Earth Matters

Andrea Pinochet
HAY & CLAY WORKSHOP
08.12.2022

CLAY

Clay

Natural pozzolons

Lime

Portland cement

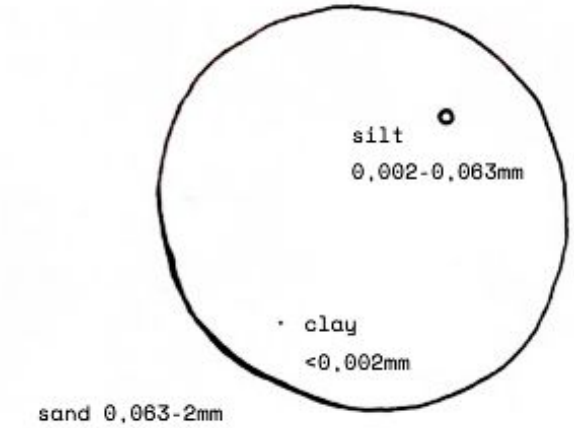
Slag

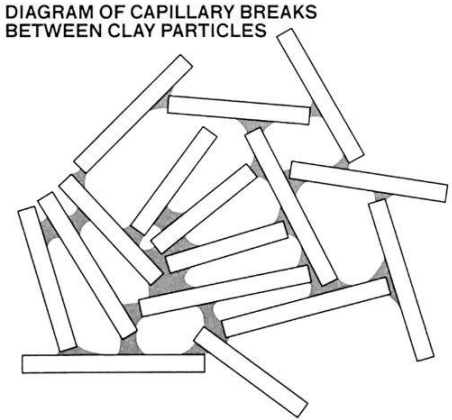
Silica fume

Fly ash

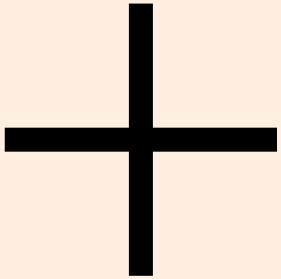
Different types of inorganic binders

0,002





Structure of clay. Drawing by student Lavinia Raissa. Images from Pisé. Rammed Earth book.

aggregate  **binder** *(matrix)*  **composite**

“Concrete” is a generic name that refers to a composite of granules held together by a binding agent. Earth is therefore a “concrete made of clay”

Alain Ruellan, 1993

water

clay

aggregate

+

reinforcement

additives

Clay + Stones
Sand

Natural fibers
Wood
Straw
Hay
Hemp
Rice husk
Coffee husk
etc.

The composition determines the properties !

Properties are defined by:

Type
Quantity
Size
Form
Distribution

w/c

Different clay colors depend on the mineral composition.

Photo of Leirfjord in Nordland.

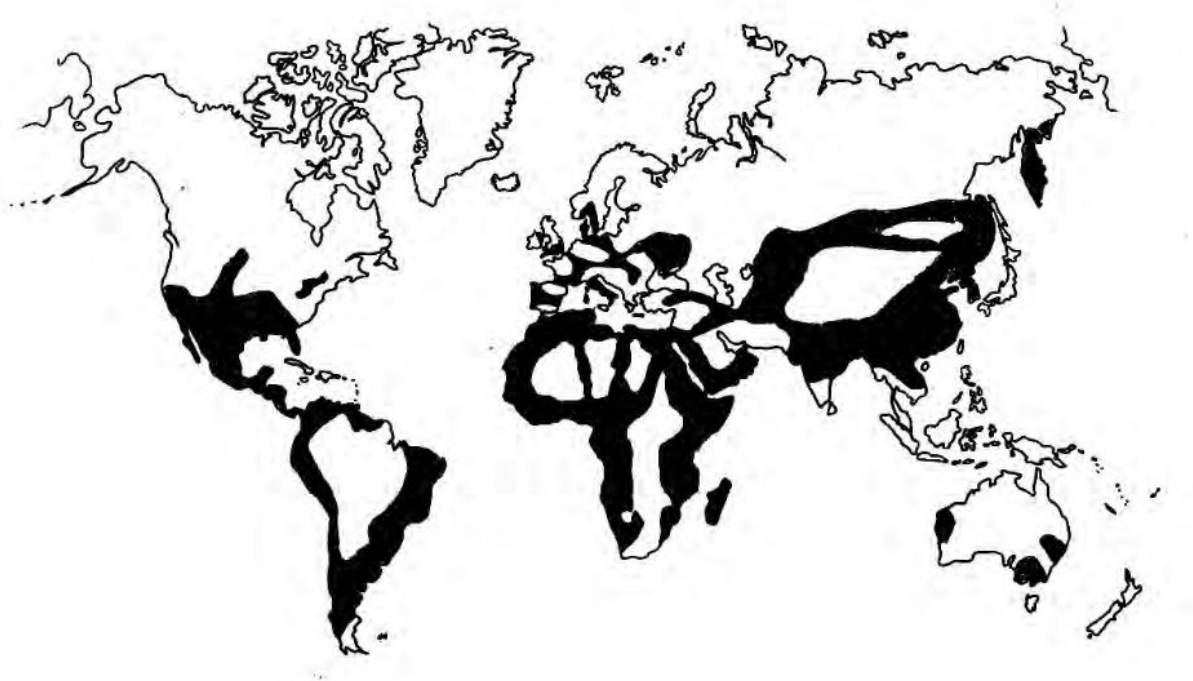
Blåleire

CLAY

- Antibacterial
- Hygroscopic
- Does not burn
- Good acoustics
- Anti-static
- Minimally processed
- Locally sourced

Important considerations
when building with earth:

- Type element / technique
- Labor intensive
- Takes time
- Exposure / weather
- Maintenance



Extension of building with clay in the world

1.

Learn from the past…

The walled city of Shibam, 16th c, Yemen.

Tulous in Fujian Province, China.

