Rehabilitation of Half Timbered Houses with Clay Fillings in Denmark

Søren Vadstrup

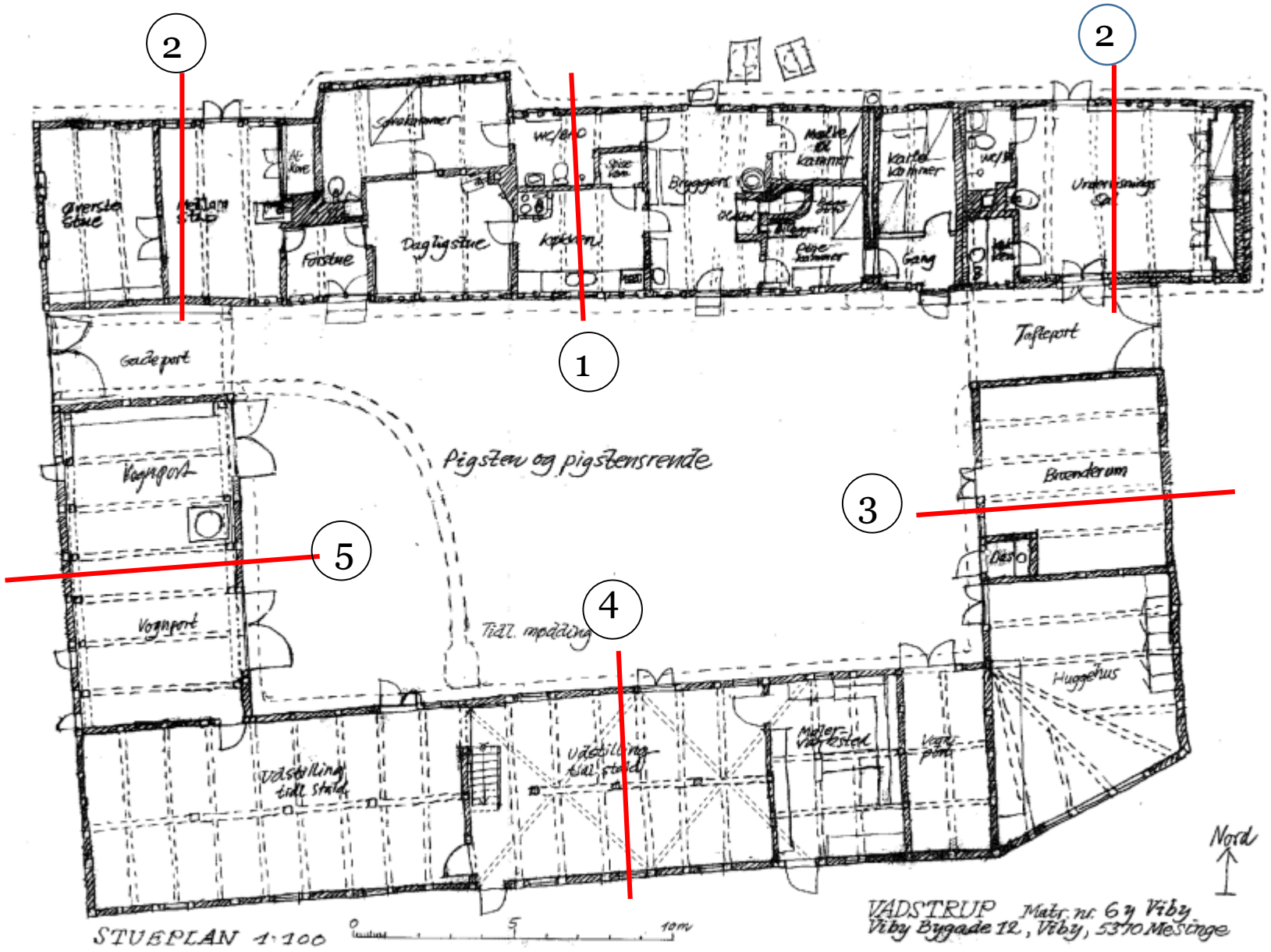
Associate proffessor
The Royal Danish Academy
of Fine Arts
in Copenhagen

Viby Bygade 12

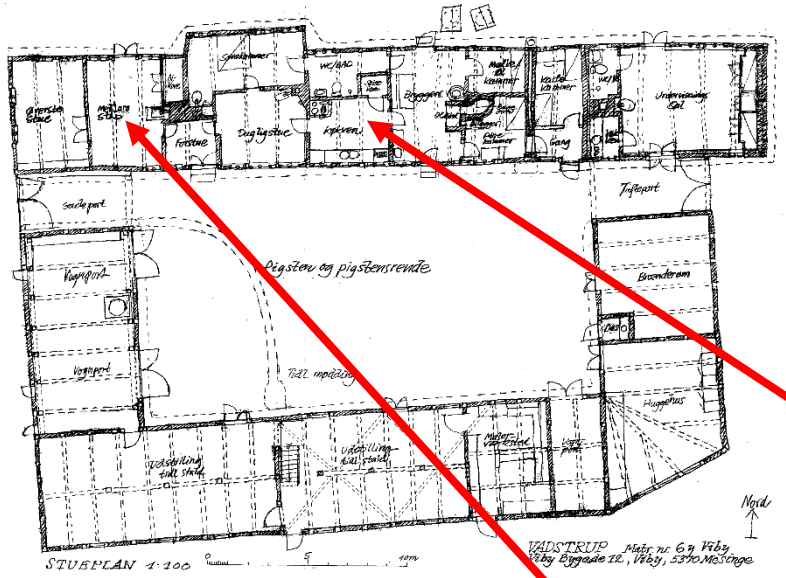
The case study takes place at a Danish four winged farm from the island of Funen with half timber construction, with a thatched roof. The farm is dating from 1740 to 1840.

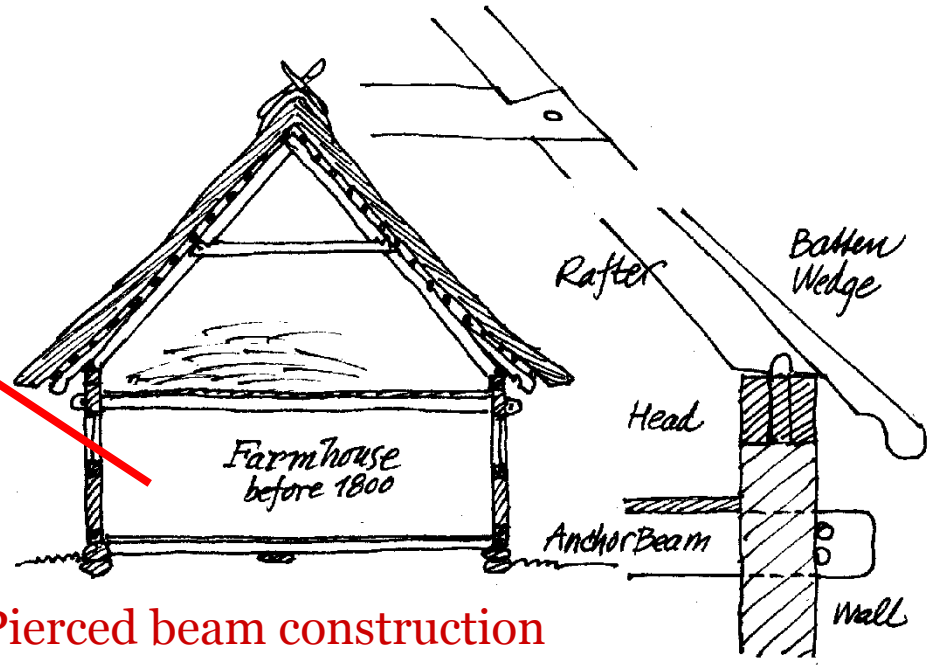
The farm consists of five different constructions – used in five different functions:

