

Optimization of wood based structural elements - Concepts for increased resource efficiency

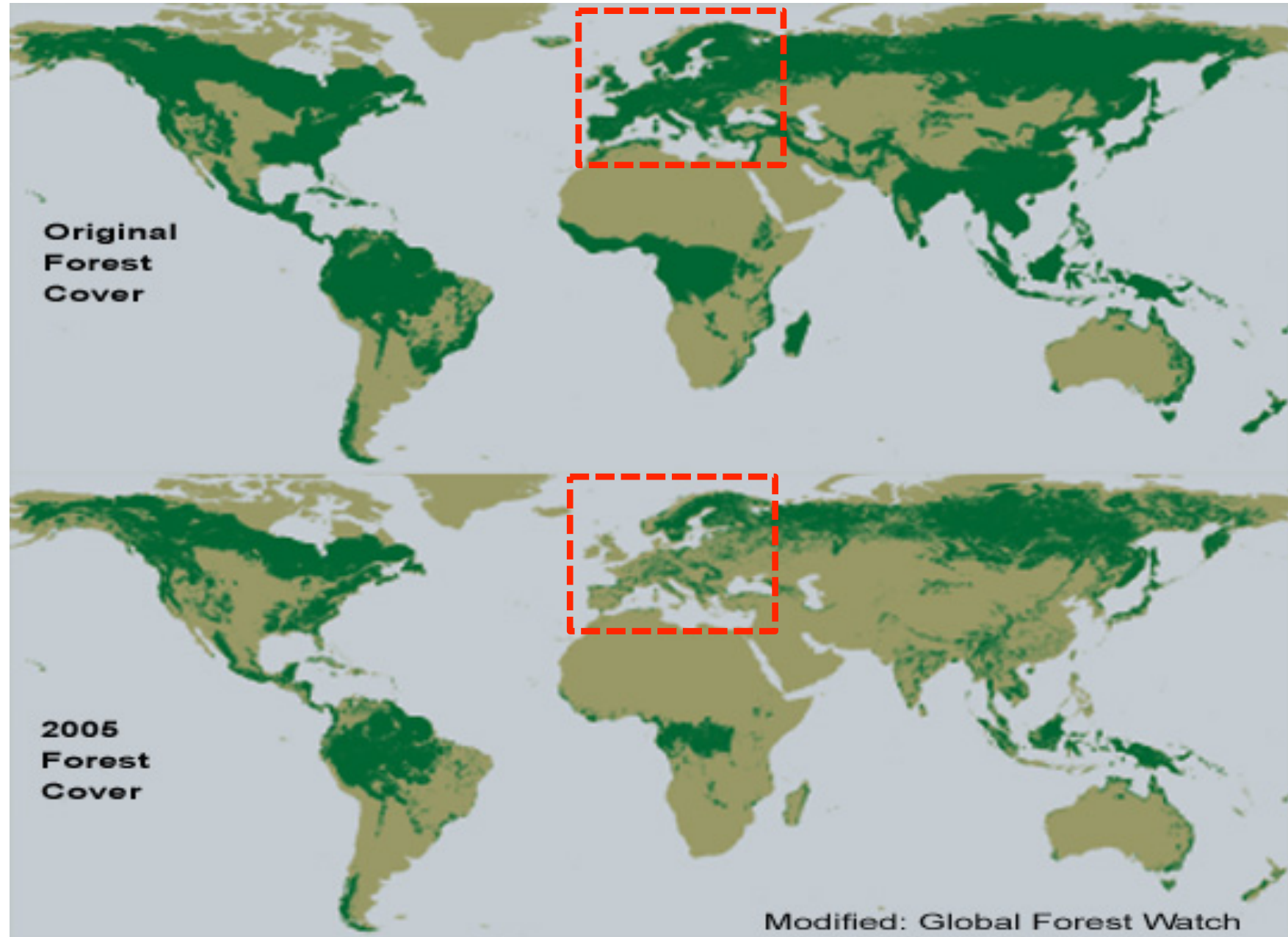
Dr. Alireza Fadai

Prof. DDI Wolfgang Winter (presenter)

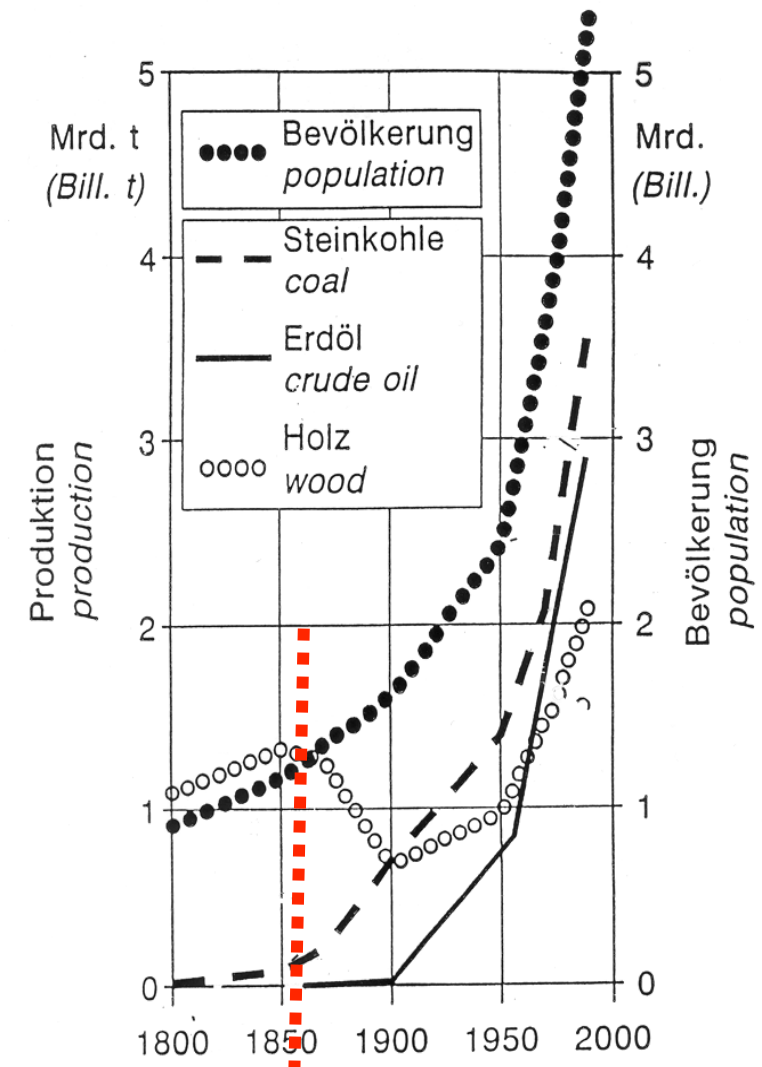
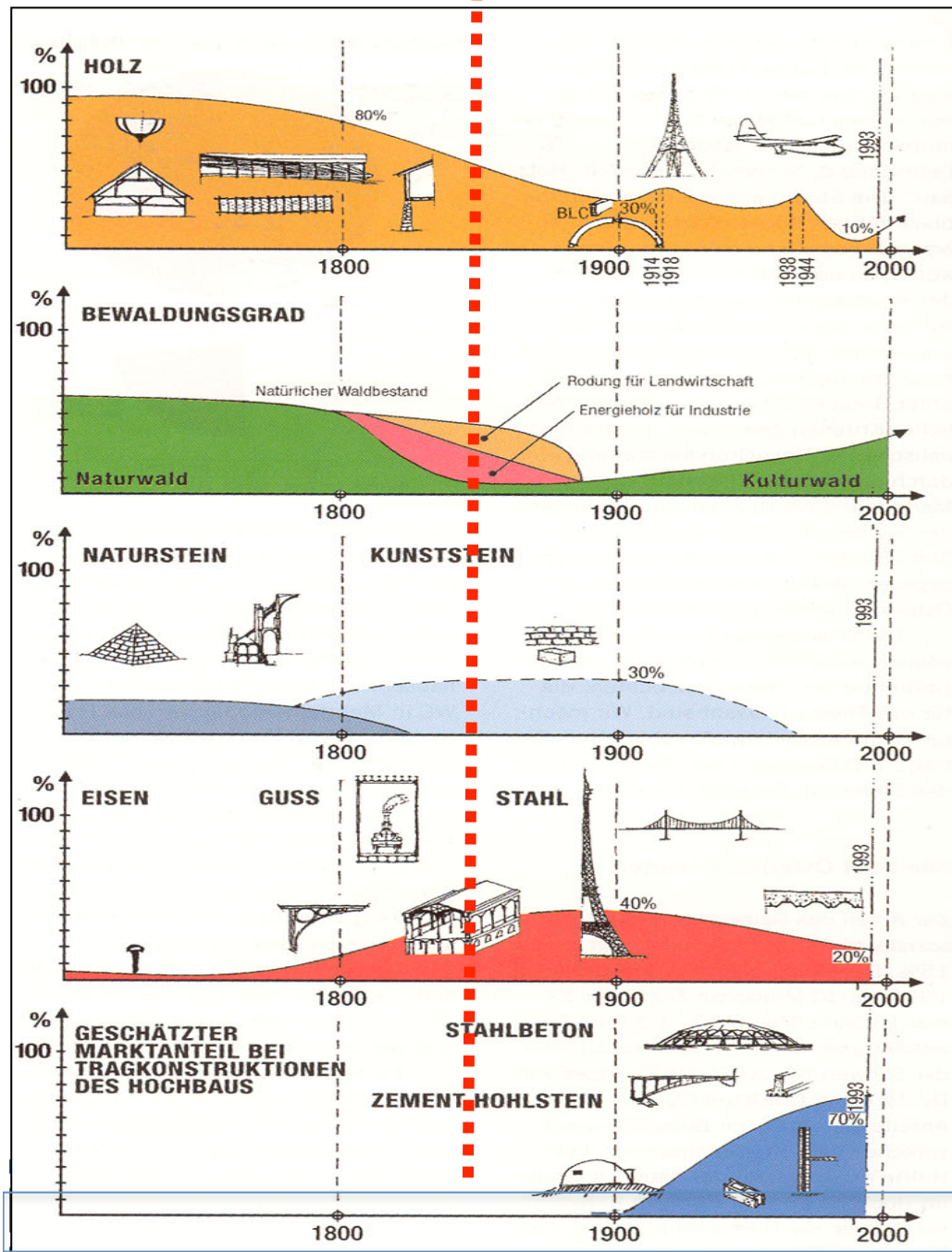


