Public Familiarity

Architectural Strategies for Social Inclusion in Assisted Living

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Abstract

This graduation project explores how assisted living for people with an intellectual disability can become more socially inclusive as part of the future transformation of the Spaanse Polder. Instead of seeing care housing as an isolated, protected facility, the project looks at how architecture can promote public familiarity and everyday participation.

The design combines care housing with public spaces such as a café and library, allowing for low-threshold encounters between residents and the neighbourhood. The different needs of residents are reflected in two living environments: the Sanctuary group, which is focused on a less stimulating environment, and the Social Hub group, which is focused on a more social environment.

The project shows that inclusive assisted living requires more than just making things accessible; dignity, visibility and social infrastructure are also important, as is the possibility for residents to participate in everyday life at their own speed.

keywords: *Public familiarity, assisted living, intellectual disablility, social inclusion, social infrastructure*

Foreword

This graduation project has both architectural interest and personal motivation: growing up with a brother with an intellectual disability has shaped the way I look at care and in particular care housing. It made me realize that inclusion is not only a social question, but also a spatial one. The places we design can either support recognition and everyday contact, or unintentionally reinforce distance and isolation.

With this project, I wanted to explore how assisted living can become more than just protected housing. My ambition was to design a building that offers safety and structure, while also creating opportunities for residents to become visible, recognised and connected members of the neighbourhood.

I would like to thank my tutors, Robbert Guis and Deepti Adlakha, for their guidance and feedback during the process. Their input helped me balance the relationship between research and design.

I also would like to thank BambuLab for making great machines that helped bring my digital models into physical form.

I am also thankful to my family, friends and groupmembers for their support during the development of this project.

I dedicate this project to my brother, Mike.

Justin Zethof
09/06/2026

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Introduction

Problem statement

Social inclusion is the process of improving the terms of participation for those disadvantaged by disability, age, or economic status *(United Nations, 2016)*. However, in reality, care buildings often work as "vulnerable spaces": in these places, rules and safety are often seen as more important than the residents' need to be part of the community. This often creates a feeling of being trapped inside: residents are safe, but they are separated from the outside world *(De Ruiter et al., 2023)*.

This challenge is very specific in the context of the Spaanse Polder. Historically, this area was a successful and high-quality industrial district. Today, the area is changing; new urban plans, such as the Plan van Zus, aim to transform the Spaanse Polder into a new residential neighborhood. The spatial challenge is that even in new developments, care housing for people with an intellectual disability is often designed as a isolated building. It becomes an seperated block within the urban fabric, creating a barrier for both the residents and their neighbors *(Overmars-Marx, 2018)*.

This project investigates how housing design can dismantle these barriers, by looking into how the layout, the public program, architecture and the transition zones of a building can prevent this separation.

The design assignment is to create an assisted living facility that does more than providing just basic housing. It should function as social infrastructure that supports connection and interaction *(Klinenberg, 2018)*. By focusing on the design of the layout, the public program, architecture and the transition zones, the project aims to achieve public familiarity. By creating these daily connections with the neighborhood, the project supports the emancipation of residents with an intellectual disability, making sure they become a recognized and active part of the new community in the Spaanse Polder.

Relevance

The need for this project is found in the realisation that simply moving care facilities to neighborhoods does not guarantee social inclusion. Research shows that physical proximity is not enough to create social interaction: without intentional design, residents of assisted living facilities often benefit significantly less from local social networks than their neighbors *(Overmars-Marx, 2018)*.

In addition, the social networks of people with an intellectual disability are often remarkably small and vulnerable, existing primarily of family members and healthcare workers, rather than members of the local community *(Kamstra, 2017)*. This issue is extra urgent because 50% of the Dutch population already suffers from loneliness *(Eenzaamheid | Leeftijd en Geslacht, n.d.)*, and people with disabilities in particular experience significantly increased levels of loneliness *(Vereniging Gehandicaptenzorg Nederland, 2024)*.

Also having a housing crisis that requires 247,000 new homes in Zuid-Holland by 2030 *(Ministerie van Algemene Zaken, 2023)*, there is a clear need for new inclusive ways of living. This is especially critical because, as Czischke et al. *(2025)* state: "Low-income households, older singles, migrants, and disabled residents are still doubly disadvantaged: housing affordability remains tight, while social infrastructure is often lacking."

Professionally, this project addresses the responsibility of the architect to go beyond providing basic housing and instead design social infrastructure that fosters connection *(Klinenberg, 2018)*. This research contributes to architectural knowledge by investigating how the spatial layout, the public program, architecture, and the transition zones can be used to achieve public familiarity. By testing these four instruments in the Spaanse Polder, the project explores how architectural design can break down social barriers and support the emancipation of people with an intellectual disability.

Objective & motivation

My motivation is personal: my brother has an intellectual disability and relies mostly on familiy and the digital world for connection. I believe architecture must provide physical alternatives for social ties beyond the digital world, and even family and caregivers. My ambition is to get rid of stereotypes by designing an inviting building that promotes socializing. By prioritizing openness and social inclusion, the building becomes an inclusive beacon in the Spaanse Polder. In the end, I hope this research helps me to improve the quality of life and sense of belonging for this group throughout my future professional career.

Scope

This project is located in the Spaanse Polder, an industrial zone transforming into a mixed use residential area. The scope focuses on an assisted living building for residents with an intellectual disability. The building is has a maximum footprint of 30x30 meters and consists of 6 to 8 floors. To serve as social infrastructure, the building is integrated with an active public plinth on the ground floor, such as a library or community cafe.

The main design challenge focuses on removing the "barrier-experience" with architectural solutions. The research is limited to aspects of architecture, specifically investigating four things: spatial layout, public programming, architectural identity, and transition zones. The urban transformation gives the context, while the study focuses on how the building can help with public familiarity.

Research and design questions

Main Question

How can the architectural design of an assisted living facility in the Spaanse Polder foster social inclusion and support the emancipation of residents with an intellectual disability?

Sub-questions

Which socio-spatial needs of the residents must the design focus on to help them feel at home and more independent?

In what ways can the internal spatial organization and floor plan facilitate low-threshold encounters and visibility between residents and the neighborhood?

Which types of public programming are most effective in attracting the local community and creating a shared social infrastructure?

How can the architectural expression and visibility of the building promote the recognition and status of residents with an intellectual disability within the urban fabric?

Which architectural strategies for transition zones can best balance the need for resident privacy and safety with social openness toward the public realm?

II

Approach

Methods

Design strategy

The methodology uses a research by design approach, with a cycle between researching and designing. The process is guided by the theoretical framework of Overmars-Marx *(2018)*, which serves as a evaluation tool on how effectively the design supports public familiarity. By adding these principles with the context of the Spaanse Polder, the project tests how architectural princples can remove the different barriers that residents experience.

Research techniques

The research begins with a analysis of the typoligy of current inclusive housing projects to find successful spatial strategies. This is supported by an extensive collaborative site analysis of the Spaanse Polder.

To bridge social needs with architectural form and layout, user journey mapping will be used: by simulating the daily routines of multiple unique persons, varying in their level of disability and their tolerance to sensory overload. The building can be tested on how it supports their specific needs for both safety and social interaction. These tests directly impact the design versions: different versions of the floor plans and transition zones are compared to find the best balance between openness and protection.

Expected output

The output will be a graduation report with a collection of architectural princples, impressions and drawings. This result moves past a conceptual layout to emphasize theoretical realizability; through facade explorations and construction studies, the design shows that the proposed social infrastructure is a technically feasible solution instead of just being a concept. Crucially, the final design is supported by a theoretical framework that proves how the building complies with the requirements for social inclusion. By aligning spatial choices with social theories, the result provides a validated model for an living environment that specifically addresses the needs and emancipation of residents with an intellectual disability.


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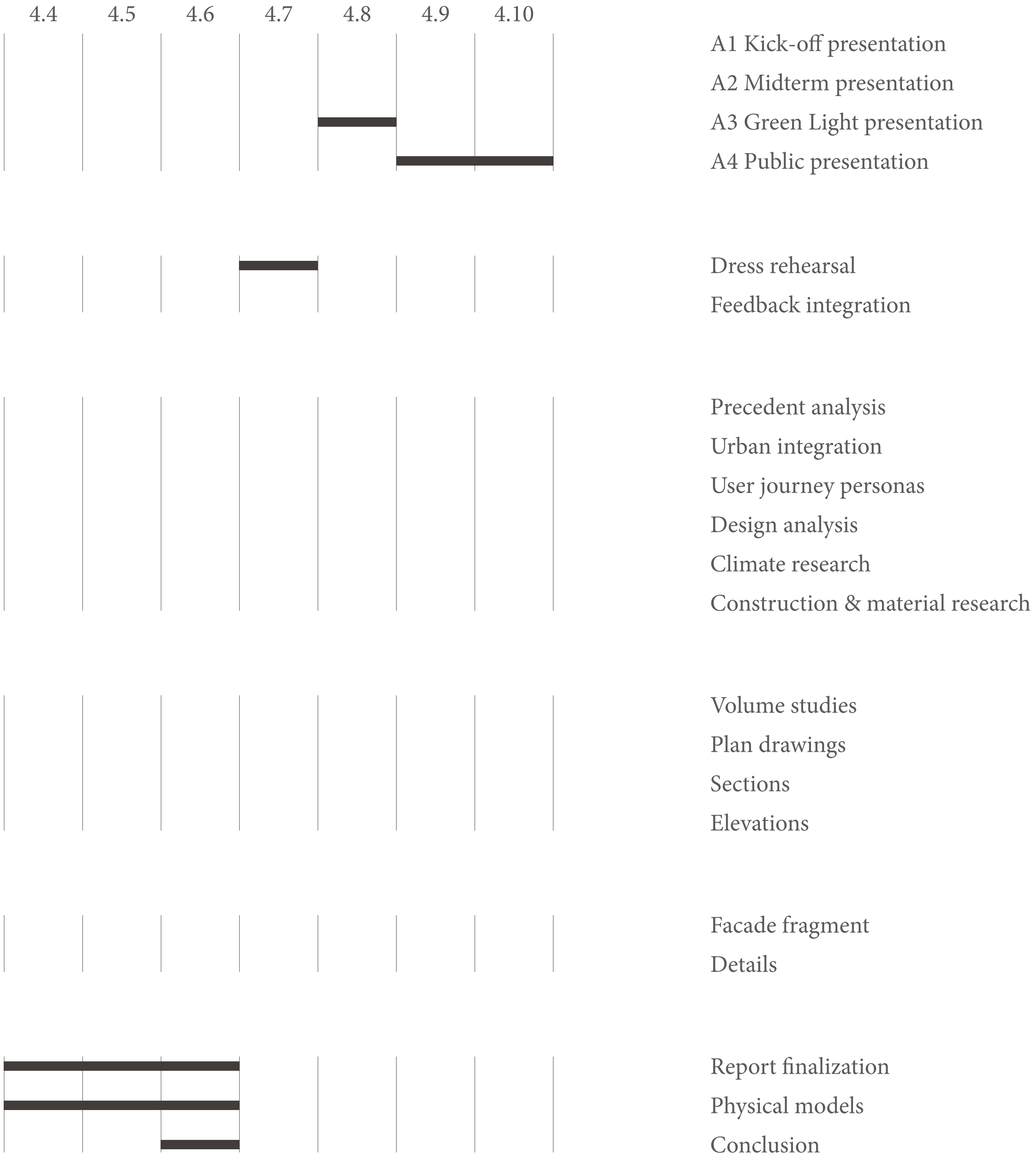
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A1 Kick-off presentation
A2 Midterm presentation
A3 Green Light presentation
A4 Public presentation
Dress rehearsal
Feedback integration
Precedent analysis
Urban integration
User journey personas
Design analysis
Climate research
Construction & material research
Volume studies
Plan drawings
Sections
Elevations
Facade fragment
Details
Report finalization
Physical models
Conclusion

Theoretical framework

Literature

The literature research focuses on the social and spatial needs of people with an intellectual disability within the built environment. A central concept is the “barrier-experience” *(Overmars-Marx, 2018)*, which describes how physical structures can unintentionally cause exclusion and disorientation. To remove these barriers, the design must focus on autonomy and a feeling of home. While traditional care environments often focus on surveillance, this research suggests that spatial legibility and predictability are essential for the independence of the resident. Providing individuals with control over their physical environment reduces stress and strengthens social emancipation.

Furthermore, the theory of social infrastructure *(Klinenberg, 2018)* is used to define the connection with the neighborhood. Instead of aiming for total social integration, which can be overwhelming for some of this target group, the project focuses on public familiarity. This concept suggests that mutual recognition and casual, low-threshold encounters between residents and neighbors form the basis of a safe social network. Architecture helps by creating spaces that offer both protection and opportunities for contact. This allows residents to keep control over the amount of social interaction they experience, transforming the building into a supportive base for urban life.

Precedent research

Hart van Vathorst in Amersfoort is relevant because it combines care, living, working, a church, childcare and a public restaurant within one multifunctional care building. The project shows how assisted living can become part of a wider social infrastructure instead of functioning as a closed care building, especially the public restaurant on the ground floor is important for low-threshold interaction with the neighbourhood. At the same time, the residential floors are divided into smaller living groups, allowing residents to pick an environment that fits with their needs.

Hof van Leijh in Haarlem shows how care housing can be integrated into a mixed residential building with an active neighbourhood plinth. The project has both regular housing and care apartments and including homes for people with an intellectual disability. Its plinth includes social infrastructure, such as a care support centre and De Buurtwinkel, which functions as a social heart for residents and neighbours. Particularly relevant is the fact that people from SIG work in the plinth, turning the building into a place where living, care, meeting and working come together.

City Archive Delft by Office Winhov was used as a reference for architectural expression. Its façade shows how brick can be used to create depth and rhythm with a strong identity. Recessed planes and vertical brick patterns produce a façade that changes with light and shadow. This helped the goal to design a façade that is not only fitting within the context, but also distinctive and visible within the neighbourhood.

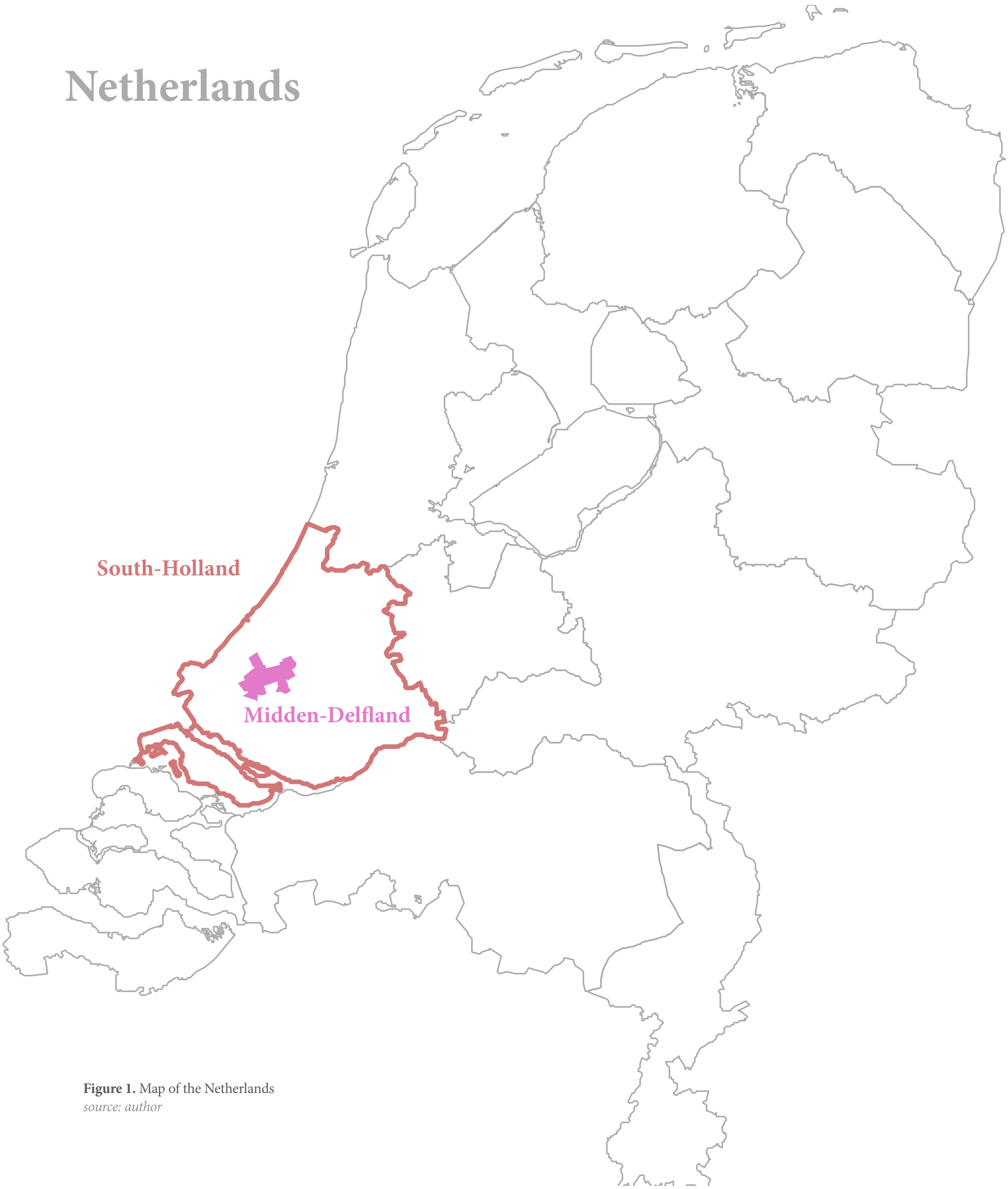

Figure 1. Map of the Netherlands
source: author

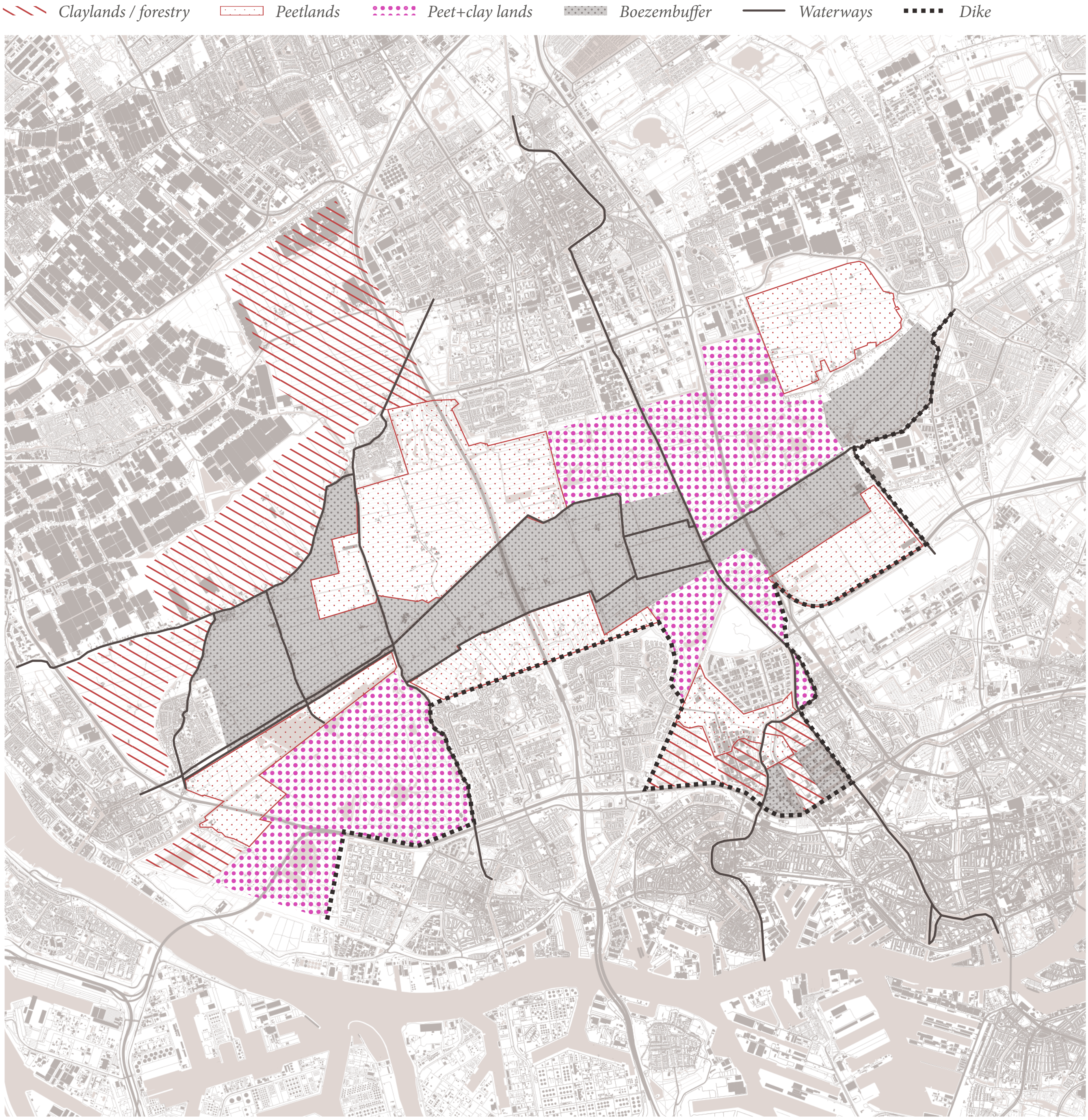

Figure 2. Regional context and infrastructure of the masterplan of ZUS in Midden-Delfland
source: author, groupwork

Site

The site analysis connects the social theories of inclusion to the industrial reality of the Spaanse Polder. Based on collaborative group research, the district is currently dominated by large-scale logistics and heavy industry, which creates both physical and mental barriers. Infrastructure analysis reveals that walkable paths are underdeveloped and often shared with heavy traffic. For residents with an intellectual disability, this lack of safe infrastructure represents a major "barrier-experience" that limits autonomy. Furthermore, the total lack of social spaces within the Polder confirms the isolation of the location, highlighting the need for the project to introduce its own social infrastructure.

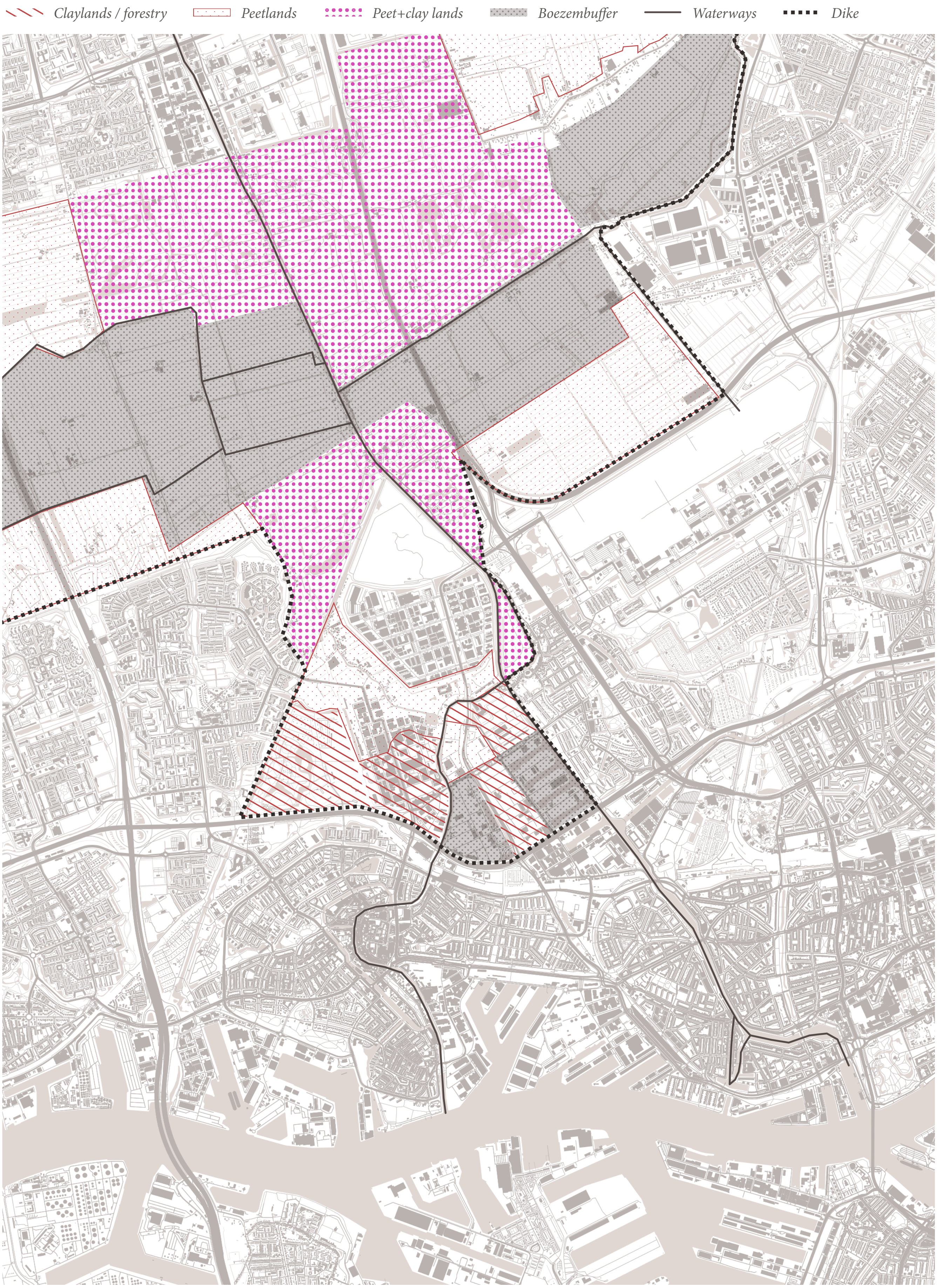

Figure 3. Developed addition on the masterplan of ZUS
source: author, groupwork

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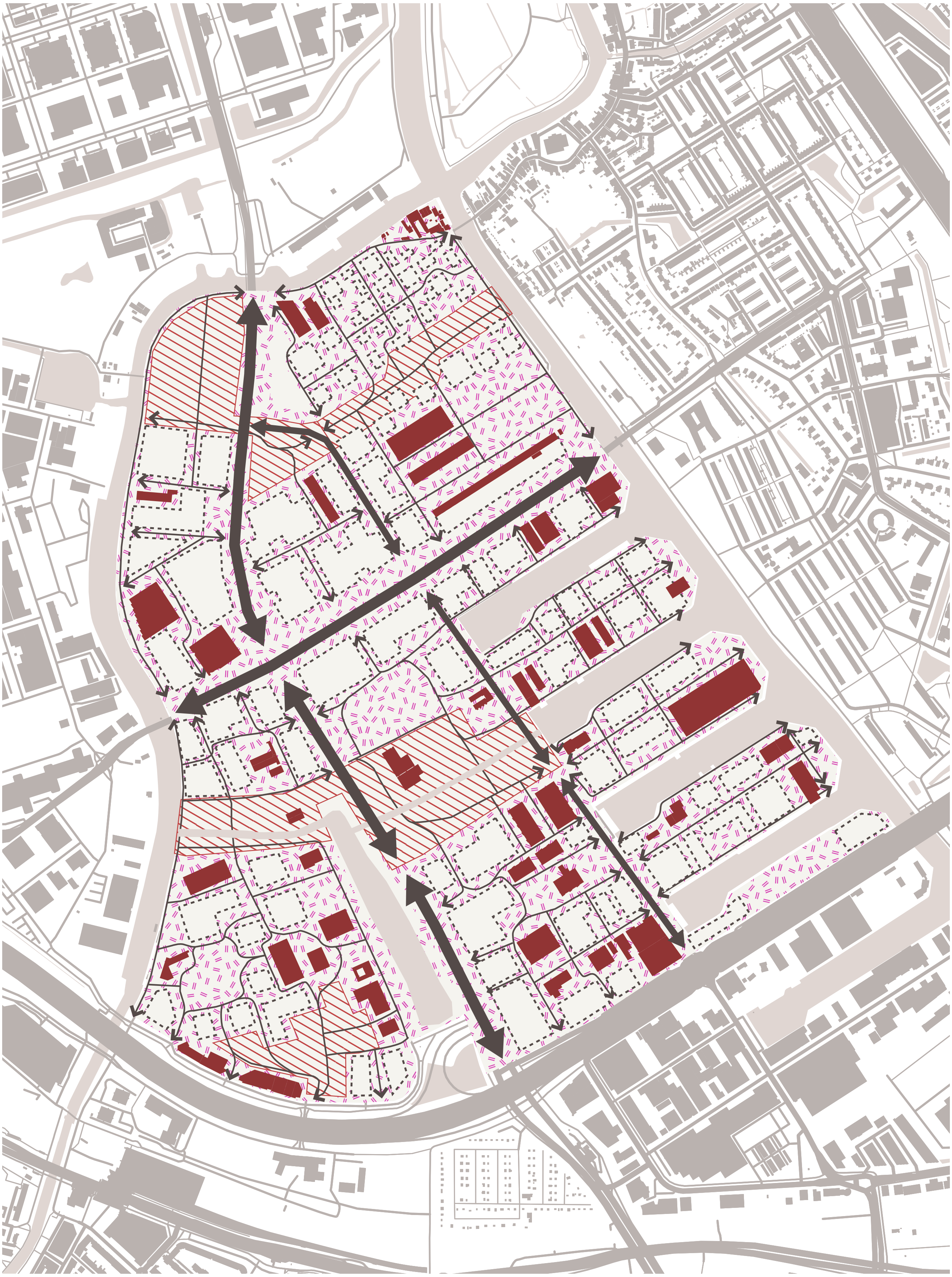

Figure 4. Developed masterplan for the Spaanse Polder
source: author, groupwork

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Figure 5. Developed neighbourhood Spaanse Puzzel for the Spaanse Polder
source: author, groupwork

1:3.000

To address these challenges, a new Masterplan was developed by the group, envisioning a transformation into a productive, mixed-use neighbourhood. The plan integrates housing, social life, and light industry to make living possible. A key feature is the production forest set in a strict 5 by 5-meter grid, combined with buffers for water for climate adaptation. This green structure is designed to be dominant, with building volumes placed at least 10 to 15 meters apart to maintain a park like setting. New public areas, footpaths, and greenhouses are added to improve accessibility and create a welcoming environment for all users.
The Masterplan sets strict preconditions for the new housing typologies to stimulate social interaction. A primary requirement is the addition of public or commercial functions to the building plinths to attract people from the neighborhood. Additionally, placing manufacturing buildings in close distance to residential buildings is intended to help casual contact between different groups.

III

Results

Residents

Definition

This project focuses on residents with different intellectual disabilities, both MID and ID, whose presence in the city is an important step towards local emancipation. According to Overmars-Marx *(2018)*, true social inclusion is more than physical presence; it requires meaningful social infrastructure that actively prevents loneliness and creates a sense of belonging. The architecture functions as this essential 'social infrastructure' *(Klinenberg, 2018)*, bridging the gap between the private dwellings and the public space of the Spaanse Polder.

To achieve this, the design uses a dual-group strategy validated by research into residential placement and group dynamics. The sanctuary groups of 7 residents are supported by the findings of Felce et al. *(1991)*, which show that smaller group sizes significantly improve interactions between staff and clients and adaptive functioning while preventing social friction. For residents with higher behavioral or cognitive impairment scores, these smaller groups have an defence against sensory overload while maintaining the intimacy needed for social growth.

On the other end, the social hub groups of 15 residents serve as a small society. As suggested by Overmars-Marx *(2018)*, these larger groups act as a practice ground for participation, encouraging the social interaction necessary for development and the prevention of isolation.

This double approach recognizes that the needs of these two groups are not exclusive; the Social Hub will also have sensory buffers to protect its residents, while the Sanctuary still is an inclusive environment. These configurations together make sure that residents not only have a place to live, but are also empowered as visible, participating members of the local community.

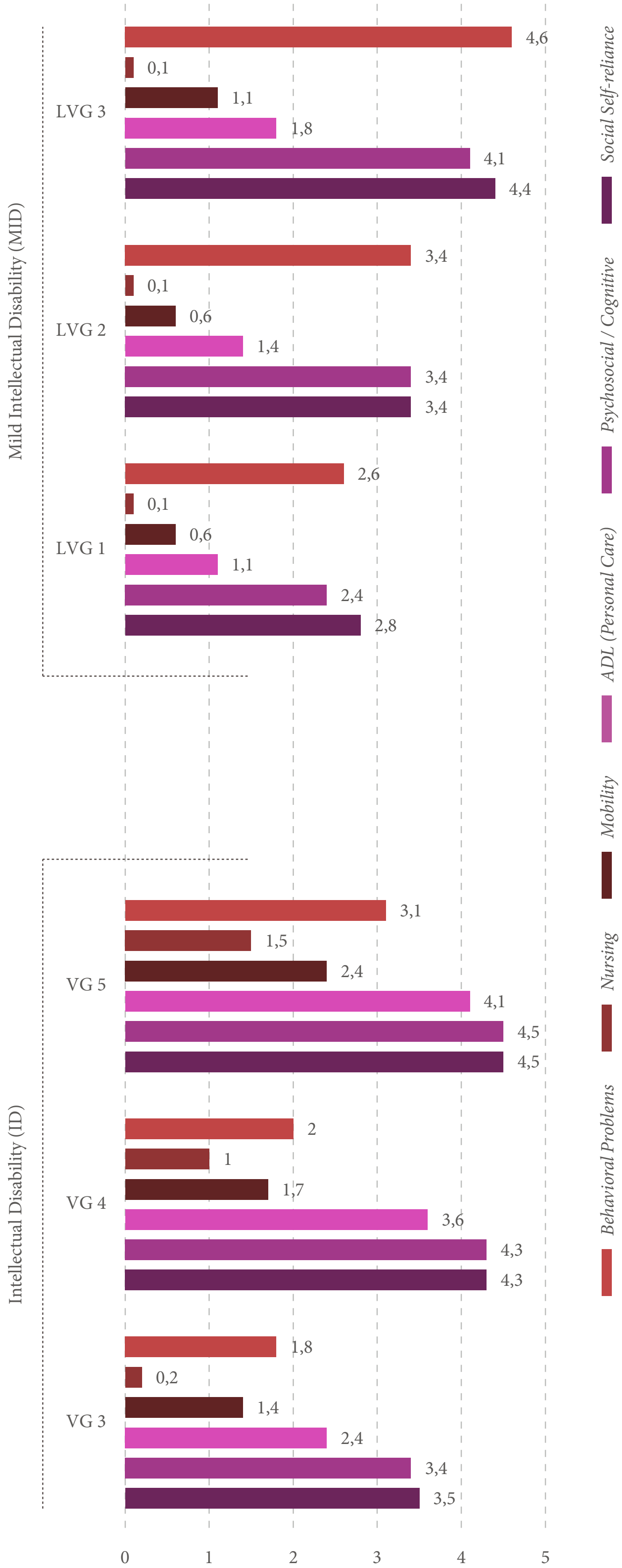


Figure 6. Overview of disability scores for VG and LVG care profiles
source: author, (CIZ & Ministerie van Volksgezondheid, Welzijn en Sport (VWS), n.d.)

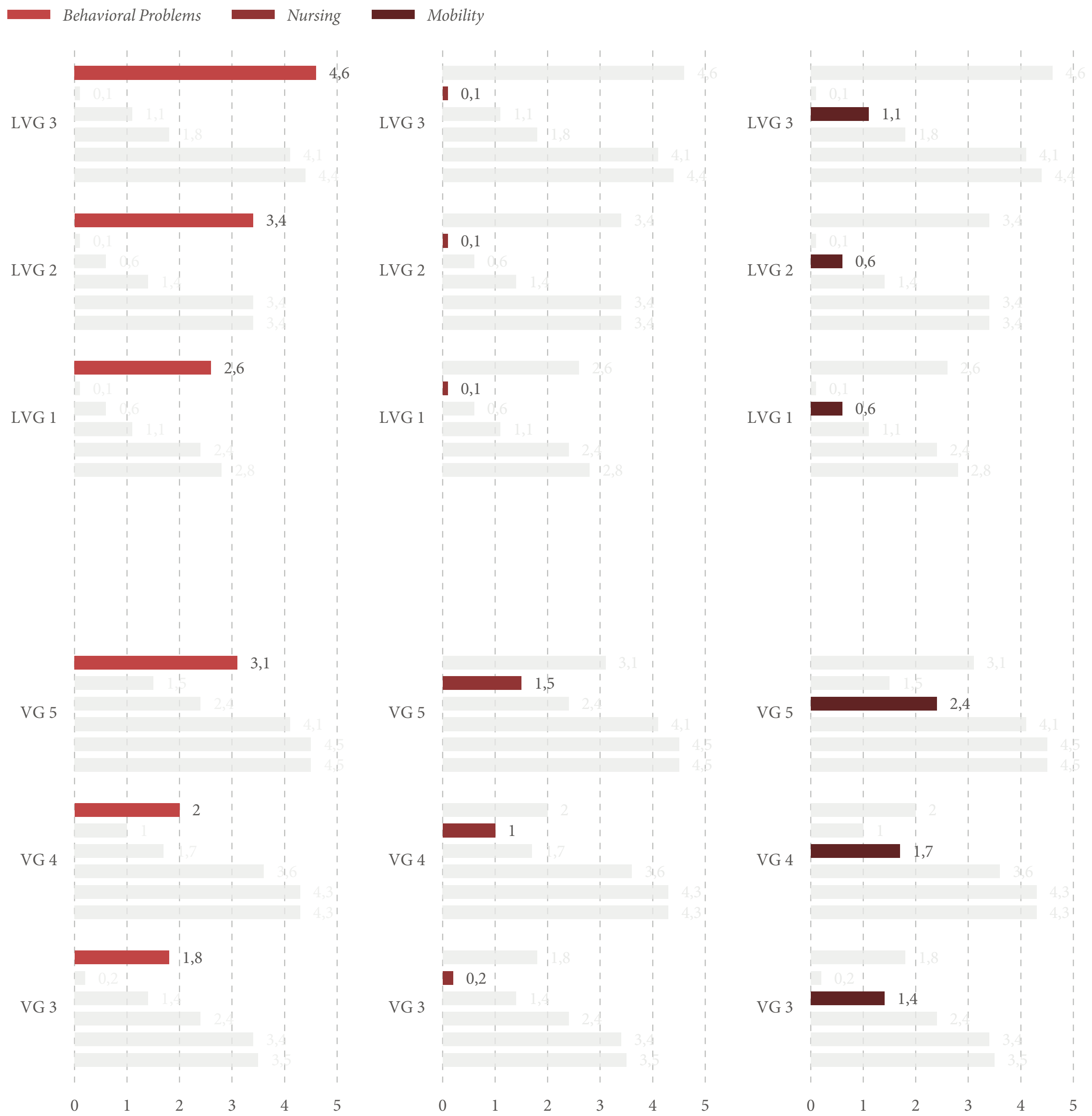


Figure 7. Comparison of disability scores for selected VG and LVG care profiles
source: author, (CIZ & Ministerie van Volksgezondheid, Welzijn en Sport (VWS), n.d.)

Comparing disability scores

The scores show the primary physical and regulatory reasons for the layout of the building. Behavioral Problems represent the biggest peak, especially for the LVG 3 profile with a peak score of 4,6. This score shows that it is necessary to have a small-scale group of 7 to minimize sensory overload and social friction. Nursing scores are consistently low across all profiles, with VG 5 showing a minor peak at 1.5, indicating that medical infrastructure remains secondary to psychosocial guidance. The Mobility data shows that, while VG residents require more physical accessibility, the LVG groups remain highly mobile, supporting their integration into the more dynamic areas of the building.

Figure 8. Comparison of disability scores for selected VG and LVG care profiles
source: author, (CIZ & Ministerie van Volksgezondheid, Welzijn en Sport (VWS), n.d.)

The distribution of ADL, Psychosocial / Cognitive, and Social Self-Reliance scores defines the required care infrastructure. All profiles have high Psychosocial / Cognitive impairment, with VG 4 and VG 5 reaching scores of 4,5. This data shows a highly intuitive and legibly designed environment is needed to reduce cognitive fatigue and prevent sensory overload. In regards to ADL, the higher scores in the VG sector require large private units equipped for physical assistance. Meanwhile, the moderate Social Self-Reliance scores of LVG 1 and 2 justify the social hub; these residents benefit from the social complexity of 15-person groups, which stimulates their social development and community engagement *(Landesman-Dwyer et al., 1980)*.

Figure 9. Grouping of VG and LVG residents
source: author, (CIZ & Ministerie van Volksgezondheid, Welzijn en Sport (VWS), n.d.)

Grouping residents

The double group organization is defined by the characteristics of specific care profiles and their collective environmental needs. By grouping residents based on their CIZ disability scores, the building takes a collective approach to shared challenges. The Sanctuary groups, consisting of residents from VG4/5 and LVG 3, offer a stable environment where safety and silence are the main priorities, while still allowing for social interaction. On the other side, the Social Hub brings together residents from VG3 and LVG1/2 to form a small society. This grouping promotes socialization, enabling residents to practice community interaction in a controlled environment.

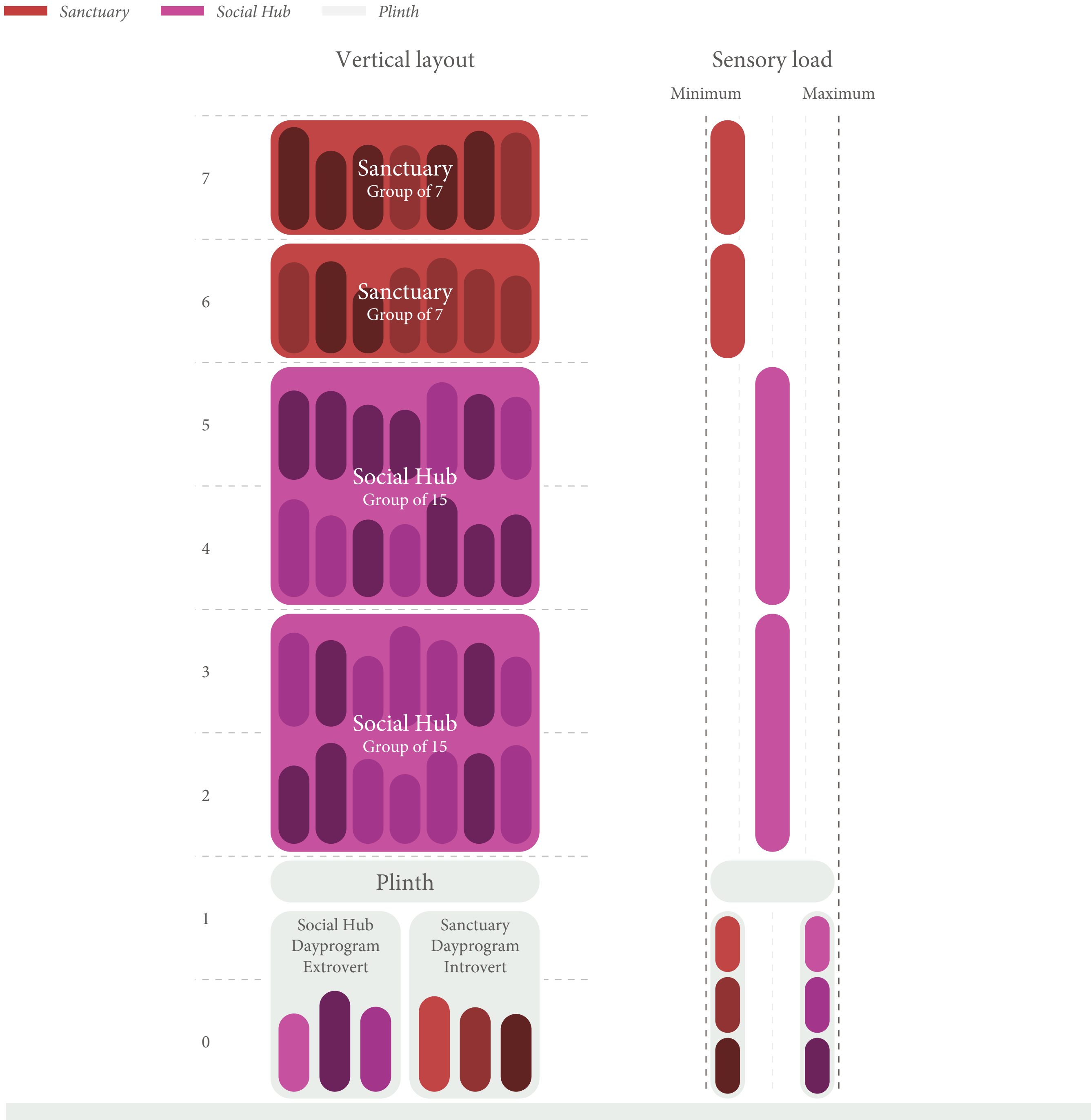


Figure 10. Spatial distribution of Sanctuary and Social Hub profiles across building levels
source: author

Vertical layout

The building's vertical layout represents a social gradient: the lower floors house a small society of VG 3 and LVG 1/2 residents in groups of 15, prioritizing urban emancipation *(Overmars-Marx, 2018)* near the public plinth. By utilizing the plinth as public space and social infrastructure *(Klinenberg, 2018)*, the design houses both opportunities for day programs for the residents, and public familiarity: the casual, repeating interactions that foster neighborhood belonging and reduce social stigma. The upper floors serve as a sanctuary for VG4/5 and LVG 3 residents. This vertical hierarchy ensures a safe, low-sensory environment for those with higher behavioral scores, effectively separating essential social participation from sensory load.

Sanctuary	Social Hub	Nr.	Entrance and circulation	1	2	3
x	x	1.0	Free width of passages (doors, hallways) > 850mm; for wheelchair routes >1200mm	x		x
x	x	1.1	Threshold-free access: height difference < 2mm or bridged with a 1:10 ramp	x		
x	x	1.2	Hallway width in group housing > 1500mm to allow two people (including a caregiver) to pass each other	x		x
x	x	1.3	Clear visual marking of the entrance and threshold transitions using color contrast	x	x	x
x		1.4	Orientation point/resting spot directly at the entrance where residents can acclimatize (decompression zone)		x	
x	x	1.5	Unambiguous route from the entrance to private quarters via a logical guidance line (change in floor material or color band)	x	x	x
x		1.6	No blinding light at the entrance: no large unshielded glass facade sections directly opposite the door			x
			Bedroom			
x	x	2.0	Turning space for wheelchair: 1500mm by 1500mm clear space next to the bed	x		
x		2.1	Fixed layout structure of the room (fixed spot for bed, desk, wardrobe); no confusing open spaces		x	x
x	x	2.2	Muted colors on walls: no highly saturated primary colors; neutral tones as a base		x	x
x	x	2.3	Blackout possibility: blackout curtains or blackout roller blinds			
x		2.4	Sound-absorbing material on at least one wall or ceiling (acoustic panels, soft wall covering)		x	x
x	x	2.5	Sufficient and closed storage space: wardrobes with doors to minimize visual chaos		x	x
			Sanitary			
x	x	3.0	Free width of passages (doors, hallways) > 850mm; for wheelchair routes >1200mm	x		
x	x	3.1	Threshold-free shower area: shower floor surface > 900mm by 900mm	x		
x	x	3.2	Grab bars/support at the toilet and shower (or provisions for later installation)			x
x	x	3.3	Neutral, matte finish: no high-gloss surfaces that cause glare			x
x	x	3.4	Good ventilation: no buildup of odors; mechanical exhaust with low noise levels		x	

Figure 11. Resident compatibility checklist
source: author

Sanctuary	Social Hub	Nr.	**Common**			
x	x	4.0	Logical, clear routing through the common area without dead ends		x	
x	x	4.1	Zoning: distinction between dining area, seating area, and potentially a quiet activity spot (visual or material-technical)		x	
x	x	4.2	Free walking route width > 1200mm through the common area (wheelchair accessible)	x		x
x		4.3	Sound-absorbing ceiling or wall panels: no hard flat ceilings above the dining area		x	x
x	x	4.4	No visual clutter: closed storage units, limited decoration		x	x
			Kitchen			
x	x	5.0	Worktop accessible from a wheelchair: free space under the counter > 700mm high in one section	x		
x	x	5.1	Sufficient extraction capacity to directly remove cooking odors		x	
x	x	5.2	Induction or ceramic hob: no open flame; safer and less odor		x	x
x	x	5.3	Simple, consistent layout of cabinets and appliances		x	
x	x	5.4	Standard worktop height: 650mm – 900mm	x		x
			Retreat Room			
x		6.0	Dimmable light in the retreat room, no fluorescent; preferably no window facing a busy outdoor area		x	x
x		6.1	Soft materials: carpet or cork, upholstered seating, or a floor mattress			x
x		6.2	No transit function: the room is not located on a walking route		x	x

Resident compatibility checklists

The checklist serves as the bridge between the needs of the residents and the physical architectural design. By combining accessibility standards with specific neuro-inclusive requirements, the checklist ensures that the Sanctuary floors provides the necessary sensory protection and predictability, while the Social Hub floor house safe social interaction.

Site

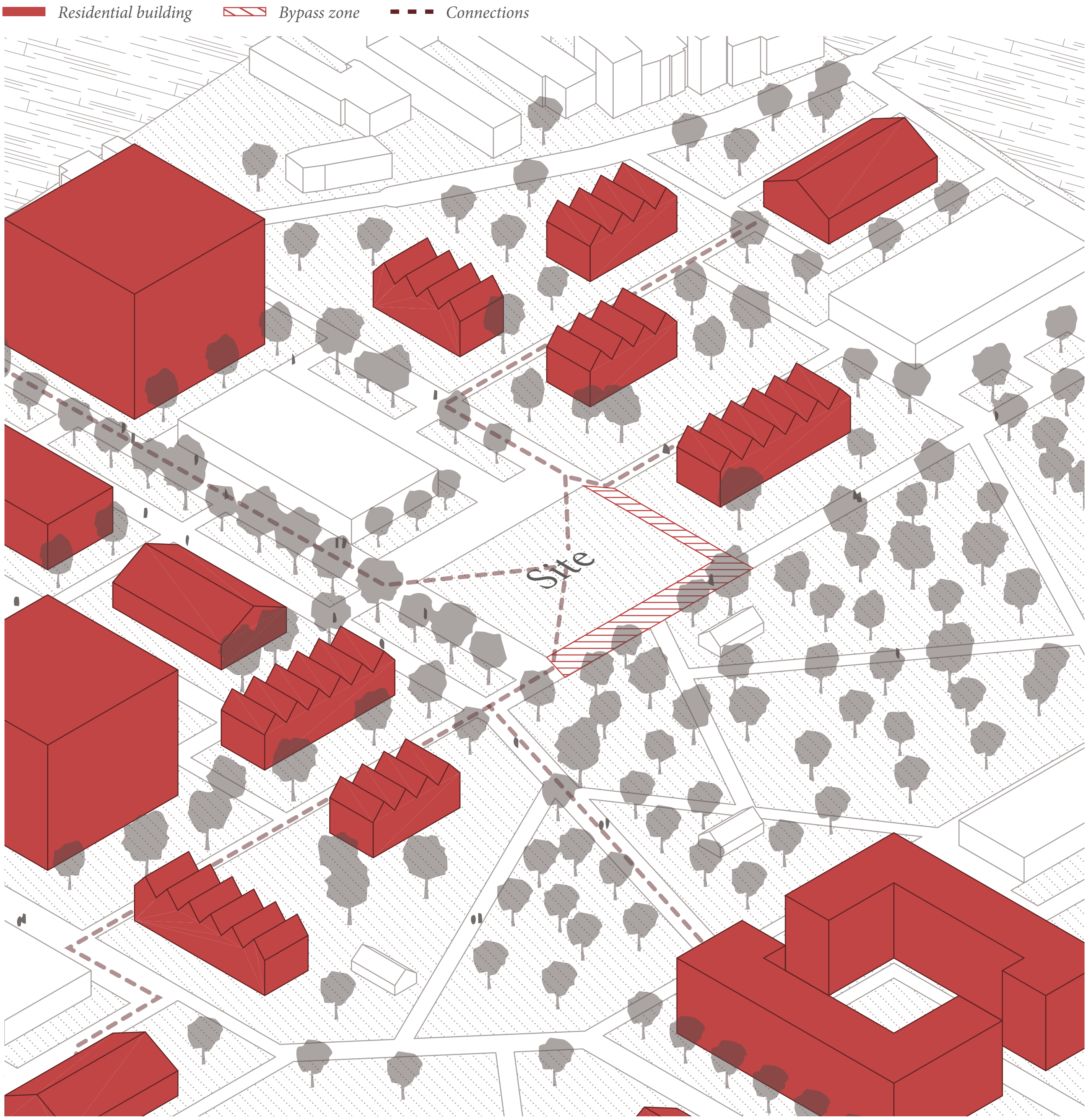


Figure 12. Connections with nearby dwellings
source: author

Local recognition

By adding a public library, the project creates a destination that connects the building to the neighborhood. This ensures a connection with the local community that is both lasting and meaningful, allowing for frequent, low-threshold visits that are necessary to build mutual recognition and social trust between residents and their neighbors.

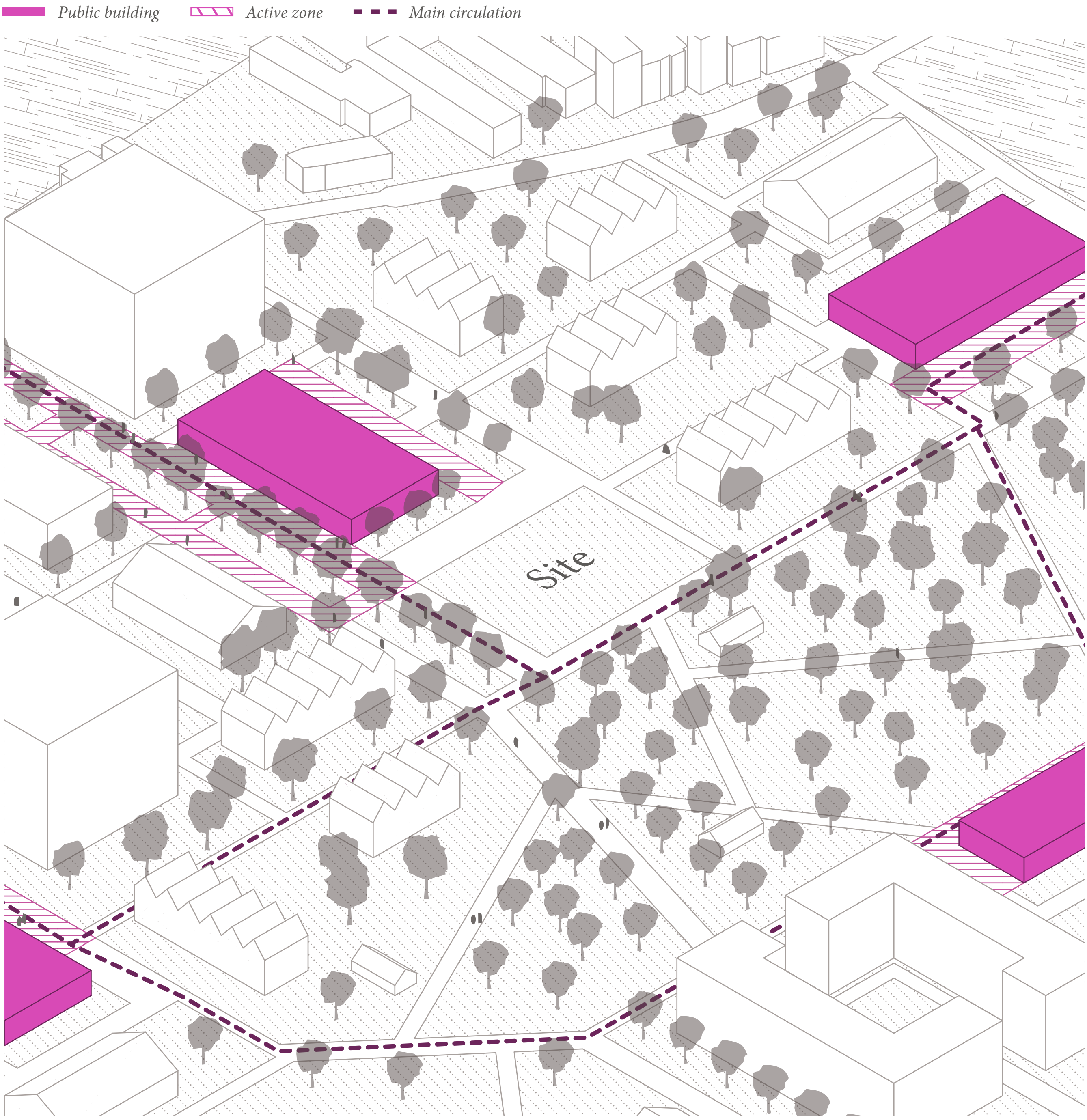


Figure 13. Connections with nearby public buildings
source: author

Public attraction

In addition to the library, the café attracts a wider public from beyond the Spaanse Polder. By housing visitors from the city, the café functions as a social hub, further preventing the building from becoming isolated. These visitors bring the diverse and spontaneous encounters necessary for the residents' social emancipation.

Figure 14. Types of roads around the site
source: author

Accessability

The site is surrounded by shared pedestrian and cycle paths. Situated just outside the neighborhood is a primary road, which will serve as a vital transport link for both people and goods, facilitating accessibility to and from the area.

Figure 15. Types of greenery around the site
source: author

Greenery

One side of the site is adjacent to a park, creating an environment that is significantly quieter than the commercial street. Therefore, it serves as the ideal location to position the library, aligning the need for focus with the quiet environment.

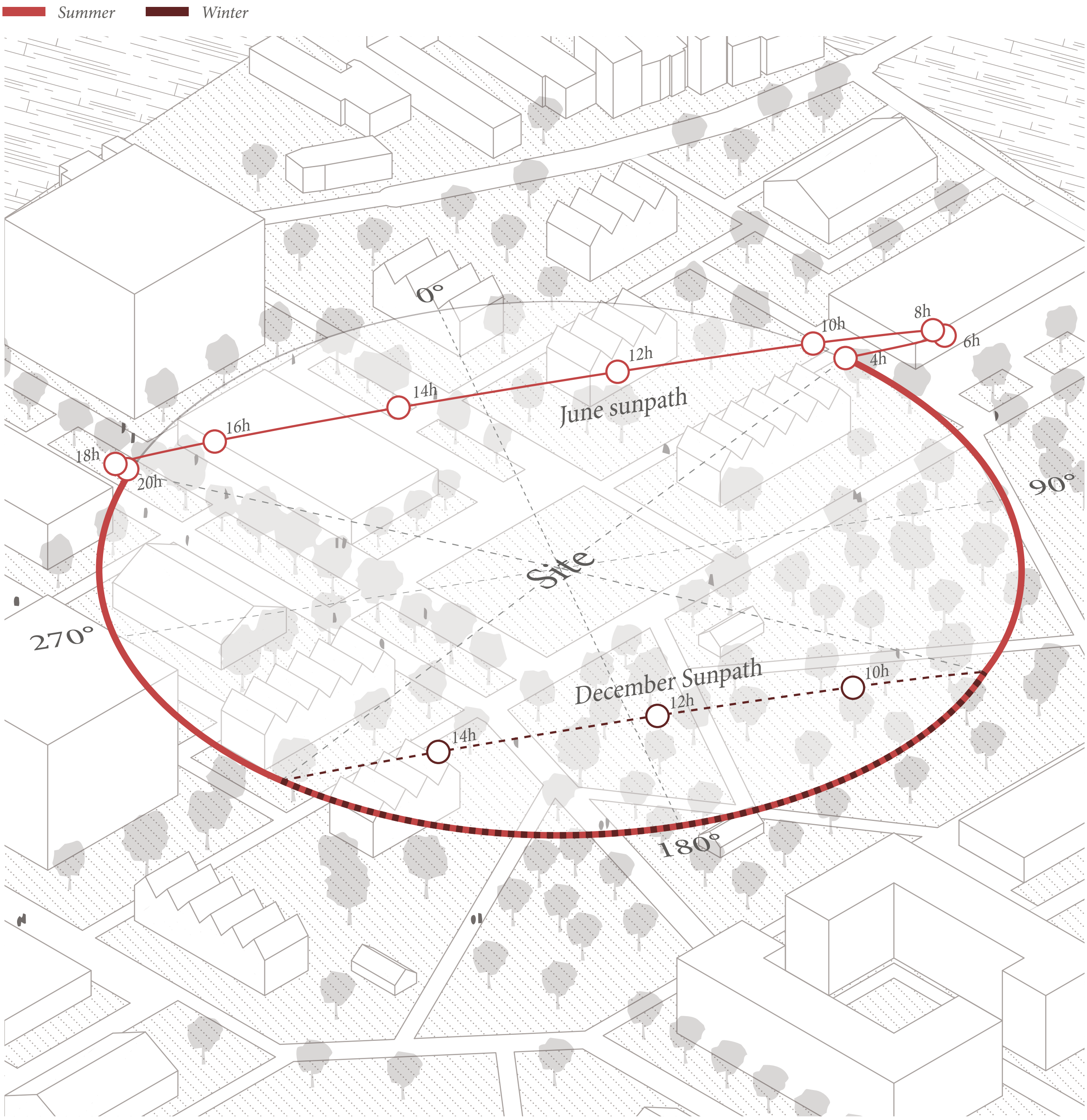


Figure 16. Sunpath around the site
source: author

Solar

The summer sunpath provides strong daylight from the south, while the lower winter sun reaches deeper into the site. This supports the placement of collective spaces and shared outdoor areas where natural light can improve comfort.

Wind direction frequency

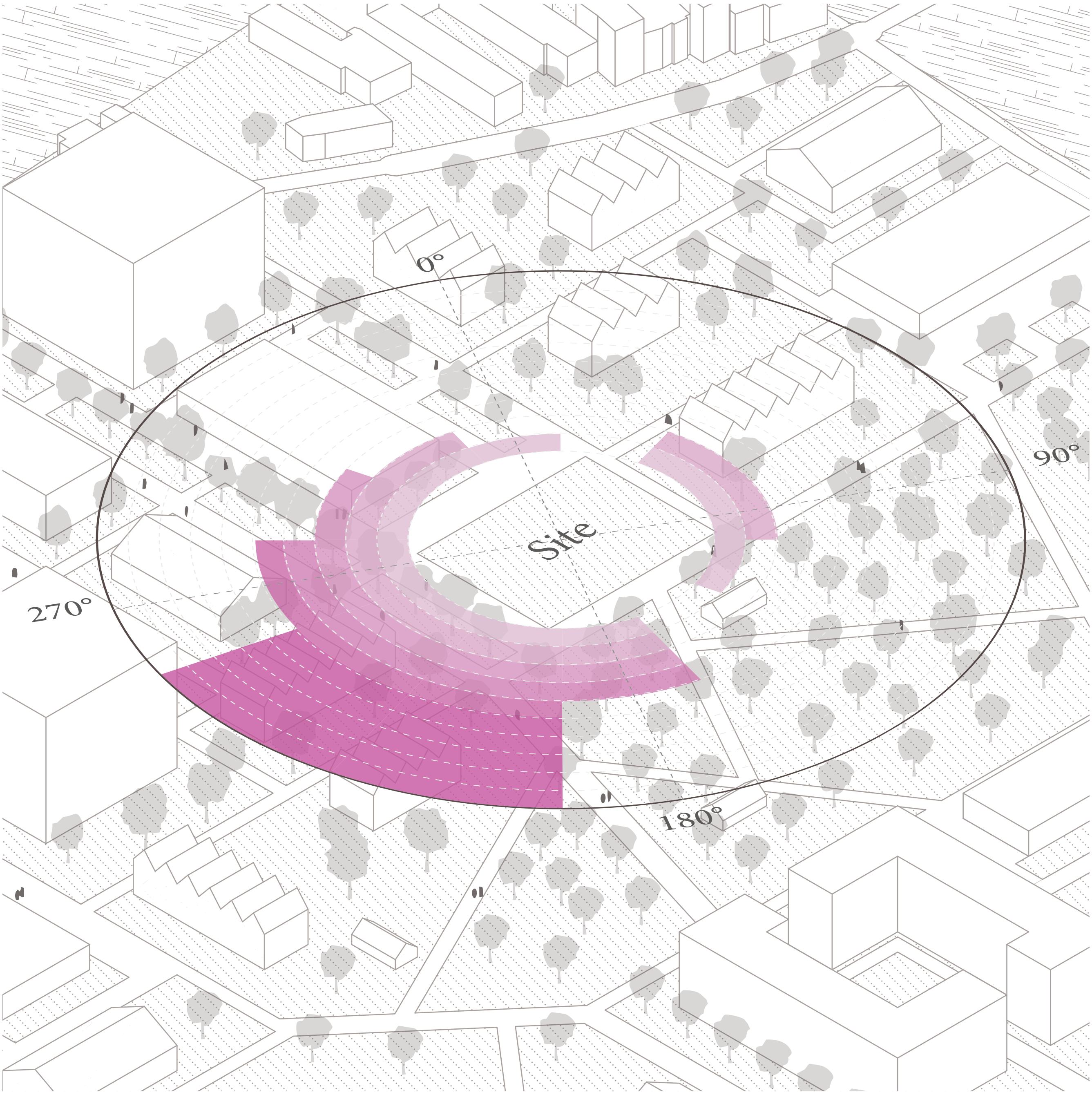


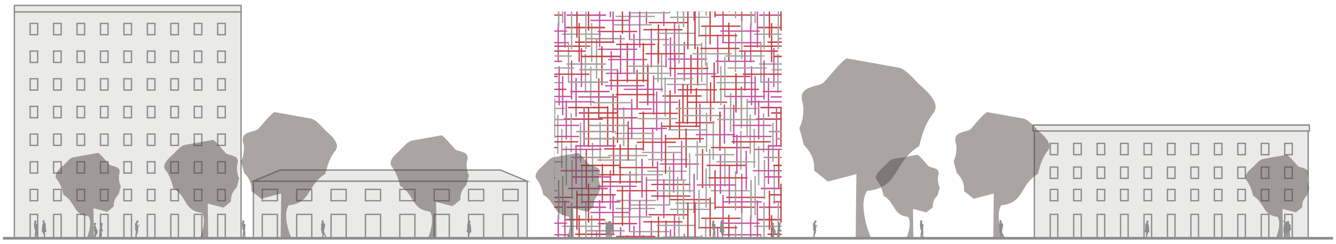
Figure 17. Wind exposure around the site
source: author

Wind

The surrounding greenery and park edge help reduce wind impact and create calmer outdoor conditions. This makes the quieter side of the plot more suitable for protected entrances and low-stimulus functions.

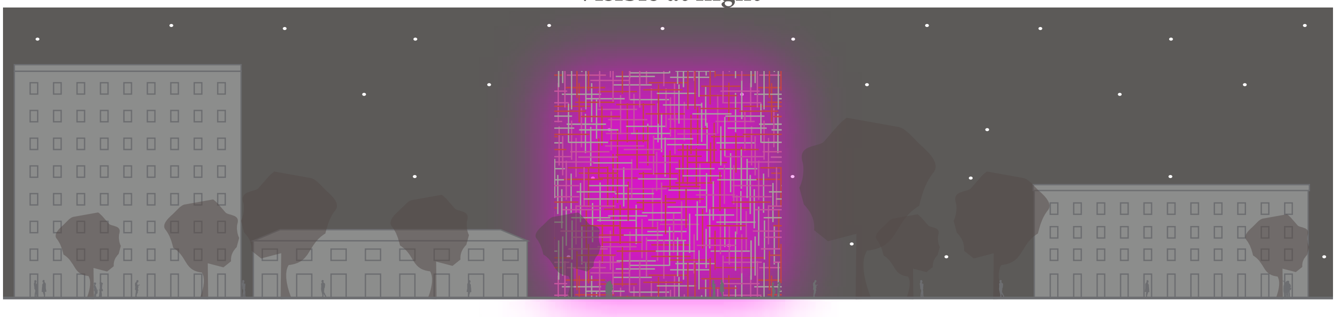
Building concept

Landmark



The building is a recognisable landmark with a unqiue design, supporting orientation, pride and emancipation.