- The living house before 1800 (Pierced beam construction) and after 1800 (Truss and beam construction)
- Stables (Horizontal wind cross construction)
- Threshing floor (Double collar beam construction)
- Coach house (Double strap construction)

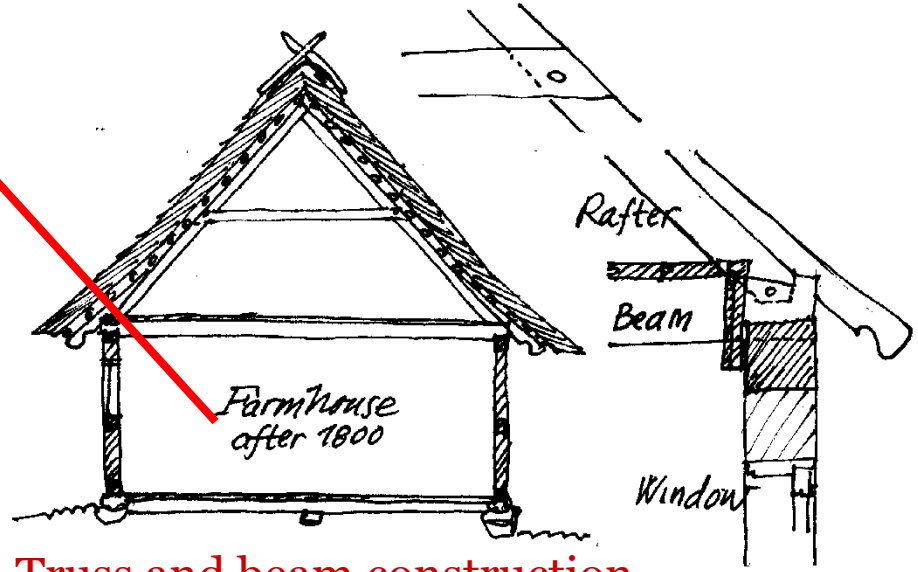