Ping Tiang Village, China

Icelandic Turf House

1.

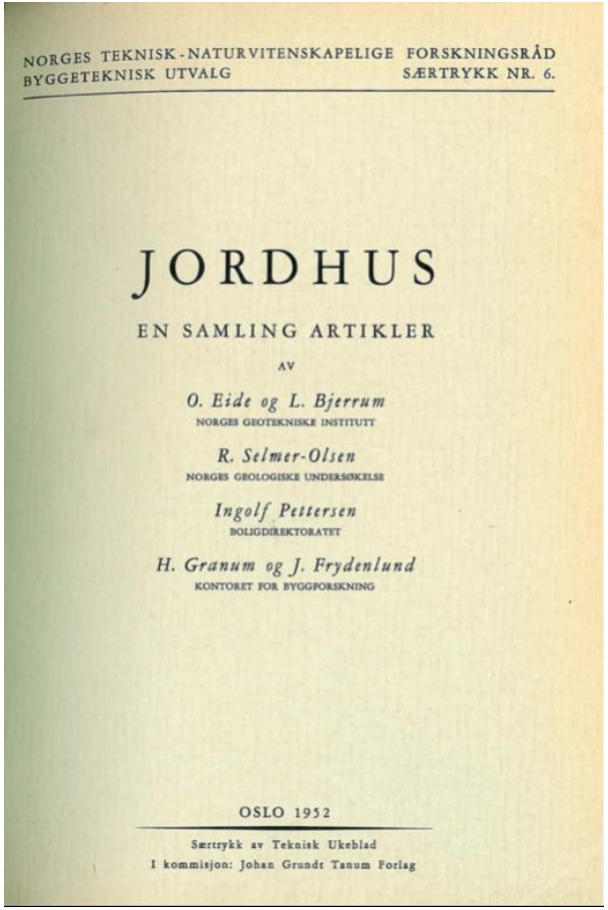
…and your context (TEK)

Traditional Ecological Knowledge

Late 1800s

1920-30

After WWII



NORGES TEKNISK-NATURVITENSKAPELIGE FORSKNINGSRÅD
BYGGETEKNISK UTVALG — SÆRTRYKK NR. 6.

JORDHUS

EN SAMLING ARTIKLER

AV

O. Eide og L. Bjerrum
NORGES GEOTEKNISKE INSTITUTT

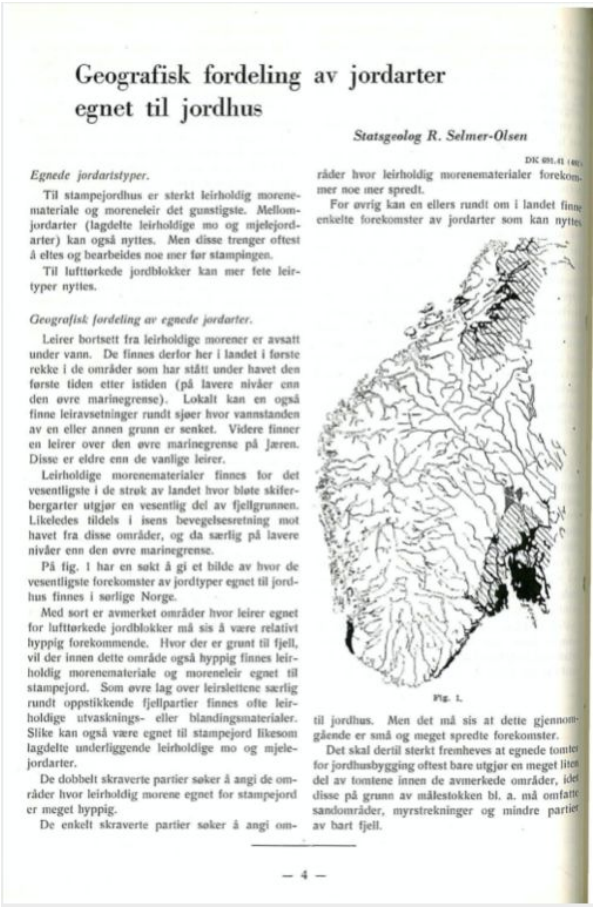
R. Selmer-Olsen
NORGES GEOLOGISKE UNDERSØKELSE

Ingolf Pettersen
BOLIGDIREKTORATET

H. Granum og J. Frydenlund
KONTORET FOR BYGGFORSKNING

OSLO 1952

Særtrykk av Teknisk Ukeblad
I kommisjon: Johan Grundt Tanum Forlag



Geografisk fordeling av jordarter egnet til jordhus

Statsgeolog R. Selmer-Olsen

DK 691.41 (48)

Egnede jordartstyper.

Til stampejordhus er sterkt leirholdig morenemateriale og moreneleir det gunstigste. Mellomjordarter (lagdelte leirholdige mo og mjelejordarter) kan også nyttes. Men disse trenger oftest å eltes og bearbeides noe mer før stampingen.

Til lufttørkede jordblokker kan mer fete leirtyper nyttes.

Geografisk fordeling av egnede jordarter.

Leirer bortsett fra leirholdige morener er avsatt under vann. De finnes derfor her i landet i første rekke i de områder som har stått under havet den første tiden etter istiden (på lavere nivåer enn den øvre marinegrense). Lokalt kan en også finne leiravsetninger rundt sjøer hvor vannstanden av en eller annen grunn er senket. Videre finner en leirer over den øvre marinegrense på Jæren. Disse er eldre enn de vanlige leirer.

Leirholdige morenemateriale finnes for det vesentligste i de strøk av landet hvor bløte skifferbergarter utgjør en vesentlig del av fjellgrunnen. Likeledes tildels i isens bevegelsesretning mot havet fra disse områder, og da særlig på lavere nivåer enn den øvre marinegrense.

