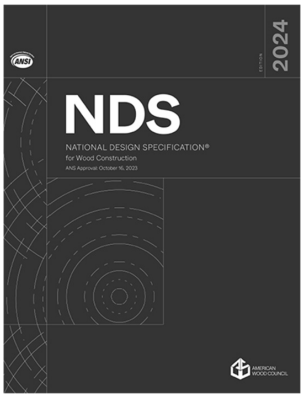
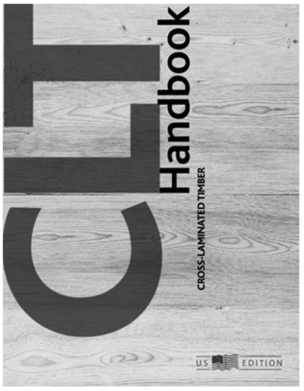
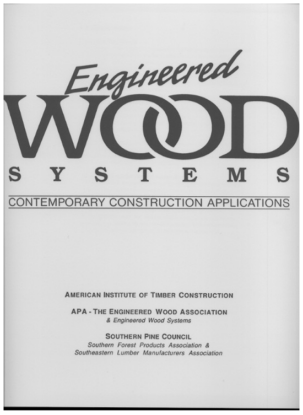
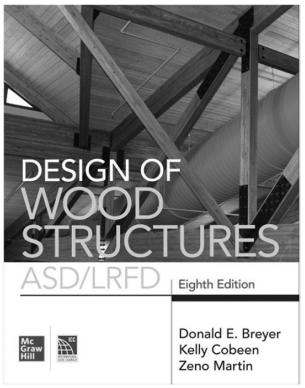
Wood Design Properties





- Dimensioned Sizes
- Moisture and Drying
- Grading
- Engineered Wood Products



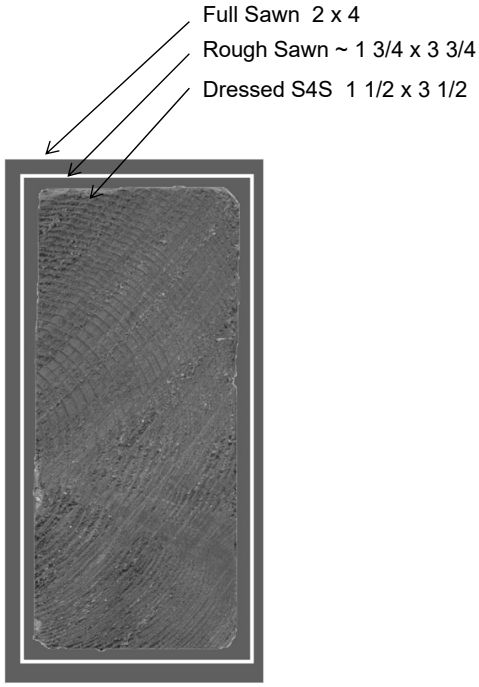


SIZE NOMINCLATURE

Full Sawn
- The size delivered is the full nominal size
- Not generally available

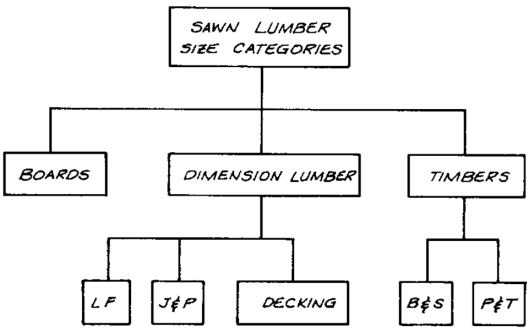
Rough Sawn
- Rough sawn condition with no surface planing
- Because no surfaces are planed, sizes are approximately 1/8” larger than S4S

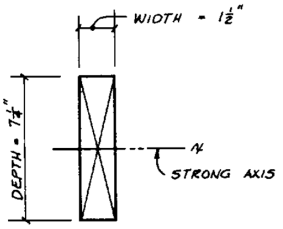
Dressed
- The size after shrinkage from drying and surface planing
- Typically dressed on all 4 sides S4S