Institut für Architekturwissenschaften
Tragwerksplanung und Ingenieurholzbau
o.Univ.Prof. DDI Wolfgang Winter

« Without cultivated forests no sustainable supply with timber as building material



Marketshare of building materials in Europe since 1800



Entwicklung der Weltbevölkerung seit 1800 und Verbrauch an Rundholz, Steinkohle und Erdöl

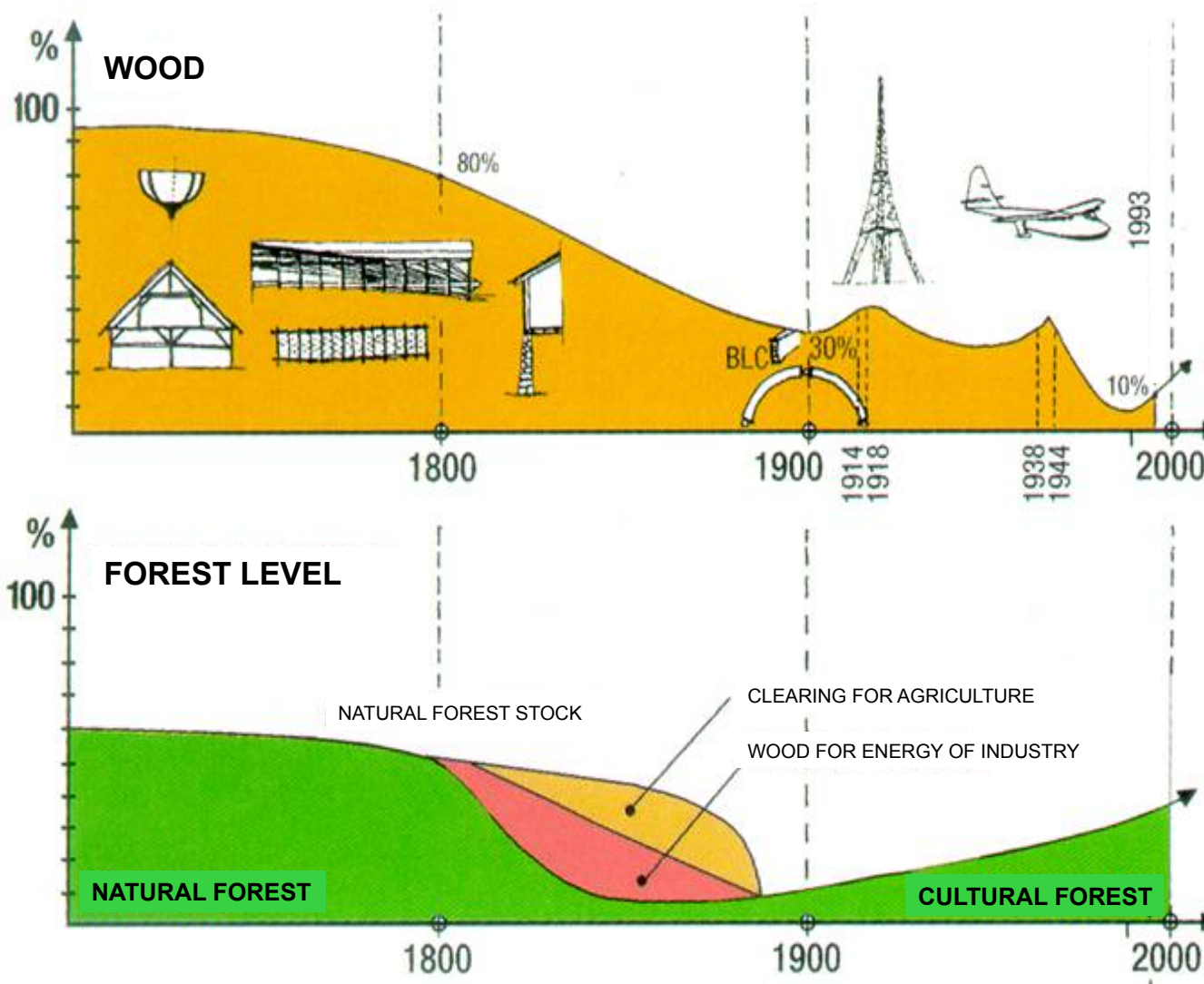
Quelle: H. Schulz in Holz als Roh- und Werkstoff 51 (1993) 75-82



Mixed structures : Wood combined with mineral materials as protection against water and fire
 Left : Massive wood protected by clay and brics
 Right : wood and clay in Japan ⁴

European Wood Culture

Role (marketshare) of wood in europe's building activities



- until 1800:
all in natural materials,
stone, clay, timber
- 19.th century:
resource shortage
by energy use (steel
production)
- forest laws limiting
consumption of wood
- steel replaces timber
- since 1900:
reinforced concrete
- today:
forests are recovered,
in Europe 30-50% of
annual growth not used

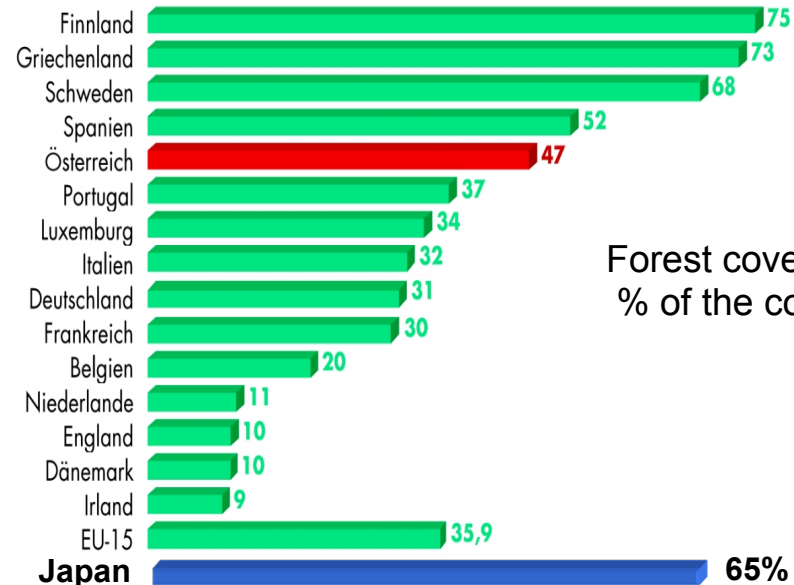
Ecology | Why more wood?

エコロジー | なぜ木造が求められているか？

Ressource availability

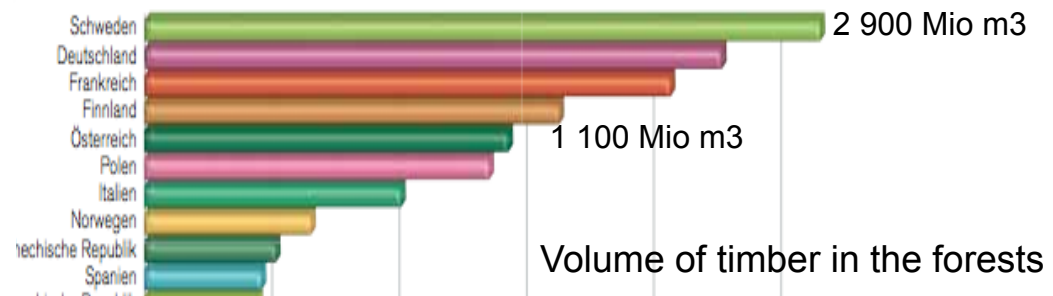
Austria

Population	Area km ²	Forest km ²	Annual growth.	Annual cut
8 Mio	90.000	45.000	30 Mio m ³	20 Mio m ³ (ca. 60%) EU ca. 50%

