A BUILDING SYSTEM FOR THE FUTURE

ARCHITECTURAL ENGINEERING GRADUATION STUDIO

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COLOFON

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PREFACE

It was after gathering experience working as a designer and architectural draftsman, combined with the ever increasing appalling impacts of climate change, that I realised the construction sector faces a huge challenge.

The building industry is responsible for a large amount of CO2 emissions, and there are no indicative signs that these will reduce in upcoming years. Through my passion for the aerospace industry, which is rapidly innovating, I have recognised the importance of accepting the need for change and thinking of the future. This has led me to develop and elaborate upon a building system that I am confident can greatly increase sustainable construction practices, as will be demonstrated in this book.

First and foremost, I would like to thank Pieter Stoutjesdijk, Gilbert Koskamp, and especially Thijs Asselbergs for their informative and delightful mentoring. This work would have not been possible without them, whom from beginning to end, have encouraged and supported my ambitions.

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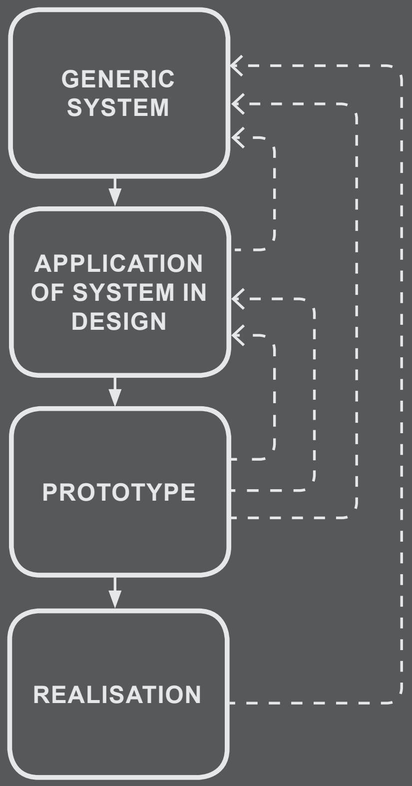
INTRODUCTION

In face of climate change, a large challenge was posed to the construction section as the European Union introduced requirements to reduce CO2 emissions; these must be reduced by 40% before 2030, and all member states have to achieve carbon neutrality by 2050. At the time of writing, the construction industry in the Netherlands is responsible for a large part of CO2 emissions, and due to the lack of significant changes in the industry in recent decades, a meaningful reduction of emissions in the coming years seems unlikely. The difficulty of lowering emissions is further amplified by the major housing shortage, for which it is estimated that one million homes must be built before 2030 to meet the population's demand in the Netherlands. Furthermore, the construction sector is far behind in terms of environmentally conscious innovation when compared to sectors such as technology and transportation. Architects, contractors, engineers, and civil servants therefore have to join arms to implement large-scale in-depth reforms and accept much-needed innovation.

This booklet presents the results of an innovative building system that can contribute to the sustainability of the construction sector. This concept was developed based on six months of research in which nine timber building systems were tested for their degree of flexibility and demountability. A framework was then created, where a chosen system was further developed, step by step, into a building concept that can be applied on a large scale. An attempt was made to incorporate every aspect that a building must satisfy without compromising simplicity. The development of the system has a generic and an applied phase. In the generic phase, the basis of the system is laid, which in theory is the same for every building. In the applied phase, the system is further elaborated based on the design assignment, which in this case concerns a temporary student building that must be transformed into laboratory and office functions after 10 years. Although the two phases are separate, the gaps in the generic part become visible when the system is tested in an actual design, resulting in a generic and specific phases that have continuous exchange and influence on each other. In practice, such a standardised system that is to be applied on a large scale is further fine-tuned after it has been realised and experimented with many times.

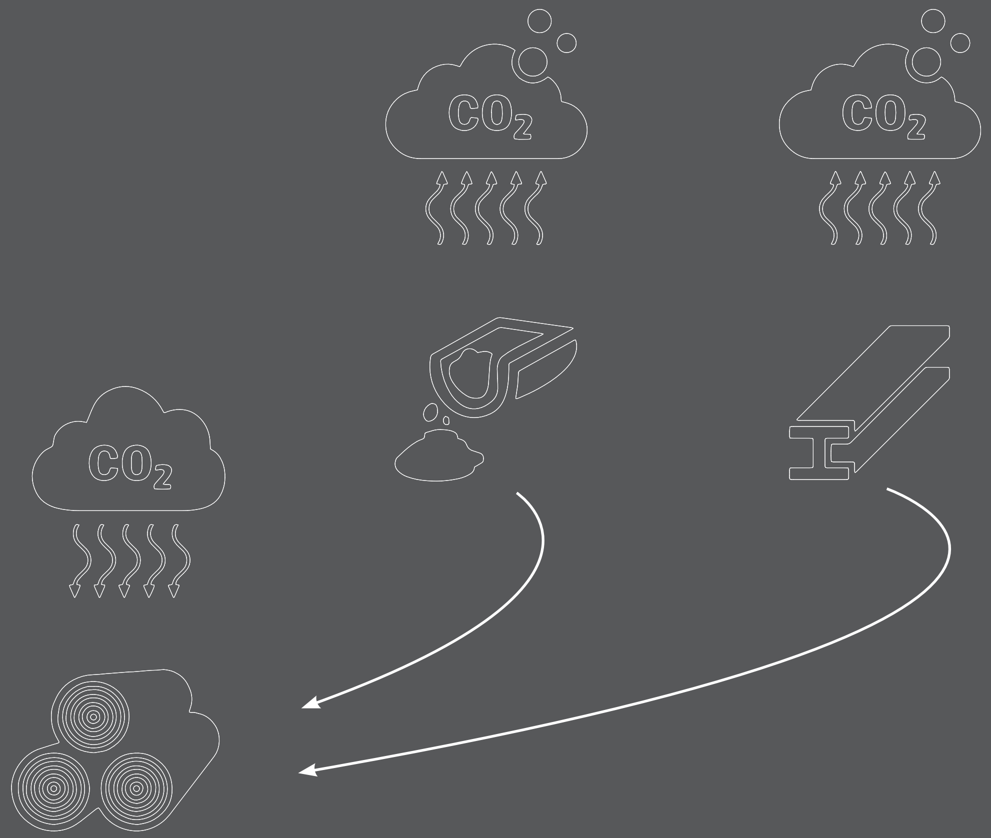


1. CONDUCTED RESEARCH

CO2 EMISSIONS

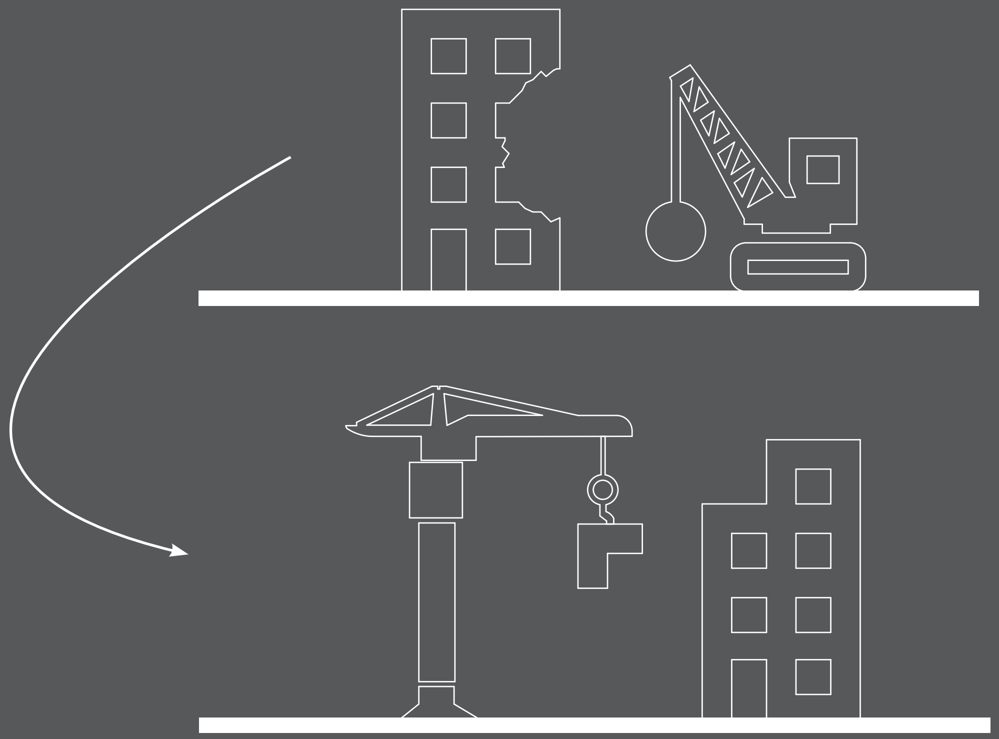
The main structure of a building is made of concrete, steel, timber, or a combination of these. The functional and financial properties are often decisive in choosing a material for the load-bearing structure. In residential construction, (prefabricated) timber is increasingly being used, and is also slowly being introduced in utility buildings, which traditionally use concrete or steel, both of which have enormous CO2 emissions. Concrete requires cement, and CO2 is released when limestone (calcium carbonate) is converted into calcium oxide, which is a key ingredient. In addition, cement plants burn large amounts of coal, gas, and other fossil fuels to generate the heat needed to break up limestone. High temperatures of approximately 1,000°C are also necessary to produce steel to ensure that the reduction process, where the separation of the oxygen atom from the iron oxide compound occurs, is fast enough and to prevent iron ore particles from sticking together.

The above processes lead to about two tonnes and one tonne of CO2 being released for every tonne of steel and concrete produced, respectively. It is puzzling why these high emitting materials are still widely used when timber stores CO2 instead of releasing it. A tree stores CO2 as it grows, thus utilising wood in construction would trap that CO2 instead of it being released once the tree dies and rots. A valid counter-argument often heard is that once the tree is cut down, it can no longer absorb CO2, which is why trees should only be cut in well-managed forests where more trees are planted than cut down. An increase in demand for this type of wood also provides additional funding for managed forests, which is further beneficial to battle current deforestation practices.



DEMOLISHING AND REUSE

The main structure of a building is calculated to last 50 years at minimum, but in reality the lifespan of the elements that compose the main structure is many times longer. The maximum lifespan is almost never reached as buildings are demolished to repurpose the site. During the design phase little consideration is given to future demolition, resulting in a structure that can only be dismantled with brute force, in which nothing can be reused and everything must be forged, pulverised, or burned. It should be compulsory to design every building as demountable so that at least the main structure is reusable. For example, steel connections can be bolted instead of welded, facilitating disassembly. When a compression layer is poured over concrete floors, these cannot be disassembled. However, there are alternatives to joining concrete floors that allow for dismantling, such as a hybrid floor in which concrete is combined with steel or concrete. Furthermore, timber elements can be screwed or bolted so that they can be reused.



CHANGING FUNCTIONS

There are several different types of buildings with varying functions. Architecture and the functionality of a building ensure that there is a visible difference between, for example, an office building and a residential building. Some distinctions are not immediately visible, such as stronger structures or, in the case of public buildings, better soundproofing or safer escape routes. Each function has specific requirements, further complicating the process of changing the function of a building over time. Ideally, every building should be able to be transformed for another purpose.

Although the plethora of empty offices in the Netherlands could be used to compensate for the lack of housing, in many cases this is impossible because the requirements and facilities imposed for residential functions do not fit within the old building. When possible, it is often not viable as excessive time and money is required since the building has to be redesigned and several additional facilities are needed. Investing in adaptable, flexible, and demountable buildings now will prevent future wasted or misused spaces as buildings would be transformed to meet the unexpected demands and regulations of the future.

STANDARDISATION

The Madaster is a register of materials used in a building, which has been in existence for several years. The materials and elements are registered and stored, which facilitates the creation of a future inventory of which materials can be reused. However, there is one problem: the uniqueness of every building. It is difficult for an architect to design a new building with different materials from a number of buildings that are demolished or dismantled.

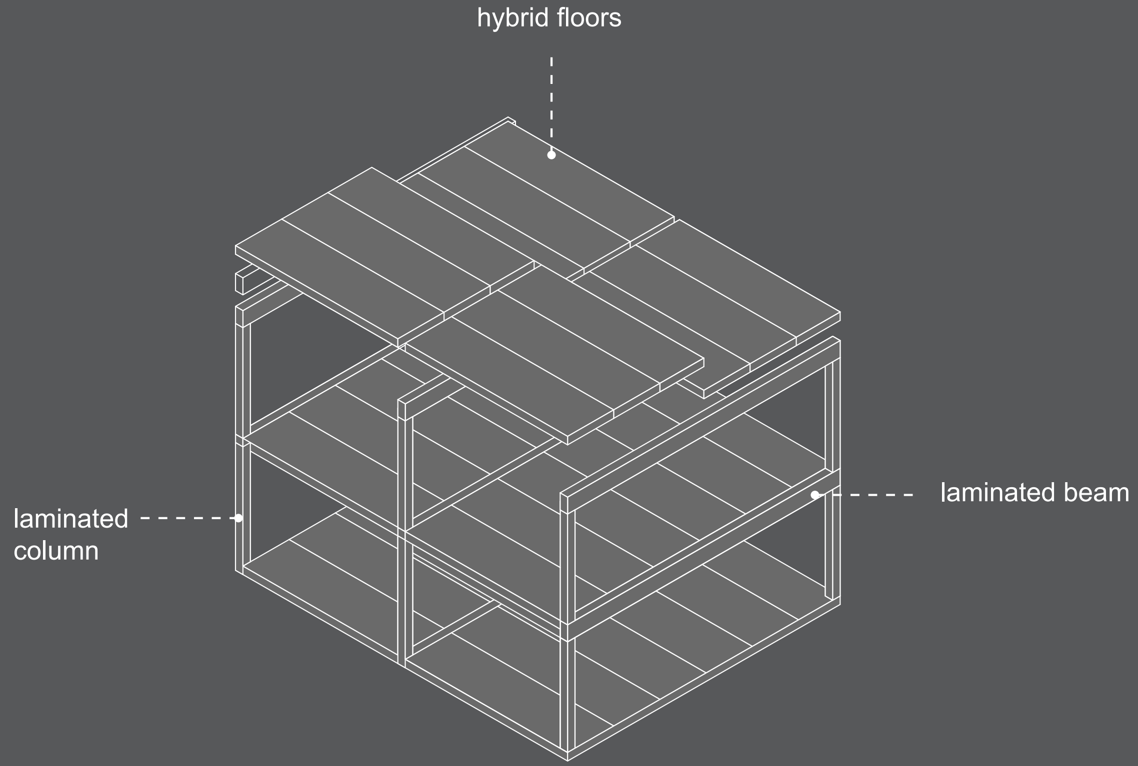
To counteract this, the rarely discussed topic of 'standardisation' in the construction industry could be further explored and developed. Whilst standardisation does occur in building products, which leads to production and industrialisation of products to a high degree, it is completely absent in architecture. The reason for this is unclear, except that architects are known for wanting to leave their signature in their designs, which may be limited with standardisation. However, it does not mean that all buildings will look similar. All the components that are not visible and hidden behind the finish must come from a catalogue of a limited number of different elements, which will also aid the architect when redesigning a building for its new function.

TIMBER BUILDING SYSTEM

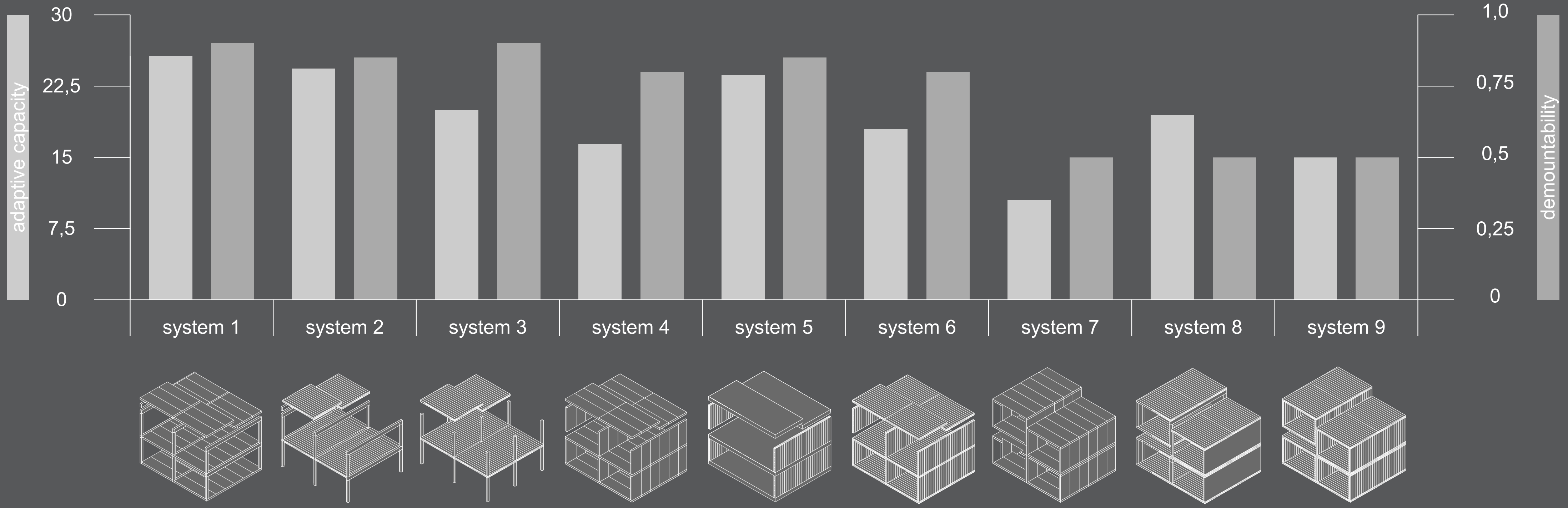
Timber constructions are often assembled from multiple techniques into a hybrid system to meet structural requirements and building regulations. Combining different elements intelligently increases the freedom in design and allows timber construction to be more frequently used in complex and laborious projects. However, such a structure does not necessarily consist entirely of timber. For heavier loads and to provide stability, timber is often combined with steel or concrete. Steel joints can serve as connections between various elements, and steel strips or cables are fastened between or onto timber frames to provide rigidity. Although concrete may also provide stability, in combination with timber it is mainly used for its mass. Although timber structures can be made in a traditional way, this is antiquated due to labour intensity and complexity. Nowadays, a prefabricated system allows large quantities of construction components to be produced and ready for assembly before on-site construction begins.

Nine prefabricated timber systems are assessed for their demountability and adaptive capacities. The variations in between, which differ in method or type of components or elements, are based on preliminary literature research of timber constructions. These methods can be divided into three categories, in which the level of prefabrication and assembly differ. The first category consists of a column/beam skeleton construction that arrives at the building site in individual parts, which provides a high degree of adaptive capacity and is ideal for utility buildings. The second method also involves assembly on site, but of wall and floor elements. This is often used in residential construction, but also in utility constructions, since individual apartments require separation which can be done by the load-bearing walls. The final method involves an assembly of modules on site. These are ready-to-use modules, or containers, that often include installations and sup-parts. Similar to hybrid timber systems, combinations of these methods can be made.

