# CLT - healthy, solid and cost-efficient

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# MASSIV LUST AS

massivtre i Luster


Norway
Sweden
A
Stjordal
Trondheim
Kristiansund
Molde
Alesund
Östersund
Ornsköldsvi
Sundsvall
Hudiksvall
Lillehammer
Mora
Hamar
Elverum
Falun
Gävle
Borlänge
Bergen
Fana
Sandvika
Oslo
Uppsala
Drammen
Västerås
Haugesund
Moss
Karlstad
Örebro
Eskilstuna
Täby
Stockho
Tonsberg
Sarpsborg
Fredrikstad
Sodertalje
Stavanger
Porsgrunn
Sandnes
Norrköping
Trollhättan
Linkoping
Kristiansand
Borås
Jönköping
Visby
Gothenburg


Sognefjellsvegen
Riksvei 55
Rådhusvegen
Gaupne hotel AS
Sandvikvegen
Johnsavegen
Haugavegen
Gaupne Bilsenter
Shell
Grandane
Rv55
Pluscamp Sandvik
Pluscamp Sandvik kafeteria & kiosk
Pluscamp Sandvik kafeteria og kiosk
Sandvikvegen
Sognefjellsvegen
A
Massiv Lust AS
Mekanisk industri
Fugløyri
Flystripe
Grandane
Tvingeborgneset
Sandvikvegen
Sandvik
Dypvannskai
Tvingeborgneset
Riksvei 55

# 4 departments

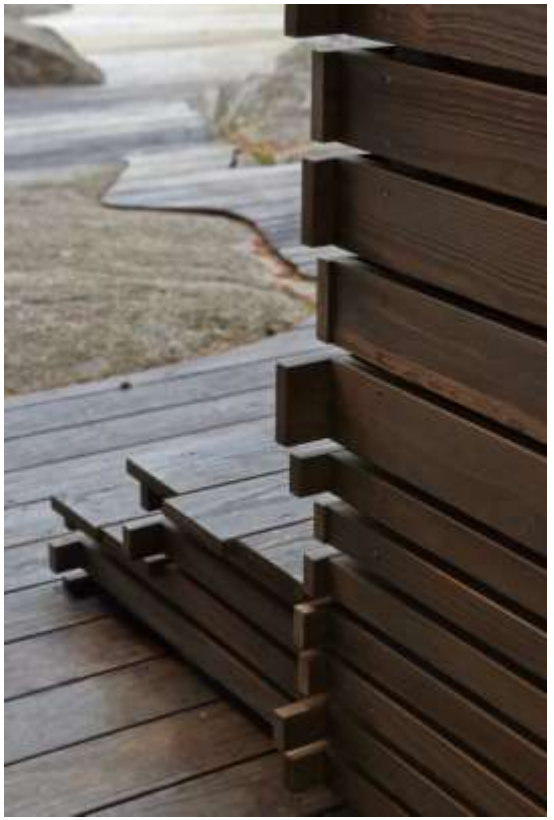
Architectural design

Production

CNC-Formatting

Mounting

Architectural design and CLT programing



Production

# High quality spruce from the Norwegian forest

# Engineered wood - Cross laminated timber

# Flat-packed and Ready-to-assemble

CNC-Formatting

# High precision CNC milling

millimeter precision

Mounting

# Mobile mounting team

Mounting

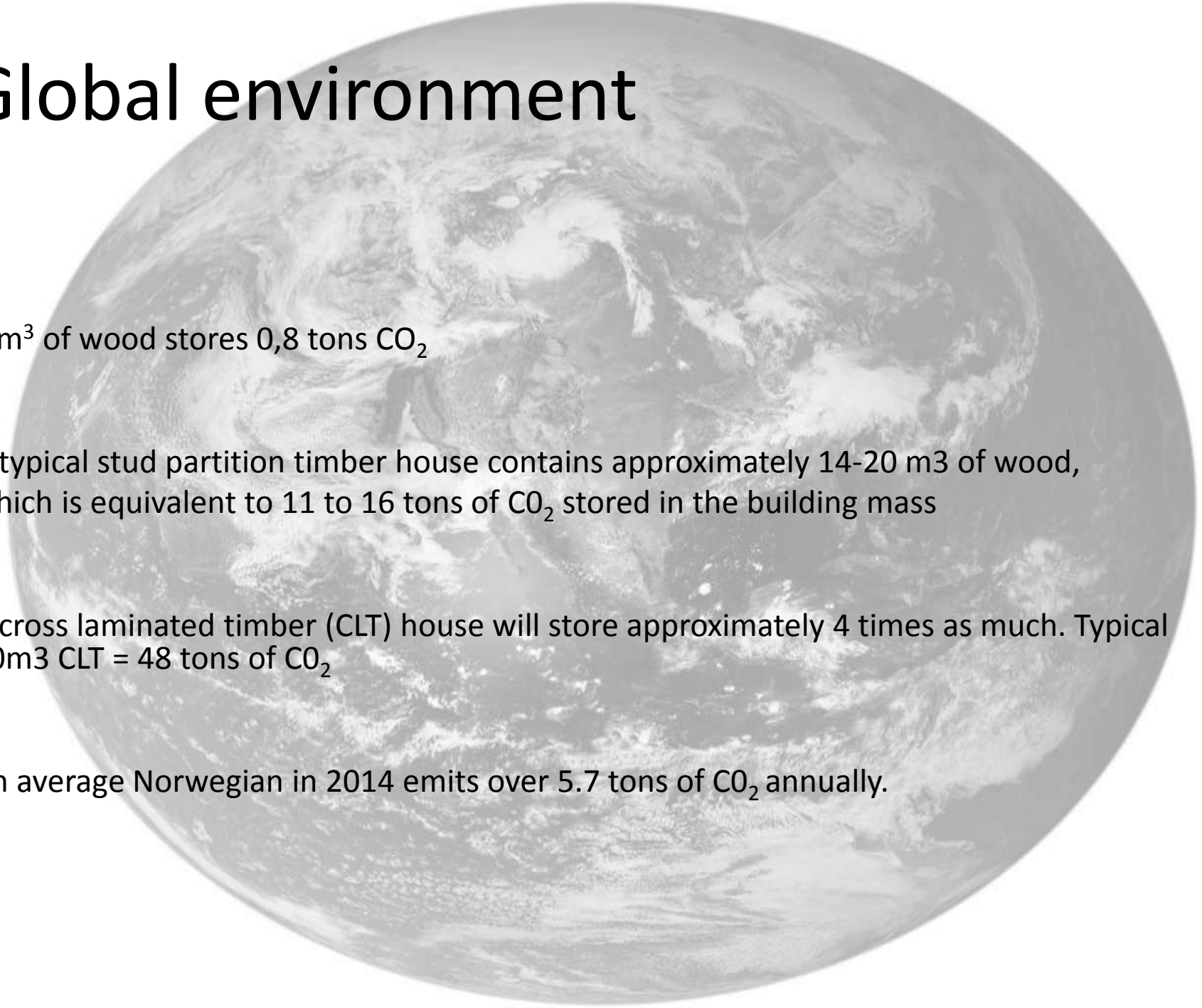
# Mounting CLT and Glulam

# Why we shall engage in the forest and timber constructions

The trees capture light energy and converts it to sugar energy, in the presence of chlorophyll, using carbon dioxide ($CO_2$) and water ($H_2O$).
The tree release $O_2$
The carbon C remains in the tree.
Photosynthesis is powered by sunlight.

- Trees are a natural and renewable resource
- Carbon trapped in the forest will be stored in the wood materials until combustion
- Young forest in good growth takes up a lot of $CO_2$, mature forest in a lesser extent, while overripe forest may increase $CO_2$ emissions
- Storing carbon in buildings is better than a forest dying on root
- Burning wood is climate neutral energy. This is because it emits just as much CO2 through the chimney into the air - as the tree absorbed from the air when it grew in the forest
- Increased use of wood materials can reduce the use of materials such as concrete and steel

# Global environment



1 $m^3$ of wood stores 0,8 tons $CO_2$

A typical stud partition timber house contains approximately 14-20 m3 of wood, which is equivalent to 11 to 16 tons of $C0_2$ stored in the building mass

A cross laminated timber (CLT) house will store approximately 4 times as much. Typical 60m3 CLT = 48 tons of $C0_2$

An average Norwegian in 2014 emits over 5.7 tons of $C0_2$ annually.

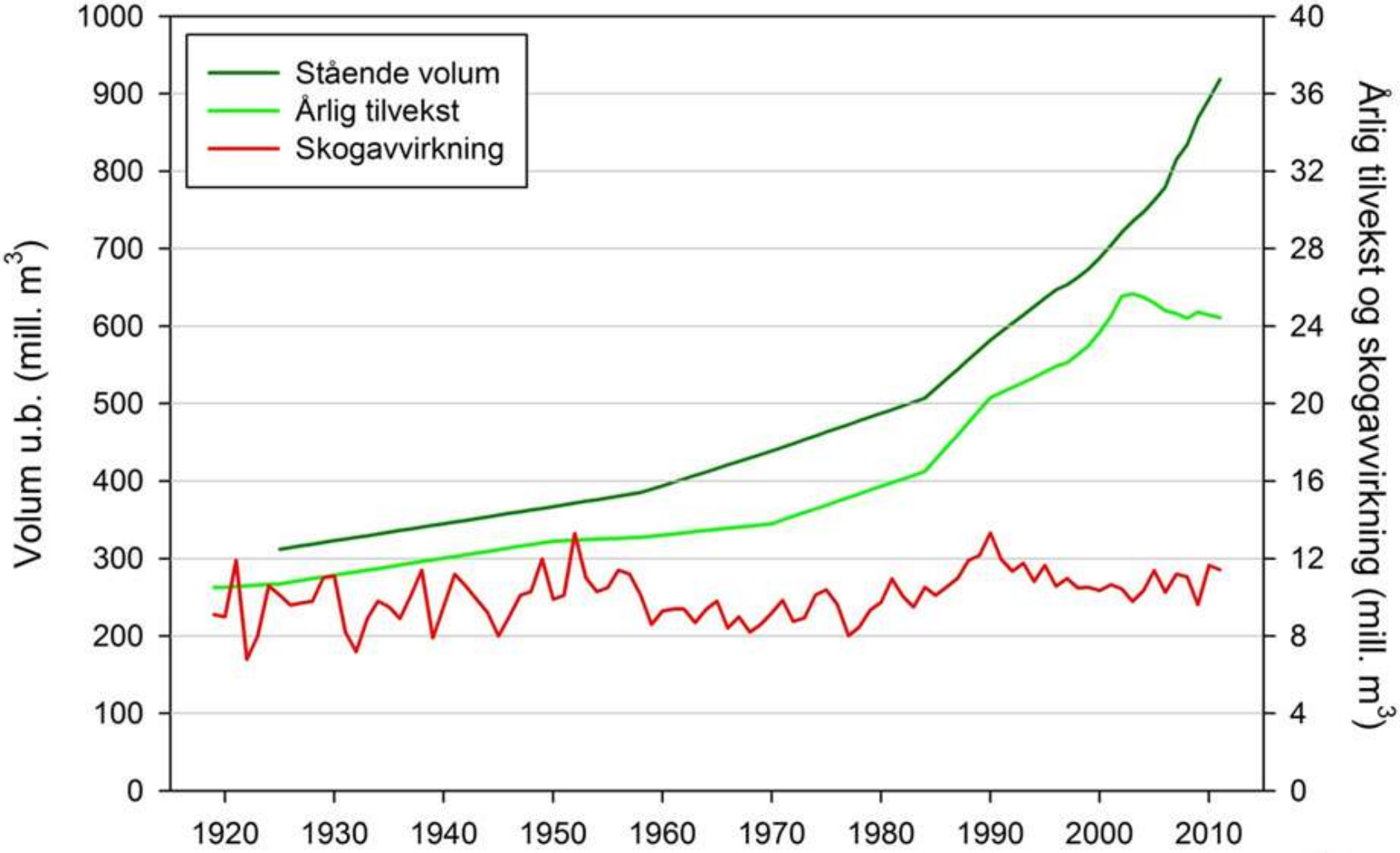
# Condition and potential in Norwegian forest industry today