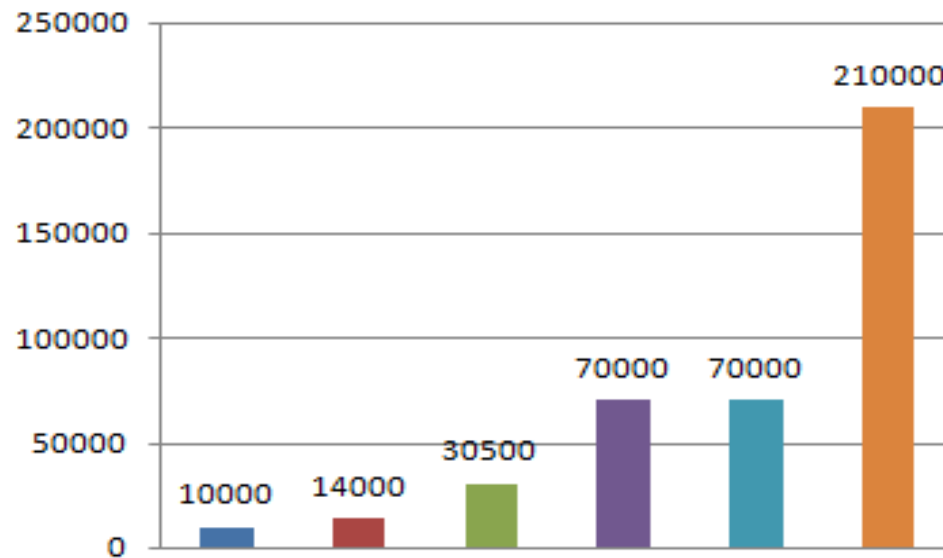


Waldfläche in Prozent der Staatsfläche

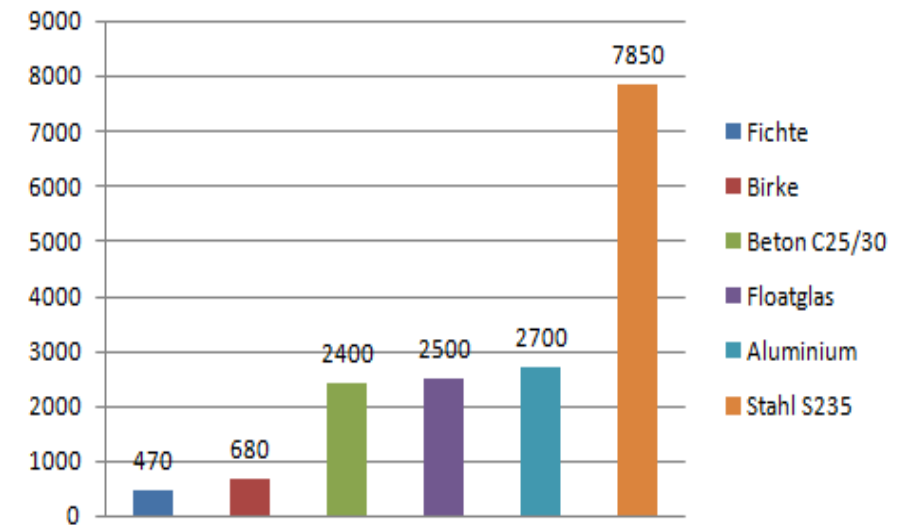
(Quelle: INLECF/FAO 1007)



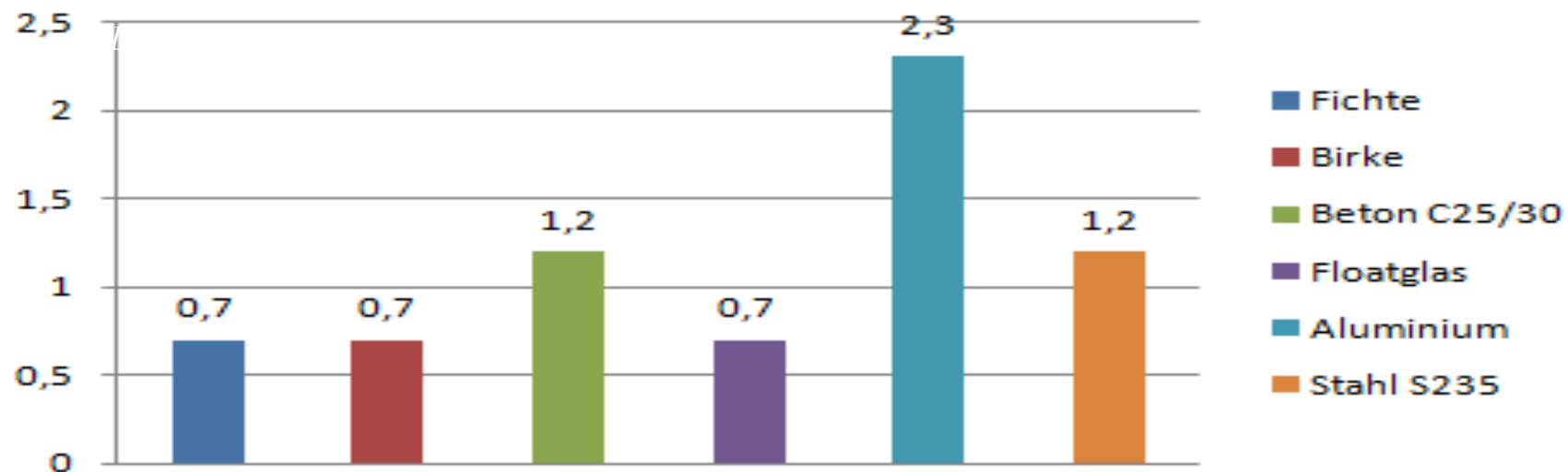
Europe's forests cover 35% Only 50% of annual growth is used



Youngs modulus (Mpa/cm²)



Gravity kg / m³



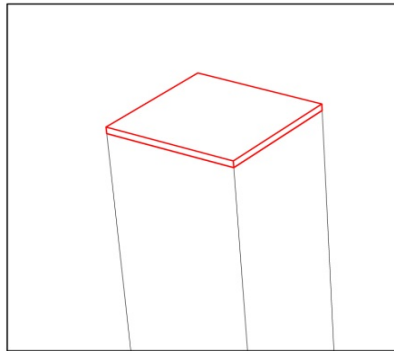
Thermic allongation in mm of a 1m element under 100 degree K.

Thermal Elongation

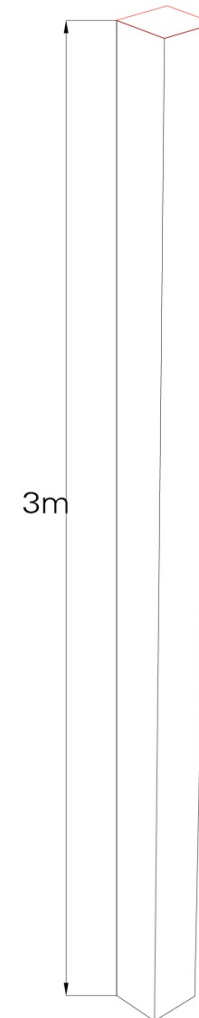
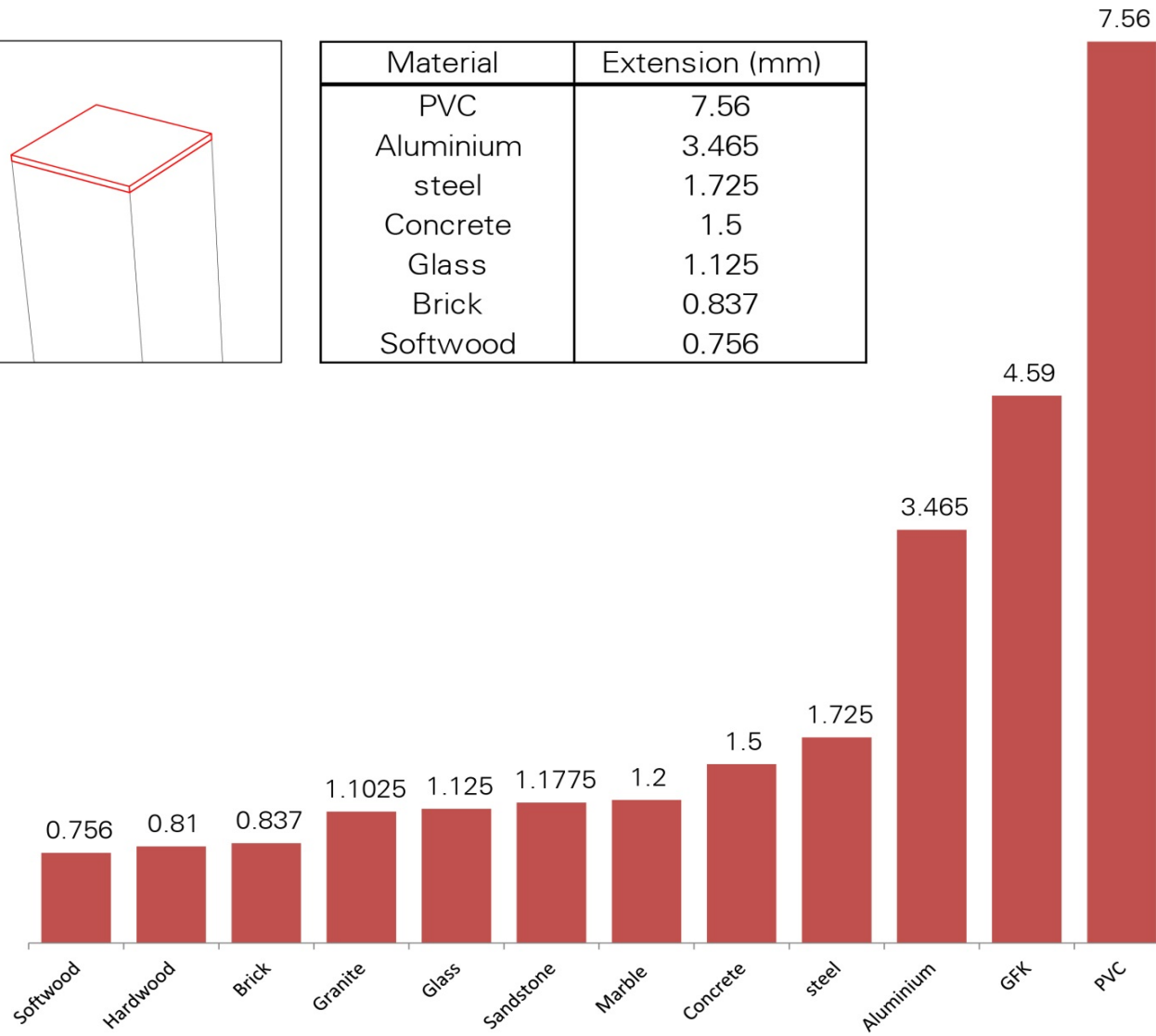
Section: Square Column 15x15cm