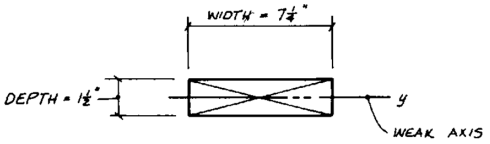
SIZE CATAGORIES

Boards	1 to 1½ in. thick 2 in. and wider
Dimension lumber	2 to 4 in. thick 2 in. and wider
Timbers	5 in. and thicker 5 in. and wider





2 x 8 SECTION



8 x 2 SECTION

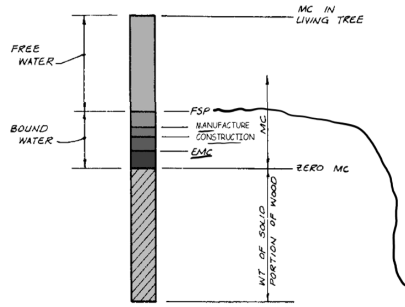
SIZE CATAGORIES

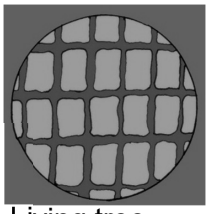
Symbol	Name	Nominal dimensions: Thickness	Nominal dimensions: Width	Examples of sizes
LF SLF	Light Framing and Structural Light Framing	2 to 4 in.	2 to 4 in.	2 × 2, 2 × 4, 4 × 4
SJ&P	Structural Joist and Plank	2 to 4 in.	5 in. and wider	2 × 6, 2 × 14, 4 × 10
	Stud	2 to 4 in.	2 to 6 in.	2 × 4, 2 × 6, 4 × 6 (lengths limited to 10 ft and shorter)
	Decking*	2 to 4 in.	4 in. and wider	2 × 4, 2 × 8, 4 × 6
B&S	Beams and Stringers	5 in. and thicker	More than 2 in. greater than thickness	6 × 10, 6 × 14, 12 × 16
P&T	Posts and Timbers	5 in. and thicker	Not more than 2 in. greater than thickness	6 × 6, 6 × 8, 12 × 14

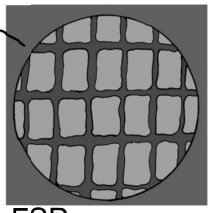
*Decking is normally stressed about its minor axis. In this book, all other bending members are assumed to be stressed about the major axis of the cross section, unless otherwise noted.

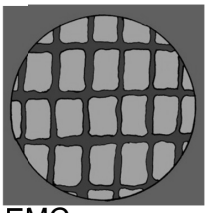
Moisture Content

- MC = %water to oven dry wood
- In a living tree, MC can be 200%
- "free water" is contained in cell cavity
- "bound water" is within the cell wall
- Fiber Saturation Point (FSP) is the MC at 0% free and 100% bound water FSP is about 30%
- Equilibrium Moisture Content (EMC) is reached in service



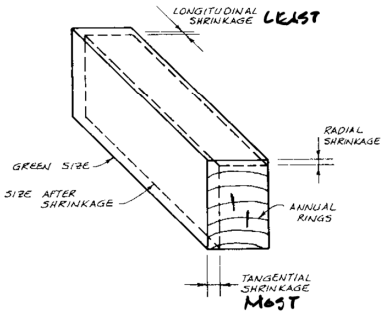

Living tree


FSP


EMC

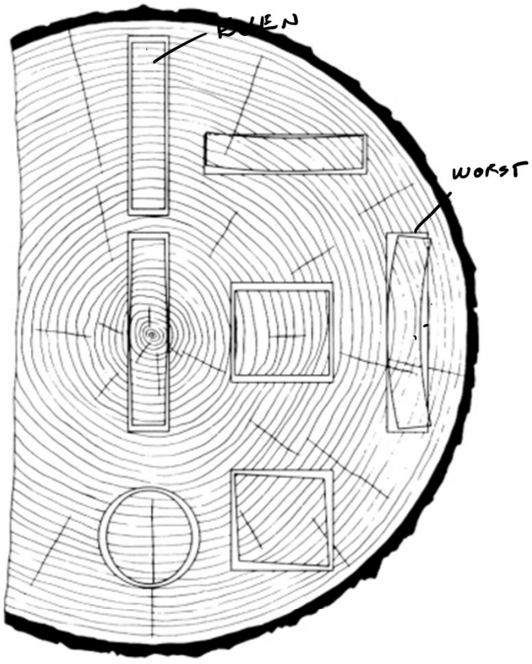
Shrinkage

- Shrinkage begins once MC<FSP
- Shrinkage is not the same in each direction
- Uncontrolled shrinkage results in splits