The results show how an on-site assembly of columns and beams provide the highest flexibility and demountability. This highest scoring method has been used as a starting point for designing the system that is shown in this document.



ADAPTIVE CAPACITY AND DEMOUNTABILITY

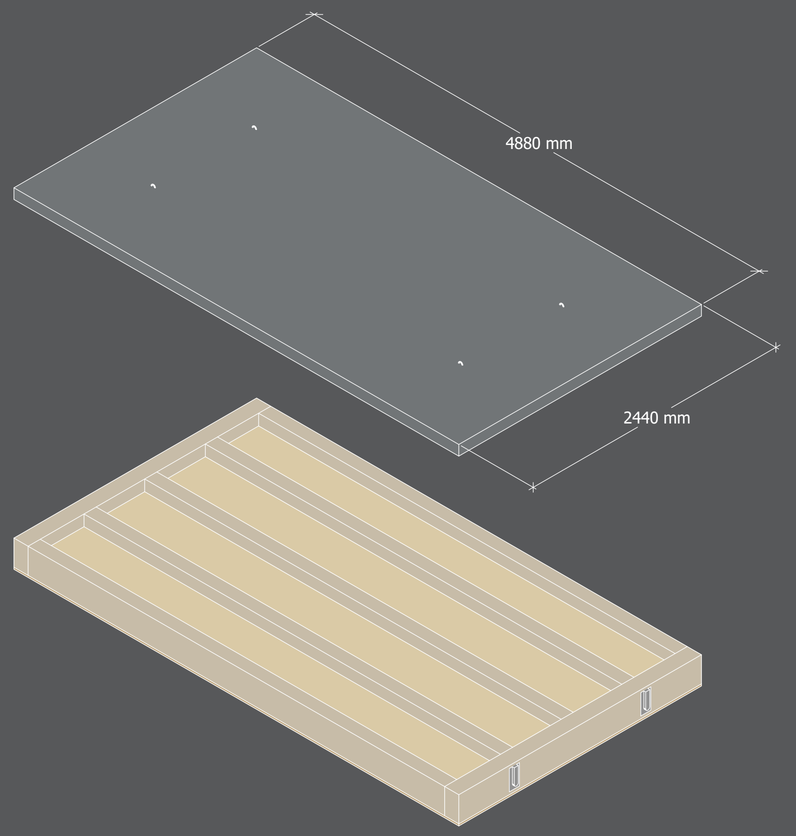


2. GENERIC SYSTEM DESIGN

LOAD-BEARING FLOORS

To determine the dimensions of the main structure, the dimensions of a single floor are first determined. The hybrid load-bearing floor consists of a combination of timber beams with a concrete top layer that acts as a mass. The timber floor has steel dovetail joints at the ends that are hidden in the beam and guarantee a high level of fire safety as the timber will protect the joint.

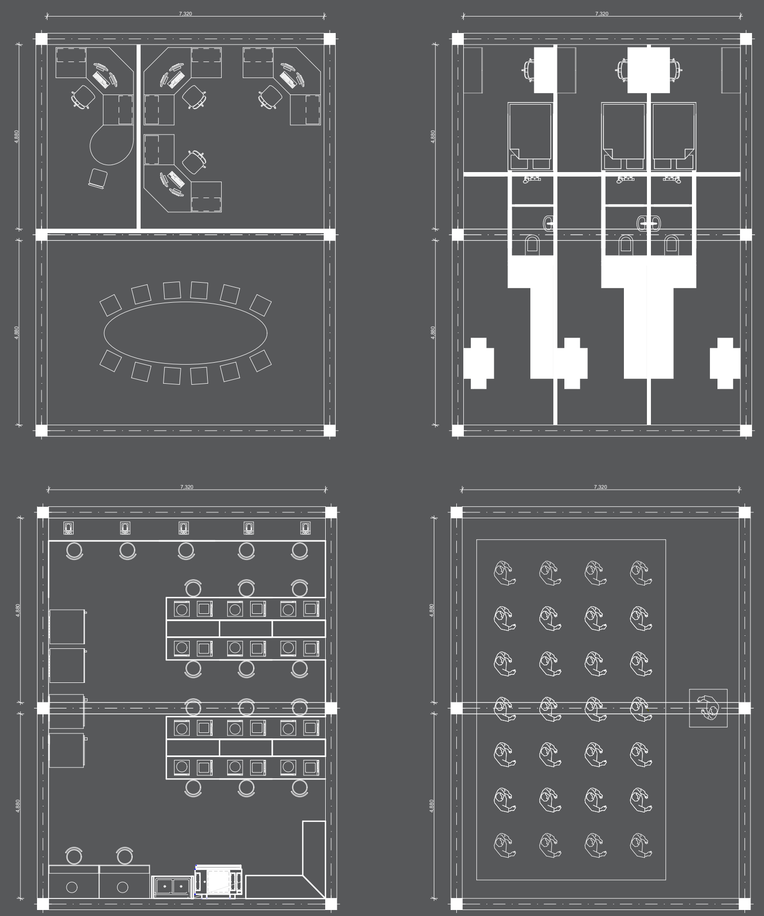
The spruce wooden beams are provided with insulation and a stabilisation plate with a high tensile stress to keep the element perpendicular. The concrete top layer is fully circular due to the embedded screw holes, which can be attached and removed at any time. The width of a floor is based on a standard panel of 1.22m*2.44m and can be laid lengthwise with no sawing loss. The length of the floor is 4.88m (multiple of 1.22m), a common size for pine beams.



FLOOR PLAN STUDIES

A column and beam system means that there are large uninterrupted horizontal expansion possibilities as there is only a column at each corner. However, it is important that this column is not in the way. In order to determine the greatest distance between the columns, a floor plan study was carried out into the most common functions that the building must have, such as offices, meeting rooms, study areas, studios, laboratories, and sports areas. The length is most important here, since the width can be extended without interruption by connecting ‘modules’.

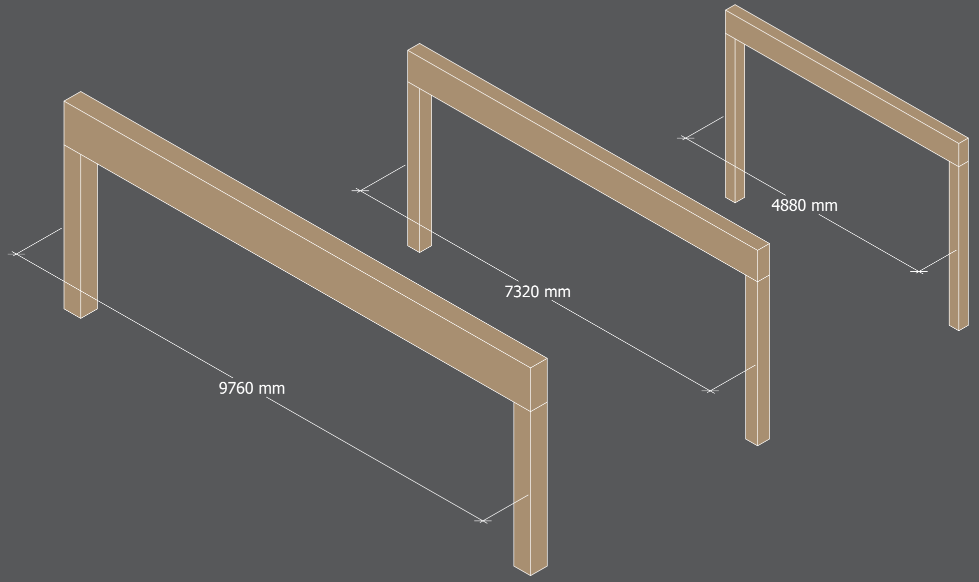
The length between the columns is a multiple of 2.44m (a floor width). It is crucial to determine this size accurately and not over-design as the weight on the beam will increase and its dimensions will grow exponentially. The conclusion is that a size of 7.32m (three floor widths) is sufficient for a large space such as a meeting room or a sports hall, whilst it is also possible to divide this space into three if that is required for narrow studios or office spaces.



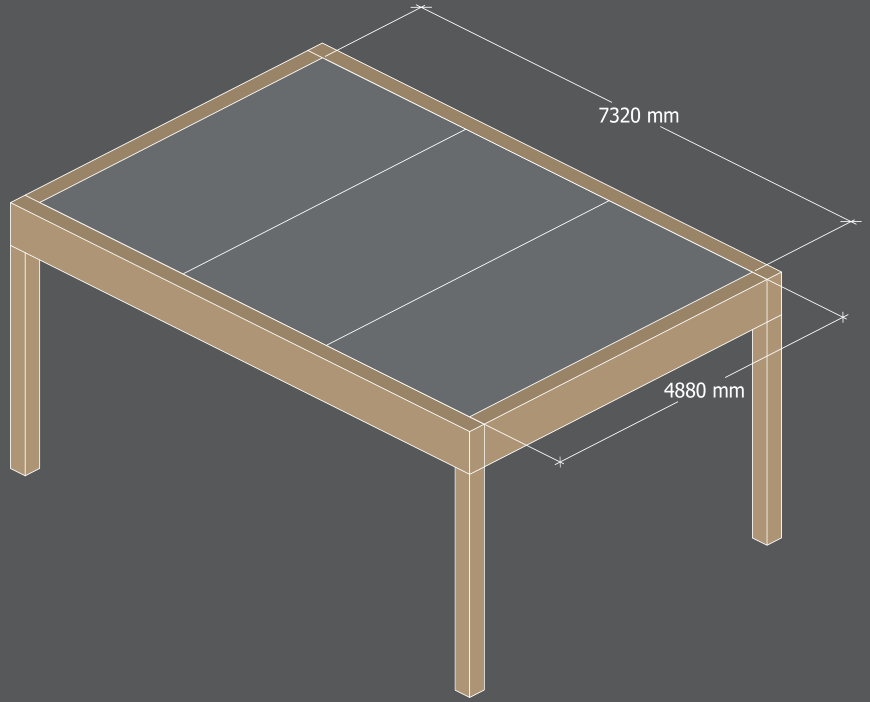
BEAMS, COLUMNS AND SPAN WIDTH

The length of the beam is a multiple of 2.44m (a floor width). The floor plan study shows that 4.88m provides insufficient width for larger spaces. 7.32m turns out to be sufficient, so a beam size of 9.76m is omitted. This benefits the dimensions of the beams and columns, since these increase exponentially as they grow in length.

The dimensions of the columns and beams were determined based on several reference projects. The columns have a size of 300x300mm and the beams 300x600mm.

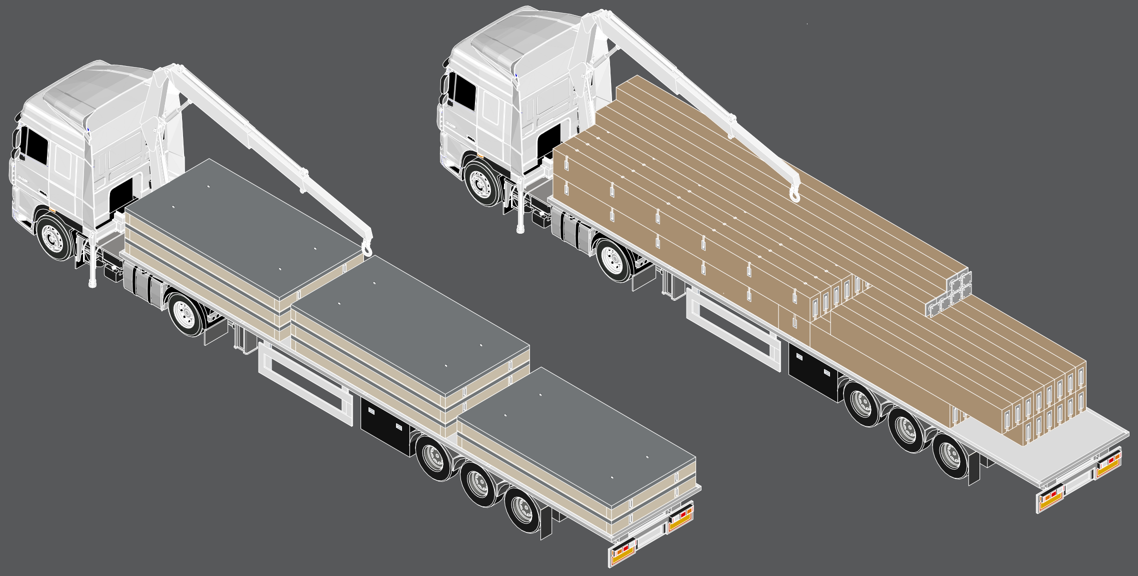


GRID SIZE



TRANSPORT

Logistics should be considered as an important aspect when designing a system that is to be applied on a large scale. Elements are made horizontally in the workshop and are then lifted onto a lorry which transports the load to a storage facility or building site. Elements can't be too wide, long, or heavy, since transport regulations can't be exceeded. Each element within this system is designed to remain within the maximum dimensions for normal transport without the need for additional permits. Furthermore, all elements can be lifted by a light crane from and onto the truck.



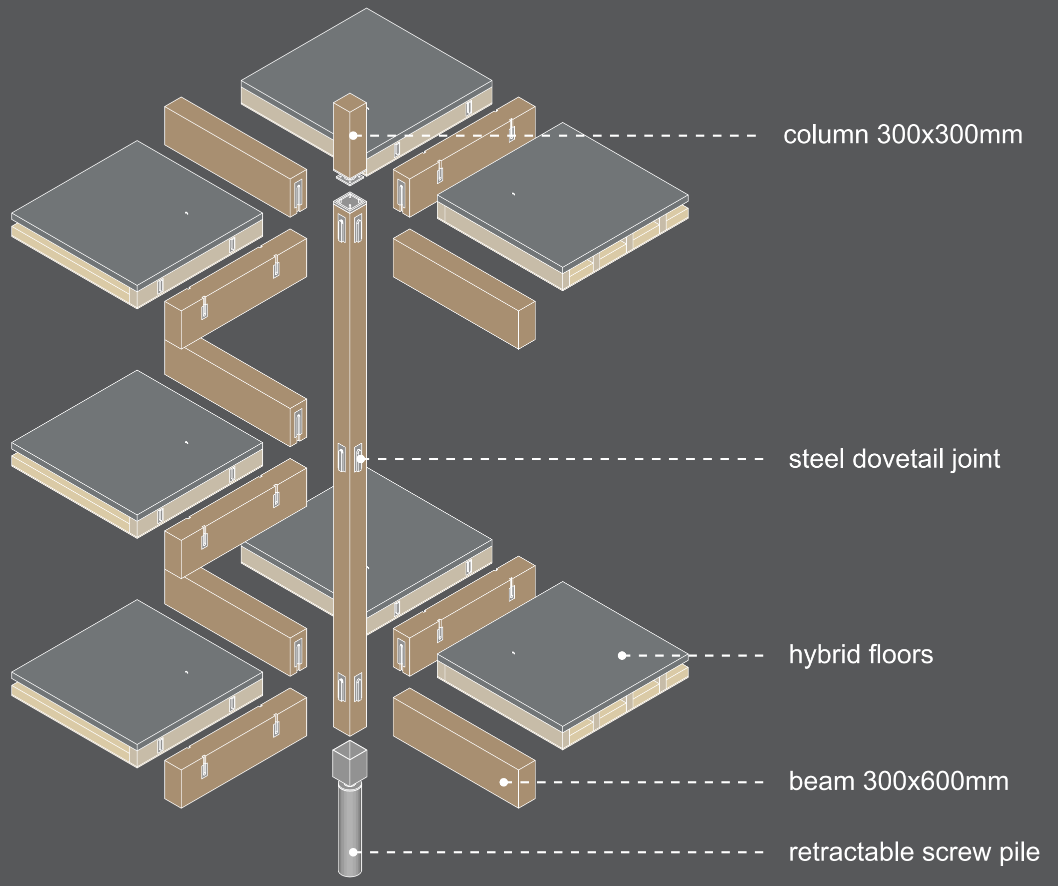
JOINTS

Most buildings are founded on permanent concrete piles that, in most cases, remain in place forever. On top of the piles, there are concrete beams and floors which damages the soil and when it is demolished , an area of small fragments of gravel and concrete remains preventing nature from recovering.

Nowadays, there are methods to avoid damaging the landscape when making a foundation. As an example, the concrete piles can be replaced by steel screw piles. These, as the name suggests, are screwed into the ground and can be removed at any time. Timber can not be used for any type of foundation, unless it´s kept underwater to prevent oxygen from affecting the wood. Therefore timber is normally only used for elements that won´t be exposed to moisture, as it is not resistant.

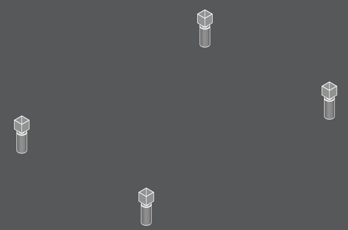
In areas where floods occur, which is the case for this project, timber can not be used for the ground floor. However, raising the ground floor and the timber foundation from the surface solves this problem and also results in the landscape being untouched when the building is being dismantled.

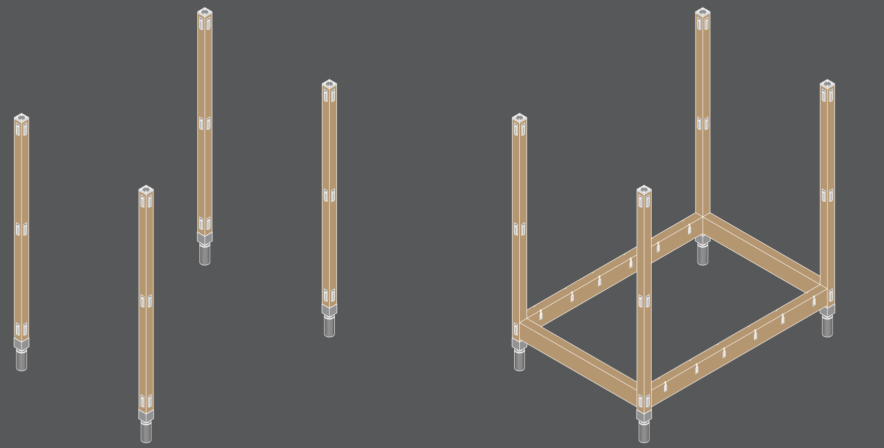
The timber columns are two storeys tall and have steel dovetail joints to which the beams are connected. The beams are also provided with dovetail joints on both sides, between which the floor panels are laid. Wind braces can be placed between the beams if required for stability.