På fig. 1 har en søkt å gi et bilde av hvor de vesentligste forekomster av jordtyper egnet til jordhus finnes i sørlige Norge.

Med sort er avmerket områder hvor leirer egnet for lufttørkede jordblokker må sis å være relativt hyppig forekommende. Hvor der er grunt til fjell, vil der innen dette område også hyppig finnes leirholdig morenemateriale og moreneleir egnet til stampejord. Som øvre lag over leirslettene særlig rundt oppstikkende fjellpartier finnes ofte leirholdige utvasknings- eller blandingsmaterialer. Slike kan også være egnet til stampejord likesom lagdelte underliggende leirholdige mo og mjelejordarter.

De dobbelt skraverte partier søker å angi de områder hvor leirholdig morene egnet for stampejord er meget hyppig.

De enkelt skraverte partier søker å angi områder hvor leirholdig morenemateriale forekommer noe mer spredt.

For øvrig kan en ellers rundt om i landet finne enkelte forekomster av jordarter som kan nyttes

Fig. 1.

til jordhus. Men det må sis at dette gjennomgående er små og meget spredte forekomster.

Det skal dertil sterkt fremheves at egnede tomter for jordhusbygging oftest bare utgjør en meget liten del av tomtene innen de avmerkede områder, idet disse på grunn av målestokken bl. a. må omfatte sandområder, myrstrekninger og mindre partier av bart fjell.

Jordhus, Byggeteknisk Særtrykk Nr.6, Norges Teknisk- Naturvitenskapelige Forskningsråd Utvalg, 1952.

Fig. 3. Maskinfremstilling av leirblokker.

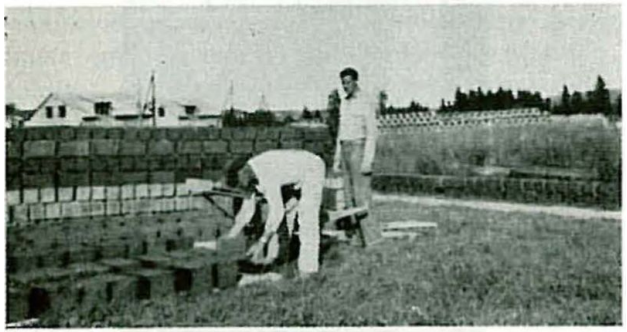
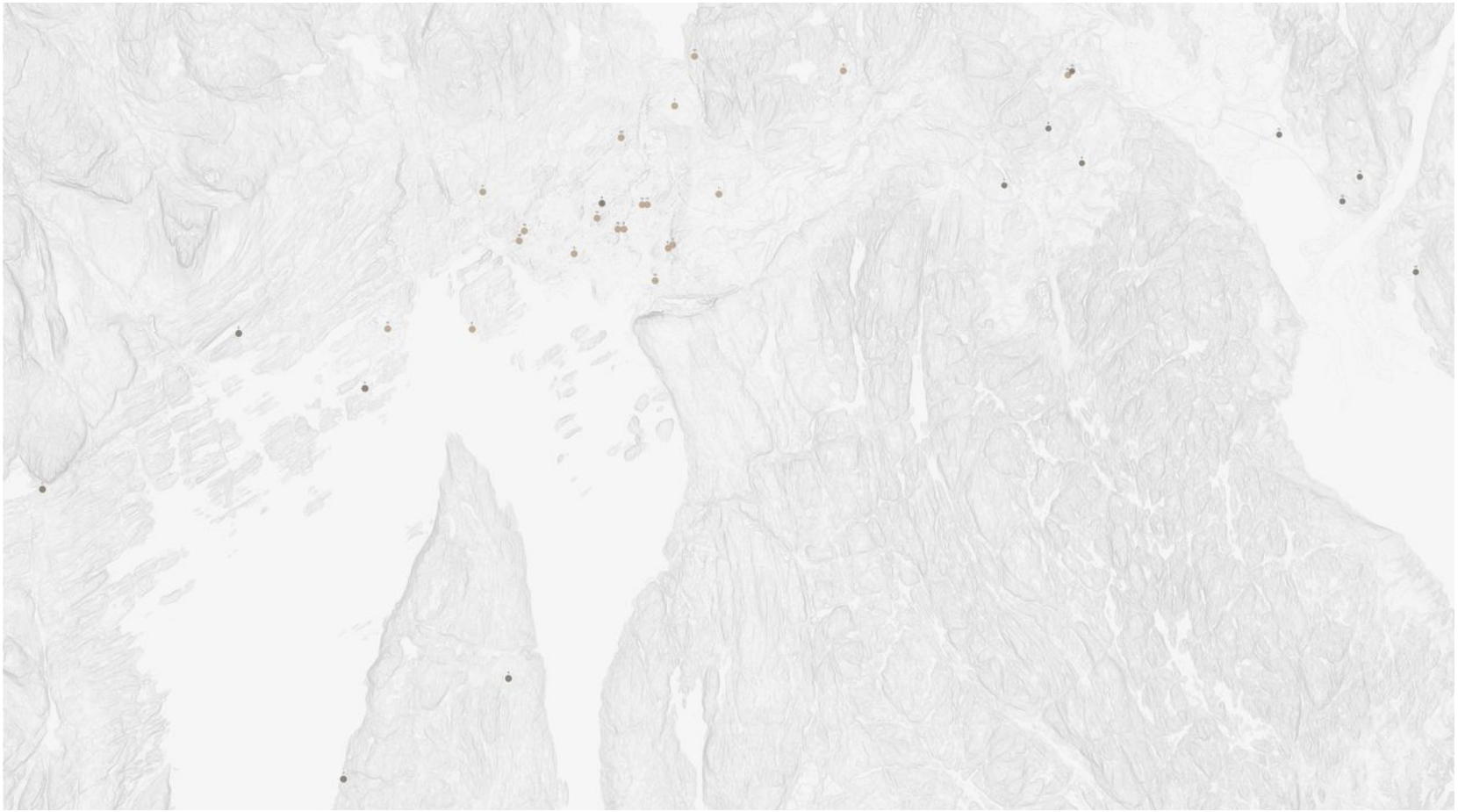


