

An architectural rendering of a modern building's interior. The space features a large glass wall on the left, framed in a light-colored wood, which looks out onto a courtyard with a swimming pool and other buildings. The interior walls are clad in vertical wooden slats. A long, low, light-colored bench is positioned against the slatted wall. The lighting is warm and directional, creating strong shadows and highlights on the wooden surfaces.

UN-IMPAIRED STUDY

GRADUATION PRODUCTS  
TESS TEGELBERG



## NEURODIVERGENT \*

\*Neurodivergent can be defined as a person whose neurocognitive functioning diverges significantly from the dominant societal standards of "normal".

"Neurodivergence (the state of being neurodivergent) can be largely or entirely genetic and innate, or it can be largely or entirely produced by brain-altering experience, or some combination of the two (autism and dyslexia are examples of innate forms of neurodivergence, while alterations in brain functioning caused by such things as trauma, long-term meditation practice, or heavy usage of psychedelic drugs are examples of forms of neurodivergence produced through experience)."  
(Walker, 2020)

# U N - I M P A I R E D S T U D Y

There is a trend visible in the number of diagnoses of Autism Spectrum Disorder (New York Times, 2002) and Attention Deficit Disorder (Visser, et al., 2014).

Officially, 9% of students at the TU Delft are registered as students with a disability (TU Delft, 2020a). However, ECIO (Expertisecentrum Inclusief Onderwijs) estimates that 30% of students in universities have an impairment and 10% of total students are impacted in their studies by this impairment (Centrum Hoger Onderwijs Informatie, 2019). In 2018, the TU Delft had 24.703 students (TU Delft, 2019), leaving 2.470 students whose studies are impacted by their impairment.

The TU Delft has committed to the Declaration of intent UN Convention higher education institutions where they declare that they:

- *Wish to be inclusive educational institutions, where every student participates in the education on an equal basis with other students and every student feels welcome and accepted irrespective of background.*
- *To this end will carry out activities in the field of education for the implementation of general accessibility.*
- *To this end will connect objectives and activities in the field of education that link up with the joint approach of the State and administrative partners for the implementation of the Convention.*
- *To this end will cooperate with each other to share knowledge and develop policy by which inclusion in education is enhanced and strengthened.*

To this end they have formulated a policy document describing how they (plan to) address, assess and improve their policies regarding students with impairments (TU Delft, 2020a). However, the document is lacking in one area: the physical study facilities at the TU Delft. As Winston Churchill famously stated: “We shape our buildings, thereafter they shape us”. The physical environment one studies in has great effect on oneself.

The TU Delft is renewing the campus and wants to invest in world-class facilities (TU Delft, sd). In 2018, the new educational building Pulse was completed. It has 1.020 education spaces and approximately 160 self-study spaces (TU Delft, 2020b). At the end of 2019 the TU Delft started building another new educational building: Echo (TU Delft, 2020c). The TU Delft is building extra study facilities for their neurotypical students, but it is missing an opportunity to build a futureproof, inclusive building for self-study for all its students.

Therefore, the main research question of this paper is:

“In what way can the needs and wishes of neurodiverse students be combined with the needs and wishes of neurotypical students to create an inclusive study facility for the TU Delft?”

I have tried to answer this question by first researching the needs and wishes of the neurotypical students and the needs and wishes from the neurodiverse students.

These were compared to see where the needs and wishes are of no influence on each other, match or contradict one another. From this, it will become visible what to implement in the design and what to avoid.

(2002, October 20). New York Times, pp. Section 4, p. 40.  
Centrum Hoger Onderwijs Informatie. (2019). Jaarrapport 2018 Studeren met een functiebeperking. Jaarrapport, Expertisecentrum Inclusief Onderwijs.  
TU Delft. (2019, Januari 07). Studentenpopulatie. Retrieved from TU Delft: <https://www.tudelft.nl/over-tu-delft/leiden-en-cijfers/onderwijs/studentenpopulatie/>  
TU Delft. (2020a). Studeren met een Functiebeperking Beleidsdocument 2020-2022. Nottite, Delft.  
TU Delft. (2020b). Pulse. Retrieved from Campus development TU Delft: <https://campusdevelopment.tudelft.nl/en/project/pulse/>  
TU Delft. (2020c). Echo. Retrieved from Campus development TU Delft: <https://campusdevelopment.tudelft.nl/en/project/echo-2/>  
TU Delft. (sd). TU Delft Campus Strategy. Retrieved on June 25, 2020, from TU Delft: <https://tu-delft.nl/leiden.com/tu-delft-campus-strategy/campusstrategy/>  
Visser, S. N., Danielson, M. L., Bitsko, R. H., Holbrook, J. R., Kogan, M. D., Ghandour, R. M., . . . Blumberg, S. J. (2014, January 31). Trends in the Parent-Report of Health Care Provider-Diagnosed and Medicated Attention-Deficit/Hyperactivity Disorder: United States, 2003-2011. *Journal of the American Academy of Child & Adolescent Psychiatry*, 34-46 e2.



# ARCHITECTS' HANDBOOK

## BUILDING SCALE

The students interviewed had a lot of input on their environment in the building scale. I will firstly address the issues where the neurotypical and neurodiverse students were in agreement. After that, I will discuss the differences of opinions.

The main element all interviewed students agreed upon was that a studyspace should not be in the walking path. For all students it is very distracting to have people walk past regularly: the environment must be tranquil. As mentioned in the City Scale, tranquility was named by all but one student. This seems to be an important factor in the make-or-break of the educational environment. However, even though the students wish the environment to be tranquil, they don't wish it to be devoid of others. All interviewees voiced their wish for there to be other students who are also studying. This creates a study atmosphere that motivates. This way there is also a sense of social security and purpose: you feel less inclined to slack off when people around you are hard at work.

Another element the students agreed upon was lighting, for when you cannot read a text, you cannot comprehend the text. Emma elaborated on this element further, stating she prefers warm and natural light, while others expressed their need for large windows.

Lastly, the students agreed on the need for well constructed spaces. They found the need for better attention paid to especially how floors are constructed. It is very distracting when you bounce up and down in your chair when a person walks past or uses the stairs because the construction of the floor is not sturdy enough.

Regarding the elements where the groups differed in opinion, an important element is the setup of the building with its uses. Part of the Autism Spectrum Disorder (ASD) diagnosis in DSM-5 is "Insistence on sameness [...] (e.g. extreme distress at small changes, difficulty with transitions, rigid thinking patterns [...])" (American Psychiatric Association, 2013). This means that if a person with ASD finds themselves lost for example, their stresslevels rise far more than a neurotypical's stresslevels. To make sure the risk of this occurring is lowered, it is important to think about the predictability of the main layout of the building. When a building is sorted logically in use, and therefore predictable, it should be far less likely for a person to feel lost. In my research, Mark and Rachel expanded on this by stating they would like a single-use building. By designing a building where it is abundantly clear what the use is, since there is but one, it inherently becomes far more predictable and there are less transitions to overcome.

Lastly, regarding the space sizes, the neurotypical and neurodiverse students differed greatly. The neurotypical students opted for larger, but sectioned, spaces, while the neurodiverse students opted for smaller spaces, preferably longer than they are wide. This could perhaps be due to the need of some neurodiverse people to keep an overview of their surroundings but could also benefit neurotypical students such as Stephen.

## CITY SCALE

When searching for a home, the location is deemed the most important factor. This can be thought of as just as important in learning environments as it is deemed in housing.

According to Attention Restoration Theory (Bell, 2001), directed attention (studying) drains ones amount of attention. This means that there is a finite amount of attention available to a person at a certain time.

*People with Attention Deficit Disorder (ADD), for instance, have what can be described as a faulty impulse filter. Every noise made or shift seen is registered, whereas a neurotypical person would not actively notice these impulses. The effect this has on people with ADD is that their amount of attention drains more rapidly and could therefore be in need of replenishment sooner.*

As the pool of attention drains, it becomes increasingly difficult to focus and therefore study. According to Kaplan, nature is the way to replenish ones attention amount. In his article The restorative benefits of nature he describes four components of restorative environments, namely: Being away, Fascination, Extent and Compatibility. These four components are well represented in nature, making it the ideal environment to restore ones attention. (Kaplan, 1995)

This was also agreed upon by the interviewees. Both neurotypical and neurodiverse students listed view of greenery as a positive attribute. Rachel also stated that she would like the building to be far from the city centre as this would result in less people, more nature and less hustle and bustle.

Aside from proximity to nature, noise levels can have a great impact on study-achievements and are therefore important to consider when desiging. Noise can impact performance greatly, both during exposure and through aftereffects (possibly due to draining ones attentionlevels) (Bell, 2001). "[noise]... "masks" internal speech, or makes it more difficult to "hear ourselves think"" (Poulton, 1977). Additionally, quiet or tranquility was mentioned by all but one interviewee as an important factor in the succes of the study environment. Therefore, positioning the building in its context so that places of concentration are more quiet is advisable.

## ROOM SCALE

Inside the room, materials are the most important element since materials have the ability to abate many an impulse. Softer materials such as carpets and fabrics can be instrumental in absorbing sounds, such as footsteps or conversations. However, the colours of the materials used could also form an impulse in itself. Four out of the six students interviewed discribed that they liked either "calm colours" or "not just white". Emma listed white in the same breath as harsh colours, indicating that white might well be a harsh colour. It could therefore be better to look into pastels, darker shades or natural materials. I believe it's not necessary to forgo all use of the colour white, but the understanding that white is the most basic colour, and therefore low-impulse, is in my opinion, a misconception.

*Another part of the diagnosis of Autism Spectrum Disorder according to DSM-5 is "Hyper- or hyporeactivity to sensory input or unusual interest in sensory aspects of the environment." (American Psychiatric Association, 2013). According to Dawson (1998, pp. 479-485) this can be explained by the lack of hierarchy in impulses. A neurotypical person would rate social stimuli as more important than non-social stimuli, while a person with ASD would rate them equally important. Therefore, they can be relatively more affected by environmental stimuli such as heat, light, sound and smell.*

