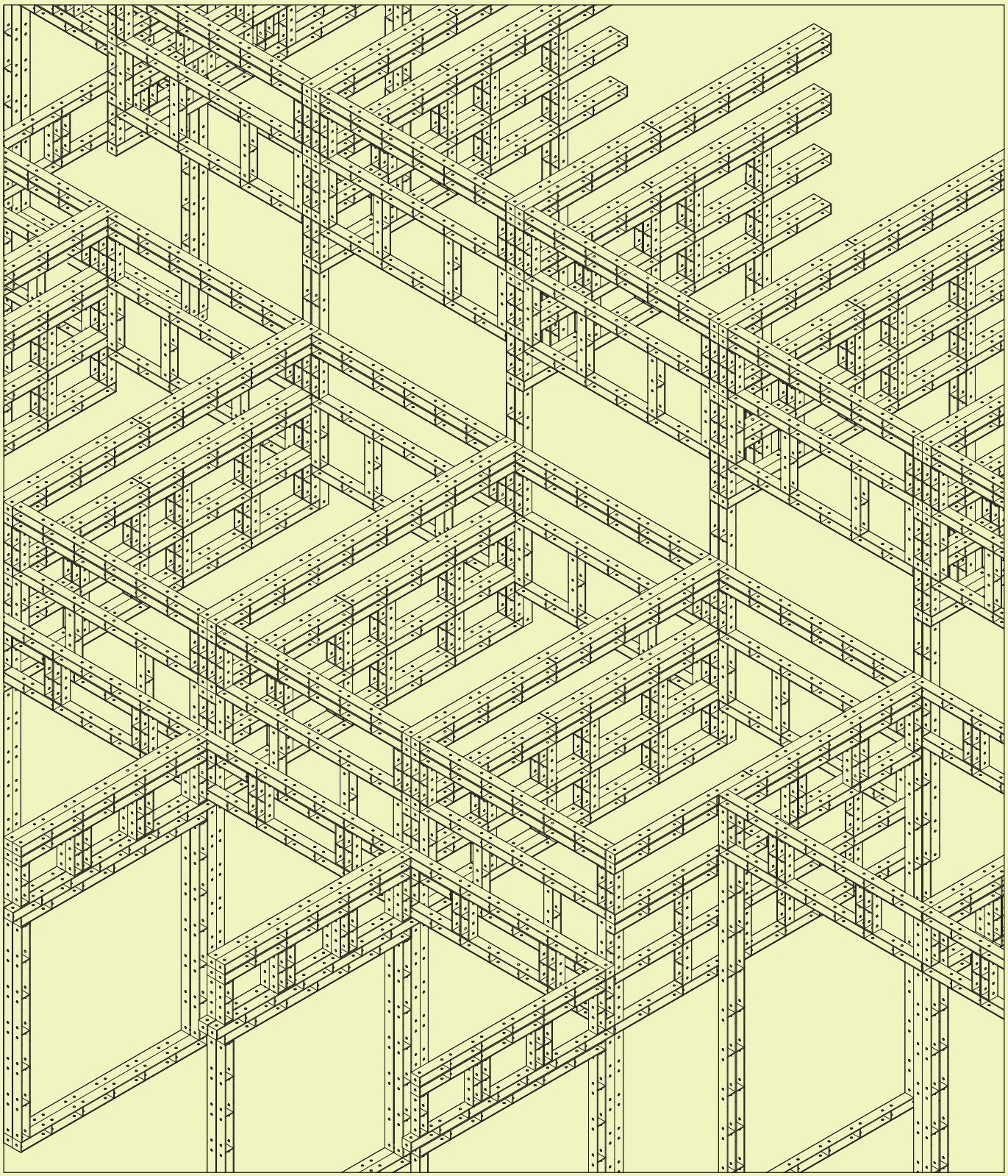
Tectonics & disassembly



Augusta Blohm

Tectonics & disassembly

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Augusta Blohm

Examiner: Per-Johan Dahl

Supervisor: Gediminas Kirdeikis

Contents

Abstract

The construction of a building does not always work the way it appears to work. Within a theoretical framework rooted in writings by Eduard Sekler, Karl Bötticher and Martin Heidegger, this thesis presents a discussion on the importance of the tectonic expression when designing a building with the intent that it should be easy to disassemble. Is it enough to make a building dismountable, or does the building also need to appear to be dismountable?

I have designed a dismountable art gallery. With the help of a list of four core principles of design for disassembly, I try to navigate the process of purposely trying to emphasize specific construction aspects. Quickly, it becomes apparent that the tectonic expression should in fact be able to make a building easier to disassemble. The easier it is to understand how forces act on the building, and how different building elements can be taken apart, the easier it will be to disassemble it. But are these practical uses for tectonics all there is? What about "impractical" values, such as expressing moods and creating atmosphere?

Sekler, whose definition of the word tectonics lays the foundation of the thesis, argues that the most successful architecture cannot be designed through conscious control. Is trying to express disassembly not an attempt at taking conscious control? Can it be guaranteed that the building ends up expressing what it needs to express for it to be easy to disassemble?

In conclusion, it appears as though the value of tectonics for design for disassembly depends on which core principle the particular design desicions are referring to, and what part of the building is being designed.

Research question

How can a building's disassembly potential be expressed? And is this important when designing for disassembly?

Method

Alongside a theoretical investigation, I will design a building that can be disassembled. I will try to find ways to give the building a tectonic expression of its potential to be disassembled.

Aim

- To develop a deeper understanding of the concepts tectonics and design for disassembly.
- To add to established theoretical discussions on the topic of tectonics, by exploring how tectonics might relate to design for disassembly.
- To explore how to design with the specific tectonic intention of creating an expression for disassembly.

Part 1: Introduction to Theory

Defining tectonics

The word tectonics comes from the Greek word tekton, meaning builder or carpenter which is related to the Sanskrit word for carpentry, taksan (Frampton 1995). Tectonics has been used in discussions about architecture since 1830, when Karl Otfried Müller's *Handbook of the Archaeology of Art* was published. His use of the word was criticized from an etymological standpoint (Frampton 1995). Since then, the meaning of tectonics has been debated.

In 1965 Eduard Sekler provided a proposition a for a definition of tectonics, by comparing it to the concepts structure and construction (Sekler 1965). According to Sekler, structure refers to an ordered arrangement of constituent parts and construction refers to the concrete realization of a principle or system (ibid.). Tectonics is then defined as follows:

> "When a structural concept has found its implementation through construction, the visual result will affect us through certain expressive qualities which clearly have something to do with the play of forces and corresponding arrangement of parts in the building, yet cannot be described in terms of construction and structure alone. For these qualities, which are expressive of a relation of form to force, the term tectonic should be reserved." (Sekler 1965 , p. 89)

My understanding of this is that structure can be described through physics as a vector diagram of how forces act on a building. Construction can be described through more practically applied engineering as a set of calculations taking into consideration dimensioning and the specific material qualities and how these respond to specific loads present in the building. Finally, tectonics can be defined as how the structure and construction seem to work based on what the building is expressing though its form.

Sekler's definition of tectonics was inspired by Karl Bötticher who suggested some similar ideas about the relation between expression and construction in his trilogy The Tectonic of the Hellenes, published between 1843 and 1852 (Sekler 1965). Bötticher suggested that building elements at a conceptual level have a "core-form" which consists of whatever is mechanically necessary and statically functional, as well as an "art-form" which is the means of how the core-form is expressed (Frampton 1995). According to Bötticher, the role of the art-form is to symbolically enhance the core-form (ibid.).

For the sake of this project, I am defining design for disassembly as a construction principle dealing with some mechanically necessary aspects of a building, and I am setting out to explore how an art-form could enhance these aspects.

The architect's intention

Bötticher implies that the architect should have a specific intention with the art-form; to create an expression of a building's core-form. A similar idea is expressed by 18th century art critic Etienne La Font De Saint-Yenne: "It is not enough to make a building solid, judgment must estimate it as such" (Sekler 1965, p. 90).

This statement stresses the importance of the experience of the people who will be "observing" the building, while designing a building with a specific, predetermined tectonic characteristic (solidity). Bötticher's indication is that the architect should work intentionally with creating a tectonic expression, and that this fails if they do not succeed in making "the judgement" read the end result as they initially had intended.

An alternative design approach could be to work more intuitively, without specific tectonic intentions. Such a building would still end up with a tectonic expression according to the definition of the term as proposed previously, only that the architect would give up some control of what the building expresses. Sekler seems to promote this type of design principle:

> "Both in creating and judging architecture those attempts will be most successful which are nourished from and return to a fullness of being that is no longer wholly subject to conscious control or completely amenable to intellectual analysis" (Sekler 1965, p. 95)

Architecture that is created as a subject of conscious control will not be the most successful, according to Sekler.

The observers' judgement

If tectonic expression is given legitimacy by the judgement of those that observe the building and receive the impression of its tectonic qualities, it becomes difficult, maybe even impossible, to scientifically determine what a building's expression is. Whose judgement was La Font De Saint-Yenne referring to? Is he indicating that when evaluating a building, everyone will achieve the same impression? Either way, I struggle to imagine how this data would be collected. Maybe this is what Sekler is referring to when he claims that successful attempts at judging architecture will not be completely amenable to intellectual analysis?

I assume that this interpretation of "the judgement" is not what La Font De Saint-Yenne had in mind. Instead, I think the idea of tectonics as something that is experienced by the judgement is based on the belief that there is a canon of how architecture is experienced, and that most people will interpret a building in a similar way. I find the notion of the canonical impression of architecture interesting, but I doubt it is true. Even if it is, how would I be able to apply this in my design process?

Tadao Ando provides the following suggestion for how to go about designing something timeless and universal, by using the human body as a common point of reference:

> "Since man has an asymmetrical physical structure with a top and a bottom, a left and a right, and a front and a back, the articulated world, in turn, naturally becomes a heterogeneous space." (Frampton 1995, p. 11).

Ando indicates that space, and architecture as an extension of that, is experienced similarly by everyone, because of the way we experience the world through our bodies. This could mean that by giving form to a building by relating tectonic intentions to the body, it could be universally estimated to be the same expression. A criticism of using "the body" as a universal reference point in architecture is of course that everyone has a unique body, and how we interpret our bodily experiences probably vary. The specific examples Ando raises however, about how a body has "a top and a bottom, a left and a right, and a front and a back" I think might, despite how bodies differ, be so general that they can be classified as universal human experiences. Maybe this is the key to designing for "the judgement"?

What is a tectonic expression, and does it matter?

To gain a better understanding of tectonics, I turn to philosophy. In Martin Heidegger's essay *What is a Thing?* a thing is defined as "the existing bearer of many existing yet changeable properties" (Heidegger 1967, p. 34). Some examples of things as listed in the essay include a rock, a plant and an animal. Based on this logic, I say that a building is a thing. Heidegger continues to describe things by introducing the idea of qualities:

> "A thing is always something that has such and such properties, always something that is constituted in such and such a way. This something is the bearer of the properties; the something, as it were, underlies the qualities. This something is what endures, and we always return to it again as the same when we are in the process of determining the qualities." (Heidegger 1967, p. 33)

As I am reading this text and imagining the "thing" that is talked about as a building, Heidegger's description of properties resembles Bötticher's description of the core-from. Similarly, I am thinking that what Heidegger refers to as qualities could include tectonics, which aligns with Sekler's definition about how tectonics is a result of the implementation of the construction.

Assuming this, the notion of endurance becomes interesting. The core-form endures, whereas the tectonic expression does not. Given that the disassembly potential has been defined as a core-form property, it appears as though the core-form might be more important than the art-form. Is the core-form what really matters?

Design for disassembly

The meaning of design for disassembly is perhaps self-explanatory, defined in the book *Building a Circular Future* as a "holistic design approach where the intention is to make any given product easy to disassemble into all its individual components" (Guldager Jensen & Sommer 2018, p. 34). The main driving force behind designing for disassembly is generally to avoid wasting resources, either financial or environmental.

Design for disassembly is an old concept. Reusing building material is economic and practical, and it has been known to be used during times of scarcity of building materials (Guldager Jensen & Sommer, 2018, pp. 22-23). Dismountable timber constructions have been used in many cultures across the world for hundreds of years (ibid.). Since the industrial revolution, steel has been used for many dismountable constructions. One such example is Crystal Palace, built in 1851 (see page 14).

Though it has been used throughout history, the importance of design for disassembly has increased because of the urgency of climate change. Governments and global organizations are stressing the importance of developments in circular economies and less wasteful consumption patterns (Guldager Jensen & Sommer, 2018). The demand for construction is estimated to increase by 70% in the coming 10 years globally, even though the construction sector already is the source of 40% of energy used in Europe and 35% of materials used globally (ibid.).

I believe that architects alone are not going to find the smartest technical and economical solutions for increased ease of reusing building materials. Reorganising the building sector requires many different types of expertise.

Even though building materials are already being recycled, for the sake of the environment this needs to be done to a larger extent. This is perhaps more an organisational problem than a matter of architecture. Another problem when it comes to reusing and recycling building elements is that they are often "down-cycled", meaning that they are less useful in their reused or recycled form than when they were used as how was originally intended. Both problems could be helped by engineering smarter ways to construct buildings, to make disassembly easier, as well as to improve the quality of recycled products. Once again, I feel as though architects are not the ideal expert to take on the challenges.

For this thesis, I have been trying to focus what I believe is the most important aspect of circularity and design for disassembly for architects: to suggest ways to arrange reusable building elements in meaningful and qualitative ways. With this, I want to emphasize that this thesis does not set out to investigate how to reorganise the building sector, or how to find smart new technical solutions. It is to explore the relevance of tectonics, with the aim to suggest an interesting dismountable system of reusable elements, and a building that can be made using that system.

Since I have no practical experience with design for disassembly, I have studied literature on the topic. This has helped me form an understanding of what it means for a building to be easy to disassemble. For the sake of this thesis, I have compiled a list of four core principles that I suggest define what makes a building dismountable.

Four core principles of design for disassembly

The following list has been complied by me, as a selection of some principles listed in the book *Design for Disassembly in the built environment: a guide to closed-loop design and building* (King County Solid Waste Division 2006).

- ***Simple structure and form***

The structure should be simple and compiled of repeated components of the same size (ibid.).

- ***Interchangeability***

Building components should be able to be switched (ibid.). A modular building principle is helpful for this.

- ***Accessible connectors***

Visually, physically and ergonomically accessible connections simplifies the disassembly process (ibid.).

- ***Spaces and building elements suitable for practical disassembly on site***

Disassembly should be able to occur without obvious hindrances (ibid.). If for example a building element on the second floor is disassembled and should be taken out of the building, does it fit in the staircase and through the door?

The value of tectonics for design for disassembly

The practical value

Going back to the two differing views on the matter, it could be argued that either it is not enough to make a building dismountable, and that judgment must estimate it as such. Or it could be argued that it is enough to make a building dismountable, because this is what endures. The design for disassembly principles seem to indicate that the former is more accurate than the latter.

The visual accessibility of connectors call for the core-form to be expressed though the appearance of the building. The connectors should not just be there, it should be apparent that they are. It is important that the art-form expresses the core-from. Furthermore, for the sake of disassembly, it would be impractical if a structure appears to be complex, even if it is simple at the core-form level. Although such a building could still be disassembled, the appearance of complexity would make this harder. Once again, it is important that the art-form matches the core-form. Already, I feel as though the question about whether the tectonic expression when designing for disassembly matters has been answered: yes, it matters because it has practical value for the disassembly process.

The impractical value

Neither Sekler nor Bötticher talk about tectonics as a tool to make buildings more practical. Still, they claim it is important. Bötticher refers to it as the art-form. The value of art is different than the value of the practical. Can tectonics enrich design for disassembly by making it exciting? Playful? Impressive? I get the sense that these "impractical" values should not be underestimated.

Design FOR disassembly – an inherent intention?

Keeping the art-form close to the core-form seems to be what is practical for disassembly. This is also what Bötticher advocated for. He also expresses concern of the risk of the art-form not expressing the core-from. In the case of disassembly, I am thinking that this could mean that a building that technically can be disassembled might appear as though it cannot. Similarly, a building that cannot be disassembled could be made to appear as though it can.

This makes Sekler's criticism of the intention difficult. Without the intention to express the core-form through the art-form, is the risk not larger that the art-form ends up not aligning with the core-form? What if a building is designed so that it can, at a core-form level, be disassembled, but it ends up not appearing to be that way at all? What if the connectors are all hidden, and the structure appears complicated? This goes against some of the design for disassembly principles, and I would argue that such a building was not designed for disassembly at all. There is an inherent intention within the concept design for disassembly. There can be intuitive design, or even intuitive disassembly, but intuitive design for disassembly sounds like an oxymoron.

Crystal Palace

Crystal Palace was designed for the great exhibition of 1851 by gardener/architect Joseph Paxton (Merin 2013). At the time, iron was a relatively new building material, and architects were experimenting with an increased use of glass (Frampton 1995). Paxton had been developing a construction technique for glass buildings, using prefabricated cast iron elements and glass of a standardized measurement (Merin 2013).

Because of the temporary nature of the exhibition, the palace was constructed with the fabrication, transportation, and disassembly of the individual building elements in mind (Frampton 1995). The design was based around a 2.5m cladding module, with spans varying from 7 to 22m (ibid.). These measurements were based on the practically imposed rules that no element should weigh more than one ton, for the ease of assembly, and that glass panels should be as large as possible, because that would turn out cheapest (ibid.).

Since each module was self-supporting, the assembly allowed for flexibility at the construction site (Merin 2013).

After the exhibition, Crystal Palace was dismounted and rebuilt in another area of London, Sydenham Hill (Merin 2013). It was ruined in a fire in 1936 (ibid.).

In regards to it's tectonic expression, Crystal palace is striking as a megastructure built up of a seemingly endless repetition of similar modules. The arch roof breaks the pattern of the repeated modules. It's shape and scale seem customized to the project and appears as though it would be difficult to disassemble and even harder to reuse.

Overall, the scale of the building is huge, whereas the details (including the individual building elements and the connections) are in relation very small. This gives me the impression that disassembly would be time consuming.

Each module apears to have a top, a middle and a bottom part. The top and bottom sections create long horizontal lines in the facade. The top parts all have an arch which highlights the vertical direction of forces. The bottom part appears solid and heavy, and it rests on top of the small decorative circle above the arch of the module below. I associate the circle and the arch to the strength of eggs in the vertical direction, and they appear to stabilize the overall structure.

Generally, the expression of Crystal palace seem to align with the design for disassembly checklist previously presented.

Nakagin Capsule Tower

Nakagin Capsule Tower, the first built example of capsule architecture, was designed by architect Kisho Kurokawa and built in Ginza, Tokyo in 1972 (Kisho Kurokawa architect & associates no date). The tower was made as a prototype representing the principles of the Metabolist movement: metabolism, exchangeability, and recyclability (ibid.).

The tower is made up of a concrete core, to which 140 capsules are attached by four high-tension bolts each (Nakagin Capsule Tower no date). In total, the tower ranges from 11 to 13 capsules in height, arranged at various 90-degree angle orientations (ibid.). Each capsule measures 2.3 m × 3.8 m × 2.1 m, and the idea was that capsules could be combined to create larger spaces (ibid.). The capsules are made of a lightweight steel frame and equipped with built-in furniture (ibid.).

The Metabolist movement was a small group of architects in postwar Japan, centered around the philosophy of famous modernist Kenzo Tange and loosely influenced by Marxist ideals (Pallardy & Tikkanen 2019). In 1960, they released their manifesto Metabolism: The Proposals for New Urbanism in which they promoted the idea that the built environment's development should mimic processes of biological growth (ibid.). Amongst other things, the group developed a new masterplan for the development of Tokyo, and proposed various megastructures inspired by processes found in nature (ibid.).

A central part of the initial concept was that the capsules were going to be disassembled from the core and replaced routinely, but this never became reality (Crook 2022). The tower was demolished in 2022 (ibid.).