Visible at night



At night, the building remains visible as a point of orientation and as a billboard for the neighbourhood.

Adjusted biophilic implementation

Biophilic elements are implemented according to sensory sensitivity.

Figure 18. Architectural design principles
source: author

Architectural principles

Biophilic design is used to create a warmer and less institutional environment. According to Usip et al. *(2025)* nature-integrated architecture significantly enhances occupant wellbeing, with documented improvements including a 15% reduction in stress hormones and a 25% enhancement in cognitive performance. Therefore, this building uses natural materials, plants, daylight, and soft textures to promote familiarity and sensory comfort. For the Sanctuary group, these elements are applied in a way that aligns with their sensory sensitivities. Matte, muted colors and subtle textures prevent overstimulation. In the Social Hub, biophilic elements are more prevalent, further promoting mental wellness.

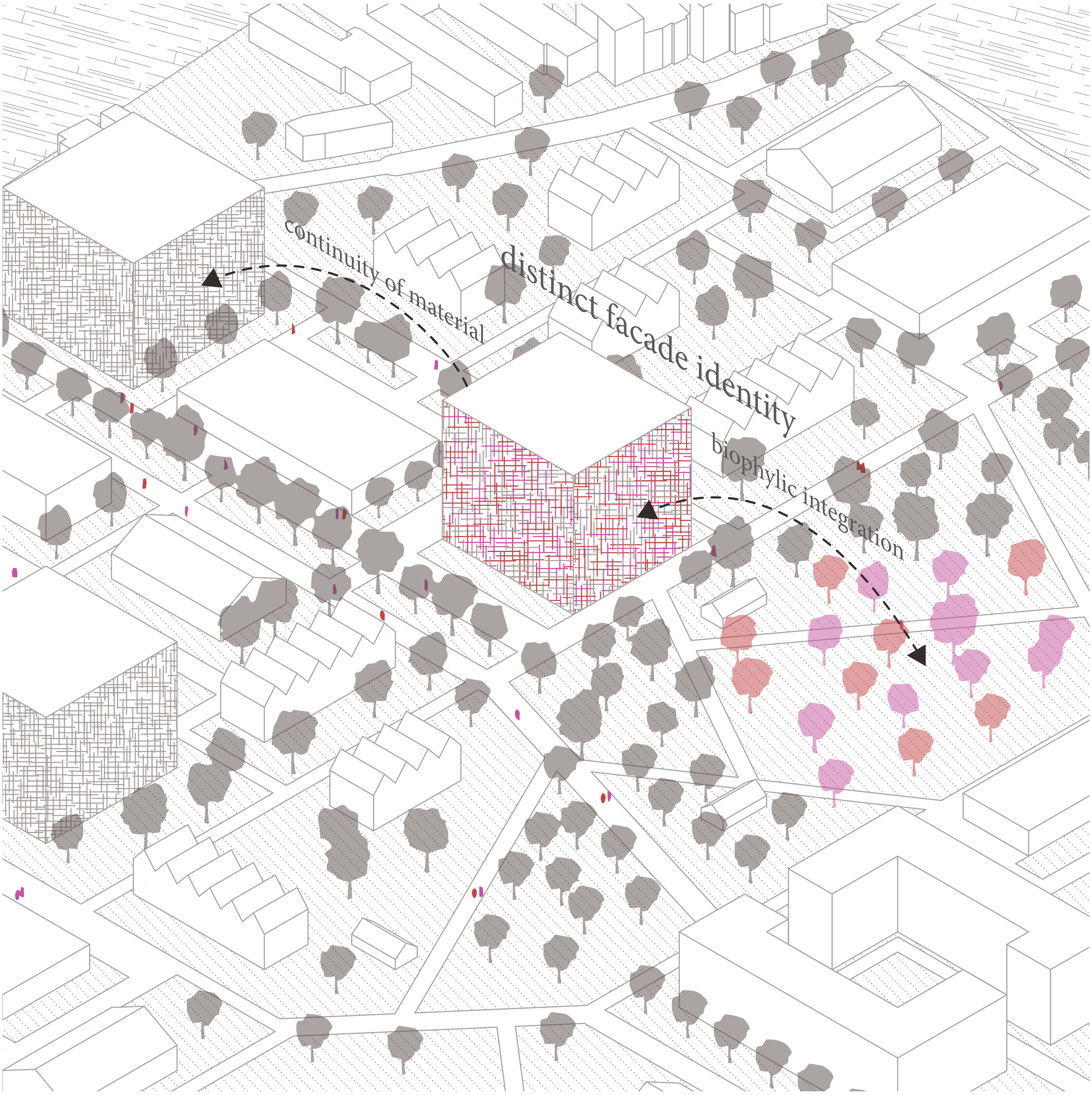
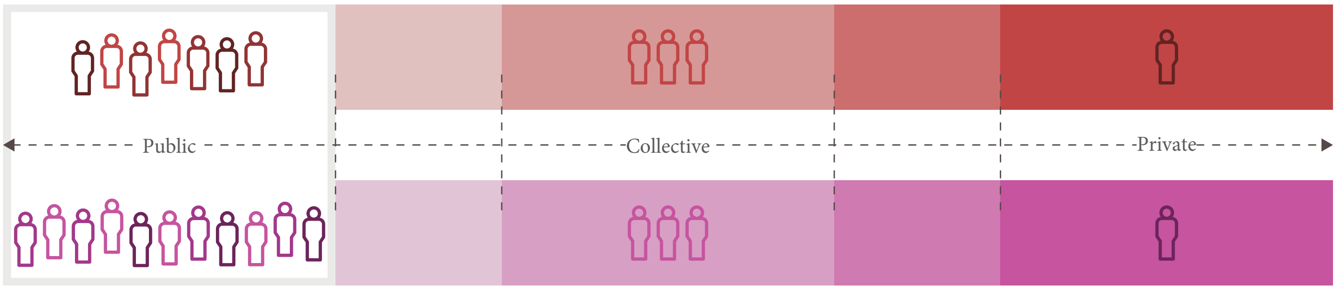


Figure 19. Contextual architectural expression
source: author

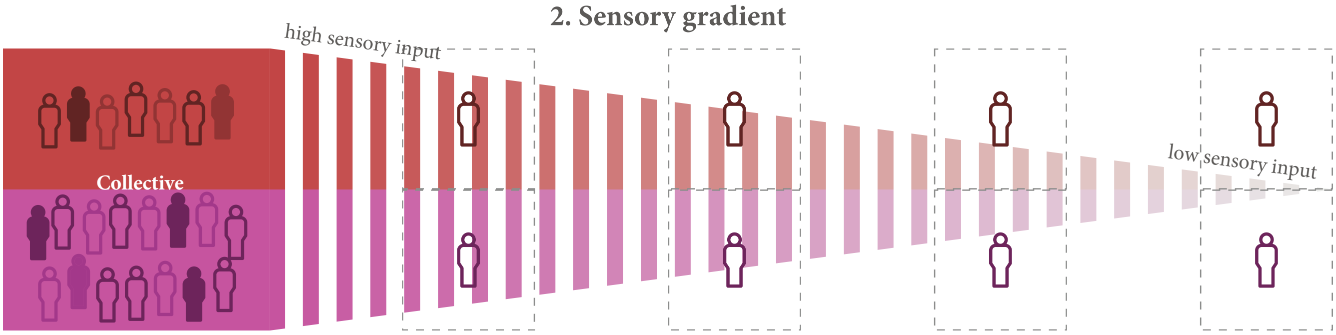
The building should not only respond to the sensory needs of its residents, but also fit within the current architecture of housing. In the architecture, familiar elements such as brick, rhythm, depth and recognizable façade proportions are used to create continuity with the urban fabric. This project combines these contextual references with biophilic principles, creating an eclectic façade language in which tactility, natural expression and contemporary residential character support both recognition and inclusion.

1. Public to private gradient



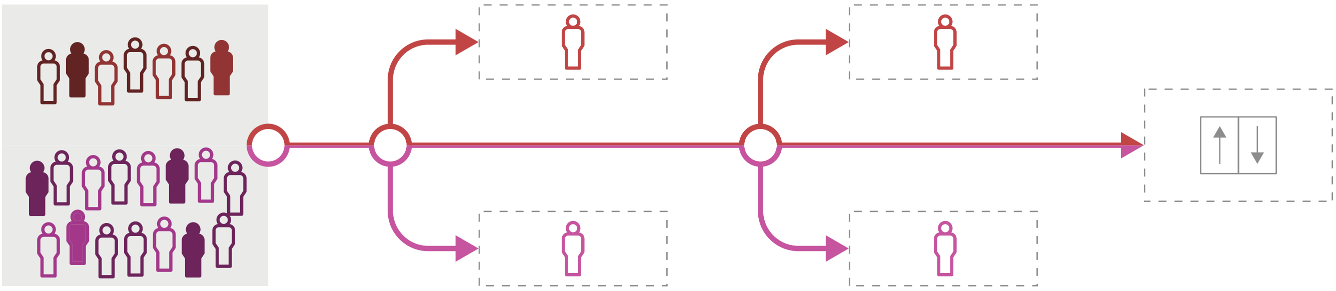
The plan creates a gradual transistion from public areas to collective spaces and private apartments

2. Sensory gradient



Stimulating spaces are placed closer to active zones, while quiet rooms are more protected.

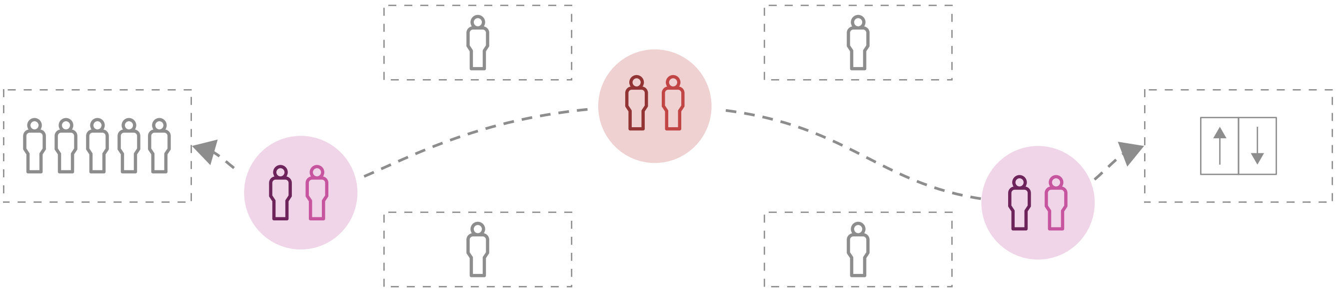
3. Clear routing



Simple and legible circulation supports independence and reduces confusion.

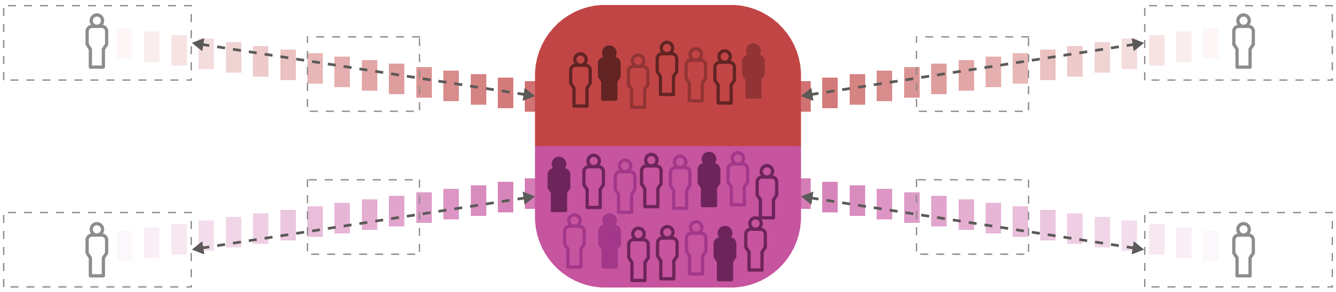
Figure 20. Spatial design principles
source: author

4. Low treshold encounters



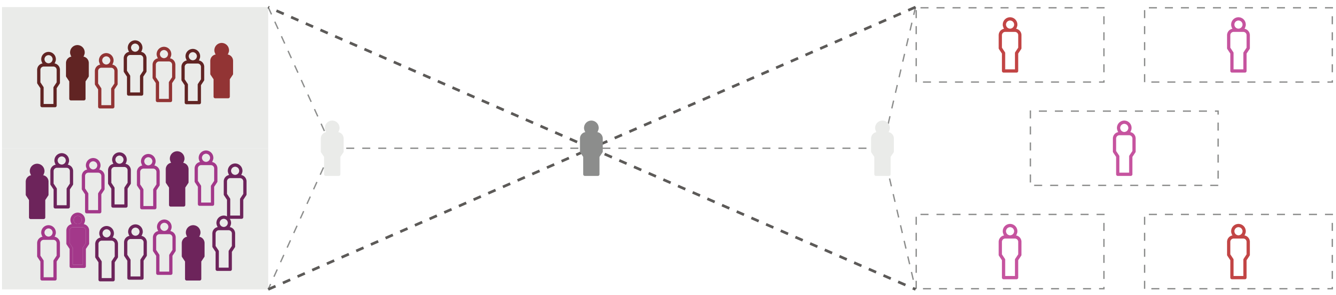
Shared spaces are placed along daily routes to support informal encounters.

5. Retreat and protection



Buffer spaces and retreat rooms allow residents to withdraw when needed.

6. Staff visibility and safety



Staff positions allow discreet overview of common areas while keeping a domestic atmosphere.

Spatial design principles

These principles translate resident needs into spatial design aspects. They show how the floorplan responds to privacy, sensory control, circulation, informal encounters, retreat spaces, and staff oversight, based on the compatibility checklist, Together, they form the connection between user requirements and the final floor plans.

ID	Room	Number of Units [n]	Usable Area per Room [m2]	Total Usable Area [m2] * 1,2	Spatial Proximity	Spatial Requirements	Daylight	Public	Staff	Social Hub Residents	Sanctuary Residents
A1.0	Living area with kitchen	8	25	240	Common	Low Stimulus Wheelchair friendly	Yes		x		x
A1.1	Kitchen	6	10	72	Common	Low Stimulus Wheelchair friendly	Yes		x		x
A1.2	Living room	6	15	108	Common	Low Stimulus Wheelchair friendly	Yes		x		x
A1.3	Bedroom	14	20	336	Common	Low Stimulus Wheelchair friendly	Yes		x		x
A1.4	Sanitary	14	10	168	Common	Low Stimulus Wheelchair friendly	No		x		x
A1.5	Storage	14	5	84	Common	Low Stimulus Wheelchair friendly	No		x		x
A1.6	Hall	14	5	84	Common	Low Stimulus Wheelchair friendly	No		x		x
A2.0	Living area with kitchen	28	25	840	Common	Wheelchair friendly	Yes		x	x	
A2.1	Bedroom	28	20	672	Common	Wheelchair friendly	Yes		x	x	
A2.2	Sanitary	28	10	336	Common	Wheelchair friendly	No		x	x	
A2.3	Storage	28	5	168	Common	Wheelchair friendly	No		x	x	
B1.0	Lounge & Dining area	2	50	120	Residential	Low Stimulus Wheelchair friendly	Yes		x		x
B1.1	Kitchen area	2	30	72	Residential	Low Stimulus Wheelchair friendly	Yes		x		x
B1.2	Staff Office	2	15	36	Residential	Low Stimulus Wheelchair friendly	Yes		x		x
B1.3	Storage	2	5	12	Residential	Low Stimulus Wheelchair friendly	No		x		x
B1.4	Staff Bedroom	2	10	24							
B1.5	Staff Senitary	2	5	12							
B2.0	Lounge & Dining area	2	50	120	Residential	Wheelchair friendly	Yes		x	x	
B2.1	Kitchen Area	2	30	72	Residential	Wheelchair friendly	Yes		x	x	
B2.2	Staff Office	2	15	36	Residential	Wheelchair friendly	Yes		x	x	
B2.3	Storage	2	5	12	Residential	Wheelchair friendly	No		x	x	

Figure 21. Program of requirements
source: author

ID	Room	Number of Units [n]	Usable Area per Room [m2]	Total Usable Area [m2] * 1,2	Spatial Proximity	Spatial Requirements	Daylight	Public	Staff	Social Hub Residents	Sanctuary Residents
C1.0	Lobby	1	80	96	Draft Portal Wheelchair parking area	Low Stimulus Wheelchair friendly	Yes	x	x	x	x
C1.1	Draft portal	1	5	6	Lobby	Low Stimulus Wheelchair friendly	Yes	x	x	x	x
C1.2	Wheelchair parking area	1	20	24	Lobby	Low Stimulus Wheelchair friendly	Yes		x	x	x
C1.3	Bicycle Storage	1	40	48		Wheelchair friendly	No		x	x	x
C1.4	Staff Room	1	20	24		Accessible for library and cafe	Yes		x		
C1.5	Dressing Room	1	10	12			No		x		
C1.6	Laundry Room	1	25	30			No		x		
C1.7	Consultation Room	2	25	60		Wheelchair friendly	Yes		x	x	x
C1.8	Sanitary	2	25	60		Wheelchair friendly	Yes		x	x	x
D1.0	Seating Area	1	80	96	Bar & Kitchen Sanitary	Wheelchair friendly	Yes	x	x	x	
D1.1	Bar & Kitchen	1	30	36	Seating area Storage	Accessible for resident workers	Yes	x	x	x	
D1.2	Storage	1	15	18	Bar & Kitchen		No	x	x	x	
D1.3	Sanitary	2	10	24	Seating area	Wheelchair friendly	No	x	x	x	
D1.4	Office	1	10	12	Lobby		No		x	x	
E1.0	Reading Square	1	60	72		Low Stimulus Wheelchair friendly	Yes	x	x	x	x
E1.1	Shelving Area	1	40	48		Low Stimulus Wheelchair friendly	Yes	x	x	x	x
E1.2	Computer Area	1	30	36		Low Stimulus Wheelchair friendly	Yes	x	x	x	x
E1.3	Helpdesk	1	15	18		Low Stimulus Wheelchair friendly	Yes	x	x	x	x
E1.4	Sanitary	2	10	24	Helpdesk	Wheelchair friendly	No	x	x	x	x
E1.5	Office	1	10	12			No		x	x	x
E1.6	Back Office	1	5	6			No		x	x	x
F1.0	Stairs			0			No	x	x	x	x
F1.1	Elevator		6	0		Wheelchair friendly	No	x	x	x	x
F1.2	Installations	1	300	360			No		x		

Program of requirements

The Program of Requirements translates resident needs into spatial requirements. It determines room types, sizes, accessibility, daylight, proximity and user groups, forming a framework for the floor plans.

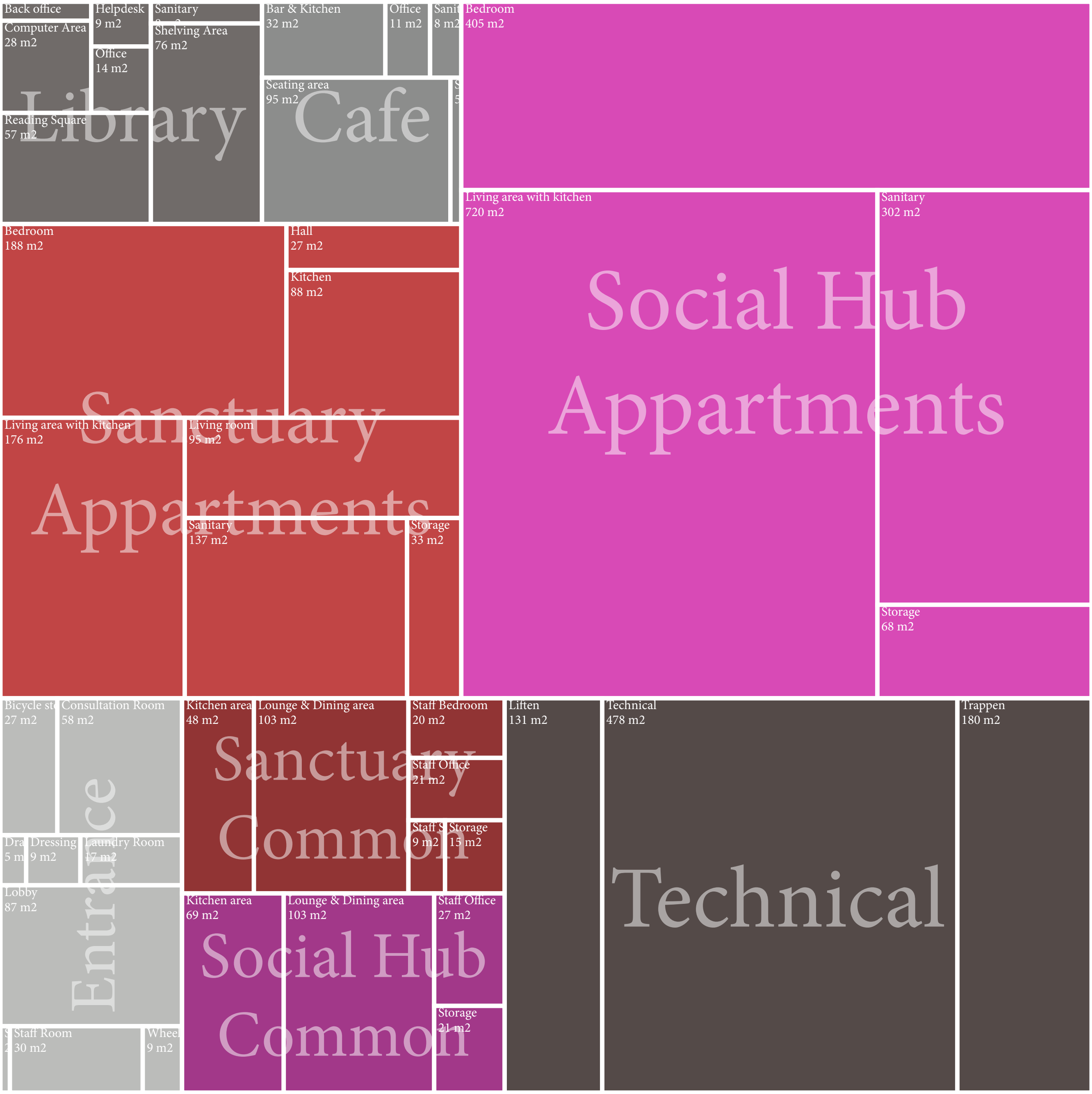


Figure 22. Comparison of sizes of different zones located in the building
source: author

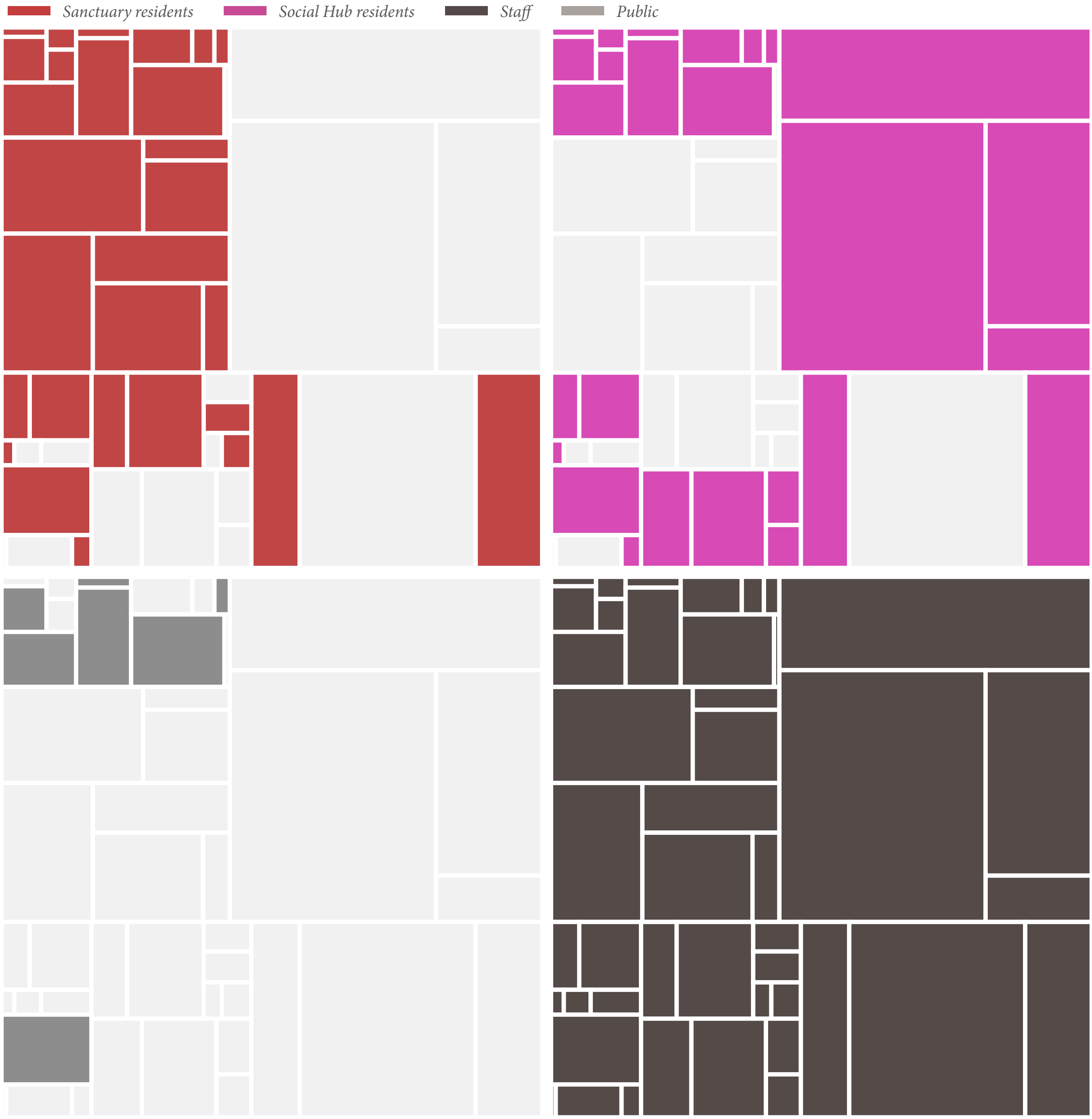


Figure 23. Access to rooms per type of person
source: author

Program sizing

The majority of the total floor area is reserved for the apartments themselves. These are primarily the spaces that belong to the Social Hub and Sanctuary groups. The remaining space is dedicated to common areas and public functions located in the plinth of the building. Together, these spaces create a perfect balance, providing residents with plenty of private space without compromising the building's public functions. While the apartments are private, the care needs of the residents are also important. A unique feature of this plan is that staff members have access to all areas of the building, including the private apartments. This allows them to provide support and ensure safety whenever needed.

Figure 24. Vertical circulation by resident group (1:150)
source: author

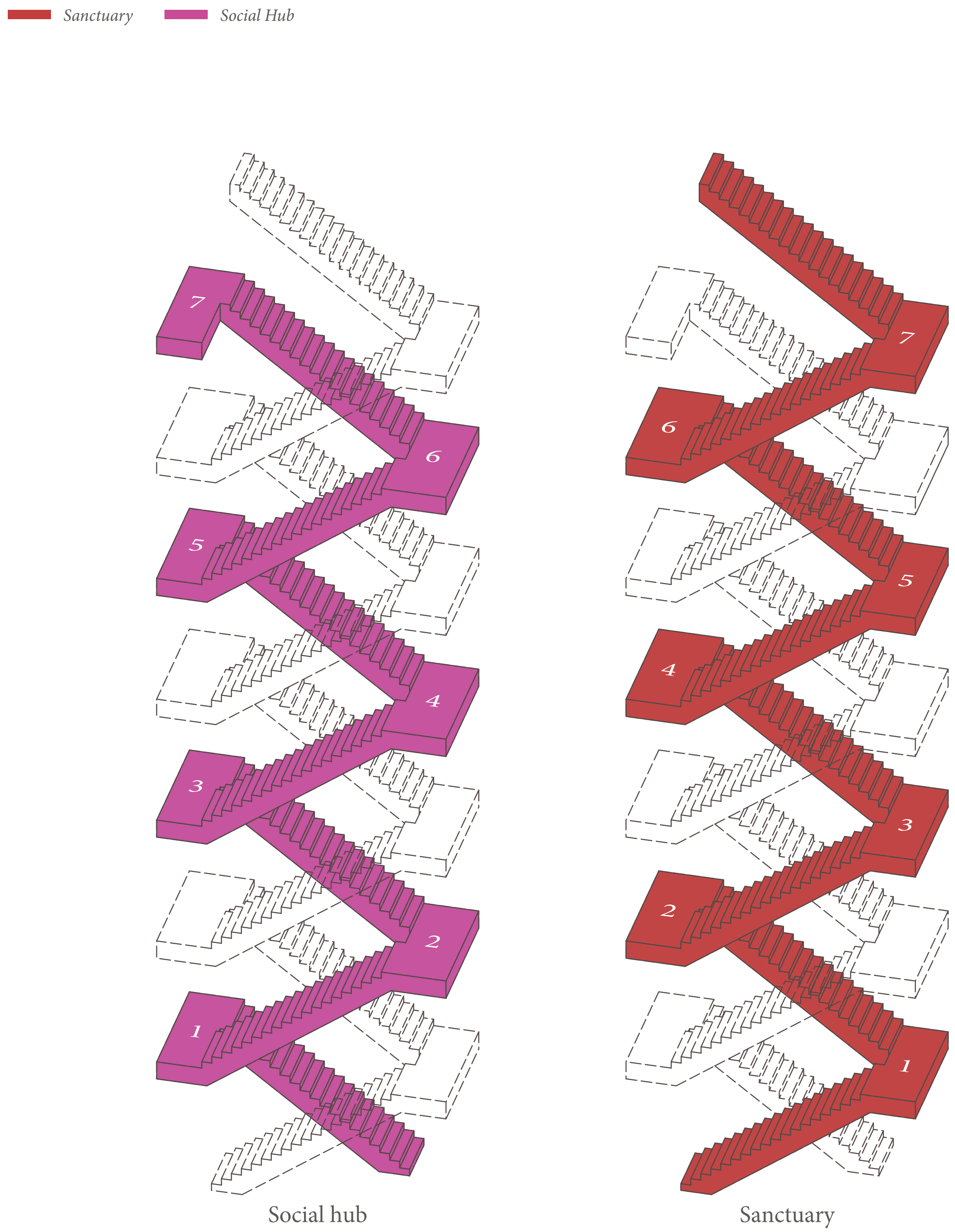


Figure 25. Stair connections for Social Hub and Sanctuary (1:150)
source: author

Vertical circulation

The vertical circulation is designed with separate stair and elevator access for the Social Hub and Sanctuary groups. This creates clear, predictable routes and limits unnecessary overlap between residents with different sensory needs. The stairs in the Social Hub support visual connection and informal encounters across floors. In contrast, the circulation in the Sanctuary remains calmer and more protected, with diffuse film on the windows.

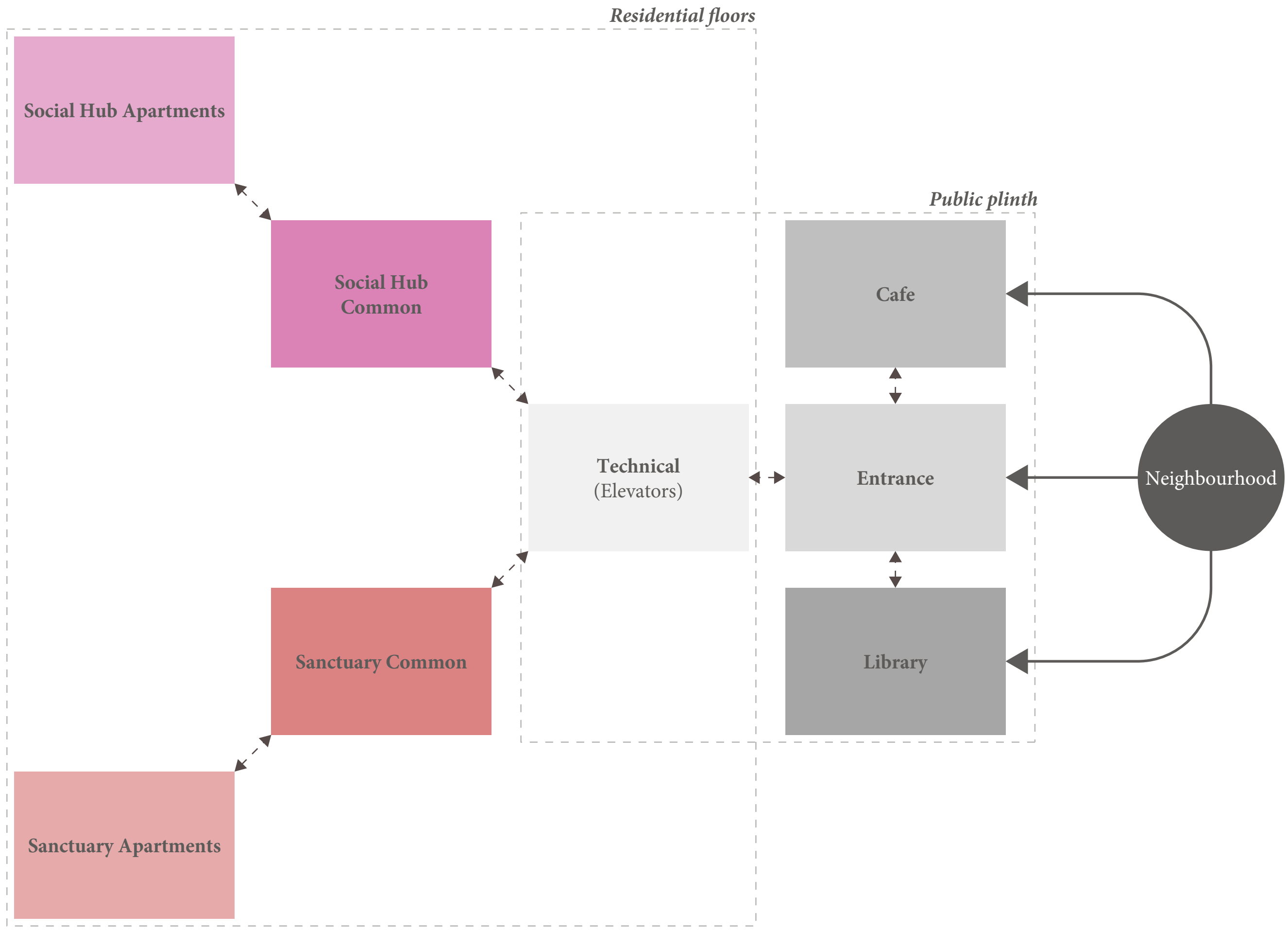


Figure 26. Connections principle
source: author

Program clustering

The public functions in the plinth connect the building with the neighborhood. The entrance forms a central transition space between the neighborhood and the residential floors, connecting the café and library to the internal circulation core. Common areas are placed between public and private zones, creating a gradual transition towards the apartments. The Social Hub and Sanctuary groups are organized as separate clusters, allowing each group to have its own collective space.

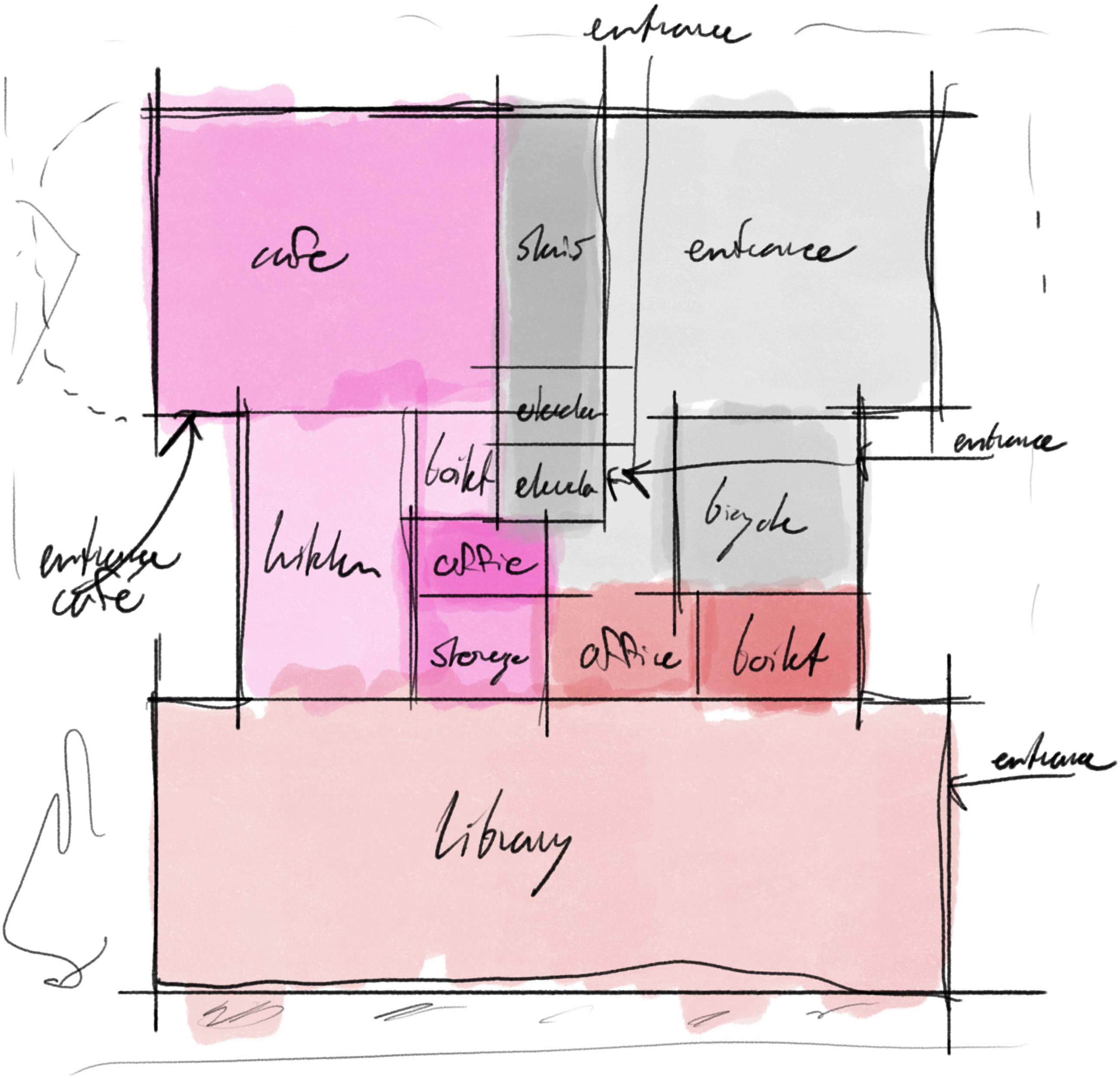


Figure 27. Ground floor principle
source: author

Ground floor idea

The ground floor translates the program clustering into a public plinth. The café and library serve as the neighborhood connection point, and the entrance and central core connect these public spaces to the residential floors. Routes to the day programs are organized to prevent conflicts or overstimulation when Social Hub and Sanctuary residents cross paths, ensuring a clear and protected transition.

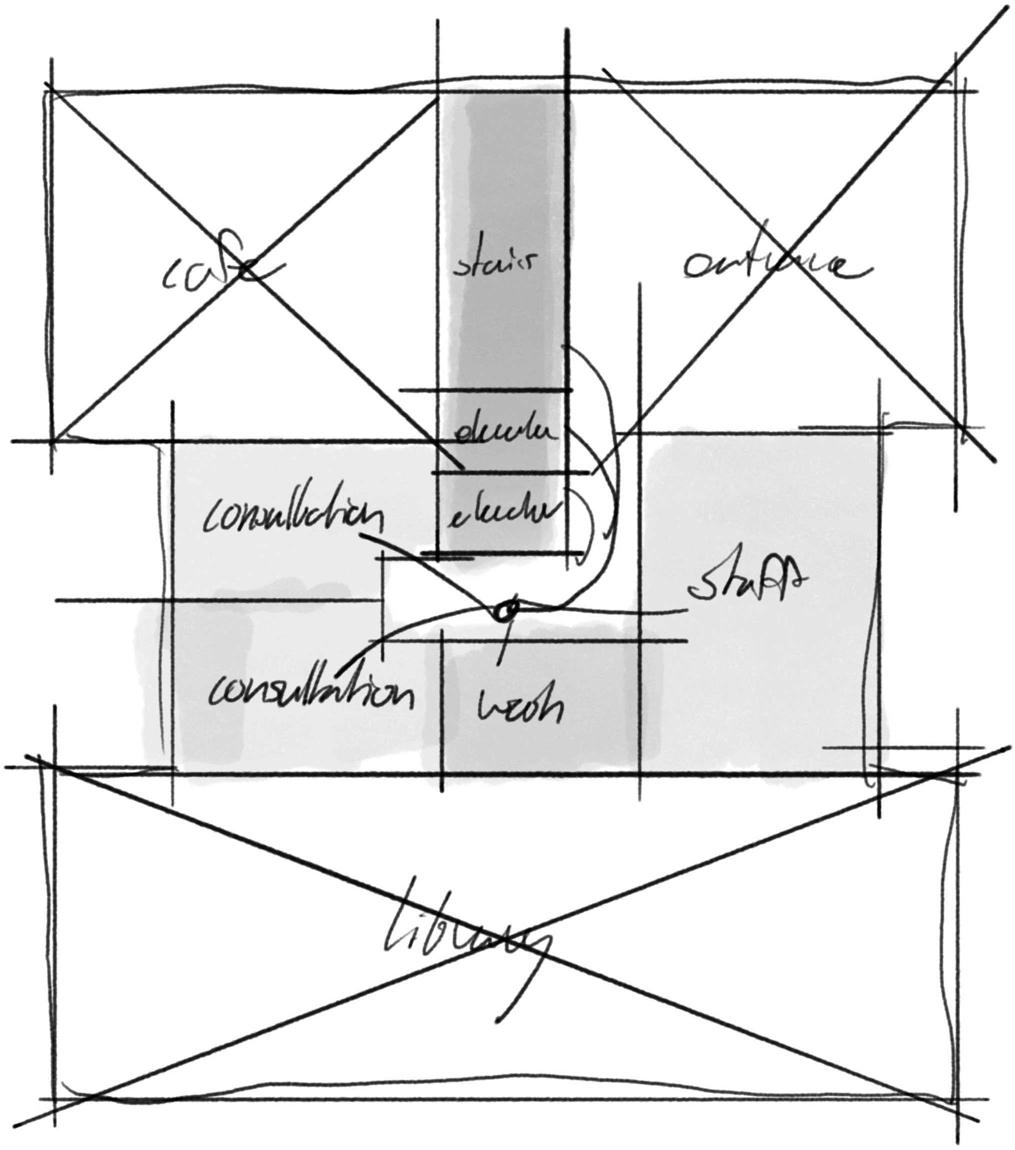


Figure 28. 1st floor principle
source: author

1st floor idea

The first floor acts as a support layer between the public plinth and the residential groups. Staff rooms, consultation spaces and service functions are placed close to the core for accessibility. This strengthens the principle of clear routing, while keeping care related spaces available without disturbing the residential atmosphere of the upper floors.

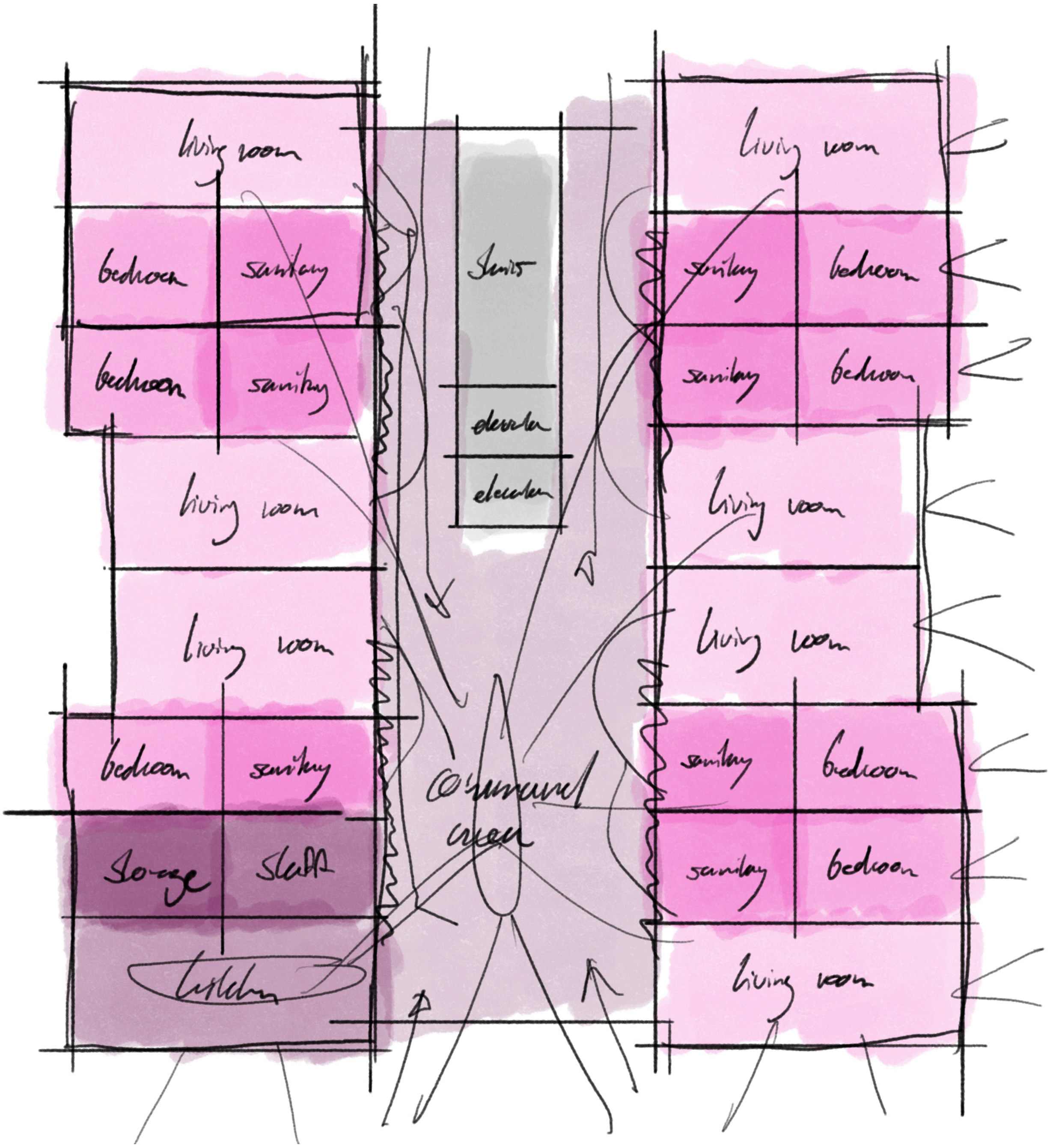


Figure 29. Social hub 1st floor principle
source: author

Social hub 1st floor idea

The first Social Hub layer is organised around a large collective living space. Apartments are placed around this shared space, creating daily moments of interaction along the route to private rooms. This follows the principles of low-threshold encounters and public-to-private transition, while keeping the group connected to the active lower part of the building.

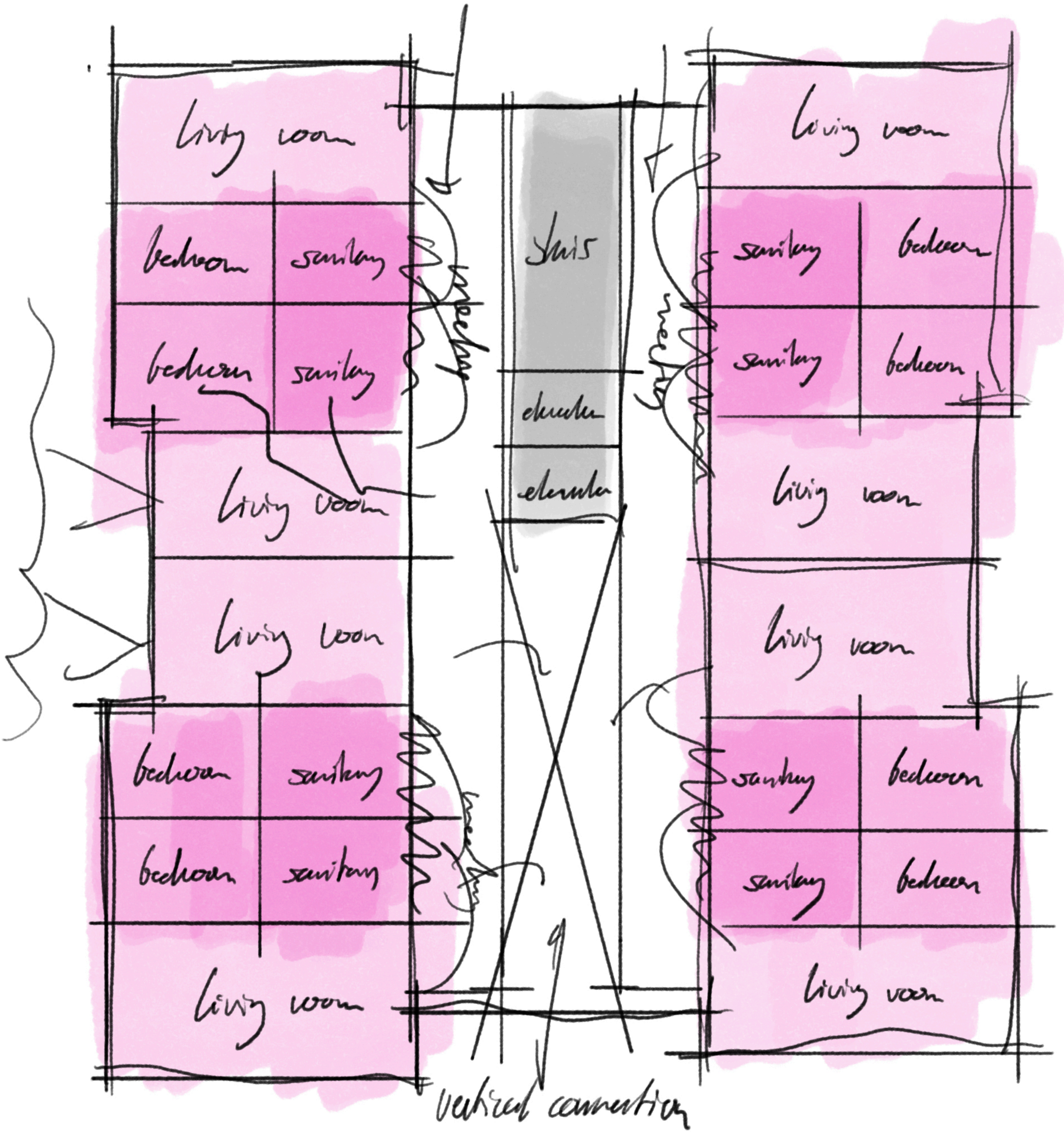


Figure 30. Social hub 2nd floor principle
source: author

Social Hub 2nd floor idea

The second Social Hub layer is strongly connected to the lower layer via the central void, which allows for visual contact across the collective space. Wide galleries provide space for movement, rest, and casual, low-threshold interactions. This strengthens the social character of the group while offering enough distance from the more active shared areas.

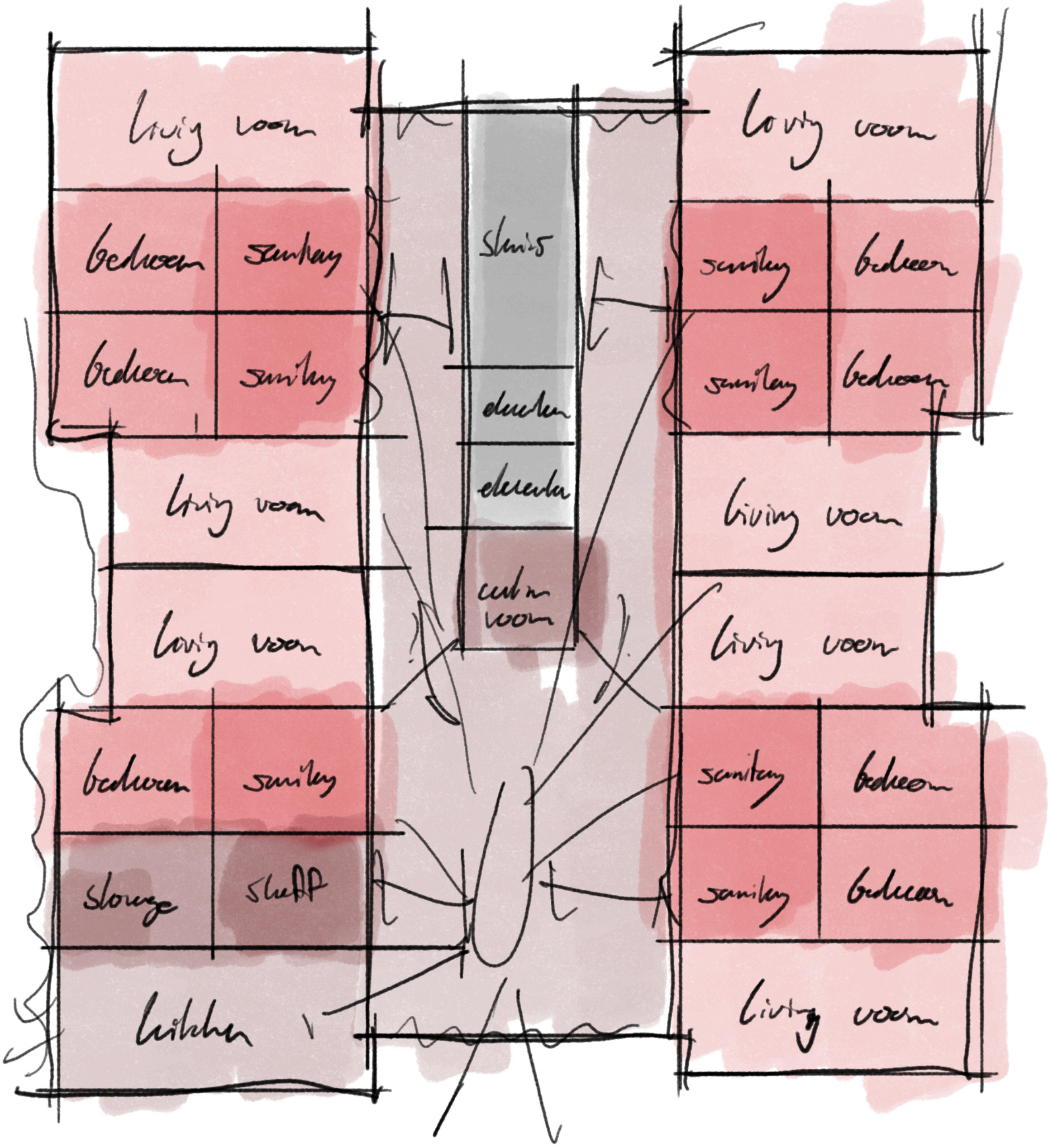


Figure 31. Sanctuary floor principle
source: author

Sanctuary floor idea

The Sanctuary floor applies the same clustering logic to create a calmer, more protected layout. Smaller resident groups are organized around collective spaces with clear routing and staff visibility. Private rooms are located far from public activity to allow for sensory control, privacy, and predictability, while still making safe social interaction possible.

Floorplans

Weak points Strong points

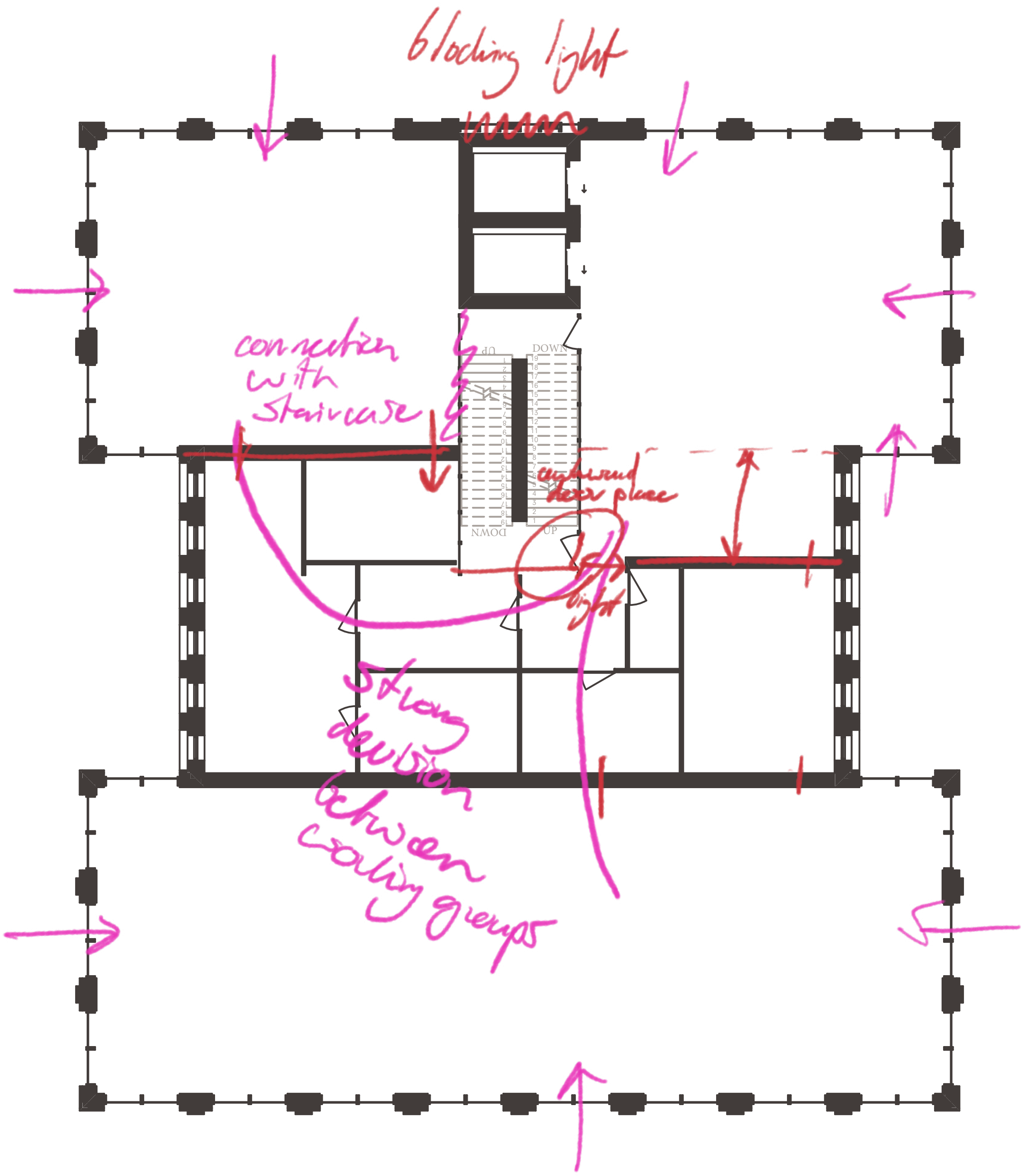


Figure 32. 1st variant of ground floor (1:200)
source: author

Ground floor 1st variant

The first variant separates the day-program spaces for both resident groups, preventing direct conflict. However, the elevators block daylight and the wall alignment remains unclear.

Weak points   Strong points

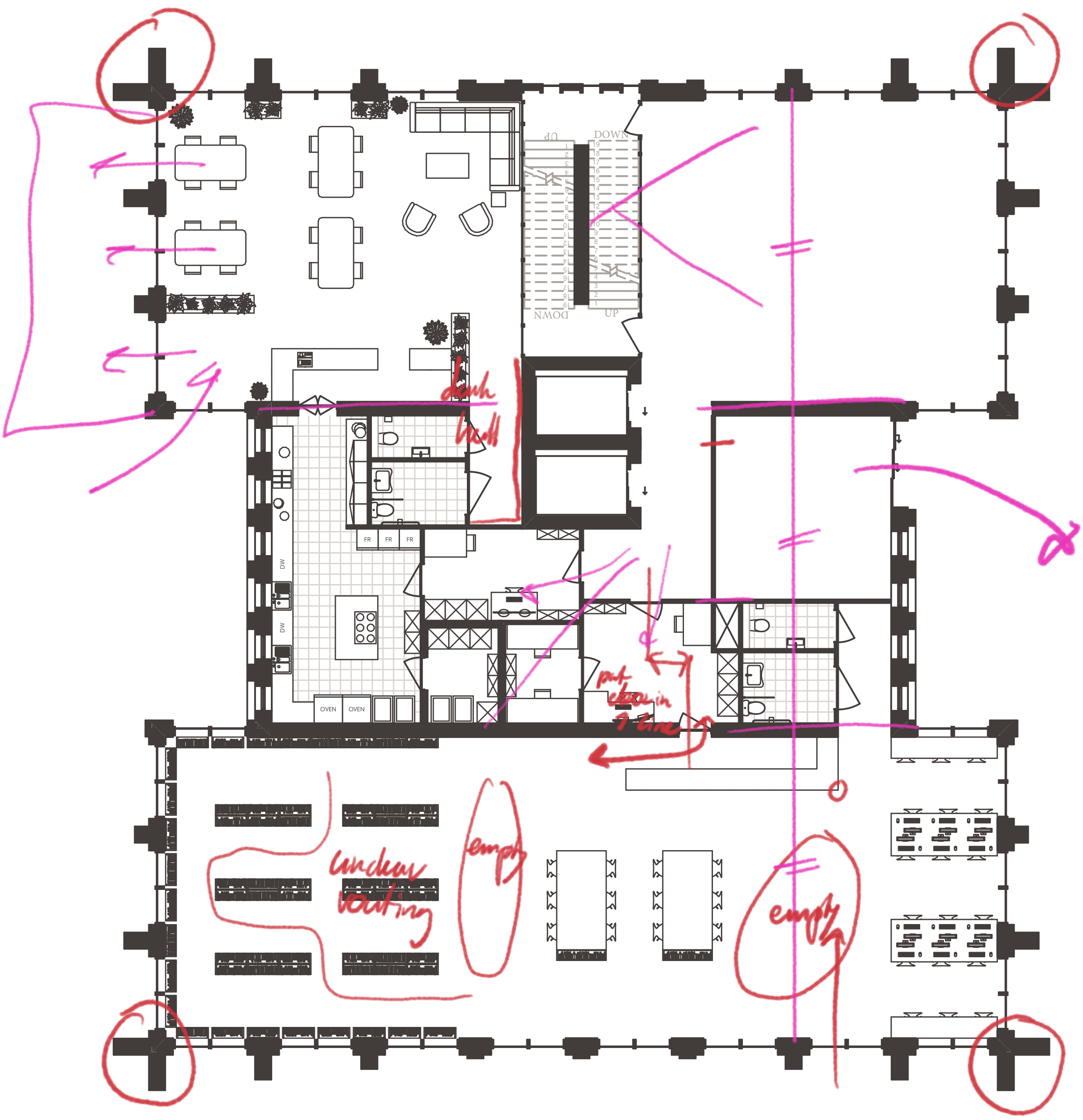


Figure 33. 2nd variant of ground floor (1:200)
source: author

Ground floor 2nd variant

The second variant improves the connection between the stairs, lobby and café. The internal bicycle storage is also added, but the library layout and façade organisation require further exploration.

Weak points   Strong points

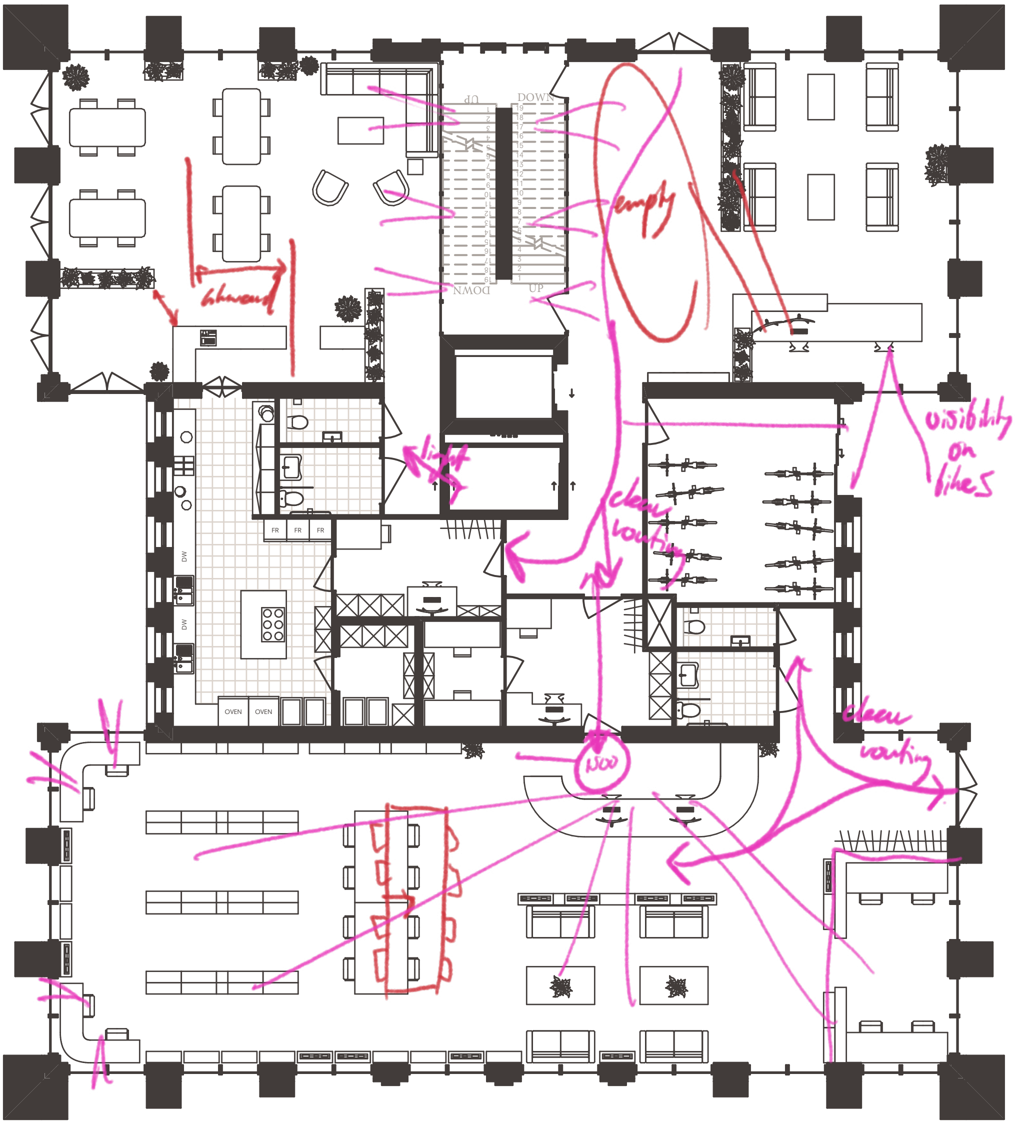


Figure 34. 3rd variant of ground floor (1:200)
source: author

Ground floor 3rd variant

This variant almost solves the ground floor organisation. The main remaining issues are the layout of the lobby, café and library.