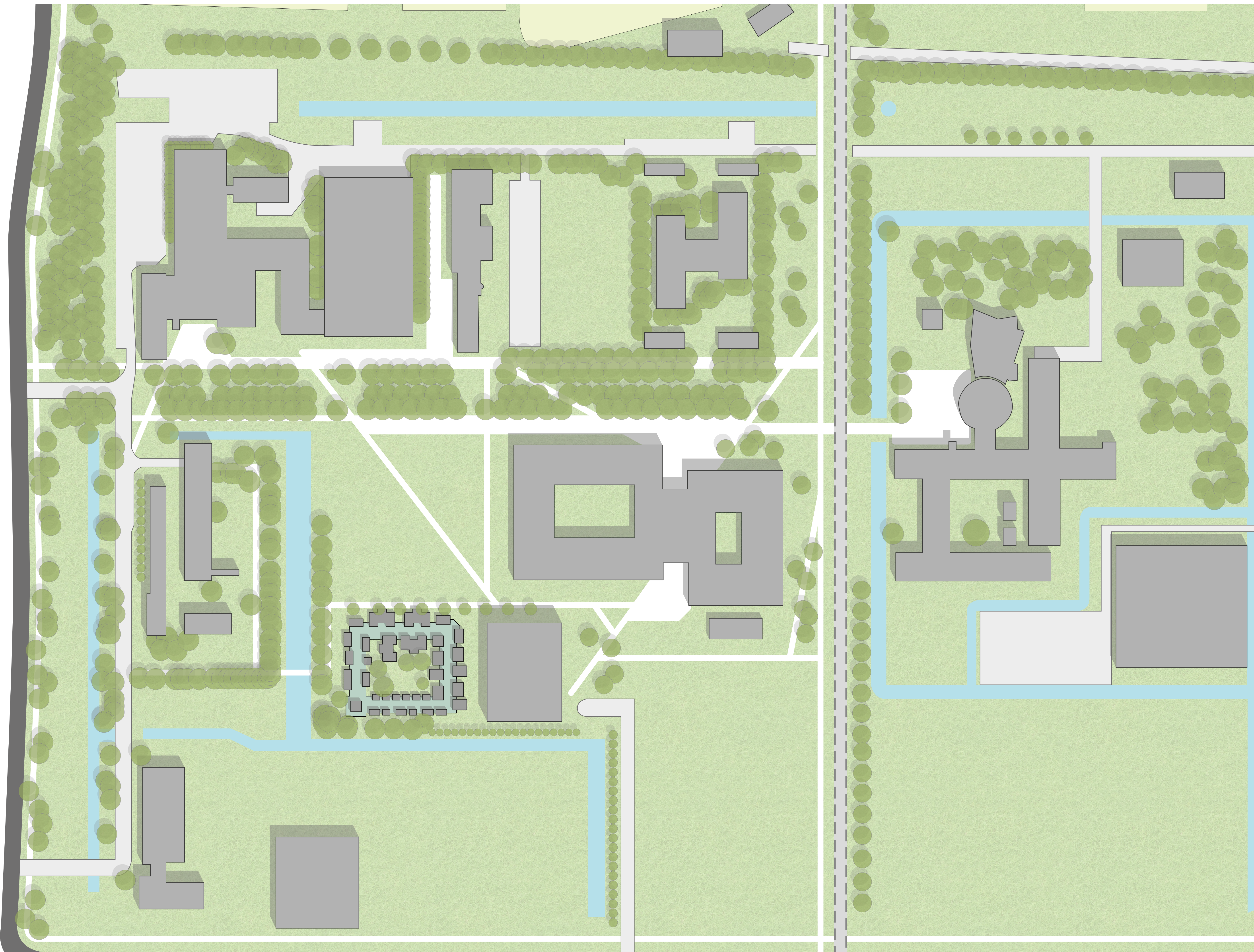
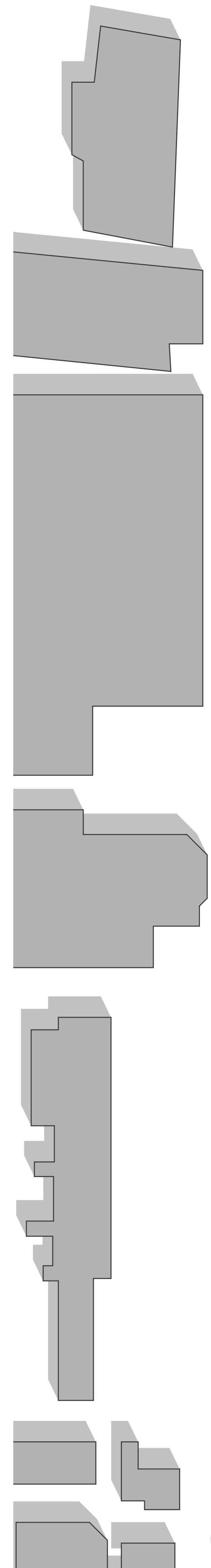
During the designprocess it could therefore be vitally important to realise this since it can impact the user greatly. One way to relieve the issue could be to grant the user some form of control. The ability to be able to turn the heat on, change the light intensity, shut the blinds, close or open doors and windows, provides the user with a possibility to cope with the original impulse. The more control we have, the better we adapt to impulses (Bell, 2001). Control over the environment was favourably mentioned by two of the three neurodiverse students.

The final element regarding room scale is overview and the furniture layout. While Emma is less distracted when her desk faces a wall or window, Rachel misses the overview of her surroundings and gets less distracted when facing the door. It might be helpful to take heed of this when furnishing the room and perhaps providing moveable desks.

*"Excersising meaningful control over environmental conditions allows the individual to tailor them to one's needs and preferences. By definition, the conditions one prefers should be those that produce high environmental satisfaction." (Marquardt, Veitch, & Charles, 2002)*

