A FOOD HOUSE

HANDCRAFT

AARHUS SCHOOL OF ARCHITECTURE
MAY 2016

Watercolour by
Erik Toft, Architect.

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THE PEOPLE BEHIND THE WORKSHOP

The workshop

Creating a profile and true awareness Nordic craft, leads towards sustainability as an important aspect in building design. Generally speaking, the higher the expenses for the processing of the materials is, the higher are the ecological indicators. The higher the amount of non renewable ingredients, such as fillers, additions, binders etc., the worse the indicators are. Therefore, it also become an important goal in the project to create new solutions, designed and constructed with as few materials as possible and renewable.

The focus will be on 4 different natural materials exploring the properties of the materials, architectural and technical design.

Vernacular architecture

Architecture that makes use of common regional forms and materials at a particular place and time; sometimes includes strong ethnic influences of an immigrant population; usually modest, unassuming, and unpretentious, and often a mixture of traditional and more modern styles or a hybrid of several styles. Houses are often owner-built by people familiar with local materials, regional climatic conditions, and local building customs and techniques.

The handar school

Handar is the old Norse word for hands. It is the hand's practical ability to create, sculpt and make a sustainable difference in our world, which are the starting point for this school. The school aims, through various training, initiatives and collaboration, to give a practical foundation for sustainability and creative work. The school is owned and managed by Simon Jul Jørgensen and Frank Erichsen.

Prof. Walter Unterrainer
From 1980 to 2012 own architectural office in Feldkirch / Vorarlberg / Austria.

Ecological aspects in architecture from town planning scale into detail, avoiding sick building syndromes as well as economic construction methods by self-building or radical prefabrication were key issues of the office since it started.
From1984 specializing in energy efficient architecture and building of "controlled experimental" innovative strategies in practice. The office has finished altogether more than 150 projects in different scales, new buildings as well as renovations, housing projects, farmhouses, school renovations, office- and industrial buildings as well as interior design.

From 1994-2016 teachhing at University of Liechtenstein, Kunstuniversität Linz/Austria, the School of Architecture in Ljubljana/Slovenia and Umea School of Architecture.

From 2007 honorary professor at the Aarhus School of Architecture.

From 2013 professor for sustainable architecture at the Aarhus School of Architecture and coordinator of research Lab "Emerging Architectures".

Assoc. Prof. Heidi Merrild
Constructing architect, having 15 years of experience from architectural offices in Denmark, doing project roll out from concept to implementation and project management.

Work experience within: passive house concept PHPP, sustainability, energy design and life cycle assessments in buildings from detailing more overall building concepts, together with experience in hospital design and healing architecture with focus on air quality, daylight hybrid ventilation.

Merrild has completed the Master in Energy and Green Architecture, MEGA, and certifications as DGNB and Cradle to Cradle consultant. Teaching experience for almost 7 years within the field of building design and construction, specialized in materials and design for disassembly.

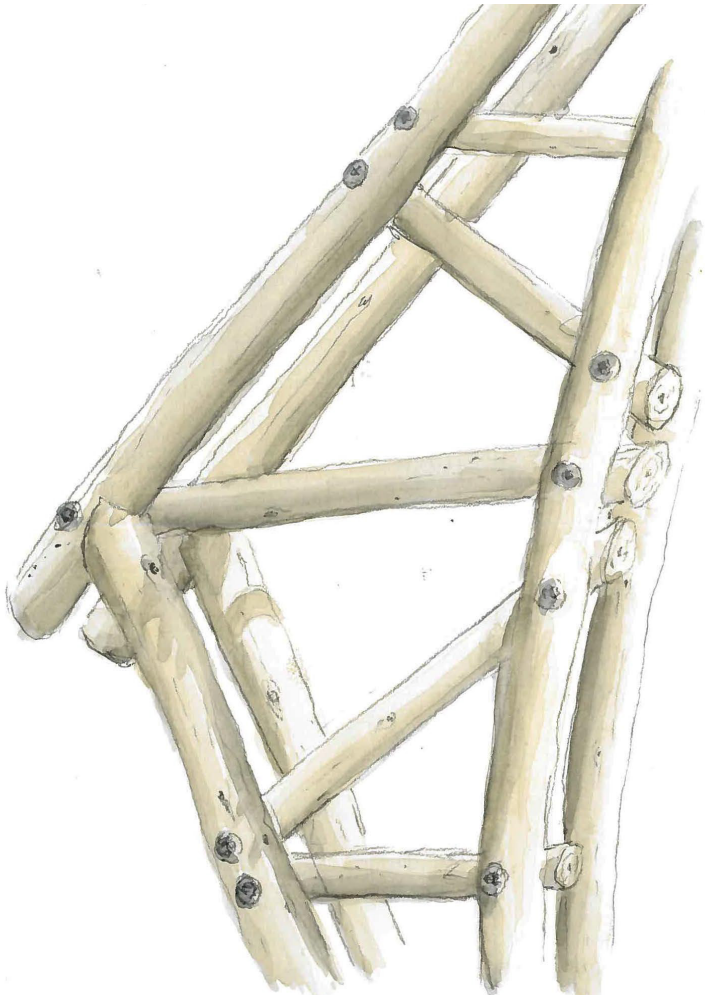
From 2015 Teaching Associate Professor in at the Aarhus School of Architecture and teaching in environmental and sustainable engineering in architecture and responsible for the MLAB, a material library.

Frank Erichsen
Works with self-sufficiency and has many years of experience, especially from Norway, in farming and restoration of historical buildings.

Erichsen has been teaching at Grenå production school in traditional craftwork and since 2008 he is a host at Danish national TV, with the program "Bonderøven" which conveys self-sufficiency, craft skills and sustainability.

RAFTER STRUCTURE

CONSTRUCTING THE FRAME OF THE HOUSE



Harvesting wood

The wood that was used for construction was the Danish Cypress tree, and was chosen due to its strength, flexibility and the straightness of its trunk.

Harvesting the wood started by visiting woods with a healthy amount of mature trees. The trees were felled with a chain saw, and were stripped of any branches and leaves by hand axes. They were then transported back to the work site for debarking.
The trees were debarked once brought back as fresh trees are easier to debark. The trunks were stripped of their bark as insects living within the bark and would deteriorate the quality of the wood if left on.

Trimming a tree

There goes a story with the forest from which the cypress was harvested for this workshop, it is as follows.

There was a man who needed to decorate church with cypress trees. So he went to the owner of the forest and got his permission to harvest Cypress for his decorations. When the owner of the forest, paid a visit he saw that only the tops of the trees were cut off. Located in the top of the tree, is a hormone that distinguishes the trunk from the branches. Due to the tops being cut off, the tree lost this ability and as a result started to grow wildly towards the sun. This made the crowns of the cypress trees in this particular forest straighter and very useful for the purpose of rafter construction.

