TECHNISCHE UNIVERSITÄT DRESDEN

Hankin Distinghuished Lecture

PENN STATE, November 14th, 2006

New Technologies in Wood Construction

- Examples from Practice and Research

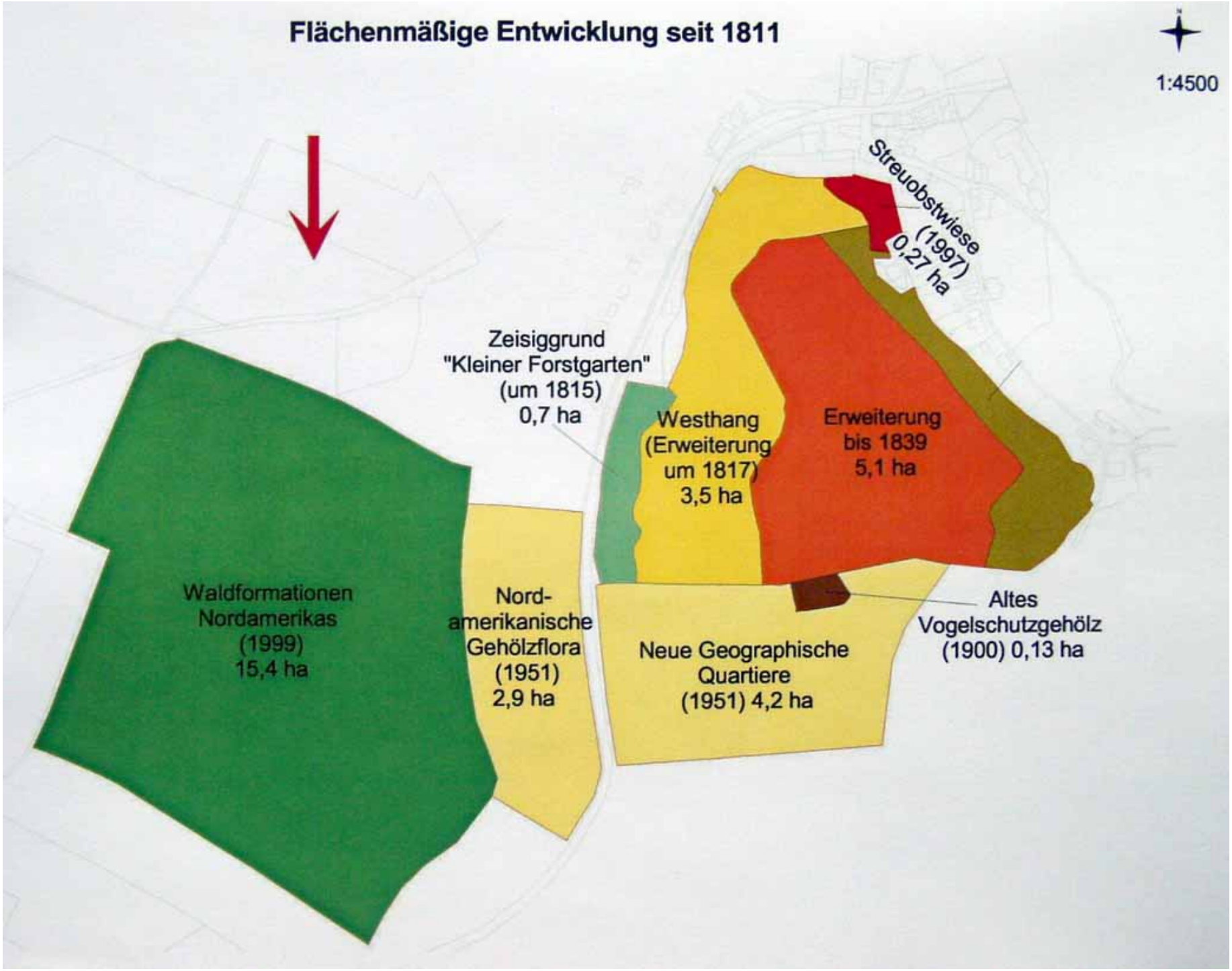
Prof. Dr.-Ing. Peer Haller

Institut für Stahl- und Holzbau
Technische Universität Dresden

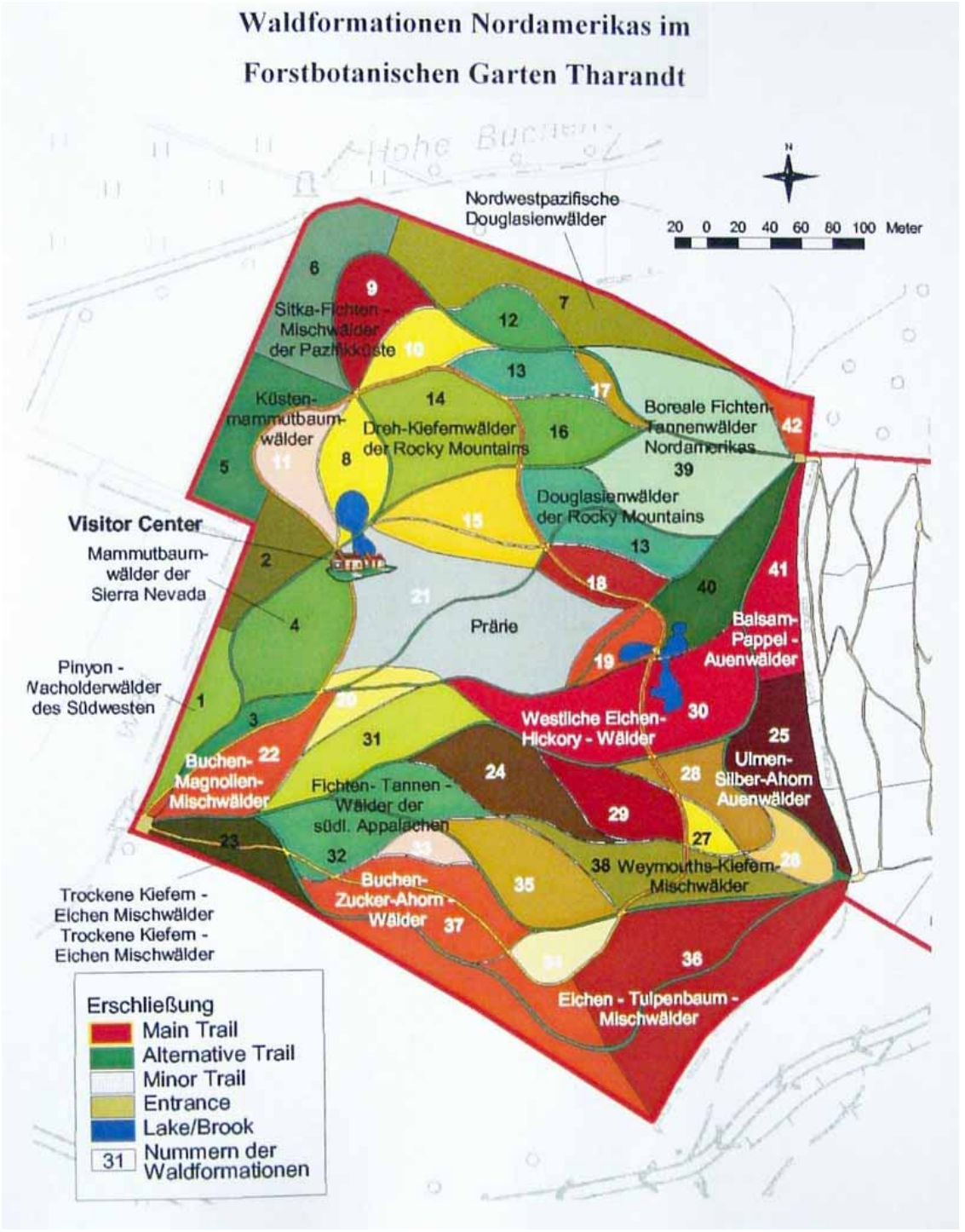

Lichtenauer
MINERALQUELLEN
MINERALWASSER
NATRIUMARM

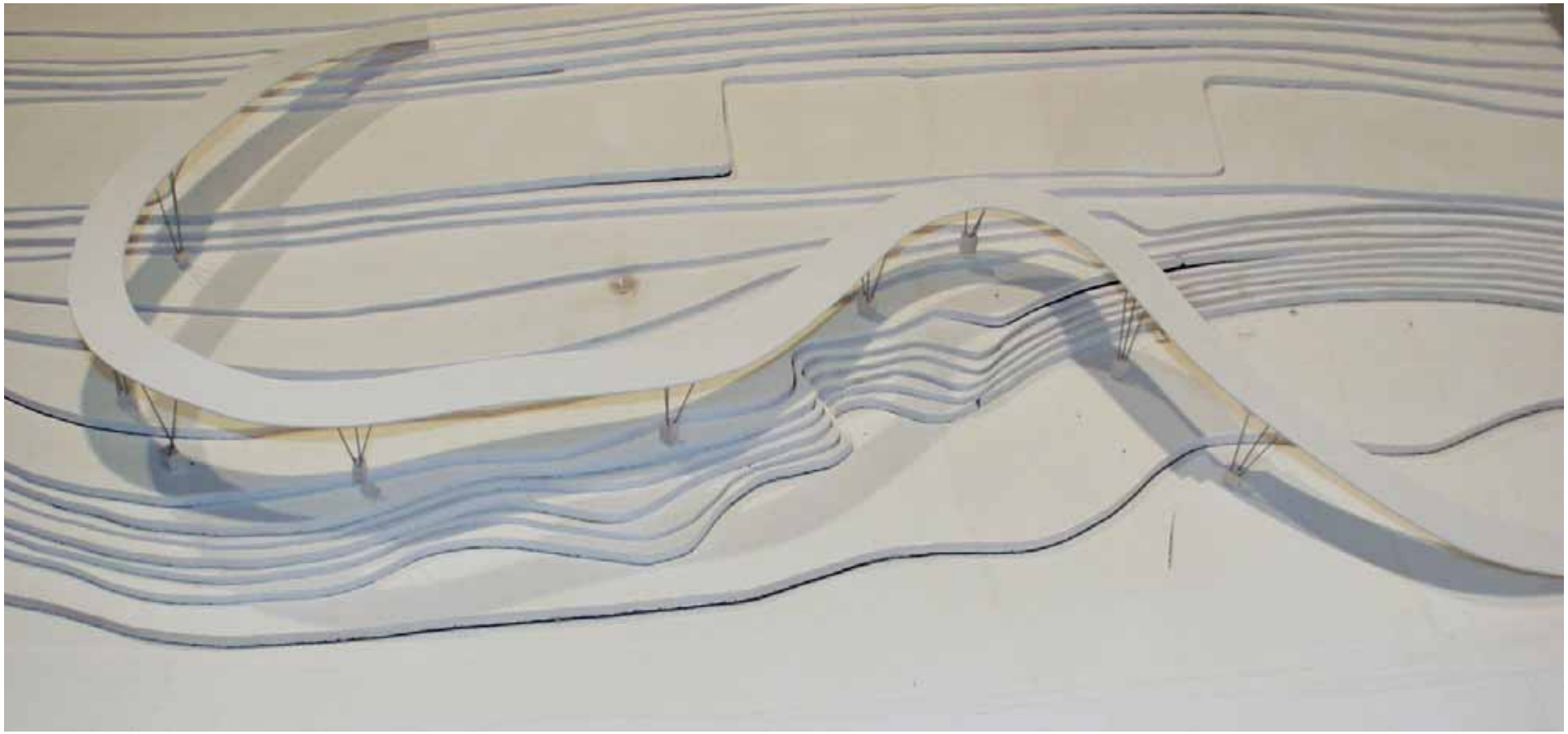
Pedestrian Bridge in the Botanical Garden at Tharandt

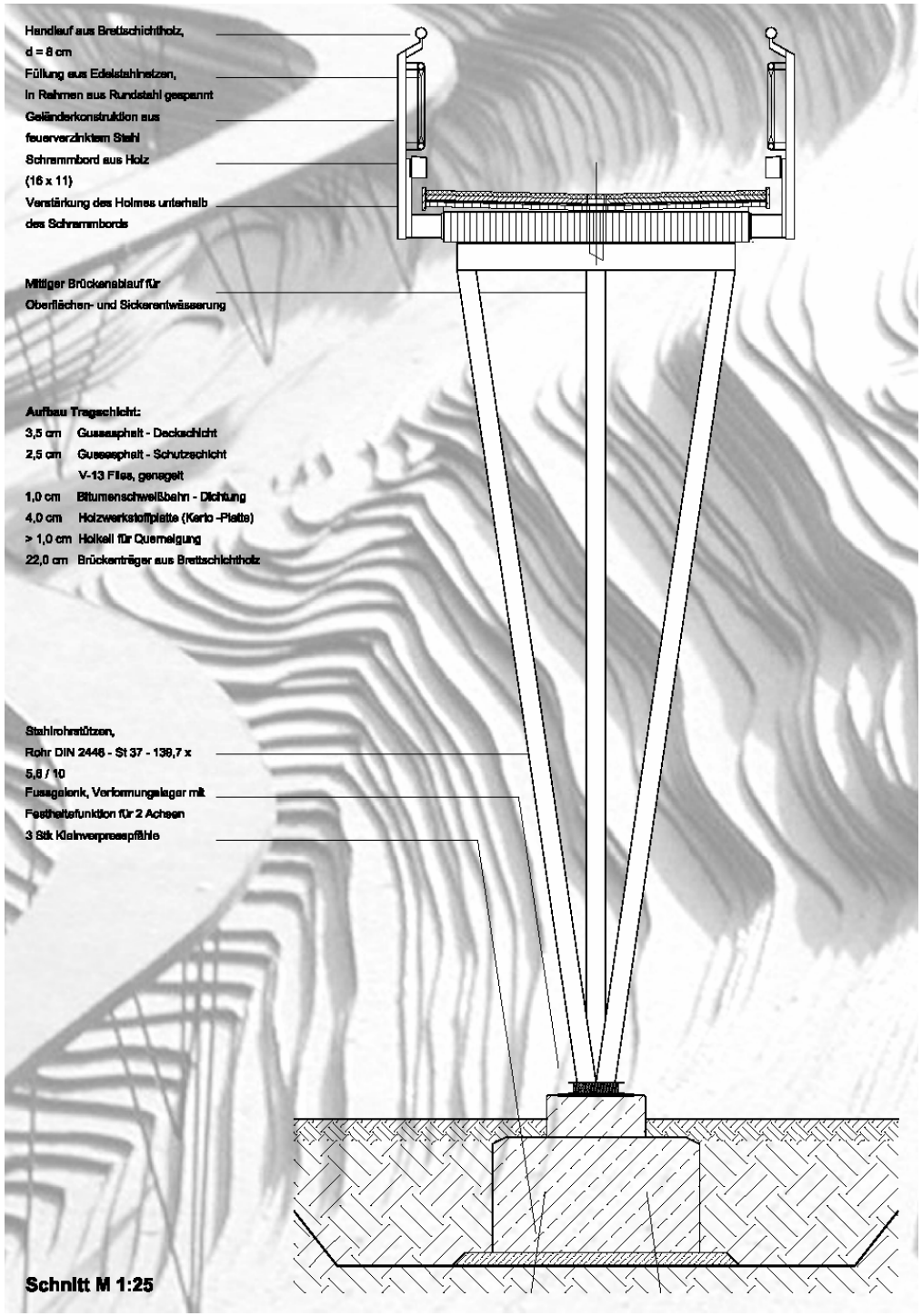
- Realization From a Student‘s Competition in Architecture


Flächenmäßige Entwicklung seit 1811
1:4500
Streuobstwiese
(1997)
0,27 ha
Zeisiggrund
"Kleiner Forstgarten"
(um 1815)
0,7 ha
Westhang
(Erweiterung
um 1817)
3,5 ha
Erweiterung
bis 1839
5,1 ha
Waldformationen
Nordamerikas
(1999)
15,4 ha
Nord-
amerikanische
Gehölzflora
(1951)
2,9 ha
Neue Geographische
Quartiere
(1951) 4,2 ha
Altes
Vogelschutzgehölz
(1900) 0,13 ha

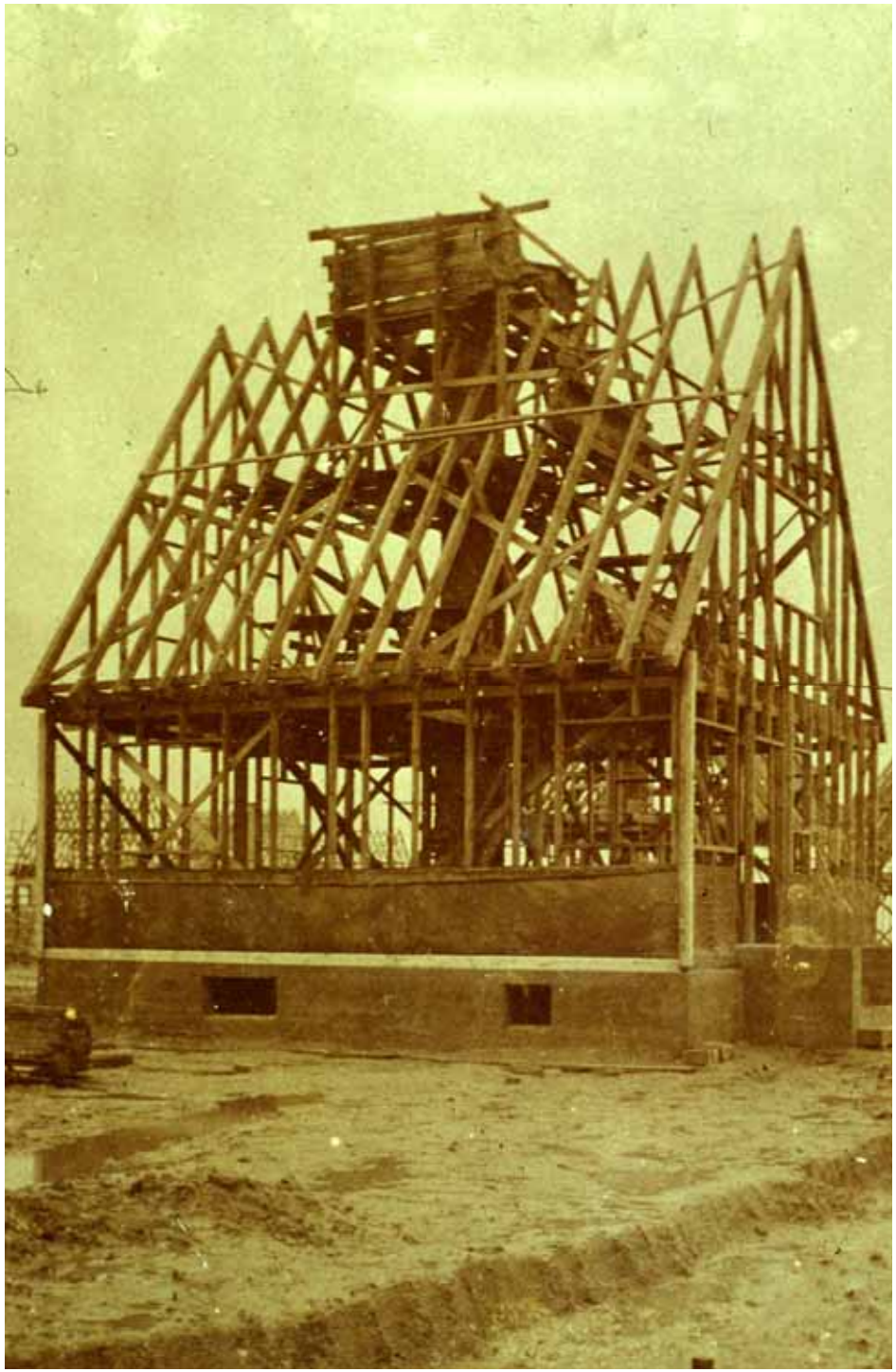
Waldformationen Nordamerikas im Forstbotanischen Garten Tharandt

