1E6 Structural timber and glulam

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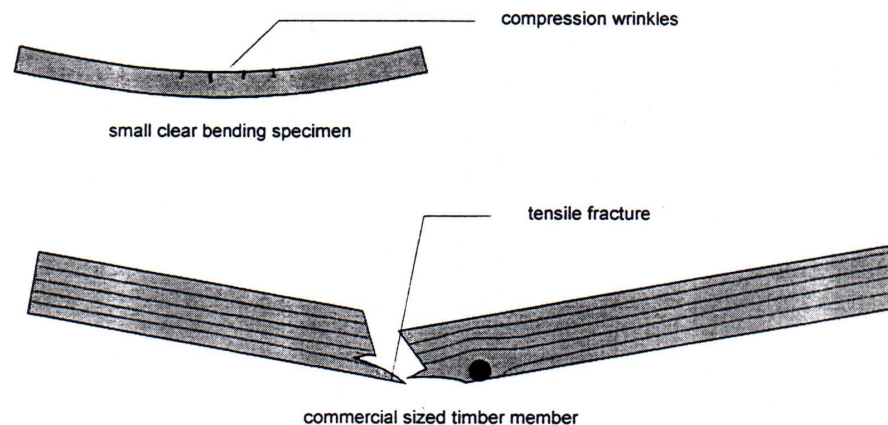
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Introduction

"... The two products – wood, in the sense of clear defect-free wood and timber, in the sense of commercial timber – have to be considered as two different materials and that must be respected when strength properties are developed for engineering purposes. ..."
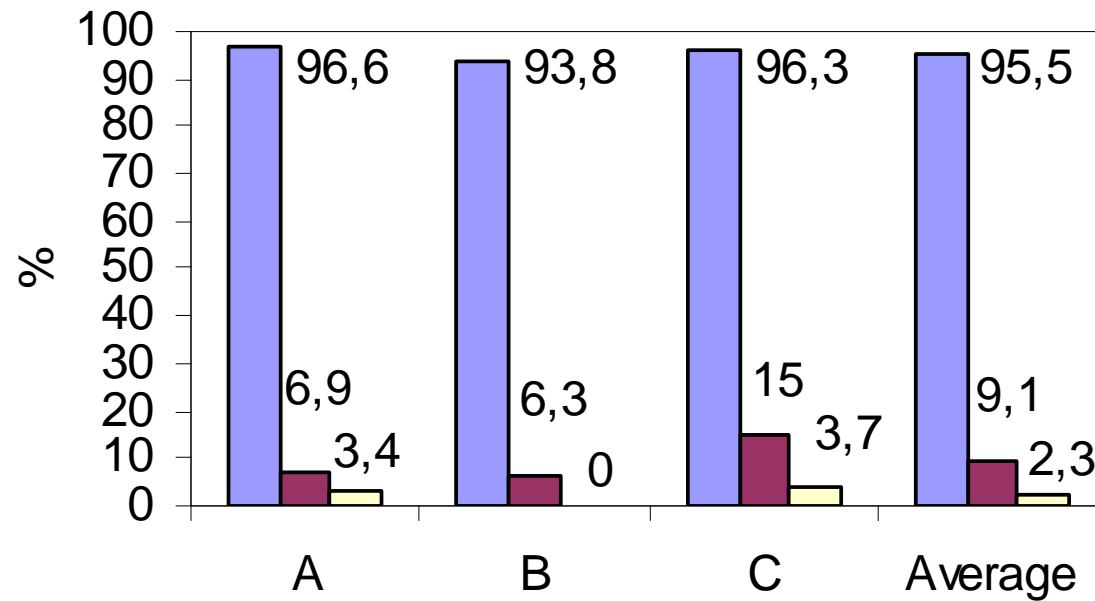

compression wrinkles

small clear bending specimen

tensile fracture

commercial sized timber member

Grading and evaluation
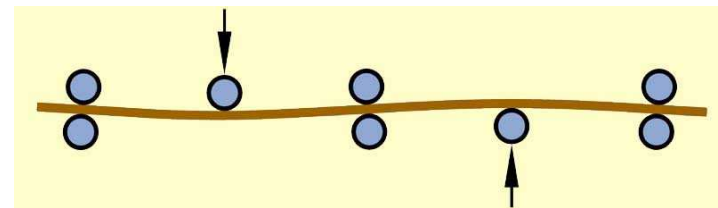
- Visual grading method

- Stress grading method

- Evaluation methods
    - Penetration method
    - Others NDT methods
        - Stress wave method
        - Ultrasound method
        - Impact sounding method
        - Pull out method

Visual grading

A chart with the following data:

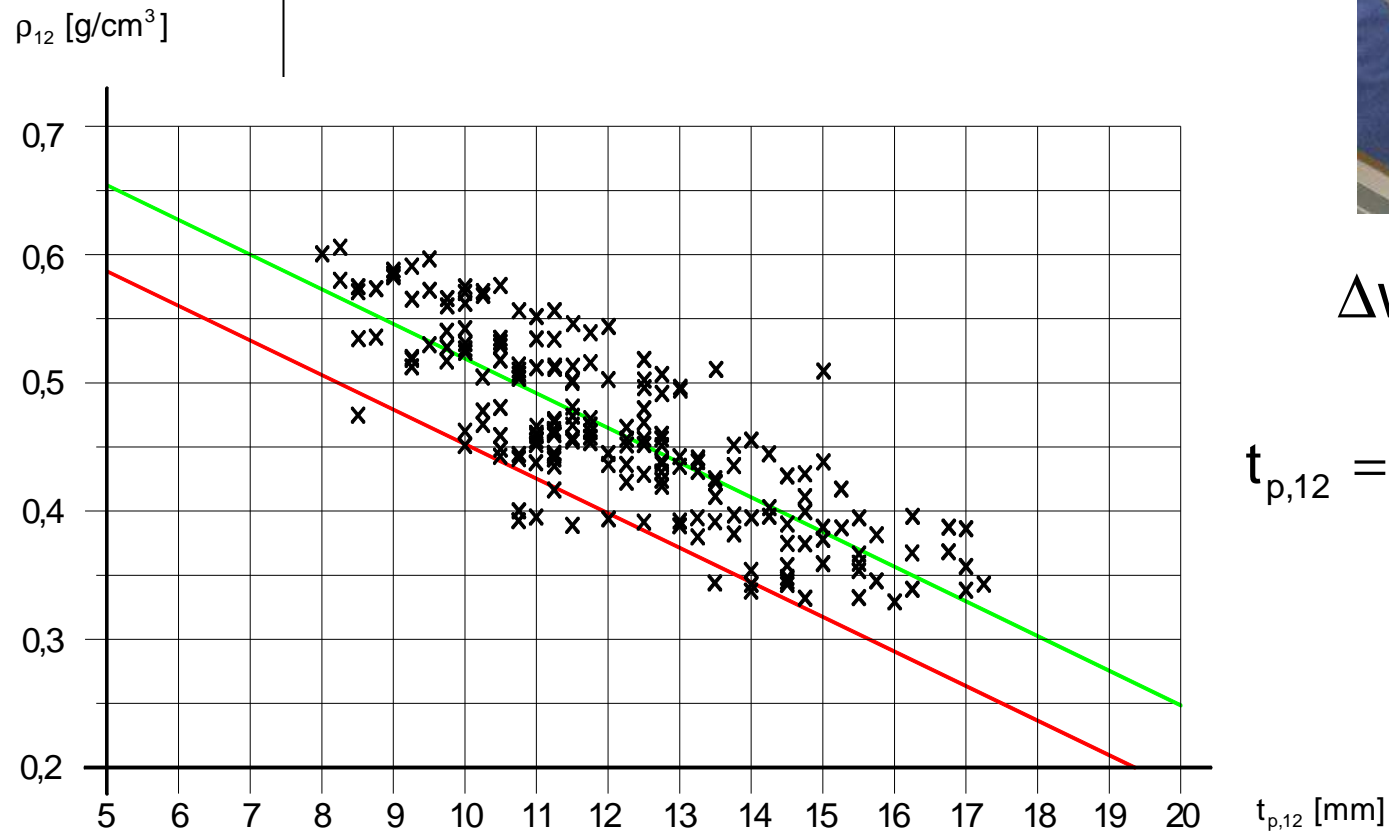| Category	Knot	Slope of grain	Annual ring
A	96,6	6,9	3,4
B	93,8	6,3	0
C	96,3	15	3,7
Average	95,5	9,1	2,3

Y-axis: %

Stress grading

Penetration method

relationship between the depth of penetration and density
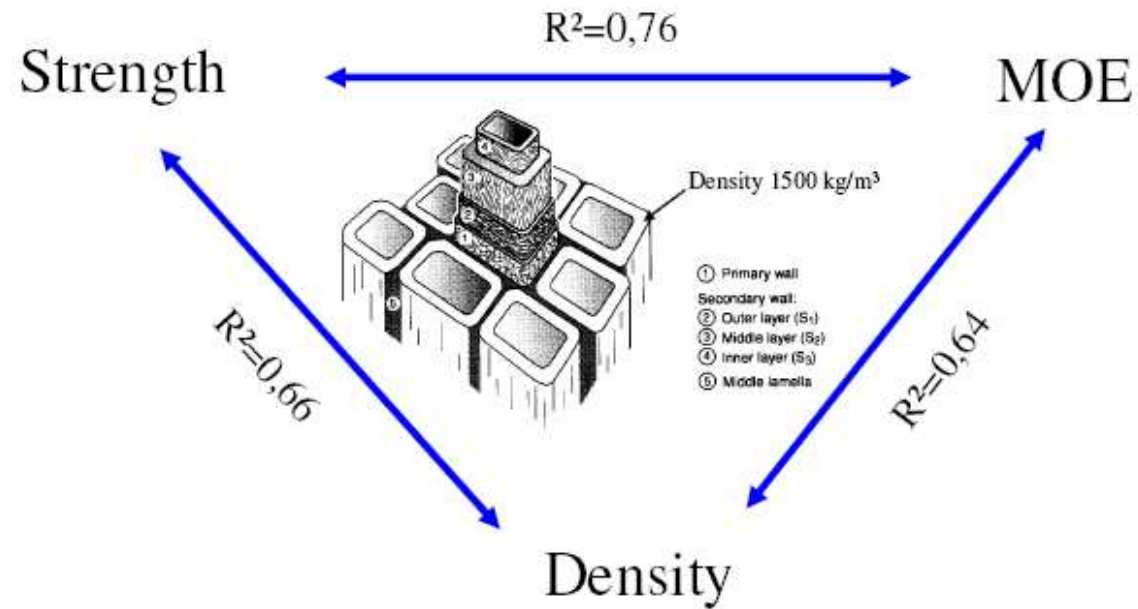