Norway's land area: 31 million acres
Norwegian forest area: 12 million acres
Productive forest: 8 million acres

More than one third of Norway is covered by forest and one 4th is productive forest

Tree species distribution: 44% spruce, 31% pine and 25% hardwood

Standing timber volume in the Norwegian forests is now more than twice as large as 100 years ago, and there is now 912 million m3 of timber in our forests.
An increase of about 50 percent in volume over the last twenty years.




*Kilde: Norsk institutt for skog og landskap og Statistisk sentralbyrå*

skog+ landskap

Annual growth: 23,7 million m3

Annual logging: 7-9 million m3

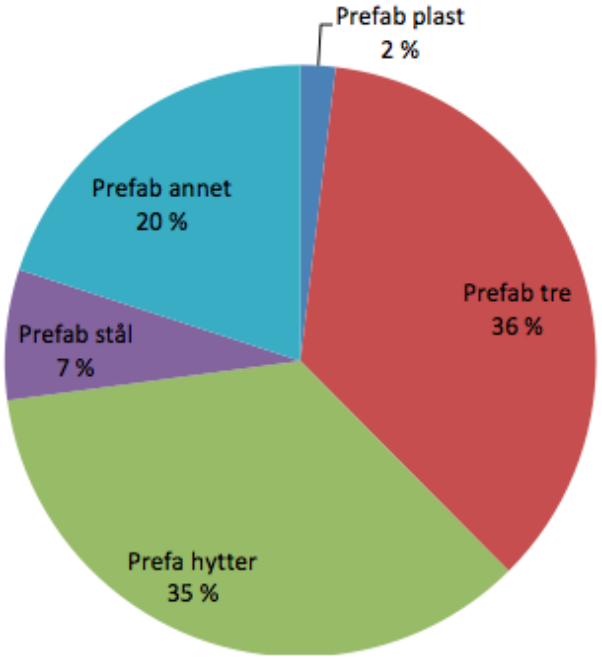
We take out just over 1/3 of the annual increase in the Norwegian forest


Remember: Young trees have a higher $CO_2$ binding

Older mature forest covers 40% of our productive forest.

| | 1992 | 2012 |
|---|---|---|
| Prefab plast | kr 4 252 432 | kr 48 135 300 |
| Prefab tre | kr 18 247 779 | kr 896 203 565 |
| Prefa hytter | kr 37 591 955 | kr 887 669 430 |
| Prefab stål | kr 182 672 773 | kr 178 985 655 |
| Prefab annet | kr 41 243 189 | kr 503 037 730 |
| Totalt | kr 284 008 128 | kr 2 514 031 680 |

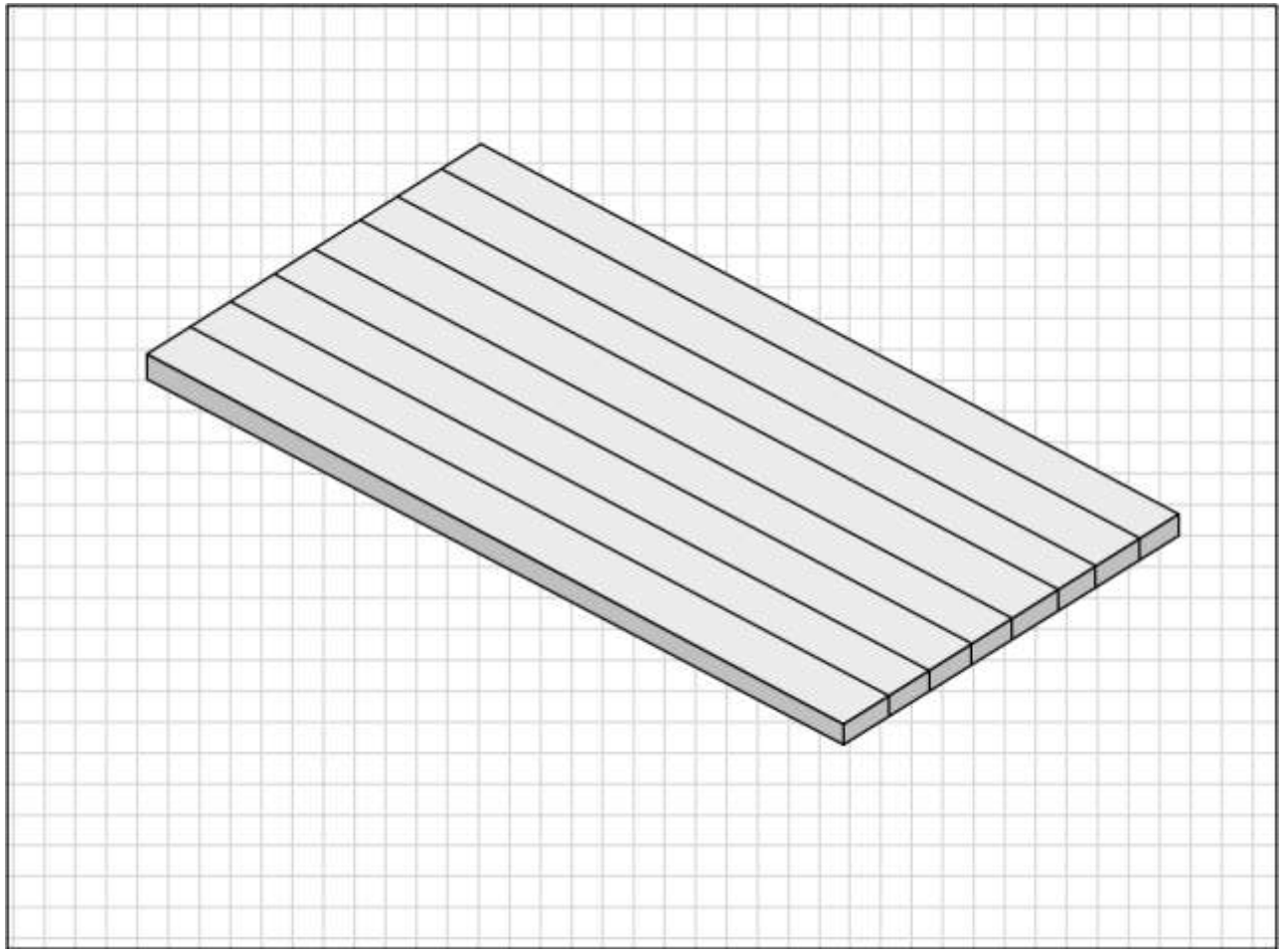
Import of prefab houses and building elements: An increase of 785% over 20 years!