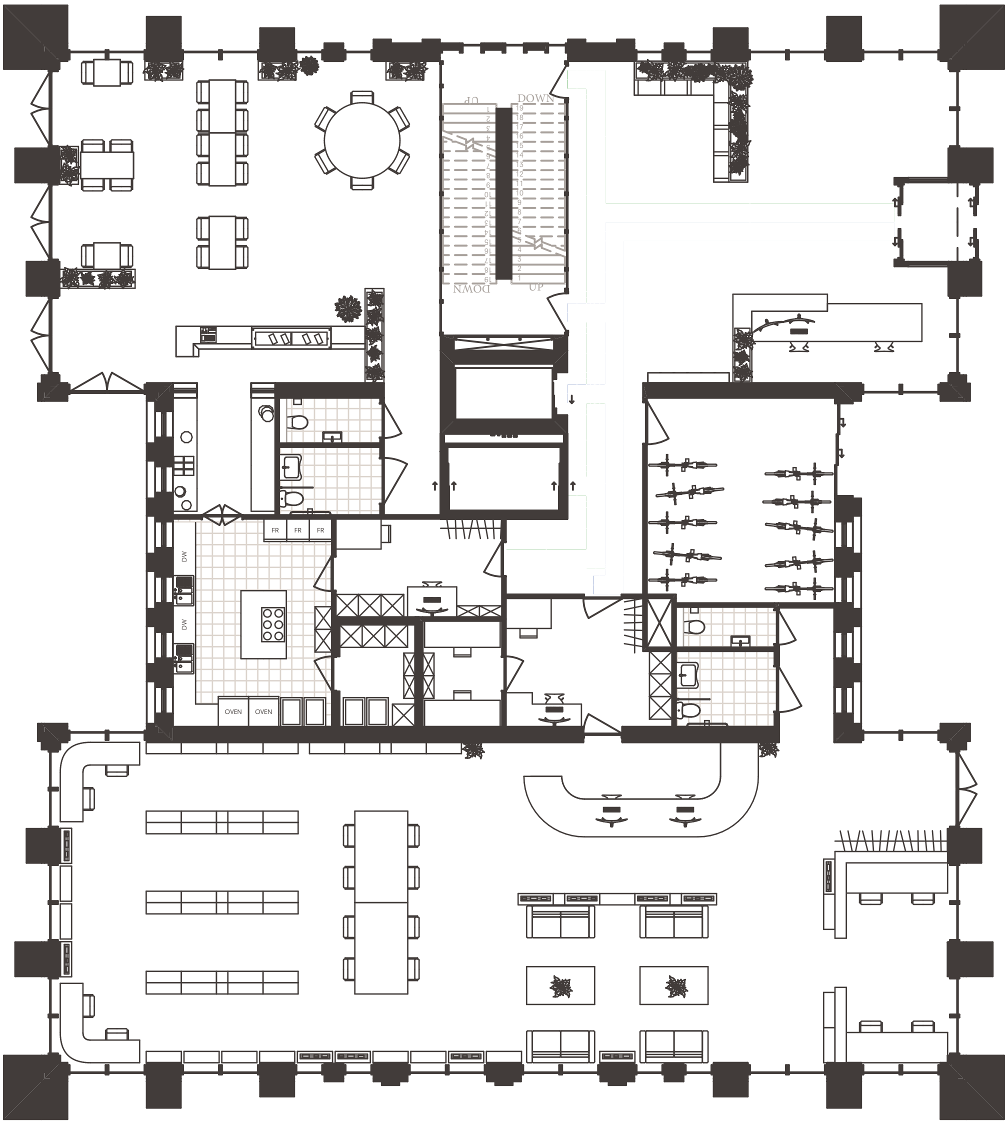


Figure 35. Final variant of ground floor (1:200)
source: author

Ground floor final variant

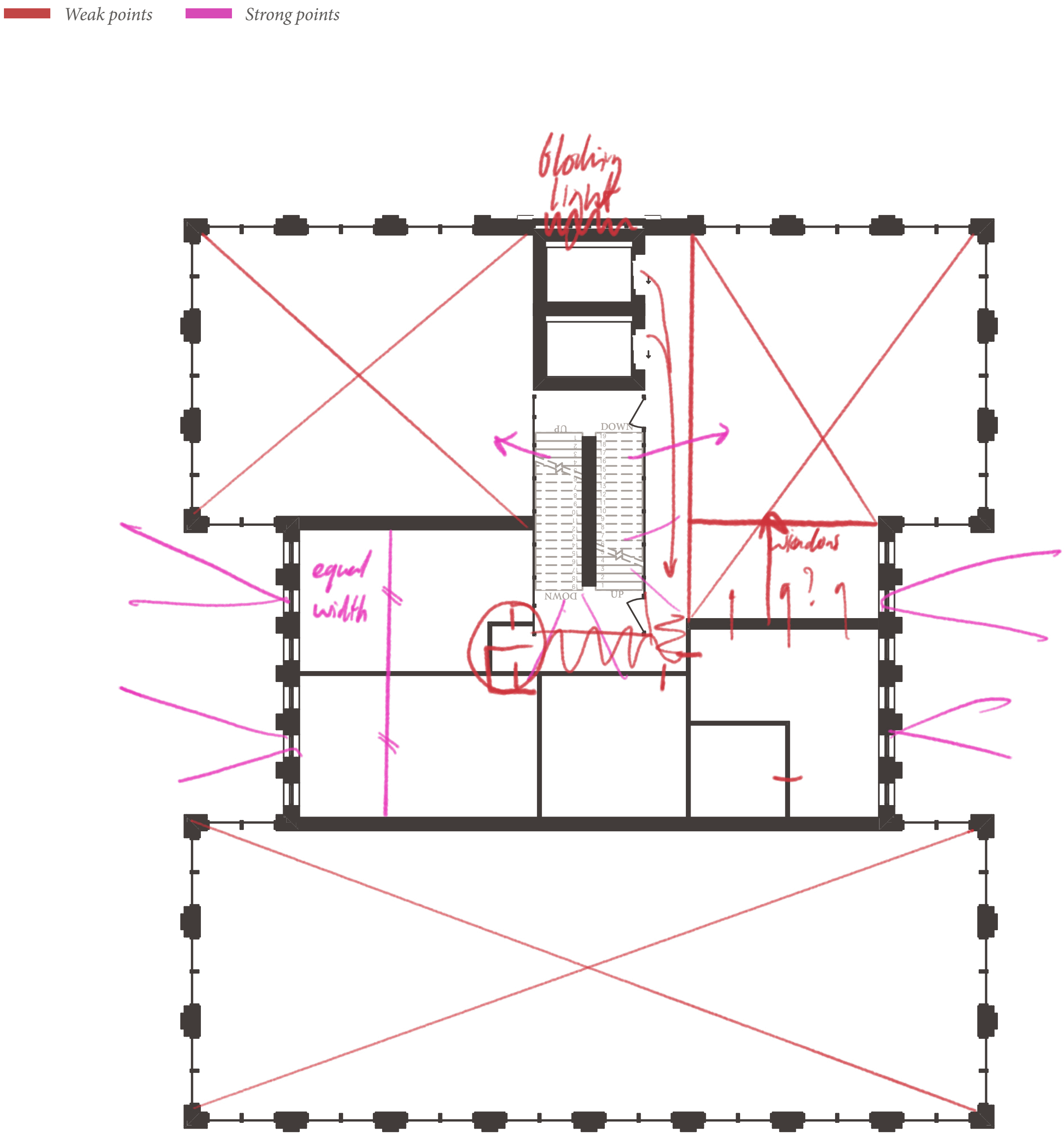


Figure 36. 1st variant of 1st floor (1:200)
source: author

1st floor 1st variant

The first support-floor variant has narrow corridors and misaligned walls. Daylight is also blocked by the lift core positioned near the façade.

Weak points Strong points

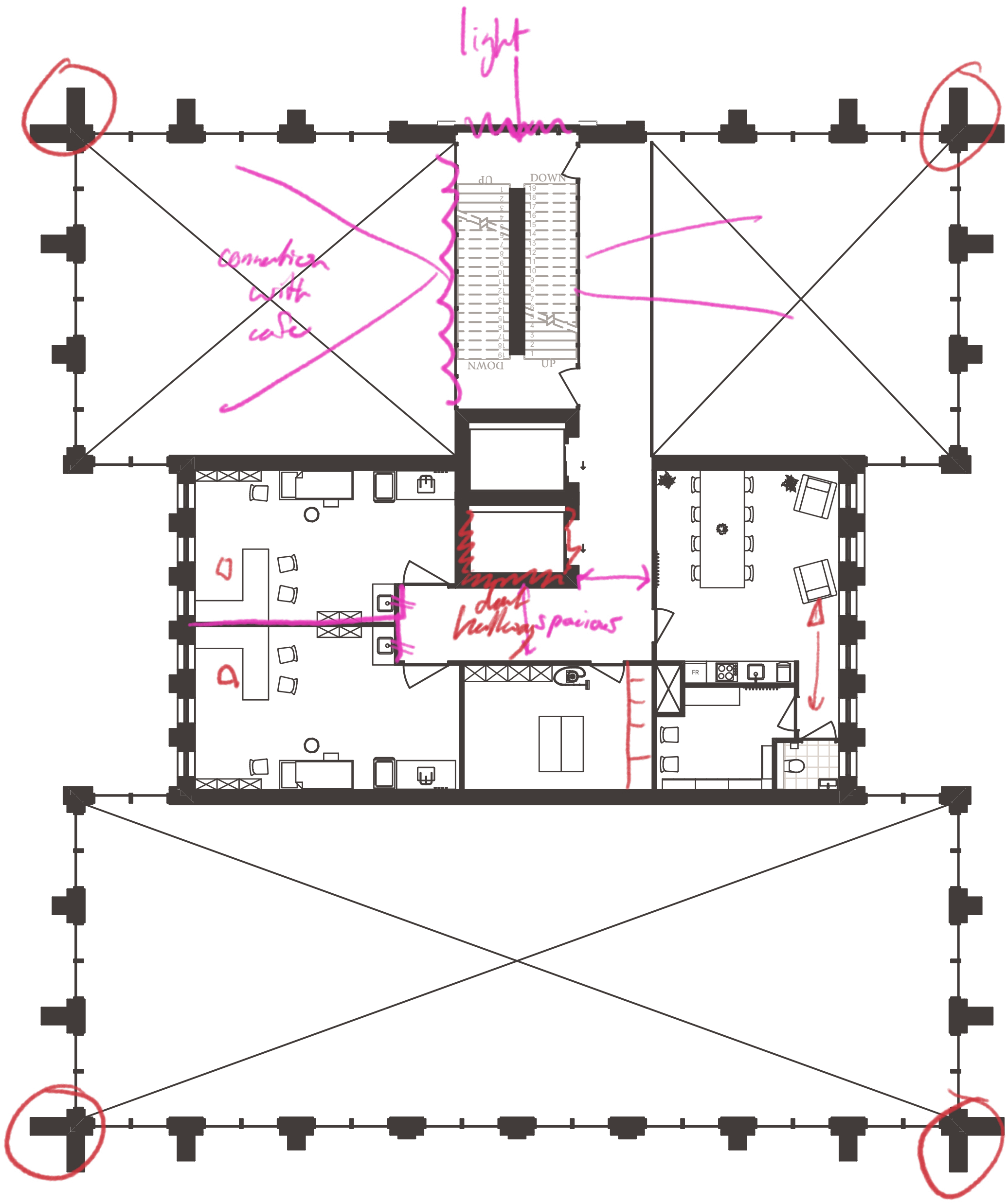


Figure 37. 2nd variant of 1st floor (1:200)
source: author

1st floor 2nd variant

The core area around the lifts remains too dark. The spatial flow between support functions and the architectural expression of the façade need further development.

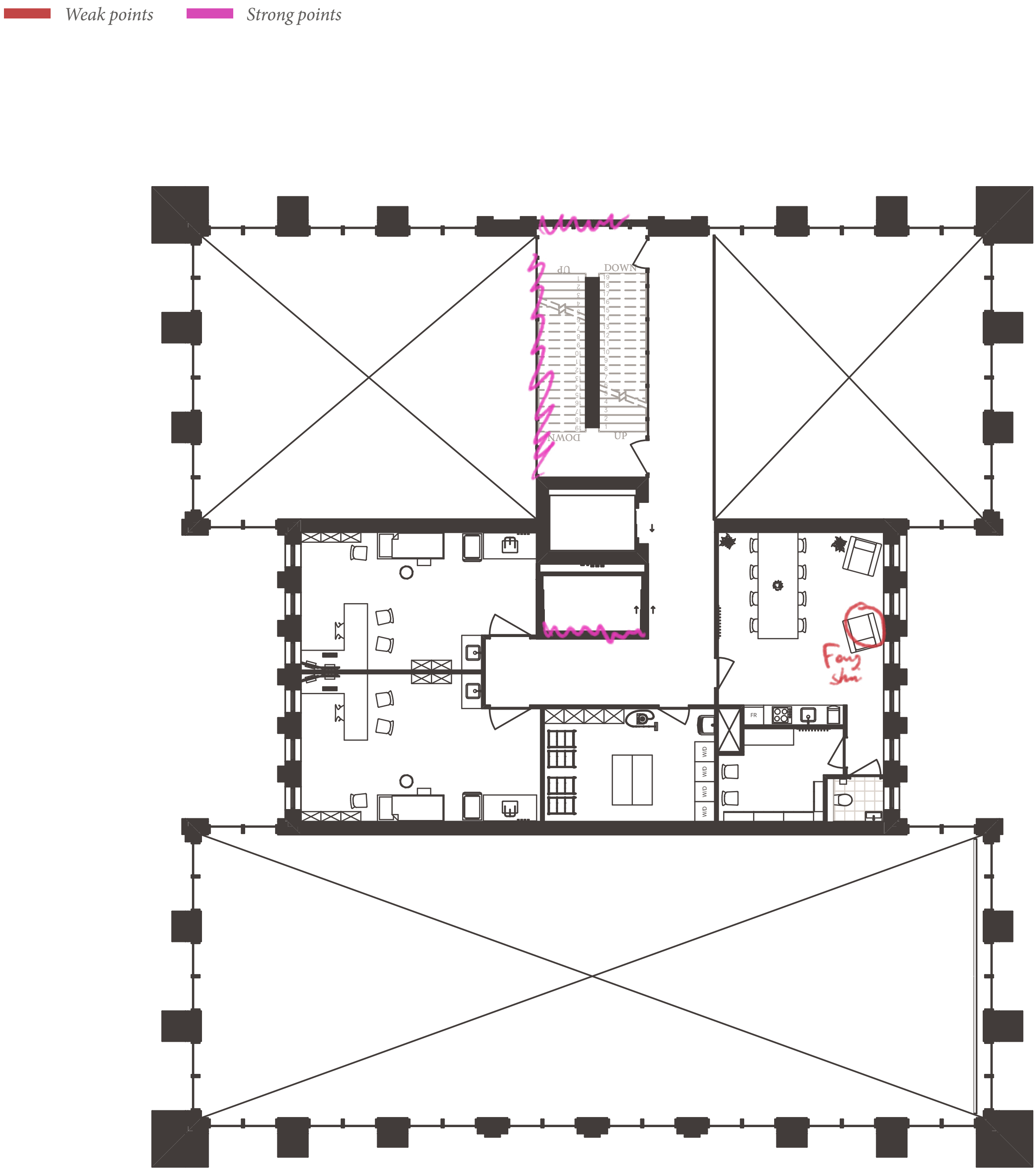


Figure 38. 3rd variant of 1st floor (1:200)
source: author

1st floor 3rd variant

This variant is close to the final layout. The stair now connects to the café, while daylight enters the centre of the building.

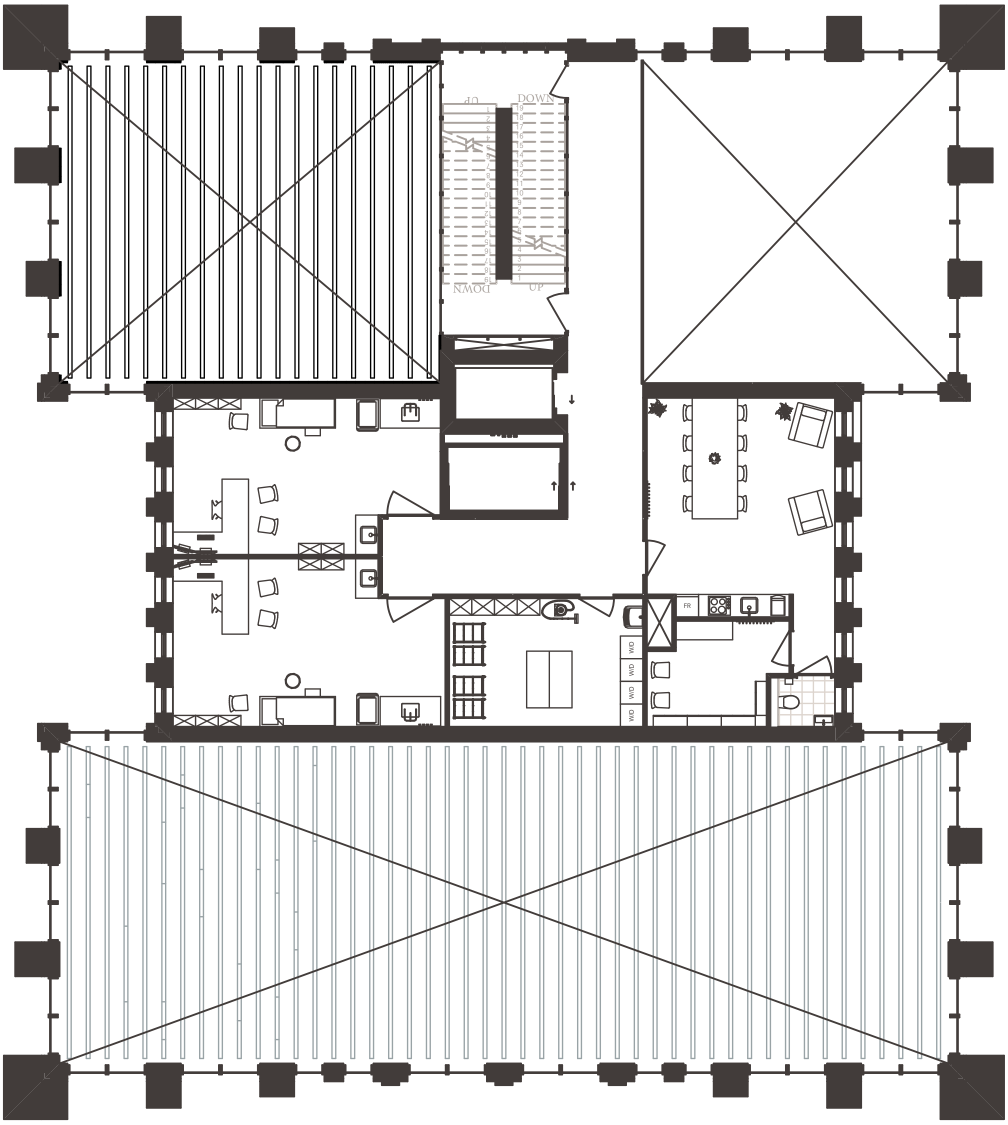


Figure 39. final variant of 1st floor (1:200)
source: author

1st floor final variant

Weak points Strong points

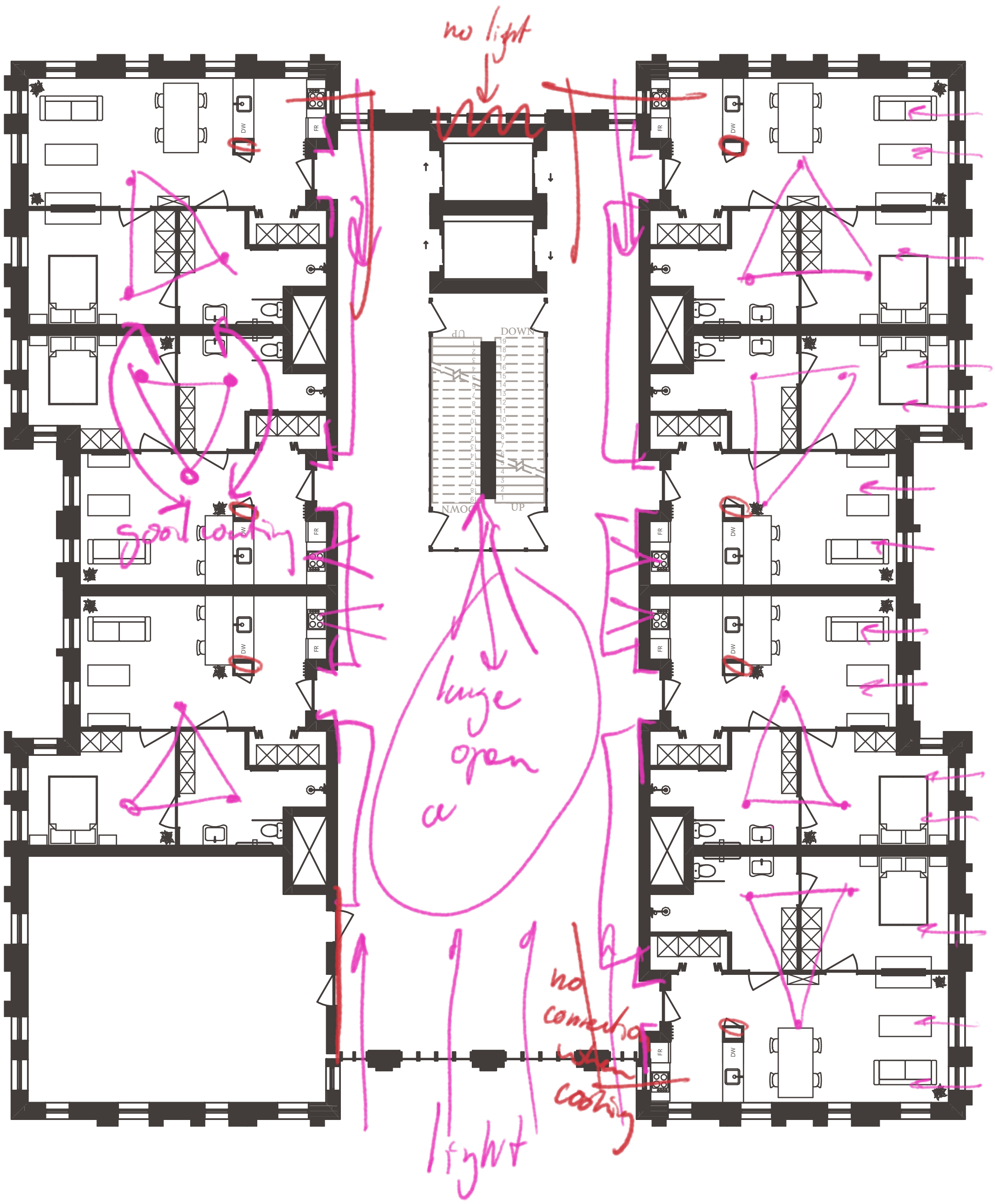


Figure 40. 1st variant of Social hub 1st floor (1:200)
source: author

Social hub 1st floor 1st variant

The apartment layout already works well, but daylight is blocked by the elevators and the technical spaces are too small.

Weak points   Strong points

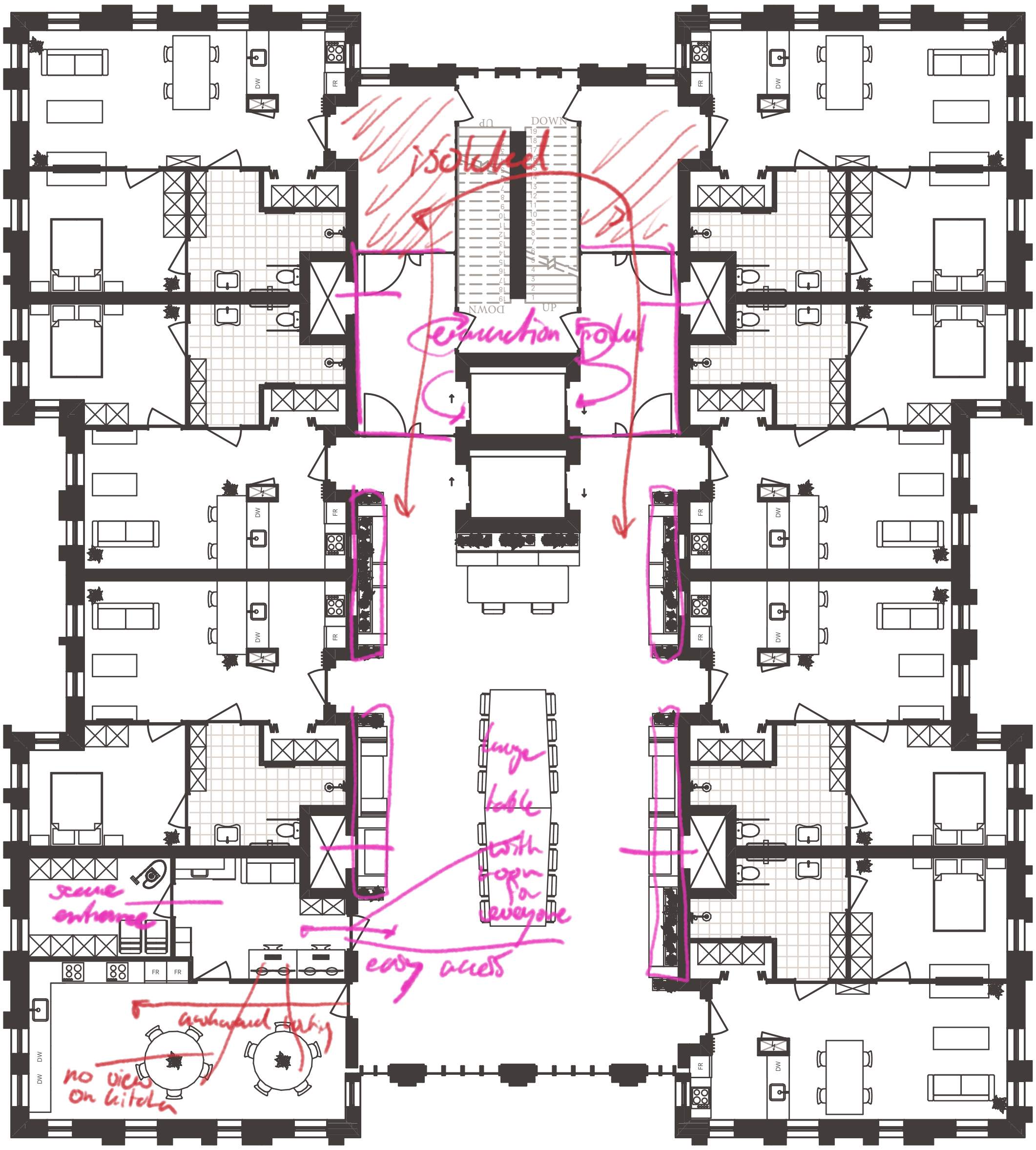


Figure 41. 2nd variant of Social hub 1st floor (1:200)
source: author

Social hub 1st floor 2nd variant

The communal kitchen and staff area are too disconnected, reducing overview. The fire chamber also separates the upper apartments from the collective group.

Weak points   Strong points

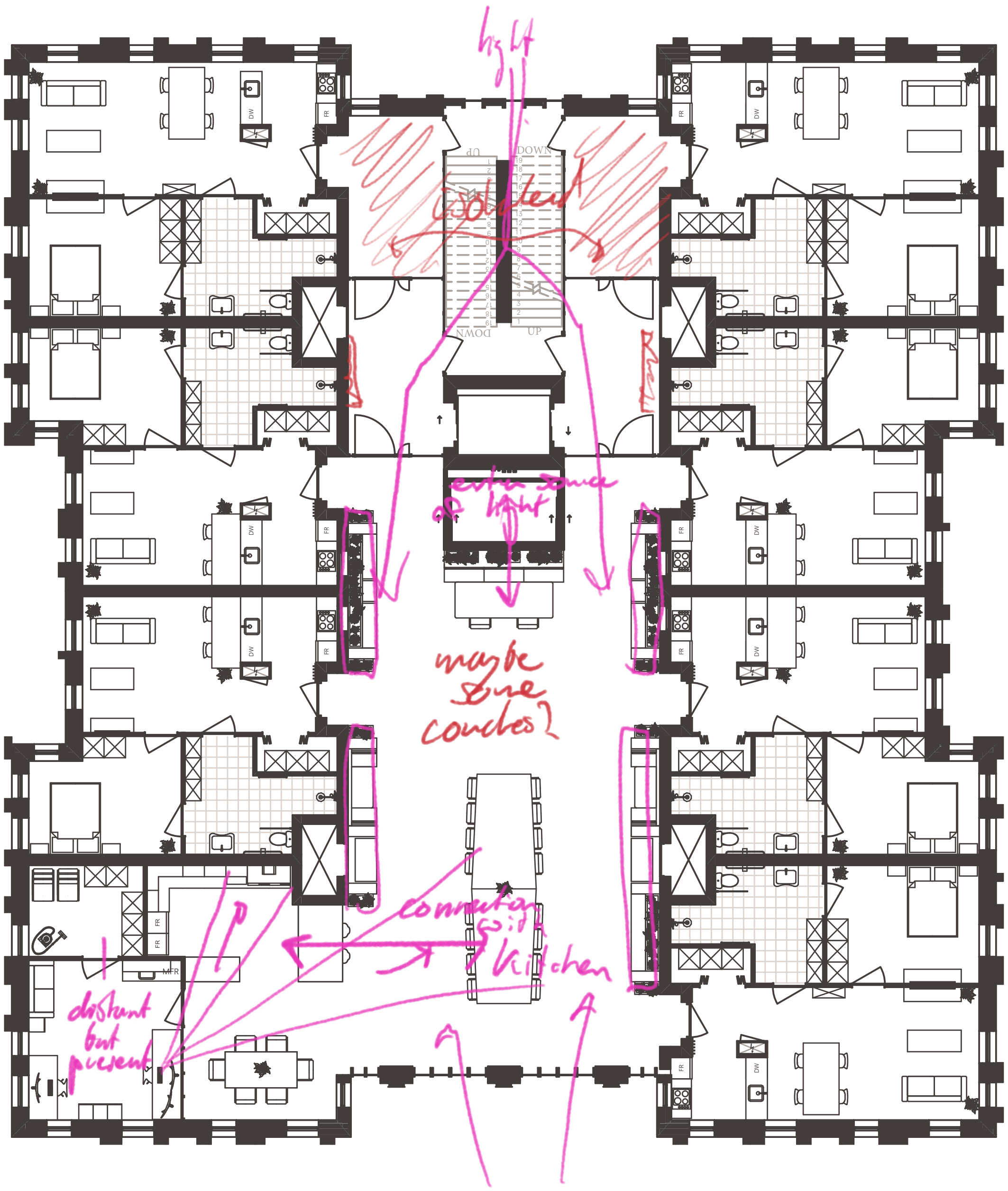


Figure 42. 3rd variant of Social hub 1st floor (1:200)
source: author

Social hub 1st floor 3rd variant

The communal space can be furnished more effectively, while the upper apartments are still too disconnected from the rest of the group.

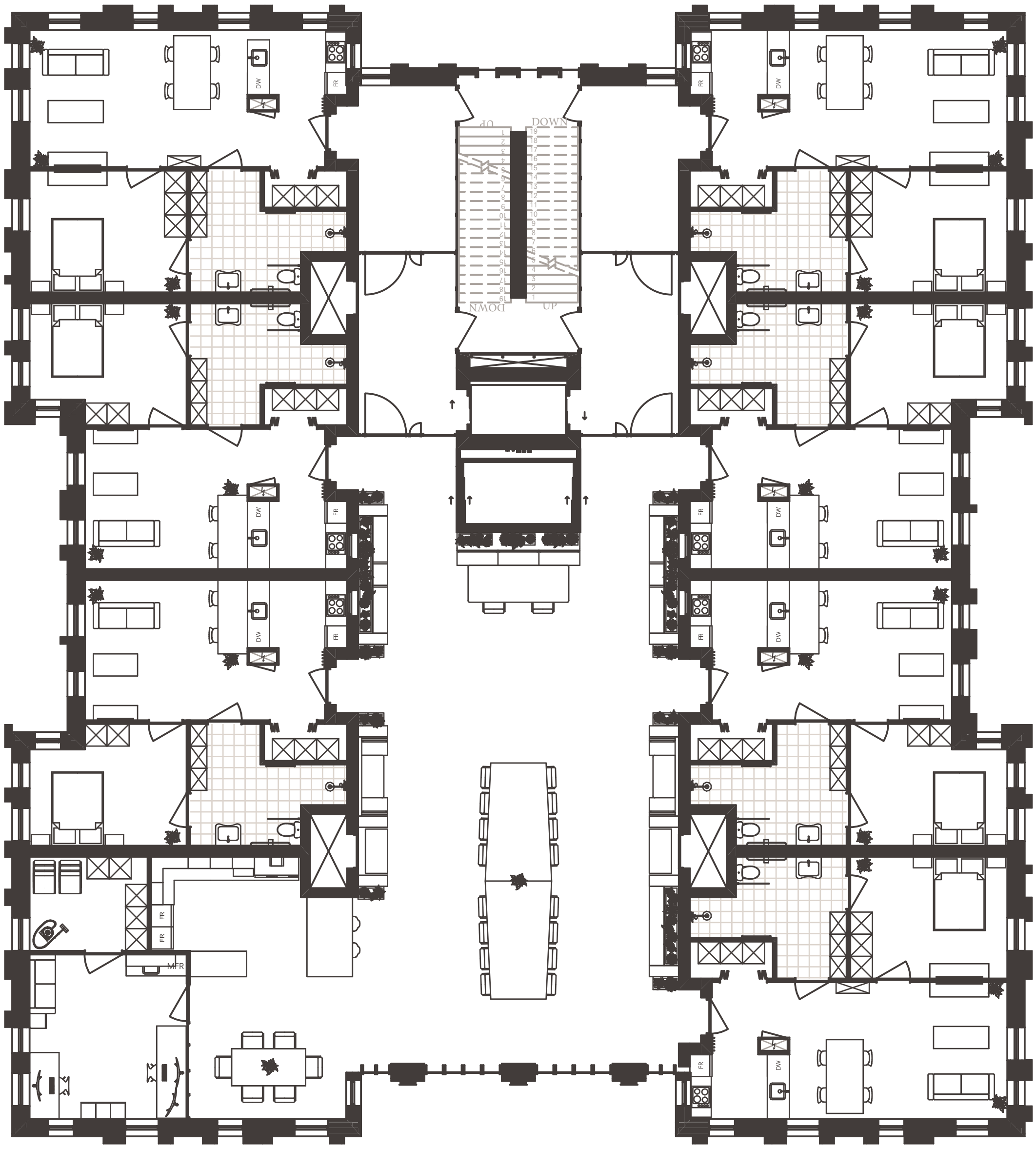


Figure 43. final variant of Social hub 1st floor (1:200)
source: author

Social hub 1st floor final variant

Weak points *Strong points*

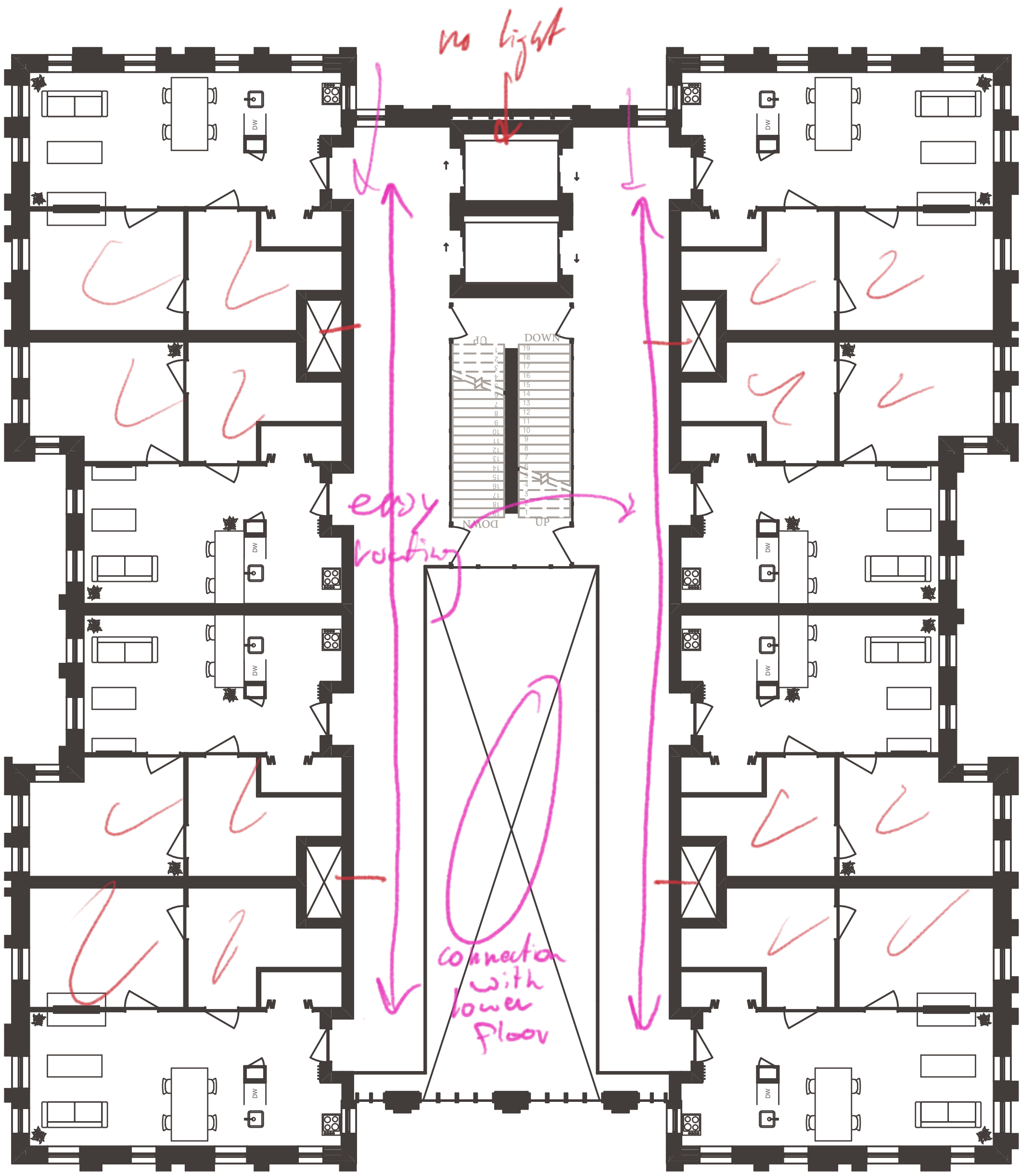


Figure 44. 1st variant of Social hub 2nd floor (1:200)
source: author

Social hub 2nd floor 1st variant

This variant explores the void connection, but the gallery remains too small and offers little space for furniture or informal encounters.

Weak points   Strong points

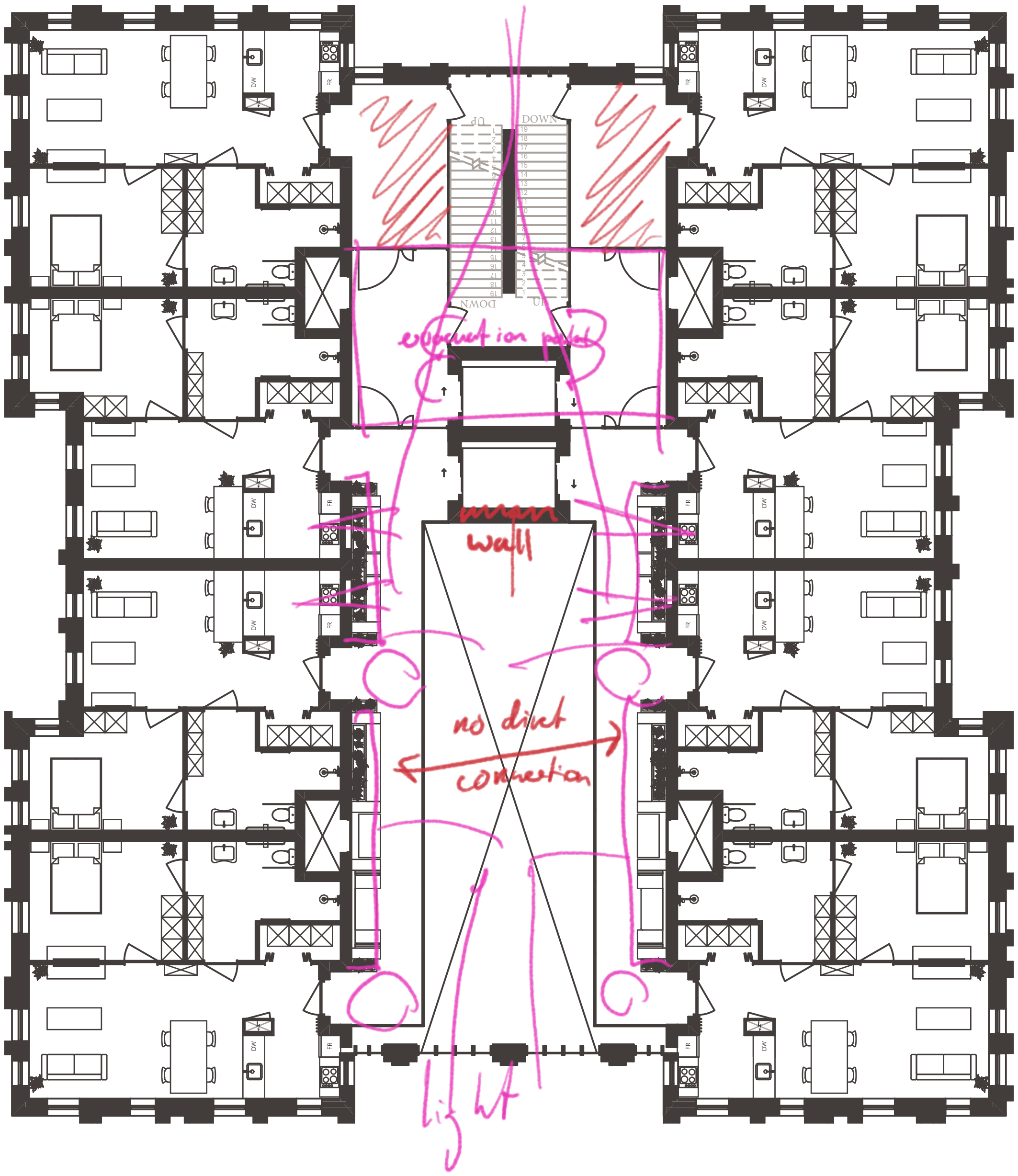


Figure 45. 2nd variant of Social hub 2nd floor (1:200)
source: author

Social hub 2nd floor 2nd variant

Movement between both sides of the floor is not possible, which weakens social interaction and limits the collective character of the layout.

Weak points   Strong points

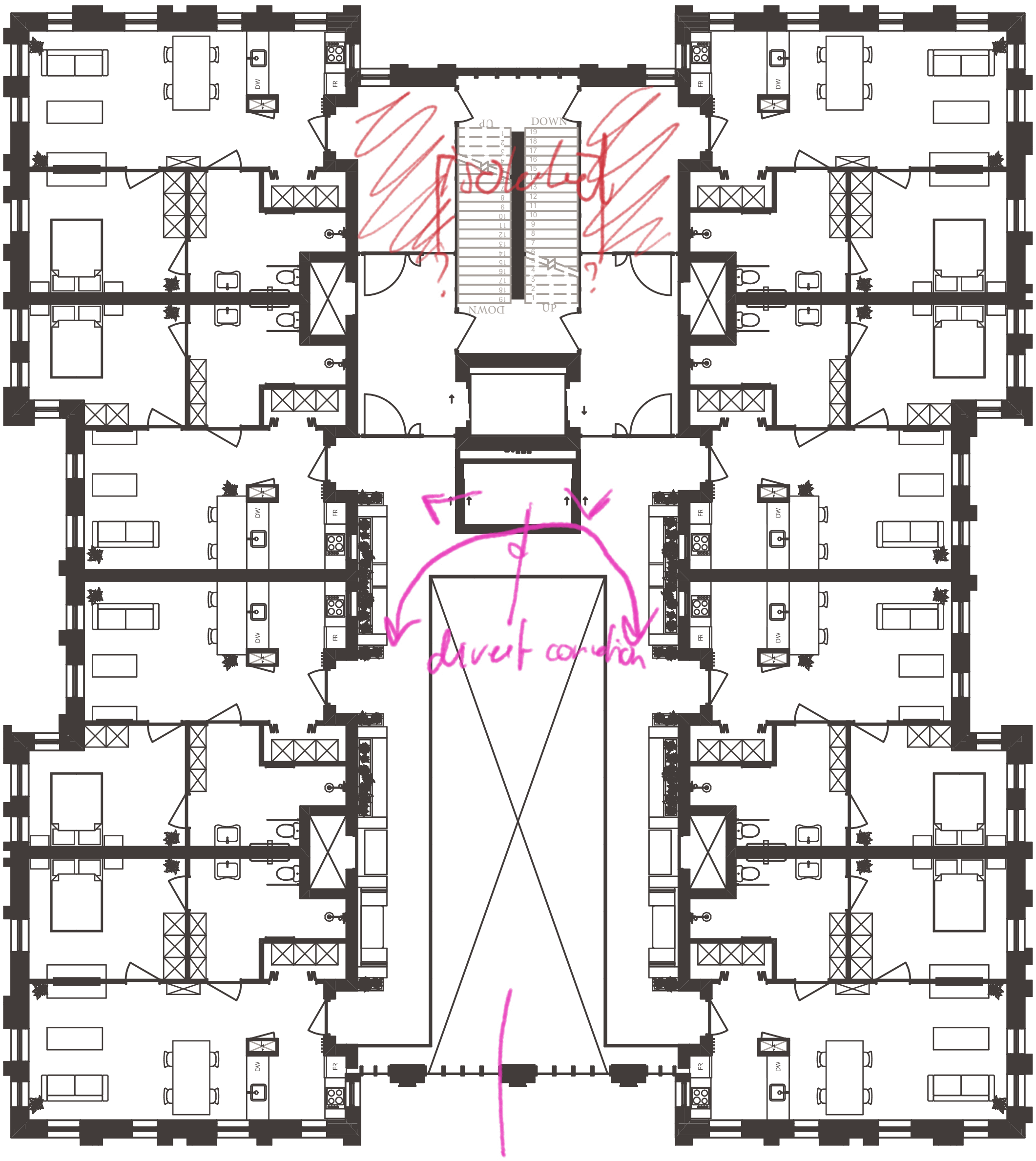


Figure 46. 3rd variant of Social hub 2nd floor (1:200)
source: author

Social hub 2nd floor 3rd variant

The upper apartments remain disconnected by the fire chamber, reducing the sense of belonging within the Social Hub group.

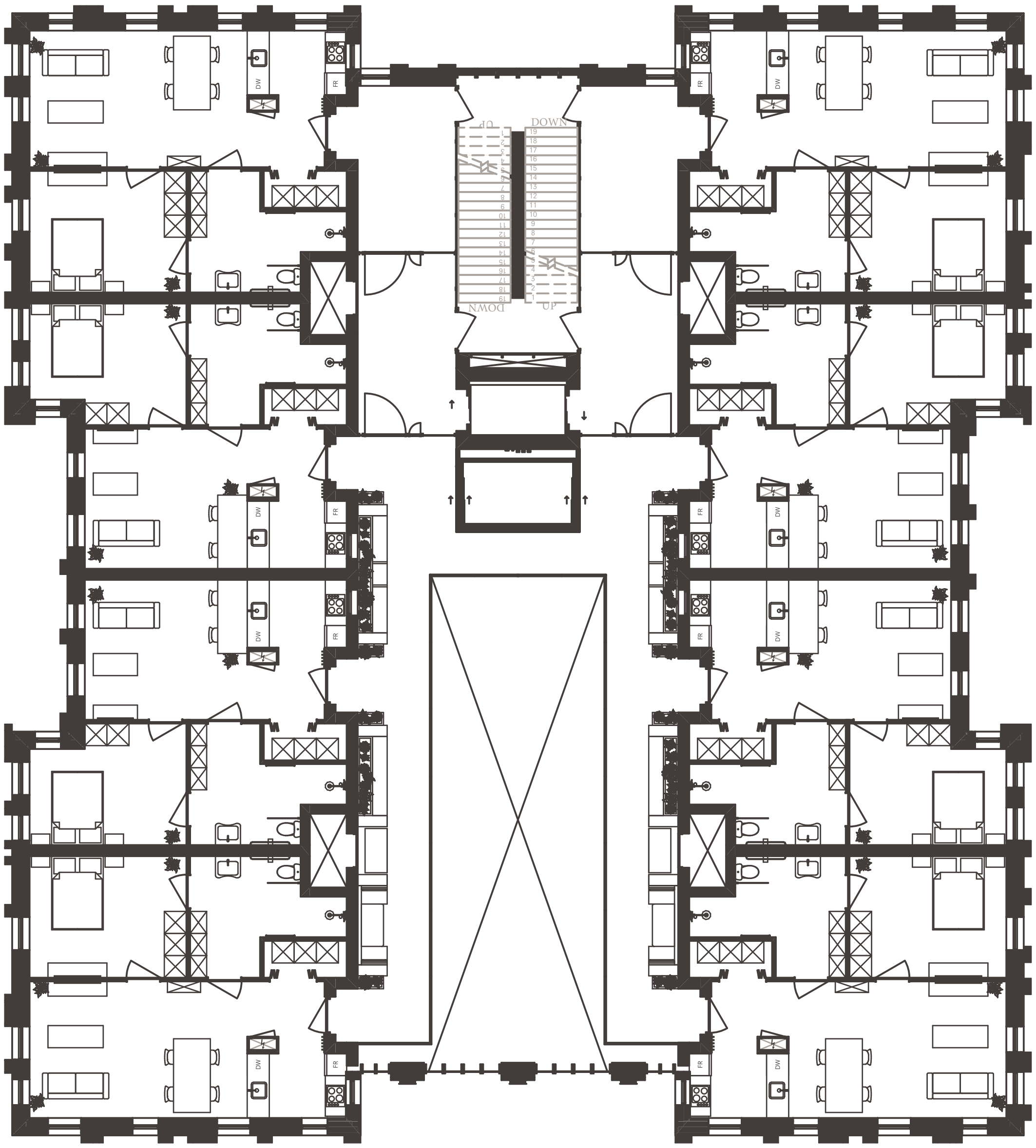


Figure 47. final variant of Social hub 2nd floor (1:200)
source: author

Social hub 2nd floor final variant

Weak points   Strong points

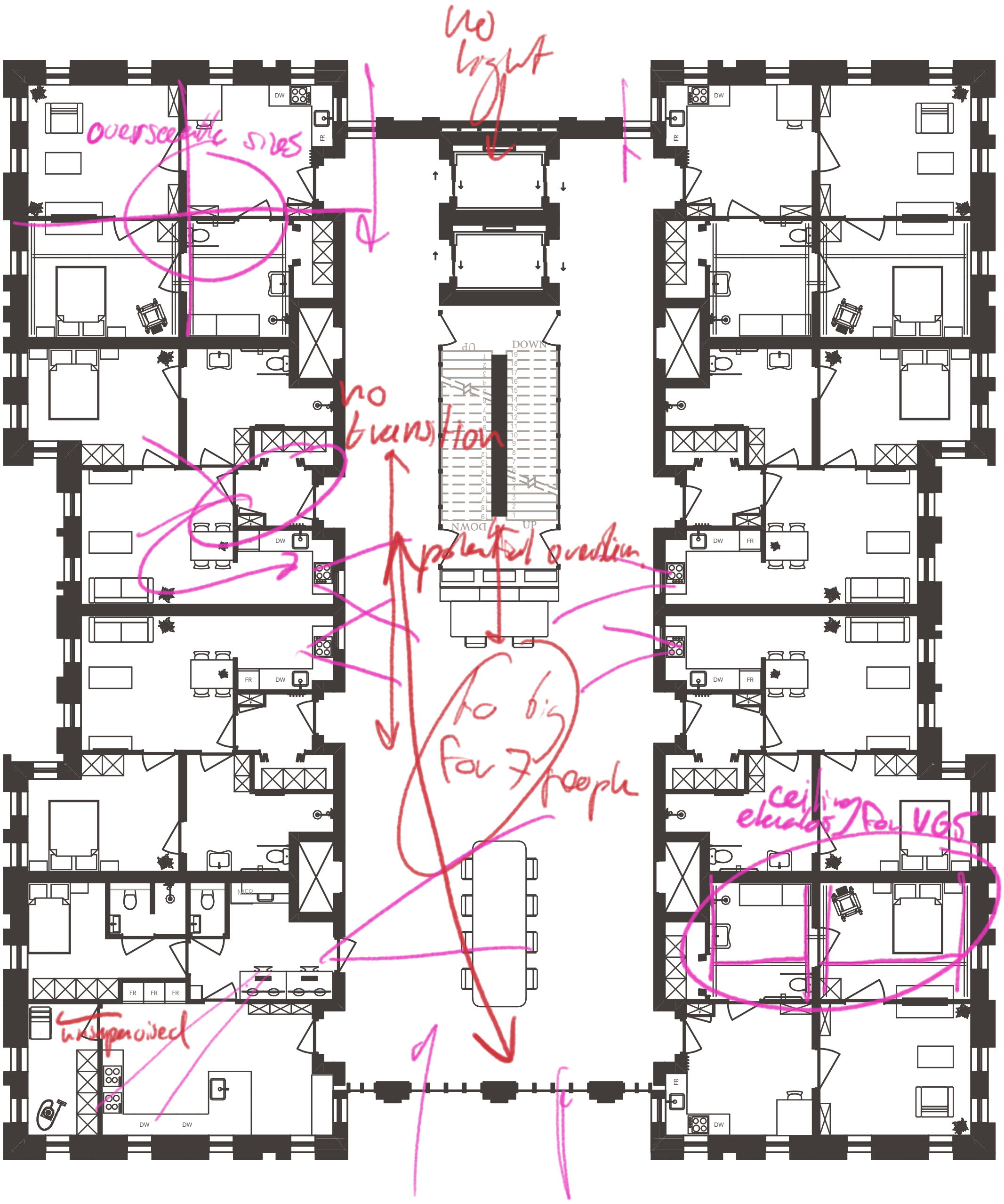


Figure 48. 1st variant of Sanctuary (1:200)
source: author

Sanctuary 1st variant

The communal area is too large for 7 residents, while the kitchen and staff space need a more efficient and protected organisation.

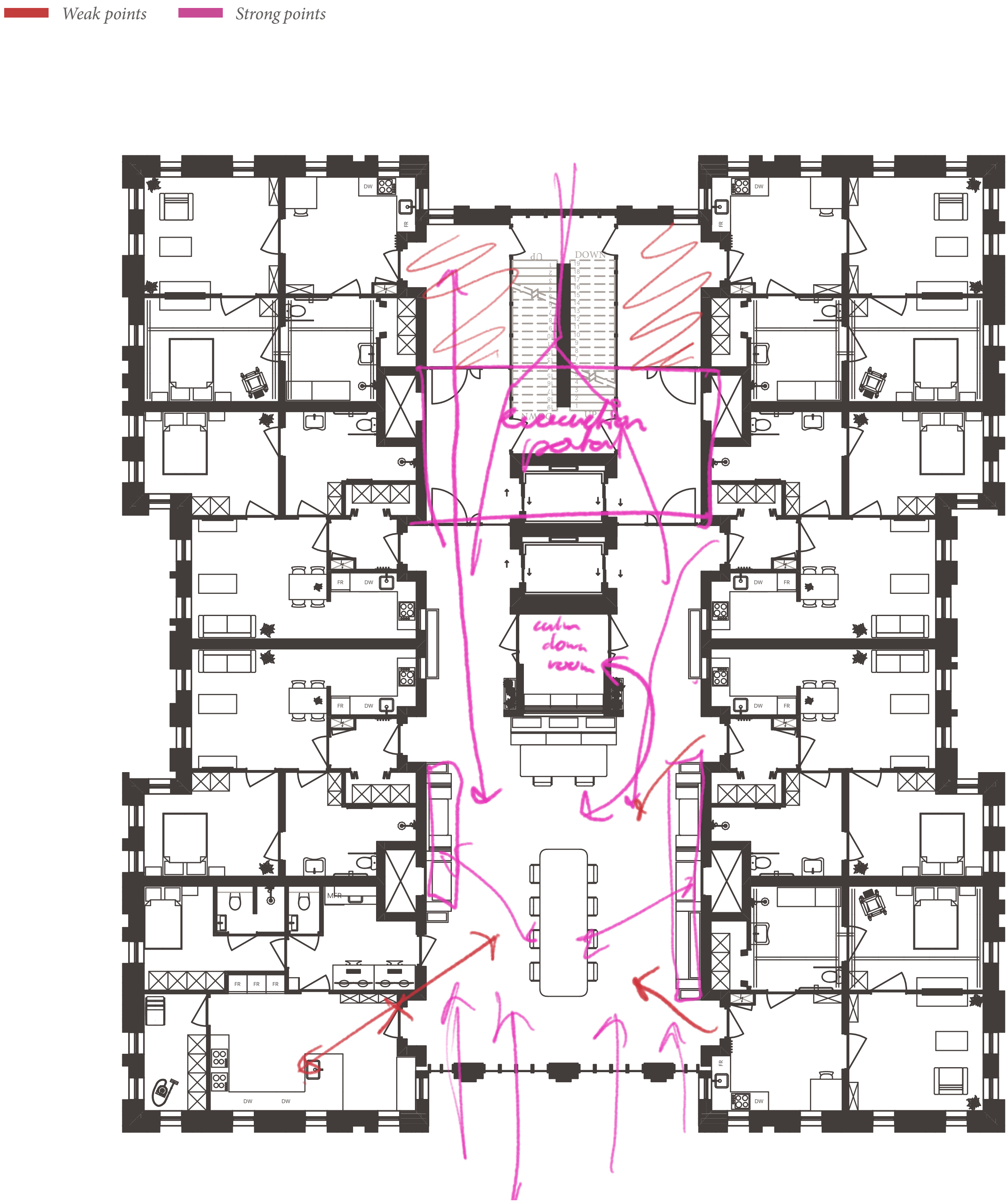


Figure 49. 2nd variant of Sanctuary (1:200)
source: author

Sanctuary 2nd variant

The kitchen and communal space are not well connected. The upper apartments are also separated from the rest of the group.

Weak points   Strong points

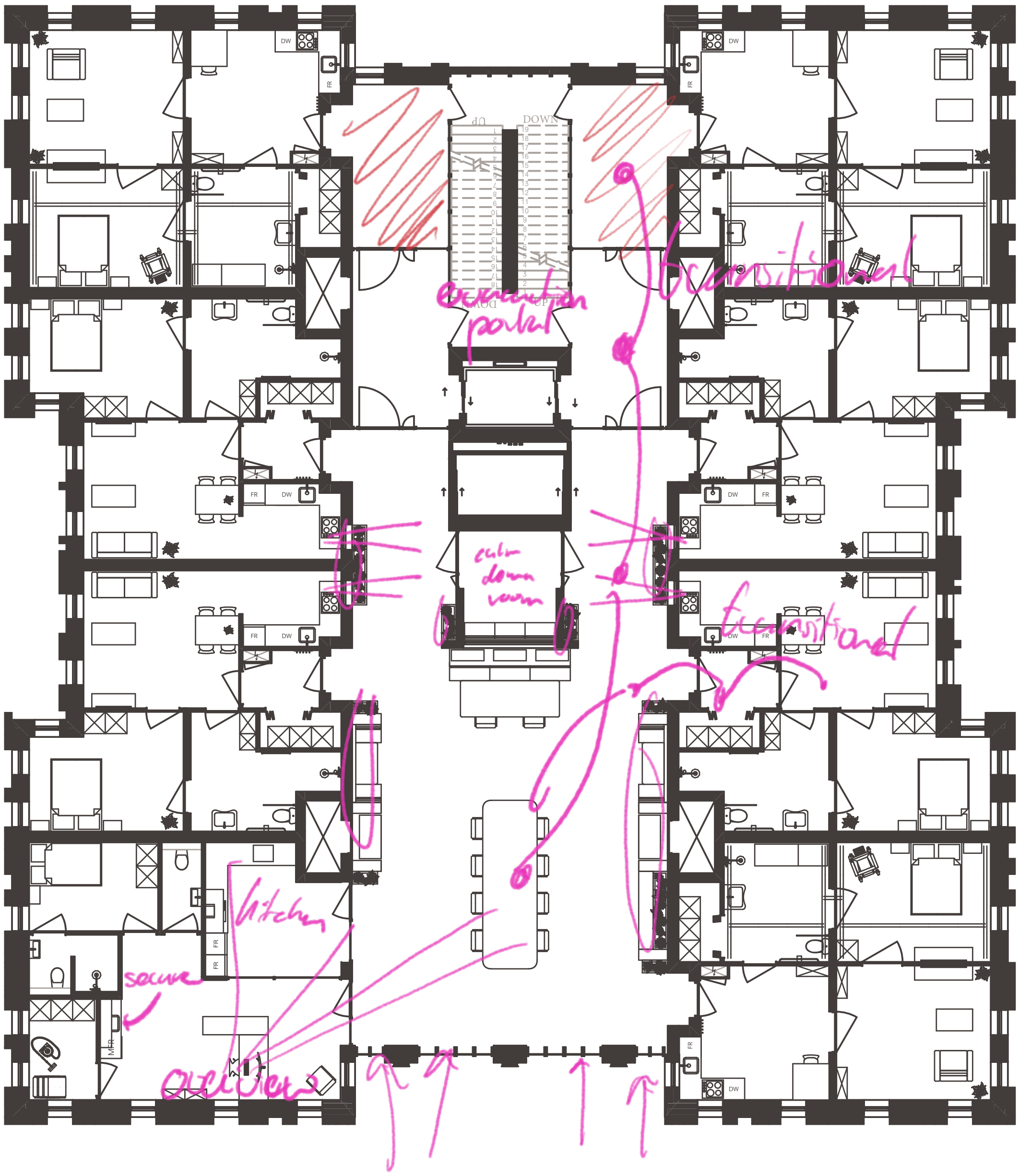


Figure 50. 3rd variant of Sanctuary (1:200)
source: author

Sanctuary 3rd variant

The staff room now overlooks both the kitchen and communal space, supporting safety and guidance without disturbing the domestic atmosphere.

