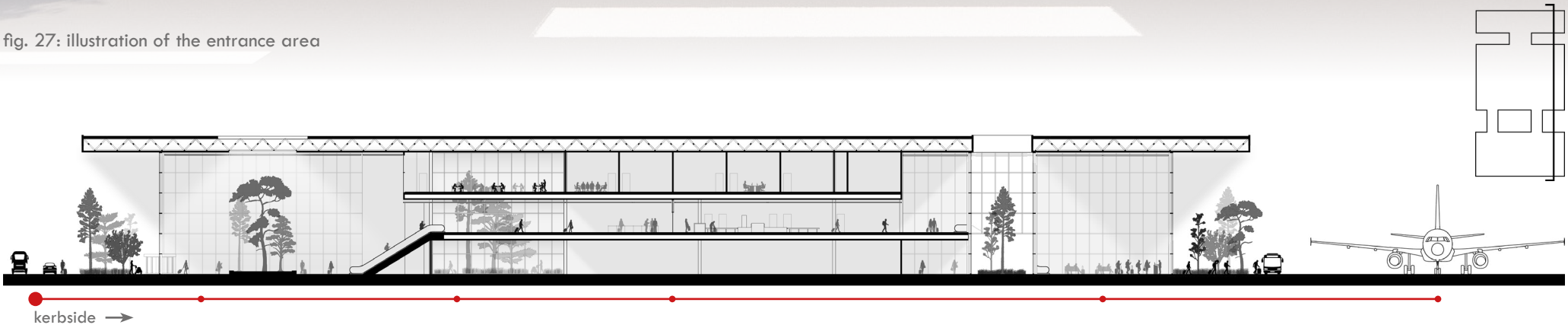


fig. 28: section AA

Step 2: self check-in kiosks & baggage drop

When you enter the terminal as a passenger, you will find your way into a spacious hall where the self-service check-in kiosks are located, allowing you to print your boarding pass. You can then drop your luggage at the self-service baggage drop-off points. Passengers who already have a boarding pass and are travelling with carry-on luggage only can proceed directly to the escalators located next to the baggage drop-off area.

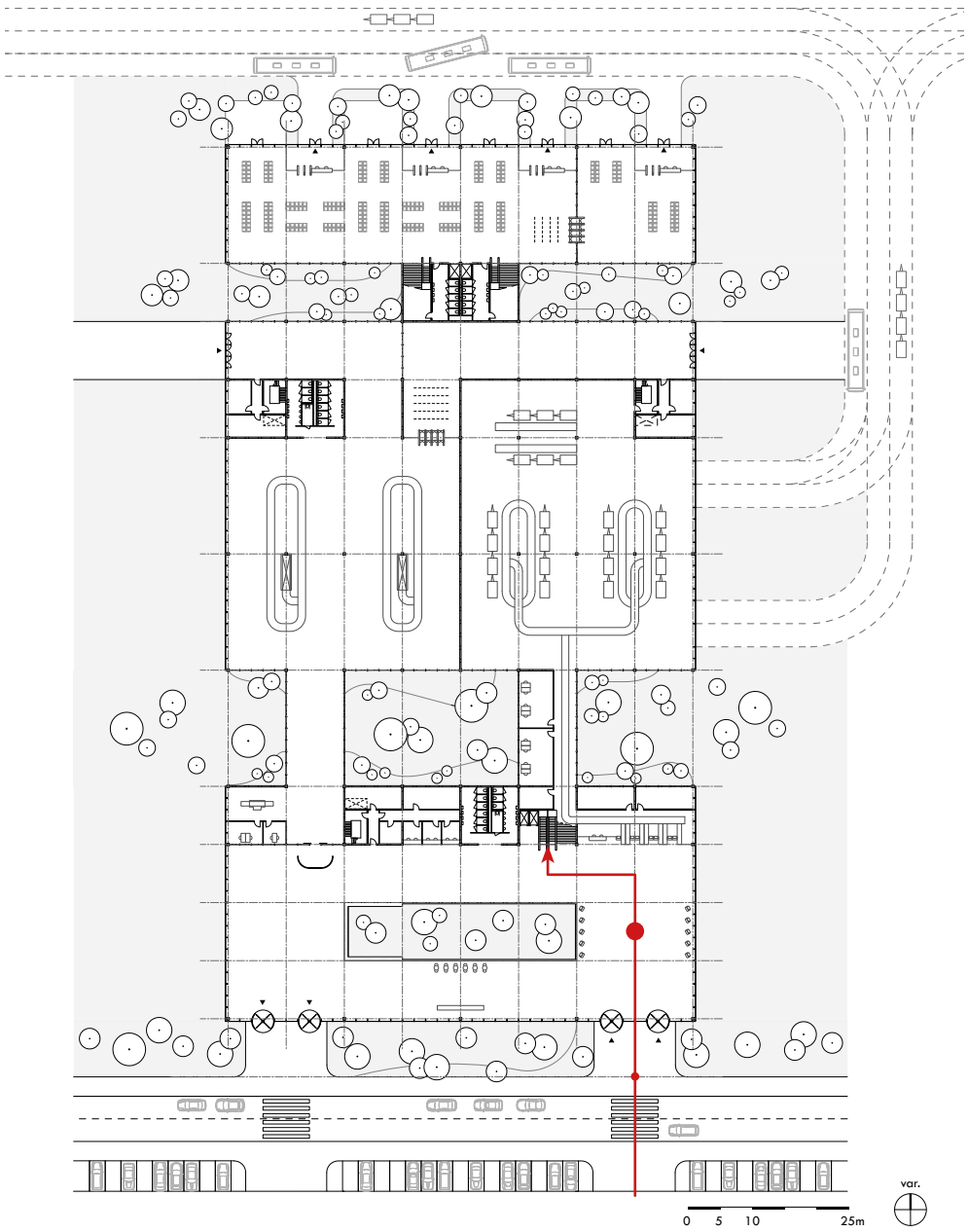


fig. 29: ground floor plan

fig. 30: illustration of the departure hall



fig. 31: section AA

Intermezzo: green zone passage

After checking in the baggage, passengers take the escalator to the first floor. To reach security, you go through a green area. This not only offers a pleasant view, it also reduces the stress level of passengers, and serves as a physical separation between the first step of the process and the next: the security check.

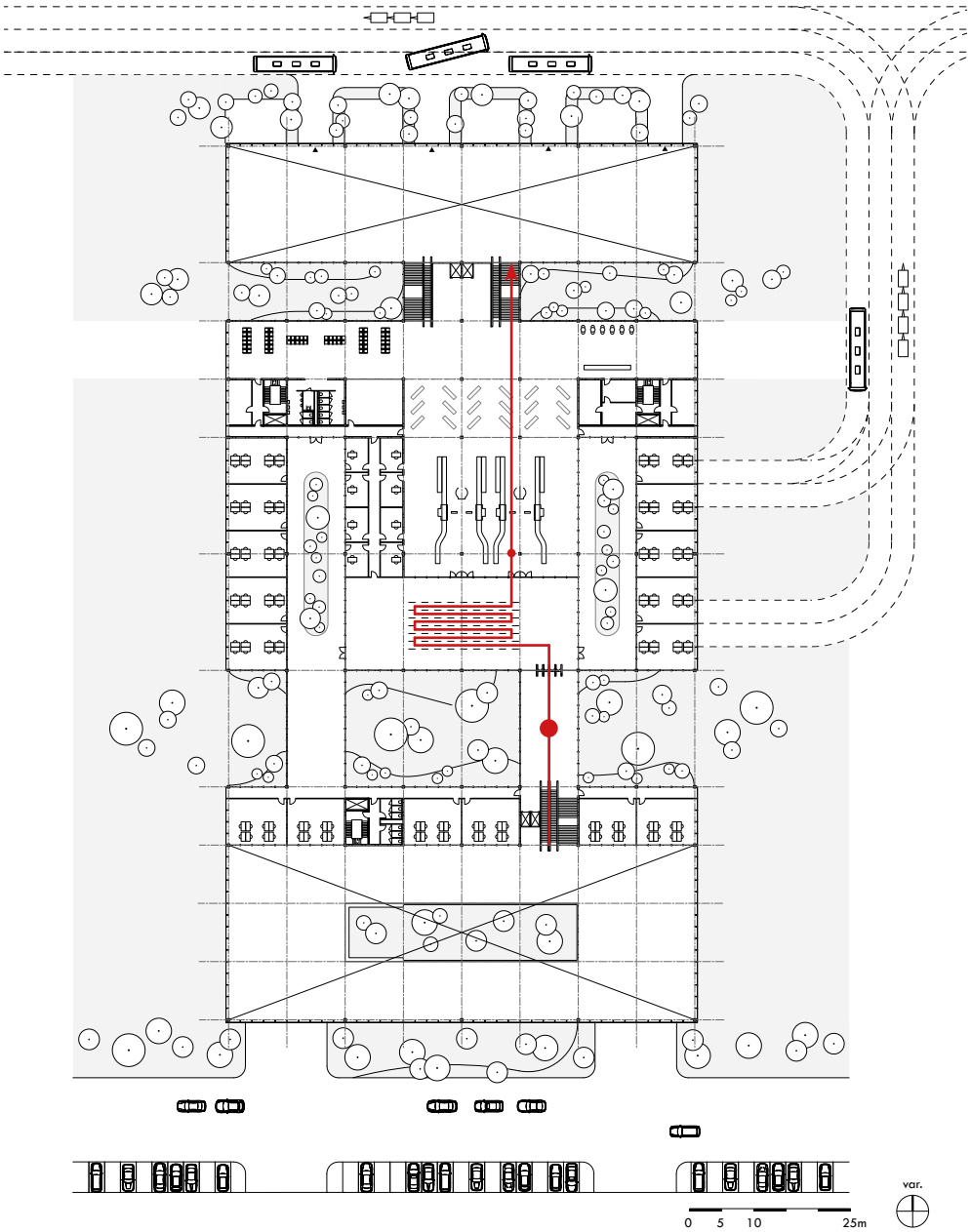


fig. 32: first floor plan

fig. 33: illustration of the green zone passage



fig. 34: section AA

Step 3: security control

The terminal has been designed according to the one and a half level concept, which means that security checks take place on the first floor. This space has been designed with future growth in mind, giving it a more spacious feeling. Plenty of natural light enters on one side, as the security checkpoint is located next to a green area. This combination ensures that passengers queuing for security checks can wait in a pleasant environment.

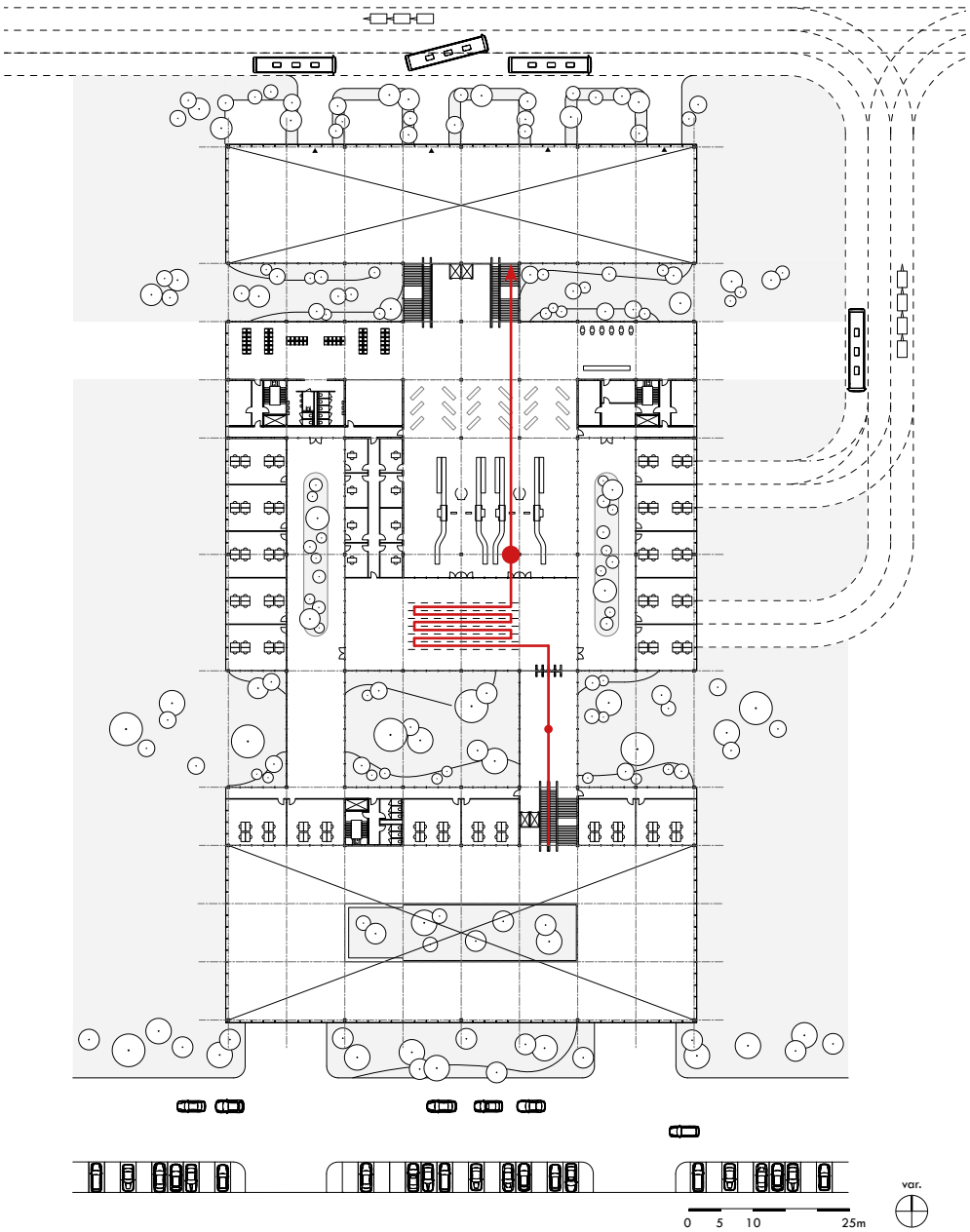


fig. 35: first floor plan

fig. 36: illustration of the security control



fig. 37: section AA

Step 4: hold room & boarding

After security, passengers will find a duty-free area with a few shops and bars. This space is adjacent to the next green zone, allowing natural light to enter the building here as well. The green zone forms the transition between the processing area and the airside concourse, where the waiting area is located for passengers waiting to board their flight. The waiting area has been designed as a large, open space with high ceilings to make the wait more pleasant. In addition, passengers can also wait outside in the extra green zone that has been created.

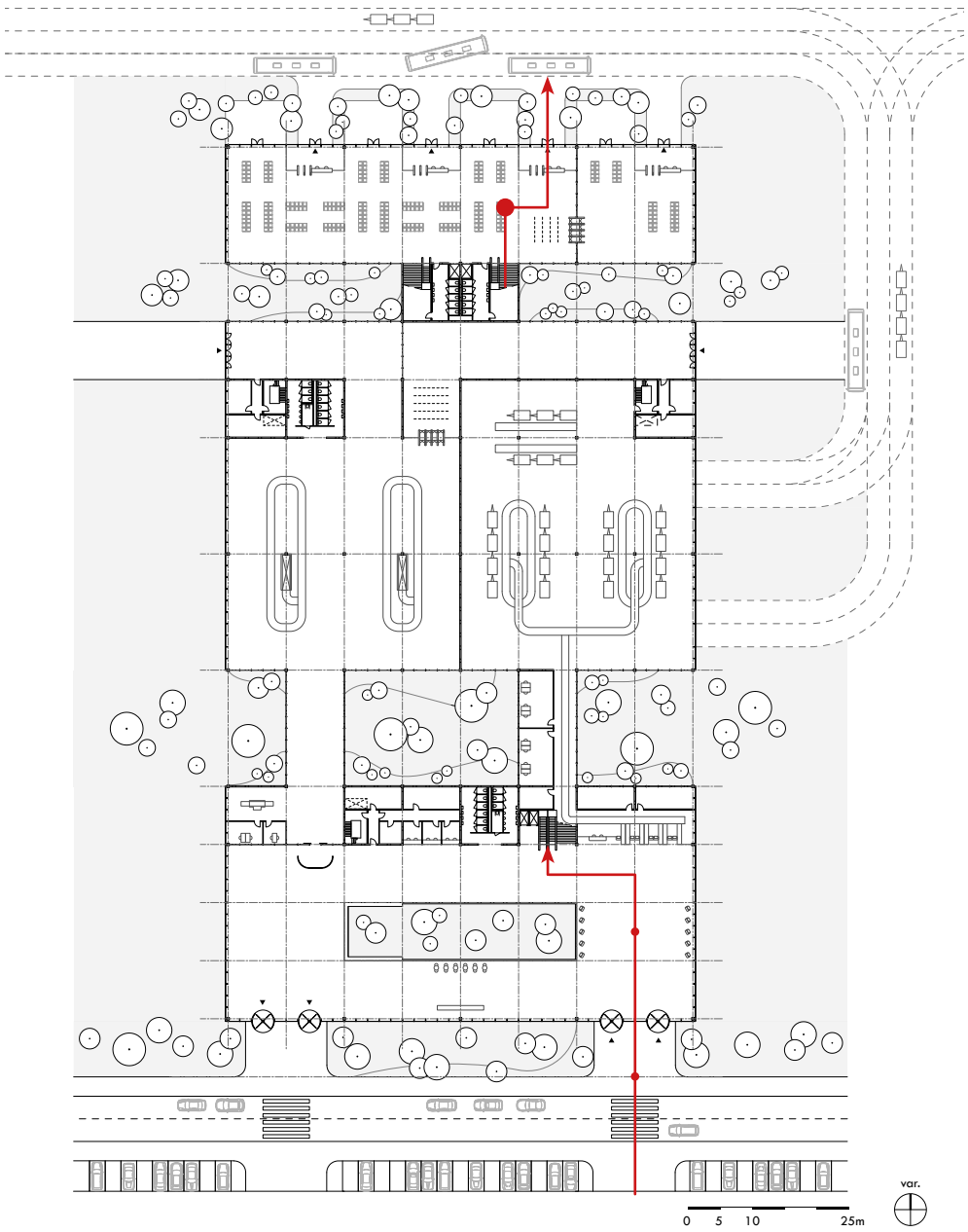


fig. 38: ground floor plan

fig. 39: illustration of the hold room and gates



fig. 40: section AA

Step A: arrival at terminal

Arriving passengers reach the terminal by bus and then enter a corridor that leads them to the baggage hall. In many airports, this corridor is a long, dark passageway with no natural light. However, in this design, an attempt has been made to make the corridor as pleasant as possible by connecting it to one of the green zones. This allows daylight to enter, and passengers walk past the greenery, as shown in figure 42.