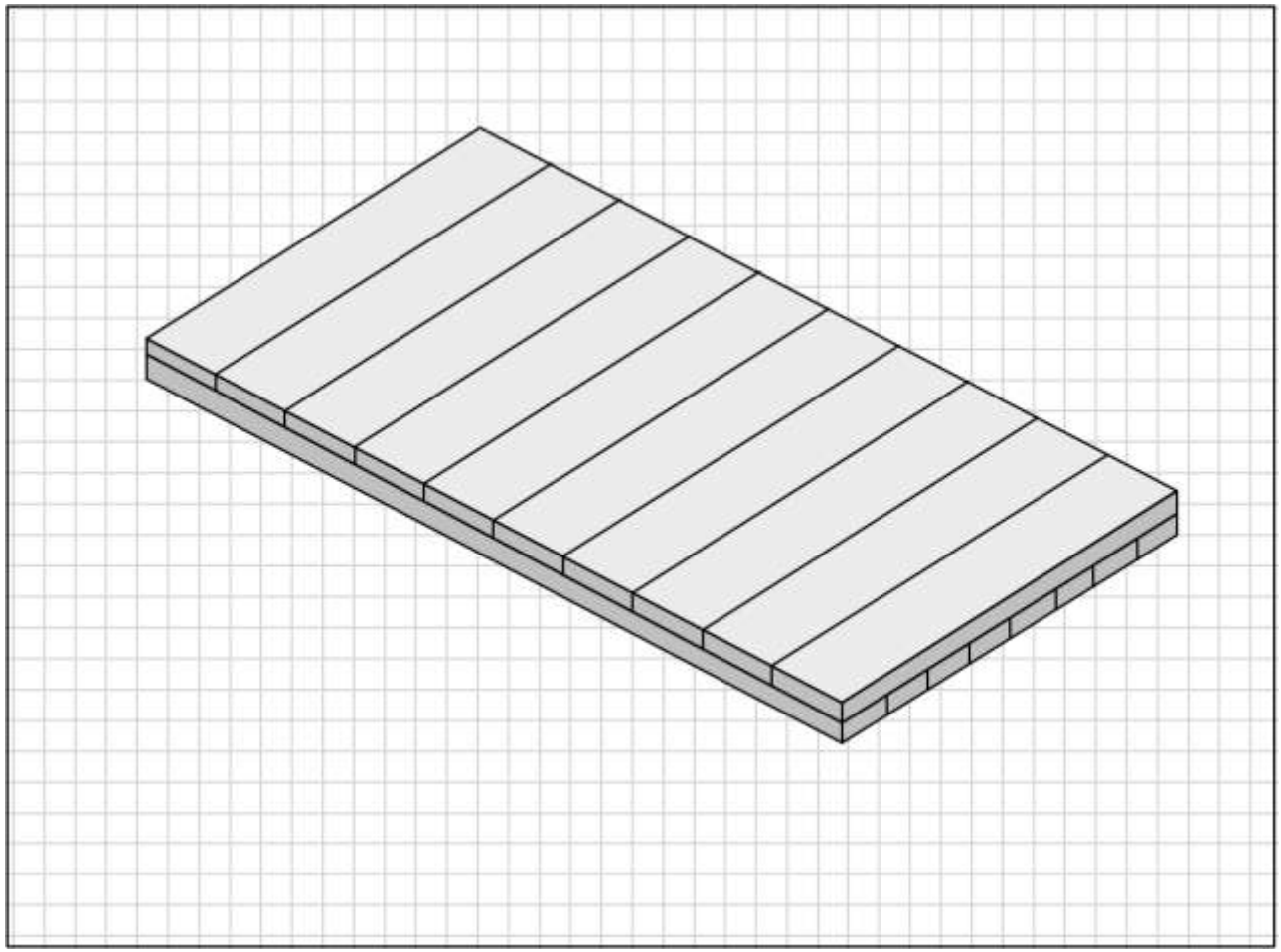

71% of imported building elements are virtually pure wood products

# What is CLT

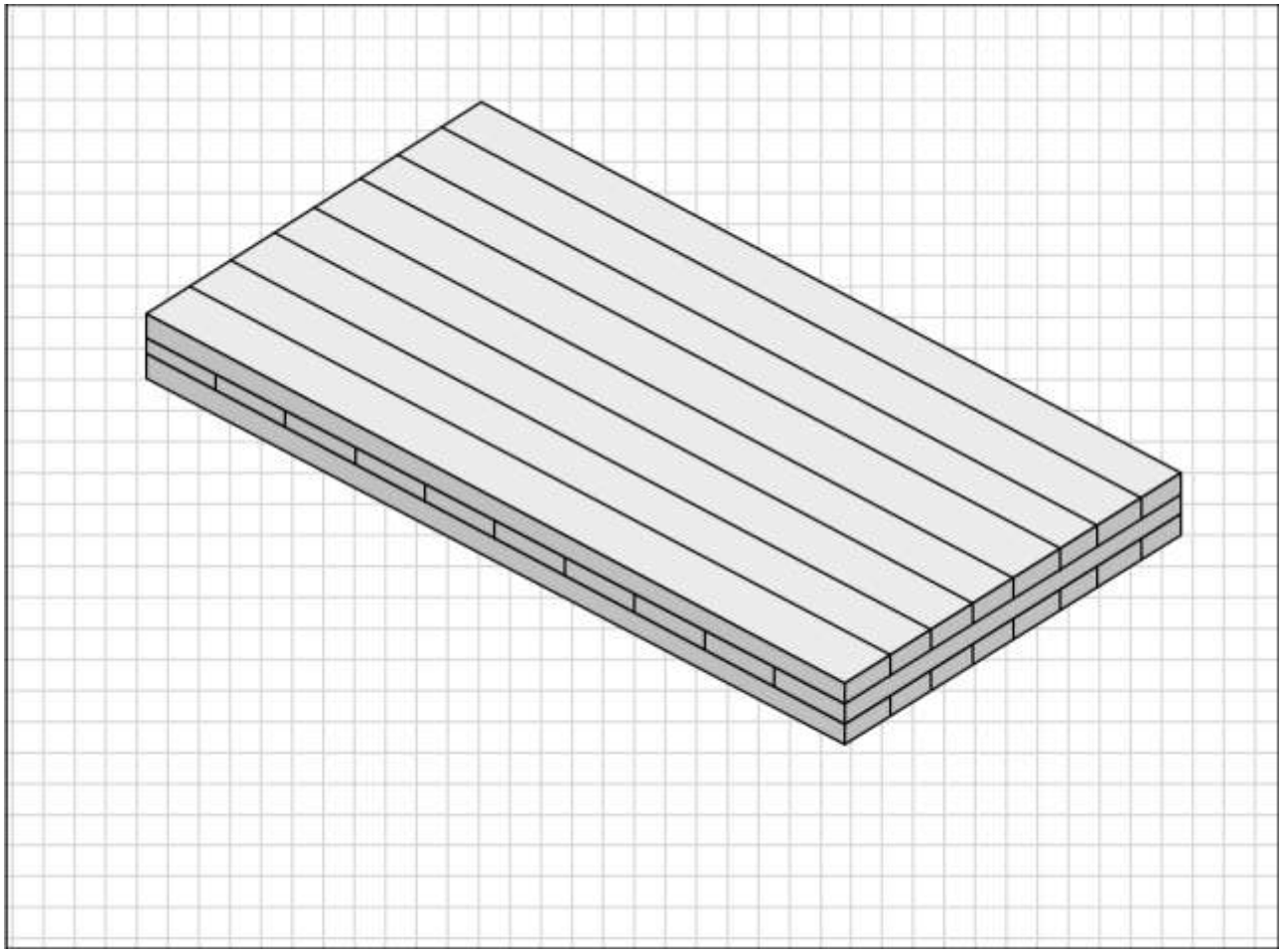
Cross Laminated Timber



Cross Laminated Timber

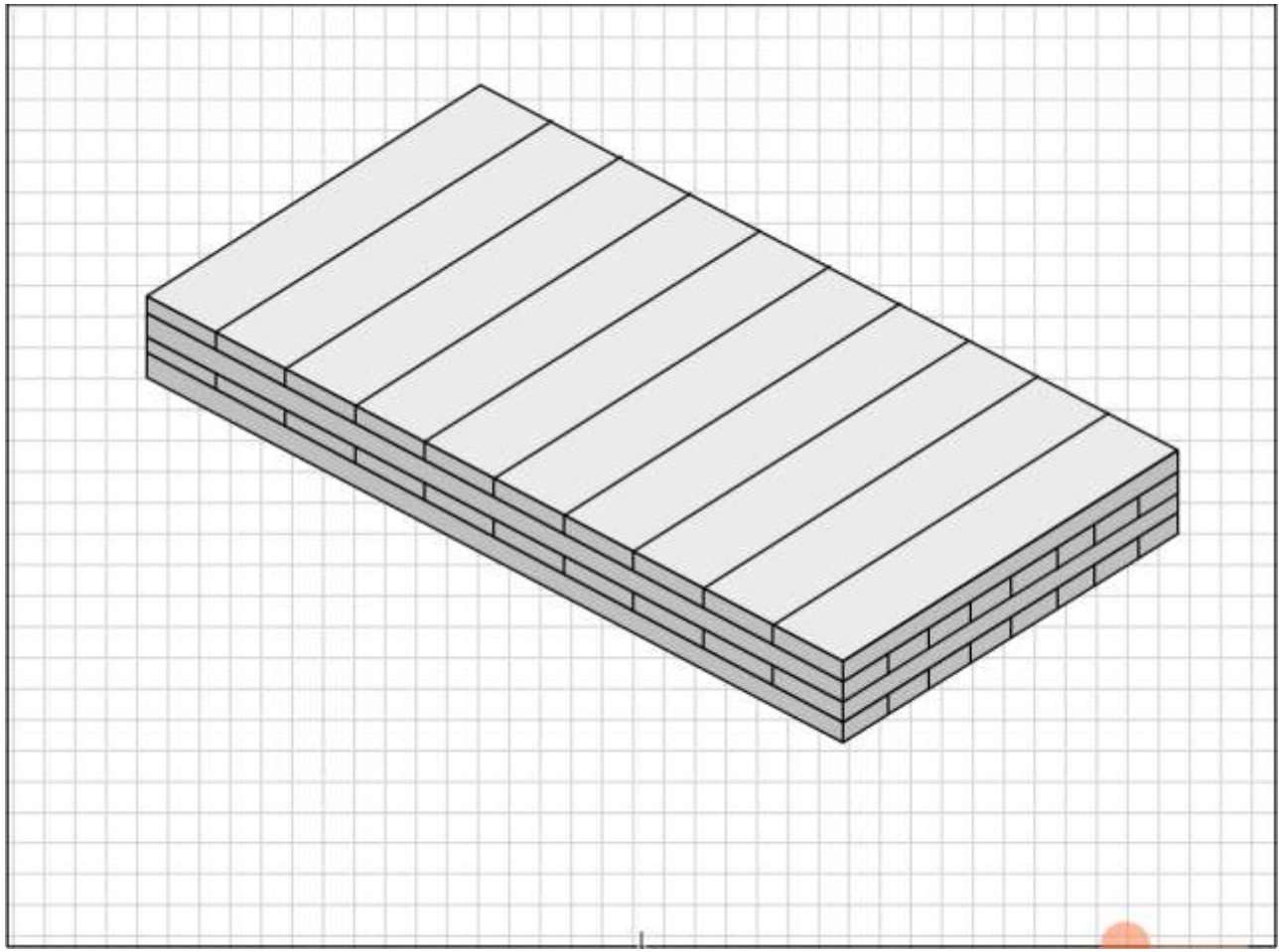


Cross Laminated Timber