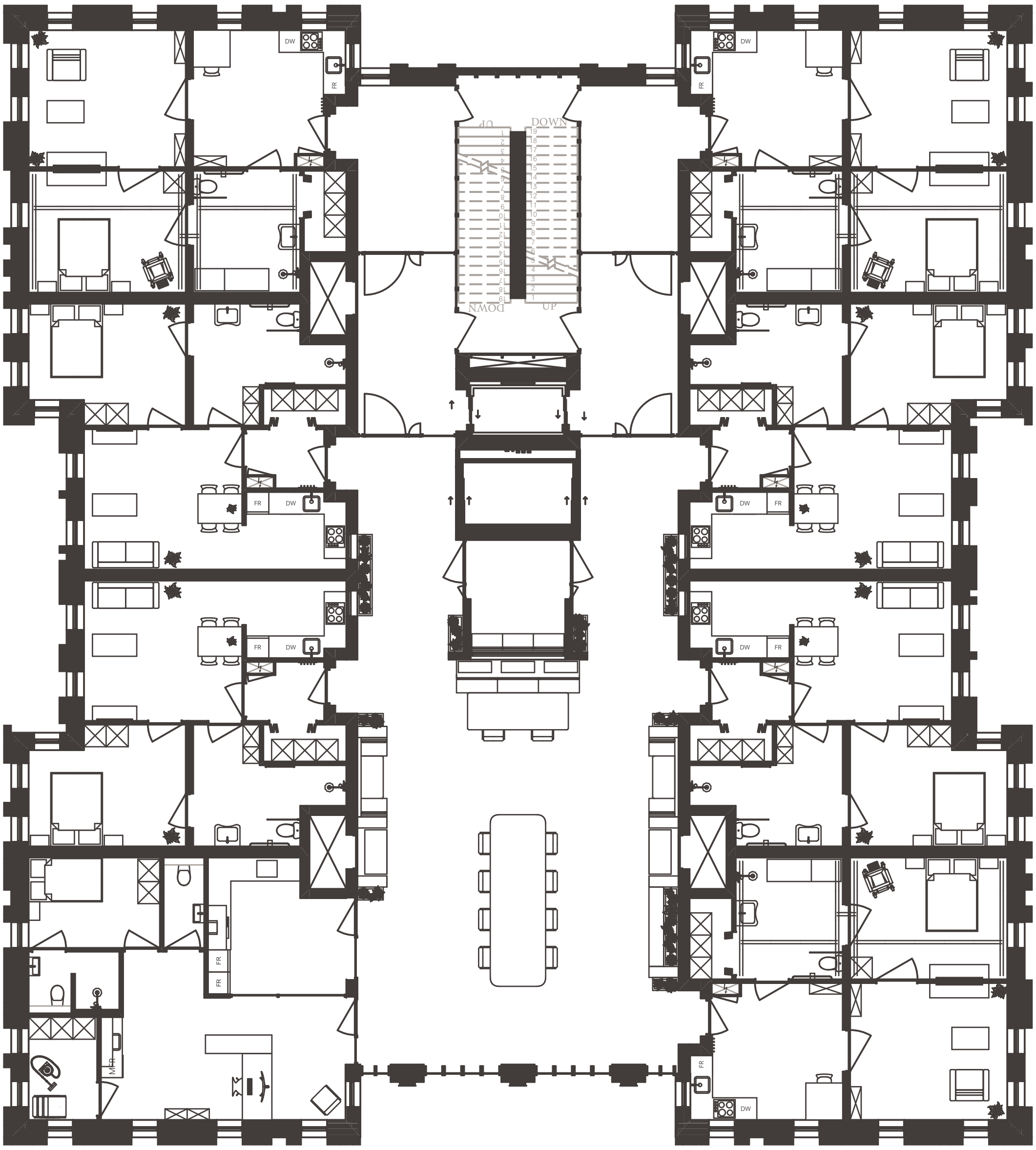
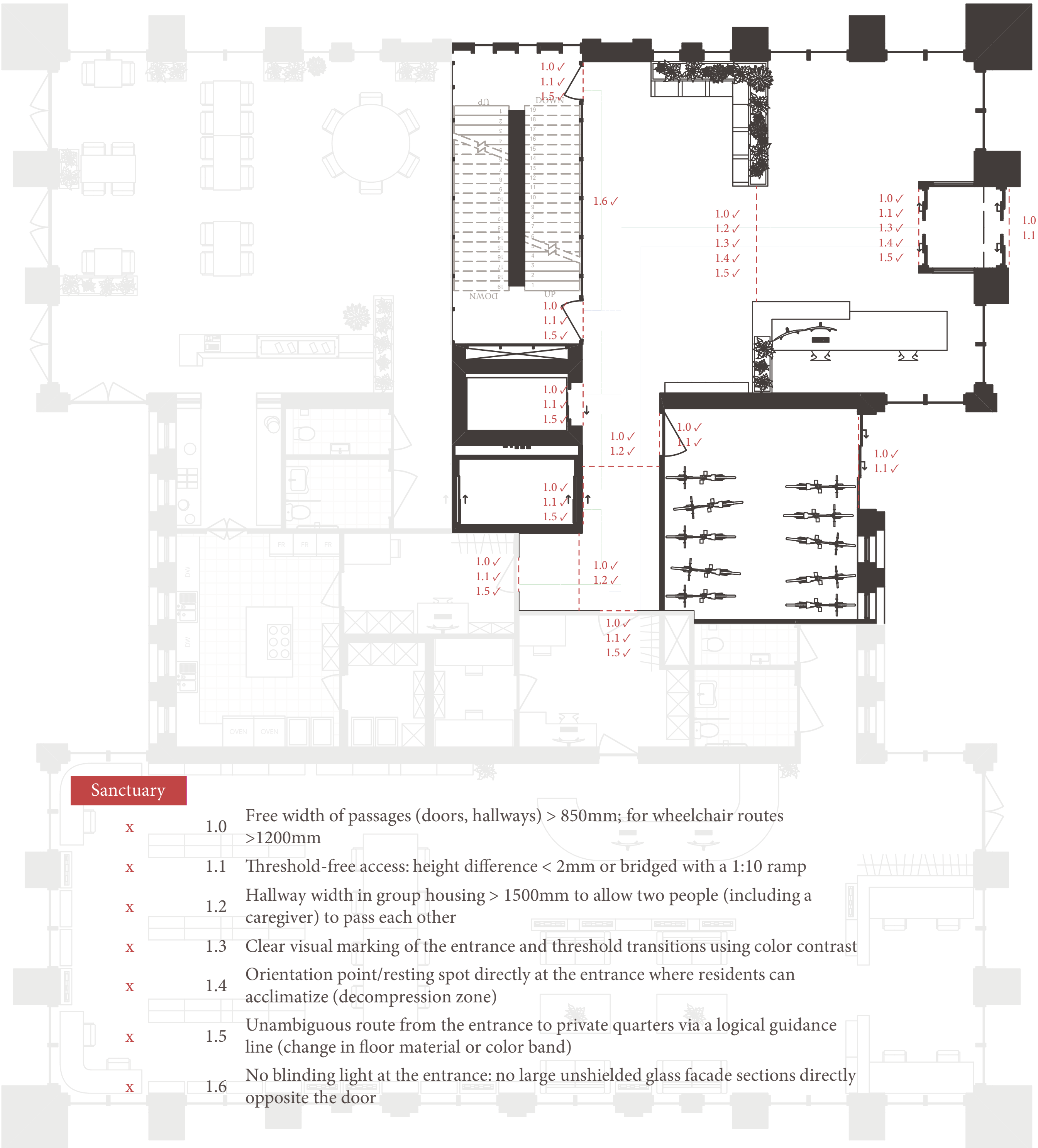


Figure 51. final variant of Sanctuary (1:200)
source: author

Sanctuary final variant

Checklist



Sanctuary

x	1.0	Free width of passages (doors, hallways) > 850mm; for wheelchair routes >1200mm
x	1.1	Threshold-free access: height difference < 2mm or bridged with a 1:10 ramp
x	1.2	Hallway width in group housing > 1500mm to allow two people (including a caregiver) to pass each other
x	1.3	Clear visual marking of the entrance and threshold transitions using color contrast
x	1.4	Orientation point/resting spot directly at the entrance where residents can acclimatize (decompression zone)
x	1.5	Unambiguous route from the entrance to private quarters via a logical guidance line (change in floor material or color band)
x	1.6	No blinding light at the entrance: no large unshielded glass facade sections directly opposite the door

Figure 52. Layout of the ground floor (1:150)
source: author

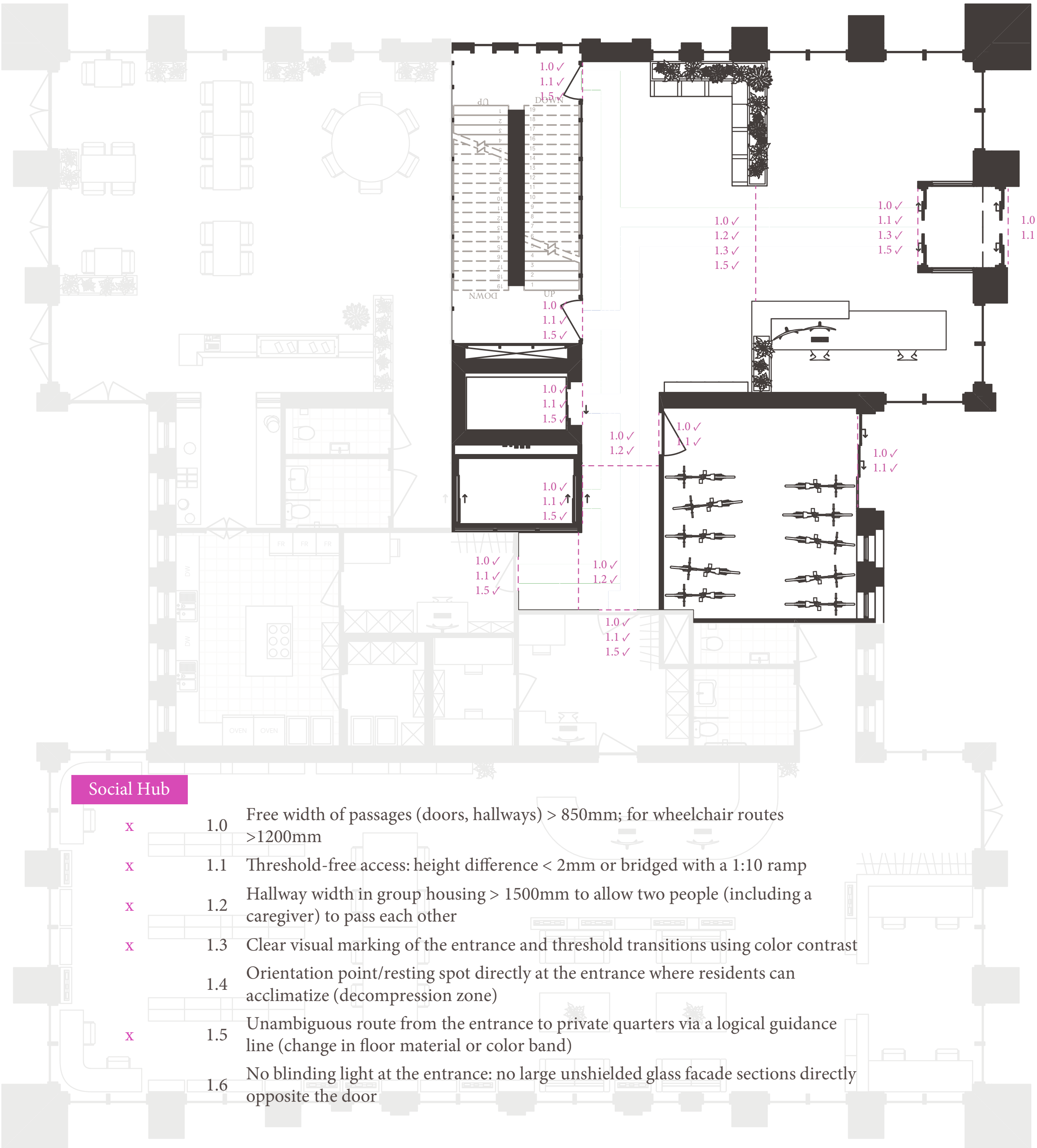
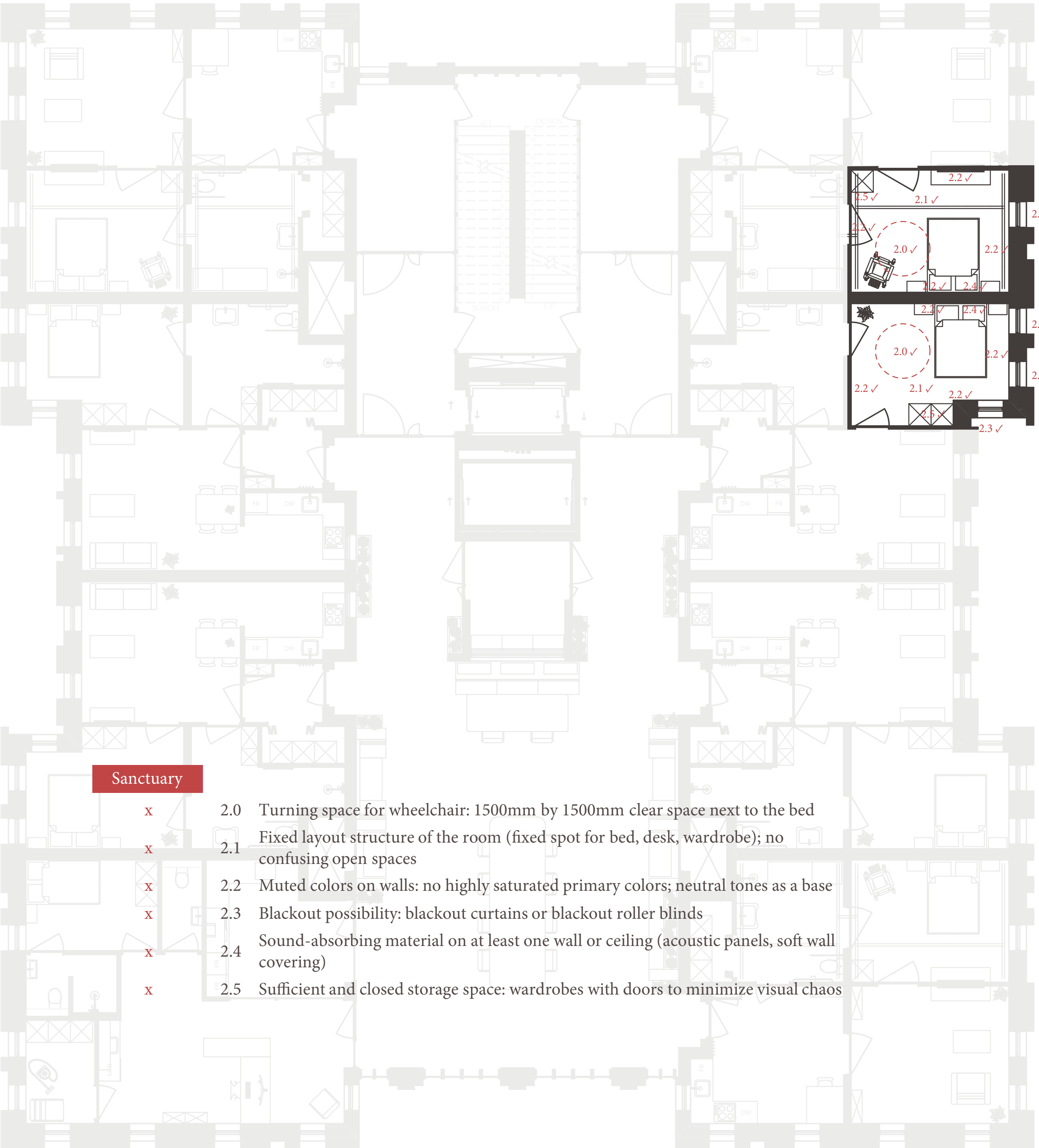


Figure 53. Layout of the 1st floor (1:150)
source: author

Entrance and circulation checklist

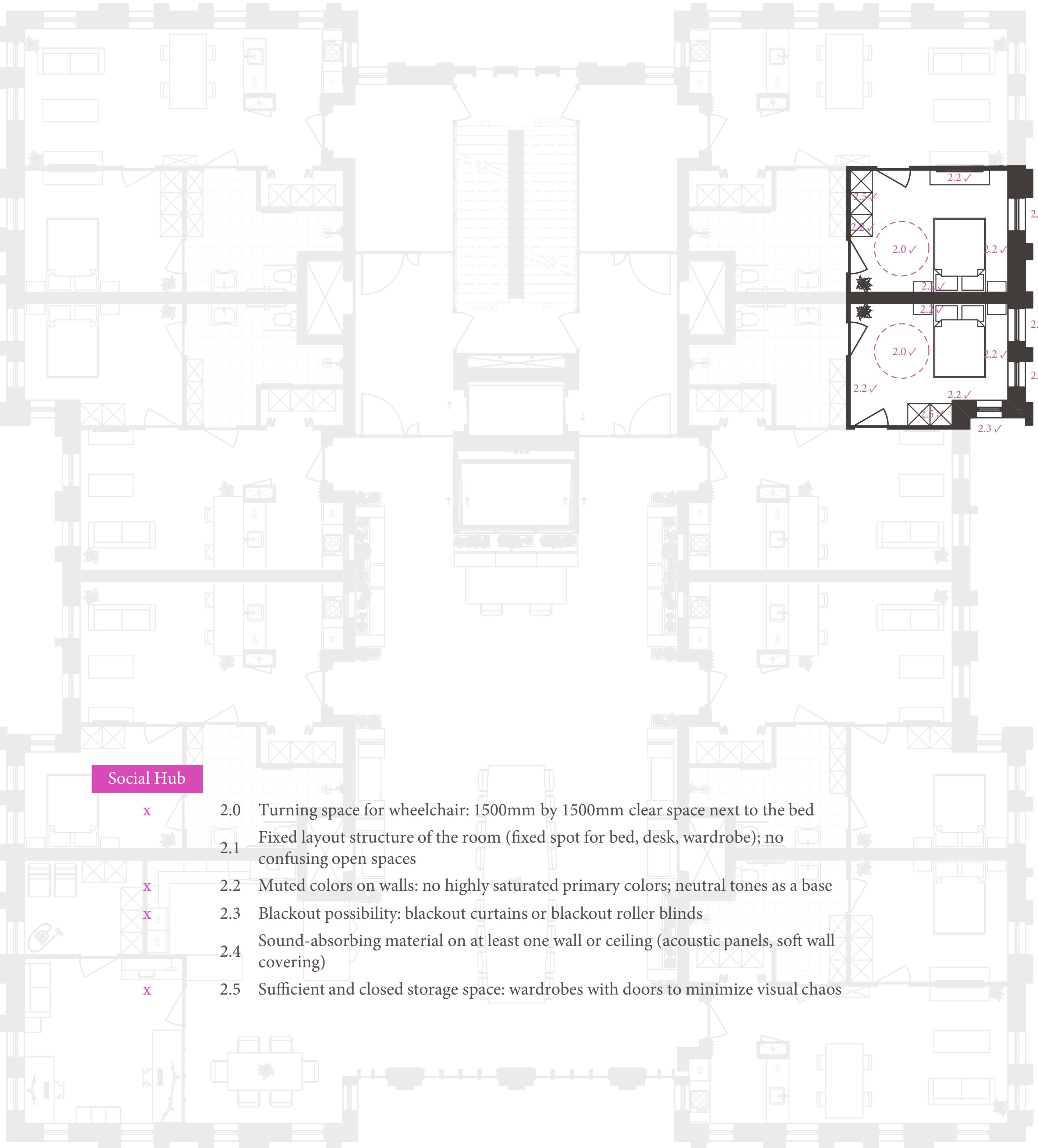
The entrance meets the checklist requirements by providing threshold-free access, clear routing, sufficient passage width, visual guidance and a calm decompression zone for both resident groups.



Sanctuary

x	2.0	Turning space for wheelchair: 1500mm by 1500mm clear space next to the bed
x	2.1	Fixed layout structure of the room (fixed spot for bed, desk, wardrobe); no confusing open spaces
x	2.2	Muted colors on walls: no highly saturated primary colors; neutral tones as a base
x	2.3	Blackout possibility: blackout curtains or blackout roller blinds
x	2.4	Sound-absorbing material on at least one wall or ceiling (acoustic panels, soft wall covering)
x	2.5	Sufficient and closed storage space: wardrobes with doors to minimize visual chaos

Figure 54. Checklist for Sanctuary bedroom (1:150)
source: author



Social Hub		
x	2.0	Turning space for wheelchair: 1500mm by 1500mm clear space next to the bed
	2.1	Fixed layout structure of the room (fixed spot for bed, desk, wardrobe); no confusing open spaces
x	2.2	Muted colors on walls: no highly saturated primary colors; neutral tones as a base
x	2.3	Blackout possibility: blackout curtains or blackout roller blinds
	2.4	Sound-absorbing material on at least one wall or ceiling (acoustic panels, soft wall covering)
x	2.5	Sufficient and closed storage space: wardrobes with doors to minimize visual chaos

Figure 55. Checklist for Social Hub bedroom (1:150)
source: author

Bedroom checklist

The bedrooms meet the checklist requirements by combining wheelchair turning space, fixed room layouts, muted colours, blackout options, acoustic treatment and closed storage.

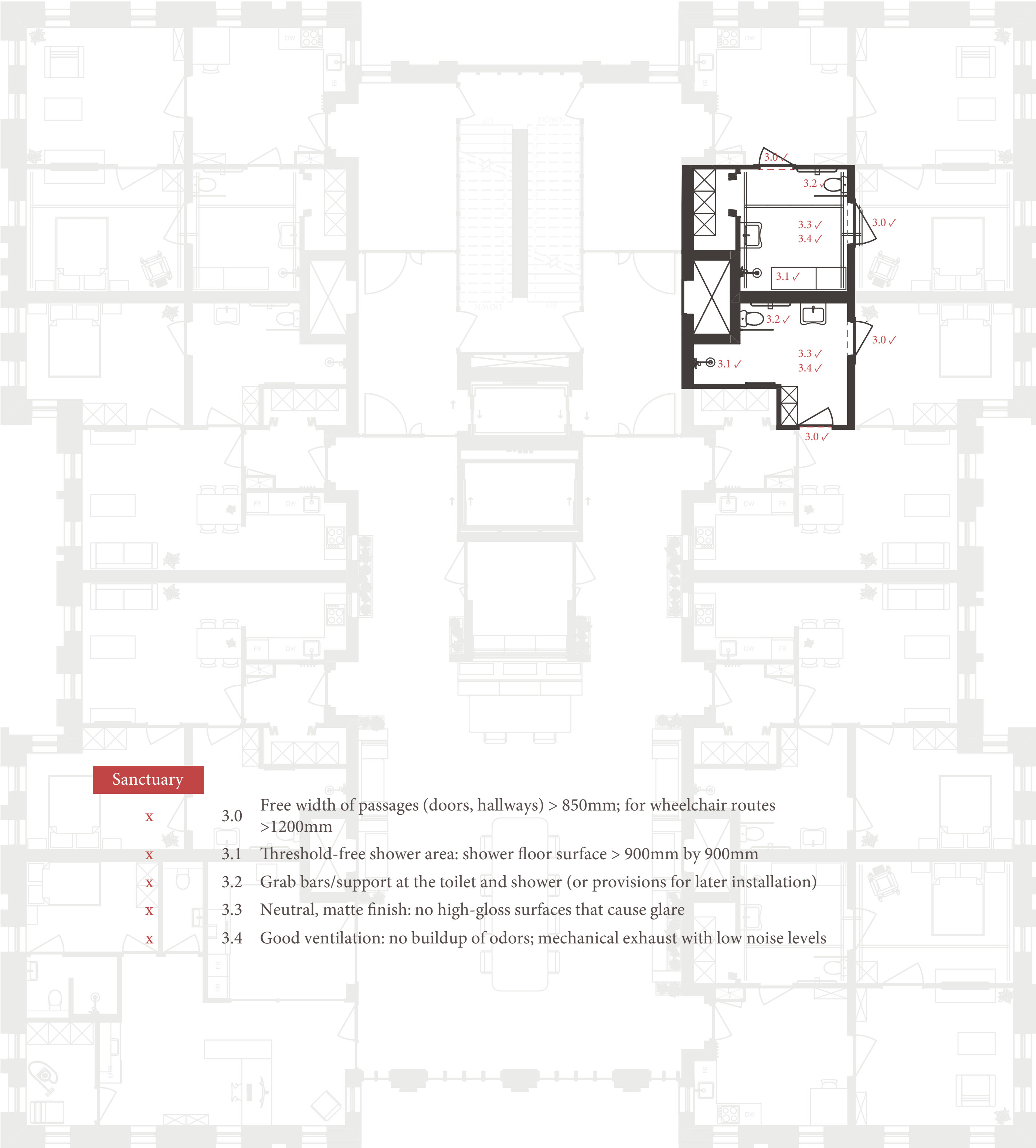


Figure 56. Checklist for Sanctuary sanitary (1:150)
source: author

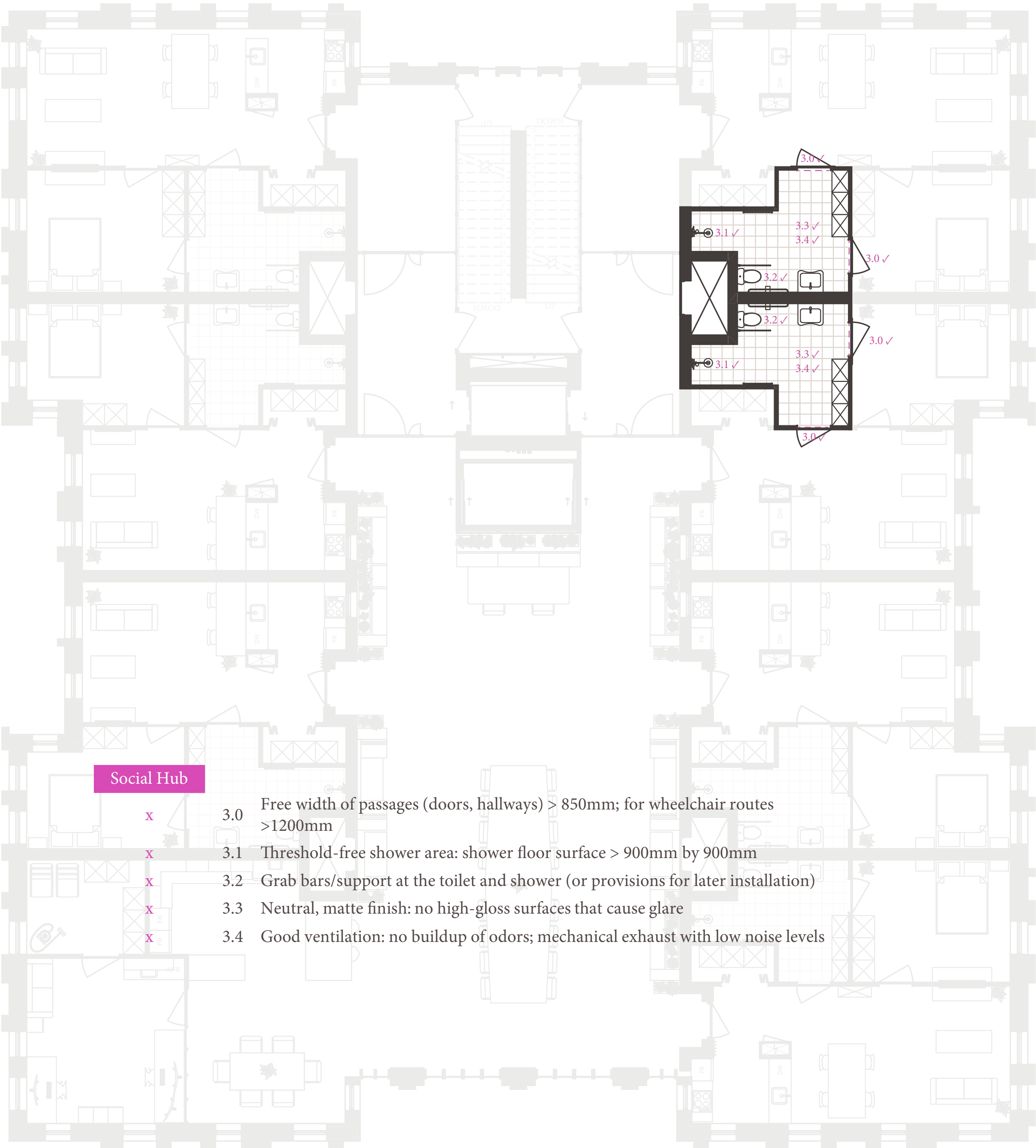


Figure 57. Checklist for Social Hub sanitary (1:150)
source: author

Sanitary checklist

The sanitary spaces meet the checklist requirements through wheelchair-accessible passages, threshold-free showers, support provisions, matte finishes and quiet mechanical ventilation.

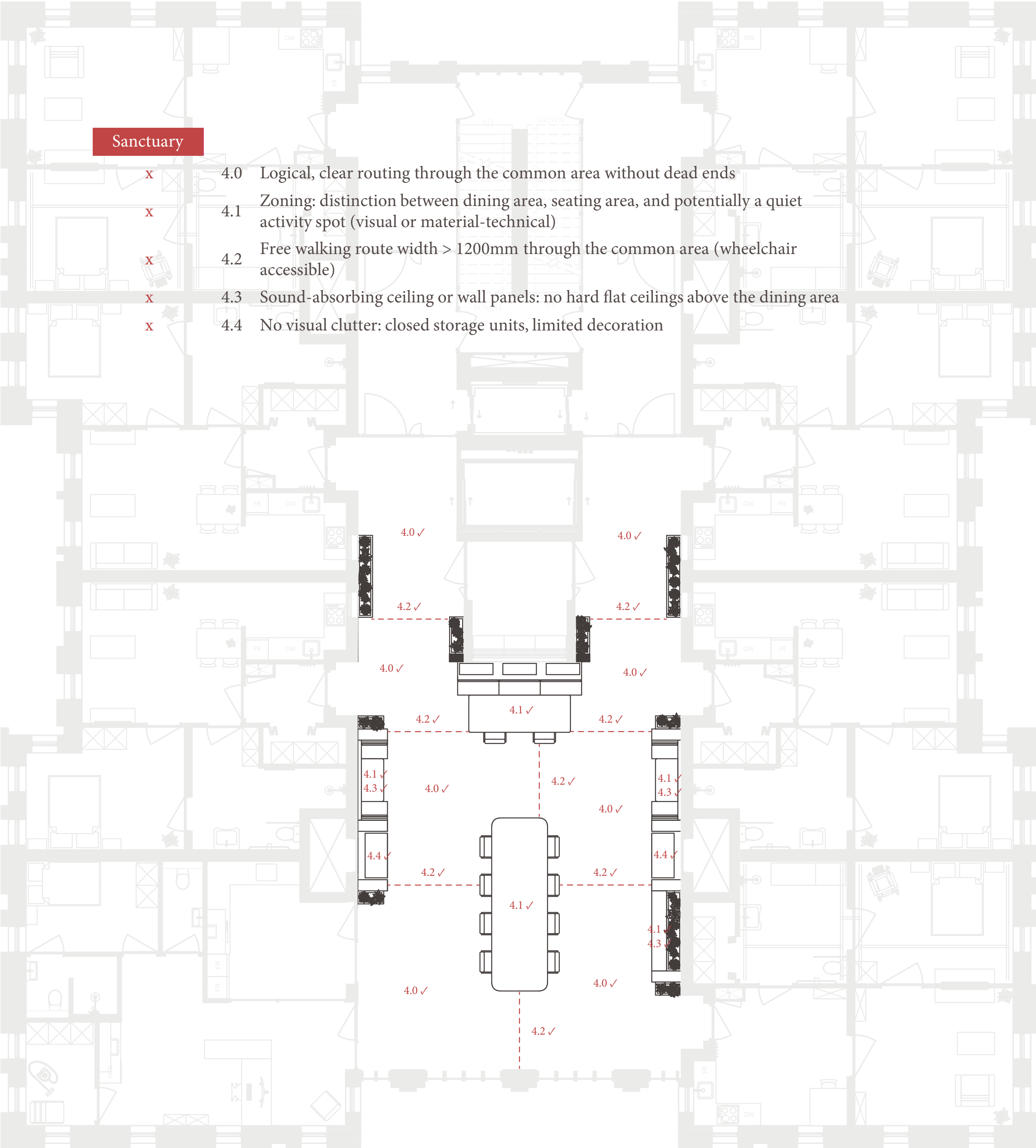


Figure 58. Checklist for Sanctuary common area (1:150)
source: author

Social Hub

x	4.0	Logical, clear routing through the common area without dead ends
x	4.1	Zoning: distinction between dining area, seating area, and potentially a quiet activity spot (visual or material-technical)
x	4.2	Free walking route width > 1200mm through the common area (wheelchair accessible)
	4.3	Sound-absorbing ceiling or wall panels: no hard flat ceilings above the dining area
x	4.4	No visual clutter: closed storage units, limited decoration

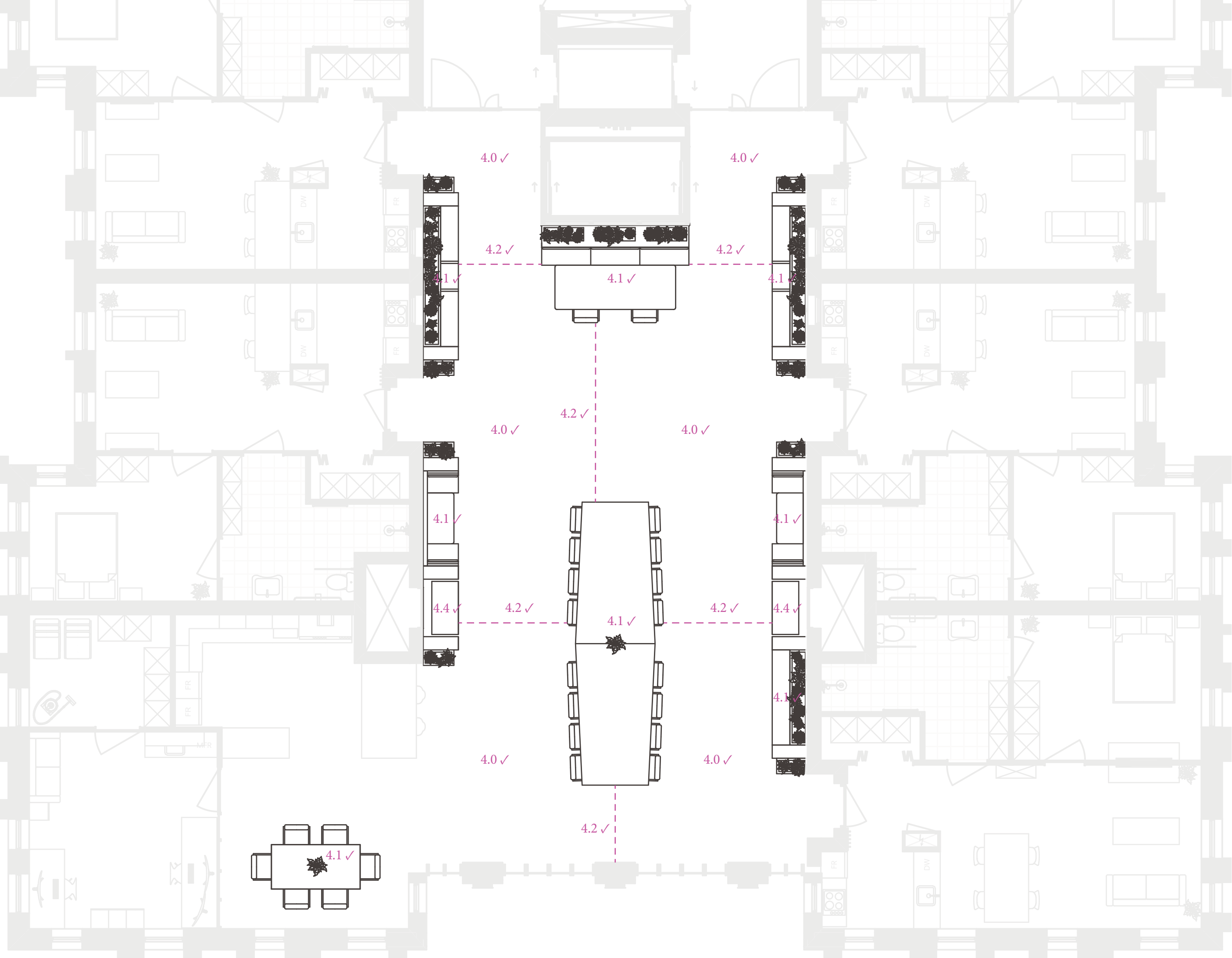


Figure 59. Checklist for Social Hub common area (1:150)
source: author

Common checklist

The common areas meet the checklist requirements through clear routing, accessible walking widths, spatial zoning, acoustic treatment and controlled visual clutter.

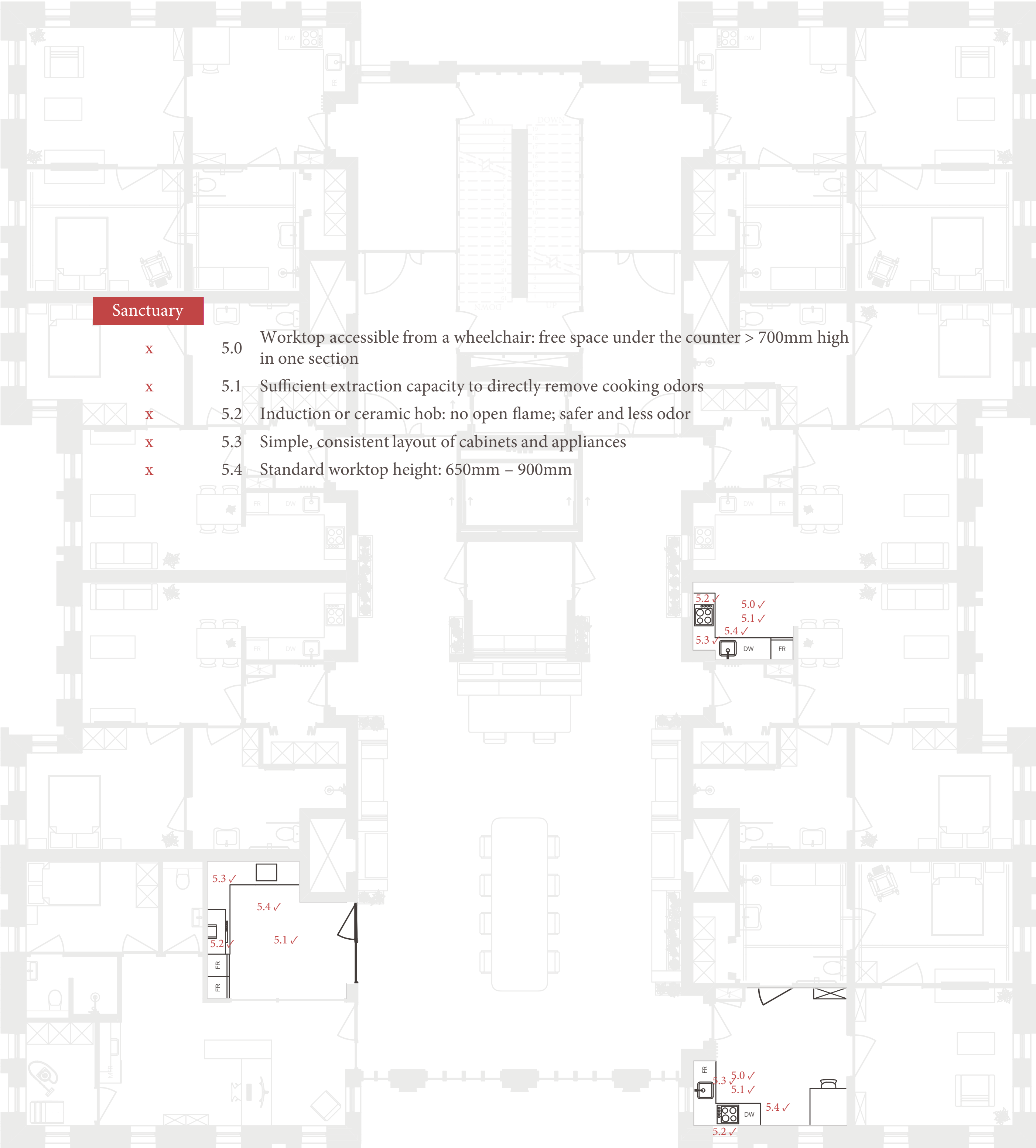


Figure 60. Checklist for Sanctuary kitchens (1:150)
source: author

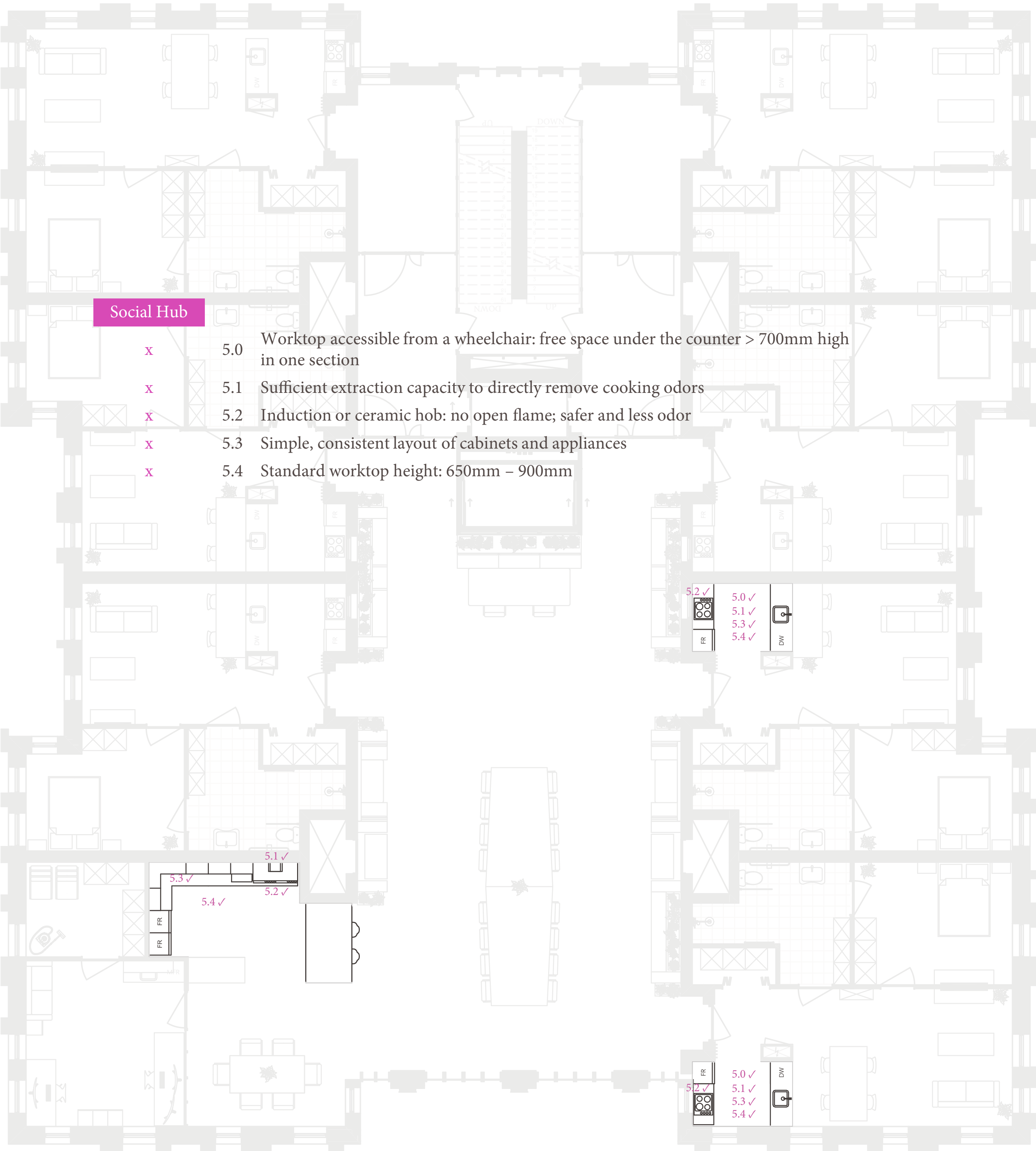


Figure 61. Checklist for Social Hub kitchens (1:150)
source: author

Kitchen checklist

The kitchens meet the checklist requirements through wheelchair-accessible worktops, safe cooking appliances, sufficient extraction, consistent cabinet layouts and adjustable worktop heights.

Sanctuary

x	6.0	Dimmable light in the retreat room, no fluorescent; preferably no window facing a busy outdoor area
x	6.1	Soft materials: carpet or cork, upholstered seating, or a floor mattress
x	6.2	No transit function: the room is not located on a walking route

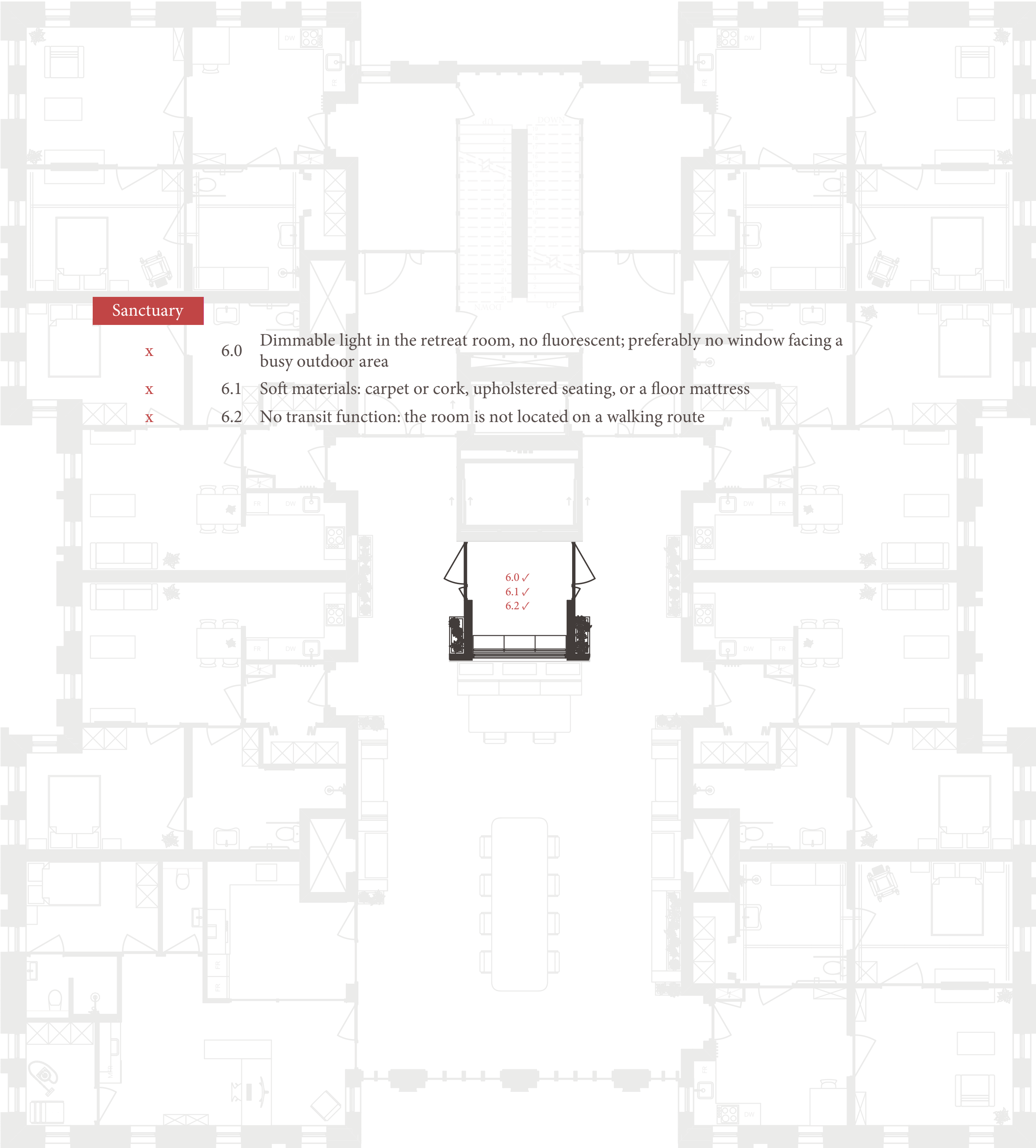


Figure 62. Checklist for Sanctuary retreat room (1:150)
source: author

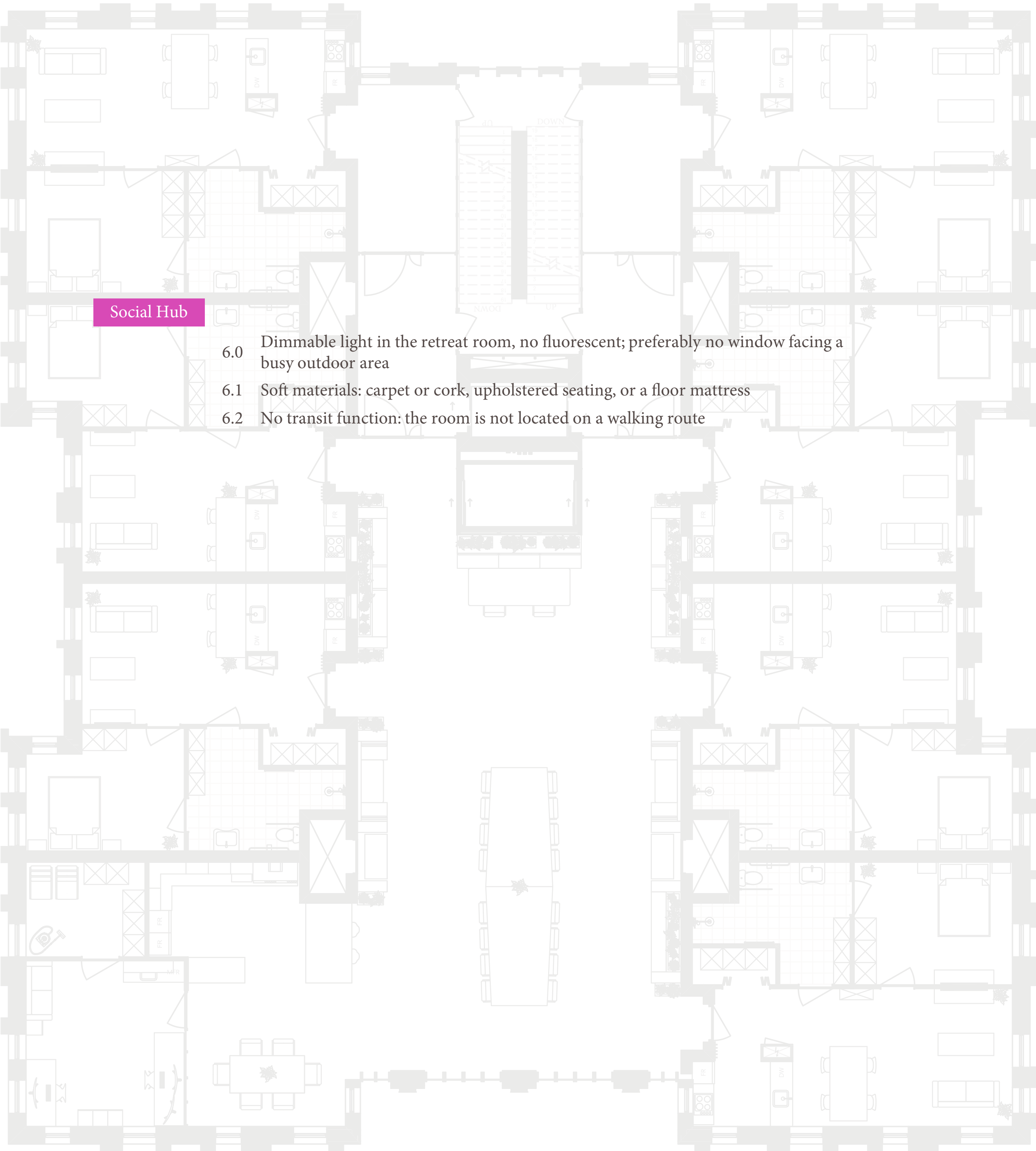


Figure 63. Checklist for Social Hub retreat room (1:150)
source: author

Retreat room checklist

The retreat rooms meet the checklist requirements by providing dimmable lighting, soft materials and a protected position outside the main walking routes.

User journey mapping

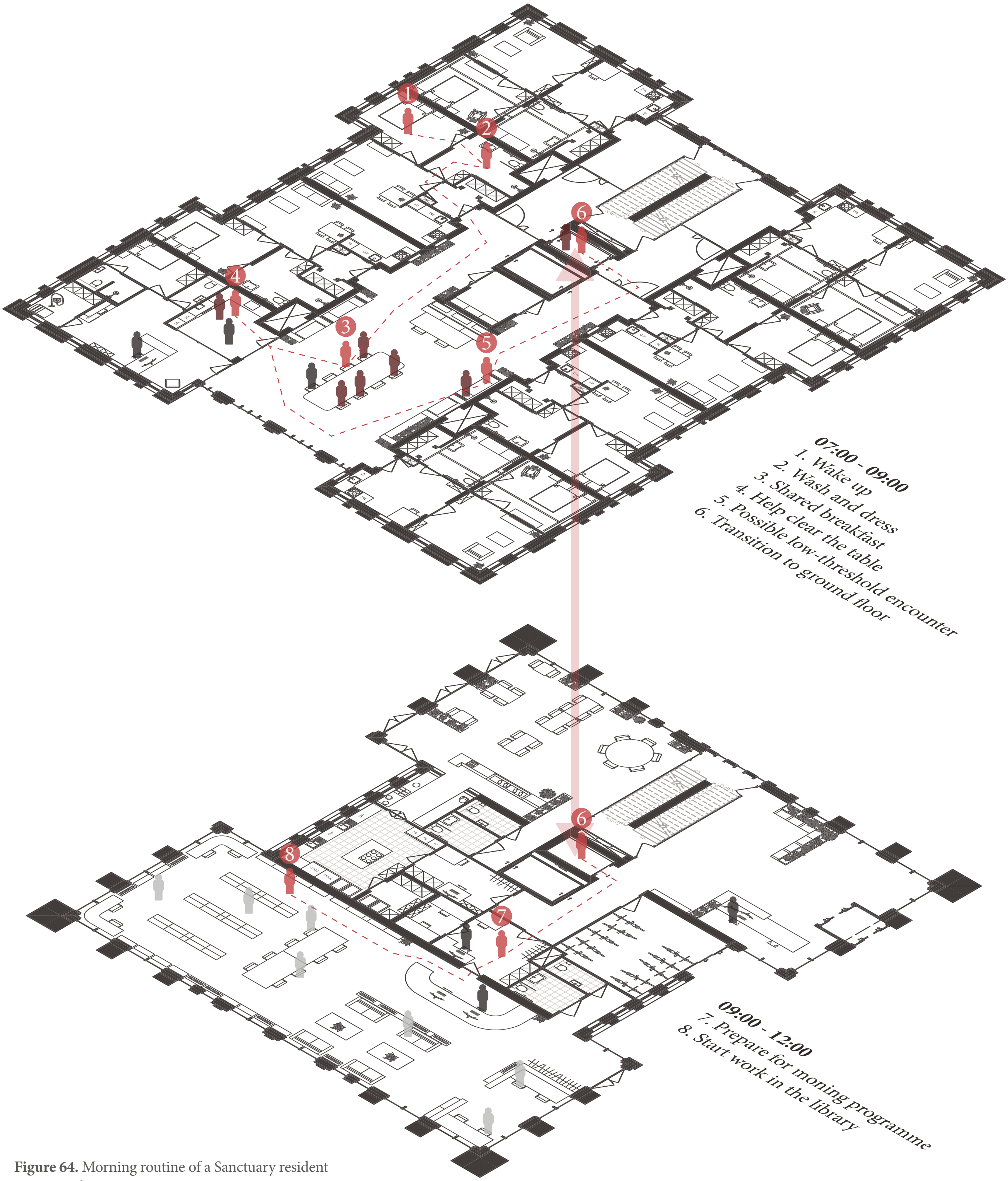


Figure 64. Morning routine of a Sanctuary resident
source: author

Sanctuary resident

The user journey shows how the building has a predictable daily rhythm for a Sanctuary resident. The route moves slowly from private space to collective spaces, then to the public plinth for dayprogram activity, and back again to the residential floor. Moments such as shared breakfast, helping in the kitchen and low-threshold encounters allow social

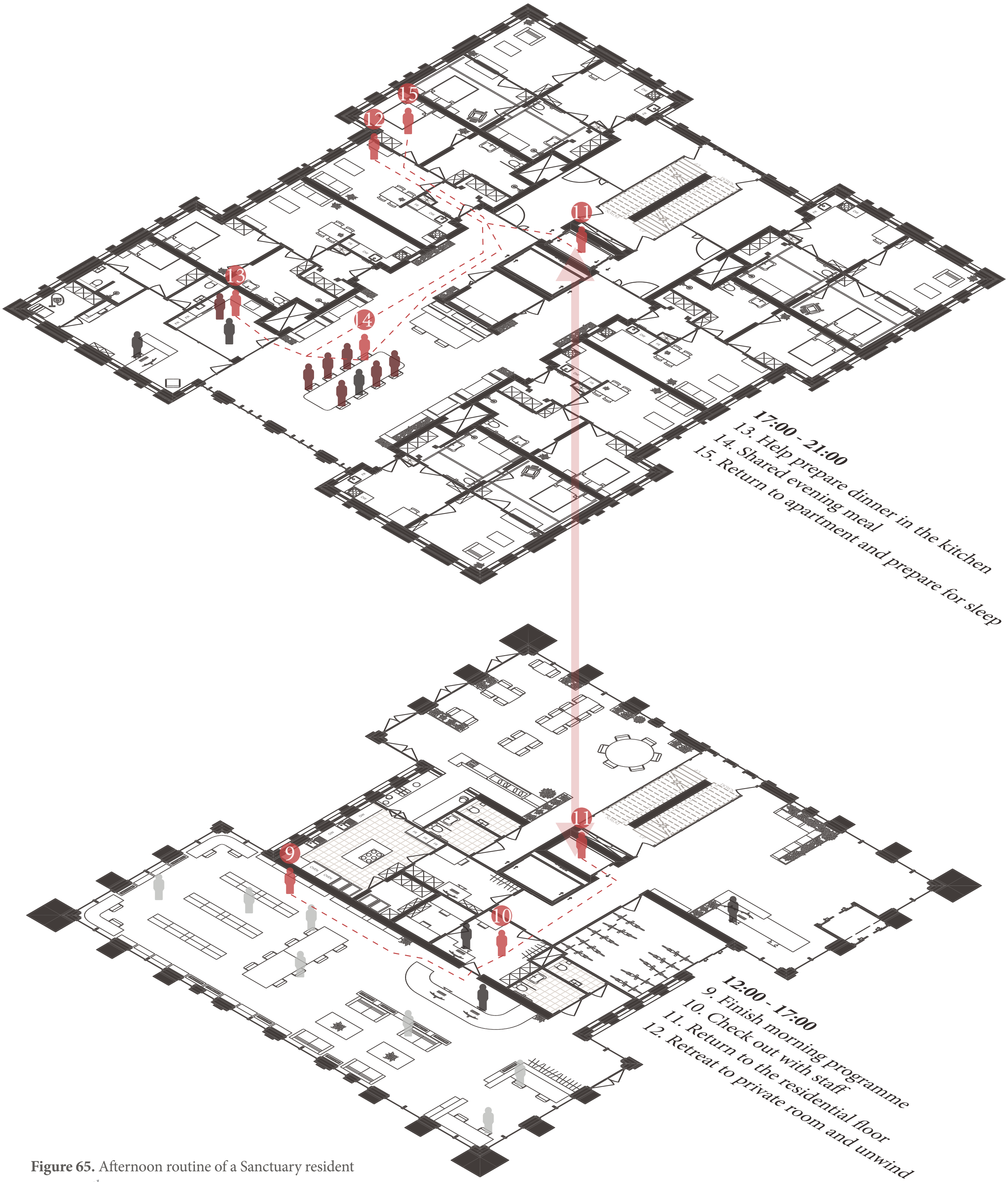


Figure 65. Afternoon routine of a Sanctuary resident
source: author

interaction without force. At the same time, the resident can return to their private room to recover before rejoining the group. In this way, the building balances structure, autonomy, retreat and social interaction throughout the day.

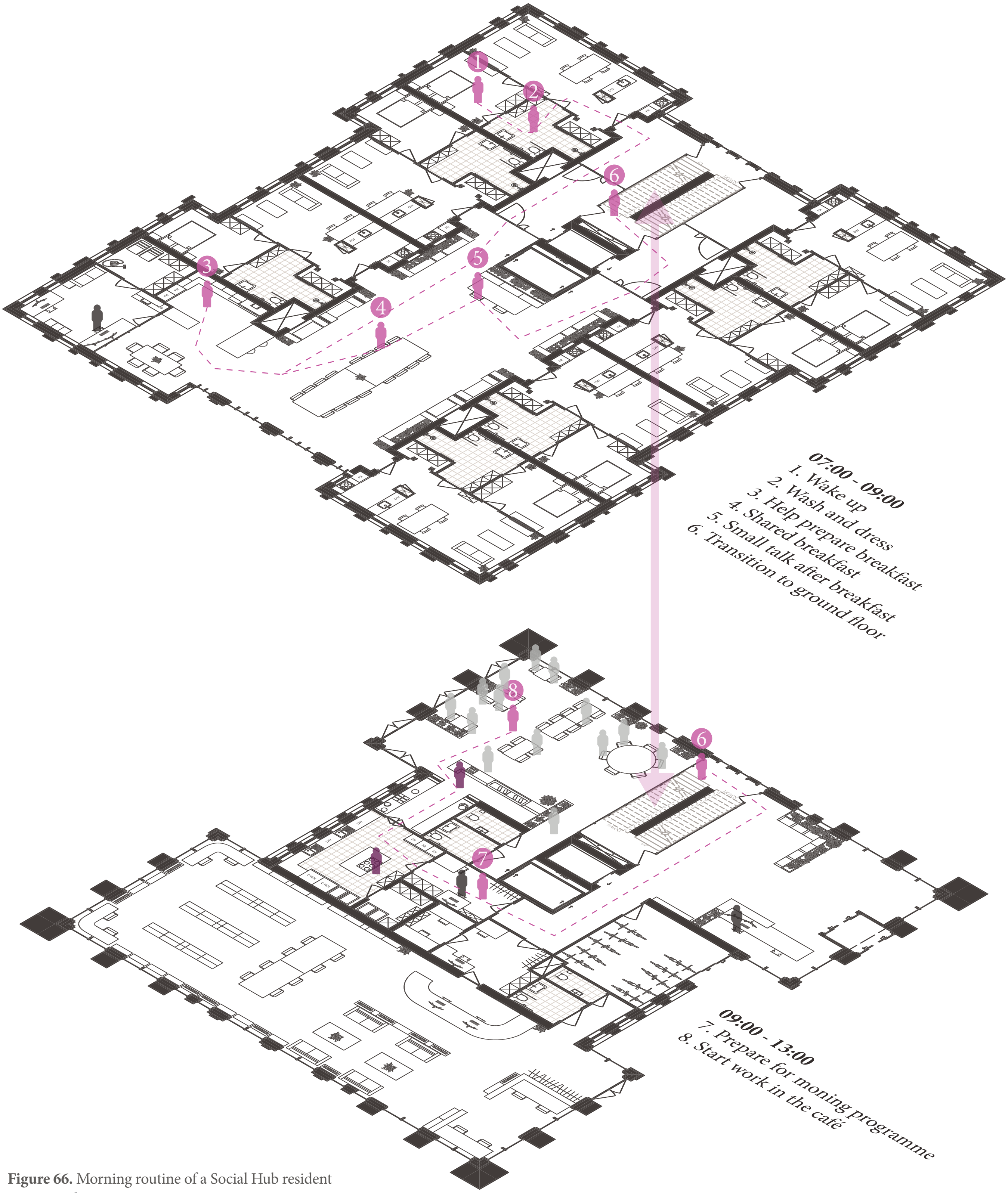


Figure 66. Morning routine of a Social Hub resident
source: author

Social Hub resident

The Social Hub journey follows a more active daily rhythm, moving between routines, collective living and public participation in the public plinth. Working in the café and moving through the neighbourhood create low-threshold

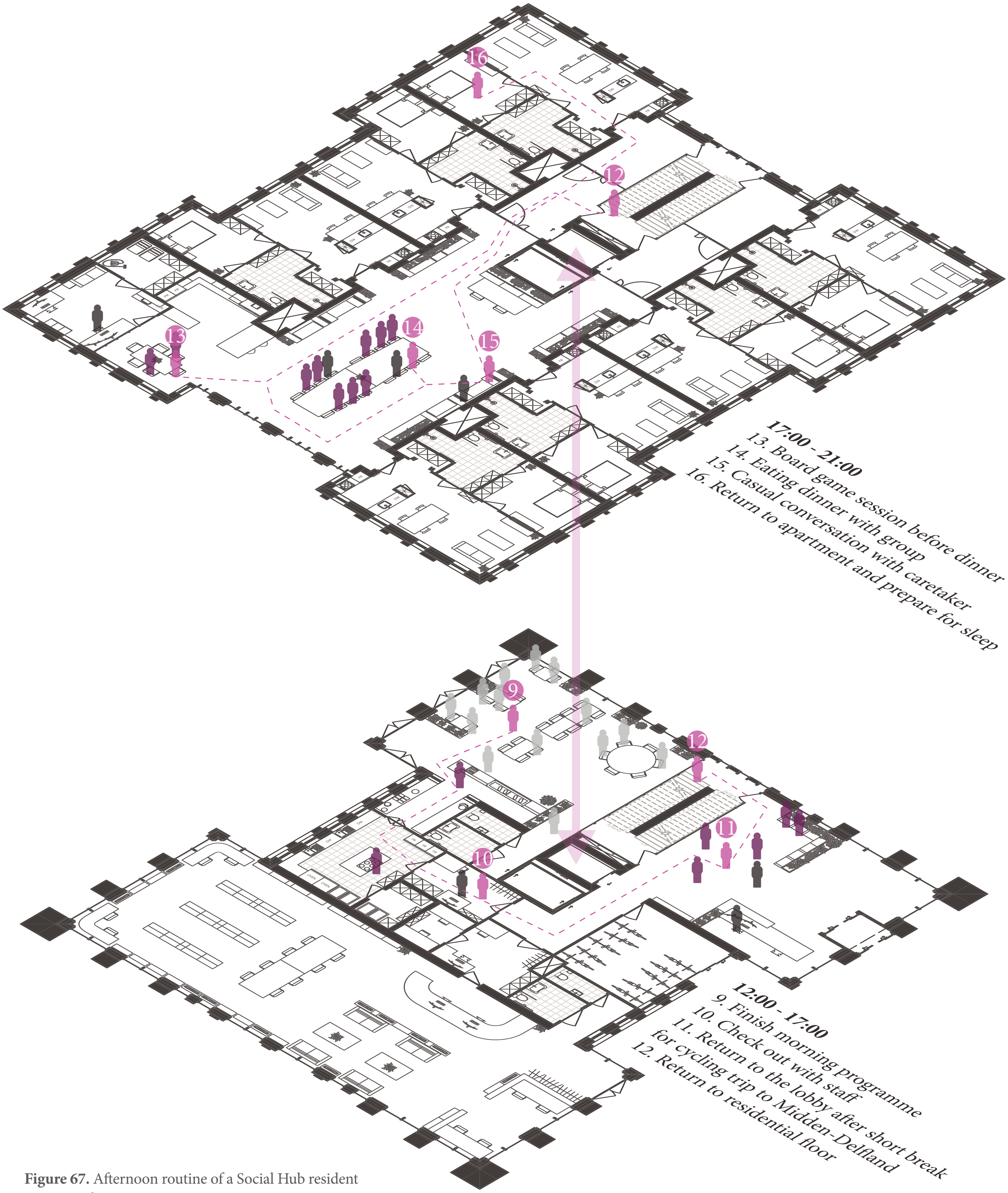


Figure 67. Afternoon routine of a Social Hub resident
source: author

contact with the local community. After these social moments, the journey returns to the residential floor, where the resident can relax before rejoining the group for dinner and the evening routine.

Apartments

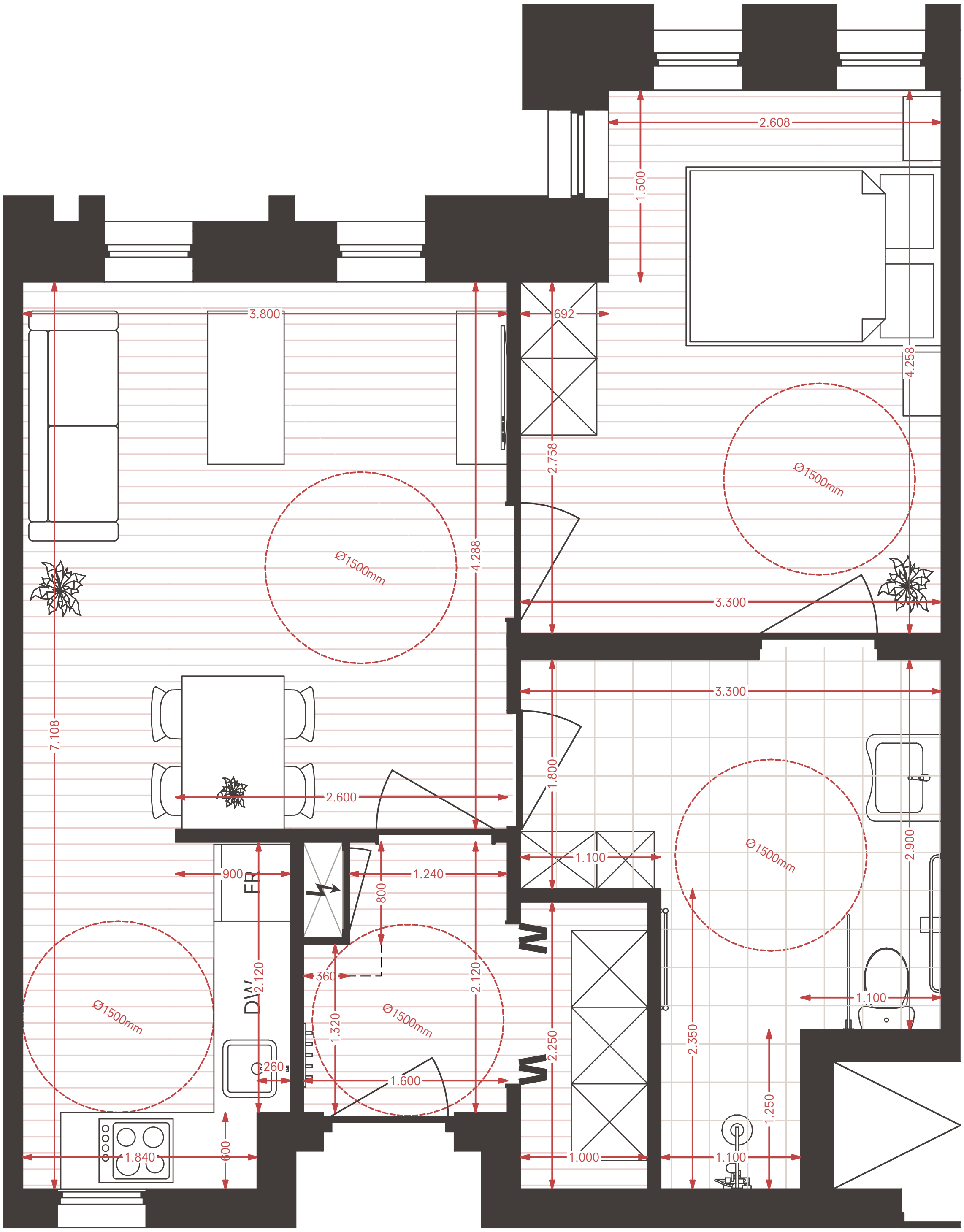


Figure 68. Floorplan of sanctuary apartment
source: author

Sanctuary apartments

The Sanctuary apartments are organised as seperated floorplans, creating a sequence of smaller transitions between living, sleeping, sanitary and entrance areas. This supports orientation and reduces direct exposure between functions. Wheelchair turning circles are placed throughout the plan.