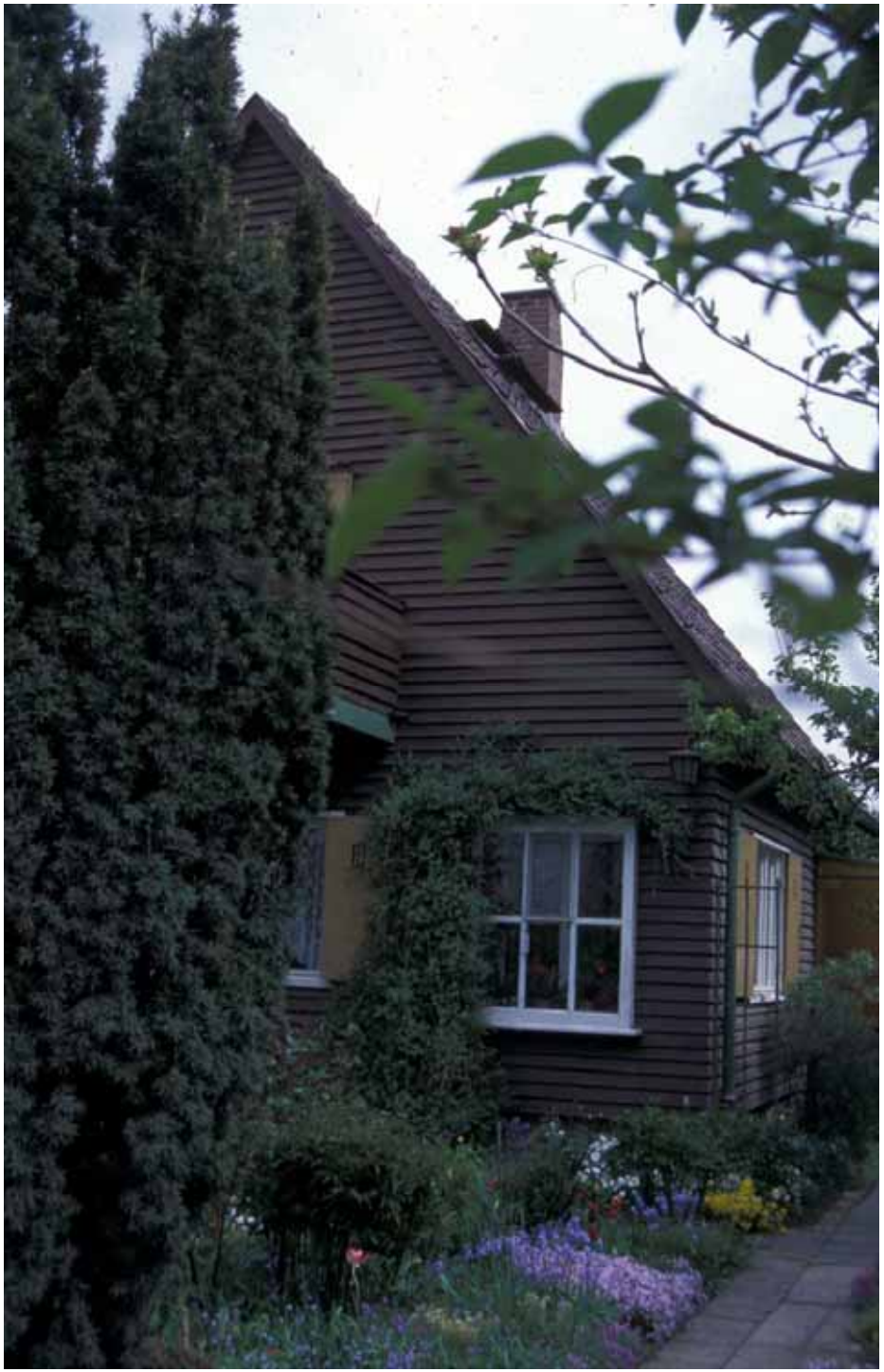


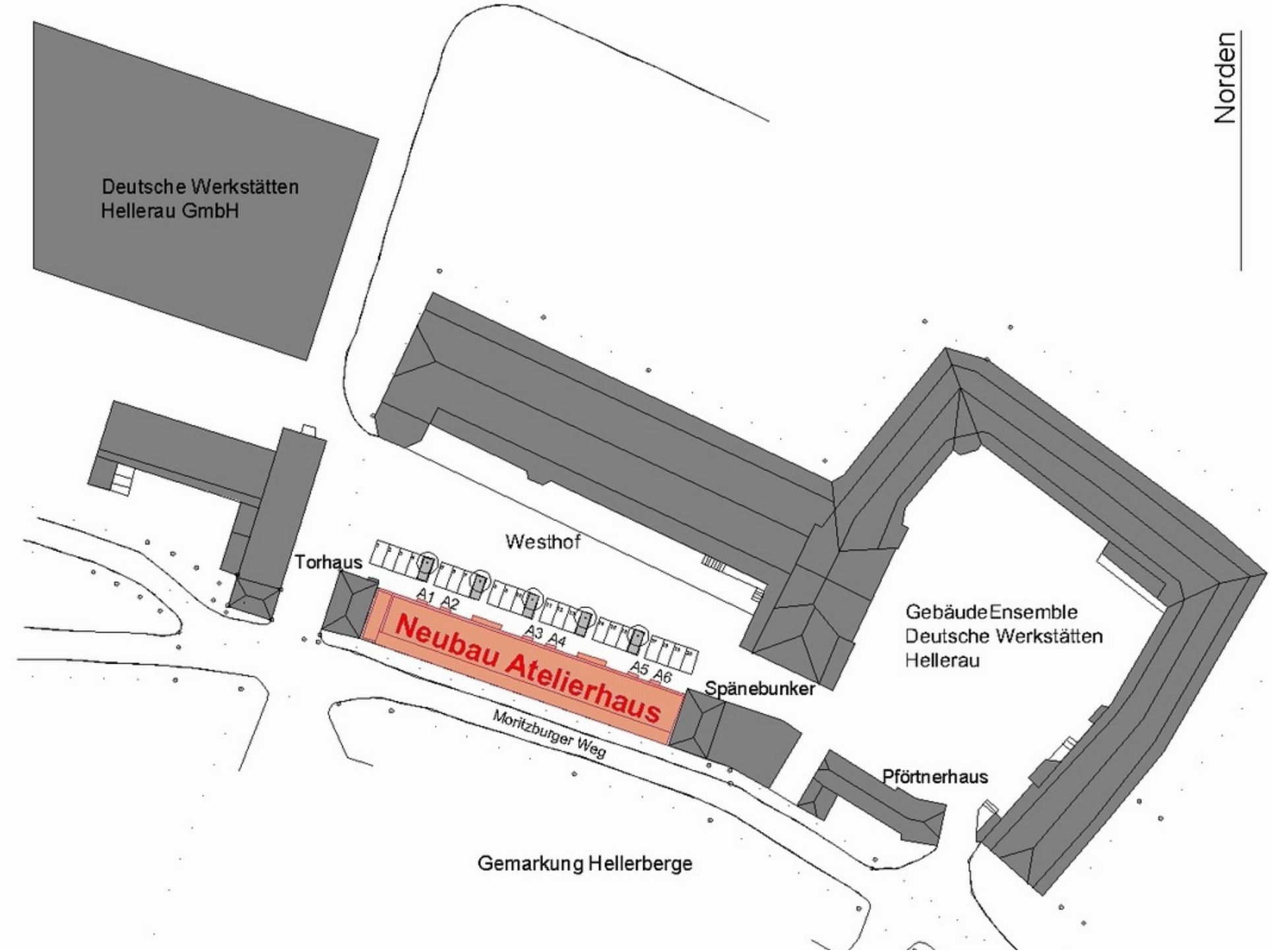



Handlauf aus Brettschichtholz,
d = 8 cm
Füllung aus Edelstahlnetzen,
in Rahmen aus Rundstahl gespannt
Geländerkonstruktion aus
feuerverzinktem Stahl
Schrammbord aus Holz
(16 x 11)
Verstärkung des Holmes unterhalb
des Schrammbords
Mittiger Brückenablauf für
Oberflächen- und Sickerentwässerung
Aufbau Tragschicht:
3,5 cm Gussasphalt - Deckschicht
2,5 cm Gussasphalt - Schutzschicht
V-13 Fliss, genagelt
1,0 cm Bitumenschweißbahn - Dichtung
4,0 cm Holzwerkstoffplatte (Kerto -Platte)
> 1,0 cm Holkeil für Quemeigung
22,0 cm Brückenträger aus Brettschichtholz
Stahlrohrstützen,
Rohr DIN 2448 - St 37 - 139,7 x
5,6 / 10
Fussgelenk, Verformungslager mit
Festhaltefunktion für 2 Achsen
3 Stk Kleinverpresspfähle
Schnitt M 1:25

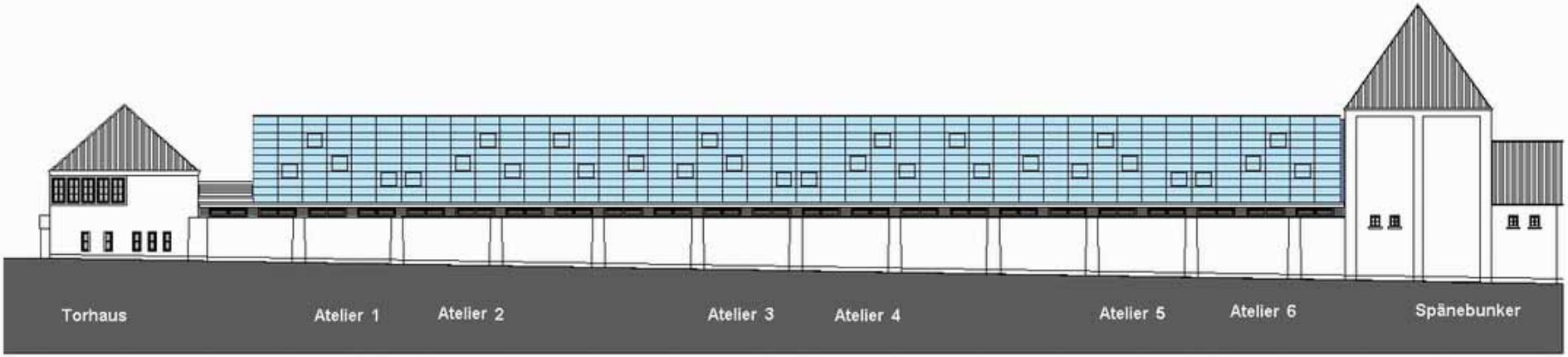
A New Solid Timber Studio Building in Dresden / Hellerau



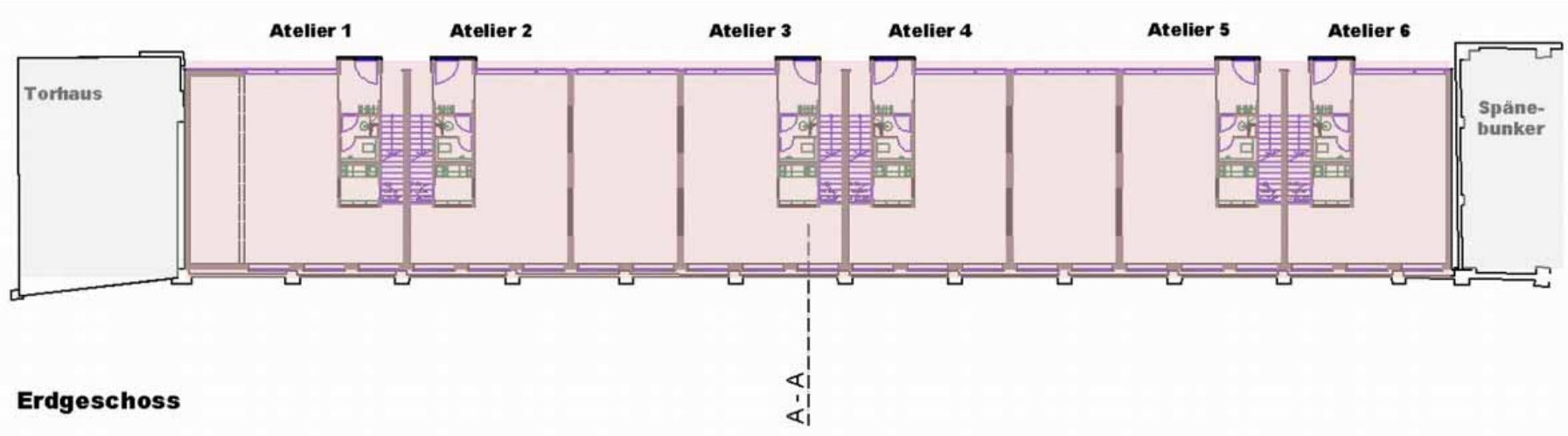



Norden
Deutsche Werkstätten
Hellerau GmbH
Westhof
Torhaus
A1 A2
A3 A4
A5 A6
Neubau Atelierhaus
Spänebunker
Moritzburger Weg
Pförtnerhaus
Gebäude Ensemble
Deutsche Werkstätten
Hellerau
Gemarkung Hellerberge

Norden



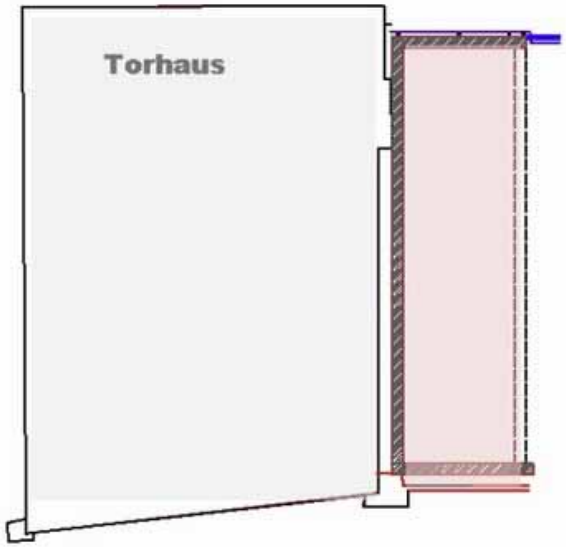
Süden



Erdgeschoss

Sondermodul

Anzahl: 1

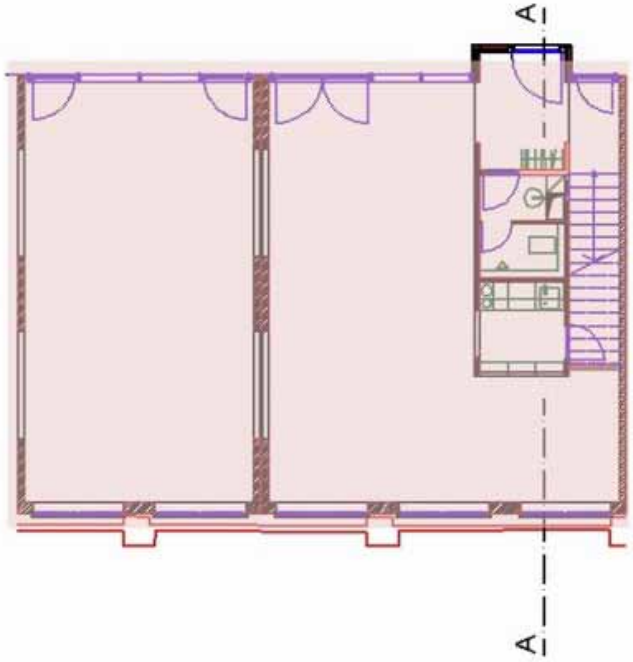


Erweiterungsmodul

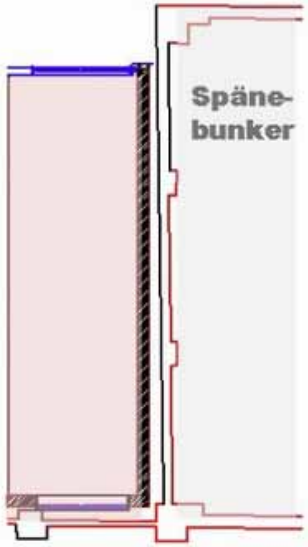
Anzahl: 2

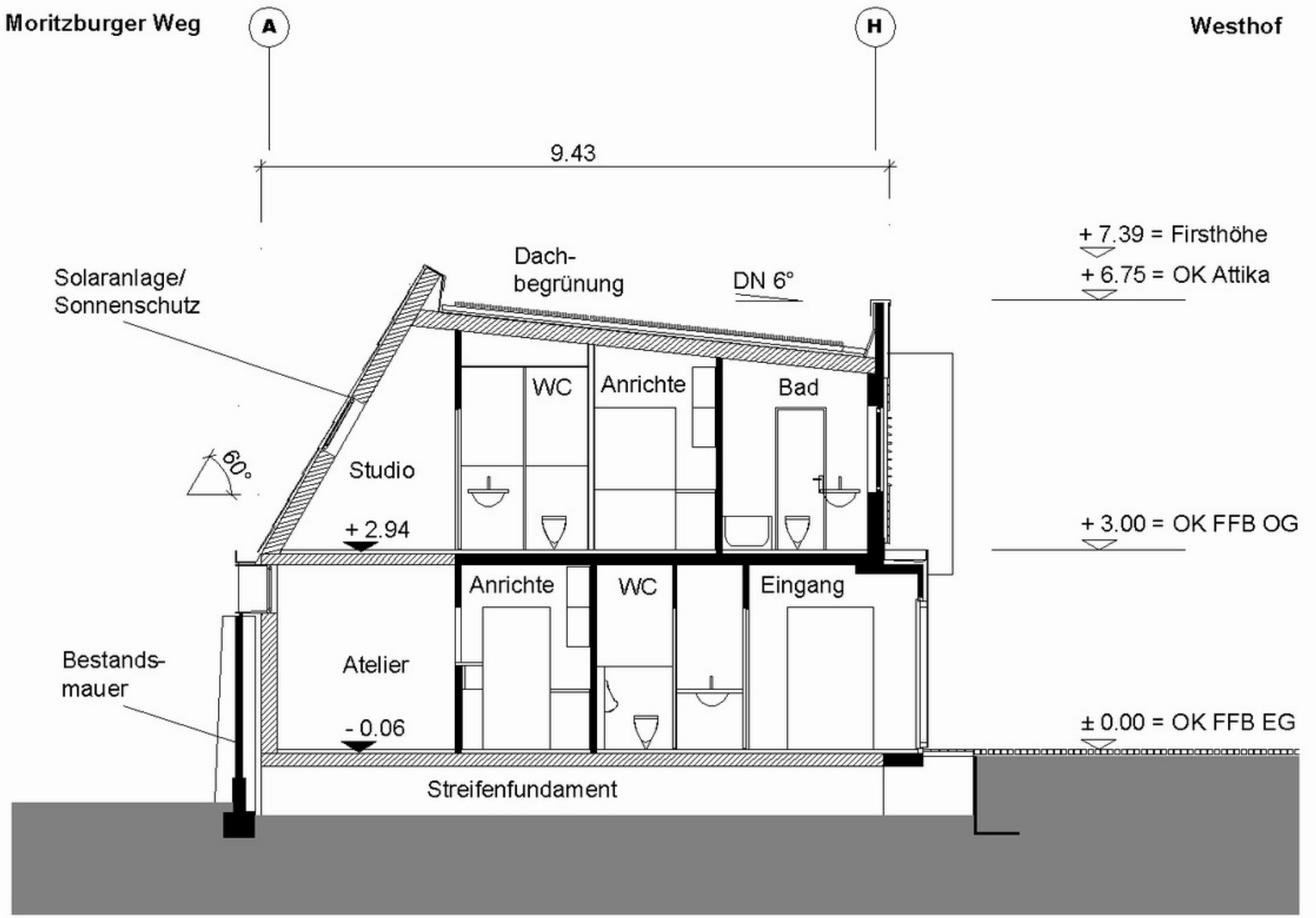
Grundmodul

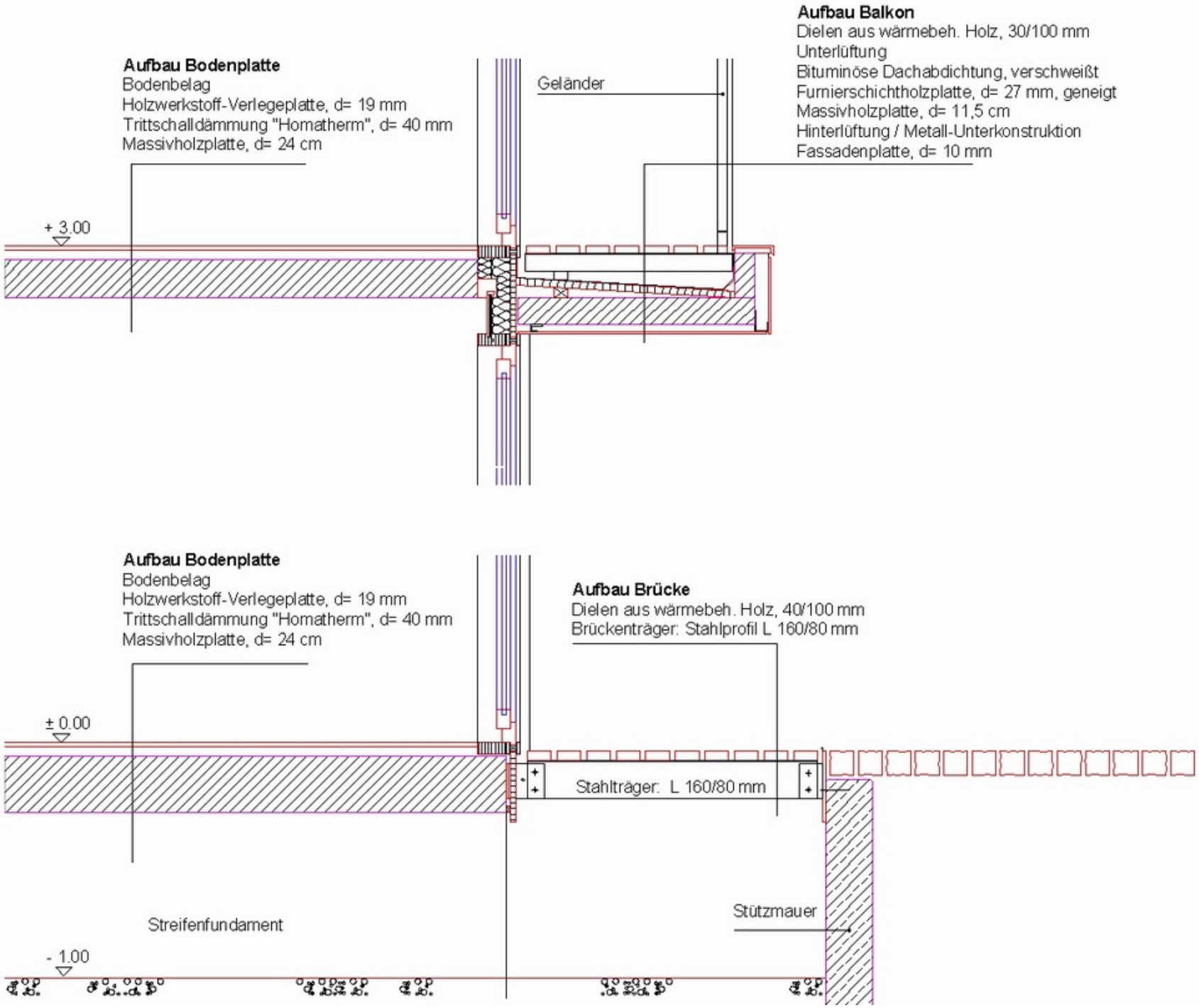
Anzahl: 3+3
(je seitenverkehrt)