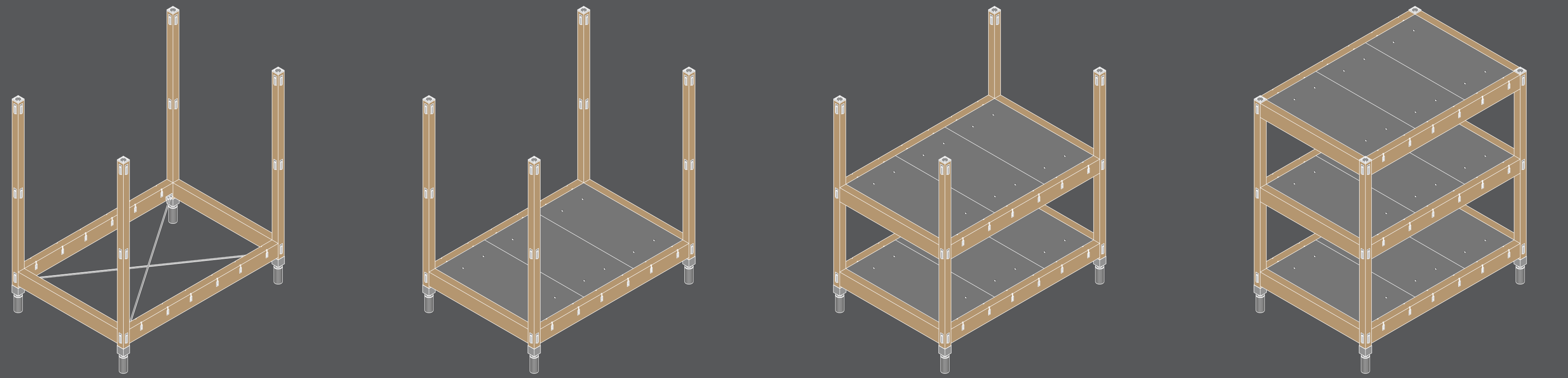


CONSTRUCTION ORDER

When the building site is ready for construction, the screw piles are drilled into the ground (1). The two-storey tall columns (2) are attached to the screw piles and temporarily braced. The first beams are placed between the dovetail connections (3) and if required, wind bracers are applied (4). The hybrid floors are placed between the beams (5) before proceeding with stacking in the same order (6&7). The maximum height of this building system is six storeys. This is not only due to the structure's strength but also to more demanding fire safety requirements for buildings with floors higher than 21 meter.

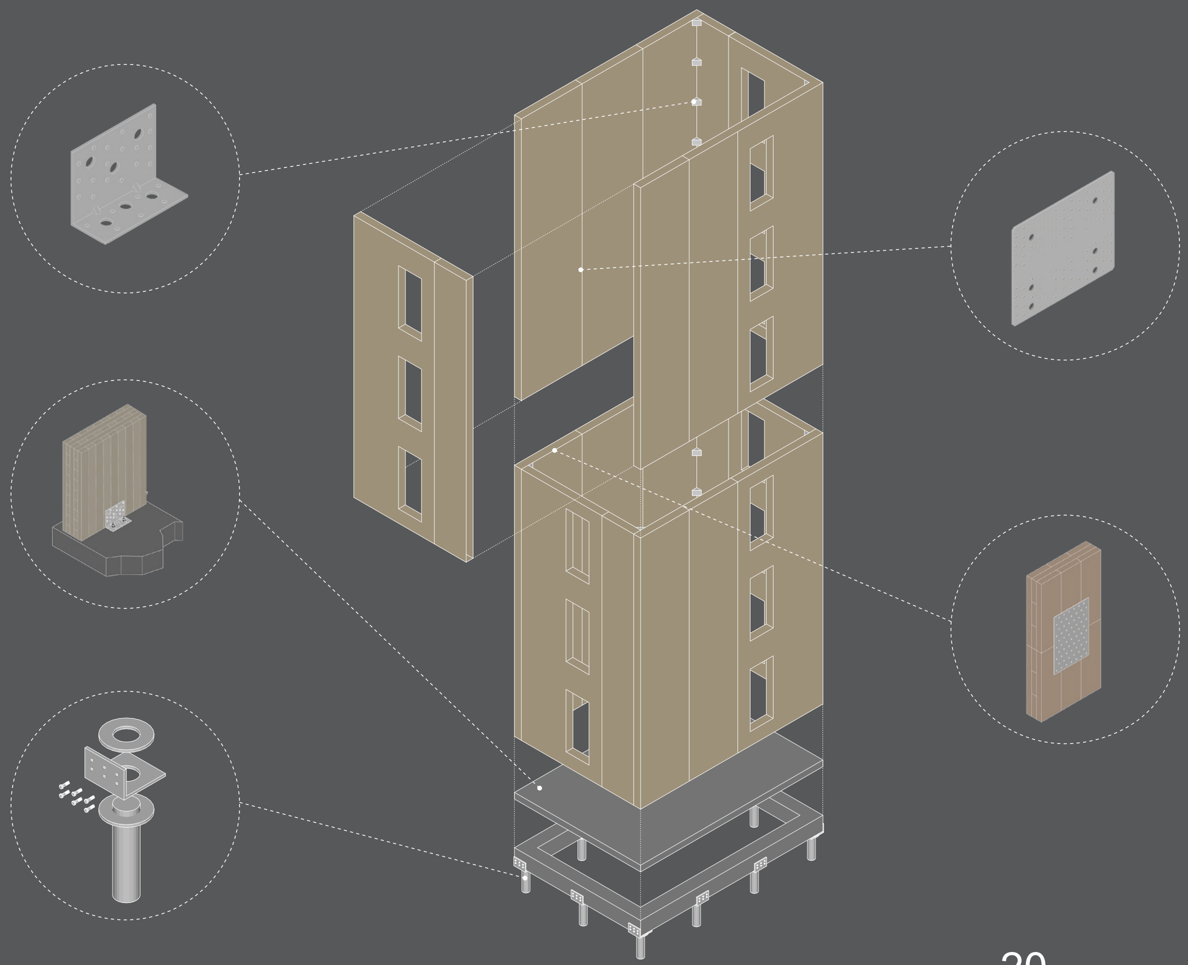






DEMOUNTABLE CORE

The wind load on the facades is transferred to the core through the floors. Only the core has a concrete floor as foundation which is placed lower than others due to the lift shaft and because of the forces that are transferred to the foundation by the solid CLT walls. The concrete foundation under the core is designed to be fully demountable so that all parts of the building can be removed from the building site without leaving the landscape damaged. The CLT walls are three stories tall and are connected with angle irons and secured to the concrete foundation slab.

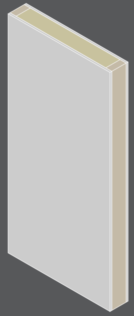


PARTITION WALLS

The fire resistance (R) is the time for which a construction element continues to perform its function in the event of a fire, or in most cases, the time until failure of the element.

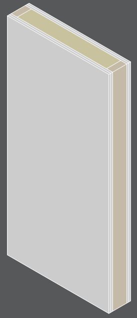
With regard to the fire resistance of constructions three important criteria are distinguished (R, E and I):
- moment of collapse (R)
- the separating function (E)
- the insulation capacity during a fire (I).

Not all characteristics are required, depending on the building element and for example whether it is a load bearing element or not. The resistance or behaviour is indicated with the code and the number of minutes that the resistance indicates for the relevant characteristic.



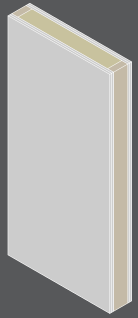
- Gipsplaat 12,5mm
- Regelwerk 38x89mm
- Cellulose
- Gipsplaat 12,5mm

EI 30
Rw = 38 dB



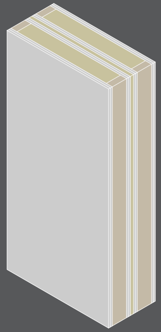
- 2x gipsplaat 12,5mm
- Regelwerk 38x89mm
- Cellulose
- 2x gipsplaat 12,5mm

EI 60
Rw = 43 dB



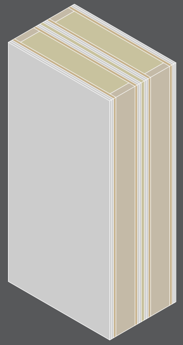
- 2x gipsplaat 12,5mm
- OSB 15mm
- Regelwerk 38x120mm
- Cellulose
- OSB 15mm
- 2x gipsplaat 12,5mm

REI 60
Rw = 46 dB



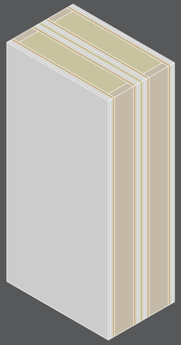
- Gipsplaat 12,5mm
- Regelwerk 38x89mm
- Cellulose
- Gipsplaat 12,5mm
- Mineral wool 20mm

REI 60
Rw = 59 dB



- 2x gipsplaat 12,5mm
- OSB 15mm
- Regelwerk 38x120mm
- Cellulose
- OSB 15mm
- 2x gipsplaat 12,5mm
- Mineral wool 20mm

REI 90
Rw = 60 dB



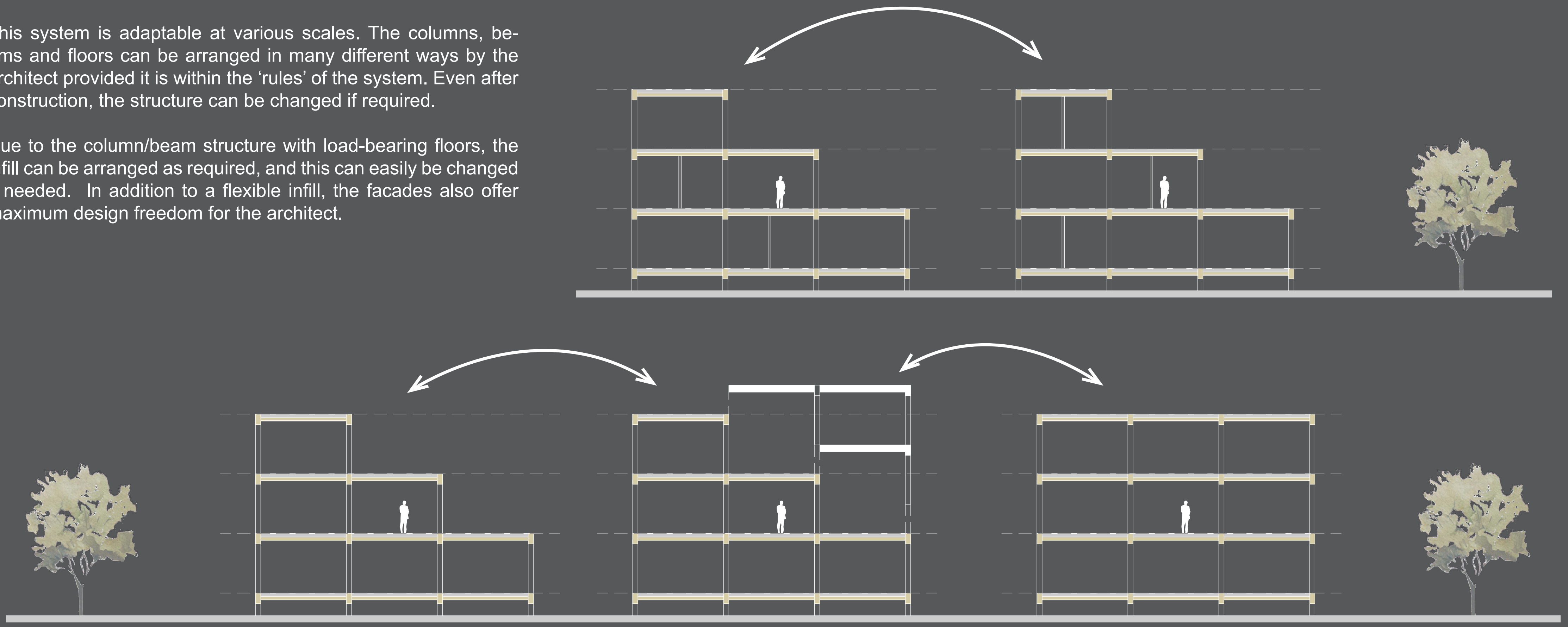
- 2x gipsplaat 12,5mm
- OSB 15mm
- Regelwerk 38x120mm
- Cellulose
- OSB 15mm
- 2x gipsplaat 12,5mm
- Mineral wool 50mm

REI 90
Rw = 64 dB

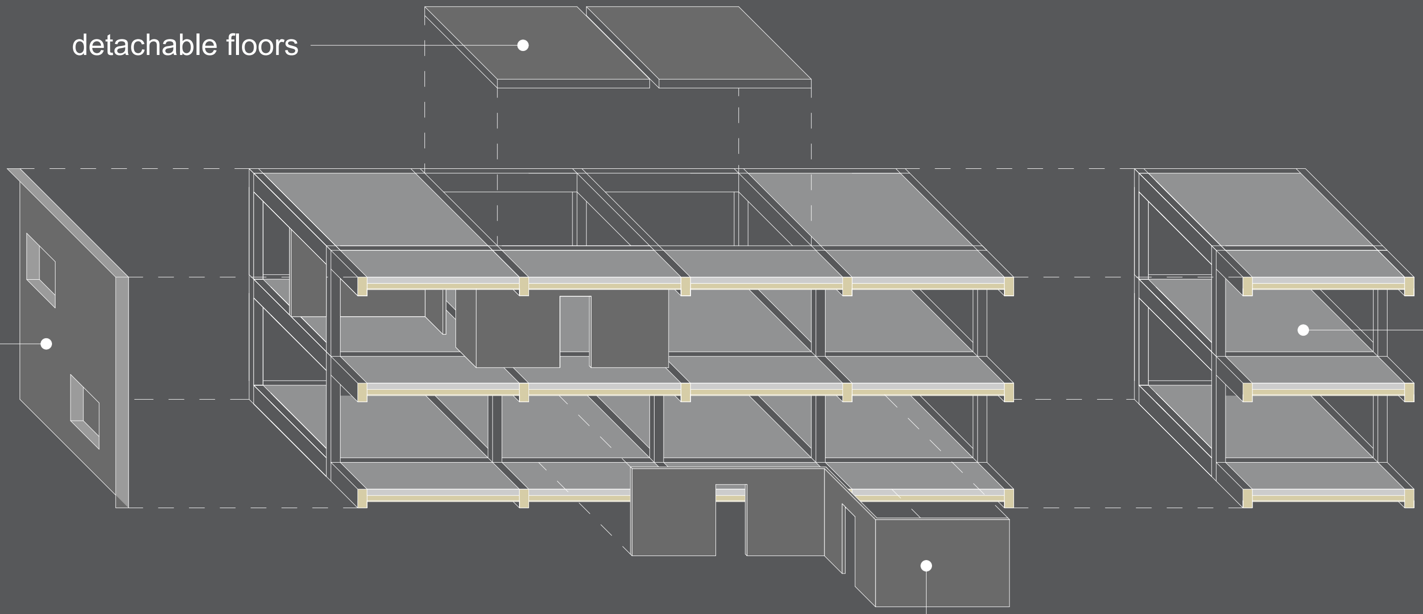
ADAPTABILITY

This system is adaptable at various scales. The columns, beams and floors can be arranged in many different ways by the architect provided it is within the 'rules' of the system. Even after construction, the structure can be changed if required.

Due to the column/beam structure with load-bearing floors, the infill can be arranged as required, and this can easily be changed if needed. In addition to a flexible infill, the facades also offer maximum design freedom for the architect.



ARCHITECTURAL FREEDOM

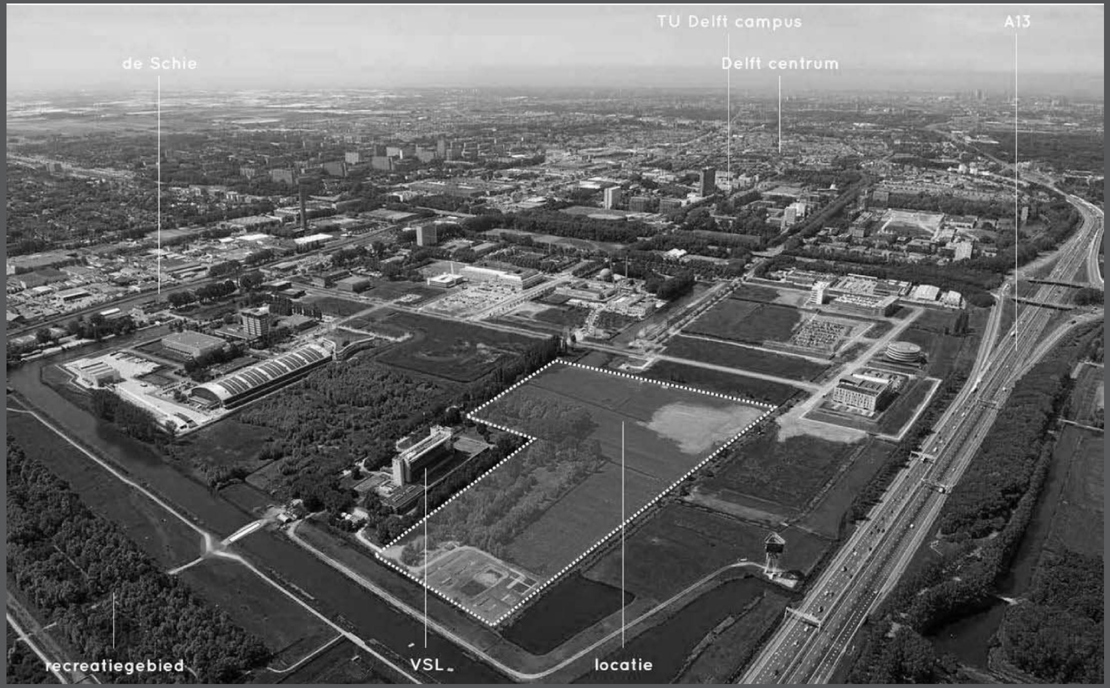


3. LOCATION FOR BUILDING DESIGN

LOCATION

Due to the lack of student accommodation in Delft, the municipality commissioned Wurck to carry out an urban development study to explore if this location on the south side of the TU campus would be suitable for temporary student housing. Students are currently dispersed over the city, leading to nuisances such as renting accommodation that is intended for a different group. The municipality therefore envisions a proportion of students moving to the campus. Initially, DUO's plan is to build 500 studios, but the municipality indicated that they do not mind if this is scaled up. A larger number could potentially make small facilities and amenities feasible which enhances the liveability.

The TU Delft wishes to develop this area as a science park in approximately 10 years from now, to attract different companies and institutions. The student accommodations are therefore only temporary, as the board of the TU is concerned about combining industry and housing at the same location. However, 10 years is too brief a period for a building to be viable, thus negatively impacting the sustainability of this plan. This initiative calls for an alternative approach to prevent the structure from being demolished after 10 years.