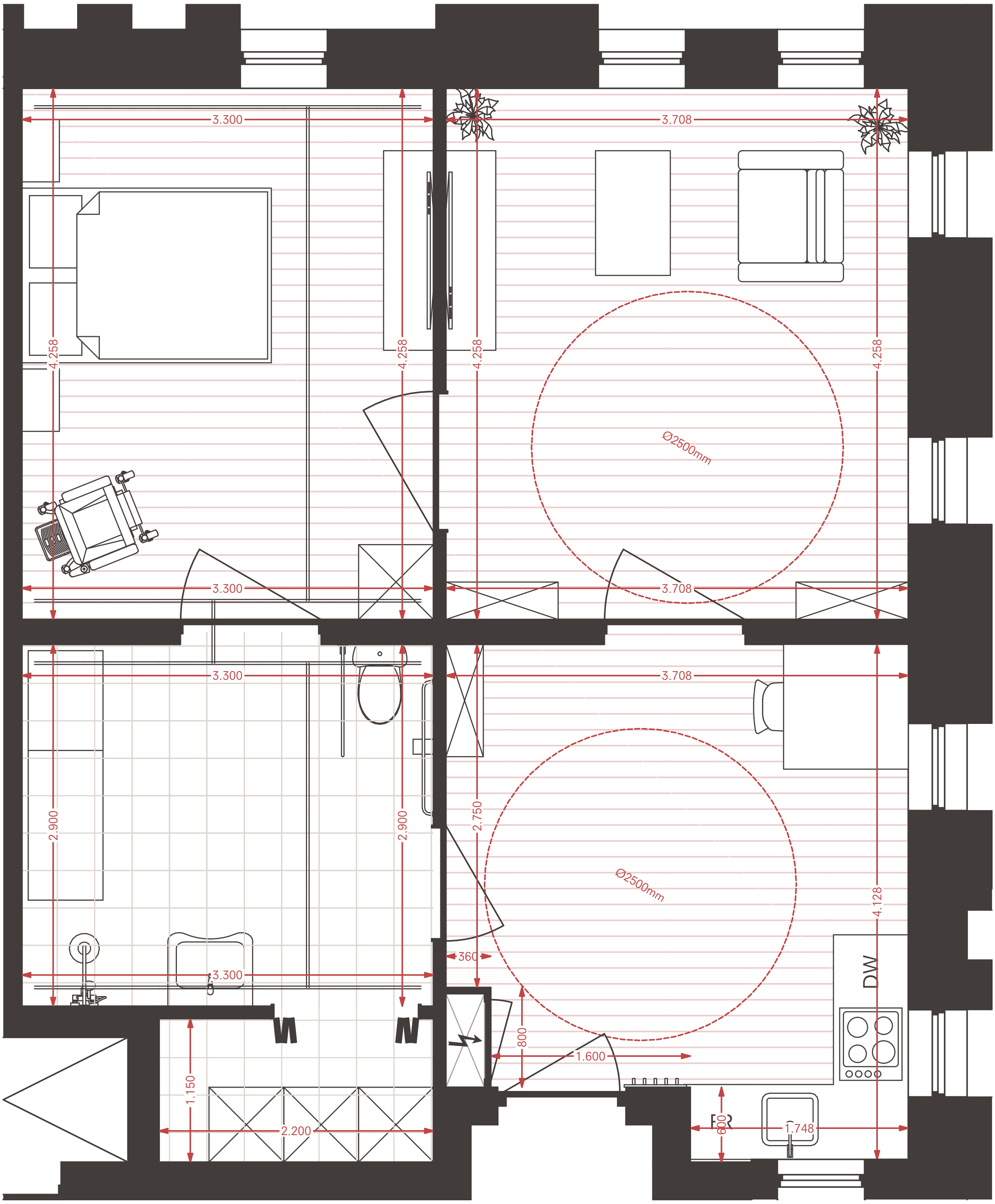


Figure 69. Floorplan of sanctuary corner apartment
source: author

The corner apartment is designed for residents with heavier physical limitations, including larger turning spaces and the possibility of ceiling hoists between the bedroom and sanitary area.

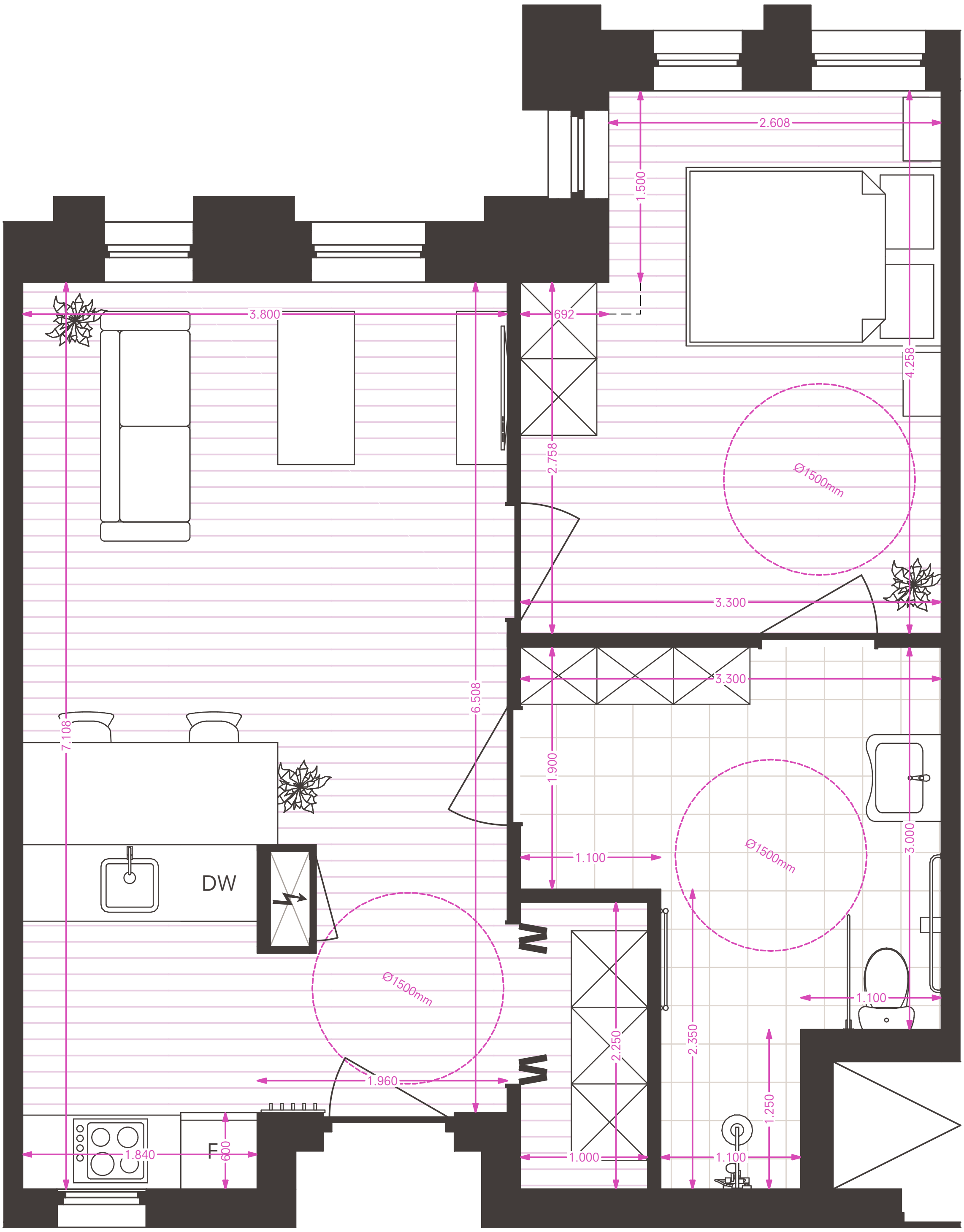


Figure 70. Floorplan of social hub apartment
source: author

Social Hub apartments

The Social Hub apartments have a more open living area, adjusting for sensory sensitivity and informal use of the apartment. The bathroom, bedroom and living room are directly connected, making the layout easy to understand

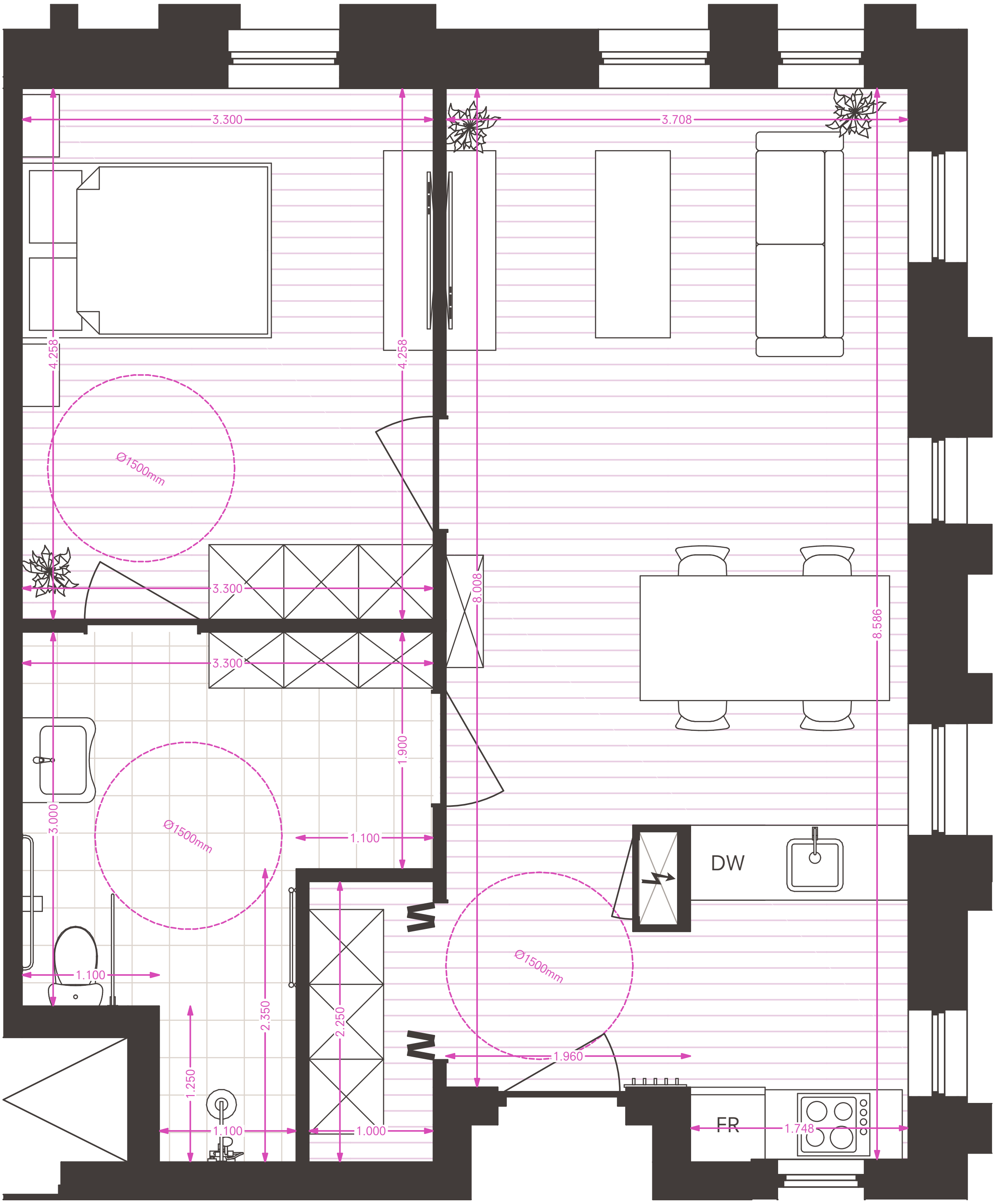


Figure 71. Floorplan of social hub corner apartment
source: author

and efficient to use. In the corner apartment, this open organisation is continued on a larger scale, providing generous movement space while maintaining a clear relationship between care and everyday living.

Facade

Figure 72. Exterior elevation of design 1 for the facade (1:150)
source: author

Design 1

This facade has a standard window layout in the plane of the facade, which makes it look balanced. However, the lack of tactility and depth makes the facade feel rather ordinary. From the outside, there is no visible distinction between the

Figure 73. Interior section of design 1 for the facade (1:150)
source: author

different groups, causing them to lose their identity. Inside the apartments, the windows appear uniform and repetitive, providing even daylight but little spatial variation.

Figure 74. Exterior elevation of design 2 for the facade (1:150)
source: author

Design 2

This facade builds on the previous design, but introduces a subtle layer of tactility through the use of relief in the brickwork. This adds a slight variation in depth and shadow, giving the facade more texture and a more refined appearance.

Figure 75. Interior section of design 2 for the facade (1:150)
source: author

However, the overall window layout remains unchanged, maintaining a balanced but still fairly standard composition.

Looking at the windows in the interior of the apartments, nothing has changed.

Figure 76. Exterior elevation of design 3 for the facade (1:150)
source: author

Design 3

This facade aims for maximum connection with the outside through large, open windows. This increases visibility of residents, making them more recognizable and supporting social inclusion. However, this level of openness may be

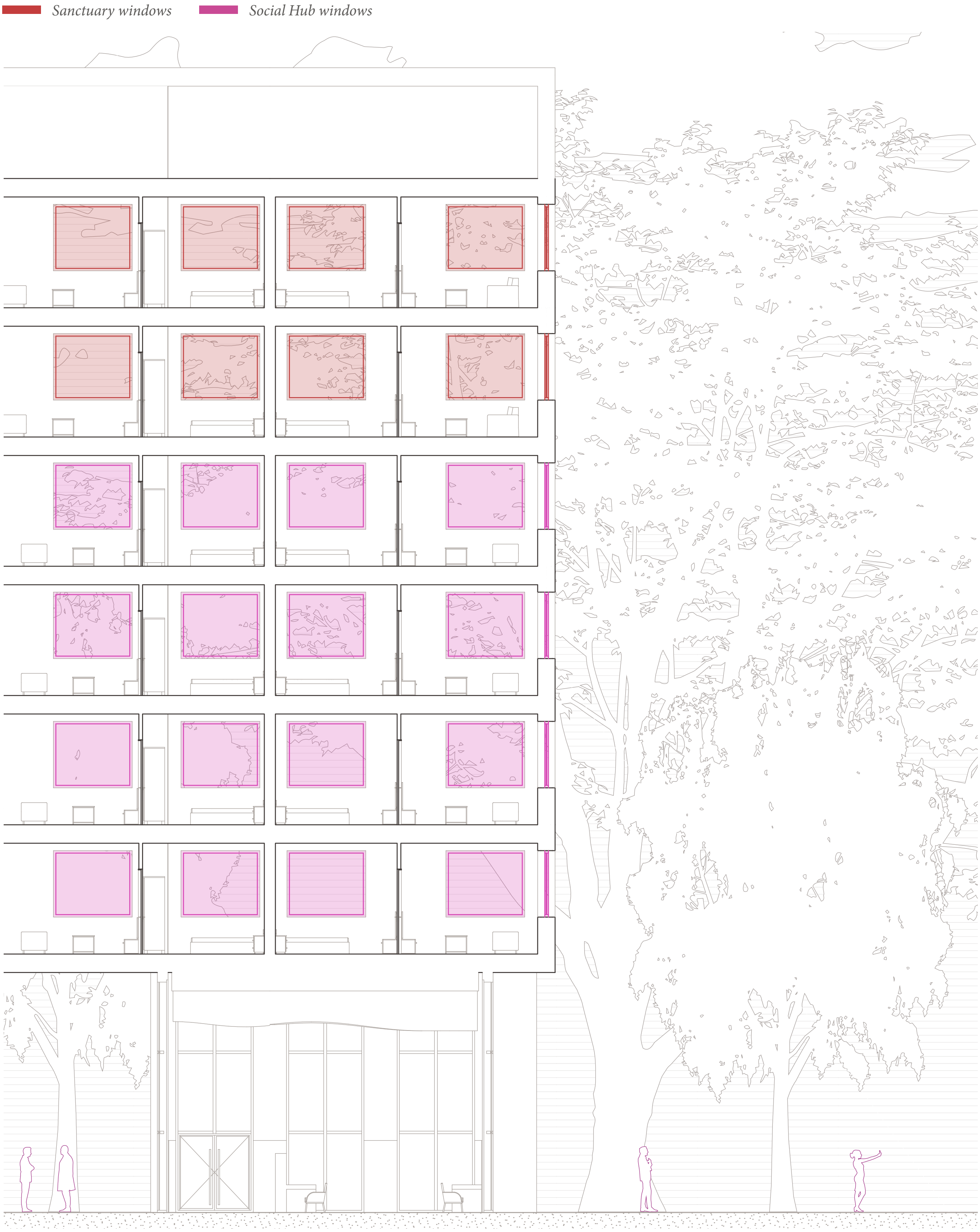


Figure 77. Interior section of design 3 for the facade (1:150)
source: author

too intense for the sanctuary group. The lack of filtering or buffering exposes them strongly to outside stimuli, which can feel overwhelming and reduce privacy and calm within these spaces.

Figure 78. Exterior elevation of design 4 for the facade (1:150)
source: author

Design 4

This facade assigns narrow windows to the sanctuary group and larger windows to the social hub group, responding more directly to their sensory sensitivity. While this creates a clearer functional distinction, it also leads to a fragmented

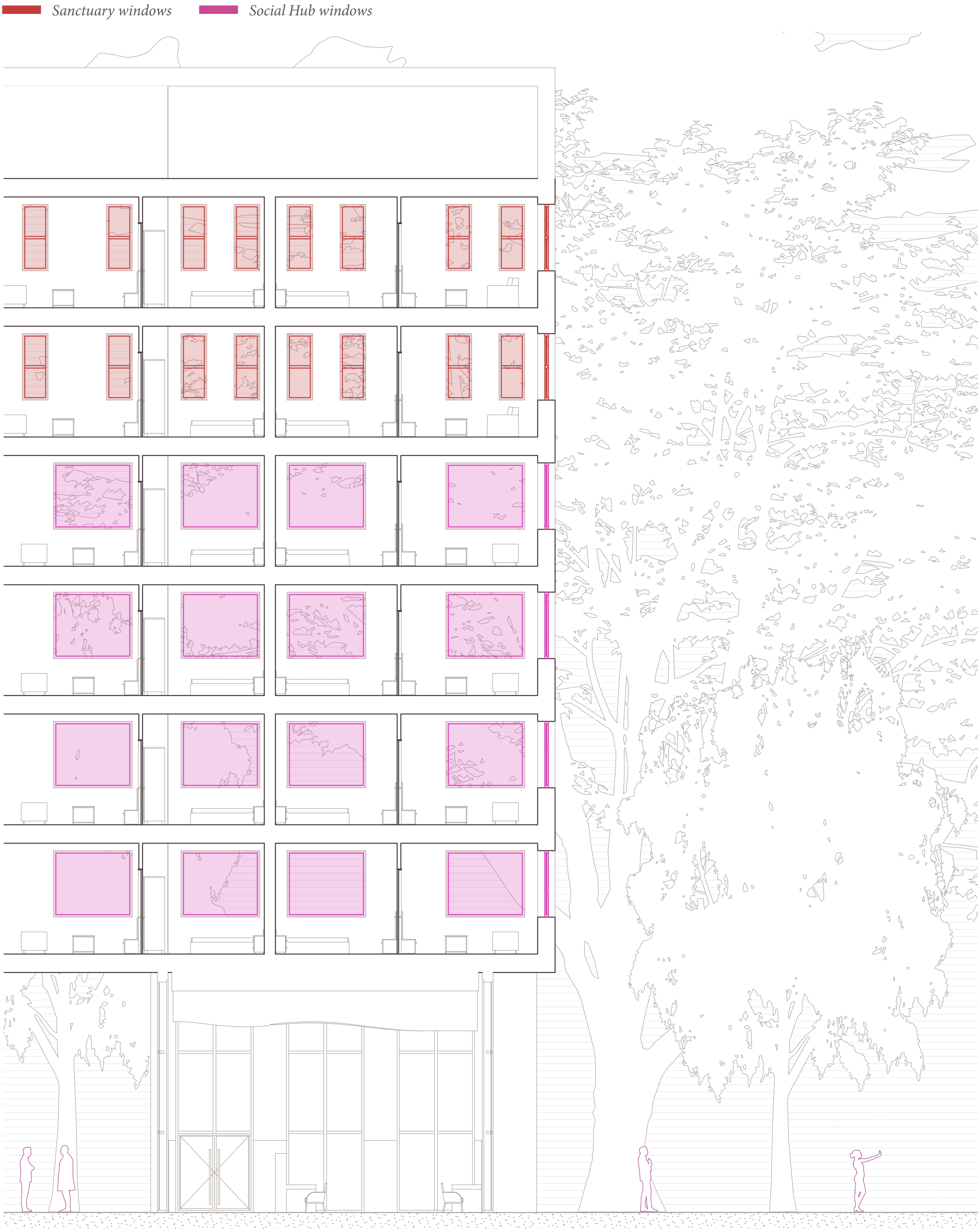


Figure 79. Interior section of design 4 for the facade (1:150)
source: author

appearance. The lack of a unifying element in the facade reduces the sense of connection between the groups, making the building read as a collection of separate parts rather than a cohesive whole.

Figure 80. Exterior elevation of design 5 for the facade (1:150)
source: author

Design 5

This facade uses a consistent window width across all units, creating a stronger sense of order and unity. The distinction between groups is expressed through height: the sanctuary group has lower windows, while the social hub features

Figure 81. Interior section of design 5 for the facade (1:150)
source: author

taller, near floor-to-ceiling openings. While this adds some variation, the overall facade still feels quite standard and lacks a strong, distinctive character.

Figure 82. Exterior elevation of design 6 for the facade (1:150)
source: author

Design 6

This facade introduces a gradient in tactility, from a more random and expressive texture at the bottom to a calmer and smoother surface towards the top. This reflects differences in sensory sensitivity, with more dynamic expression

Figure 3. Interior section of design 6 for the facade (1:150)
source: author

for Social Hub groups and a quieter character for Sanctuary groups. At the same time, the facade becomes more unique and recognizable, improving the identity of the building and supporting the emancipation of its residents.

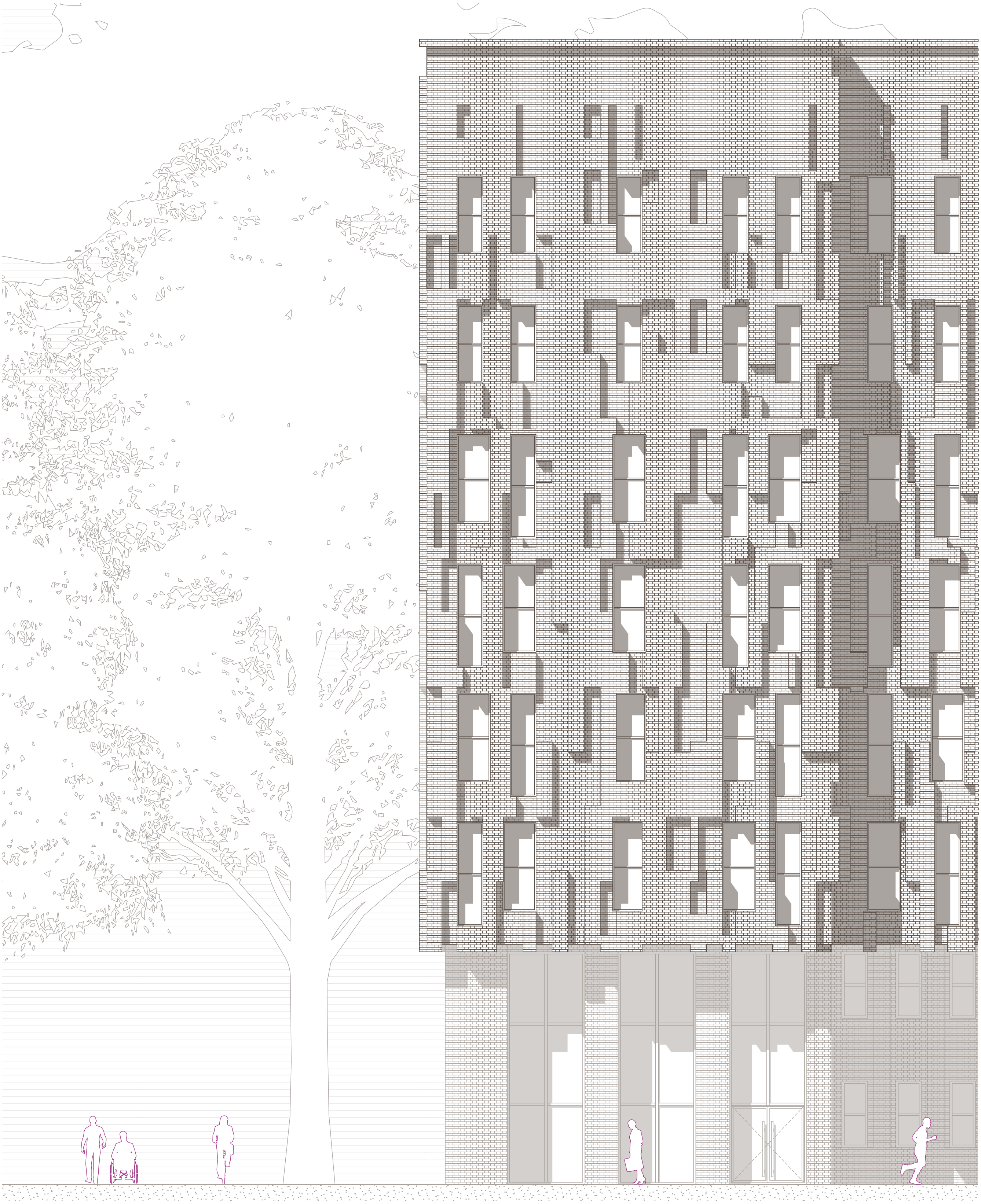


Figure 84. Exterior elevation of design 7 for the facade (1:150)
source: author

Design 7

This facade extends the tactile pattern further upward, creating a stronger vertical continuity across the elevation. The expression becomes more consistent, while still maintaining variation. The windows of the social hub groups are now

Figure 85. Interior section of design 7 for the facade (1:150)
source: author

differentiated: some are lower and wider, while others are narrower and taller. This introduces more diversity in the facade and reflects different sensory sensitivity, while keeping an overall coherent composition.

Construction

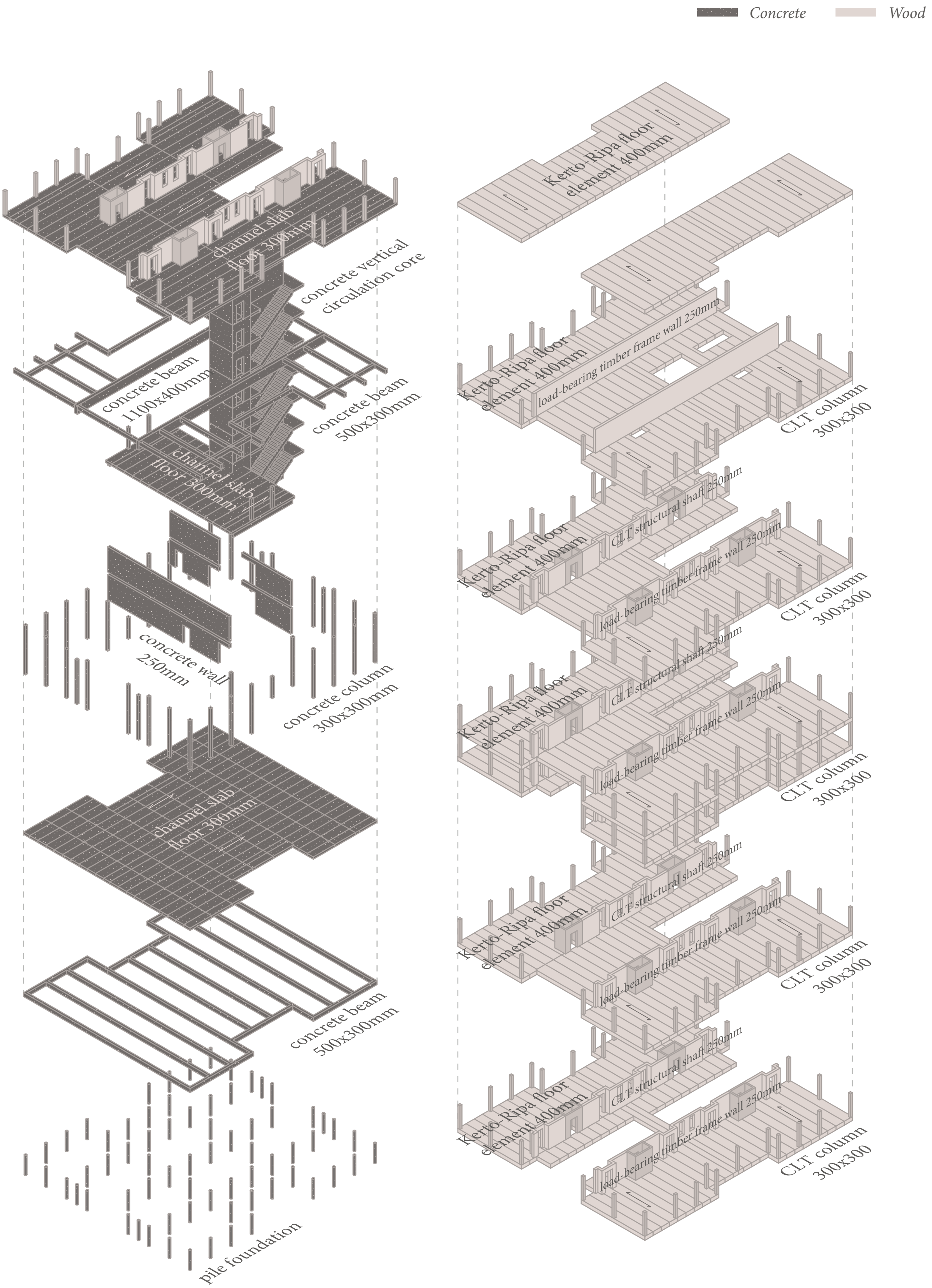


Figure 86. Exploded axo of the main load bearing construction (1:600)
source: author

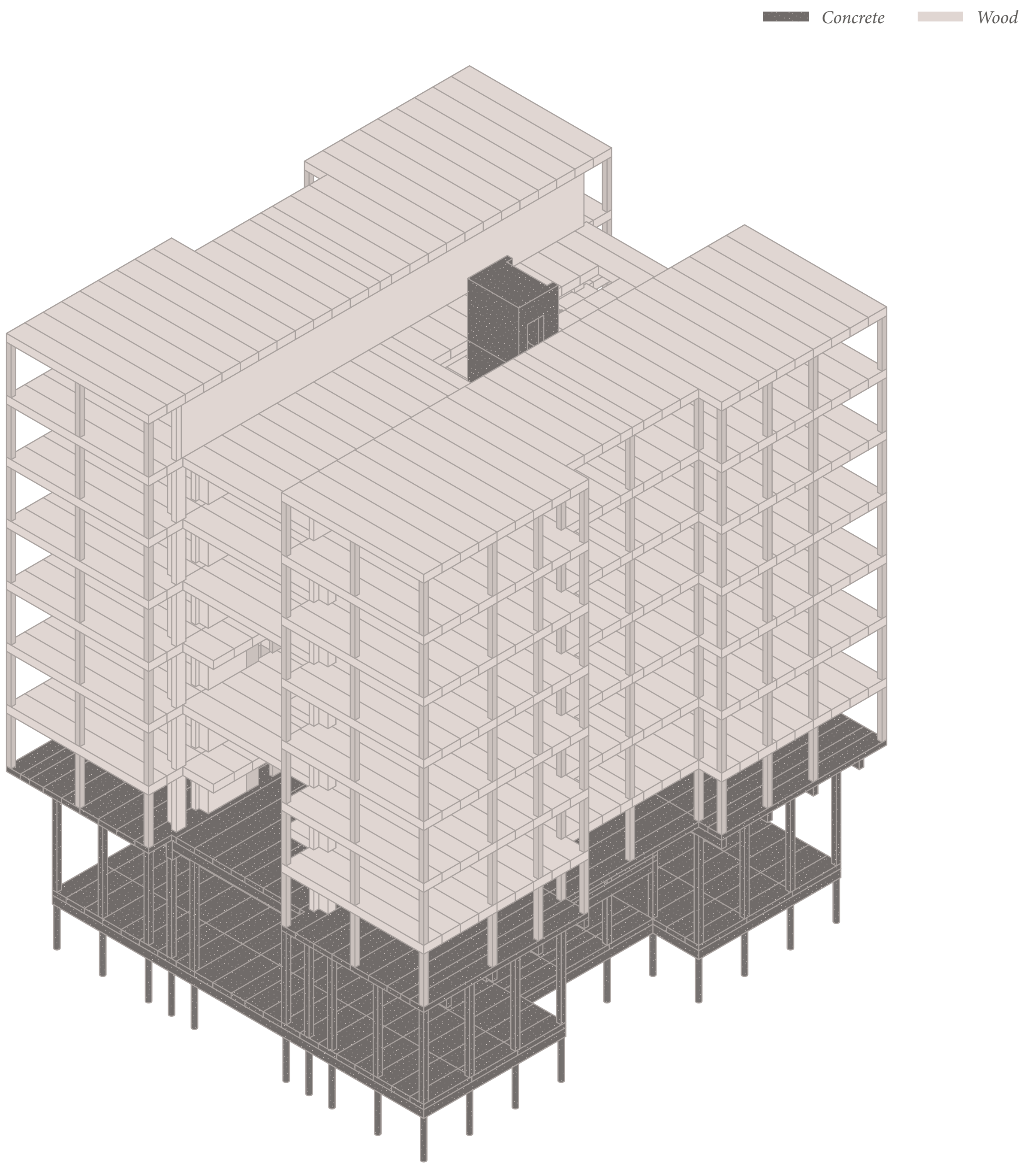


Figure 87. Axo of the main load bearing construction (1:300)
source: author

Main load bearing construction

The main load-bearing structure has a concrete plinth and a lightweight timber residential structure. The concrete plinth allows for larger spans in public areas and concentrated load transfer at ground level. Above the plinth, the residential floors are primarily made of timber using CLT and timber frame wall elements. The vertical circulation core is the only concrete element on the residential floors, providing stability and structural continuity.

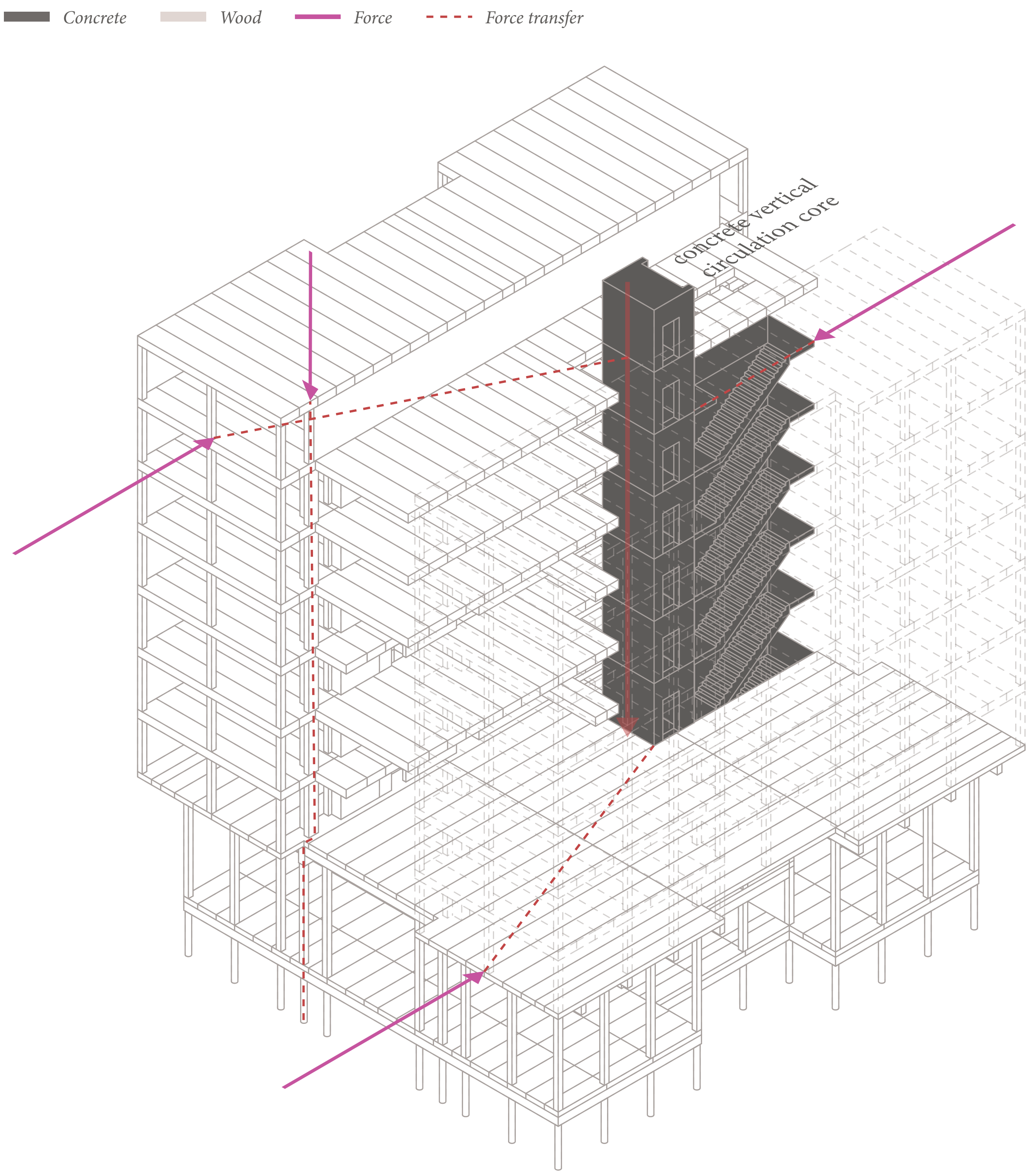


Figure 88. Sectional axo of the main load bearing construction stability (1:300)
source: author

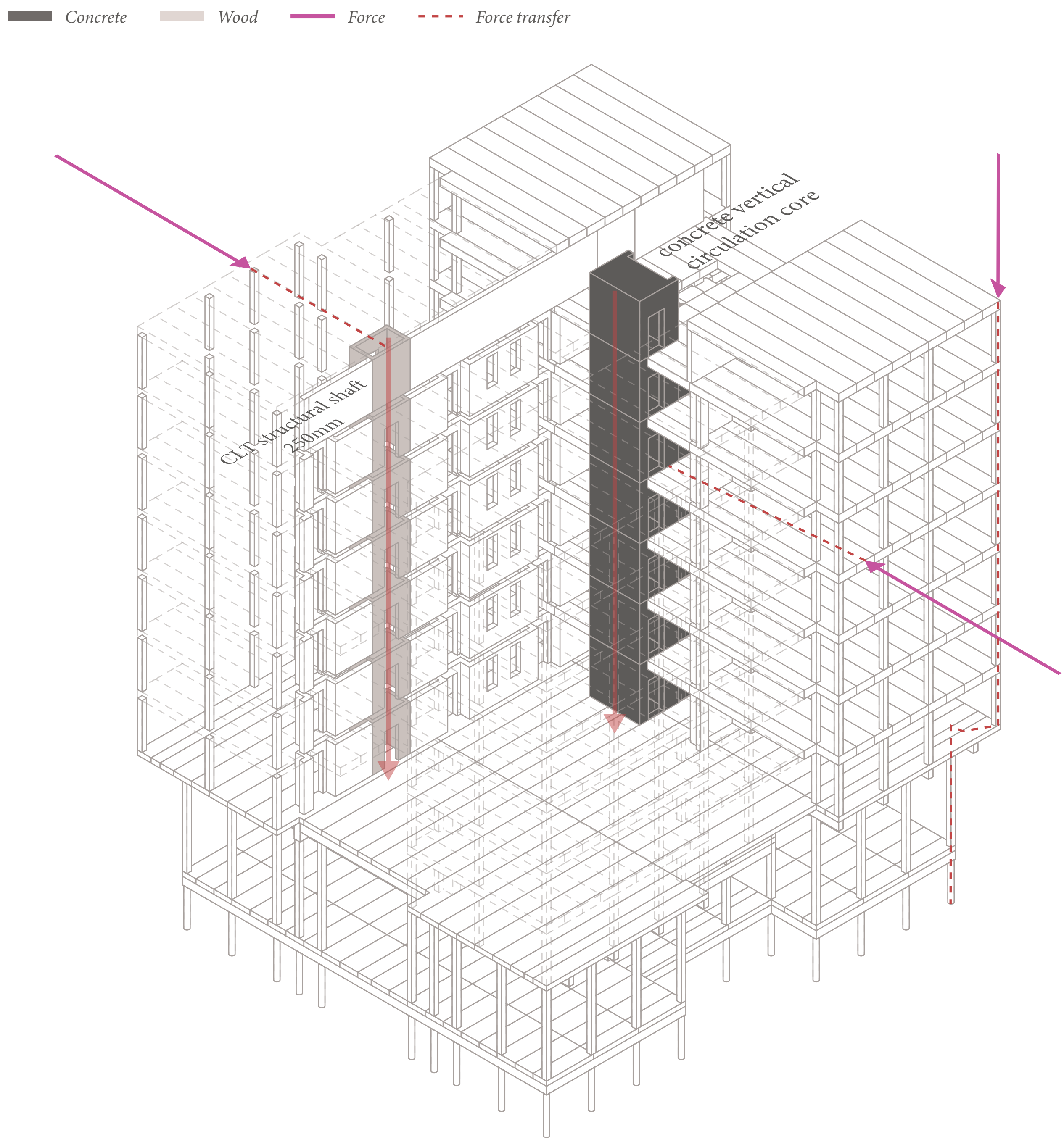
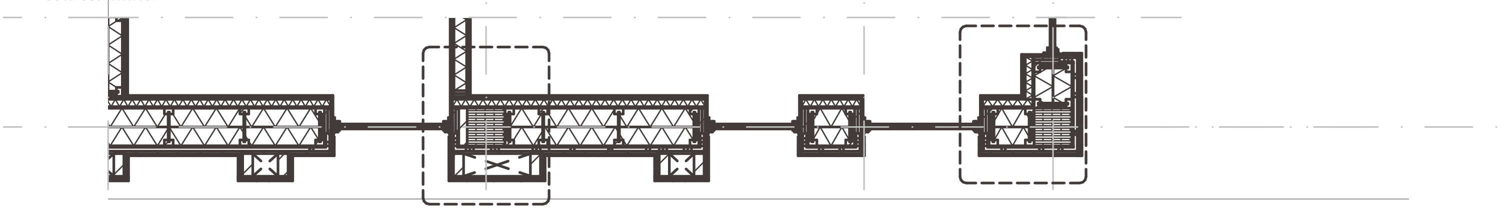


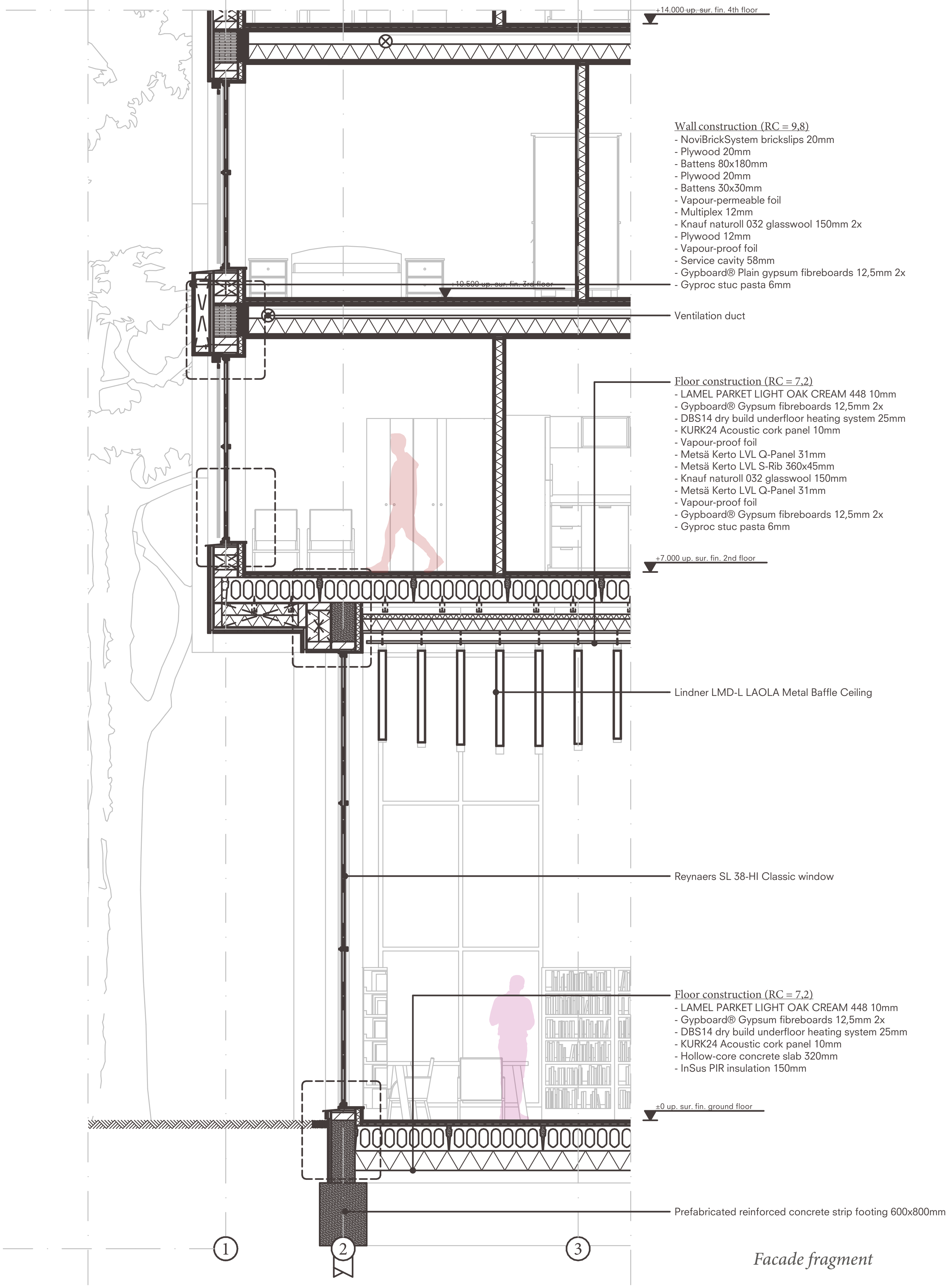
Figure 89. Sectional axo of the main load bearing construction stability (1:300)
source: author

Stability

The stability of the building is provided by the concrete plinth and the concrete vertical circulation core. The lightweight timber residential structure transfers its vertical loads through CLT and timber frame wall elements, while horizontal forces are stabilised by the rigid concrete core. At the transition between timber and concrete, the plinth functions as a transfer structure, redistributing concentrated loads from the rotated upper floors to the foundation.

Figure 90. Facade fragment 1(1:60)
source: author





Facade fragment

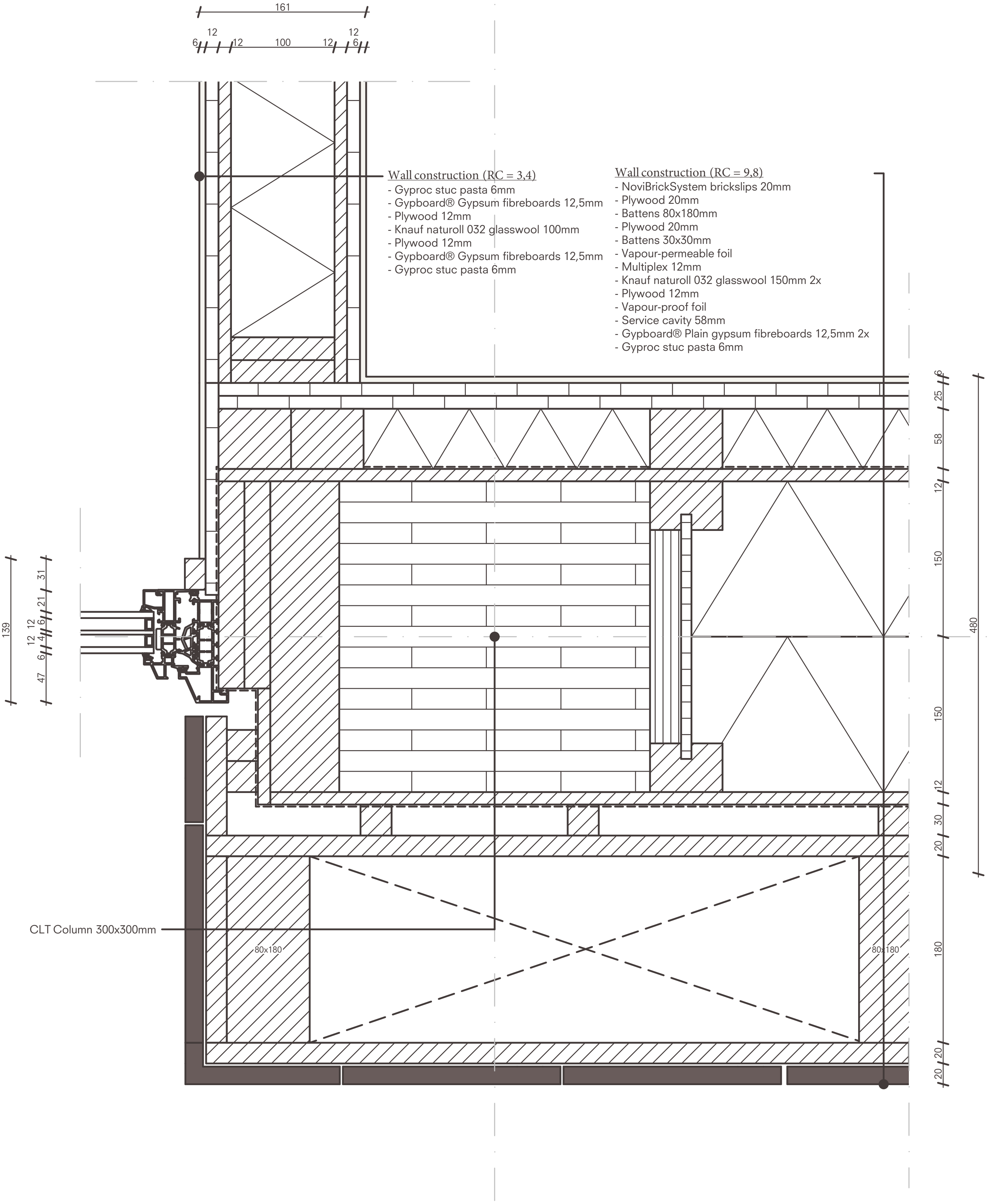


Figure 91. Horizontal detail 1(1:5)
source: author

Detail 1

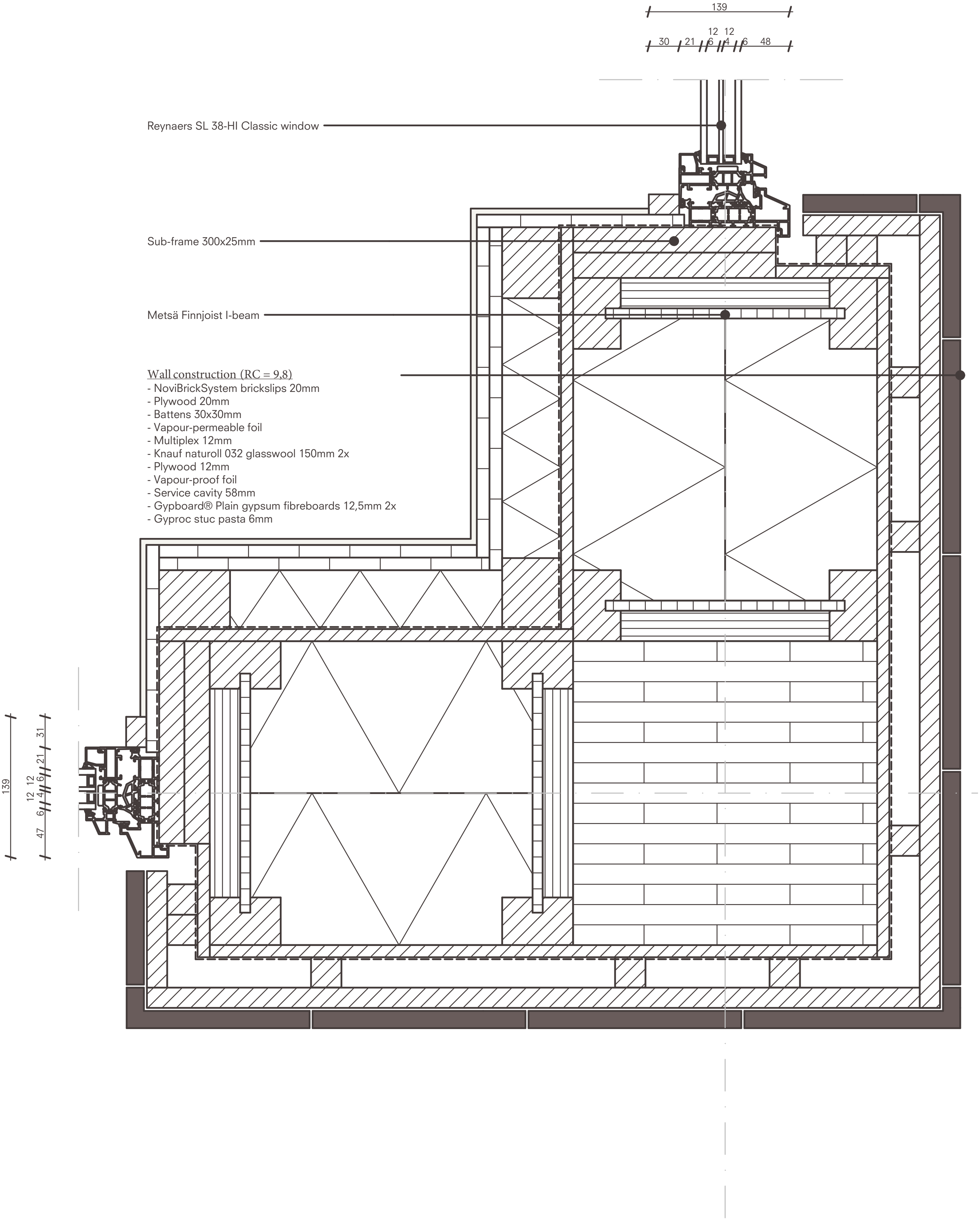


Figure 92. Horizontal detail 2 (1:5)
source: author

Detail 2

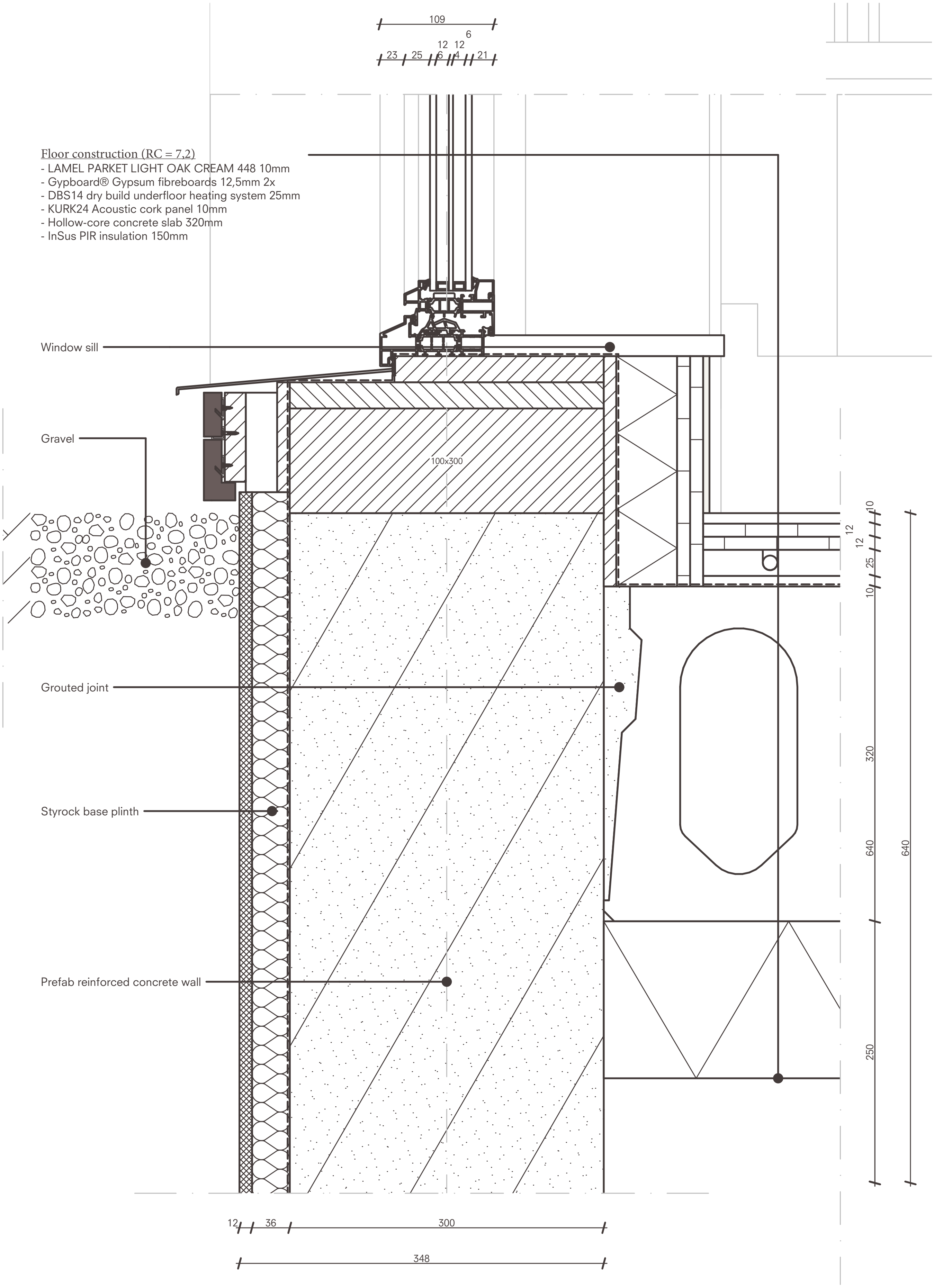


Figure 93. Vertical detail 1 (1:5)
source: author

Detail 3

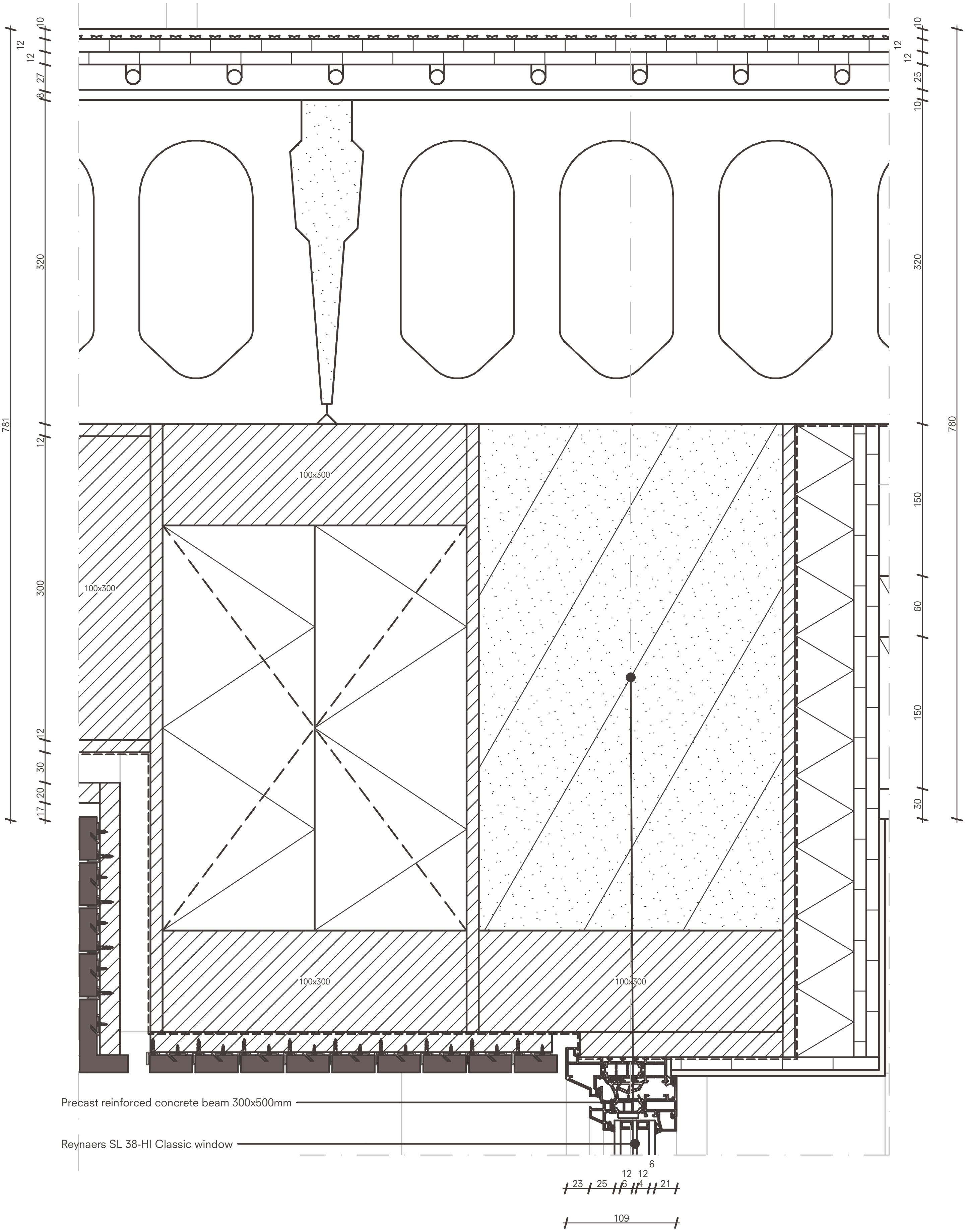


Figure 94. Vertical detail 2 (1:5)
source: author

Detail 4

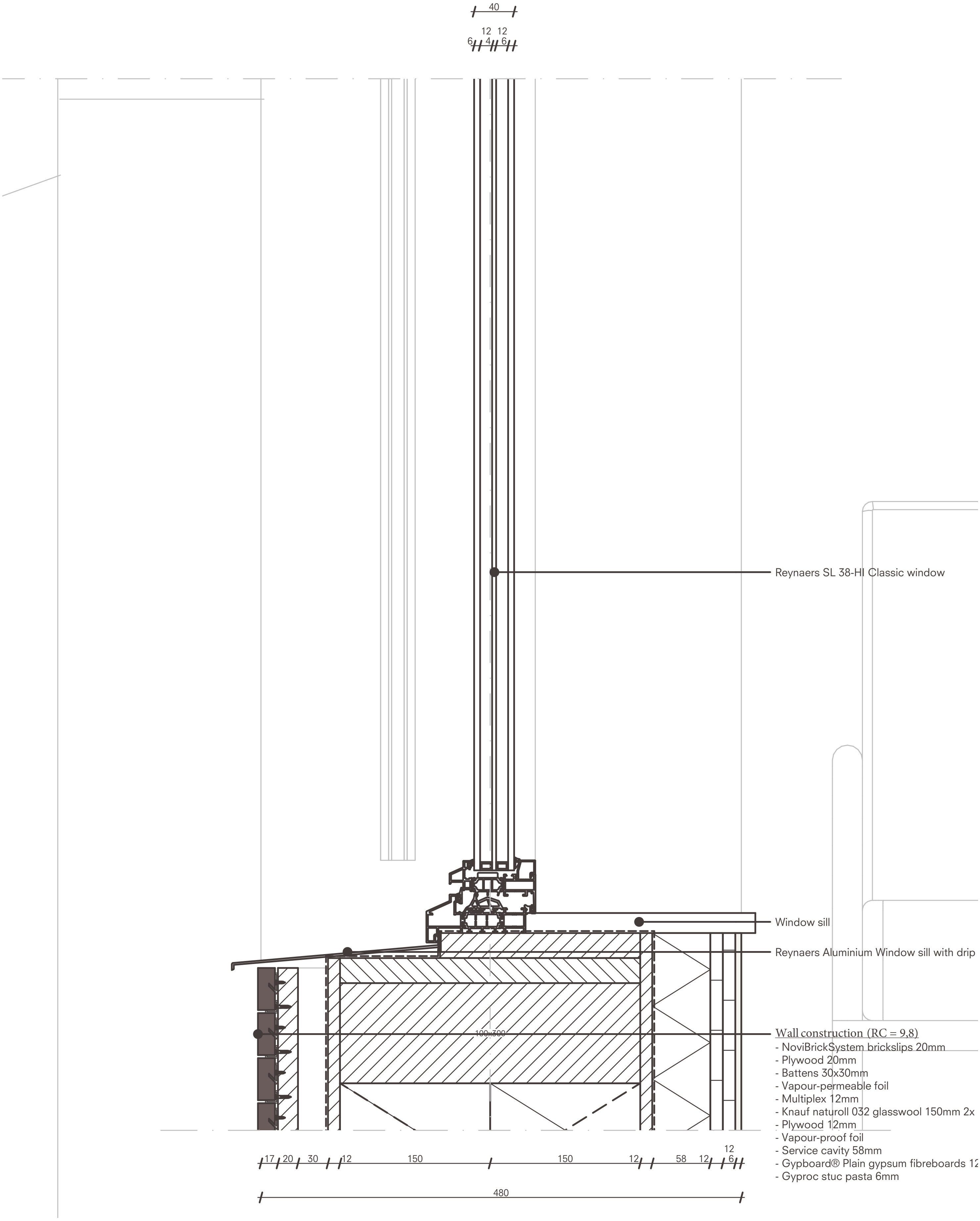


Figure 95. Vertical detail 3 (1:5)
source: author

Detail 5

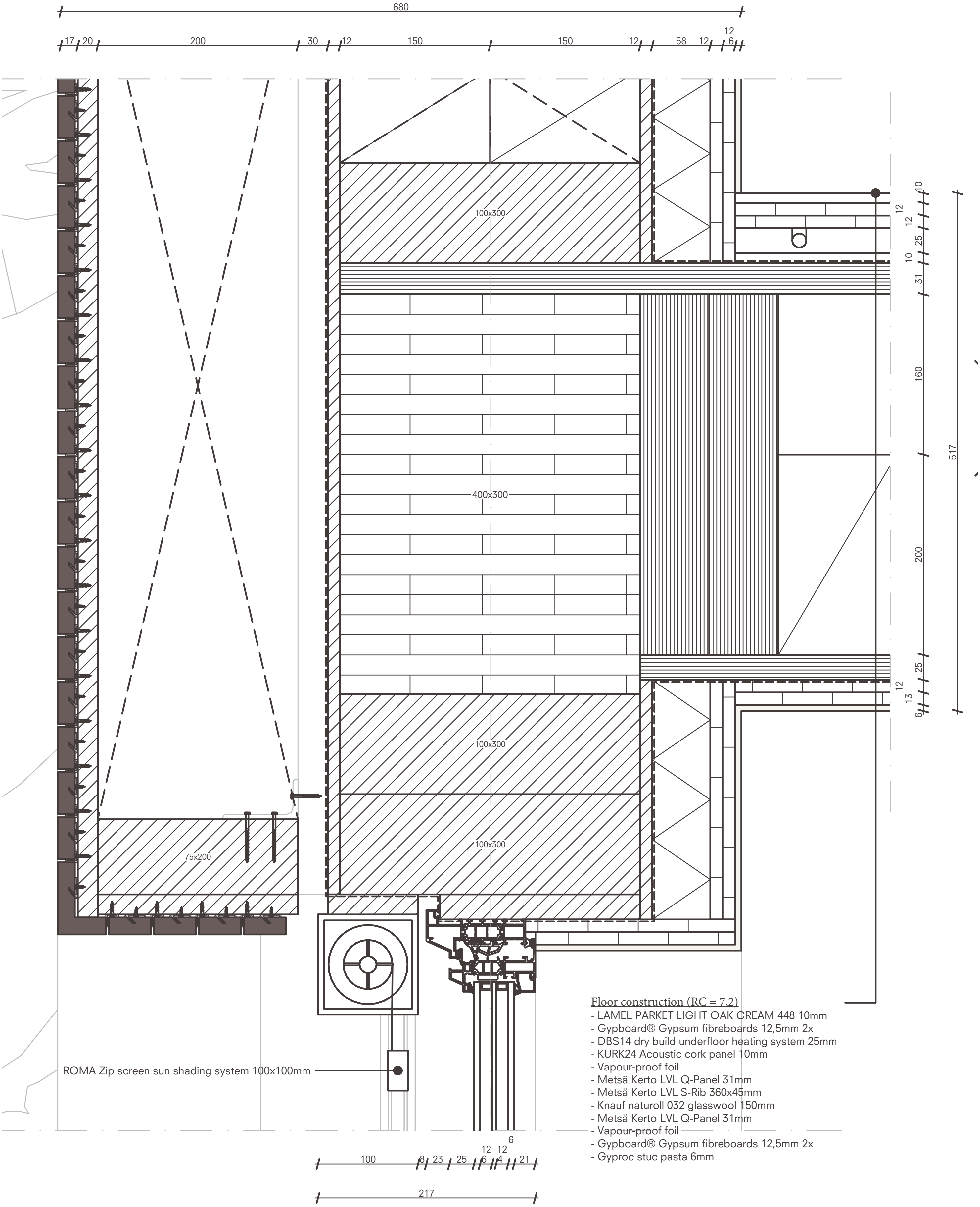


Figure 96. Vertical detail 4 (1:5)
source: author

Detail 6

Climate

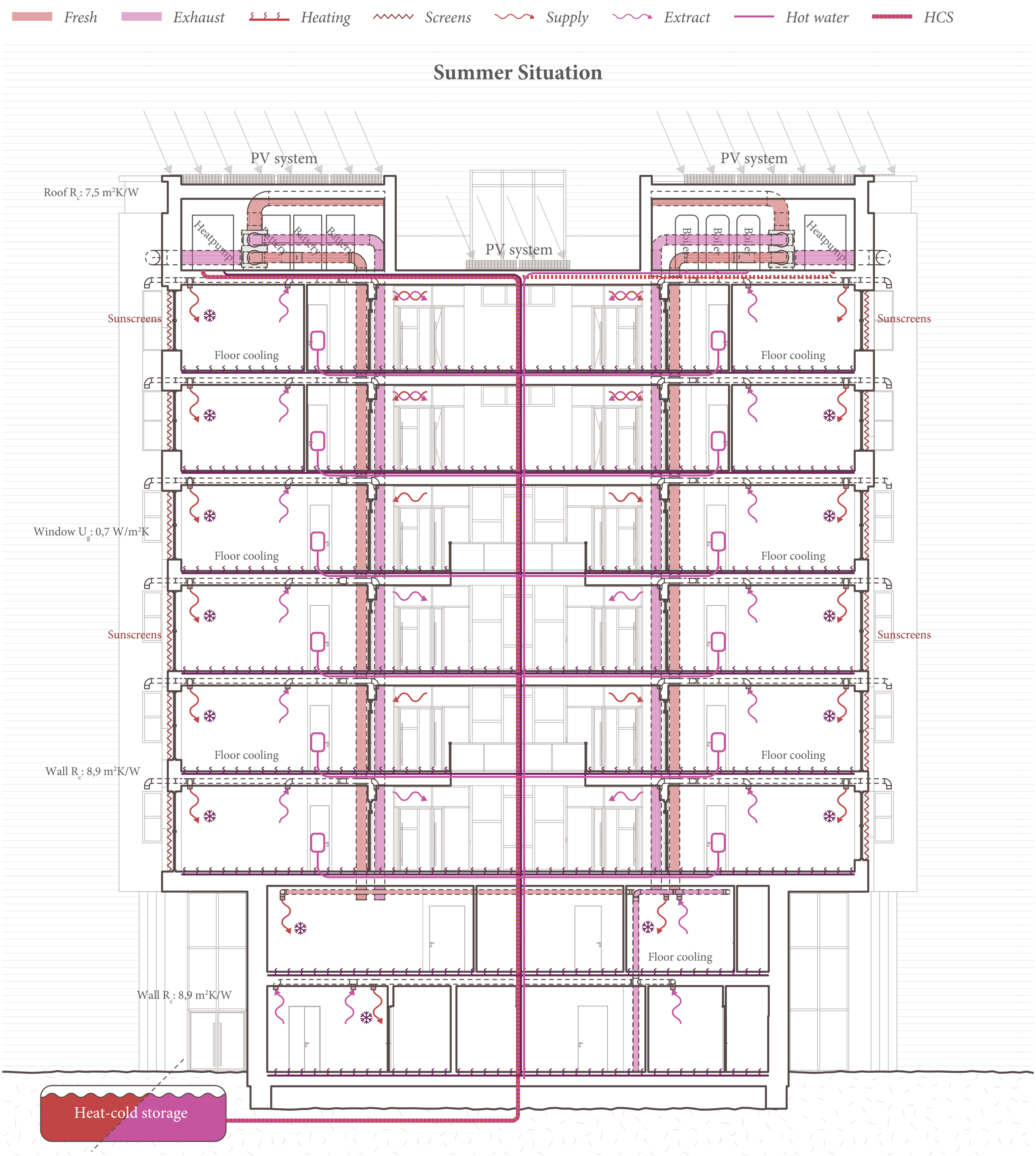


Figure 97. Summer climate scheme section (1:200)
source: author

Summer climate scheme

In the summer, the building limits overheating through external sun protection, high insulation values, floor cooling and system D ventilation. The heat-cold storage system provides cool water to the floors, while the ventilation system supplies chilled air. PV panels generate electricity and battery storage supports evening use.