Wood is harvested in the forest

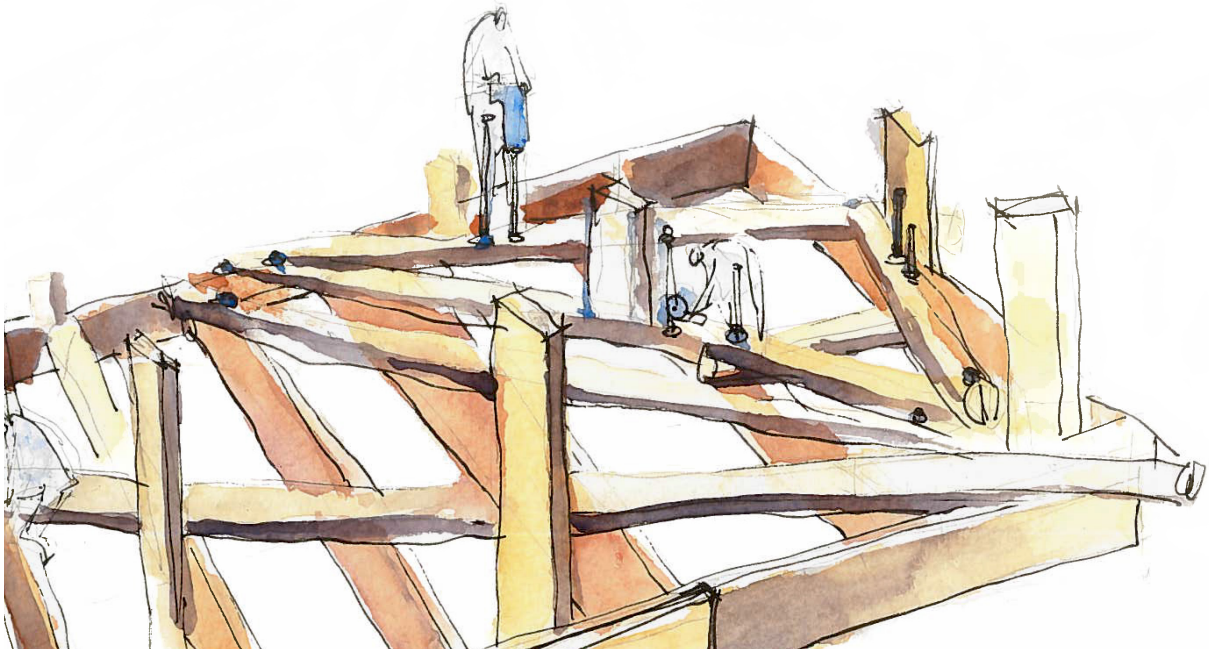
Debarking the newly cut wood

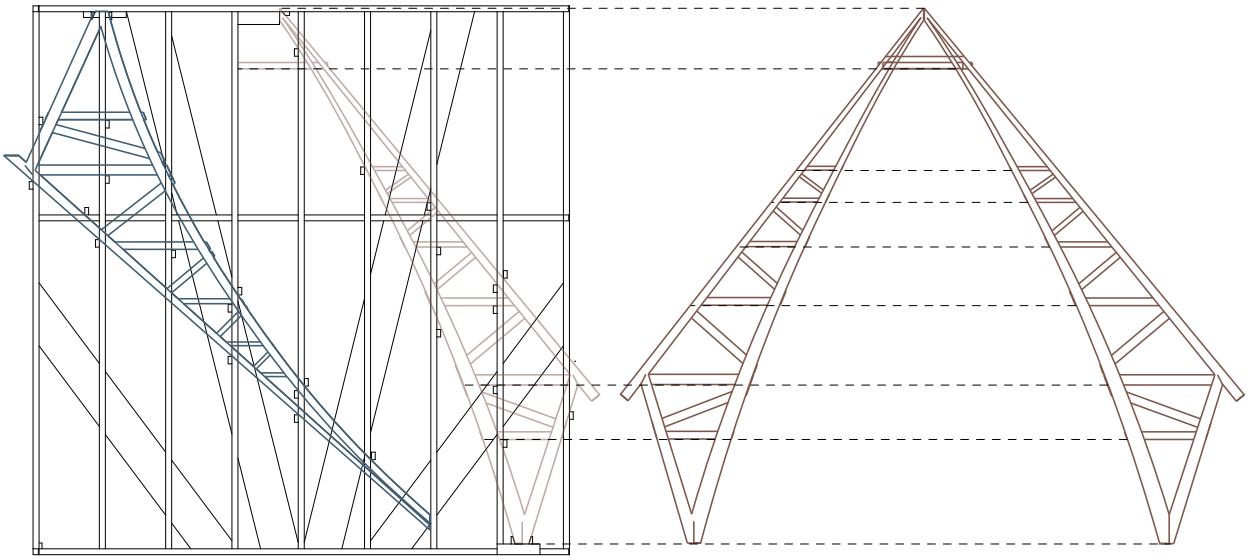
Making the rig

There was a two-part process in creating the structure upon which the roofing would be attached. A grid template was first created which acted as a guide for bending the cypress pieces into the position.
This allowed varying lengths of cypress pieces to be assembled on the grid which was eventually connected into rafters. In relation to the larger construct, the rafters served to structurally uphold the roofing and walls.
The purpose of the rig was to create an efficient system of producing multiple rafters. The grid acted as a map and base for assembling the rafter, allowing workers to assemble the pre-cut pieces of cypress into a whole without the need of remeasuring.

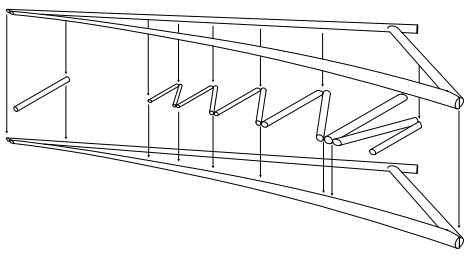
Dealing with non uniform wood pieces were problematic as it meant minor adjustments had to be made to fit pieces together. For this reason the rig additionally served to hold pieces together whilst adjustments were made.

The rig was made out of Wooden battens 45 X 195mm, and were assembled as a rectangular grid by screws and nails. Points which marked out the form of the rafter, were marked out on the grid and indicate the positions where pieces would meet and be joined.

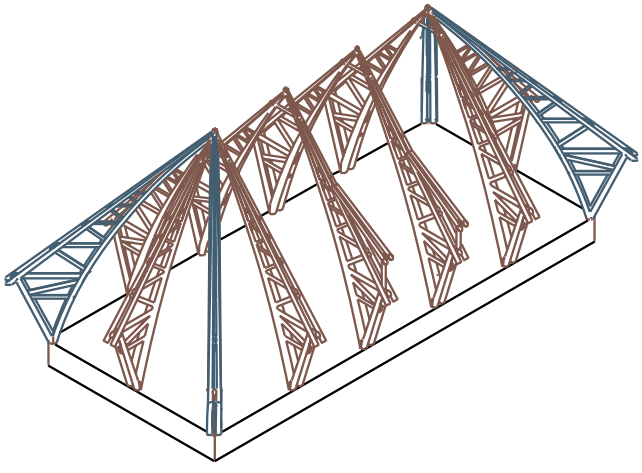




There are two types of rafters in the construction; shorter ones for the middle part and the ends of the building (depicted as red), and wider ones for the corners (depicted as blue). Both types were made on the same rig, but opposite each other to make best use of the space. See the axonometric drawing for the placement of the two types of rafters.