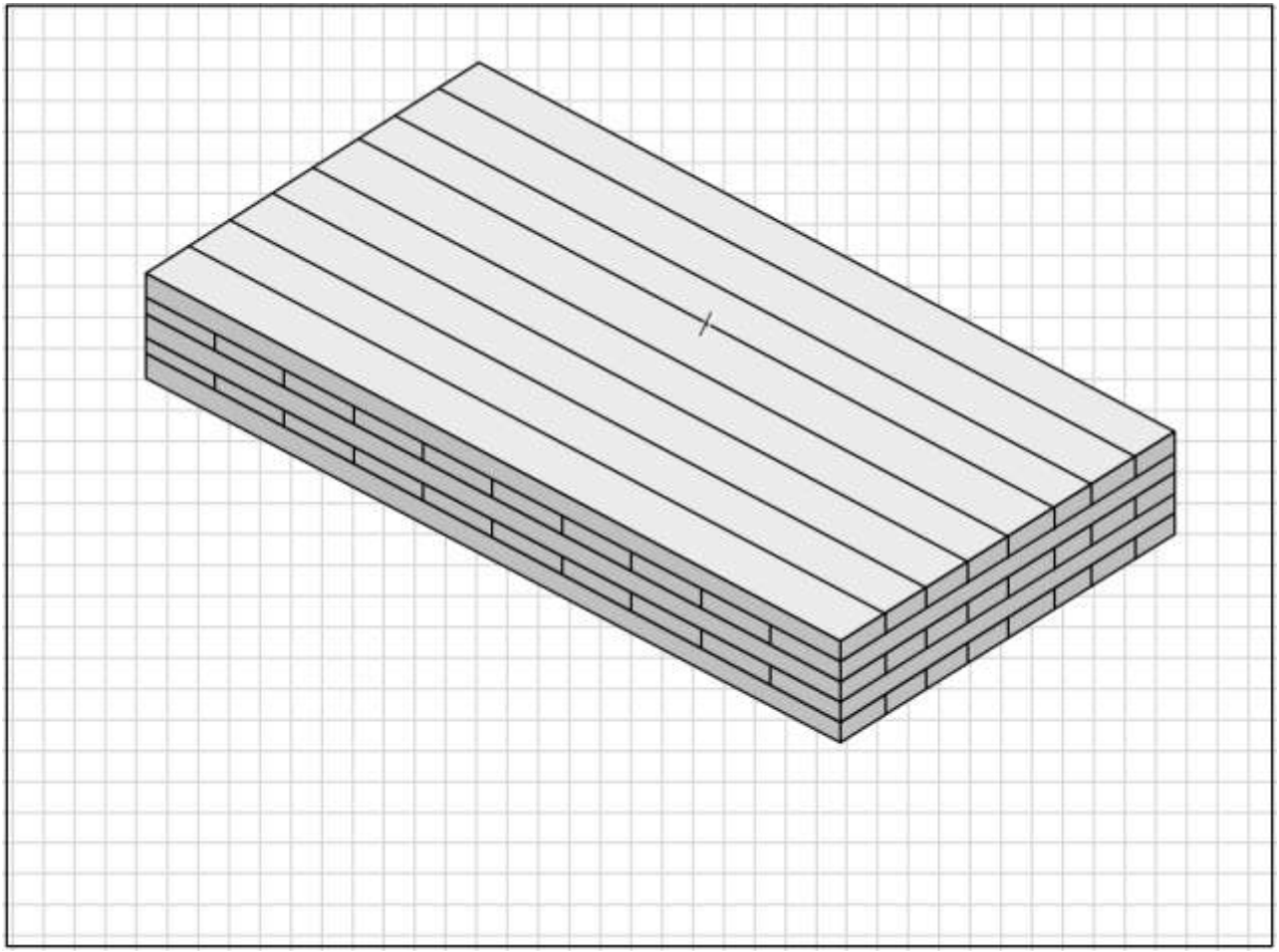


3 layer

Cross Laminated Timber



Cross Laminated Timber



5-7-9 layer

+ various combinations

# Light and strong

The density of reinforced concrete is 2400 kg/m3

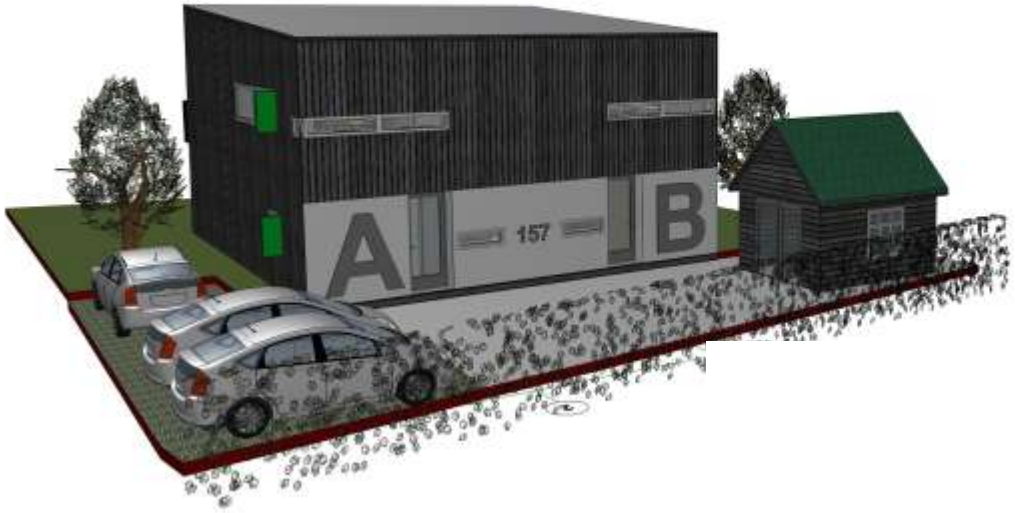
Nordic spruce has a mean density of > 450 kg/m$^3$.

