IN-FORM

earthLAB Studio

Supported by Riksbyggen
”Den Goda Staden” fund.

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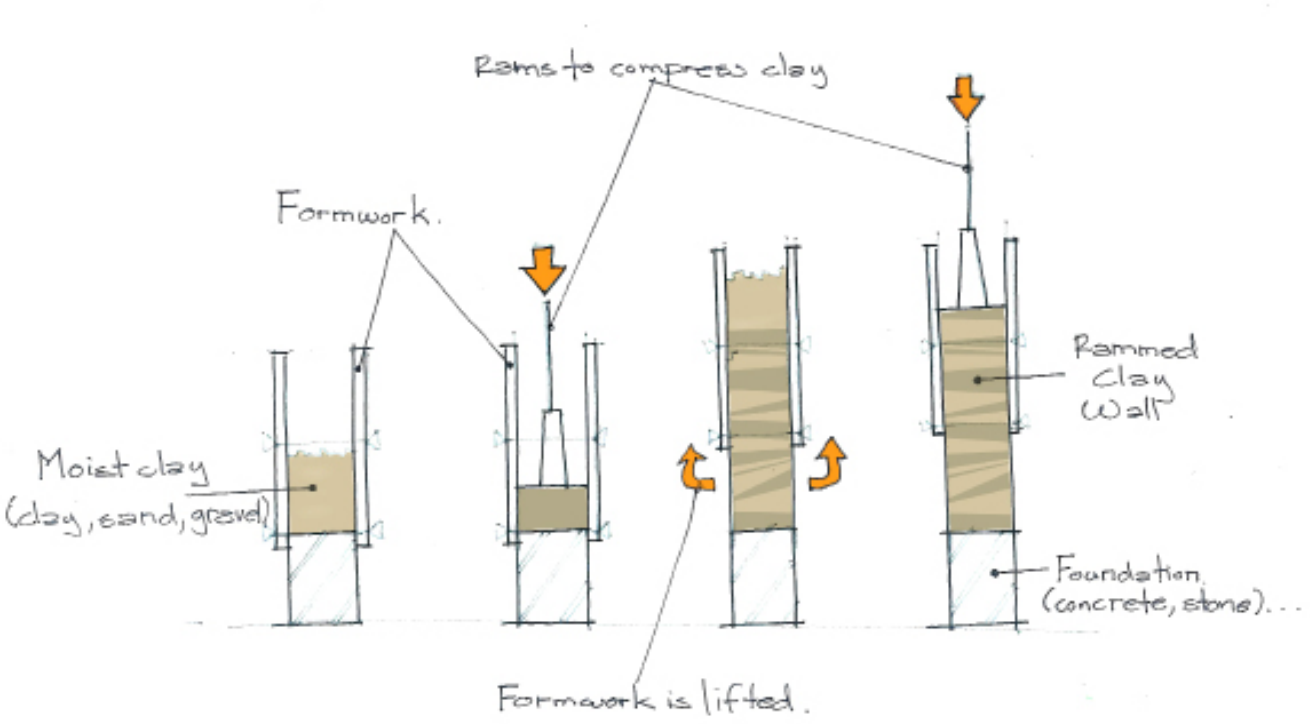
Introduction.

earthLAB Studio has explored, built and researched earth as a building material since 2014. We believe that building with earth is a form of expression. In this expression of building with earth, we at earthLAB are passionate about a specific method of earth building known as rammed earth. In this method there is a form, usually made of wood or metal, which is filled with non-organic earth, the earth is then compacted or rammed, and the form removed after compaction. Essentially the earth is self-standing and loadbearing.



This process however has certain limitations, for example; the time to assemble-disassemble the form is considerable, leaving the method in disadvantage with more conventional techniques. The weather can affect how and when to build, since earth is sensitive to water and moisture before it has had time to fully cure. Even so ,we believe that this beautiful material has the potential of being used in diverse constructions in combination with a smart architecture. Here is where InForm comes into the play. Through this project we have aimed to experiment with the formwork aspect of rammed earth and in doing so hope to decrease the construction time and thus make the technique more affordable for smaller-scale constructions, and at the same time more convenient and accessible to small building firms and self-builders.

Background.

Building with earth can enable the use of local material as a building material. This makes it easy to keep accurate control and avoid toxins in the building material. Earth walls regulate temperature and moisture in a passive way, without energy-intensive technology. The material is inexpensive, plus it has a beautiful timeless aesthetic expression. Earth is a friendly material that can be used in several different contexts, such as walls, stoves, floors and furniture. Despite the fact that rammed earth has many properties that are sought in today's architecture, it is difficult to gain access to knowledge about how to build with it.

Today, there are several challenges in the construction industry and residential environment eg. toxins in building materials, poor indoor air quality affecting human health, poor heat storage and few choices of building materials, negative climate impact in the manufacture of building materials and building materials that are produced far away. In many countries of origin, it is also often bad conditions for those who manufacture the materials. Building with earth, on the other hand, is a sustainable method that uses local, natural materials.

“Ever since we learned to build homes and cities around 10,000 years ago, earth has undoubtedly been one of the most widely used construction materials in the world (Guillard).”

This technology has been around for thousands of years, but knowledge has disappeared. Today there is a renaissance where some actors have started building with rammed earth, including in Austria, the USA, Australia, Canada, Germany and more. At earthLAB, we believe that more and more countries will start thinking about different alternative materials such as earth. In Sweden, there are only a few players who use rammed earth, and we want to bring this to Sweden and other countries.

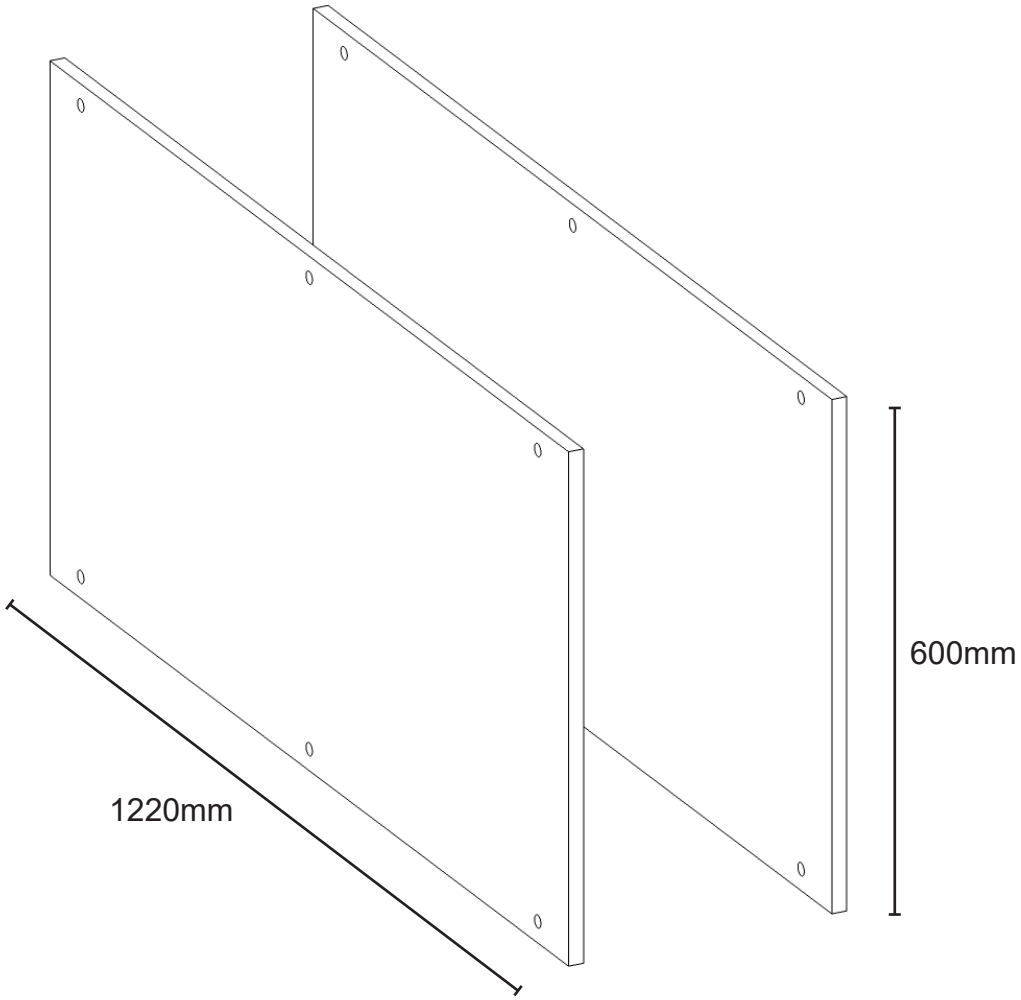
Aim.

The purpose of the Inform project is to develop a rammed earth formwork that is accessible to everyone and results in health-friendly, beautiful and sustainable buildings or building parts. We aim do this by conveying drawings for this formwork together with instructions on how to use it. Our experience with rammed earth has made us aware of problems that hinder the method from being used. The formwork often used are difficult to install and adjust. Thus, Inform aims to be physically light, but at the same time strong and easy to disassemble and assemble. In Sweden, the target group for this product is people who are especially interested in building their own houses with alternative, sustainable building methods and small companies that want to be able to offer an increased range of architectural materials. On a global scale, we see that it can help many people to a better living environment. During our work in Kenya and Mexico, we have learned that many leave earth-built houses to move to concrete houses. We work to change the image of earth as a poor building material and show that it is a good and sustainable alternative. We intend to do this both in Sweden and at international level by encouraging designers, builders and homeowners to consider earth as an alternative to expand the possibilities for sustainable buildings.

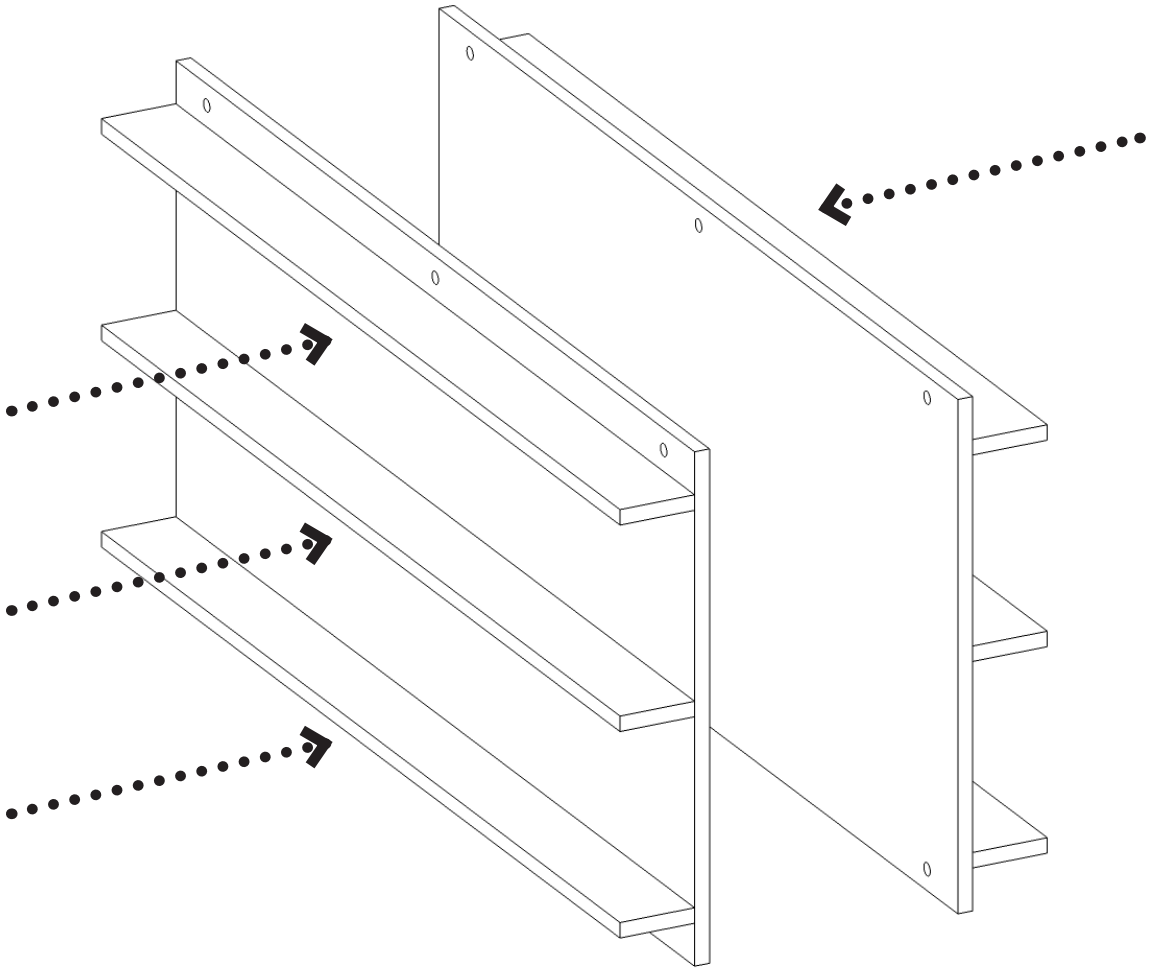
Chapter 1: Rammed earth formwork typologies.