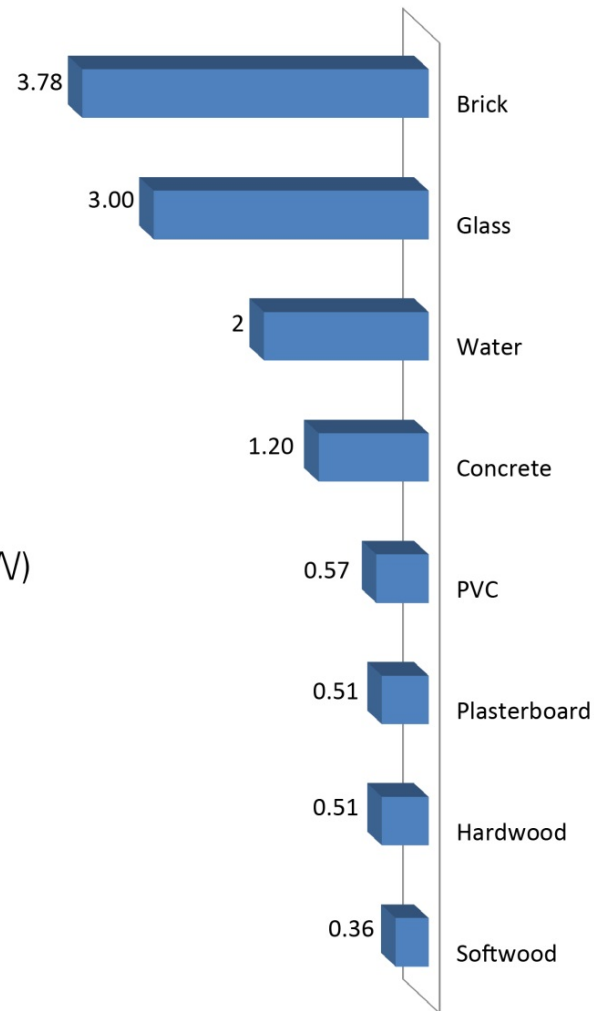
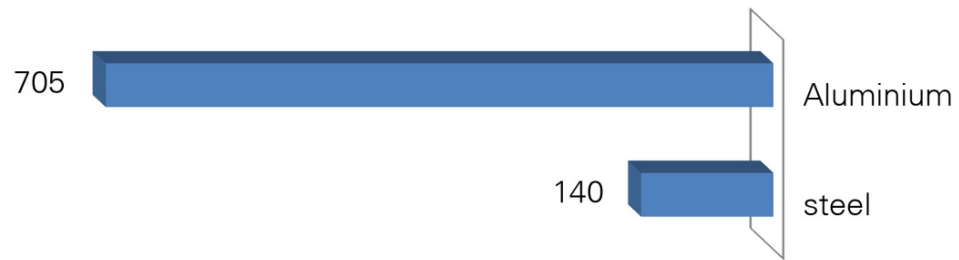
Height: 3m

Temperature variation: 50K



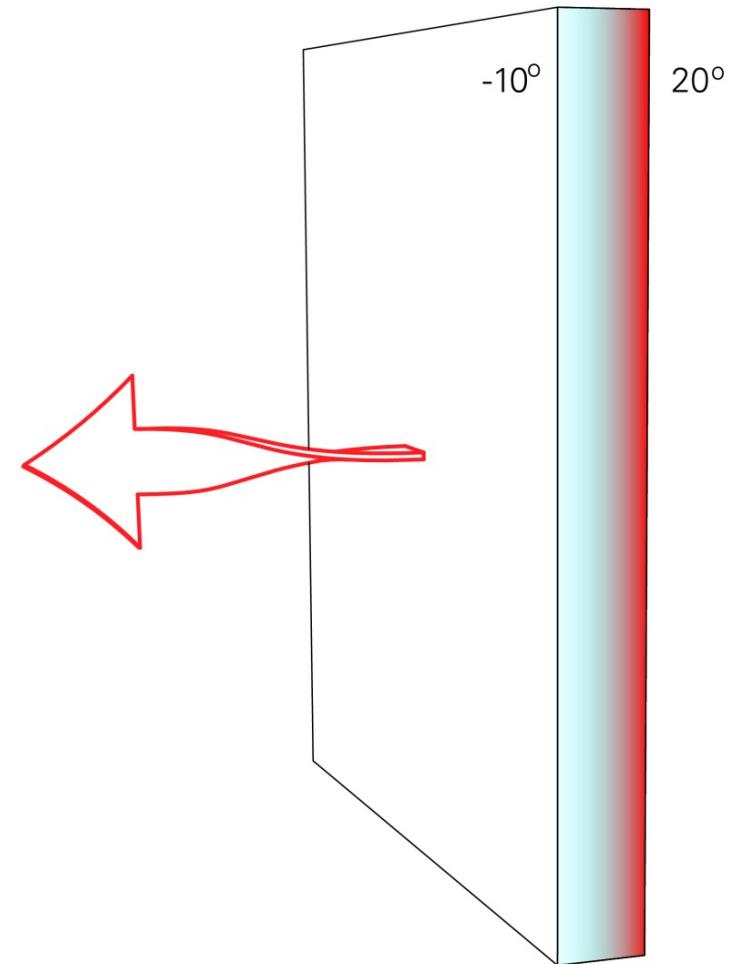
Material	Extension (mm)
PVC	7.56
Aluminium	3.465
steel	1.725
Concrete	1.5
Glass	1.125
Brick	0.837
Softwood	0.756





Thermal Conductivity

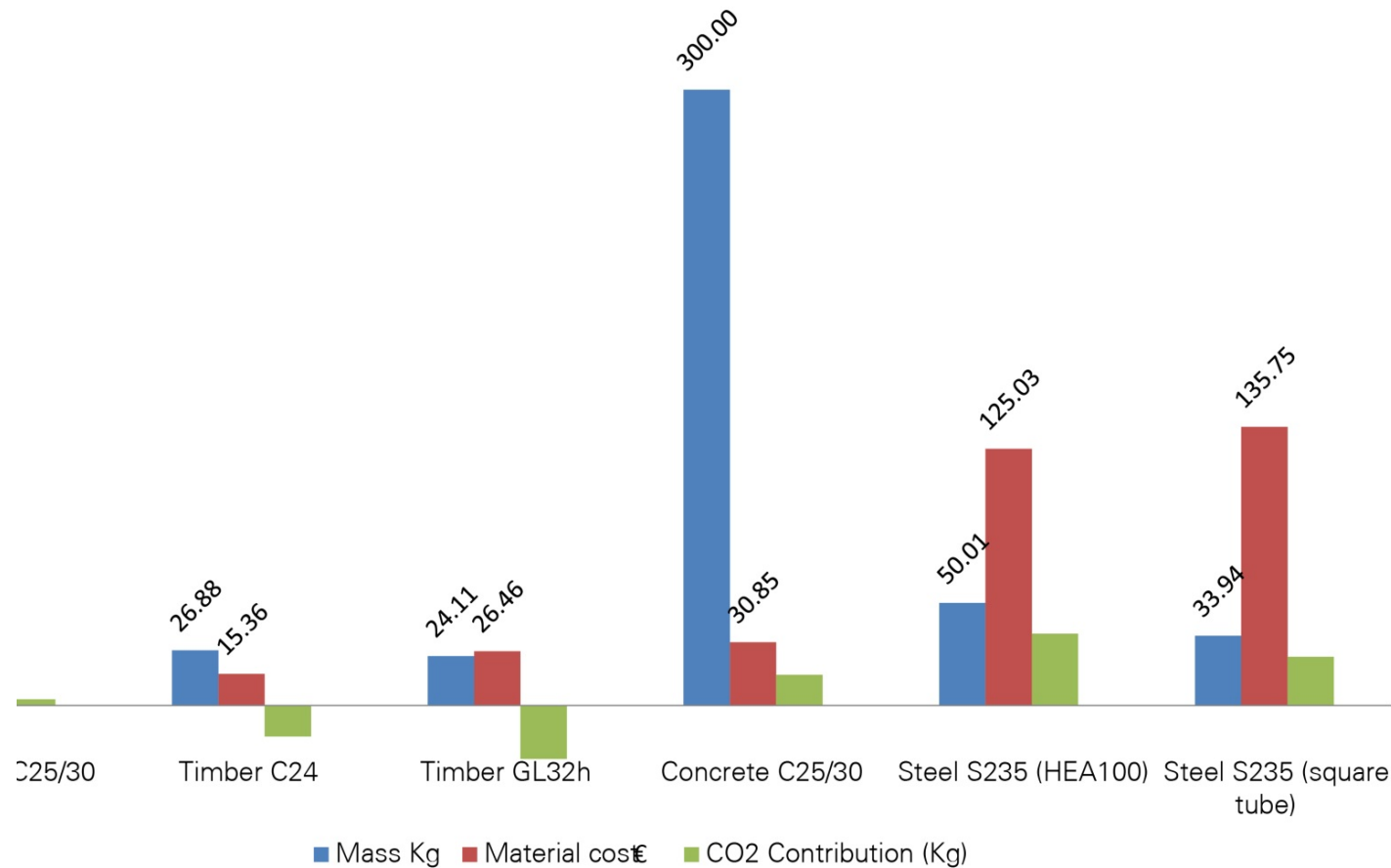
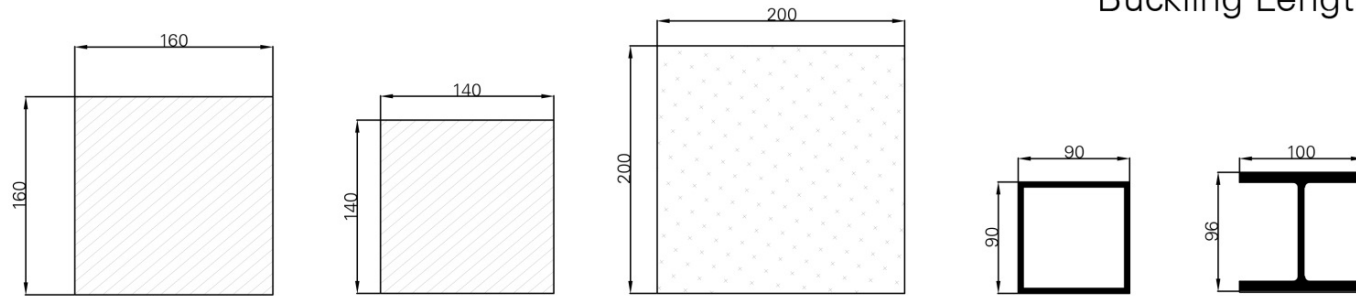
Section thickness: 10cm
Temperature difference: 30K