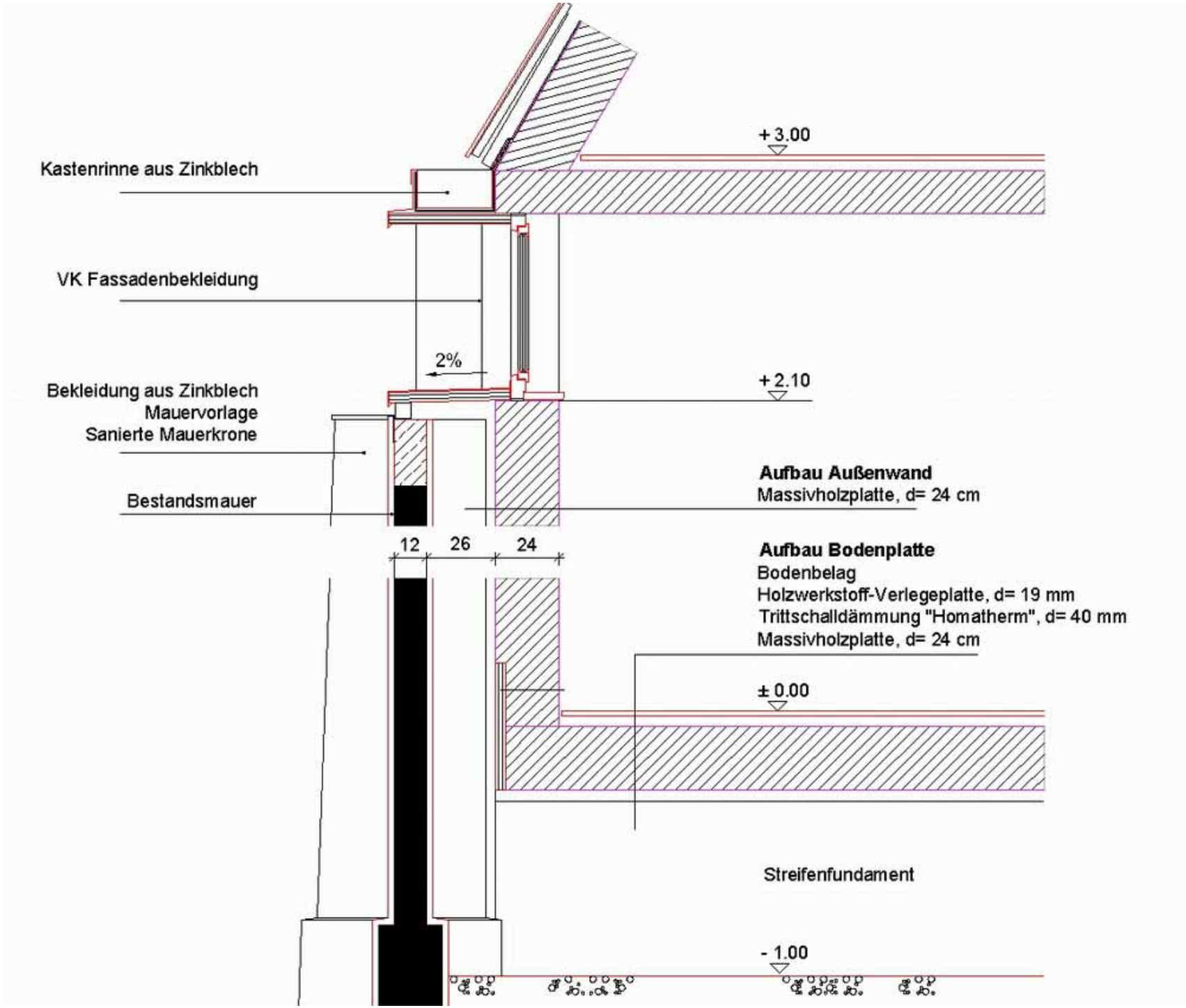


Atelier 6




Moritzburger Weg
A
H
Westhof
9.43
+ 7.39 = Firsthöhe
+ 6.75 = OK Attika
Solaranlage/
Sonnenschutz
Dach-
begrünung
DN 6°
WC
Anrichte
Bad
60°
Studio
+ 2.94
+ 3.00 = OK FFB OG
Anrichte
WC
Eingang
Bestands-
mauer
Atelier
- 0.06
± 0.00 = OK FFB EG
Streifenfundament


Aufbau Balkon
Dielen aus wärmebeh. Holz, 30/100 mm
Unterlüftung
Bituminöse Dachabdichtung, verschweißt
Furnierschichtholzplatte, d= 27 mm, geneigt
Massivholzplatte, d= 11,5 cm
Hinterlüftung / Metall-Unterkonstruktion
Fassadenplatte, d= 10 mm
Geländer
Aufbau Bodenplatte
Bodenbelag
Holzwerkstoff-Verlegeplatte, d= 19 mm
Trittschalldämmung "Homatherm", d= 40 mm
Massivholzplatte, d= 24 cm
+ 3.00
Aufbau Bodenplatte
Bodenbelag
Holzwerkstoff-Verlegeplatte, d= 19 mm
Trittschalldämmung "Homatherm", d= 40 mm
Massivholzplatte, d= 24 cm
Aufbau Brücke
Dielen aus wärmebeh. Holz, 40/100 mm
Brückenträger: Stahlprofil L 160/80 mm
± 0.00
Stahlträger: L 160/80 mm
Stützmauer
Streifenfundament
- 1.00


+3.00
Kastenrinne aus Zinkblech
VK Fassadenbekleidung
2%
+2.10
Bekleidung aus Zinkblech
Mauervorlage
Sanierte Mauerkrone
Bestandsmauer
Aufbau Außenwand
Massivholzplatte, d= 24 cm
12
26
24
Aufbau Bodenplatte
Bodenbelag
Holzwerkstoff-Verlegeplatte, d= 19 mm
Trittschalldämmung "Homatherm", d= 40 mm
Massivholzplatte, d= 24 cm
± 0.00
Streifenfundament
- 1.00

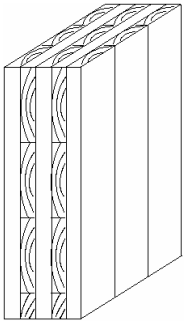
Production of Panels from Sawn Wood

Vacuum-Pressure

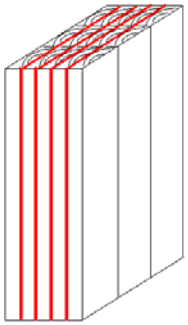
CNC Manufacturing

Robot (Merck Holzbau)

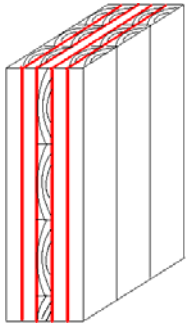
Traglast (kN)