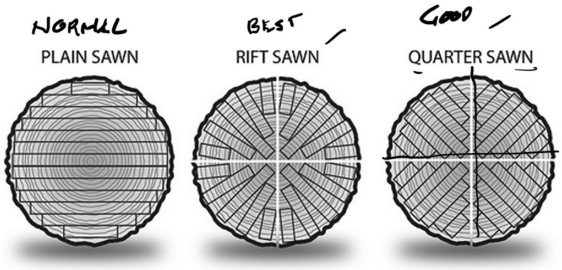
Shrinkage

- Is different in different directions
- Longitudinal is the least
- Across the grain is more
- Circumferential is greatest



Cut

- Plain Sawn – most economical and common
- Quarter Sawn – less warping
- Rift Sawn – least warping but more waste



Yard Dry

- Initial free water is removed
- stacked separated by 1” stickers
- Air dried outdoors or under cover
- Dry rate depends on humidity and circulation
- Coating ends reduces splitting
- Takes ~ weeks to months

Kiln Dry - KD

- Enclosed in humidity controlled chamber
- Introduction of controlled heat
- Air circulation
- Dried to < %18

Heat Treated - HT

- temperature raised to 53° C (127° F) for 30 min.
- kills organisms
- requirement for imports

GRADING

Visual Grading

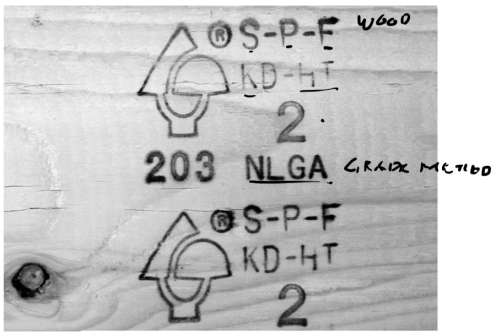
Each member is assessed for visual defects. (splits, knots, density, etc.)

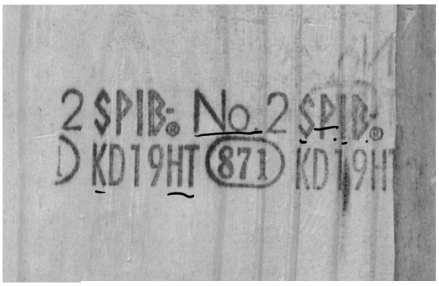
Machine Evaluated Lumber (MEL)

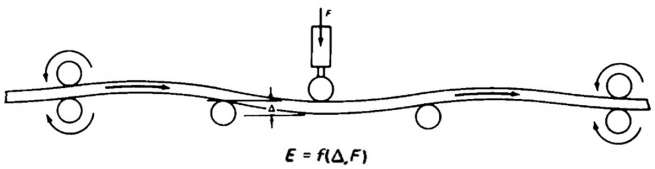
Each member is assessed for density using x-ray technology.

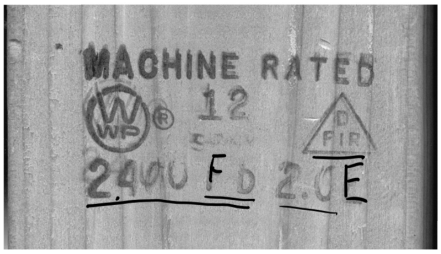
Machine Stress Rated (MSR)

Each member is stressed by running it through rollers which measure the deflection and stiffness. The E modulus in bending can be calculated from the deflection.





