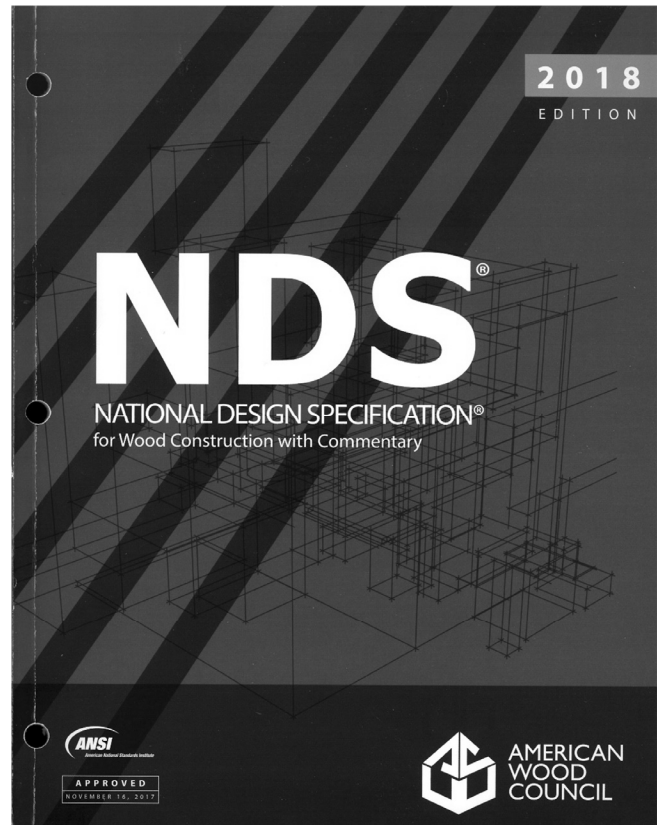


## Architecture 324 Structures II

### Wood Design Properties

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



### SIZE NOMINCLATURE

#### Full Sawn

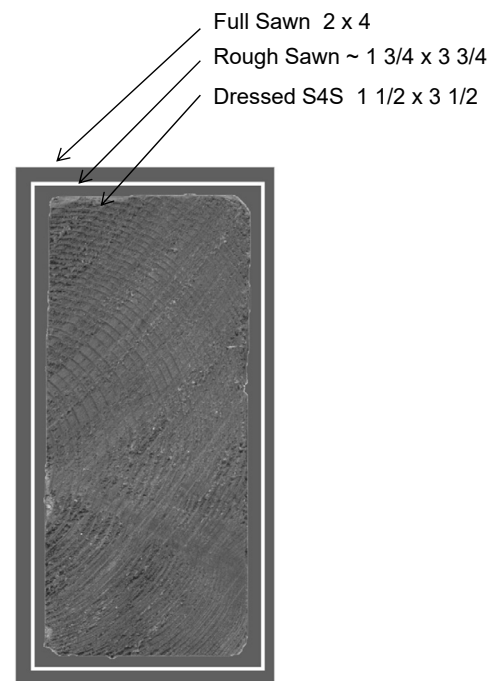
- The size delivered is the full nominal size
- Not generally available

#### Rough Sawn

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

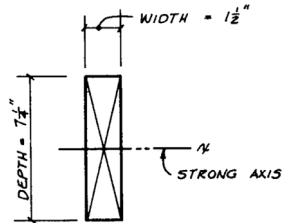
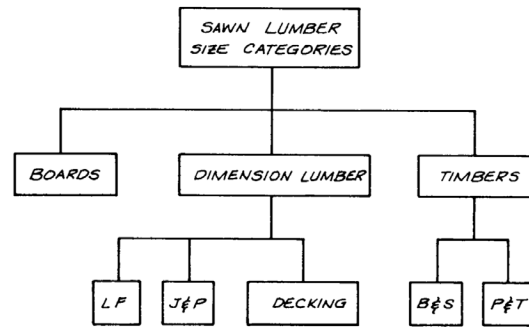
#### Dressed