This corridor will later serve an important function in the terminal's expansion. It will ensure that departing and arriving passengers are physically separated from one another.

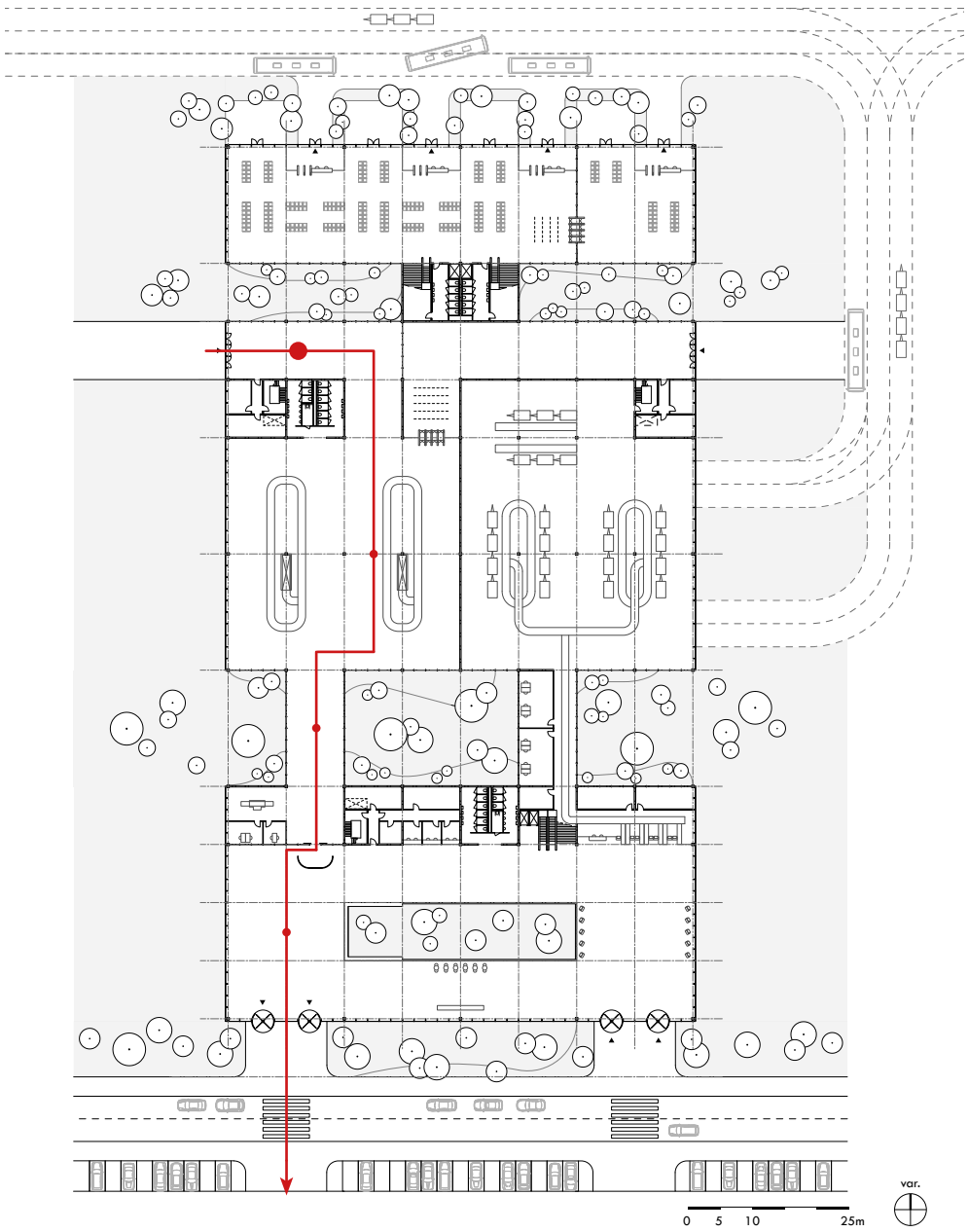


fig. 41: ground floor plan

fig. 42: illustration of the arrival corridor

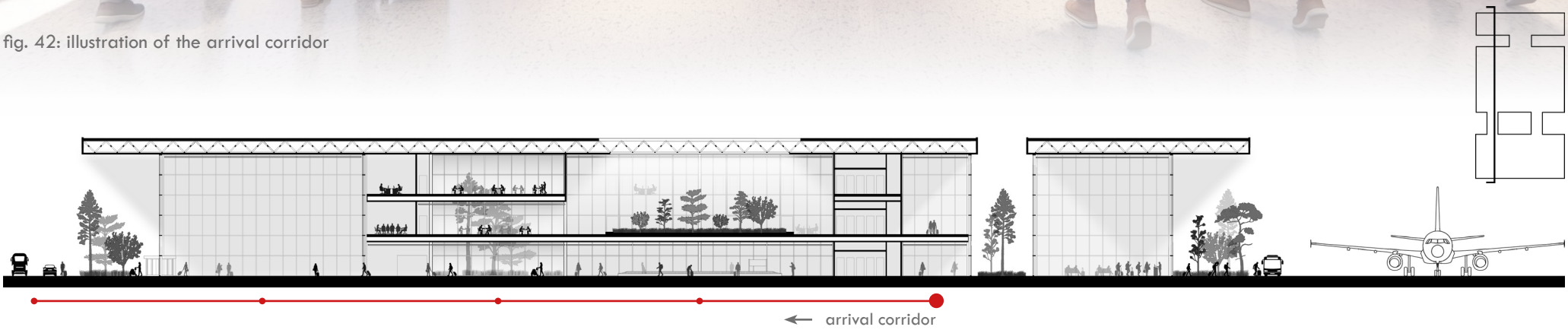


fig. 43: section BB

Step B: baggage claim

Less design attention is often paid to the areas for arriving passengers. A prime example is the baggage hall. This is mostly a large, dark space where a lot of people wait in crowded conditions. However, in this case, the baggage hall is situated directly alongside one of the green zones, allowing passengers to look out onto a green environment whilst waiting for their luggage. In addition, the presence of daylight creates a more pleasant space for waiting.

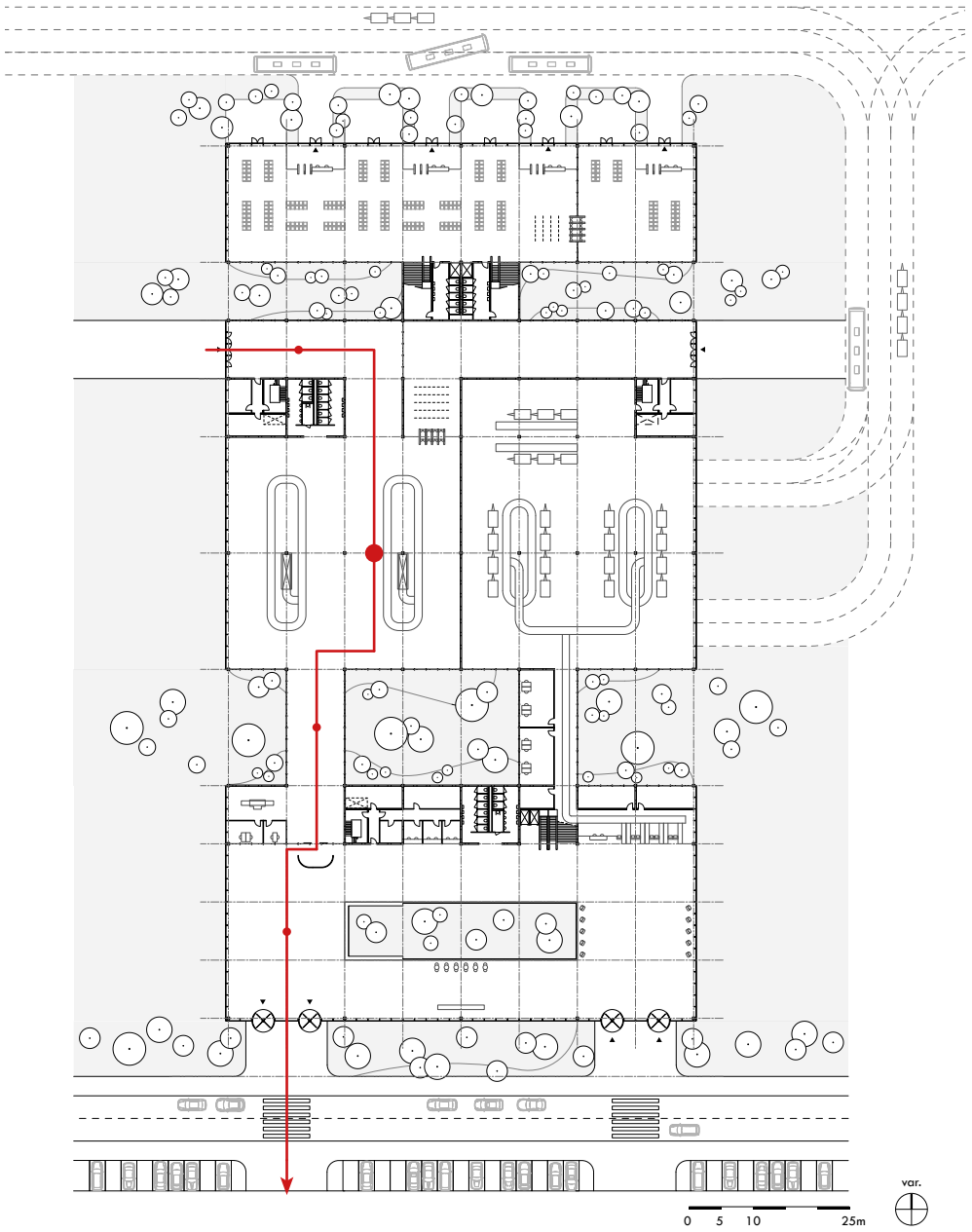


fig. 44: ground floor plan

fig. 45: illustration of the baggage claim area



fig. 46: section BB

Intermezzo: green zone passage

After collecting baggage from the baggage carousel, passengers walk through the green zone before reaching the arrivals hall. This not only creates a pleasant atmosphere, but also serves as a physical barrier between the final step in the process and access to the public area.

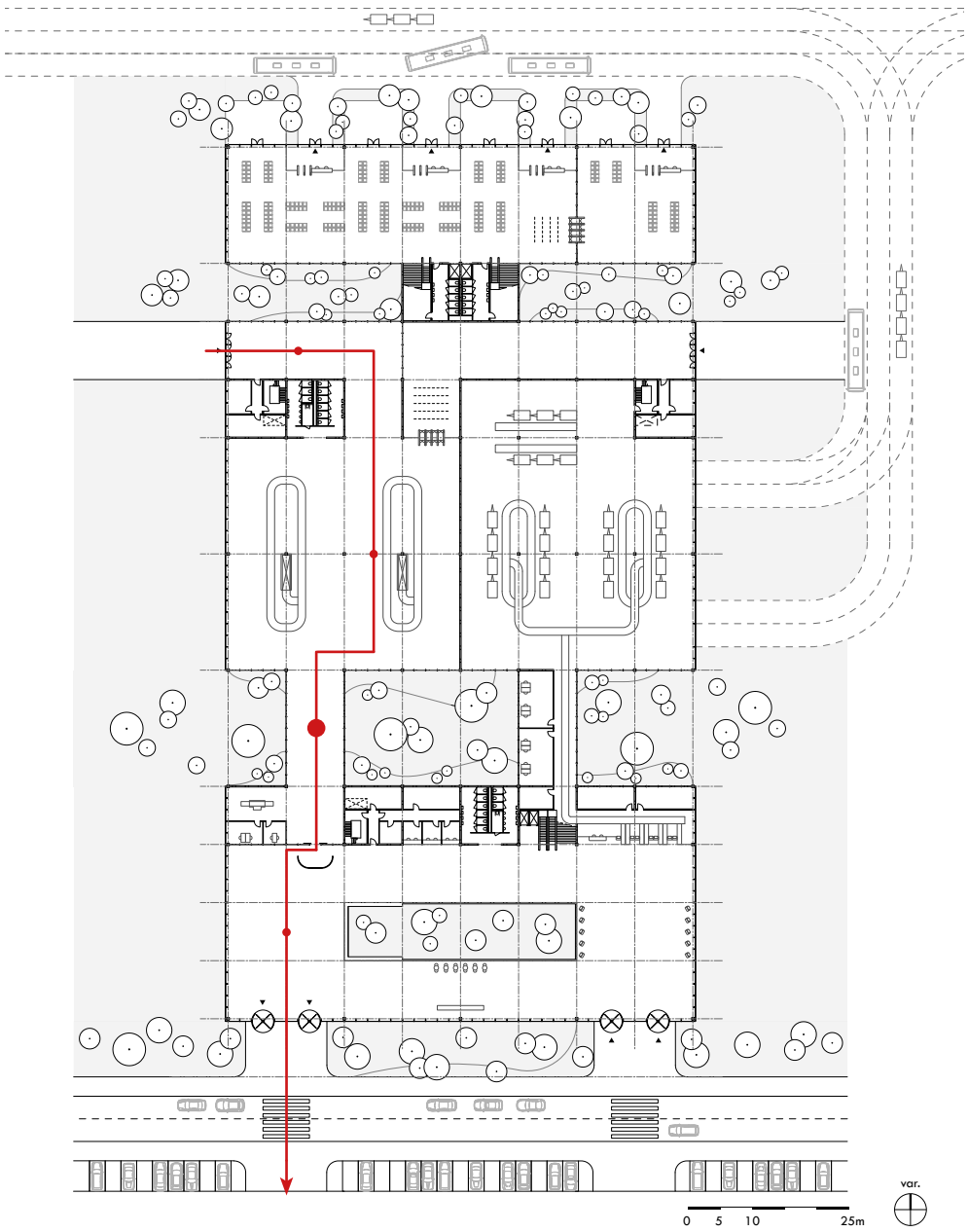


fig. 47: ground floor plan



fig. 48: illustration of the green zone passage

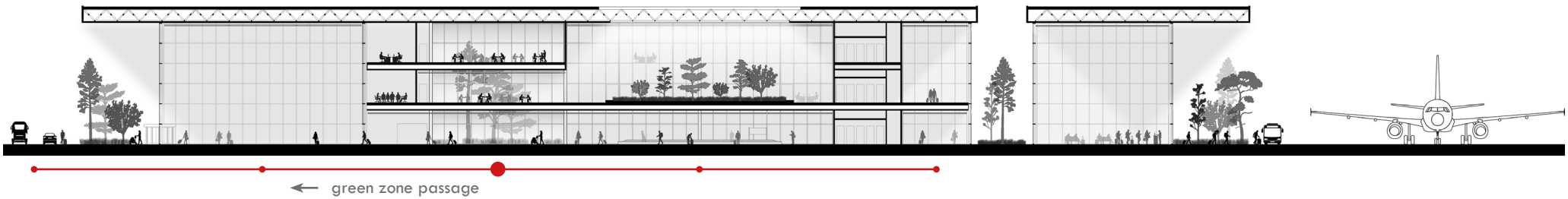


fig. 49: section BB

Step C: arrival hall

After collecting the luggage, the passenger walks through a green area to the arrivals hall. The arrivals hall is connected to the departures hall, creating a large, open space. This is the result of the one and a half level concept chosen for this design. The arrivals hall also houses car rental companies and a few shops and bars. Passengers can leave the terminal via the revolving doors.