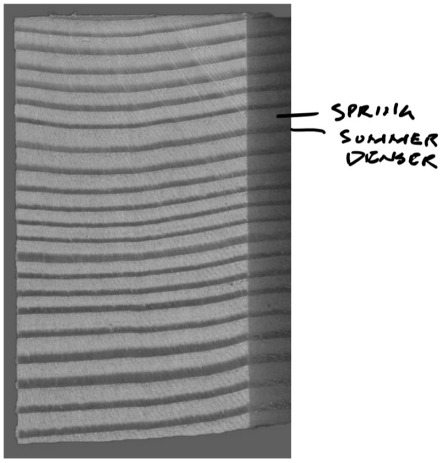


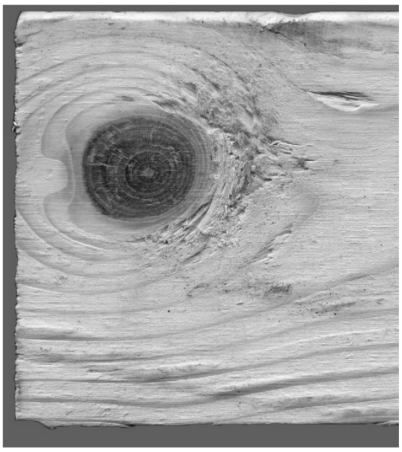


GROWTH CHARACTERISTICS

Annual Rings

- Latewood is denser and stronger than earlywood.
- Sapwood is the actively living part of the tree. It is younger and transports water more readily than heartwood. The strength of the two is about the same.
- Density can be gauged visually by noting the % of latewood to earlywood



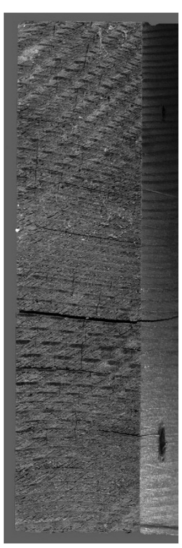


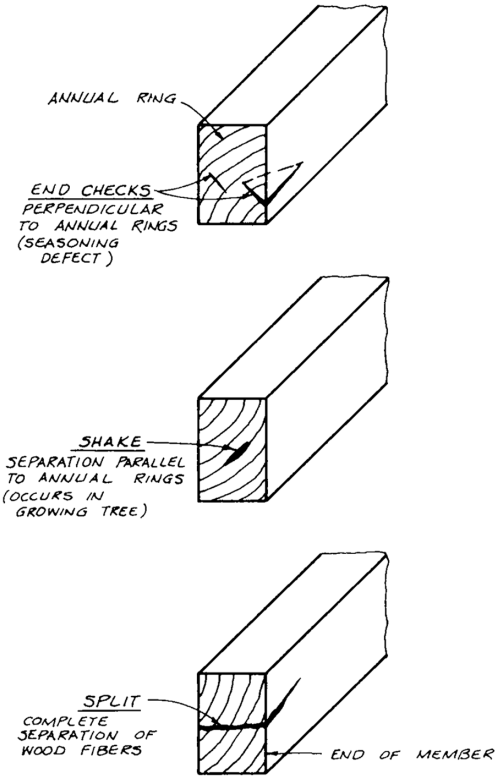
Knots

- Knots result from tree branches
- Knots weaken the member and effect the grading

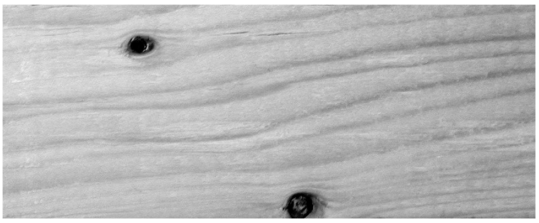
Checks, Shakes and Splits

- All three are defects which weaken the wood
- **Checks and splits** are seasoning defects
- **Shakes** result from stress in the growing tree

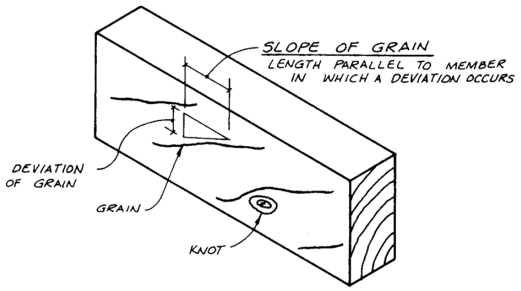




Slope of Grain

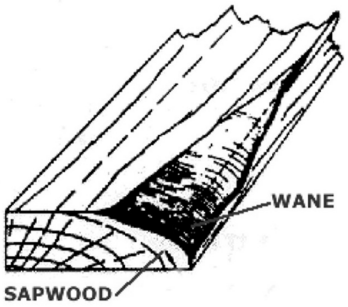


- The slope of the grain is taken in relation to the long edge of the member
- It is measured as a ratio e.g. 1” in 8”
- Increase in slope lowers the strength of the member