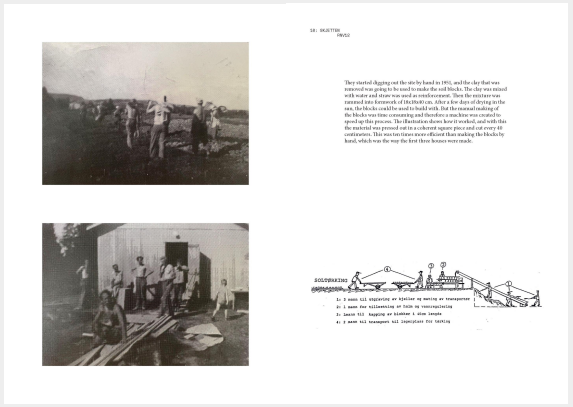
Fig. 4. Lagring av blokker.

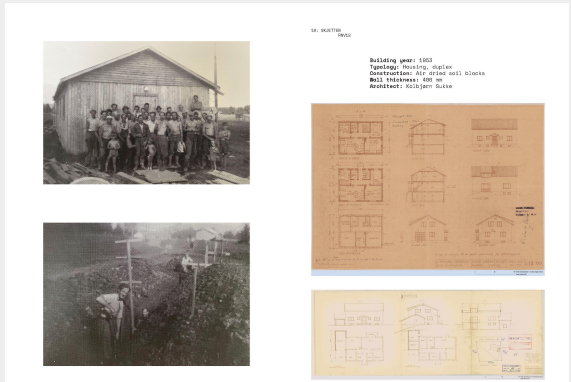
Fig. 1. Vellykket stampejordhus.

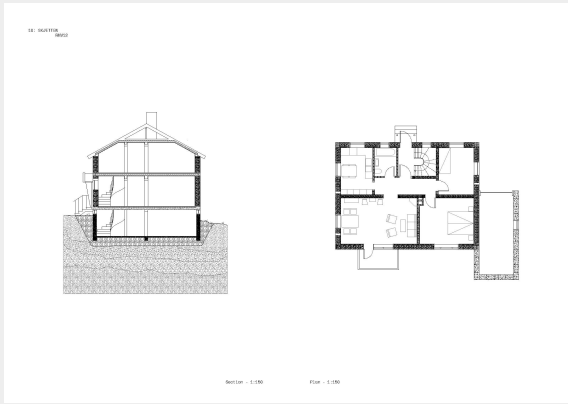
Images from Jordhus, Byggeteknisk Særtrykk Nr.6, 1952. Drawing from BBL-posten article.



Map of soil samples and surveyed houses in Oslo, Earthly Archive, Earth Matters studio, AHO, 2021.







Earth house survey book by student Beatrice Liv, Earthly Archive, Earth Matters studio, AHO, 2021.

Granulometry test of earth samples from Oslo, Earthly Archive, Earth Matters studio, AHO, 2021.

2.

Get your hands dirty

Material characterization workshop, Earth Matters studio, AHO, 2021.



Hempcrete and clay workshops, Wasted! + Earth Matters studio, AHO, 2021-2022.

Clay workshops, Earth Matters studio, AHO, 2021.

3.

Document the work

Material samples, Earth Matters studio, AHO, 2021.

Procedure

1. **Dry sample if needed**
2. **Sieve sample through different size apertures**
3. **Organize samples according to particle distribution**

Equipment

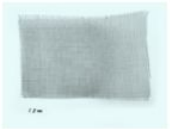
soil sample
weight
sieve - 1.8 mm
sieve - 1 mm
sieve - 0.6 mm
sieve - 0.35 mm

Using this experiment, we tried to find out the constituents of the different samples.

From the 18 samples available, we chose 10 x 400 g to pour into jars with water. This simple field test gave us the opportunity to select with the naked eye the most interesting (i.e., most layered/diverse) samples on which we performed the "dry" granulometry test. The selection was done by sight with performance as a building material in mind.
We chose two samples that we expected to behave well as a building material, and one sample that we expected the opposite. In addition, we selected a sample that was not in the jars, in order to be able to compare the granulometry with the stone made from this soil at the same time.

Particle size analysis allows us to determine the respective quantitities of the various elements making up the soil.
This knowledge can help us estimate which soil will perform better or worse as a building material.

Since the size of the mesh of the sieves at our disposal ranges from 1.8 mm to 0.35 mm, all our particles can be considered as 'sand'.
More advanced and precise techniques are required to make further subdivisions into loams and clays.