LOCATION

2km

2km

200m

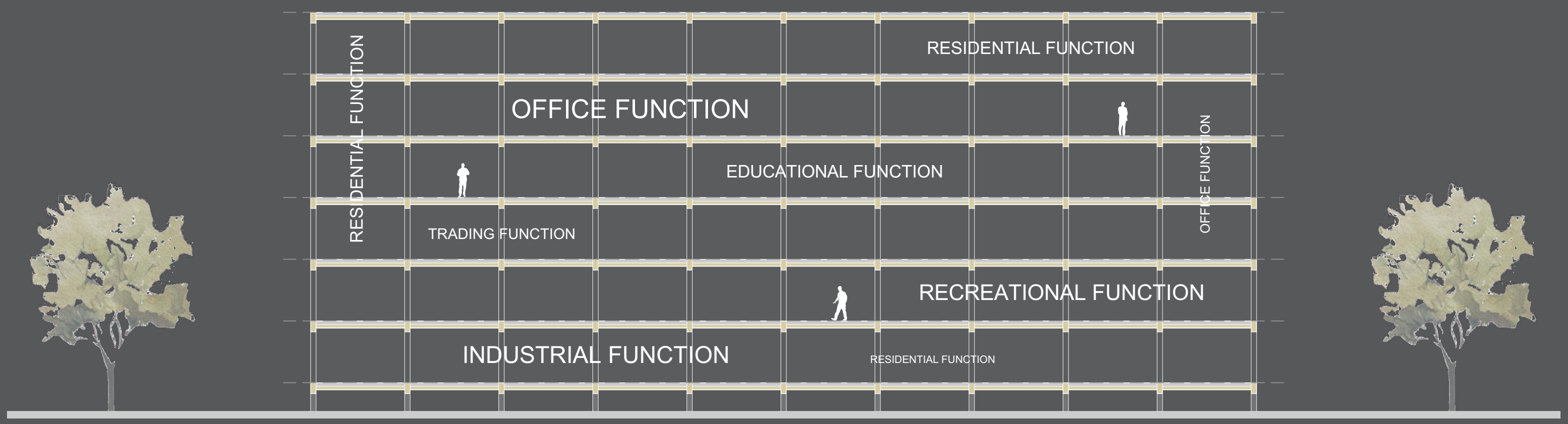
200m

4. SPECIFIC SYSTEM DESIGN

MULTIFUNCTIONAL

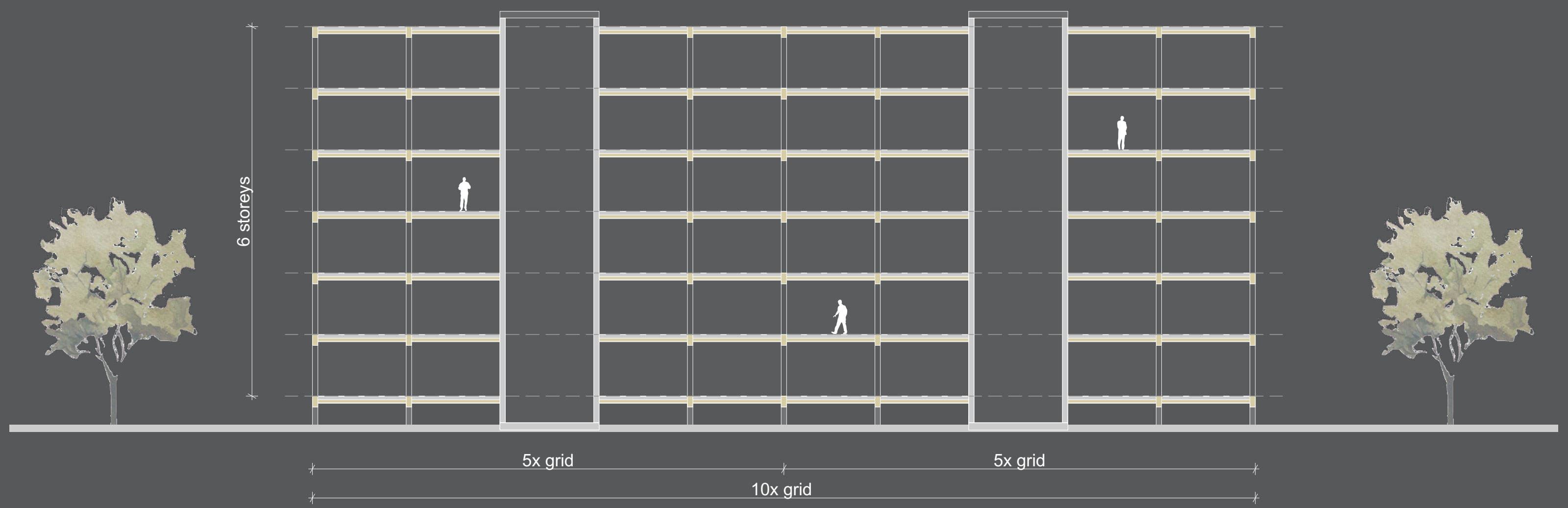
After approximately 10 years, the student building will change into offices and laboratories. It is therefore essential to create a structure that can accommodate these functions, and perhaps others in the future. The design for this building focuses on the accommodation of students, but with an eye to the future.

In the future, it will be up to the architect to transform and use the 'rules of the system' to design a new and fitting layout that suits the new function.



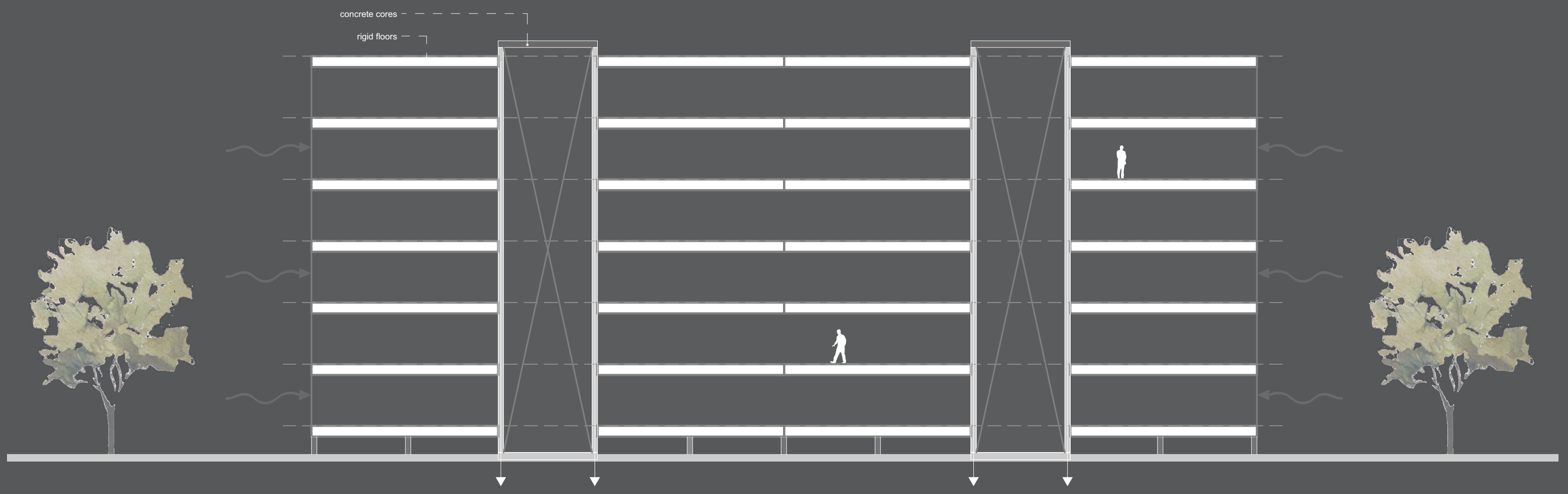
BUILDING'S WIDTH

Once the building transforms from studios to offices and laboratories, it must be possible to create large spaces that may be required. The width of the full building is determined by the studios situated on either side of the core and is 10 times the width of a module. In addition, all parties involved have stated that social safety on the site is low. A strong community inside the building is therefore desired since this ensures a safe environment. The building has a total of six floors, which is also the maximum height of the building system.



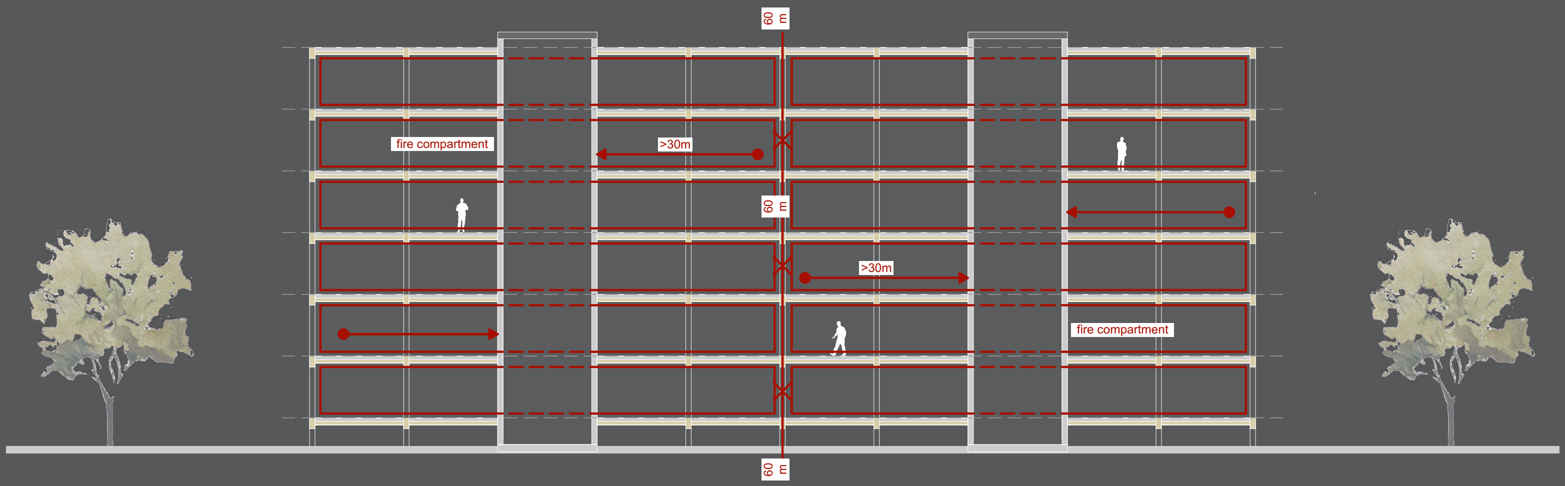
STABILITY

The floors are coupled and where necessary, steel wind braces are attached to transfer the horizontal forces caused by wind loads to the core. The cross laminated walls transfer the forces to the concrete foundation on the screw piles.



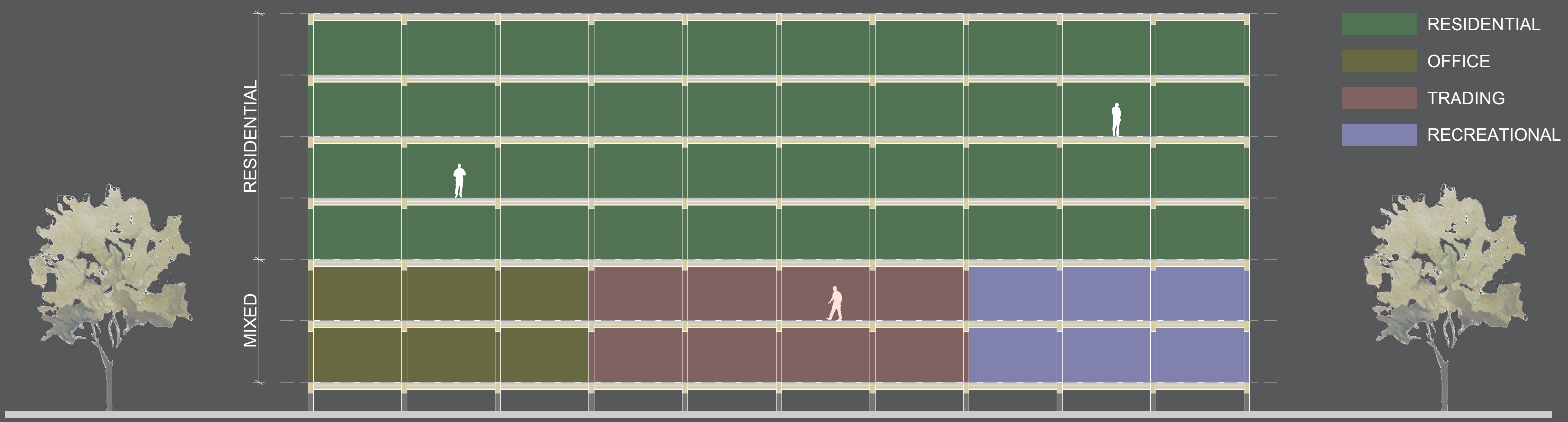
FIRE SAFETY

No more than 1000 square metres of floor space may be allocated on an escape route. Seen from above, each building section consists of a series of 5 linked modules in both length and width. In the middle there is the core, which may not be further than 30m from any point within the fire compartment. The separation between a fire compartment shall be at least 60 minutes fire resistant and the separation between a sub-fire compartment 30 minutes.



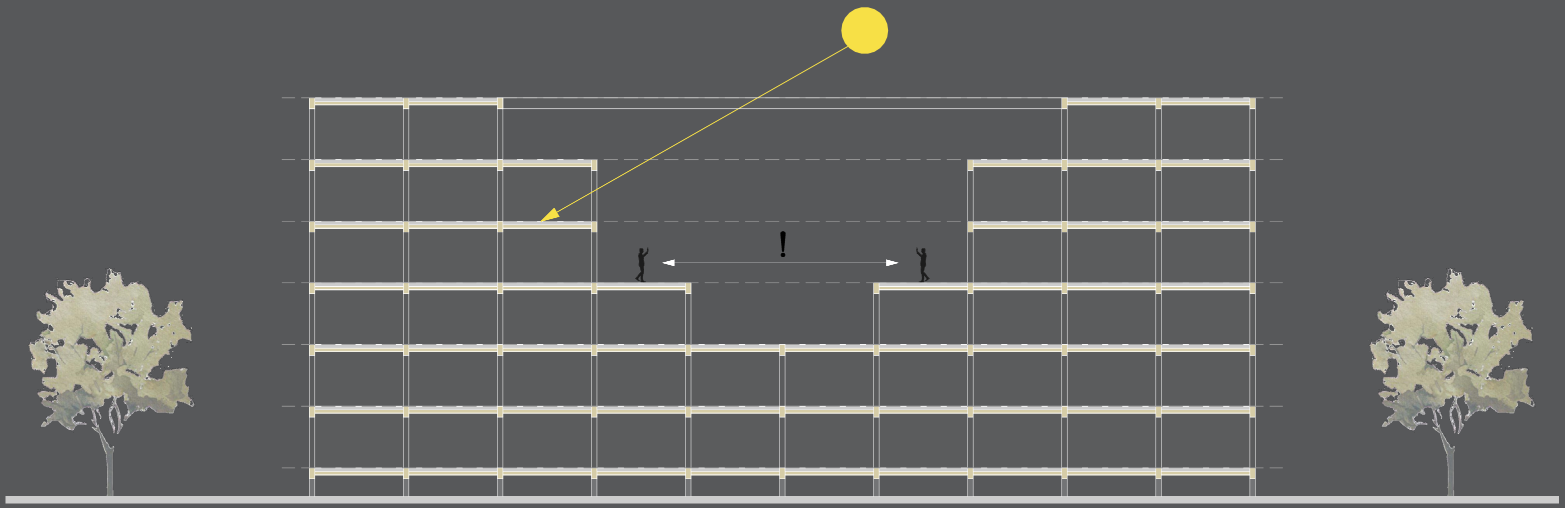
PUBLIC FUNCTIONS

The municipality is supportive of building a large number of student houses on the campus. The location will be built for approximately 8000 square metres, divided between two buildings. Both buildings can accommodate approximately 400 students, and a number of public facilities such as a supermarket, a library, a coffee bar and a gym will be included.



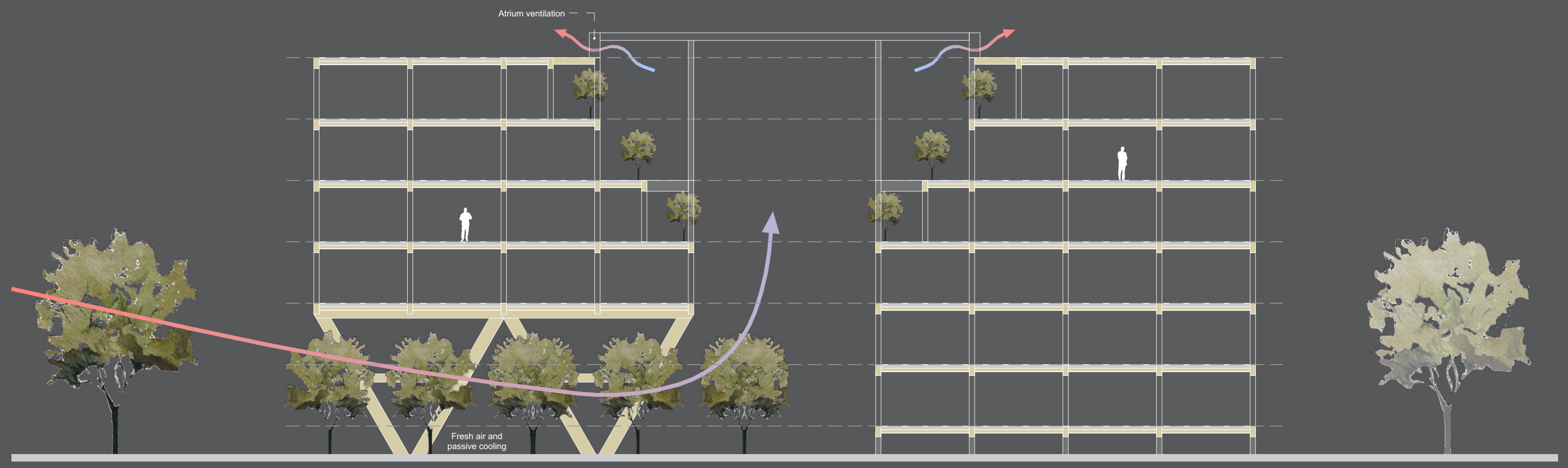
STEPPED FACADES

Studios are situated on either side of each core resulting in studios adjacent to the inner side not receiving any daylight or ventilation. For this reason, the inner façades will have a stepped shape creating a living space on the inside, contributing to making a community.



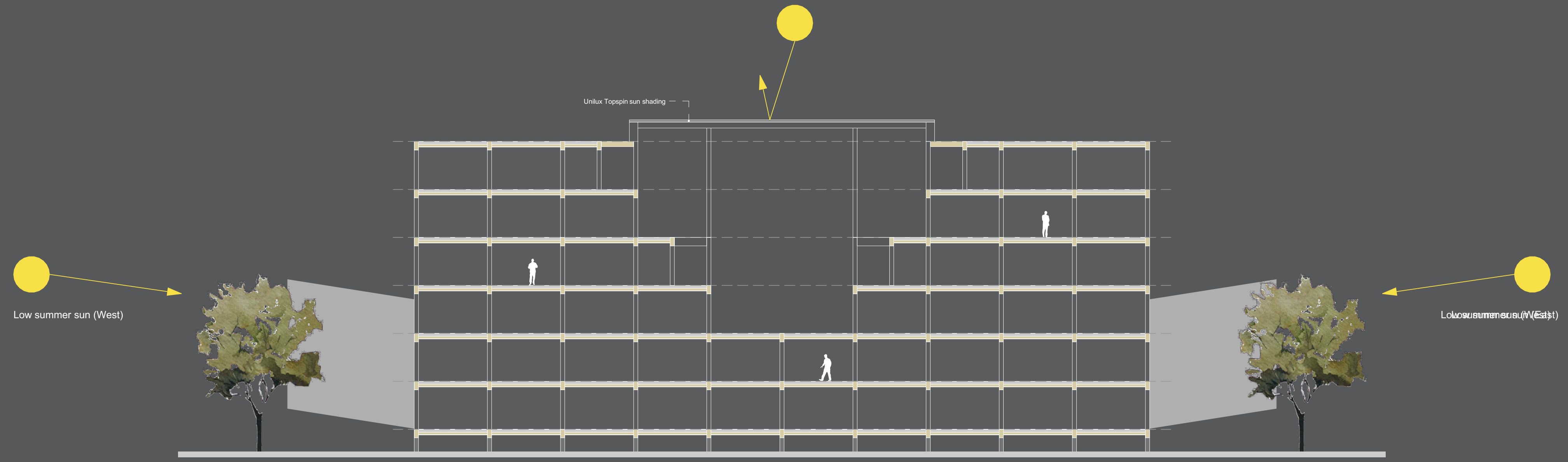
AIR TUNNELS

The atrium is passively ventilated and cooled by air tunnels integrated in the south-west façade which are filled with trees and shrubs. The pressure of the wind makes the warm air, that rises when heated, leave through the openings in the atrium’s roof. The air tunnels and the plants, bushes and trees also support fauna in the atrium.