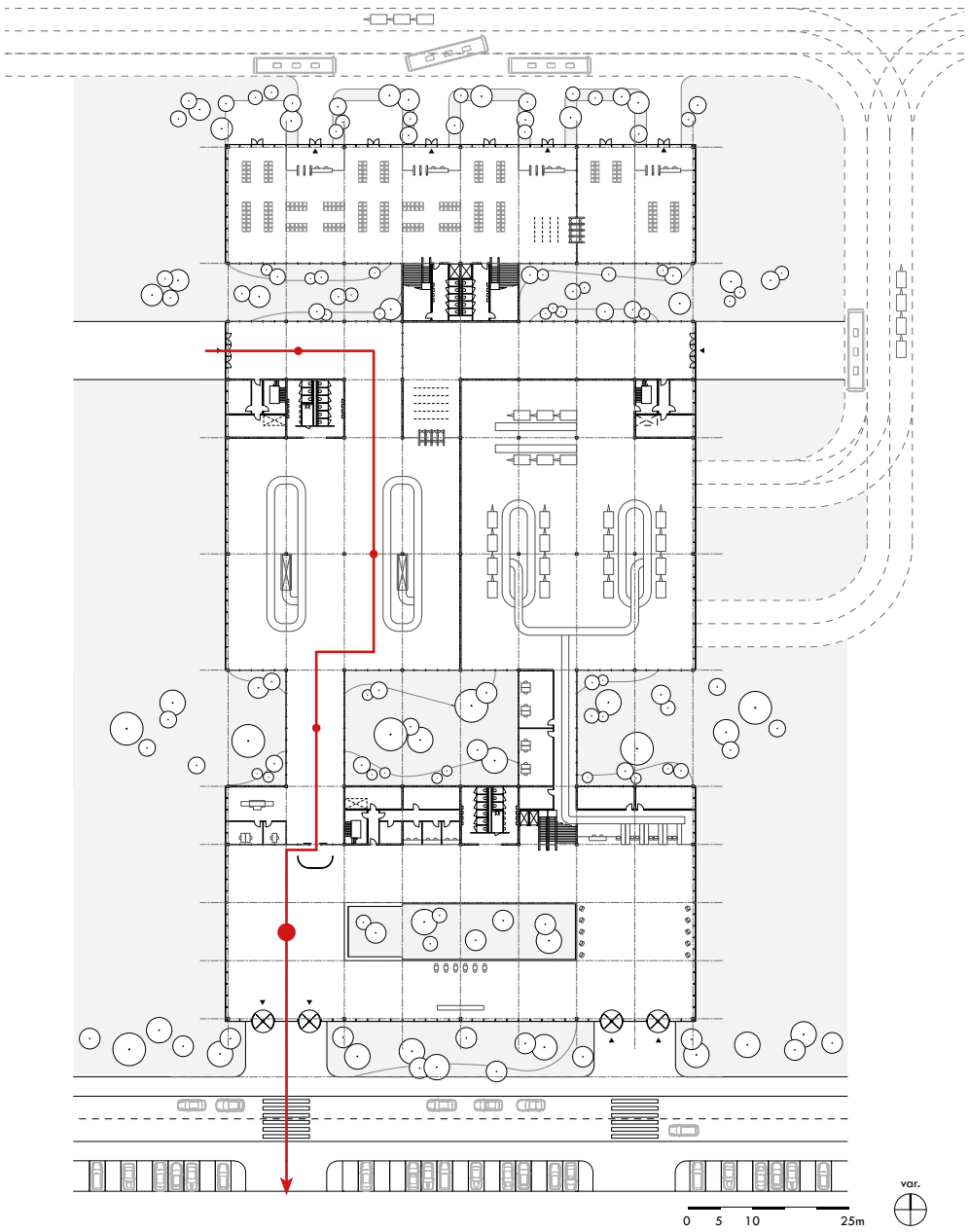


fig. 50: ground floor plan

fig. 51: illustration of the arrival hall

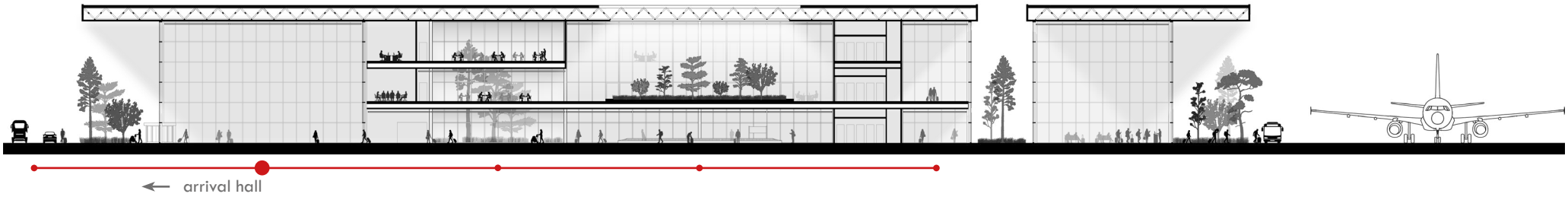


fig. 52: section BB

Facade detailing

As previously mentioned, the facade is fully modular and can be disassembled. It is constructed using a modular curtain wall system in which the modules can be modified. Figure 53 shows a section of the facade consisting entirely of glass. The detailed drawings on the right show how the facade fixing system is designed to be modular and demountable.

A 'second' facade of perforated panels has been added in front of the curtain wall to block direct sunlight and thus reduce the heating effect on the building. The choice of this 'second' facade was explained earlier in section 04.2. There is a variation in the perforation density in order to create a more varied and interesting facade appearance. In addition, the panels with a higher perforation rate have been positioned at eye level, so that people have a better view to the outside.