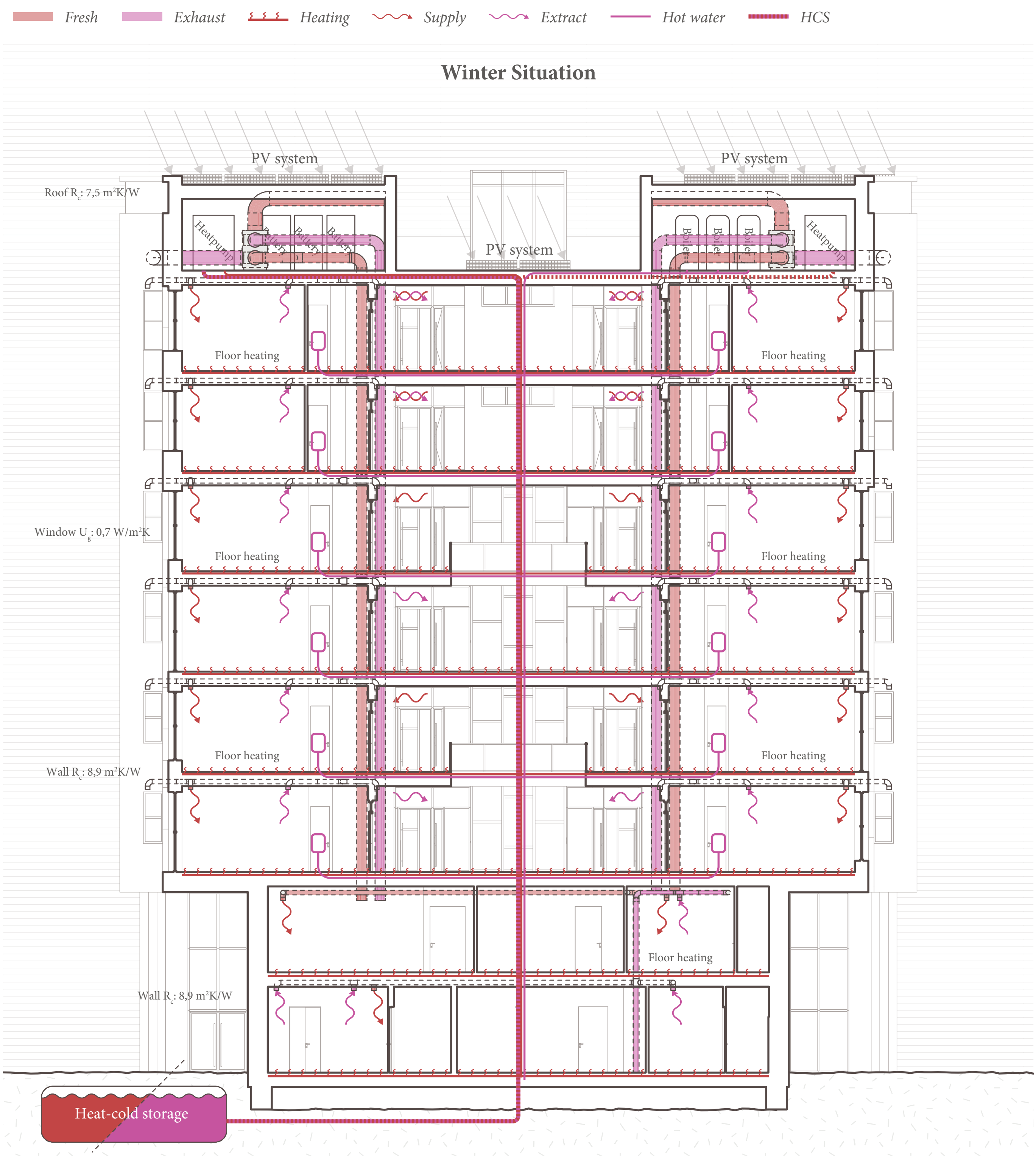


Figure 98. Winter climate scheme section (1:200)
source: author

Winter climate scheme

In the winter, the heat pump uses stored thermal energy from the heat-cold storage system to supply low-temperature floor heating and hot water. The insulated building reduces heat loss, while mechanical ventilation with heat recovery maintains air quality without a high energy demand, creating a stable and comfortable indoor climate.

Sanctuary

Supply Corner Apartment | **Area [m^2]**
- Kitchen 14,58
- Living room 15,77
- Bedroom 14,05 +

44,40 m^2

(1)(a) habitable area · 0.9 $dm^3/s/m^2$

44,40 m^2 · 0,9 $dm^3/s/m^2$ = 39,96 dm^3/s

1 dm^3/s = 3,6 m^3/h

► 39,96 dm^3/s = 143,856 m^3/h

Exhaust Corner Apartment | **Vent [dm^3/s]**
- Living area with kitchen 21
- Sanitary 14 +

35 dm^3/s

(3) cooking appliance = 21 dm^3/s
(5) Toilet or bathroom = 7 dm^3/s or 14 dm^3/s

= 35 dm^3/s

1 dm^3/s = 3,6 m^3/h

► 35 dm^3/s = 126 m^3/h

Sanctuary
Corner Apartment

143,856 m^3/h > 126 m^3/h

► 143,856 m^3/h supply

► 143,856 m^3/h exhaust

Supply Mid-unit Apartment | **Area [m^2]**
- Living area with kitchen 21,97
- Bedroom 13,01 +

34,98 m^2

(1)(a) habitable area · 0.9 $dm^3/s/m^2$

34,98 m^2 · 0,9 $dm^3/s/m^2$ = 31,482 dm^3/s

1 dm^3/s = 3,6 m^3/h

► 31,482 dm^3/s = 113,3352 m^3/h

Exhaust Mid-unit Apartment | **Vent [dm^3/s]**
- Living area with kitchen 21
- Sanitary 14 +

35 dm^3/s

(3) cooking appliance = 21 dm^3/s
(5) Toilet or bathroom = 7 dm^3/s or 14 dm^3/s

= 35 dm^3/s

1 dm^3/s = 3,6 m^3/h

► 35 dm^3/s = 126 m^3/h

Sanctuary
Mid-unit Apartment

113,3352 m^3/h < 126 m^3/h

► 126 m^3/h supply

► 126 m^3/h exhaust

Supply Social hub Shared Space | **Area [m^2]**
- Lounge & Dining area 51,27 +

51,27 m^2

(1)(a) habitable area · 0.9 $dm^3/s/m^2$

51,27 m^2 · 0,9 $dm^3/s/m^2$ = 46,143 dm^3/s

1 dm^3/s = 3,6 m^3/h

► 46,143 dm^3/s = 166,1148 m^3/h

Exhaust Social hub Shared Space | **Vent [dm^3/s]**

= 0 dm^3/s

1 dm^3/s = 3,6 m^3/h

► 0 dm^3/s = 0 m^3/h

Social Hub
Shared Space

166,1148 m^3/h < 0 m^3/h

► 166,1148 m^3/h supply

► 166,1148 m^3/h exhaust

Supply Sanctuary Staff | **Area [m^2]**
- Kitchen Area 24,05
- Staff Office 10,26
- Staff Bedroom 10,03 +

44,34 m^2

(1)(a) habitable area · 0.9 $dm^3/s/m^2$

44,34 m^2 · 0,9 $dm^3/s/m^2$ = 39,906 dm^3/s

1 dm^3/s = 3,6 m^3/h

► 39,906 dm^3/s = 143,6616 m^3/h

Exhaust Sanctuary Staff | **Vent [dm^3/s]**
- Kitchen area 21
- Sanitary 14
- Sanitary 7 +

42 dm^3/s

(3) cooking appliance = 21 dm^3/s
(5) Toilet or bathroom = 7 dm^3/s or 14 dm^3/s

= 42 dm^3/s

1 dm^3/s = 3,6 m^3/h

► 42 dm^3/s = 151,2 m^3/h

Sanctuary
Sanctuary Shared Space

143,6616 m^3/h > 151,2 m^3/h

► 151,2 m^3/h supply

► 151,2 m^3/h exhaust

Figure 99. Ventilation requirement calculations for the Sanctuary units
source: author, (Rijksoverheid, 2026)

Supply Extract

Entrance

Supply Ground Floor | **Area [m²]**
- Lobby | 86,57 +
86,57 m²

(1)(a) habitable area · 0.9 dm³/s/m²

86,57 m² · 0,9 dm³/s/m² = 77,913 dm³/s
1 dm³/s = 3,6 m³/h
► 77,913 dm³/s = 280,4868 m³/h

Exhaust Ground Floor | **Vent [dm³/s]**

= 0 dm³/s
1 dm³/s = 3,6 m³/h
► 0 dm³/s = 0 m³/h

Entrance Ground Floor
280,4868 m³/h > 0 m³/h
► 280,4868 m³/h supply
► 280,4868 m³/h exhaust

Supply 1st Floor | **Area [m²]**
- Staff Room | 21,72
- Consultation Room | 30,21
- Consultation Room | 27,66 +
79,59 m²

(1)(a) habitable area · 0.9 dm³/s/m²

79,59 m² · 0,9 dm³/s/m² = 71,631 dm³/s
1 dm³/s = 3,6 m³/h
► 71,631 dm³/s = 257,8716 m³/h

Exhaust 1st Floor | **Vent [dm³/s]**
- Sanitary | 7
- Laundry Room | 14 +
21 dm³/s

(3) cooking appliance = 21 dm³/s
(5) Toilet or bathroom = 7 dm³/s or 14 dm³/s

= 21 dm³/s
1 dm³/s = 3,6 m³/h
► 75,6 dm³/s = 75,6 m³/h

Entrance 1st Floor
257,8716 m³/h < 75,6 m³/h
► 257,8716 m³/h supply
► 257,8716 m³/h exhaust

Besluit Bouwwerken Leefomgeving Article 4.122

(1)(a) The minimum ventilation rate for a habitable area is 0.9 dm³/s per square meter of floor area.

(3) Any habitable area or habitable room containing a cooking appliance must be equipped with a ventilation system with a minimum capacity of 21 dm³/s, as determined by the NEN 1087 standa

(5) Toilet and bathroom facilities must be equipped with a ventilation system with a minimum capacity (as determined by NEN 1087) of: a. 7 dm³/s for a toilet; and b. 14 dm³/s for a bathroom.

Figure 100. Ventilation requirement calculations for the Entrance units
source: author, (Rijksoverheid, 2026)

Ventilation requirements

These calculations show the supply and exhaust requirements based on floor area and usage, as defined by Dutch building regulations. These calculations guarantee a healthy indoor environment that supports the sensory needs and well-being of residents.

Social Hub

Supply Corner Apartment | **Area [m²]**
- Living area with kitchen 26,63
- Bedroom 14,05 +

40,68 m²

(1)(a) habitable area · 0.9 dm³/s/m²

40,68 m² · 0,9 dm³/s/m² = 36,612 dm³/s

1 dm³/s = 3,6 m³/h

▸ 36,612 dm³/s = 131,8032 m³/h

Exhaust Corner Apartment | **Vent [dm³/s]**
- Living area with kitchen 21
- Sanitary 14 +

35 dm³/s

(3) cooking appliance = 21 dm³/s
(5) Toilet or bathroom = 7 dm³/s or 14 dm³/s

= 35 dm³/s

1 dm³/s = 3,6 m³/h

▸ 35 dm³/s = 126 m³/h

Social Hub
Corner Apartment

131,8032 m³/h > 126 m³/h

▸ 131,8032 m³/h supply

▸ 131,8032 m³/h exhaust

Supply Mid-unit Apartment | **Area [m²]**
- Living area with kitchen 21,72
- Bedroom 13,01 +

34,73 m²

(1)(a) habitable area · 0.9 dm³/s/m²

34,73 m² · 0,9 dm³/s/m² = 31,257 dm³/s

1 dm³/s = 3,6 m³/h

▸ 31,257 dm³/s = 112,5252 m³/h

Exhaust Mid-unit Apartment | **Vent [dm³/s]**
- Living area with kitchen 21
- Sanitary 14 +

35 dm³/s

(3) cooking appliance = 21 dm³/s
(5) Toilet or bathroom = 7 dm³/s or 14 dm³/s

= 35 dm³/s

1 dm³/s = 3,6 m³/h

▸ 35 dm³/s = 126 m³/h

Social Hub
Mid-unit Apartment

112,5252 m³/h < 126 m³/h

▸ 126 m³/h supply

▸ 126 m³/h exhaust

Supply Social hub Shared Space | **Area [m²]**
- Lounge & Dining area 51,27 +

51,27 m²

(1)(a) habitable area · 0.9 dm³/s/m²

51,27 m² · 0,9 dm³/s/m² = 46,143 dm³/s

1 dm³/s = 3,6 m³/h

▸ 46,143 dm³/s = 166,1148 m³/h

Exhaust Social hub Shared Space | **Vent [dm³/s]**

= 0 dm³/s

1 dm³/s = 3,6 m³/h

▸ 0 dm³/s = 0 m³/h

Social Hub
Shared Space

166,1148 m³/h < 0 m³/h

▸ 166,1148 m³/h supply

▸ 166,1148 m³/h exhaust

Supply Social hub Staff | **Area [m²]**
- Kitchen Area 34,52
- Staff Office 13,68 +

48,2 m²

(1)(a) habitable area · 0.9 dm³/s/m²

48,2 m² · 0,9 dm³/s/m² = 43,38 dm³/s

1 dm³/s = 3,6 m³/h

▸ 43,38 dm³/s = 156,168 m³/h

Exhaust Social hub Staff | **Vent [dm³/s]**
- Kitchen Area 21 +

21 dm³/s

(3) cooking appliance = 21 dm³/s

= 21 dm³/s

1 dm³/s = 3,6 m³/h

▸ 21 dm³/s = 75,6 m³/h

Social Hub
Shared Space

156,168 m³/h < 75,6 m³/h

▸ 156,168 m³/h supply

▸ 156,168 m³/h exhaust

Figure 101. Ventilation requirement calculations for the Social Hub units
source: author, (Rijksoverheid, 2026)

Supply *Extract*

Cafe

Supply Cafe	**Area [m^2]**
- Seating Area	94,50
- Bar & Kitchen	31,81
- Office	11,44 +
	137,75 m^2

(1)(a) habitable area · 0.9 $dm^3/s/m^2$

137,75 m^2 · 0,9 $dm^3/s/m^2$ = 123,975 dm^3/s

1 dm^3/s = 3,6 m^3/h

► 123,975 dm^3/s = 446,31 m^3/h

Exhaust Corner Apartment	**Vent [dm^3/s]**
- Bar & Kitchen	21
- 2x Sanitary	14 +
	35 dm^3/s

(3) cooking appliance = 21 dm^3/s
(5) Toilet or bathroom = 7 dm^3/s or 14 dm^3/s

= 35 dm^3/s

1 dm^3/s = 3,6 m^3/h

► 35 dm^3/s = 126 m^3/h

Cafe

446,31 m^3/h > 126 m^3/h

► 446,31 m^3/h supply

► 446,31 m^3/h exhaust

Library

Supply Library	**Area [m^2]**
- Reading Square	57,30
- Shelving Area	76,05
- Computer Area	28,39
- Helpdesk	9,13
- Office	13,88
- Back Office	5,88 +
	190,63 m^2

(1)(a) habitable area · 0.9 $dm^3/s/m^2$

190,63 m^2 · 0,9 $dm^3/s/m^2$ = 171,567 dm^3/s

1 dm^3/s = 3,6 m^3/h

► 171,567 dm^3/s = 617,6412 m^3/h

Exhaust Library	**Vent [dm^3/s]**
- 2x Sanitary	14 +
	14 dm^3/s

(3) cooking appliance = 21 dm^3/s
(5) Toilet or bathroom = 7 dm^3/s or 14 dm^3/s

= 14 dm^3/s

1 dm^3/s = 3,6 m^3/h

► 14 dm^3/s = 50,4 m^3/h

Library

617,6412 m^3/h < 50,4 m^3/h

► 617,6412 m^3/h supply

► 617,6412 m^3/h exhaust

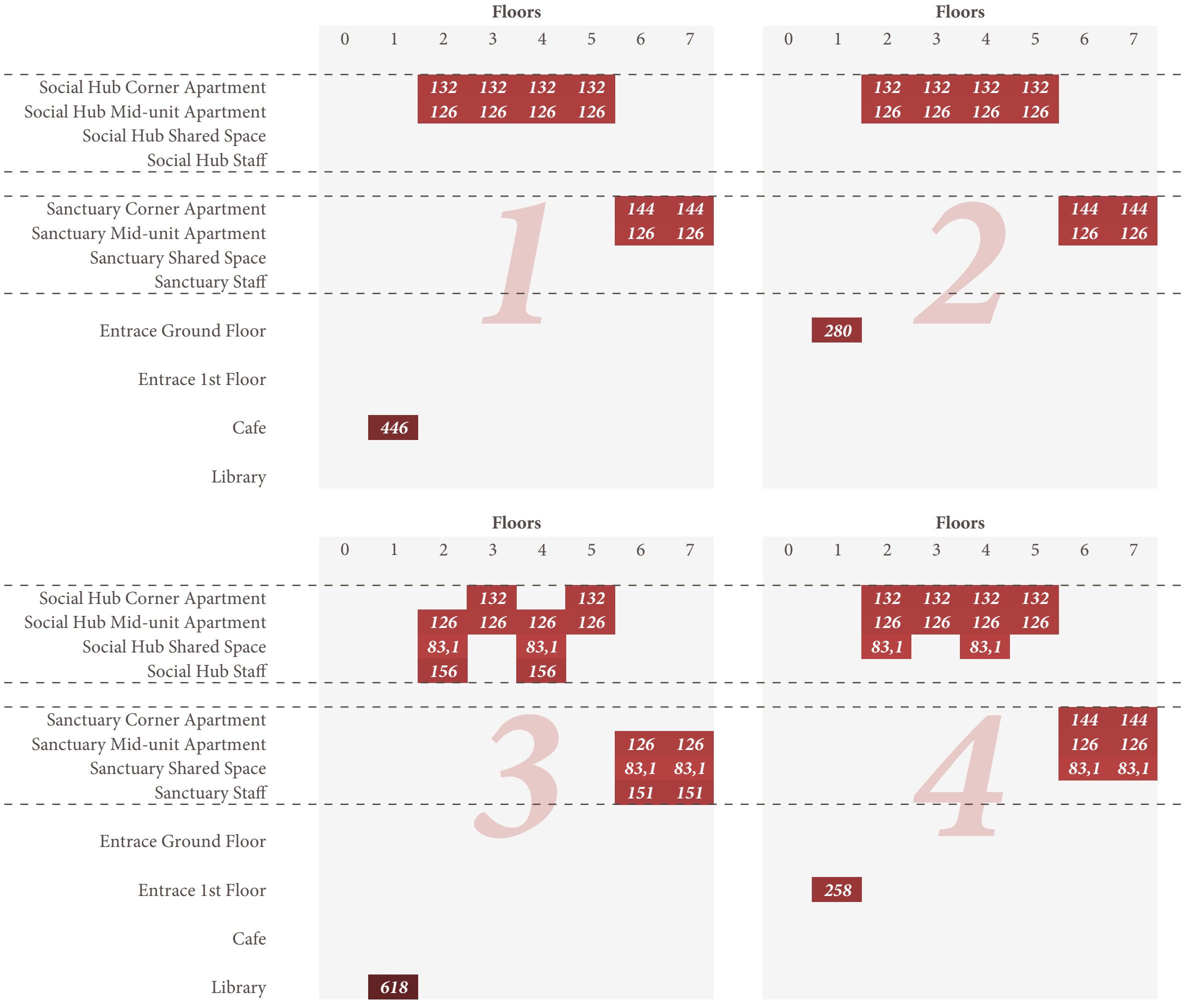
Besluit Bouwwerken Leefomgeving Article 4.122

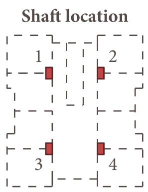
(1)(a) The minimum ventilation rate for a habitable area is 0.9 dm^3/s per square meter of floor area.

(3) Any habitable area or habitable room containing a cooking appliance must be equipped with a ventilation system with a minimum capacity of 21 dm^3/s, as determined by the NEN 1087 standa

(5) Toilet and bathroom facilities must be equipped with a ventilation system with a minimum capacity (as determined by NEN 1087) of: a. 7 dm^3/s for a toilet; and b. 14 dm^3/s for a bathroom.

Figure 102. Ventilation requirement calculations for the Cafe and Library units
source: author, (Rijksoverheid, 2026)





Total supply

- Shaft 1 2017,2348 m³/h
- Shaft 2 1851,4116 m³/h
- Shaft 3 2584,2132 m³/h
- Shaft 4 2161,026 m³/h +

8613,8856 m³/h

Figure 103. Total supply ventilation requirement calculations per shaft
source: author

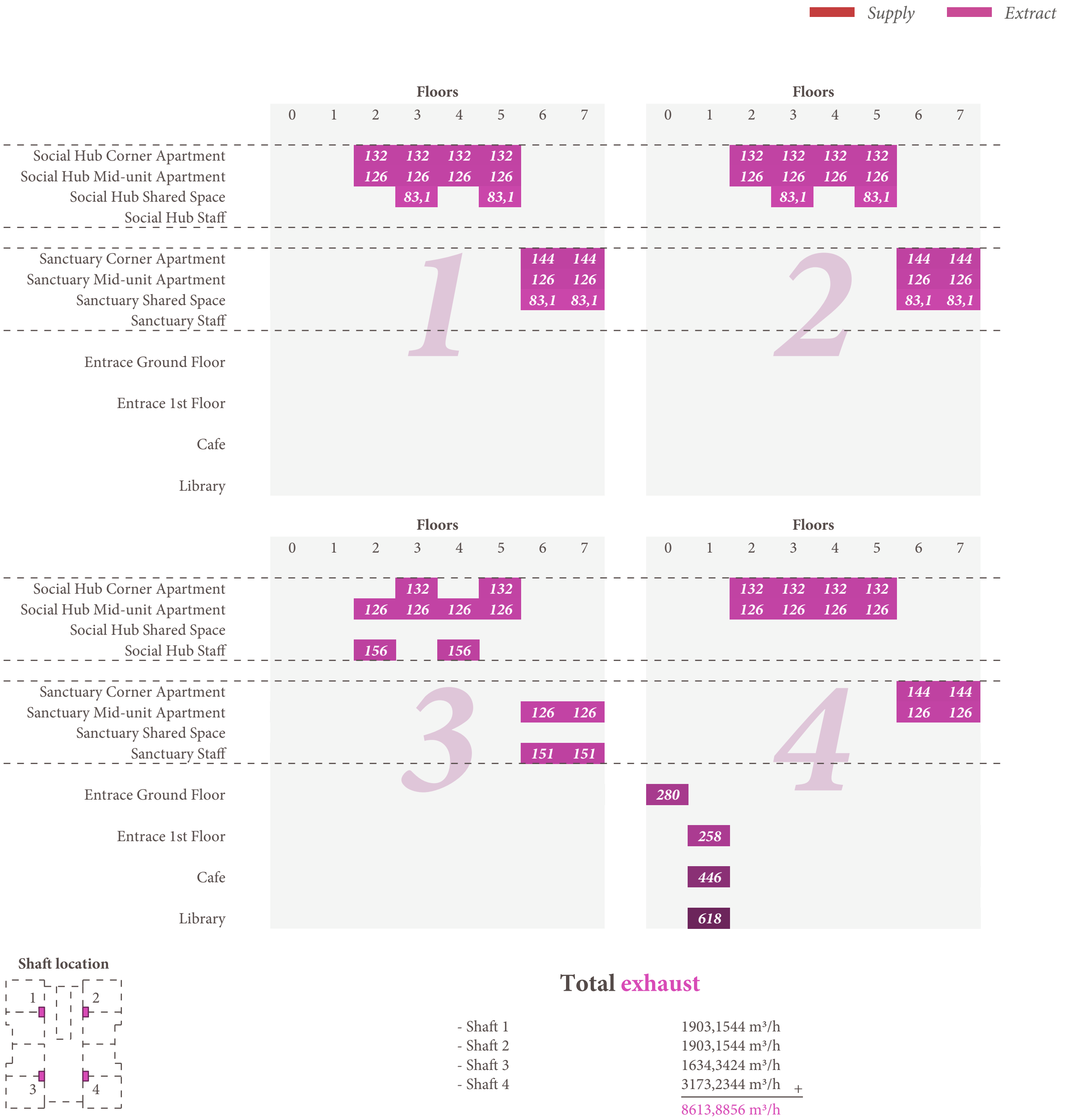
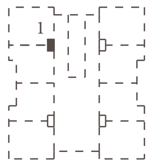


Figure 104. Total exhaust ventilation requirement calculations per shaft
source: author

Total ventilation per duct

Overview of the total ventilation needs per shaft. These calculations determine the required duct diameters to make sure that the building is sufficiently ventilated and provides a comfortable indoor climate.

Shaft 1



- Required supply 2017,2348 m³/h

= 2017,2348 m³/3600s

= 0,560343 m³/s

- Maximum air velocity 3 m/s

$$= \frac{0{,}560343 \text{ m}^3\text{/s}}{3 \text{ m/s}} = 0{,}186781 \text{ m}^2 \approx 0{,}187 \text{ m}^2$$

2 x Ø355 duct = 0,198 m²

0,187 m² < 0,198 m²

► 2 x Ø355 duct at 3m/s

Duct diameter [mm]

Amount of ducts [n]	80	100	125	150	160	180	200	224	250	280	300	315	355	400	450	500	600	630	710	800	900	1000
1	0,005	0,008	0,012	0,018	0,02	0,025	0,031	0,039	0,049	0,062	0,071	0,078	0,099	0,126	0,159	*0,196*	*0,283*	*0,312*	*0,396*	*0,503*	*0,636*	*0,785*
2	0,01	0,016	0,025	0,035	0,04	0,051	0,063	0,079	0,098	0,123	0,141	0,156	*0,198*	*0,251*	*0,318*	0,393	0,565	0,623	0,792	1,005	1,272	1,571
3	0,015	0,024	0,037	0,053	0,06	0,076	0,094	0,118	0,147	0,185	*0,212*	*0,234*	0,297	0,377	0,477	0,589	0,848	0,935	1,188	1,508	1,909	2,356
4	0,02	0,031	0,049	0,071	0,08	0,102	0,126	0,158	*0,196*	*0,246*	0,283	0,312	0,396	0,503	0,636	0,785	1,131	1,247	1,584	2,011	2,545	3,142
5	0,025	0,039	0,061	0,088	0,101	0,127	0,157	*0,197*	0,245	0,308	0,353	0,39	0,495	0,628	0,795	0,982	1,414	1,559	1,98	2,513	3,181	3,927
6	0,03	0,047	0,074	0,106	0,121	0,153	*0,188*	0,236	0,295	0,369	0,424	0,468	0,594	0,754	0,954	1,178	1,696	1,87	2,376	3,016	3,817	4,712
7	0,035	0,055	0,086	0,124	0,141	0,178	0,22	0,276	0,344	0,431	0,495	0,546	0,693	0,88	1,113	1,374	1,979	2,182	2,771	3,519	4,453	5,498
8	0,04	0,063	0,098	0,141	0,161	*0,204*	0,251	0,315	0,393	0,493	0,565	0,623	0,792	1,005	1,272	1,571	2,262	2,494	3,167	4,021	5,089	6,283
9	0,045	0,071	0,11	0,159	0,181	0,229	0,283	0,355	0,442	0,554	0,636	0,701	0,891	1,131	1,431	1,767	2,545	2,806	3,563	4,524	5,726	7,069
10	0,05	0,079	0,123	0,177	*0,201*	0,254	0,314	0,394	0,491	0,616	0,707	0,779	0,99	1,257	1,59	1,963	2,827	3,117	3,959	5,027	6,362	7,854
11	0,055	0,086	0,135	*0,194*	0,221	0,28	0,346	0,433	0,54	0,677	0,778	0,857	1,089	1,382	1,749	2,16	3,11	3,429	4,355	5,529	6,998	8,639
12	0,06	0,094	0,147	0,212	0,241	0,305	0,377	0,473	0,589	0,739	0,848	0,935	1,188	1,508	1,909	2,356	3,393	3,741	4,751	6,032	7,634	9,425
13	0,065	0,102	0,16	0,23	0,261	0,331	0,408	0,512	0,638	0,8	0,919	1,013	1,287	1,634	2,068	2,553	3,676	4,052	5,147	6,535	8,27	10,21
14	0,07	0,11	0,172	0,247	0,281	0,356	0,44	0,552	0,687	0,862	0,99	1,091	1,386	1,759	2,227	2,749	3,958	4,364	5,543	7,037	8,906	11
15	0,075	0,118	0,184	0,265	0,302	0,382	0,471	0,591	0,736	0,924	1,06	1,169	1,485	1,885	2,386	2,945	4,241	4,676	5,939	7,54	9,543	11,78

- Required exhaust 1903,1544 m³/h

= 1903,1544 m³/3600s

= 0,528654 m³/s

- Maximum air velocity 3 m/s

$$= \frac{0{,}528654 \text{ m}^3\text{/s}}{3 \text{ m/s}} = 0{,}176218 \text{ m}^2 \approx 0{,}177 \text{ m}^2$$

2 x Ø355 duct = 0,198 m²

0,177 m² < 0,198 m²

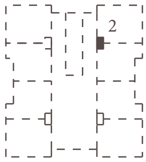
► 2 x Ø355 duct at 3m/s

Duct diameter [mm]

Amount of ducts [n]	80	100	125	150	160	180	200	224	250	280	300	315	355	400	450	500	600	630	710	800	900	1000
1	0,005	0,008	0,012	0,018	0,02	0,025	0,031	0,039	0,049	0,062	0,071	0,078	0,099	0,126	0,159	*0,196*	*0,283*	*0,312*	*0,396*	*0,503*	*0,636*	*0,785*
2	0,01	0,016	0,025	0,035	0,04	0,051	0,063	0,079	0,098	0,123	0,141	0,156	*0,198*	*0,251*	*0,318*	0,393	0,565	0,623	0,792	1,005	1,272	1,571
3	0,015	0,024	0,037	0,053	0,06	0,076	0,094	0,118	0,147	*0,185*	*0,212*	*0,234*	0,297	0,377	0,477	0,589	0,848	0,935	1,188	1,508	1,909	2,356
4	0,02	0,031	0,049	0,071	0,08	0,102	0,126	0,158	*0,196*	0,246	0,283	0,312	0,396	0,503	0,636	0,785	1,131	1,247	1,584	2,011	2,545	3,142
5	0,025	0,039	0,061	0,088	0,101	0,127	0,157	*0,197*	0,245	0,308	0,353	0,39	0,495	0,628	0,795	0,982	1,414	1,559	1,98	2,513	3,181	3,927
6	0,03	0,047	0,074	0,106	0,121	0,153	*0,188*	0,236	0,295	0,369	0,424	0,468	0,594	0,754	0,954	1,178	1,696	1,87	2,376	3,016	3,817	4,712
7	0,035	0,055	0,086	0,124	0,141	*0,178*	0,22	0,276	0,344	0,431	0,495	0,546	0,693	0,88	1,113	1,374	1,979	2,182	2,771	3,519	4,453	5,498
8	0,04	0,063	0,098	0,141	0,161	0,204	0,251	0,315	0,393	0,493	0,565	0,623	0,792	1,005	1,272	1,571	2,262	2,494	3,167	4,021	5,089	6,283
9	0,045	0,071	0,11	0,159	*0,181*	0,229	0,283	0,355	0,442	0,554	0,636	0,701	0,891	1,131	1,431	1,767	2,545	2,806	3,563	4,524	5,726	7,069
10	0,05	0,079	0,123	*0,177*	0,201	0,254	0,314	0,394	0,491	0,616	0,707	0,779	0,99	1,257	1,59	1,963	2,827	3,117	3,959	5,027	6,362	7,854
11	0,055	0,086	0,135	0,194	0,221	0,28	0,346	0,433	0,54	0,677	0,778	0,857	1,089	1,382	1,749	2,16	3,11	3,429	4,355	5,529	6,998	8,639
12	0,06	0,094	0,147	0,212	0,241	0,305	0,377	0,473	0,589	0,739	0,848	0,935	1,188	1,508	1,909	2,356	3,393	3,741	4,751	6,032	7,634	9,425
13	0,065	0,102	0,16	0,23	0,261	0,331	0,408	0,512	0,638	0,8	0,919	1,013	1,287	1,634	2,068	2,553	3,676	4,052	5,147	6,535	8,27	10,21
14	0,07	0,11	0,172	0,247	0,281	0,356	0,44	0,552	0,687	0,862	0,99	1,091	1,386	1,759	2,227	2,749	3,958	4,364	5,543	7,037	8,906	11
15	0,075	0,118	*0,184*	0,265	0,302	0,382	0,471	0,591	0,736	0,924	1,06	1,169	1,485	1,885	2,386	2,945	4,241	4,676	5,939	7,54	9,543	11,78

Figure 105. Duct diameter size calculations for supply and exhaust ventilation in shaft 1
source: author

Supply Extract



Shaft 2

- Required supply: 1851,4116 m³/h = 1851,4116 m³/3600s = 0,514281 m³/s
- Maximum air velocity: 3 m/s

$$= \frac{0{,}514281 \text{ m}^3/\text{s}}{3 \text{ m/s}} = 0{,}171427 \text{ m}^2 \approx 0{,}172 \text{ m}^2$$

2 x Ø355 duct = 0,198 m²

0,172 m² < 0,198 m²

► 2 x Ø355 duct at 3m/s

Duct diameter [mm] / Amount of ducts [n]

n	80	100	125	150	160	180	200	224	250	280	300	315	355	400	450	500	600	630	710	800	900	1000
1	0,005	0,008	0,012	0,018	0,02	0,025	0,031	0,039	0,049	0,062	0,071	0,078	0,099	0,126	0,159	**0,196**	**0,283**	**0,312**	**0,396**	**0,503**	**0,636**	**0,785**
2	0,01	0,016	0,025	0,035	0,04	0,051	0,063	0,079	0,098	0,123	0,141	0,156	**0,198**	**0,251**	**0,318**	0,393	0,565	0,623	0,792	1,005	1,272	1,571
3	0,015	0,024	0,037	0,053	0,06	0,076	0,094	0,118	0,147	**0,185**	**0,212**	**0,234**	0,297	0,377	0,477	0,589	0,848	0,935	1,188	1,508	1,909	2,356
4	0,02	0,031	0,049	0,071	0,08	0,102	0,126	0,158	**0,196**	0,246	0,283	0,312	0,396	0,503	0,636	0,785	1,131	1,247	1,584	2,011	2,545	3,142
5	0,025	0,039	0,061	0,088	0,101	0,127	0,157	**0,197**	0,245	0,308	0,353	0,39	0,495	0,628	0,795	0,982	1,414	1,559	1,98	2,513	3,181	3,927
6	0,03	0,047	0,074	0,106	0,121	0,153	**0,188**	0,236	0,295	0,369	0,424	0,468	0,594	0,754	0,954	1,178	1,696	1,87	2,376	3,016	3,817	4,712
7	0,035	0,055	0,086	0,124	0,141	**0,178**	0,22	0,276	0,344	0,431	0,495	0,546	0,693	0,88	1,113	1,374	1,979	2,182	2,771	3,519	4,453	5,498
8	0,04	0,063	0,098	0,141	0,161	0,204	0,251	0,315	0,393	0,493	0,565	0,623	0,792	1,005	1,272	1,571	2,262	2,494	3,167	4,021	5,089	6,283
9	0,045	0,071	0,11	0,159	**0,181**	0,229	0,283	0,355	0,442	0,554	0,636	0,701	0,891	1,131	1,431	1,767	2,545	2,806	3,563	4,524	5,726	7,069
10	0,05	0,079	0,123	**0,177**	0,201	0,254	0,314	0,394	0,491	0,616	0,707	0,779	0,99	1,257	1,59	1,963	2,827	3,117	3,959	5,027	6,362	7,854
11	0,055	0,086	0,135	0,194	0,221	0,28	0,346	0,433	0,54	0,677	0,778	0,857	1,089	1,382	1,749	2,16	3,11	3,429	4,355	5,529	6,998	8,639
12	0,06	0,094	0,147	0,212	0,241	0,305	0,377	0,473	0,589	0,739	0,848	0,935	1,188	1,508	1,909	2,356	3,393	3,741	4,751	6,032	7,634	9,425
13	0,065	0,102	0,16	0,23	0,261	0,331	0,408	0,512	0,638	0,8	0,919	1,013	1,287	1,634	2,068	2,553	3,676	4,052	5,147	6,535	8,27	10,21
14	0,07	0,11	**0,172**	0,247	0,281	0,356	0,44	0,552	0,687	0,862	0,99	1,091	1,386	1,759	2,227	2,749	3,958	4,364	5,543	7,037	8,906	11
15	0,075	0,118	0,184	0,265	0,302	0,382	0,471	0,591	0,736	0,924	1,06	1,169	1,485	1,885	2,386	2,945	4,241	4,676	5,939	7,54	9,543	11,78

- Required exhaust: 1903,1544 m³/h = 1903,1544 m³/3600s = 0,528654 m³/s
- Maximum air velocity: 3 m/s

$$= \frac{0{,}528654 \text{ m}^3/\text{s}}{3 \text{ m/s}} = 0{,}176218 \text{ m}^2 \approx 0{,}177 \text{ m}^2$$

2 x Ø355 duct = 0,198 m²

0,177 m² < 0,198 m²

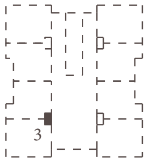
► 2 x Ø355 duct at 3m/s

Duct diameter [mm] / Amount of ducts [n]

n	80	100	125	150	160	180	200	224	250	280	300	315	355	400	450	500	600	630	710	800	900	1000
1	0,005	0,008	0,012	0,018	0,02	0,025	0,031	0,039	0,049	0,062	0,071	0,078	0,099	0,126	0,159	**0,196**	**0,283**	**0,312**	**0,396**	**0,503**	**0,636**	**0,785**
2	0,01	0,016	0,025	0,035	0,04	0,051	0,063	0,079	0,098	0,123	0,141	0,156	**0,198**	**0,251**	**0,318**	0,393	0,565	0,623	0,792	1,005	1,272	1,571
3	0,015	0,024	0,037	0,053	0,06	0,076	0,094	0,118	0,147	**0,185**	**0,212**	**0,234**	0,297	0,377	0,477	0,589	0,848	0,935	1,188	1,508	1,909	2,356
4	0,02	0,031	0,049	0,071	0,08	0,102	0,126	0,158	**0,196**	0,246	0,283	0,312	0,396	0,503	0,636	0,785	1,131	1,247	1,584	2,011	2,545	3,142
5	0,025	0,039	0,061	0,088	0,101	0,127	0,157	**0,197**	0,245	0,308	0,353	0,39	0,495	0,628	0,795	0,982	1,414	1,559	1,98	2,513	3,181	3,927
6	0,03	0,047	0,074	0,106	0,121	0,153	**0,188**	0,236	0,295	0,369	0,424	0,468	0,594	0,754	0,954	1,178	1,696	1,87	2,376	3,016	3,817	4,712
7	0,035	0,055	0,086	0,124	0,141	**0,178**	0,22	0,276	0,344	0,431	0,495	0,546	0,693	0,88	1,113	1,374	1,979	2,182	2,771	3,519	4,453	5,498
8	0,04	0,063	0,098	0,141	0,161	0,204	0,251	0,315	0,393	0,493	0,565	0,623	0,792	1,005	1,272	1,571	2,262	2,494	3,167	4,021	5,089	6,283
9	0,045	0,071	0,11	0,159	**0,181**	0,229	0,283	0,355	0,442	0,554	0,636	0,701	0,891	1,131	1,431	1,767	2,545	2,806	3,563	4,524	5,726	7,069
10	0,05	0,079	0,123	**0,177**	0,201	0,254	0,314	0,394	0,491	0,616	0,707	0,779	0,99	1,257	1,59	1,963	2,827	3,117	3,959	5,027	6,362	7,854
11	0,055	0,086	0,135	0,194	0,221	0,28	0,346	0,433	0,54	0,677	0,778	0,857	1,089	1,382	1,749	2,16	3,11	3,429	4,355	5,529	6,998	8,639
12	0,06	0,094	0,147	0,212	0,241	0,305	0,377	0,473	0,589	0,739	0,848	0,935	1,188	1,508	1,909	2,356	3,393	3,741	4,751	6,032	7,634	9,425
13	0,065	0,102	0,16	0,23	0,261	0,331	0,408	0,512	0,638	0,8	0,919	1,013	1,287	1,634	2,068	2,553	3,676	4,052	5,147	6,535	8,27	10,21
14	0,07	0,11	0,172	0,247	0,281	0,356	0,44	0,552	0,687	0,862	0,99	1,091	1,386	1,759	2,227	2,749	3,958	4,364	5,543	7,037	8,906	11
15	0,075	0,118	**0,184**	0,265	0,302	0,382	0,471	0,591	0,736	0,924	1,06	1,169	1,485	1,885	2,386	2,945	4,241	4,676	5,939	7,54	9,543	11,78

Figure 106. Duct diameter size calculations for supply and exhaust ventilation in shaft 2
source: author

Shaft 3



- Required supply 2584,2132 m³/h

$= 2584,2132\ m^3/3600s$

$= 0,717837\ m^3/s$

- Maximum air velocity 3 m/s

$= \dfrac{0,717837\ m^3/s}{3\ m/s} = 0,239279\ m^2 \approx 0,240\ m^2$

2 x Ø400 duct = 0,251 m²

$0,240\ m^2 < 0,251\ m^2$

► 2 x Ø400 duct at 3m/s

Duct diameter [mm]

Amount of ducts [n]	80	100	125	150	160	180	200	224	250	280	300	315	355	400	450	500	600	630	710	800	900	1000
1	0,005	0,008	0,012	0,018	0,02	0,025	0,031	0,039	0,049	0,062	0,071	0,078	0,099	0,126	0,159	0,196	0,283	0,312	0,396	0,503	0,636	0,785
2	0,01	0,016	0,025	0,035	0,04	0,051	0,063	0,079	0,098	0,123	0,141	0,156	0,198	0,251	0,318	0,393	0,565	0,623	0,792	1,005	1,272	1,571
3	0,015	0,024	0,037	0,053	0,06	0,076	0,094	0,118	0,147	0,185	0,212	0,234	0,297	0,377	0,477	0,589	0,848	0,935	1,188	1,508	1,909	2,356
4	0,02	0,031	0,049	0,071	0,08	0,102	0,126	0,158	0,196	0,246	0,283	0,312	0,396	0,503	0,636	0,785	1,131	1,247	1,584	2,011	2,545	3,142
5	0,025	0,039	0,061	0,088	0,101	0,127	0,157	0,197	0,245	0,308	0,353	0,39	0,495	0,628	0,795	0,982	1,414	1,559	1,98	2,513	3,181	3,927
6	0,03	0,047	0,074	0,106	0,121	0,153	0,188	0,236	0,295	0,369	0,424	0,468	0,594	0,754	0,954	1,178	1,696	1,87	2,376	3,016	3,817	4,712
7	0,035	0,055	0,086	0,124	0,141	0,178	0,22	0,276	0,344	0,431	0,495	0,546	0,693	0,88	1,113	1,374	1,979	2,182	2,771	3,519	4,453	5,498
8	0,04	0,063	0,098	0,141	0,161	0,204	0,251	0,315	0,393	0,493	0,565	0,623	0,792	1,005	1,272	1,571	2,262	2,494	3,167	4,021	5,089	6,283
9	0,045	0,071	0,11	0,159	0,181	0,229	0,283	0,355	0,442	0,554	0,636	0,701	0,891	1,131	1,431	1,767	2,545	2,806	3,563	4,524	5,726	7,069
10	0,05	0,079	0,123	0,177	0,201	0,254	0,314	0,394	0,491	0,616	0,707	0,779	0,99	1,257	1,59	1,963	2,827	3,117	3,959	5,027	6,362	7,854
11	0,055	0,086	0,135	0,194	0,221	0,28	0,346	0,433	0,54	0,677	0,778	0,857	1,089	1,382	1,749	2,16	3,11	3,429	4,355	5,529	6,998	8,639
12	0,06	0,094	0,147	0,212	0,241	0,305	0,377	0,473	0,589	0,739	0,848	0,935	1,188	1,508	1,909	2,356	3,393	3,741	4,751	6,032	7,634	9,425
13	0,065	0,102	0,16	0,23	0,261	0,331	0,408	0,512	0,638	0,8	0,919	1,013	1,287	1,634	2,068	2,553	3,676	4,052	5,147	6,535	8,27	10,21
14	0,07	0,11	0,172	0,247	0,281	0,356	0,44	0,552	0,687	0,862	0,99	1,091	1,386	1,759	2,227	2,749	3,958	4,364	5,543	7,037	8,906	11
15	0,075	0,118	0,184	0,265	0,302	0,382	0,471	0,591	0,736	0,924	1,06	1,169	1,485	1,885	2,386	2,945	4,241	4,676	5,939	7,54	9,543	11,78

- Required exhaust 1634,3424 m³/h

$= 1634,3424\ m^3/3600s$

$= 0,453984\ m^3/s$

- Maximum air velocity 3 m/s

$= \dfrac{0,453984\ m^3/s}{3\ m/s} = 0,151328\ m^2 \approx 0,152\ m^2$

2 x Ø315 duct = 0,156 m²

$0,152\ m^2 < 0,156\ m^2$

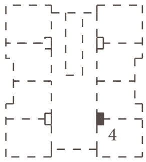
► 2 x Ø315 duct at 3m/s

Duct diameter [mm]

Amount of ducts [n]	80	100	125	150	160	180	200	224	250	280	300	315	355	400	450	500	600	630	710	800	900	1000
1	0,005	0,008	0,012	0,018	0,02	0,025	0,031	0,039	0,049	0,062	0,071	0,078	0,099	0,126	0,159	0,196	0,283	0,312	0,396	0,503	0,636	0,785
2	0,01	0,016	0,025	0,035	0,04	0,051	0,063	0,079	0,098	0,123	0,141	0,156	0,198	0,251	0,318	0,393	0,565	0,623	0,792	1,005	1,272	1,571
3	0,015	0,024	0,037	0,053	0,06	0,076	0,094	0,118	0,147	0,185	0,212	0,234	0,297	0,377	0,477	0,589	0,848	0,935	1,188	1,508	1,909	2,356
4	0,02	0,031	0,049	0,071	0,08	0,102	0,126	0,158	0,196	0,246	0,283	0,312	0,396	0,503	0,636	0,785	1,131	1,247	1,584	2,011	2,545	3,142
5	0,025	0,039	0,061	0,088	0,101	0,127	0,157	0,197	0,245	0,308	0,353	0,39	0,495	0,628	0,795	0,982	1,414	1,559	1,98	2,513	3,181	3,927
6	0,03	0,047	0,074	0,106	0,121	0,153	0,188	0,236	0,295	0,369	0,424	0,468	0,594	0,754	0,954	1,178	1,696	1,87	2,376	3,016	3,817	4,712
7	0,035	0,055	0,086	0,124	0,141	0,178	0,22	0,276	0,344	0,431	0,495	0,546	0,693	0,88	1,113	1,374	1,979	2,182	2,771	3,519	4,453	5,498
8	0,04	0,063	0,098	0,141	0,161	0,204	0,251	0,315	0,393	0,493	0,565	0,623	0,792	1,005	1,272	1,571	2,262	2,494	3,167	4,021	5,089	6,283
9	0,045	0,071	0,11	0,159	0,181	0,229	0,283	0,355	0,442	0,554	0,636	0,701	0,891	1,131	1,431	1,767	2,545	2,806	3,563	4,524	5,726	7,069
10	0,05	0,079	0,123	0,177	0,201	0,254	0,314	0,394	0,491	0,616	0,707	0,779	0,99	1,257	1,59	1,963	2,827	3,117	3,959	5,027	6,362	7,854
11	0,055	0,086	0,135	0,194	0,221	0,28	0,346	0,433	0,54	0,677	0,778	0,857	1,089	1,382	1,749	2,16	3,11	3,429	4,355	5,529	6,998	8,639
12	0,06	0,094	0,147	0,212	0,241	0,305	0,377	0,473	0,589	0,739	0,848	0,935	1,188	1,508	1,909	2,356	3,393	3,741	4,751	6,032	7,634	9,425
13	0,065	0,102	0,16	0,23	0,261	0,331	0,408	0,512	0,638	0,8	0,919	1,013	1,287	1,634	2,068	2,553	3,676	4,052	5,147	6,535	8,27	10,21
14	0,07	0,11	0,172	0,247	0,281	0,356	0,44	0,552	0,687	0,862	0,99	1,091	1,386	1,759	2,227	2,749	3,958	4,364	5,543	7,037	8,906	11
15	0,075	0,118	0,184	0,265	0,302	0,382	0,471	0,591	0,736	0,924	1,06	1,169	1,485	1,885	2,386	2,945	4,241	4,676	5,939	7,54	9,543	11,78

Figure 107. Duct diameter size calculations for supply and exhaust ventilation in shaft 3
source: author

Supply Extract



Shaft 4

- Required supply: 2161,026 m³/h $= 2161{,}026\ \text{m}^3/3600\text{s} = 0{,}600285\ \text{m}^3/\text{s}$
- Maximum air velocity: 3 m/s

$$= \frac{0{,}600285\ \text{m}^3/\text{s}}{3\ \text{m/s}} = 0{,}200095\ \text{m}^2 \approx 0{,}201\ \text{m}^2$$

2 x Ø400 duct = 0,251 m²

0,201 m² < 0,251 m²

► 2 x Ø400 duct at 3m/s

Duct diameter [mm]

Amount of ducts [n]	80	100	125	150	160	180	200	224	250	280	300	315	355	400	450	500	600	630	710	800	900	1000
1	0,005	0,008	0,012	0,018	0,02	0,025	0,031	0,039	0,049	0,062	0,071	0,078	0,099	0,126	0,159	0,196	0,283	0,312	0,396	0,503	0,636	0,785
2	0,01	0,016	0,025	0,035	0,04	0,051	0,063	0,079	0,098	0,123	0,141	0,156	0,198	0,251	0,318	0,393	0,565	0,623	0,792	1,005	1,272	1,571
3	0,015	0,024	0,037	0,053	0,06	0,076	0,094	0,118	0,147	0,185	0,212	0,234	0,297	0,377	0,477	0,589	0,848	0,935	1,188	1,508	1,909	2,356
4	0,02	0,031	0,049	0,071	0,08	0,102	0,126	0,158	0,196	0,246	0,283	0,312	0,396	0,503	0,636	0,785	1,131	1,247	1,584	2,011	2,545	3,142
5	0,025	0,039	0,061	0,088	0,101	0,127	0,157	0,197	0,245	0,308	0,353	0,39	0,495	0,628	0,795	0,982	1,414	1,559	1,98	2,513	3,181	3,927
6	0,03	0,047	0,074	0,106	0,121	0,153	0,188	0,236	0,295	0,369	0,424	0,468	0,594	0,754	0,954	1,178	1,696	1,87	2,376	3,016	3,817	4,712
7	0,035	0,055	0,086	0,124	0,141	0,178	0,22	0,276	0,344	0,431	0,495	0,546	0,693	0,88	1,113	1,374	1,979	2,182	2,771	3,519	4,453	5,498
8	0,04	0,063	0,098	0,141	0,161	0,204	0,251	0,315	0,393	0,493	0,565	0,623	0,792	1,005	1,272	1,571	2,262	2,494	3,167	4,021	5,089	6,283
9	0,045	0,071	0,11	0,159	0,181	0,229	0,283	0,355	0,442	0,554	0,636	0,701	0,891	1,131	1,431	1,767	2,545	2,806	3,563	4,524	5,726	7,069
10	0,05	0,079	0,123	0,177	0,201	0,254	0,314	0,394	0,491	0,616	0,707	0,779	0,99	1,257	1,59	1,963	2,827	3,117	3,959	5,027	6,362	7,854
11	0,055	0,086	0,135	0,194	0,221	0,28	0,346	0,433	0,54	0,677	0,778	0,857	1,089	1,382	1,749	2,16	3,11	3,429	4,355	5,529	6,998	8,639
12	0,06	0,094	0,147	0,212	0,241	0,305	0,377	0,473	0,589	0,739	0,848	0,935	1,188	1,508	1,909	2,356	3,393	3,741	4,751	6,032	7,634	9,425
13	0,065	0,102	0,16	0,23	0,261	0,331	0,408	0,512	0,638	0,8	0,919	1,013	1,287	1,634	2,068	2,553	3,676	4,052	5,147	6,535	8,27	10,21
14	0,07	0,11	0,172	0,247	0,281	0,356	0,44	0,552	0,687	0,862	0,99	1,091	1,386	1,759	2,227	2,749	3,958	4,364	5,543	7,037	8,906	11
15	0,075	0,118	0,184	0,265	0,302	0,382	0,471	0,591	0,736	0,924	1,06	1,169	1,485	1,885	2,386	2,945	4,241	4,676	5,939	7,54	9,543	11,78

- Required exhaust: 3173,2344 m³/h $= 3173{,}2344\ \text{m}^3/3600\text{s} = 0{,}881454\ \text{m}^3/\text{s}$
- Maximum air velocity: 3 m/s

$$= \frac{0{,}881454\ \text{m}^3/\text{s}}{3\ \text{m/s}} = 0{,}293818\ \text{m}^2 \approx 0{,}294\ \text{m}^2$$

2 x Ø450 duct = 0,318 m²

0,294 m² < 0,318 m²

► 2 x Ø450 duct at 3m/s

Duct diameter [mm]

Amount of ducts [n]	80	100	125	150	160	180	200	224	250	280	300	315	355	400	450	500	600	630	710	800	900	1000
1	0,005	0,008	0,012	0,018	0,02	0,025	0,031	0,039	0,049	0,062	0,071	0,078	0,099	0,126	0,159	0,196	0,283	0,312	0,396	0,503	0,636	0,785
2	0,01	0,016	0,025	0,035	0,04	0,051	0,063	0,079	0,098	0,123	0,141	0,156	0,198	0,251	0,318	0,393	0,565	0,623	0,792	1,005	1,272	1,571
3	0,015	0,024	0,037	0,053	0,06	0,076	0,094	0,118	0,147	0,185	0,212	0,234	0,297	0,377	0,477	0,589	0,848	0,935	1,188	1,508	1,909	2,356
4	0,02	0,031	0,049	0,071	0,08	0,102	0,126	0,158	0,196	0,246	0,283	0,312	0,396	0,503	0,636	0,785	1,131	1,247	1,584	2,011	2,545	3,142
5	0,025	0,039	0,061	0,088	0,101	0,127	0,157	0,197	0,245	0,308	0,353	0,39	0,495	0,628	0,795	0,982	1,414	1,559	1,98	2,513	3,181	3,927
6	0,03	0,047	0,074	0,106	0,121	0,153	0,188	0,236	0,295	0,369	0,424	0,468	0,594	0,754	0,954	1,178	1,696	1,87	2,376	3,016	3,817	4,712
7	0,035	0,055	0,086	0,124	0,141	0,178	0,22	0,276	0,344	0,431	0,495	0,546	0,693	0,88	1,113	1,374	1,979	2,182	2,771	3,519	4,453	5,498
8	0,04	0,063	0,098	0,141	0,161	0,204	0,251	0,315	0,393	0,493	0,565	0,623	0,792	1,005	1,272	1,571	2,262	2,494	3,167	4,021	5,089	6,283
9	0,045	0,071	0,11	0,159	0,181	0,229	0,283	0,355	0,442	0,554	0,636	0,701	0,891	1,131	1,431	1,767	2,545	2,806	3,563	4,524	5,726	7,069
10	0,05	0,079	0,123	0,177	0,201	0,254	0,314	0,394	0,491	0,616	0,707	0,779	0,99	1,257	1,59	1,963	2,827	3,117	3,959	5,027	6,362	7,854
11	0,055	0,086	0,135	0,194	0,221	0,28	0,346	0,433	0,54	0,677	0,778	0,857	1,089	1,382	1,749	2,16	3,11	3,429	4,355	5,529	6,998	8,639
12	0,06	0,094	0,147	0,212	0,241	0,305	0,377	0,473	0,589	0,739	0,848	0,935	1,188	1,508	1,909	2,356	3,393	3,741	4,751	6,032	7,634	9,425
13	0,065	0,102	0,16	0,23	0,261	0,331	0,408	0,512	0,638	0,8	0,919	1,013	1,287	1,634	2,068	2,553	3,676	4,052	5,147	6,535	8,27	10,21
14	0,07	0,11	0,172	0,247	0,281	0,356	0,44	0,552	0,687	0,862	0,99	1,091	1,386	1,759	2,227	2,749	3,958	4,364	5,543	7,037	8,906	11
15	0,075	0,118	0,184	0,265	0,302	0,382	0,471	0,591	0,736	0,924	1,06	1,169	1,485	1,885	2,386	2,945	4,241	4,676	5,939	7,54	9,543	11,78

Figure 108. Duct diameter size calculations for supply and exhaust ventilation in shaft 4
source: author

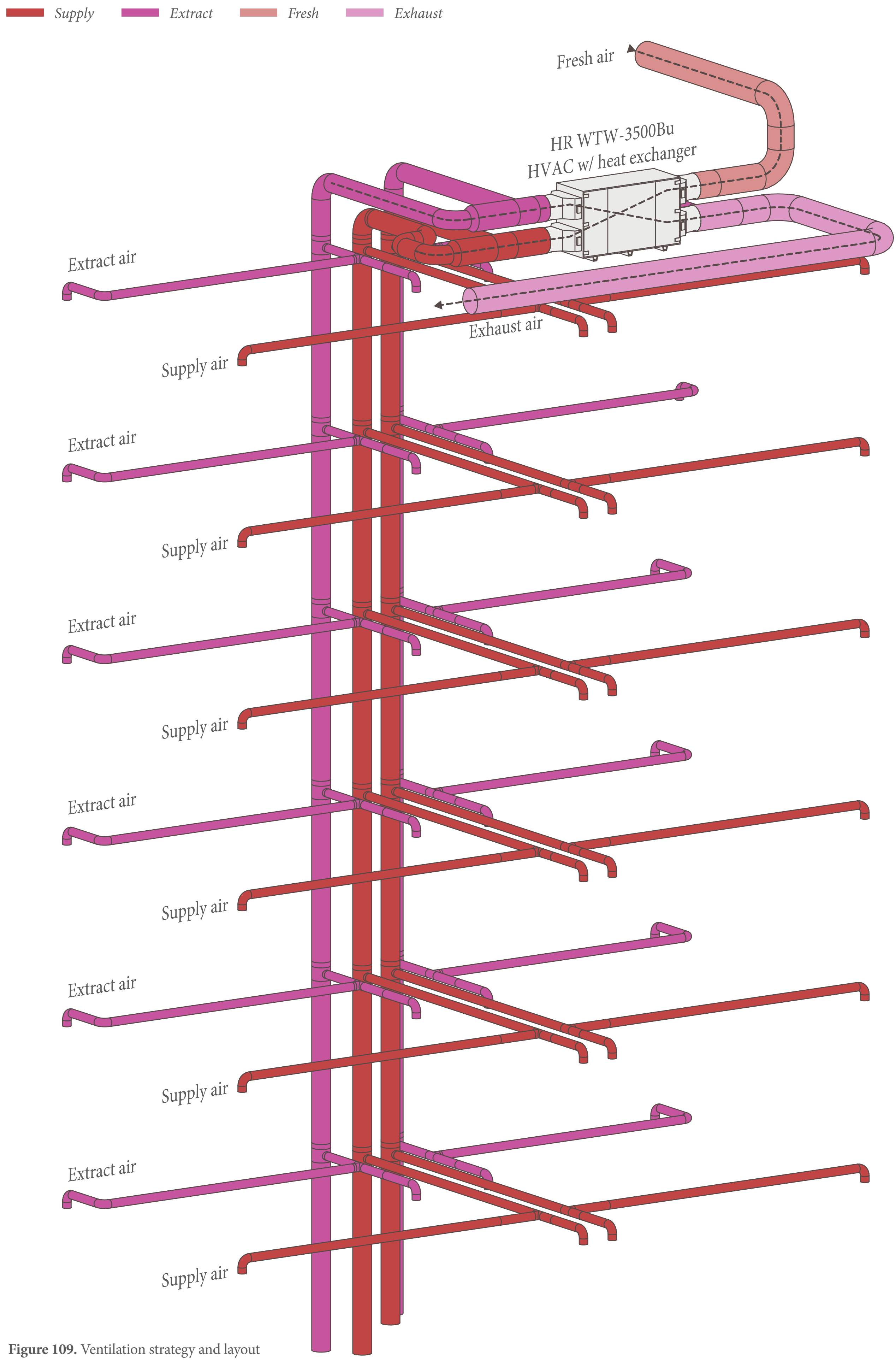


Figure 109. Ventilation strategy and layout
source: author

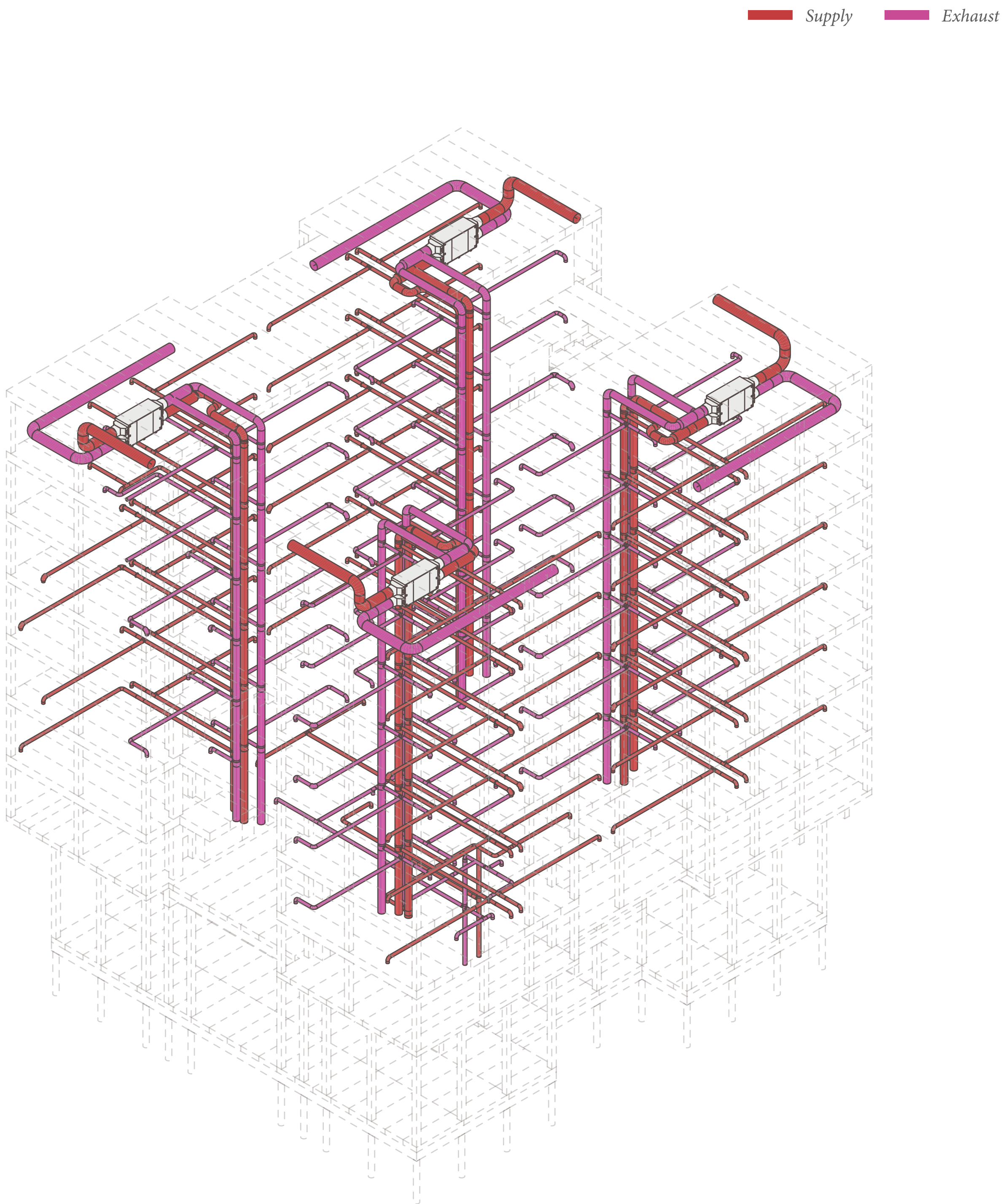


Figure 110. Axo of the ventilation ducts (1:300)
source: author

Ventilation strategy

The building uses a mechanical ventilation system D with heat recovery. Instead of one central air handling unit, four smaller units are connected to the main vertical shafts. This improves redundancy and limits large horizontal ductwork. Residents can adjust ventilation levels within their own apartment, giving them more control over and sensory conditions.