Since rammed earth is used worldwide, the way it is built varies from place to place. In this chapter we analyse the most common form works in rammed earth.

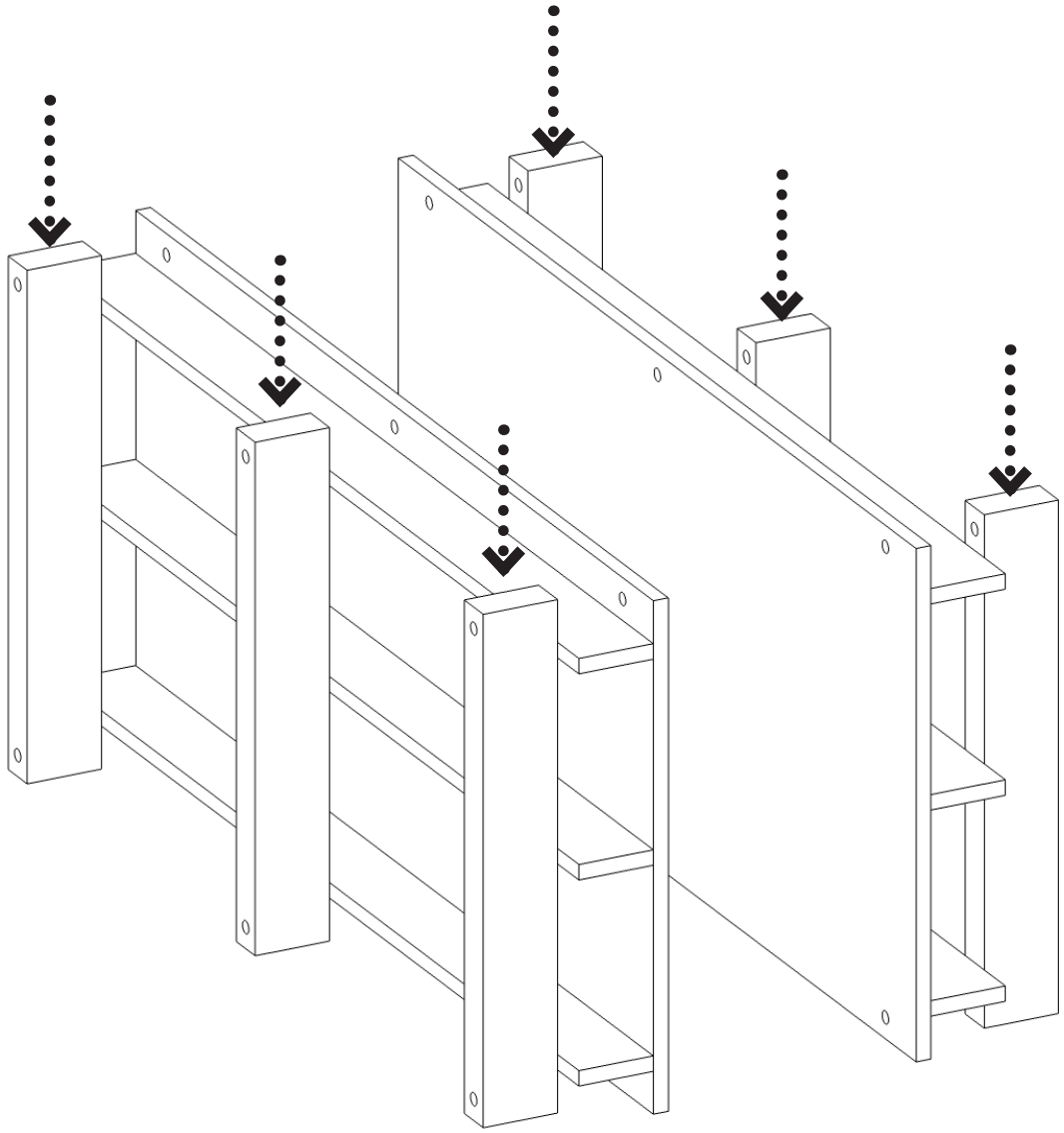
Common form.
Sides are usually 18mm plywood. Stable, heavy; it needs at least 2 persons to assemble form.



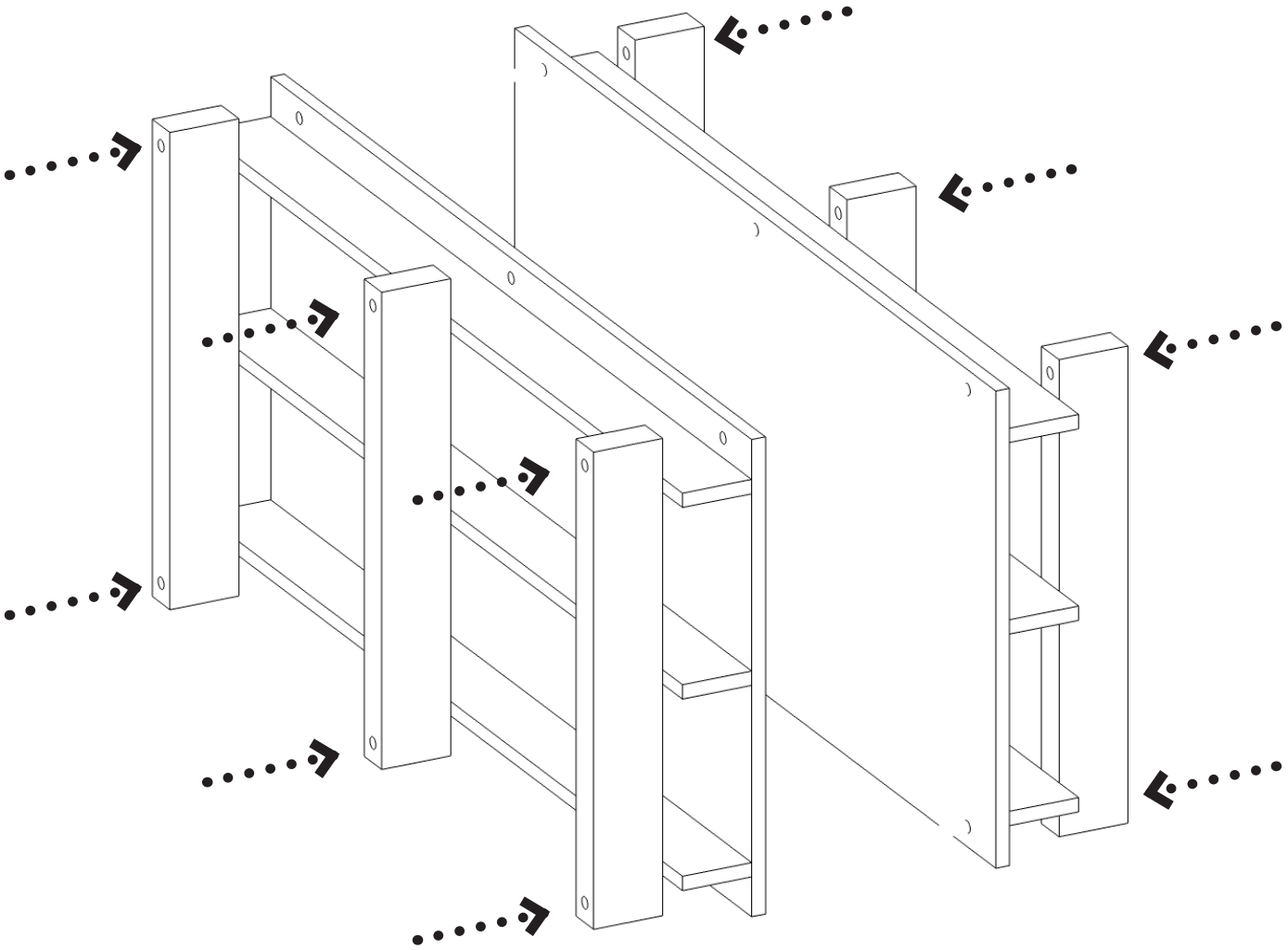
Common form.
Ribs can be 90x18mm wood. They prevent bulging.



Common form.
Verticals can be 90x45mm wood. They hold the steel rods and keep the form in place.



Common form.
Rods can be 12mm in diameter. They hold the two sides together and prevent lifting.



Other types of forms.
Type 1 - typical, vernacular type form.

Type 2 - industrial type form.

Type 1 - typical, vernacular type form.


Type 2 - industrial type form.


Type 1 - typical, vernacular type form.

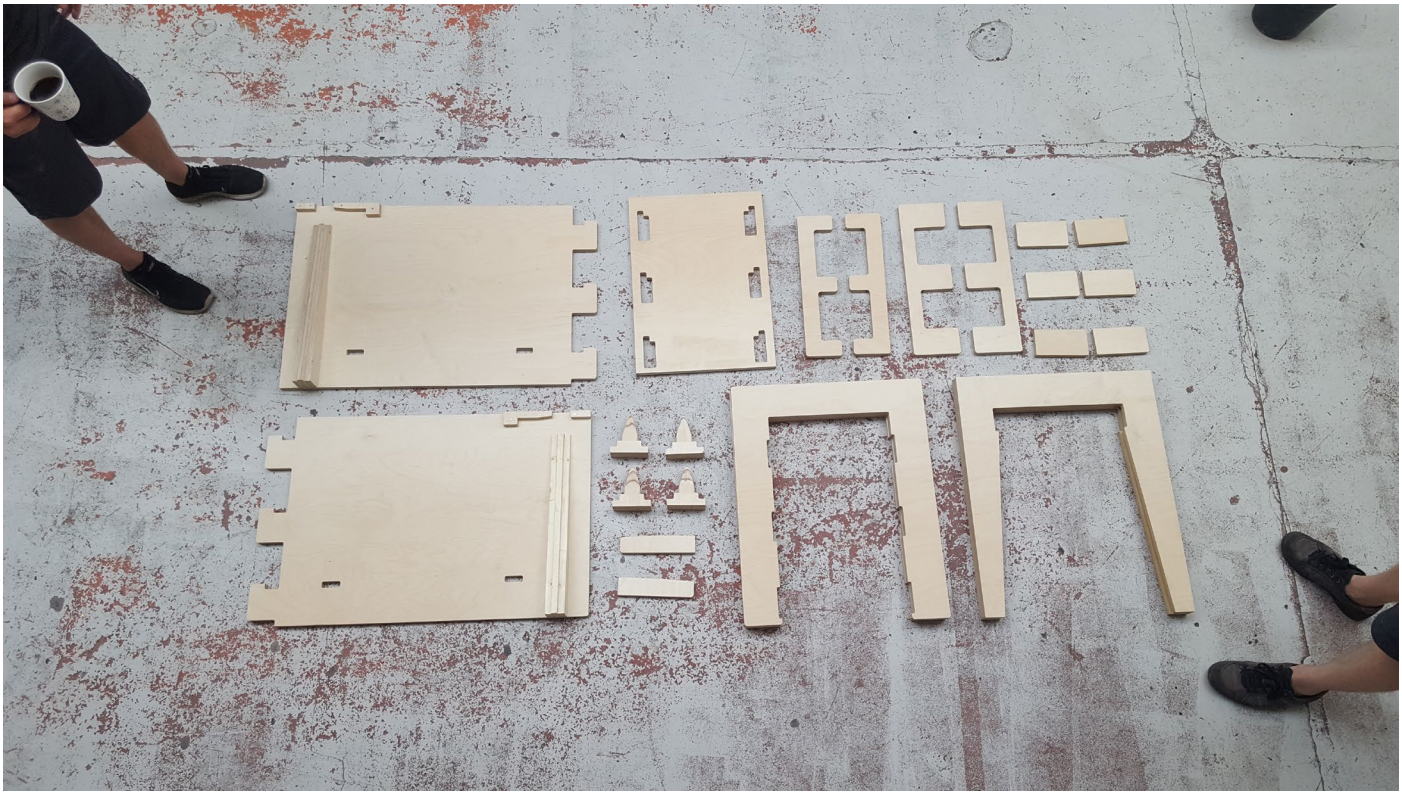
Chapter 2: Key aspects and functions.