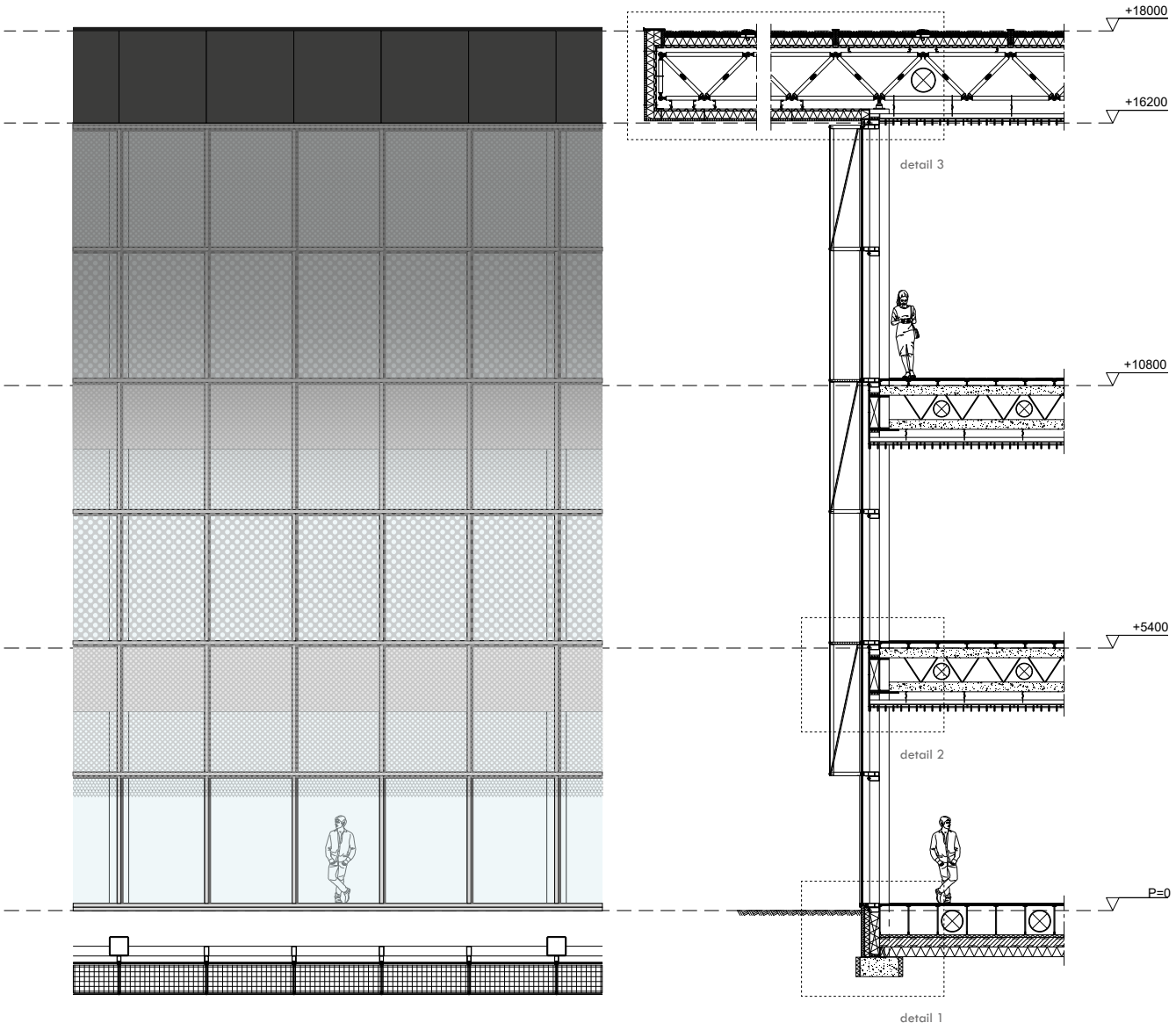


fig. 53: facade fragment drawing

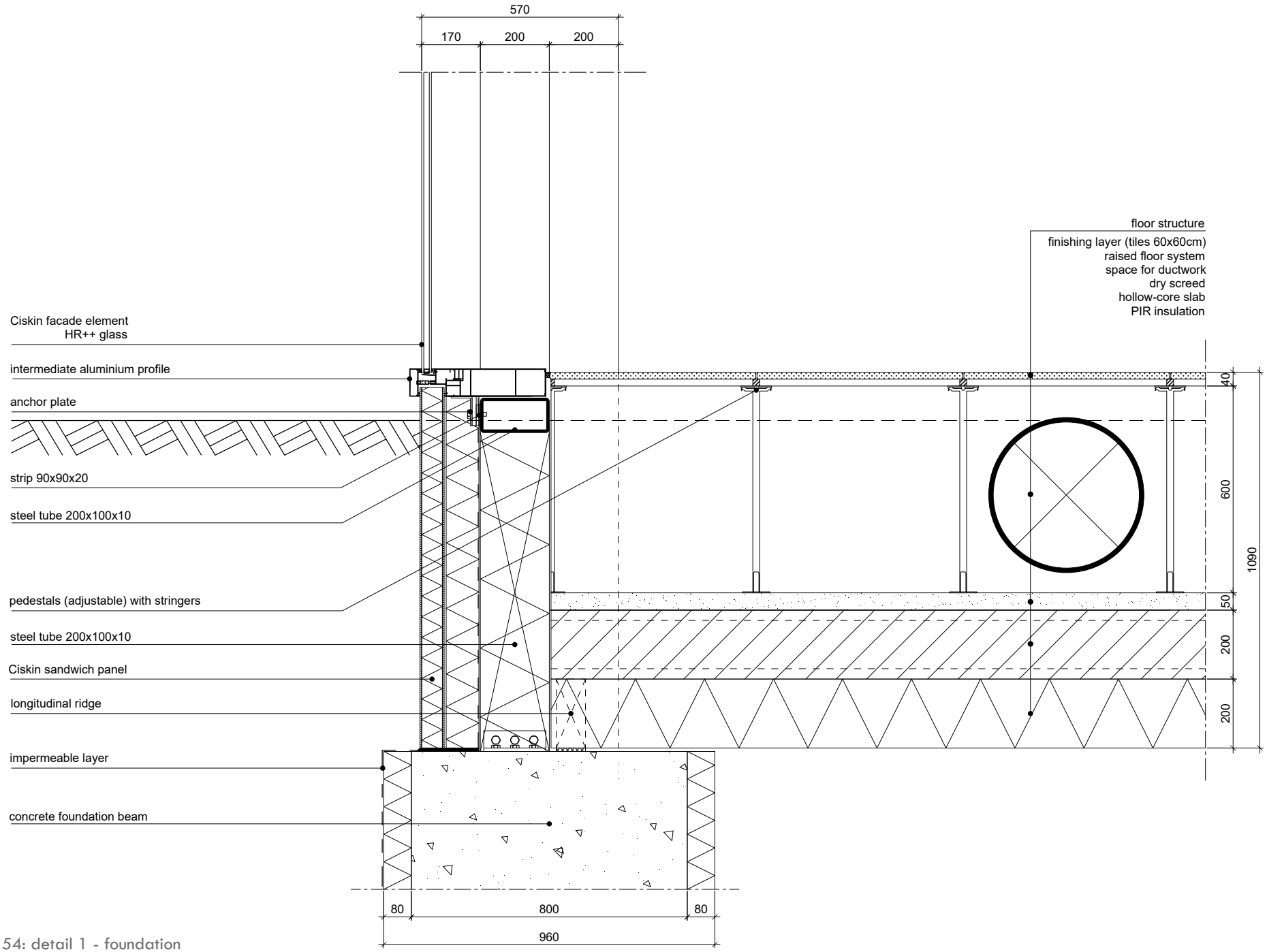


fig. 54: detail 1 - foundation

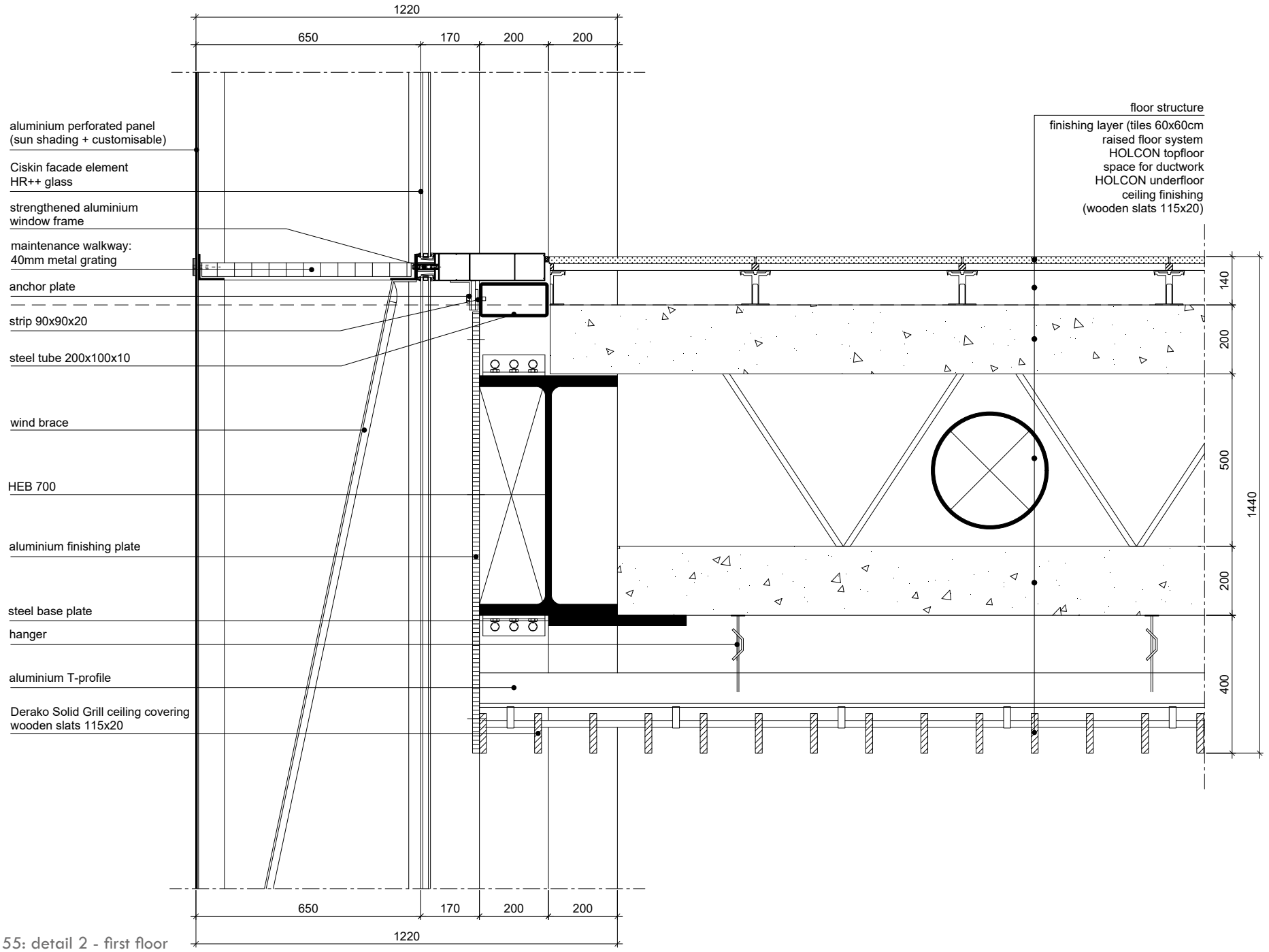


fig. 55: detail 2 - first floor

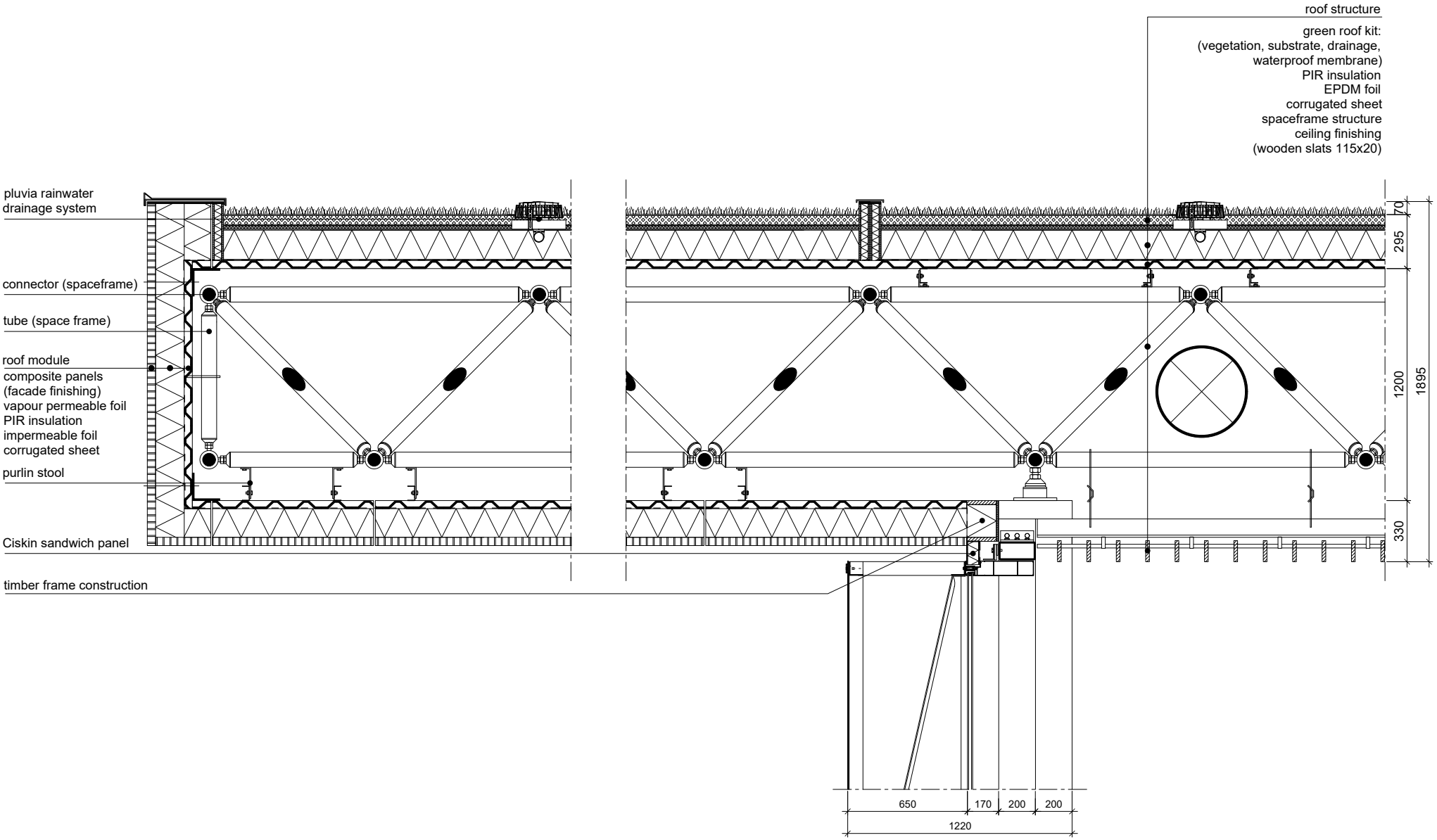


fig. 56: detail 3 - roof

Indoor climate

The indoor climate in a terminal is a significant factor that should not be ignored. Given the large spaces, there is a substantial need for an efficient ventilation system. Type D ventilation has been chosen, featuring both mechanical supply and extraction. The supply of fresh air is combined with cooled or heated air. In summer, natural extraction is also possible via the roof windows, which can be opened.

The air ducts are integrated into the Holcon floors and the roof structure. The air ducts between the floor slabs are designed for the smaller spaces in the terminal, including offices and restrooms. The air ducts between the roof structure are intended for the large spaces including the departure and arrival hall and the waiting areas. This has created two distinct air handling systems that operate independently of one another. As the terminal expands, new air systems will be added, meaning that over time there will be several separate air systems within the terminal.

The terminal's roof has been designed as a combination of green roof modules with solar panels and opening skylights. To generate energy, the green roof is fitted with vertical bifacial solar panels. These are not standard solar panels, but small vertical panels with open spaces between them. As a result, the green roof is less covered by solar panels.

Rainwater is drained via a pluvia system and is then collected beneath the building to flush toilets and supply water to the green areas.

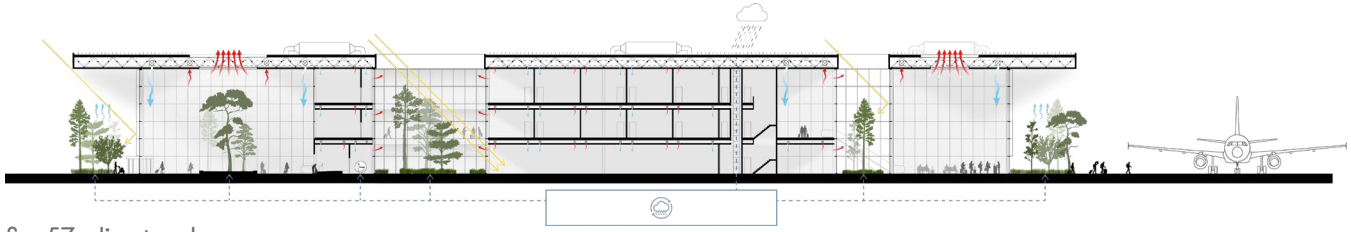


fig. 57: climate scheme summer

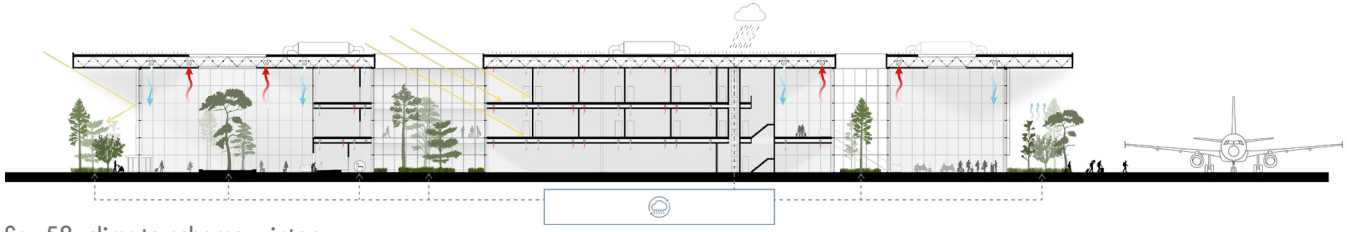


fig. 58: climate scheme winter

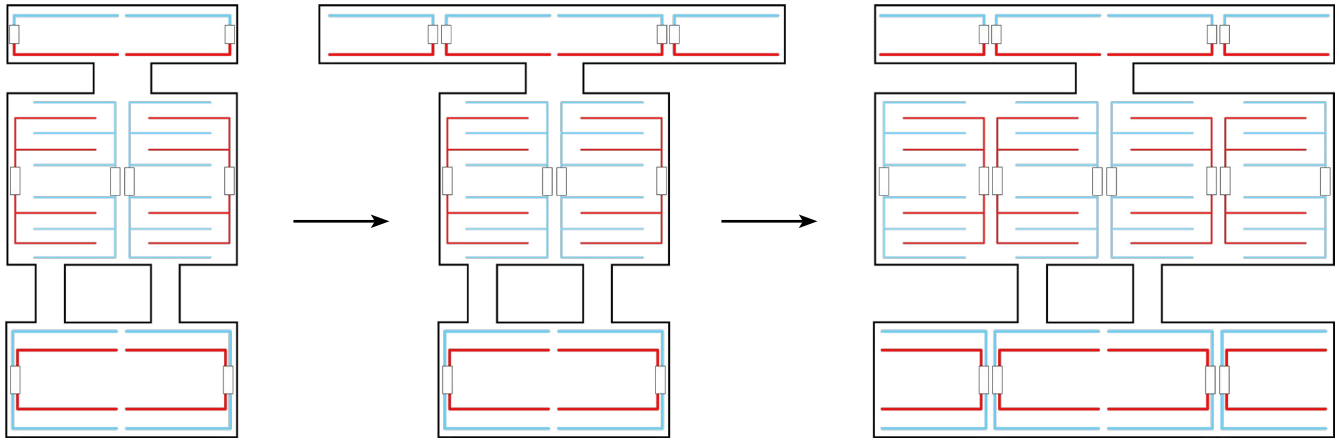


fig. 59: schematic drawing of the ventilation system's expansion

Construction detailing

Figure 61 shows an exploded view of the construction. The terminal's structure consists mainly of 400x400mm steel columns with HEB 700 steel beams. The beams are strong enough to support the Holcon floors. A Holcon floor is 1800 mm wide and consists of an upper and lower floor. The bottom floor is smaller to create space for accessing the pipework. The space between two bottom floors is filled with a cement-bonded board. A detailed sketch of the connection between a steel column, HEB beam and Holcon floor can be seen in figure 60.

The roof is constructed from a space frame. This consists of steel tubes connected to one another in a triangular pattern via joints. This construction allows for large open spaces due to its high rigidity and strength, meaning the roof effectively functions as a single large slab. To provide additional stability, a number of wind bracing members have been added, which can be seen in the exploded view in figure 61.

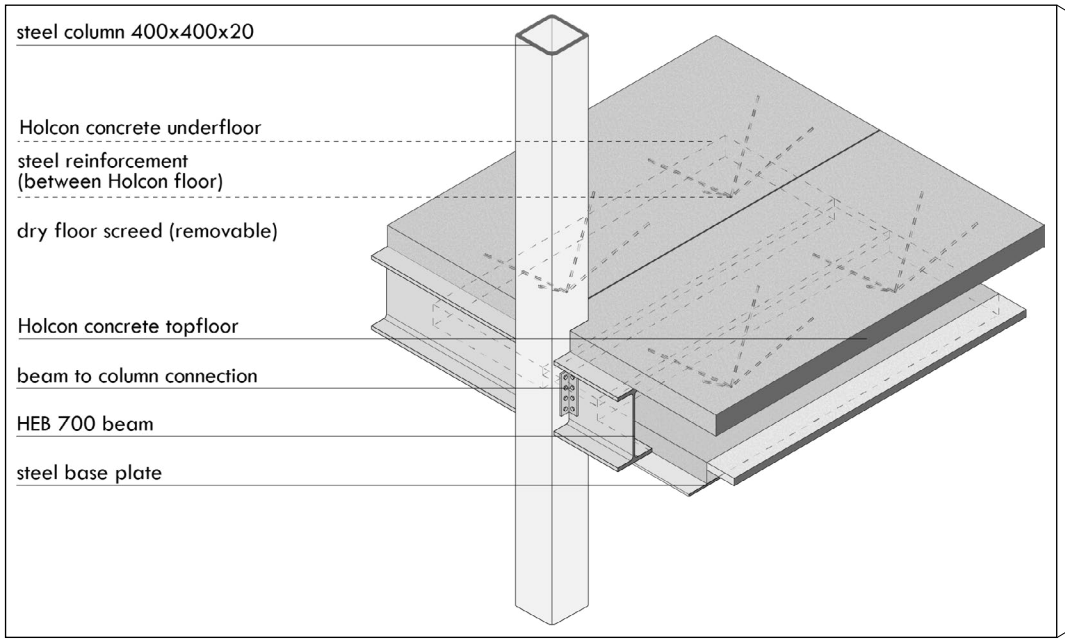


fig. 60: drawing of structural connection

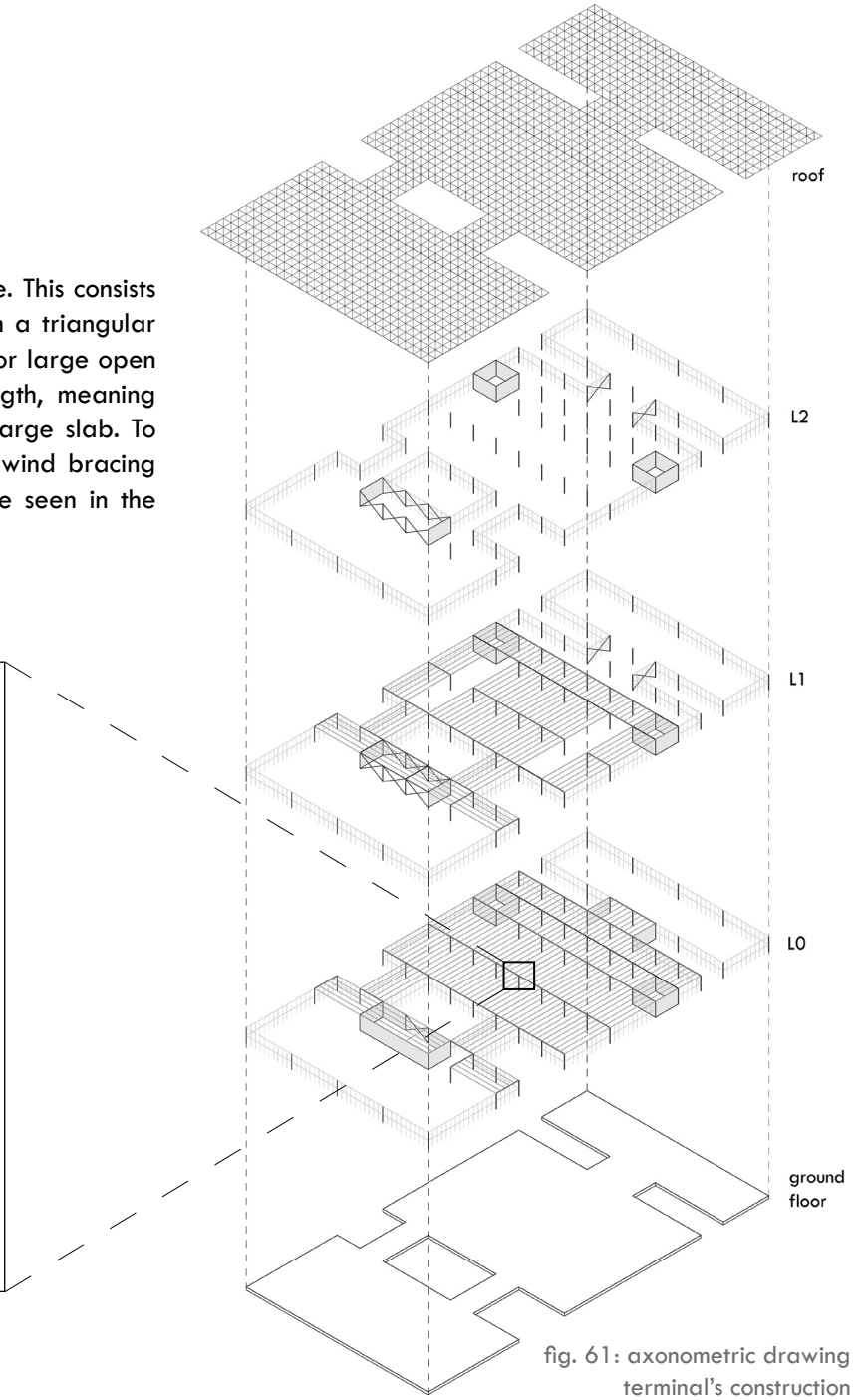


fig. 61: axonometric drawing terminal's construction

05 Conclusion

This research examined the possibility of designing an adaptive system for an airport terminal that is independent of the construction site. Airports are enormous, complex buildings and are constantly evolving due to changing factors such as shifting passenger needs, fluctuating demand for flights, changing operational requirements and technological developments in aircraft. In addition, external factors increase the need for terminals to be more flexible in order to respond easily to these changing factors. Therefore, the following main question was formulated: *how can an airport terminal be designed as an adaptable framework that can adjust to changing air travel conditions over time?*

This main research question has been divided into three sub-questions: *1. Which terminal typology is most suitable for adaptive design? 2. Which elements of a terminal building need to be flexible, and to what extent? 3. Which architectural design strategies can support long-term adaptability in an airport terminal?* This research did not focus on possible changes in air travel conditions in the future, as many factors influence this and the future is an uncertain factor. The focus was therefore primarily on accommodating growth scenarios, and by designing the spaces to be as flexible as possible to be able to respond easily to potential future changes.