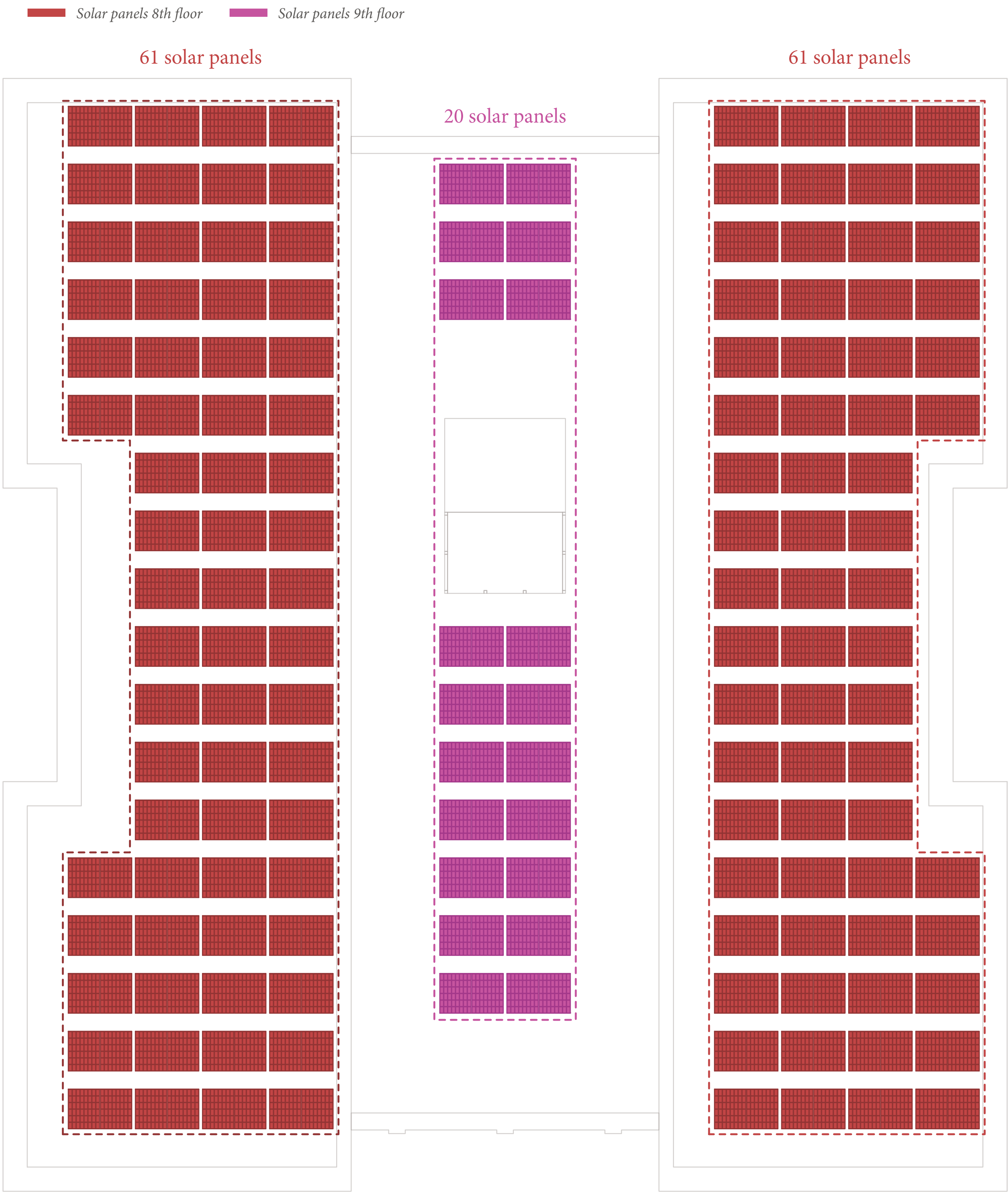


Figure 111. PV system layout on the 8th and 9th floor (1:150)
source: author

Orientation and tilt correction factor [%]

Roof orientation [°]: East (−90) – South (0) – West (90)

Panel angle [°]	−90	−75	−60	−45	−30	−15	0	15	30	45	60	75	90
90	56	60	64	67	69	71	71	71	71	69	65	62	58
80	63	68	72	75	77	79	80	80	79	77	74	69	65
70	69	74	78	82	85	86	87	87	86	84	80	76	70
60	74	79	84	87	90	91	93	93	92	89	86	81	76
50	78	84	88	92	95	96	97	97	96	93	89	85	80
40	82	86	90	95	97	99	100	99	98	96	92	88	84
30	86	89	93	96	98	99	100	100	98	96	94	90	86
20	87	90	93	96	$\boxed{97}$	98	98	98	97	96	94	91	88
10	89	91	92	94	$\boxed{95}$	95	96	95	95	94	93	91	90
0	90	90	90	90	90	90	90	90	90	90	90	90	90

$$= \frac{97 + 95}{2} = 96\%$$

PV system capacity

Solar panel
- Name: Jinko Solar 460 Wp N-Type TOPcon Full Black Dual Glass 1762×1134×30mm
- Wp: 460
- Amount: 142

$$460 \cdot 142 = 65320 \text{ Wp}$$

Efficiency
- Solar panel efficiency: 96% = 0,96
- $\text{Total}_{\text{kWh/year}}$: $\text{Total}_{\text{Wp}} \cdot 0{,}88$

$$= 65320 \text{ Wp} \cdot 0{,}88 \cdot 0{,}96$$
$$= 55182{,}336 \text{ kWh/year}$$

Solar power per apartment

Apartments
- Amount: 44

Solar panels
- Power generation: 55182,336 kWh/year

$$= \frac{55182{,}336}{44} \approx 1254 \text{ kWh/year}$$

Figure 112. PV system yield calculations
source: author, (zonnepanelen-leggen.be, n.d.)

PV system

The photovoltaic system is spread across the roofs of the 8th and 9th floors and uses a total of 142 solar panels. With a capacity of 460 Wp per panel, the system has a total installed capacity of 65,32 kWp. The roof's orientation and the panels' angle result in an average correction factor of 96%. According to the Dutch annual yield factor, the expected yearly production is 0.88 kWh per Wp. These factors lead to an expected yearly production of approximately 55,182 kWh. Divided over 44 apartments, this equals roughly to 1,254 kWh per apartment per year. Therefore, the PV system covers a large part of the residential electricity demand during the day, while shared functions and technical installations remain dependent on the grid.

Floorplans

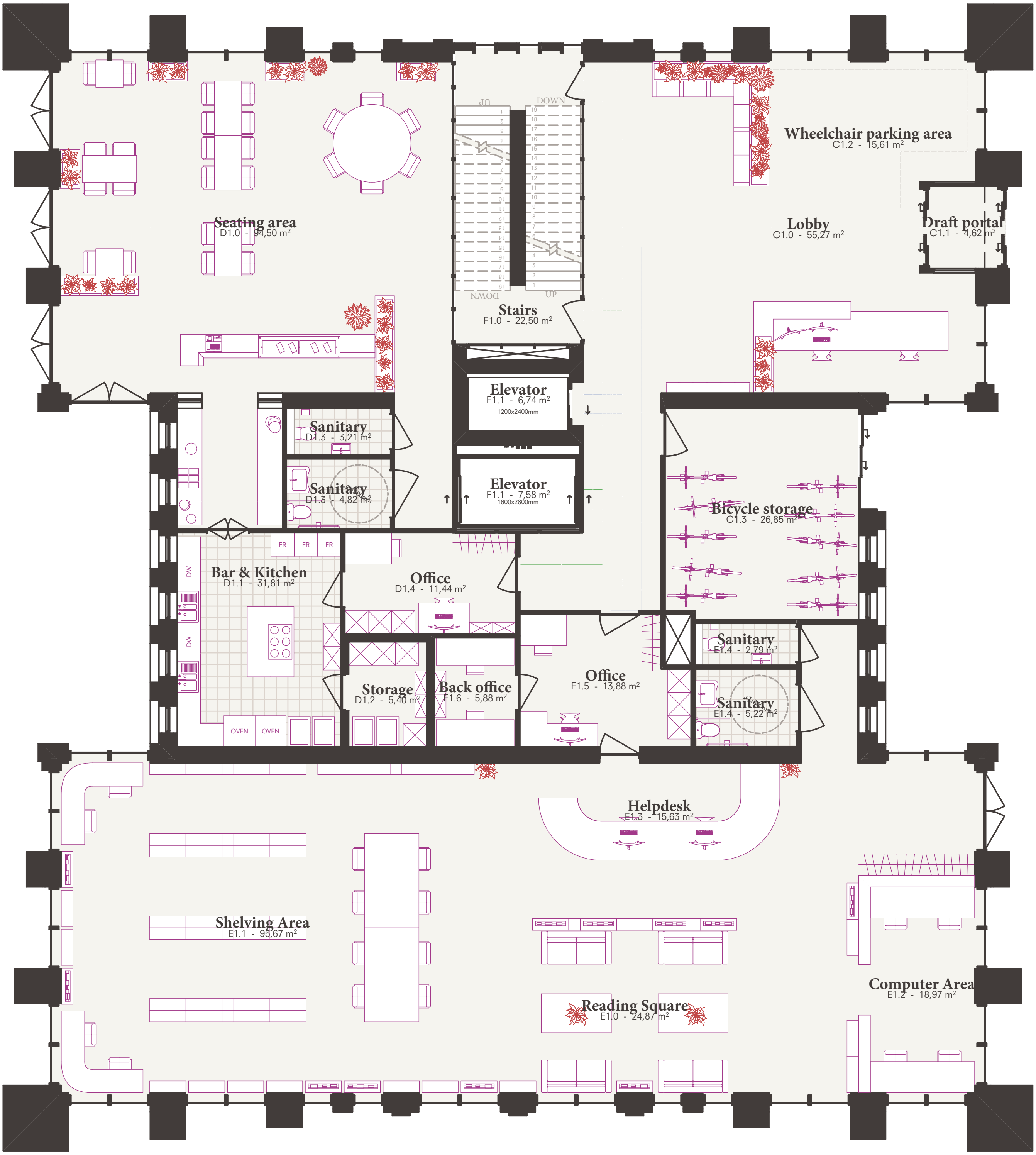


Figure 113. Layout of the ground floor (1:150)
source: author

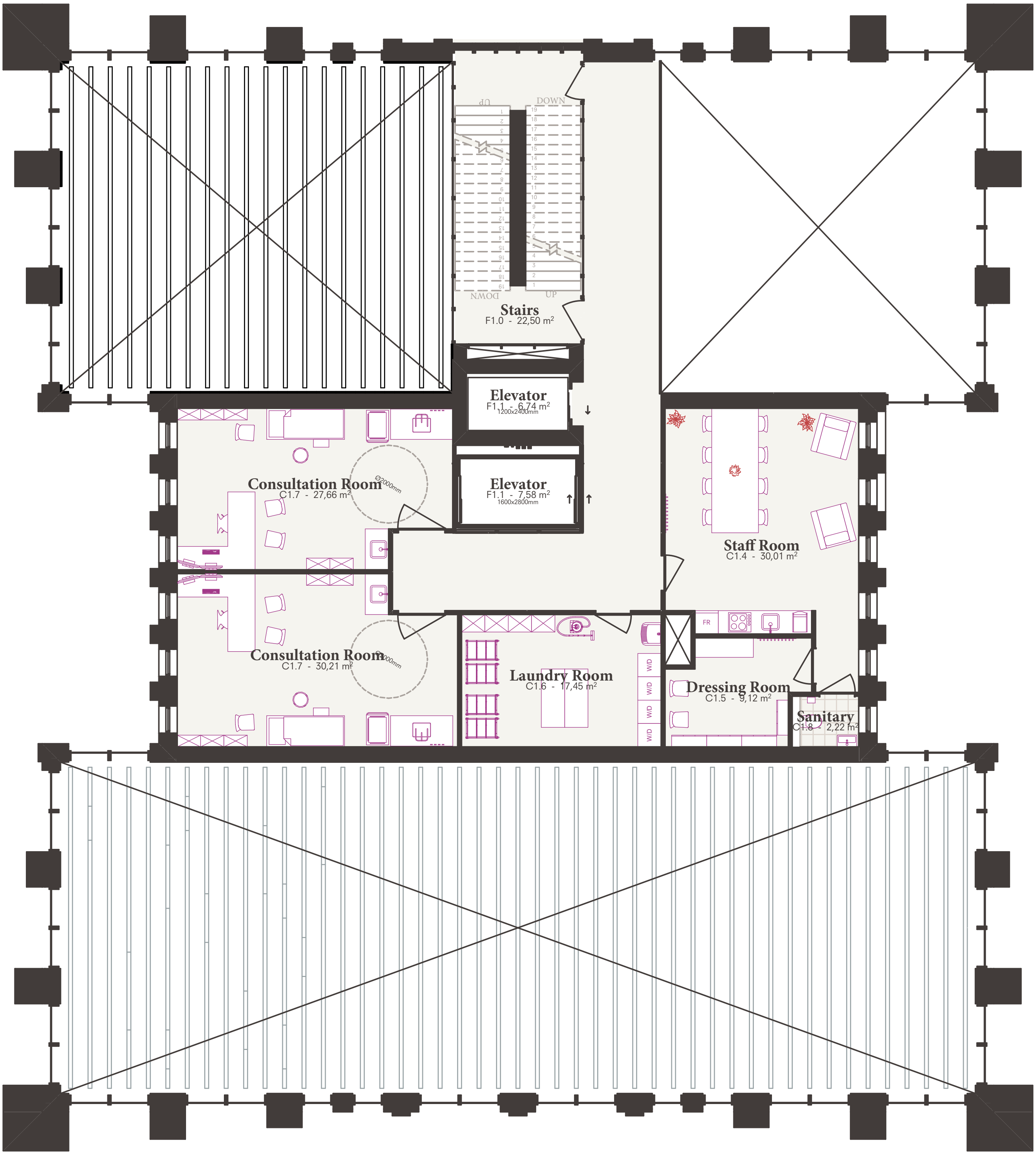


Figure 114. Layout of the 1st floor (1:150)
source: author

Regular floorplans

The ground floor showcases the zoning of the public plinth, which functions as social infrastructure for the Spaanse Polder. The first floor mostly consists of support rooms, including two consultation rooms for medical examinations of residents.

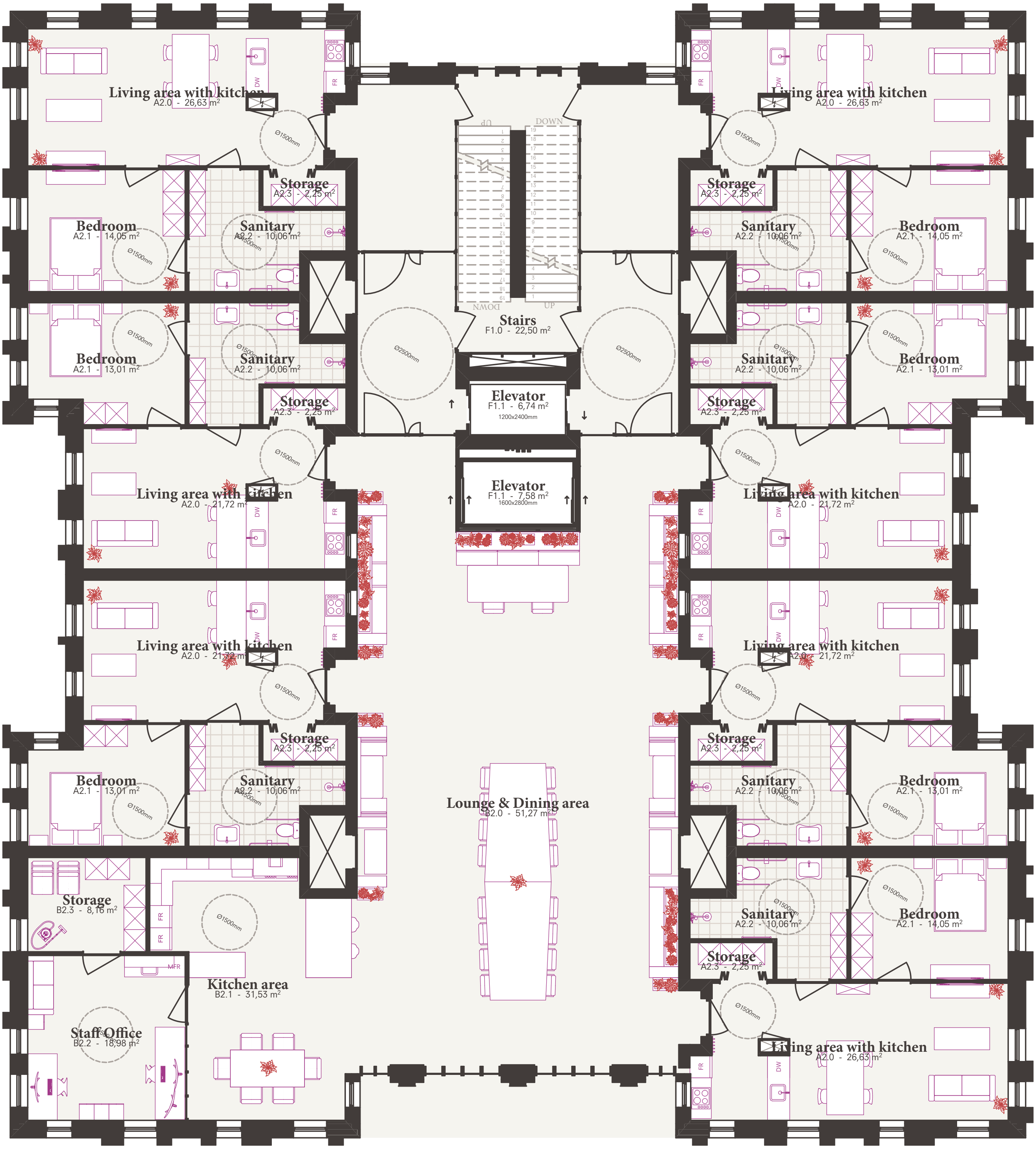


Figure 115. Layout of the 2nd and 4th floor (1:150)
source: author

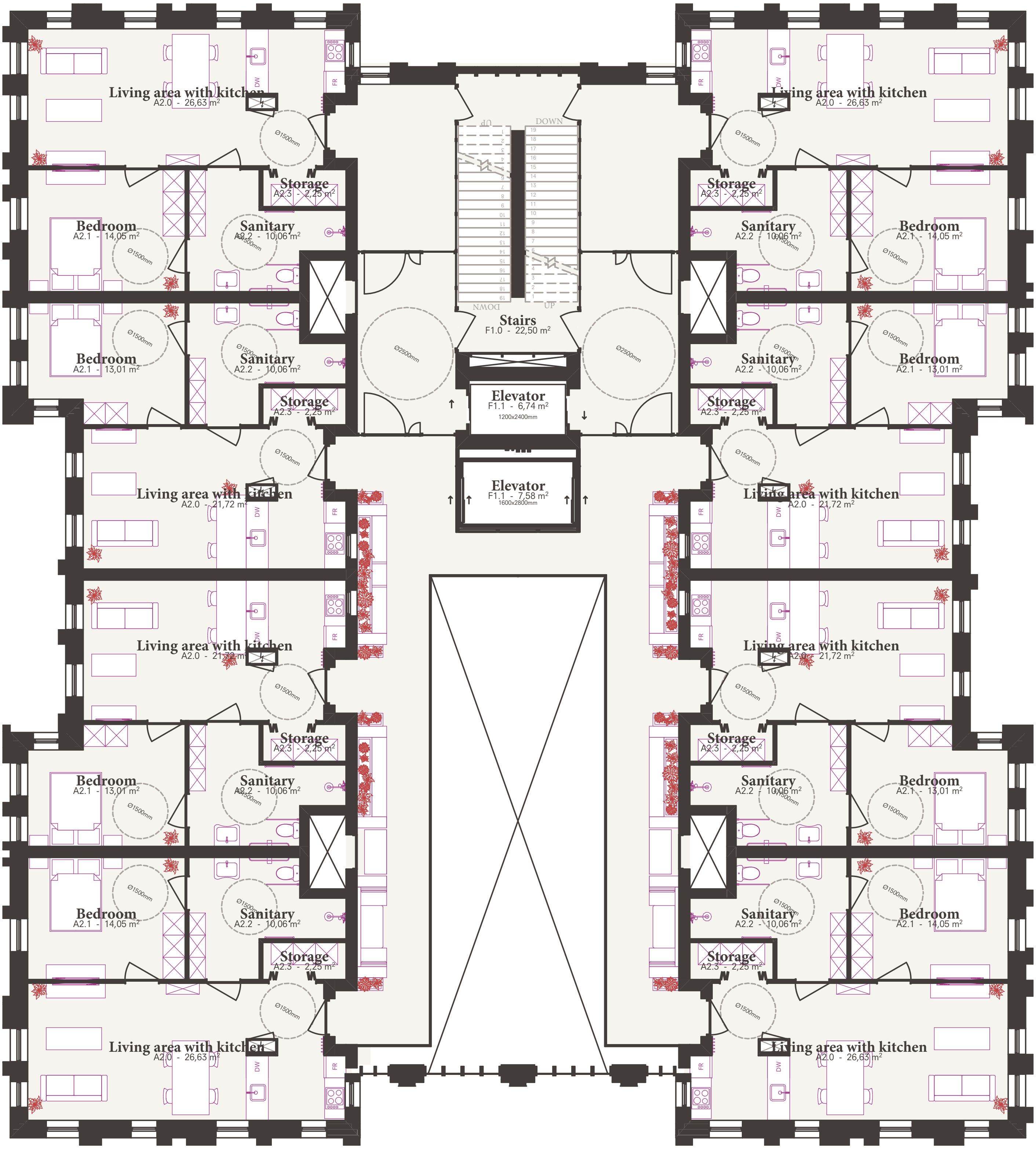


Figure 116. Layout of the 3rd and 5th floor (1:150)
source: author

The second and fourth floors have a central void that creates a double-height space in the lounge and dining area. This improves the social atmosphere of the Social Hub. The built-in furniture promotes spontaneous interactions and informal encounters between residents.

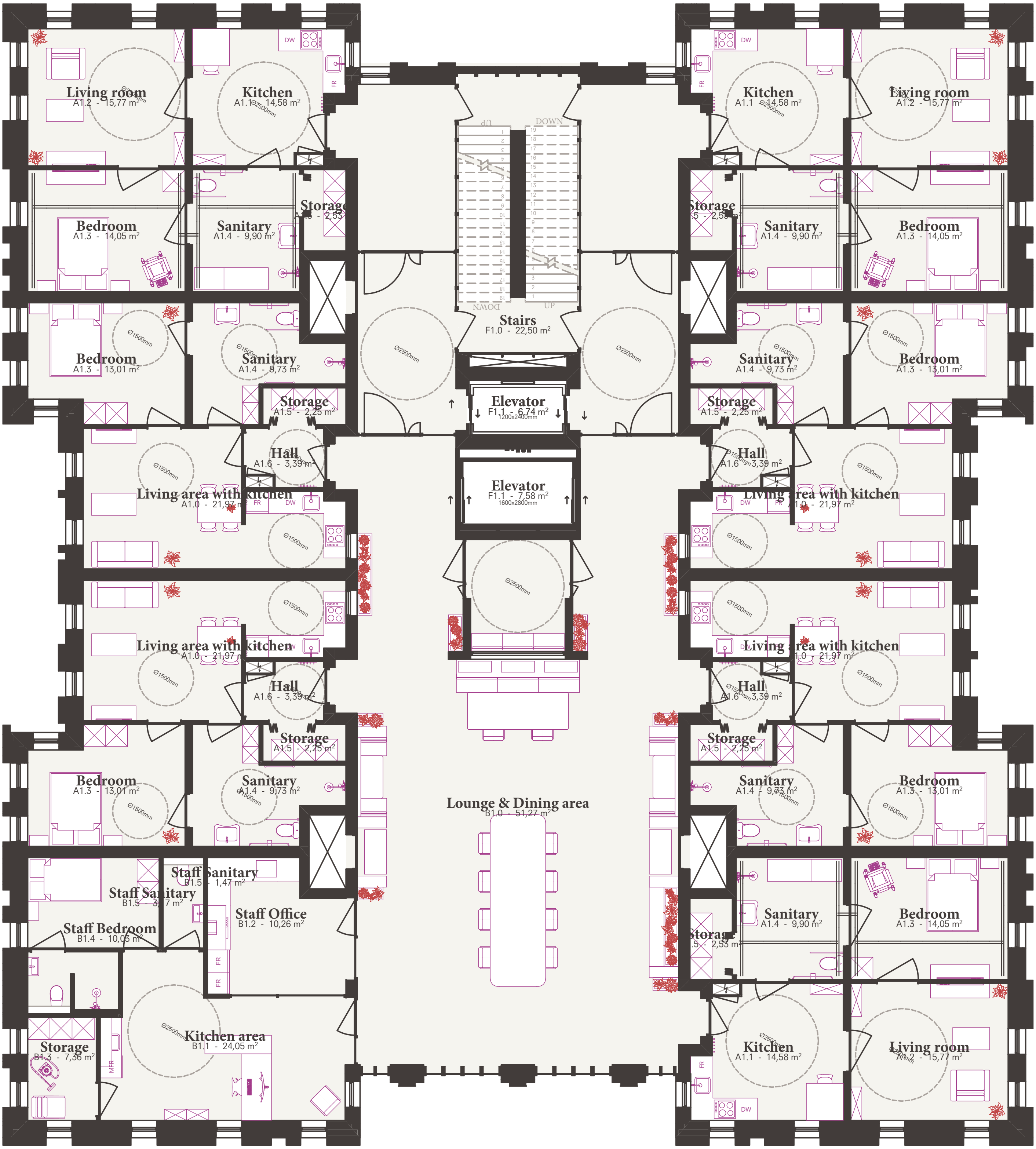


Figure 117. Layout of the 6th and 7th floor (1:150)
source: author

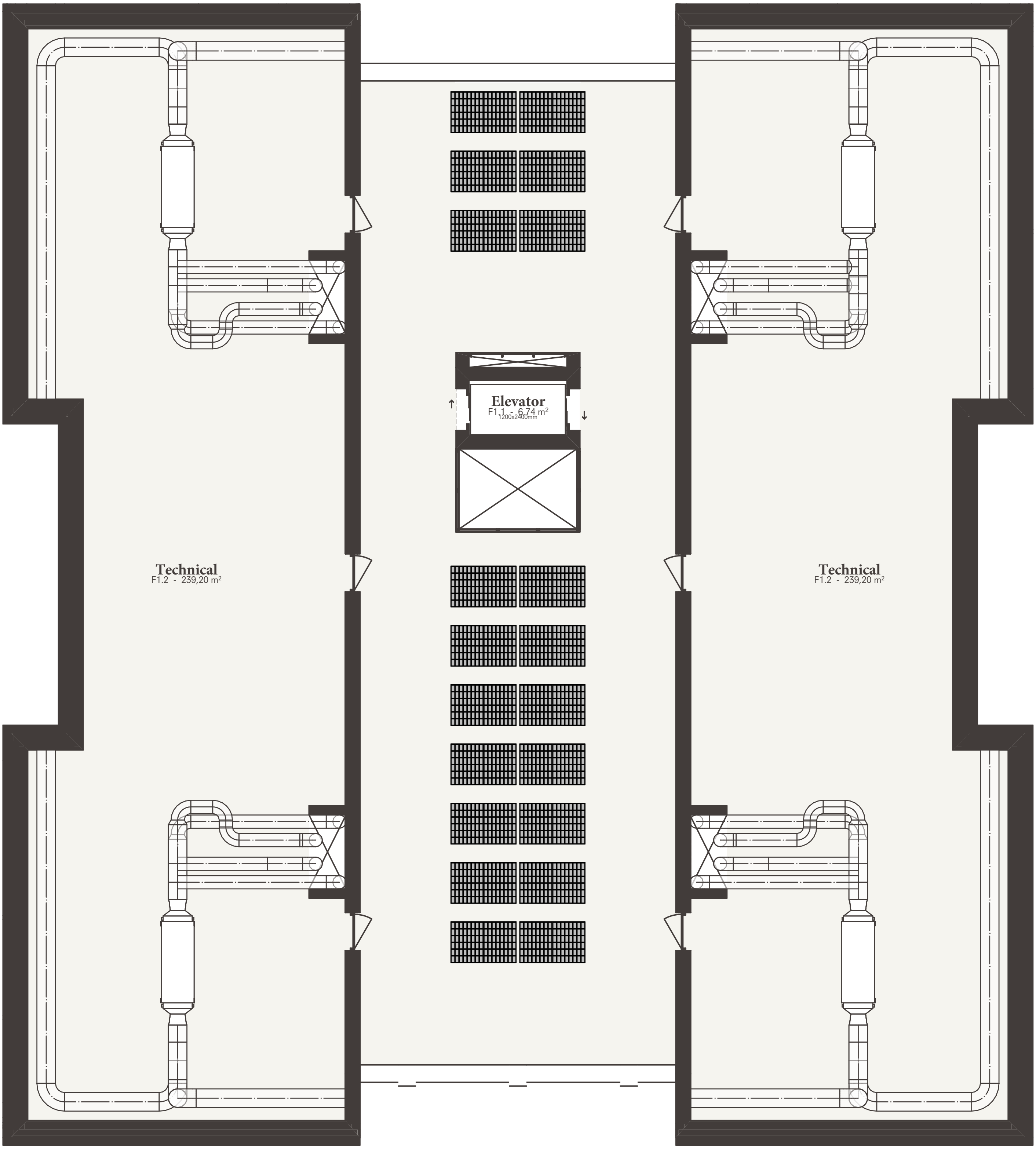


Figure 118. Layout of the 8th floor (1:150)
source: author

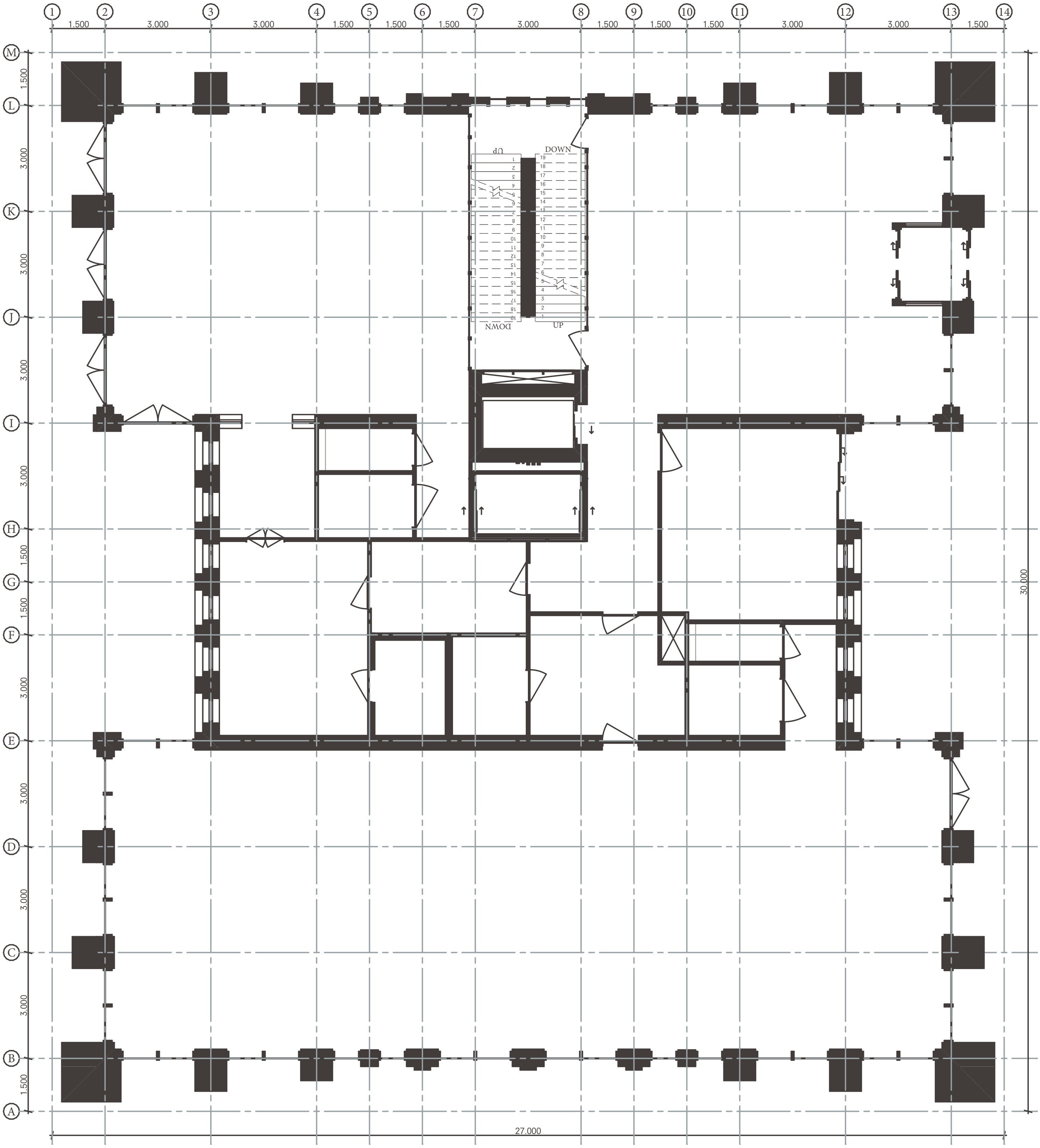


Figure 119. Dimensional layout of the ground floor (1:150)
source: author

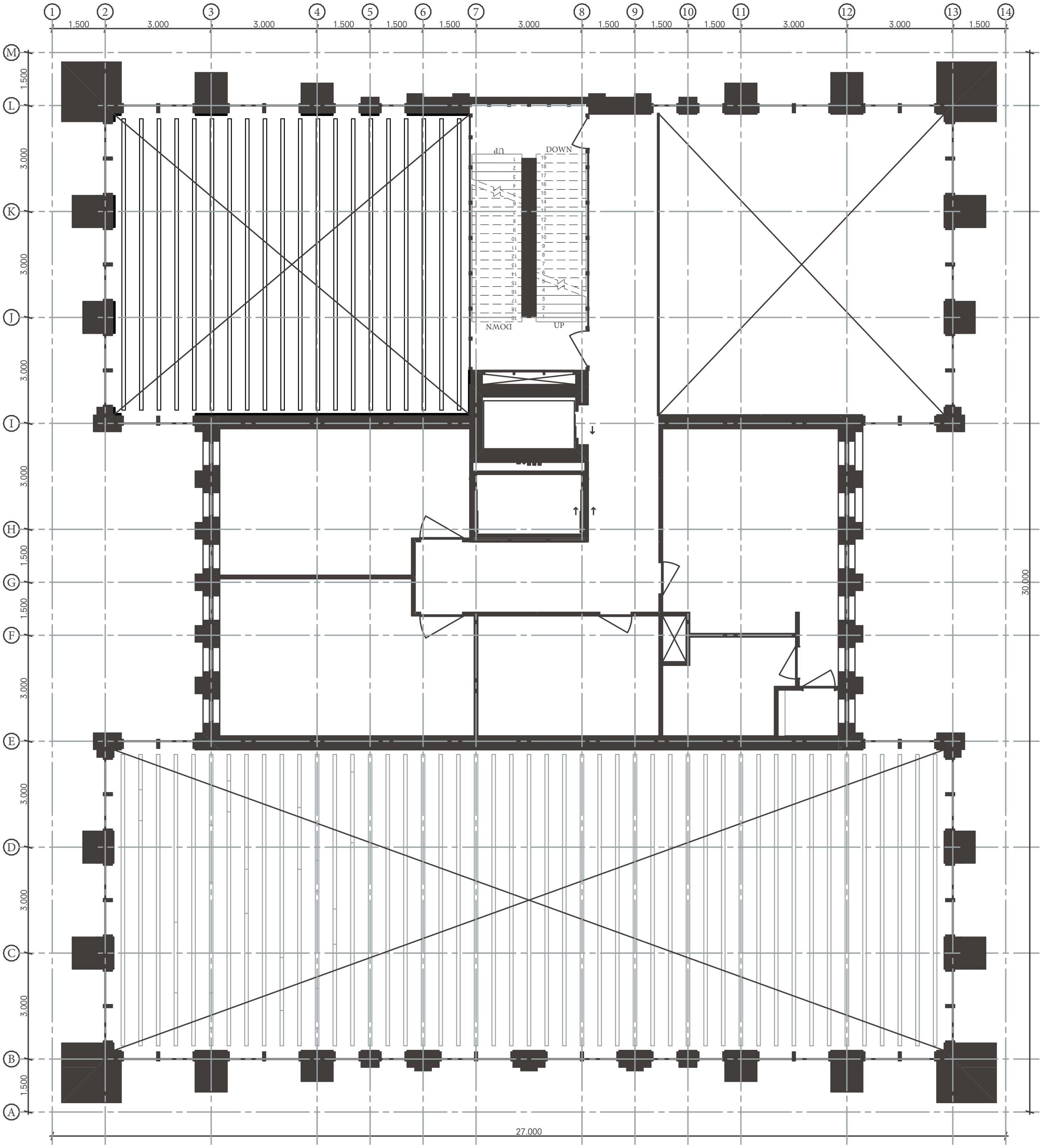


Figure 120. Dimensional layout of the 1st floor (1:150)
source: author

Dimensional floorplans

To ensure maximum adaptability in the public plinth, the ground floor has a column-free structural design. The design provides a flexible floor plan by utilizing long-span floors, which can reach a maximum length of 9 meters.

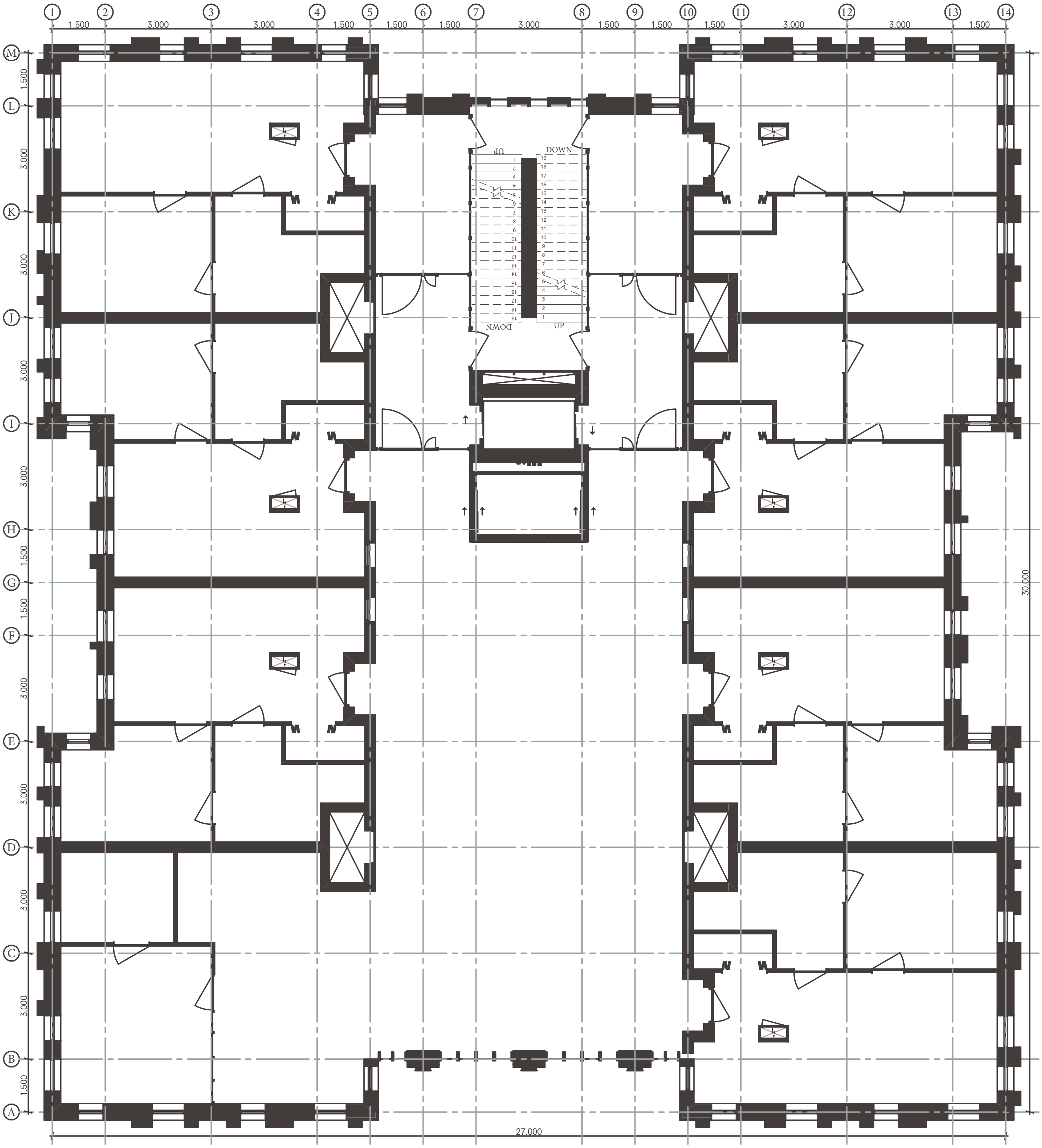


Figure 121. Dimensional layout of the 2nd and 4th floor (1:150)
source: author

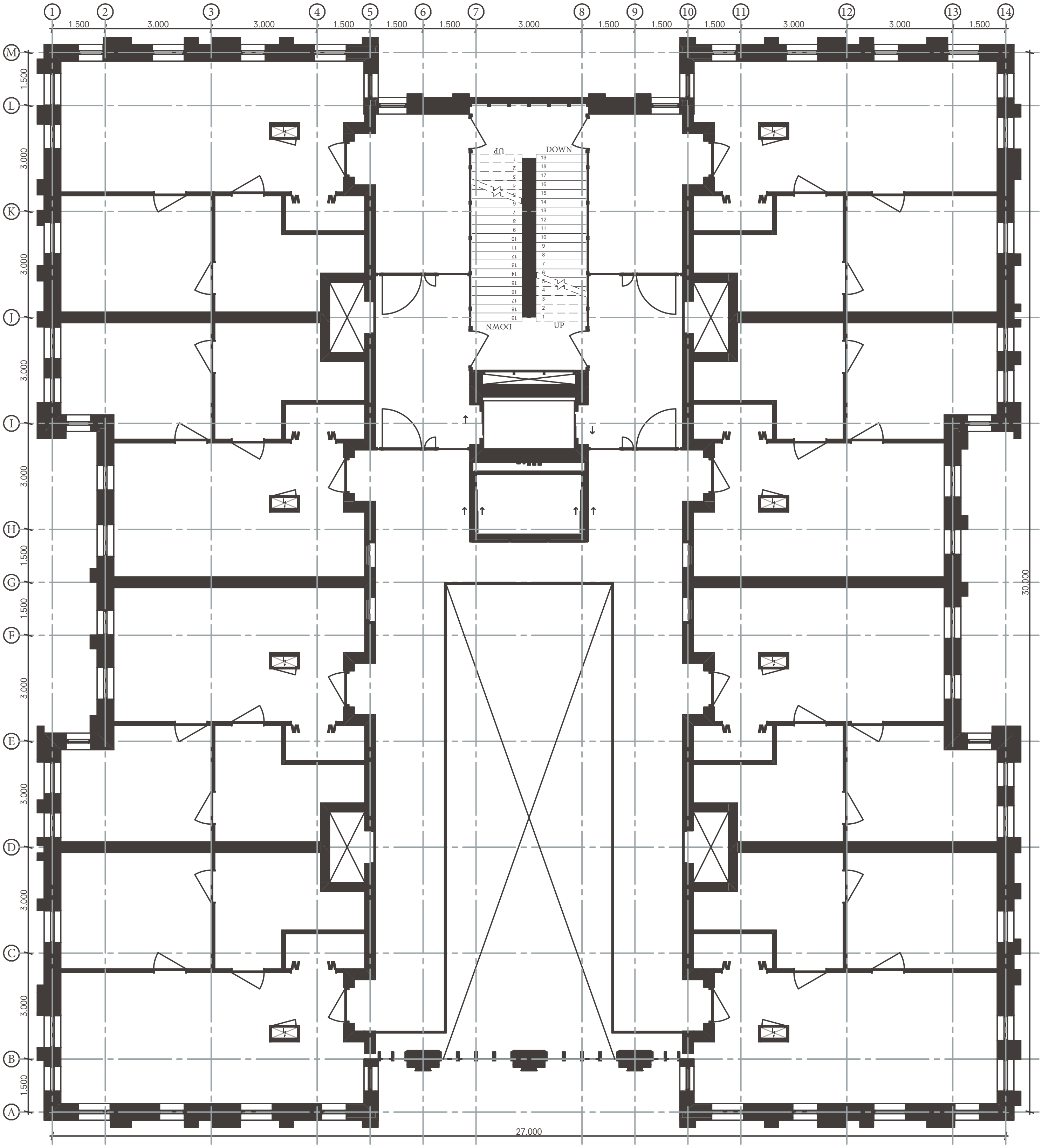


Figure 122. Dimensional layout of the 3rd and 5th floor (1:150)
source: author

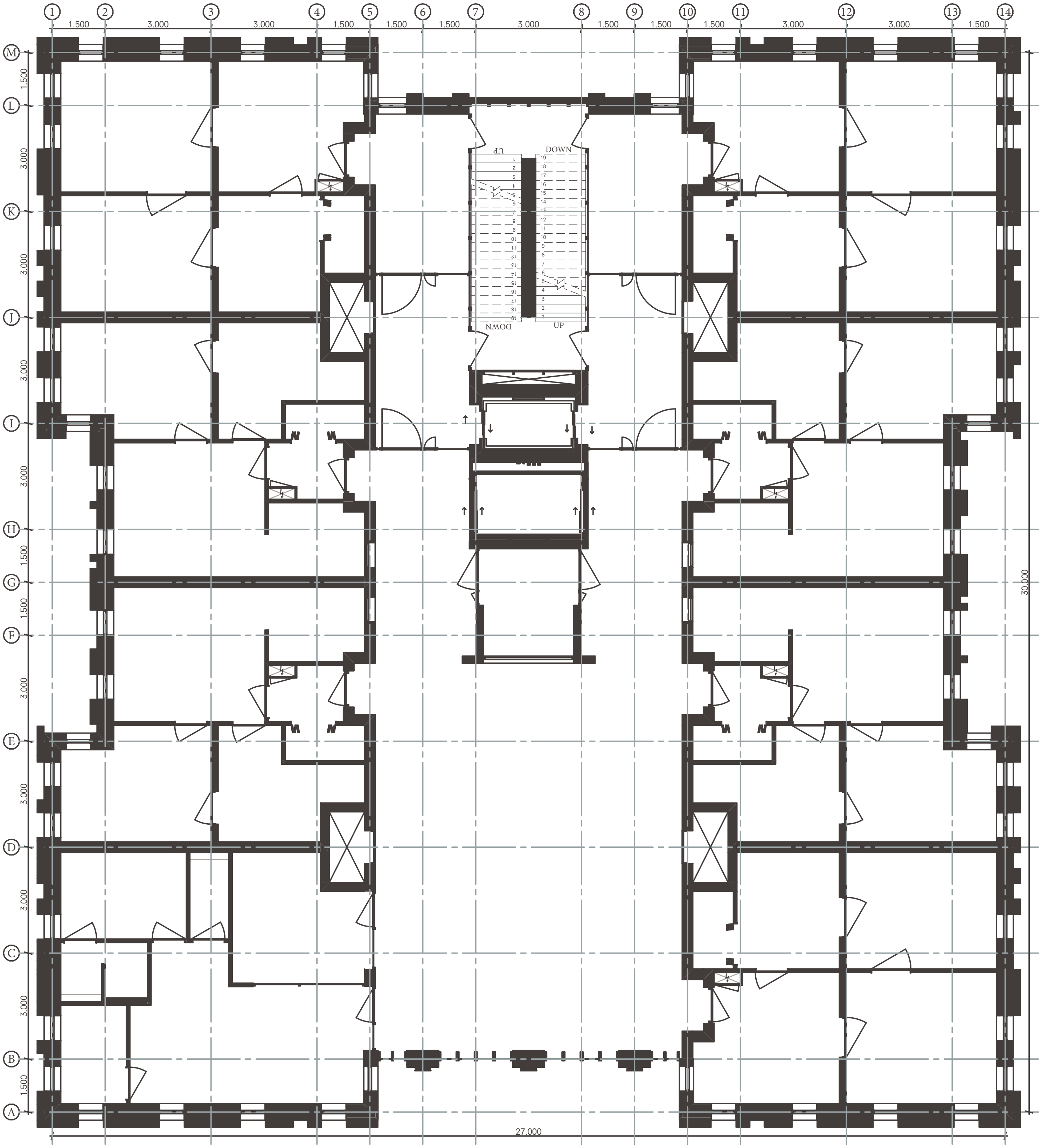


Figure 123. Dimensional layout of the 6th and 7th floor (1:150)
source: author

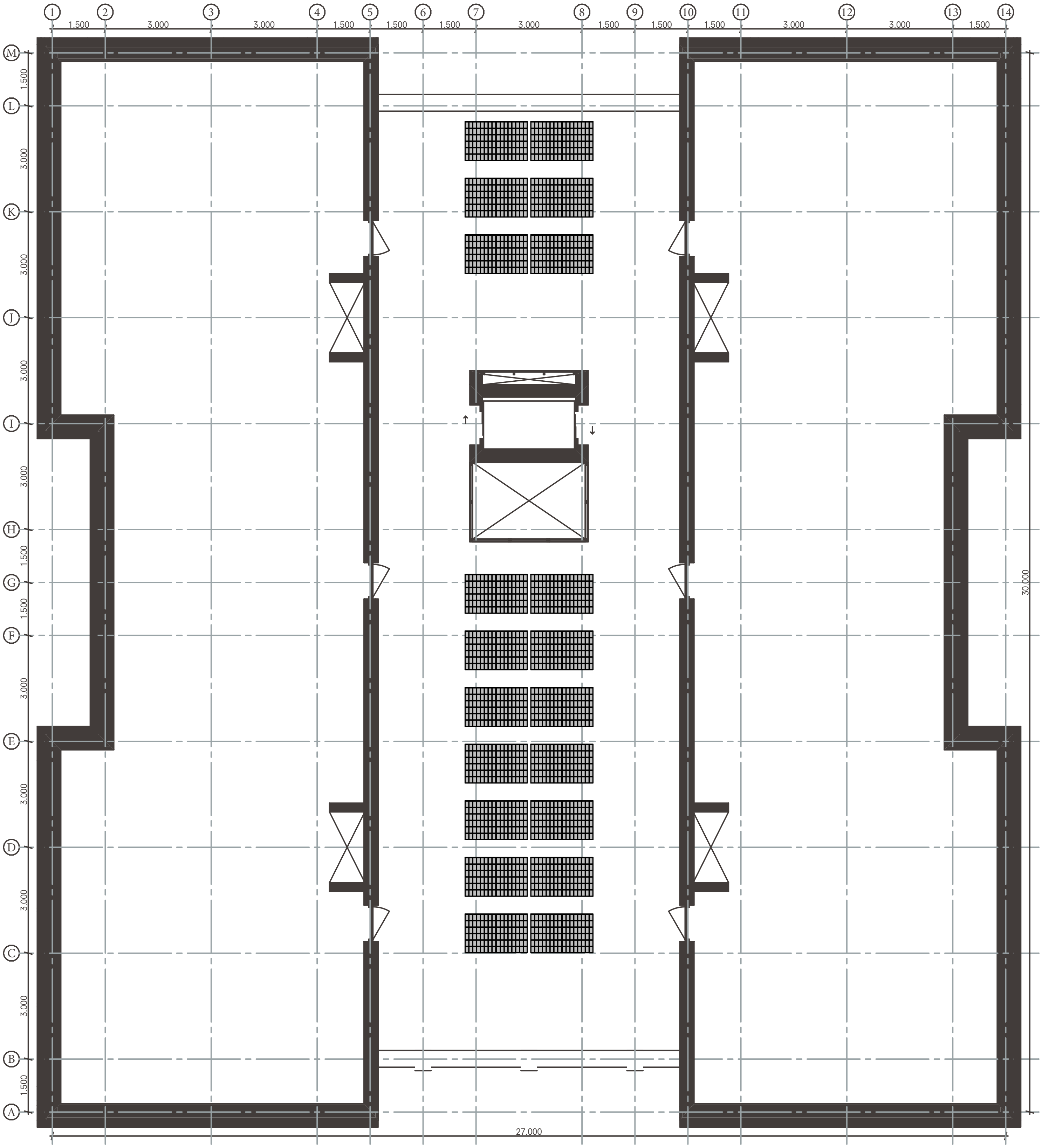


Figure 124. Dimensional layout of the 8th floor (1:150)
source: author

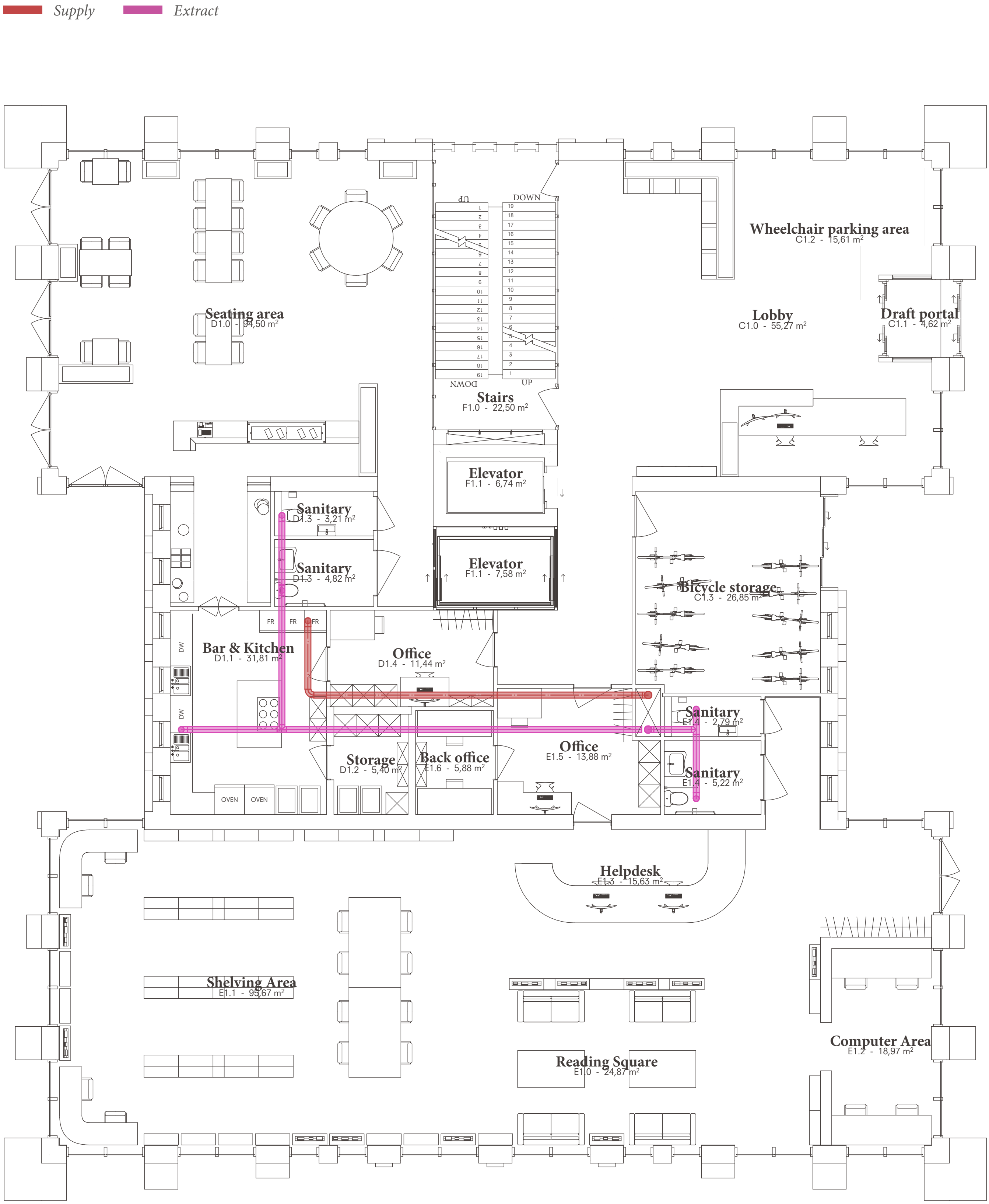
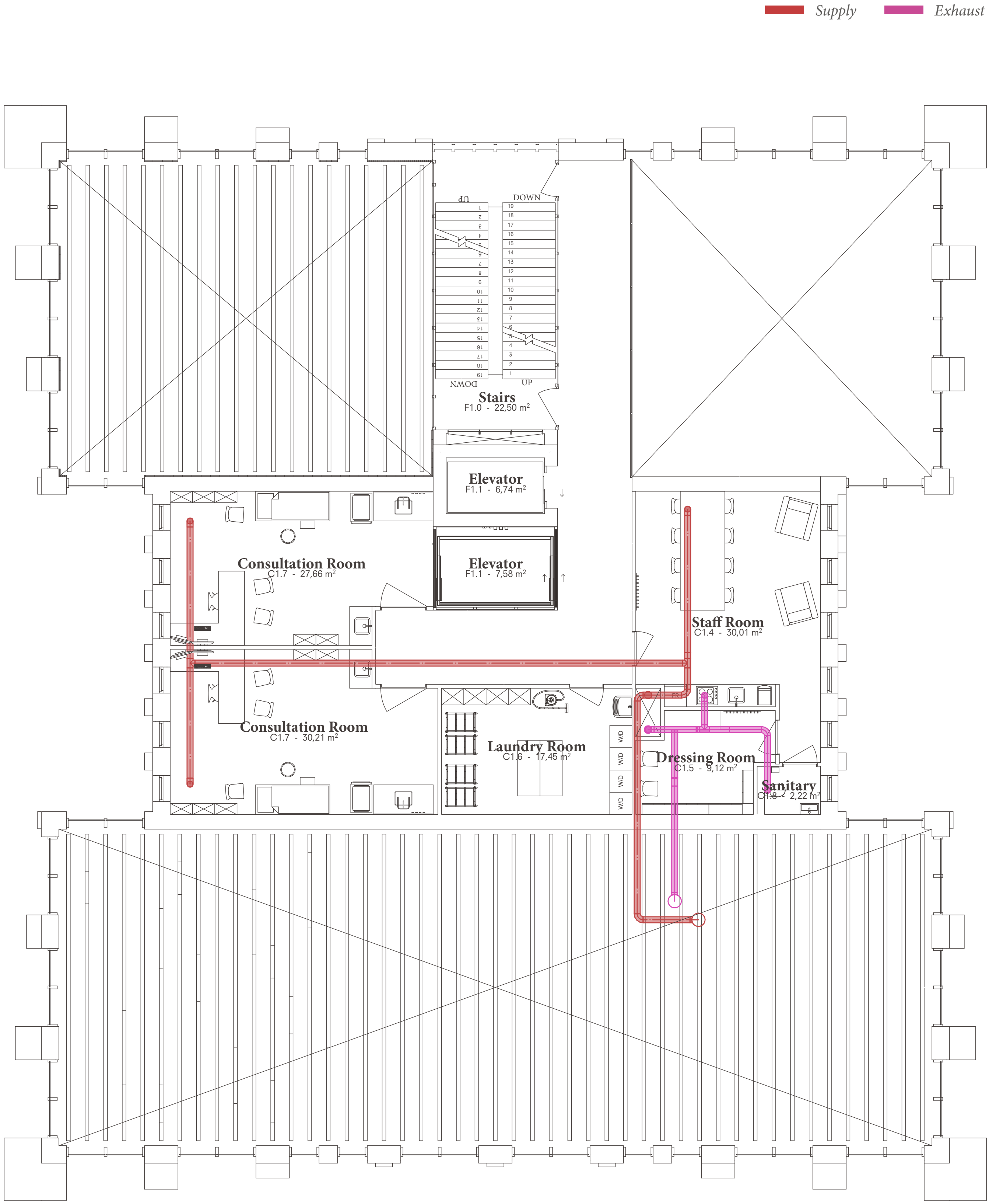


Figure 25. Ventilation duct layout of the ground floor (1:150)
source: author



Ventilation floorplans

Figure 126. Ventilation duct layout of the 1st floor (1:150)
source: author

The ground floor needs mechanical ventilation for specific zones, primarily the kitchen and sanitary facilities. The supply and extract ducts for the large open areas are strategically positioned to end at the bottom of the vertical service shafts.