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

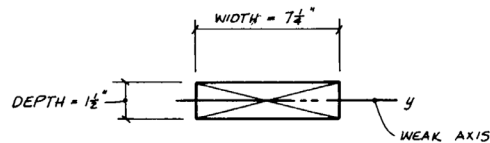


## SIZE CATAGORIES

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

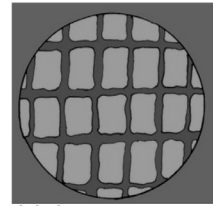
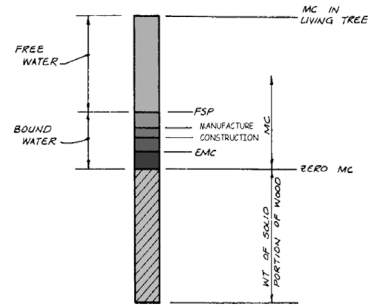
## SIZE CATAGORIES

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

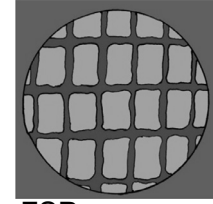
\*Decking is normally stressed about its minor axis. In this book, all other bending members are assumed to be stressed about the major axis of the cross section, unless otherwise noted.

## Moisture Content

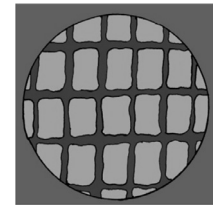
- $MC = \% \text{water to oven dry wood}$
- In a living tree, MC can be 200%
- “free water” is contained in cell cavity
- “bound water” is within the cell wall
- Fiber Saturation Point (FSP) is the MC at 0% free and 100% bound water  
FSP is about 30%
- Equilibrium Moisture Content (EMC) is reached in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



Living tree



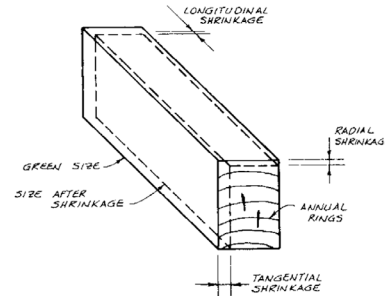
FSP



EMC

## Shrinkage

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

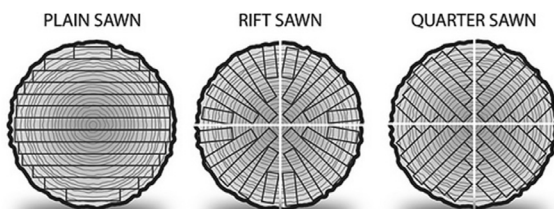
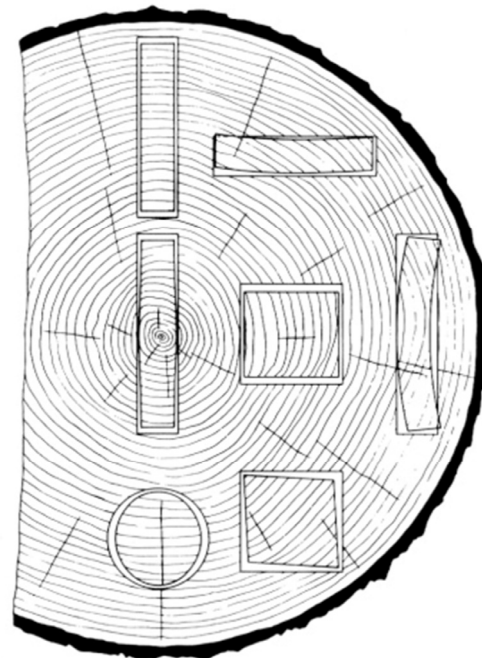


## Shrinkage

- 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

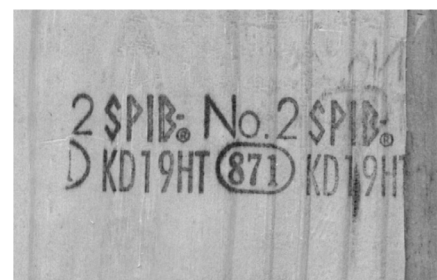
### Visual Grading

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



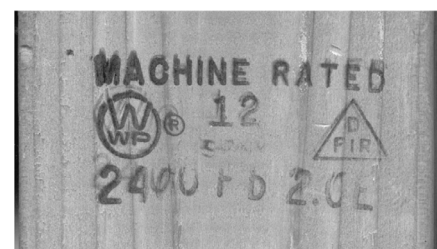
### Machine Evaluated Lumber (MEL)