A combination of literature reviews and analyses of the various terminal typologies has resulted in a matrix in which the transporter typology proved to be the most suitable for an adaptive design. However, the linear typology also proved to be relatively suitable for this purpose. The least suitable typologies were found to be the satellite and midfield X-shaped typologies, as these consist of an airside building that is completely surrounded by aircraft and is therefore difficult to adapt. For the second sub-question, a combination of three case studies and a literature review has resulted in an overview of the spatial and functional elements of a terminal, classified by layers. Each layer has its own lifespan, and by designing in separate layers, individual layers can be easily replaced. This extends the lifespan of a building.

For the third and final sub-question, a literature review has identified five design strategies that can contribute to the design of an adaptive terminal. These five strategies are: designing with layers, open-plan layout, modularity, geometric simplicity and buffer zones.

These three sub-questions formed an important basis for answering the main research question. The research has resulted in the design of an airport terminal that is designed for various growth phases and can be customised to suit the for the building region. A configurator has been developed as an adaptable framework in which the terminal can be assembled entirely to the client's needs through a series of steps. The general terminal has not been designed to be location-specific, thereby achieving maximum flexibility and enabling it to be realised in a variety of locations.

However, it is worth noting that the construction site is often a major obstacle to achieving adaptability. When developing the Master Plan, many long-term infrastructure-related factors are determined. However, if it turns out that the infrastructure imposes limits on growth potential, the terminal's design can be as adaptive as it likes, but the construction site remains the critical factor.

The layout of the terminal allows for expansion in width and, depending on the location, also towards the landside. The design is based on three separate zones with two service zones in between. These service zones contain all the essential elements that are unlikely or impossible to relocate. The three separate areas can effectively be regarded as an open-plan layout and are therefore quite flexible in terms of configuration and designed with the future in mind.

06 Recommendations & reflection

Recommendations

This design for an adaptive airport terminal could represent a major step towards flexible design in the aviation industry. A review of the literature revealed that attention to flexible terminal design is still limited and lagging behind that of other building typologies. There are already a few terminals that utilise, for example, a modular construction, but which lose their flexibility due to other factors. In this research, the aim was specifically to realise an adaptive design that takes all manner of factors into account.

The final design focuses solely on point-to-point traffic, which means that the terminal is used only by passengers for whom the terminal is either the point of departure or the final destination. Transfer passengers have not been taken into account, as they could present additional challenges in terms of passenger flows and security. Including transfer passengers was simply not feasible within the timeframe of this research. It may therefore be of interest for a follow-up study to examine whether this design remains adaptable when designed with transfer passengers in mind.

Another recommendation could be to explore different terminal volume options. The final design resulting from this research consists of a rectangle with significant depth. For further research or to expand the configurator, it may be worthwhile to consider other possible volumes of the terminal. A first example is to explore a rectangle with a wider front facade and reduced depth. Another example is investigating the possibility of rotating a part of the terminal. Studies of existing terminals frequently revealed that the terminal is oriented around a central landside square, meaning that the terminal is partially rotated.

A third and final recommendation would be to investigate how the terminal can incorporate non-aviation functions into the building in the event of declining demand. The initial intention was to pay attention to this, but due to time constraints and other priorities, no further investigation was carried out. However, in my opinion, this is a very interesting design challenge.

Reflection

Looking back on this research, I would say that designing a terminal is more complicated than I thought; in particular, combining it with the aim of creating an adaptive design proved to be a major challenge. During the early stages, I struggled to define the scope of the research and wasn't quite sure which direction I wanted to take. I found it difficult to focus on a particular direction, as I wanted to do everything, but simply wasn't enough time for that and it wasn't realistic. In the end, I chose to focus my research on adaptive design, as I realised there were still opportunities to be explored in this field.

At times, I had trouble getting to grips with the process, because there were so many aspects to figure out that it was difficult to find a clear structure. That's when my supervisors helped steer me in the right direction. Once the design phase began, I realised that designing the floor plan for an airport is one of the most important aspects of the design, as a well-designed floor plan has a direct impact on the terminal's functionality. I revised and optimised the floor plans several times, and I am now satisfied with the final result. The need to design with future growth in mind also added an extra layer of complexity to the floor plan design process.

I think that the final result is a well-balanced combination of architecture and building technology. Whilst I was initially concerned that the adaptive aspect might make this research too technical, I can now say that I was also able to focus sufficiently on the building's architecture. I must admit, however, that due to the adaptive aspect of this research, the building has ended up with a less spectacular and distinctive design than some of the reference projects I had in mind. Simply because modularity is difficult to apply to curved forms, for example. In the end, I used the designs of Mies van der Rohe as a reference, where minimalism and transparency are central.

To conclude, before starting this graduation project, I thought I would have plenty of time to consider all the design aspects, but I must admit that this was not the case. The research part took up more time than expected, and optimising the floor plans took longer than I had anticipated. It was a process in which research and design came together, and that ultimately led to a design proposal that I can be satisfied with.

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Fig. 4 - 5: own illustration

Fig. 6: Burchard, J. (2025). The Shape of Our Existing Buildings. ArchDaily. Accessed on 25 March 2026 via https://www.archdaily.com/965934/the-shape-of-our-existing-buildings

Table 1 - 2: own illustration

Fig. 7 - 13: own illustration

Appendix I:

Table I.1: own illustration

Fig. I.1: own illustration

Fig. I.2: Stilte in de lucht; vanaf Rotterdam Airport vliegt niets meer. (2020). NU.nl. Accessed on 21 March 2026 via https://www.nu.nl/economie/6045560/stilte-in-de-lucht-vanaf-rotterdam-airport-vliegt-niets-meer.html?referrer=https%3A%2F%2Fwww.google.com%2F

Fig. I.3: own illustration

Fig. I.4: Terminal 2 Gesellschaft. (2017). Munich Airport. Accessed on 21 March 2026 via https://www.munich-airport.com/terminal-2-gesellschaft-4047628

Fig. I.5: own illustration

Fig. I.6: Rome Fiumicino Airport, FCO. (n.d.). Avion Tourism. Accessed on 21 March 2026 via https://www.aviontourism.com/en/airport/rome-fiumicino-FCO

Fig. I.7: own illustration

Fig. I.8: Malpensa Airport MXP. (2017). Malpensa Airport Information Guide | Malpensa Airport. Accessed on 21 March 2026 via https://www.malpensaairporttravel.com/

Fig. I.9 - I.10: own illustration

Fig. I.11: Pittsburgh beautiful. (2024). Pittsburgh International Airport. Pittsburgh Beautiful. Accessed on 26 January 2026 via https://www.pittsburghbeautiful.com/2023/02/27/pittsburgh-international-airport/

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Appendix II:

Fig. II.1: Shuchi, S., Drogemuller, R., & Kleinschmidt, T. (2012). Flexible airport terminal design: towards a framework. In Proceedings of the IIE Asian Conference 2012 (pp. 348-356). National University of Singapore.

Table II.1: own illustration

Fig. II.2: own illustration

Fig. II.3: Aeroporto Raffaello Sanzio - Falconara Marittima – Ancona – Italy – gmp Architekten - Federico Covre. (2023). Federico Covre. Accessed on 24 March 2026 via https://www.federicocovre.com/project/aeroporto-raffaello-sanzio-gmp-architekten

Fig. II.4: Aeroporto Raffaello Sanzio - Falconara Marittima – Ancona – Italy – gmp Architekten - Federico Covre. (2023). Federico Covre. Accessed on 24 March 2026 via https://www.federicocovre.com/project/aeroporto-raffaello-sanzio-gmp-architekten

Fig. II.5 - II.6: own illustration

Fig. II.7: Aeroporto Raffaello Sanzio - Falconara Marittima – Ancona – Italy – gmp Architekten - Federico Covre. (2023). Federico Covre. Accessed on 24 March 2026 via https://www.federicocovre.com/project/aeroporto-raffaello-sanzio-gmp-architekten

Fig. II.8: Aeroporto Raffaello Sanzio - Falconara Marittima – Ancona – Italy – gmp Architekten - Federico Covre. (2023). Federico Covre. Accessed on 24 March 2026 via https://www.federicocovre.com/project/aeroporto-raffaello-sanzio-gmp-architekten

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Fig. II.11 - II.12: own illustration

Fig. II.13: Sánchez, D. (2024). Eindhoven Airport Extension & Hotel / KCAP + De Bever Architecten. ArchDaily. Accessed on 24 March 2026 via https://www.archdaily.com/405930/eindhoven-airport-extension-and-hotel-kcap-architects-and-planners-de-bever-architecten

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Fig. II.15: own illustration

Fig. II.16: Ly, L. (2022). Passenger facilities at LaGuardia's multibillion dollar Terminal B are officially complete. CNN Travel. Accessed on 24 March 2026 via https://edition.cnn.com/travel/article/laguardia-airport-terminal-b-completion-new-york

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Appendix III:

Fig. III.1: Tilman, H. (2023). Een Apeldoorn bellen – Transformatie van Centraal Beheer door Herman Hertzberger. Harm Tilman. Accessed on 25 May 2026 via https://harmtilman.nl/blog/een-apeldoorn-bellen-transformatie-van-centraal-beheer-door-herman-hertzberger/

Fig. III.2: Tilman, H. (2023). Een Apeldoorn bellen – Transformatie van Centraal Beheer door Herman Hertzberger. Harm Tilman. Accessed on 25 May 2026 via https://harmtilman.nl/blog/een-apeldoorn-bellen-transformatie-van-centraal-beheer-door-herman-hertzberger/

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Fig. III.4: Canham, J. (2022). Crown Hall — Mies van der Rohe Society. Mies van Der Rohe Society. Accessed on 25 May 2026 via https://www.miessociety.org/mies-buildings/blog-post-title-two-793r4-yjaj6-fm4kw-2krsa-shmmd-6z38e-4ejzw

I appendix: terminal typologies and their adaptive potential

This appendix contains the elaboration of the first sub-question: *which terminal typology is most suitable for adaptive design?* As explained in the theoretical framework, there are several typologies for an airport terminal building. In this section, these typologies are assessed against six different criteria that affect the level of adaptability in airport design, which has resulted in a matrix.

Criteria for the matrix

This matrix provides a qualitative comparison of airport terminal configurations. It is constructed by combining literature of airport planning and design, studies on the various airport configurations and several reference projects. The typologies are reviewed under the following criteria, by using three different levels of reference (high/ medium/low):

1. *operational flexibility:* ability to adjust day-to-day operations (flows, gates, security layouts) without physical changes;
2. *tactical flexibility:* ability to reconfigure spaces or systems in the short–medium term (two to five years) with limited construction;
3. *strategic flexibility:* ability to adapt to long-term changes in demand, airline models, or airport role through expansion or shrinkage;
4. *suitability as O&D airport:* ability to efficiently process origin and destination passengers with short walking distances and simple flows;
5. *suitability as hub airport:* ability to support transfer passengers and high connectivity;
6. *potential for non-aviation reuse:* ability to accommodate non-aviation functions if air traffic demand declines.

Table I.1 shows the outcomes of the matrix. It becomes clear that the transporter configuration is most appropriate for adaptive airport design, because of its high flexibility in all three categories (operational, tactical and strategic) and the high potential for reuse. The scores given in the matrix are explained in more detail on the following pages including an existing airport as an example for clarification.

Limitations of the matrix

It is worth noting that this matrix does not define one specific configuration as 'the best' overall option, because factors including the total construction costs, operational disruption during construction work and other operational factors have not been taken into account for this research. That is because this study only considers the most important aspects that relate to an adaptive airport terminal design.

Airport typology	Operational flexibility	Tactical flexibility	Strategic flexibility	Suitability as O&D	Suitability as hub	Potential reuse	Score	Comments
Transporter	🟩🟩🟩	🟩🟩🟩	🟩🟩🟩	🟩🟩🟩	🟥	🟩🟩🟩	16	adaptable to daily peak hours, easily expandable and high potential reuse because terminal is not connected to aircrafts, low suitability as hub due to buses that bring passengers from terminal to aircraft.
Linear	🟩🟩🟩	🟨🟨	🟩🟩🟩	🟨🟨	🟥	🟩🟩🟩	14	simple structure and organisation principles, easy to expand at both ends of the building, centralised processer may result in long walking distances to gate making it unfunctional for transfers.
Pier	🟩🟩🟩	🟨🟨	🟩🟩🟩	🟩🟩🟩	🟨🟨	🟨🟨	15	shared facilities inside pier, easy to expand by extending pier or adding a new pier, functions well for high O&D and medium hub activity.
Satellite	🟨🟨	🟨🟨	🟨🟨	🟨🟨	🟩🟩🟩	🟥	12	tactical flexiblity is limited by the need for an above-ground or underground connection, expansion possible but limited due to connector between terminal and satellite building, highly suitable for transfers, but not for potential reuse due to airside location.
Midfield (linear)	🟩🟩🟩	🟨🟨	🟩🟩🟩	🟨🟨	🟩🟩🟩	🟥	14	high operational flexibility because of long, simple structure, tactical flexibility is limited by the need for an above-ground or underground connection, easily expandable by extending concourses or by adding new concourse.
Midfield (X-shaped)	🟨🟨	🟨🟨	🟨🟨	🟥	🟩🟩🟩	🟥	11	operational flexiblity is limited because larger aircraft stands are only positioned at the end of the concourse, less possibility of expansion due to specific geometry, low potential reuse due to airside location.

table I.1: matrix of airport typologies assessed against flexibility criteria

Explanation of the matrix
Below is a detailed description of the results from the matrix for each typology.

Transporter configuration
'provides a complete separation of passenger facilities from those required to service and maintain the aircraft. Aircraft and aircraft-servicing functions are remotely located from the terminal.' (p. 176, Landrum & Brown, 2010). Often passengers are transported by buses from the terminal building to the aircraft. An example of the transport configuration is Rotterdam The Hague airport in the Netherlands (fig. I.1 and I.2).

A transporter configuration provides significant operational flexibility due to its adaptability for short daily peak hours and seasonal traffic peaks (Neufville & Odoni, 2013). Also for the tactical flexibility is a transporter concept very efficient because each facility within an airport can be adjusted if necessary. And because the parking spots of aircraft are situated far away from the terminal, it allows for easy expansion, therefore improving the strategic flexibility (Landrum & Brown, 2010). Hence, all three criteria classified as high in the matrix.

The disadvantage of transporter terminals is the need for buses to bring passengers from the terminal to the aircraft and the other way round which is time-consuming. That makes it not useful for an hub location and therefore labelled as low in the matrix (Landrum & Brown, 2010).

The potential reuse of the transporter configuration is classified as high, because several examples in the past show the possibility to house different functions in the terminal building. In addition, the aircraft parking spots are located independently from the terminal building, making the terminal easier to convert to other functions. This is particularly interesting for airports that have strong seasonal variations in air travel demand such as summer and winter destinations (Neufville & Odoni, 2013). A first example is Ellinikon International Airport in Athens, closed in 2001 and now being redeveloped into an urban area as part of the city, costing around eight billion euros. Almost the complete site is already demolished, except for the terminal building. The terminal building will be remained to use for exhibitions, an event venue and a cultural hub (Qubein, 2024). A second example is Atatürk Airport in Istanbul. This former airport closed in 2019 for passenger flights and three years later for cargo operations. Today, the site is redeveloped into a giant park with sport facilities. The terminal buildings will be transformed into a Technopark. There will be space for thousands of startups, a science centre, a software and artificial intelligence school and technology workshops (Aa, 2025).

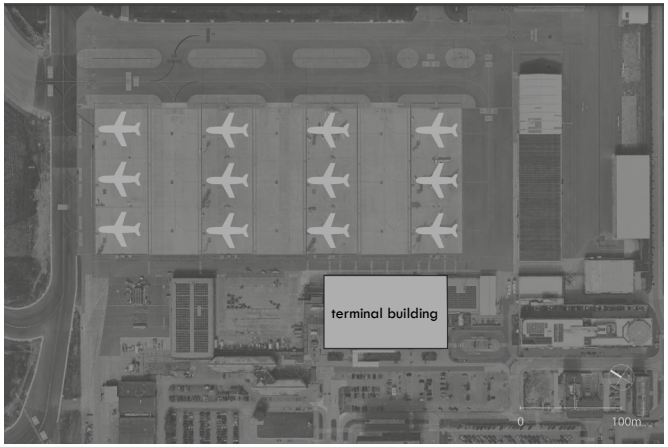


fig. I.1: illustration of Rotterdam The Hague Airport with its transporter typology


fig. I.2: aircraft aprons at Rotterdam The Hague Airport

Linear configuration

'consists of a single passenger processing area adjacent to a single common hold room area, which, in turn, is adjacent to the aircraft parking apron. Aircraft boarding is handled via a series of gates that lead directly to the aircraft parking apron or to passenger loading bridges, which are spaced along the terminal face.' (p. 172, Landrum & Brown, 2010). An example is Munich Airport in Germany (fig. I.3 and I.4)

The linear concept is known for its simple structure with all facilities under one roof and its simple organisational principles (Landrum & Brown, 2010). It can operate with or without permanently assigning specific gates to particular airlines, making it highly operationally flexible (Ashford et al, 2011).