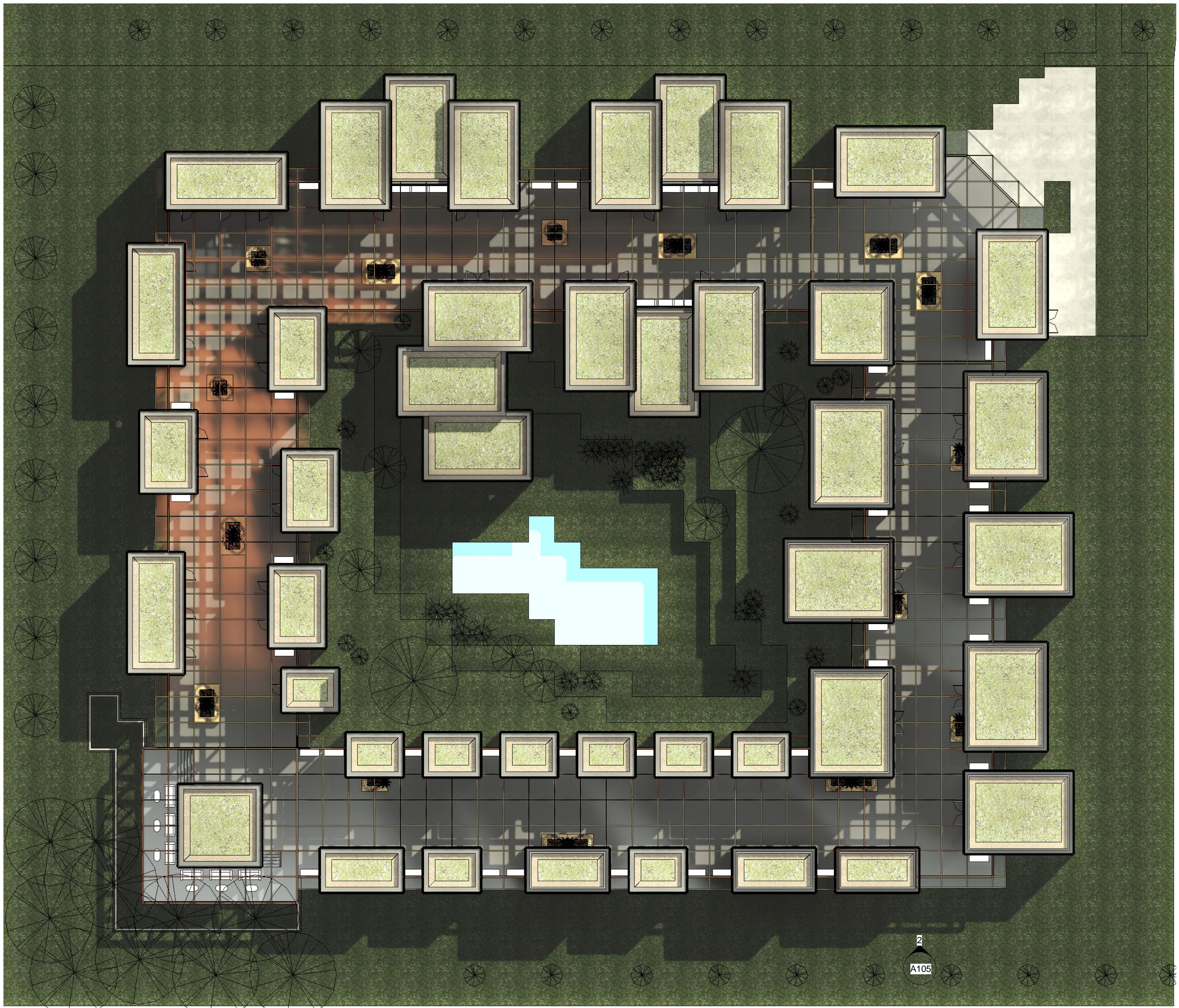


SITE  
1:1000  
⊙





TOP  
VIEW  
1:200



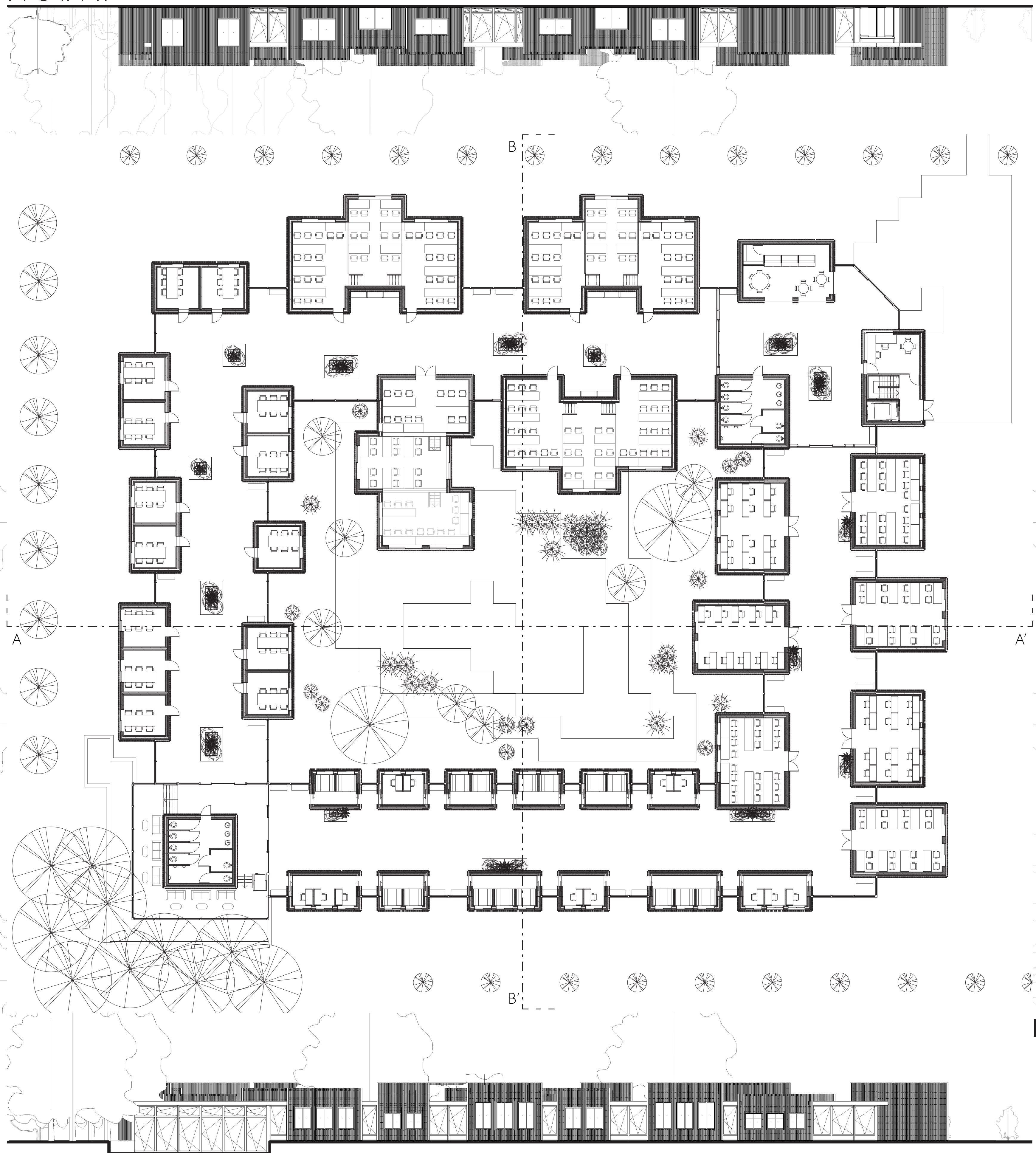


# GROUND FLOOR PLAN, ELEVATIONS AND SECTIONS

1:200



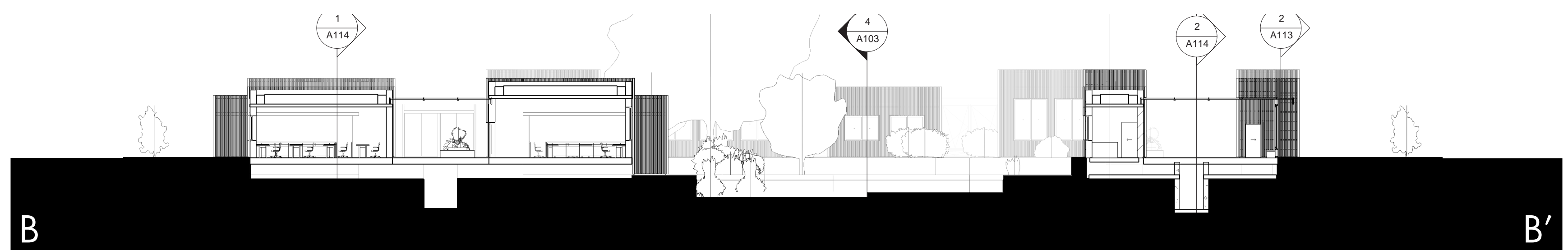
NORTH



WEST

EAST

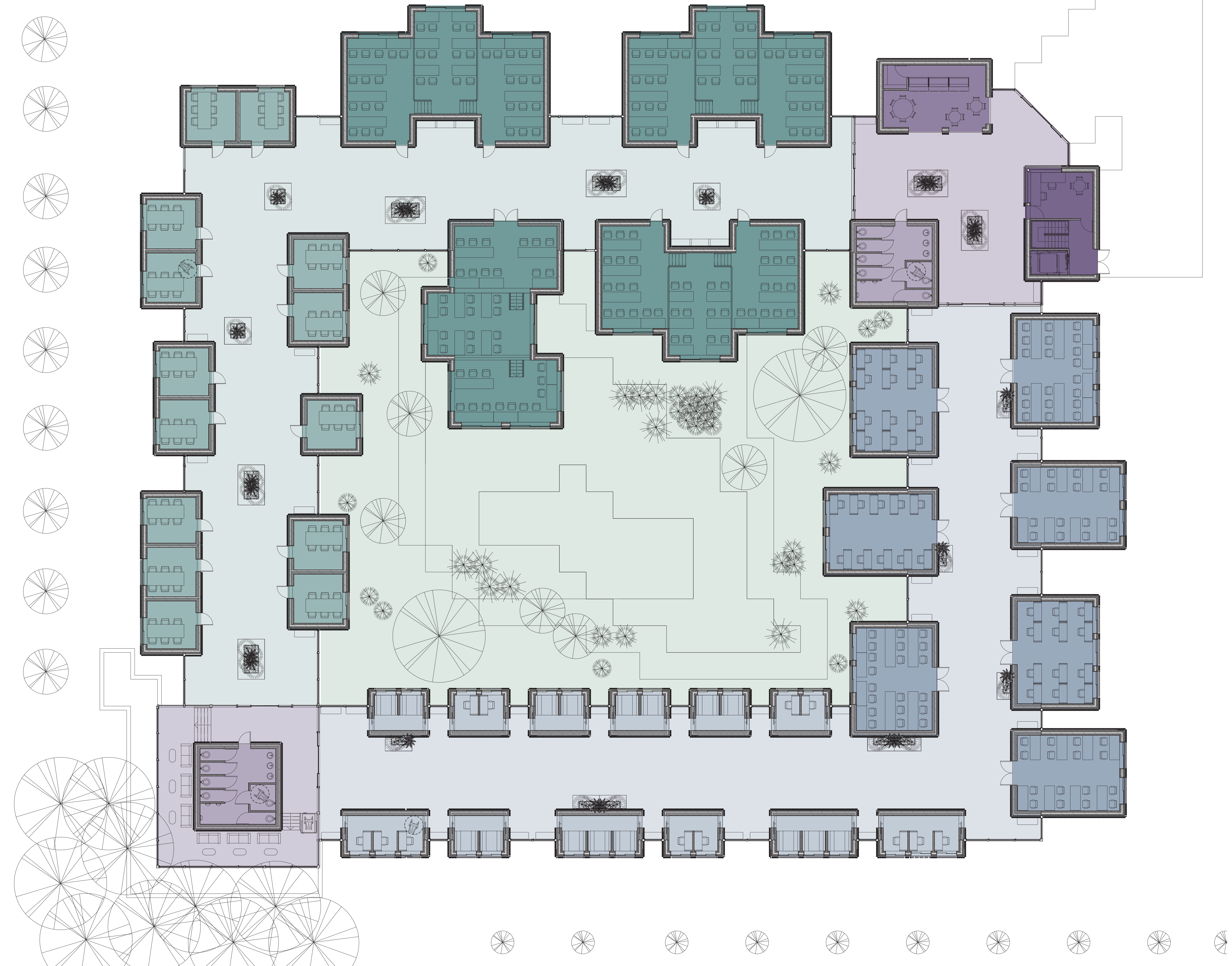
SOUTH





GROUND FLOOR

1:300



- Entrance
- Reception
- Café
- Bathroom
- North-West hallway
- Large studyhalls
- Groups rooms
- South-East hallway
- Small studyhalls
- Studynooks
- Lounge
- Bathroom
- Courtyard





Large studyhall



Large studyhall - view on courtyard



Small studyhall



Large studyhall



Small studyhall

## STUDY SPACES

When studying, the objective is to be able to be able to focus. All study spaces have exterior window blinds, adjustable by the students. While the spaces have large windows, there is little exterior distraction, as the courtyard is not accessible for students. This means that there is always a tranquil view available.

One result of the research was that diversity in space is important to be able to accommodate everyone. The neurotypical students wanted larger, yet subdivided study halls. The neurodiverse students opted for smaller studyrooms where there is more overview and more private spaces. All students noted that though too many people is distracting, a few people can really boost the study atmosphere.

To accommodate more diversity in the smaller studyrooms, some rooms have moveable furniture. Additionally, the smallest studynooks have either booths or height-adjustable desks.