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



### Machine Stress Rated (MSR)

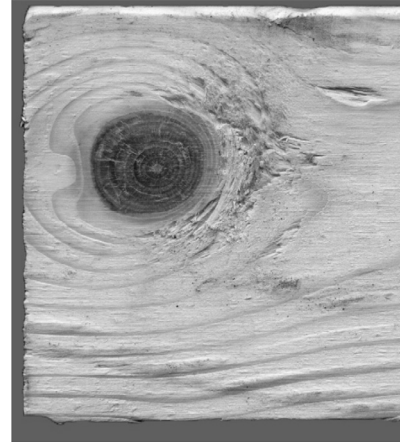
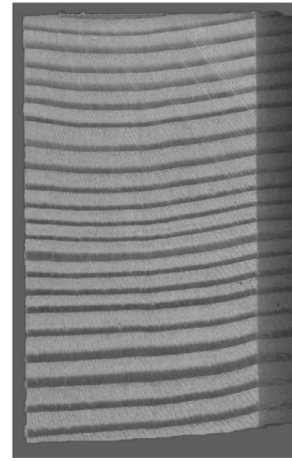
Each member is stressed by running it through rollers which measure the deflection and stiffness. The E modulus in bending can be calculated from the deflection.



## 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

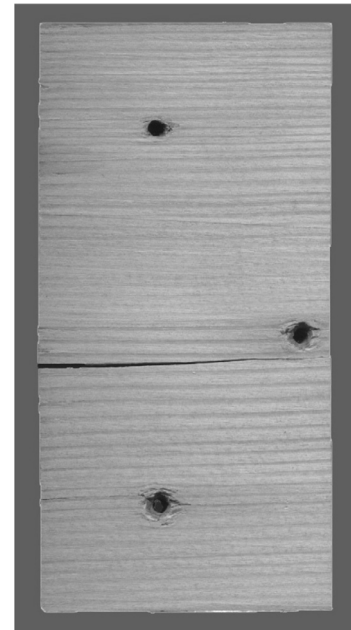
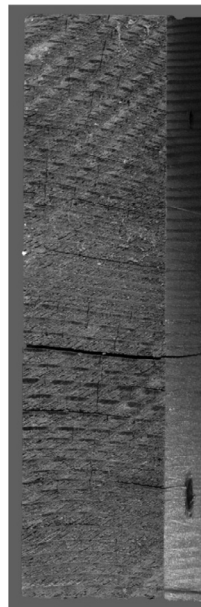


### Knots

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

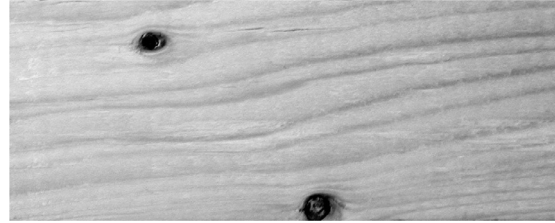
### Checks, Shakes and Splits

- 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

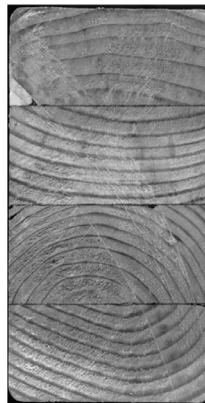
- The slope of the grain is taken in relation to the long edge of the member
- It is measured as a ratio e.g. 1" in 8"
- Increase in slope lowers the strength of the member



## 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.)	<b>Western Species</b>							
	2-1/2	3-1/8	5-1/8	6-3/4	8-3/4	10-3/4	12-1/4	14-1/4
	<b>Southern Pine</b>							
	-	3	5	6-3/4	8-1/2	10-1/2	-	-



2005 NDS

# Engineered Wood Products

## Prefabricated Wood I-Joists

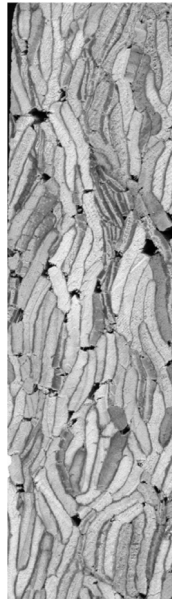
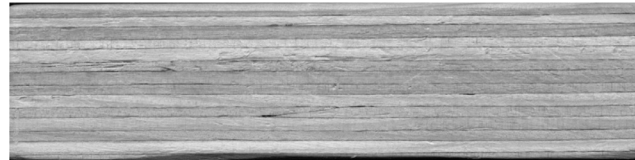
- ASTM D 5055
- Standard dimensions
- Specifications per manufacturer