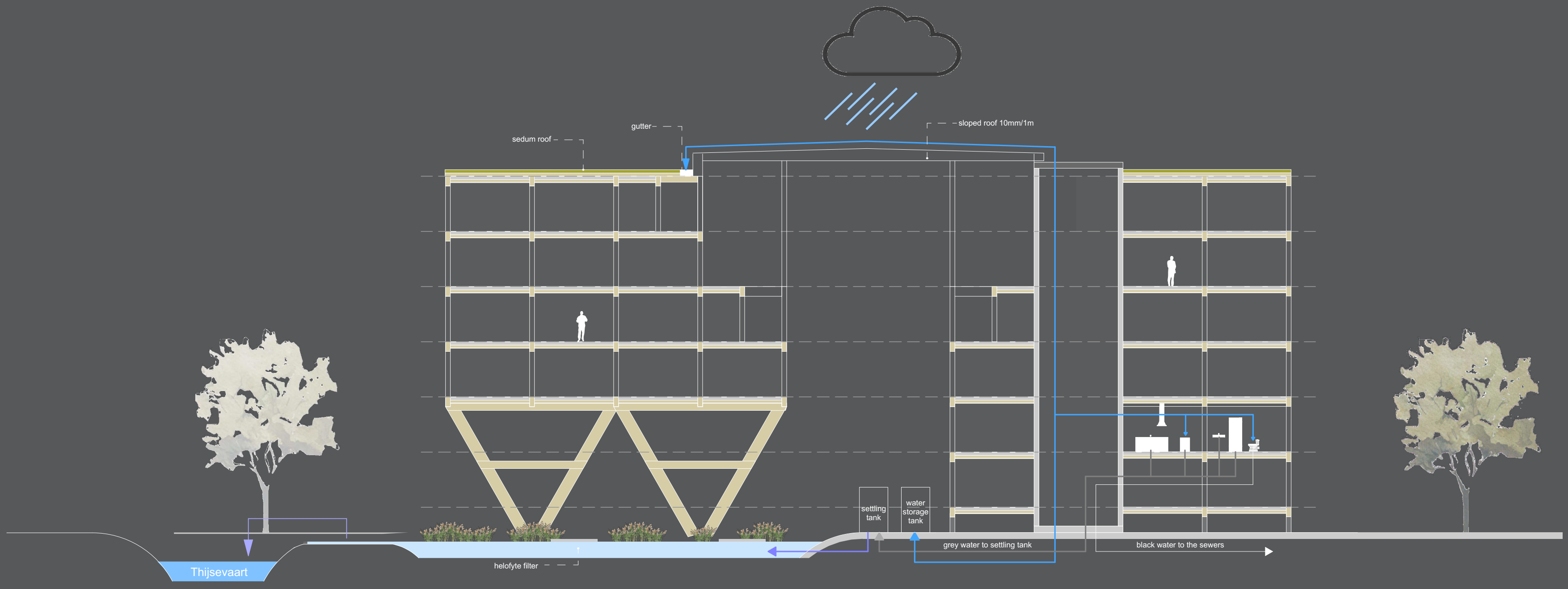
PASSIVE SUN SHADING

Trees provide part of the north-east facade with passive sun shading for the low summer sun in the morning and the south-west façade in the afternoon. The atrium roof is equipped with automatic sun blinds that close at a specific sun intensity hitting the atrium.



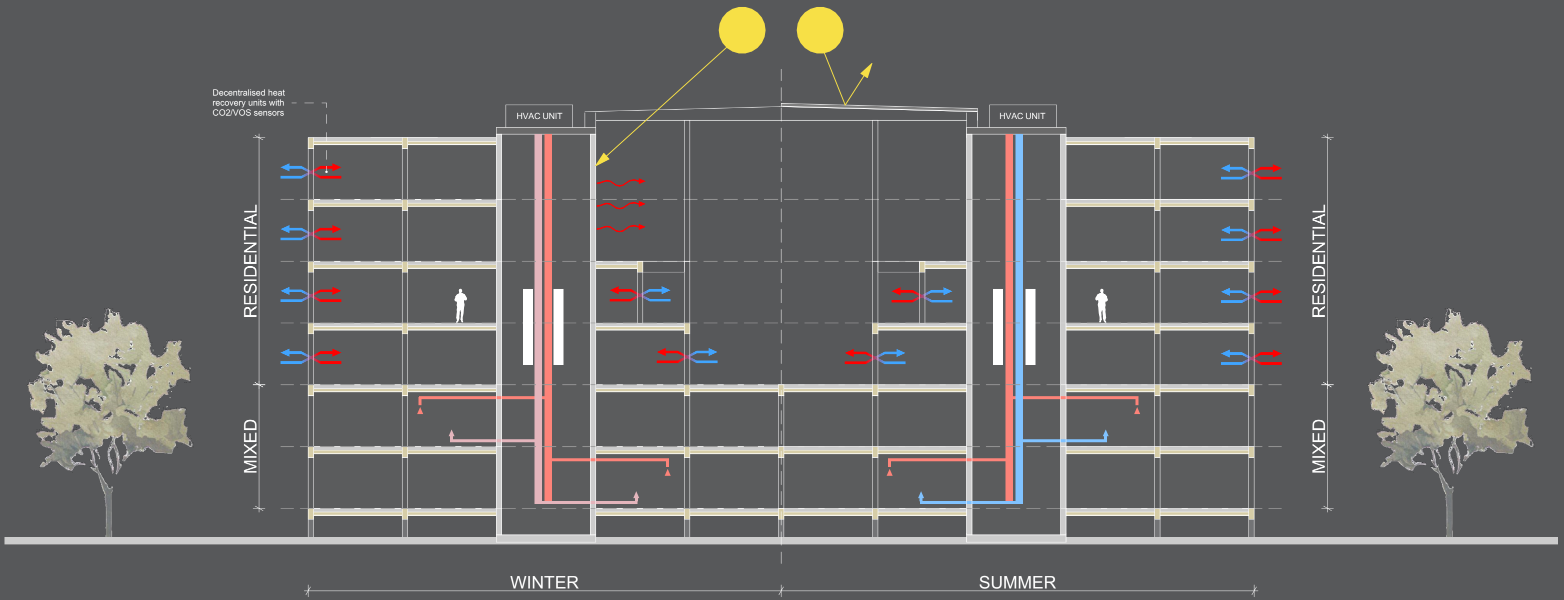
WATER

Rainwater is collected on the atrium's roof and is used for toilet flushing and for laundry machines. All domestic water except that from the toilet is sent to a sceptic tank where the water is coarsely filtered. The water is then purified by helophytes before flowing to the Thijsevaart. Most of the rainwater and domestic water is discharged into the surface water, which helps to reduce the pressure on the sewers during heavy rainfall.



VENTILATION

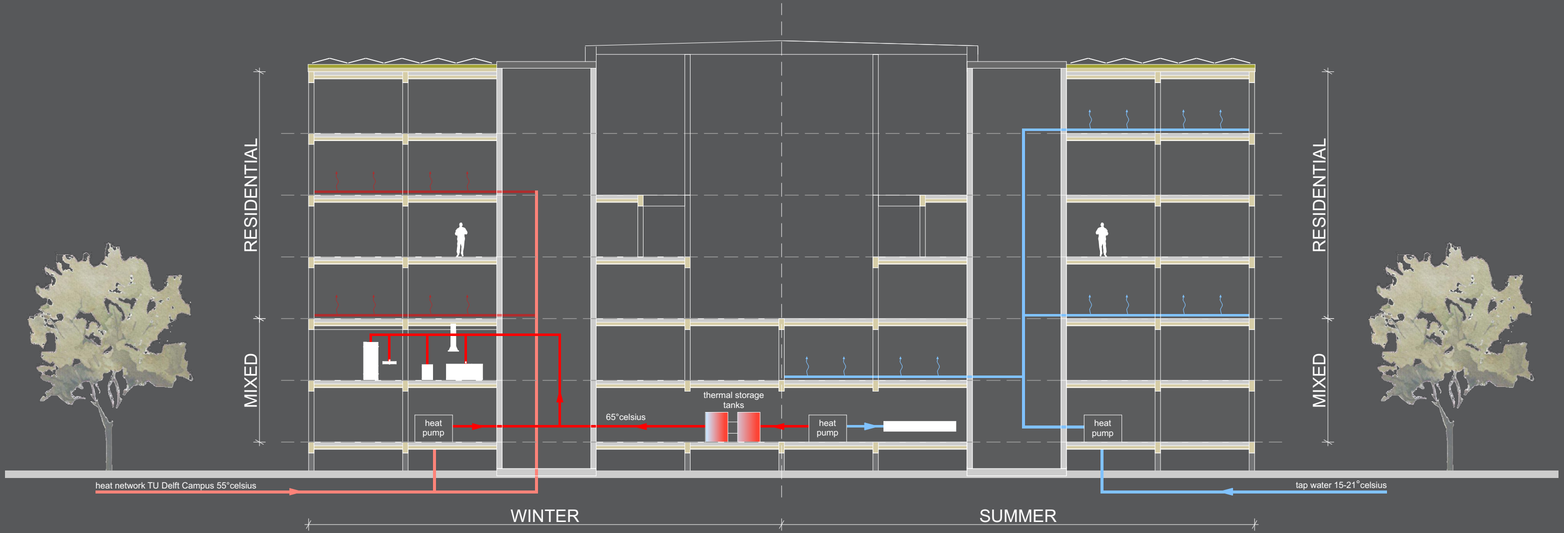
The studios are decentrally ventilated by air handling units with heat recovery. For the studio's facing the atrium, the air in the atrium is pre-heated by the sun in winter and pre-cooled in summer. The public functions in the lower two layers are centrally ventilated by HVAC (heat, ventilation and air conditioning) units on the roof.



HEATING AND COOLING

The TU Delft campus owns a heat network that supplies hot water at 55 degrees Celsius. This is sufficient for heating the building with underfloor heating (low temperature heating), but not warm enough for the domestic water usage. Therefore, the water is further heated by a heat pump that can also cool the tap water in the summer.

The supermarket uses a lot of energy for refrigeration, which releases heat as a by-product. This heat is stored in thermal tanks and is used in combination with the heat network.

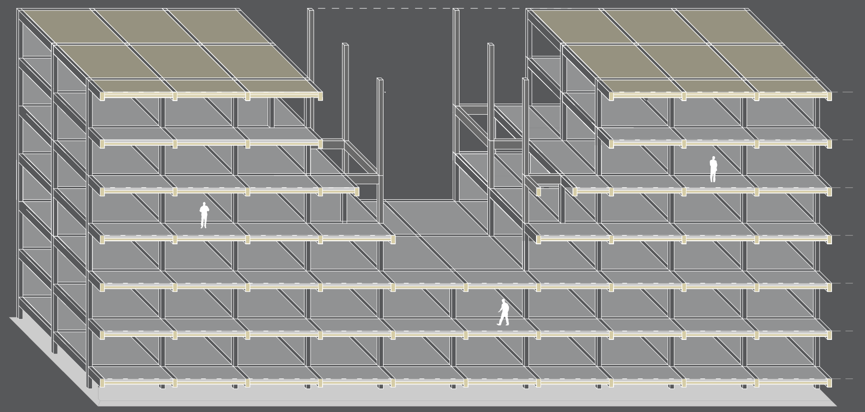


TRANSFORMATION

The building system is multifunctional, which means that it can change function at any time with minimal intervention. Not only can the building easily change function, the building itself can also change shape due to its high adaptability.

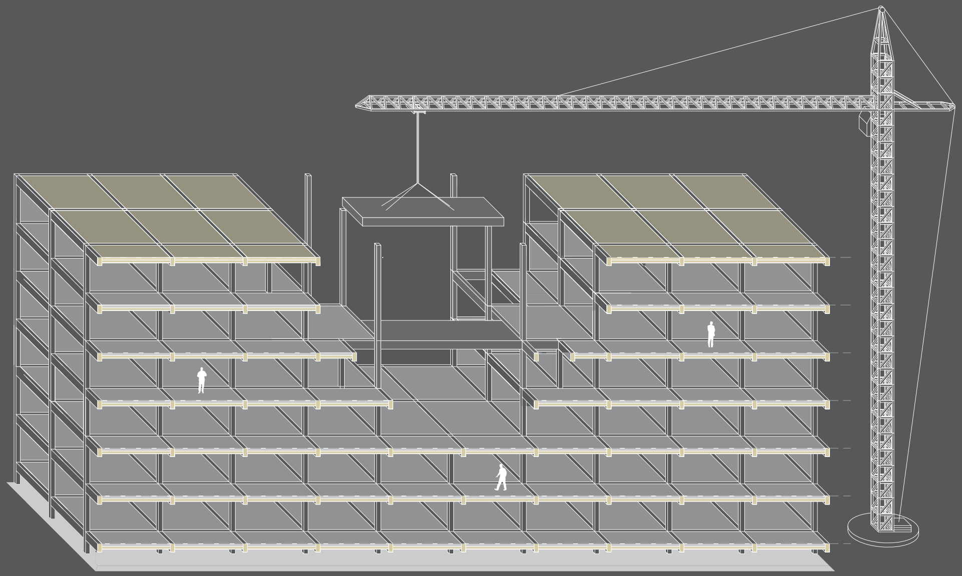
The atrium is basically a covered outdoor space to ensure that each studio receives sufficient daylight and ventilation. Once the studios make way for offices and laboratories, it may be desirable to create more or different types of floor space. The main structure is designed to be capable of being altered without major modifications. This means that elements can be removed or added without having to replace any structural elements. However, for any alteration a new permit must be requested. The municipality will assess all changes according to the building regulations

If any constructive elements are added in the atrium, the demountable roof will first be temporarily removed where necessary. A crane will then lift the beams, columns and floor sections inside where they will be installed.

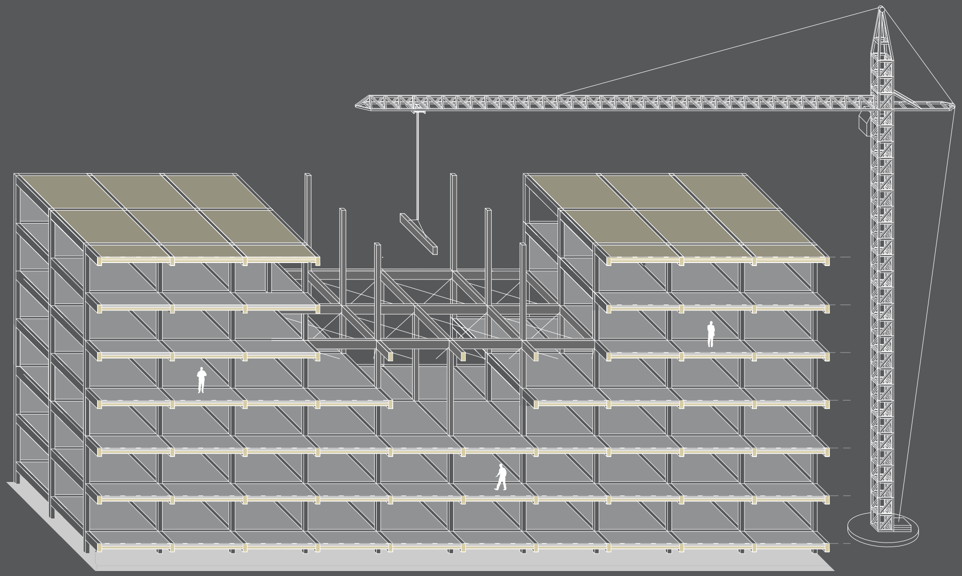


1. The roof is temporarily dismantled and all B-elements that are not part of the main structure are removed.

TRANSFORMATION

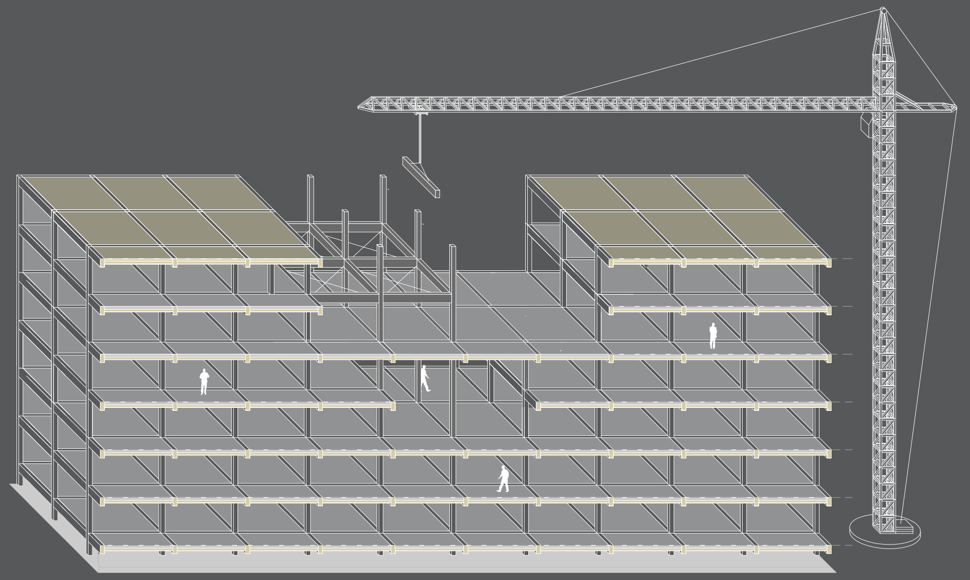


2. B-elements, which are not part of the main structure (A-elements), are dismantled and removed to make space for A-elements.