Key aspects and functions.
Small form to build large volumes.

Focus points.
-No metal fasteners.
-Quick to assemble and dissassemble.
-Light weight.
-All wood of one type (plywood).
-Replicable
-Inexpensive.

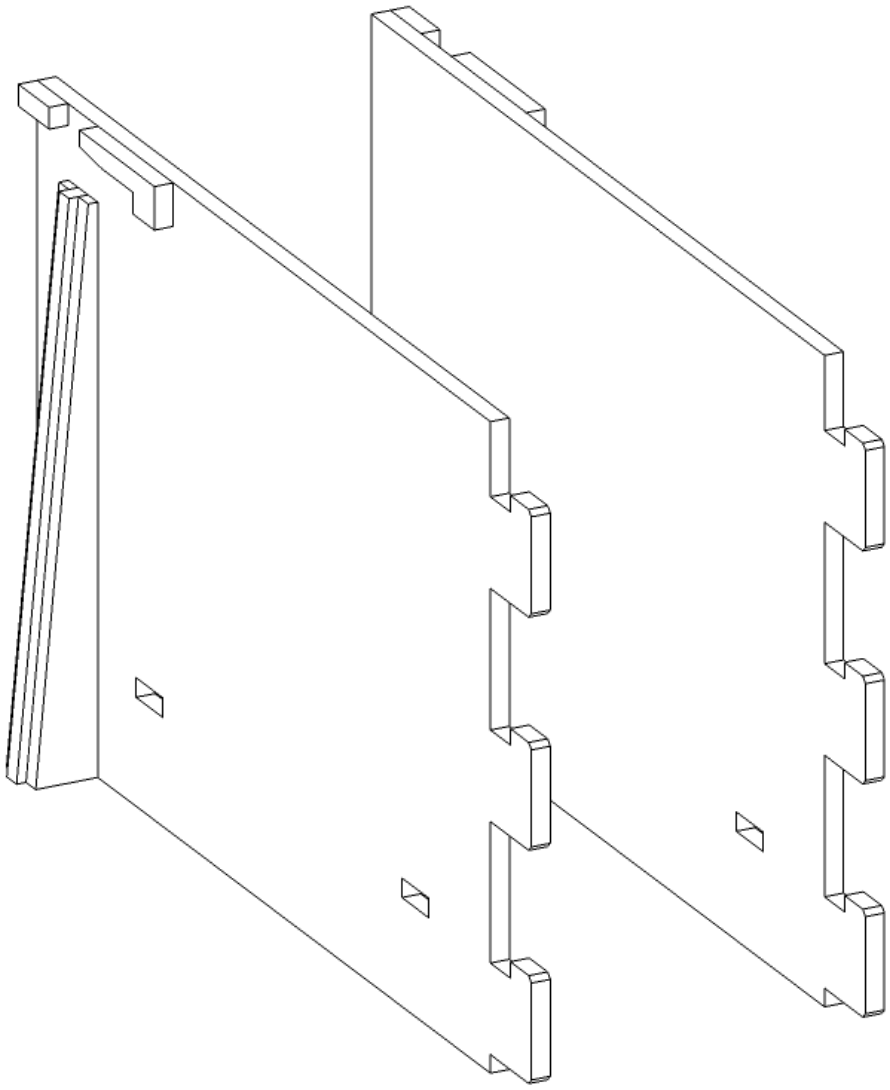
Chapter 3: In-form development.

FInal concept.

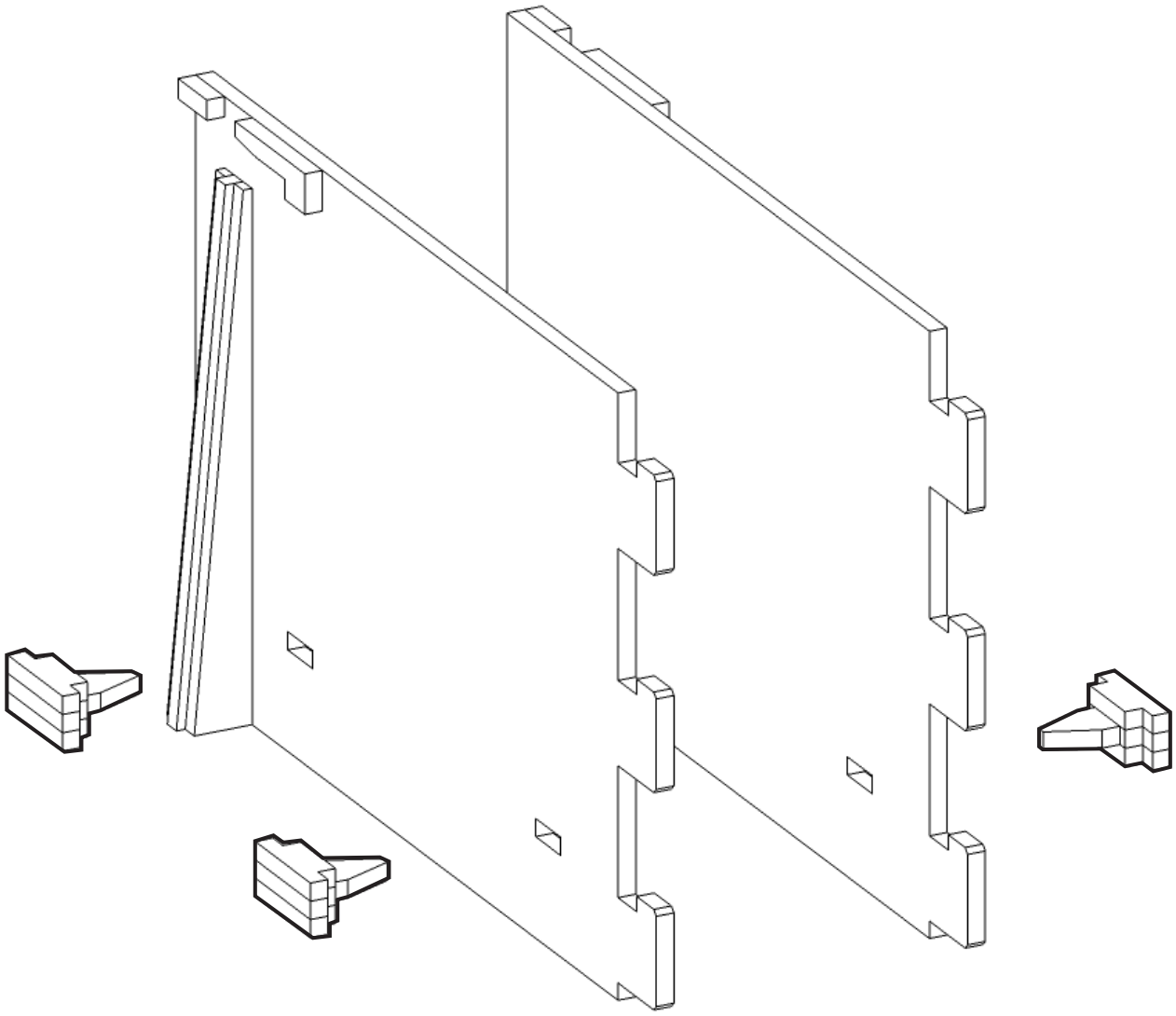


Chapter 3: In-form development.

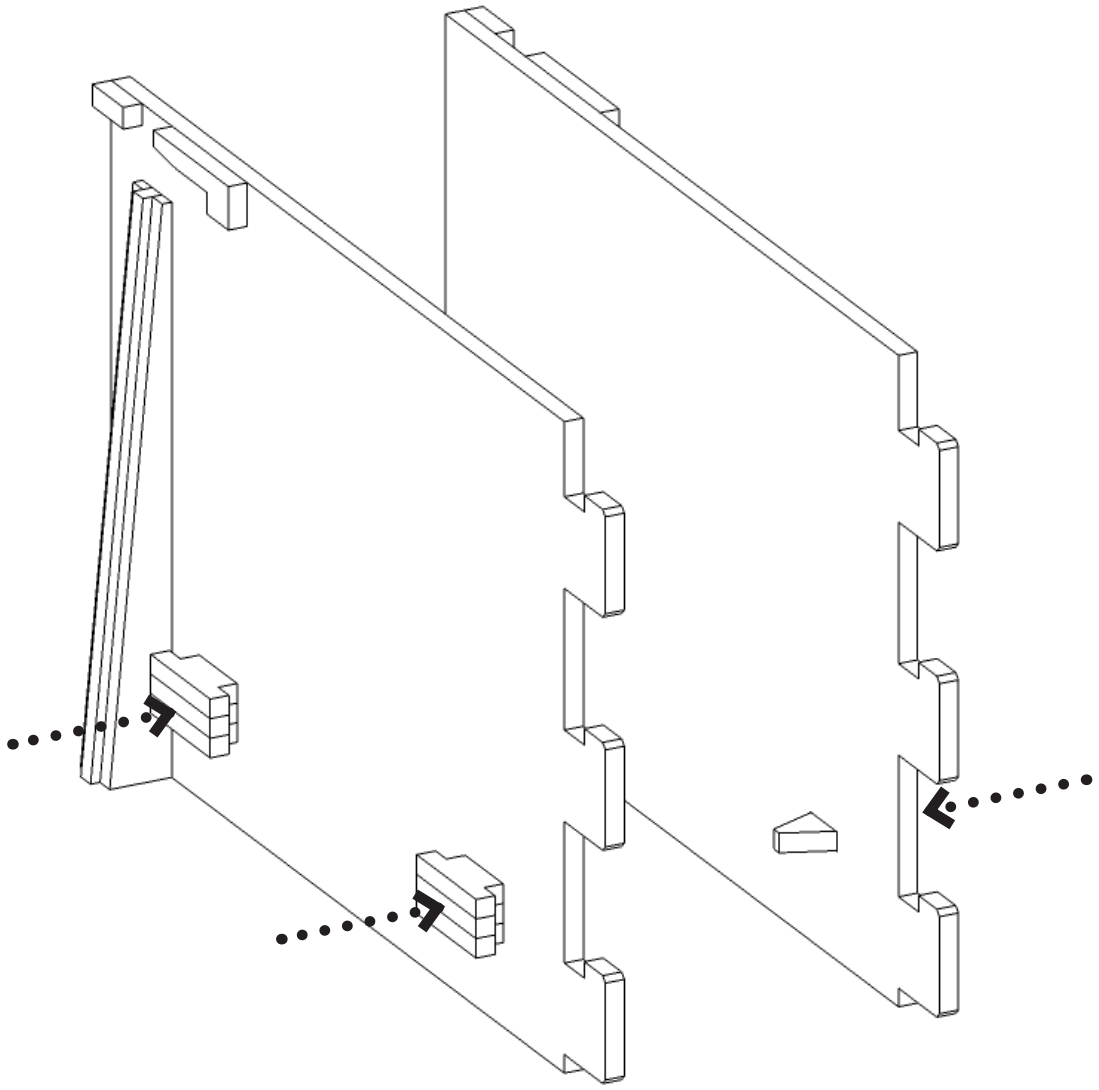
Design and assembly.
Sides, 18 mm plywood.