Small studyhall



Group space  
UN-IMPAIRED STUDY



Studynook

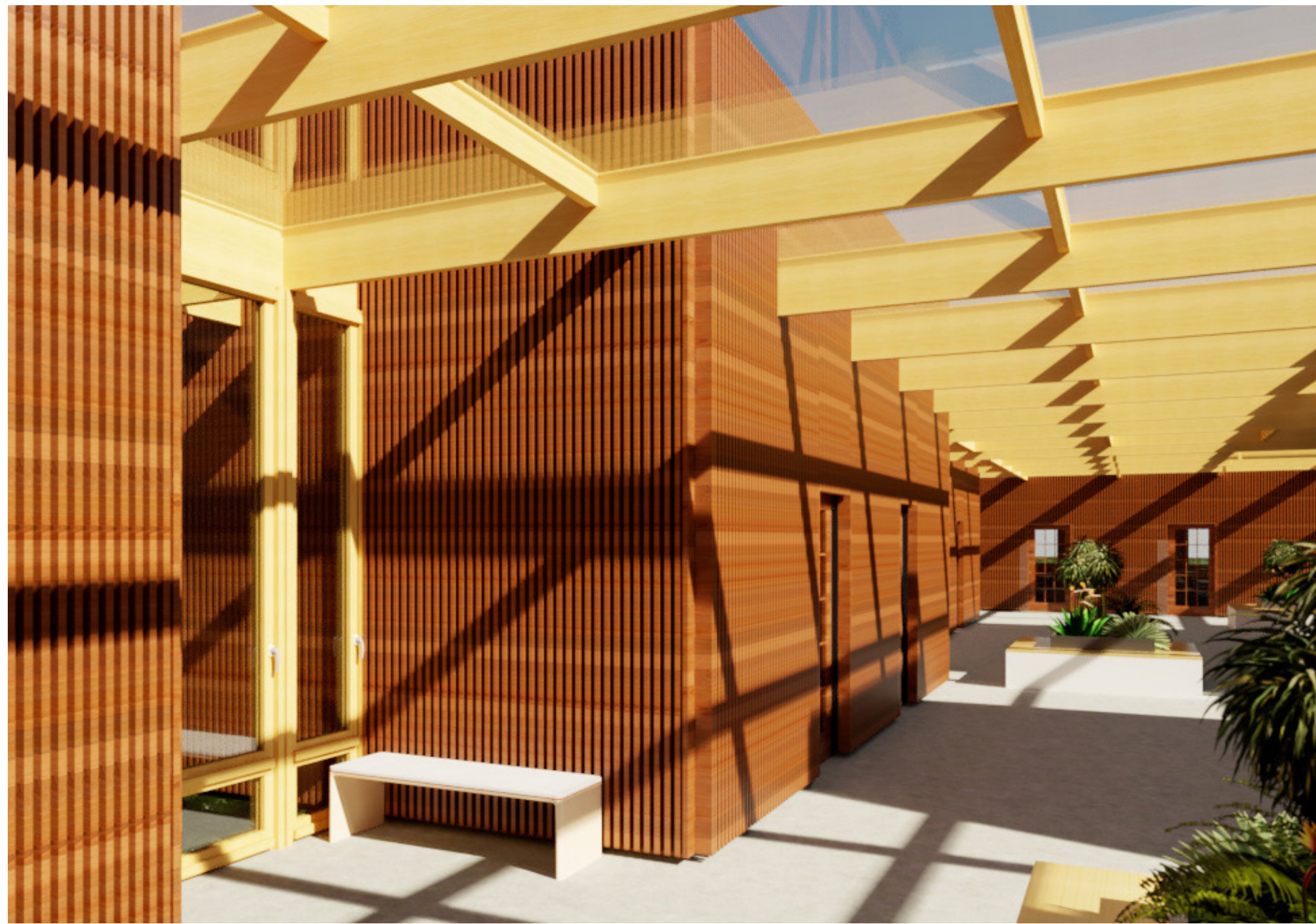


Studynook





Bench in hallway between group spaces



I N - B E T W E E N - S P A C E

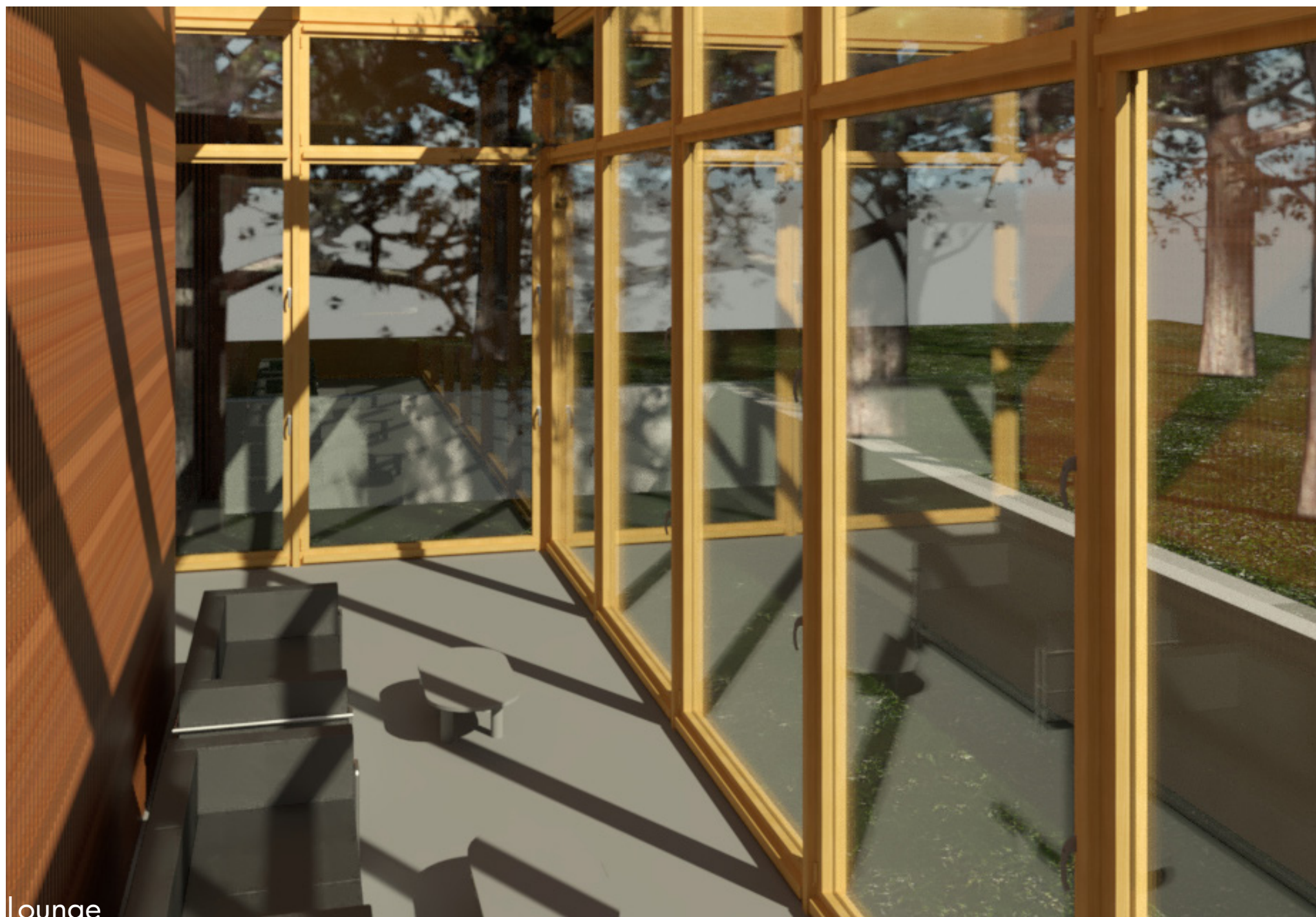
Breaks could be deemed as important as studying. So when not in the studyrooms, it is best to be in a restorative environment to restore the ability to focus. A restorative environment is an environment where there is a sense of "being away", fascination, extent and to which the person is compatible. This is best found in nature. (Kaplan, 1995)

I've tried to accomplish these requirements by creating a contrast between inside the "study-boxes" and in the hallway. The boxes are demarcated while the hallway is spacious in all directions, fully glazed, providing that connection with nature to recuperate.

Kaplan, S. (1995). The Restorative Benefits of Nature: Toward an Integrative Framework. *Journal of Environmental Psychology*(15), 169-182.



South-East corner



Lounge



View of courtyard

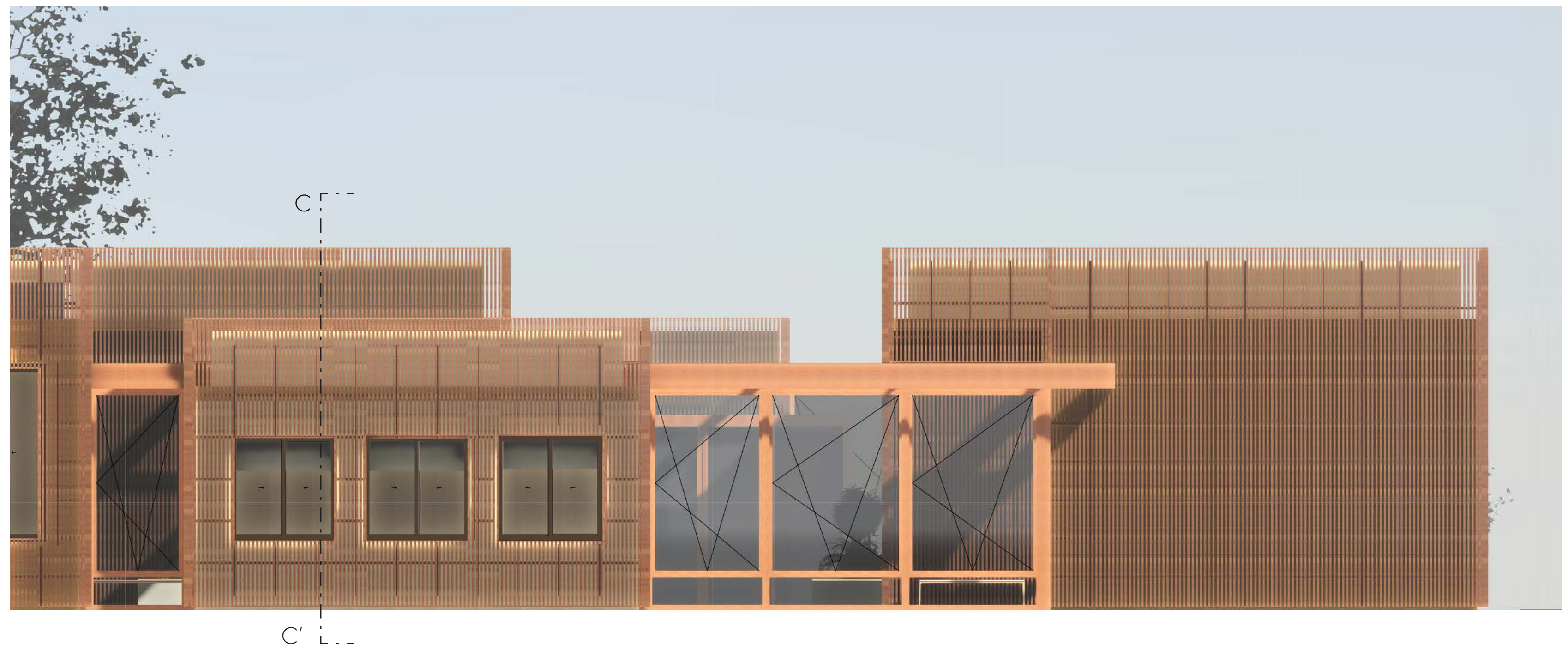
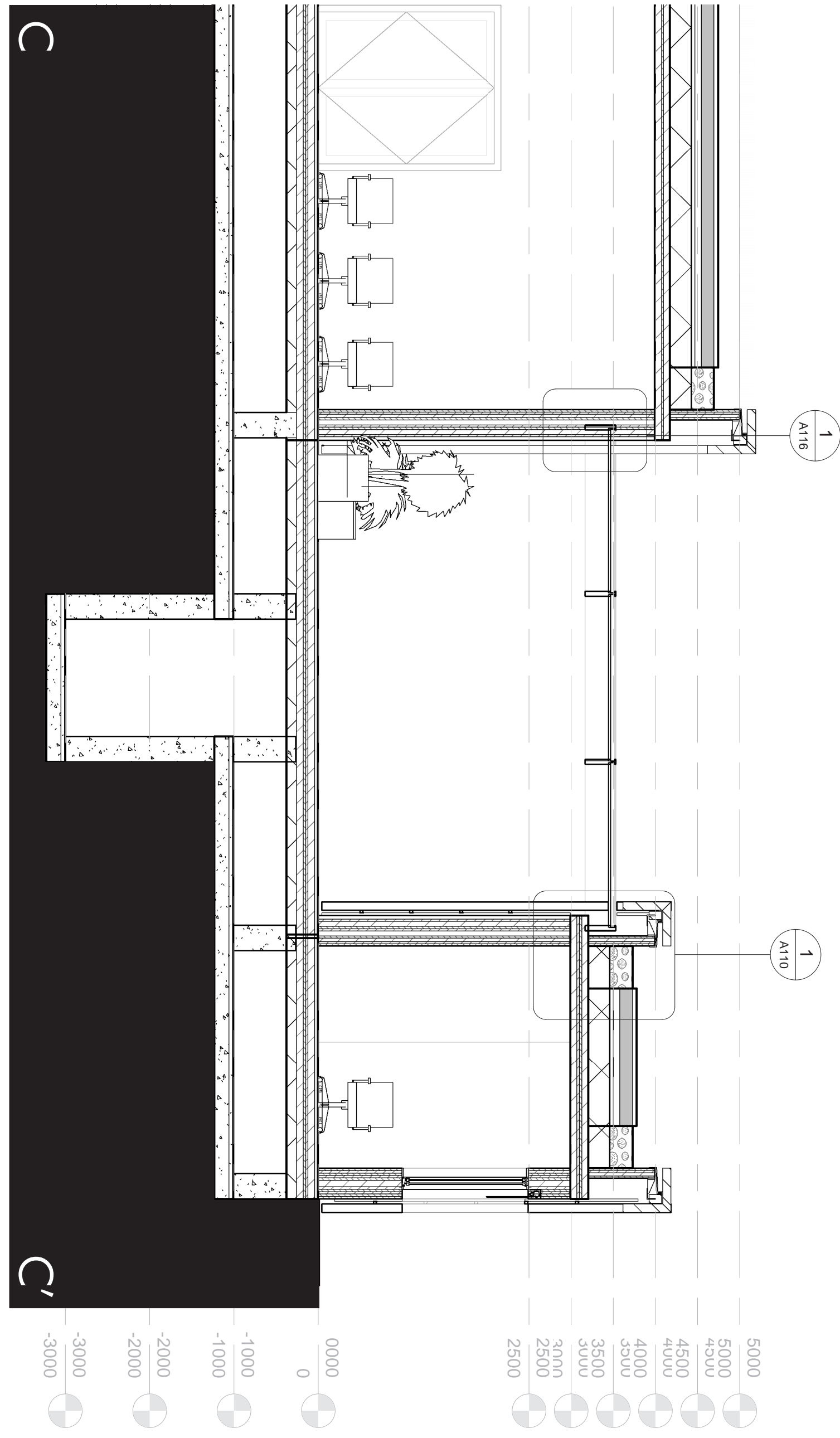