a.
Sample 07:
Grefsen

b.
Sample 14:
St. Hanshaugen

c.
Sample 15:
Thune Byggeplass

d.
Sample 18:
Aho

a. Sample 07: Grefsen

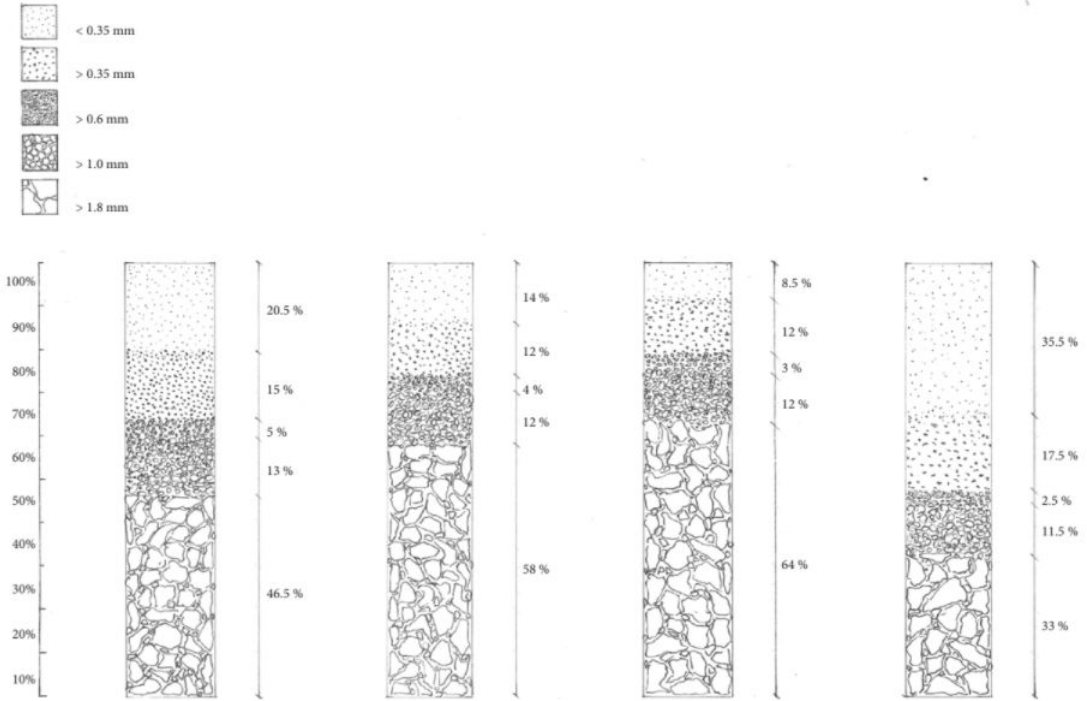
Conclusion

S7, taken at Grefsen, seemed like a good sample beforehand. We thought it contained a relatively large amount of clay, and thus would function well as a sturdy and solid building block.

The dry test showed that this sample consisted of almost half of particles of the largest kind. In addition, about 20% consisted of particles of the smallest kind.
Because of our available measurement methods, these particles still fall under the heading of 'sand', but from this we could deduce that this sample could contain relatively large amounts of clay and silt.

The result of this soil in a building block was rather compact and stable, with some loose material.

"Lab Report," Earth Matters studio, AHO, 2021.



Comparative drawing of granulometry of different soil samples in Oslo by student Eva Van Geldorp. Earth Matters, AHO.

Soil Sample 03 - Ammerud

a. b. c.

	Added water	Diameter before drop	Diameter after drop
a.	0 ml	34 mm	37 mm
b.	5 ml	37 mm	50 mm
c.	5 ml	38 mm	81 mm

Soil Sample 07 - Grefsen

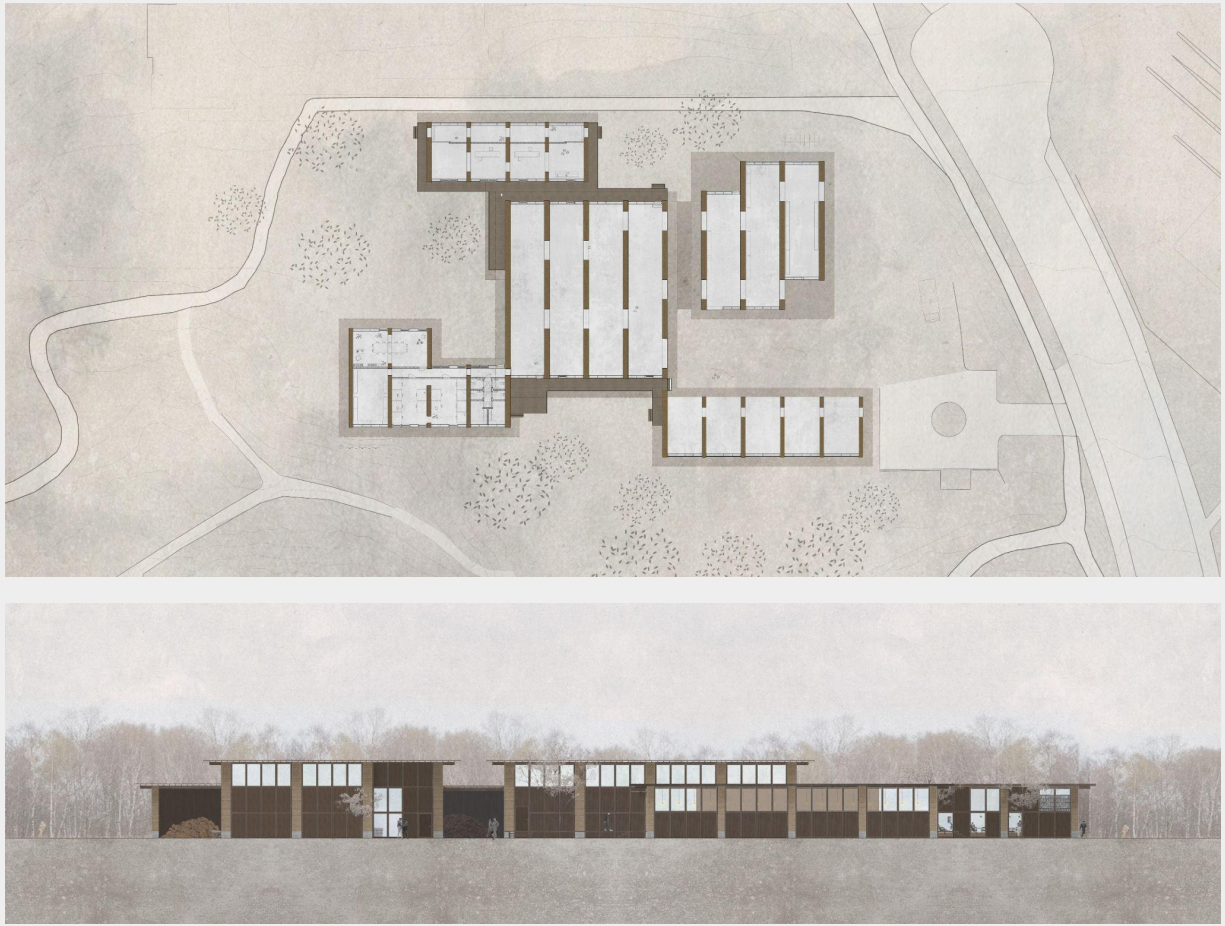
a. b. c.