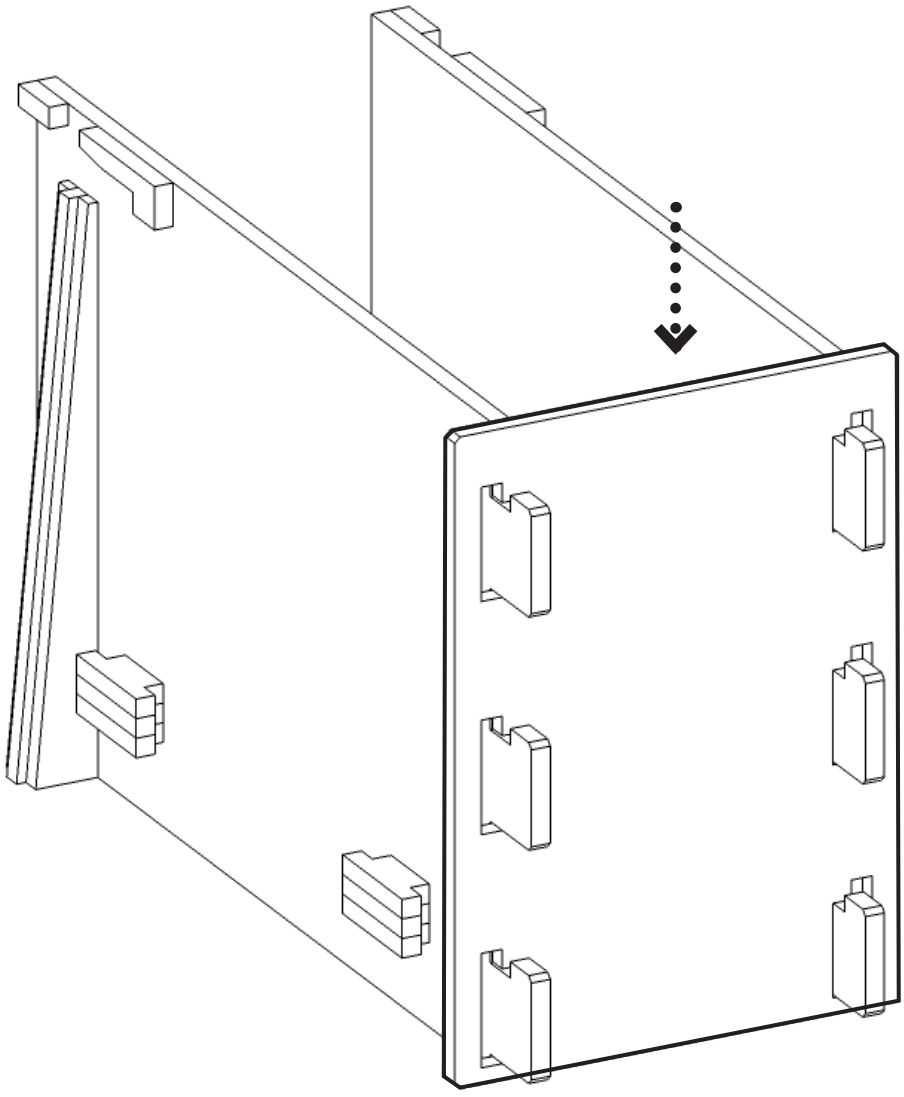
Design and assembly.
Support plugs.



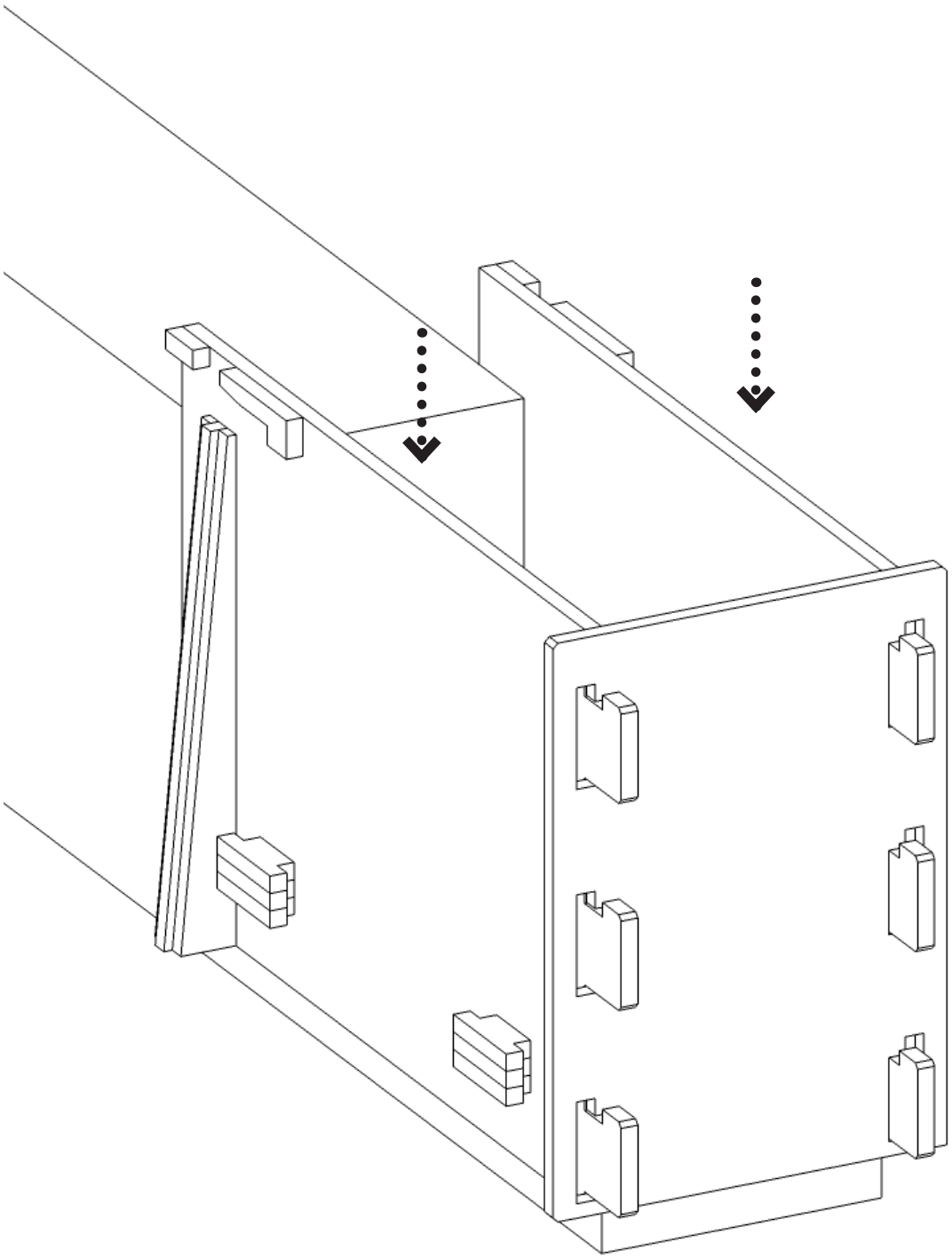
Design and assembly.
Support plugs.



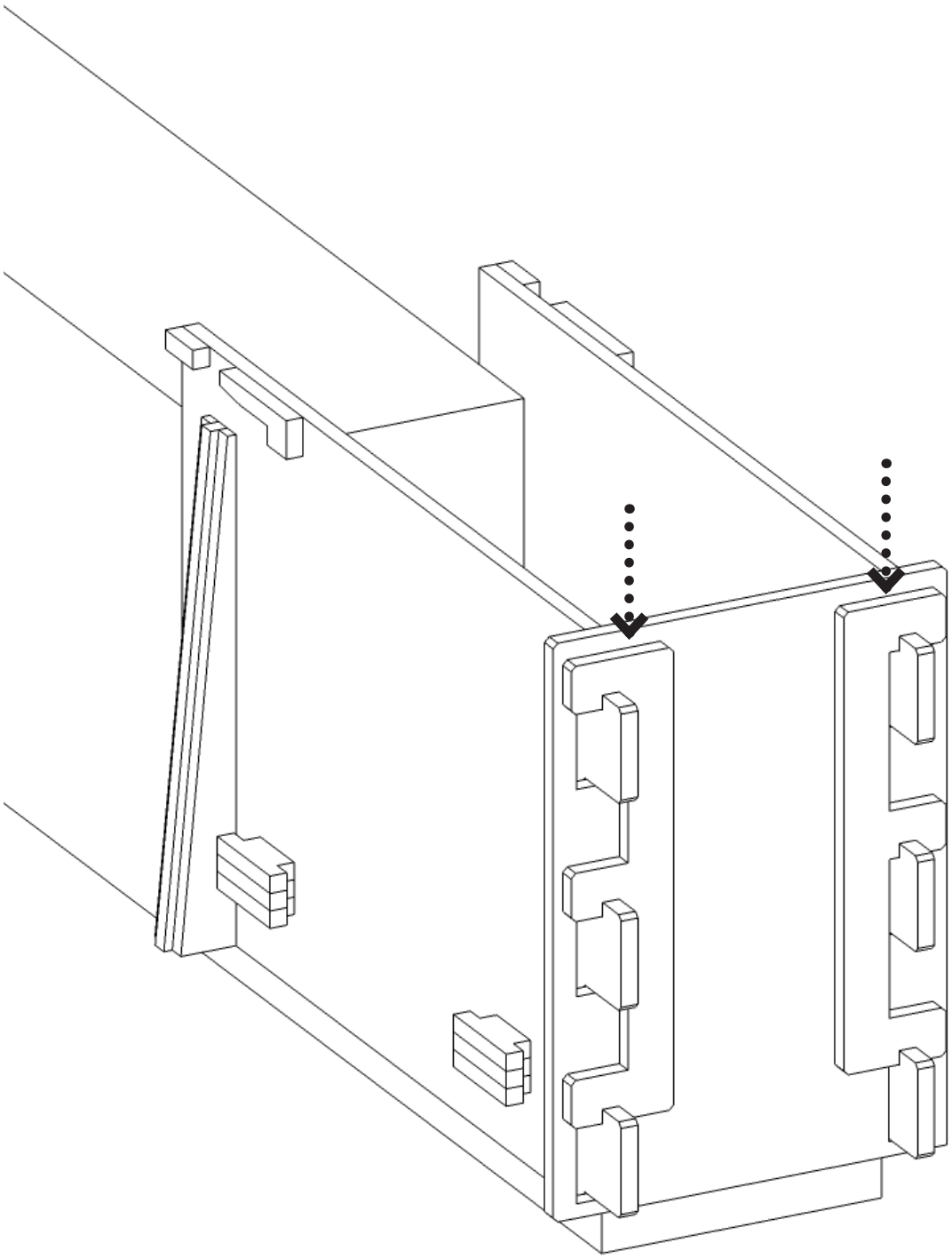
Design and assembly.
End piece - lateral.