In-between studynooks



SOUTH-EAST CORNER

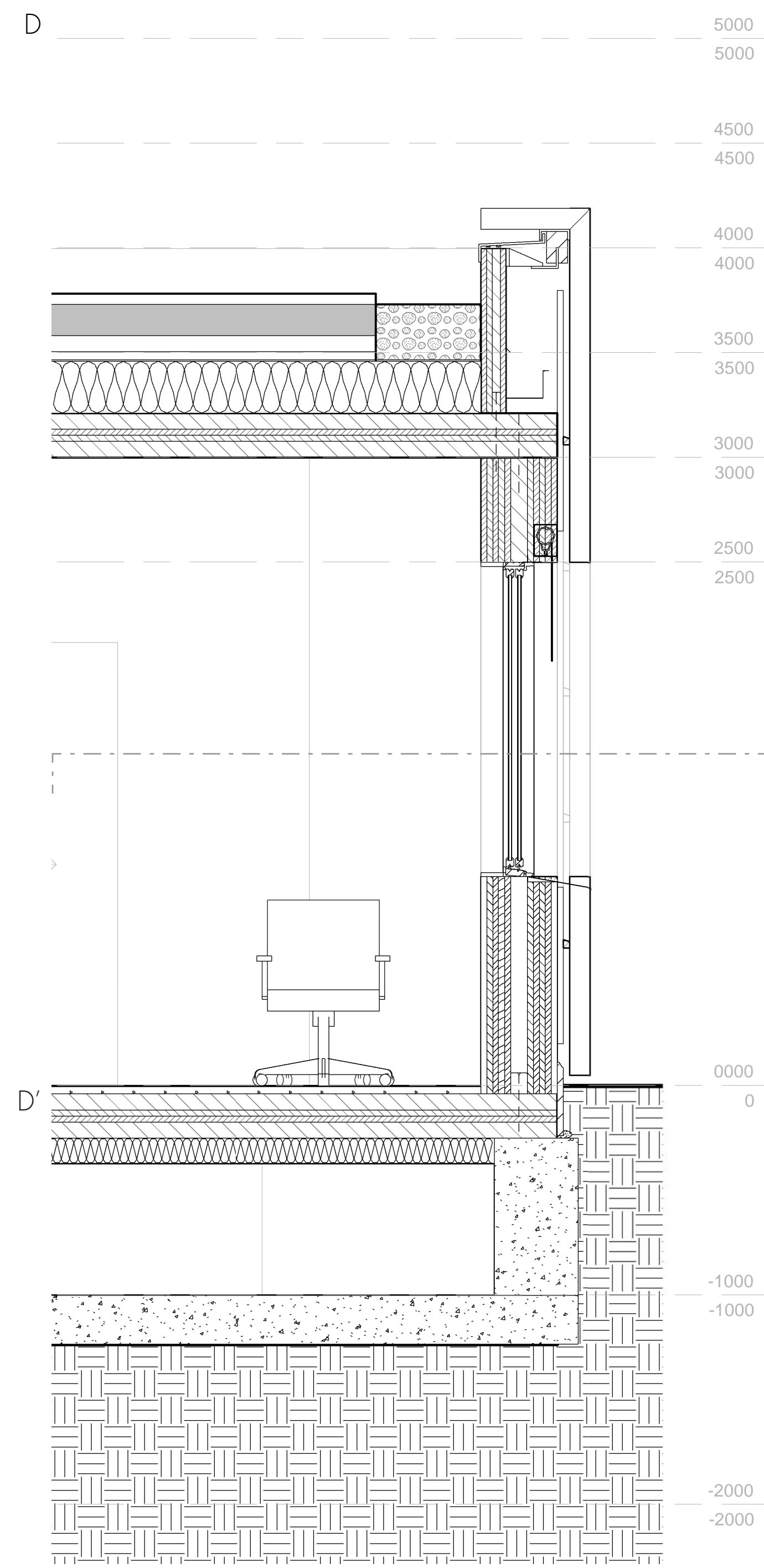
1:50



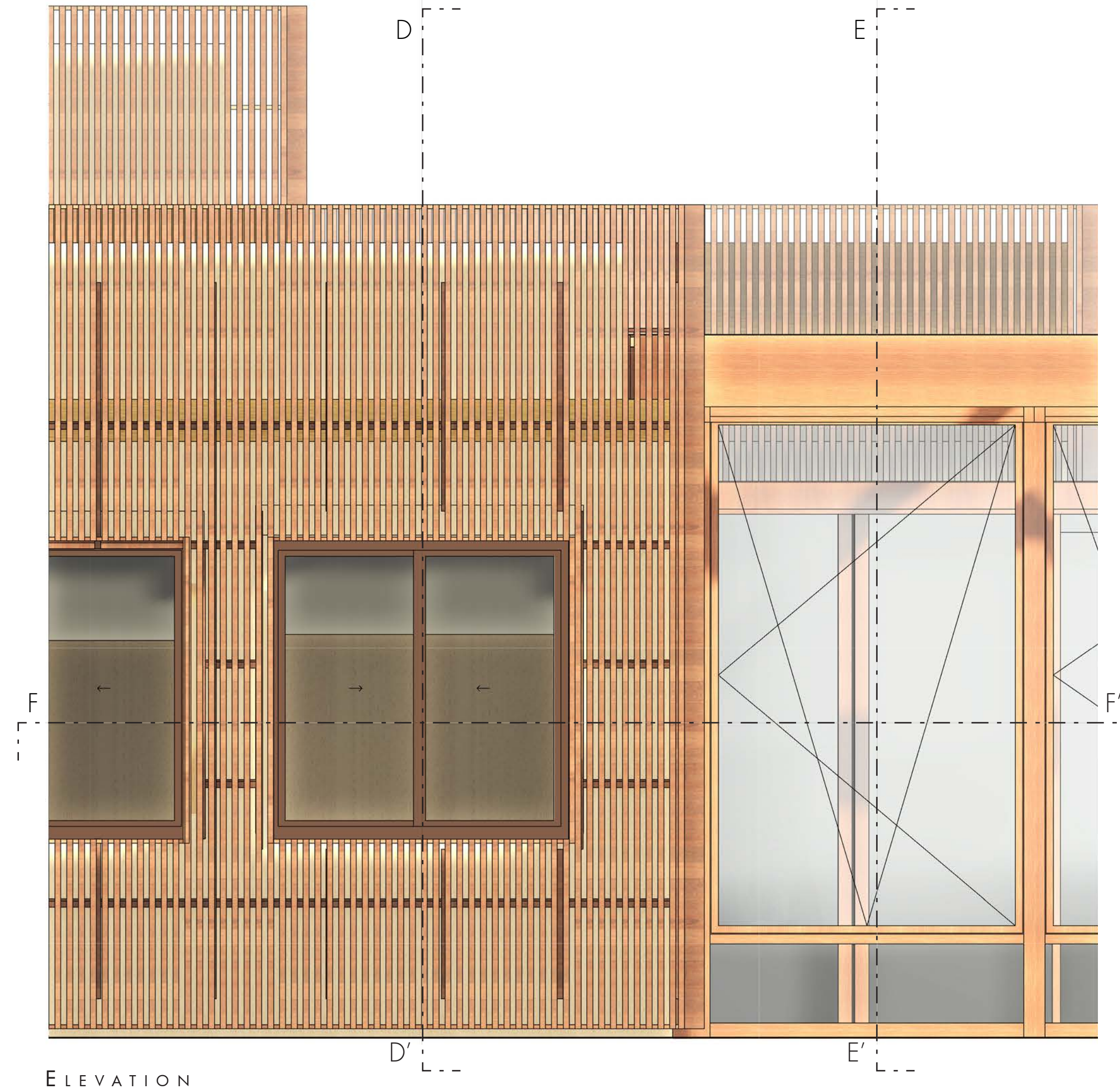


# FACADE SECTION

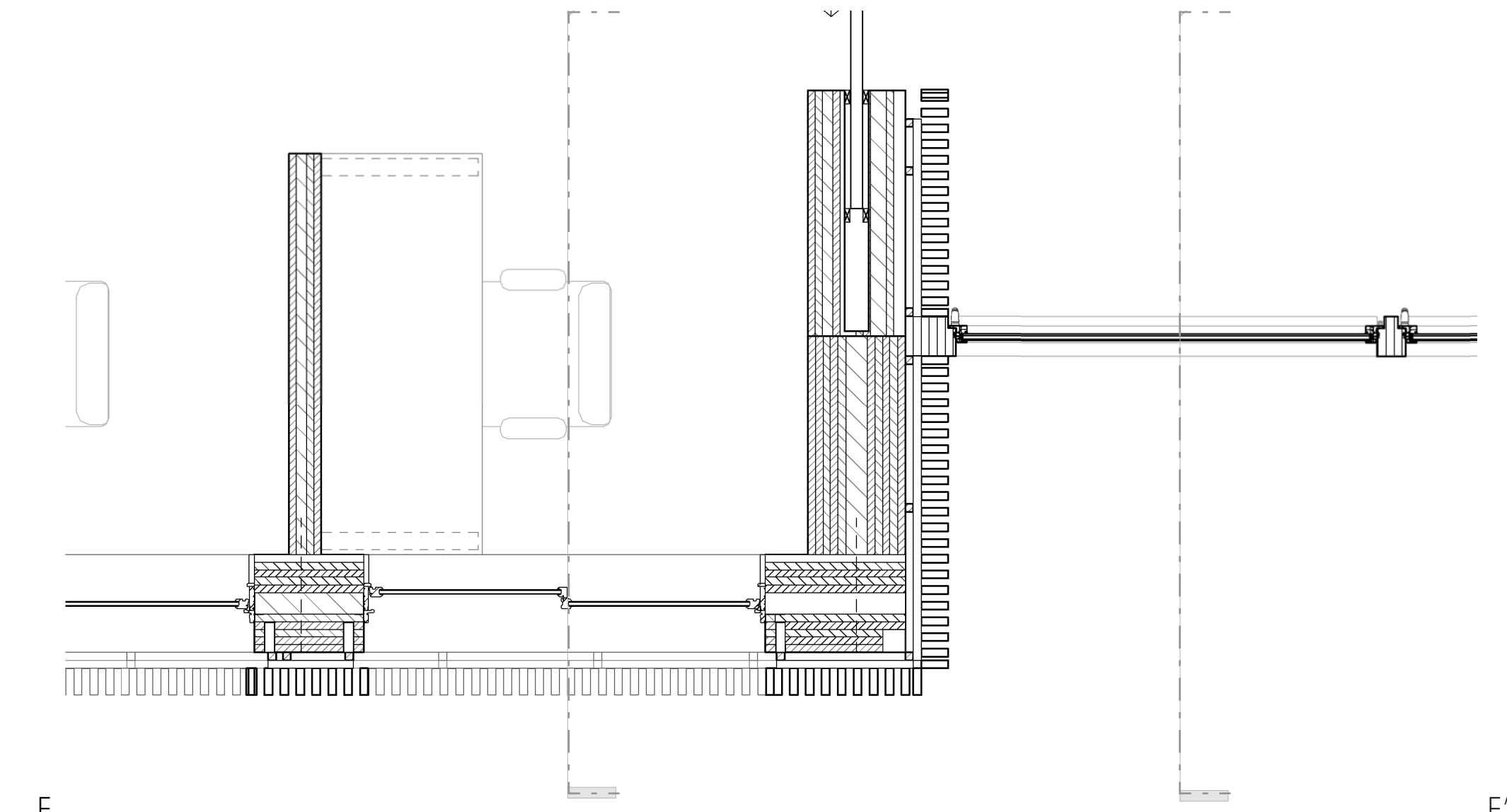
1:20



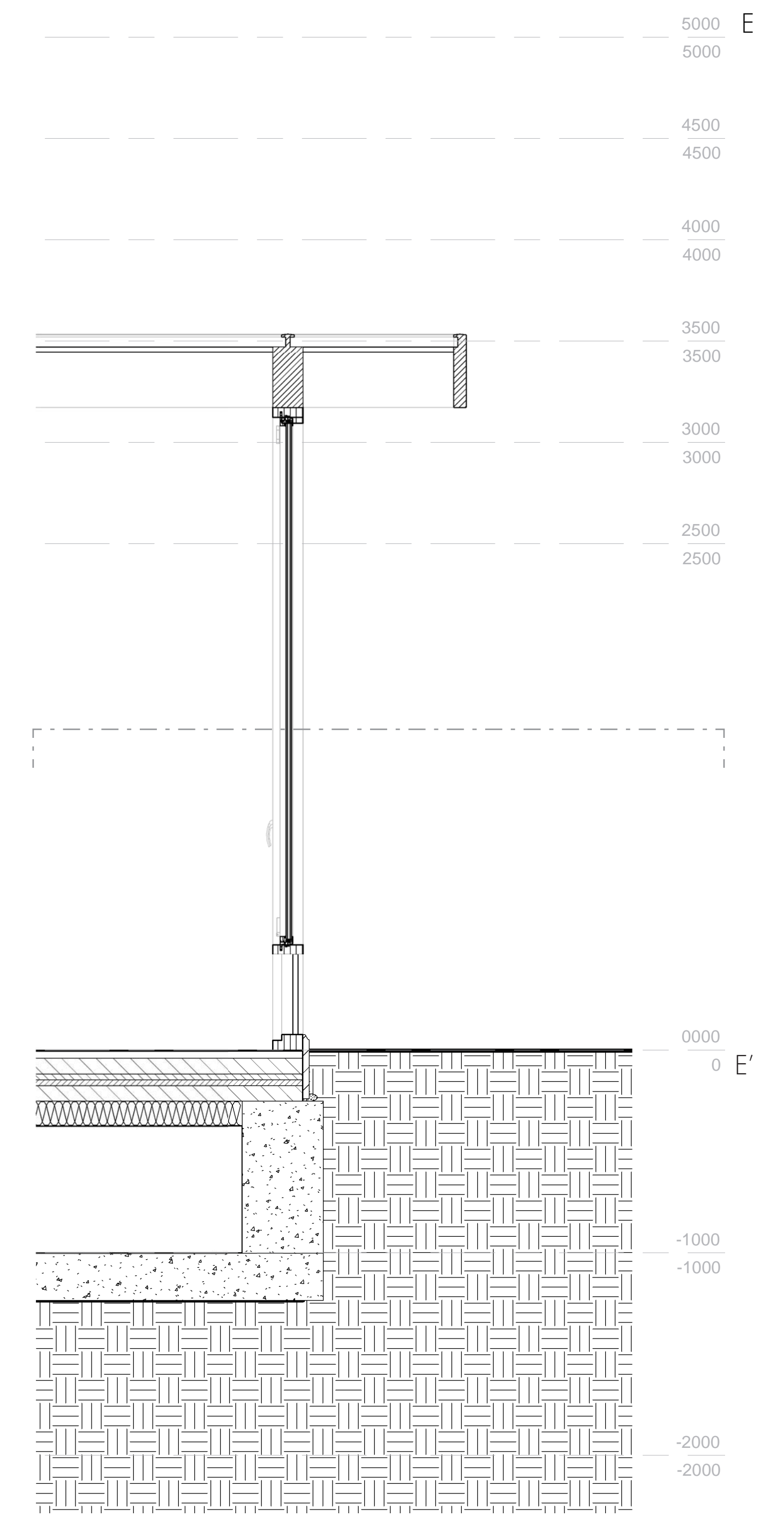
BOX SECTION



ELEVATION



HORIZONTAL SECTION



CURTAIN WALL SECTION



# WALL-CURTAIN ROOF EDGE DETAIL

1:5

# INNER ROOF EDGE DETAIL

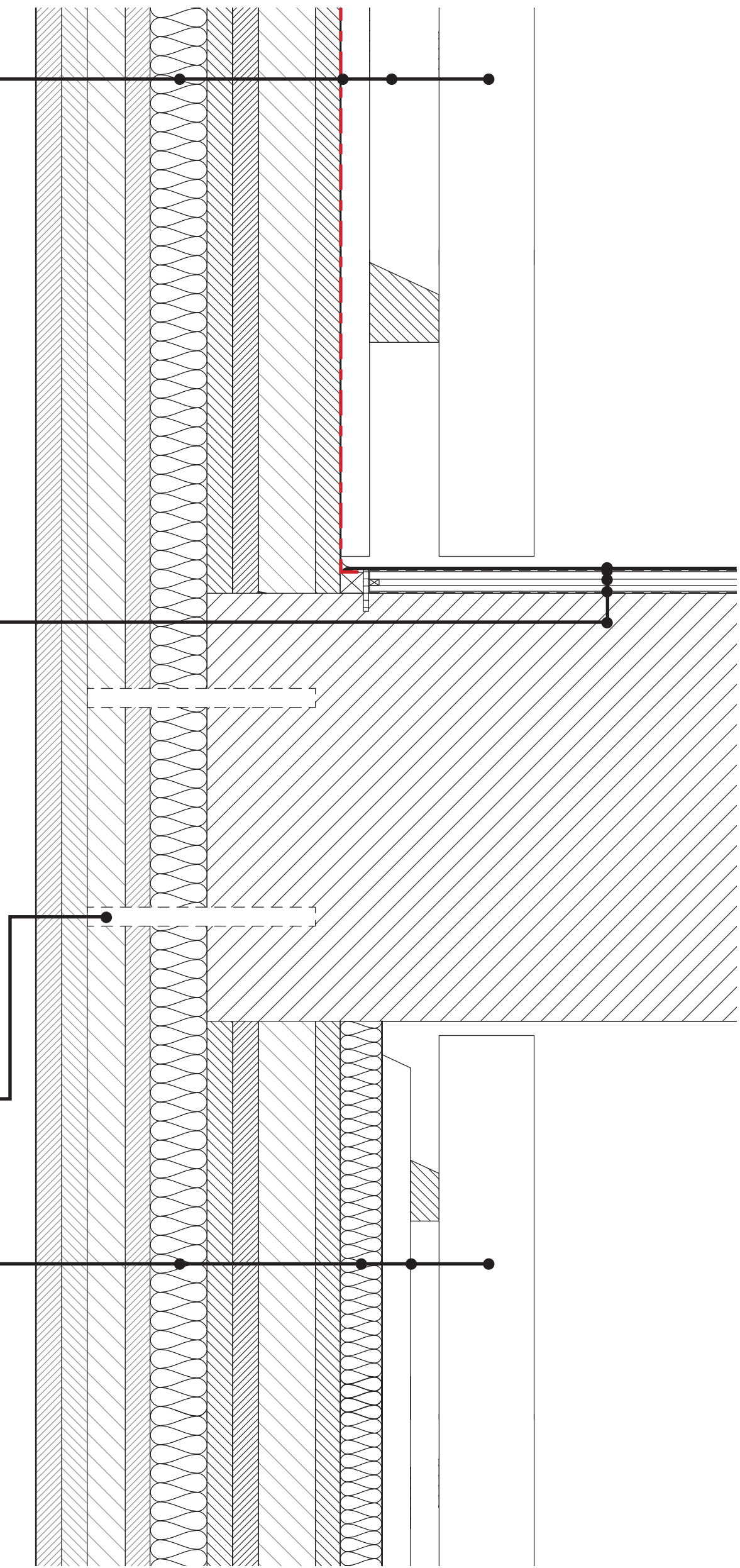
1:5

OAK CLADDING 30x100MM  