Axial Loadbearing Capacity

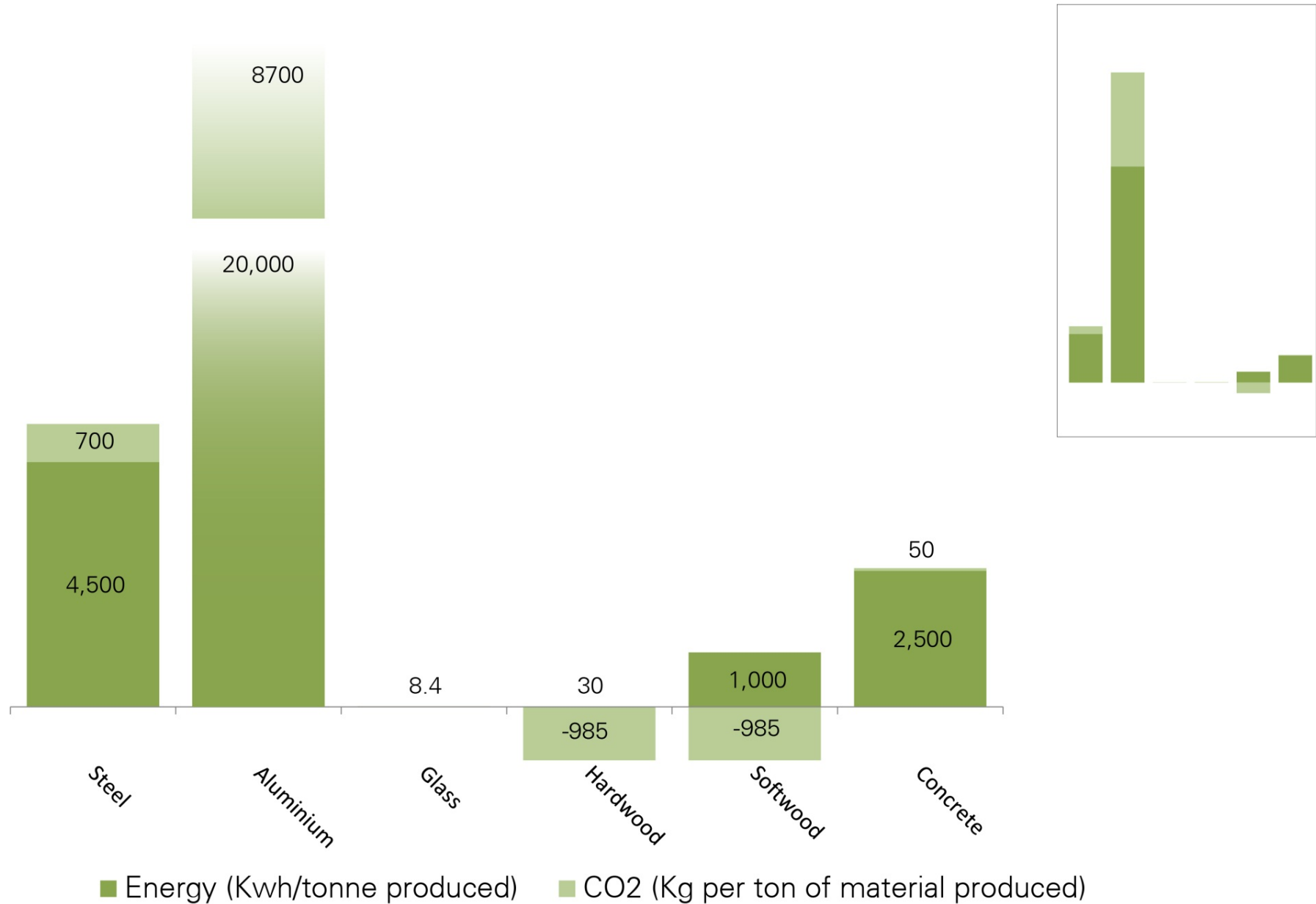
Column Load: 125kN

Buckling Length: 3000mm



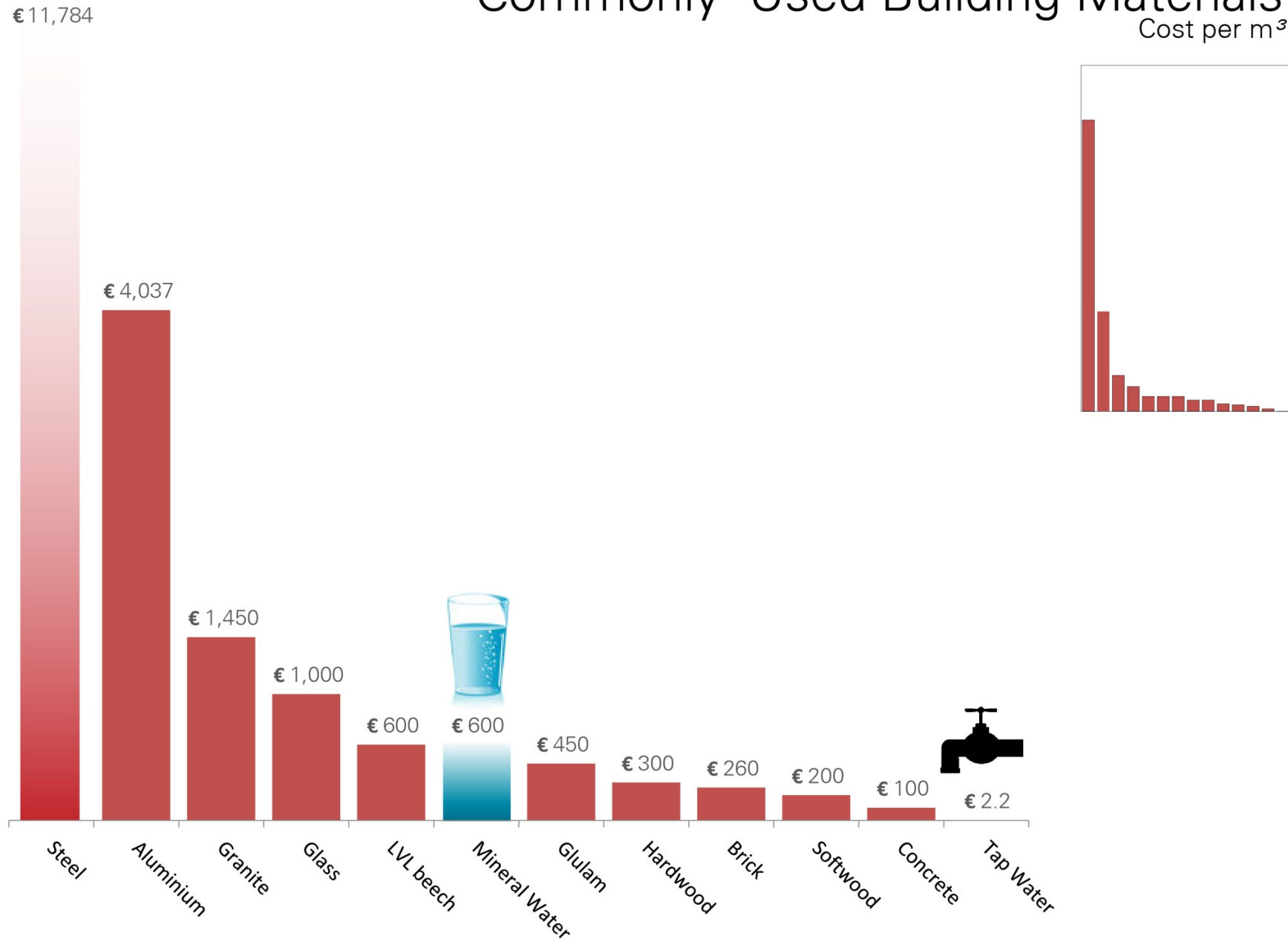
Commonly Used Building Materials

Energy Consumption and Carbon Dioxide production



Commonly Used Building Materials

Cost per m³

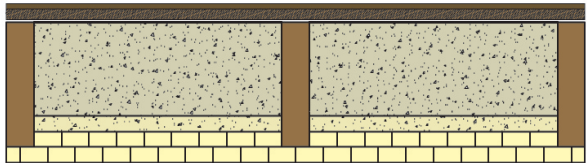
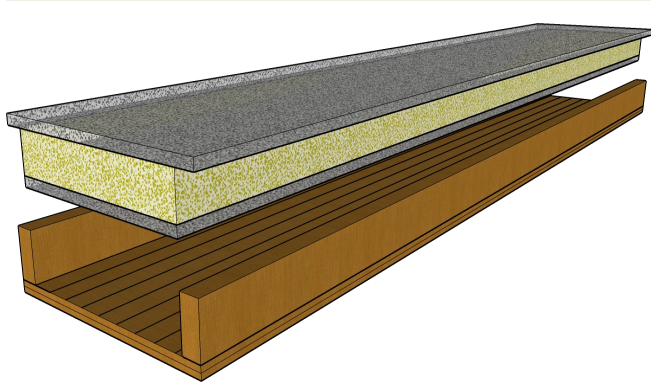