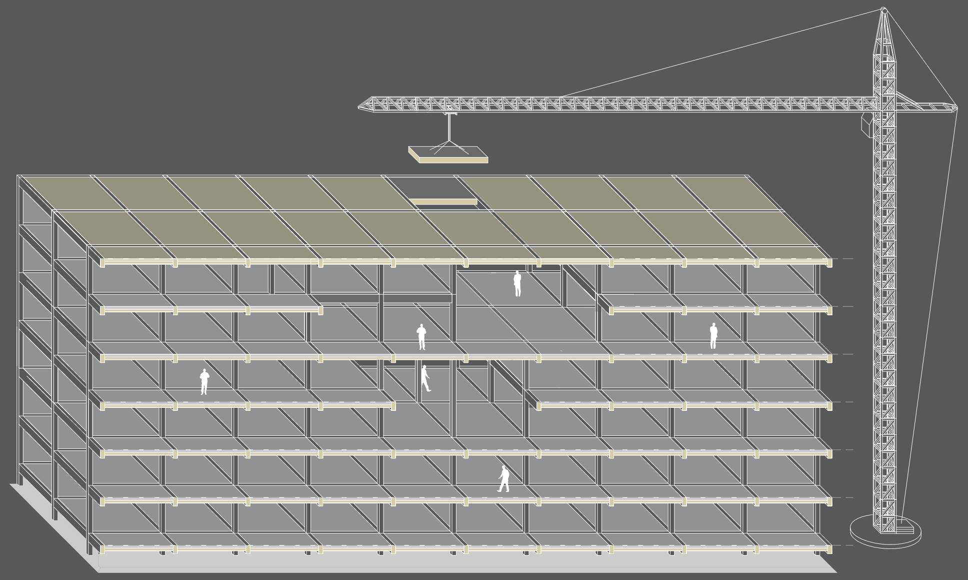


3. Columns, beams and steel wind braces are assembled according to the new design.

TRANSFORMATION



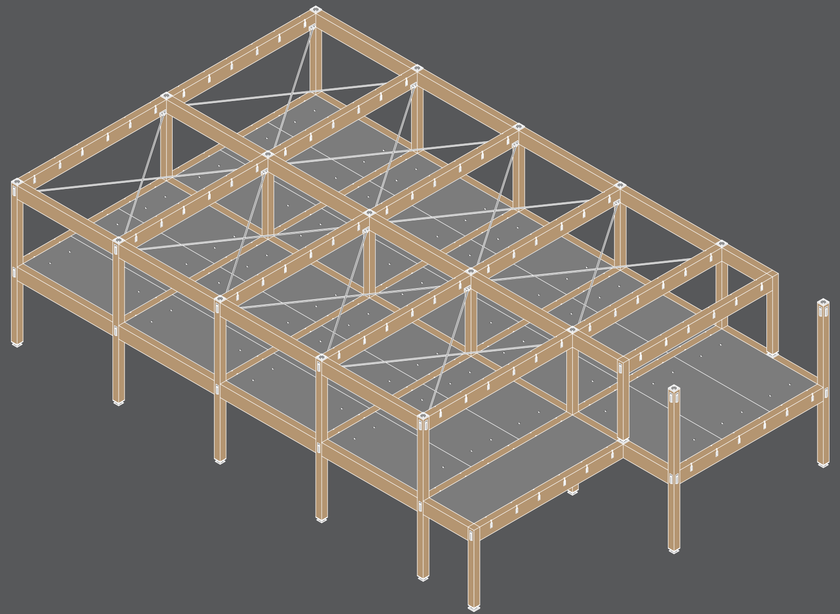
4. Floors are laid between the beams and in the same order the next floor is built.



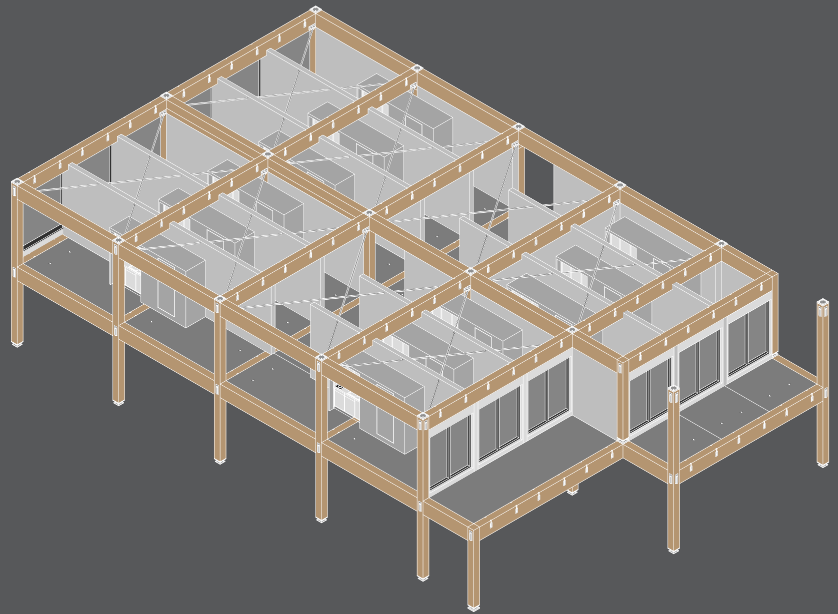
5. The roof is being closed

TRANSFORMATION

The diagrams below show a transformation from studios to offices. Diagrams 1-3 show how the structure is built and in what order the infill for the studios is built, in 4-6 the structure is modified and in 7-8 the space is changed to an office function.

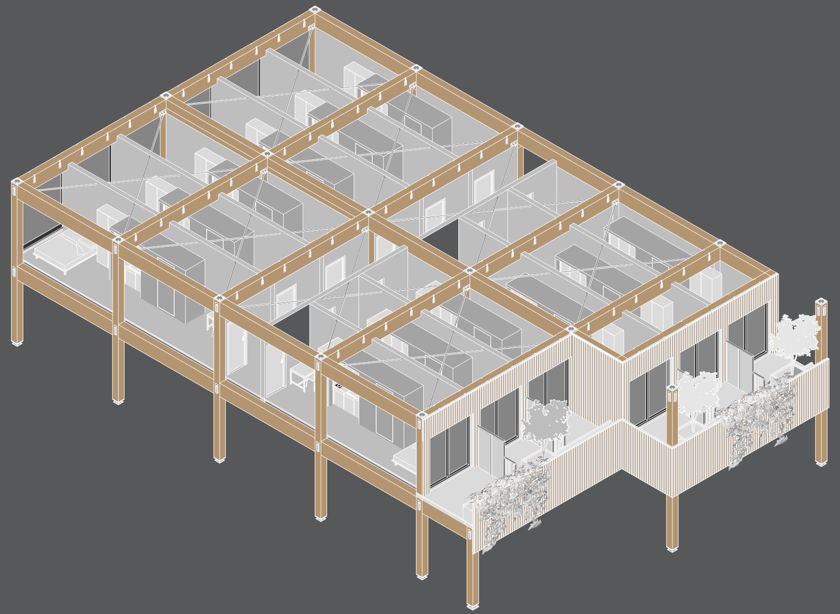


1. The main structure is finished and ready for the infill to be installed. Besides the main structure, a number of B-elements have been added. These are elements that are not part of the main system, but are additional elements to the design. The architect is free to add personal touches to the design of the main system.

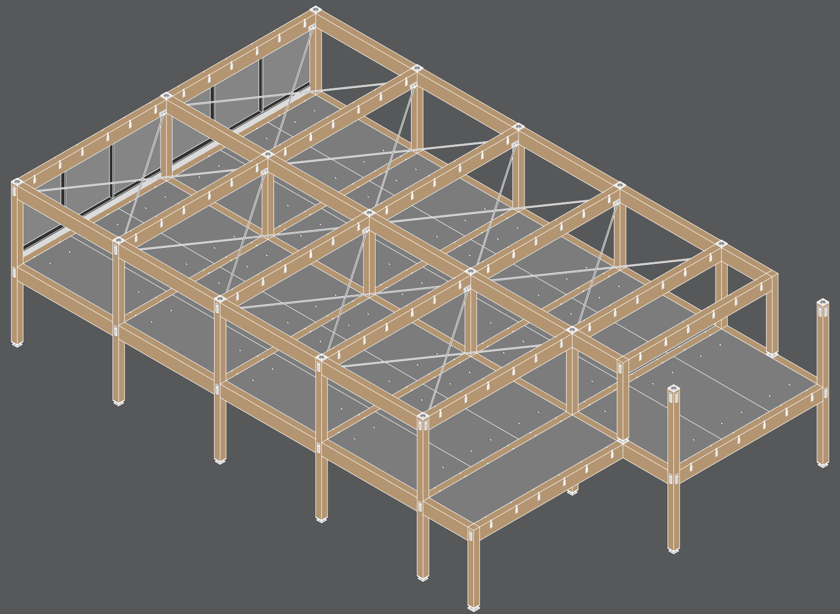


2. The infill consists of every element that is not part of the supporting structure, such as the facades, non-load-bearing walls, installations, sanitary facilities and furniture. First, the outer walls and inner walls that separate the studios are installed. Then the prefab kitchens and bathrooms are installed, which will be removed and reused after 10 years.

TRANSFORMATION

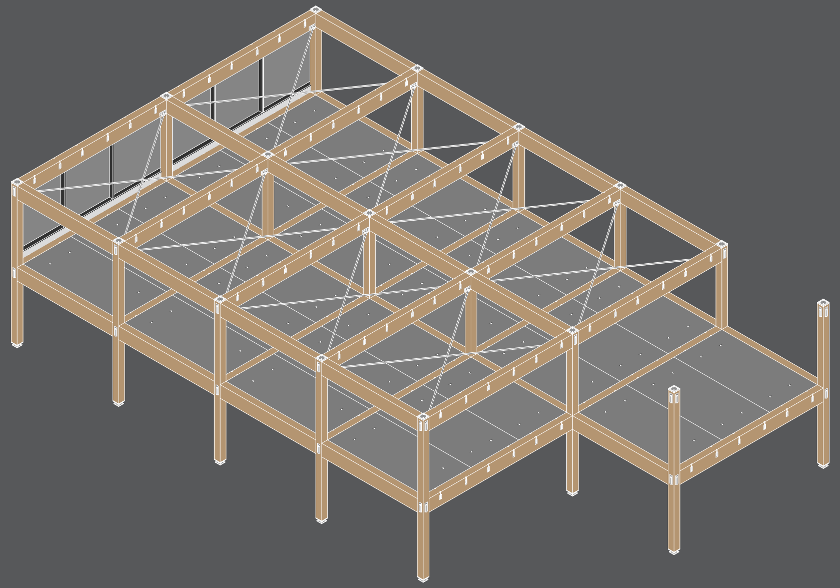


3. Once the kitchen and bathroom is in place, the plumbing is installed, which is ‘hidden’ in a raised floor. This is followed by the floor, ceiling, doors and finally the furniture.

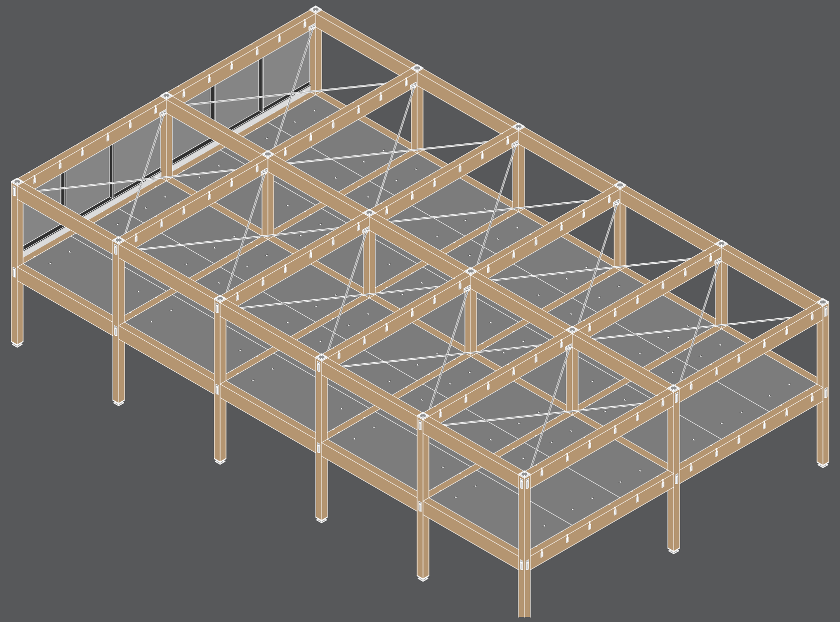


4. After approximately 10 years, the studios make way for offices and laboratories. First, the infill is removed except for the outer facades.

TRANSFORMATION

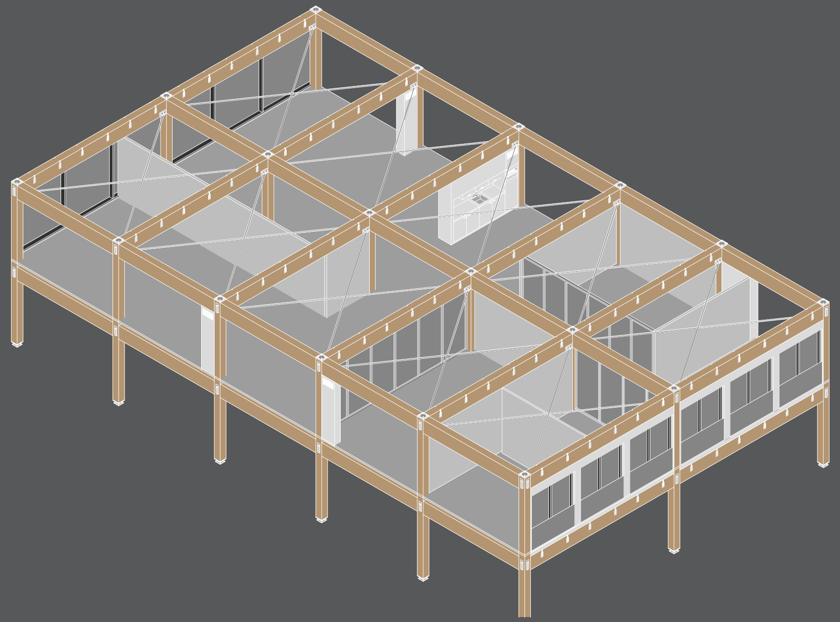


5. To demonstrate the high degree of adaptability, the area for the offices is enlarged in the following diagrams. The B-elements that can be seen in diagram 4 are removed in diagram 5 to make way for elements that will connect to the main structure.

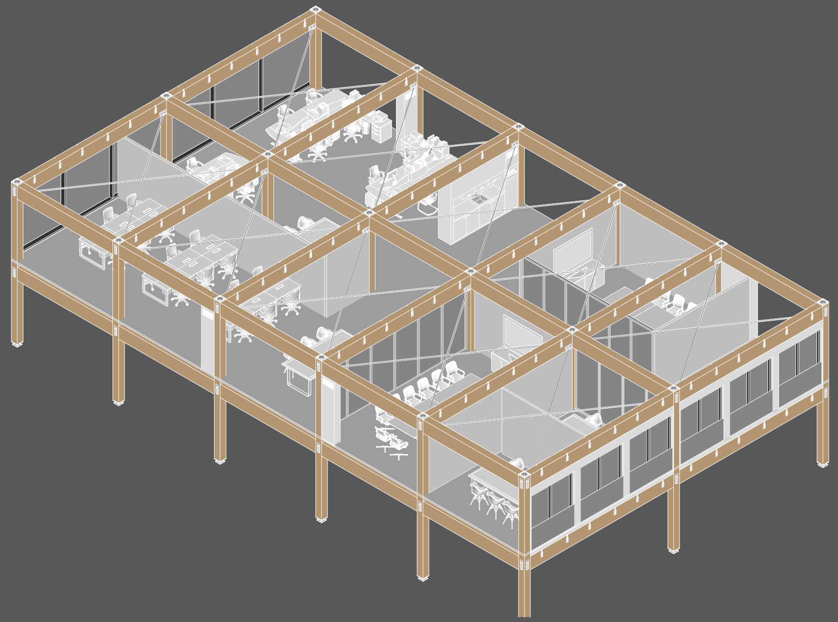


6. Columns, beams and floors are added, enlarging the area.

TRANSFORMATION



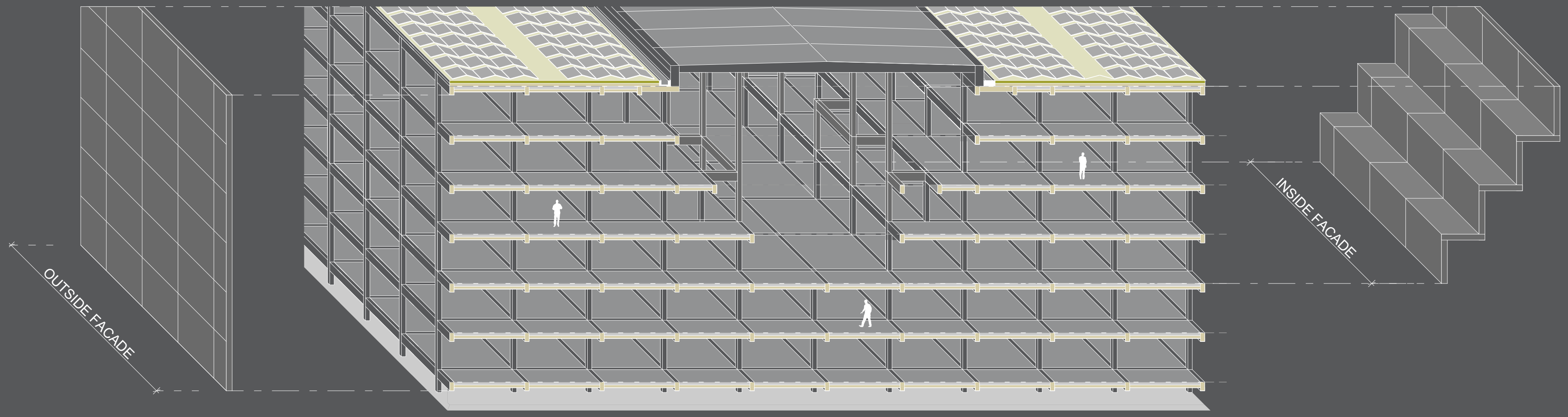
7. As with the studios, the first part of the infill, consisting of walls and installations, is installed.



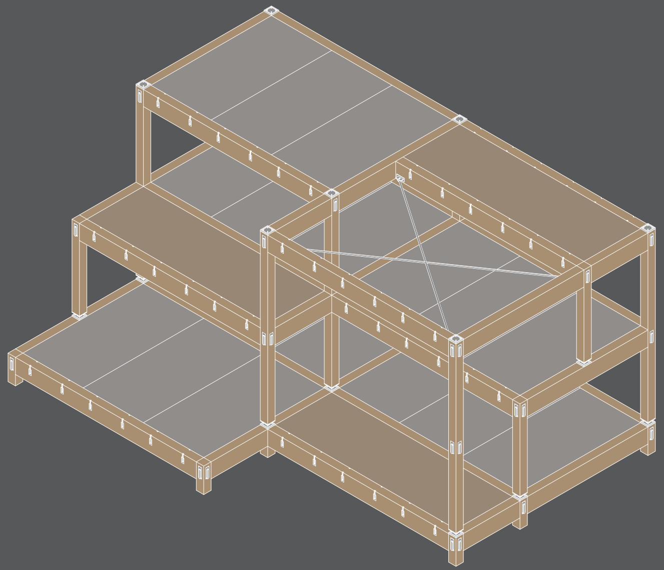
8. lastly, the furniture in installed.