$$\Delta w = w - 12$$

$$t_{p,12} = t_p \left(1 - 0,007\ \Delta w\right)$$

$$\rho_{12} = -0,027\,102\ t_{p,12} + 0,727\,987$$

correlation between properties

contribution of NDT

| Strength class according to ČSN 73 2824-1 (idt DIN 4074)	Bending strength according to NAD ČSN P EN 1995-1-1 and ČSN P EN 1995-2 [MPa]	Density [kg/m³]	Strength calculation [MPa]	Strength test [MPa]
S 10	22	460	33,983	40,04
S 10	22	402	34,221	41,50
S 13	27	437	31,282	49,37
S 10	22	492	44,040	50,90
S 13	27	409	39,775	55,41
S 13	27	537	61,395	77,22

Determination of properties
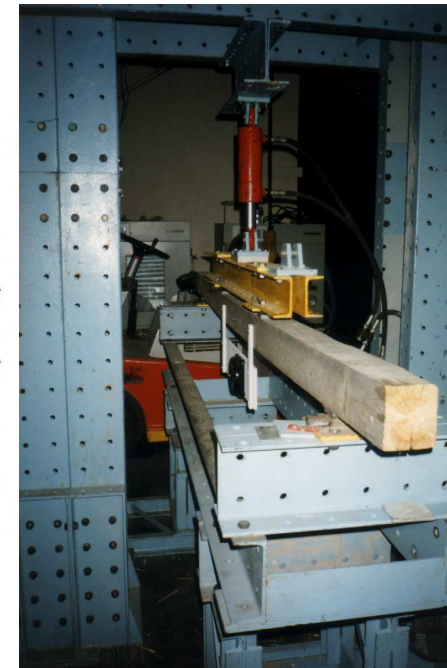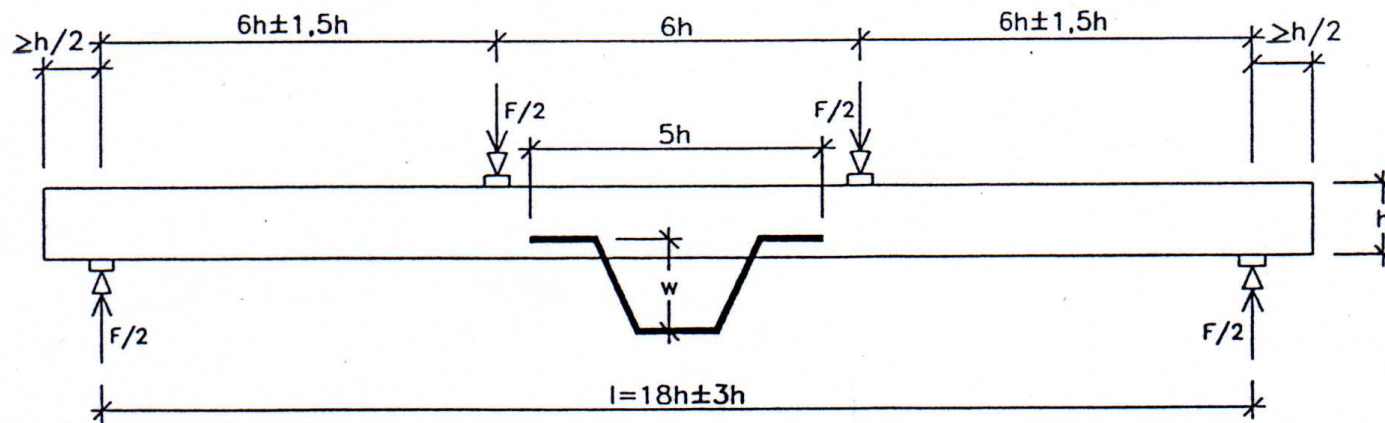
test results (spruce)

