

Using wood as a material

- Composed of
 - Cellulose
 - Lignin
 - Hemicelluloses
- General properties
 - High strength/weight
 - Durable
 - Dry wood
 - Good insulator of heat
 - Good insulator of sound
 - Good insulator of electricity
 - Absorbs and dissipates vibrations
 - Aesthetically pleasing that can be enhanced by stains, varnishes and lacquers
 - Easily shaped, repaired and joined with nails, screws, glues and dowels
 - Resists corrosion

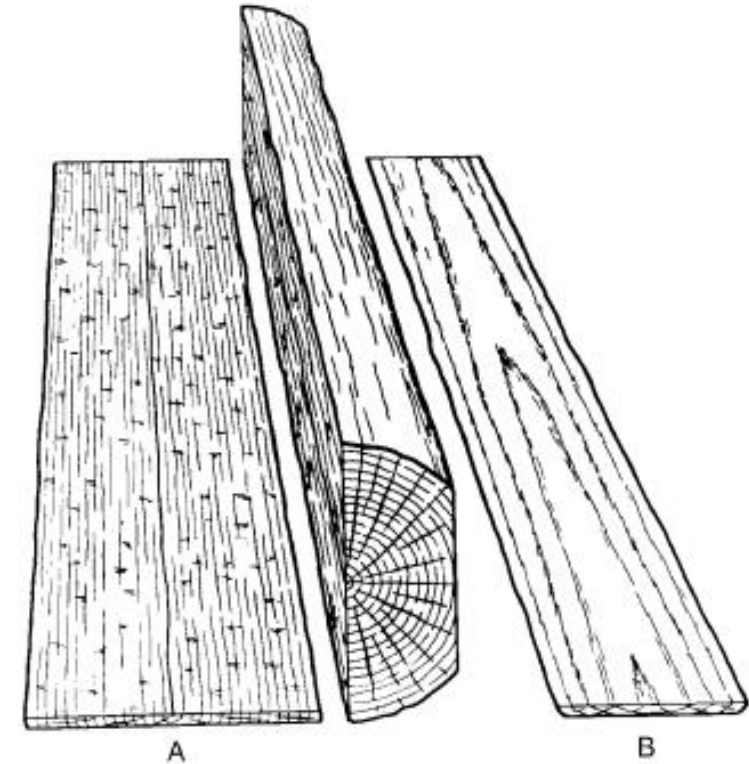
Structure of wood

- Primarily composed of hollow, elongated, spindle-shaped cells parallel to each other along the trunk of the tree
- The difference between the wood that is formed early in the growing season (Earlywood) and that formed later (Latewood) is sufficient to produce well-marked annual growth rings
 - Earlywood has relatively large cavities and thin walls
 - Latewood has smaller cavities and thicker walls
 - The amount of Earlywood and Latewood depends on the environmental conditions when growing.
 - Earlywood and Latewood have different mechanical properties