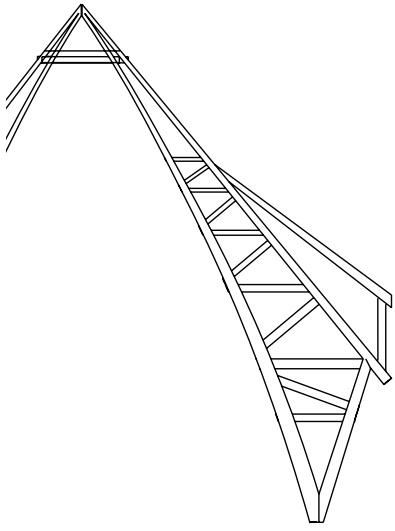
Layers in the construction



The two types of rafters

Opening

To make the arch above the entrance, we extended the height of the construction on the two middle rafters. This made a base to bend the roof boards across to get the right curve.



Section of rafters.
The added rafters creates the opening of the foot house.

BRICK WORK

BUILDING OVEN, CHIMNEY AND BENCH FROM BRICKS

Material

When building a food house one of the primary elements is the baking oven. Thus, the fireplace for the heating of the oven was the first structure to be built on top the precast concrete base. Both masonry and carpentry techniques were practized and used as the arches defining the inner spaces were created upon wooden support framework.

Principal products used for building were recycled clay bricks (from the structure that formerly inhabited the space of the food house in construction) and clay mortar to bind it all together. Most of the brickwork was conducted during our first few days on the farm in Revn. The refinement process continued throughout all three weeks.

Process

Our ways of working were very organic, the "technical" drawings were drawn right on top of the concrete slab and even the shape of the arch was drawn along the curve of a hanging piece of string. All the materials had to be prepared, bricks were transported to the site with the help of a wheelbarrow, while clay, gravel and water were blended together resulting in a clay mortar. The mortar base consisted of one part water and four parts clay, with gravel added as needed in order to end up with a suiting texture.

Picture: When building our primary baking oven the four outer walls of the square shape were produced first, after inserting the wooden arch frame the vault/ceiling bricks were carefully stacked on top.

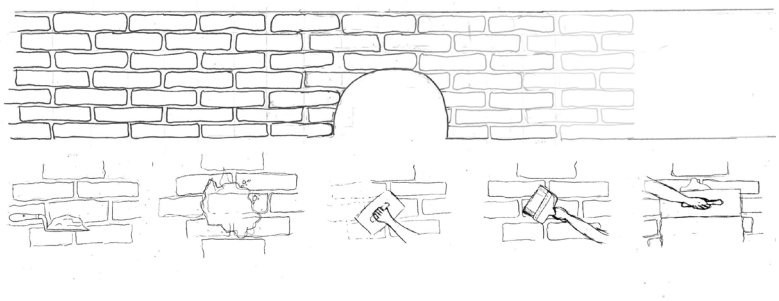
Technique

Bricks alternate with mortar to create the base and “glue” to keep the bricks in place. Mortar is spread to form a base, the individual brick is then put on top and wiggled to set it in place only to be surrounded by more mortar on the side where an other brick is going to be placed next. After the structure has had some time to set (in our case, overnight) the refining work can commence. Going over the entire surface with a wet sponge and more mortar to fill in any cracks or irregularities will result in an even and aesthetic surface.

1.

2.

3.



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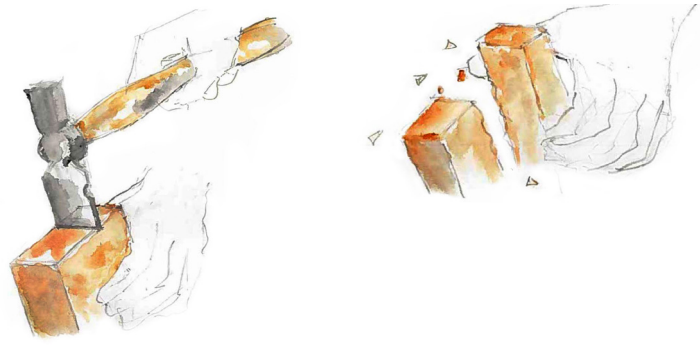


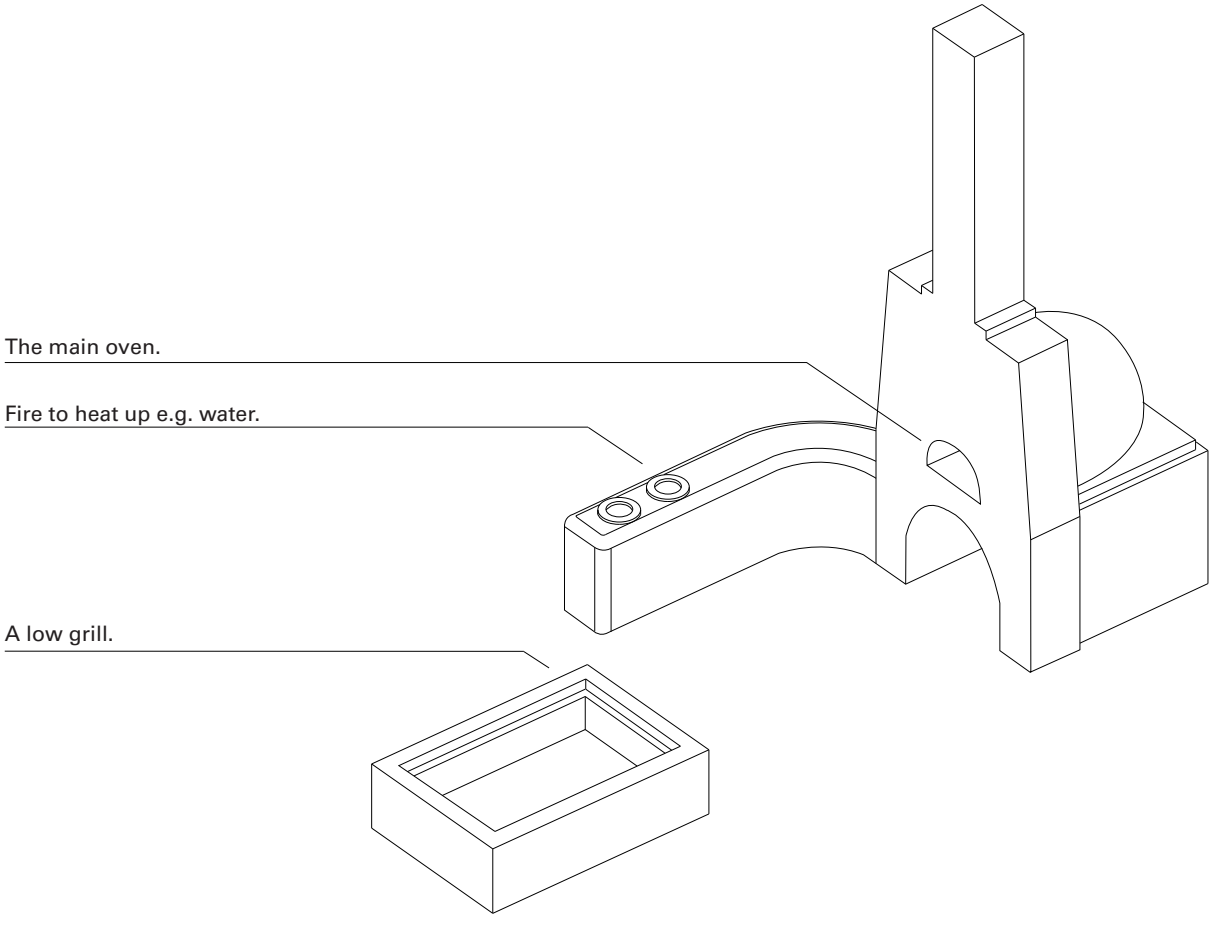
1. Tools for the brickwork.
2. Tools for adding clay.
3. A thin layer of clay is added to the final brickwork.
4. Bricks are being customized for the perfect fit.