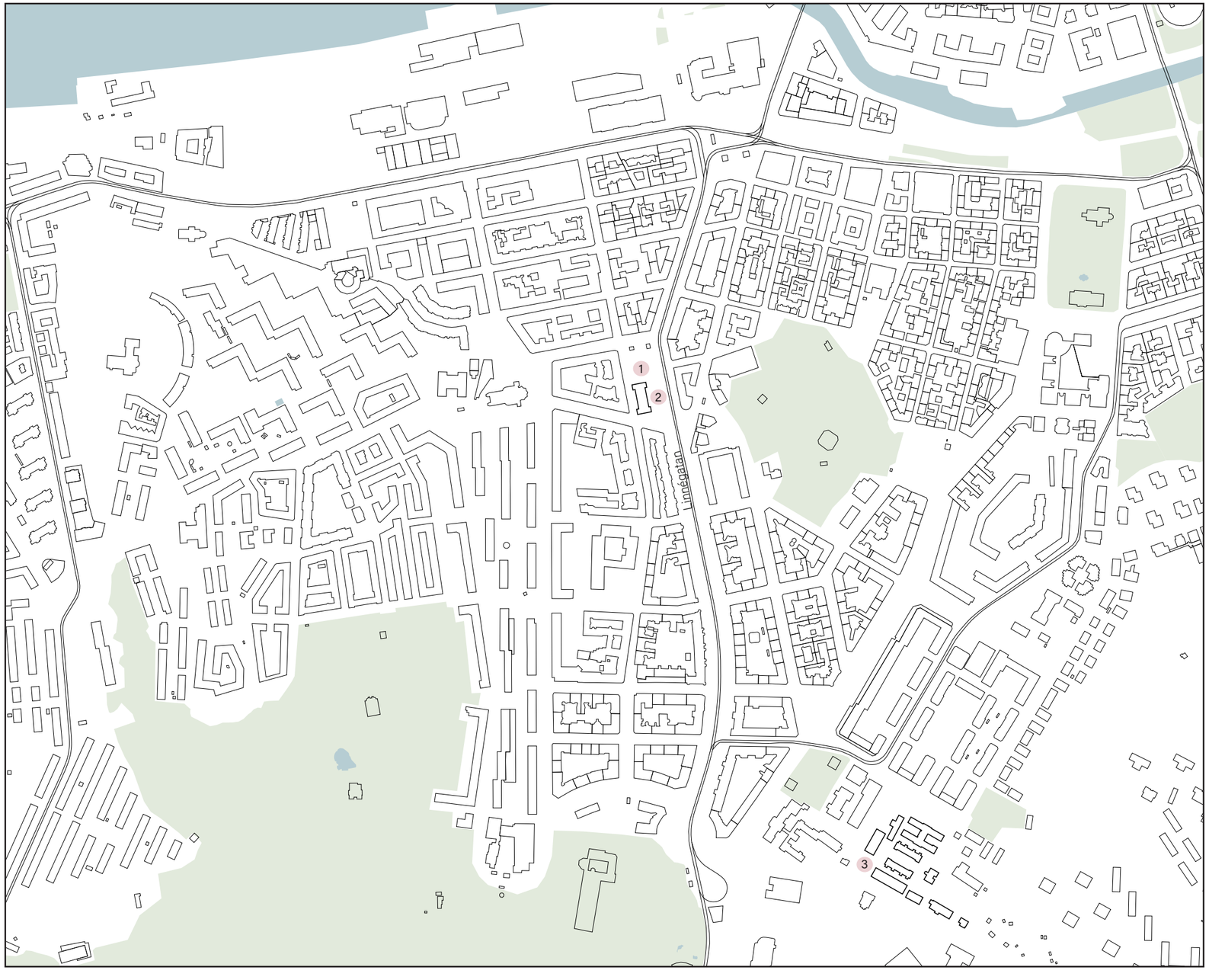
The gap between each capsule indicates that they do not depend on each other for support, which speaks of the specific disassembly concept of the project. Behind the capsules, the core emerges. The red color emphasizes its importance for the building. The smooth surfaces and lack of visual connectors mystifies the relationship between the core and the capsules. By looking at the building, it is not clear how the capsules could practically be removed.

The interior of the capsules is made up of elaborate built-in furniture. It's the opposite of what the design for disassembly checklist is promoting. The interior, along with the large, smooth exterior surfaces is expressing that not all the building components of the tower can be disassembled.

Part 2: Context and Program

Kv 1 Plantaget

I am working at a site along Linnégatan in Olivedal, Gothenburg. Directly south of my site is a building called Viktoriahuset. The building, designed by architect Bror Viktor Adler, was built in 1875 and thus became the first brick building in the area (Föreningen Viktoriahuset no date). It was used as a school from when it was built until 1975 and the site that I am working with was used as a school yard (ibid.). My site is now a parking lot. Since the school shut down, Viktoriahuset has been changed internally, but the external appearance is in many ways preserved (Lönnroth, Ander & Lundgren 1999, p. 188).



1. The site
2. Viktoriahuset
3. Konstepidemin

Building and demolishing along Linnégatan

City plans for the area, including the new boulevard Linnégatan, were developed in the 1800s (Lönnroth, Ander & Lundgren 1999). Where Linnégatan is today, there used to be a stream, Djupedalsbäcken (ibid.). The stream was culverted and the buildings along Linnégatan were constructed between 1895-1930 (ibid.). Some of these buildings were eventually damaged by settlement and were demolished and replaced with more modern buildings in the 1970s and 80s (ibid.). This has left a significant impact on the area. Some of the houses that were demolished in areas near the site were never replaced, and there has been debates regarding potential reconstruction of those original buildings (Lisinski, Krabo & Johansson 2018).

Original buildings and buildings from after the demolitions. Photos are taken at the site.

Early photo of Olivedal, Viktoriaskolan to the right (Prinsgatan 1900 early 1900s).

Although the area is attractive today, it received some rather harsh criticism around the time it was built. An architecture critic wrote a reflection of the doom of permanence of the architecture in this new part of the city in 1919, in which he expressed concern over the speed at which the area had been built, and that it might be there for centuries, as a colossal monument in stone over the recent architectural trends (Fredberg 1919-1922, p. 503).

Design for disassembly for resilient urban architecture

This area (like most urban areas) has been built and demolished and then rebuilt again. It has been appreciated and criticized. This makes me wonder what would have happened if the buildings along Linnégatan had been designed for disassembly. What if, when those buildings were damaged, instead of demolishing them and building new buildings, the damaged parts could be replaced with new parts while the rest remained the same? Or if those buildings from the 80's had been designed for disassembly, maybe they would have been disassembled now and replaced with copies of the original buildings? Maybe, had many people shared the sentiments of the man from 1919 who criticized the area, all buildings in the area would have been short-lived if they could easily be disassembled. Maybe they had been replaced with something better? Or something worse?

I think there are three main consequences of design for disassembly at the scale of the city:

1. There will never be a need to demolish – buildings can be repaired and adjusted forever.
2. Removing a building will be a less permanent action. If a situation calls for it, a building can be there for a while, then be removed, and then come back in its original form. Building elements can be saved for future reassembly.
3. Building a building will be less permanent. If it ends up unpopular or problematic, removing it is easier than demolishing it.

Because of this, I believe design for disassembly has the potential to change people's perception of permanence of the built environment. Cities can become resilient against decay. In future cities designed for disassembly, all good buildings can be kept forever. Those that turn out to not be good can be removed, and the building element can be used for something else. Maybe that could motivate a bigger investment in creating quality architecture?

Art at the site

I am suggesting this site is suitable for an art gallery. Near my site, there are two large culture and art establishments: Konstepidemin and Hagabion (inside Viktoriahuset) that could work as potential collaborating partners for exhibitions and art festivals. Furthermore, the area is full of people. Hopefully, the location could attract spontaneous visitors to the gallery since there are usually a lot of people passing by Linnégatan, and the popular tourist area Haga is nearby.

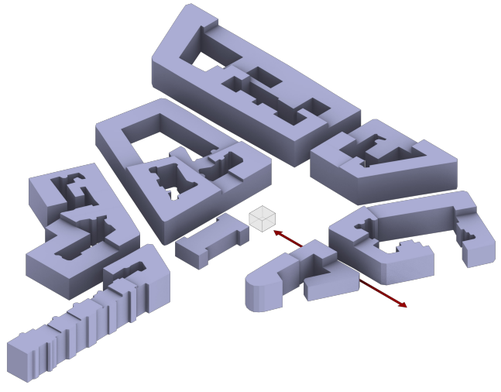
A dismoutable gallery

I am using the art-gallery program as a source of inspiration for thinking about disassembly. For each new exhibition, art might need to be displayed in different ways. Thus, it makes sense that exhibition spaces have some level of flexibility internally. Externally, the building does not have an especially frequent need for disassembly. This is something that I am trying to reflect to with my design.

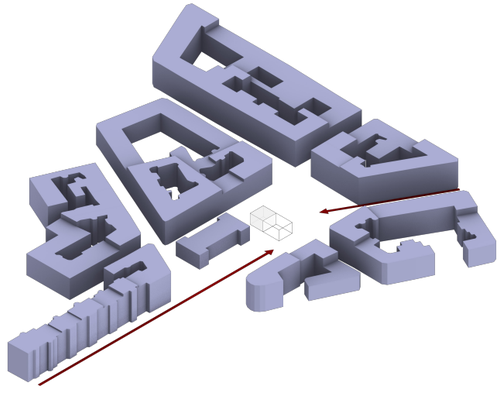
Furthermore, a gallery is a type of space where people might return as exhibitions change. I think this creates an interesting foundation for expressing disassembly. If the building changes between visits, is that enough to communicate to people that the building is, at least to some extent, dismountable?

Site strategies

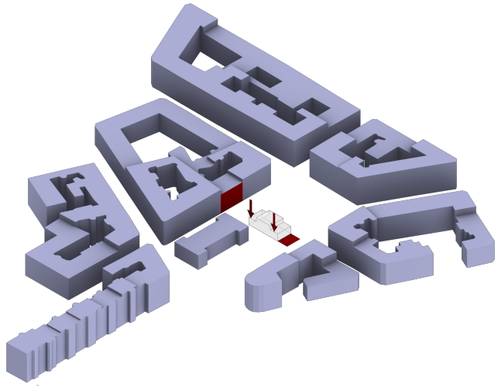
Even though dismountable buildings could have a short lifespan without major environmental and financial drawbacks, they might also have a long lifespan where disassembly could be used to repair the building. The lifespan of the building can only to some extent be decided in advance. Careful adjustment and integration to the site will be good either way. Therefore, I have tried to understand the site and design accordingly.



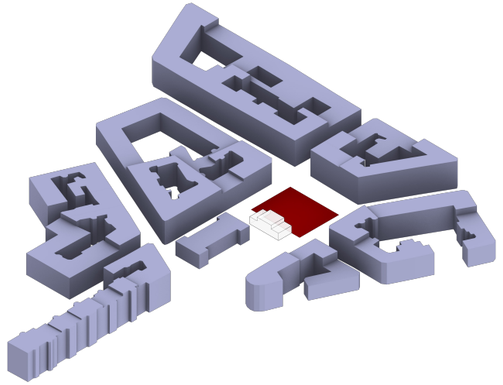
Align building with axiality



Elongate building to make it visible from Linnégatan in both directions and to frame the space in front of viktoriahuset



Lower the building height towards neighbouring building to avoid limiting their view and daylight access. Lower the building height in the opposite end of the building, to emphasise space in front of the facade facing Linnégatan.

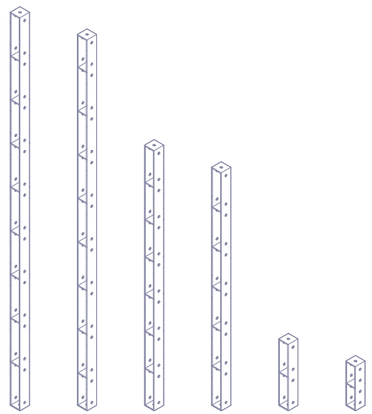


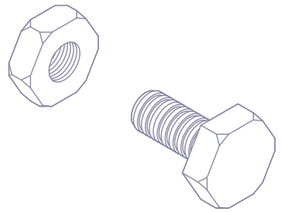
The site is too large for my project, so I leave space for other use

Part 3: Elements and Modules

steel frame kit

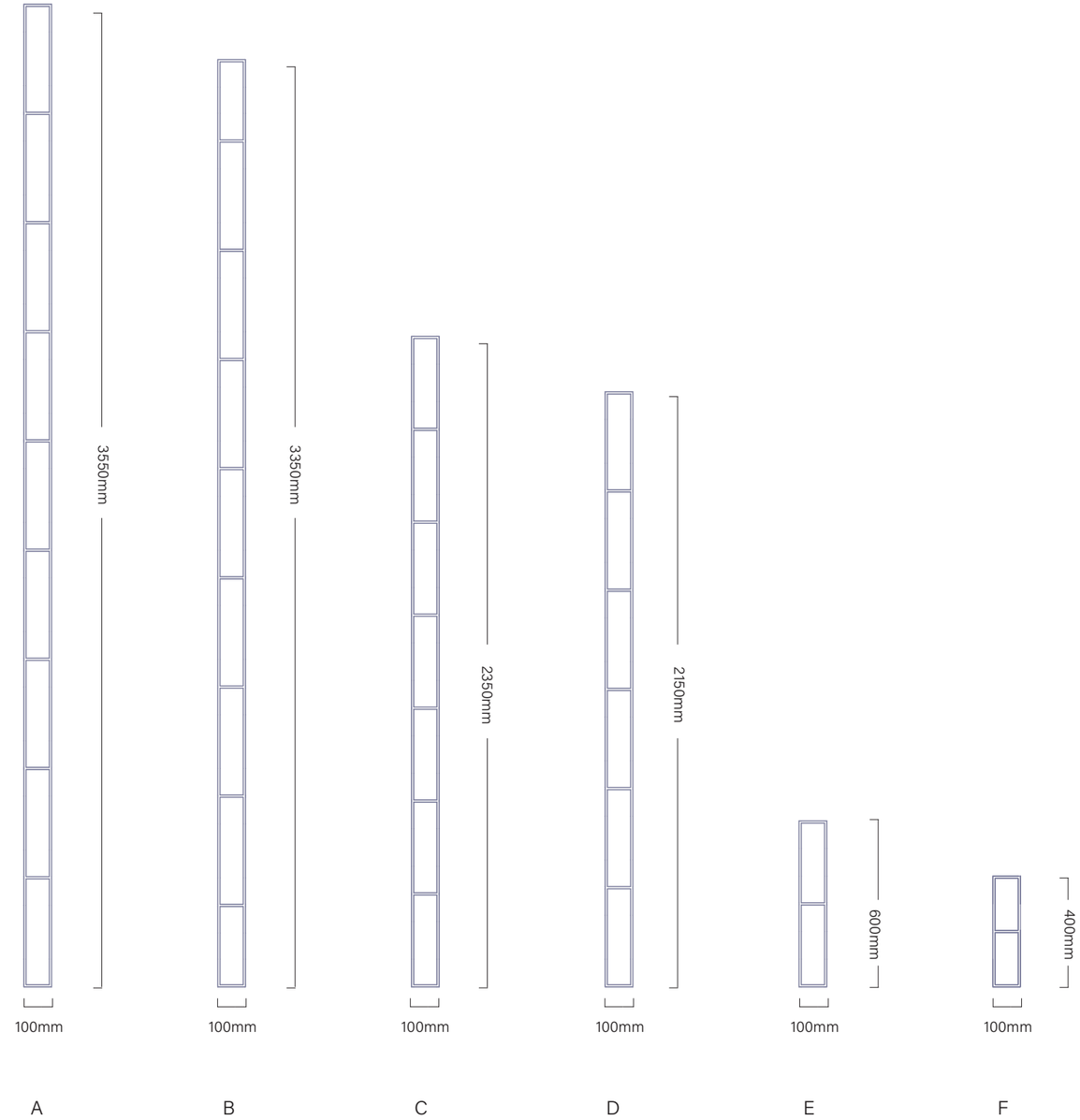
Simple structure and form





My first step in designing for disassembly has been to design a steel frame construction. As a way to make it dismountable according to the first design for disassembly principle simple structure and form, the steel frame consists of only six components. The components are of different lengths and have pre-drilled holes that can be used for attaching them together with bolts and nuts.

The steel elements



prototype

Simple structure and form

Testing the principle

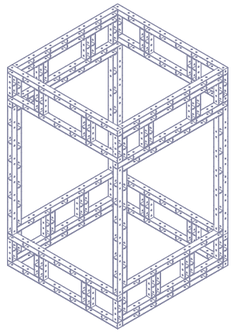
This prototype was made to test the method of attaching steel components together. The pieces can be put together in a lot of different ways, side to side, end to end or side to end, at right angle intervals.

The components are made of welded steel, and attached with hex screws and nuts.

modules

Simple structure and form

Modules made up of the steel elements

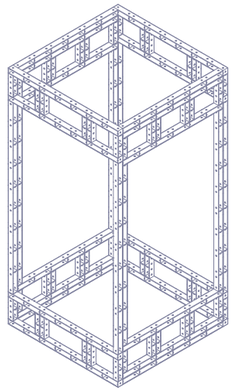


module 1

14 * C

16 * D

48 * F



module 2

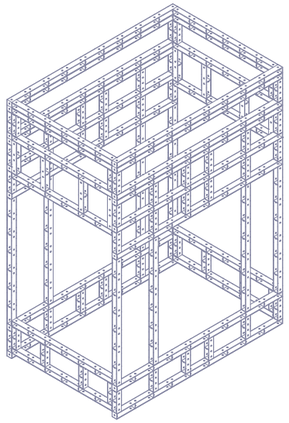
4 * A

4 * B

8 * C

12 * D

48 * F



module 3

16 * A

8 * C

12 * D

8 * E

52 * F

Using the six steel elements, I have created three modules: one short, one tall and one wide. The different modules represent some ways the components can be combined into bigger structures. Furthermore, multiple modules can be attached together to form an entire building.