Tactical flexibility in linear airport terminals is originally limited by the fact that check-in and security facilities need to be copied along each gate in order to allow for short walking distances (Landrum & Brown, 2010). In addition, single gates do not supply enough business for realising important stores (Neufville & Odoni, 2013). Nowadays, they combine the separate check-in and security areas into one centralised zone to decrease the cost for security. In consequence, the walking distance will increase and could be relatively long (Neufville & Odoni, 2013). Therefore qualified as medium in the matrix.

Strategic flexibility is a major advantage of the linear terminal concept due to the possibility of easily expansion to both ends of the building (Gedeon, n.d.). Components including the landside, airside or terminal, can be expanded independently or in combination giving considerable flexibility to the linear concept (Landrum & Brown, 2010). Thus, labelled as high in the matrix.

The linear configuration is ideal for origin and destination airports up to circa one million annual passengers (Gedeon, n.d.). According to Landrum & Brown (2010) a linear terminal functions well for low-activity O&D airports. On the other hand, it does not function for transferring passengers because of the long walking distances within the terminal building (Neufville & Odoni, 2013). Therefore classified as middle for OD suitability and low as hub function.

The linear typology is suitable for reuse, as has been demonstrated in the past by several former airports. One example is Berlin Tempelhof, that has been closed for commercial flights in 2008. Nowadays the airport site is transformed into a park and an event location. The terminal building is used for several temporary and permanent cultural and creative activities (Comberg, 2018). Another example is Berlin Tegel Airport, that closed in 2020 for the public. The site will be used to built a technology park and new apartments. The former terminal building will be used to house a campus of Beuth University (Former Airport Berlin Tegel TXL, 2025).

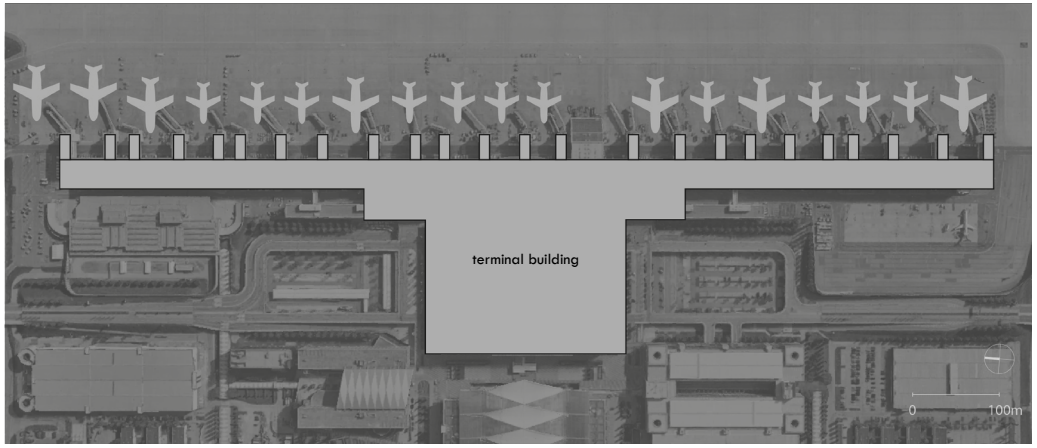


fig. I.3: illustration of the linear terminal at Munich Airport with the aircraft aprons directly at the terminal



fig. I.4: Aircrafts parked in a linear way at Munich Airport

Pier configuration

'In the pier concept, aircraft are parked on both sides of a concourse that extends from the terminal. Aircraft are usually arranged around the axis of the pier in a perpendicular, nose-in parked relationship. Access to the terminal area is at the base of the concourse or pier.' (p. 175, Landrum & Brown, 2010). An example of the pier configuration is Rome Fiumicino Airport in Italy (fig. I.5).

The operational flexibility of the pier concept can be defined as high, because passengers make use of shared facilities inside the pier and therefore declining the area required for lounged by thirty percent or more. In addition, airplanes can be parked on both sides of the pier, allowing for more aircrafts being stationed closer to the main terminal (Neufville & Odoni, 2013). Thus, classified as high in the matrix.

According to Landrum & Brown (2010) the pier configuration improves tactical flexibility, because functions including check-in, baggage drop-off and security, are completely separated from the concourse activities including waiting areas, shopping and boarding, and therefore being able to adapt to the changing requirements. However, according to Neufville & Odoni (2013) the pier configuration is often a 'simply relatively narrow extension' (p. 576) making it less easy to fully adapt to future needs. Therefore categorised as middle in the matrix.

The pier typology can have various possibilities to expand, including the extension of an existing pier to realise additional gates, or a larger expansion by constructing an entire new pier connected to the main terminal (Landrum & Brown, 2010). These possibilities have led to the classification of high in the matrix.

According to Landrum & Brown (2010) this typology functions well for medium to high activity at O&D airports and hub locations. However, for an hub airport, the maximum annual passenger rate is set to 45 million passengers for domestic flights and 35 million passengers for international flights (Ashford et al, 2011). Neufville & Odoni (2013) even believes that finger piers are recommended if the quantity of transfer passengers is low. Thus it is characterised as middle in the matrix, because after a certain amount of passengers, the pier concept becomes inefficient.

The pier configuration is classified as middle for the potential of reuse since the concourse are still connected to the main terminal and thus connected to landside. However, the often narrow and long dimensions of the concourses make it difficult to host different functions. One example that shows this difficulty is Stapleton International Airport in Denver. The airport closed in 1995 and has been redeveloped into an urban living area. The entire terminal building has been demolished including the five piers. Only the control tower has been remained and is nowadays used as restaurant and game hall (Som, 2018).



fig. I.5: illustration of the pier typology at Rome Fiumicino Airport



fig. I.6: aircrafts parked along the pier at Rome Fiumicino Airport

Satellite concept

'is a building developed on airside that is completely surrounded by aircraft and is connected to the processing areas of the terminal via an underground, at-grade, or overhead connector. This satellite building houses the passenger hold rooms, as well as various services and amenities for the passengers.' (p. 175, Landrum & Brown, 2010). Milan Malpensa Airport in Italy is an example of the satellite configuration (fig. I.7 and I.8).

Tactical flexibility within a satellite concept is achieved by the fact that passenger and aircraft functions are disconnected and therefore can act independently (Landrum & Brown, 2010). Gedeon (n.d.) defines the satellite configuration as efficient use of the total amount of space. However, the need for an above-ground or underground connection lead to high operating costs and limitations with air traffic by an above-ground connection. Thus, classified as middle in the matrix. The operational flexibility also depends on this connector between the terminal and the satellite, because an above-ground connection leads to difficulties with aircraft manoeuvrings and gate changes (Neufville & Odoni, 2013). This is why the operational flexibility of the satellite concept is also labelled as middle.

Since the satellite is separated from the main terminal, it has potential to expand in diverse directions. Mostly, the satellite will be expanded by adding (small) piers to increase the number of gates. A restriction to this expansion is the need to update or adjust the APM that is often used to connect the satellite to the terminal building (Landrum & Brown, 2010). The strategic flexibility is therefore labelled as middle in the matrix.

The satellite typology functions well for busy O&D airports and is highly suitable for transferring passengers. They normally do not need facilities at the landside area and can remain inside the satellite. The only sidenote is the possibility that connecting passengers have to move between the satellites to get on a connecting flight (Gedeon, n.d.). Despite this possible movement, the suitability as hub function is classified as high.

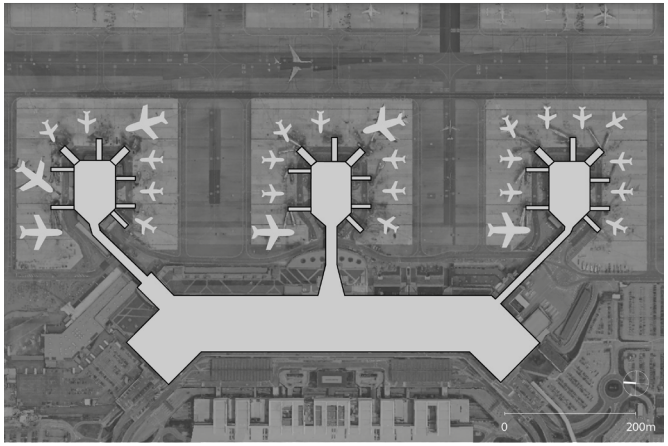


fig. I.7: illustration of satellite buildings at Milan Malpensa Airport



fig. I.8: satellite buildings connected to main terminal with above-ground connections at Milan Malpensa Airport

Midfield configuration (linear and X-shaped)
'is the concept of independent passenger buildings, often located far from the passenger building, which passengers access from the groundside.' (p. 580, Neufville & Odoni, 2013). There are two types of midfield: linear and X-shaped.

The operational flexibility for the midfield linear concept is considered to be high, because the long simple structure with aircraft stands and dual taxiways on both sides allow for easy aircraft movements between the gates without restrictions for larger aircraft (Neufville & Odoni, 2013). For the X-shaped concept, the operational flexibility is labelled medium, because larger aircraft need to be positioned at the end of the X since the corners of the X do not allow sufficient parking space.

Midfield linear concourses allow flexibility for changing gates between airlines and the main terminal can adapt partly to developing check-in areas and security zones. However, the APM is for the same reason as by the satellite concept a restriction in the tactical flexibility. Therefore labelled to be medium in the matrix.

The strategic flexibility of the midfield linear configuration is comparable to the linear concept and thus considered to be high, since the building structure and shape are the same. The expansion of a single concourse can be achieved in both ends of the building. Another possibility is the addition of a new linear concourse. For the X-shaped concept, expansion is slightly more difficult because the geometry is more specific allowing for less expansion options.

The midfield linear configuration works well for transferring passengers, therefore categorised as high in the matrix (Neufville & Odoni, 2013). For functioning as O&D airport, the linear configuration is superior to the X-shaped. Aircrafts can be parked closer to the central part of the concourse and thus decreasing the walking distance. That is why the linear is labelled as medium for the suitability of O&D airport, while the X-shaped is thus categorised as low. Larger aircraft cannot be placed in the corners of the building due to the ninety-degrees angle, making the walking distance higher (Neufville & Odoni, 2013).

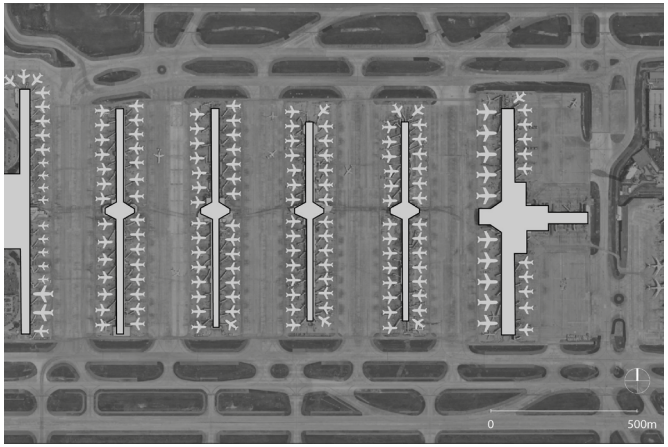


fig. I.9: illustration of the linear midfield terminals at Hartfield-Jackson Atlanta Airport

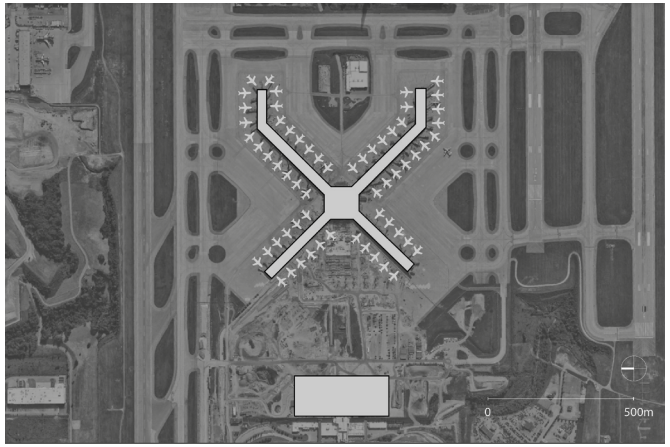


fig. I.10: illustration of the X-shaped terminal at Pittsburgh International Airport



fig. I.11: Pittsburgh International Airport from above



fig. I.12: aircrafts parked along the linear terminals at Hartfield-Jackson Atlanta Airport from above

II appendix: required flexibility of terminal elements

This appendix attempts to answer the following sub-question: *Which elements of a terminal building need to be flexible, and to what extent?* Based on Brand's shearing layers and three case studies, an overview has been created showing the degree of flexibility for the various spatial and functional elements.

Three different airports have been analysed to gain a better understanding of the various spatial and functional ellements that a terminal building consists of. Three airports of varying sizes in terms of passenger numbers were used for the analysis. Ancona Airport in Italy is considered a small airport (< 1 million passengers per annum (mppa)), Eindhoven Airport in The Netherlands a medium-sized airport (5–10 mppa) and LaGuardia Airport in the United States a large airport (>25 mppa). This selection was made to determine whether additional functions are added as the airport handles more passengers.

The analysis of these airports is described on the following pages. The outcomes were then categorised according to Brand's shearing layers. Table II.1 shows a significant difference in the level of flexibility and the lifespan per shearing layer. The shearing layers are classified into the three types of flexibility (operational, tactical and strategic). Only the site is excluded from this classification, as it falls outside the scope of this research and design project.

The structural layer forms an important foundation for the terminal building and its potential for future adaptability, and thus the terminal's lifespan. An inappropriate structure leads to costly renovations as we have seen at the TWA terminal at JFK airport or at Pittsburgh International airport. The service layer can be considered also as an important layer for the functioning of a terminal building as it is the driving force behind it. The position of service cores inside the terminal is from the utmost importance for the future of the building since the technical installations change every 7 to 15 years and thus need space to adapt.

The elements that are classified under the shearing layer 'space plan' are the elements mostly used by travelling passengers and employees. These elements are always evolving due to technical developments. Therefore, there must be sufficient space and capacity to adapt to new technological developments in the future.

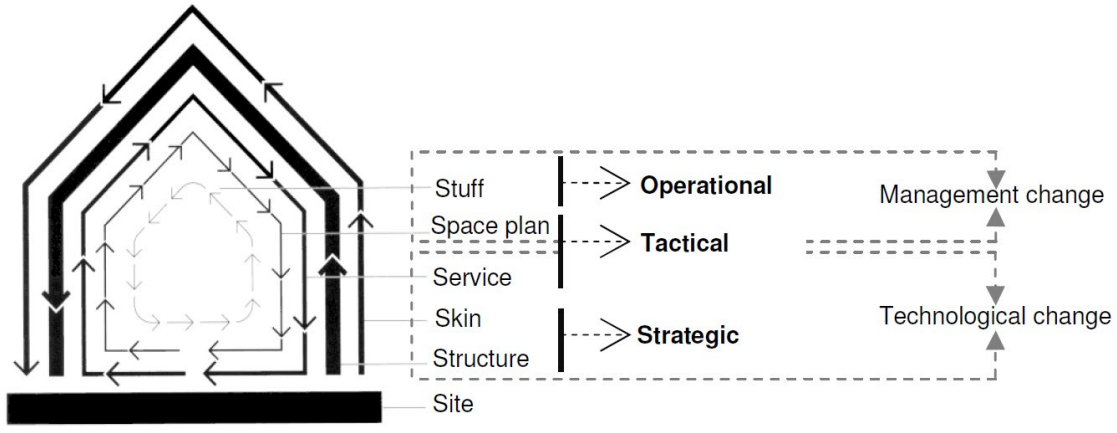


fig. II.1: shearing layers by Brand applied to airport design

Type of flexibility	Shearing layer	Elements	Level of flexibility	Comments
	site	geographical location, runway, taxiway, apron	(almost) never	the urban location of the airport with its boundaries and context.
Strategic flexibility	structure	columns, beams, floors, foundation (including seismic systems), roof structure, shafts, vertical circulation (structural components)	very low (30-60+ years)	the structure forms the foundation of the airport. Load-bearing elements are unlikely to change over time, so the structure needs to be designed thoroughly.
	skin	facades, glazing systems, roof covering, weather protection systems	low (ca. 20 years)	the exterior of the building changes every twenty years to keep up with fashion or technology.
Tactical flexibility	service	technical installations, HVAC systems, vertical circulation (equipment), baggage handling system, restrooms (plumbing)	medium (7-15 years)	the driving force behind the building: its technical systems. Become obsolete or wear out after seven till fifteen years.
	space plan	walls and partitions, (vertical) circulation, restrooms (layout), functional zoning: entrance hall, check-in area, security control, passport control, hold room and lounges, concessions, offices (police & administration), baggage claim area, arrival hall	medium (3-30 years)	the interior layout of the building. Frequently used commercial spaces, including airports, can change every three years, while quiet dwellings might change after thirty years.
Operational flexibility	stuff	moveable partition walls, furniture, queue barriers	high (daily/weekly)	all the stuff of the interior that can switch places daily or weekly.

table II.1: overview of the level of flexibility in airport design

The following pages containt the analysis of three airports to provide a better understanding of the various elements and functions of a terminal building. The analysis is mainly focused on the interior layout and construction. Since not all information, including elevation drawings and cross-sections, was accessible, available images and descriptive information have sometimes been used as a reference.