5 different and specialized constructions in the same farmhouse

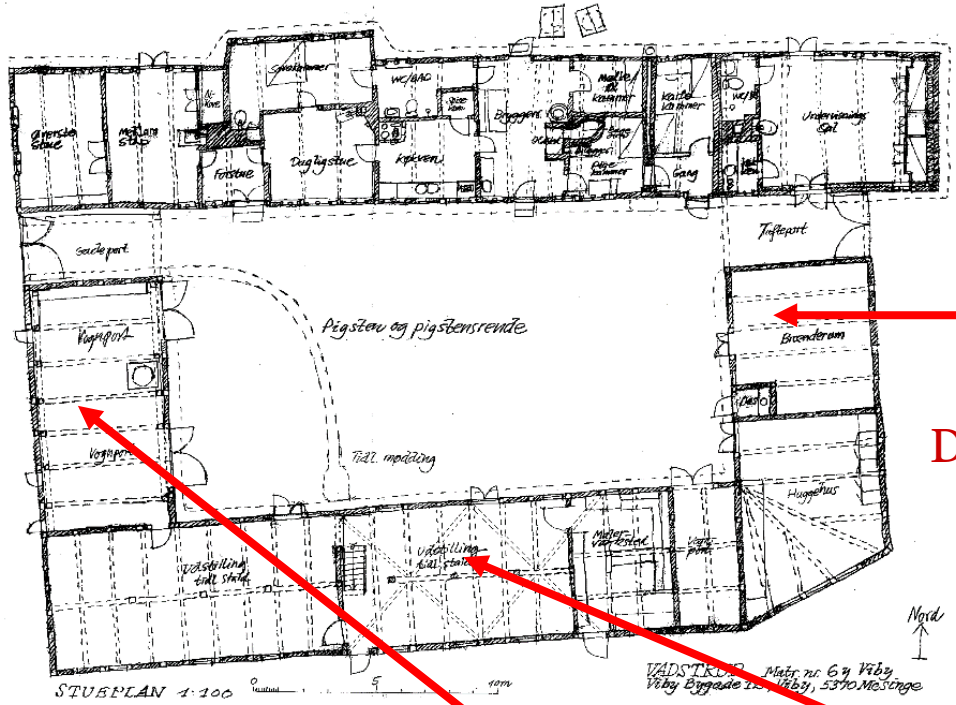


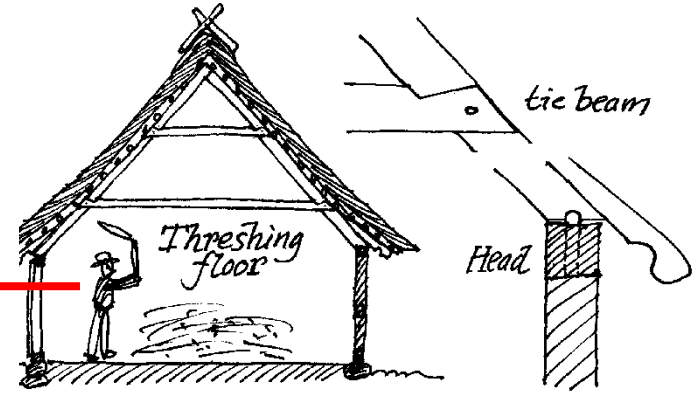


Pierced beam construction

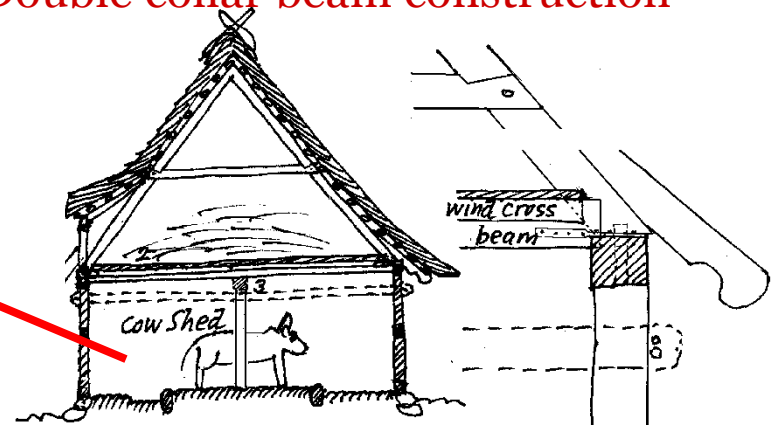


Truss and beam construction

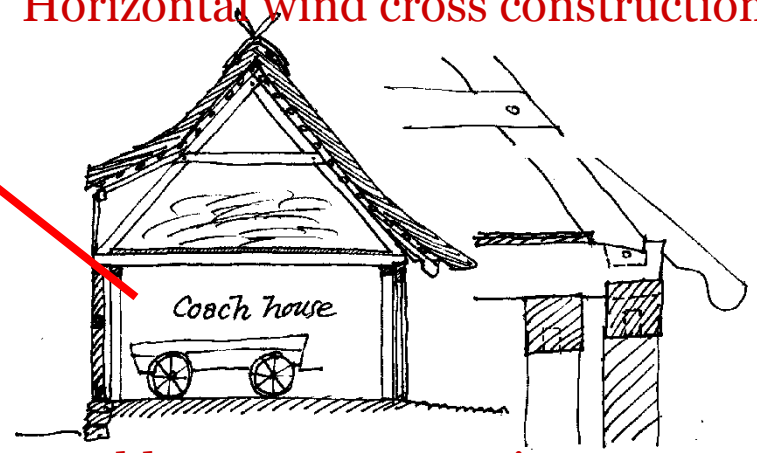