| Specimen	ρ_{12}	Knot ratio	Annual ring	Slope of grain	E_{stat}	f_m
11	537	0,17	0,88	42,0	18 197	77,22
12	437	0,22	1,43	2,0	11 375	55,85
13	449	0,22	1,59	19,0	13 225	51,93
14	441	0,26	2,65	27,0	11 650	47,04
15	450	0,24	1,80	14,0	14 037	39,54
16	554	0,12	1,00	14,0	16 184	75,81
17	541	0,30	1,51	43,0	17 244	61,68
18	539	0,10	1,45	44,0	14 195	69,79
19	406	0,30	3,72	60,0	6 718	24,33
20	473	0,25	3,53	59,0	8 675	27,32
21	479	0,20	2,10	15,0	14 577	50,88

factor for calculation
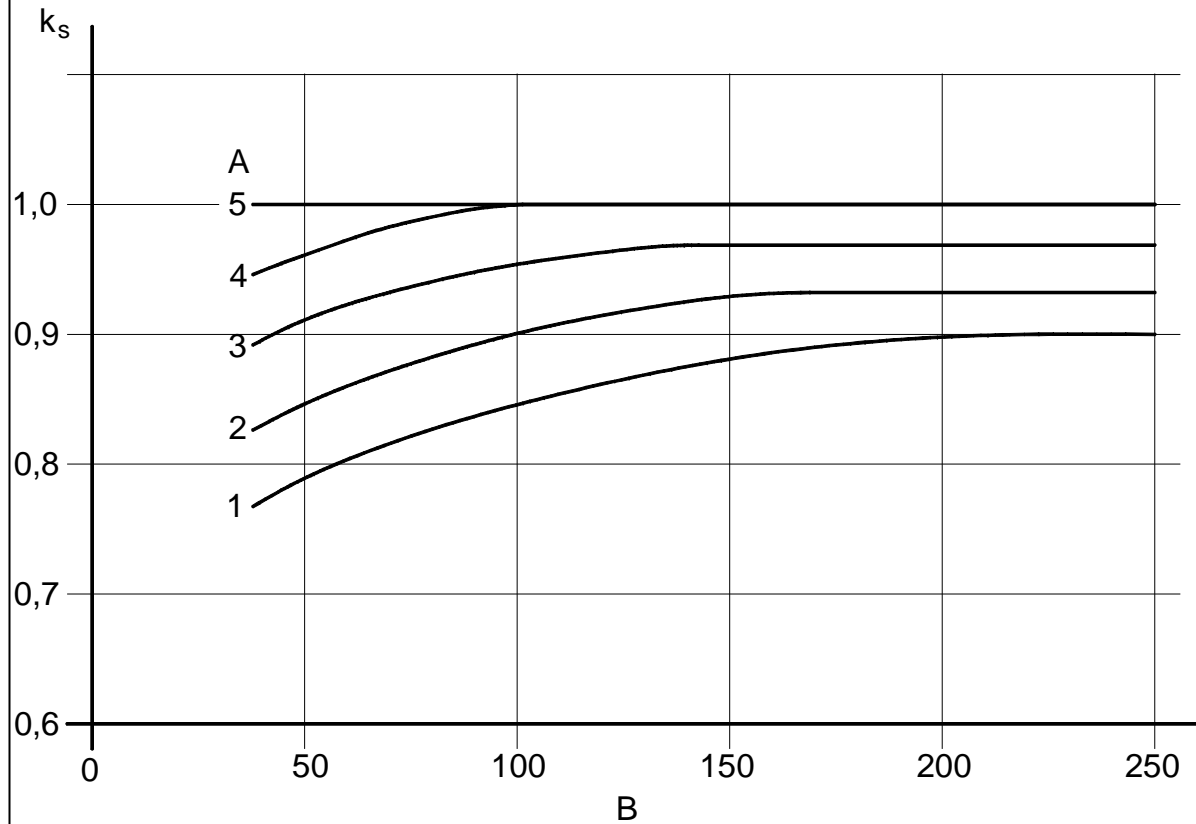
A - number of samples
B - number of specimens in the sample

strength properties

Strength properties		Strength classes Characteristic values (in MPa)		
		Coniferous		
		(spruce, fir, pine, larch)		
		S 13	S 10	S 7
Bending	$f_{m,k}$	27	22	16
Tension	$f_{t,0,k}$	16	13	10
	$f_{t,90,k}$	0,3	0,3	0,3
Compression	$f_{c,0,k}$	22	20	17
	$f_{c,90,k}$	5,1	5,1	4,6
Shear	$f_{v,k}$	2,5	2,4	1,8
Modulus of elasticity	$E_{0,mean}$	12 000	10 000	8 000
	$E_{0,05}$	8 000	6 700	5 400
	$E_{90,mean}$	400	330	270
	$E_{90,05}$	270	220	180
Shear modulus	G_{mean}	750	630	500
	G_{05}	500	420	330
Density	ρ_k	380	370	350