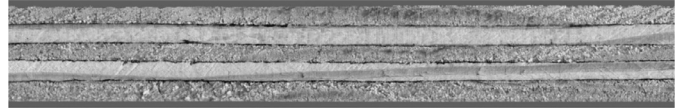
# Engineered Wood Products

## Structural Composite Lumber

- **Laminated Veneer Lumber (LVL)**
  - Veneer  $\leq \frac{1}{4}$ "
- **Parallel Strand Lumber (PSL)**
  - Strand thickness  $\leq \frac{1}{4}$ "
- Specifications per manufacturer



# 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 veneer and reconstituted wood based material



# Engineered Wood Products

## Wood Structural Panels

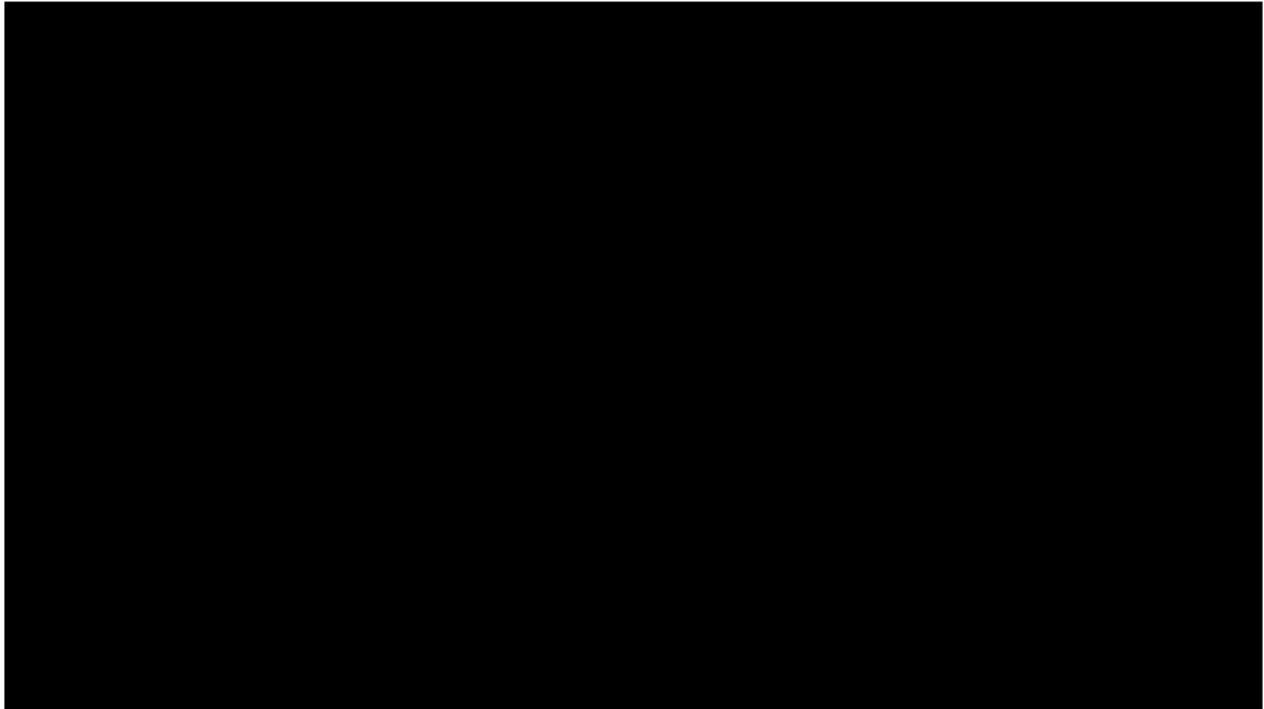
- **Cross Laminated Timber (CLT)** – cross laminated wood panels using at least three layers of boards or dimensioned lumber pressed and glued together. Thickness of layers varies from 5/8 inch to 2.0 inches. The width to pieces may vary from 2.4 to 9.5 inches. Panels are produced in different widths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





# 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.