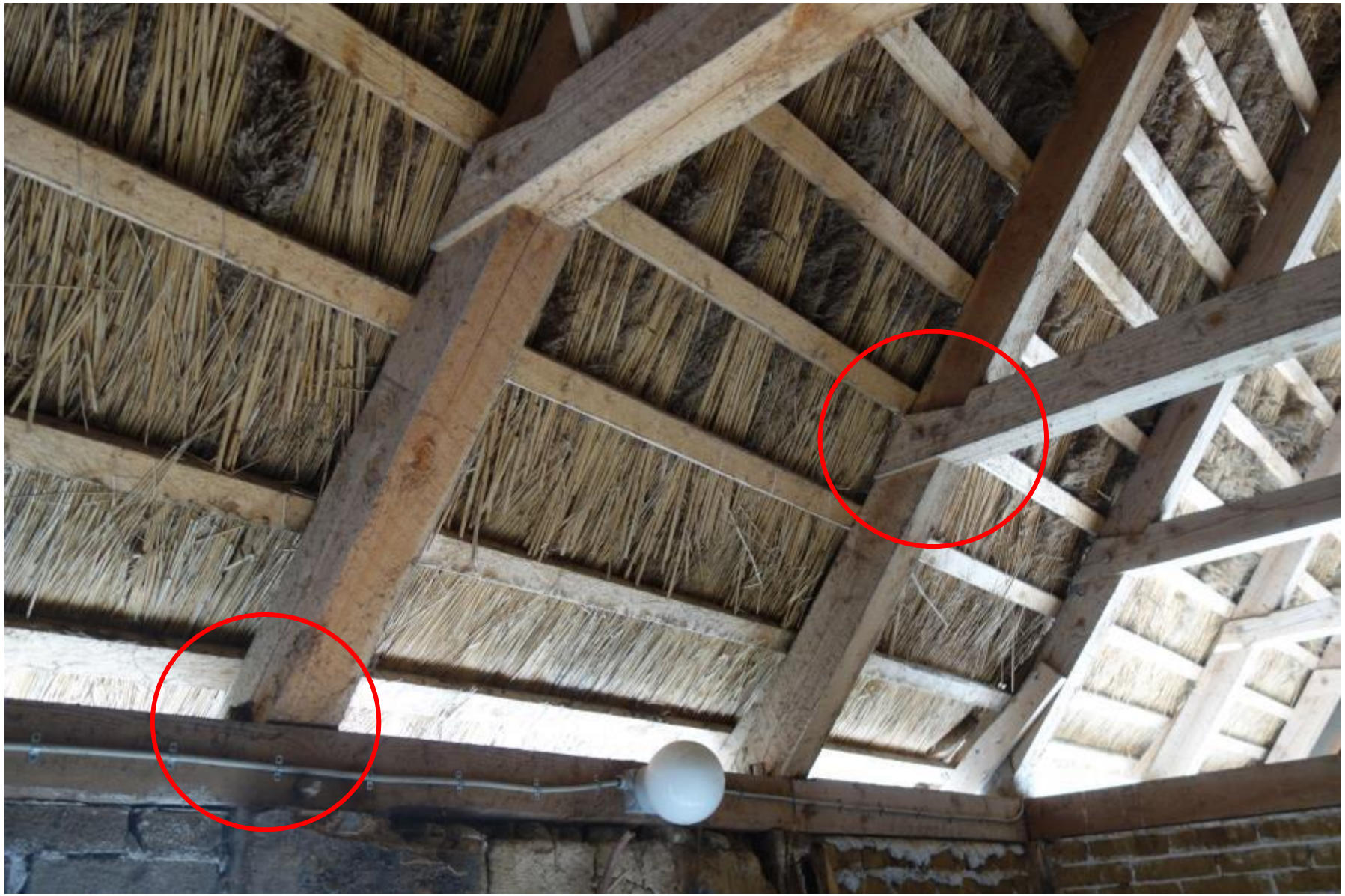
Double collar beam construction



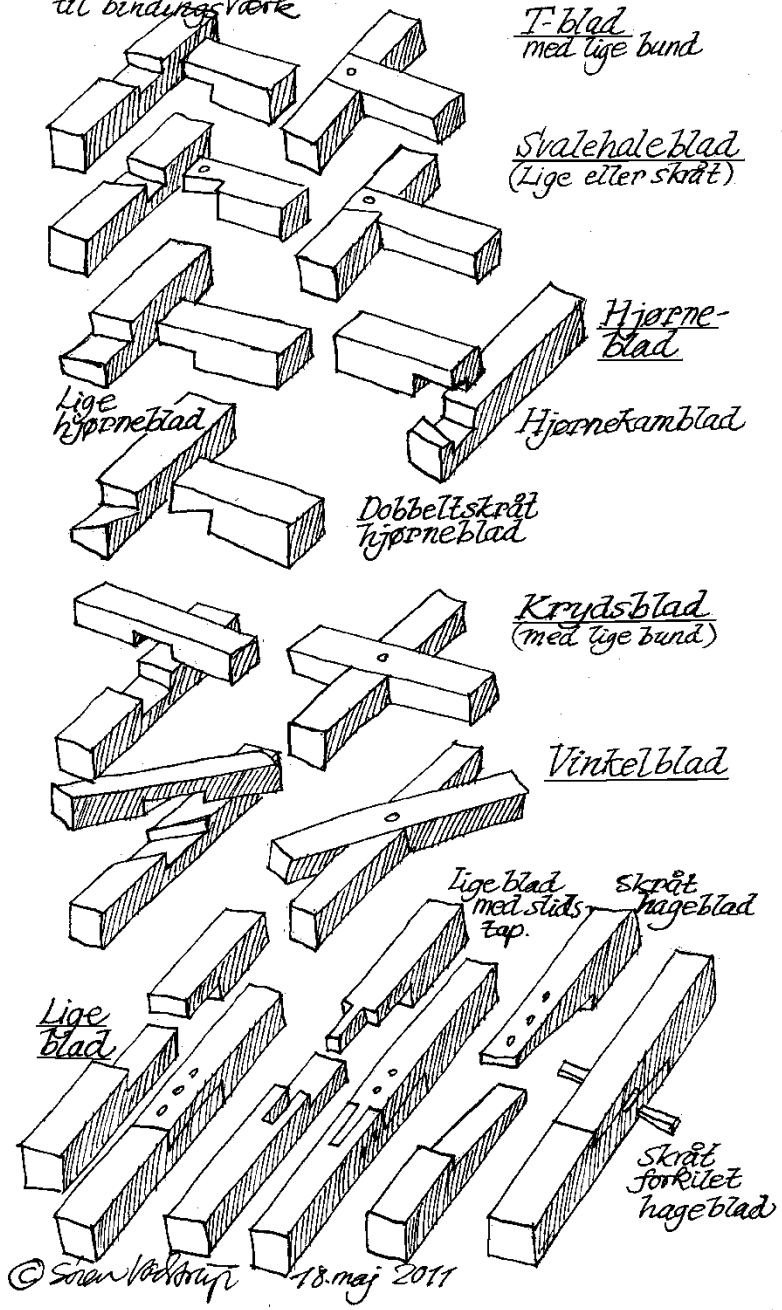
Horizontal wind cross construction



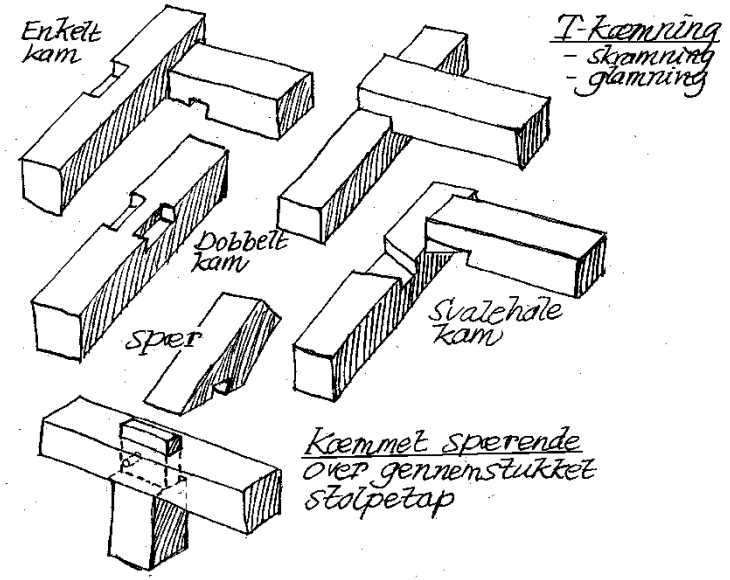
Double strap construction



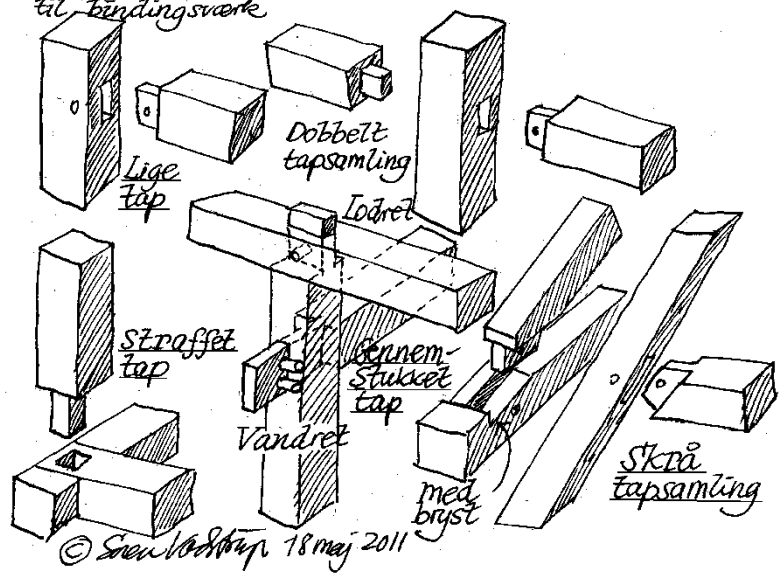
BLADSAMLINGER (Halvt-i-halvt)
til bindingsværk