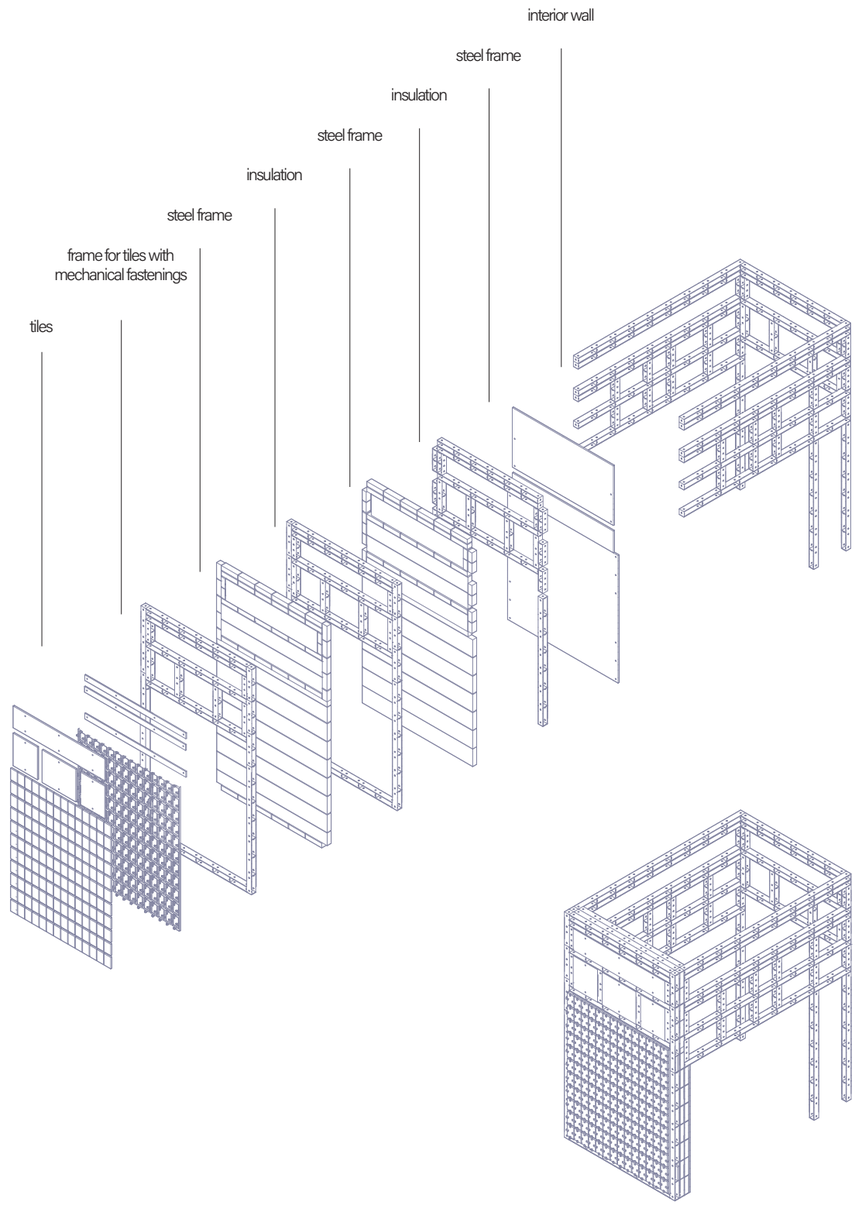
The modules serve as a framework to which walls, floors and other building elements can be attached. The idea is that different types of infill can be attached to the frame. The infill can be disassembled without dismounting the frame.

This is inspired by the construction of Crystal Palace, which was made up of self-supporting cast-iron modules as a framework for the glass walls and roof.

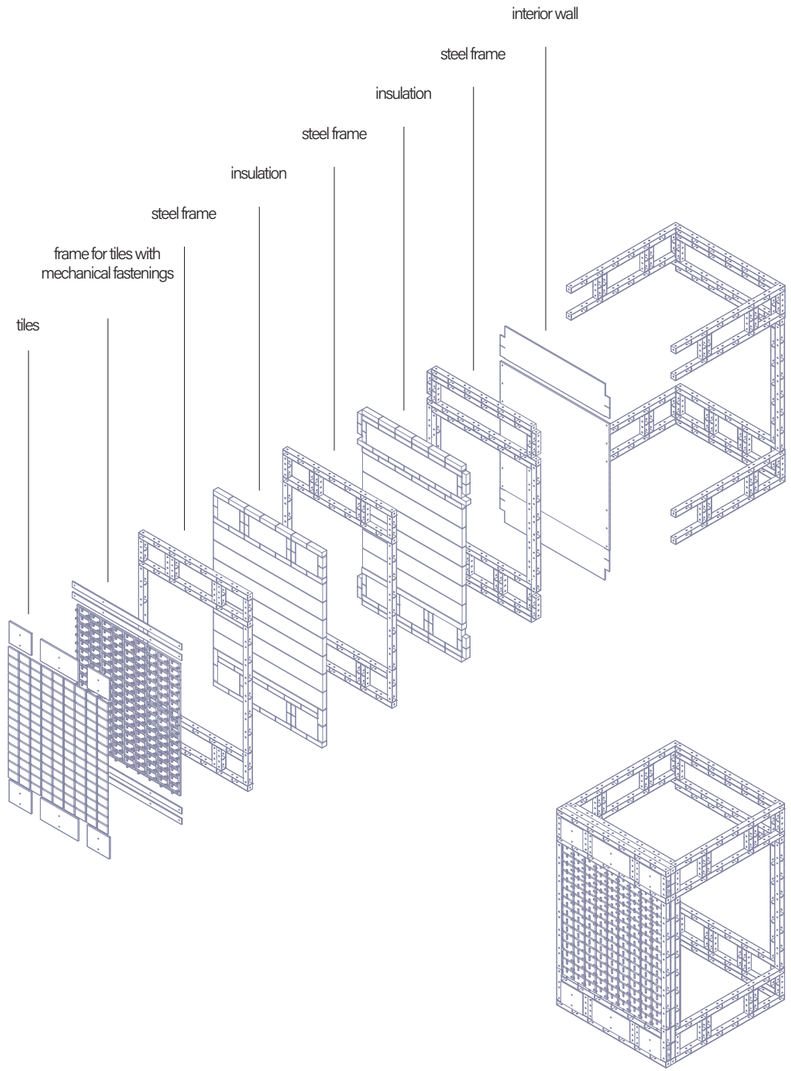
The modules can be used as elements of a three-dimensional grid that is meant to help me design a building that has a simple structure and form.