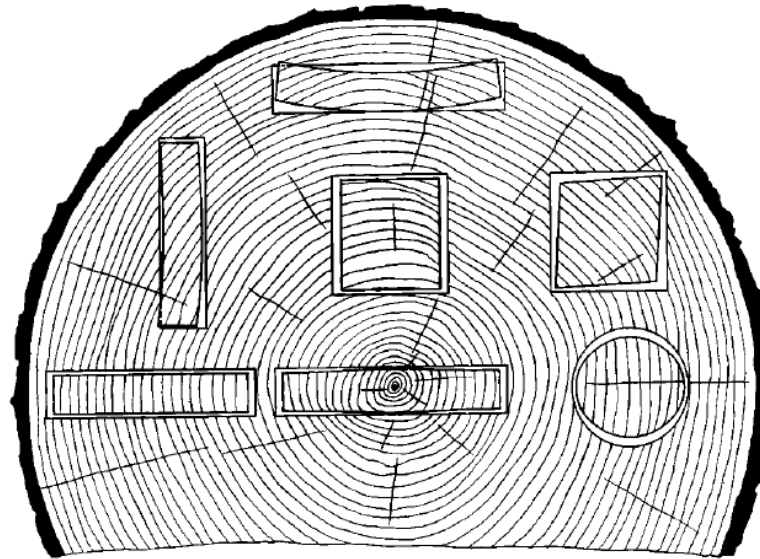
Plainsawn and Quartersawn

- Radially to the rings (A)
 - “Quartersawn” – Hardwoods
 - “Edge-grained” or “vertical-grained” – Softwoods
 - Shrinks and swells less in width
 - Holds paint better in some species.
- Tangential to the rings (B)
 - “Flatsawn” or “Plainsawn” – Hardwoods
 - “Flatsawn” or “slash-grained” – Softwoods
 - Shrinks and swells less in thickness
 - Costs less because it is more plentiful
- “bastard sawn board” – 30 -60 degrees



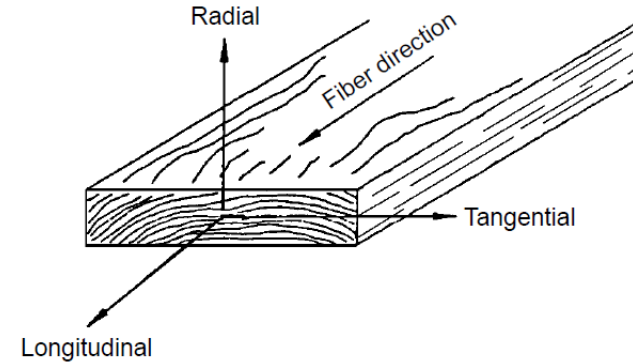
Moisture relations of wood

- Moisture of wood is defined as the weight of water, usually in a percentage, of the weight of oven dry wood.
 - In trees this can be between 30 and 200%
- Wood changes dimensions as it gains or loses moisture
 - Tangential shrinkage is about twice that of radial shrinkage, hence it is important how the wood has been cut from the tree
 - Longitudinal shrinkage is generally small



Mechanical properties

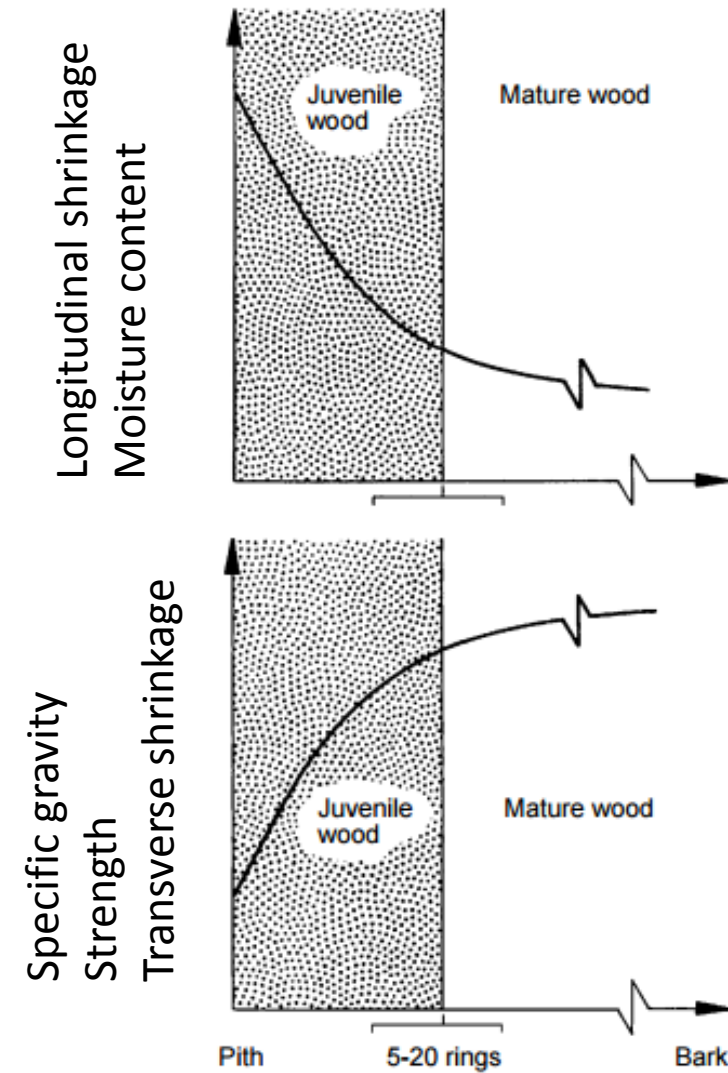
- Orthotropic (3 mutually perpendicular directions)
- Typical properties of “clear”, “straight grained” samples
 - Note that hardwoods are generally heavier, stiffer and stronger