KAMSAMLINGER (1/3-i-1/3)
kæmmede, skrammede, glammede samlinger

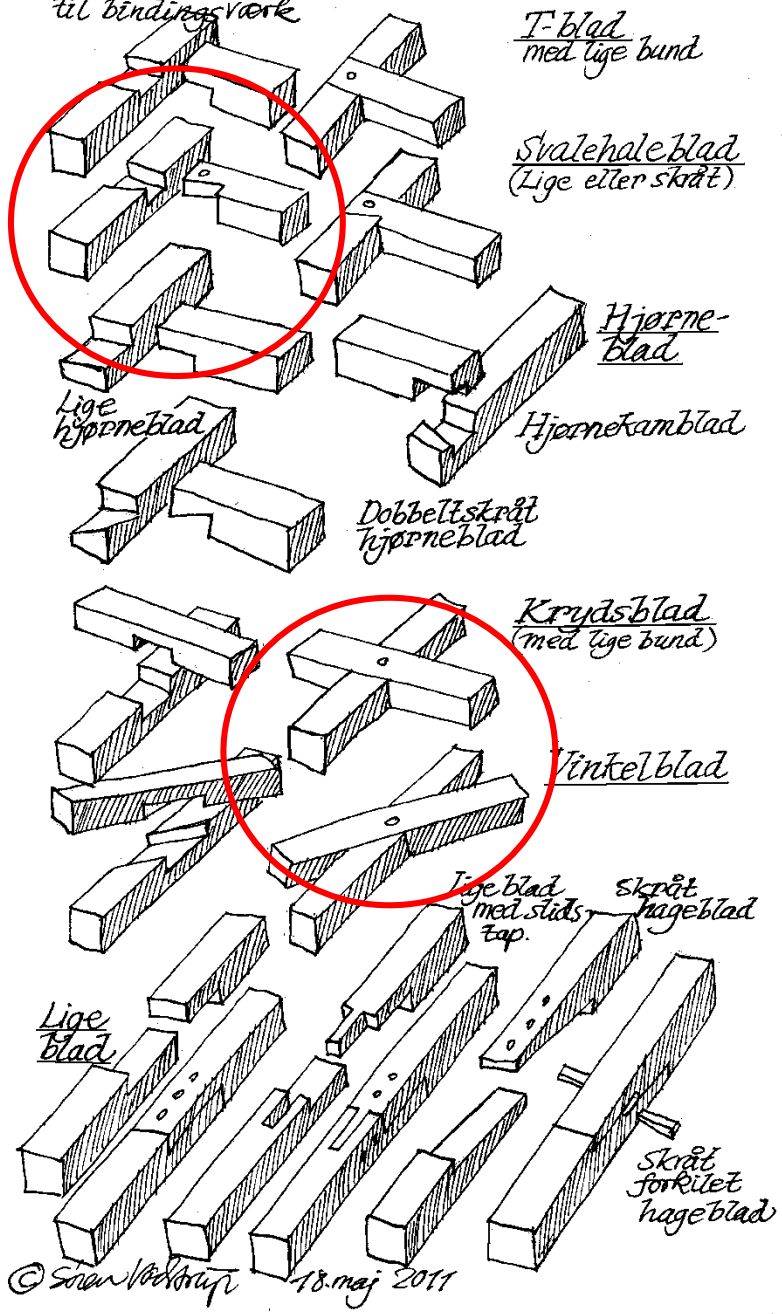


TAPSAMLINGER (1/3-i-1/3)
til bindingsværk



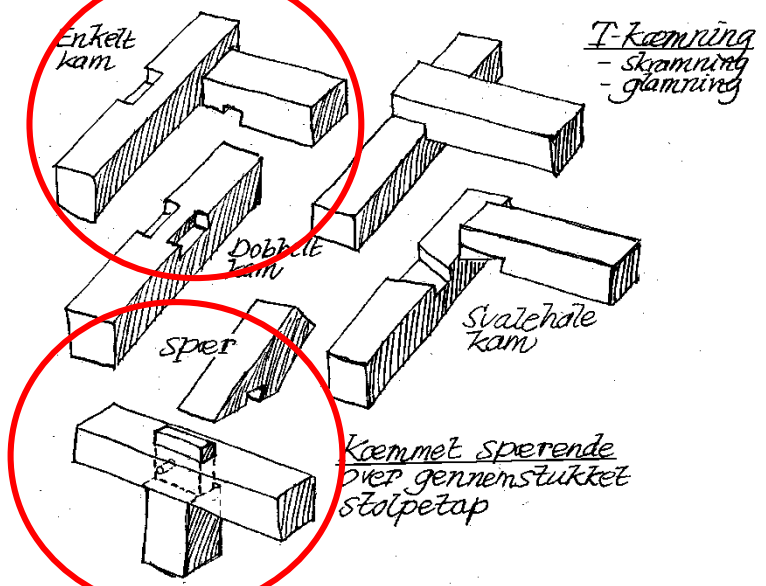
BLADSAMLINGER (Halvt-i-halvt)

til bindingsværk



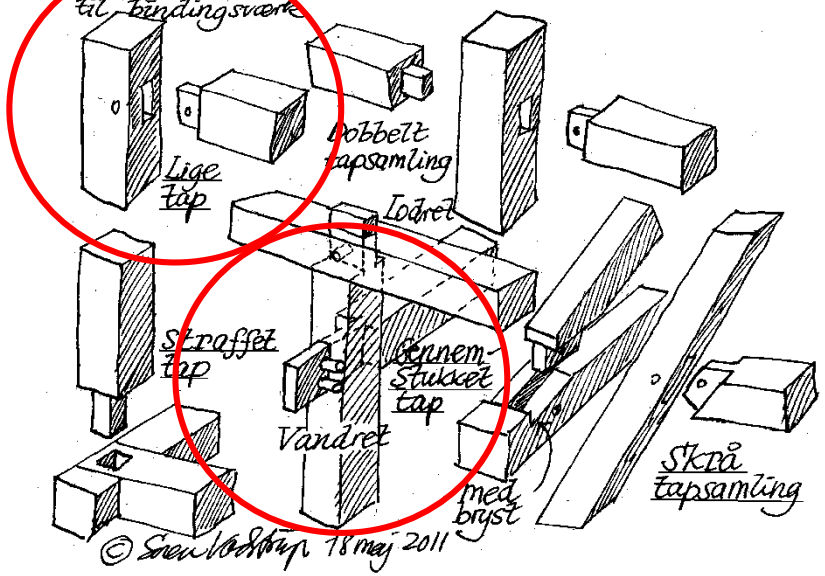
KAMSAMLINGER (1/3-i-1/3)

kæmmede, skrammede, glammede samlinger



TAPSAMLINGER (1/3-i-1/3)

til bindingsværk



Wooden joins at the timber at the four winged half timbered farm Viby Bygade 12 in Viby, Denmark

1 Bottling/tapping - straight or diagonal tenon.
Double collar beam construction

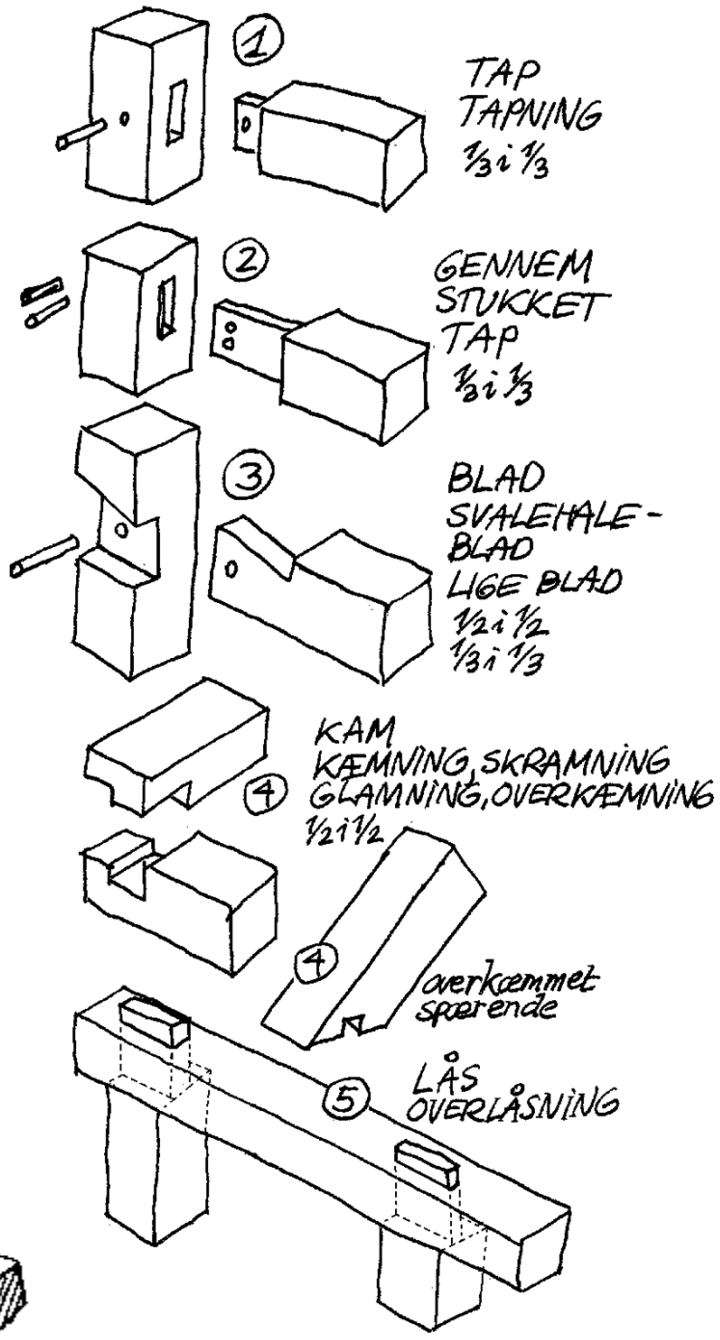
2 Pierced tenon with two locking wedges.
Pierced beam construction