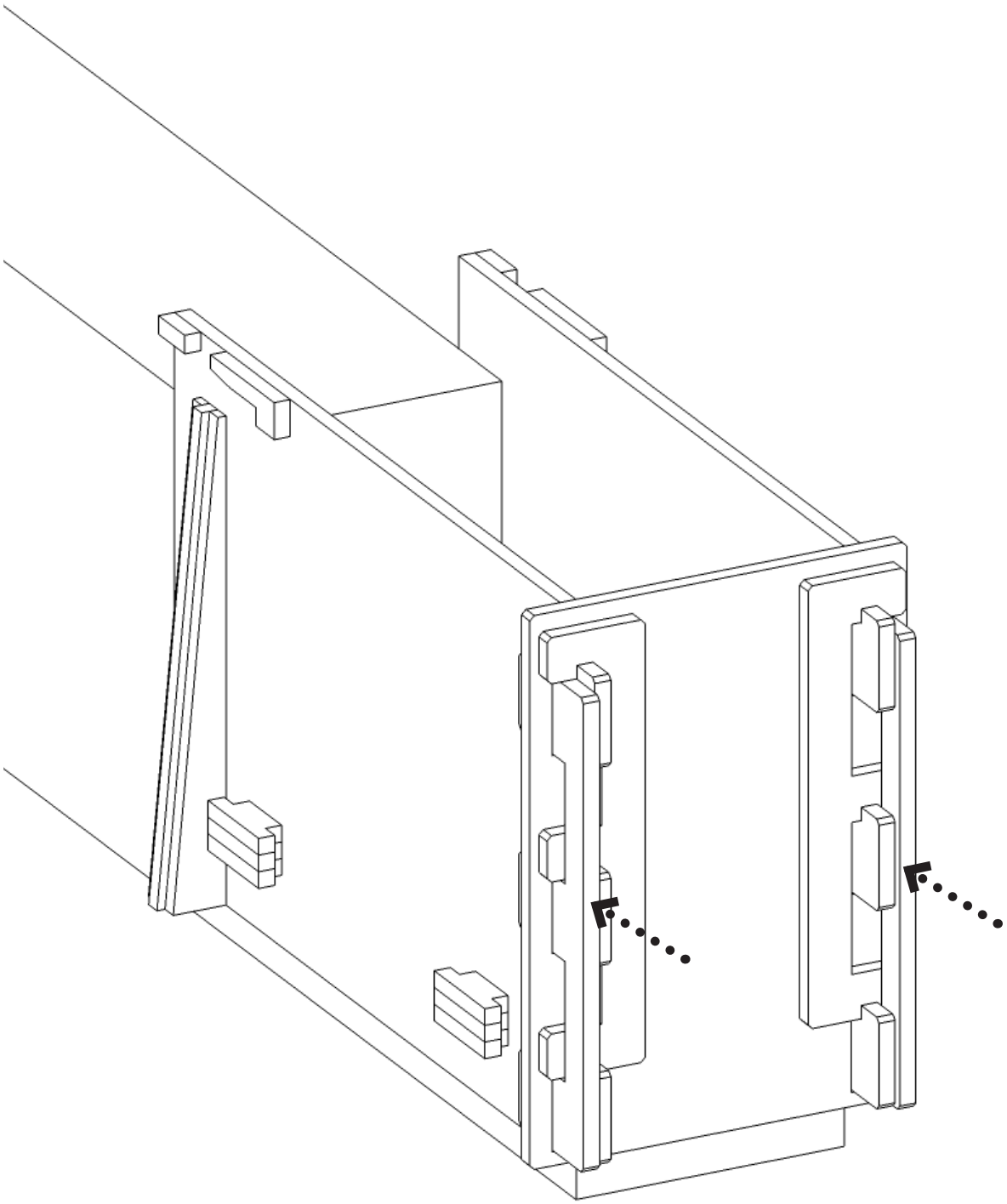
Design and assembly.
Place form in wall.



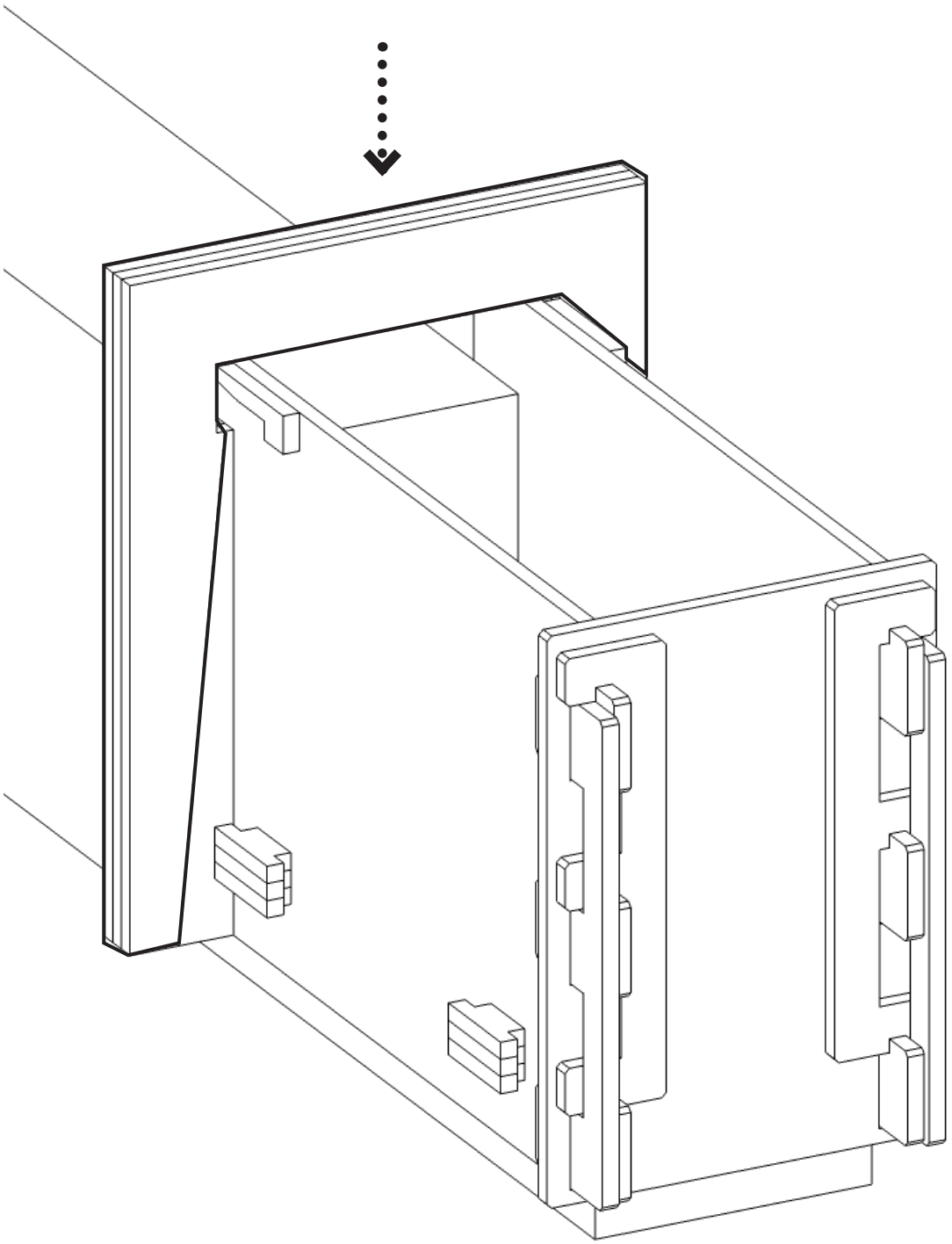
Design and assembly.
E lock pieces.



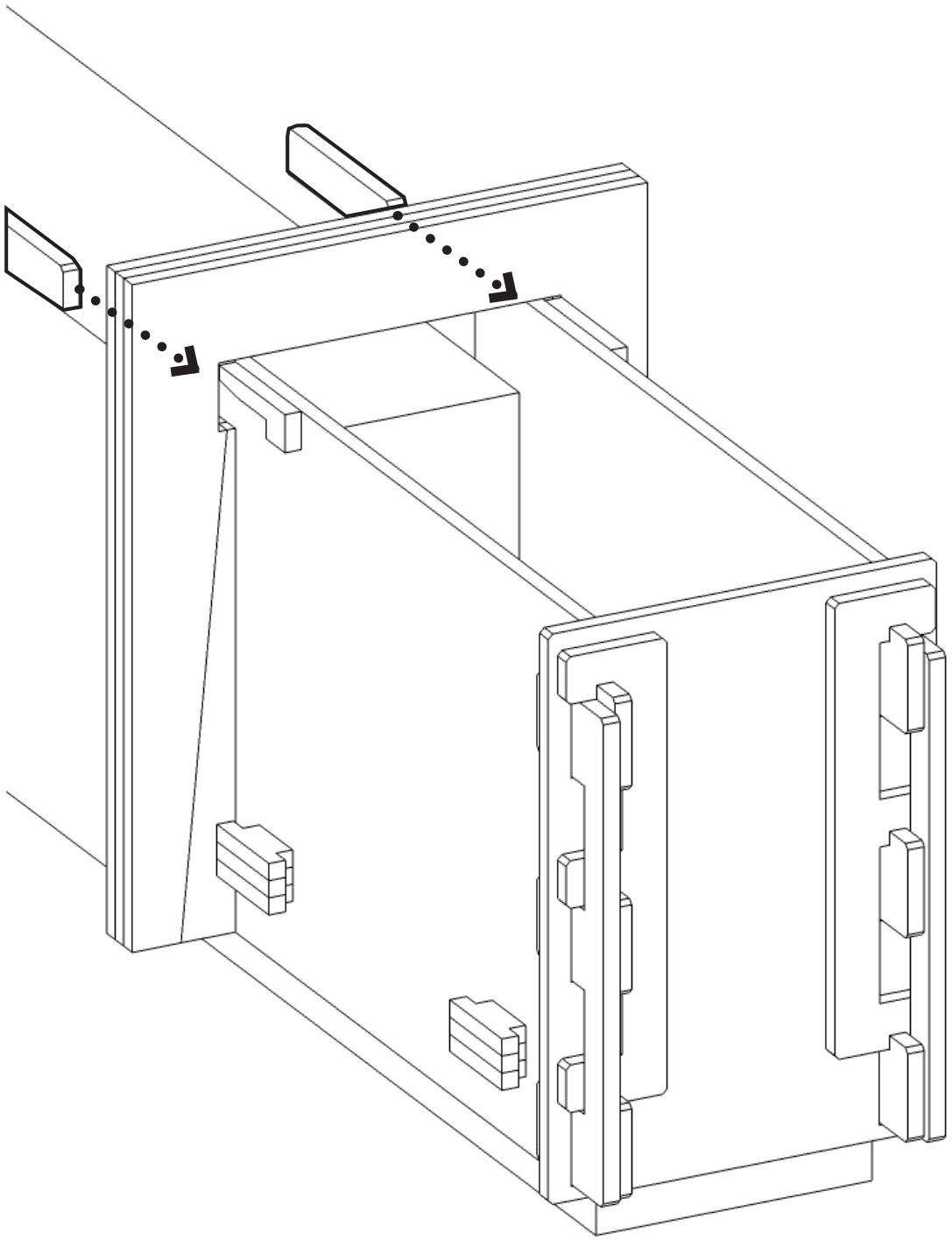
Design and assembly.
E lock pieces.



Design and assembly.
Clamp.