The three different ovens

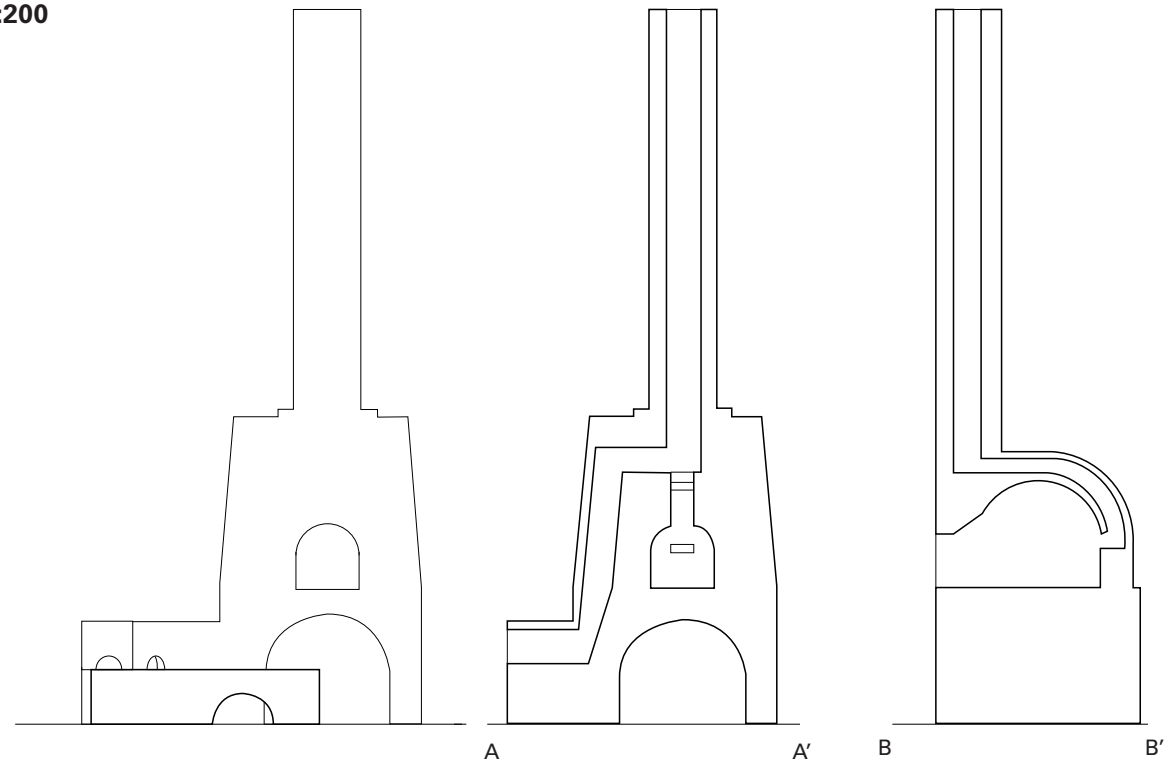
Diversity was a big theme during this workshop, we used many different techniques of craftsmanship. This, in order for us to learn as much as possible as well as for Frank to have many different examples to exhibit in the future campsite usage of the farm.

When working with indoor spaces, clay mortar is the most used medium. In the name of diversity lime mortar was made and used in the making of an open fireplace on the other side of the food house, sitting directly across from
the baking oven. In comparison to clay mortar, lime is more flexible and breathable, it being able to let any moisture trapped inside of it evaporate freely into the air.

The clay mortar can only be used indoor, where rain won't wash it away. The lime mortar can be used both indoor and outdoor.



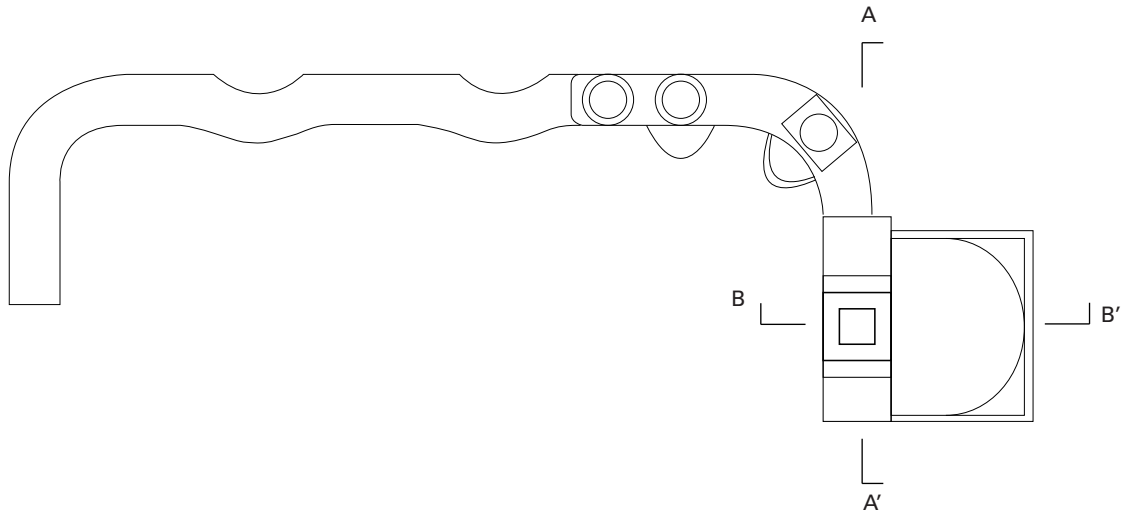
Technical drawings
1:200



Elevation

Section

Plan



Making lime mortar

First the raw lime stone is burned in under high temperature in an oven, then it is put in water where it starts disintegrating, radiating heat in the process, into a pasta like consistency. Gravel is then added into water and powdered lime pasta to create and effective mortar. All is blended in an industrial concrete mixer.
First the raw lime stone is burned under high temperature in an oven. Afterwards the lime it is put into water which starts a chemical reaction. It is being mixed in an industrial concrete mixer. In this process a lot of heat is released and the consistency change to a smooth pasta. While the mixture is hot the sand is added, this makes the final mortar both stronger and more flexible. Raw lime stone releases carbon dioxide upon heating, called a thermal decomposition or calcination. The temperature raises to above 840 degrees in the case of $CaCO_3$.

$CaCO_3$ (s) CaO (s) + CO_2 (g)

Picture left: Tandoori and brick oven (before the chimney is finished).
Picture below: The process of mixing lime mortar creates heat

CLAY WORK

COVERING THE OVEN AND BUILDING TANDOORI OVEN

Clay

One can find clay everywhere in Denmark, if one only dig deep enough.
The clay that we have been using is actually waste material from a sand-cleansing construction where the sand is used to make cement, the sand is separated and the clay becomes the waste-material of this process.