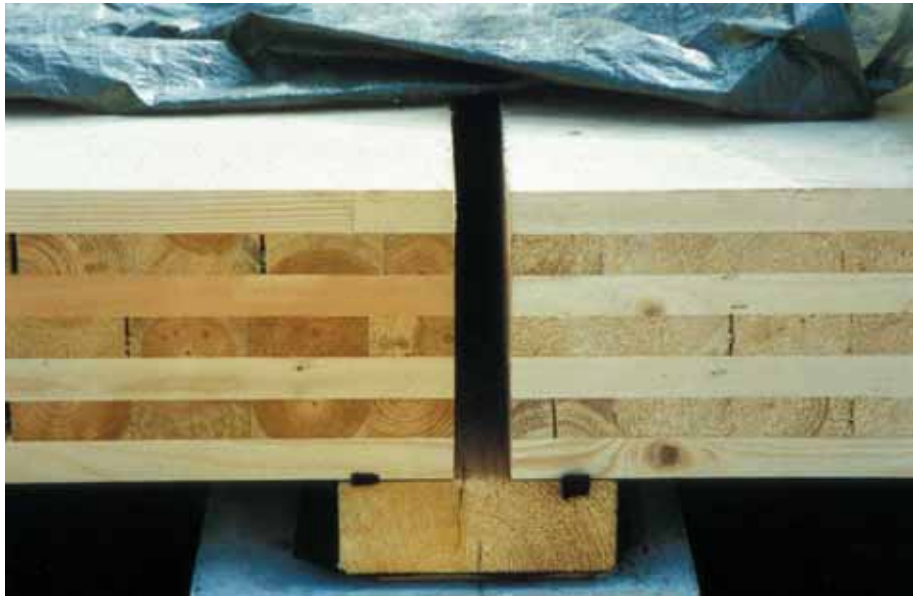
1900

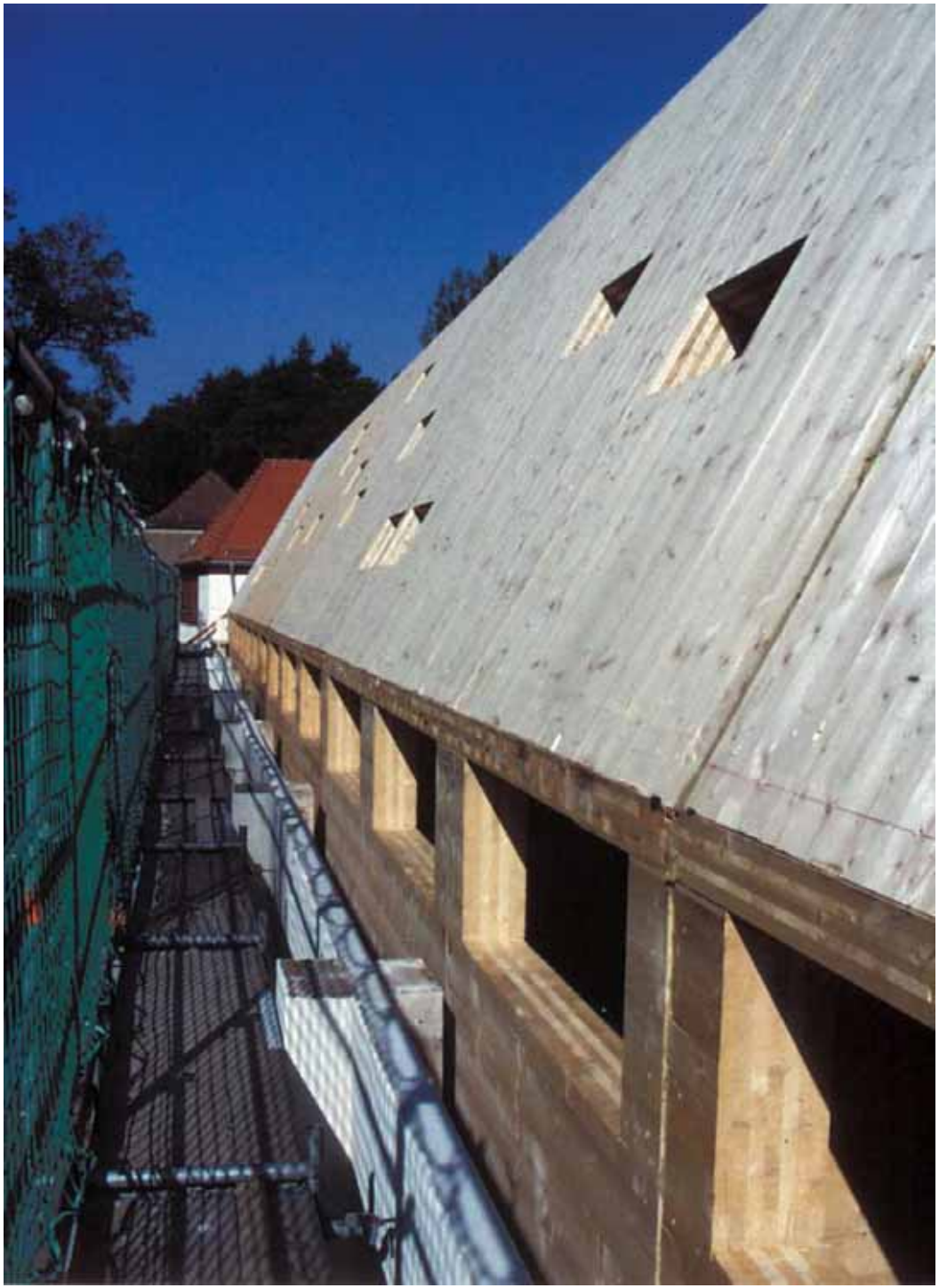


3200

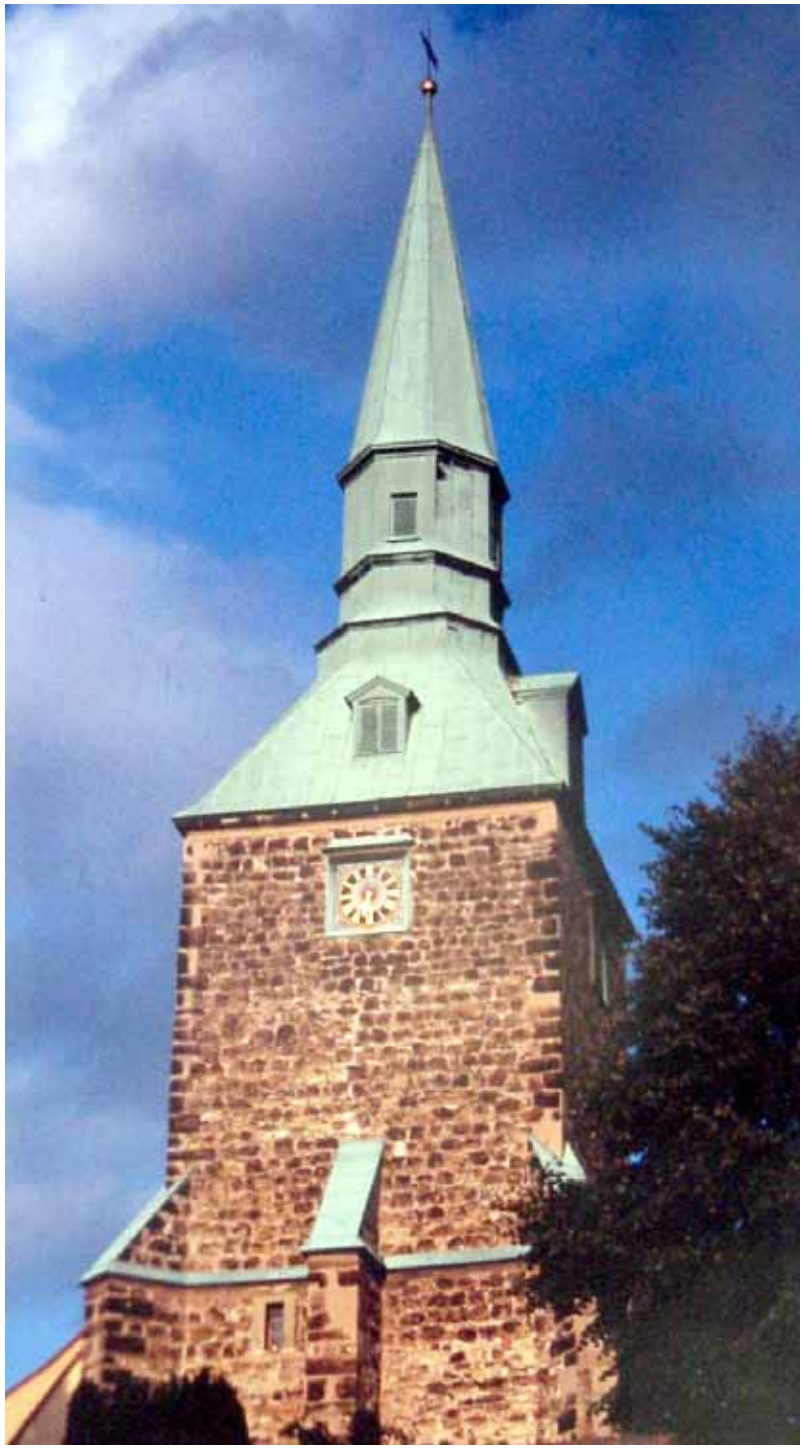


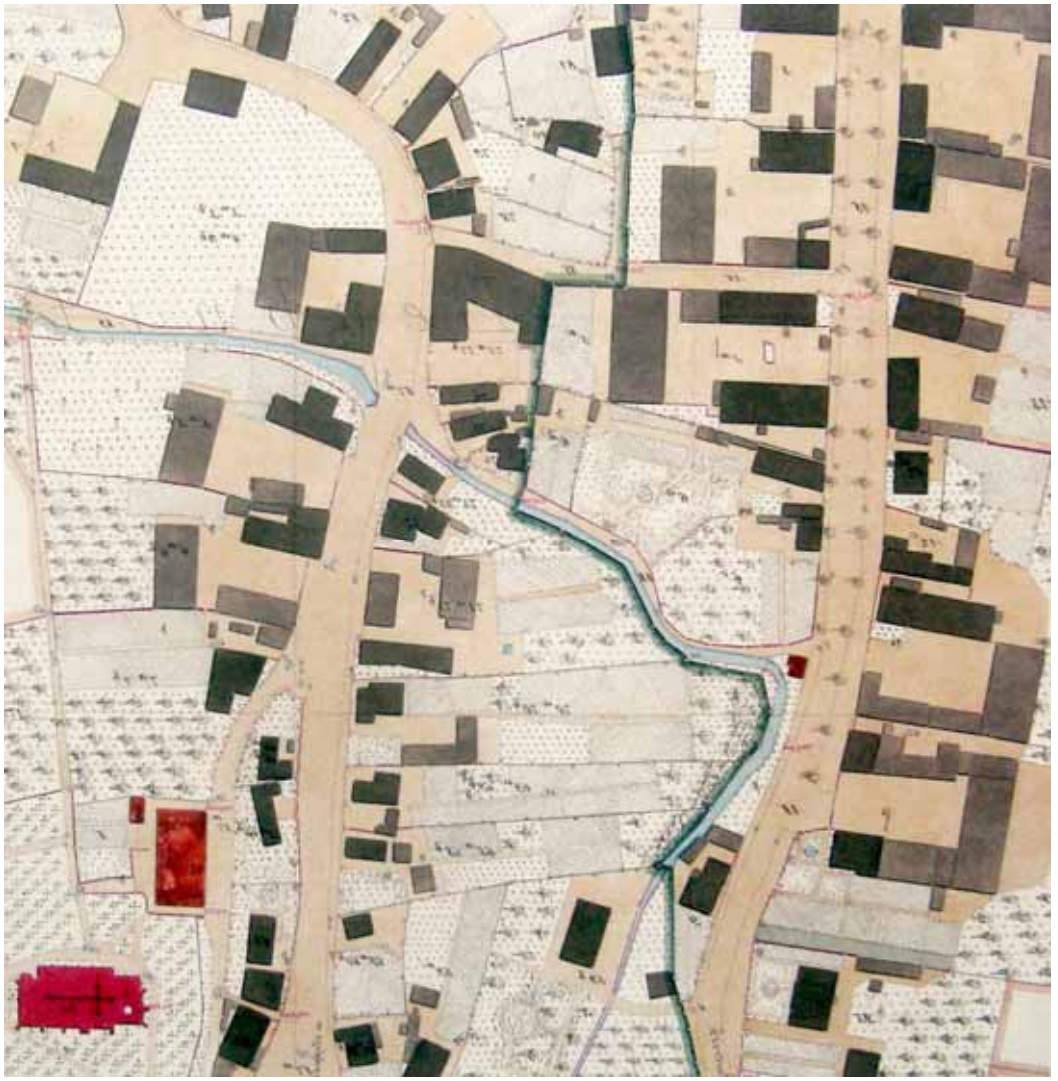
2400

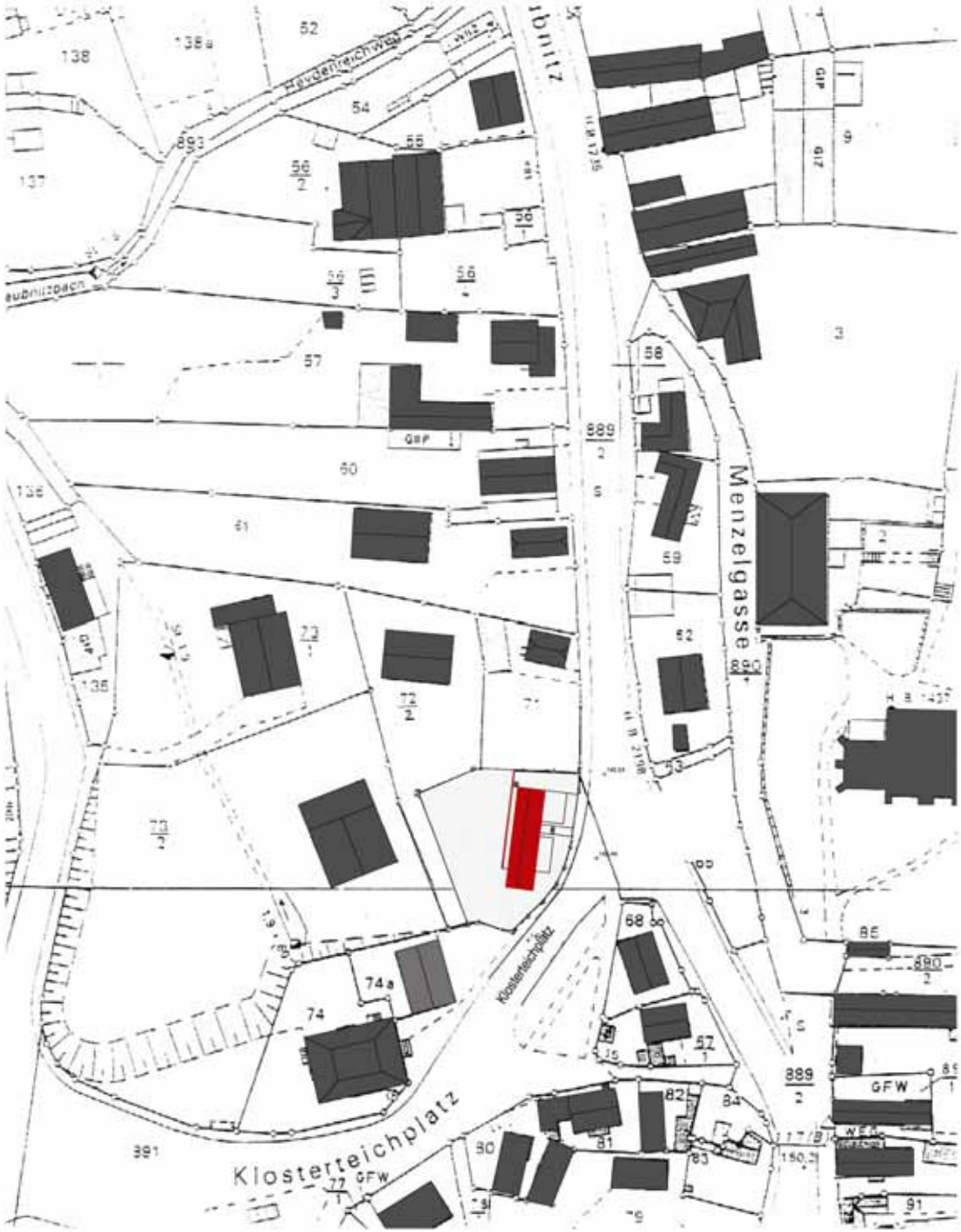


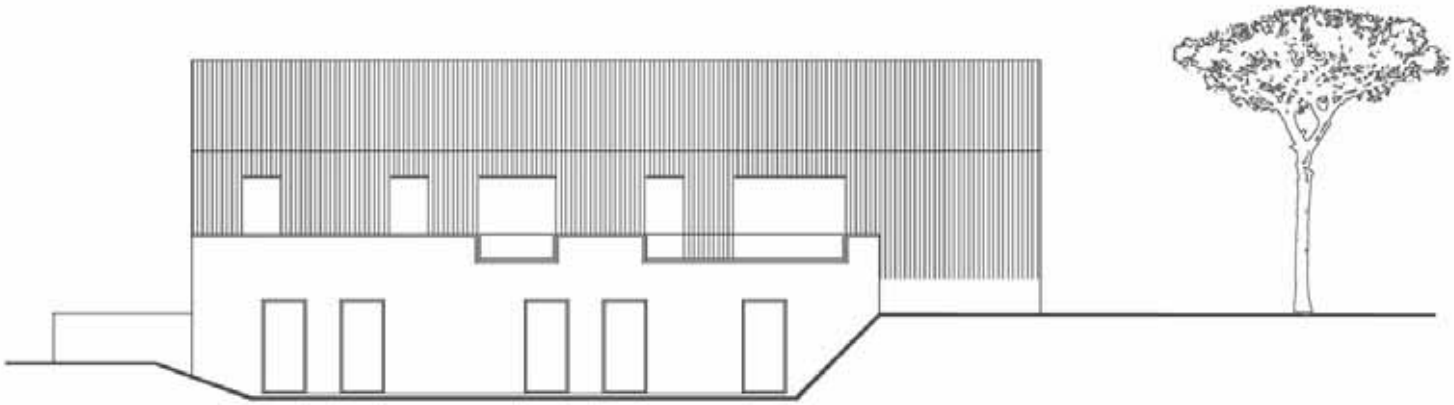


House Am Klosterteichplatz 1 at Leubnitz / Dresden

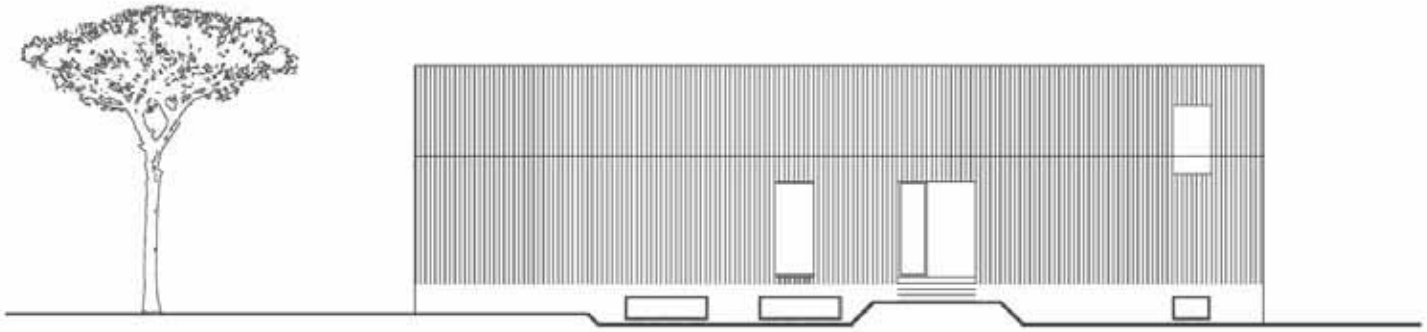




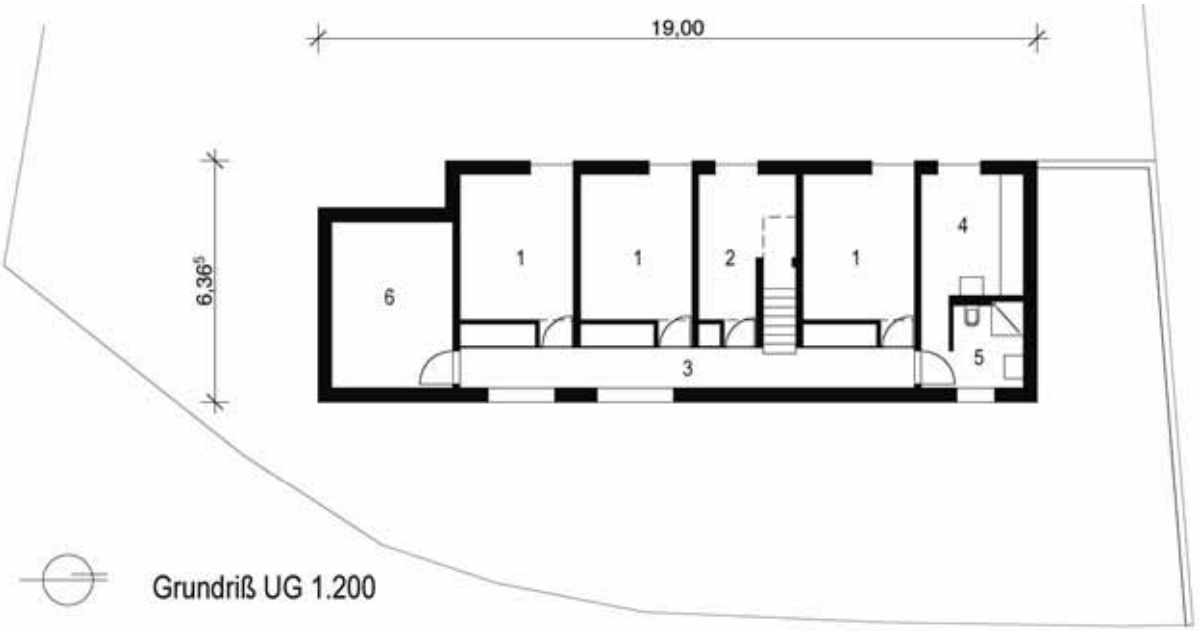

Menzelgasse
Klosterteichplatz
Klosterteichplatz
GFW
GFW



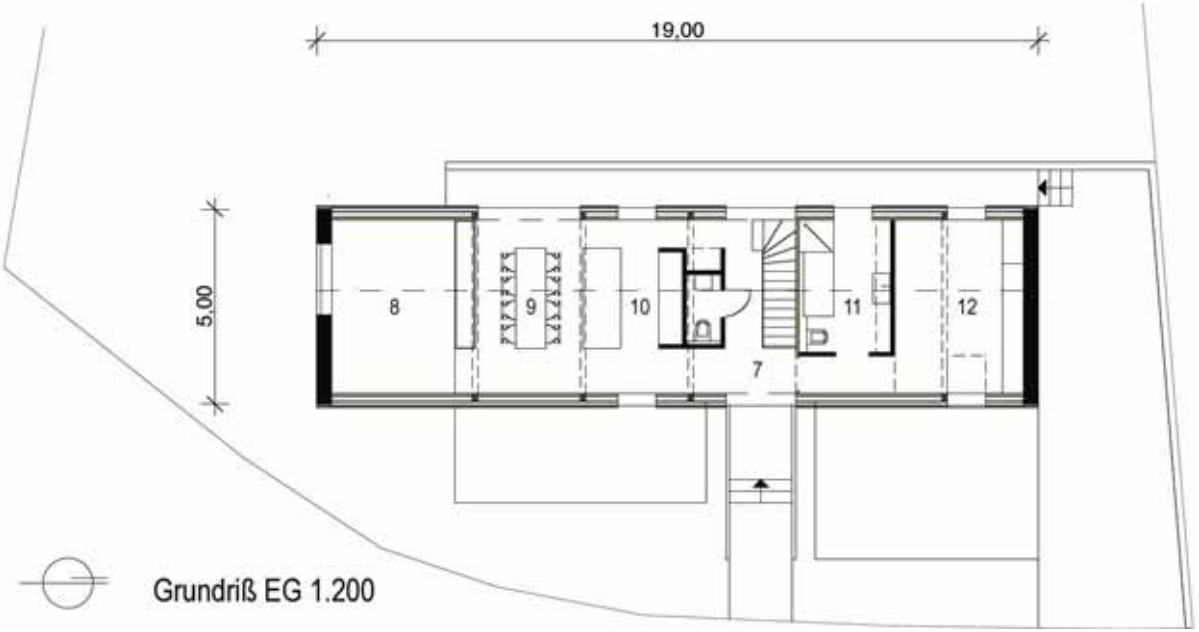
Ansicht Garten Westseite 1.200



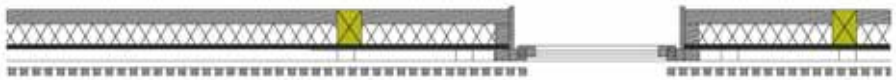
Ansicht Straße Ostseite 1.200



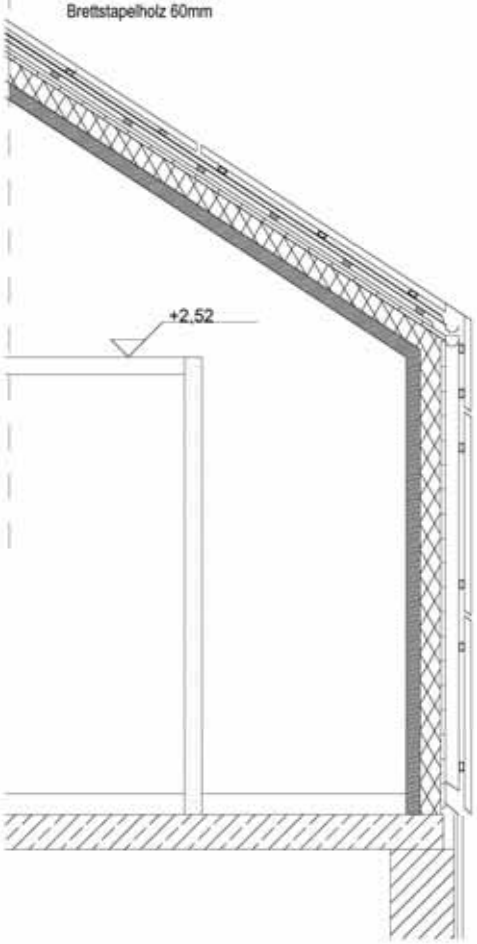
Grundriß UG 1.200



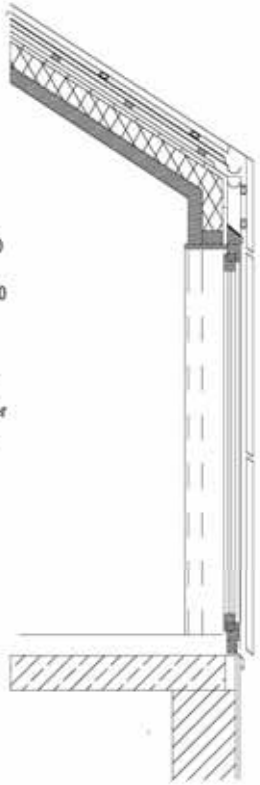
Grundriß EG 1.200

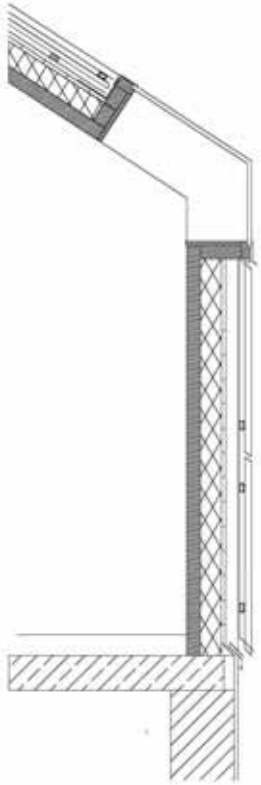


Lärchenschalung 40/40 auf Aluminium
Hohlprofil 30/50 von hinten verschraubt und
als Tafeln vorgefertigt
Lattung 30/50
Trapezblech 20-75, 1,0mm, Aluminium
Konterlattung 30/50
Lattung 24/48
Unterspannbahn
Schalung 24mm
Leimholzrahmen 160/200 mit Dämmung
120mm und Windpapier
Brettstapelholz 60mm



Lärchenschalung 40/40
Lattung 30/50
Unterkonstruktion 50/80
Unterspannbahn
Schalung 24mm
Leimholzrahmen
160/200 mit Dämmung
120mm und Windpapier
Brettstapelholz 80mm



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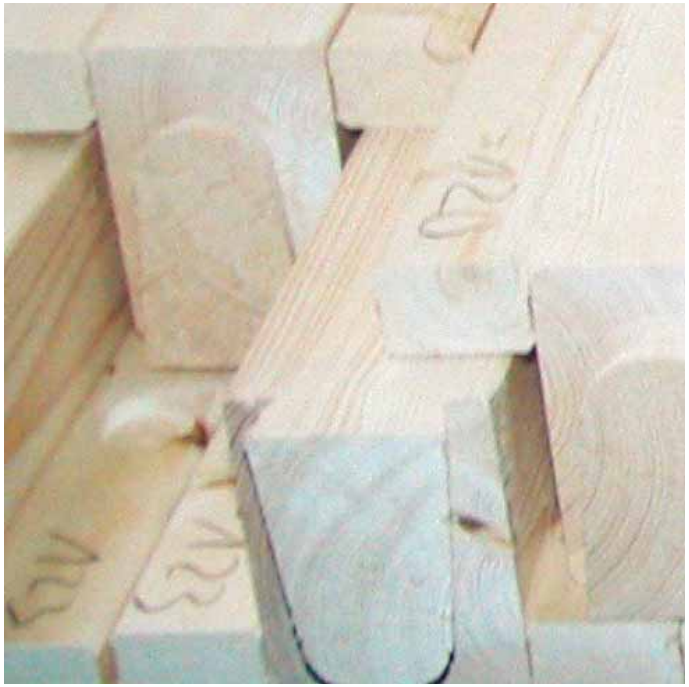
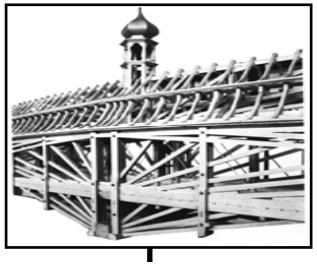


Reasearch in Wood Construction at Dresden

- Wood Forming and Textile Reinforcements

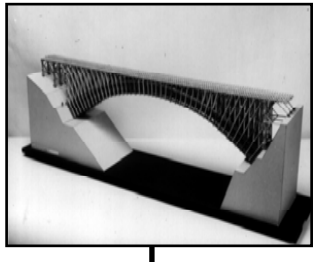
Design Development

Schaffhausen



U. Grubenmann

RW Bridge



Brown

Spruce Goose

H. Hugues

Expo Roof

J. Natterer,T. Herzog

?

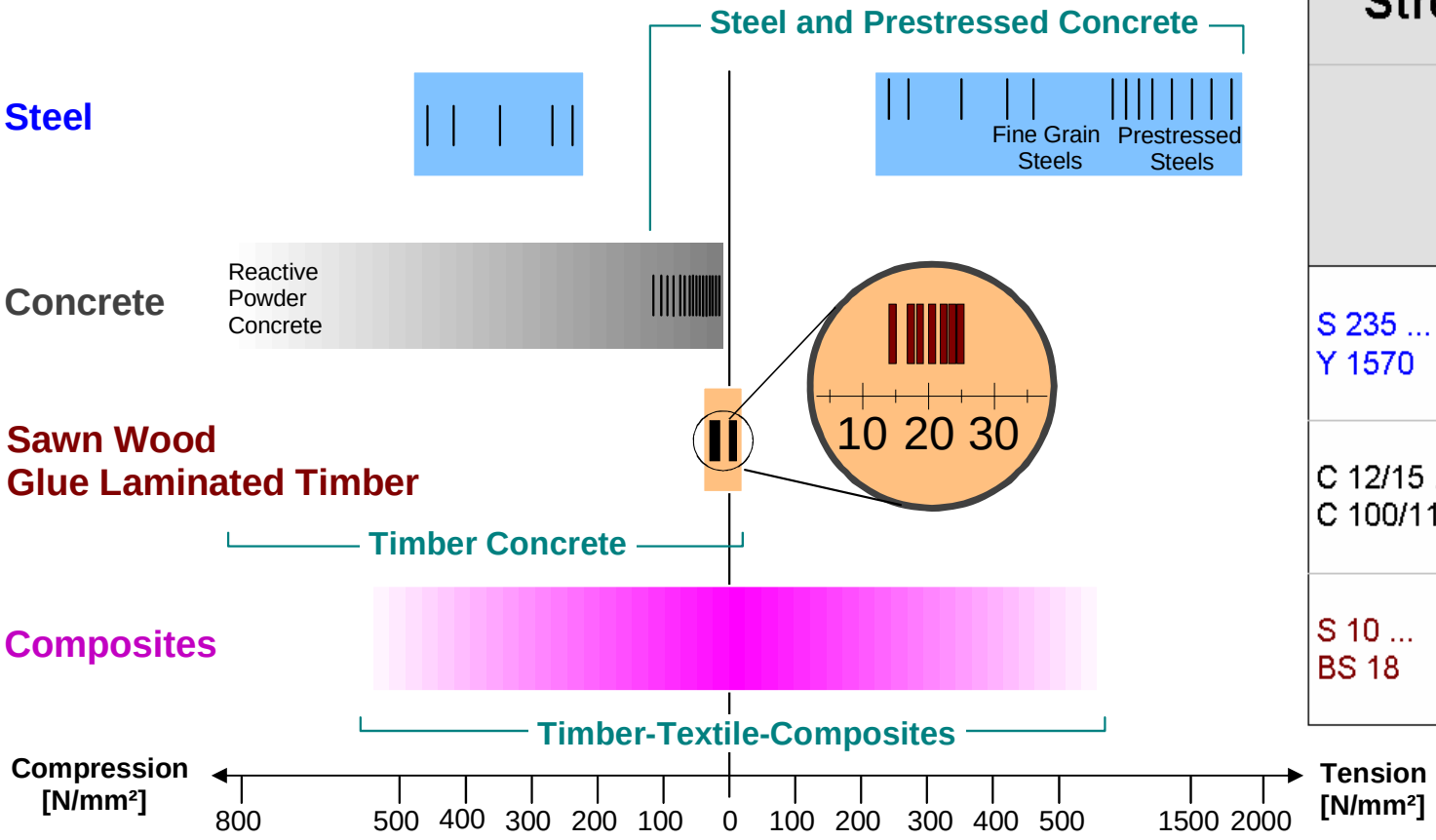
1750 **1850** **1950** **2000** **2050**

Sawing **+ Analysis** **+ Glueing** **+ Computing** **+ ?**

Technological Basis and Methods

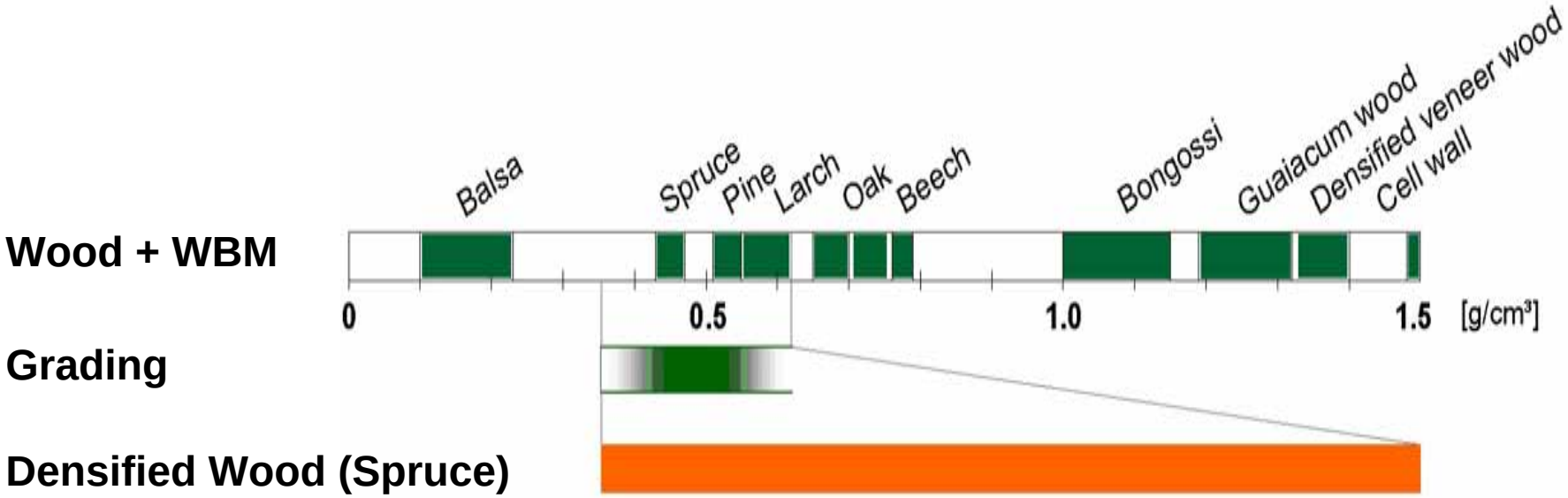

UBS

Strength Classes of Structural Materials



Strength Classes	No.	Ratio Classes	Max / Min
S 235 ... Y 1570	13	1,1 ... 1,5	6,7
C 12/15 ... C 100/115	16	1,1 ... 1,3	8,3
S 10 ... BS 18	11	1,1 ... 1,3	1,7