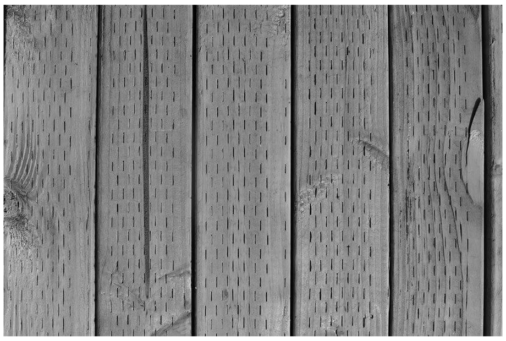
Wane

- Untrimmed bark or wood that is missing along the edge or corner of cut lumber



Pressure treating and Incising

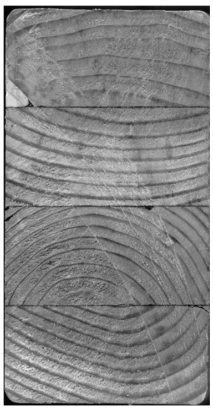
- When wood is kept dry there is generally no problem with decay. When M.C. exceeds 19% problems can result.
- Contact with soil or concrete should be avoided.
- To prevent mold or rot, a chemical preservative can be impregnated in the wood under pressure (pressure treated).
- Some wood accepts pressure treatment well (e.g. Southern Pine) while others not so well. To aid in the chemical penetration the wood surface can be incised with small cuts to increase the surface area. This however has a detrimental effect on the strength and E modulus.



Engineered Wood Products

Glulam

- Glue laminated lumber
- Stress rated and graded
- Parallel grain
- Different finish grades
- Standard widths and lams
- Straight or curved
- Size limit by transportation
- Stock or custom dimensions



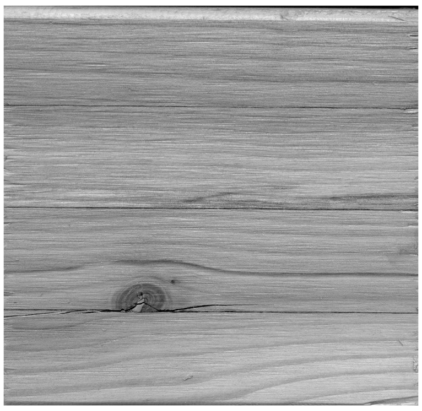
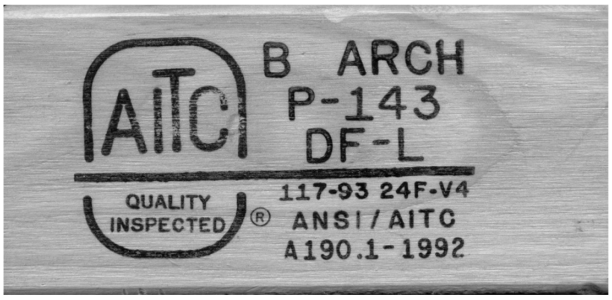


Table 5.1.3 Net Finished Widths of Structural Glued Laminated Timbers

Nominal Width (in.)	3	4	6	8	10	12	14	16
Minimum Net Finished Width (in.)	Western Species							
	2-½	3-⅛	5-⅛	6-¾	8-¾	10-¾	12-¼	14-¼
	Southern Pine							
	-	3	5	6-¾	8-½	10-½	-	-