exterior cladding

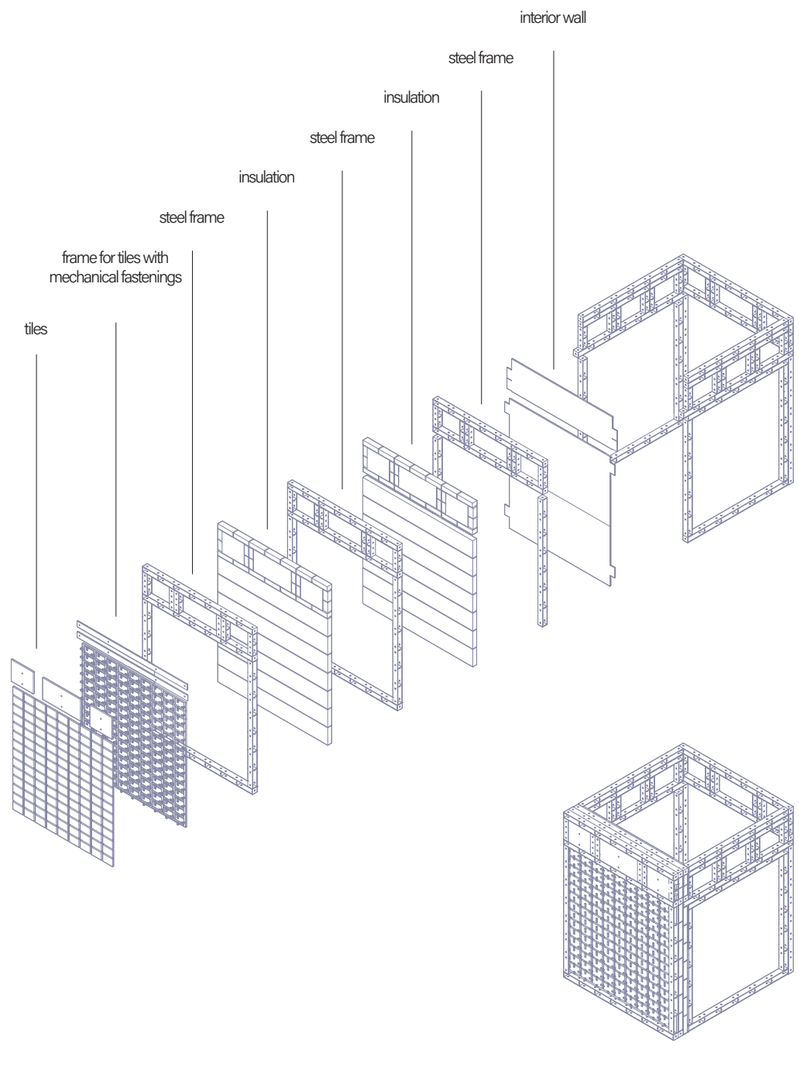
module 3.1b



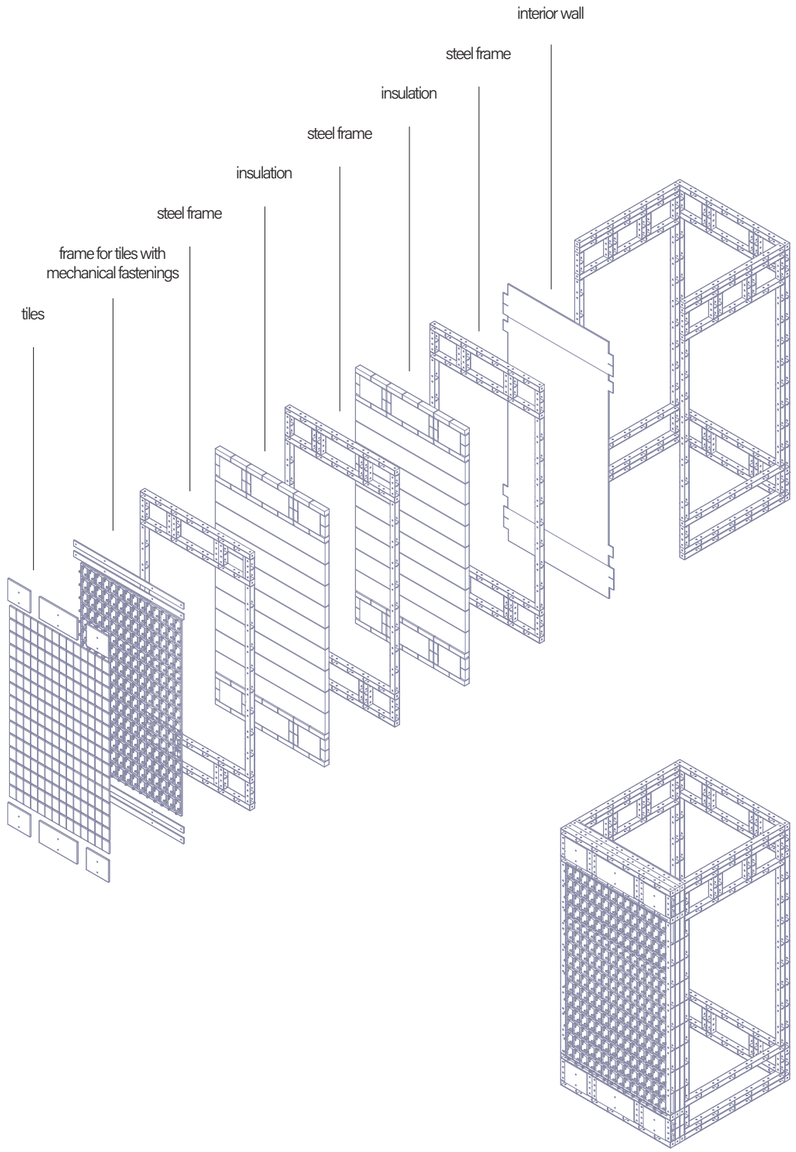
exterior cladding
module 1.1a



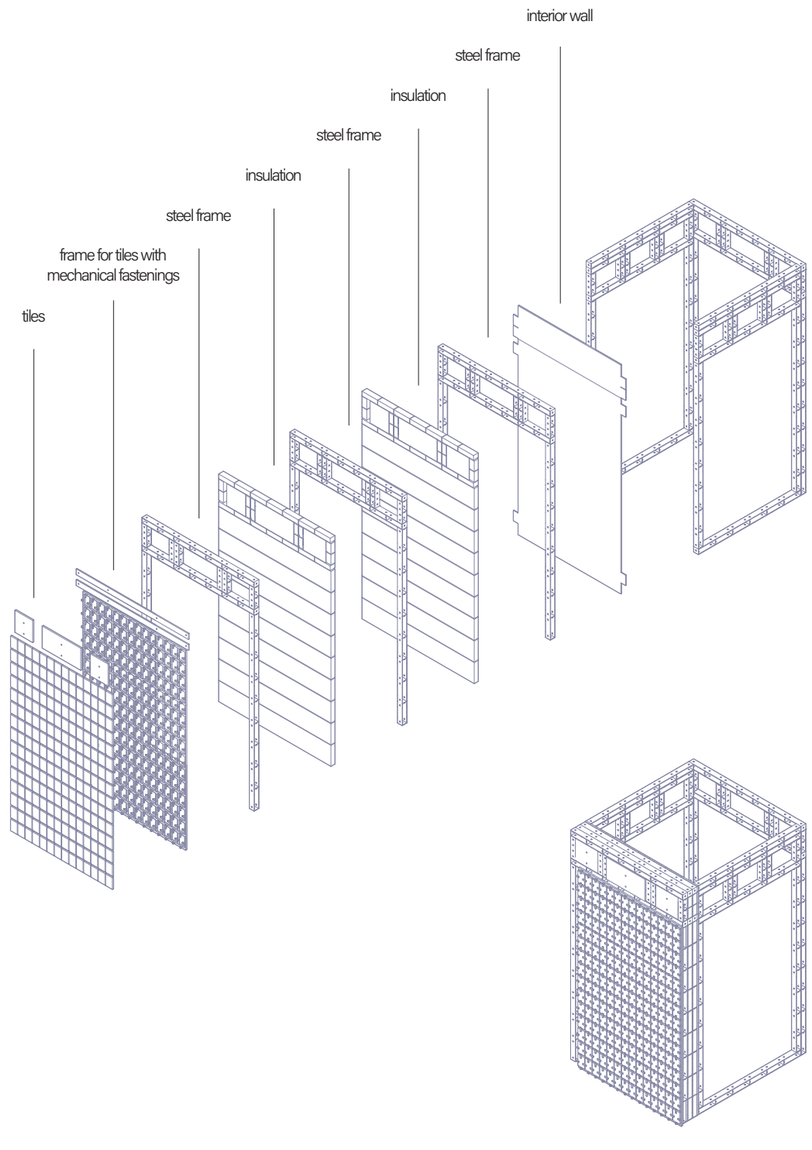
exterior cladding
module 1.1b



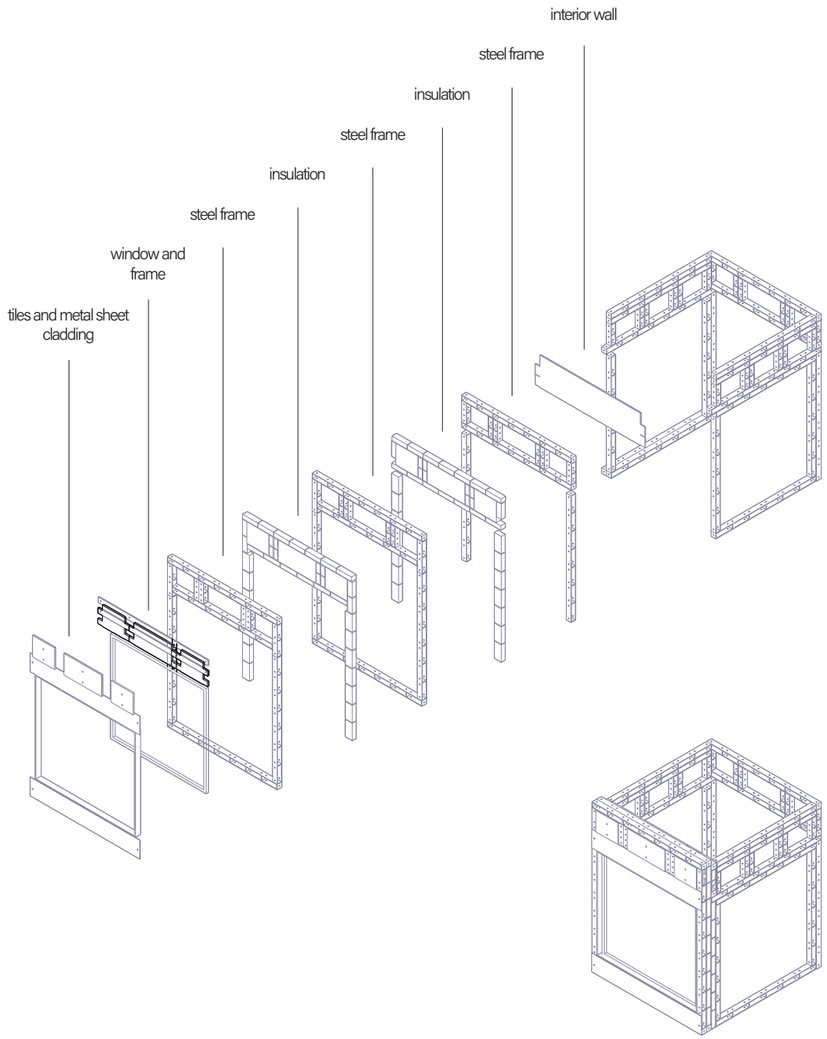
exterior cladding
module 2.1a



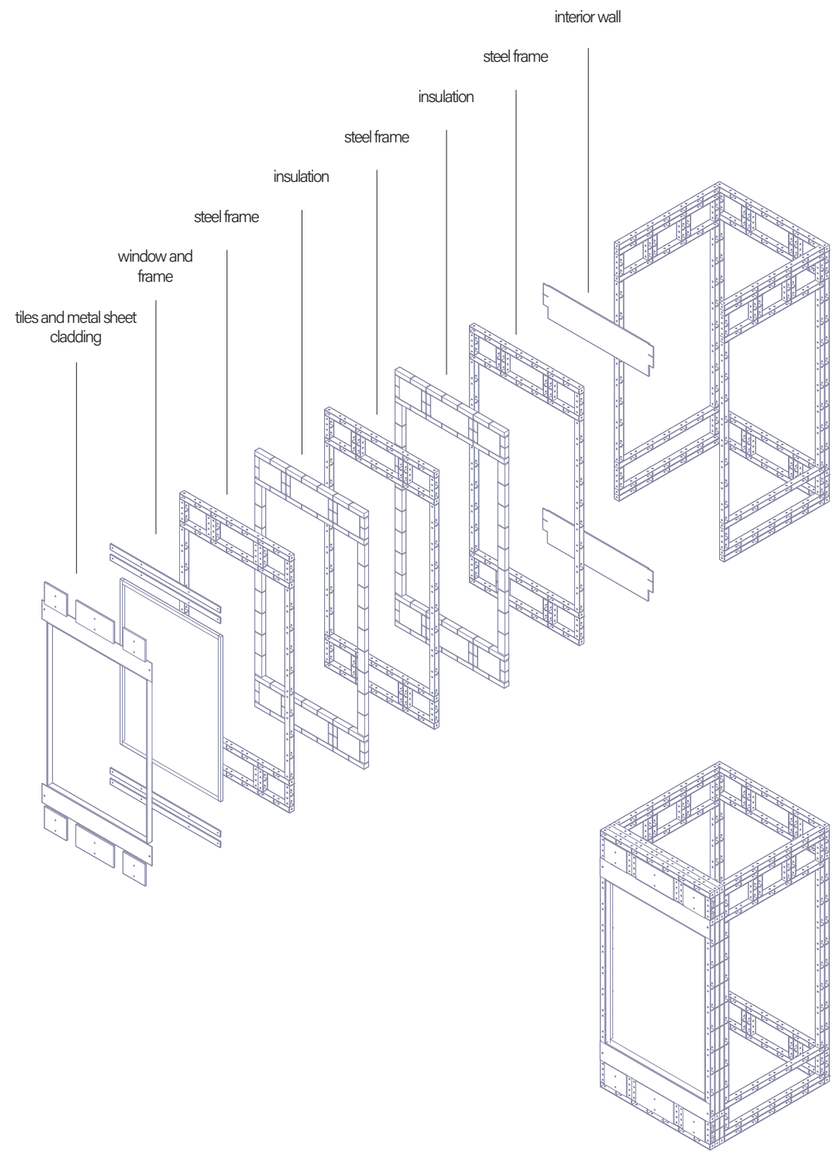
exterior cladding
module 2.1b



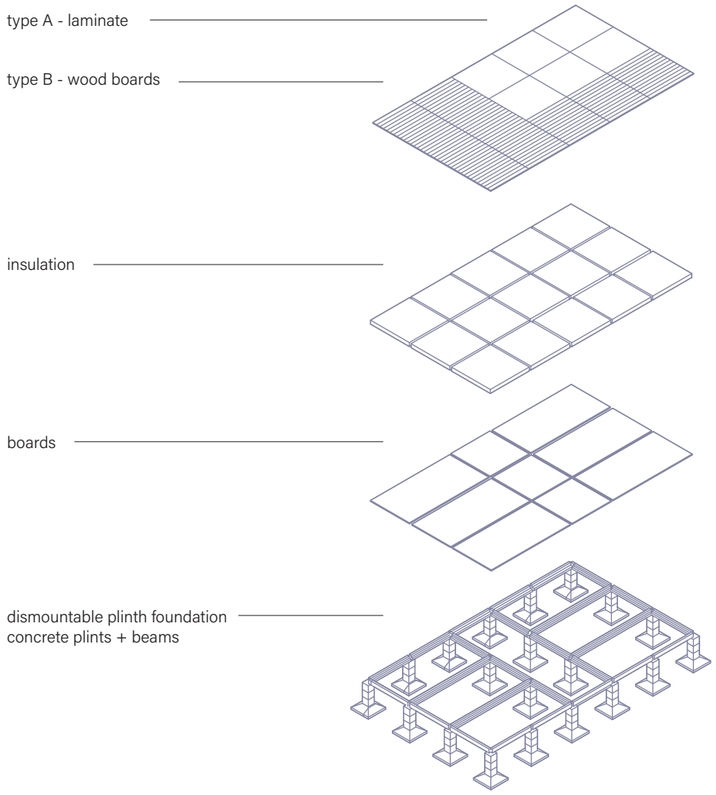
exterior cladding
module 1.2 b



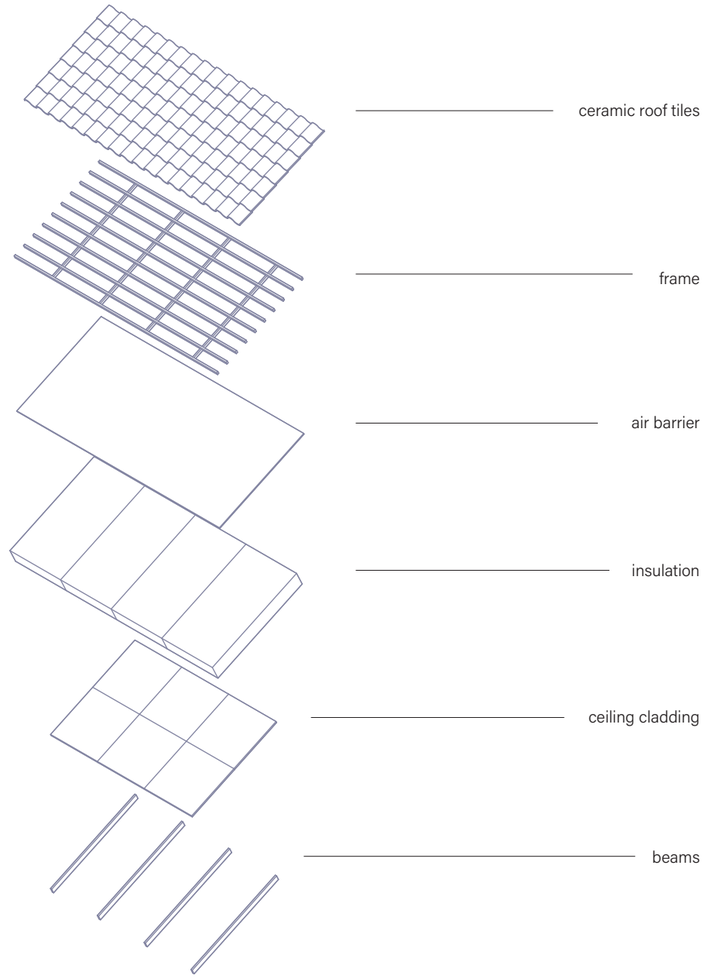
exterior cladding
module 2.2 a



floor


type A - laminate
type B - wood boards
insulation
boards
dismountable plinth foundation
concrete plints + beams

roof

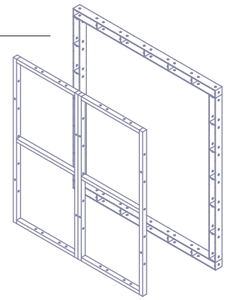

ceramic roof tiles
frame
air barrier
insulation
ceiling cladding
beams

interior walls

wall framework principle

steel frame

wooden frame
screws onto steel frame

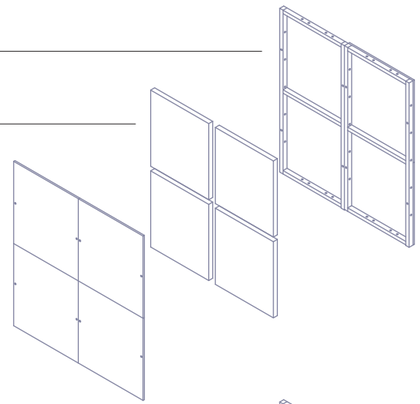


plywood cladding

wooden frame

insulation

plywood boards
screw onto wooden frame



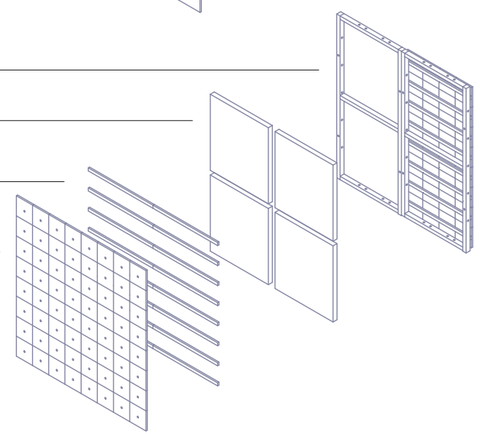
ceramic cladding

wooden frame

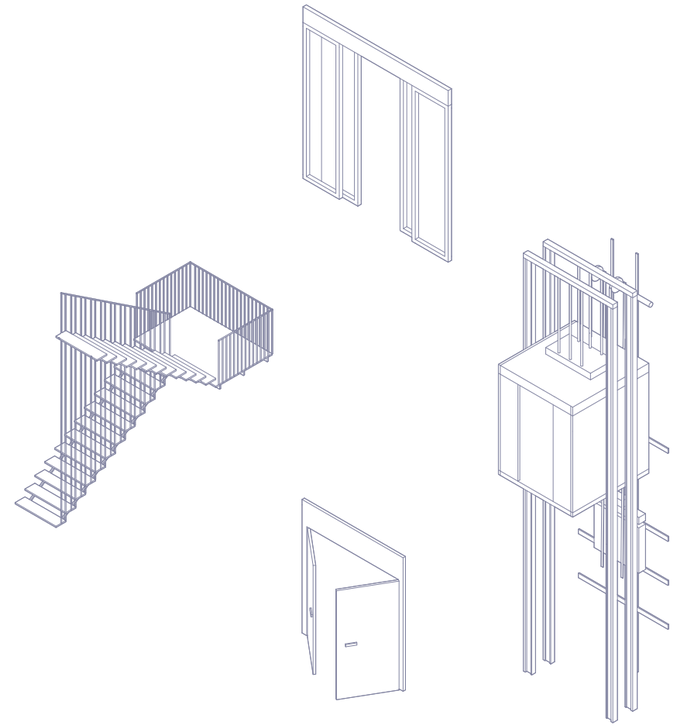
insulation

secondary frame for tiles
screws onto wooden frame

ceramic tiles
screw onto secondary frame



other building elements



For the sake of this project, I assume that the dissassembly of things such as doors, windows, lifts and ventilation systems into their constituent parts will be arranged by the supplier.

Assembly

roof and ceiling

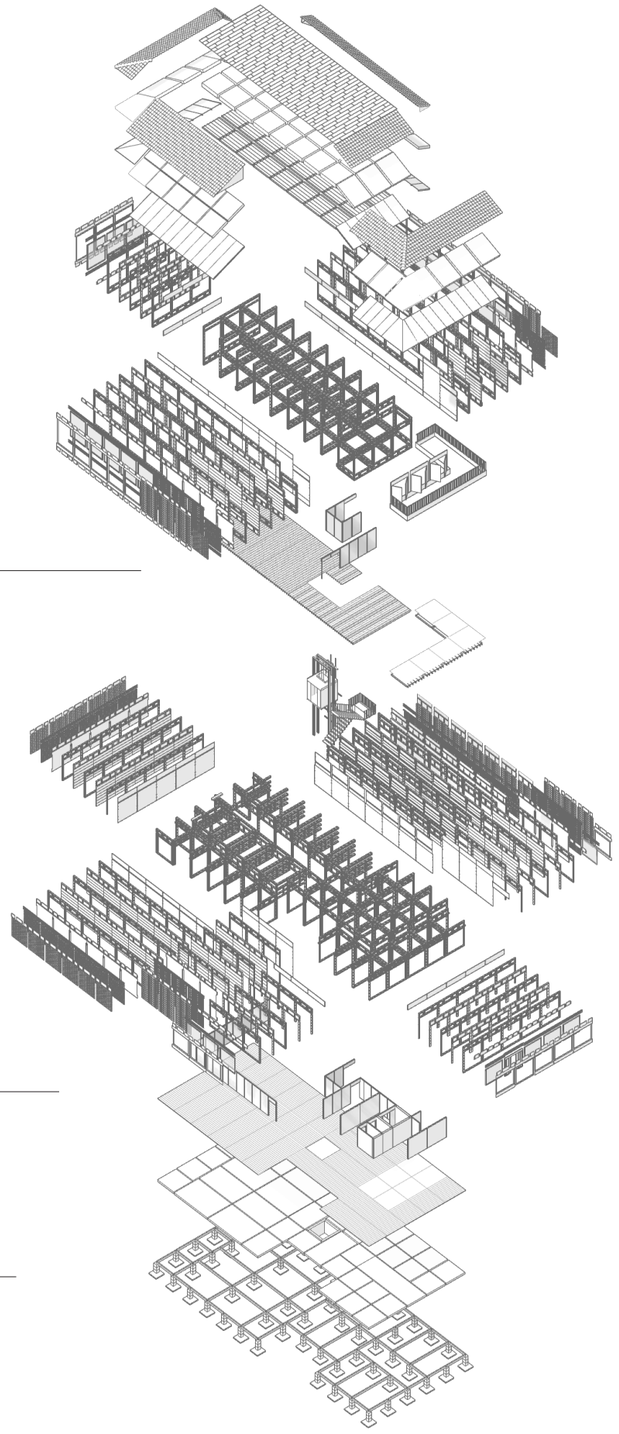
second floor frame + exterior cladding
type a

floor and interior walls
floor type B, plywood cladding

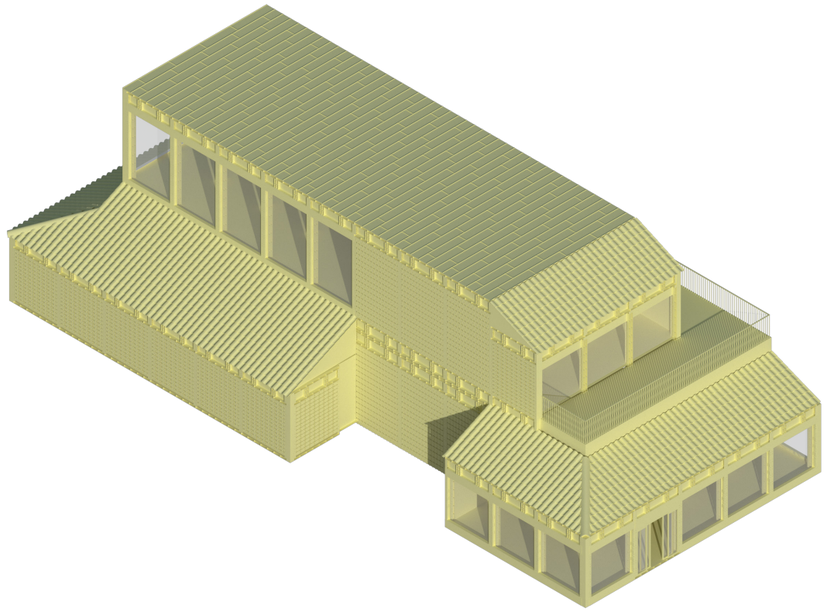
ground floor frame + exterior cladding
type b

interior walls
ceramic cladding + plywood cladding

foundation and floor
floor type A + B



the original gallery proposition

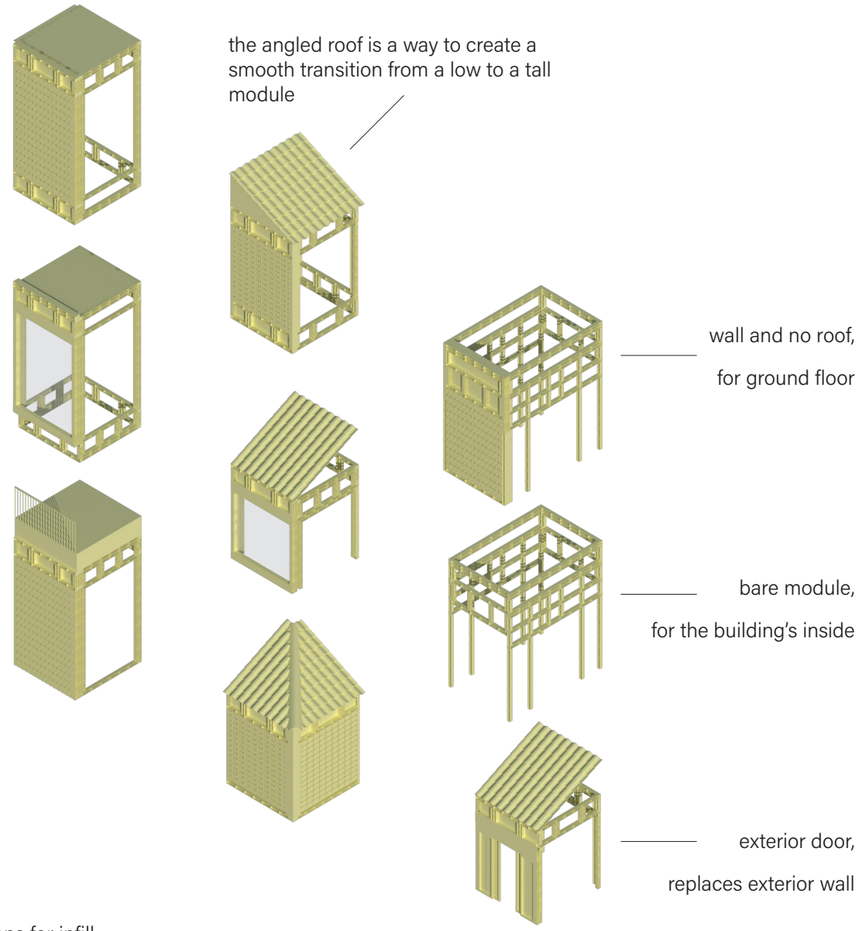


The gallery that I propose is a way to arrange modules into a building.

I have kept potential scenarios of changing the building's envelope in mind. The design is meant to be easy to vary, to expand the building, make it smaller, change the function or to reassemble it in a different way at another site.

The system of modules allows for these changes to be done in a coherent way. the changes can occur without the building losing its character. changes can be made in a way that harmonises with the original.

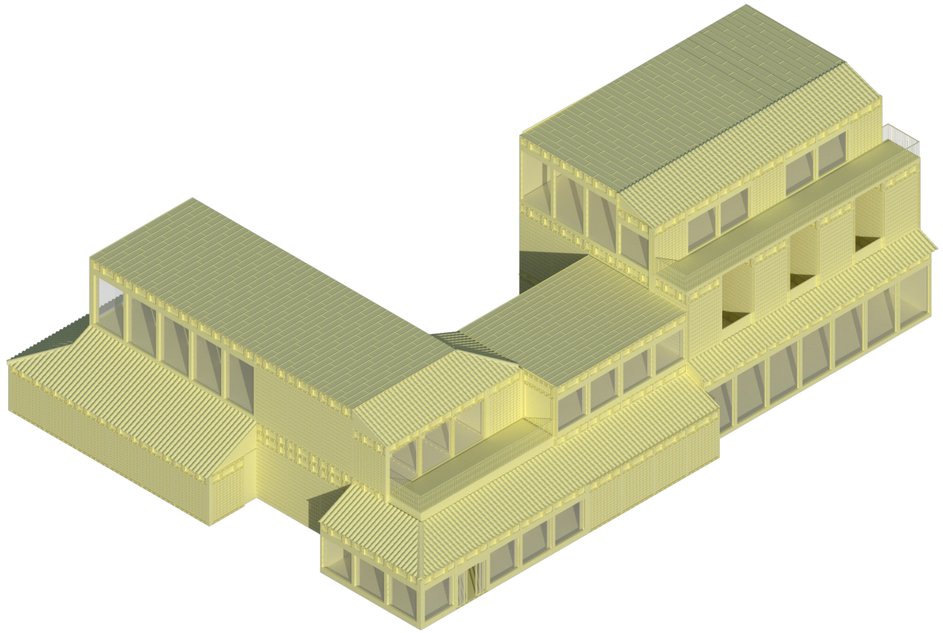
different ways to combine modules and infill



With the different options for infill, the three modules can become very versatile. Combining these in different ways allow of the creation of different buildings that look as though they belong to the same "collection".

iteration 1. expansion

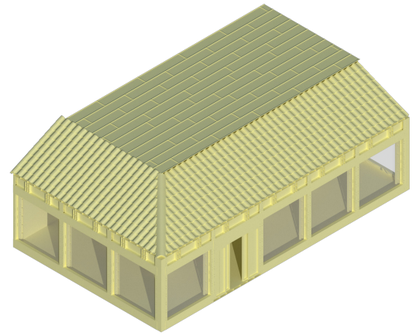
after 5 years



This is a suggestion of how the system could be used to expand the building on the site. Perhaps after a few years, the gallery needs to expand. A residency program with some dormitories, some studio spaces and more exhibition space can be added.

iteration 2. reduction

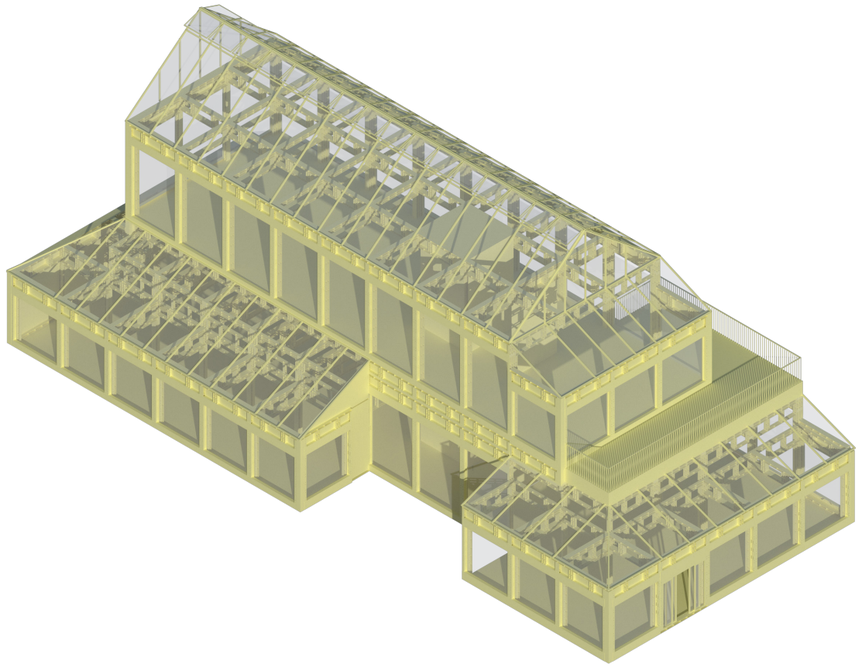
after 10 years



After a while, the art-institution might close down. The site might be turned into a square or a pocket park. In this case, the gallery can be dismounted. A small part of it can be kept and be used as a café.

iteration 3. infill change

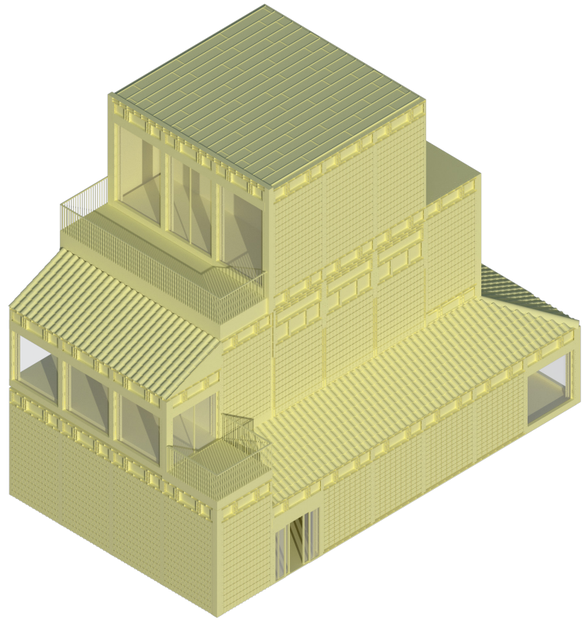
after 15 years



A while later, the park might develop into a space for urban farming. The original building can be rebuilt at the site, with a new roof and an all glass infill. The gallery can thus turn into a greenhouse.

iteration 4. total remake

after 20 years



After yet some time, the greenhouse might need to be disassembled. The modules can then be reassembled at another site in a totally different constellation.

