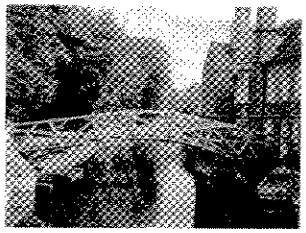
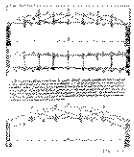
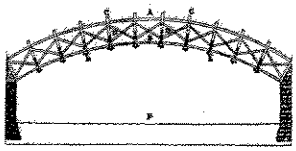
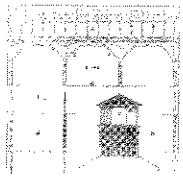
Introductory lecture

- Website: http://courses.washington.edu/cee454
- Course Outline
- Learning objectives
  - Historical context
  - Become familiar with the terminology
  - Understand how wood design differs from other materials
  - Understand how to use the design documents
  - Become familiar with the most commonly used strength distribution for wood
- Success Criteria
  - Be able to identify relevant terms
  - Be able to look up strength values in the design documents

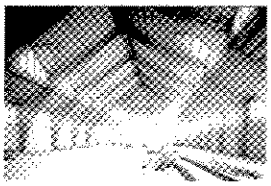


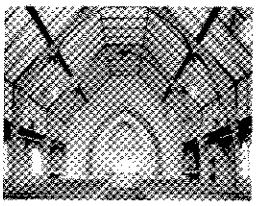




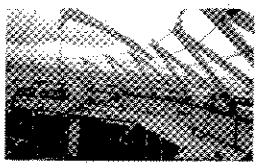


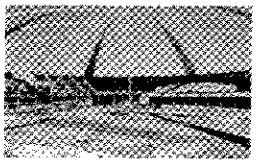
Gluelams

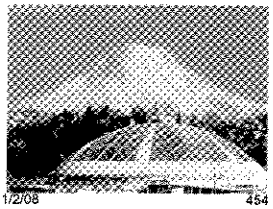


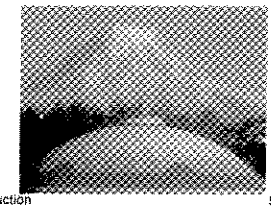


Tacoma Dome









Material properties

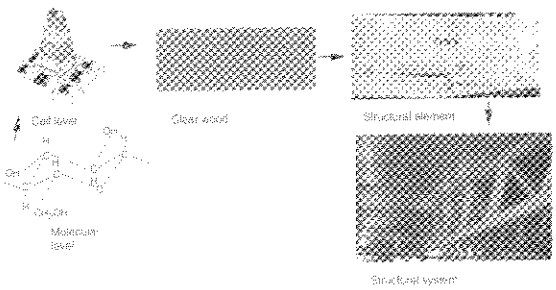


Figure 3.2 The wood chain from wood cell to finished wood

Thelandersson and Larsen (2003)

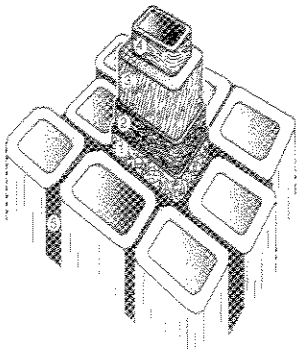


Figure 3.1 Schematic drawing of the microstructure of wood (Ormarsson, 1999)

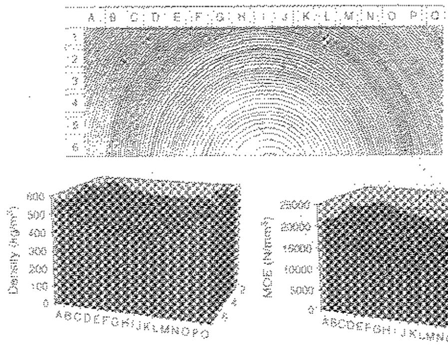
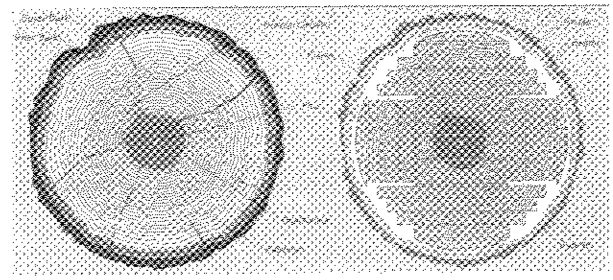