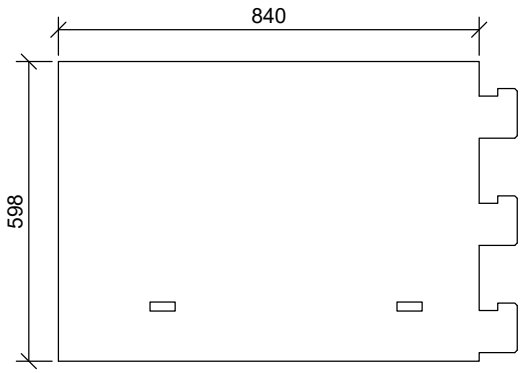


Design and assembly.
Clamp plugs.

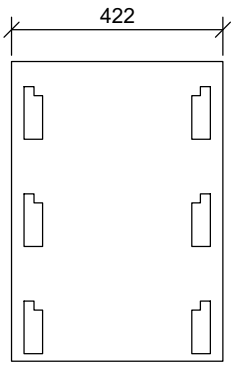


Detailed components.

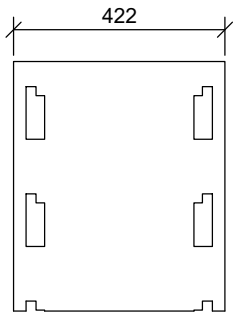
Side (x2)



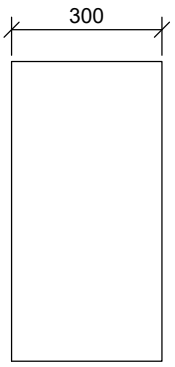
End piece full



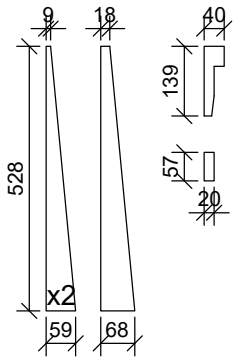
End piece short



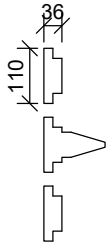
End piece plain



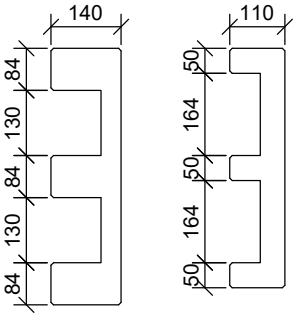
Fasten to sides (x2)



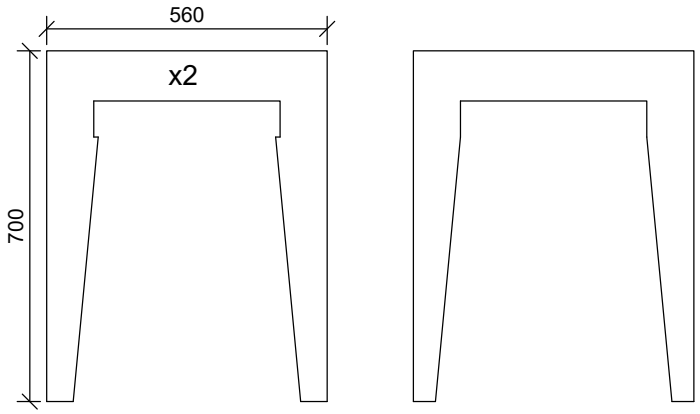
Plugs for the sides (x4)



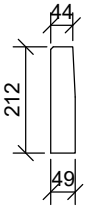
For joining sides to the end (x2)



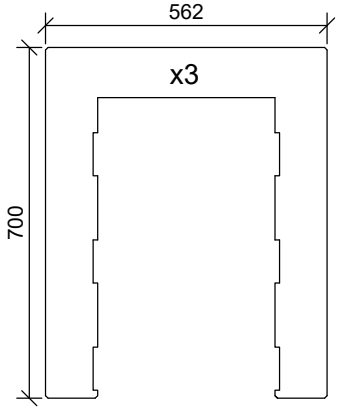
Clamp



Lock piece for clamp (x2)

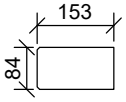


An alternative clamp design



Fasten to sides (alternative clamp design) (x4)

Wedges for alternative clamp design (x6)



Chapter 4: Discussion and conclusions.

Through the lengthy testing and development process of the inform Project we have held strong to the aim of minimizing screws or mechanical fasteners, this limited the functional and design possibilities. However, we were able to create a ‘plug-and-play’ formwork that is fast and simple to assemble and disassemble. Even though we feel that there is further testing and development to be done to truly optimize the functionality and design, this report has been created to spread the current state of the In-form project. In hopes that others can use the current design and improve on it, as this is earthLAB’s mission and aim, to spread knowledge and the use of earth as a building material.

Potential future research and imporvements.

1. During the testing of the final prototype slight deformations were documented in the plywood walls of the form. These were less than 5mm and overall does not highly affect the effectiveness of the form, however, a thicker plywood or ribbing could be used to mitigate this.
2. The development of a corner form in the same style as inform would be needed for the construction of complex structures
3. An intuitive color or symbol marking of the form components should be developed to allow for easier and faster assembly
4. In-form was developed to pack flat and be easy to move from site to site without the need for large trucks or vans. To improve portability carrying straps or case could be developed
5. Currently only one end of InForm has ‘hooks’ allowing for the end piece to be attached, this enables the ‘clamp’ side to attach to an already existing wall. When starting a stand-alone rammed earth wall with In-form a second end piece is needed on the clamp side for each elevation. This could be done by attaching a temporary end piece to that side or by creating ‘hooks’ on both side of the In-form side panels
6. In-form was designed to allow the construction of different thicknesses of wall using the same side panels, however, end pieces and clamps need to be created for each thickness of wall. More testing and development is needed to create a InForm system that allows a more easily adjustable wall thickness.

Acknowledgements.

We would especially like to thank Riksbyggen for its support through their Den Goda Staden initiative. Their support and interest in earth building is what made this project possible.

References and image sources.

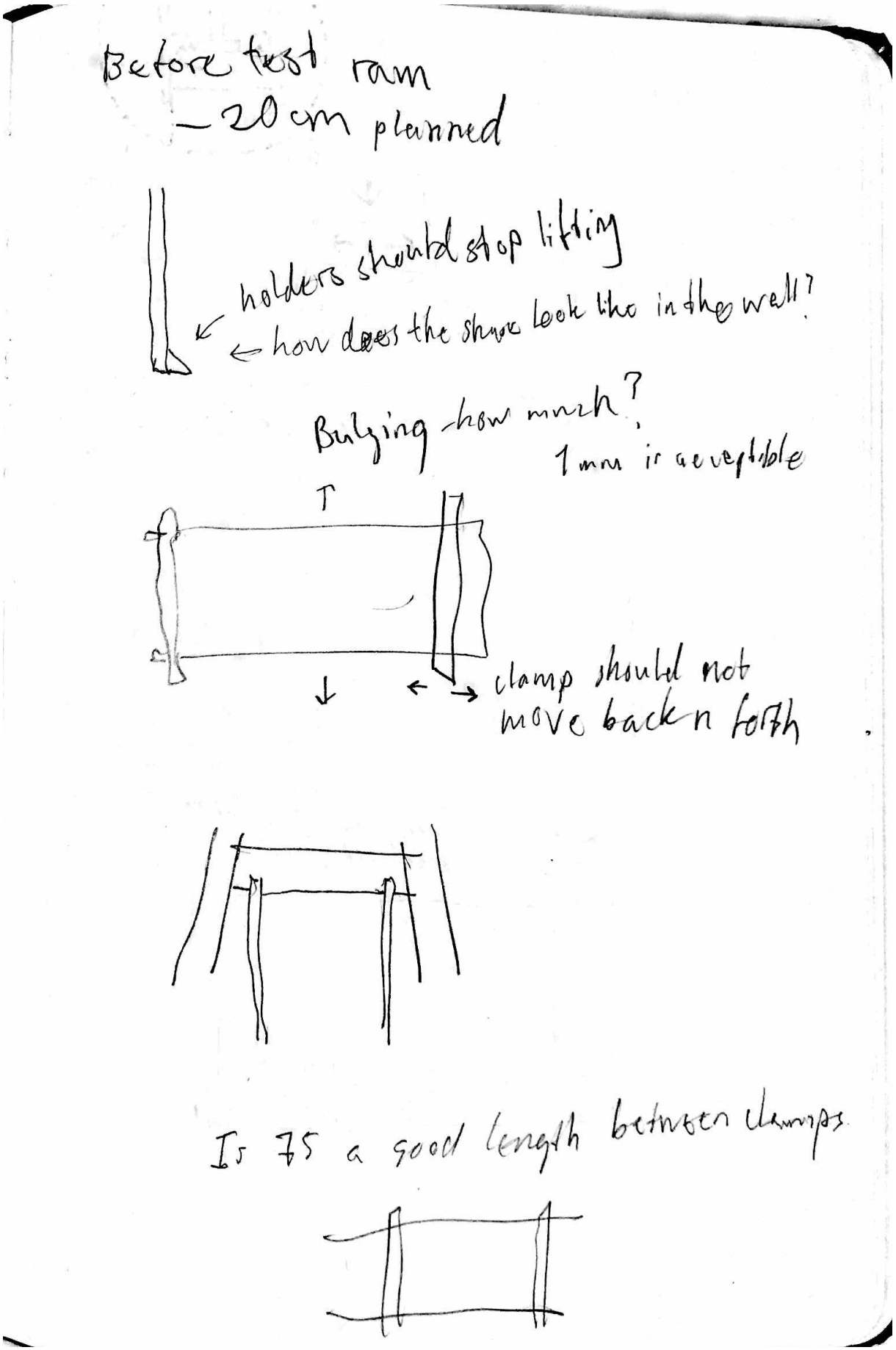
Building with Earth.
Design and Technology of a Sustainable Architecture.
Gernot Minke, 2018.

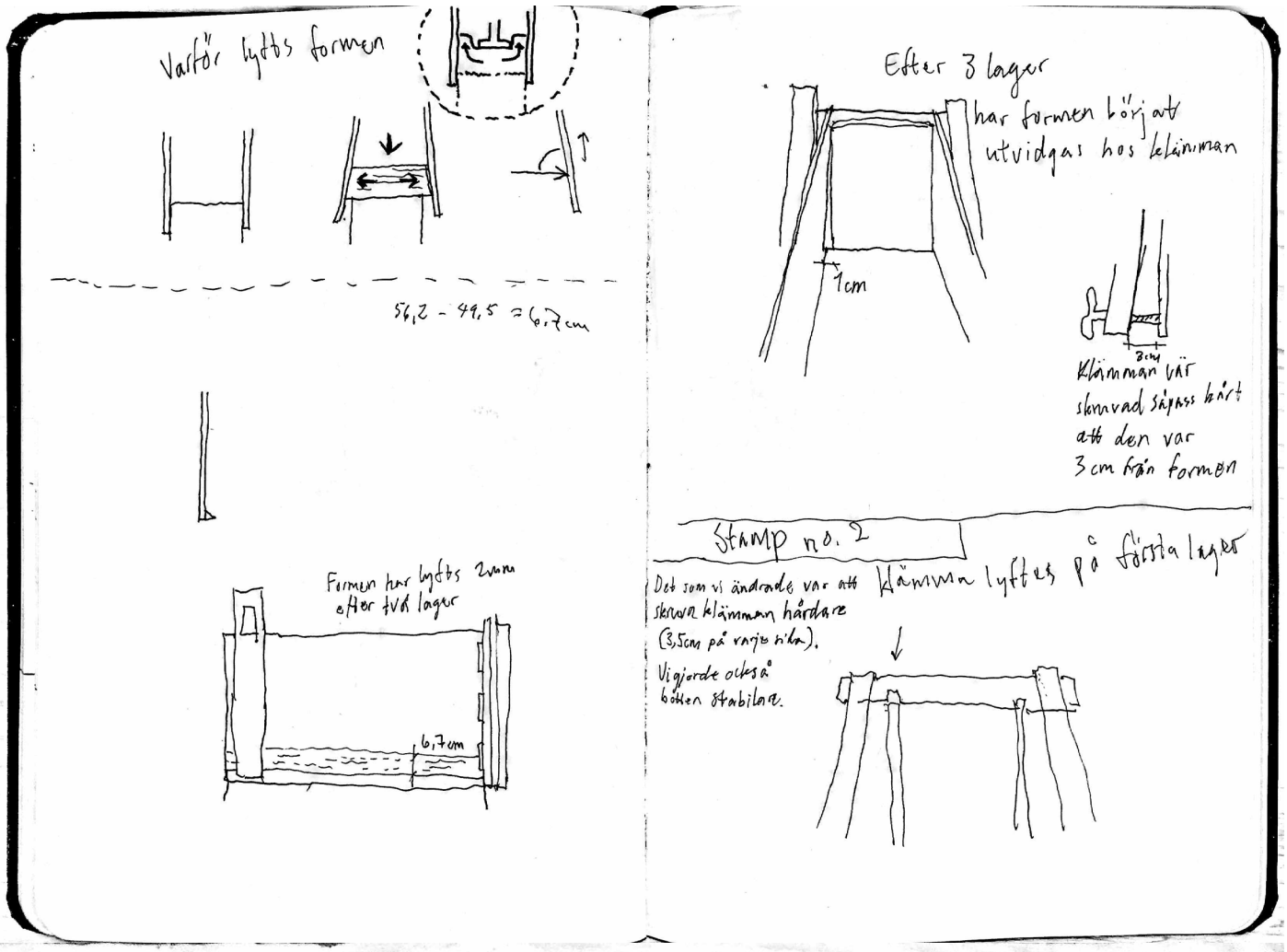
Page 7.
Ramming Earth.JPG.
Wikimedia Commons