Density of Wood and Wood based Materials



Softwood	ρ [g/cm³]
Spruce	0.43 ... 0.47
Pine	0.51 ... 0.55
Larch	0.54 ... 0.62
Densified wood (spruce)	0.43 ... >1.0
Densified veneer wood	0.90 ... 1.4

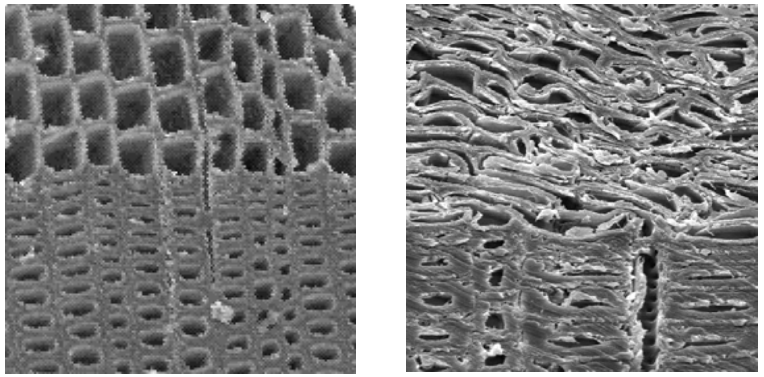
Hardwood	ρ [g/cm³]
Oak	0.65 ... 0.76
Beech	0,70 ... 0.79
Bongossi	1.02 ... 1.15
Balsa	0.10 ... 0.23
Guaiacum wood	1.19 ... 1.32

J. Sell, 1997

Densified Wood

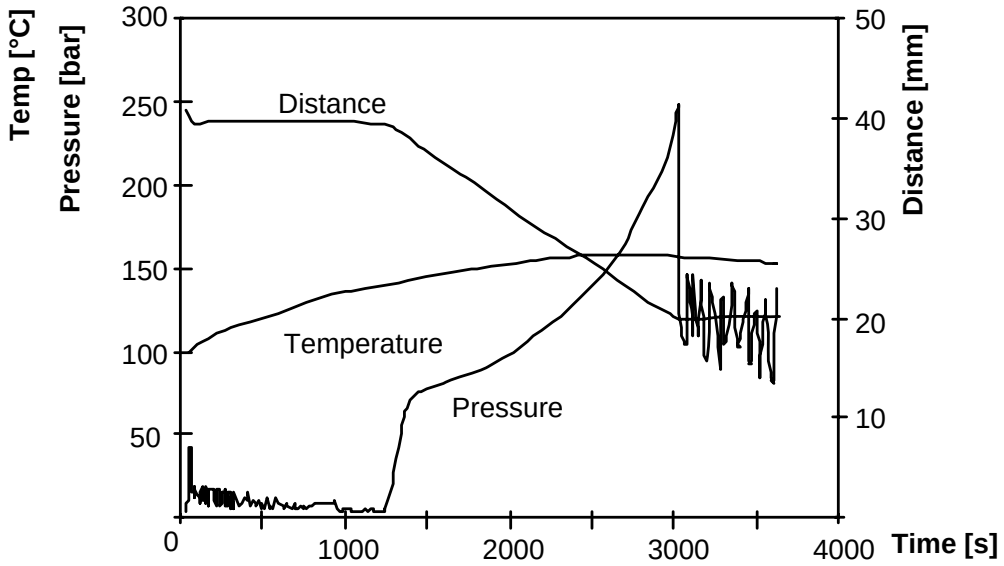
Manufacturing Process

- **Temperature:** **140 to 160°C**
- **Pressure:** **10 to 15 N / mm^2**
- **Pressure time:** **1 min / mm**
- **Material:** **Spruce**



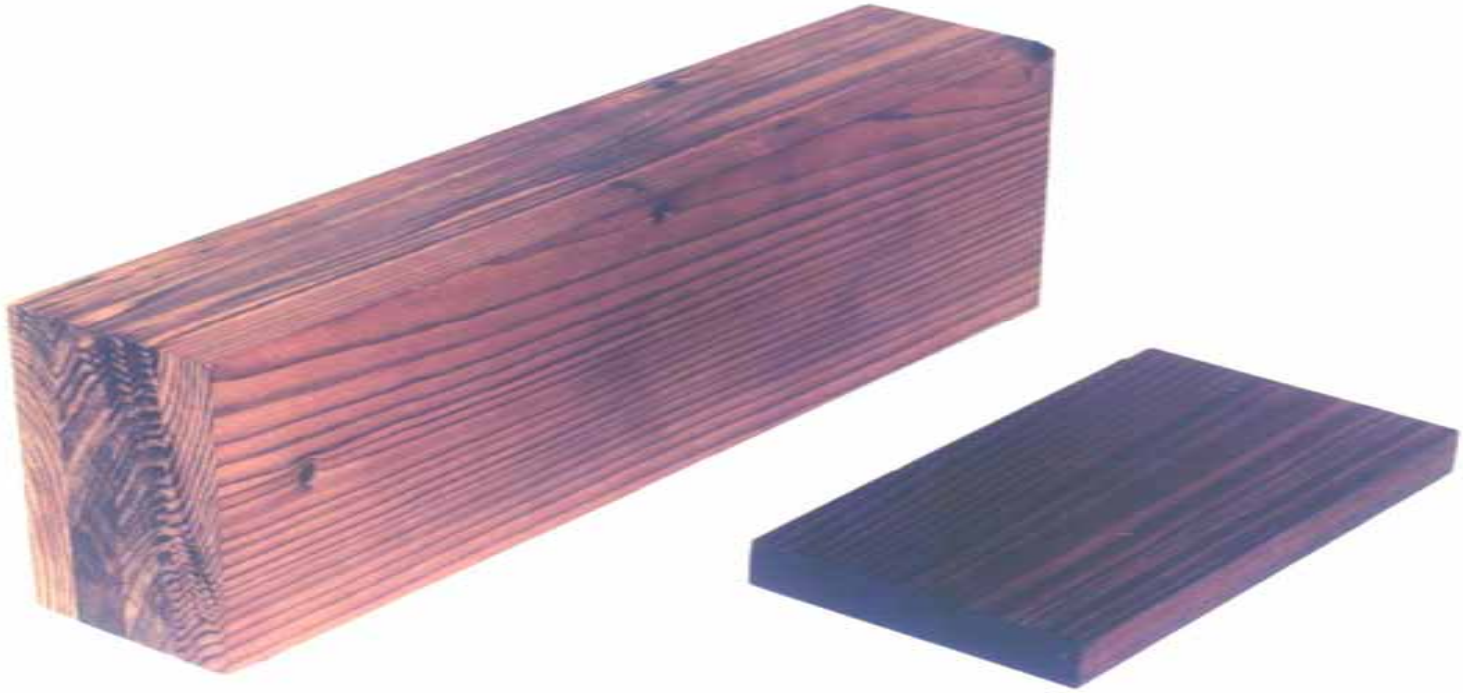
Cross Section Spruce 0% and 50% densified

Multiple Daylight Hot Press



Manufacturing Process

Oil-Heat Treated Densified Wood

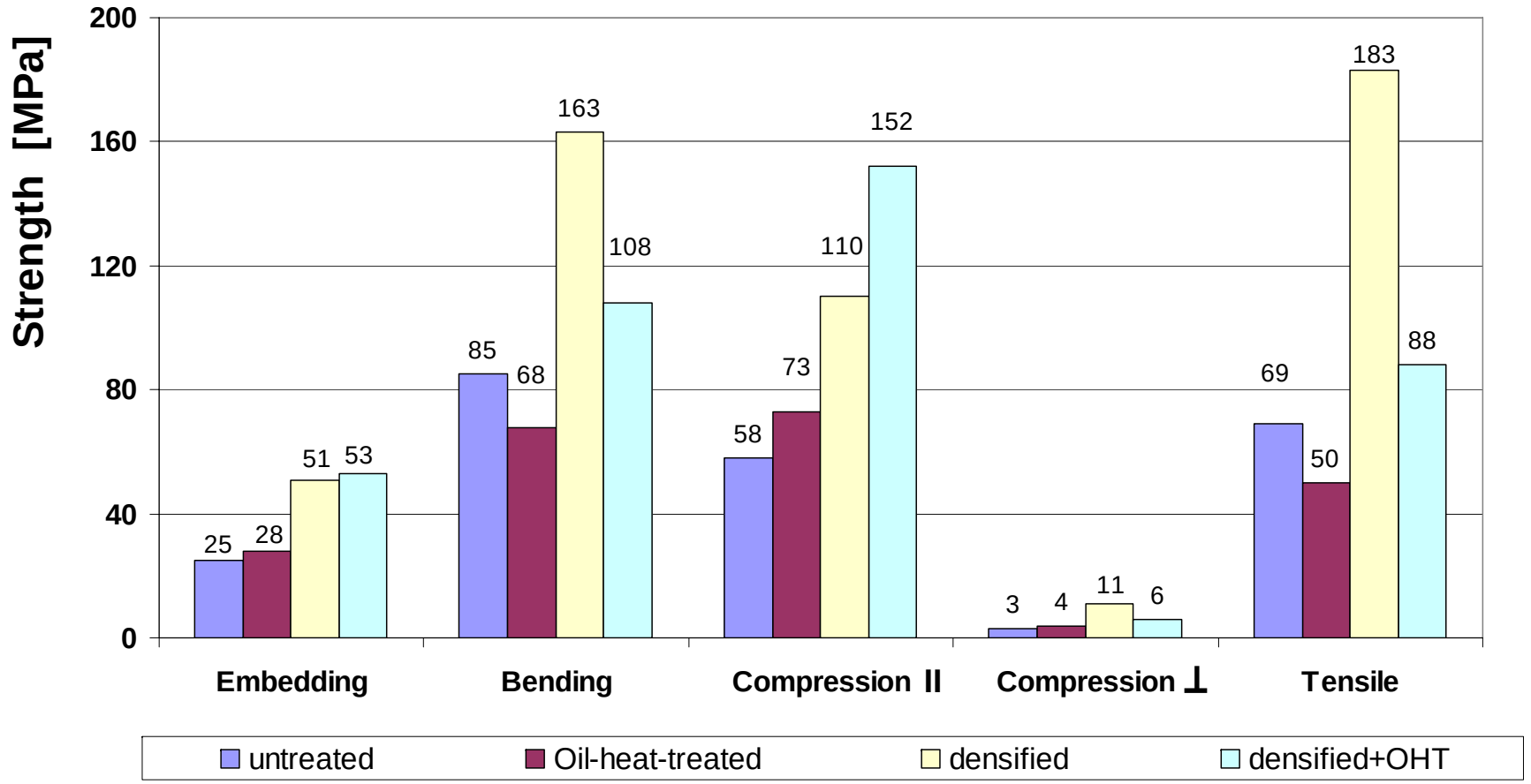


a) densified, OHT, glued

b) densified, OHT

Oil-Heat-treated densified Spruce

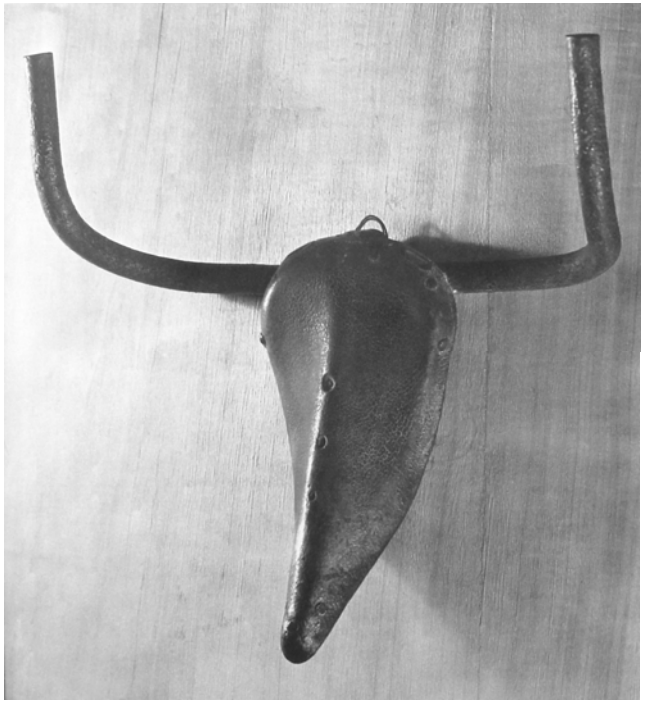
Comparison of Strength



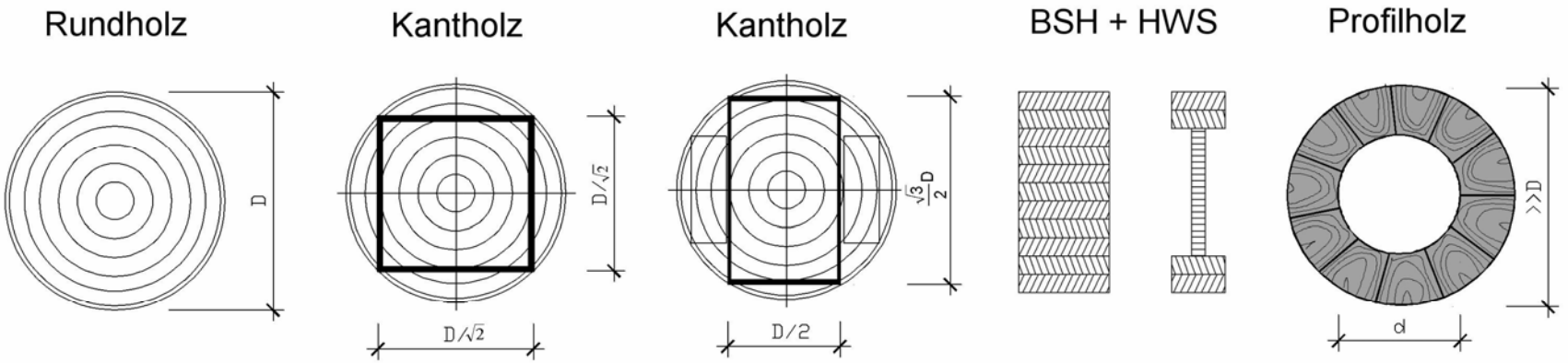
Haller, Rapp, 2001

Sich selbst zur sparsamen Verwendung von Materialien zu zwingen, ist eine Art von Beschränkung, die das Schöpferische freisetzt.

Pablo Picasso



Yield and Cross Section‘s Efficiency



$\frac{A}{A_{max}} =$	1	0,64	0,55	0,5	≈ 1
$\frac{\overline{EI}}{EI_o} =$	1	0,42	0,55	. . .	> 2

Thirty spokes surround the hub:

In their nothingness consists the carriage‘s effectiveness.

One hollows the clay and shapes it into pots:

In ist nothingness consists the pot‘s effectiveness.

One cuts out doors and windows to make the chamber:

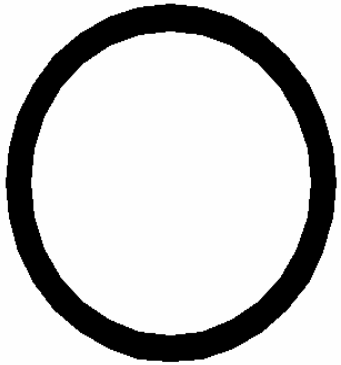
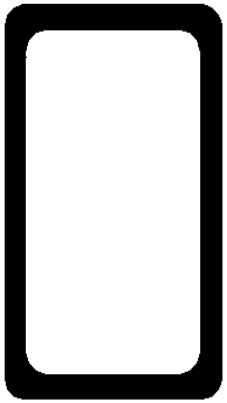
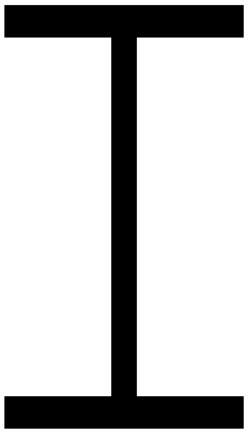
In their nothingness consists the chamber‘s effectiveness.

Therefore: what exists serves for possession.

What does not exist serves for effectiveness.

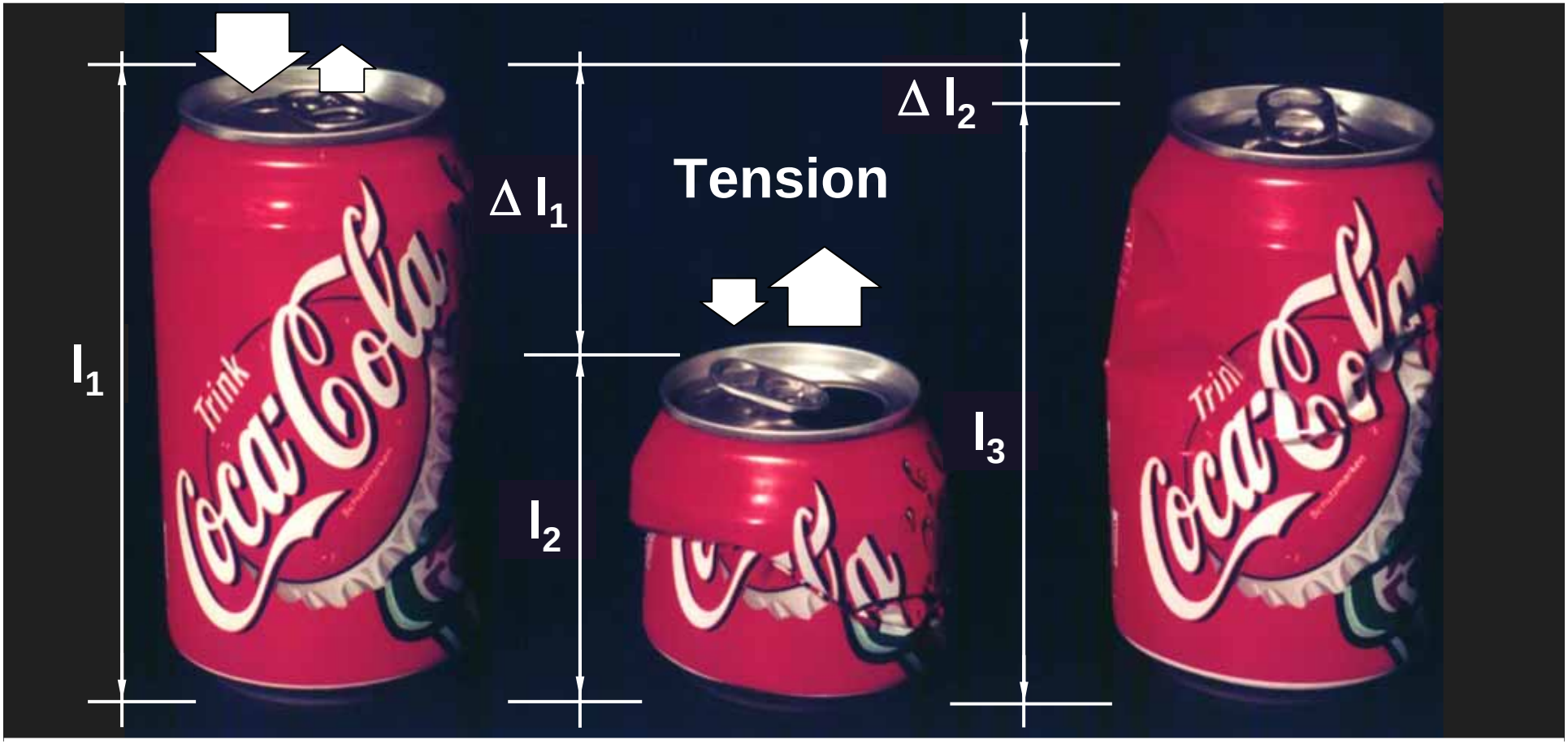
Lao Tzu, Tao Te Ching, 11

Comparison - Moment of Inertia

Full	Pipe	Rectangle	I - Profile
			
100 %	375 %	550 %	740 %

A = const

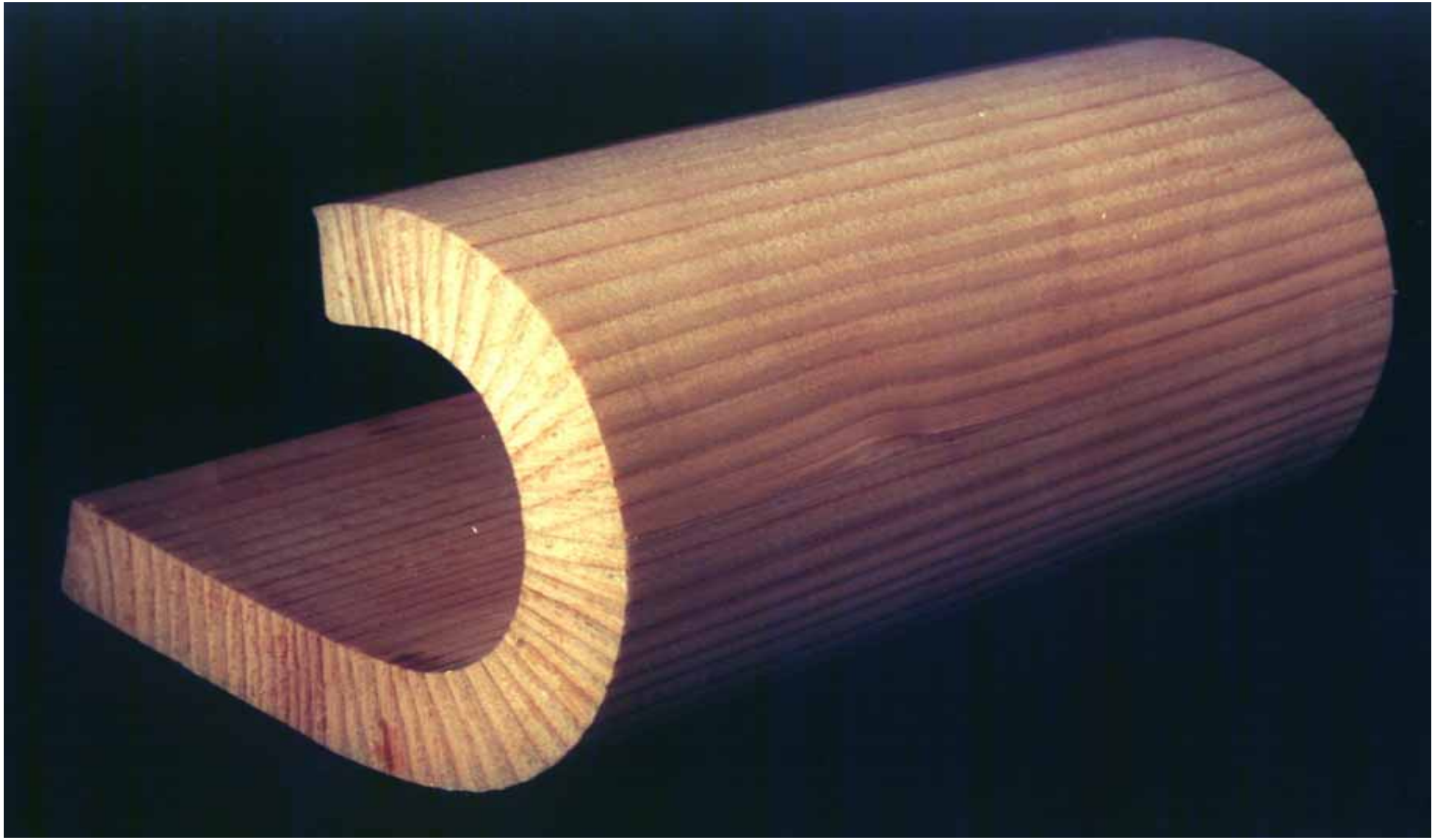
Compression



$$\varepsilon_{c,90} = \frac{\Delta l_1}{l_1} \cdot 100 \approx 50\,\%$$

$$\varepsilon_{t,90} = \frac{\Delta l_1 - \Delta l_2}{l_2} \cdot 100 \approx 100\,\%$$