Stamping of clay

The clay is spread on the ground and by foot mixed with gravel and straws. It takes a lot of time and dancing people to make this mass even and stiff enough to form. This mass is called "cob" and is approximately one part clay to one part gravel. The straw is used to keep it all together when stretching it forming the ovens. Before one can build the oven, the "cob-lumps" must be made soft. This is done by kneading the cob and forming it into oblong sausages.

Forming lumps

After the cob is mixed together by foot, we knead and roll it into lumps with a perimeter about 15 cm. This is done to keep it more moist while it is waiting to be used and to be easier to transport.

The cob material is an old building technic started in the 1600s and is especially used in Africa and the Middle East. When you build a cob house in Africa it is normal to throw the cob lumps to each other to transport it. Then we let the cob lumps lay over night so it better holds together and gets ready to use.

Proportions of hay, sand and clay

Top: The materials are stamped together
Buttom: Defining the bottom of the tandoori oven

Tandoori oven

Before you can form and build the oven, the "cob-lumps" must be made soft. This is done by kneading the cob and forming it into oblong sausages measuring 10 cm in diameter.

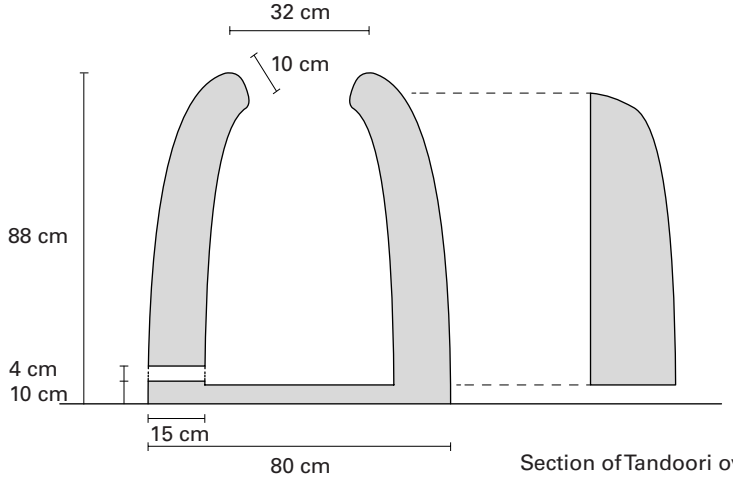
The buttom of the oven is drawn as a circle on the floor using the measurement of the template. The circle was then filled with cob 5 cm in height and the foundation had to be 100% plane. The oven was then build up by cob-sausages placed on top of each other on the periphery of the circular ground. We used our thumbs to intertwine the different layers constantly using the wooden template to determine the curved shape of the oven. We had to be carefull and not clap the oven to avoid friction.

We took a wooden stick 5 cm in diameter, and made a hole 10 cm above ground for ventilation for the embers. While building we had to make sure that the inner surface of the oven was smooth and even.
The upper 10 cm of the tandoori was thickened towards the middle making the opening smaller and enclosing the heat. The finish was rounded and the whole oven was smoothed over by using hands, tools and a small amount of water.

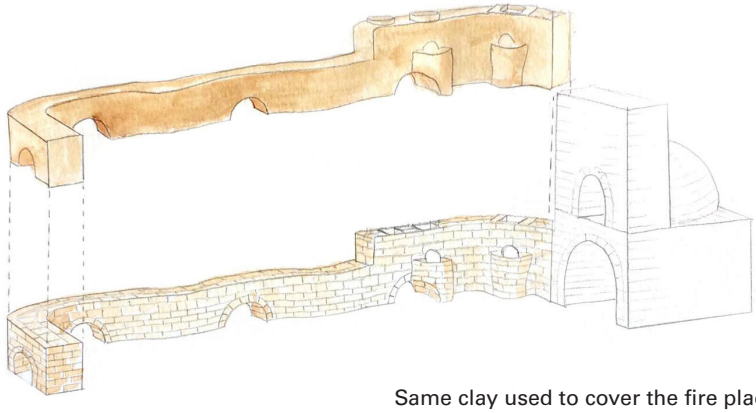
Fire place

The clay is added on top of the finished brickwork. The layer of clay is very thin in order to prevent it from cracking.

Half build Tandoori oven



Section of Tandoori oven and the template
1:20



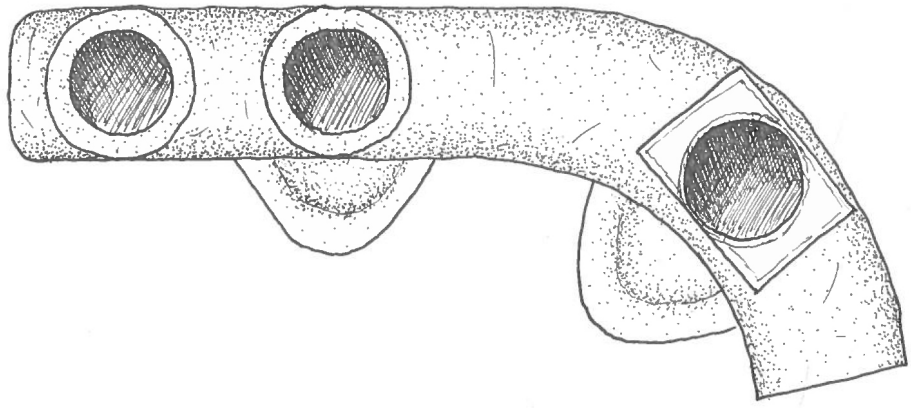
Same clay used to cover the fire place

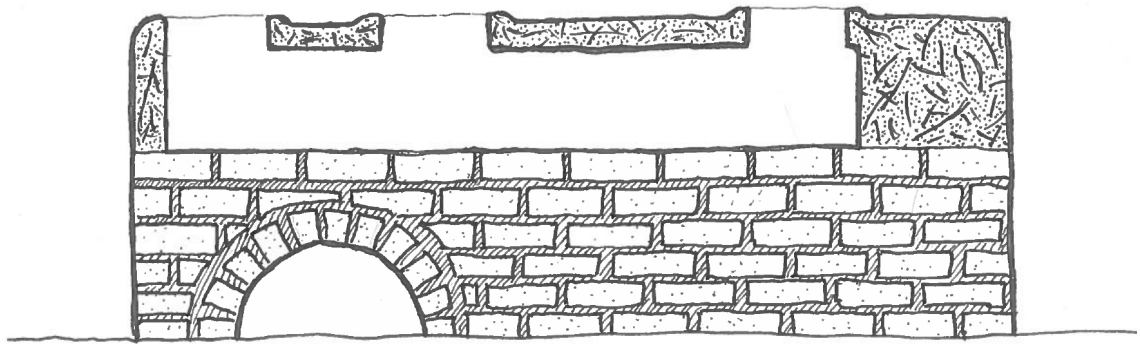
Fire place

The top part of the cooking fire place connected to the wood-burning stove is also made of the cob material.
The same technique as building the tandoori oven in used.