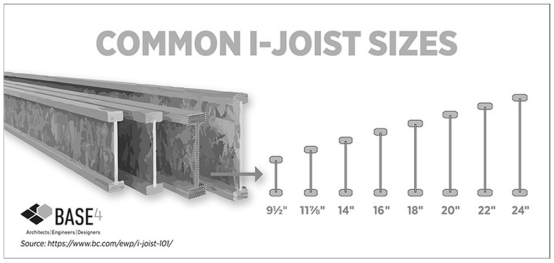
2005 NDS



Engineered Wood Products

Prefabricated Wood I-Joists

- ASTM D 5055
- Standard dimensions
- Specifications per manufacturer

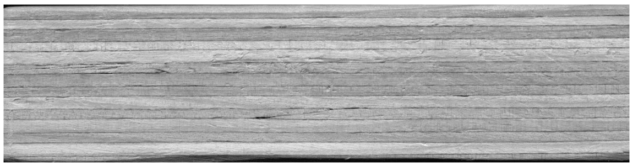


Engineered Wood Products

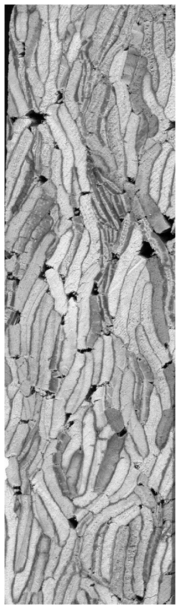
Structural Composite Lumber

- **Laminated Veneer Lumber** (LVL)
  - Veneer ≤ ¼”
- **Parallel Strand Lumber** (PSL)
  - Strand thickness ≤ ¼”
- **Laminated Strand Lumber** (LSL)
  - Strand thickness ≤ .10”

LVL



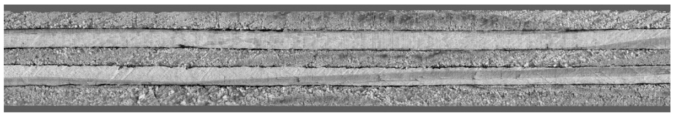
PSL



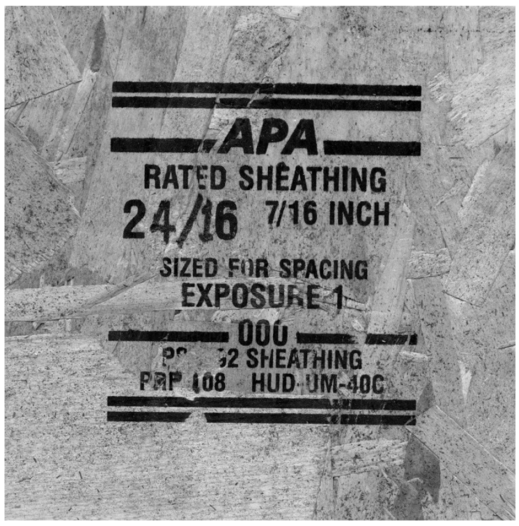
LSL

Engineered Wood Products

Wood Structural Panels



- **Plywood** – cross laminated wood veneer panels pressed and glued.
- **Oriented Strand Board** (OSB) – cross laminated layers of wood strands or wafers, compressed and glued
- **Composite Panel** – wood or plastic veneer and reconstituted wood based material



Engineered Wood Products

Wood Structural Panels

- **Cross Laminated Timber (CLT)** – cross laminated wood panels using at least three layers of boards or dimensioned lumber pressed and glued together. Thickness of layers varies from 5/8 inch to 2.0 inches. The width to pieces may vary from 2.4 to 9.5 inches. Panels are produced in different widths – commonly: 2 ft., 4 ft., 8 ft., 10 ft. and up to 60 ft. in length.

Engineered Wood Products

Wood Structural Panels

CLT

Brock Commons
Tallwood House

The University of British Columbia

18-storey, 53 m
2017

Engineered Wood Products

Wood Structural Panels - CLT

Brock Commons Tallwood House, 2017

Engineered Wood Products

Wood Structural Panels - CLT

InHabitat in Portland – 8 stories, 85 ft tall, 14 units

Engineered Wood Products

Wood Structural Panels - CLT

Ascent in Milwaukee – 25 stories, 284 ft, tallest in the world.

Engineered Wood Products

Wood Structural Panels - CLT

University of Michigan Pharmacy Building

University of Michigan Pharmacy Building

University of Michigan Pharmacy Building