Direction of densification

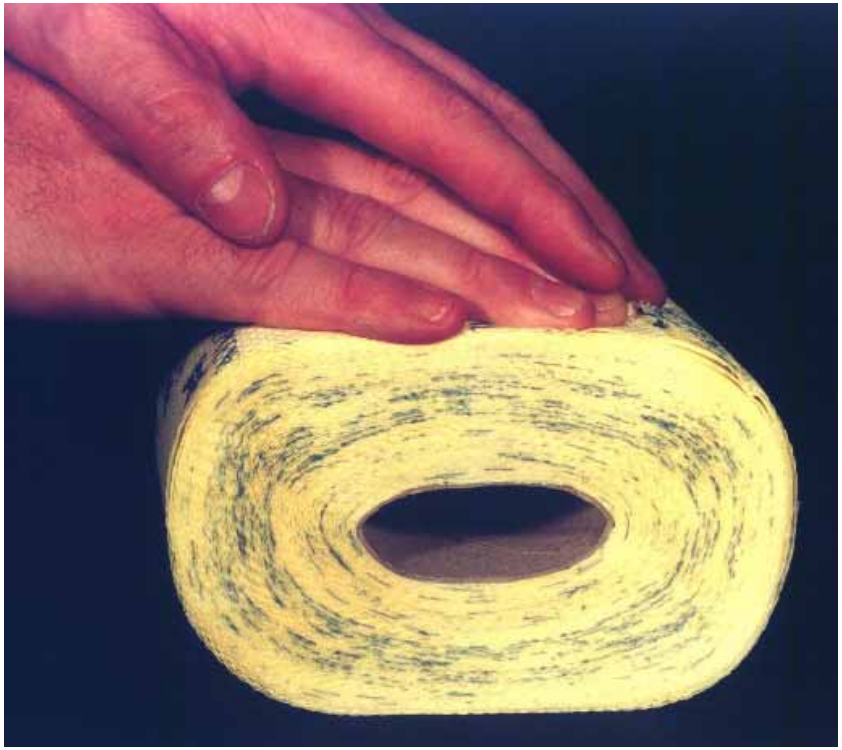


Manufacturing Principle

1. Charge

2. Closure

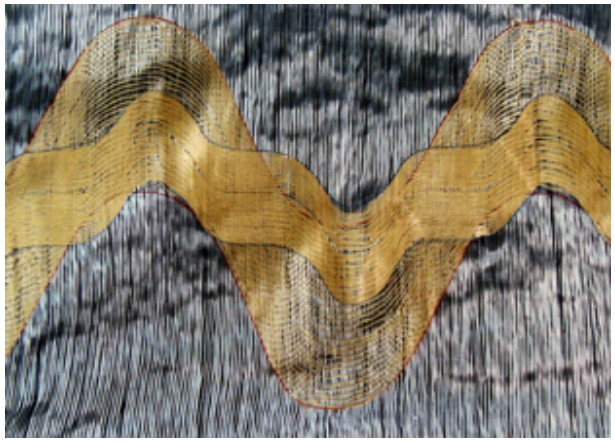
3. Pressure

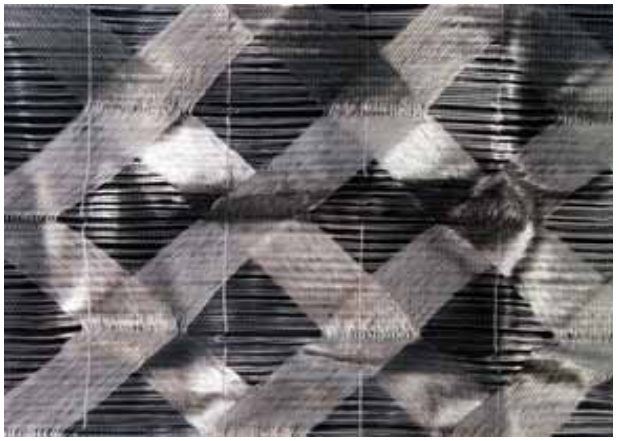


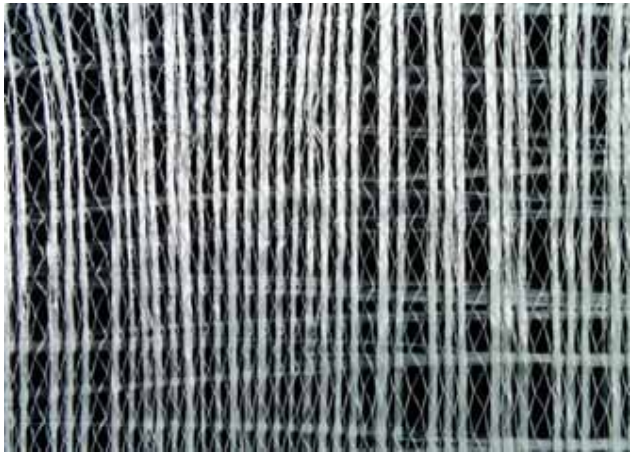
a) uniaxial compression

b) biaxial compression

Examples of Textile Structures – SFB 528

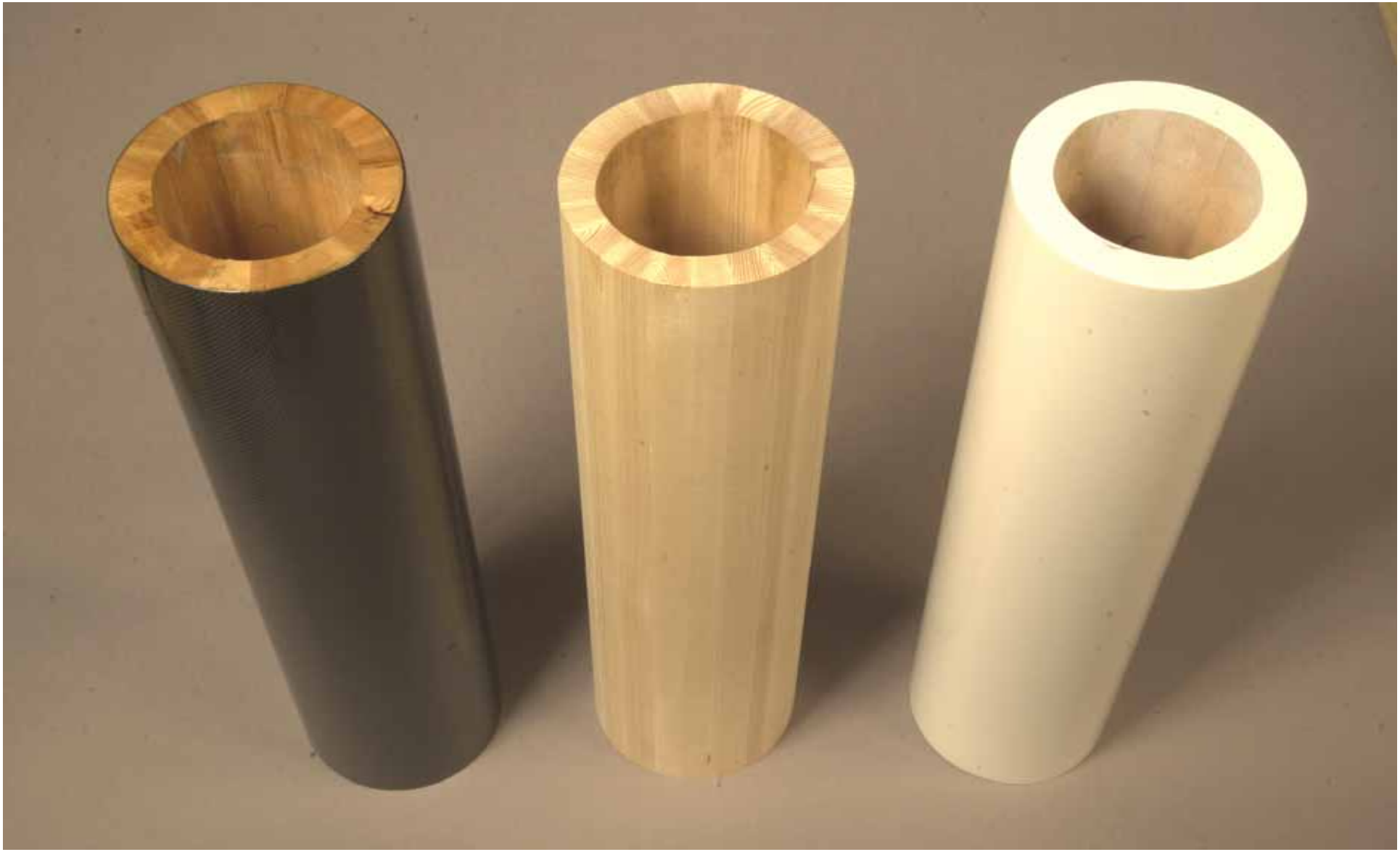




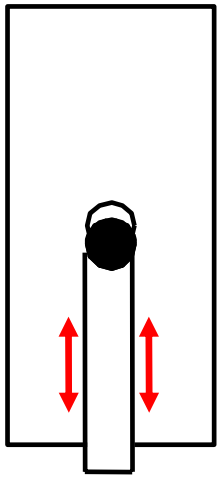




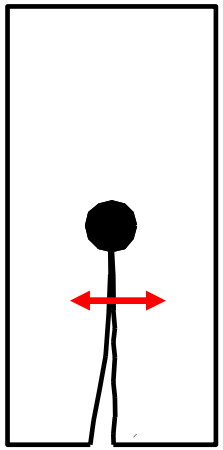
BOLENZ & SCHÄFER



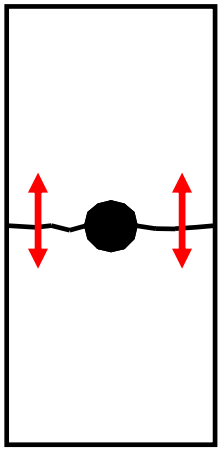
Failure Mechanisms of Dowel Type Fasteners



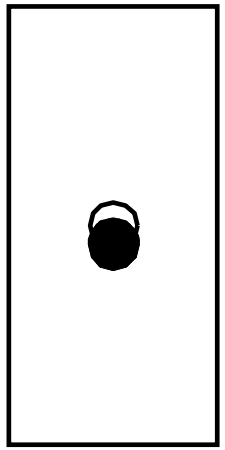
Shear



Splitting

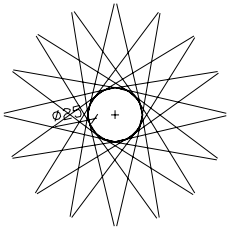


Tension



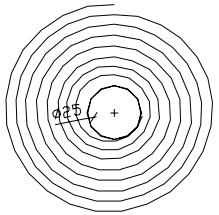
Embedding

Tailored Textile Structures



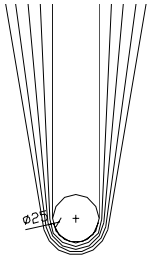
Multiaxial stitch bonded machine

Roving: 1200 tex
Material: Glass
Textile surface density: 1302 g/m²



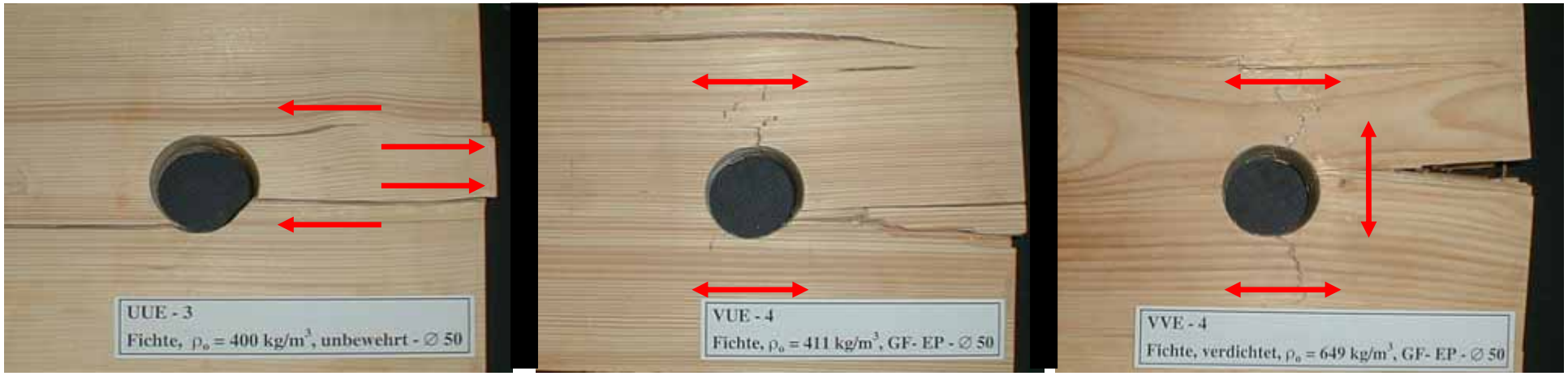
Flat knitting machine

2 x 1200 tex
Glass



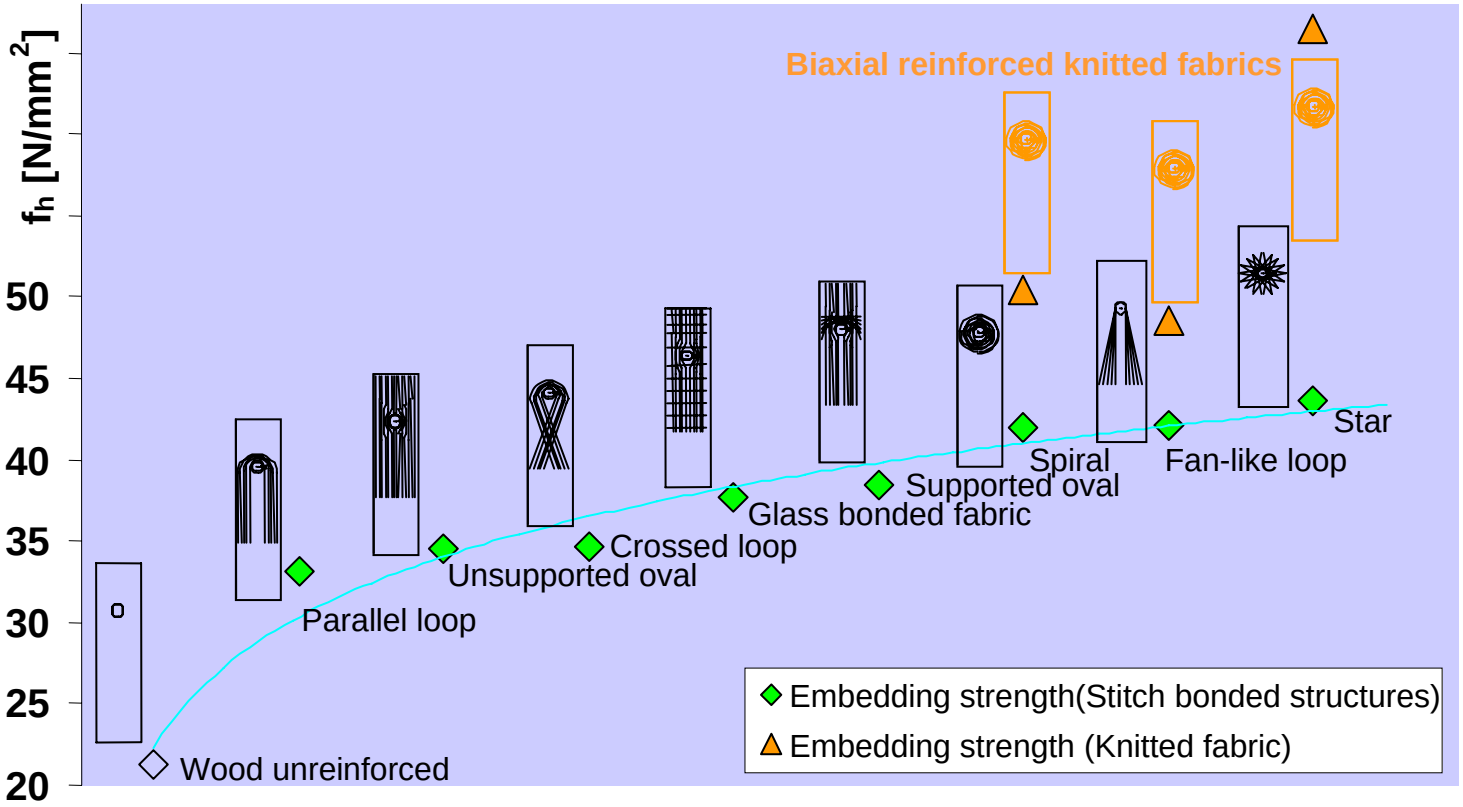
Stitch bonded machine, variable oriented fiber placement

1200 tex Glass (10 threads)
800 tex Carbon (10 threads)
300 tex Aramid (20 threads)



Spruce **Reinforced** **Reinf. + Dens.**

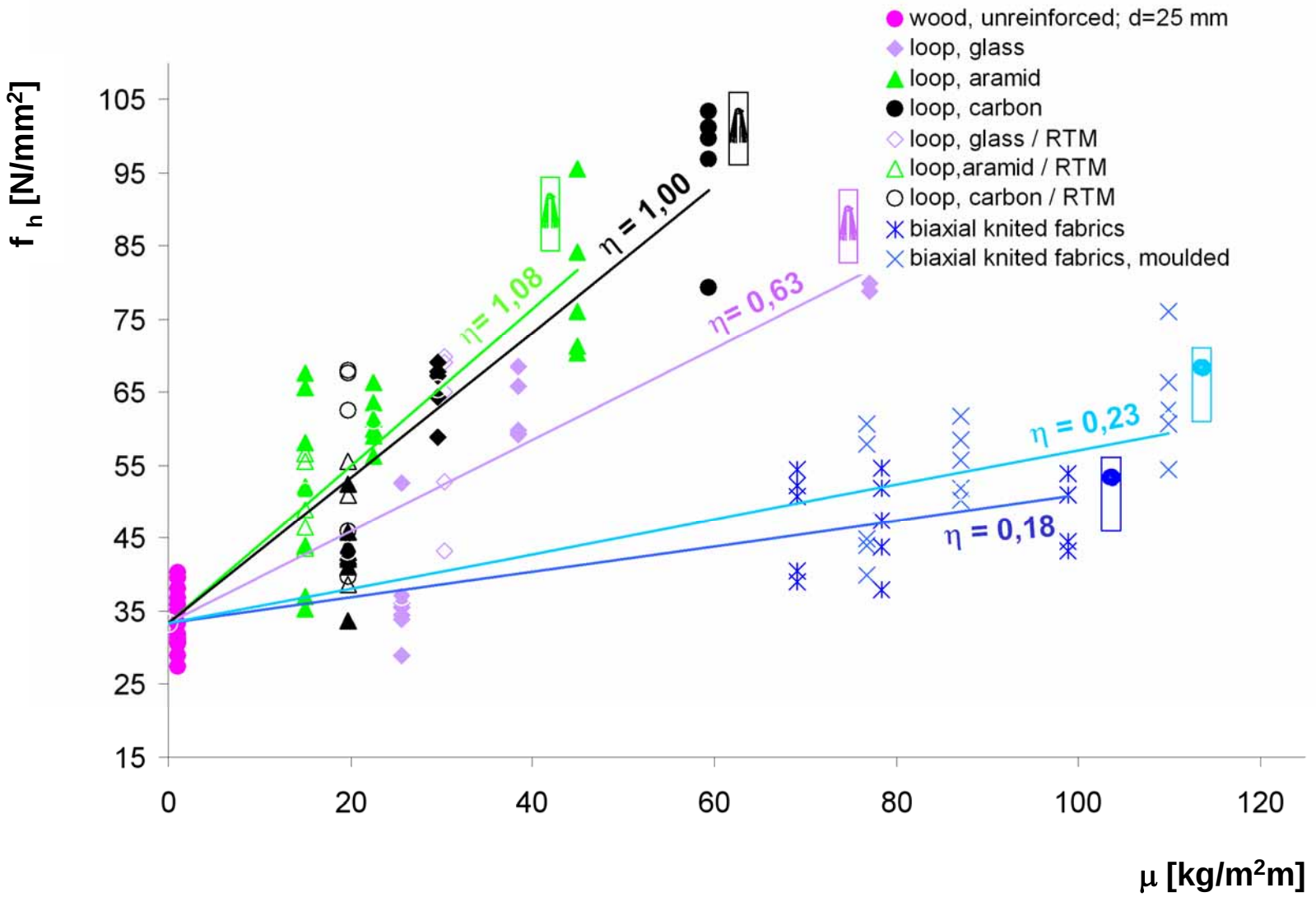
Embedding Strength of Tailor Made Textiles