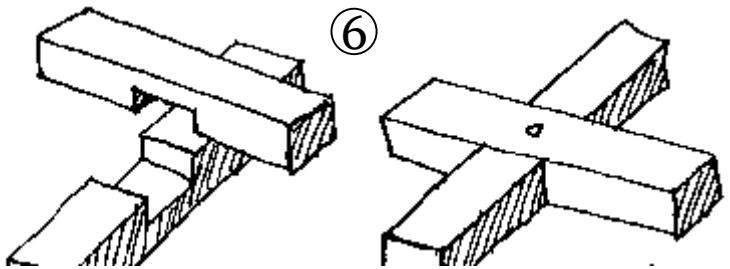
3 Straight or angled dovetail blade.
Double collar beam construction

4 Comb or combing
Truss and beam construction

5 Horizontal lock timber -
for post ends and post feet mm.

6 Angle blade and cross blade -
Wind cross in stable



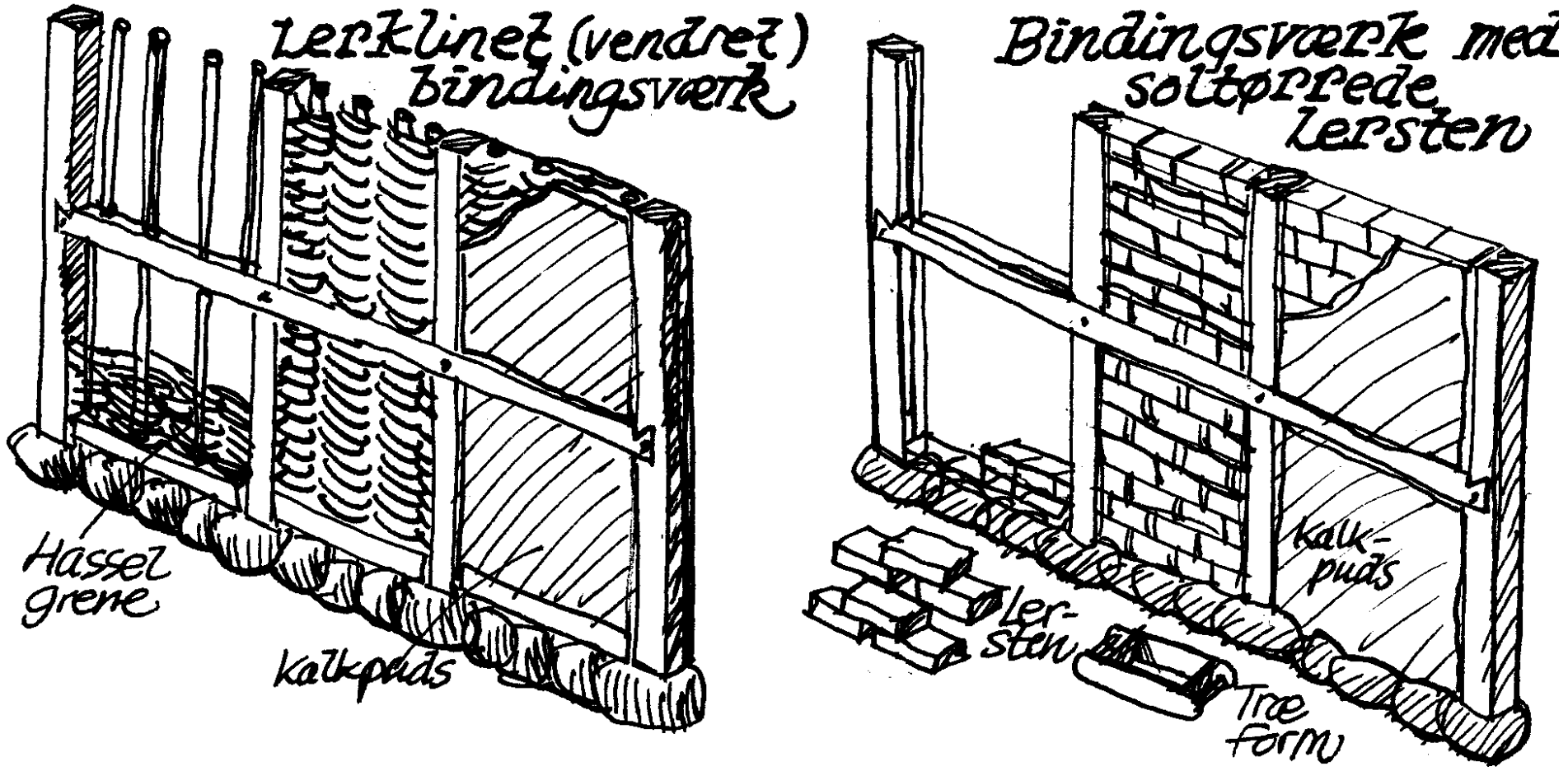


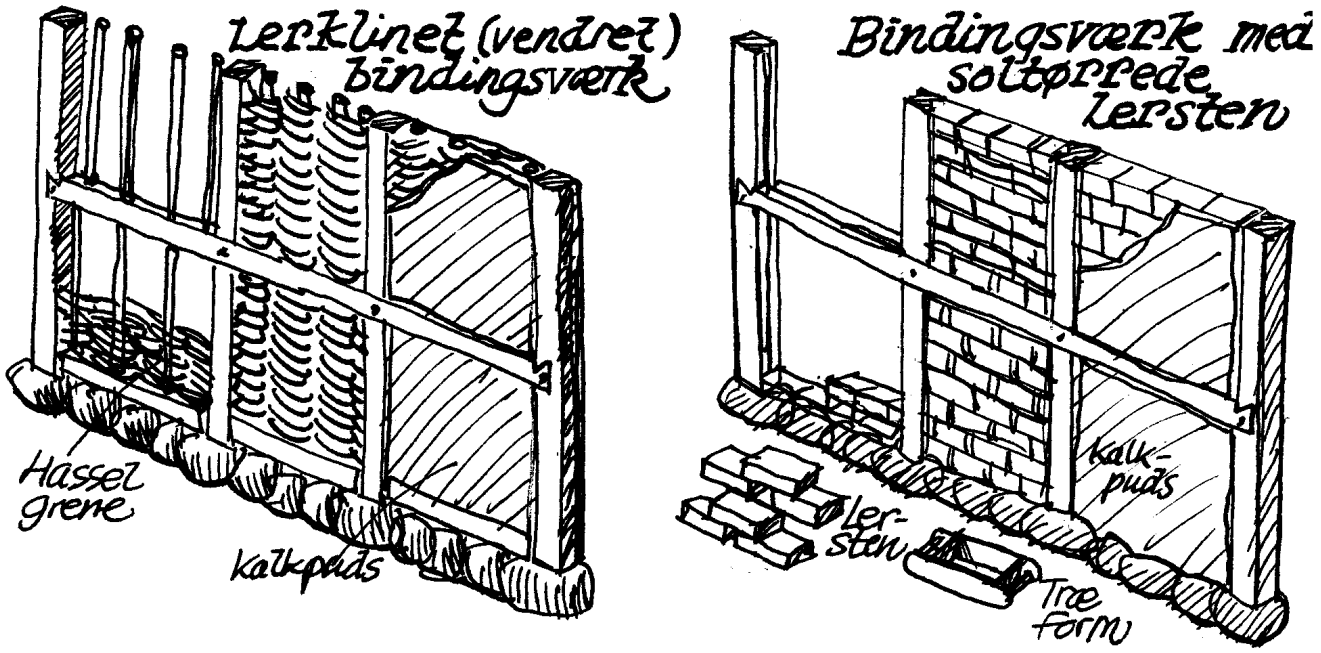
In the farm, there are five different wood species:

- Oak: half timber construction
- Elmetræ (‘the poor mans oak’): poles
- Pine: Beams, rafters, floors, lofts, windows, doors,
- Spruce: Rafters
- Beach: staples

The farm has three different fillings, between the timber construction:

- Wattle and daub (left)
- Adobe (right) covered with lime plaster
- Fired clay stones – visible stones or covered with lime plaster





Wattle and daub has been dated to the Bronze Age (1700 – 500 B.C.), but the present half-timbered structures are known in the country since the early 1400s. In the case study house the wattle and daub is situated in the outbuildings, dating from 1800 A.C.