ITI: Current research and development for structural elements

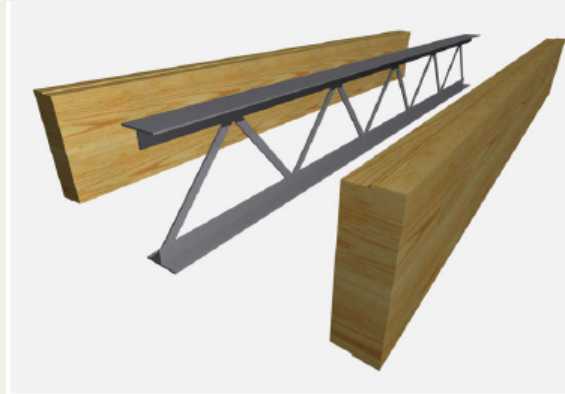
Folie 13

Ligna 29..5.2011

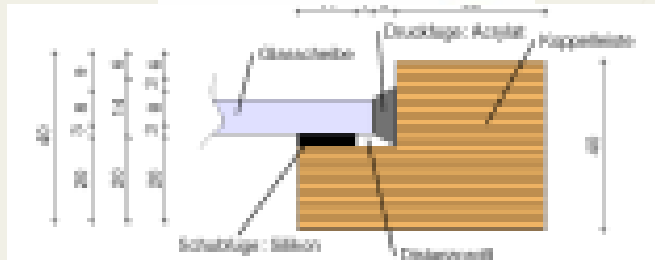
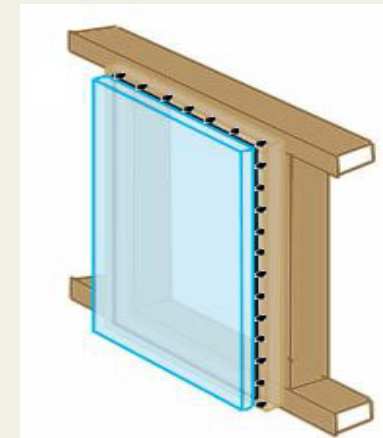
10. KONFERENZ



Timber (strand) concrete

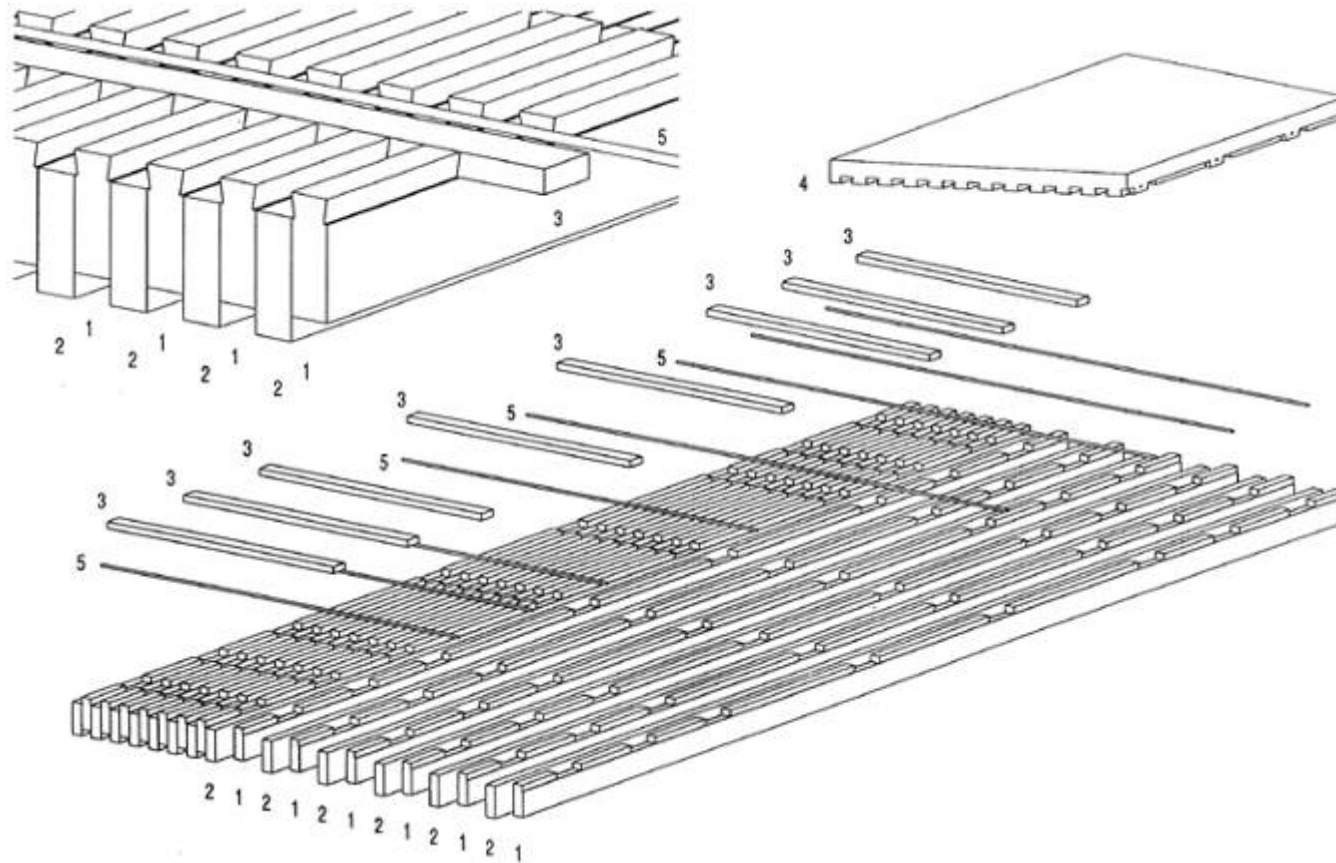


Steel-Timber Hybrid beams



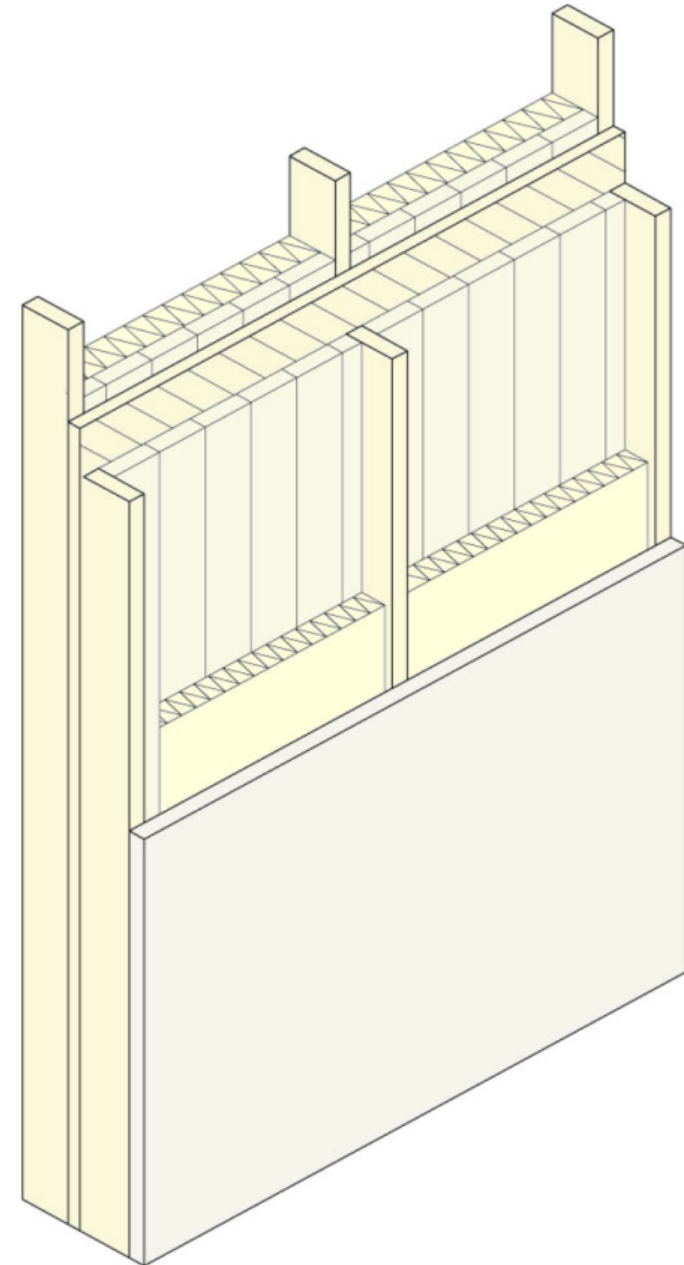
Timber-glass shearwalls

wood- heavy concrete composite slabs – without metal connectors



Technical approval in France,
System developed by Dominique Molard architect and Wolfgang Winter engineer