Material	Specific gravity	Modulus of elasticity parallel to grain (Mpa)	Compression strength parallel to grain (kPa)	Compression strength perpendicular to grain (kPa)	Tensile strength parallel to the grain (kPa)	Tensile strength perpendicular to grain (kPa)	Modulus of elasticity (MPa)/weight
Beech (American)	0.56	9,500	24,500	3,700	86,200	5,000	17.0
Oak (Overcup)	0.57	7,900	23,200	3,700	77,900	5,000	13.9
Pine (eastern white)	0.34	6,800	16,800	1,500	73,100	1,700	20.6
Spruce (Engelmann)	0.33	7,100	15,000	1,400	84,800	1,700	21.5
Aluminium (6061)	2.7	68,900			310,000	310,000	25.5
Steel (AISI1018)	7.87	205,000			440,000	440,000	26.0

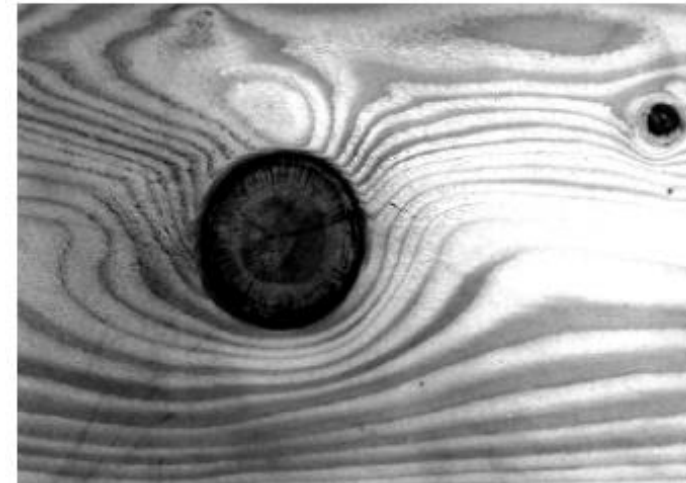
Juvenile Wood

- Juvenile wood
 - Longitudinal shrinkage may be 10 times as much
 - UTS can be 50%
 - Stiffness can be 45%