BATTENS AND COUNTER-BATTENS  
60MM  
WATER SEAL  
THOMA HOLZ100-W32-SOUND

STABALUX H CURTAIN-WALL-ROOF  
ATTACHED TO BEAM  
  
STABALUX H CLICK-PROFILE  
RUBBER STRIP  
DOUBLE GLAZING 8MM/6MM 2%  
SLANT  
RUBBER STRIP  
WOODEN BEAM 450MM

WOODEN DOWELS 10x300MM

OAK CLADDING 30x100MM  
BATTENS AND COUNTER-BATTENS  
60MM  
GIK ACOUSTICS SPOT PANEL  
44MM  
THOMA HOLZ100-W32-SOUND

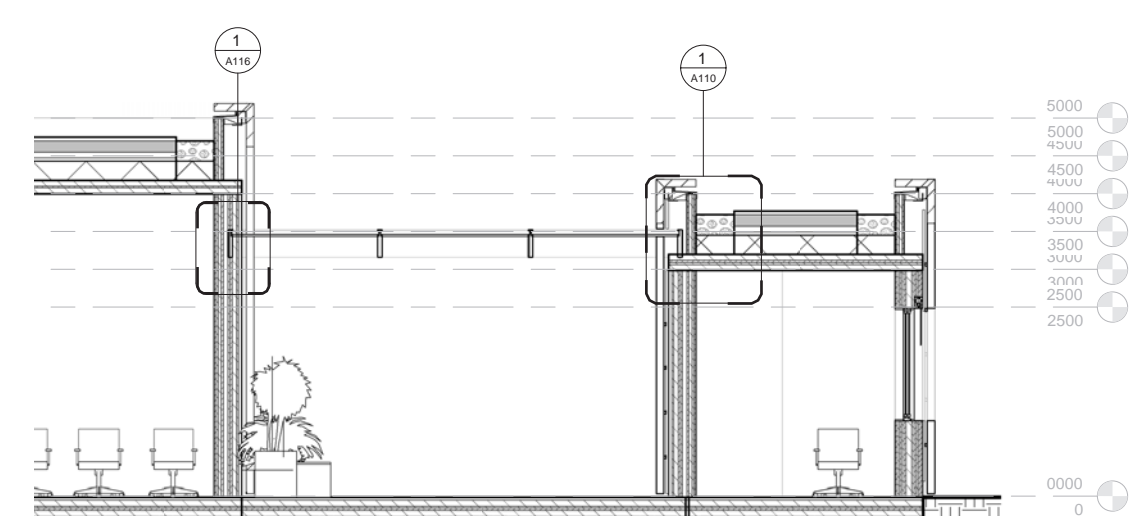
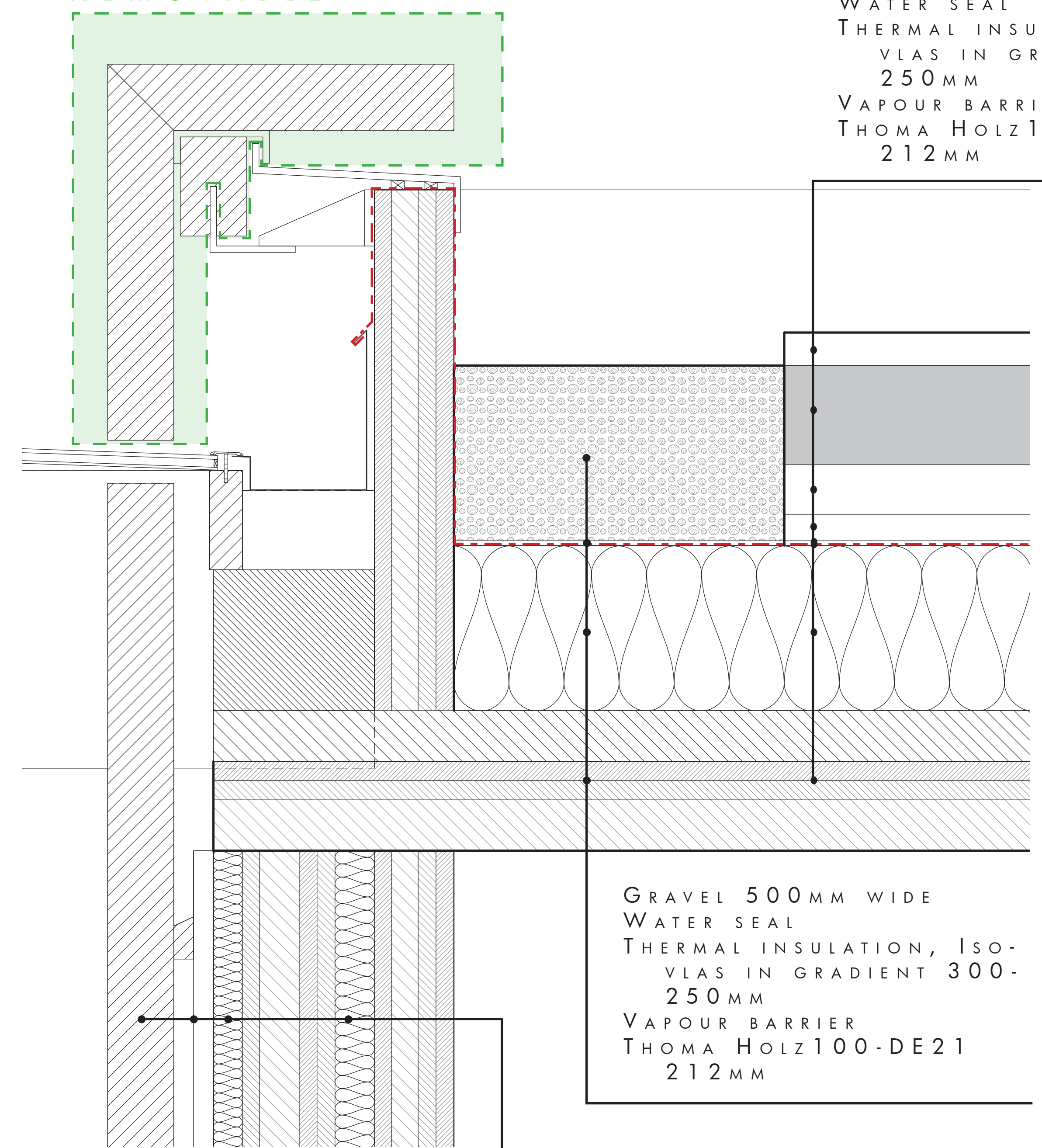