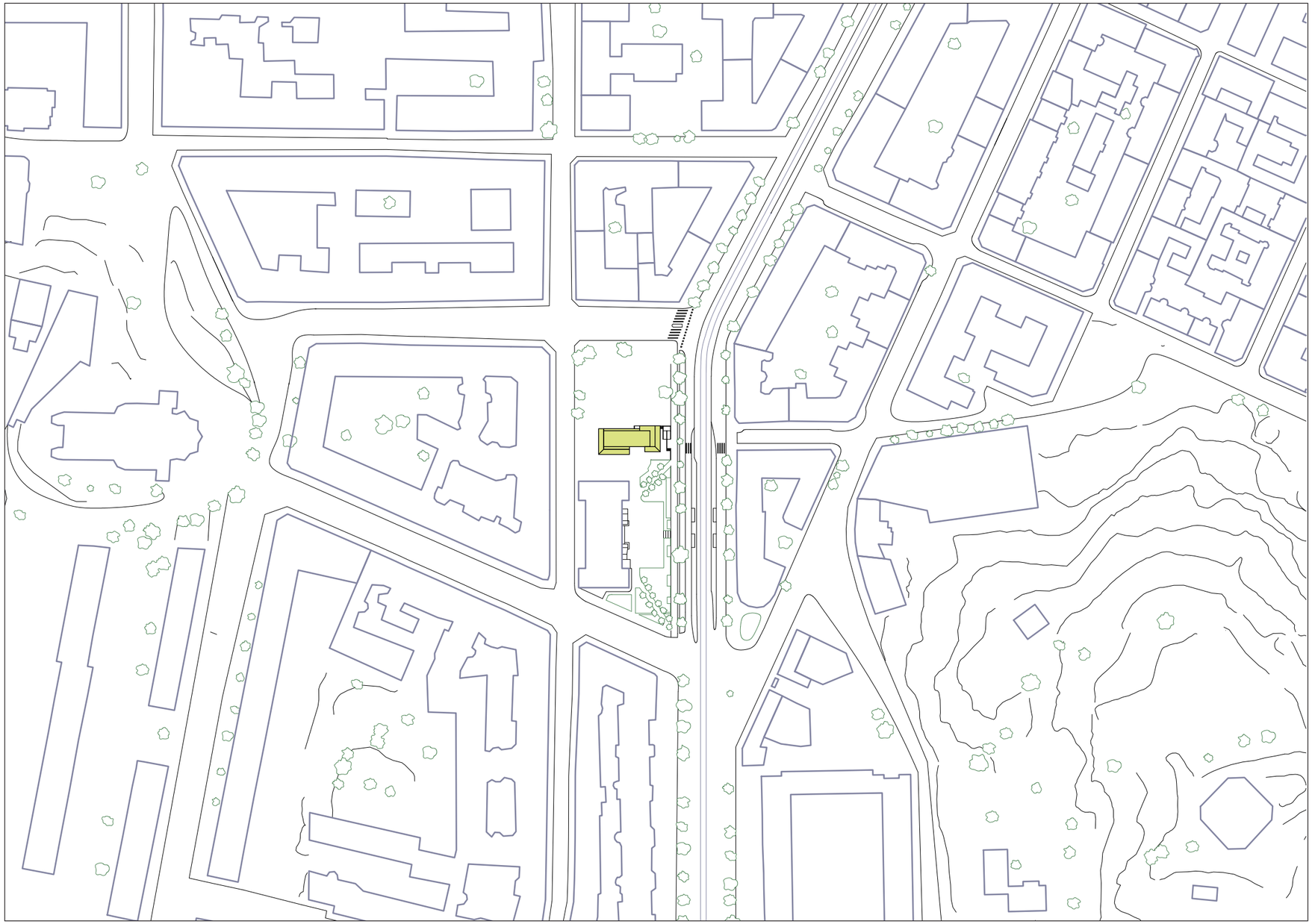
Part 4: Dismountable Art-Gallery

Elevation, east

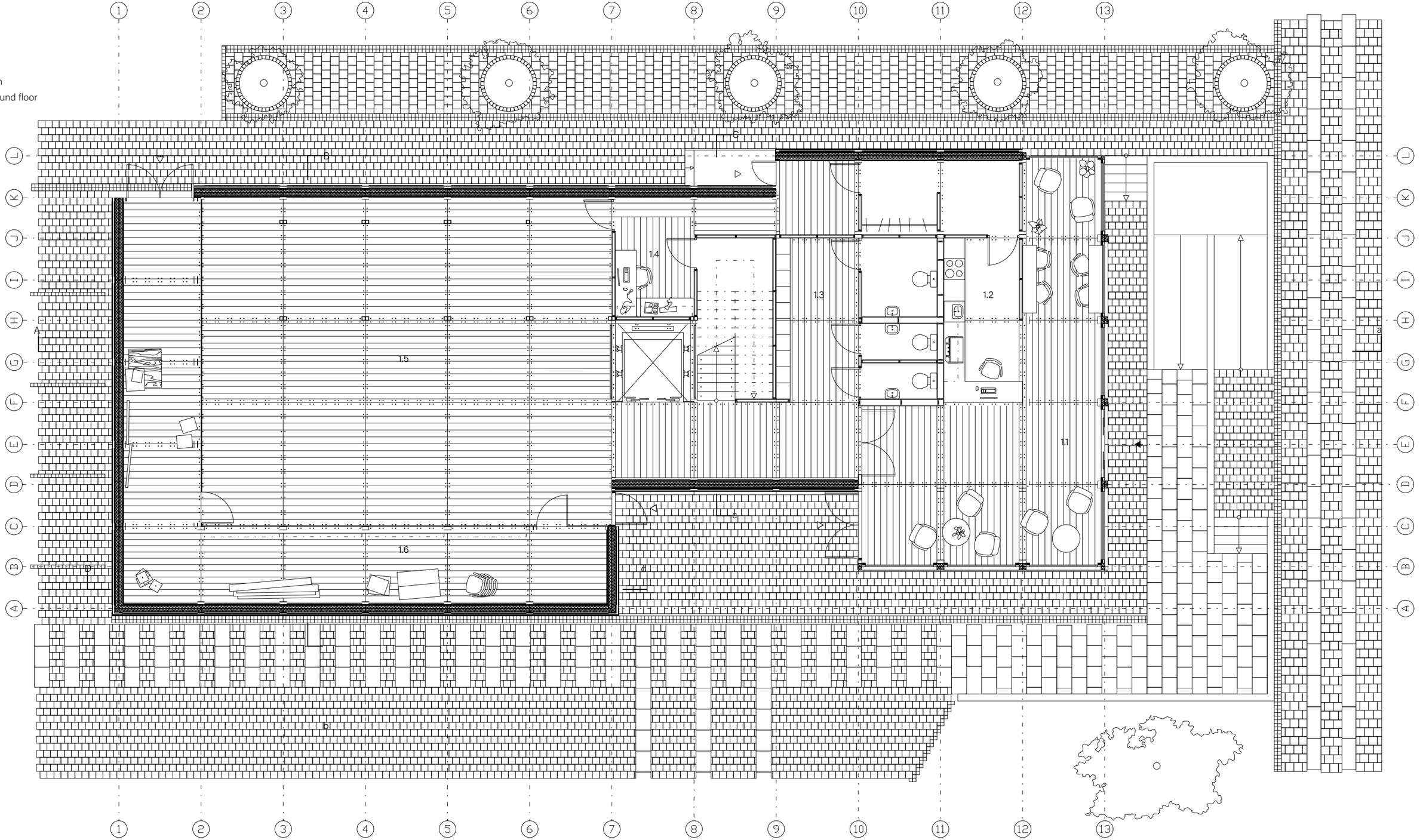
The gallery in its urban context

0 10m

Site plan



Plan
Ground floor

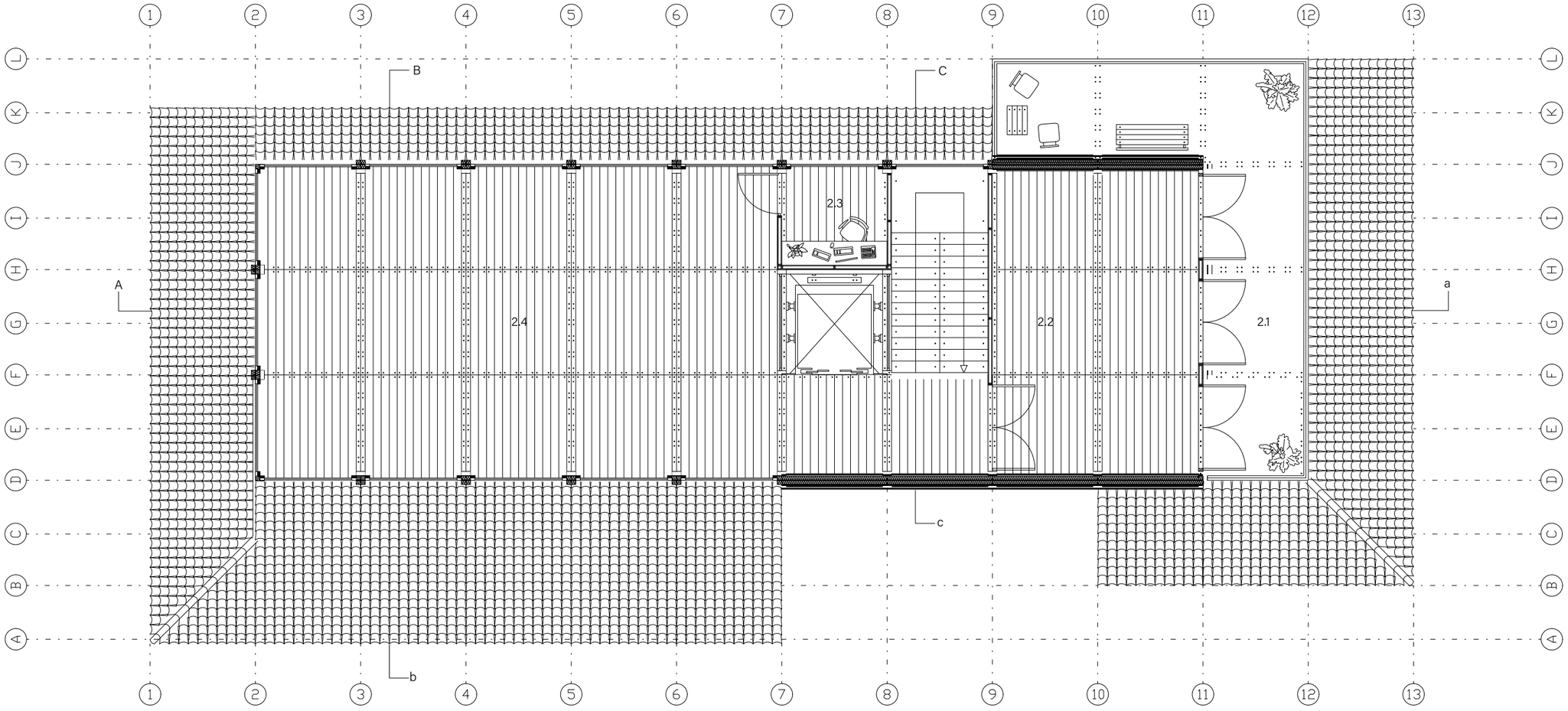


0 10m

1.1 foyer
1.2 reception desk/staff kitchen
1.3 restrooms/lockers
1.4 technical/backstage area
1.5 main exhibition space
1.6 storage space/exhibition space

Plan

Second floor



2.1 terrace

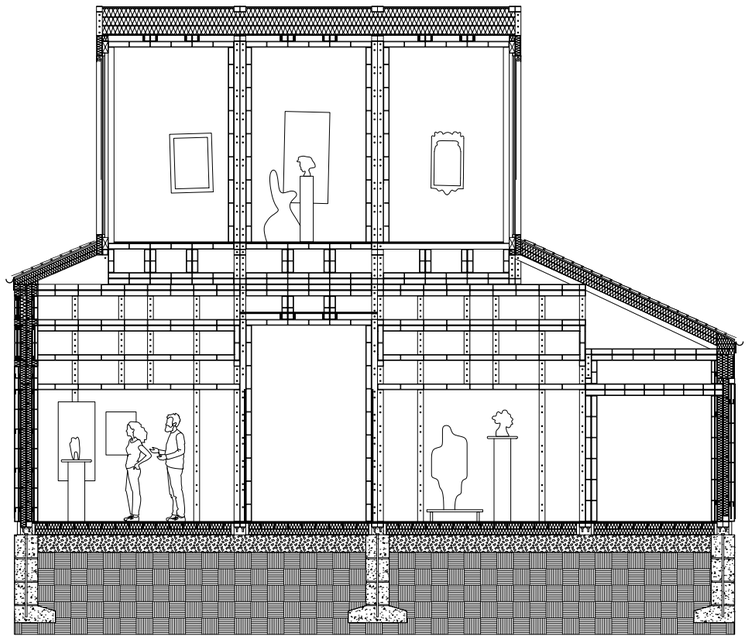
2.2 small exhibition space/blackbox

2.3 tecnical/backstage area

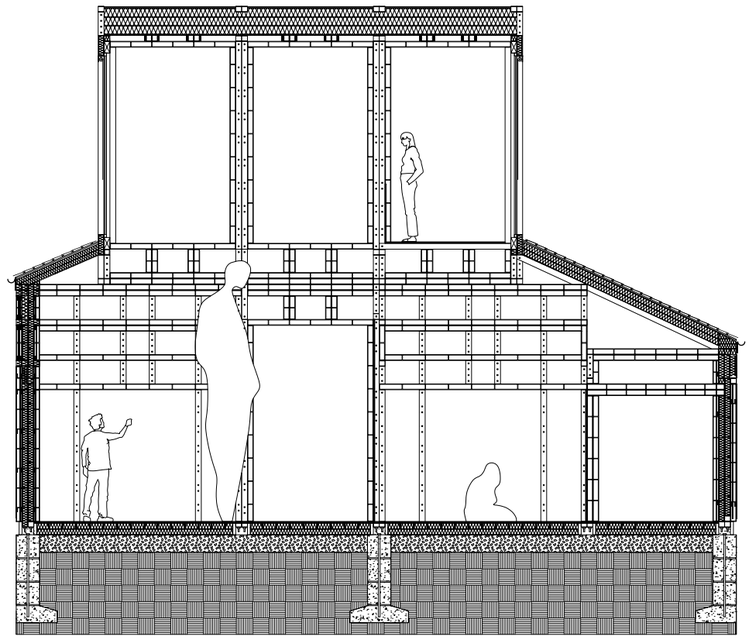
2.4 upstairs exhibition space

0 10m

Section B-b



Interchangeability



Disassembly of exhibition space

0 10m

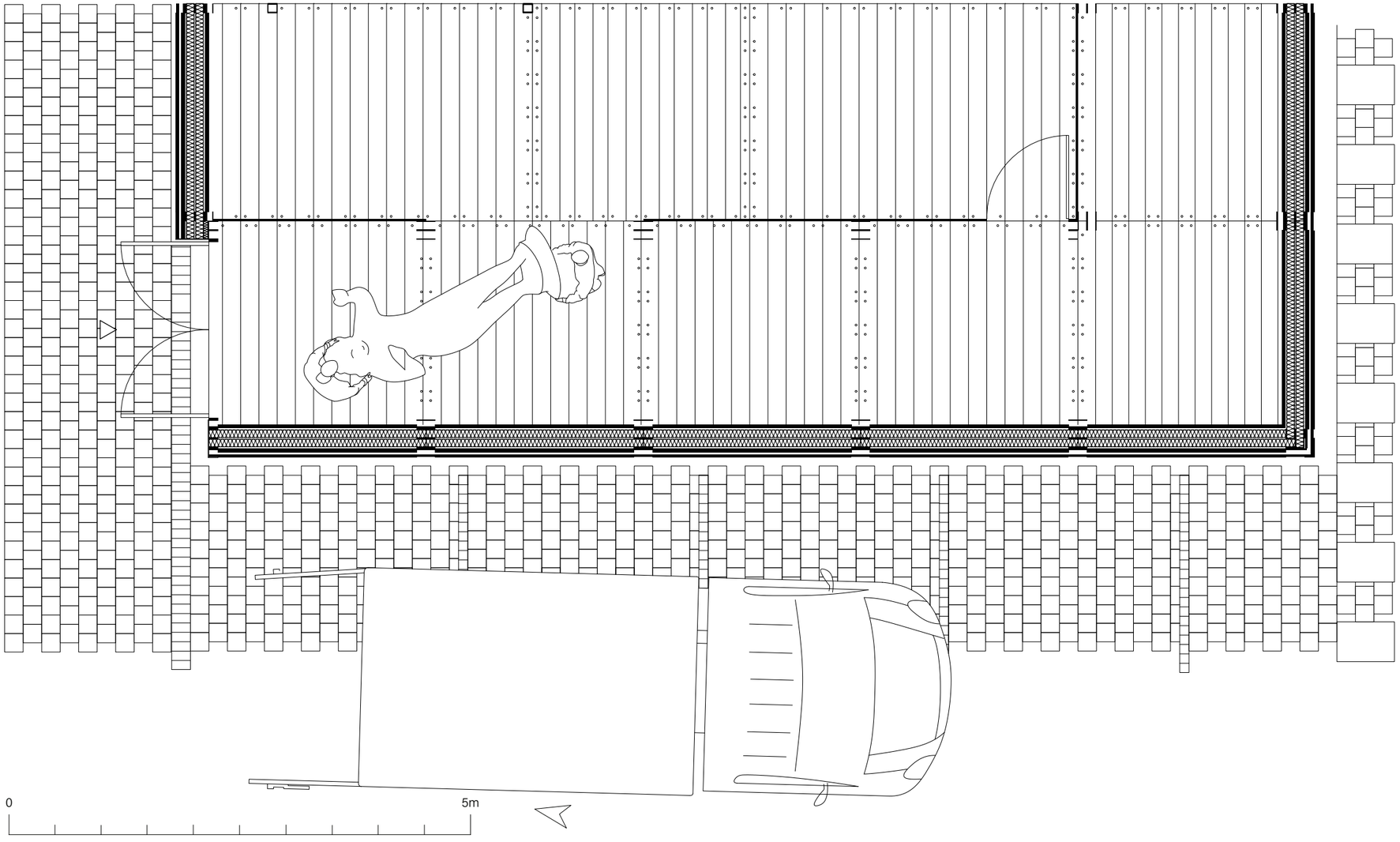
Thin walls, thick walls

When working with the interior infill of the exhibition space, I wanted to find a way to express that the interior walls are very easy to disassemble, and that they are meant to be disassembled more frequently than the exterior walls.