Adobe fillings in the half timber constructions is known in Denmark from about 1750.

In the case study house, the adobe fillings are situated in the farmhouse from 1740'ies, where it about 1800 has replaced the older wattle and daub fillings. In the outbuildings, dating from about 1800, and containing the threshing floor, the cow sheds, the coach houses and the horse staple, the adobe fillings has also replaced the wattle and daub during the years, but not in all panels. A lot of wattle and daub is still left.

The first use of fired bricks are very precisely dated in Denmark, because of the building of a strong boundary wall against Germany in 1167.

In the cities, the fired bricks were used in the half timber houses in the 1500s, but in the rural houses first until about 1850.

In the current farm there are very few timber-framed fillings with fired brick, only 4 in total. These origins from the 1950s

In the village of Viby there are several farms with Fired bricks from 1850'ies. Most of them has unplastrered visible bricks, to show the new expensive material.

The recipe for the clay mixture for both the wattle and daub and the adobe is the same:

The clay has a quite large content of sand, gravel and crushed stone, up to small chippings. These materials can constitute 70-75% relative to the clay.

There may also be mixed 'chaff', that is, little bits of straw and sawdust in the clay mass.

The high content of gravel, sand and crushed stone makes the adobe, very pressure resistant and easier to plaster on after the construction.

In the soft mass to put in the wooden forms, or on the wattle, there is, of course, water, as the sun and wind subsequent dries out.

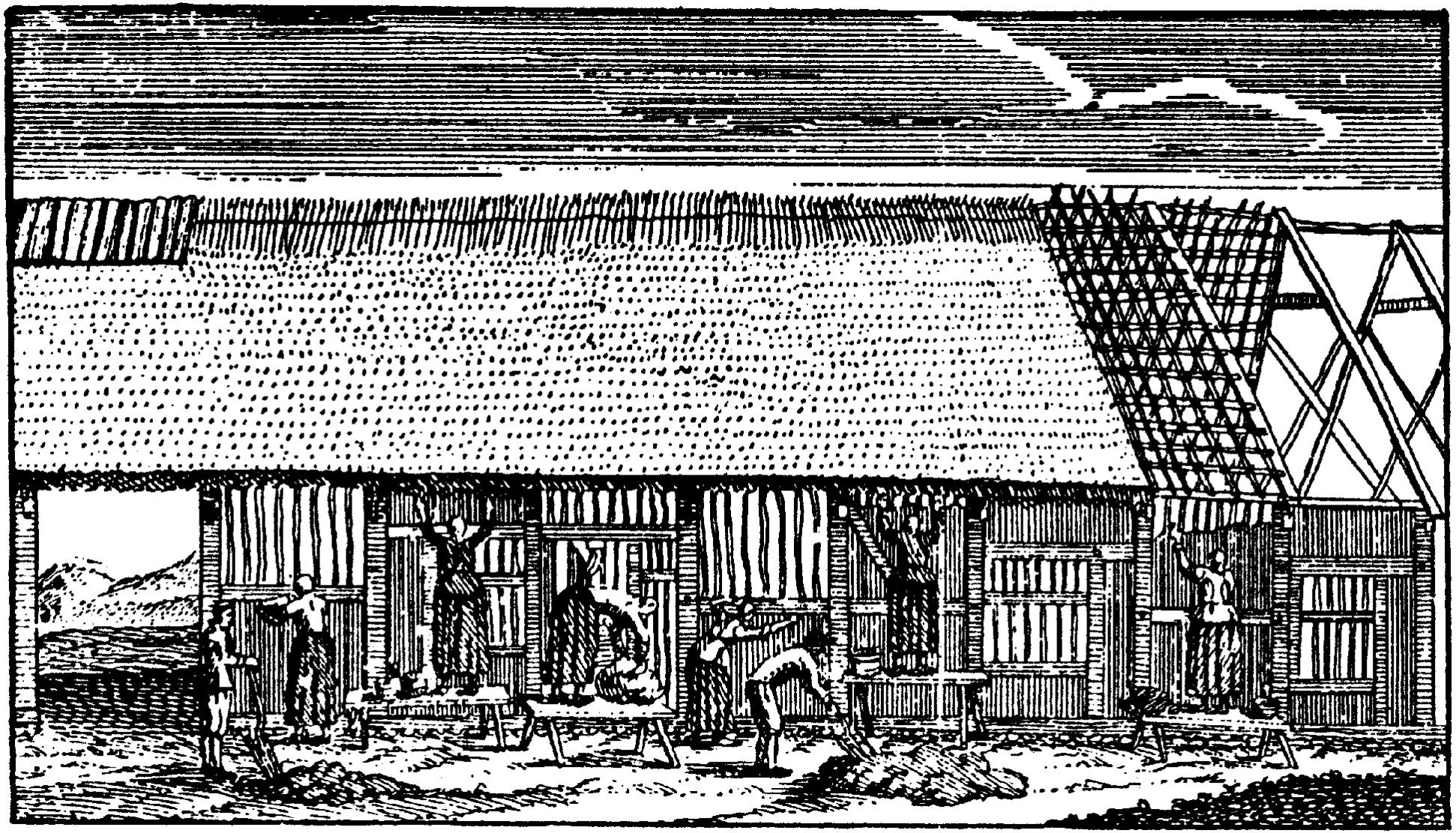
Experiment with wattle and daub

The fields between the timber frames is weaved horizontally with thin branches of hazel around three vertical wooden bars.

The clay mass is mixed well to the right consistency, then thrown on and pressed in the weaving with your hands.

The subsequent drying of the clay must be done very slowly so the wall will crack as little as possible. By mixing sawdust or cow dung in the clay mass, you can also decrease the contraction cracks.

After a few days of drying, during which the wall must avoid direct sun, you can fill the cracks with clay, after which the wall is applied a thin layer of lime mortar, while the clay is almost dry. The wall can now be whitewashed with lime wash.



The Swedish botaniks Carl von Linné bringes in his book '**Resa til Skaane'** (Travel to Skaane) from 1749 a drawing and a description of how the wattle and daub was executed:
The men carries out the heavy mixing and the women carries out the dirty plastering.

Carl von Linnés resa till Skåne 1749: 8 juli

Stavrar eller störar, tjocka som smala armar, kluvna av bokved eller al, fördela väggrummen perpendikulärt, ovantill inborrade i lejden och löshultet och nedantill fästade med en ränna uti fotträet.