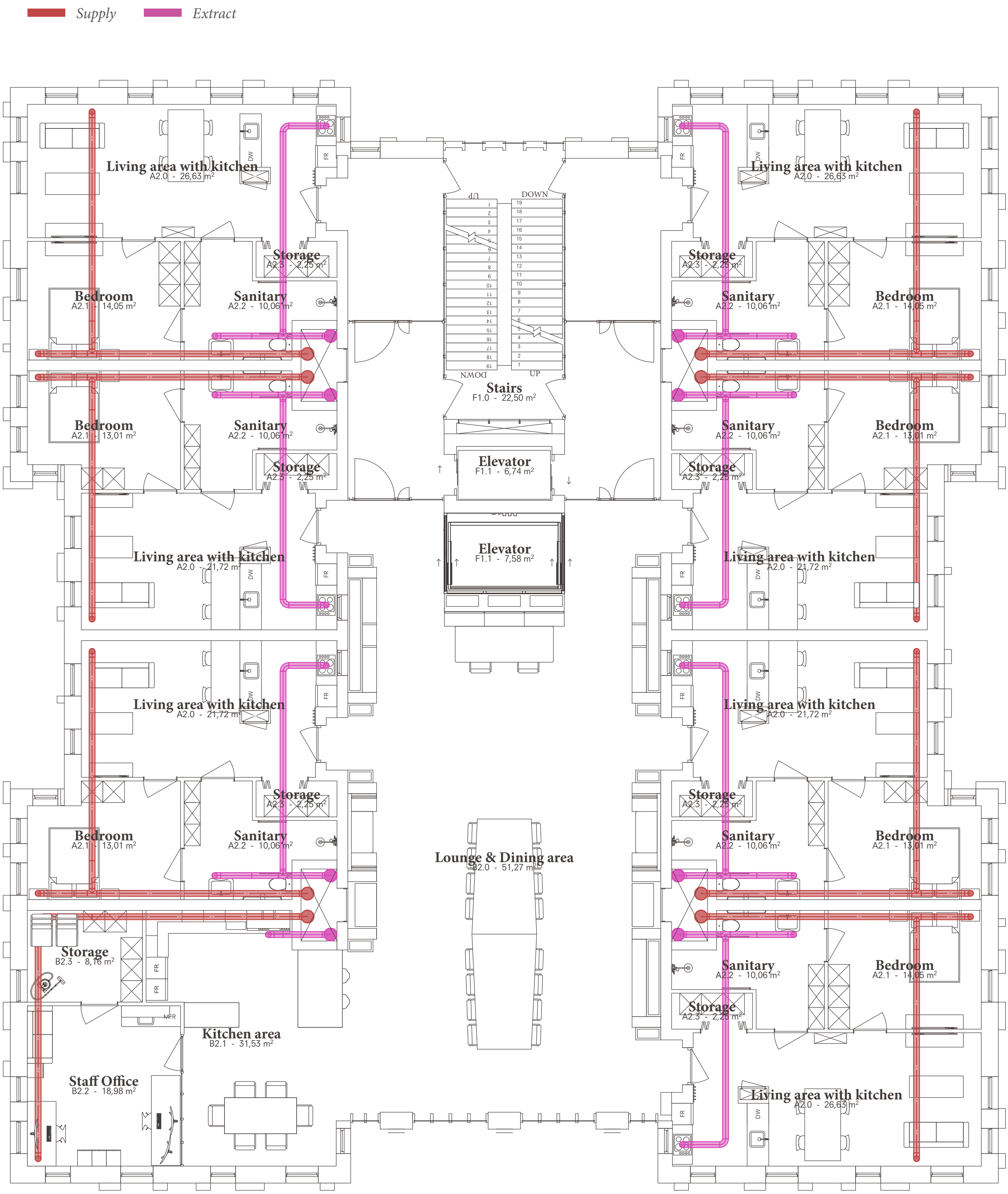


Figure 127. Ventilation duct layout of the 2nd and 4th floor (1:150)
source: author

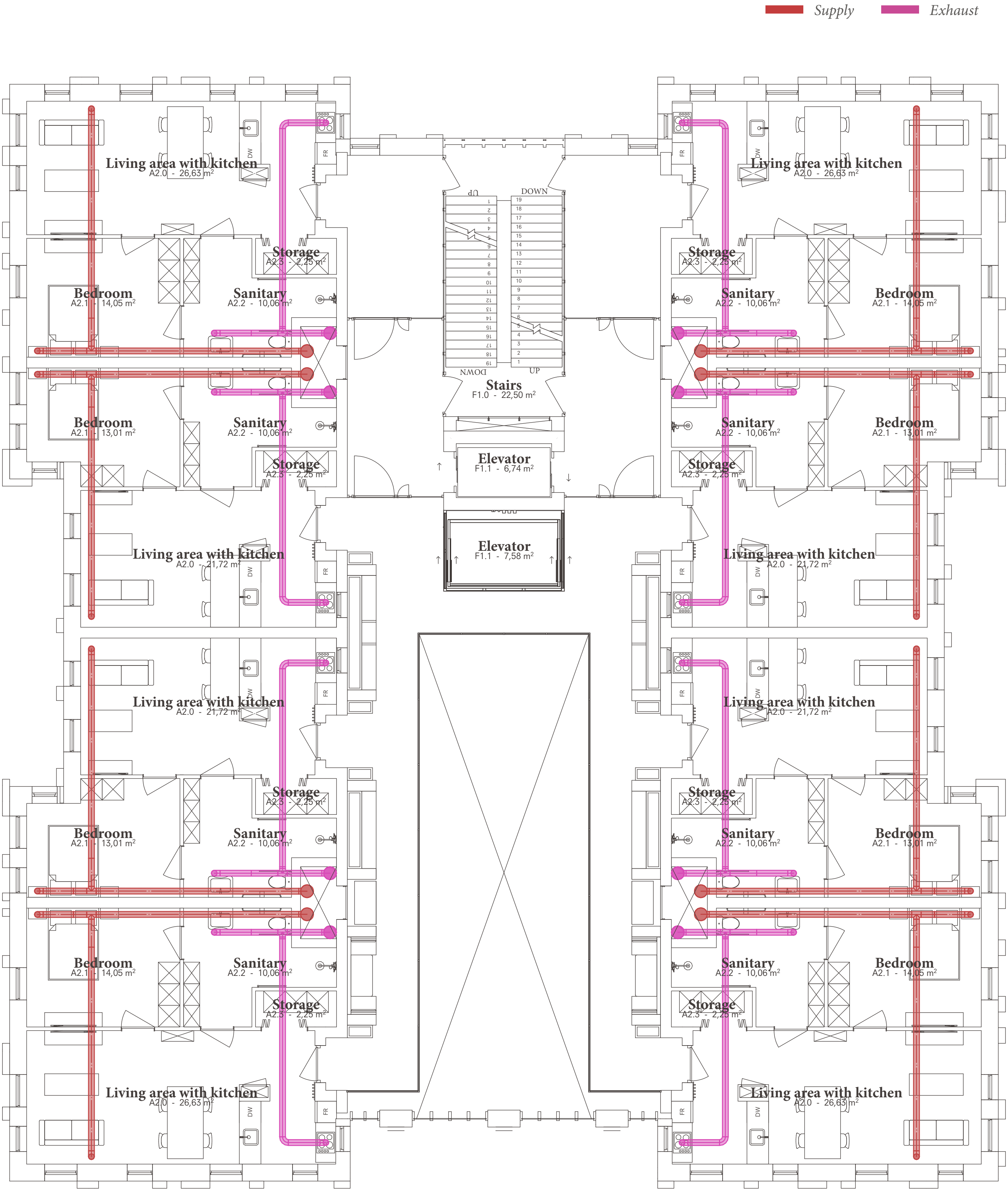


Figure 128. Ventilation duct layout of the 3rd and 5th floor (1:150)
source: author

The ventilation for the dwellings is as follows: mechanical extract ducts in wet zones *(kitchen/bathroom)* and supply ducts in dry zones *(living room/bedroom)*.

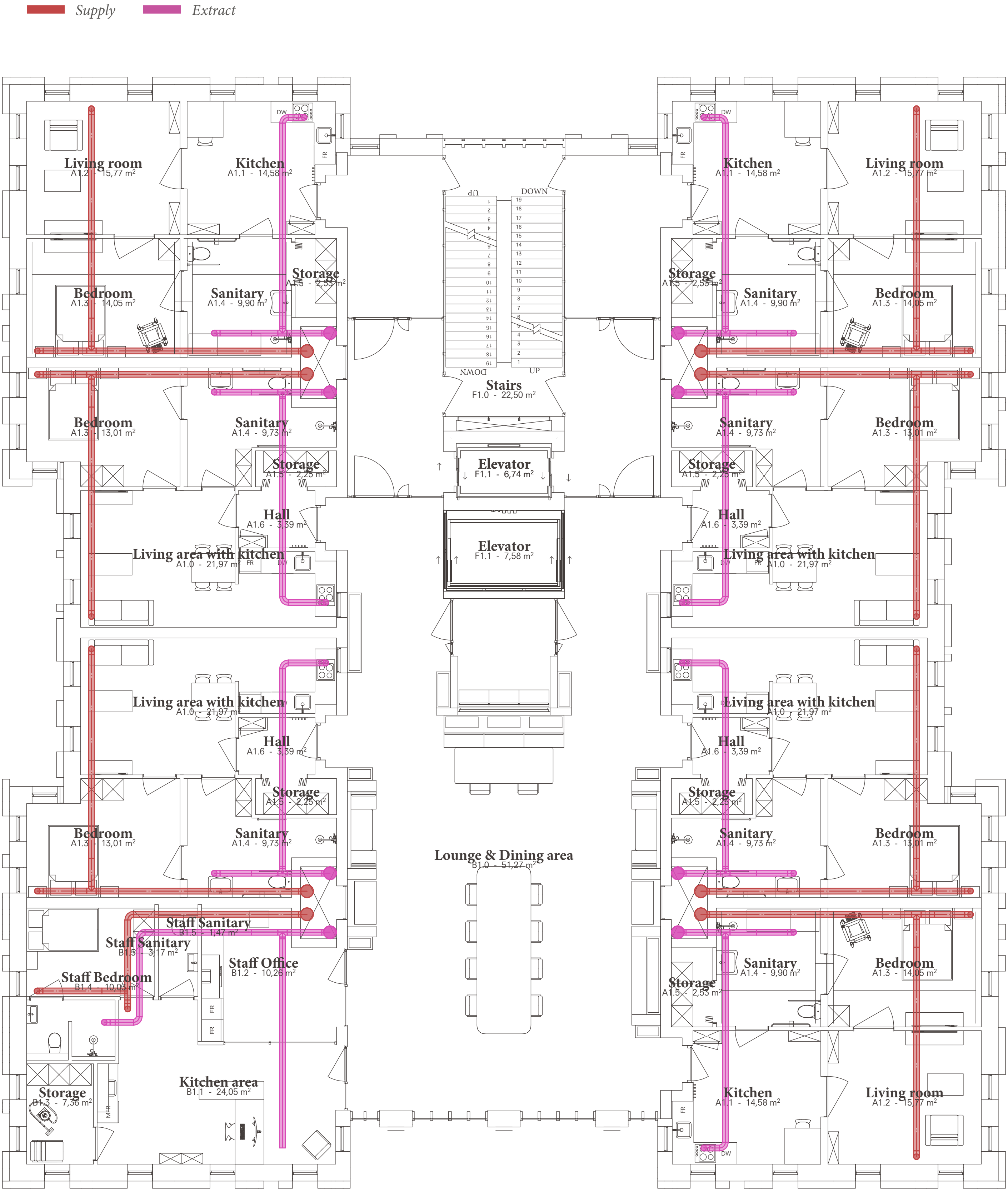


Figure 129. Ventilation duct layout of the 6th and 7th floor (1:150)

source: author

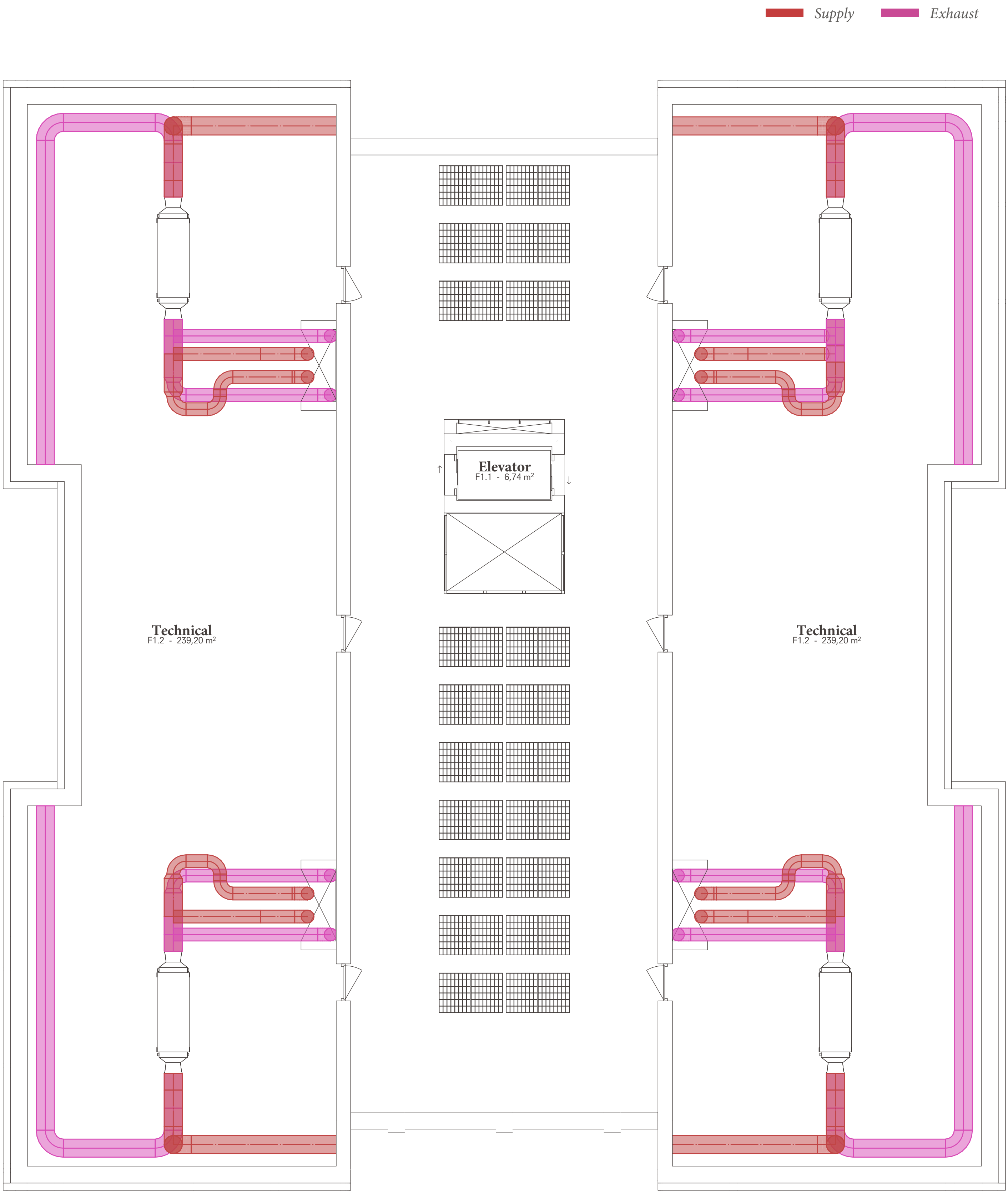


Figure 130. Ventilation duct layout of the 8th floor (1:150)
source: author

Situation

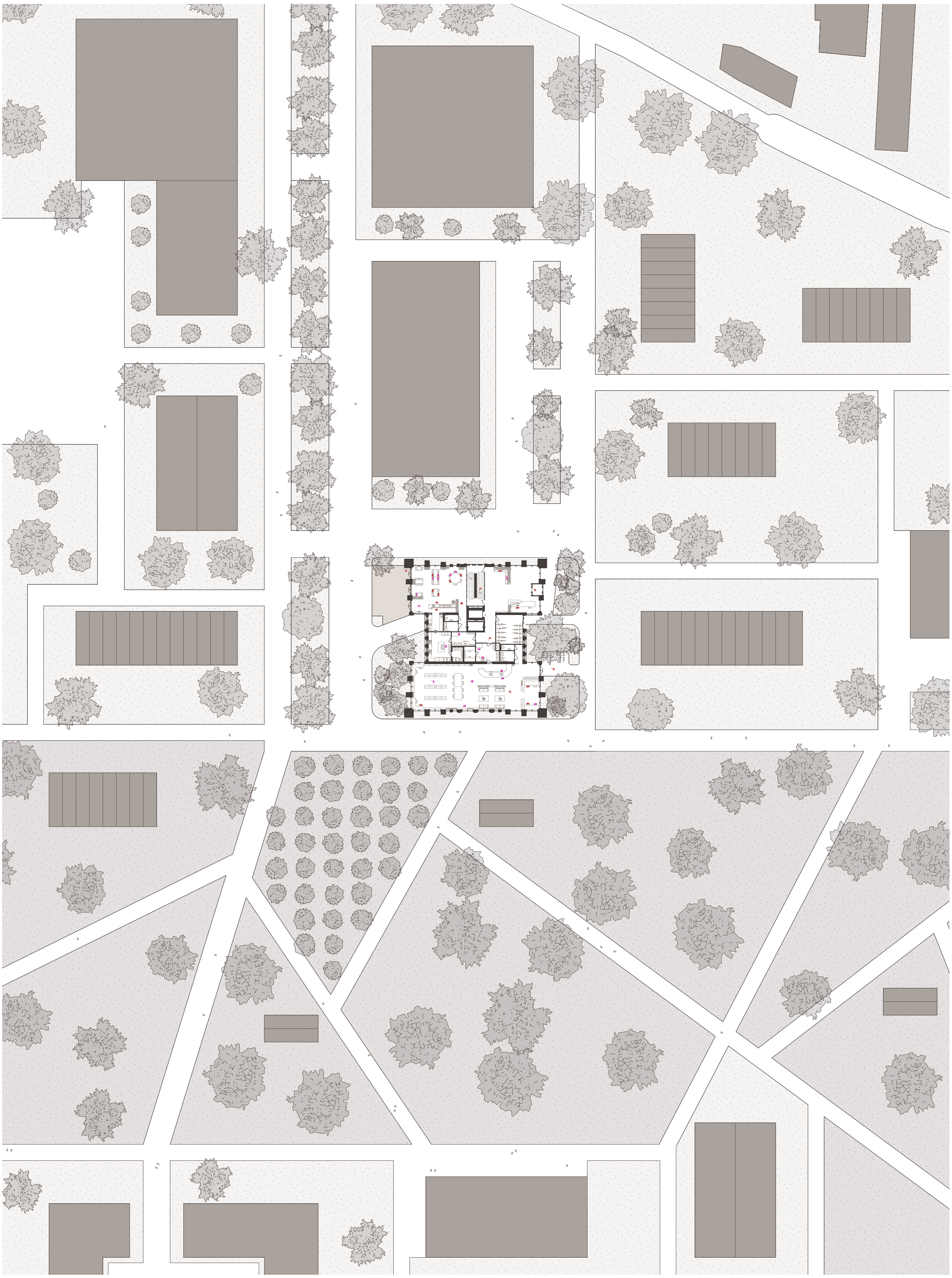


Figure 131. Context around the building (1:1000)
source: author

1:1.000

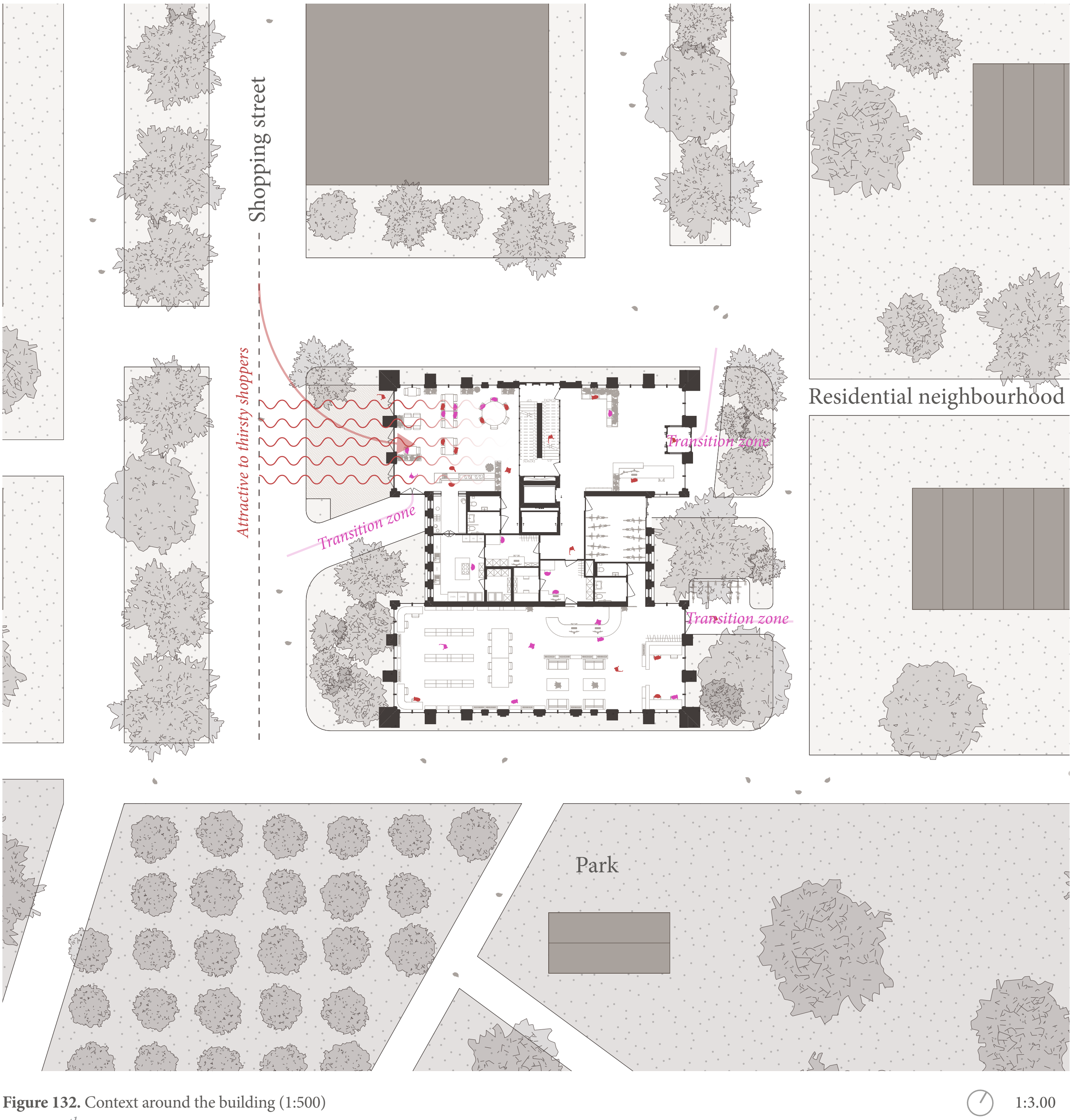


Figure 132. Context around the building (1:500)
source: author

Context

The building is surrounded by a mix of urban elements: a shopping street, a residential neighbourhood and a park. Each side creates a different type of activity around the site. The café is located on the side facing the busy shopping street, where it attracts passing visitors looking for a place to take a brake from the shopping. Transition zones around the entrances create a softer threshold between the public space and the protected interior. These zones allow residents and visitors to move gradually between the building and the public realm.

Elevations

Left facade

Figure 133. Material view of the left facade (1:200)
source: author

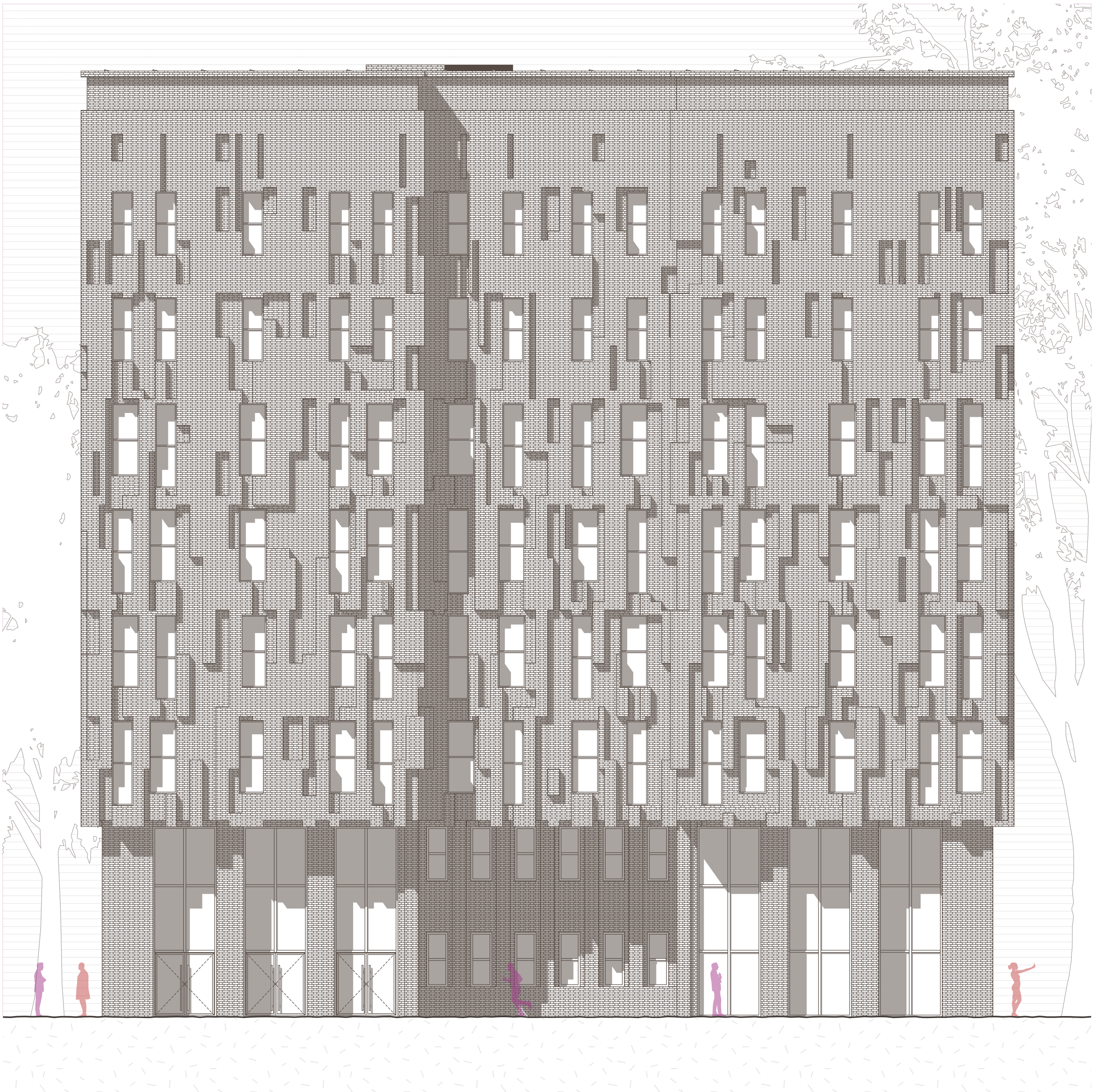


Figure 134. Monochrome view of the left facade (1:200)
source: author

Front facade

Figure 135. Material view of the front facade (1:200)
source: author

Figure 136. Monochrome view of the front facade (1:200)
source: author

Right facade

Figure 137. Material view of the right facade (1:200)
source: author

Figure 138. Monochrome view of the right facade (1:200)
source: author

Rear facade

Figure 139. Material view of the rear facade (1:200)
source: author

Figure 140. Monochrome view of the rear facade (1:200)
source: author

Sections

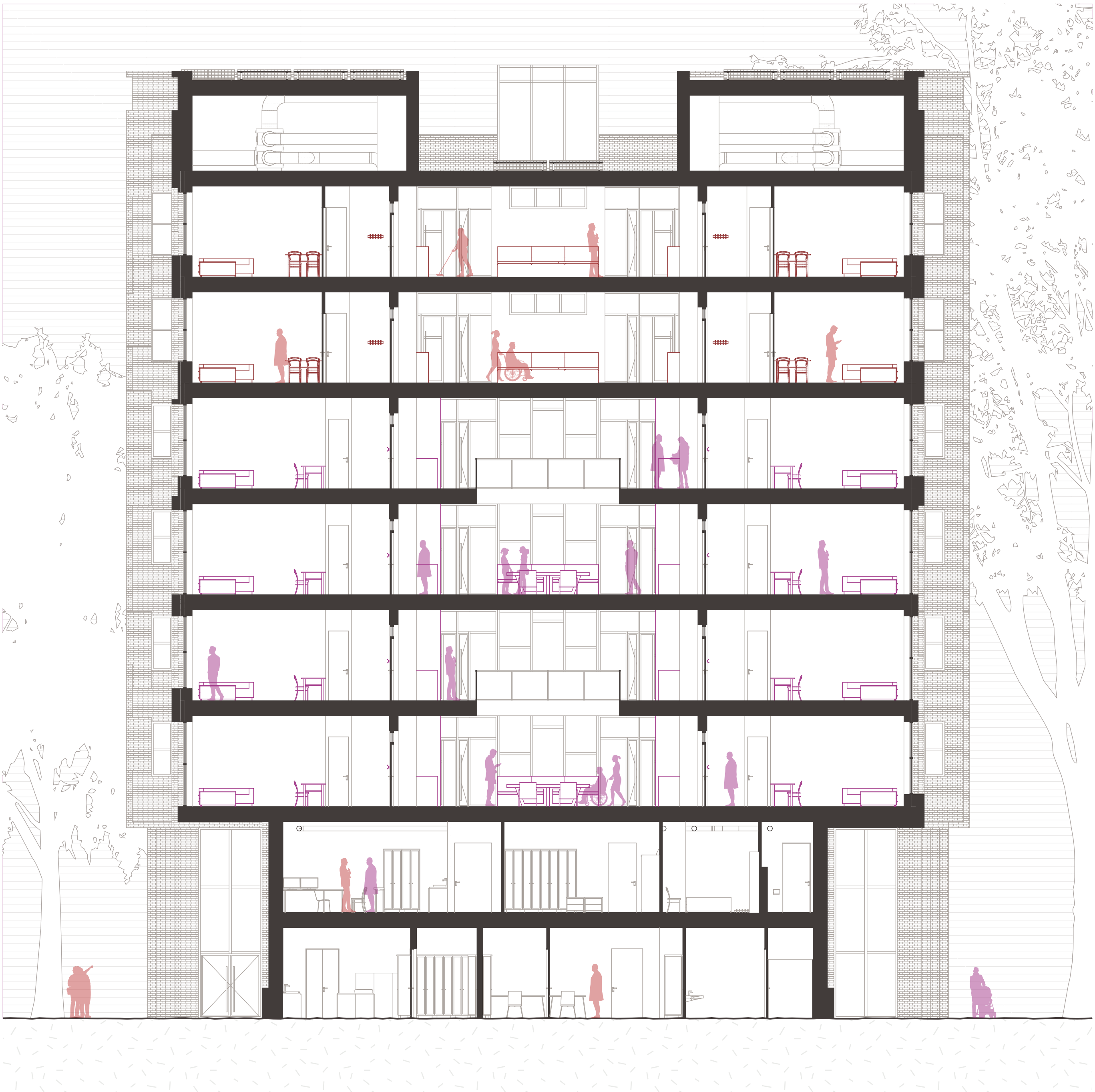


Figure 141. Section A-A (1:200)
source: author

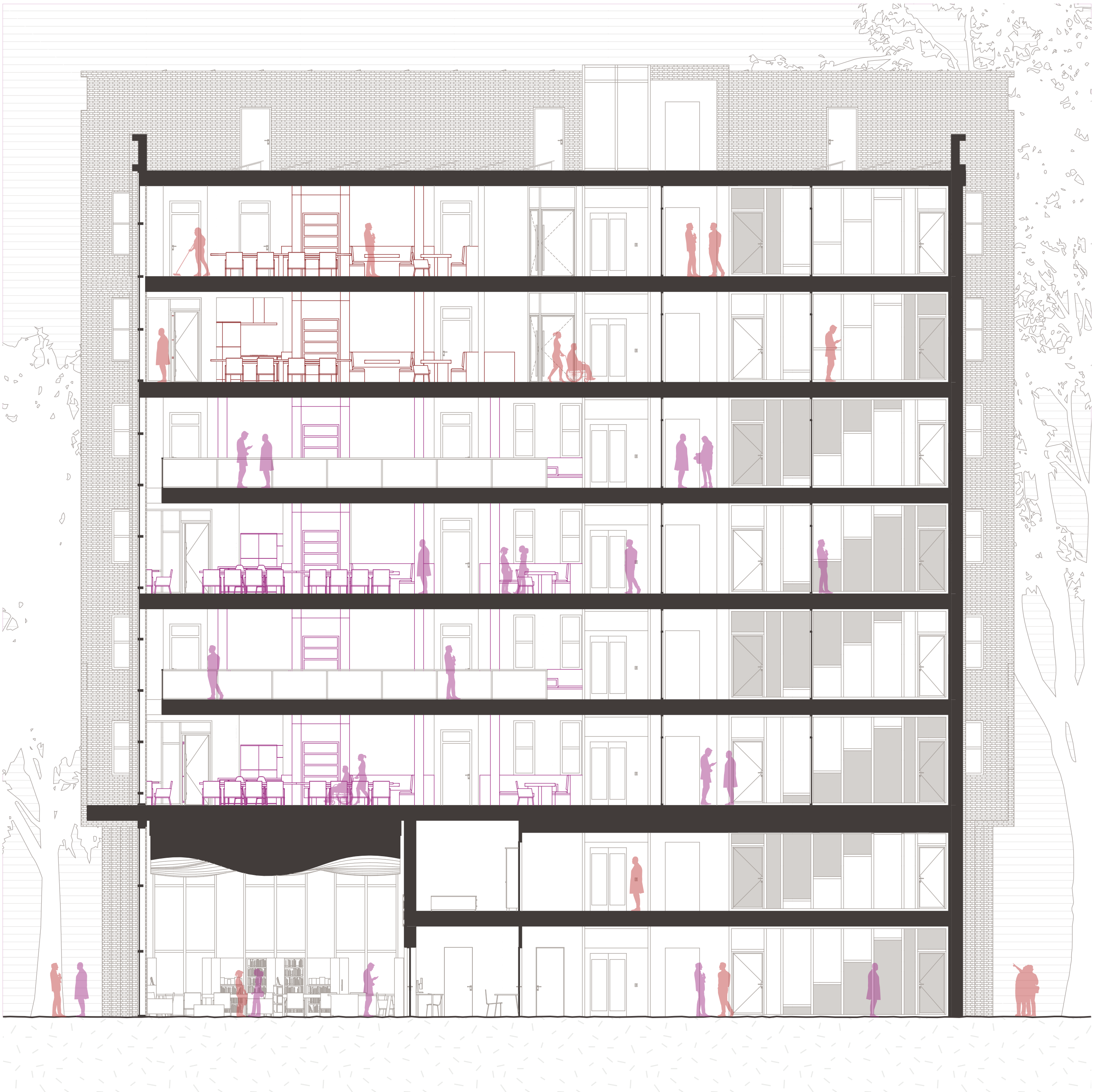


Figure 142. Section B-B (1:200)
source: author

Impressions

Figure 143. Isometric view of the building during the day
source: author

Figure 144. Close-up view of the building during the day
source: author

Figure 145. Isometric view of the building during the evening
source: author

Figure 146. Close-up view of the building during the night
source: author

Figure 147. Close-up view of the rear facade during the day
source: author

Figure 148. View of the building during the day
source: author

Figure 149. Close-up view of the rear facade during the evening
source: author

Figure 150. View of the building during the night
source: author

Figure 151. Entrance exterior during the day
source: author

Figure 152. Library entrance during the day
source: author

Figure 153. Café terrace during the day
source: author

Figure 154. View from the terrace to the library
source: author

Figure 155. Building entrance during the day
source: author

Figure 156. Building entrance during the day
source: author

Figure 157. Close-up view of vertical circulation
source: author

Figure 158. Building entrance during the day
source: author

Figure 159. Café interior during the day
source: author

Figure 160. Kitchen transition during the day
source: author

Figure 161. Café interior during the evening
source: author

Figure 162. Kitchen transition during the night
source: author

Figure 163. Vertical circulation in the café during the day
source: author

Figure 164. View of outside the café during the day
source: author

Figure 165. Vertical circulation in the café during the evening
source: author

Figure 166. View of outside the café during the night
source: author

Figure 167. Library interior during the day
source: author

Figure 168. Library interior during the day
source: author

Figure 169. Library interior during the evening
source: author

Figure 170. Library interior during the evening
source: author

Figure 171. Library interior during the day
source: author

Figure 172. Library interior during the day
source: author

Figure 173. Library interior during the evening
source: author

Figure 174. Library interior during the evening
source: author

Figure 175. Social hub shared space
source: author

Figure 176. View of the vertical circulation from the shared space
source: author

Figure 177. Social hub shared space
source: author

Figure 178. Social hub shared space
source: author

Figure 179. Social hub shared space
source: author

Figure 180. Social hub shared space, kitchen and staff room
source: author

Figure 181. Close-up view of the kitchen and staff room
source: author

Figure 182. View from staff room
source: author

Figure 183. Sanctuary shared space
source: author

Figure 184. Sanctuary shared space
source: author

Figure 185. Sanctuary retreat room
source: author

Figure 186. Sanctuary shared space
source: author

Figure 187. Exterior of retreat room within the shared space
source: author

Figure 188. View from staff room
source: author

Figure 189. Close-up view of the staff room and kitchen
source: author

Figure 190. View from inside the kitchen
source: author

Maquette

Figure 191. View of the rear and right facade
source: author

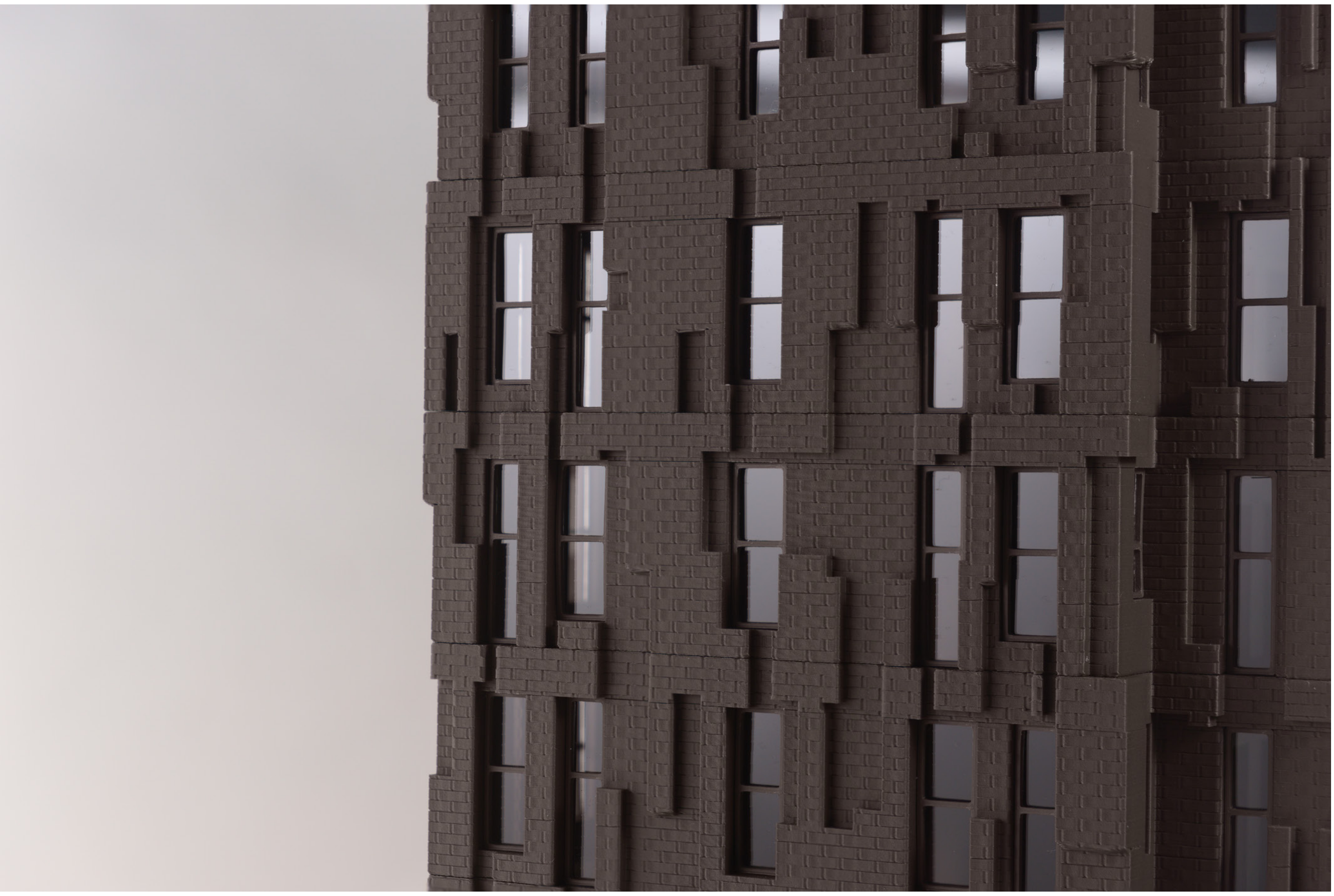


Figure 192. Close-up of facade
source: author

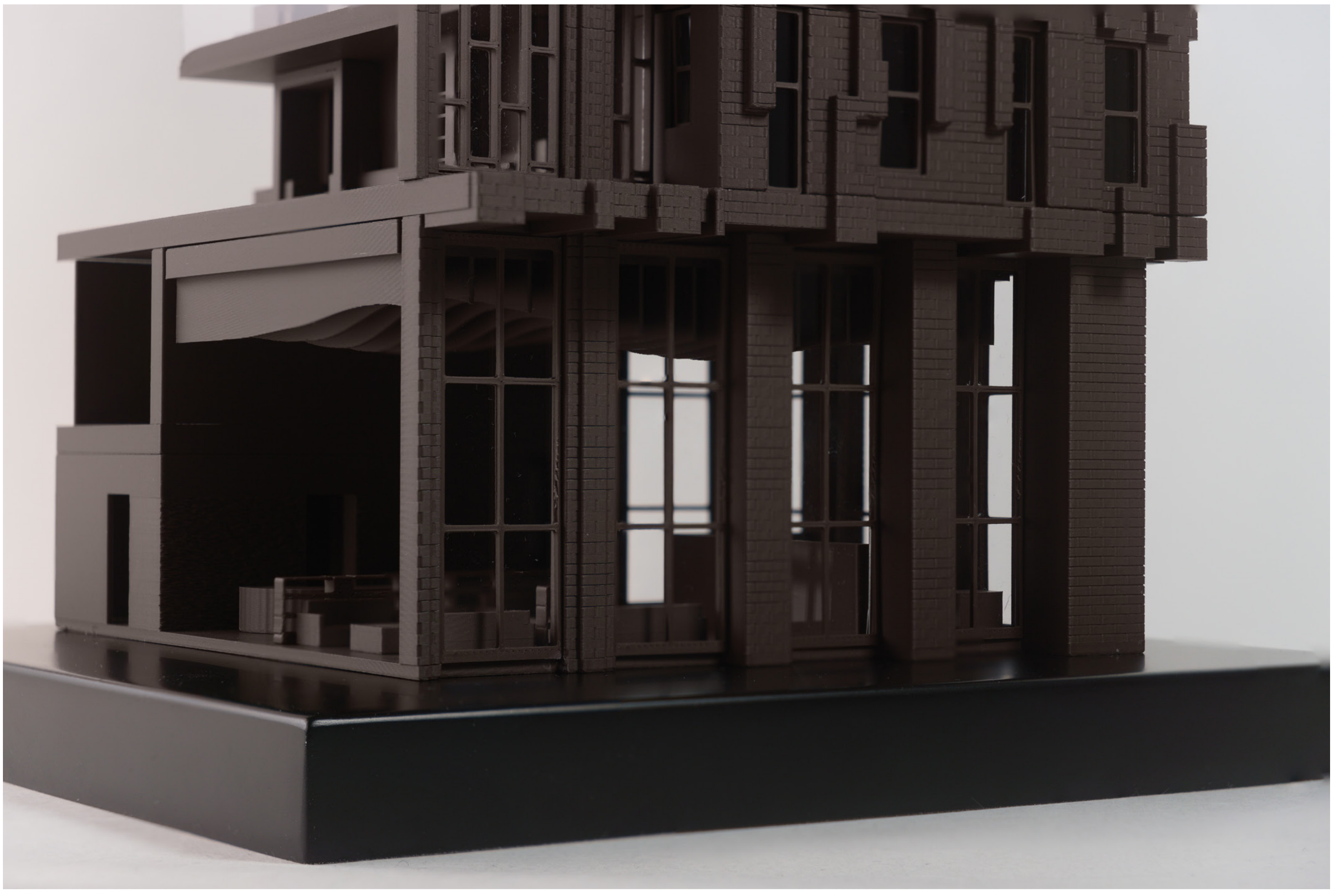


Figure 193. Close-up of the library
source: author

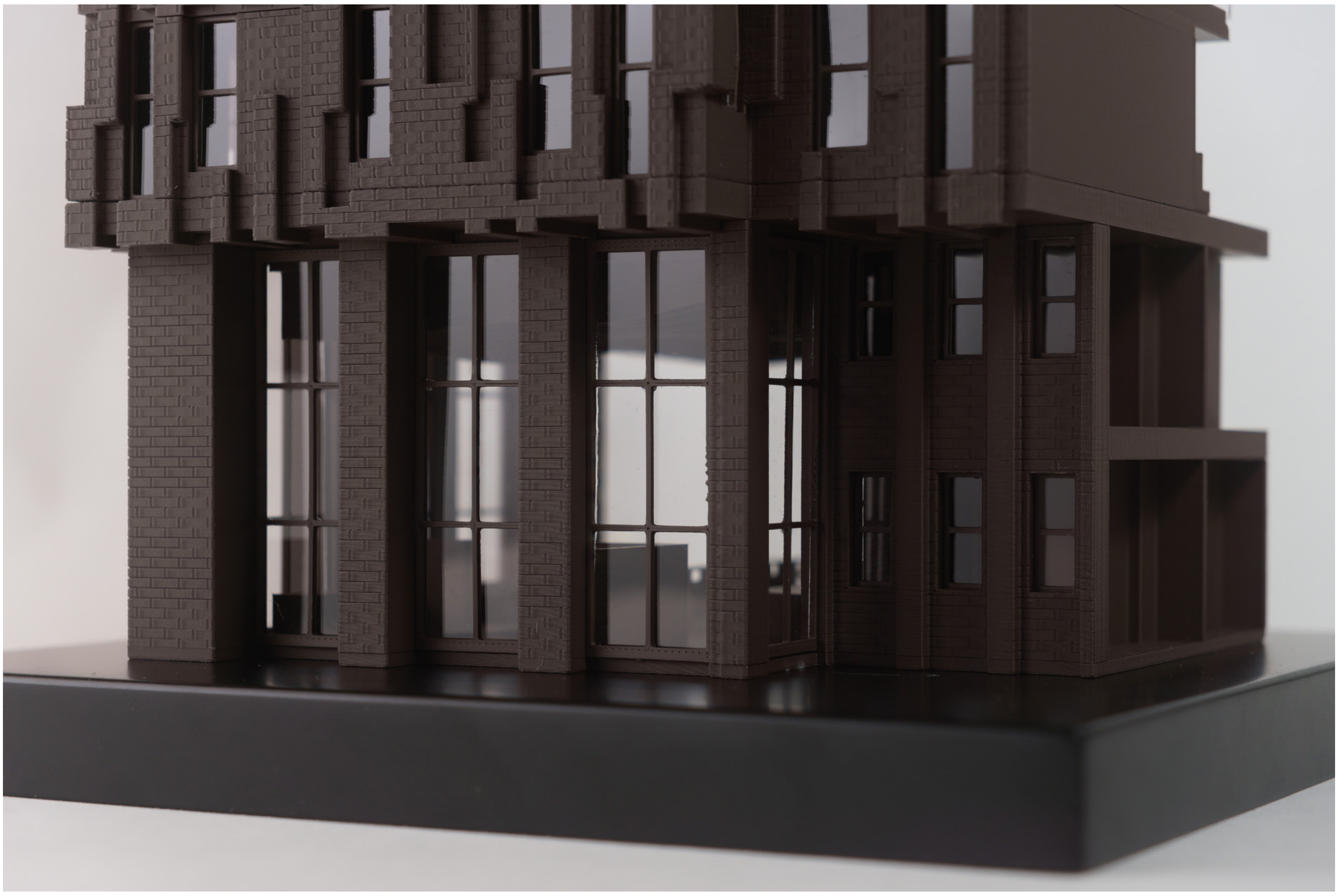


Figure 194. Close-up of the library
source: author

Figure 195. Staggered window frames
source: author

Figure 196. View of the rear facade with interior
source: author

Figure 197. View of the right facade with interior
source: author

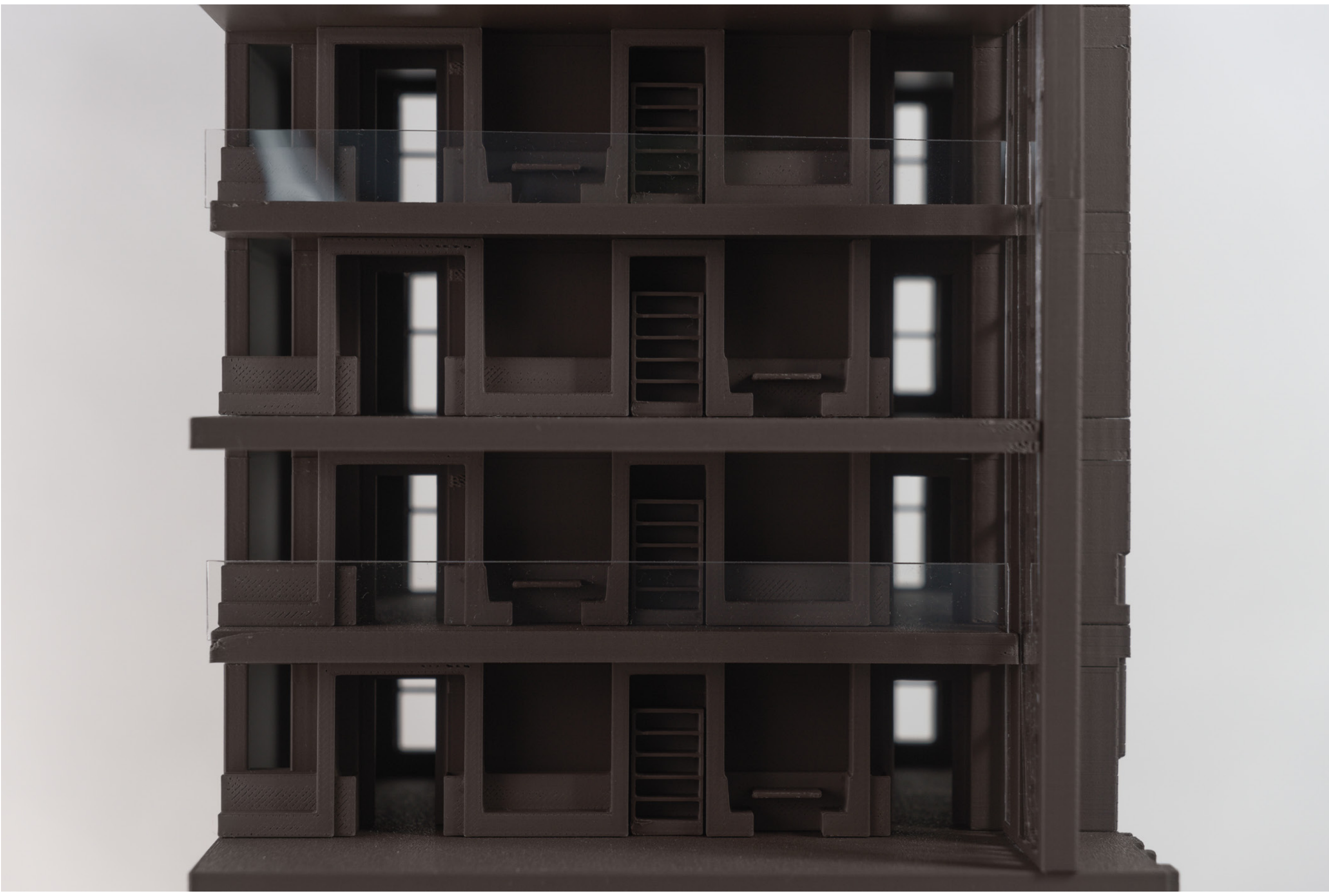


Figure 198. Social Hub levels
source: author

Figure 199. Interior view aimed at rear facade
source: author

IV

Conclusion

Conclusion

Conclusion

This graduation project looked at how the architectural design of an assisted living facility in Spaanse Polder can promote social inclusion and support the independence of residents with intellectual disabilities. The project began with the realization that while care buildings often provide safety, they can also become isolated spaces. Being built in a neighborhood doesn't automatically lead to social inclusion. For residents with intellectual disabilities, inclusion needs carefully designed architecture. The design should support independence, familiarity, predictable routines, and easy social interaction while protecting residents from senosry overstimulation and unwanted exposure.

The design addresses this issue by using the concept of public familiarity. Instead of seeking constant integration or complete openness, the building design creates repeated daily moments where residents and neighbors can interact. The café and library serve as social spaces for the new neighborhood, while the residential floors remain protected. In this way, the building does not erase the line between care and public life; instead, it makes this line gradual and promotes social interaction.

The first sub-question looked at which social and spatial needs the design should address to help residents feel at home and become more independent. The analysis of the residents revealed that they cannot be viewed as a single group. Variations in behavioral problems, nursing needs, mobility, personal care needs, psychosocial needs and social self-reliance require different spatial layouts. This resulted in the distinction between Sanctuary and Social Hub residents. Sanctuary residents live in smaller, more protected groups with calmer pathways, less biophylic architecture, retreat spaces, and predictable layouts. Social Hub residents are more communal and socially active. They are supported with larger shared areas, more space for informal interactions, and stronger links to the public. Together, these two groups demonstrate that independence stems not from maximum freedom but from achieving the right balance between repetition, choice, and support.

The second sub-question focused on how internal layouts and floor plans can promote interaction and visibility between residents and the public. The project responds to this with a layered design of public, collective, and private spaces. Public spaces create chances for interaction with the neighborhood where residents can work as part of their daily program. Shared spaces are placed along daily routes, allowing connections to form naturally. User journey maps show this well: residents move through a series of activities *(waking up, eating, working, retreating and participating)* with social interactions becoming part of daily life. Therefore, the building changes from a controlled environment into a flexible place for daily routines.

The third sub-question examined which public programs are most effective in involving the local community and creating shared social spaces. Due to their sensory compatibility with the needs of residents, the café and library were chosen. These spaces rely on regular daily visits from neighbors and visitors instead of intense or unexpected events. The library offers a quieter form of public familiarity, while the café provides a more vibrant social setting. Both programs allow residents to participate in public life in various ways, such as working, watching, helping, or casually meeting familiar people. This approach makes residents visible and recognized without subjecting them to continuous social pressure.

The fourth sub-question explored how architectural expression and visibility can promote recognition and status in an urban setting. The façade design achieved this by blending contemporary residential elements with a unique, recognizable identity. The final design does not present the building as an institutional care facility. Instead, it appears as a unique part of the new neighborhood. The variety of window shapes, textures, patterns, and depths shows the diversity of the residents while maintaining a connection to the neighborhood. Therefore, this façade plays a role in promoting the visibility and emancipation of the residents within the Spaanse Polder.

The fifth sub-question focused on transition zones and the balance between privacy and safety. This became a central aspect of the project. The entrance, lobby, circulation areas, vertical connections, shared spaces, and retreat rooms serve as thresholds rather than strict barriers. The design avoids a strict care model while ensuring residents are not overly exposed to society. Instead, it introduces gradual transitions: from public to collective, from active to calm, and from visible to protected. These transitions allow residents to decide how much interaction they want, while allowing staff to quietly support safety and orientation.

In conclusion, the project shows that assisted living can be more than just a sheltered housing facility. Through public familiarity, distinctive resident groups, seamless transitions, public programs and a recognizable architectural identity, the building serves as a connection between protection and independence. Its goal is not to force social inclusion, but to make it possible through repeated, familiar interactions. The design offers a model for assisted living where residents are seen as active and recognized members of a shared neighborhood, not hidden from the community.

Implications & recommendations

This thesis proposes that assisted living buildings should be viewed as part of a neighborhood's social infrastructure, not as separate services. For designers, this means designing daily routines and social interactions is as important as designing dwellings. Simply placing residents with intellectual disabilities in an area will not lead to social inclusion. We need spaces that allow for frequent, spontaneous interactions while protecting residents from overstimulation and unwanted exposure.

The project shows that open spaces are not the ultimate goal. For vulnerable groups, inclusion depends on the ability to choose between taking part, observing, or retreating. Instead of boundaries, designers should create gradual transitions. Public facilities, such as cafés and libraries, can encourage neighborhood connections when they are connected to clear transition zones that maintain the space's safety and predictability.

One recommendation is to start new assisted living projects by focusing on daily routines rather than just care and housing aspects. User journey maps and resident compatibility checklists can help show if a building promotessensory comfort and social interactions. These tools show how residents move and interact with others during the day and can validate the design.

For future projects, this strategy should be tested with residents, caregivers, housing providers, and neighbors. Their feedback could change the balance between independence and support, as well as between engagement and privacy. With this approach, architecture can help create care environments that are visible in the city and become a part of daily urban life that emancipates its users.

Reflection

For this project, I used a design-through-research approach where research, spatial testing, architecture, and technical development all influenced each other. At the beginning, I focused on getting to know the social positions of residents with intellectual disabilities and the challenges they face in their neighborhoods. Reading up on public familiarity, social infrastructure, and the barrier-experience helped me identify the architectural problem. It wasn't just about providing housing, but it was about creating a space that encourages independence and social interaction.

The compatibility checklists turned out to be super useful for turning these needs into spatial requirements. They allowed me to check the design based on factors like accessibility, sensory comfort, privacy, daylight, retreat, and social interaction. But I also realized that this method has its limits. If you stick to a checklist too strictly, the design can end up feeling too controlled. This was an important insight during the process, because the project shouldn't control behavior too strictly; it should create an environment where residents can choose how they want to engage.

Later in the process, user journey mapping became an important tool for validation. It shifted my focus from zoning and efficiency to the daily routines of the residents. Mapping out their daily routines helped me to see how the building is actually used, not just how it works on paper.

I also started to realize during the project that there is a difference between designing for regulations and designing for inclusion. Standards and regulations are very important to define accessibility, usability, wayfinding, contrast and safe movement through a building. They offer a good foundation to make spaces usable for a wide range of people. But I also found out that just because a building meets these standards doesn't automatically mean it's socially inclusive. A care building can be technically correct and accessible but also feel isolated or institutional. This made me wonder not only what is needed today, but what should be possible. For assisted living, I think there should be more opportunities for mixed-use buildings where housing, care, work and public functions can safely overlap. Public familiarity and architectural identity should not be seen as extra features, but as core elements of inclusion. This allowed me to place the project beyond meeting requirements, not simply as a building that works, but as a place that supports recognition and participation.

V

Back matter

References

Literature

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Images

Data management checklist

Instruction

This checklist is relevant for all graduation projects of the Master AUBS. The form is intended to highlight common aspects of graduation projects that require particular attention with regard to planning the research and data management. Relevant information and supplementary sources regarding each question are provided below each question.

With this checklist, the faculty wants to avoid that students unexpectedly find themselves in complex and stressful situations, in which ethical or privacy matters and/or other laws and regulations become an issue. In projects involving humans, certain types of data processing increase the risks to the human participants: planning such projects requires additional evaluations and advice from university staff before ethical approval can be received and the project can begin. In the case of a graduation project, obtaining additional advice or permits may delay the project with an extra education period or semester. To avoid this, it is recommended that students set up a graduation project with a low level of risk. Therefore, all students have to check their risk, by completing this checklist before their A1.

The first section of the checklist (A) should be completed by all students, together with their supervisor, during the planning of the graduation project, before the A1. It does not need to be submitted to anyone for review or approval. Please consider questions 1 to 3 carefully in relation to the intended graduation project, and answer with 'yes' or 'no'.

The second section of the checklist (B) should only be completed if the graduation project involves working with data from human participants. In that case, the student and their supervisor must apply for and receive ethical approval from the Human Research Ethics Committee (HREC) before the project can begin (see the paragraph 'Explanation and follow-up' after the questions). The student can submit the application to the HREC, but the supervisor is responsible for making sure that the project is compliant with relevant privacy regulations and ethical policies.

Section A. General considerations	yes	no
1. Is the graduation project conducted as part of an internship (at a company), or as part of a research project at TU Delft? If a student's graduation project is conducted at a company or as part of a research project at the university, questions of data ownership and intellectual property rights need to be addressed in a written graduation or internship agreement before the project begins. Student and supervisor should consult the Intellectual Property Rights of Students webpage. Additional information can also be found in the Extended Personal Research Data Workflow. If applicable, complete the Confidentiality Agreement.		x
2. Does the project involve conducting (part of) the research outside the Netherlands? Students who intend to travel abroad (even to other EU countries) for study, exchange, research, internship, or graduation project purposes need to follow the Travel Safety Protocol. This includes attending a mandatory Travel Safety Training Session: see the Disclaimer.		x
3. Will the research involve processing data from humans, such as running a survey, conducting interviews or workshops, collecting data through social media or internet forums, or re-using existing datasets about humans provided by a third party? (If 'yes', see follow-up questions 4 to 13 in Checklist B.) Students who work with data from human participants must complete the next section and apply for and receive ethical approval from the Human Research Ethics Committee (HREC) before conducting the research.		x

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Section B. Extended risk factors (only if question 3 has been answered with ‘yes’.)	yes	no
4. Will the project involve participants who may be considered vulnerable, such as the elderly, refugees or asylum seekers, ethnic minorities, patients, or people with disabi-lities? Participants who may suffer very adverse consequences (for instance, due to discrimi-nation) if their personal data became publicly available can be considered vulnerable.		x
5. Will the project involve participants who cannot themselves give informed consent for taking part in the project, but for whom consent must be obtained from a legal guardian? Participants who cannot give informed consent can include, for instance, children or participants with intellectual disabilities, mental disorders, or dementia. Such partici-pants are also considered vulnerable in the context of the General Data Protection Regulation (GDPR).		x
6. Will the project involve processing any of the special categories of personal data below? - Race - Ethnicity - Criminal offence data - Political opinion - Union membership - Religious or philosophical beliefs - Sex life and/or sexual orientation - Health data (including measurements such as heart rate) - Biometric or genetic data (including fingerprints, iris scanning, facial recognition) The General Data Protection Regulation (GDPR) defines a stricter rules for proces-sing special categories of personal data. If it is necessary to process these data in a project, it is it is important to provide additional safeguards.		x
7. Will the project involve processing personal data that could be considered sensitive, such as the ones listed below? - Information about a person’s income, debts, or other payments - Information about a person’s (un-)employment status - Information about a person’s performance at school or work - Information about relationship problems or (gambling) addiction - Information about poverty, domestic violence, or youth welfare/social work involve-ment Some types of personal data are considered sensitive, because they can have a high impact on the privacy of the data subject if other persons gain access to these data. Sensitive personal data should only be processed if necessary: in such cases, additio-nal safeguards need to be put in place.		x
8. Will the project involve processing video-recordings, or photographs of partici-pants? TU Delft considers photographic and video-materials of research participants to be sensitive personal data. If such data need to be processed, additional safeguards must be put in place.		x

Section B. Extended risk factors (only if question 3 has been answered with 'yes'.)	yes	no
9. Will the project involve sharing or transferring personal data between multiple partners or collaborating organisations involved, such as between TU Delft and an internship company? According to privacy law, sharing personal data between organisations requires a privacy agreement to be in place: setting this up takes time, and requires support from additional university staff. Furthermore, personal data sharing can potentially expose research participants to different types of risks: these risks must be considered in the ethical application.		x
10. Will the project involve deception, or covert observation of participants? In some types of research, obtaining informed consent for processing participants' personal data is not an option: for instance, if the research involves deception, or the research is covert (conducted without participants knowing about it). In such situations, the steps to mitigate risks to participants are important, and an alternative legal basis for processing the participant's data needs to be established with the help of additional support staff.		x
11. Will the project involve working with social media data? Social media data are personal data, but since it is usually not possible to ask for informed consent for processing social media data, another legal basis for processing the participant's data needs to be established. Processing of social media data also involves legal considerations related to terms of use of data from third-party platforms: therefore, research with social media data requires expert support on privacy, ethics, and legal matters.		x
12. Will the project involve using learning algorithms or other AI to analyse, combine, or otherwise process data from participants? The use of AI in research involves many considerations in terms of data protection, ethics, security, and intellectual property: for more information, see TU Delft's Instructions for use of Generative AI.		x
13. Will the project involve participants who are based in a country or countries outside of the EU? Students affiliated with TU Delft must comply with Dutch and EU regulations of personal data processing (GDPR). Furthermore, the student and their supervisor must make sure that the research complies with local (privacy) legislations of any foreign destinations. Additional support from an external (local) expert may be required.		x

Explanation and follow-up

If you have answered 'no' to all questions 4 to 13, your project is likely to be considered low or minimal-risk: see the paragraph 'Projects with minimal or low-risk' on the next page.

If you have answered 'yes' to one or more of the questions 4 to 13, your research likely involves extended or high risks to participants, according to the General Data Protection Regulation (GDPR) and TU Delft's privacy and ethical policies: for information regarding such projects, see the paragraph 'Projects with extended or high-risk' on the next pages.

Precedents

Figure 200. Architecture of Hart van Vathorst
source: Van den Berg Groep, 2016

Hart van Vathorst

Location	Amersfoort, The Netherlands
Program	Living, working
Year	2016
Architect	Van den Berg architecten, Borgerink architecten
Client	Orange Care, Accolade Zorggroep, Sprank, Downey's GKV Vathorst en Kindercentrum Bzzzonder
Gross floor area	11.600 m2

Hart van Vathorst is a multifunctional healthcare complex of approximately 11,600 m² that was completed in March 2016. What started originally as a search for inclusive childcare, developed into a complex integrating the Bzzzonder children's center, a church, a public restaurant, and

Figure 201. Interior of the ground floor of Hart van Vathorst
source: Van den Berg Groep, 2016

the healthcare institutions Sprank and Accolade. Spatially and logistically, the building was designed around flexibility and shared use of space, which, in addition to social integration, also provides operational and financial benefits. The public restaurant [11] on the ground floor functions as the beating heart for low-threshold interaction with the neighborhood. To prevent overstimulation, the building is zoned so that residents can seek out interaction but can also retreat to their own environment without disturbing the overall dynamics. This zoning is clearly visible in the

Figure 202. Floorplans of Hart van Vathorst
source: Van den Berg Groep, 2016

residential floors of Sprank's 38 clients: they have individual apartments but are also divided into small-scale, color-coded living groups with their own living rooms. In this way, the architecture facilitates specific stimulus regulation: ranging from structured living environments for residents with autism to a section for independent living featuring only an accessible support point.

Figure 203. South east corner of Hof van Leijh
source: Hans Peter Föllmi, 2020

Hof van Leijh

Location	Haarlem, The Netherlands
Program	Living, working
Year	2020
Architect	FARO Architecten
Client	Elan Wonen

Hof van Leijh in Haarlem is a residential and care building designed by FARO Architects on behalf of ELAN Wonen. The project consists of 173 homes, including rental apartments and care apartments. It creates a mixed residential environment where young and old can live togeth-

Figure 204. Public plinth of Hof van Leijh
source: Hans Peter Föllmi, 2020

er, with special attention for people who require care or support. Around half of the apartments are intended for residents with a care indication, and part of the building is designed for people with an intellectual disability. All homes are accessible without stairs or thresholds, allowing residents to continue living independently for longer.

An important part of the project is the plinth along Frans van der Wielstraat. This plinth contains social and community facilities that are intended not only for the residents

Figure 205. Street view of Hof van Leijh
source: Hans Peter Föllmi, 2020

of Hof van Leijh, but also for the surrounding neighbourhood. It includes a care support centre and 'De Buurtwinkel', an activity and service centre that functions as the social heart of the building. Residents and local people can come here for help with everyday tasks, such as grocery shopping, small household jobs or taking out waste paper.

What makes this project particularly special is that people

Figure 206. Facade of Hof van Leijh
source: Hans Peter Föllmi, 2020

from SIG work in the plinth. These are people with disabilities who, under supervision, work in De Buurtwinkel and the neighbourhood restaurant. As a result, the plinth has not only a practical and social function, but also contributes to inclusivity and participation. The presence of SIG makes the building more than just a housing complex: it becomes a place where living, care, meeting and work come together.

Figure 207. Fragment of facade of City Archive Delft
source: Stefan Müller, 2017

City Archive Delft

Location	Delft, The Netherlands
Program	Living, working
Year	2020
Architect	Office Winhov, Gottlieb Paludan Architects
Client	City of Delft

The City Archive Delft by Office Winhov was designed as a robust building for storing and accessing the history of the city. The public reading rooms are located on the ground floor, while the archive depots are placed above. The façade

Figure 208. Plinth of City Archive Delft
source: Stefan Müller, 2017

gives the building its strong architectural character. Brick is not used as a flat surface, but as a material with depth, relief and rhythm. Recessed planes and vertical brick patterns create a façade that changes with light and shadow. This gives the building a timeless and solid appearance, while also referring to Delft's rich tradition of brick architecture.