My way of doing this was to, through the art-form, make the walls very thin to highlight that they are lightweight, they are just plywood boards. I also created gaps above the walls to emphasize that they are not load bearing and that they are simply hanging onto the steel framework.

In this case, had I purely followed Heidegger's logic, and only focused on the core-form, the only thing that would matter would be to make the interior walls practically easier to disassemble than the exterior walls. The interior walls could be even thicker than the exterior ones, and the gaps above the walls would make no difference.

Ultimately, I think that the design decisions I made in regard to the art-form in this case does indeed express the building's disassembly.

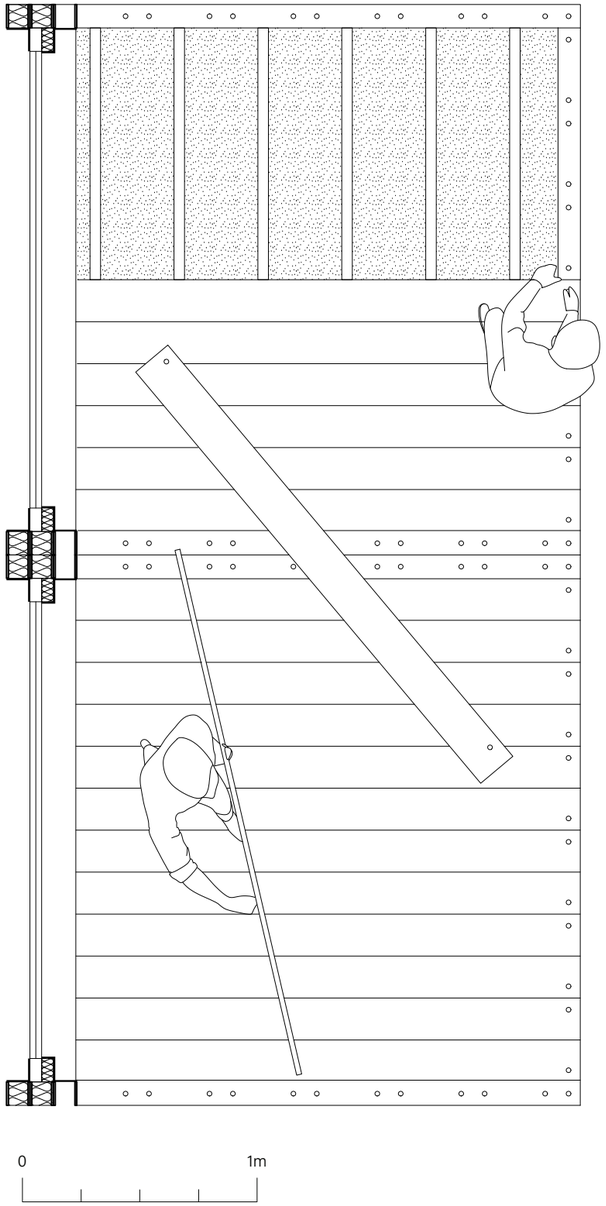


Remove walls for big art?

The program brings about some practical reasons for design for disassembly. What if someone wants to exhibit a large sculpture? The walls can be removed easily enough that disassembly for the sake of bringing art in and out of the building on a regular basis is doable.

Is there any value in trying to express this, or if it is enough that people who arrange the exhibitions are aware of this possibility?

I am thinking that, on an impractical level, the walls being removed in between exhibitions gives the building character. The people who work with setting up the exhibitions would not just be working inside the building, but also together with the building. This unusual ritual of removing and reattaching walls could hopefully be a way for people to gain special memories of the building.



The human scale and floorboards

To design a practically functional, interchangeable core-from, following Heidegger's idea that the properties of a building are what endure, it is sensible to ensure that the interior cladding is roughly human sized. Big and heavy infill pieces with varying unique designs would be much harder to replace. Similarly, a huge amount of very tiny items also run the risk of lacking convenience regarding disassembly.

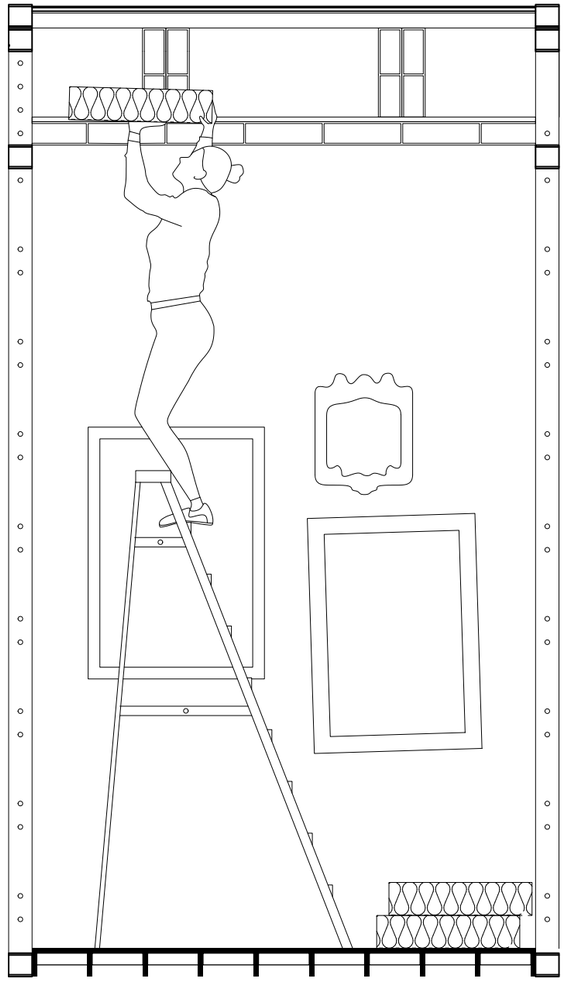
To some extent, I can see this aligning with Tadao Ando's idea about the experiences through the body being a universal point of reference. Though the size of the body was not one of the things he mentioned, I am wondering if this could be thought of in that way too. The size of the floorboards are at the "human scale". Potentially, by merely looking at the floorboards, their scale will register as manageable, and we will be able to recognize that they could be lifted and carried away by a person.

Clearly, the size of people varies, and whether the floorboards can be picked up and carried away depends on how each individual body works. So maybe the size of the floorboards will not universally communicate disassembly? Since they, at a core-form level, are not easily dismountable for everyone.

Part of section A-a

Interchangeability

Replacing insulation



0 1m

Limits of tectonic expression

Interchangeability relates more to fixing and rearranging spaces than total disassembly. Practically, this means that the current building objects could be replaced with object from somewhere else. Because of the frame-infill system with the pre-drilled holes, the potential of easily replacing building materials have been established at a core-form level. In Heidegger's words, interchangeability is a principle of the building.

Even though I have already found some success in trying to express interchangeability tectonically, I wonder if this particular aspect might remain inexpressible. The scenario of replacing building materials with something that is not there now strikes me as very complex. For people to receive this impression of a building, they would require such far-fetched association patterns that I think it lies beyond the scope of what can be expressed though an art-form.

Part of section A-a

Interchangeability

Painting

0 1m

Revisiting the building

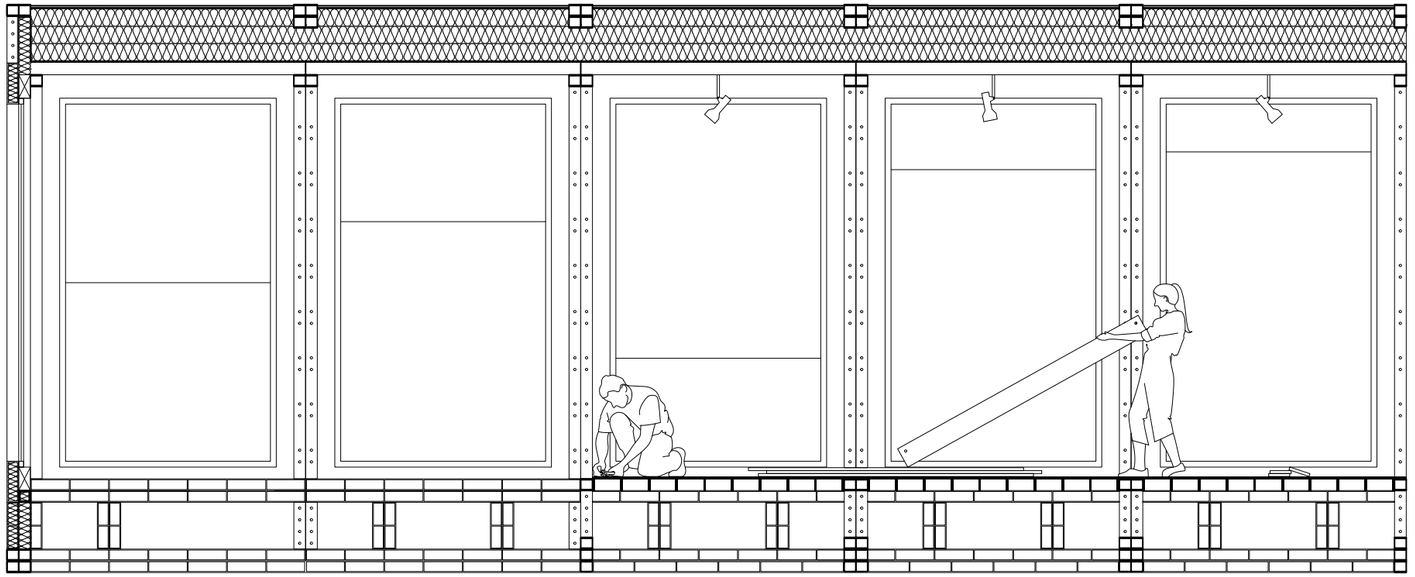
An alternative way to tackle the question of expressing the possibility of new building materials being brought into the building, it might be that people will revisit the gallery when new exhibitions have been installed. Then, the building might have changed internally: floors might have been added, or removed, windows might be covered or uncovered to adjust the lighting, and new floors or walls might have been brought into the building that were not there for the last exhibition.

Although the potential of making these types of changes is hard to communicate at one sole visit at the building, by revisiting the building these things will become apparent. Maybe tectonics could be thought of as something that is not inherent to the building statically, but something that has a temporal variable.

Part of section A-a

Interchangeability

Removing upstairs floor

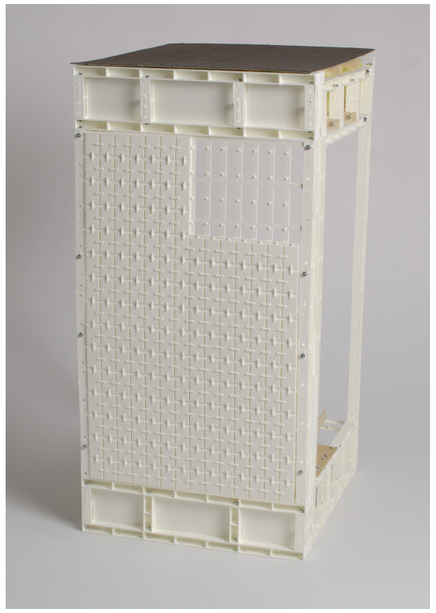


0 5m

Model photos

Accessible connectors

Nuts and bolts



Visible connectors unite

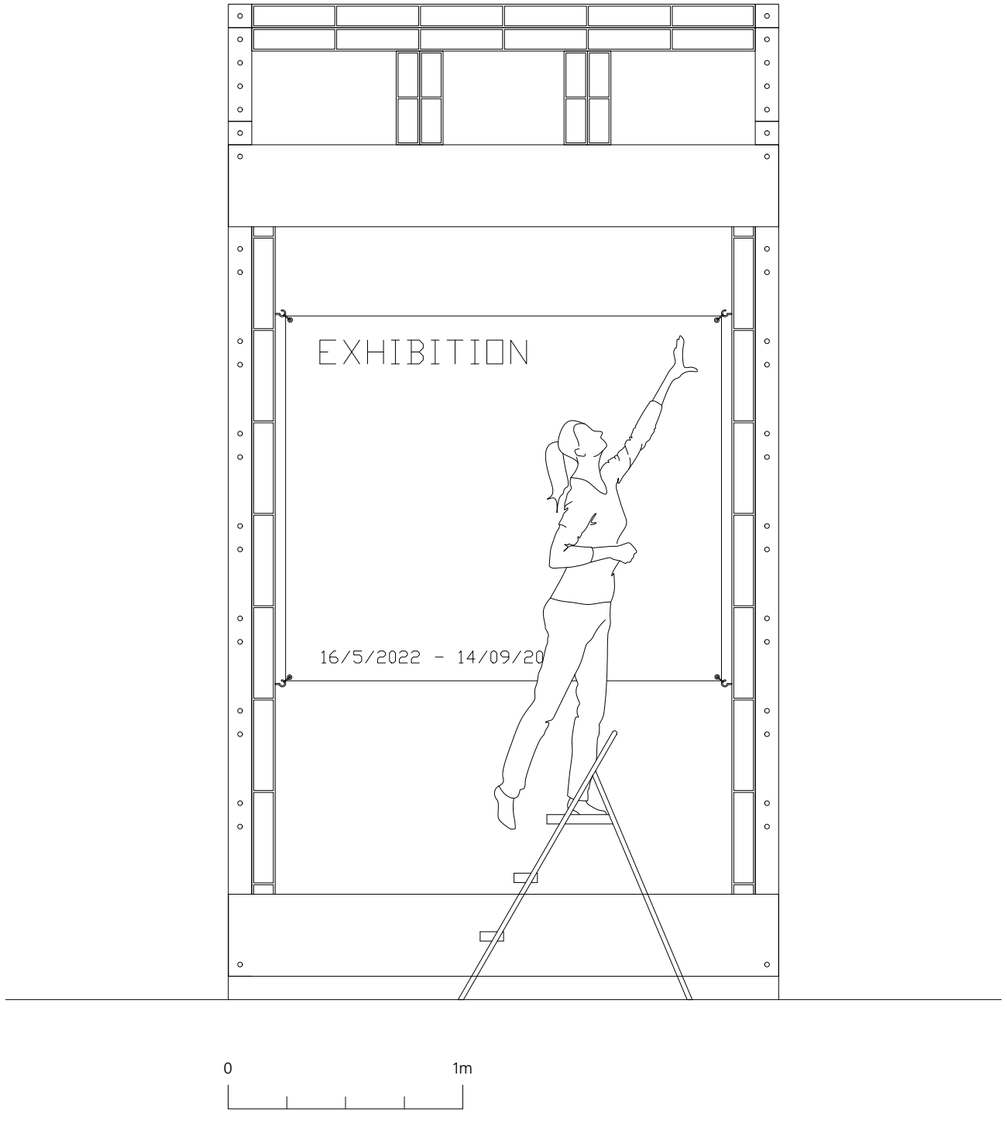
One of the core principles for design for disassembly is to make connectors accessible. The connectors are clearly functional at the level of the core-form. Furthermore, the design for disassembly principle indicates that the bolts should remain visible for easy access.

This seems to be a point where Heidegger, Sekler and Bötticher, and the design for disassembly principle all consolidate. Even though it could be argued that it is not enough to make the connectors accessible, that it needs to appear as though they are, this design for disassembly principle calls for this anyway. Therefore, there is a practical reasoning behind purposely trying to create a specific tectonic expression.

Elevation detail

Accessible connectors

Hanging poster



Fun with connectors

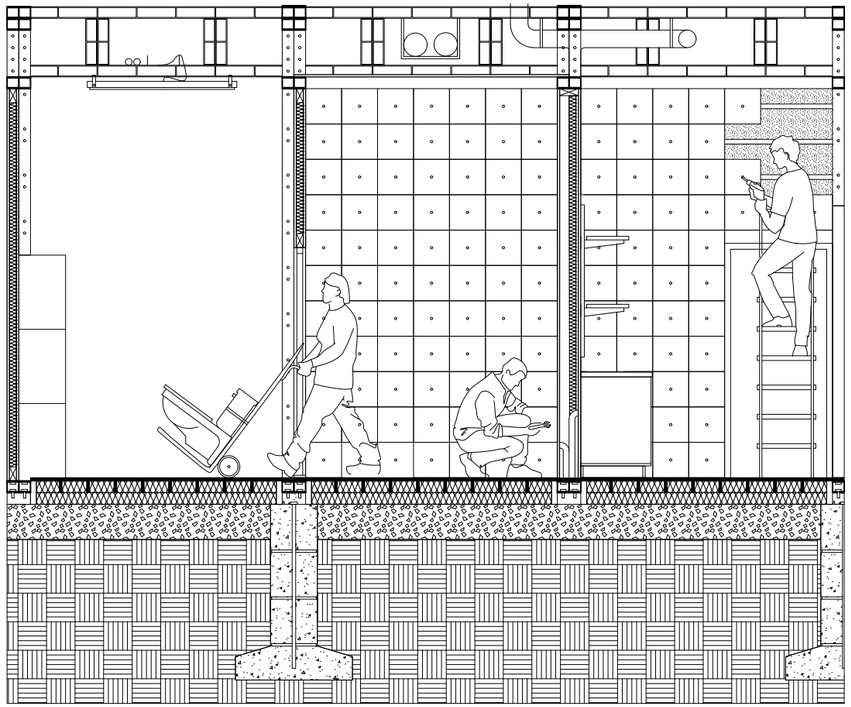
Apart from their practical value, the visible connectors and the pre-drilled holes in the steel frame create patterns and small intricate details. In this way, the constructive elements also have a decorative value.

It is possible to attach things to all the empty holes left in the steel frame, and I am hoping that this could give the building a playful atmosphere. There are endless possibilities. They can be used not only for attaching walls and floors but also furniture, art-pieces, exhibition posters or whatever other things people could think of.

Part of section A-a

Accessible connectors

Disassembly of restrooms and kitchen



Fake bolts?