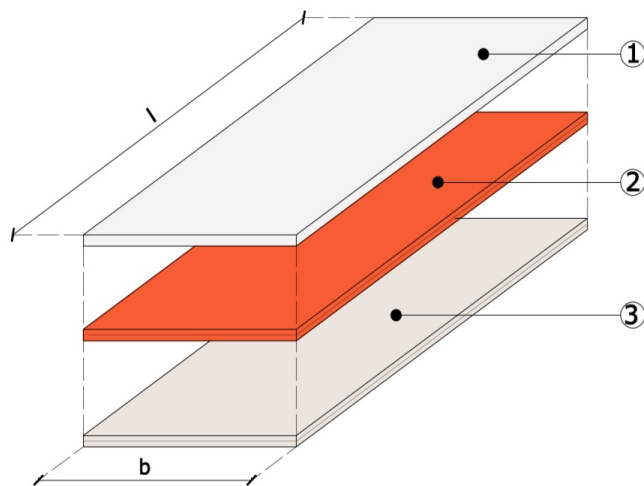
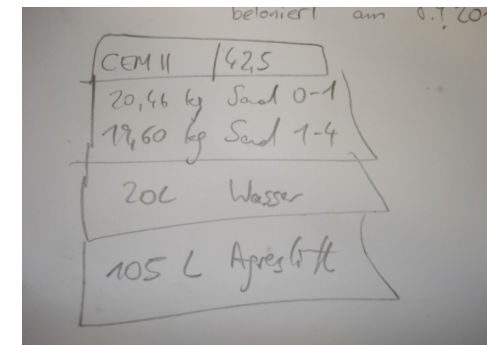
Cement Bonded Wood Composite Structures



Components (wood – lightweight concrete)

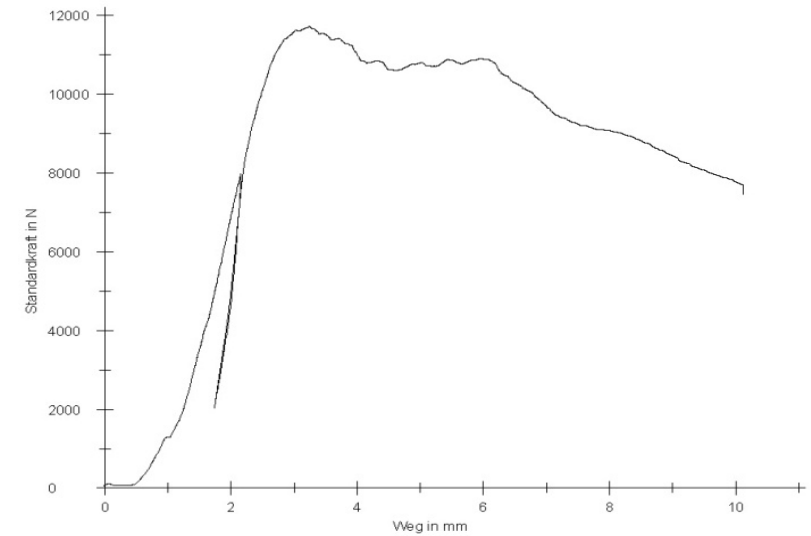
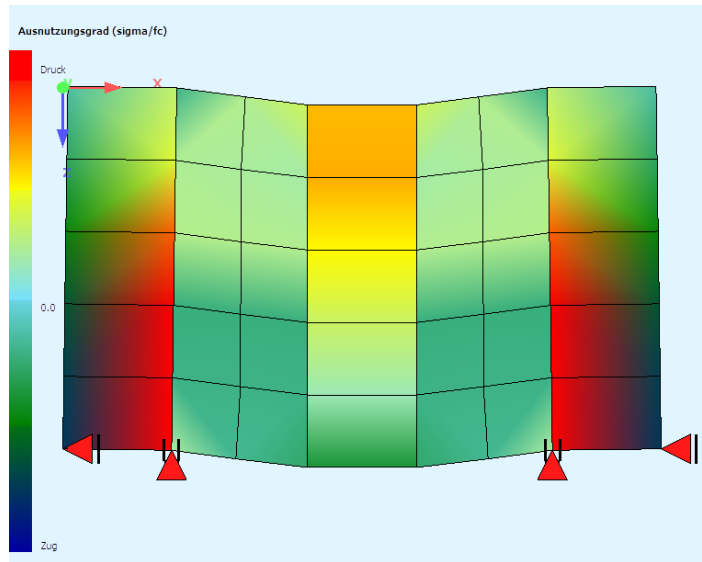
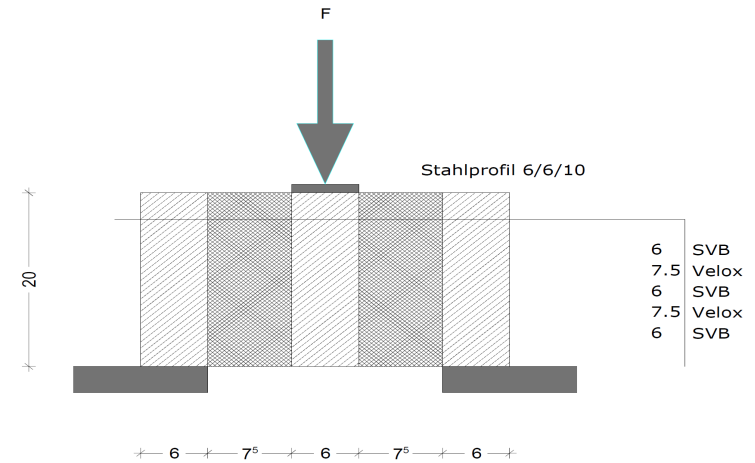


Products Velox: WS 50, WSD 35

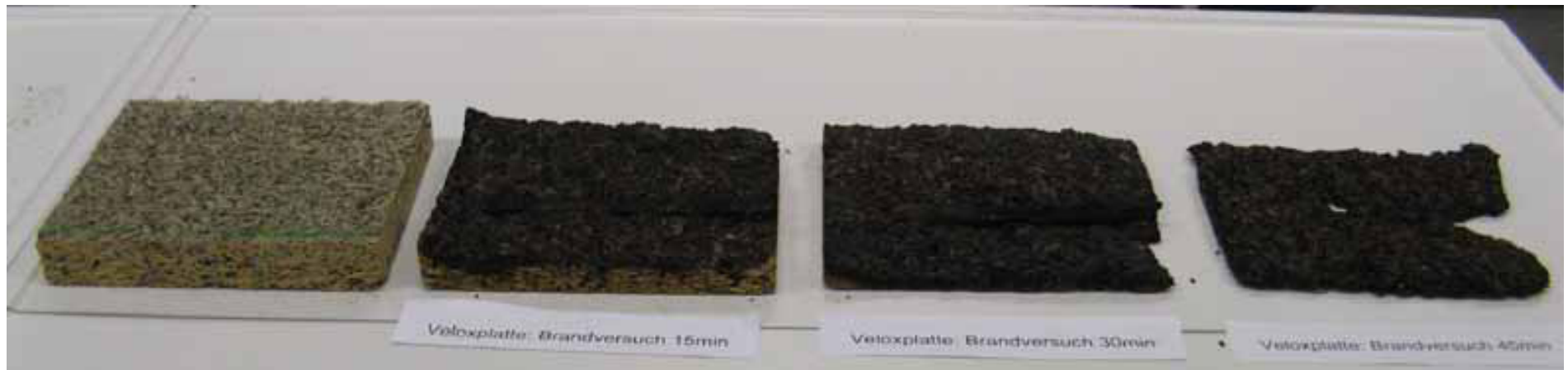


Components Agresta

Investigating the potential of VELOX' shear resistance with experiments and FEM simulations.