	Added water	Diameter before drop	Diameter after drop
a.	5 ml	36 mm	44 mm
b.	10 ml	37 mm	70 mm
c.	3 ml	38 mm	Unvalid

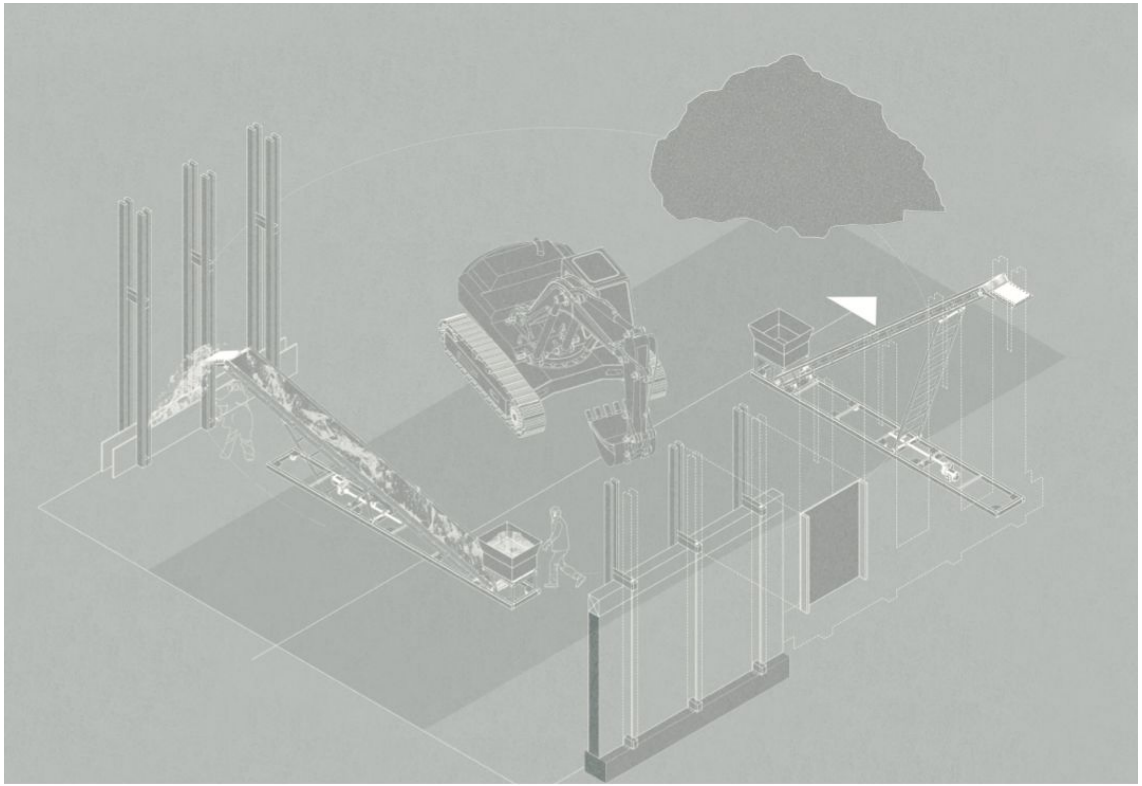
Comparative drawing of granulometry of different soil samples in Oslo by student Ingeborg Mull. Earth Matters, AHO.

4.

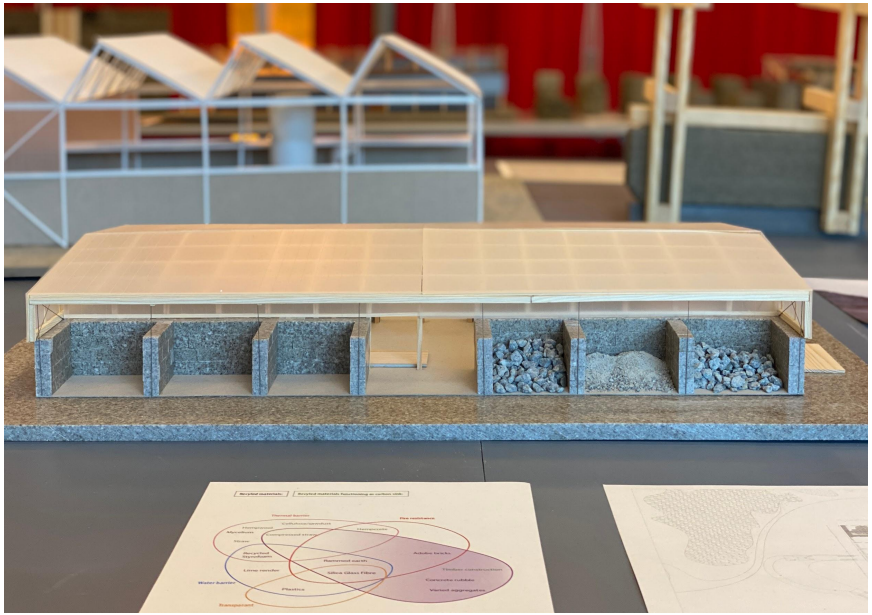
Think big

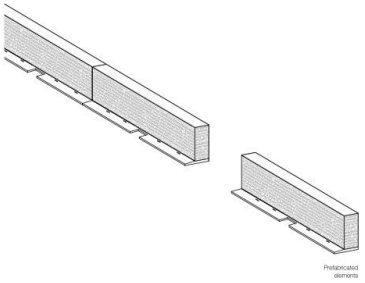


Proposal for Earth Research Center by AHO student Eva Van Geldorp. Earth Matters, AHO.