timber quality

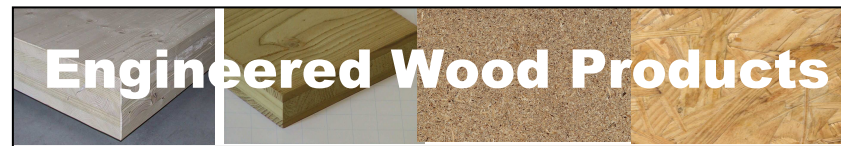# Engineered wood products

Roundwood, Logs
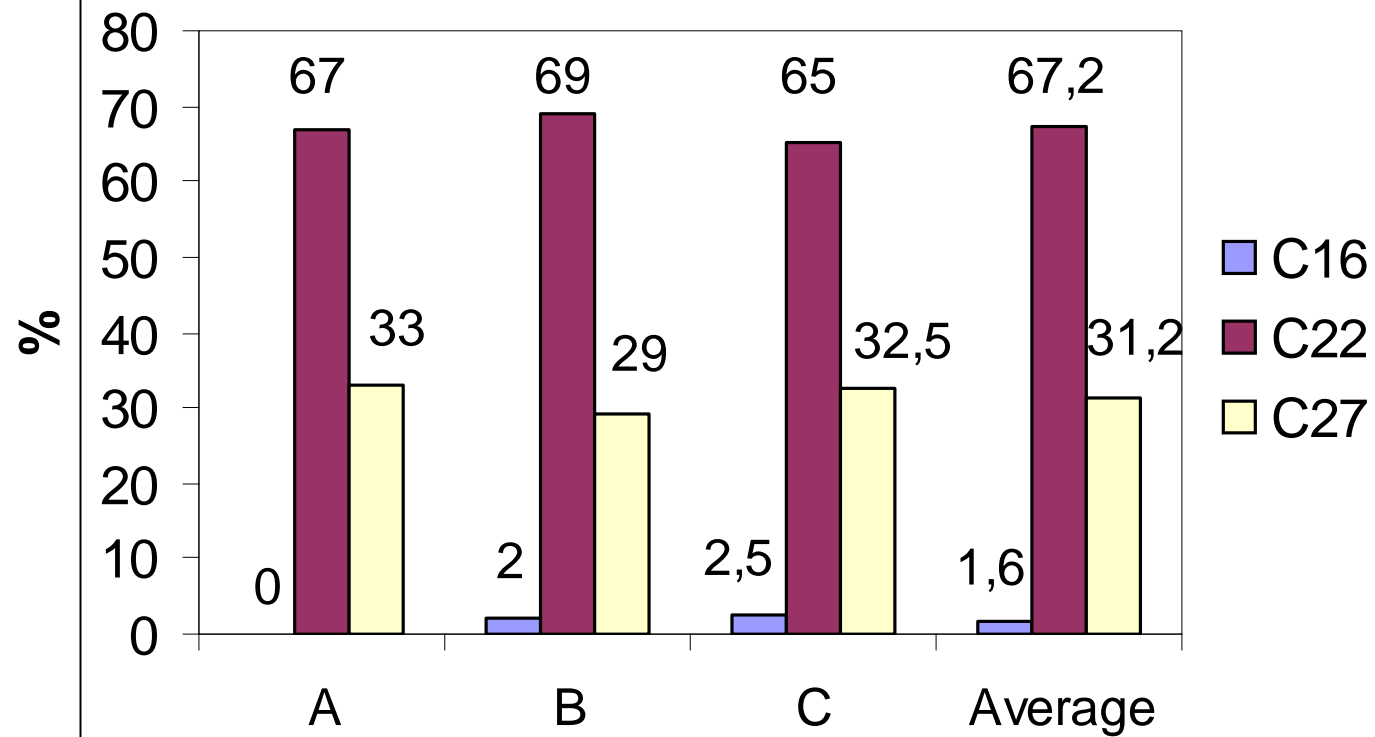
Structural timber

Engineered Wood Products

Cutting / sawing of logs in longitudinal and transversal direction