Plan and section 1:20

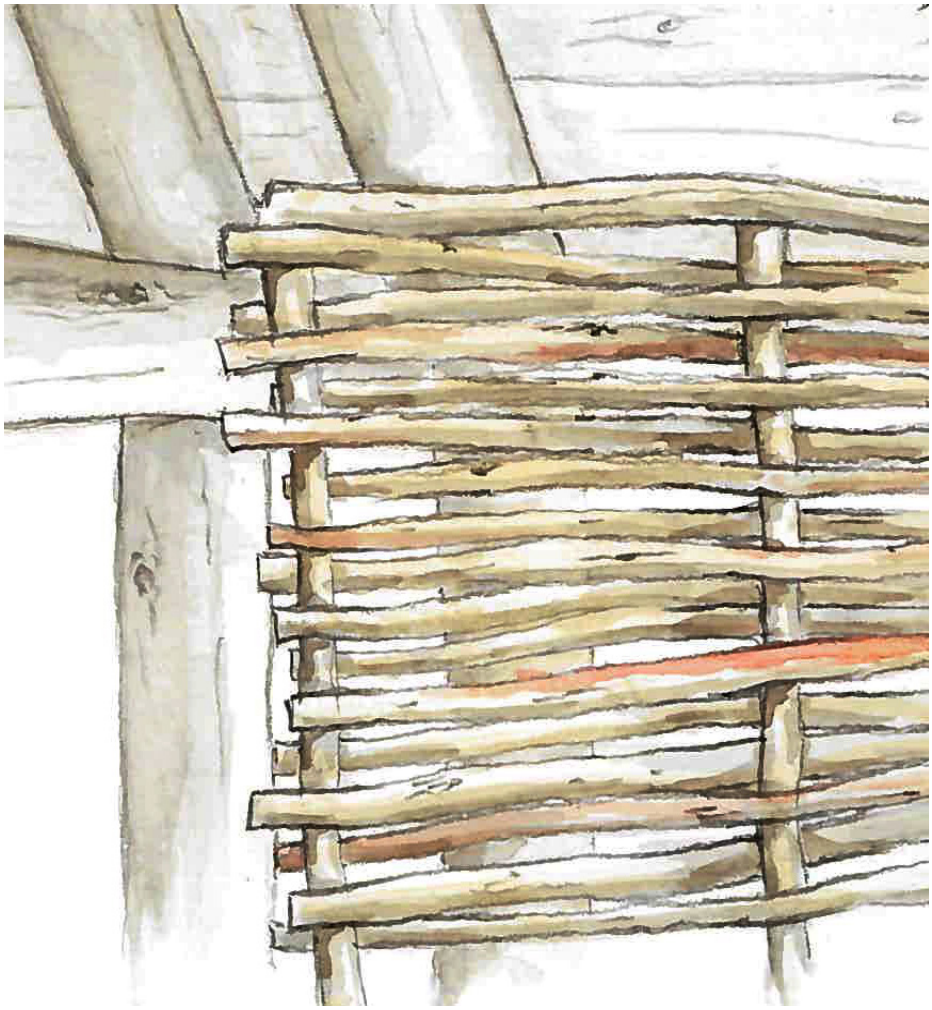
Height: 85cm
Width, inner bottom: 52cm
Width, outer bottom: 72cm
Opening: 32cm
Perimeter: 250cm





WICKERWORK

WILLOW USED AS REMOVABLE WALLS



Willow species

Willow or Salix is a plant family with approximately 450 species. There is roughly 25 species in Denmark and among the most common are Salix caprea and Salix aurita, which especially occur in thin ground in Jutland, as well as Salix cinerea which occur in sand dunes.
Willows vary from early bushes of a few centimeters to trees up to 30 meters, and they are rarely older than 50 years.

The willow family is fast growing and deciduous, and the majority of willow species grow as pioneer trees in humid ground alongside ponds and creeks.
A number of species are used as ornamental plants or energy crops.

Harvest

Willow is harvested in plantations, where the best willow grows deep within the wood. Here the willow fights its way towards the light and becomes long and straight, which is best for wickerwork. We have used energy willow for our wickerwork, which is a dry species and therefore not as easily bend when working with it. The energy crop of willow is cultivated primarily with the purpose of making it into woodchips.
White debarked willow is harvested in spring and debarked within a month where it is still moist enough to peel, whereas brown debarked willow can be harvested all year because it is boiled. The willow turns brown because the nutrients from the bark penetrate the wood.

When harvesting willow it is important to look after branches that are long, straight and do not divide into more branches below 1,5 meters. Two year willow is best for harvesting, and in general the rule applies that the smaller the marrow the stronger the willow. However single cases suggest the opposite.

Debarking

When the willow is harvested it needs to be prepared for the debarking. To do this all leaves and branches must be cut off. This is essential for the debarking tool to properly tear the bark. Debarking is easies done right after the harvest. This means the branch is still fresh and moist and the bark easiest to rip off.
The debarking tool is made of metal and roughly shaped like a V. This shape makes it possible to pull the willow branch though and rip its bark. The tool does not remove the bark but simply rip it to make is easier to peel of by hand afterwards. The debarking tool is fixed to a workbench or similar object.

When debarking it is important to pay attention to make sure the branches aren't cut too deep into the wood. This makes the branch more vulnerable and it brakes more easily when used to make wickerwork. Pull only towards yourself to remain a smooth result.

1. Debarking the wood

2. Measuring the vertical construction willows.

3. Bending willow around.

4. Gentle bend to make a mark is made in the willow.

5. The edges are cut off.

6. Closing the wickerwork.

Making the wickerwork

The lenght and height of the wicker wall is specified. This is done by measuring the distance between two rafters in the construction from the top and bottom.

Now it's time to start the wickerwork by placing the vertical willow branches according to the lenght just measured. First, holes are made in the ground withh a metal rod and one branch is placed in each of them. The distance between each hole/branch should be around 18cm. The distance between the outer branches and the one next to it should be shorter than 18cm to enable a bigger arching keeping the vertical branches in place.
The vertical branches are the basis of the wall. They should be straight and thicker than the ones used for the wicker, as they shouldn't bend or crack. When all the vertical posts are placed it's time to do the wicker.

The first horisontal willow branch is weaved in between the vertical posts, bending it slightly by each posts. Thinner branches are good to use as they are more pliable. Bending is important to keep the vertical branches as straight as possible, but be careful not to crack them. The next branch is applied in the same direction but from the opposite site of the outer post to make the branches overlap between the posts stabilizing the work The next two branches are applied in the same way but from the other side. This means the thick end of the branches shift sides for every 2nd branch adding a uniform look to the wall.

This technique is repeated until the wall has the wanted height. For each 20cm a wire is applied and bended in between the vertical posts to keep them in place. Underway the wicker is pressed down and sealed by knocking on top of the construction with a rapping iron.

Closing construction

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The wickerwork in place

THACHING ROOF

CONSTRUCTING THE FRAME OF THE HOUSE

The history of thaching

Reed for thatched roofs was one of the first roof materials used by permanently settled people mainly because of its properties as a water plant and the availability of the material.
Thatching techniques and styles were developed to suit individual needs and environments in different places.
In the Viking age thatched roofs were exclusively used as roof covering.
In medieval times, thatched roofs was still the most used roof covering.
Thatched roof were, because of fire hazard, phased out in major cities.

The material reed

The reed for thatching is harvested from inlets along the coastline during the winter, once the frost has removed the leaf. After harvesting, the reed is dried so that the water content is below 16% and then bound to sheaves. The material is already after this small amount of processing ready for thatching. Due to the low amount of processing and the fact, that reed is a locally produced material, it is a good material seen from an environmental perspective. This, and aesthetic reasons, makes the thatched reed roof a current and relevant solution.