Proposal for pilot factory by AHO student Malte Wiegand. Wasted! studio.





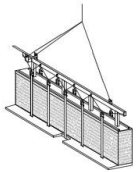
Prefabricated elements

Even though using excavated soil has a lot of advantages the production of rammed earth is very labor-intensive. The hand ramming process will take about 20-30h per m³. Pneumatically electrical ramming can reduce the time to 10h per m³. Through mechanical transport and filling the process can be reduced to 2 hours.

To increase the efficiency of the building process further a 40 m long element is produced that can be cut into elements of 9 m. The Elements with a height of 800 mm and a weight of 2.16 tonnes allow for simple transport and moving.

To support the elements for transporting it as well as avoiding the time-consuming joints hand filled afterward the timber base plates of the formwork are integrated into the wall structure. The elements are stacked and horizontally joined with an earth mortar. Similar to brick masonry, the individual elements are laid in a bond to distribute the load evenly so that the elements work as a whole wall.

They are enlarged towards one side to form an erosion break as well as to connect the elements to the load-bearing structure. The different deformation behaviors of timber and earth can be taken into account by a movement joint.

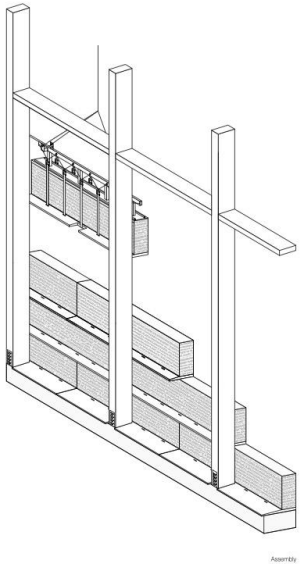


Transportation

0,92 m³ /2.16 t
rammed earth element

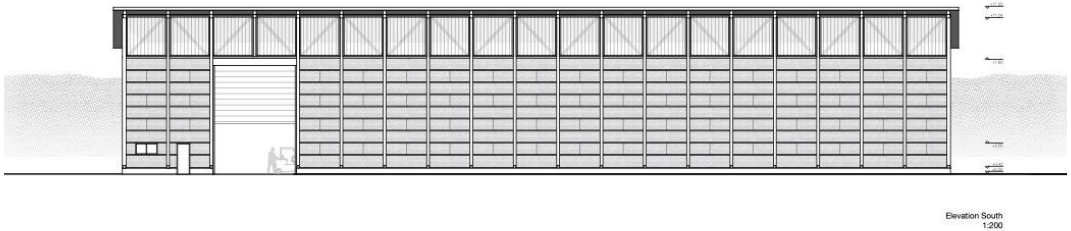
265 x 1,5 h = 397,5 h

Assuming a reduced working time of 1,5 h per m³ the wall could be build in 50 working days (397,5 hours).

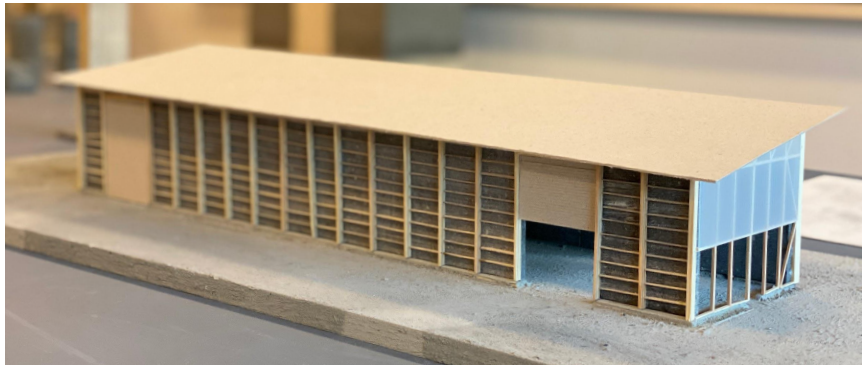


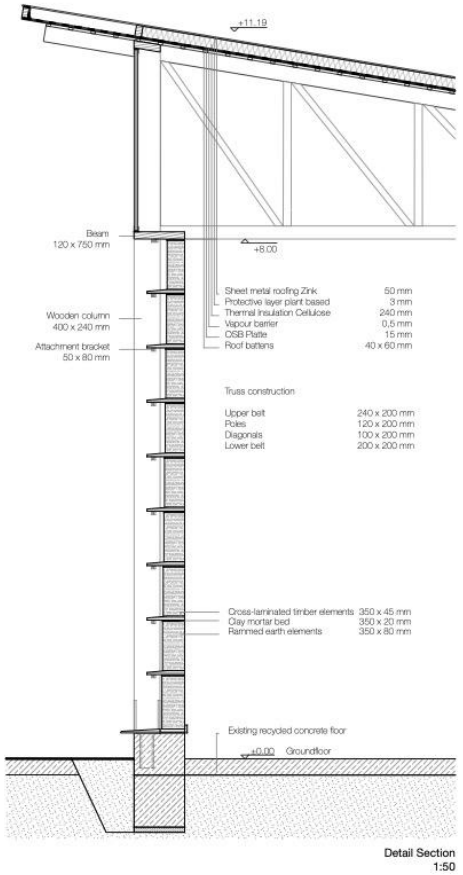
Assembly

Proposal for pilot factory by AHO student Stijn Jalon. Wasted! studio.