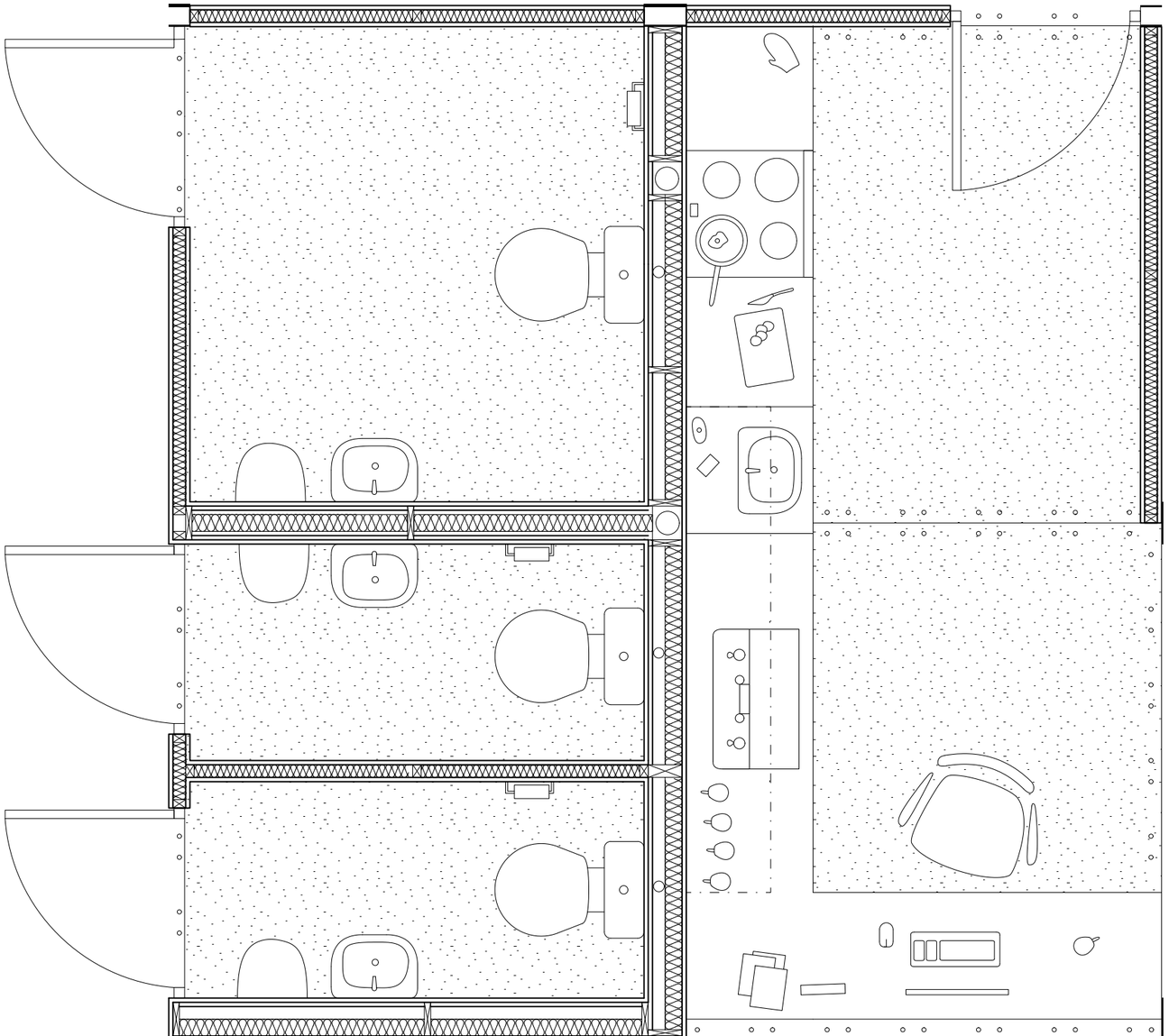
One of the most apparent challenges of designing with visible, mechanical connectors is to avoid problems with moisture in airtight buildings. For example, highly waterproof wet rooms are a type of room that would be hard to create without using chemical sealants. Perhaps there is a way to do this, an investigation on this has not been carried out in the scope of this project, but I can imagine that it would demand some non-standard solutions.

A way to solve the problem of wet rooms in a building that is meant to express that it is dismountable through the use of visible mechanical connectors, would be to try to make it appear as though the building elements in the wet room are mechanically connected even if they are not. If the expression of disassembly can be achieved by gluing on fake bolts on the bathroom tiles - why not? Is it overrated to match the art-form to the core-form?

Plan, detail

Accessible connectors

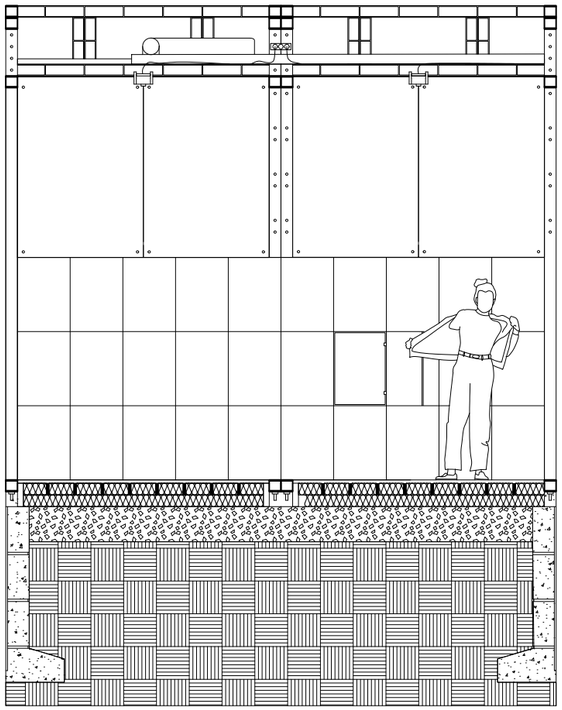
Restrooms and kitchen



Capsule tower inspiration

The size of each module is meant to be big enough to be useful on its own, while still being able to be put together with others to create bigger spaces. I found inspiration for this in the Nakagin Capsule Tower. There, each capsule was meant to be able to be a home for one person, and by combining capsules larger spaces could be created.

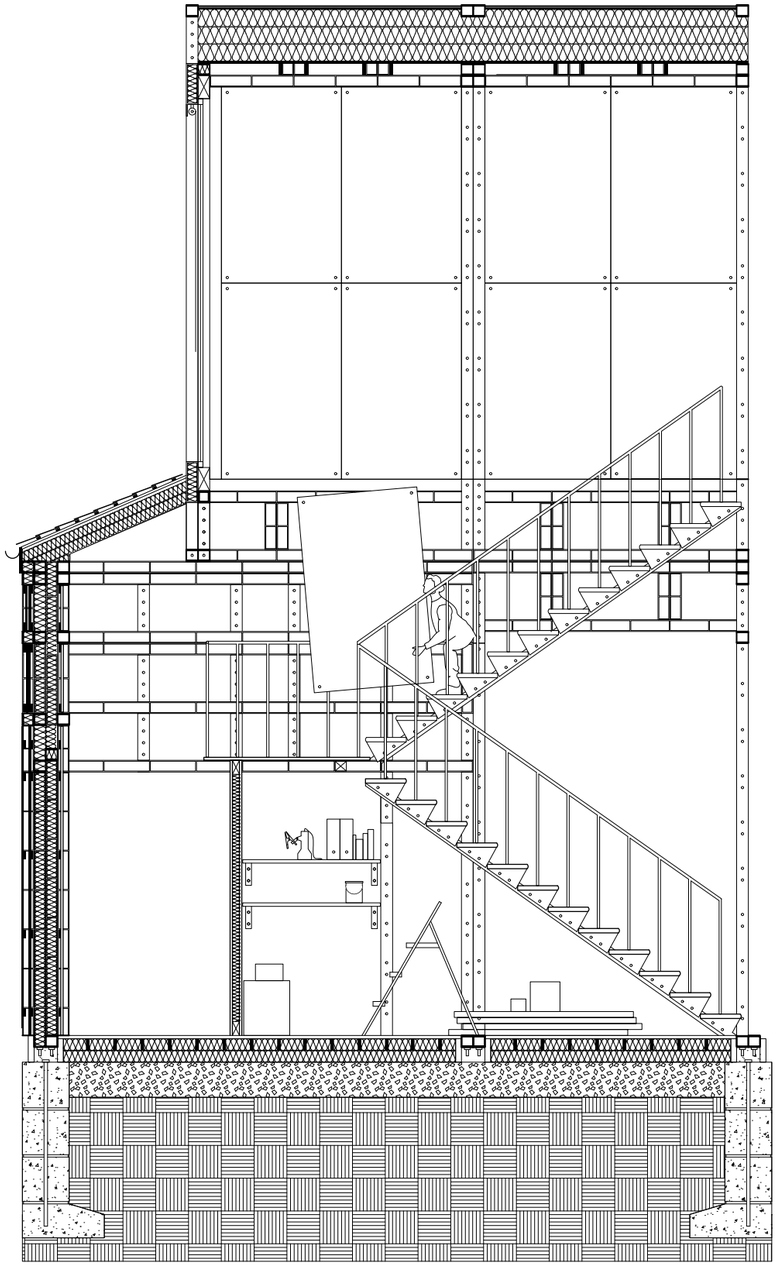
I dimensioned the modules so that one is the size of one big restroom. By dividing it in the middle, a module can become two small restrooms and by combining two modules, they can become a small kitchen.



No connection

Even easier to remove than something that is attached through a mechanical connector is something that is not attached at all. On a core-form level, avoiding built in furniture and keeping installations visible and accessible allows for the easiest disassembly possible.

For the sake of the art-form, a problem with this is that things such as free-hanging lamp cables and free-standing cabinets are so common, that their unconnectedness is unlikely to be reflected on. It might even be so, that the bolt communicates design for disassembly so much better than the lack of bolts, that it would appear as though this room is to a larger extent designed for disassembly if I had visibly bolted the cabinet in place?



Planning spaces for disassembly

The “space” part of the fourth design for disassembly principle, spaces and building elements suitable for practical disassembly on site, seems to be suited for a “Heidegger mindset”.

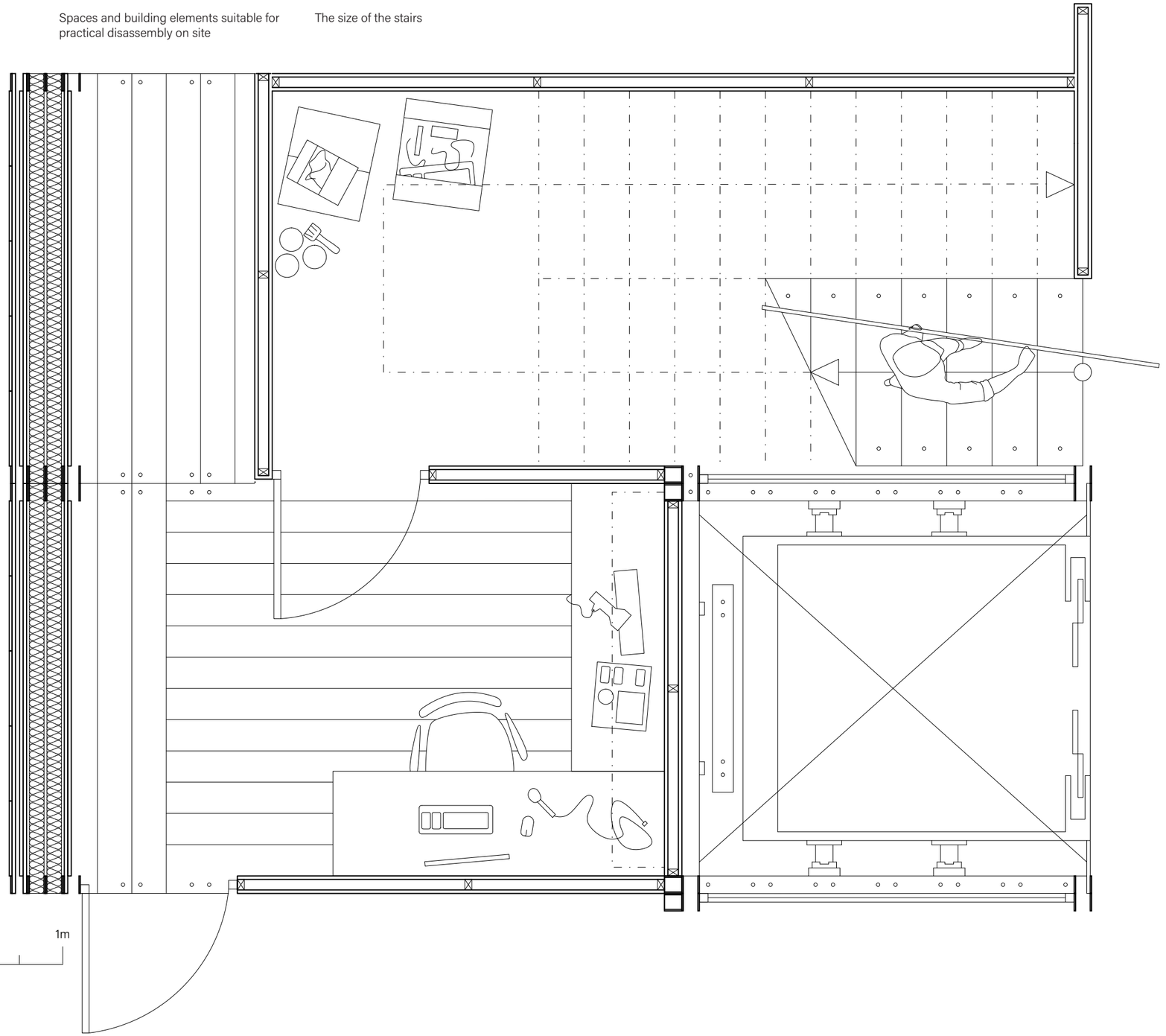
The image on the right shows a scenario where a wall has been disassembled on the second floor, and since I designed the building with this scenario in mind, the staircase has enough space so the wall piece can be moved downstairs and taken out of the building.

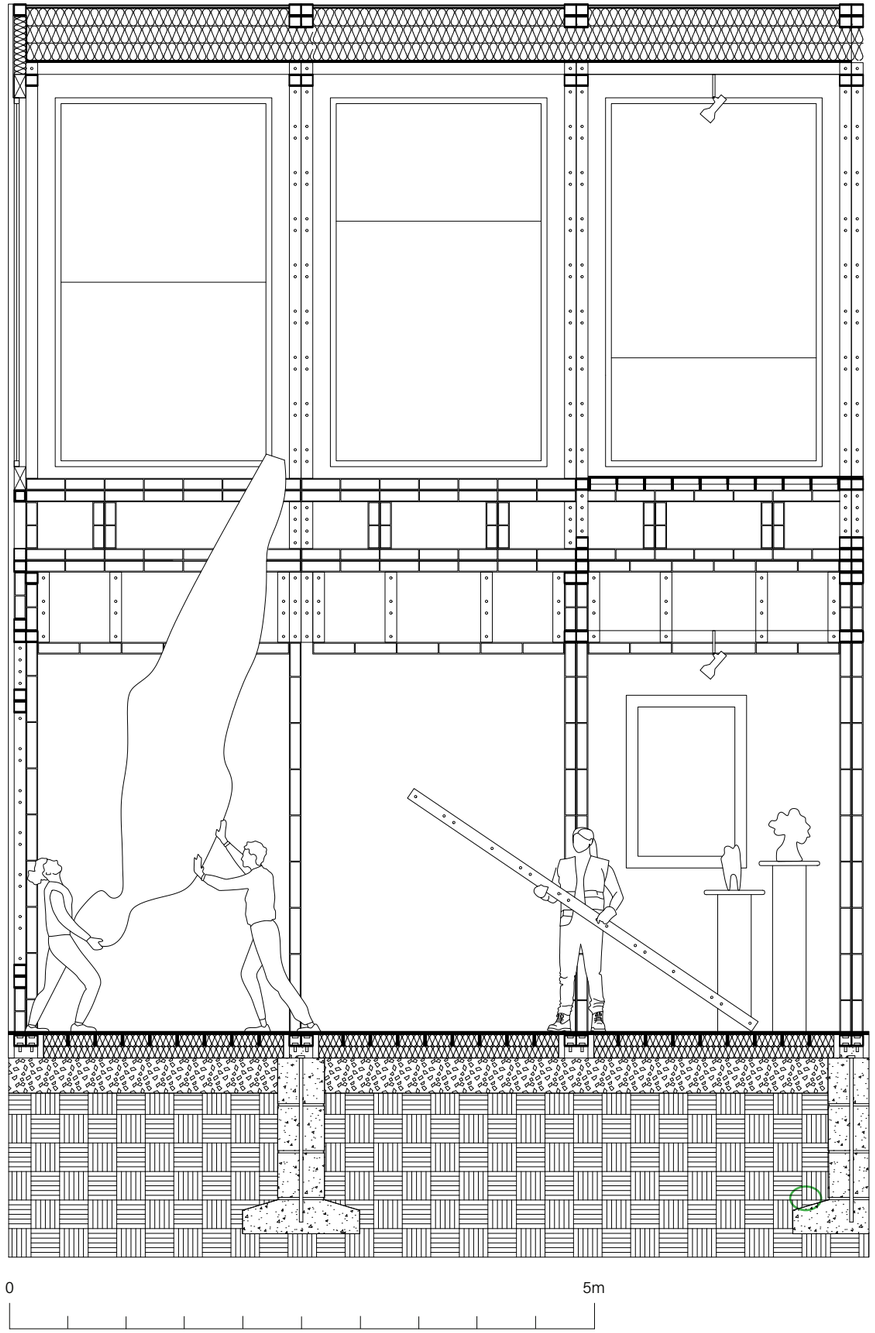
Once again, a limit of what tectonics can express seems to have been found. Planning spaces for disassembly requires complex fantasizing about series of specific scenarios playing out. However spacious I had made this staircase; I doubt this point would naturally come across without explaining this through words or illustrations.

Plan, detail

Spaces and building elements suitable for practical disassembly on site

The size of the stairs





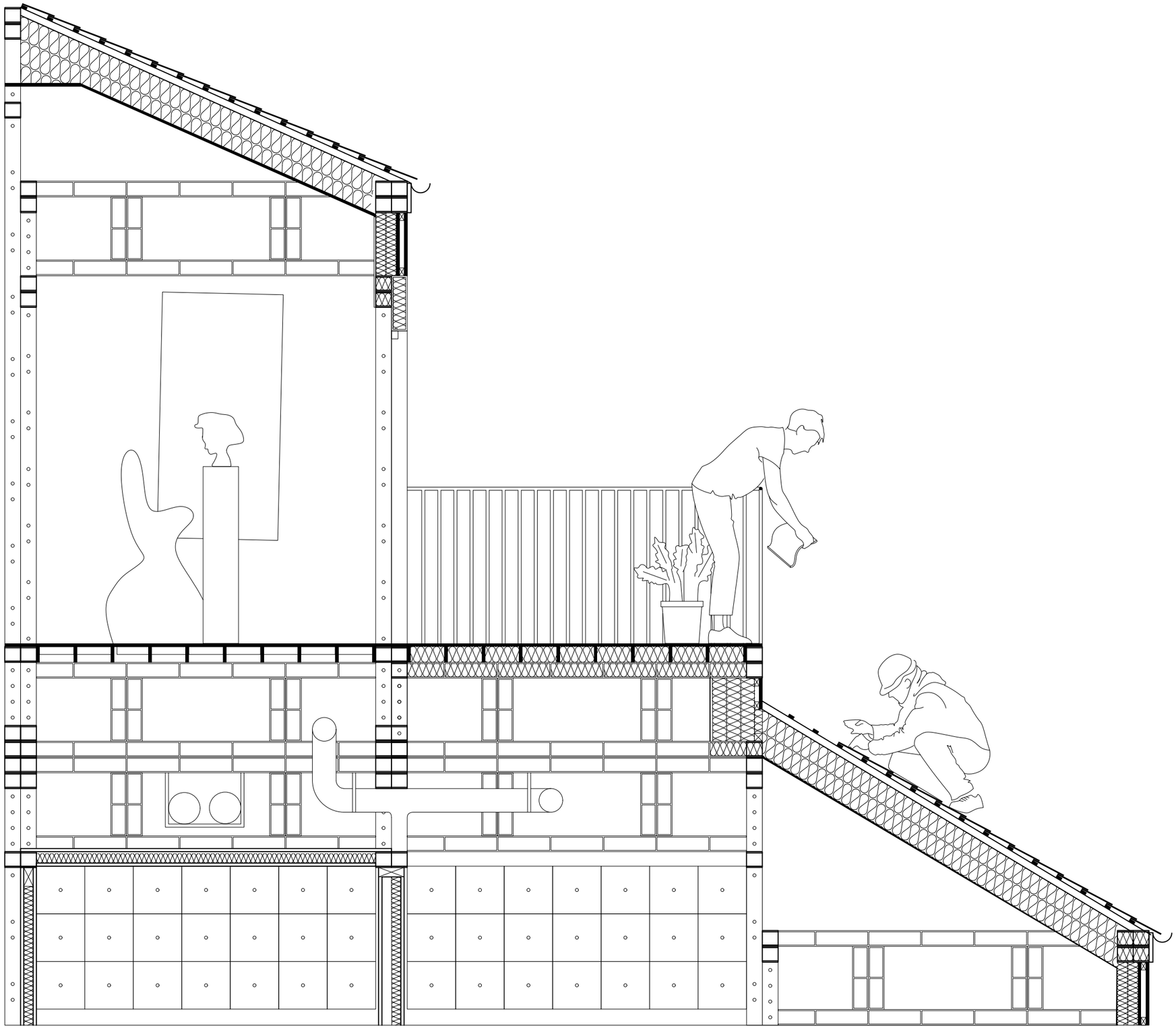
Part of section A-a

Spaces and building elements suitable for practical disassembly on site

Double ceiling height

Intentions with dimensions

Generally, designing the core-form requires intention. While working with the principle of creating spaces and building elements suitable for practical disassembly on site, working intuitively does not work. If a building element should be able to be removed in a certain way, there are some exact dimensions that will need to be taken into consideration. This might need to be measured precisely, in advance, or else the disassembly will not be able to take place. Perhaps the intuitive design can only be applied for the sake of creating tectonic expression, not for constructive aspects.