from cutting/chipping of logs/round timber and/or structural timber into particles and subsequently bonding by means of adhesives
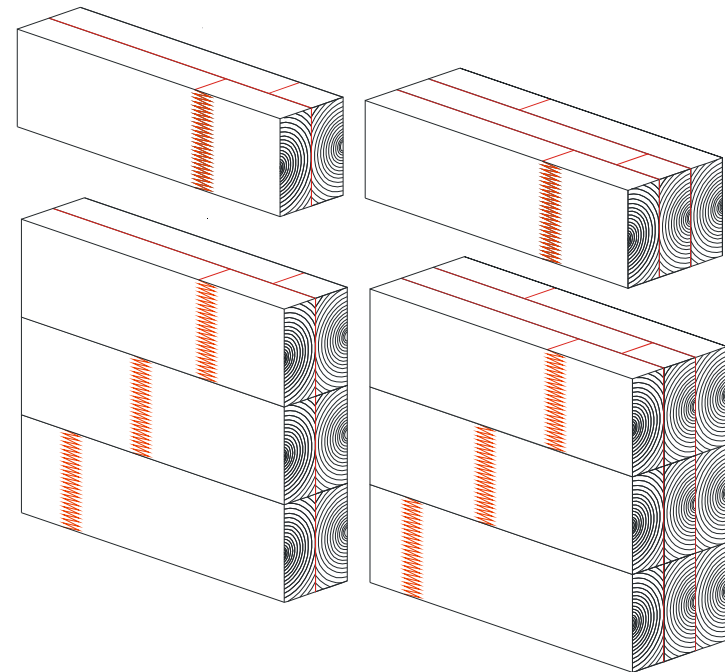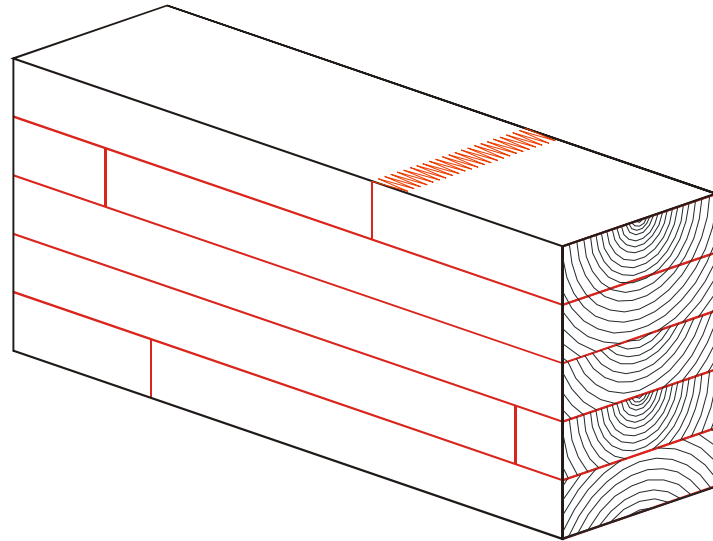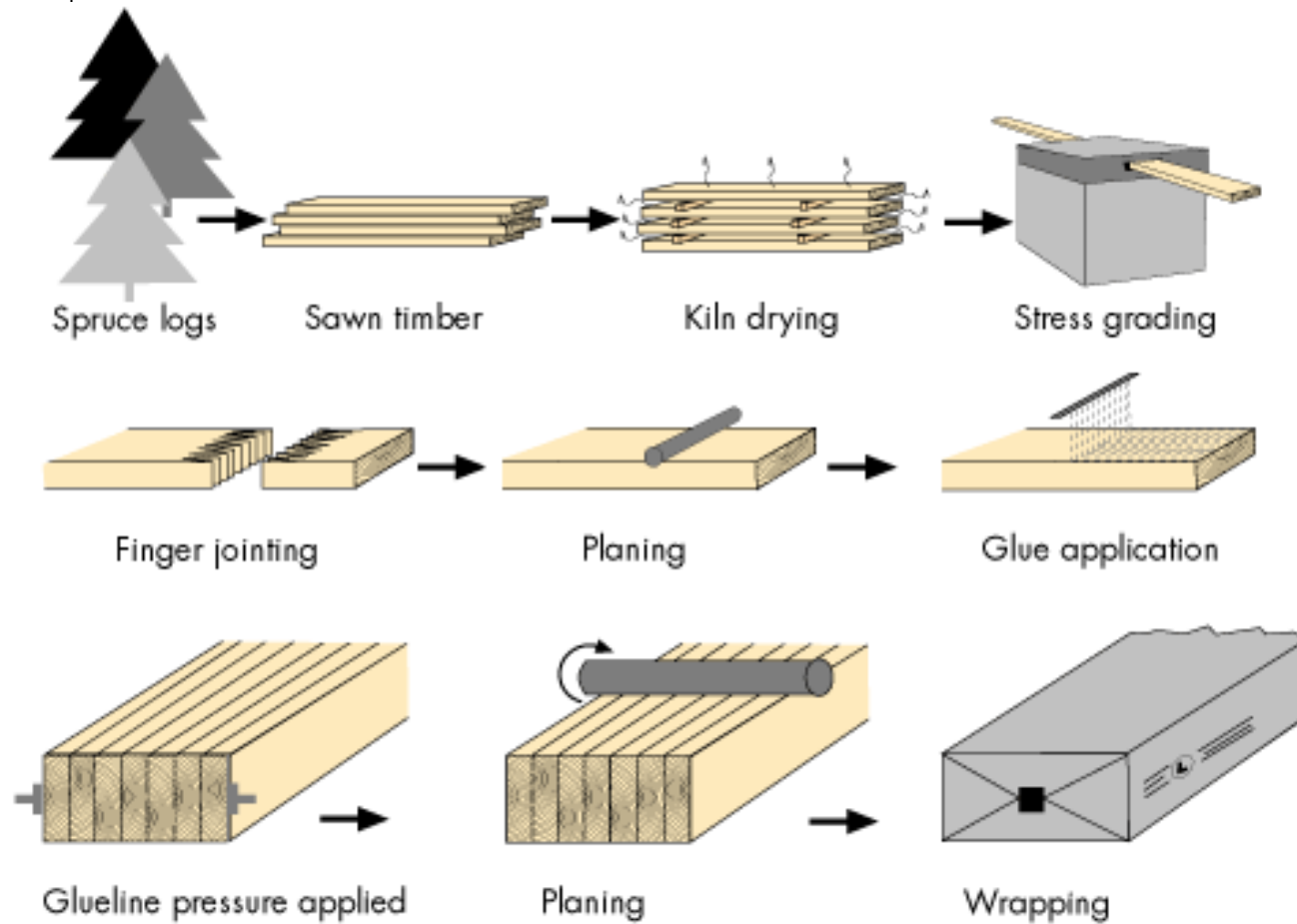
Target:

HOMOGENISATION OF MATERIAL PROPERTIES

→ Decreasing influence of anisotropic effects on the mechanical properties (strength / stiffness)

→ Decreasing influence of changes of the moisture content

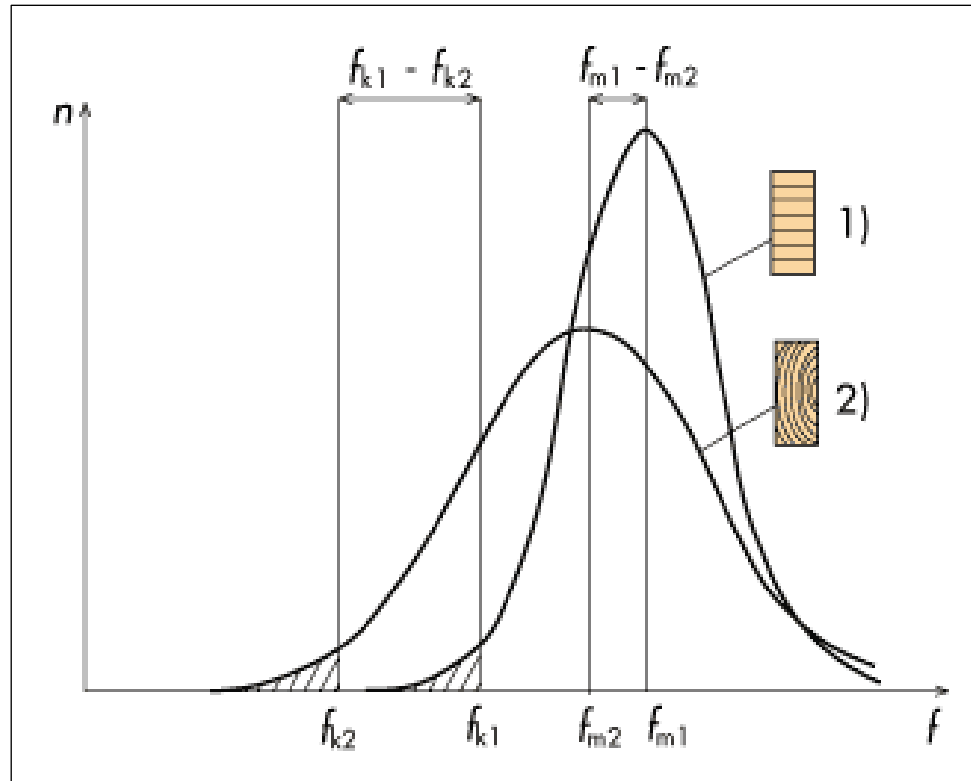→ Possibility for the production of 2D-elements (plates, panels)

Glulam

production process

Spruce logs → Sawn timber → Kiln drying → Stress grading

Finger jointing → Planing → Glue application

Glueline pressure applied → Planing → Wrapping

material properties

versatility

ILOTO

design considerations

- Aesthetics

- Prefabrication

- Transport and erection
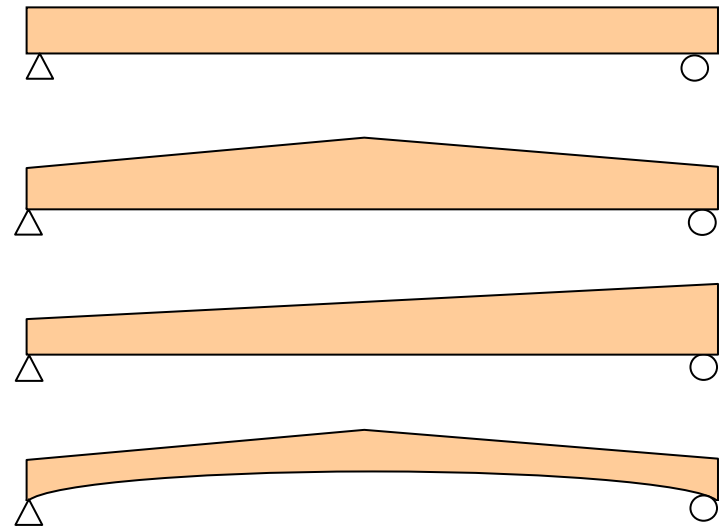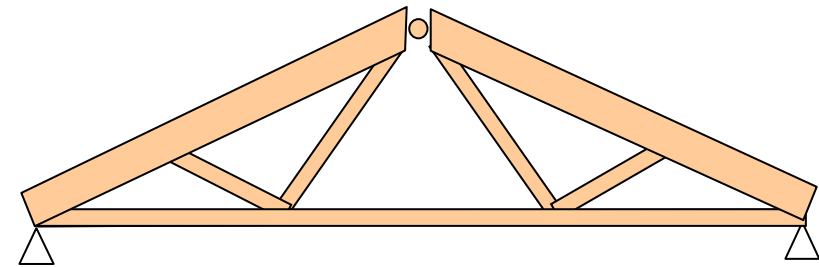
structural use of glulam