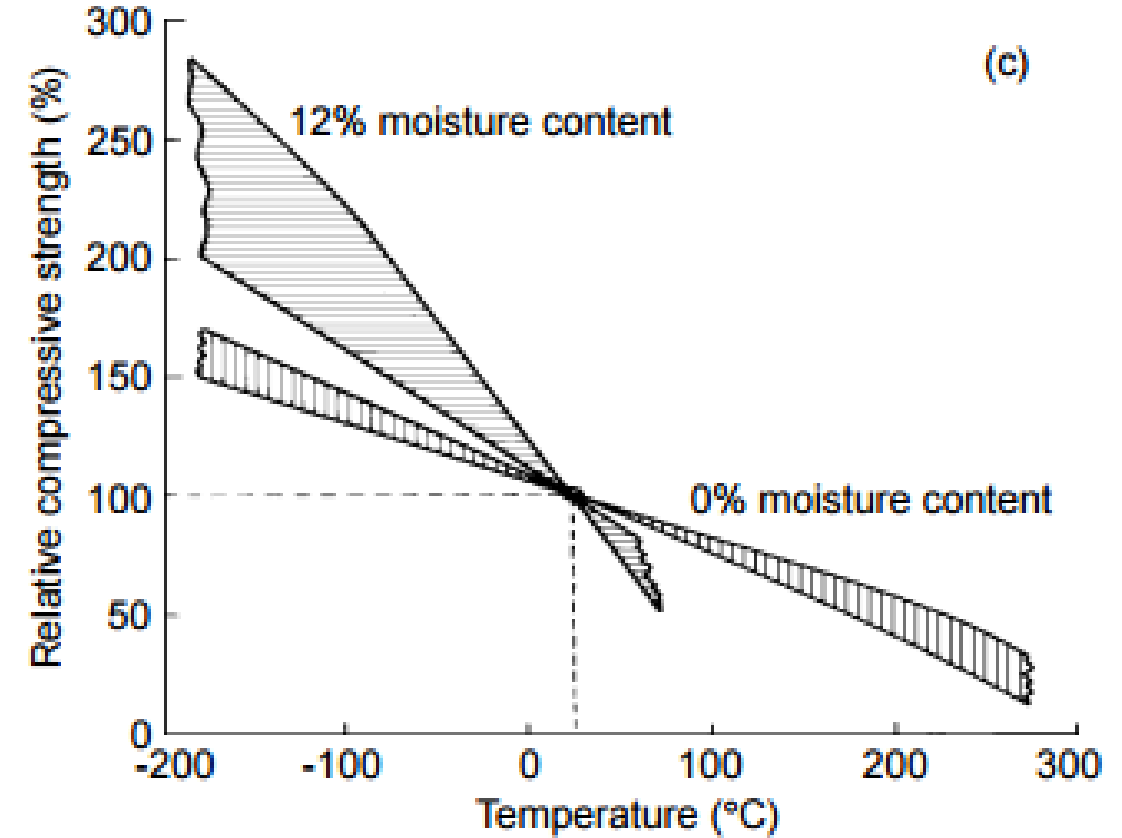
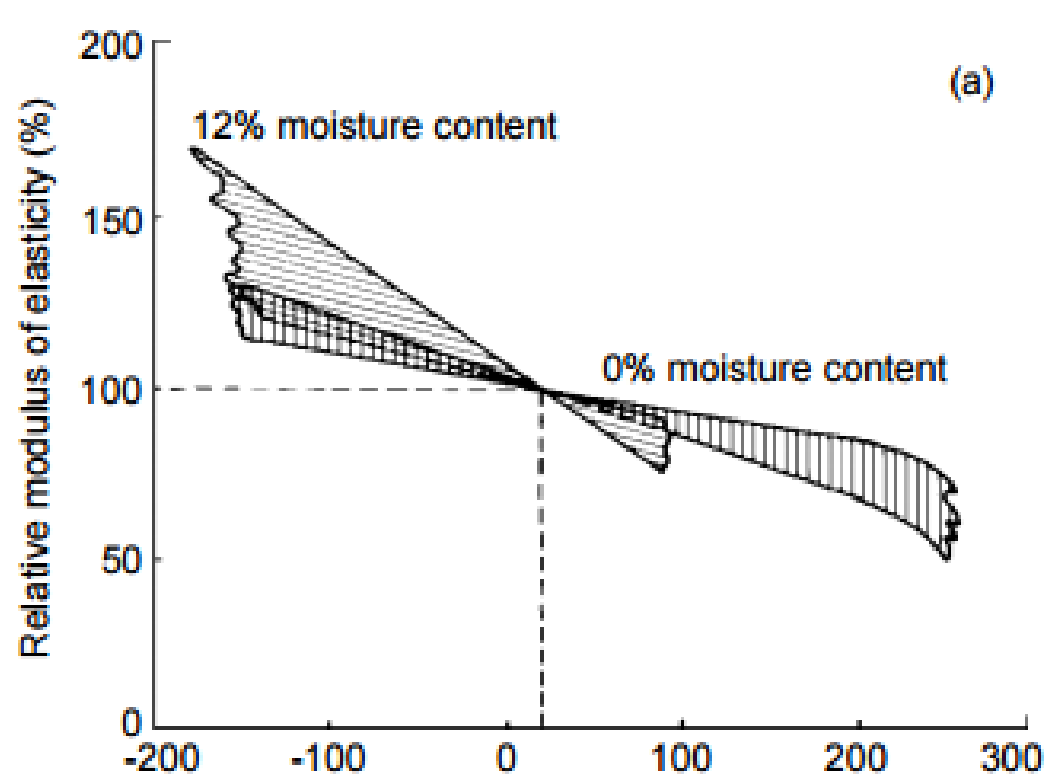