Relative to its weight wood is one of the worlds strongest building material

# Building with CLT

Some examples

# Semi-detached house in Bergen - 2013





MANISCOPIC

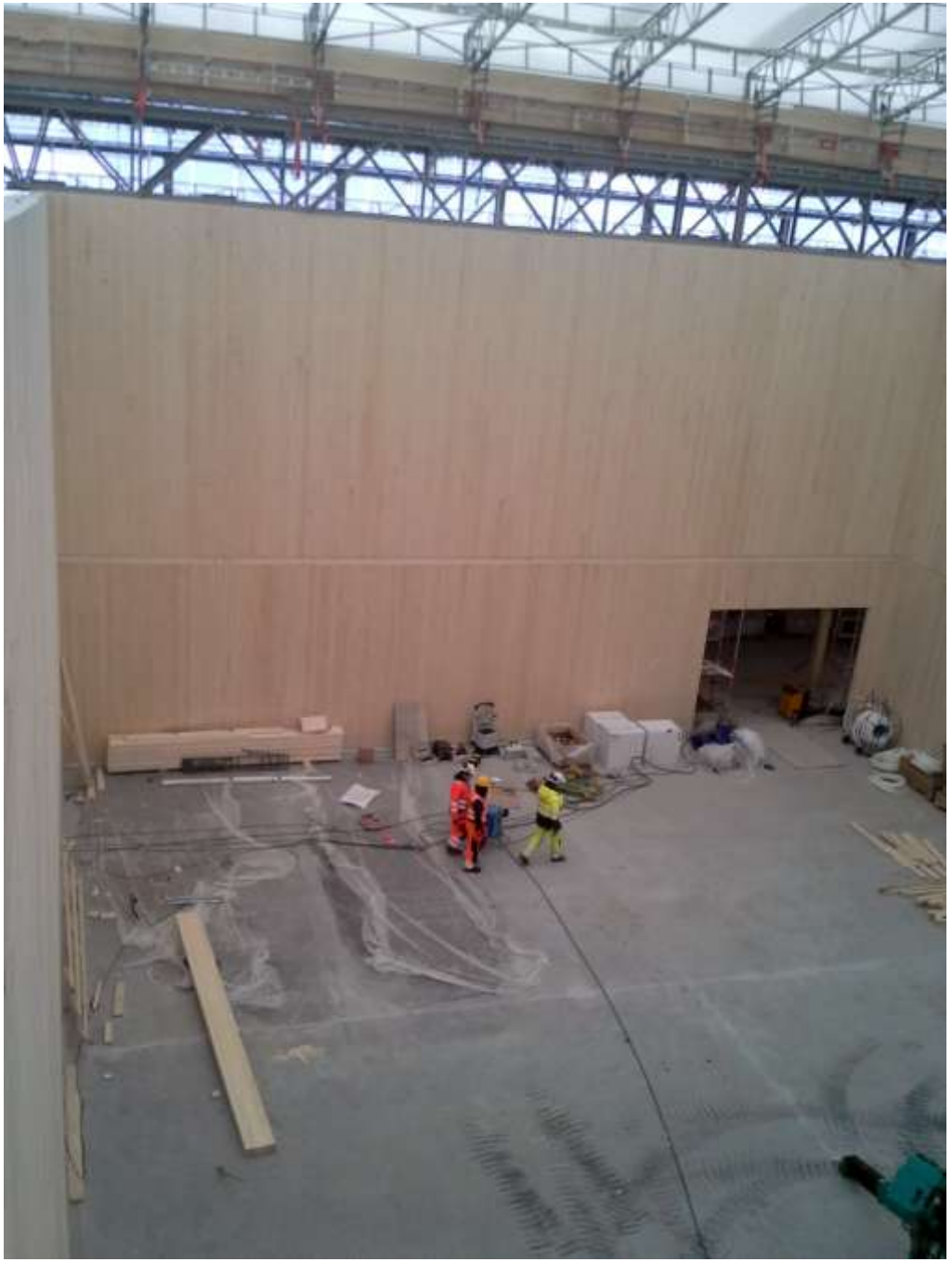

ROCK
KWOOL
ROCK
KWOOL
ROCK

# Tight construction in 4 days

Ready to move in after 3 months

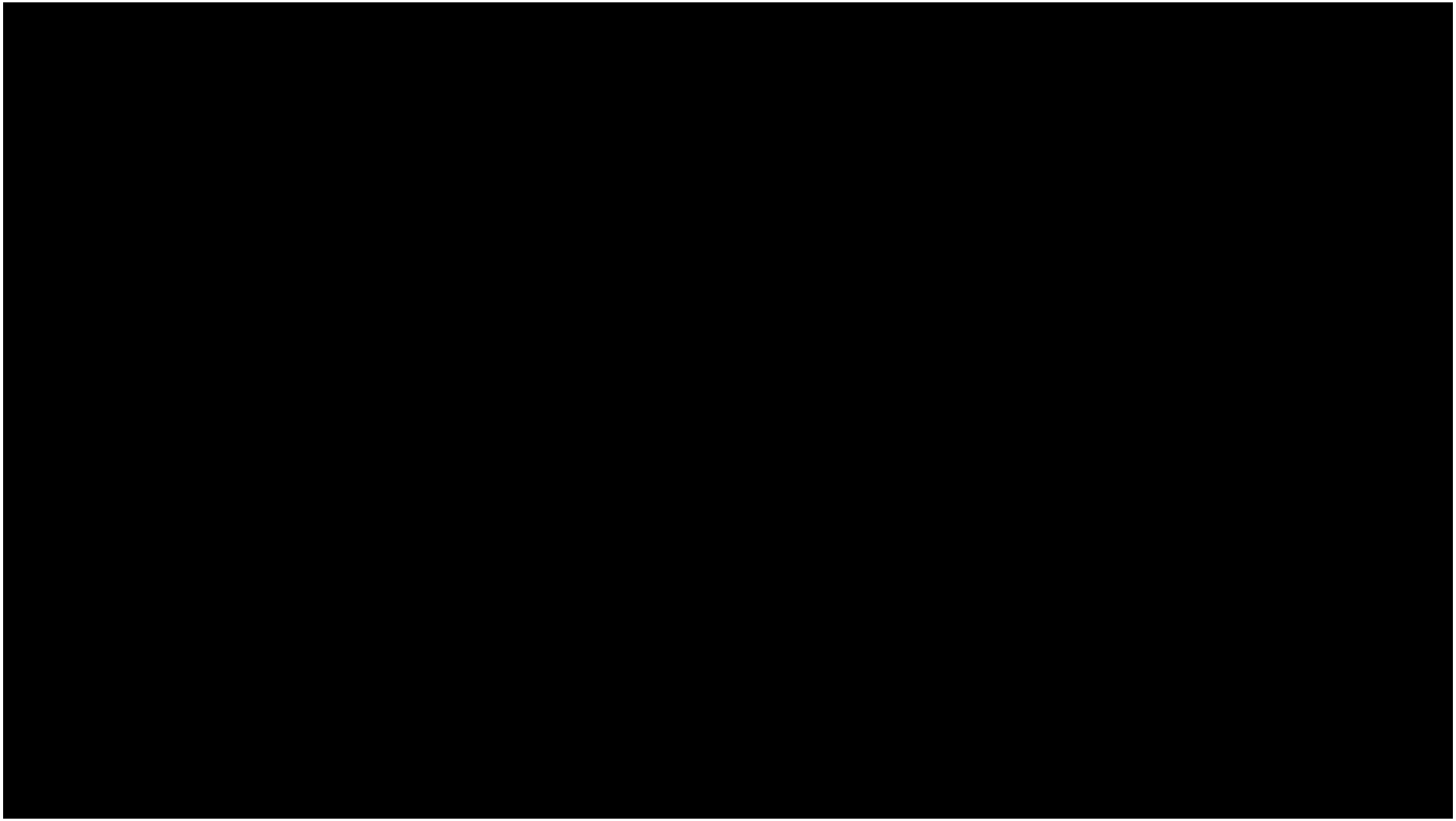
# Ulsmåg School in Bergen - 2013

7000m2 school in CLT and Glulam



# 55 days effective mounting with 1 team

# Woody15 cabin - 2014



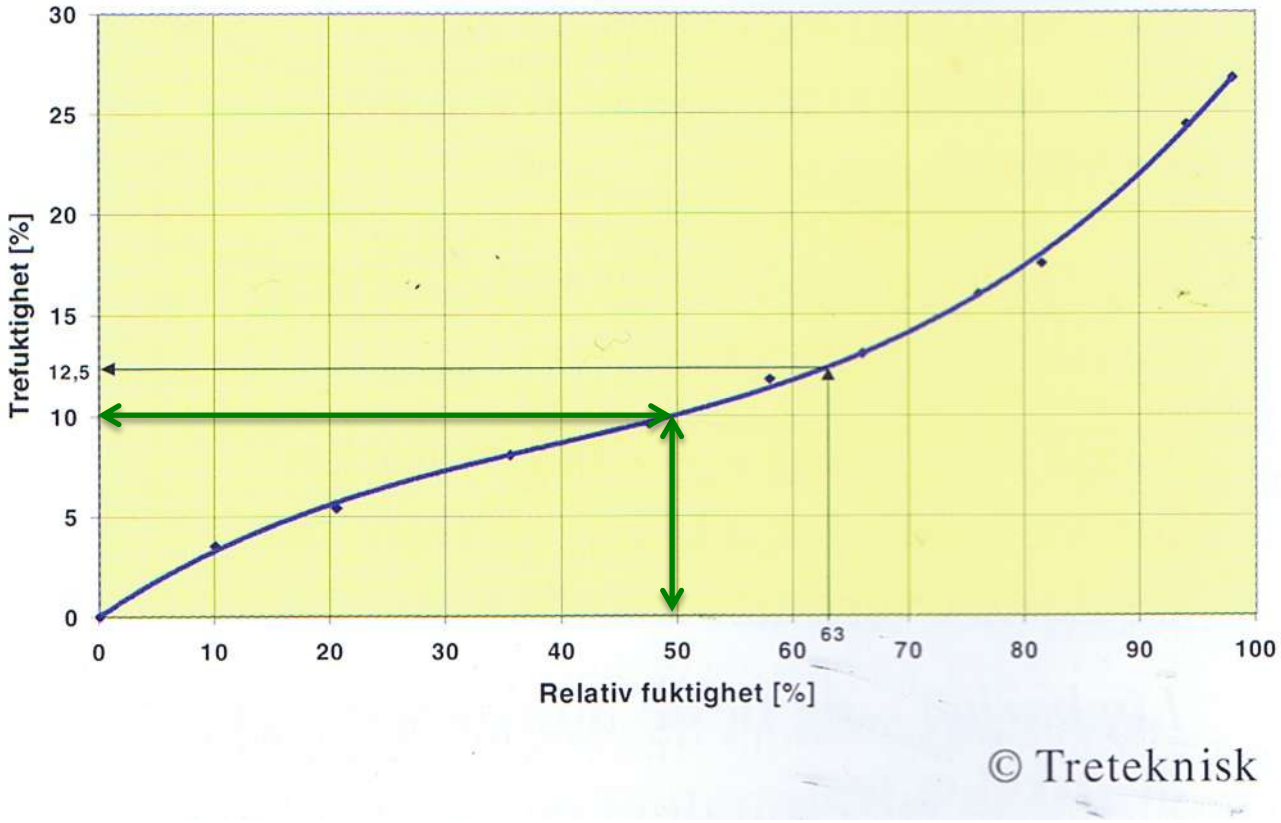
18m2 -3 hours

digital etikett

# Digital print house -2014

900m2

***Likevektsfuktighet (LVF) [%]:***
*Den fuktighet trevirket innstiller seg på etter lang tid i luft med en bestemt temperatur og relativ fuktighet.*




Equilibrium Moisture Content (EMC)


DELT
DELT

CLT mounting 15 days

Ready to move in after 4 months

# CLT´s superior properties

airtight

moisture balancing

Speed

Hygroscopic

Earthquake

pollution buffering

Thermal

decrement delay/PCM

Diffusion open

Strength

Economy

Fire resistant

Sustainability

Dynamic walls

Smell

Tactile

vapor diffusion resistance μ = 40-80

Hygrothermal

Acoustics

Water resistant

λ = 0.13 W/mK

reproductive

psychophysiological effect

millimeter precision

Vegetable/Organic

# Fire

Unexposed surface

L 40mm

X 40mm

L 40mm

X 40mm

L 40mm

0,7mm

Solid wood with full strength

Heated zone

The nominal charring rate $\beta_n$, can be taken as 0.7 mm/min as is specified in Eurocode 5 Part 1-2, Table 3.1 for one dimensional charring.