Figure 3.2 Distribution of density (at 12% m.c.) and MOE along the grain determined on 9 × 9 × 200 mm specimens cut from a 67 × 195 mm defect-free board section of Norway spruce (*Picea abies*) (Steffen *et al.*, 1997)

MOE=Modulus of Elasticity



Builder's view of wood elements: Wagner (1998)

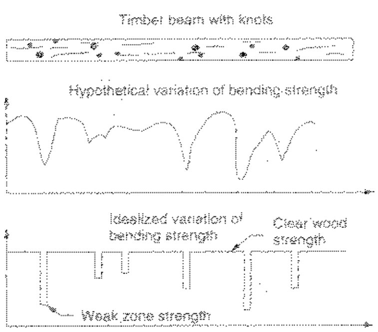


Figure 4.1 Modelling of lengthwise variation of bending strength in timber beams according to Riberholt *et al.* (1979)

Grading

- Most is done visually. Resawn lumber i.e., lumber cut from a larger graded piece, does not have the same visual grade.
- Machine stress rating (MSR) is done for a small percentage of lumber: as the piece goes through rollers, bending stress about the minor axis is applied to determine the modulus of elasticity, E.
- Machine evaluated lumber (MEL) employs X-ray technology to determine density.

$$MC = \frac{\text{moist weight} - \text{oven dry weight}}{\text{oven dry weight}} \times 100 \text{ percent}$$

Equilibrium moisture content (EMC) is the average moisture content that wood assumes in service: 7-14 % typically.
Free water is contained within cell cavities; *bound* is within the cell wall.
Complete loss of free water is known as *Fiber Saturation Point (FSP)*.
Drying of lumber to increase its structural properties is known *as seasoning*.
Incising refers to a process for chemical application to wood in which small incisions are made.

More on grading...

For structural light framing (SLF), there are several lumber stress grades:

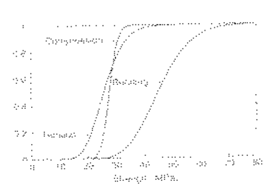
1. Select Structural
2. No.1 and Better
3. No. 1
4. No.2
5. No.3

Go to section 4 of the NDS supplement: does the bending strength F_b in Table 4A Column 1 go up or down with stress grade level?

Strength-Density Material Comparison

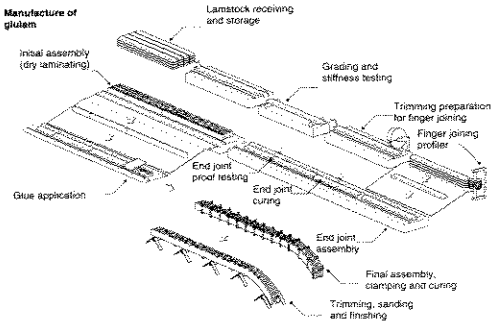
Table 1, after Thelandersson and Larsen (2003):

Material	Density [kg/m³]	Strength, MPA	Strength/Density 10^{-3} MPA*m³/kg
Structural steel	7800	400-1000	50-130
Aluminum	2700	100-300	40-110
Concrete, compression	2300	30-120	13-50
Clear softwood, tension	400-600	40-200	100-300
Clear softwood, compression	400-600	30-90	70-150
Structural timber, tension	400-600	15-40	30-80

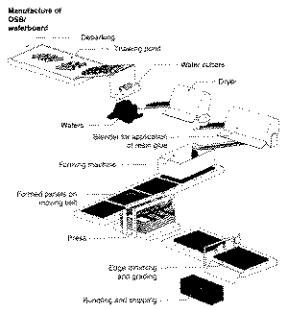


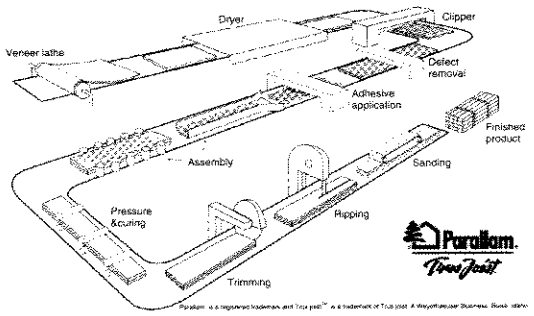
- What is the probability that the tensile strength of spruce is less than or equal to 20 MPA?
- What is the probability that the tensile strength of spruce is less than or equal to 60 MPA?
- What is the probability that the tensile strength of spruce is greater than 20 MPA?
- Greater than 60 MPA?
- How does the spruce structural element compare in strength for the three loading cases?

Contemporary Gluelam



Manufactured Wood Product (MWP) Example





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