Knots

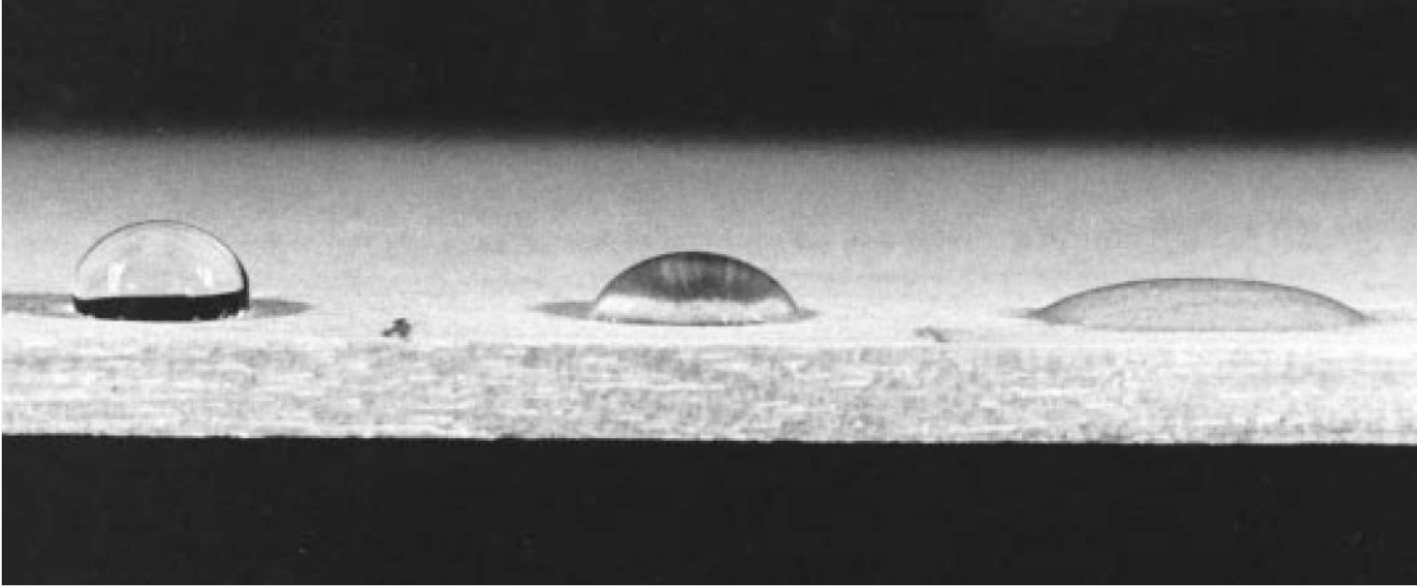
- Portion of a branch incorporated into the tree
 - Interrupts and changes directions of the fibres – therefore reducing strength and stiffness
 - Influence dependent on
 - Size
 - Location
 - Shape
 - Round (flatsawn)
 - Oval (bastard sawn)
 - “spiked” (quartersawn)
 - Knots have a greater influence on tensile strength
 - Put on the upper side of a simply supported beam!



The influence of temperature



Adhesives



Unsanded

two passes with 320 grit

four passes with 320 grit

- Drops applied at the same time and photographed after 30 seconds
- Surface should be free from dirt/defects

Vibrational Properties

- Speed of sound
 - The speed of sound in the transverse direction is about $1/5^{\text{th}}$ to $1/3^{\text{rd}}$ of the longitudinal value
 - Decreases with increasing temperature or moisture content
- Internal Friction
 - When solid material is strained, some mechanical energy is dissipated as heat
 - A function of temperature and moisture content
 - At room temperature minimum internal friction occurs at about 6% moisture content and increases as moisture content increases/decrease

Notes adapted from/further reading

- Wood Handbook: Wood as an Engineering Material, United States Department of Agriculture (1999)