REMOVABLE

GREENERY (GRASSES AND  
HERBS) >50MM  
SUBSTRATE 150MM  
WATER RETENTION LAYER  
75MM  
DRAINAGE WITH INTEGRATED  
FILTER 40MM  
GLIDE LAYER  
WATER SEAL  
THERMAL INSULATION, ISO-  
VLAS IN GRADIENT 300-  
250MM  
VAPOUR BARRIER  
THOMA HOLZ100-DE21  
212MM

GRAVEL 500MM WIDE  
WATER SEAL  
THERMAL INSULATION, ISO-  
VLAS IN GRADIENT 300-  
250MM  
VAPOUR BARRIER  
THOMA HOLZ100-DE21  
212MM

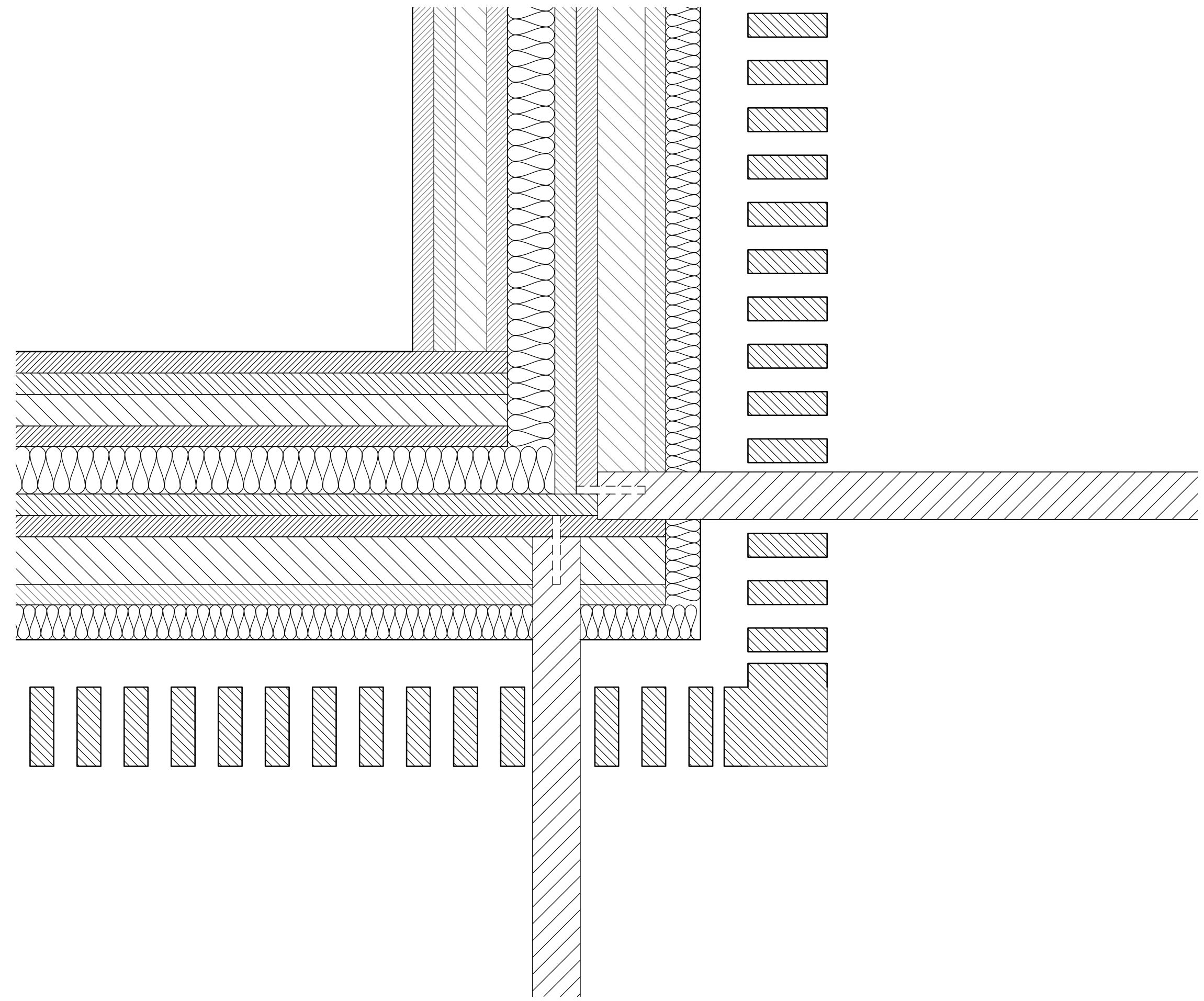
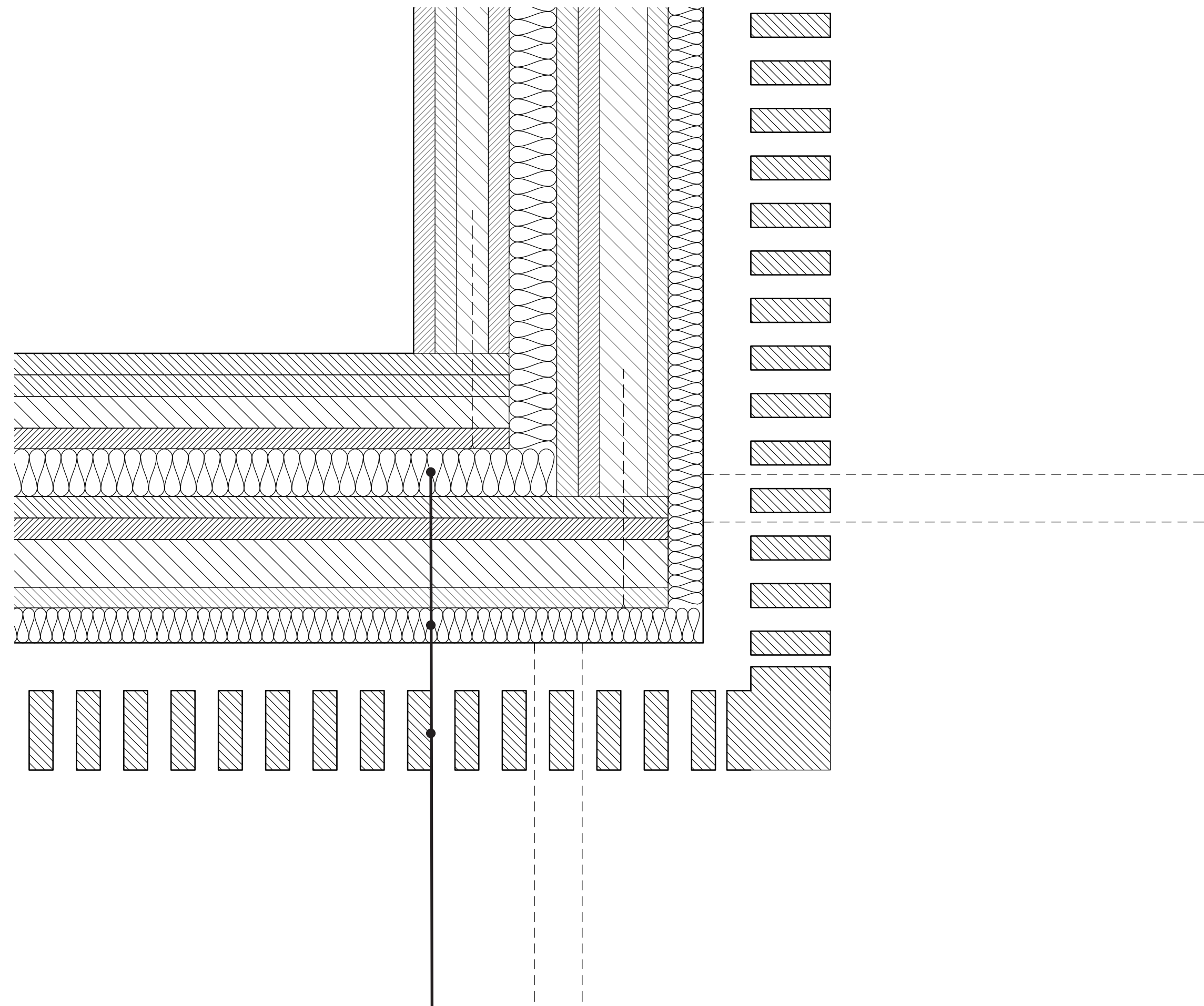
OAK CLADDING 30x100MM  
BATTENS AND COUNTER-BATTENS  
60MM  
GIK ACOUSTICS SPOT PANEL  
44MM  
THOMA HOLZ100-W32-SOUND