Unexposed surface

Solid wood with full strength

10mm

Heated zone

21 mm

Char zone

R 30

Unexposed surface

Solid wood with full strength

10mm

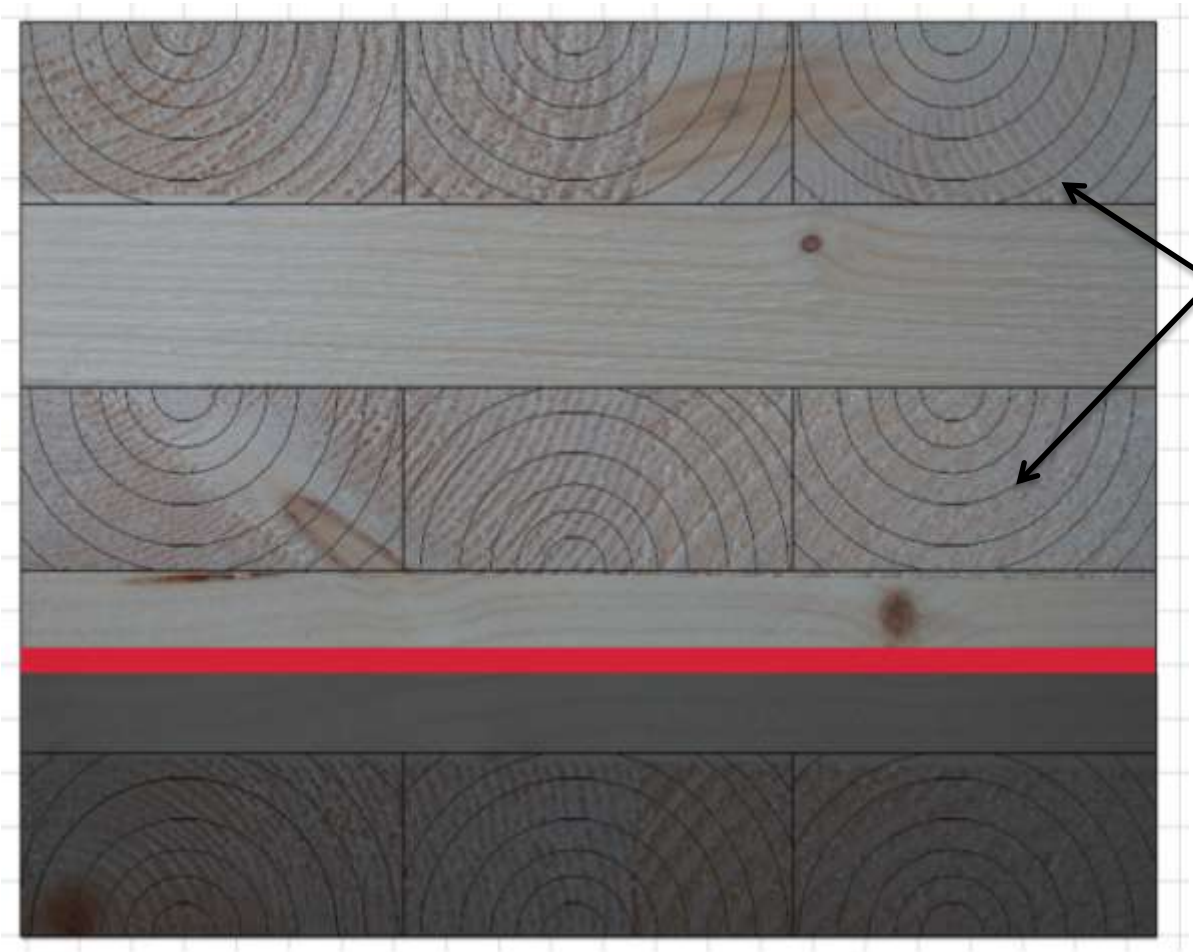
Heated zone

42mm

Char zone

R 60

Unexposed surface



Solid wood with full strength

10mm

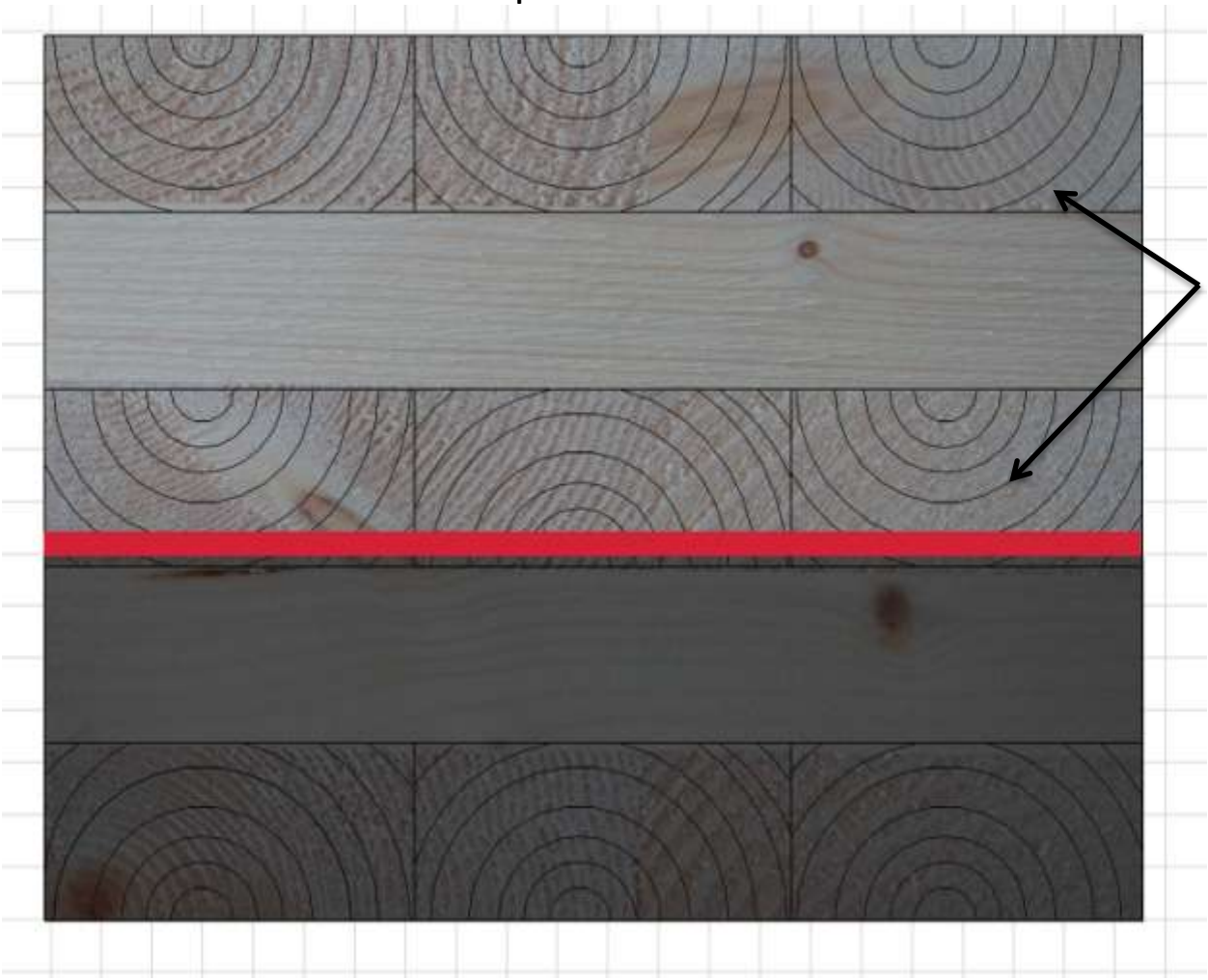
Heated zone

63mm

Char zone

R 90

Unexposed surface



Solid wood with full strength

10mm

Heated zone

84mm

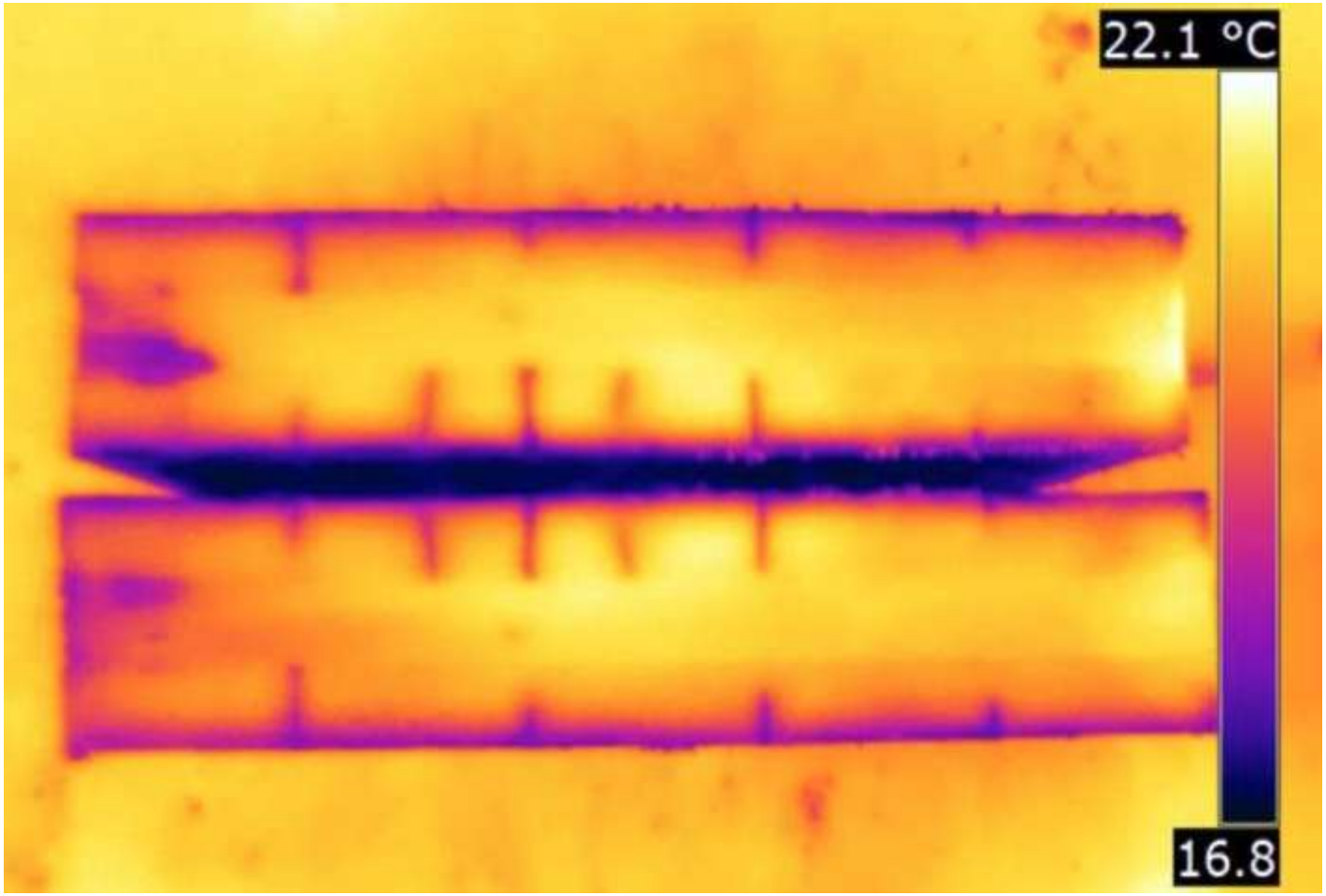
Char zone

REI 120

# Water

In Norway 83 000 water damages were reported to insurance companies in 2013.

That equals 3,4% off the total housing in the country

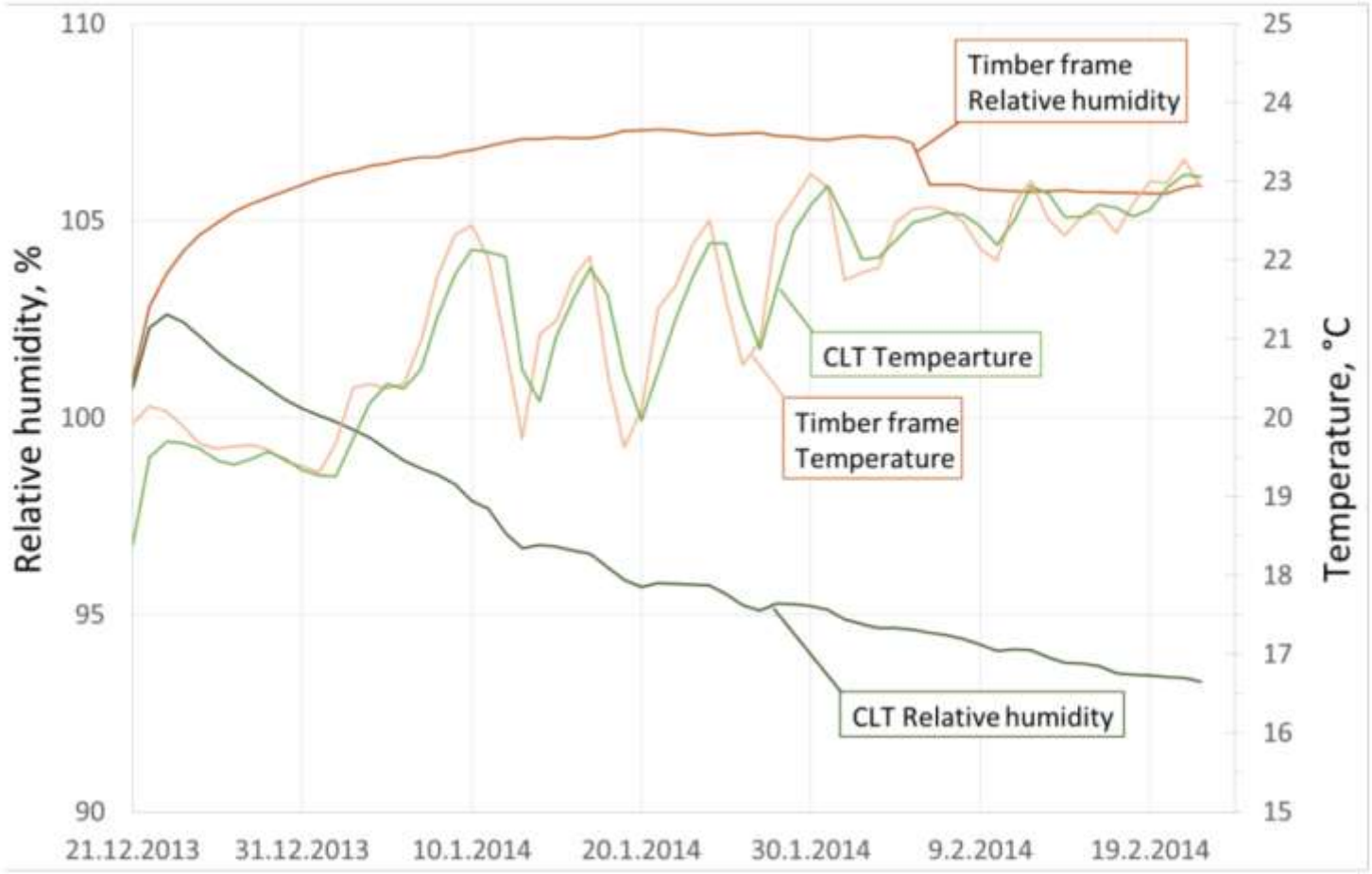



A thermal photograph of two of the CLT elements after submerged in water tanks for 48 hours. Colder areas (blue) have higher water content in the wood than warmer (yellow) areas. The elements have mainly absorbed water along their outer edges, leaving the middle of each element relatively dry.