Thatching method

The first step in the thatching process is to select the right sheaves for the layer. The Sheaves for the first layer has to be short and equally straight, because these are the ones forming the lover edge of the roof. The second layer has to be made with long sheaves to avoid the ends from the first and second layer to end in the same place and create a bump. The selected sheaves are placed on the roof and held by "knægte".

After selecting and placing the sheaves a wooden strip is pressed across them hold down by the "knægte". Its now time to spread out the reed to an even layer. During this you have to roll the sheaves to move it and still keep the direction, and hit to mix it and make it even. After spreading the sheaves the "tækkebræt", a flat shovel with holed surface, is used to hit the ends, to shape it in the same angle as the roof underneath.

When the layer is all even and following the angle of the roof boards below it is sewed with some special screws with a wire attached. They are placed in the roof boards and closed around a thicker steel wire. The layer is now finished and the next can be thatched the same way.

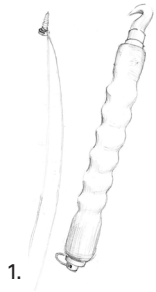
Throwing sheaves

When the sheaves are transported to the roof, a special throwing technique is used. The person on the ground is bouncing the sheaves on the lower arm and throwing it with the end first, so the reed doesn't slide out then the sheaves are caugth by the person on the roof.

Tools

When the sheaves are transported to the roof, a special throwing technique is used. The person on the ground is bouncing the sheaves on the lower arm and throwing it with the end first, so the reed doesn't slide out then the sheaves are caugth by the person on the roof.

1. "Sækkelukker" Is used to close the wire fixed to the screws then sewing the roof the modern way.
2. "Tækkestol" chair to use on the roof.
3. "Tækkebumstol" is the lower part of the chair, which like a hook catch on to the roof.
4. "Knægt" is used to hold the sheaves before spreading is out.
5. "Tækkebræt" is used to shape and angle the roof and the edges.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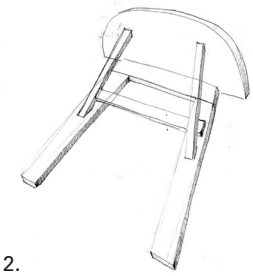
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3.


4.


5.

Sectional drawing

The sectional drawings illustrate how the sheaves are placed relative to each other. Specific sheaves are individual chosen for each layer to ensure the correct angle and thickness of the roof. Due to the fact that reed is an organic material, the sheaves will always be different in size, shape and density determined by factors such as length, thickness and shape of the individual reed, where and when it is harvested and changing weather conditions each year. It requires a skilled thatcher to select and place the individual sheaves.
Once a layer of sheaves is in place and the reed has been mixed, spread out and beaten into place, the layer is fixed and the work can continue with another layer.

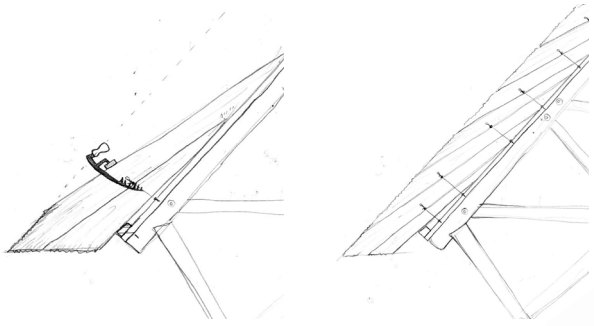
Roof board construction

The wood boards is used for the outer sheathing and covers the roof. The purpose is to minimise the fire risk and also to stabilize the rafters underneath. The rafters is made of pine wood and has a rough and a plane side. The board mesures 22*125 mm. The plane side is placed towards the inside of the house because it will be visible. The rough side is therefore placed towards the outside because it will be covered by the thatched roof.

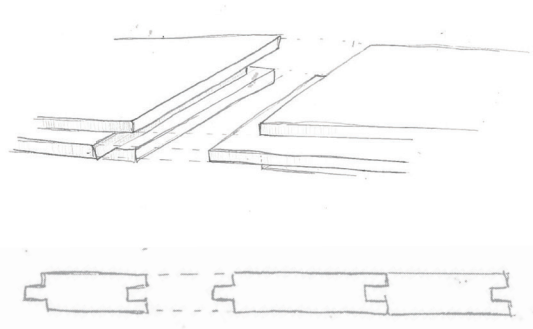
'Fer' and 'not' joints

To create a plane surface we used boards with fer and not. Fer and not is two profiles on the edges of the boards. The not is a groove in two sides of the board and the fer is a peg on the two others. Not and fer also known as a tongue and groove boards is a technique where you connect to pieces of boards. The boards grib together so they create a surface which is more stiff than the single boards. You have to be aware of which ends you cut of because they also have to grib together.

The not should always be placed downwards otherwise there will be risk of water falling into the groove.



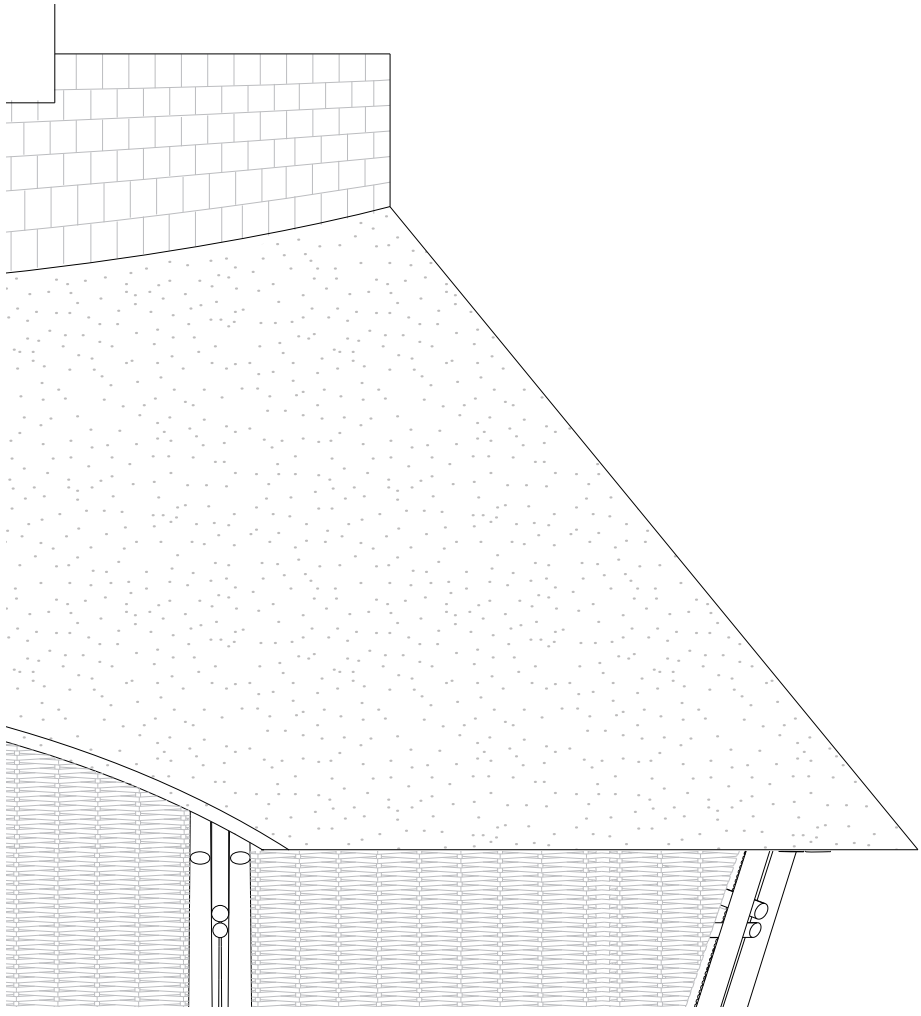
Drawings shows placing the "knægt" in the roof. And wires holding the thatched roof