Page 7.
House Building In Norhtern Vietnam.JPG
Wikimedia Commons

Appendix A.

Field notes and sketches.





First layer - Problem with lifting. Screws added to bottom (we used no fastening)

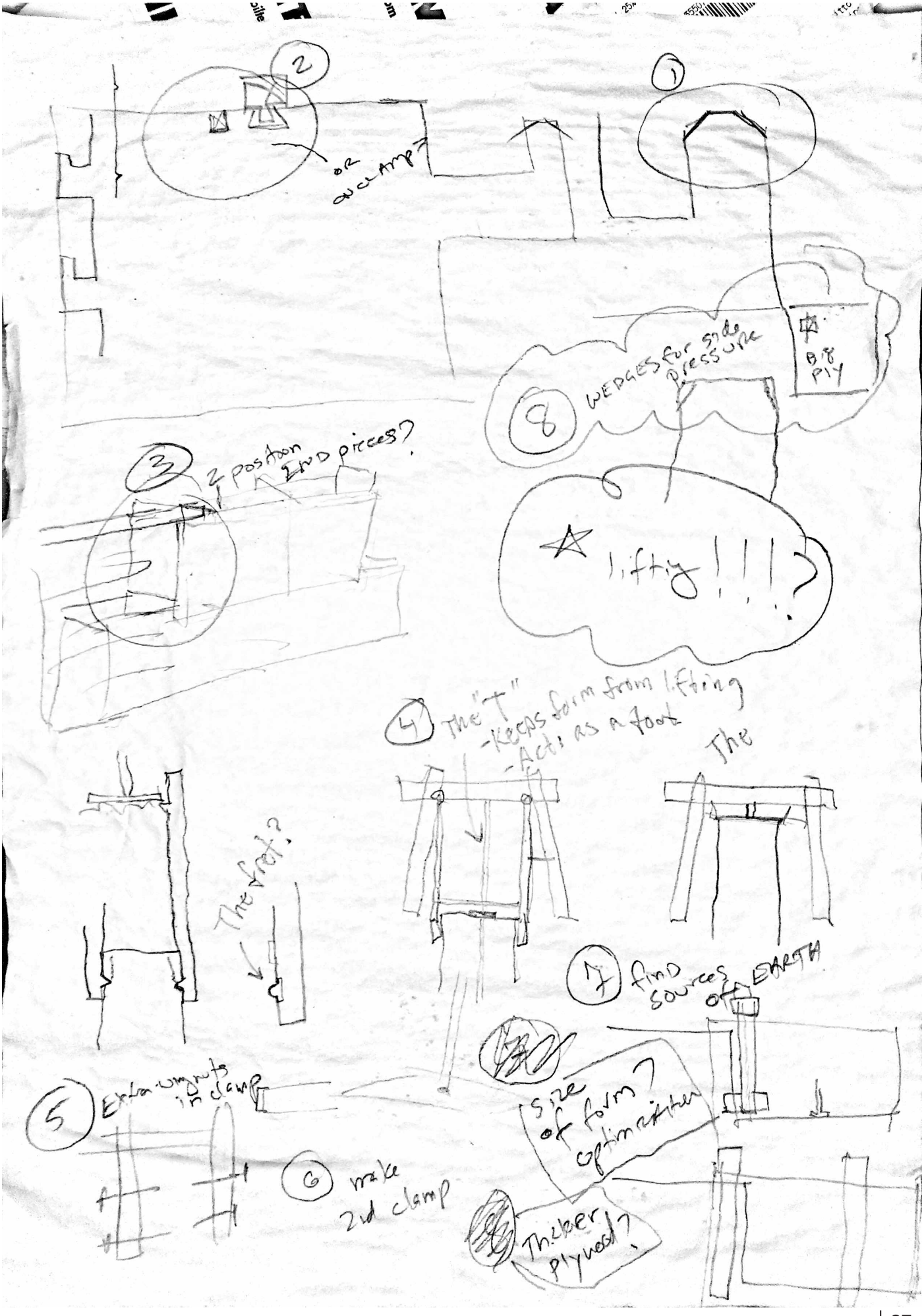
Second layer - The ⊤-clamp is moving along the top edges of the form. and it has lifted up 2mm.

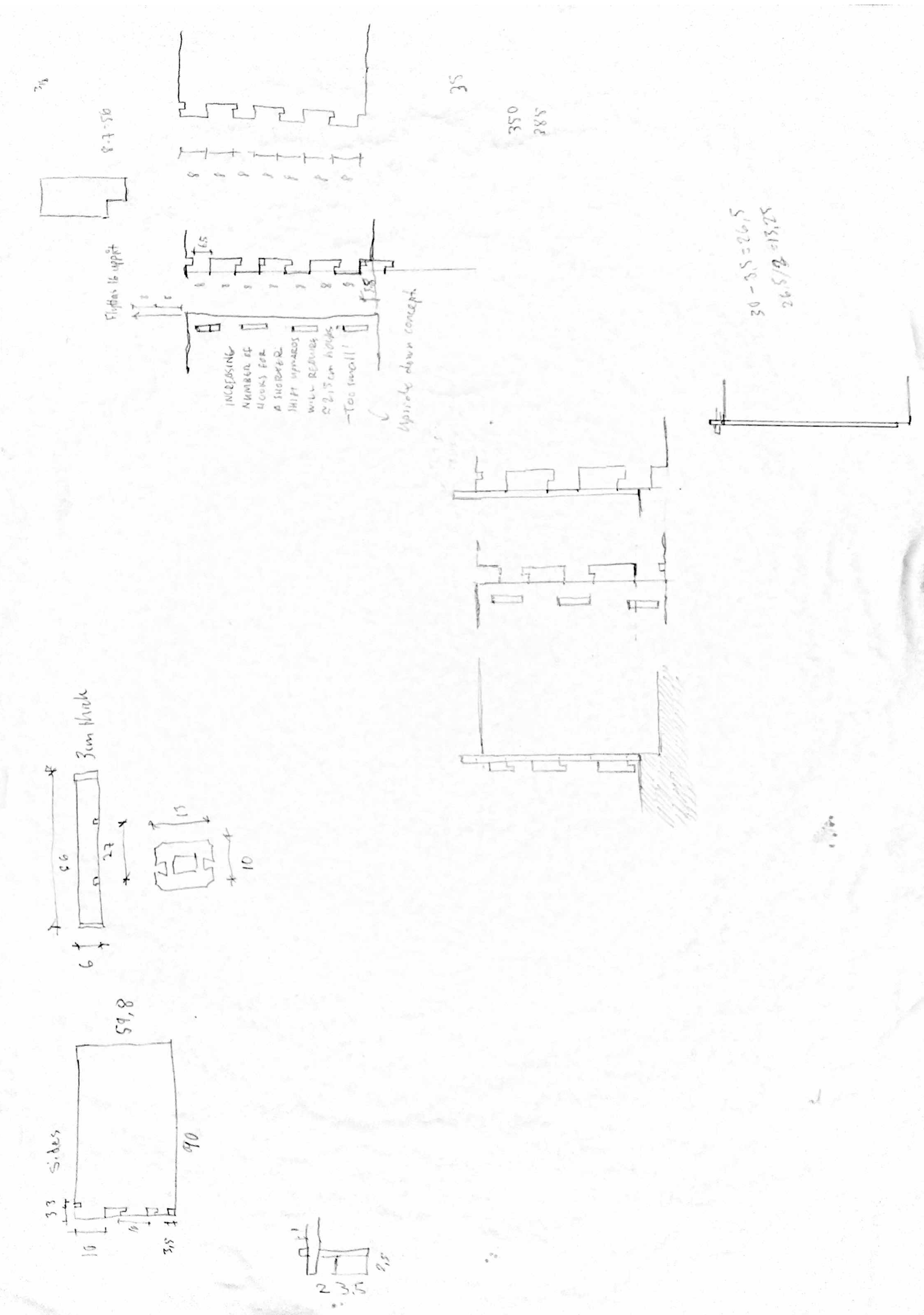
Third. - there was som bulgin ing the plywood between the clamp and the ends. between 3 - 5 mm.

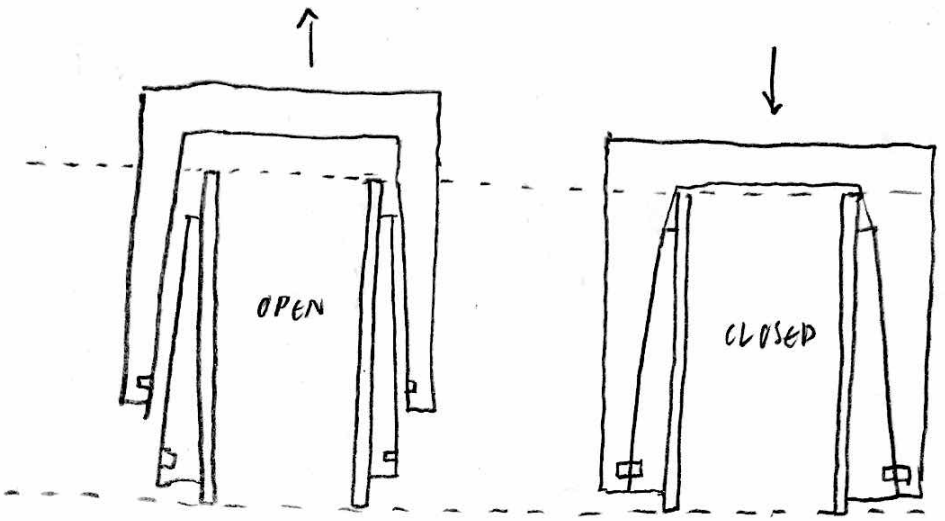
~~Problem~~ ~~The clamp seems to be~~

The wingnuts on the clamp ⊤ are in the way.