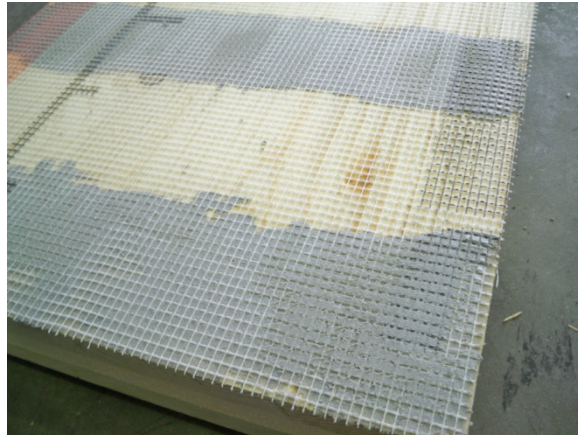
Fire tests



Fire test: Velox; 15min, 30min, 45min



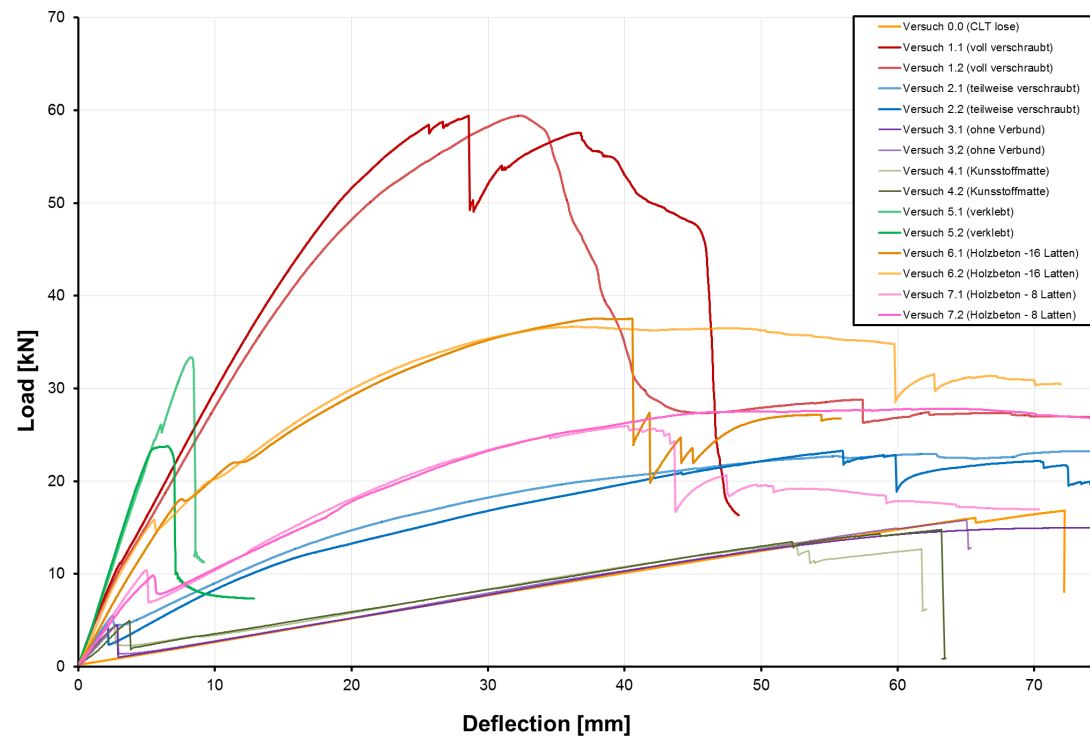
Structural Sandwich Panels (Tests)



Composite beam: glass fibre mat with two-component adhesive

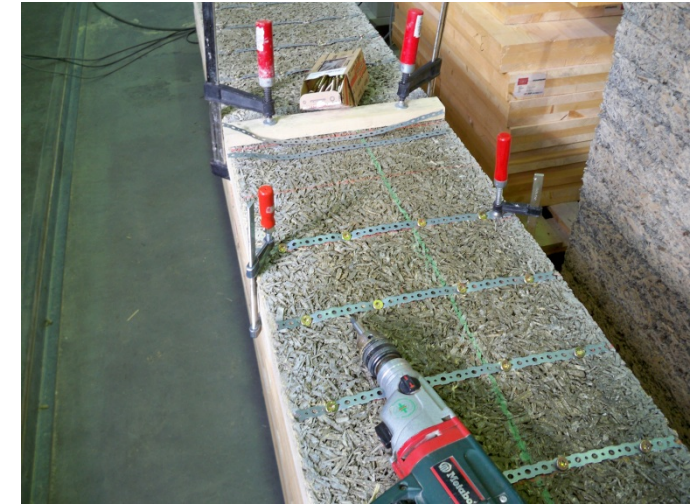


Structural Sandwich Panels (Tests)



Relation between load and deflection for different types of connection VELOX and CLT-plates.

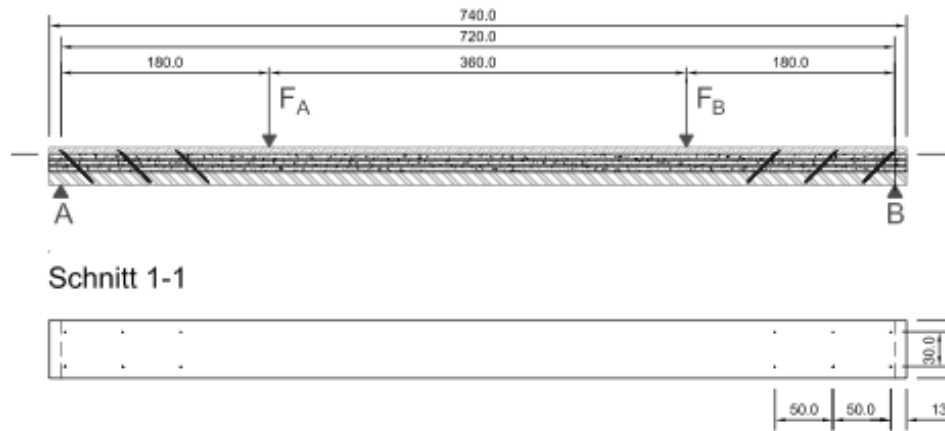
Length of tested panels: $l = 2.50\text{m}$

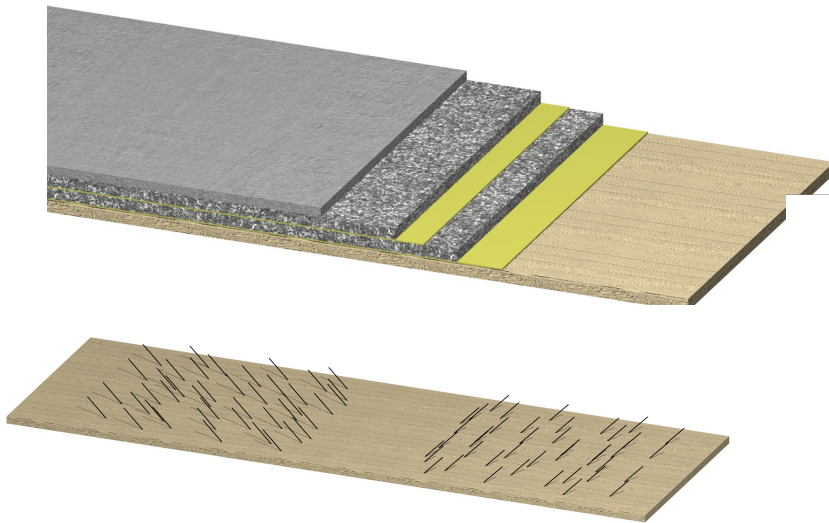


Test Nr. 1: screws



Test Nr. 5: two-component adhesive





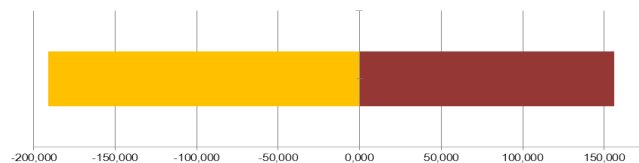
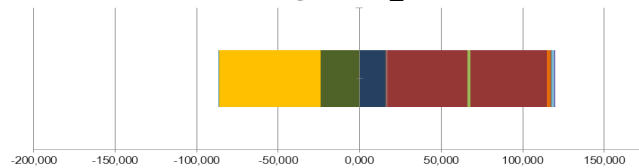
Schraubenanzahl: 112 Stück

- Beton SVB 6,0 cm
- Velox WSD 75 15,0 cm
- dazwischen 2 Lagen Sikadur-31 216 kg
- Brettbohlen 8,0 cm

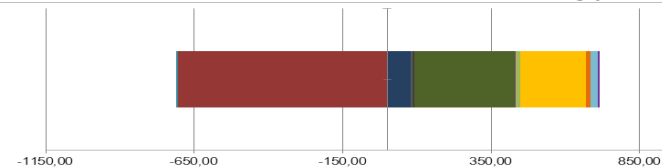
- Preis /m2: 104,10 €

- Beton (SCC)
- Transport zur Herstellungsstätte (typischerweise 20 km)/Entsorgung
- Pumpen von Beton - Herstellungsstätte
- EOL - Bauschutttaufbereitung
- Holzbeton (Velox WSD 50)
- Transport zur Herstellungsstätte (typischerweise 20 km)
- Transport zur MVA (Annahme 20 km)
- EOL - MVA
- Deponie der Verbrennungsrückstände
- Holz (Brettbohlen)
- Transport zur Herstellungsstätte (typischerweise 20 km)
- Transport zur MVA (Annahme 20 km)
- EOL - MVA
- Kleber (Sikadur 31)
- Transport zur Herstellungsstätte (typischerweise 20 km)/Entsorgung
- Schrauben (WR-T 9x350)
- Transport zur Herstellungsstätte (typischerweise 20 km)/Entsorgung
- EOL - Recyclingpotential
- Transport BAUSTELLE

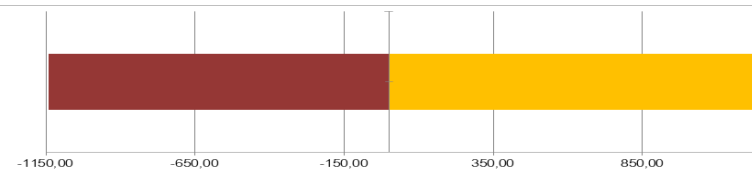
(GWP 100) kg CO₂-Äqv



Non renewable Energy (PEI_{ne}) MJ



2 layers Velox,
sawn, staggered
elements



Pure gluelam



THANK YOU!

ご清聴ありがとうございました！