Men i städerne, och där som skall vara bättre byggnad, brukas inga stavrar, utan uppmuras väggrummen med tegel.

Leret trampas med oxar eller hästar och blandas väl med halm och sand. När leret således är ältat, föres det till huset.

Kvinnfolkens göromål är att klena väggarne, och manfolken äro endast deras hantlangare, då kvinnnfolken taga upp leret såsom deg och läggat emellan stavrarne, packa det väl tillsammans omkring stavrarne och slätat med händerna, då alltid en piga står innanföre och en utanom, att väggen må bliva jämn på båda sidor.


CARL LINNÆI,
ARCHIAT. REG. ET MED. PROF. UPSAL.
Skånska
Resa,
På
Höga Öfwerhetens
Befallning
Förrättad År 1749.
Med
Rön och Anmärkningar
Uti
Oeconomien, Naturalier, Antiquiteter,
Seder, Lefnads-sätt.
Med
Tilhörige Figurer.
Med Kongl. Majrts Allernådigste Privilegio.
STOCKHOLM,
Uplagd på LARS SALVII kostnad 1751.

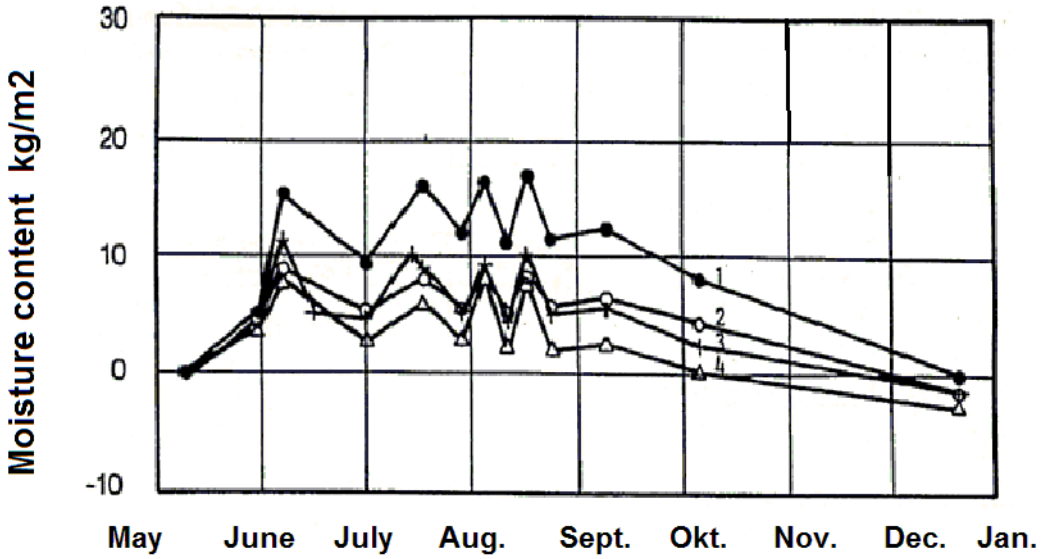
Carl von Linnés resa till Skåne 1749: 15 juli

Kalk brändes av Stevenssten, som togs på danska sidan, även av Glattvikssten, vilken tages vid Jutlands strander på 2 alnars djup under havet.

Denna senare kalkstenen består av runda stenar, stora som ett huvud, inuti like en blek lera, men hårde, och äro alldeles av samma slag med den, vi funnit vid Gärsnäs (*p*. 179).

Han giver den finaste kalk. Stämhuvudsten är av lika art med Glattvikssten men något sämre. Folket bruka här mycket kalk såsom en oumgängelig nödvändighet till sina hus att därmed vitlimma lerväggarne, på det de ej måtte bortsköljas av regnet, varföre de ock vid timande krigstider med Danmark hämta kalk långt upp i Gyinge härad.

Nu hade kalken blivit dyrare för lantmannen, sedan de som vilja hämta sten på danska sidan måste åtaga sig borgerliga *onera*



1 Adope with lime mortar

2 Adope with clay mortar

3 Wattle and daub with straw

4 Wattle and daub with cow dung

A German study has measured the moister content in 4 various timber frame walls with clay fillings, during 8 months. The result shows, that wattle and daub fillings are extremely dry both during the summer and the winter. The moister content is not above 10 kg/m² at any time, while the moister content of the air is around 70-90 kg/m² and the timber frame long above 20-30 kg/m² after rain showers.

That means that the clay walls are drying both the timber out – down to 10-15 kg/m², where it is safe for dry rot, and the interior of the house, which also will be very stable and dry.

So the unburnt clay walls keeps both the timber and the climate qiute dry.

The results of these experience are that:

The clay walls, both external and internal, are regulating the interior climate in the house, so it always are extremely dry – which is opposite the general meaning of clay buildings.

But the clay also prevents mold and mildew at the walls, as long as they are painted with lime wash or glue paint, and not plastic paint.

This is because ambient moisture will not condense on the cold walls because the clay plaster immediately 'sucks' the moisture to itself, so that no water droplets form on the surfaces.

Carl von Linnés resa till Skåne 1749: 5 juni

Husen eller våningsrummen så hos bönderna som ofta hos ståndspersonerna äro merendels här på orten fuktige och med en sällsam kvalma uppfylde.

Dock är denna starkare hos bönderna, där korsverke är med lerväggar och icke med tegel; vilka väggar på denna trakten äro de uslaste, emedan uti var kvadrat av väggen stå perpendikuläre störar ettkvarter ifrån varandra utan att vara hopflätade med några horisontelle spön, vid vilka leret slås på ömse sidor.

Conclusion

It is therefore extremely interesting that the ‘primitive’ clay walls, which the owners in thousands of timber frame buildings faithfully have removed over the years and replaced with brick - now, and particularly in the oldest construction, wattle and daub, is proved to be or have:

- easier and less expensive to maintain, among other things also because the materials are very cheap, almost free.
- protects the timber better by wiping it out
- improves the indoor climate by attracting moisture and condensing water, which also prevents mold and mildew.
- lower energy consumption because it costs much less energy to heat dry air up than humid.
- unfired clay walls also stores the produced heat or heat from the sun, for a longer time than most other materials.

These things are strong arguments and practice for the sustainability of the half timber buildings with clay as a filling material.

Sustainability?

For new constructions to day it is very difficult to answer the question of, how long time the building will last. One can hardly say anything about this, apart from construction product warranty of 5 years (!)

But for us, who work with conservation of older buildings, this issue is extremely easy to answer. We have all the examples of buildings with very long lifetimes we may want, 1: 1, right in front of us.

The four winged timber frame farm at Funen is no exception. 260 years is quite normal for Danish timber frame buildings.

We must therefore operate with a **new** definition of '*sustainability of buildings'*, here 30 years after the 'Brundtland Report': A sustainable building is a building that:

- Have held a very long time – 200 – 300 years - and still can be reused *on site*, being renovated and altered with care, so that the durability, the sustainability and the lifespan continues 100 years further *more*.

- Is built to last very long, because it consists of consists of materials and structures with a very long - at least 200-300 years* - lifetime and durability, and with a simple and environmentally friendly maintenance. (*thatched roofs and chimney pots excluded).

- Have low energy consumption - based on simple and natural solutions with a long lifetime.