*TABLE 1. Mould growth in the test elements after one, two, three and four weeks.*

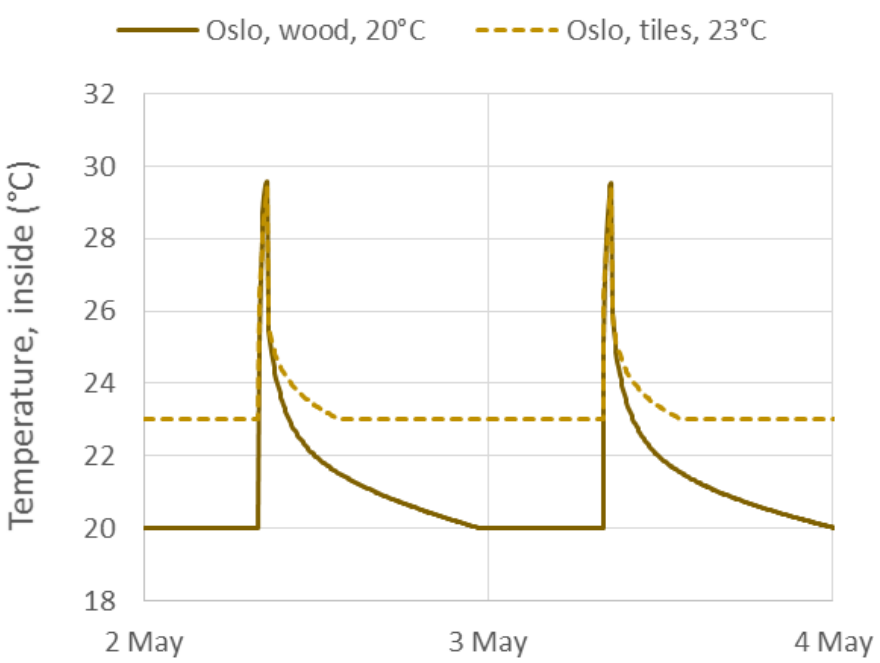
| Element | Mould growth |
|---|---|
| One week | |
| Timber framed element | Moderate growth |
| CLT element | No growth |
| Two weeks | |
| Timber framed element | Extensive growth |
| CLT element | No growth |
| Three weeks | |
| Timber framed element | Extensive growth |
| CLT element | No growth |
| Four weeks | |
| Timber framed element | Extensive growth |
| CLT element | Sparse growth |

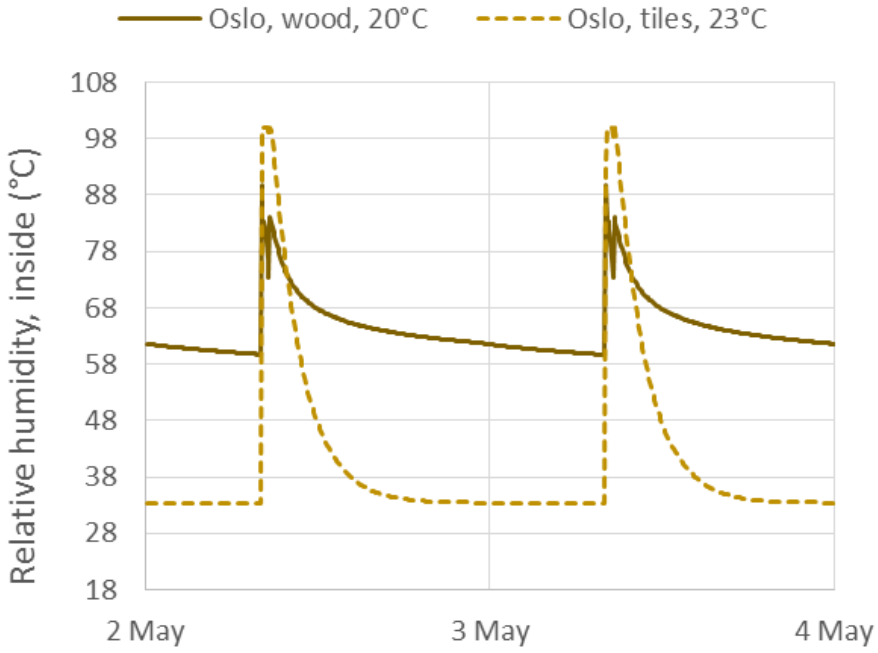
Temperature and relative humidity inside the test elements. The values for the CLT elements are average data from the three elements. The temperature delay for the CLT walls is due to their larger hygrothermal inertia.



# Hygrothermal property – the ability to absorb and desorb water

# Simulation results




Automatically heated when needed by the wood surfaces present

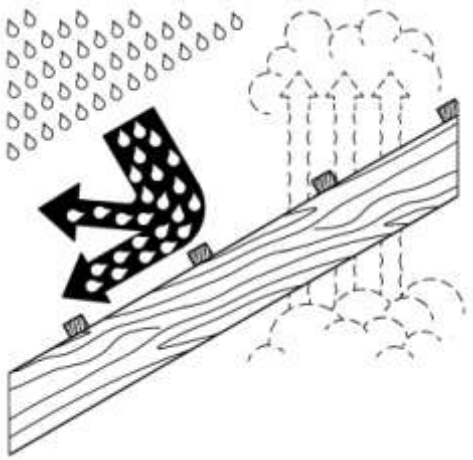
***Treoverflater gir energisparing*** **-** *Fokus på tre* -

Kristine Nore, Ph.D. - Norwegian Institute of Wood Technology, Norway

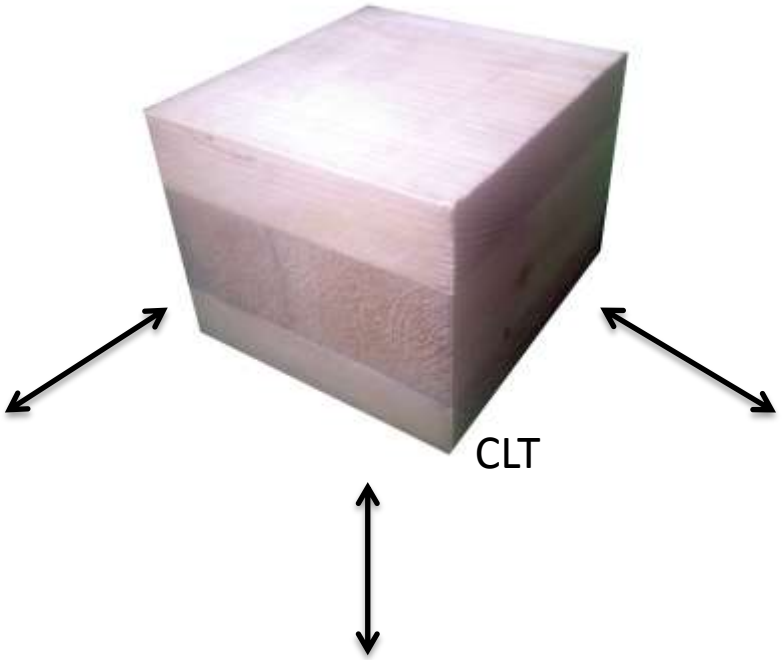
Bathhouse 2013
www.massivlust.no

Bathhouse 2013
www.massivlust.no

# Natural Ventilation and healthy indoor climate

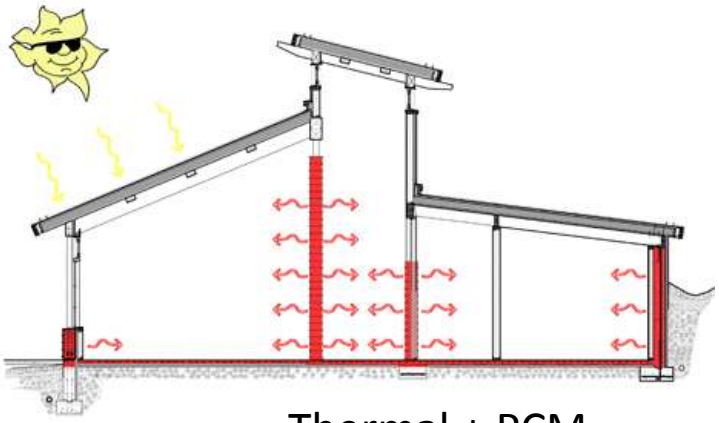


Diffusion open



CLT

Hygroscopic



Thermal + PCM

# Wood has a psychophysiological effect

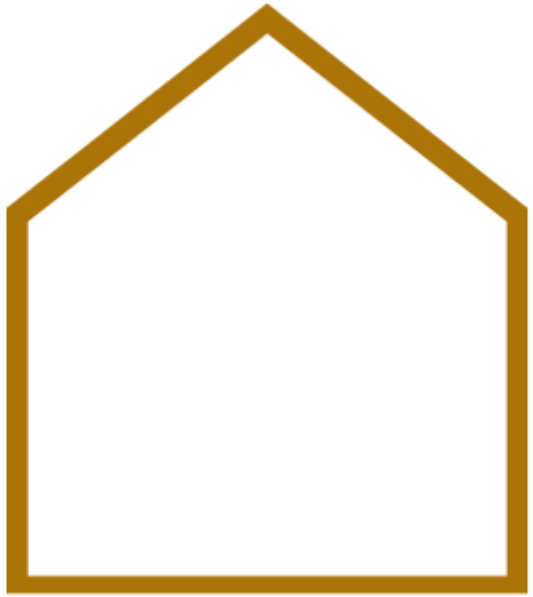
Children who are taught in a room made of solid wood reduces heartbeats per day by 8,600. Equals 6 per minute.