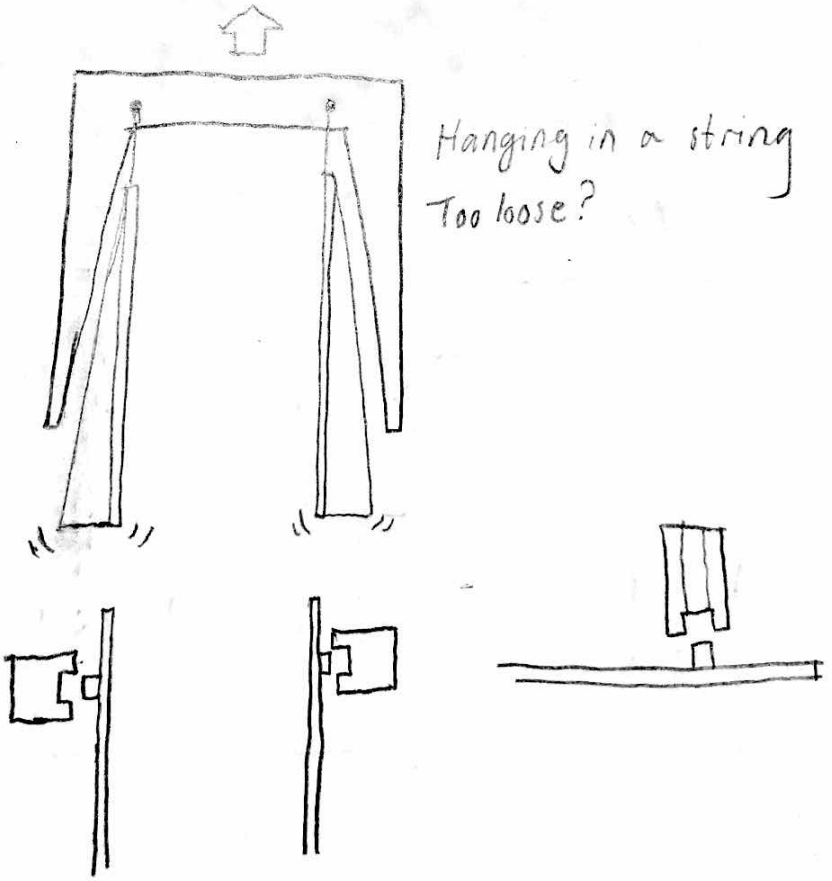
Note: it would be better to add contact higher up on the clamp ⊤

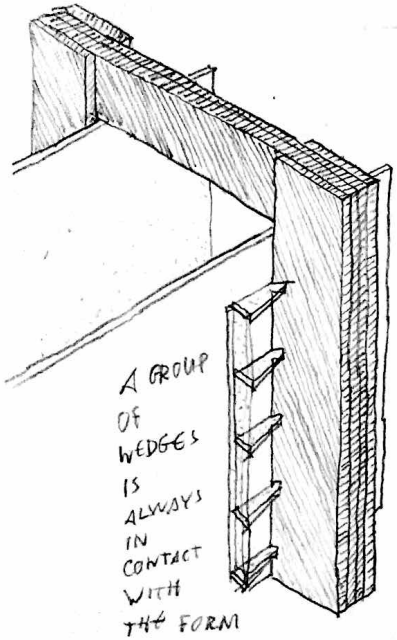

2
OR CLAMP?
1
WEDGES for side pressure
B/B PLY
2
2 position END pieces?
lifting!!!?
4
The "T"
-keeps form from lifting
-Acts as a foot
The
The foot?
7
find sources of EARTH
size of form? optimisation
5
Extra weight in clamp
6
make 2nd clamp
Timber plywood?


Sides
90
59,8
3cm thick
INCREASING NUMBER OF HOOKS FOR A SHORTER SHIFT UPWARDS WILL REQUIRE ≈2,13cm HOOKS -TOO SMALL!
Upside down concept
30 - 3,5 = 26,5
26,5/2 = 13,25



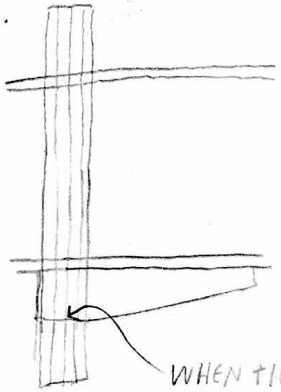
- WHEN YOU HOLD THE FORM UP BY HOLDING UP THE CLAMP, THE FORM STAYS OPEN.



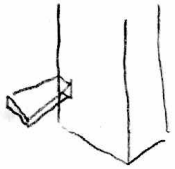


A GROUP OF WEDGES IS ALWAYS IN CONTACT WITH ~~THE~~ FORM

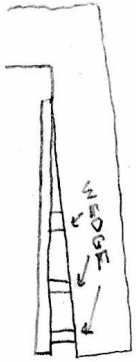
- SLIDES ON RAILS



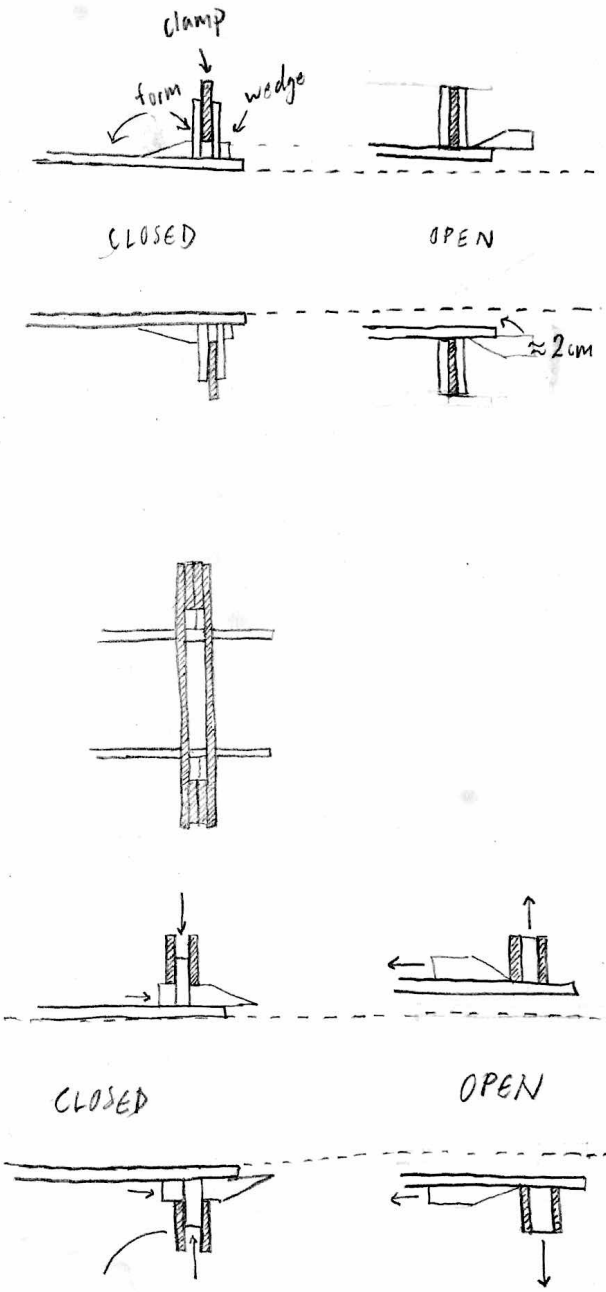
WHEN THE WEDGE IS ALL THE WAY IN IT IS IN FULL CONTACT (NOT SLANTING)

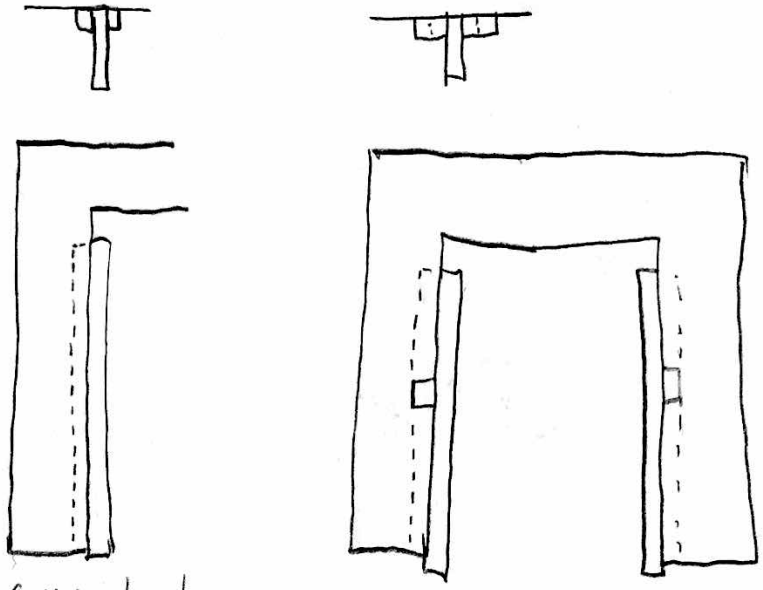


MAYBE ~~WE~~ ONLY NEED A ~~WEDGE~~ AT ~~THE BOTTOM~~



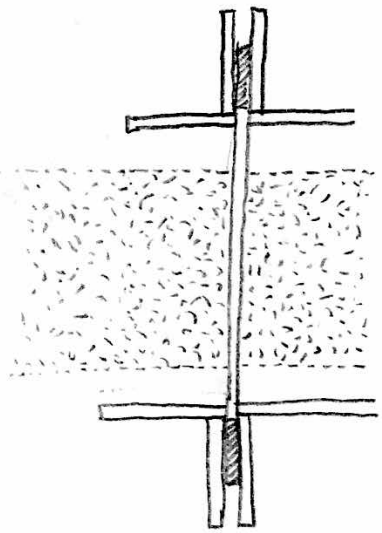
THE CLAMP IS ANGLED OUTWARDS SO IT IS EASILY LOWERED ONTO THE WALL

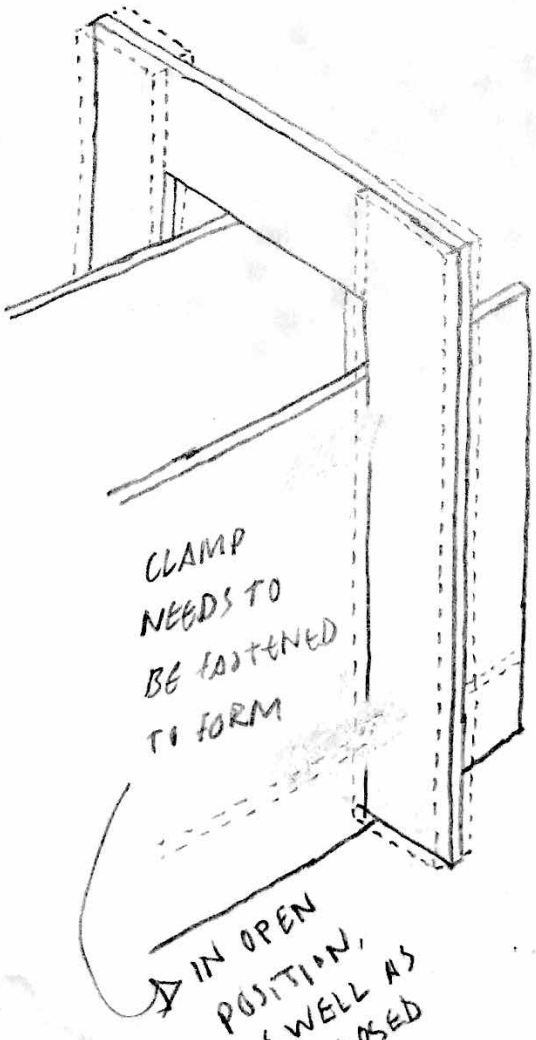




full contact
no notch
Dotted line
is vertical list

open position





closed position