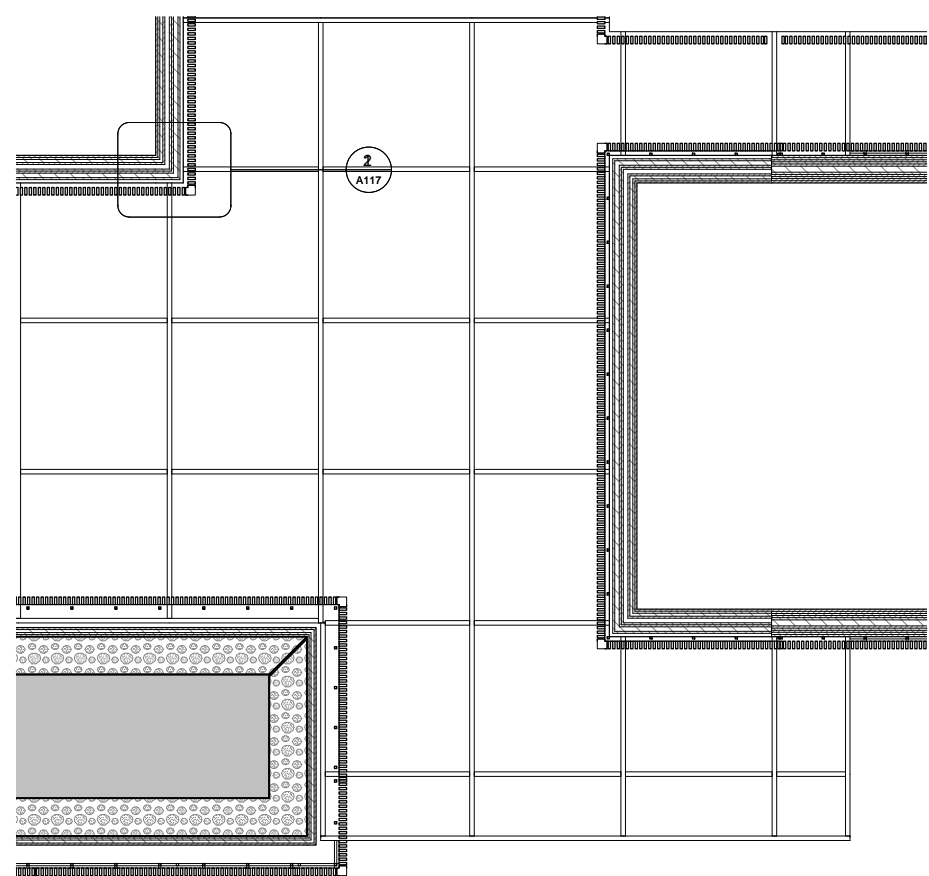


# CORNER JUNCTION DETAIL

1:5



THOMA HOLZ100-W32-SOUND  
BATTENS AND COUNTER-BATTENS 60MM  
GIK ACOUSTICS SPOT PANEL 44MM  
OAK CLADDING 30x100MM  
PRE-DRILLED PARTIALLY THREADED SCREWS 300MM

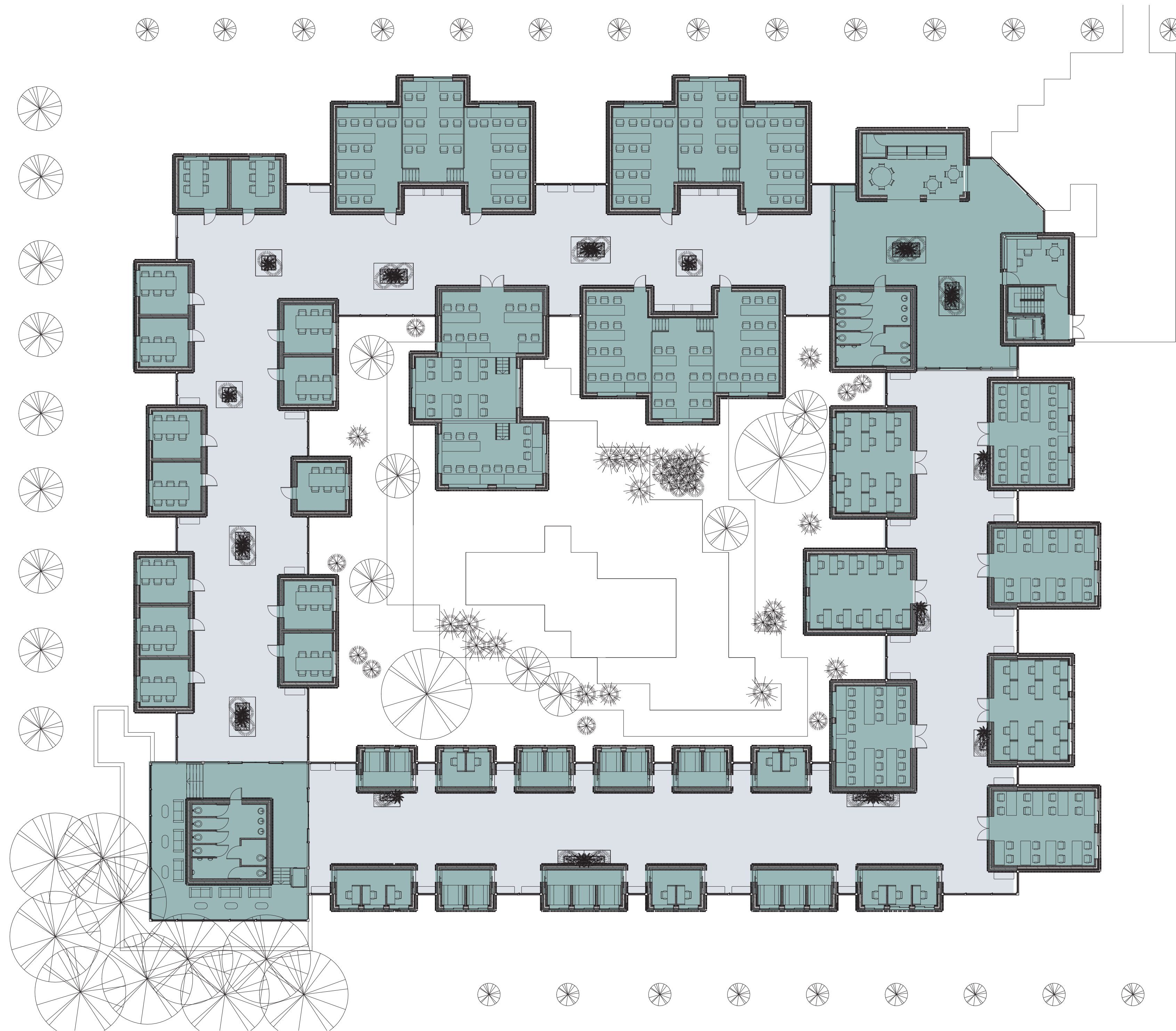




(Perceived) control is an important issue when designing for neurodiverse people. However, it would be inefficient to design all climate controls for every box on its own. Therefore I have chosen to design the climate controls in accordance with this design's theme in the background: alone, together.

*Every student is unique, yet we study together.  
Every student has their own preferences, yet other students play an integral part in it.*

We all use the TU Delfts systems, but in our own way. The climate systems in this building function from one central point but are controlled from all studyrooms separately.



There are two zones in this building: climatised zones and semi-climatised zones. The study spaces are all completely climatised while the hallways are only provided with fresh air. In winter, the hallways function as a greenhouse, keeping them somewhat warmed. In summer, the curtain walls open up, facilitating airflow to combat this greenhouse effect. When temperatures reach extremes in the hallways, the airflow can centrally be pre-heated or -cooled.

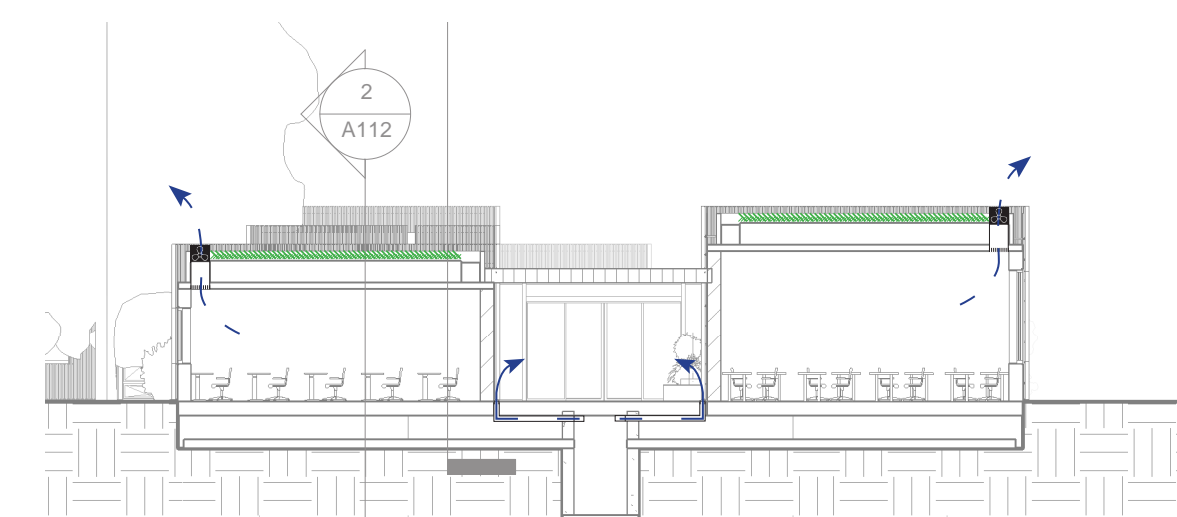
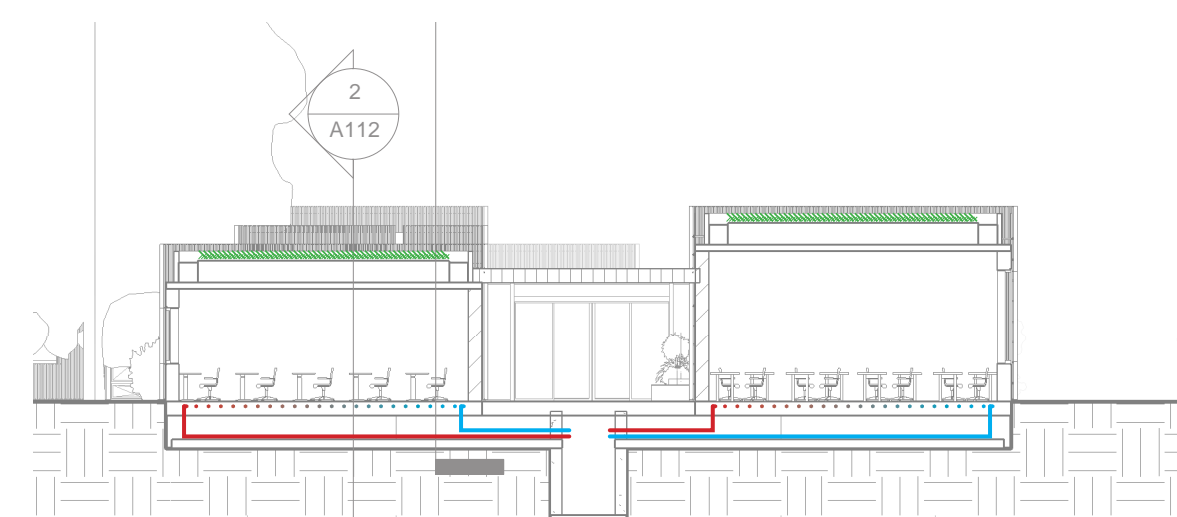
Fresh air is let in through vents along the walls in the hallways. It travels further through vents into the climatised areas after which it is extracted through the roofs of these areas.

The TU Delft has its own aquifer thermal energy storage, providing the building with heat and cool. This is used in the climatised areas through underfloor heating that is controlled in every space separately.

*Heat and light are very important for various disabilities. For instance, warmth can have a substantial effect on muscles and bones, while the control over light darkness can be of great importance to the visually impaired.*

To combat noise (especially in the hallways), the flooring is a dampened cast floor. The cast floor eliminates the immediate sound of high heels clicking, while the 35mm dampening layer muffles even more of the sounds made while walking. Additionally, the inner facades of the study spaces need less thermal properties, leaving space for a layer of GIK Acoustic SPOT panels, neatly hidden behind the open wood finish layer. This greatly deminishes the reverberation in the hallway.

- Climatised
- Semi-climatised



- Air
- Underfloor heating