Ancona airport

The first airport that has been analysed is Ancona airport in Italy. It is considered as a small sized airport and handles around half a million passengers a year (Airport Data - Ancona International Airport, 2025). The terminal consists of two rectangular shaped buildings that are connected via the old, existing terminal building. The two, new buildings are designed by GMP Architekten with a floor area of around 15.000 square meter.

As the terminal is relatively small, the interior of the building could be kept free of columns, thereby offering optimum flexibility. The structure consists of steel trusses spanning a length of 48 metres, with steel columns positioned every 7.2 metres along the exterior of the building. These steel columns support the glass facade, positioned on all four sides of the building to create optimal transparency. The aluminium roof is supported by the steel trusses.

The floorplan has been analysed for the functions it contains. It appeared that three boxes in every building contain almost all the facilities present in this terminal. This creates a sense of space in the departure hall and waiting areas, which enhances the passenger experience. On the other hand, it will be more difficult to expand (e.g. check-in desks) if necessary in the future, as they are integrated in the boxes. Same applies for the security control, as it is situated between two boxes and thus difficult to expand if necessary.

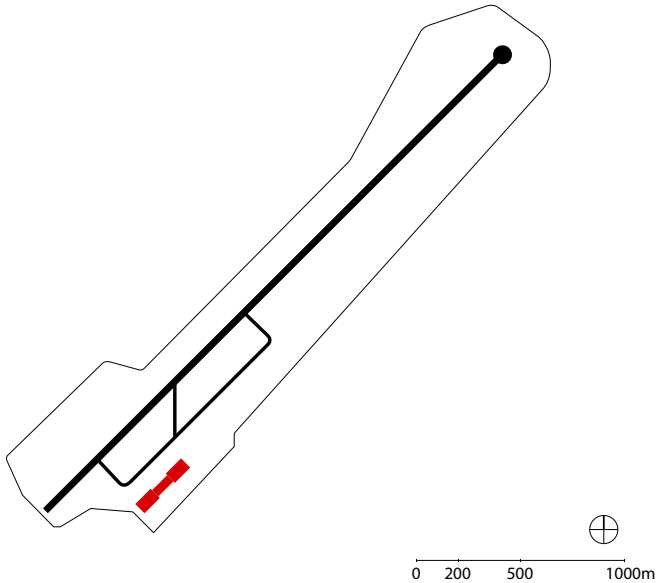


fig. II.2: situation drawing of Ancona airport



fig. II.3: baggage claim area at Ancona airport



fig. II.4: outdoor construction at Ancona airport

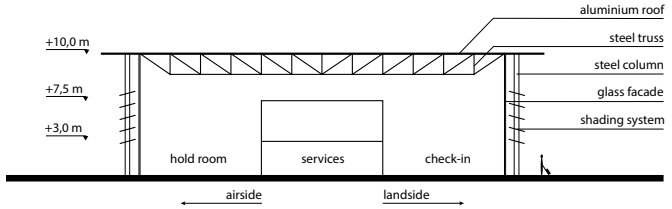


fig. II.5: schematic section of Ancona airport

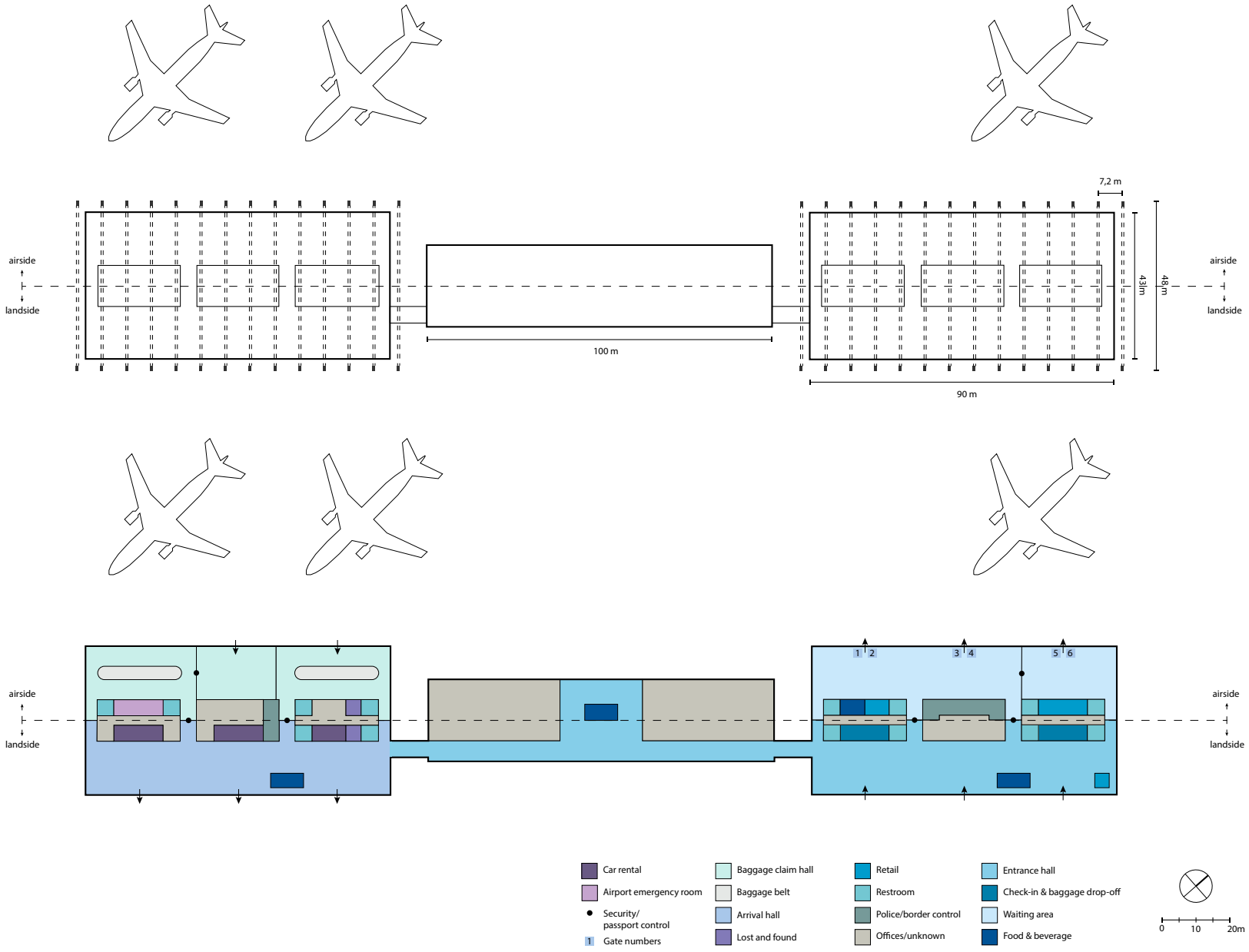


fig. II.6: above: illustration of construction floorplan, below: analysis of present functions inside the terminal



fig. II.7: exterior of the terminal building at Ancona airport



fig. II.8: space between two boxes inside the terminal

Eindhoven airport

The second airport that has been analysed for its functions is Eindhoven airport in the Netherlands. This middle-sized airport handles around 7 million passengers every year. The terminal building is orginally designed by KCAP and De Bever Architecten, and they also designed the expansion of the terminal in 2013 (visible by the red, dotted line in fig. II.12). The total floor area is circa 27.000 square meter.

Figure II.12 illustrates a schematic drawing of the construction. It shows that the structure actually consists of two different parts: a spacious, almost column-free area at landside, connected to a large space with a grid of columns representing airside.

The structure as part of the landside area is made of steel V-columns, which also serves as beams to support the curved roof (fig. II.10, II.13). The span is over 20 metres and the V-columns are positioned every 14,4 meter along the facade of the building.

The second area, as part of the airside, has a recognisable structural grid of 14,4 x 8,1 meter that is significantly smaller than the landside part. A possible explanation is that the landside area is designed to feel spacious and therefore it almost doesn't have any columns, whereas the airside area does have an additional storey, mainly comprising office spaces.

Another notable aspect is that the expansion of the terminal required additional columns in the departure hall, resulting in a relatively narrow 'space' between these V-shaped columns, as can be seen in figure X. This contrasts with the completely open space that existed before the extension.

If you compare this layout with that of Ancona Airport, it seems less structured. Possibly due to the difference in the size of the terminal, or to the later extension. There is a significant difference in the amount of space dedicated to security control. Where Ancona Airport has only one or two checkpoints, Eindhoven Airport has eight checkpoints that can be used at the same time. Also the queuing area is significantly larger.

Another striking comparison between the two airports, is the area designed for baggage claim. Both airports have almost the exact same amount of square metres namely 1500 square meter, while the amount of passengers handled every year at Eindhoven Airport is circa 14 times higher. Finally, it appears that the number of concessions increases as the size of the terminal increases.



fig. II.9: exterior of Eindhoven airport after expansion



fig. II.10: departure hall inside the terminal

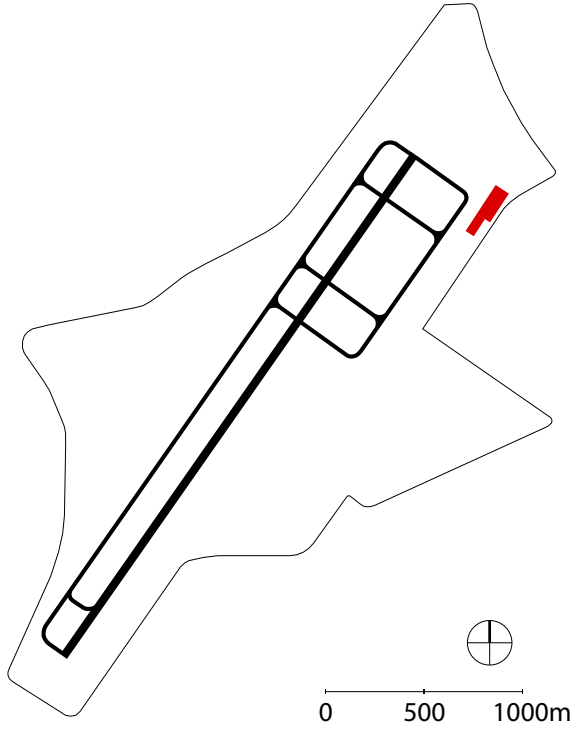


fig. II.11: situation drawing of Eindhoven airport

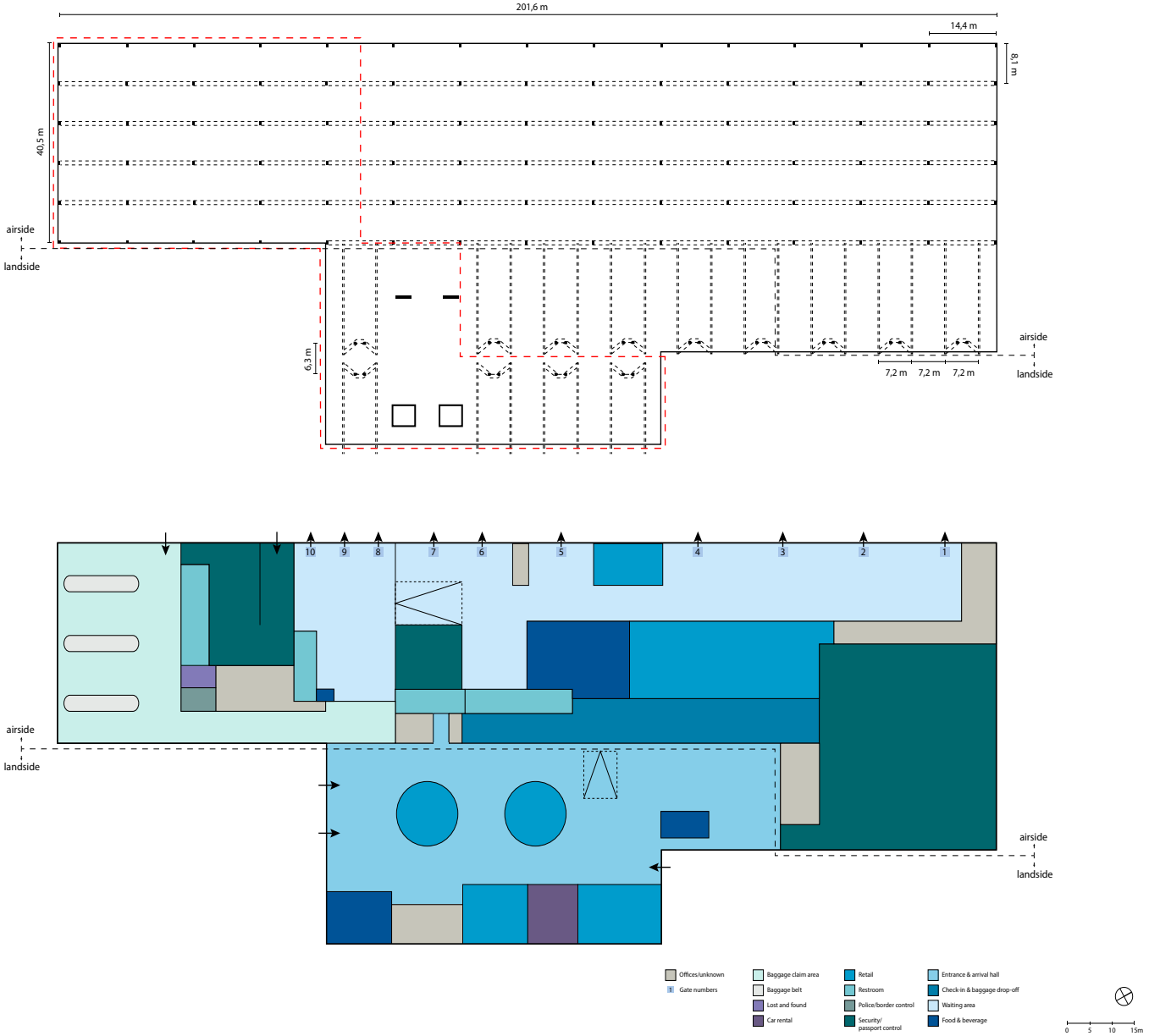


fig. II.12: above: illustration of construction floorplan, below: analysis of present functions inside the terminal



fig. II.13: interior of the terminal with the steel V-shaped columns



fig. II.14: exterior view of the entrance

LaGuardia Airport Terminal B

The third and last airport that has been analysed is LaGuardia Airport in New York, United States. Only the newly constructed Terminal B has been analysed, which in itself functions as a complete airport. This terminal is designed by HOK Architects and was completed in 2020. The total floor area is circa 80.000 square meters.

This airport has been studied only in terms of its functions and not its construction, as the latter goes beyond the scope of the generic airport concept to be designed at a later stage, due to the building's large scale and curved forms.

The facilities are spread across three floors open to the public. The lowest floor (Level 2) accommodates arriving passengers; one floor above is the departure hall with security screening; the fourth floor is primarily a leisure area with a wide variety of concessions. This floor also provides access to the two walkways leading to the gates. The three floorplans with all the functions is shown on the subsequent two pages.

What stands out from the analysis of the floorplans is the presence of a business conference centre on the same floor as the departure hall. This area is still located on the landside and is therefore also accessible to non-travelling passengers. This is an example of a facility that is unrelated to the aviation industry and could therefore expand if demand for air travel decreases (drastically) in the future.

It is also noticeable that there are several business lounges where people can wait for their flight in comfort and privacy. These lounges are often used by business passengers, but are also becoming more popular among non-business travellers.