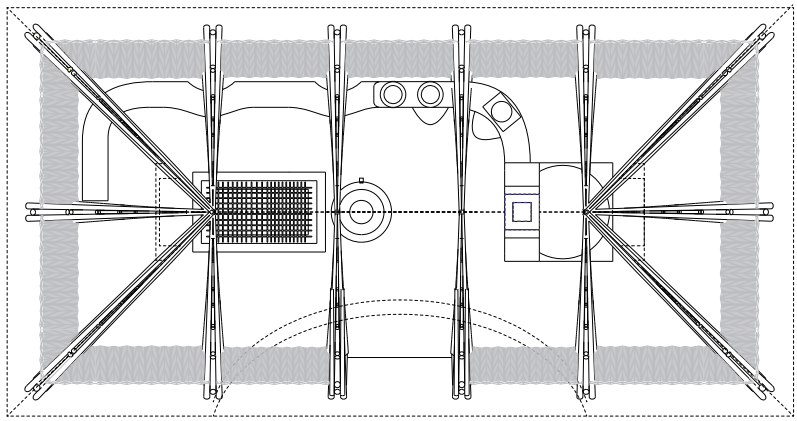


'Fer' and 'not' joints

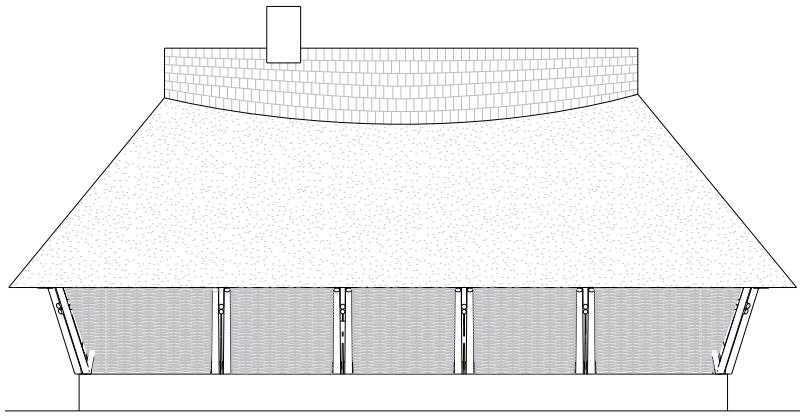
PLAN
ELEVATIONS
SECTIONS

TECHNICAL DRAWINGS OF
THE FINAL FOOD HOUSE

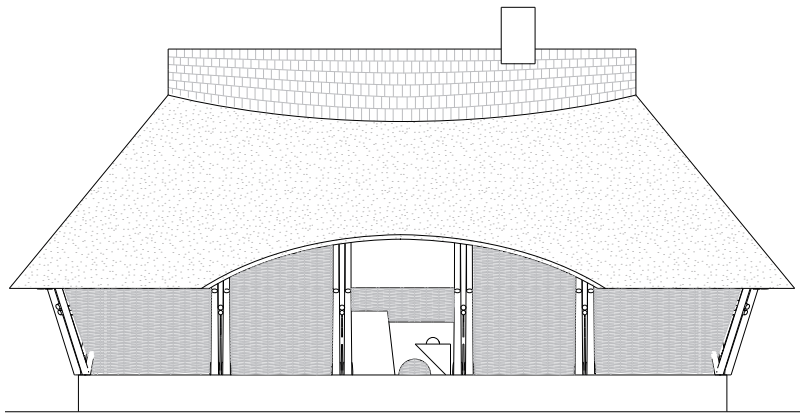




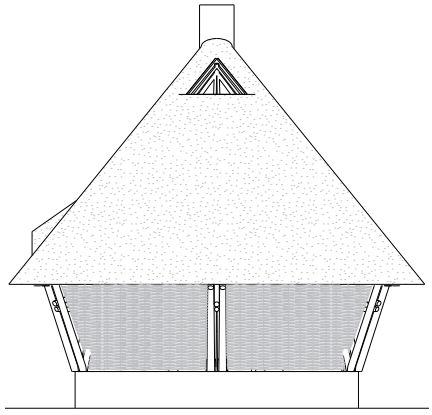
Plan
1:100



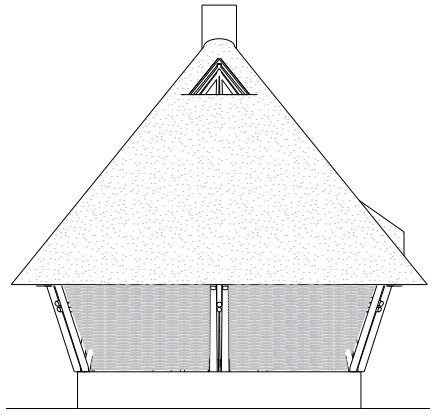
North Façade
1:100



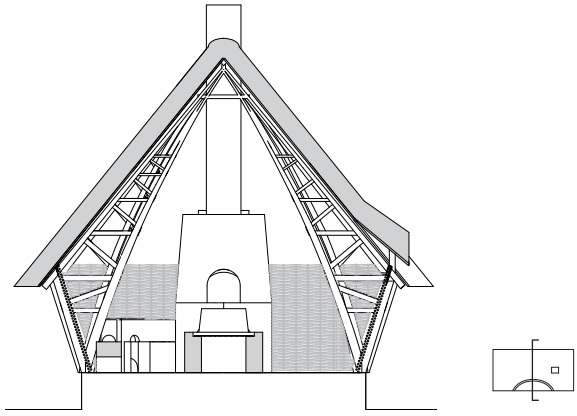
South Façade
1:100



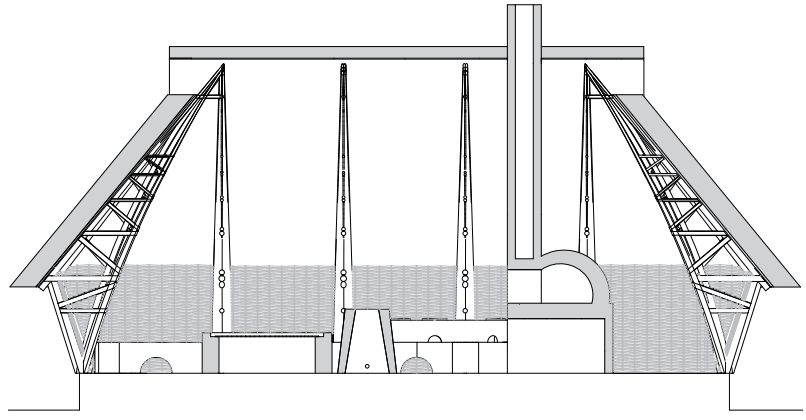
East Façade
1:100



West Façade
1:100



Cross Section
1:100



Longitudal
Section
1:100

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