Part of section A-a

Replacing roof tiles

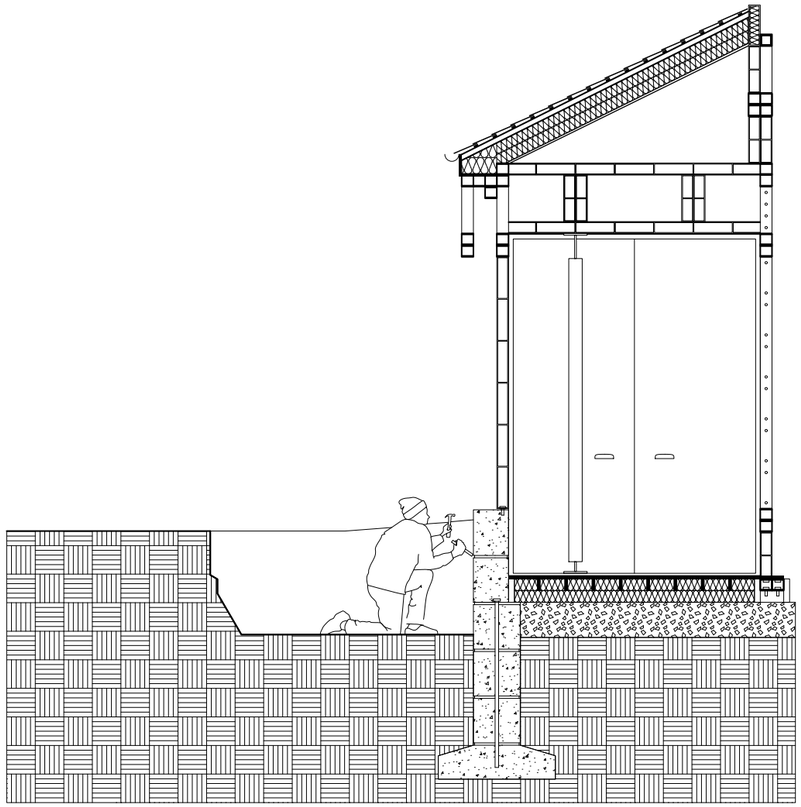
Common design for disassembly

A recurring concern throughout this project has been that I will accidentally over-complicate practical construction solutions. Not everything needs to be done in a special way just because a building is designed for disassembly. Some things that are standard today, like normal roof tiles, are already dismountable.

0 1m

Part of section A-a

Repairing the foundation



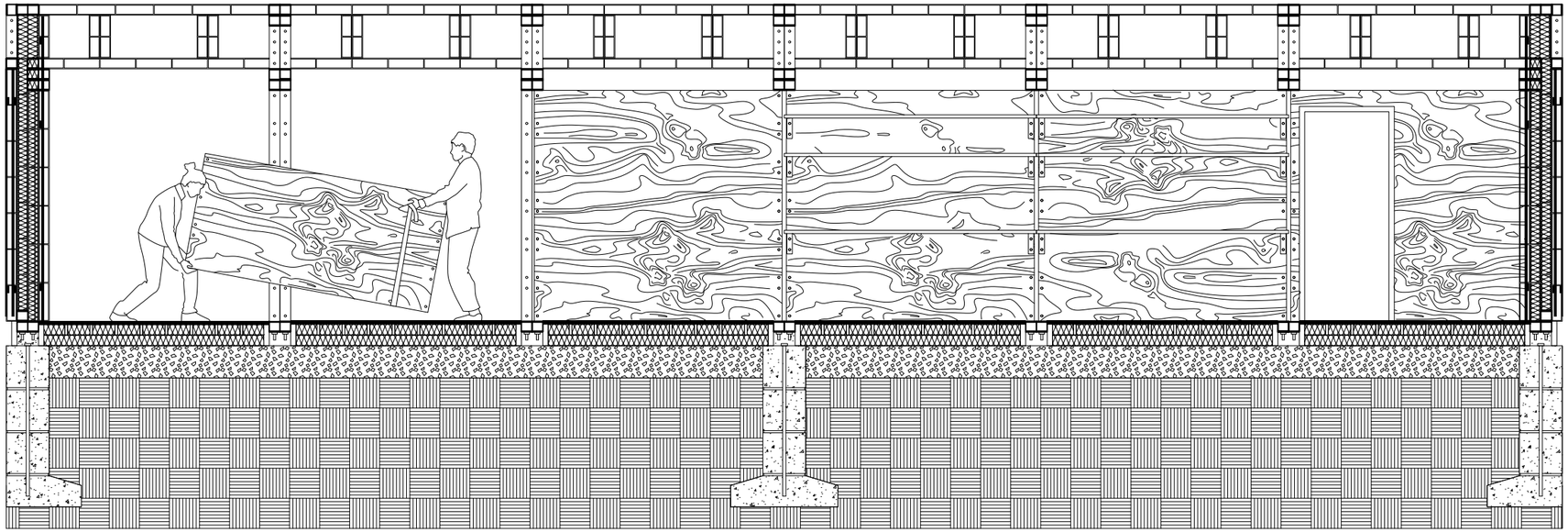
Tectonics is over-complicated

Some building elements, like the foundation, are often naturally hidden. For these elements, the art-form is not expressing anything. In cases like this, tectonics seems over-complicated. While it is possible to express the foundation, for example by lifting the building off the ground, this did not seem suitable at the site. Furthermore, it makes accessibility to and from the building more difficult.

In this case, I think it is enough that the foundation is dismountable, this does not need to be expressed.

Section D-d

Materiality

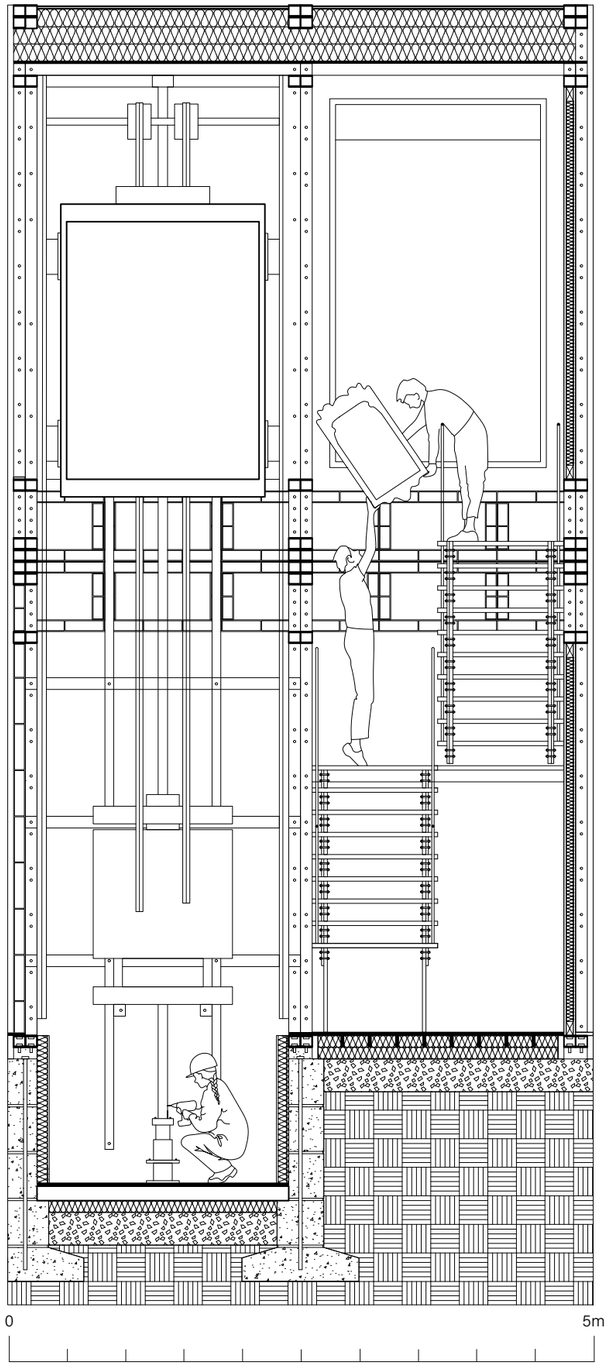


What does plywood express?

Building materials have cultural connotations. Within my cultural context, it is often perceived that wood is a lightweight building material, in comparison to heavy building materials such as concrete and brick.

Heidegger brings up the question of timelessness and universality when we express that it is the intrinsic qualities of a building object that endures. Will plywood be perceived as a lightweight building material in 200 years? Or in a small, sheltered community where concrete has never been used as a common building material? Maybe in the future, almost all buildings in Sweden might be made from wood, the heavy building elements and the lightweight building element might be made of different types of wood.

Despite this, plywood at its core-form has, relative to what people can normally lift, low density. Will this endure?



Part of section A-a

The lift and the stairs

Specialty disassembly

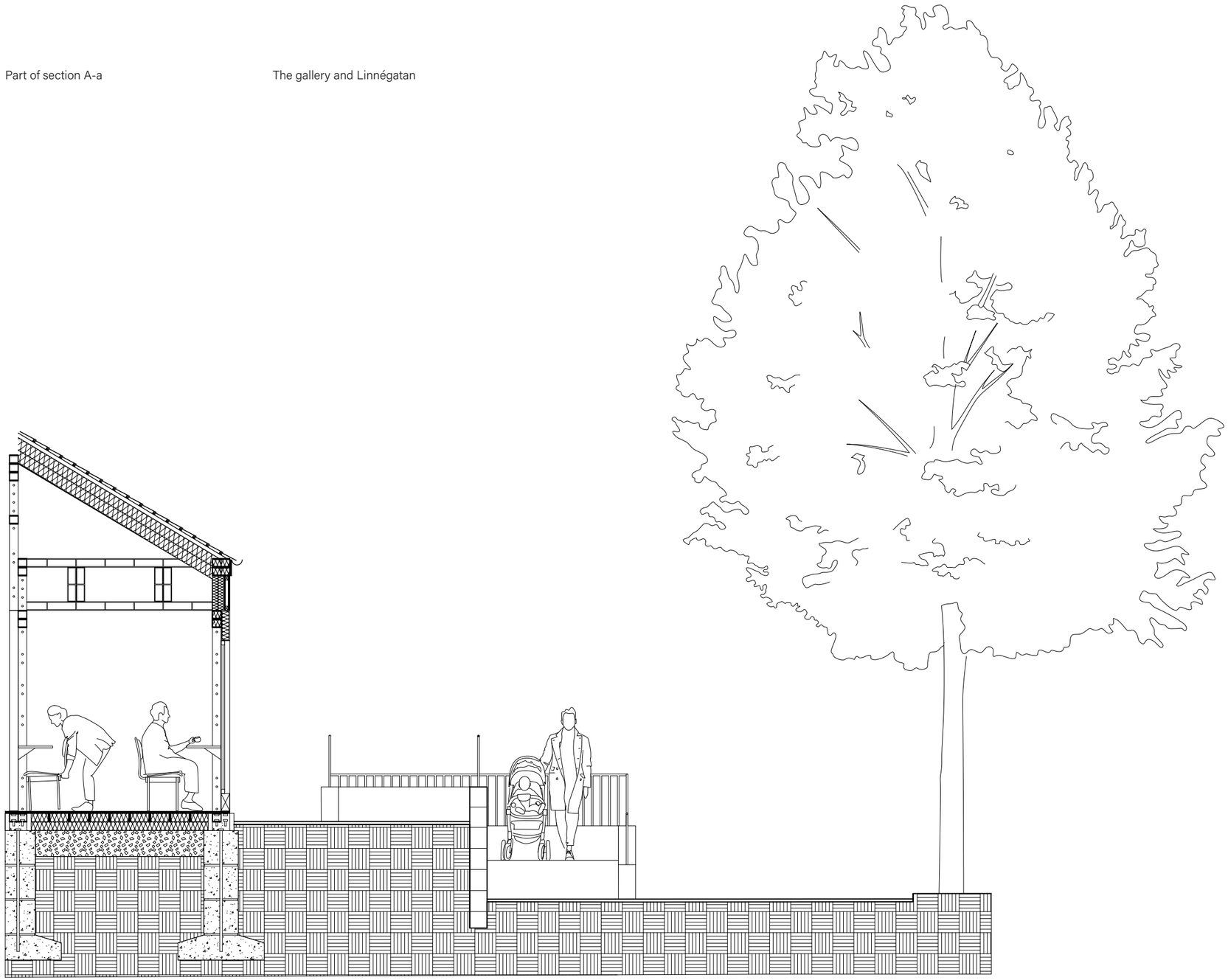
A conscious attempt was made to make the most temporary part of the building, the interior walls of the exhibition room, appear to be easier to disassemble than other walls. In a similar way, it would make sense to make the most permanent features of the building, the lift and the stairs, appear least dismountable.

I ended up deciding against that. Even though these things will require more work and special expertise to dismount on a core-form level, I tried to create a dismountable expression for them anyway, to make them suit the rest of the building better.

Even though Sekler's and Bötticher's ideas about how to express a building's structure and construction are to a significant extent aligned, Bötticher specifies that the role of the art-form is to express the core-form while Sekler takes a more neutral position on how the art-form should relate to the core-form. Thus, this design decision corresponds more with Sekler's position than with Bötticher's.

Part of section A-a

The gallery and Linnégatan



DFD = DFP

Going into this, I thought that since design for disassembly deals mainly with construction, this project would not to any substantial degree be concerned with social aspects of architecture. I was very wrong.

I am now realizing that to design for disassembly (DFD) is actually to design for people (DFP). My design process has been centered around trying to enable people to physically interact with the building and its elements in certain ways. Also, I have been trying to find ways to communicate to people though design how this can be done.

Furthermore, the whole point with designing intently with tectonics in mind, is to create interesting experiences for others.

At the urban scale, design for disassembly might have some interesting social implications. A building that can be assembled, disassembled and reassembled however often is desired or necessary, has a resilience against decay. I think this could impact people's emotional connection to the history of a place.

I made it a point to include people in my drawings, because in order to understand the disassembly of a building, I needed to understand how people might interact with the building.

Conclusion

The first conclusion I have come to as I have been working on this thesis is that designing for disassembly must be combined with a tectonic intention for the sake of achieving a truly simple structure and form and making connectors accessible.

Because of this, I want to object to Sekler's views on the topic of intention. His suggestion that the most successful architecture is not intentional does not make sense when it comes to design for disassembly. I would argue that my reference projects, Crystal Palace and Nakagin Capsule Tower, are examples of very successful cases of design for disassembly that prove Sekler's statement wrong.

However, tectonic intention does not always seem to be directly relevant when working with the design for disassembly principle spaces suitable for practical disassembly on site. In the case of my gallery, trying to create a tectonic expression for this principle seemed unnecessary and over-complicated.

As for Bötticher's theory, I appreciate his terminology. In retrospect, I realize that referring to tectonics as a building's art-form has been helpful for me in thinking about impractical values. Tectonics can do more than just what is practical for the sake of design for disassembly. Design for disassembly can become art. We have the potential of making the built environment fun and exciting. Is this not the greatest value architects can bring to society?

Regarding Heidegger's thought model of viewing a building as a thing, this was surprisingly helpful in understanding design for disassembly. I found myself coming back to the idea of endurance throughout the thesis, which become a way to question the importance of the tectonic expression. What I can conclude from this is that despite the potential of creating impractical values, sometimes intently designing for a specific tectonic expression just felt like it was too much. There are times when I believe we should honestly just focus on what will really endure.

In other words, sometimes the idea of the art-form and impractical values are more important than the core-form and what will endure, and sometimes vice versa. It appears the value of tectonics for design for disassembly depends on which of the four core principles the particular design decisions are referring to, and what part of the building is being designed.

As a tangent to the research question I have been exploring, I have been thinking about design for disassembly and what it could mean for creating resilience at an urban scale. This has been a motivation for my investigation, and a sidetrack to this thesis. Since I did not explore this in depth, I have no conclusions about this, other than that I think it is an interesting potential.

To round off, I will try to rephrase De La Saint-Yenne according to my view on tectonics and design for disassembly:

It is not enough to make a building dismountable, judgement must estimate it as such. Additionally, by playing with the judgement the experience of the building can be further enriched.

References

Ander, H., Lundgren, M. & Lönnroth, G. (1999). 'Olivedal 14', in: G. Lönnroth, (ed.) *Kulturhistorisk värdefull bebyggelse del 1.* Västerås: Joe Brig Art AB, pp. 184-195.

Crook, L. (2022). *Demolition of iconic Nakagin Capsule Tower begins in Tokyo.* Available at: https://www.dezeen.com/2022/04/12/nakagin-capsule-tower-demolition-begins-tokyo/ [Accessed 12 august 2022].

Frampton, K. (1995). *Modern arcitecture - a critical history*. fourth ed. London: Thames & Hudson Ltd.

Fredberg, C. R. A. (1919-1922). ' Djupedalen.' in: Det Gamla Göteborg: Lokalhistoriska Skildringar, Personalia och Kulturdrag. Göteborg: u.n., pp. 503-508.

Föreningen Viktoriahuset. (no date). *Första stenhuset på Linnégatan.* Available at: http://www.viktoriahuset.se/ [Accessed 23 August 2022].

Guldager Jensen, K. & Sommer, J. (2018). *Building a Circular Future.* 3rd ed. Denmark: The Danish Architectural Press.

Heidegger, M. (1967). *What is a thing?*. Chicago: Henry Regnery Company.

Kisho Kurokawa architect & associates. (no date). *Nakagin Capsule Tower*. Available at: https://www.kisho.co.jp/page/209.html (Accessed 8 August 2022).

Lisinski, A., Krabo, T. & Johansson, P. (2018). *REPLIK: Rivningarna 1967 var ett stort misstag.* Available at: https://www.goteborgdirekt.se/nyheter/replik-rivningarna-1967-var-ett-stort-misstag/reprcl!7bWxhVv5Caxin0sc01qoQ/ [Accessed 30 August 2022].

Merin, G. (2013). *AD Classics: The Crystal Palace / Joseph Paxton.* Available at: https://www.archdaily.com/397949/ad-classic-the-crystal-palace-joseph-paxton [Accessed 29 June 2022].

Nakagin Capsule Tower (no date). Available at: https://architectuul.com/architecture/nakagin-capsule-tower (CC BY-SA) [Accessed 30 July 2022].

Pallardy, R. & Tikkanen, A. (2019). *Metabolist school.* Available at: https://www.britannica.com/art/Metabolist-school [Accessed 30 August 2022].

Prinsgatan 1900 (early 1900s). [photograph] Available at: https://commons.wikimedia.org/wiki/File:Prinsgatan_1900.jpg?uselang=sv (public domain) [Accessed 7 August 2022].

Sekler, E. F. (1965). 'Structure, Construction, Tectonics.' in: *Structure in Art and Science* New York: George Brazillier, Inc., pp. 89-95.