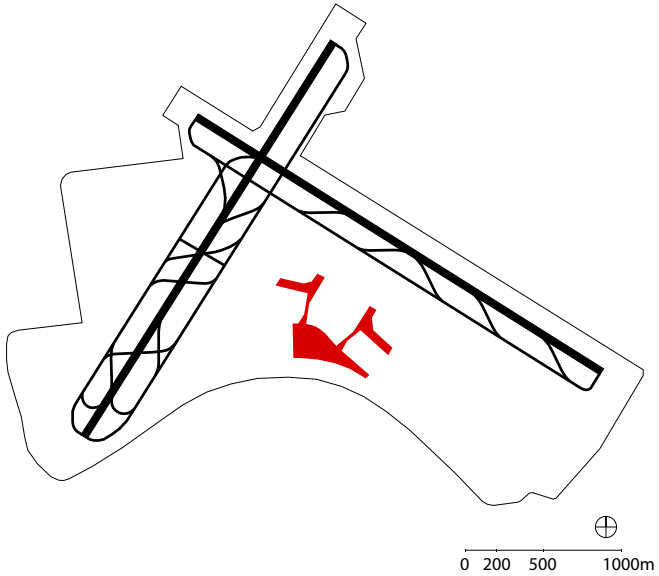


fig. II.15: situation drawing of LaGuardia Airport Terminal B



fig. II.16: above-ground corridor leading to the gates

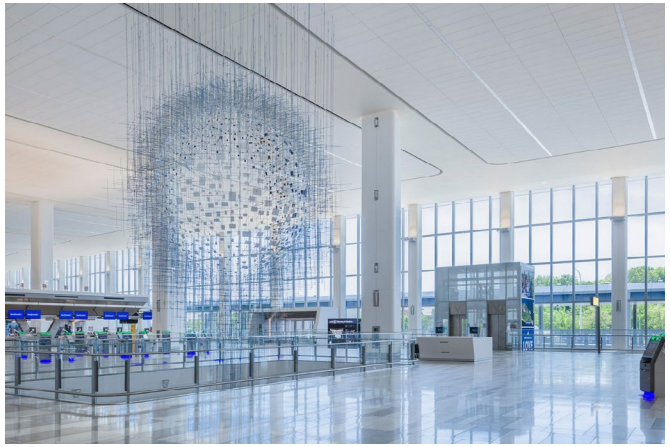


fig. II.17: departure hall



fig. II.18: hold room



fig. II.19: escalator to baggage claim, passing by the departure hall

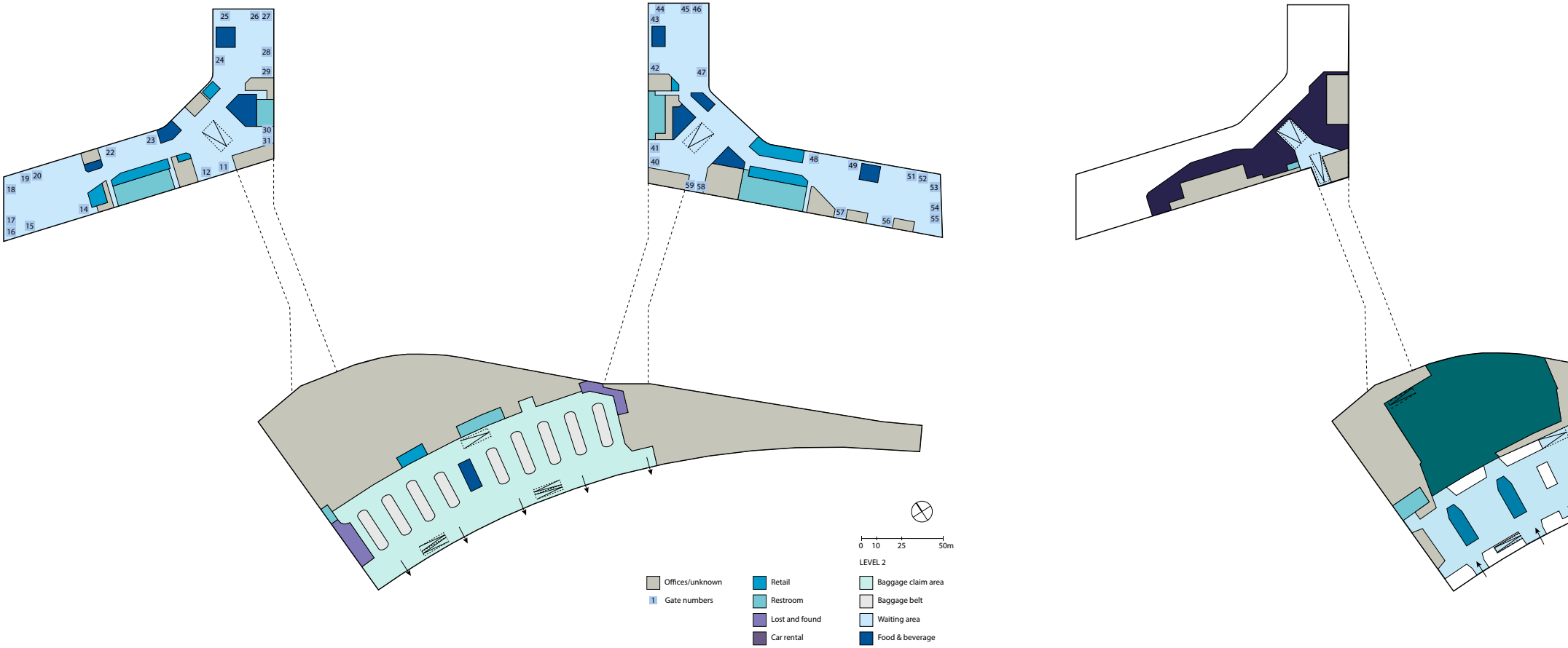
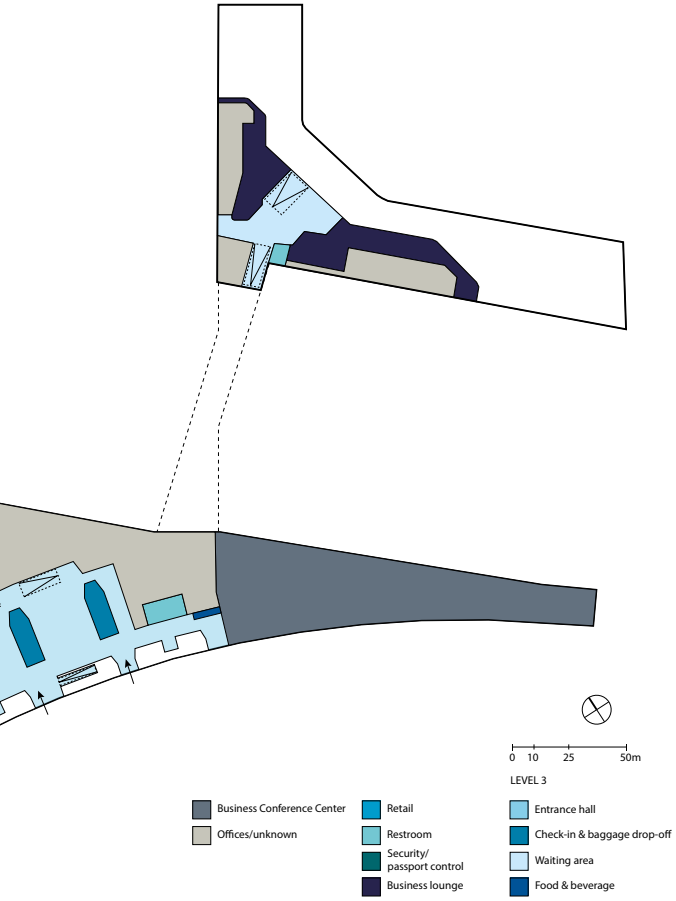
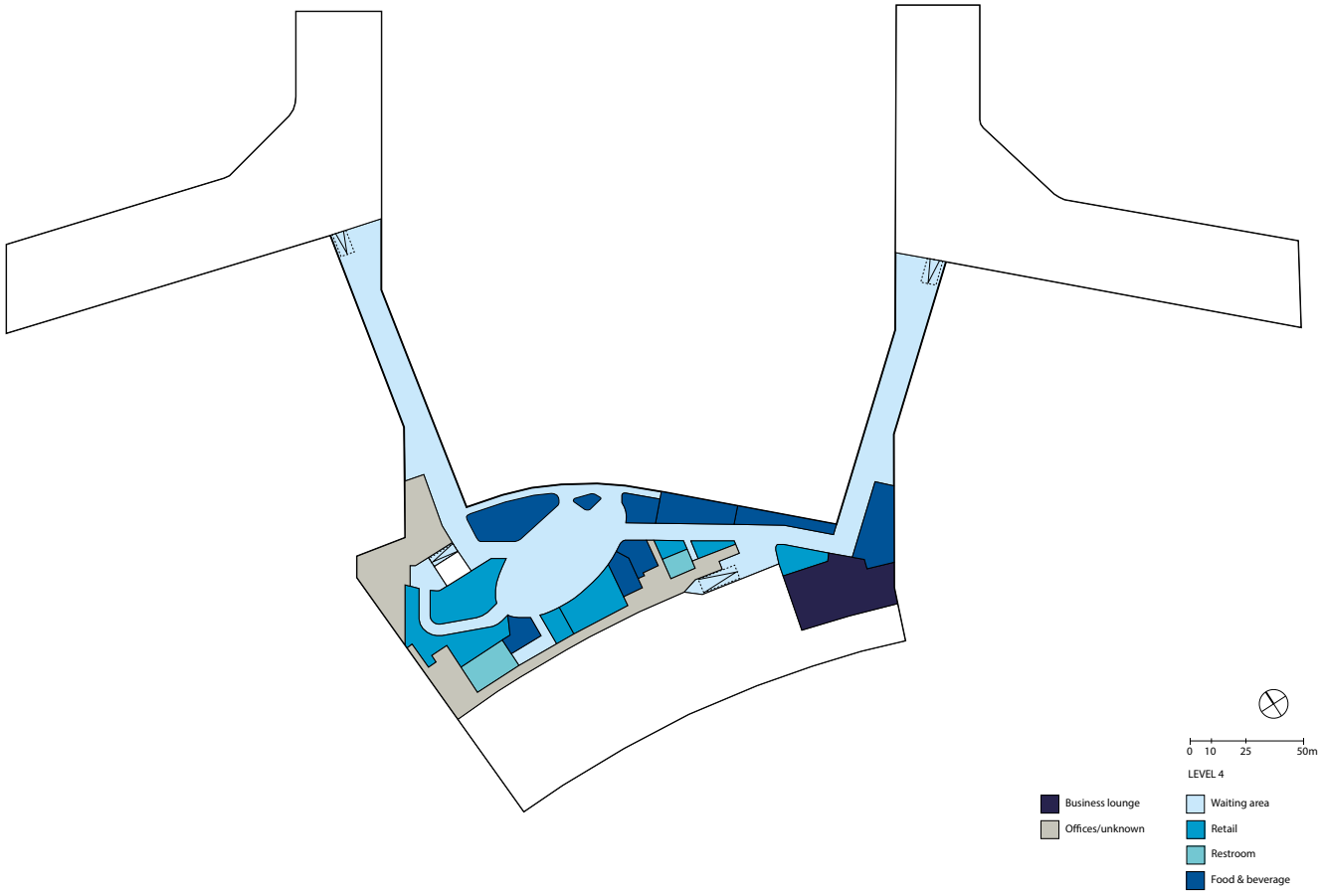


fig. II.20: analysis of present functions on level 2 (left), level 3 (middle) and level 4 (right)


0 10 25 50m
LEVEL 3
Business Conference Center
Offices/unknown
Retail
Restroom
Security/ passport control
Business lounge
Entrance hall
Check-in & baggage drop-off
Waiting area
Food & beverage


0 10 25 50m
LEVEL 4
Business lounge
Offices/unknown
Waiting area
Retail
Restroom
Food & beverage

III appendix: design strategies for long-term adaptability

Literature research has identified five key design strategies that can contribute to the design of an airport terminal as an adaptive framework. These strategies are derived from existing examples of terminal buildings and other building typologies. According to Shuchi et al (2017) flexibility in airport terminals is still relatively rare, while for other building typologies extensive research is already available on flexible design.

1. Design with layers

The first design strategy is designing with layers. As mentioned in earlier, a terminal building consists of separate layers that can be replaced without causing excessive disruption. Each layer has a different lifespan, and separating these layers from one another minimises disruption when a layer needs to be replaced (Shuchi et al, 2017). An example is the separation between the structure and skin (façade), and interior space from the service cores. By separating these layers, a terminal can be upgraded without causing significant disruption.

2. Open plan layout

A second design strategy in order to achieve adaptability is the use of an open plan layout. A straightforward layout with an open floor design, would offer a lot of flexibility for future extensions. A great example is Hertberger's office building for Centraal Beheer in Apeldoorn. The building, comprising 56 blocks of 9x9 meters, could be arranged as the employees wished. The spaces could be used as offices, but also as places to socialise or to relax (see fig. III.1, III.2 & III.3).

Also in terminal buildings, an open plan layout is crucial to to accommodate innovations in new aircrafts, check-in process or security control. Recent developments in the check-in process has eased considerably; as a result, the check-in process has become a lot simpler and quicker, without the need for expansion to accommodate growing passenger numbers (Shuchi et al, 2017).

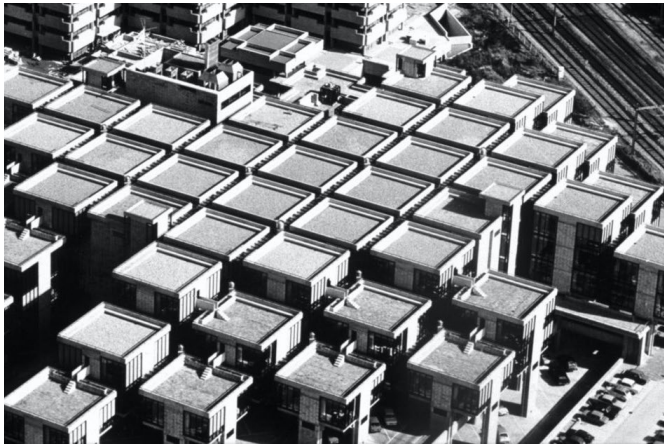


fig. III.1: exterior of Centraal Beheer office in Apeldoorn



fig. III.2: interior of Centraal Beheer office in Apeldoorn

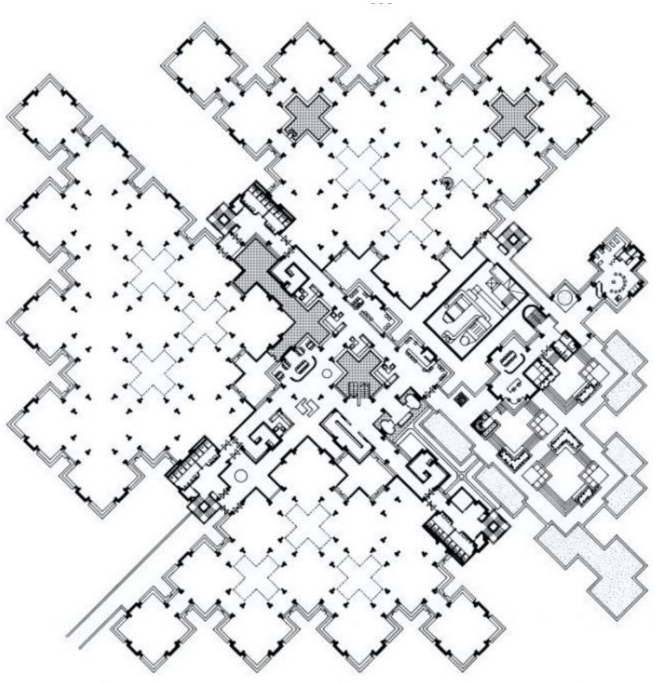


fig. III.3: floorplan of Centraal Beheer office in Apeldoorn

3. Modularity

Modular design is another key strategy in adaptable airport design. Modularity can be applied in several ways: the structural grid can be realised with a modular approach, but also the use of small modules for the internal layout contribute to this modular strategy. If expansion is needed, one or more modules are simply added to the building (Shuchi et al, 2018). This modular approach can even be extended to a 'kit-of-parts' system, in which the building consists of small components that can be assembled on site.

4. Geometrical simplicity

A simple geometry in layout design offers greater flexibility in terms of orientation for most types of buildings. A basic rectangular floor plan with a repeating pattern makes it possible to make internal spaces larger or smaller without affecting the building's functioning. A good example is S.R. Crown Hall in Chicago by Mies van der Rohe. The building is famous for its open, flexible and universal space and its minimalistic design (see fig. III.4). In addition, a simple layout provides efficient passenger flows in terminal buildings, one of the most important parts of a well function airport terminal (Shuchi et al, 2018).

5. Buffer spaces/neutral spaces

Designing a terminal building with buffer areas is also a means of creating more flexibility. These spaces could be converted from non-operational functions to operational functions. According to Shuchi et al (2018) are functionally neutral spaces highly flexible tools to respond to increasing passenger numbers or unforeseen situations.



fig. III.4: exterior of S.R. Crown Hall by Mies van der Rohe