Elephant house in Cologne

Europabrücke in Murau, Austria

typical structures
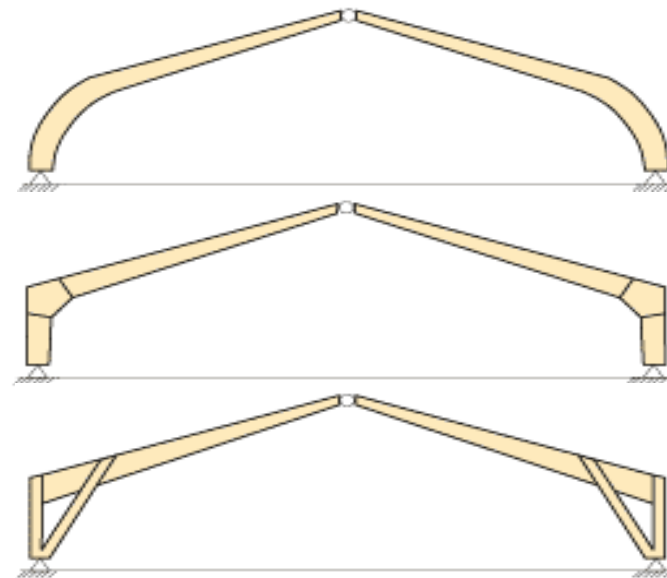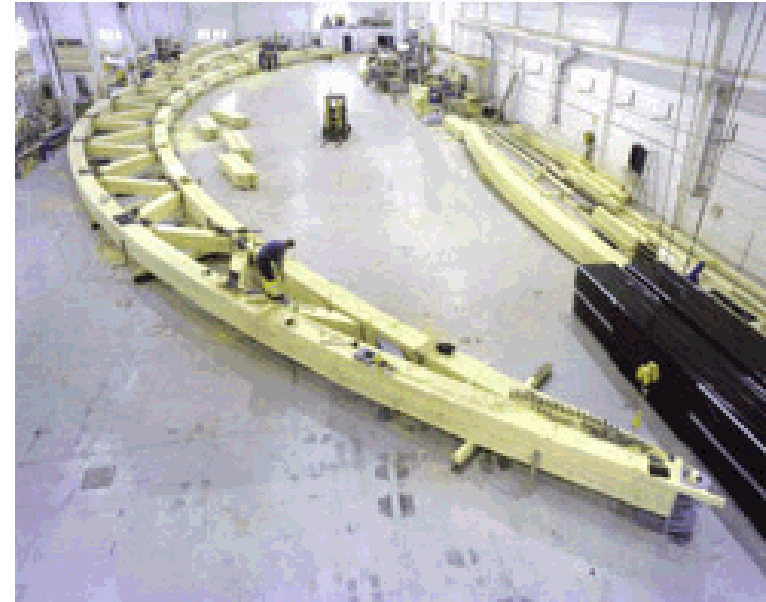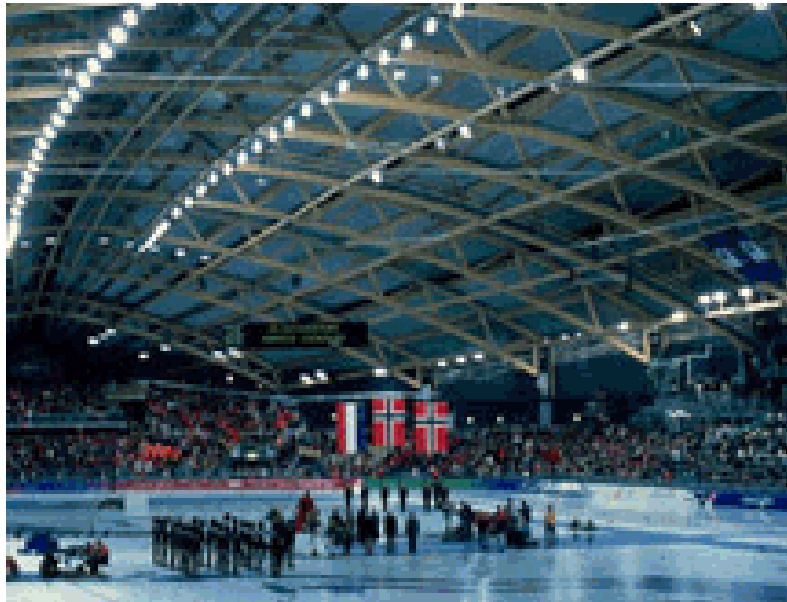

Beams

Three-pin truss

Portal frames

Arches

Thank you
for your kind attention!