FACADES

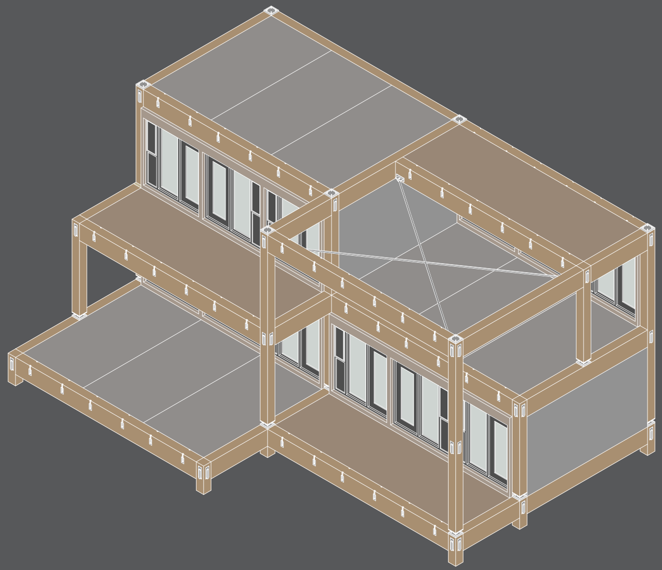
The facades are not part of the main load-bearing structure. This means that both the outer facades and the facades adjacent to the atrium offer maximum design freedom.



INNER FACADE

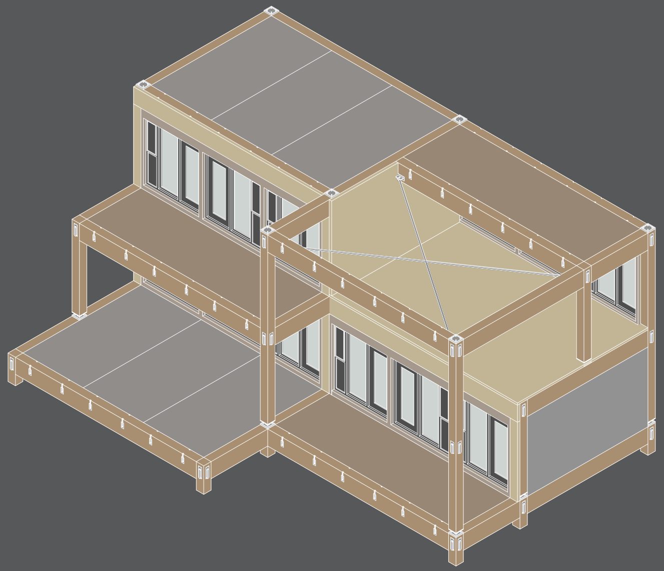


1. A-elements (main structure) and B-elements (additions not forming part of the system)

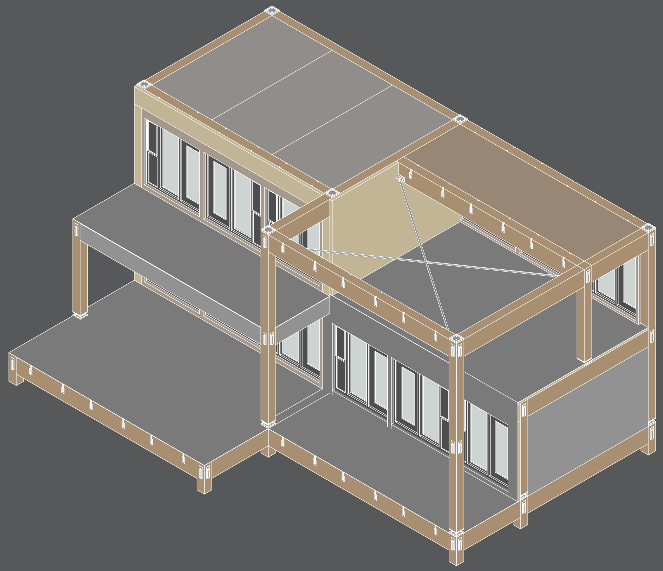


2. The building is wind and waterproof after the outer walls are installed.

INNER FACADE

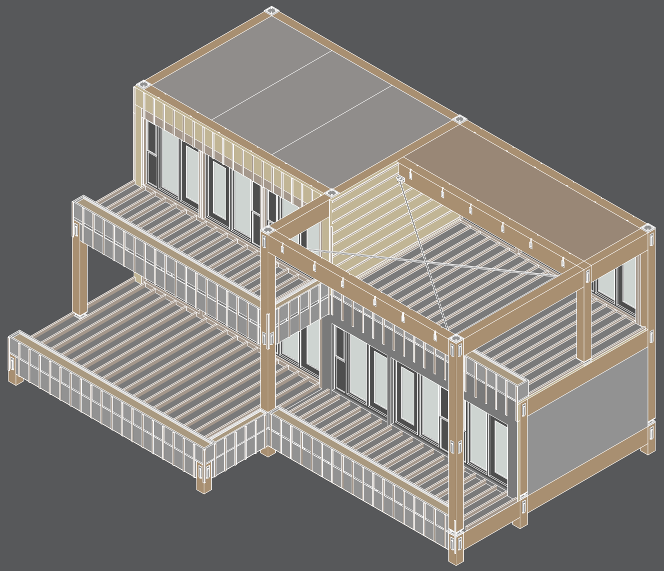


3. (Drukvaste) isolatie voor terras en gevels,

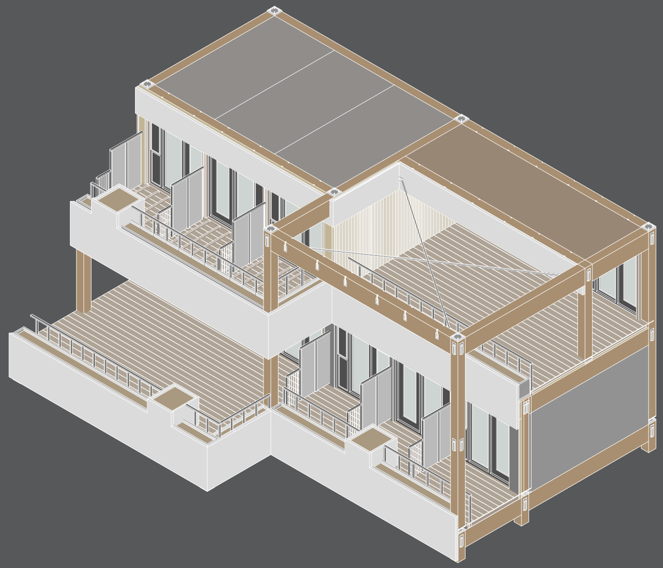


4. Pressure-resistant insulation for the terrace and normal insulation for the facade is installed.

INNER FACADE



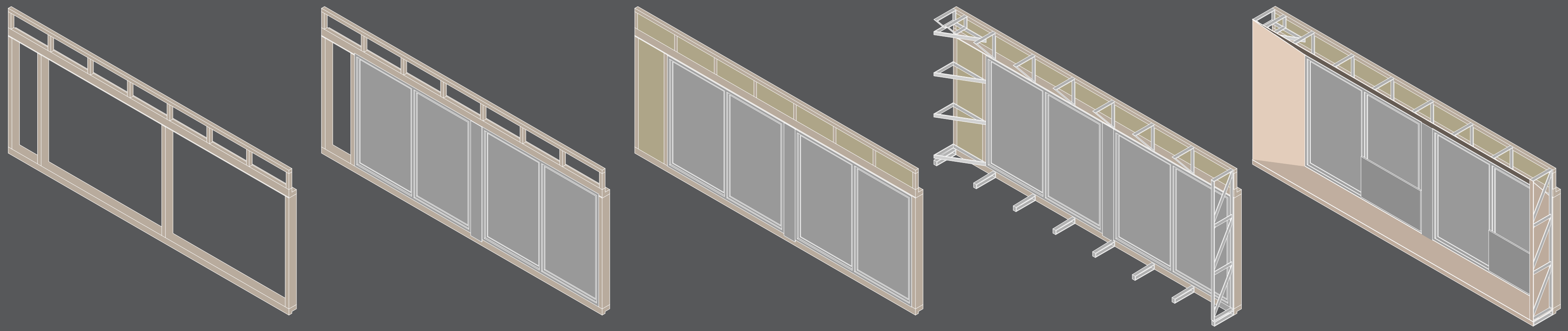
5. Battens voor de houten gevelbekleding en terras



6. Inclusief alle afwerking

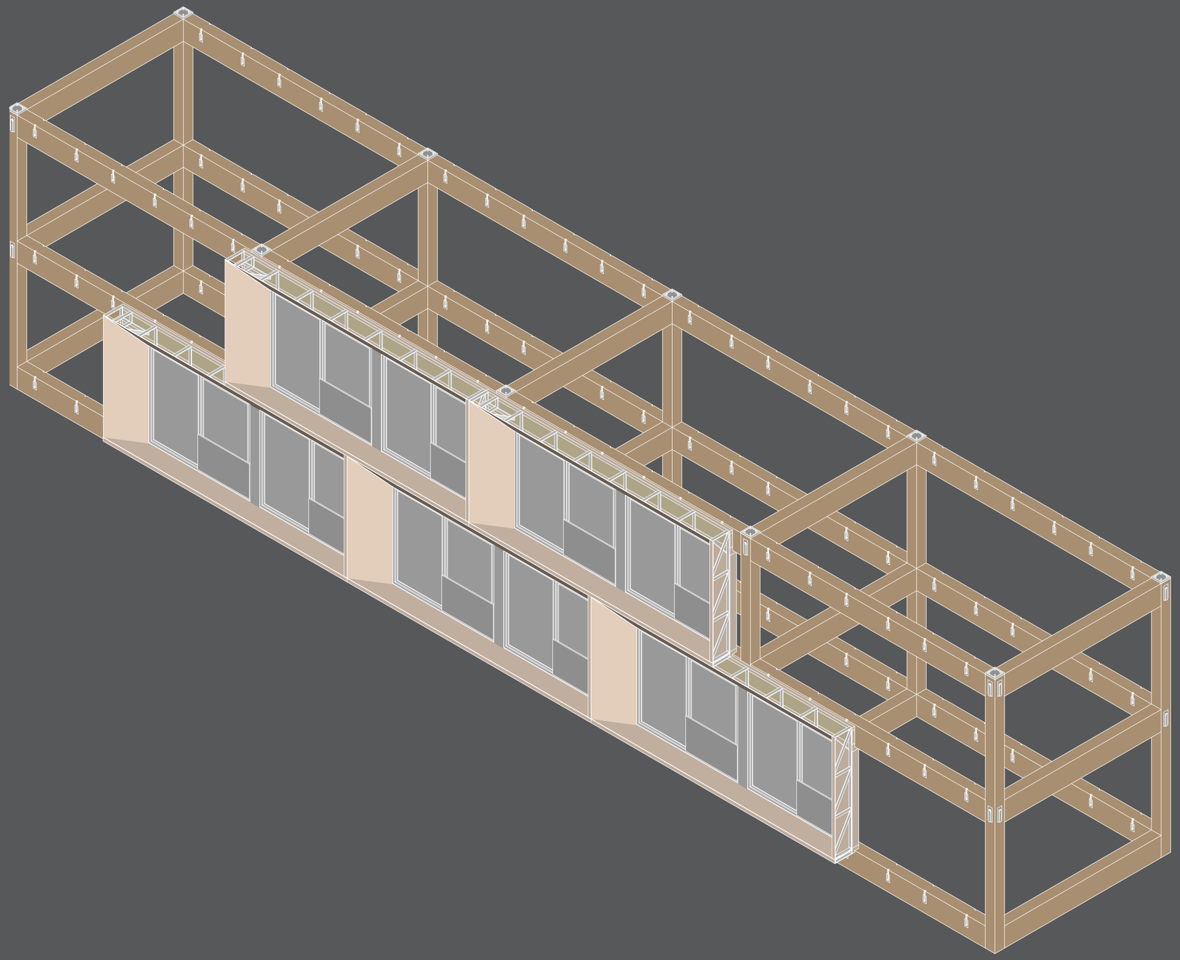
INNER FACADE

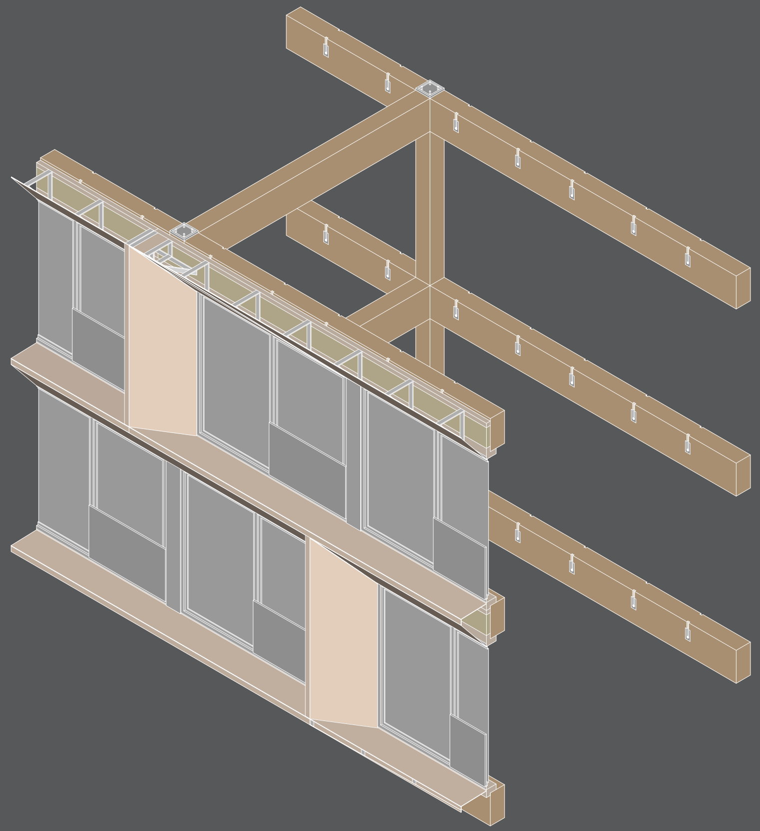
- Prefabricated facade elements



1. Timber frame 2. Window frames 3. Insulation 4. Steel supports 5. Finish

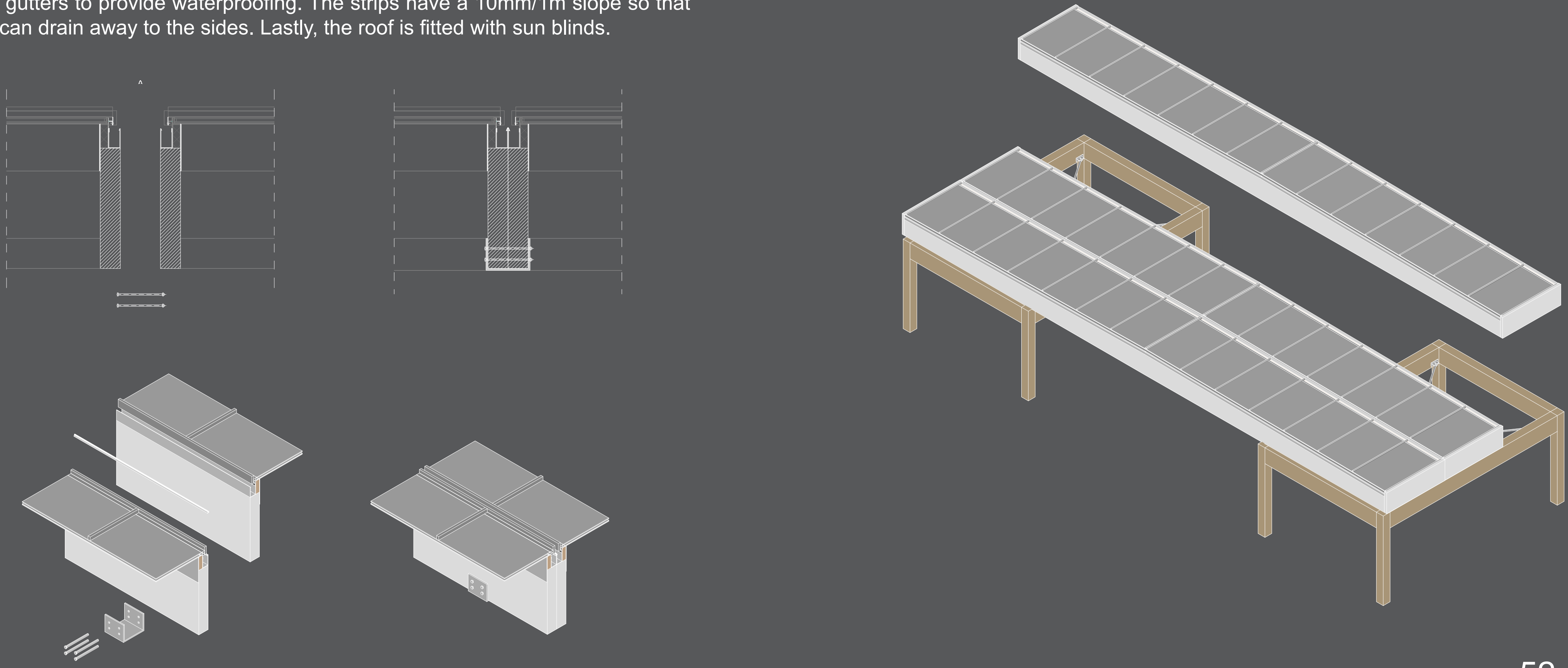
INNER FACADE



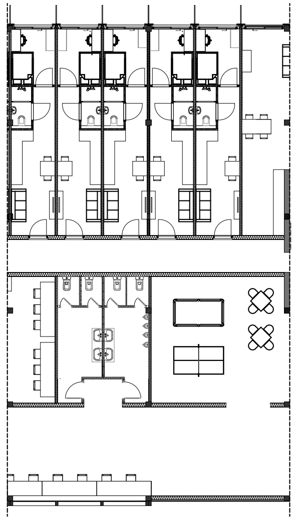


ATRIUM ROOF

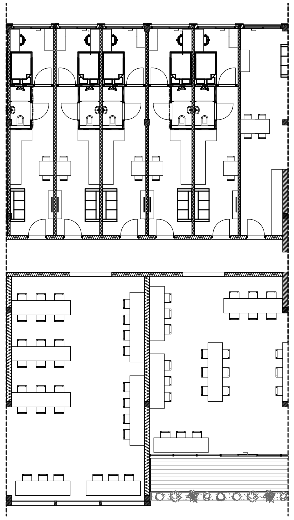
The roof above the atrium is not part of the main system, but it does fit within the demountable story. The roof is designed in prefabricated sections that are laid together and connected from the bottom. After placing the elements, a profile is pressed on top of the two gutters to provide waterproofing. The strips have a 10mm/1m slope so that the water can drain away to the sides. Lastly, the roof is fitted with sun blinds.