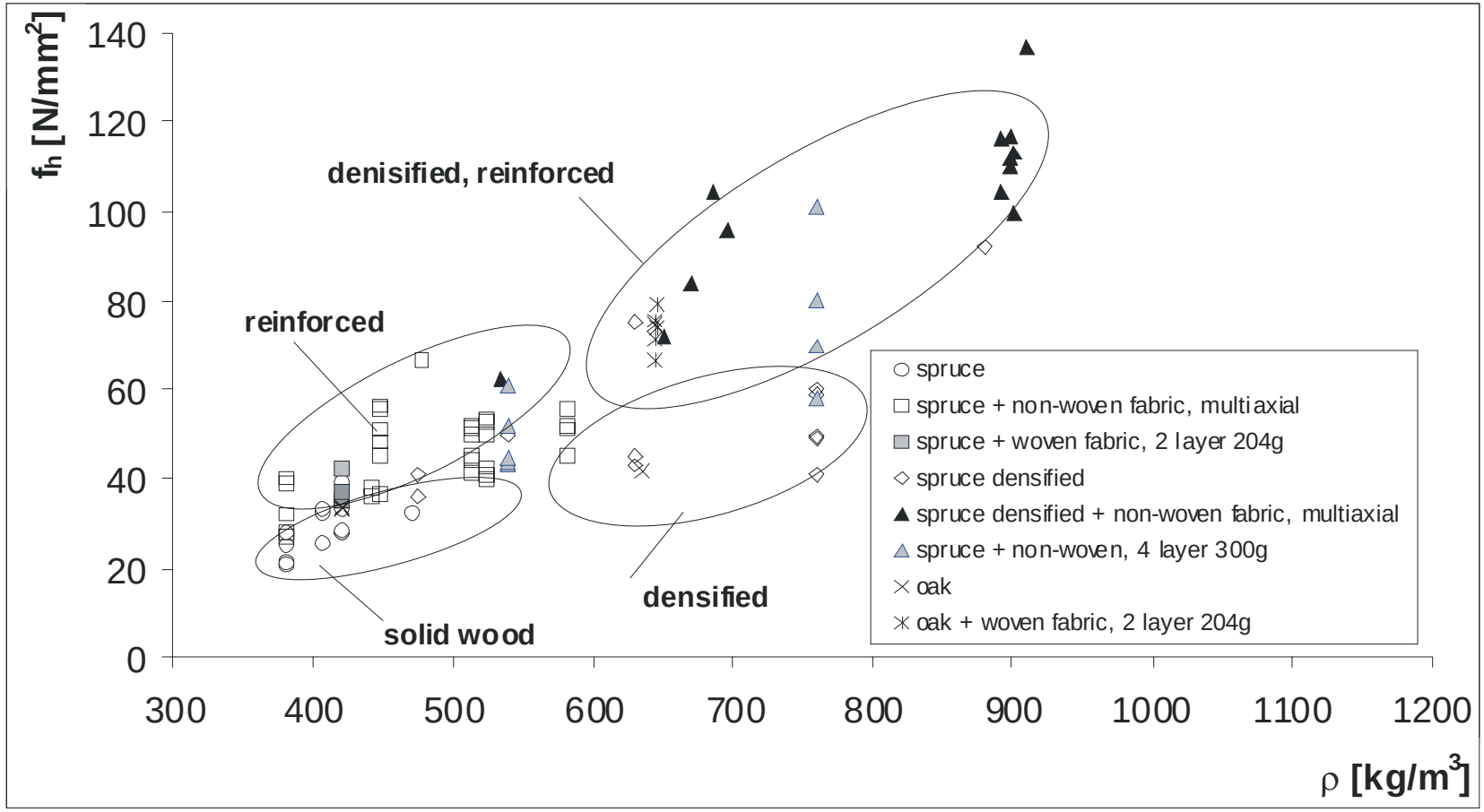
Increase in embedding strength f_h by textile reinforcement

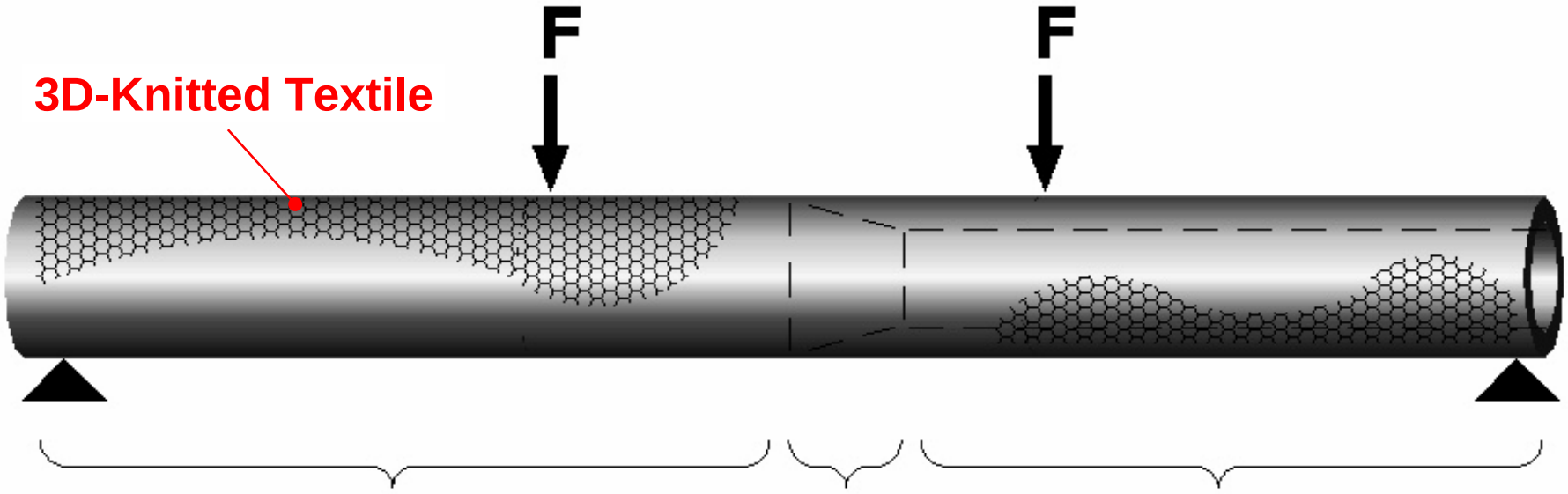
Test setup

Embedding Strength – η : Tailor-made Index



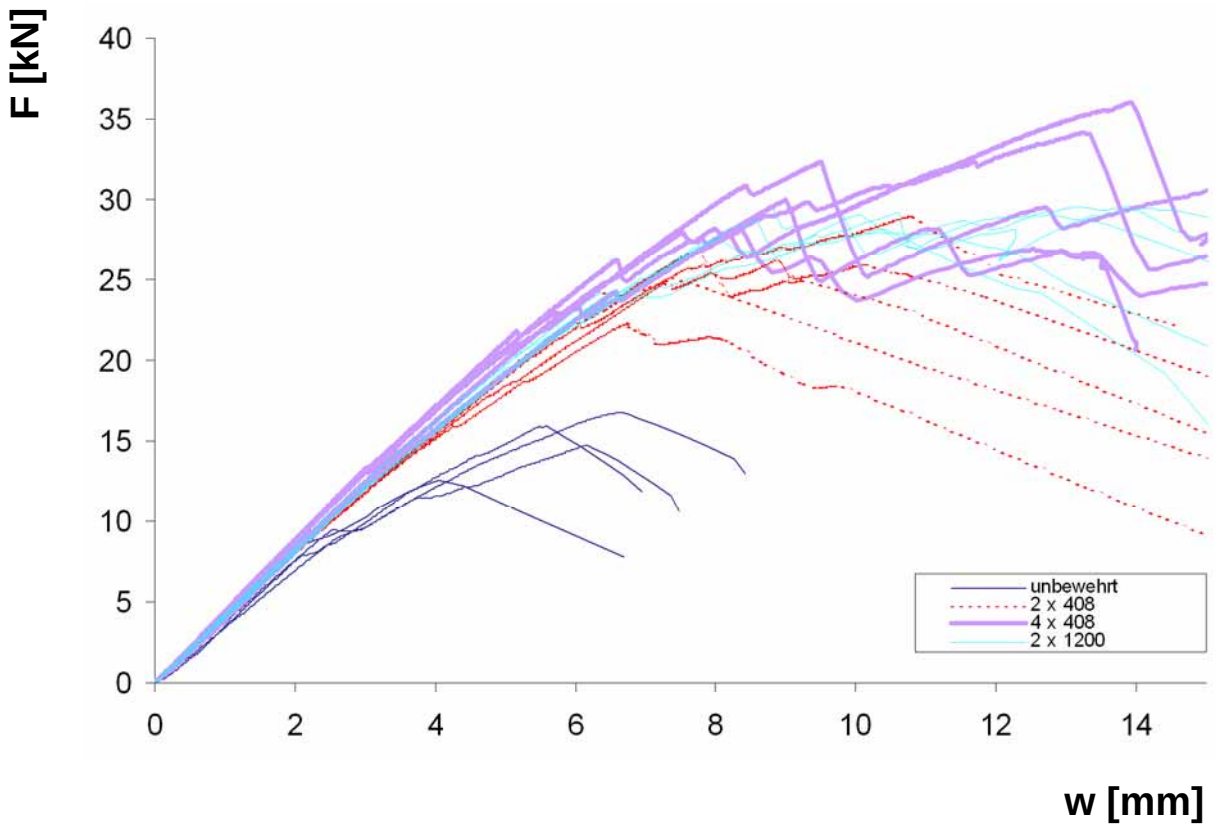
Embedding Strength According to EN 383

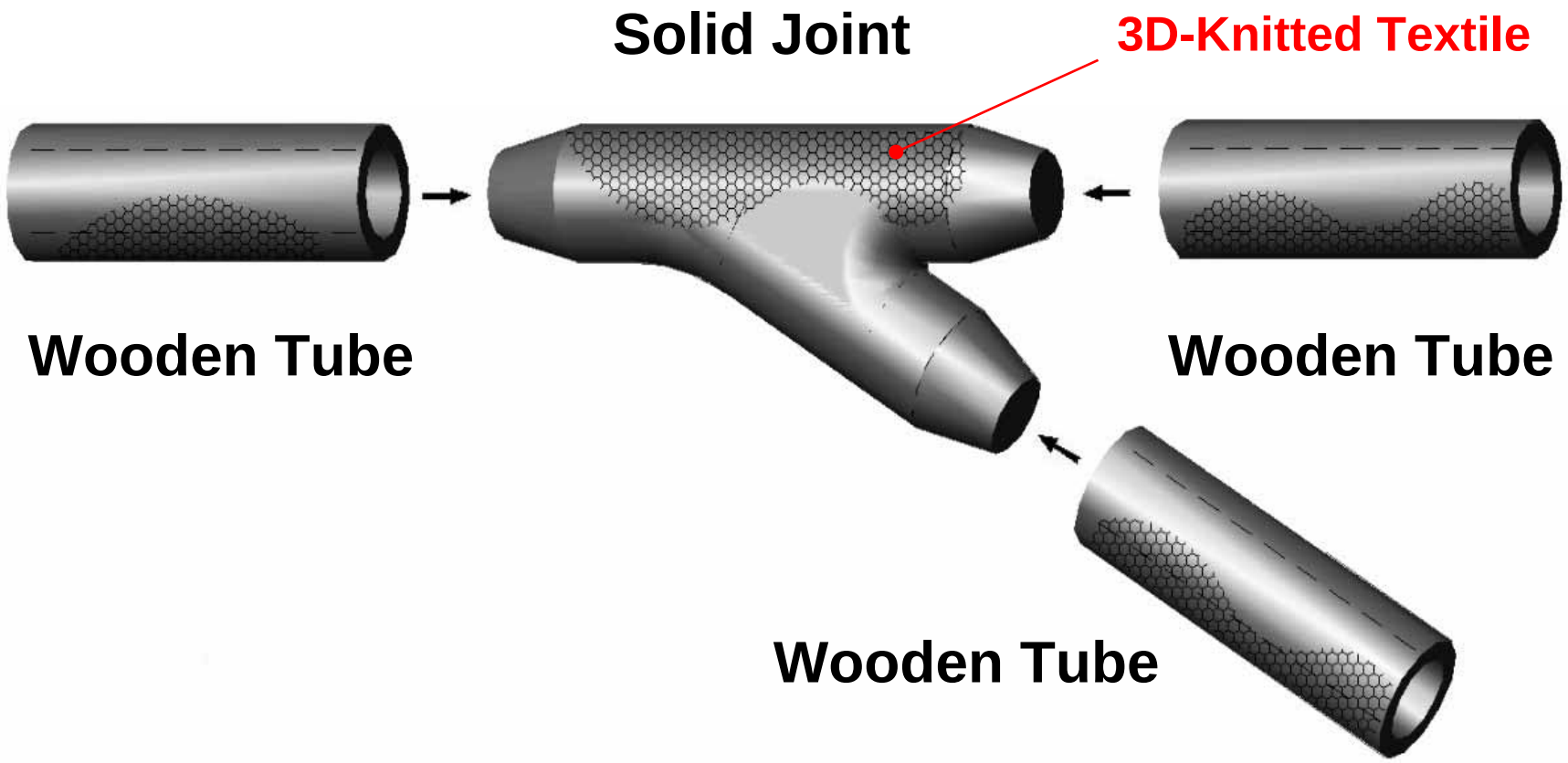


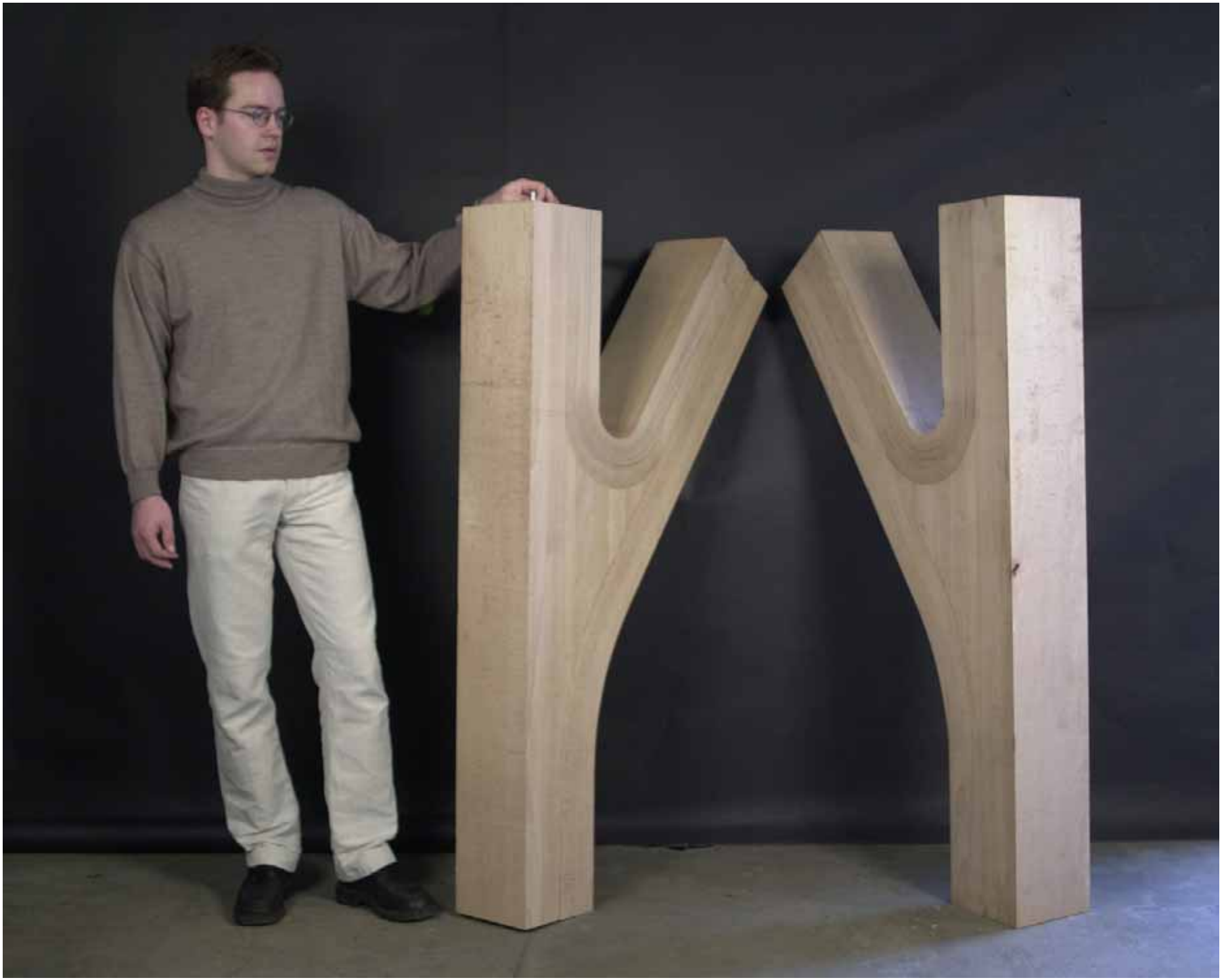

3D-Knitted Textile
F
F
Solid Round Gluelam
Joint
Wooden Tube


1_5
(2×400)