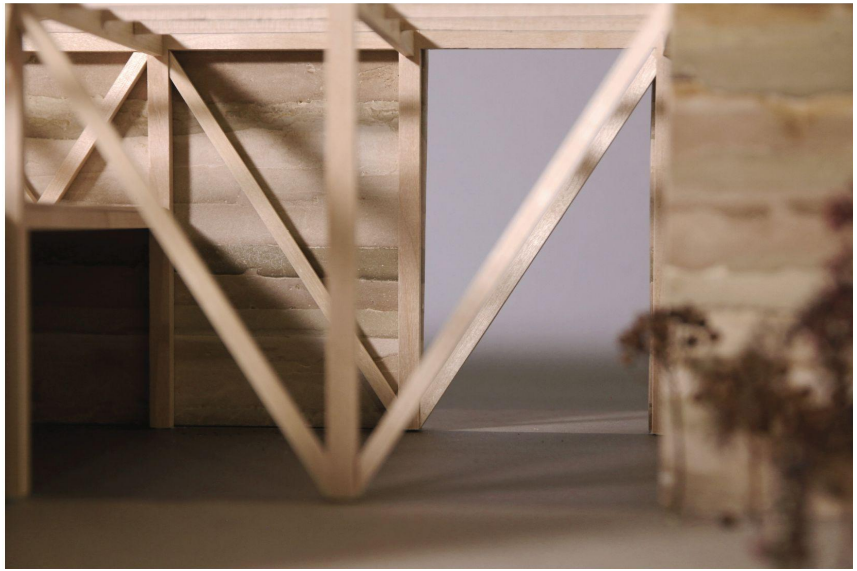
Elevation South
1:200

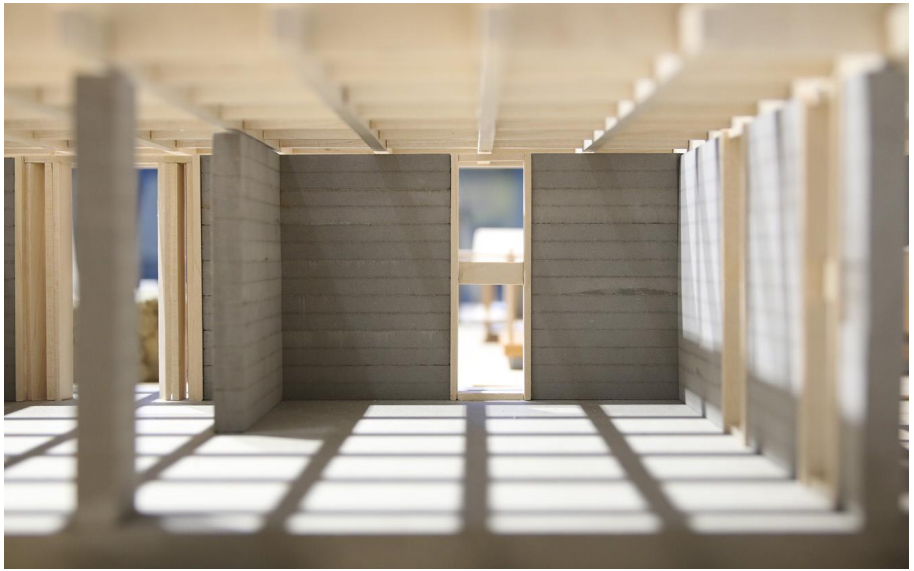




Detail Section
1:50

Proposal for pilot factory by AHO student Lavinia Raissa. Wasted! studio.





Proposal for Earth Research Center by AHO students Ingeborg Mull and Beatrice Liv. Earth Matters, AHO.

5.

Share it!

Earth Matters exhibition, 2021, AHO.

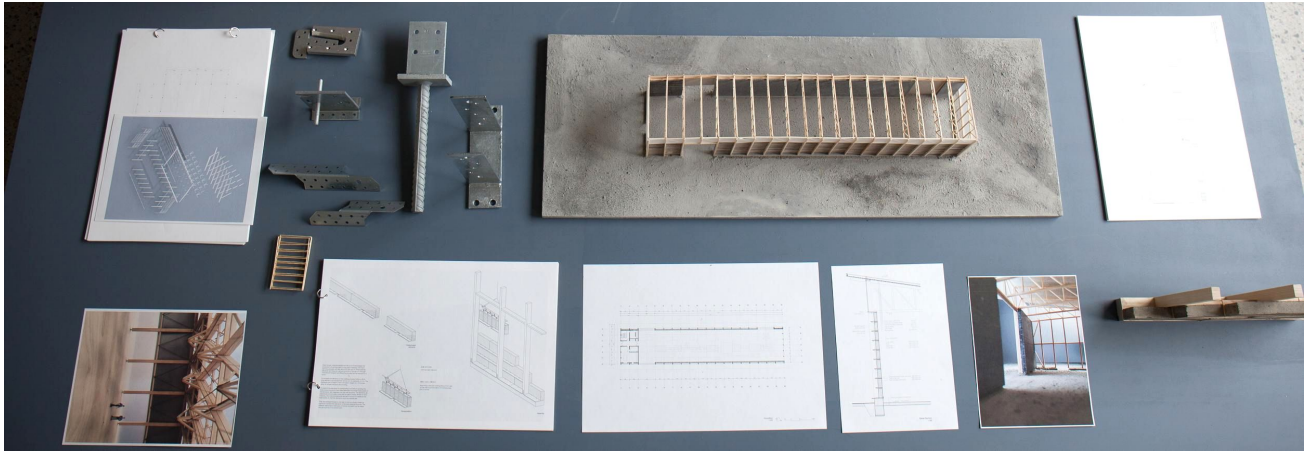
Earth Matters exhibition, 2021, AHO.

Straw studies by student Ask Holmen. Wasted! Studio, AHO Works exhibition, 2022, AHO.

Wasted! exhibition, 2022, AHO.

Wasted! exhibition, 2022, AHO.

Wasted! exhibition, 2022, AHO.



Wasted! exhibition, 2022, AHO.