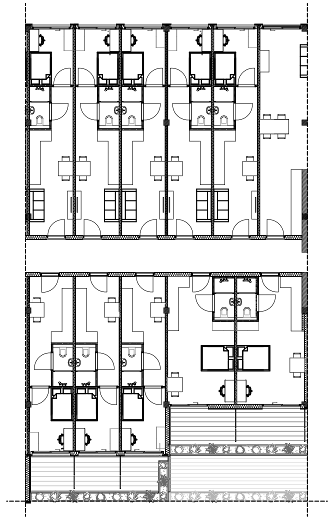
APPENDIX 1: STUDENT BUILDING



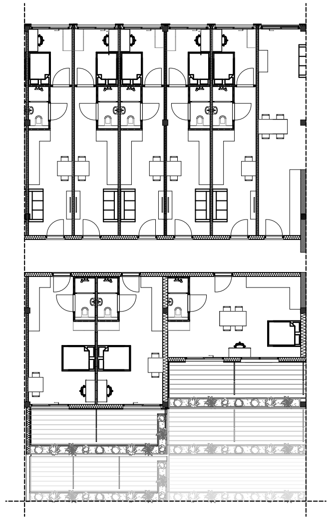
GROUND FLOOR



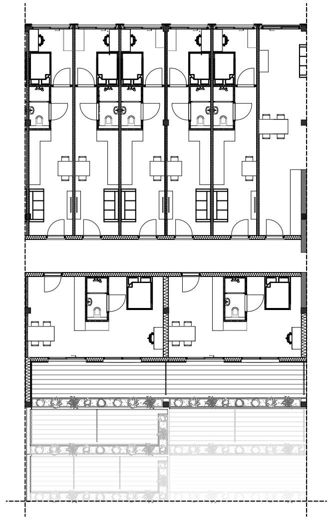
FIRST FLOOR



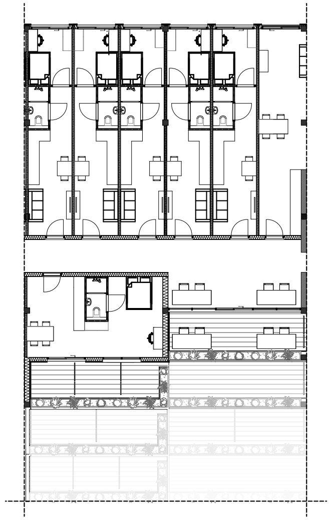
SECOND FLOOR



THIRD FLOOR

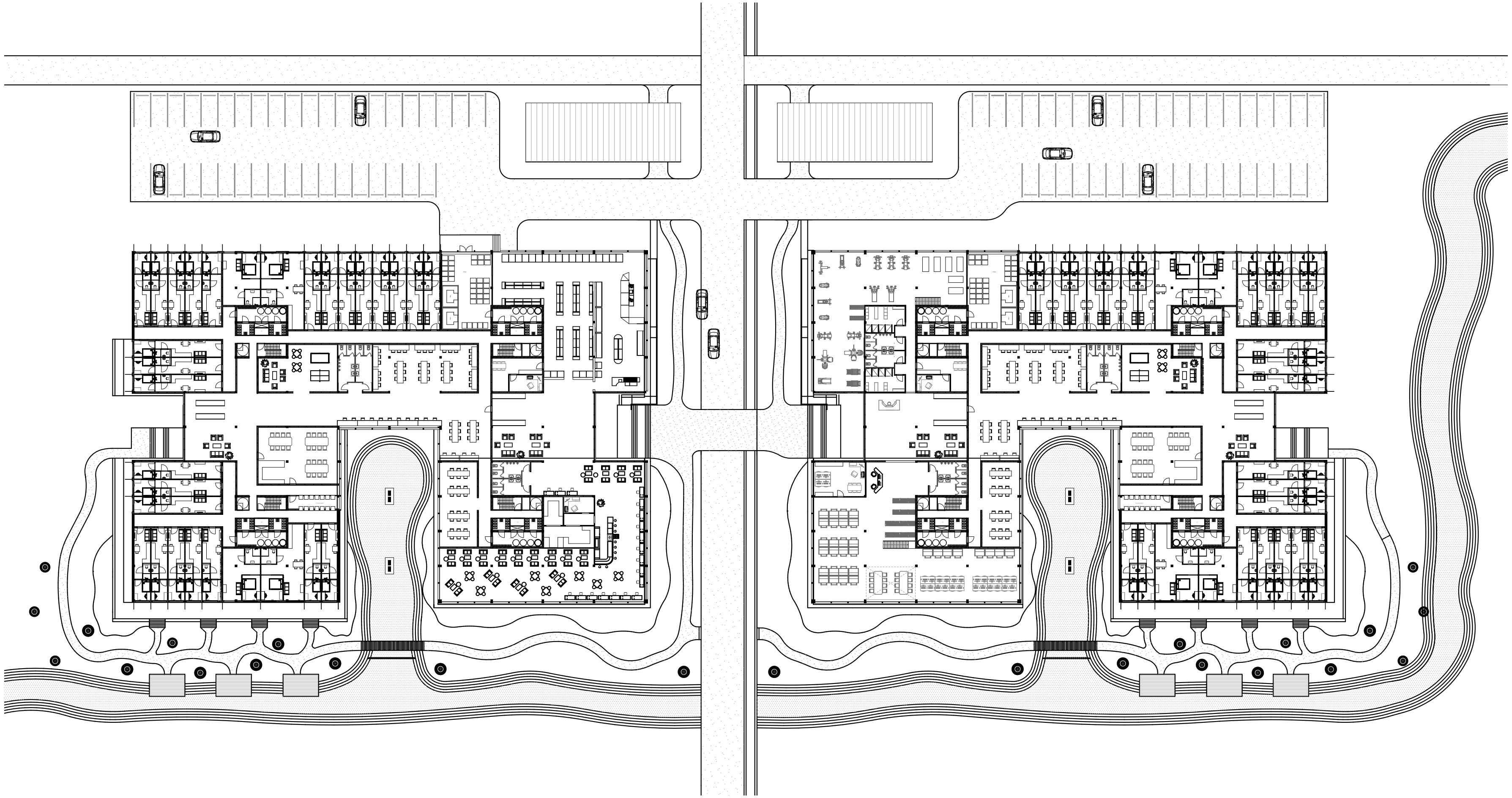


FOURTH FLOOR

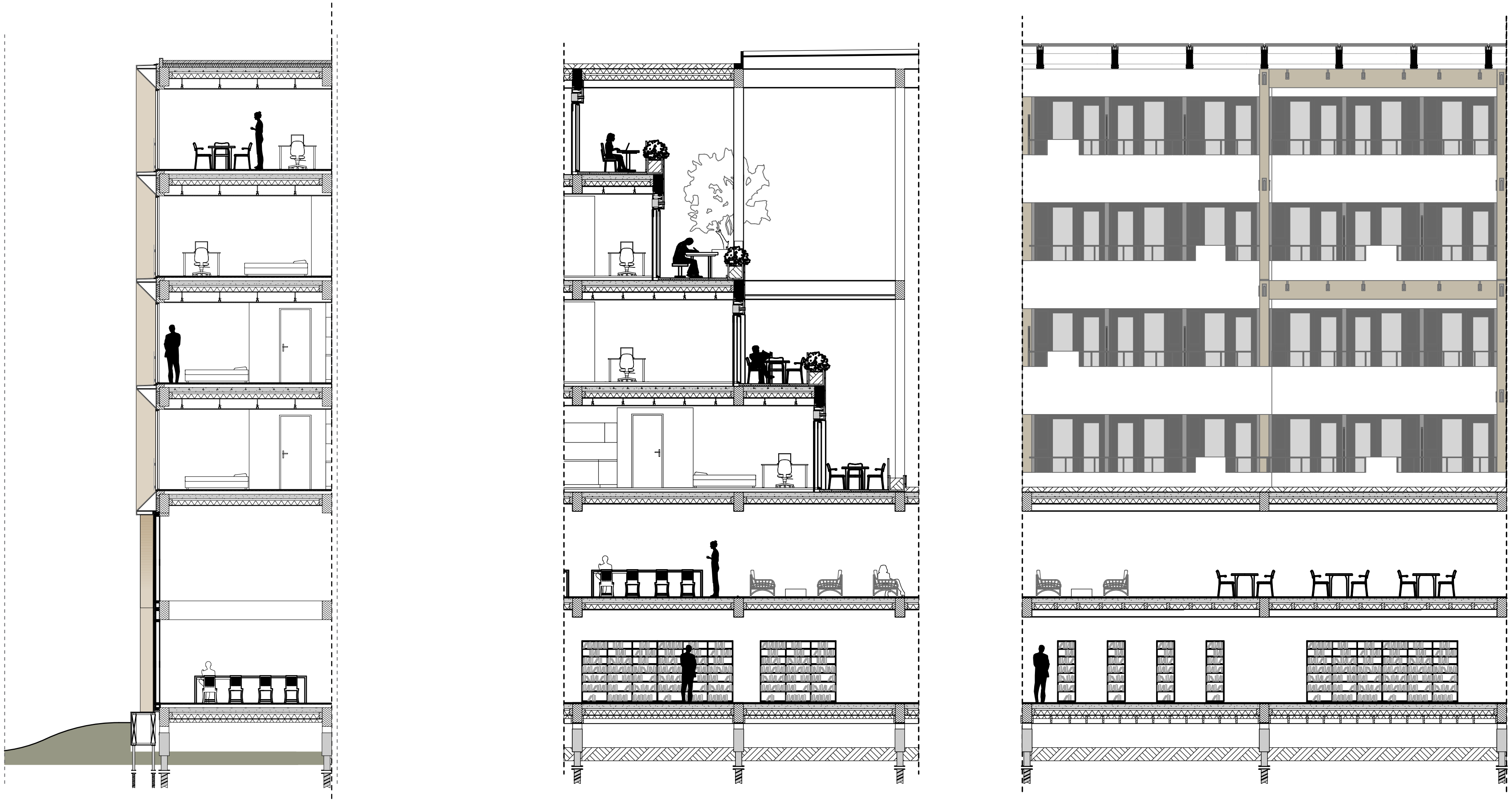


FIFTH FLOOR

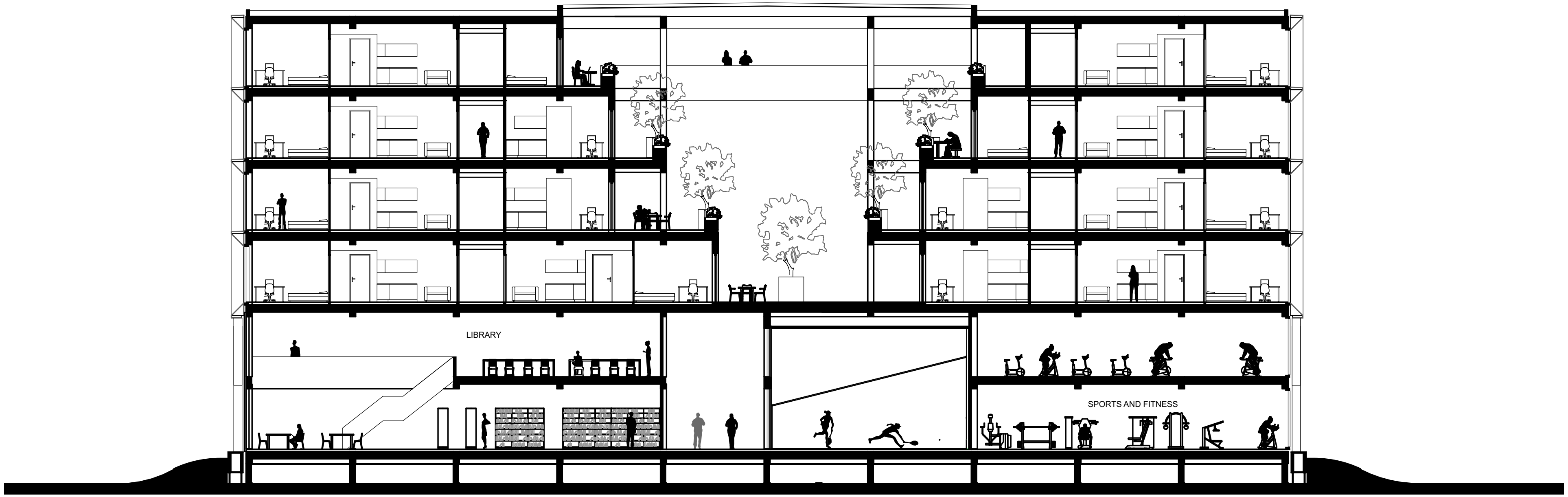
FLOOR PLANS (SECTION A-A)



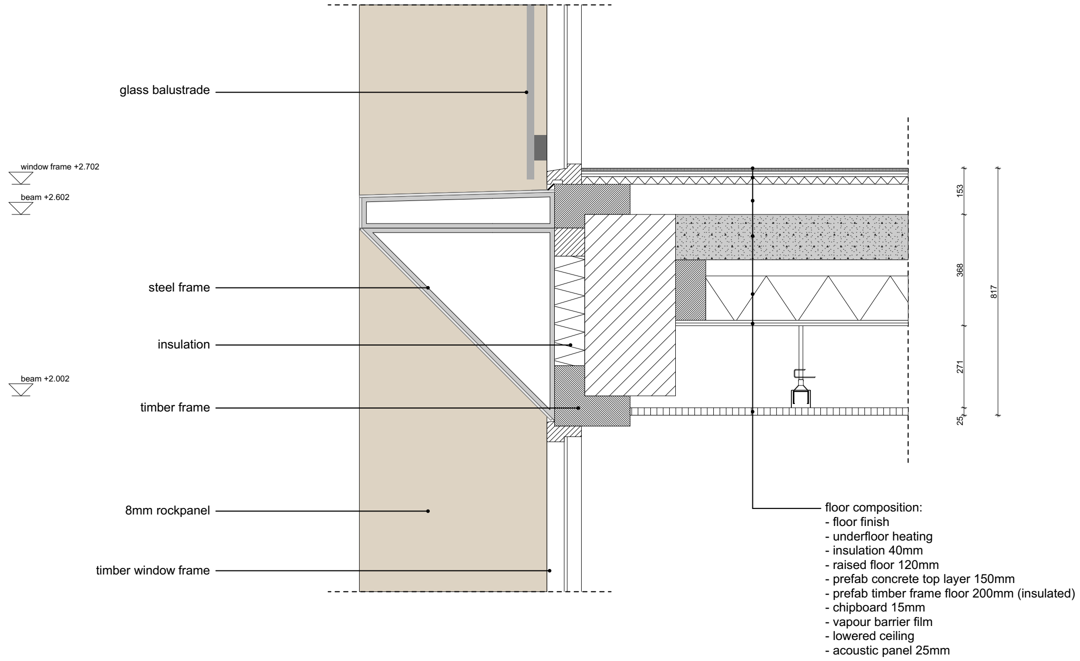
GROUND FLOOR

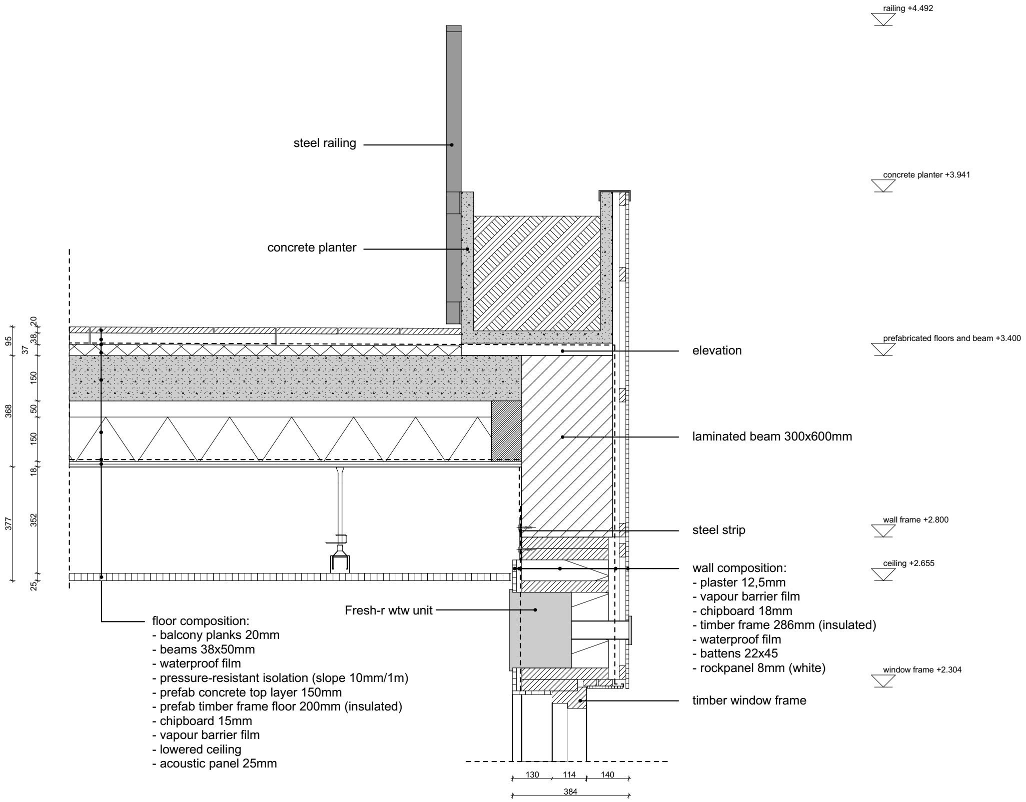


FACADE FRAGMENTS



SECTION B - B


glass balustrade
window frame +2.702
beam +2.602
steel frame
insulation
beam +2.002
timber frame
8mm rockpanel
timber window frame
153
368
817
271
25
floor composition:
- floor finish
- underfloor heating
- insulation 40mm
- raised floor 120mm
- prefab concrete top layer 150mm
- prefab timber frame floor 200mm (insulated)
- chipboard 15mm
- vapour barrier film
- lowered ceiling
- acoustic panel 25mm


railing +4.492
steel railing
concrete planter
concrete planter +3.941
elevation
prefabricated floors and beam +3.400
laminated beam 300x600mm
steel strip
wall frame +2.800
ceiling +2.655
wall composition:
- plaster 12,5mm
- vapour barrier film
- chipboard 18mm
- timber frame 286mm (insulated)
- waterproof film
- battens 22x45
- rockpanel 8mm (white)
window frame +2.304
timber window frame
Fresh-r wtw unit
floor composition:
- balcony planks 20mm
- beams 38x50mm
- waterproof film
- pressure-resistant isolation (slope 10mm/1m)
- prefab concrete top layer 150mm
- prefab timber frame floor 200mm (insulated)
- chipboard 15mm
- vapour barrier film
- lowered ceiling
- acoustic panel 25mm
130
114
140
384

DETAILS

EXTERIOR DESIGN

ATRIUM

ATRIUM


ATRIUM

STUDY AREA


STUDY AREA

STUDY AREA

ATRIUM WITH STUDIO´S (2025)

POSSIBLE FUTURE DESIGN (2035)

DOUBLE STUDIO

OFFICES


SINGLE STUDIO