GRANSIRUP
MAJ 2012
GRANSIRUP
MAJ 2012
Gransirup

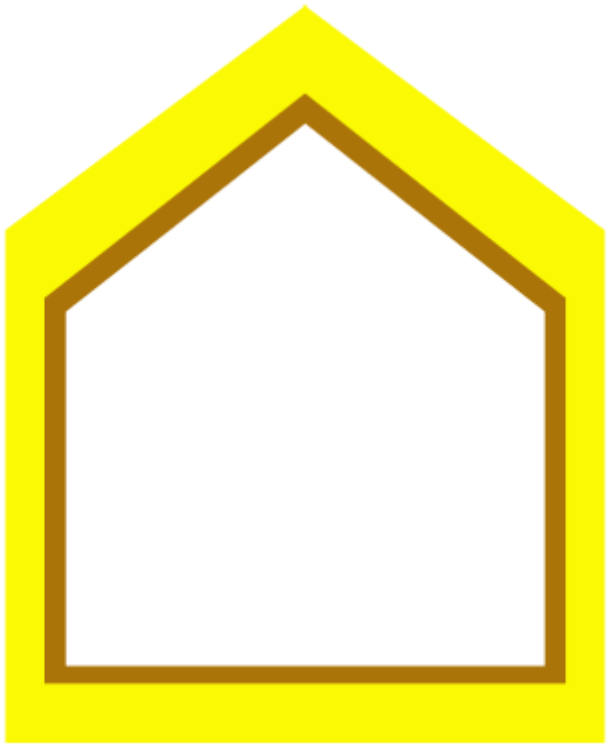

Lauterbacher Tropfen
Ernst F. Ullmann
40%vol · Originalabfüllung · 0,7l

Drink me

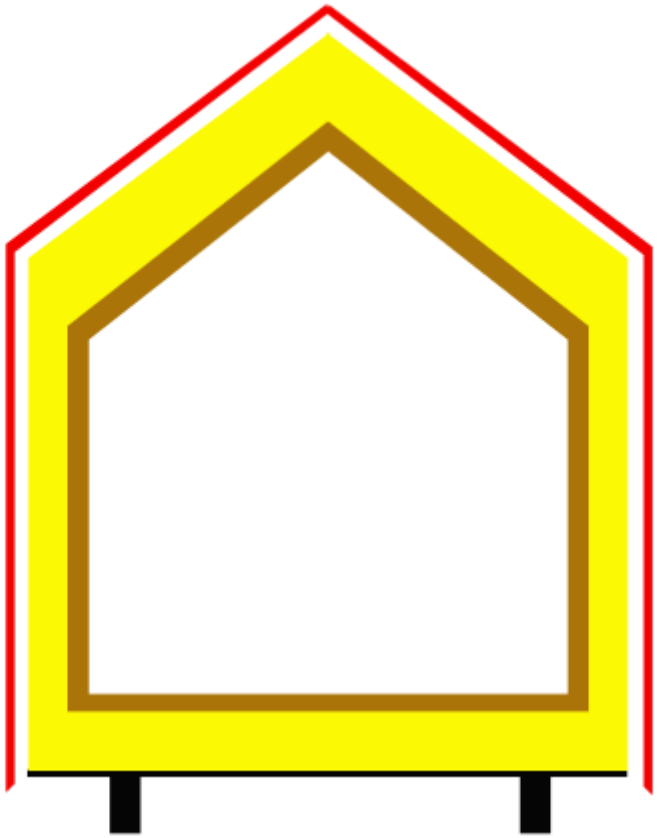
How can we build up the layers of the house



Bearing

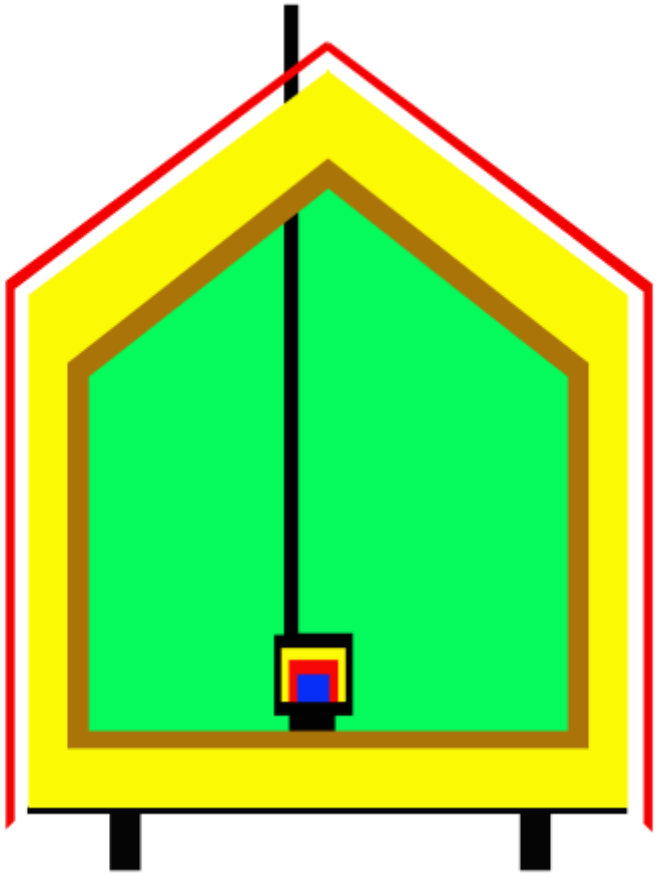


Insulating



Protective

Using 100% of the log



55% timber = Primary Structure and cladding
45% GROT-wood chip and cutoff = Insulation, bioenergy and pulp

# Wood in all layers

Dry construction 12% +- 2. Seasonal indoor air moisture equals 6 - 12% wood moisture content

Equilibrium Moisture Content (EMC)

# Cost

The Norwegian Government's aim is that by 2020, all new buildings to be erected shall be close to zero emission buildings.

To achieve zero-emission buildings, it is essential to develop climate-adapted building concepts and solutions based on renewable materials with low greenhouse gas emissions.

Wooden buildings is one of the responses to these challenges and the development of methods and proven solutions for various types of buildings for current and future generations is therefore of great strategic and market relevance for the parties involved.

# How to reduce cost with CLT-element building

Spend 2/3 of project time on architectural- and engineering design + logistics = 1/3 of project time on building site

Use more time on the architect, the consultants and planning

# Design and logistics are key to successful element construction. ALL details must be resolved BEFORE construction site.

Interaction between the different disciplines during the design phase

More interdisciplinary collaboration

Project-optimizing solutions

Leading to:

- reduced construction time
- Higher quality end product

If detailed correctly it might last for 1000 years.

Risa Meyer spiral staircase

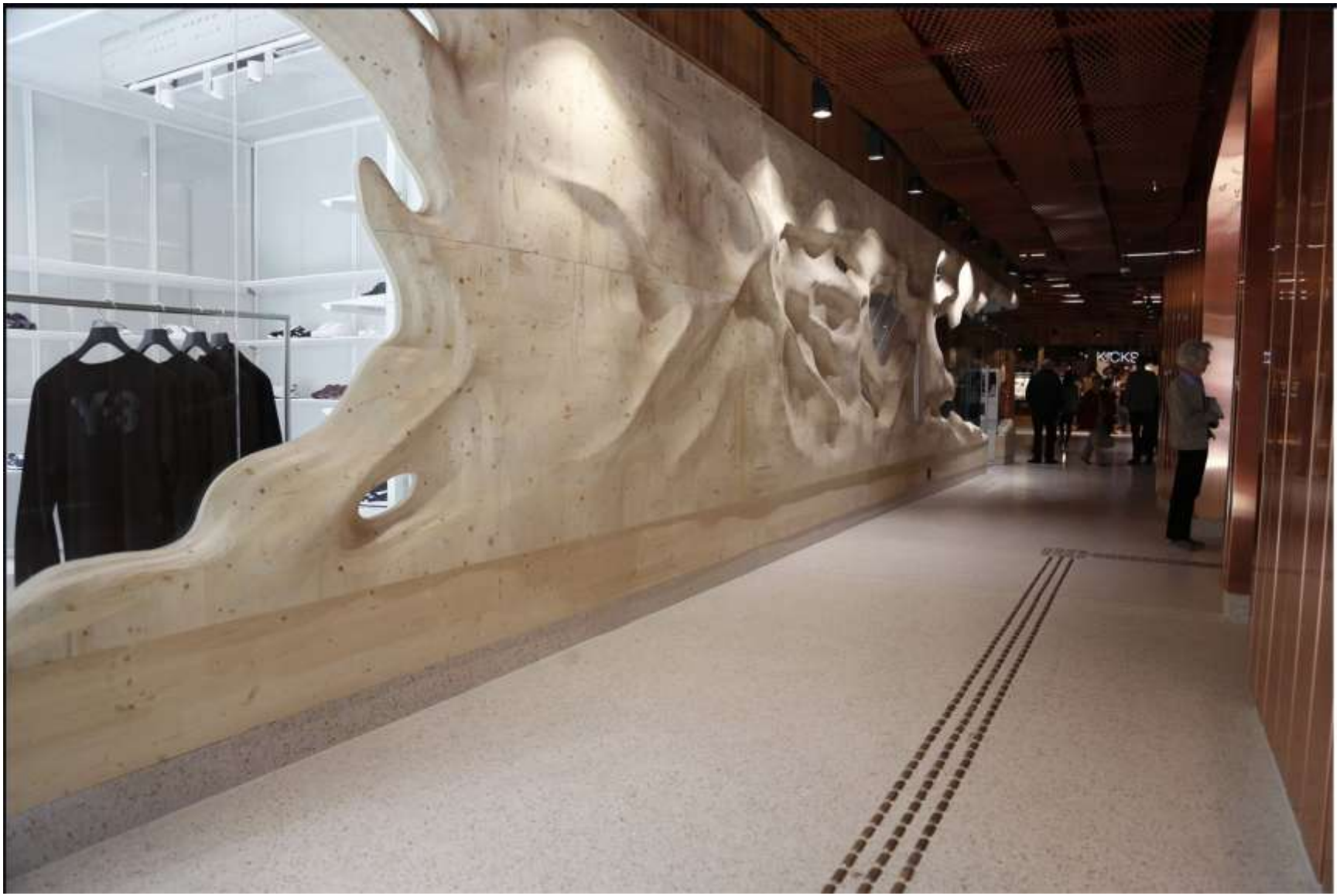
http://risameyer.no/

http://risameyer.no/

http://risameyer.no/

http://risameyer.no/

YME store Oslo



http://www.ymestore.com/

http://www.ymestore.com/

http://www.ymestore.com/

http://www.ymestore.com/

Public benches in CLT - Oslo

http://lala.no/

SØK-PRO-UTF

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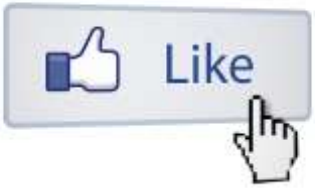
massivtre i Luster

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