Load Displacement Curve – 4 pt Bending



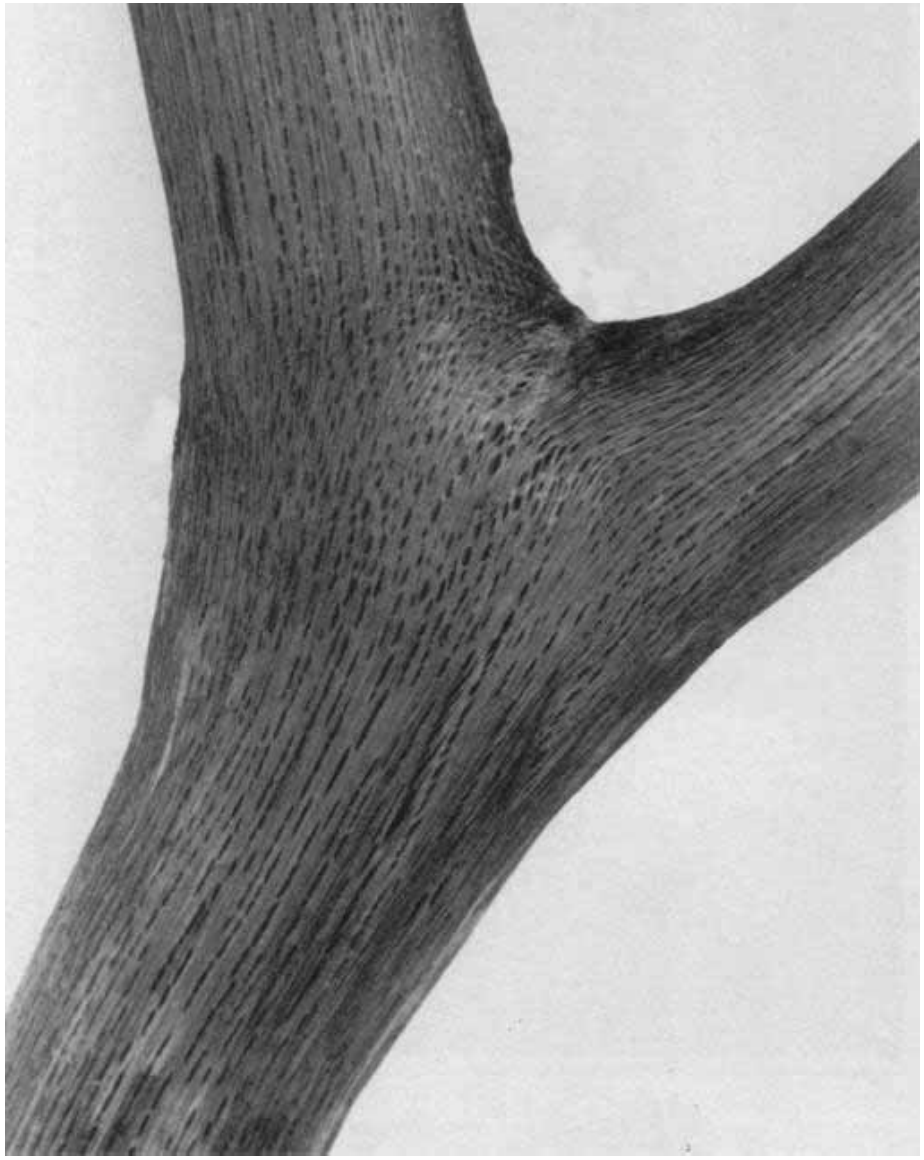

Solid Joint
3D-Knitted Textile
Wooden Tube
Wooden Tube
Wooden Tube



Poplar

Oak

Platane



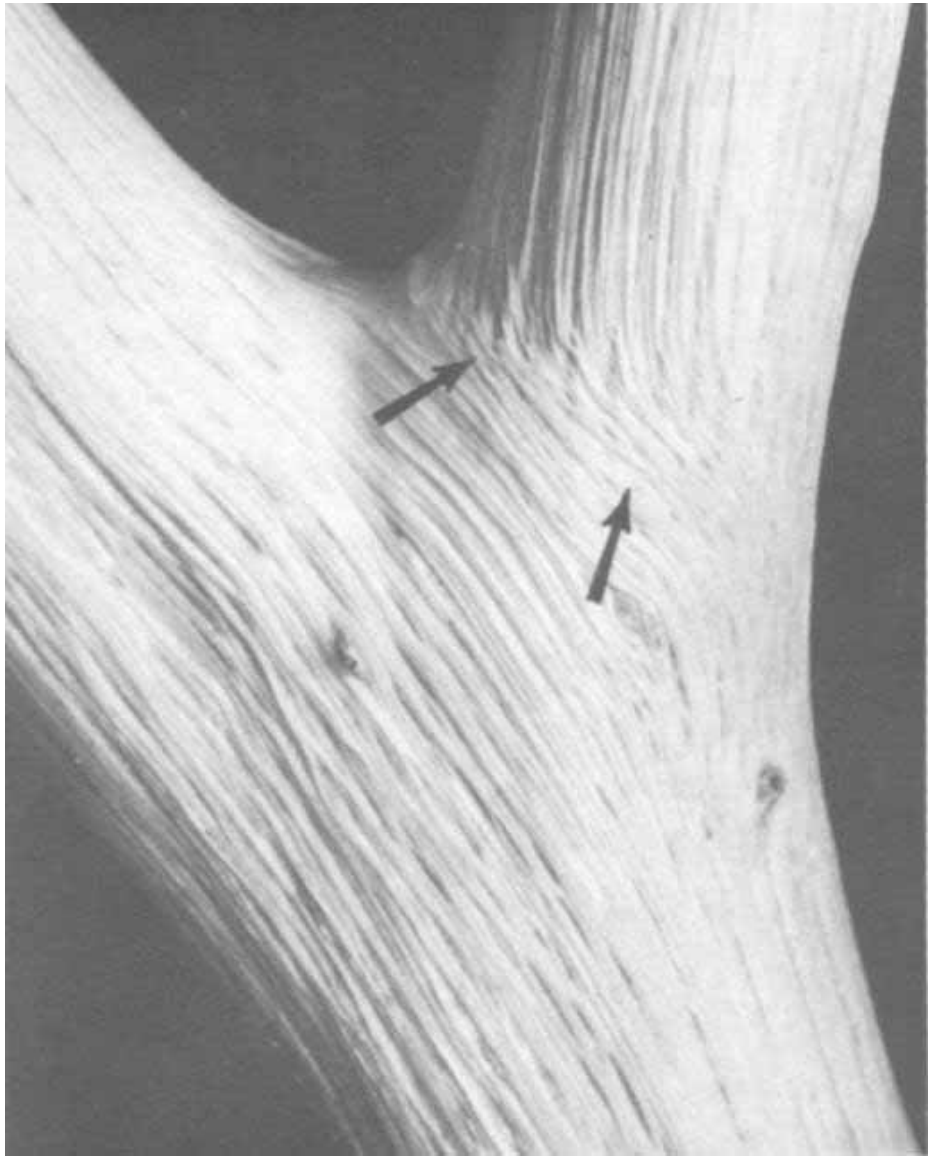
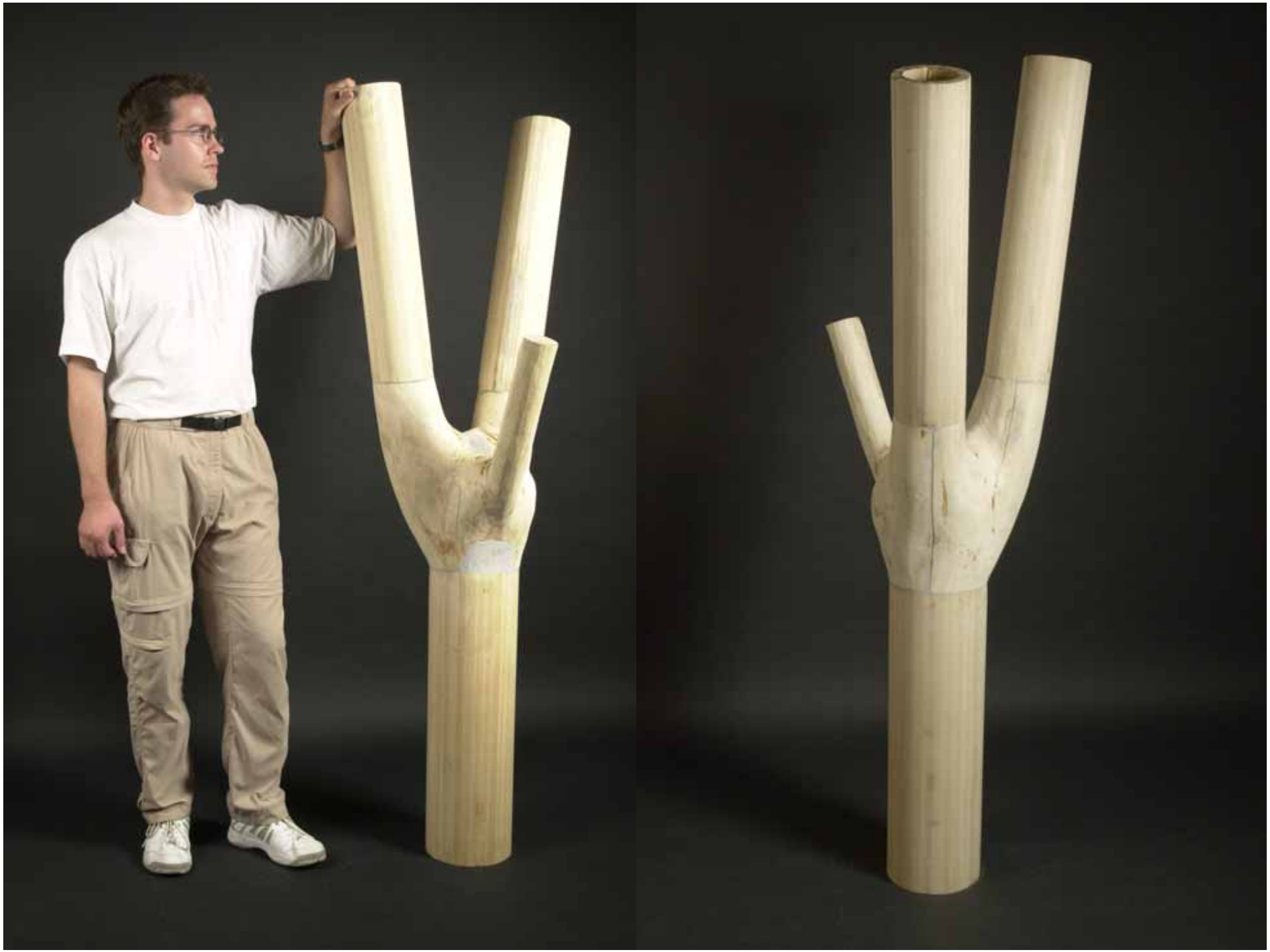
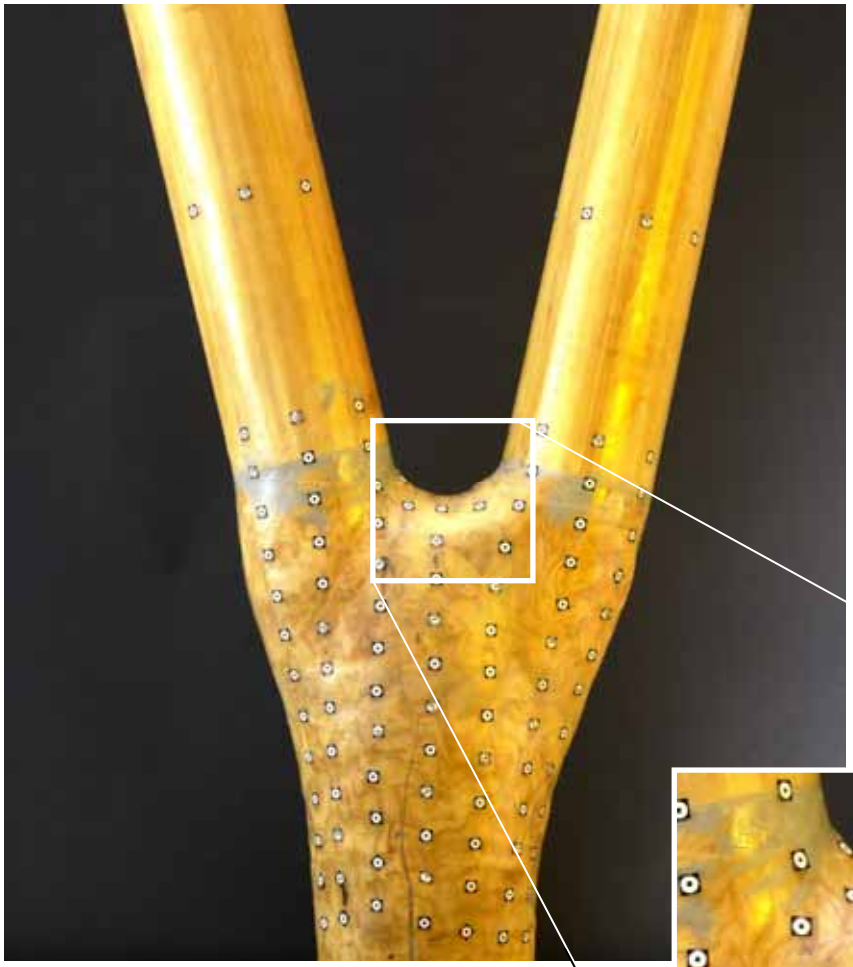


Foto: Shigo

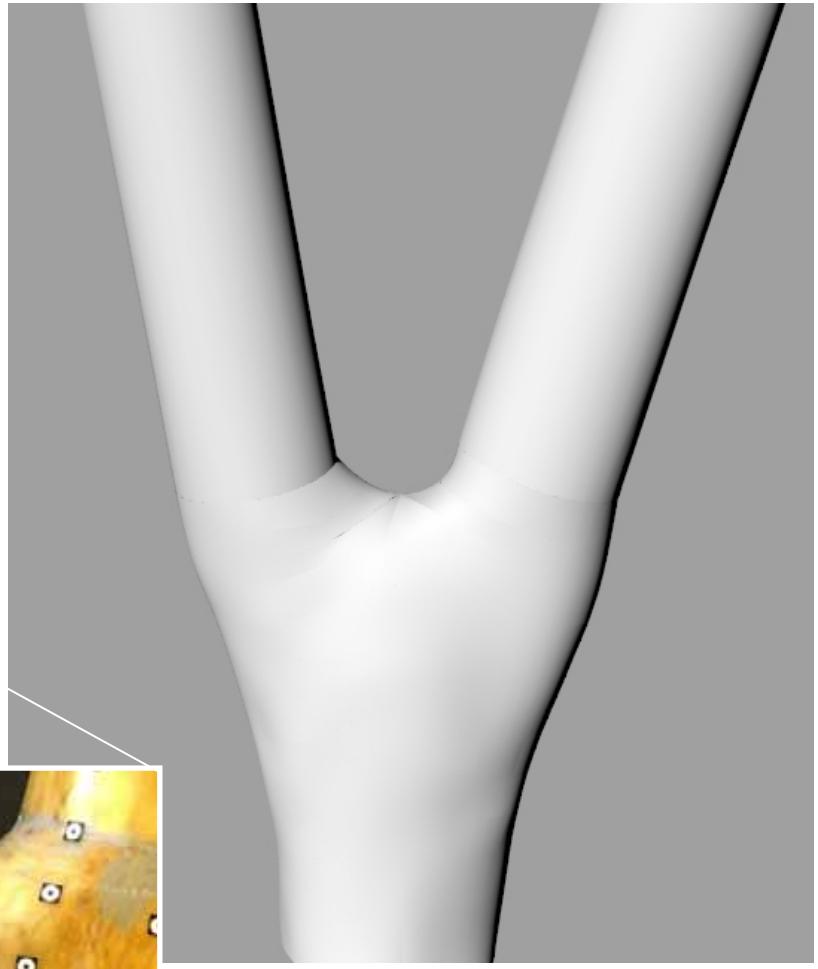


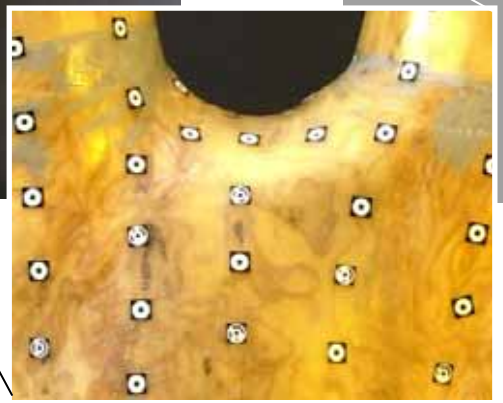
Digital Assessment of Geometry

Connection



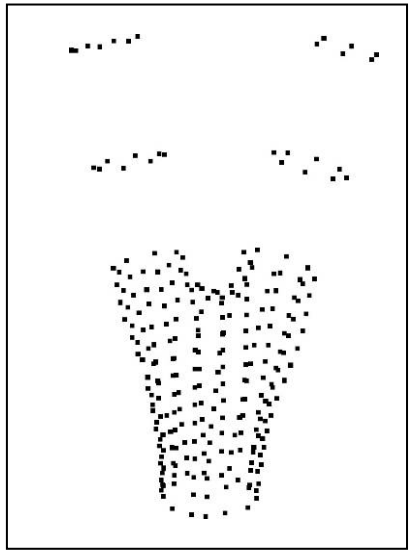
Digital Model



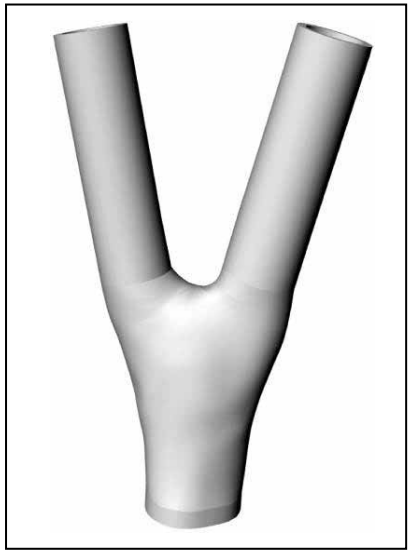


Digital Assessment

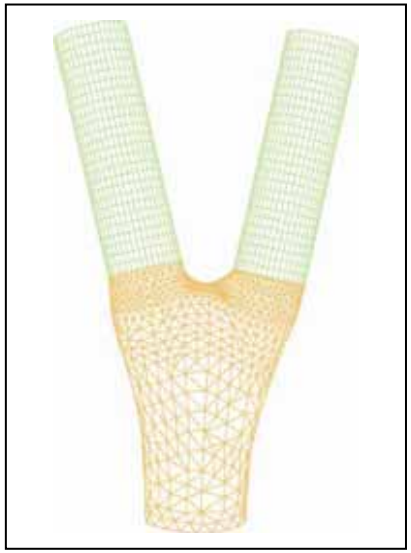
Connection + gauges



3D Coordinates



Solid Model



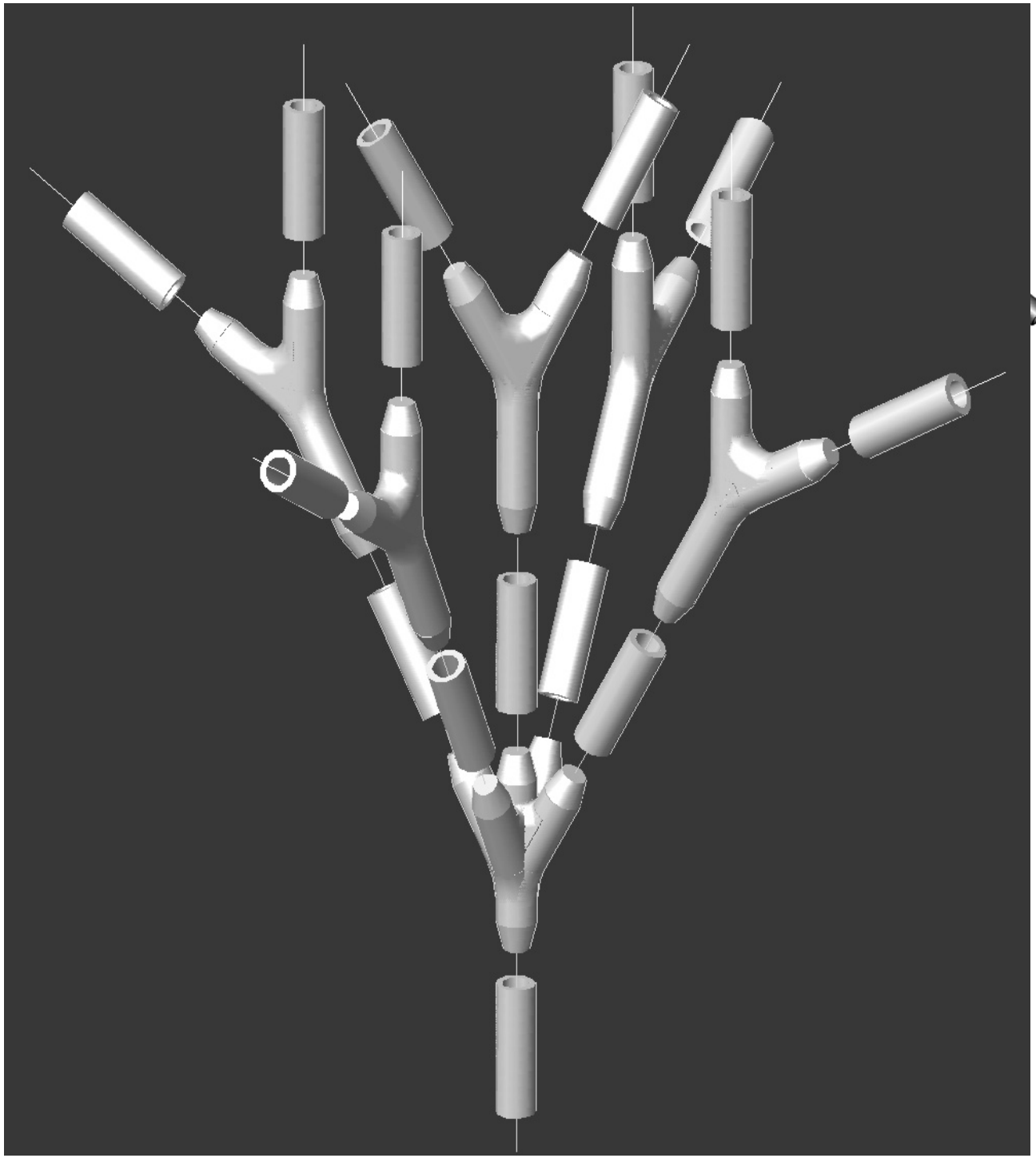
FEM Model

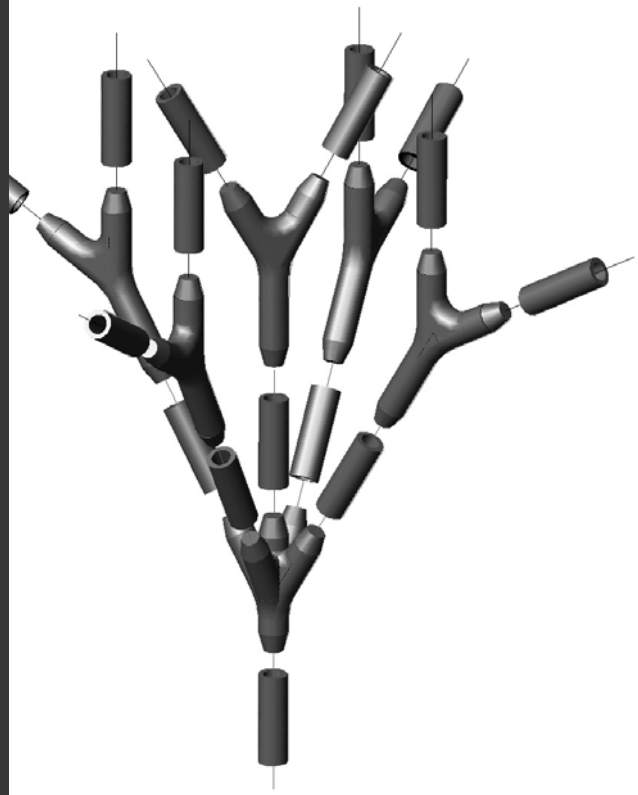
Experimental Study

Experimental Set up

Failure 1

Failure 2



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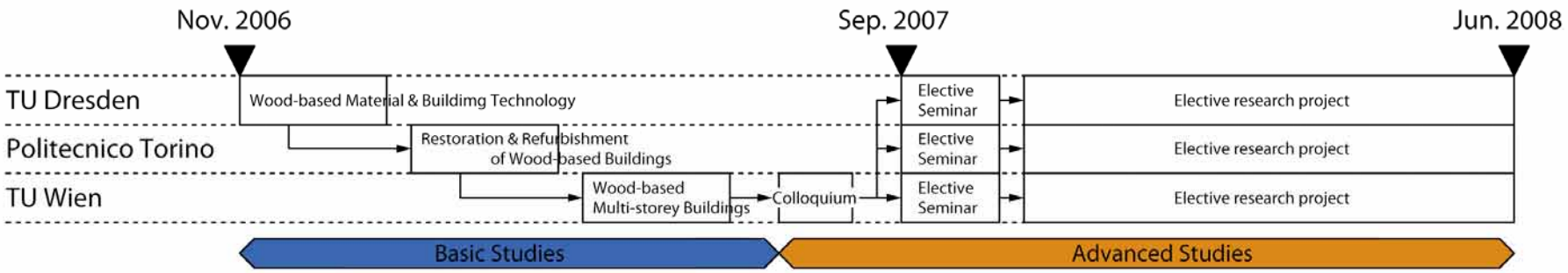
URBANWOOD.TUWIEN.AC.AT

POSTGRADUATE
MASTER PROGRAMME 2006
WOOD BASED BUILDING DESIGN FOR SUSTAINABLE URBAN DEVELOPMENT



master of science

2nd master

(joint degree)

WOOD BASED URBAN DESIGN

target group:

architects and engineers

TU VIENNA
TECHNISCHE UNIVERSITÄT DRESDEN
SCHWEIGHOFER PRIZE 2005


Thank you for your attention.