

WOOD

courtesy of PROF. S. VAIDYA


Photo: Maud Aptekar © 2010



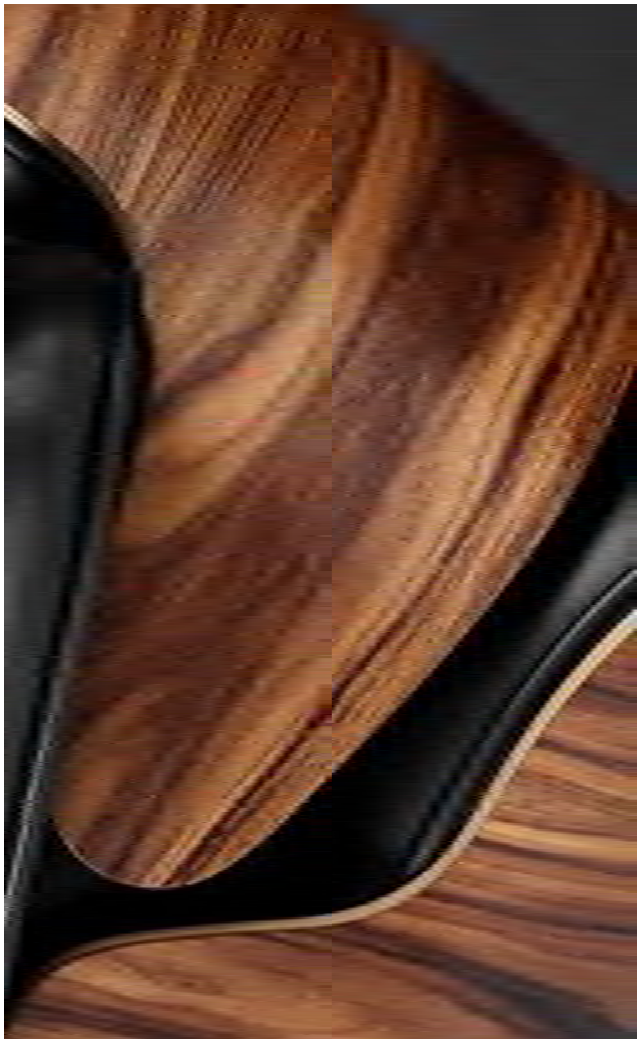
WOOD

courtesy of PROF. S. VAIDYA

Broadleafs = Hardwood

Coniferous = Softwood

courtesy of PROF. S. VAIDYA



Broadleafs = Hardwood

Coniferous = Softwood

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Softwoods:

Cedar*
Cypress*
Fir Alpine
Fir Balasm
Fir Douglas
Hemlock
Larch
Pine
Redwood*
Spruce

Uses:

Framing, Sheathing
Door frames, Window frames,
Rough Carpentry

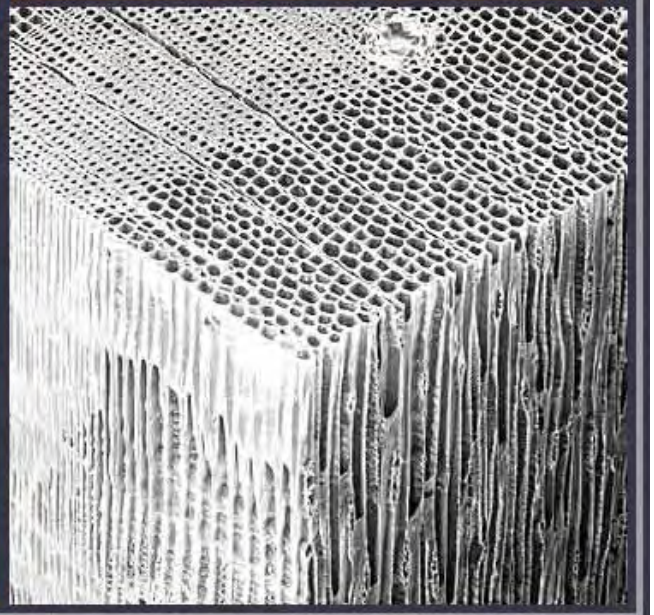
*Decay resistant words
(exterior use)

Hardwoods:

Ash
Basswood
Beech
Birch
Cherry
Mahogany
Oak
Rosewood
Teak
Walnut
Yellow poplar

Uses:

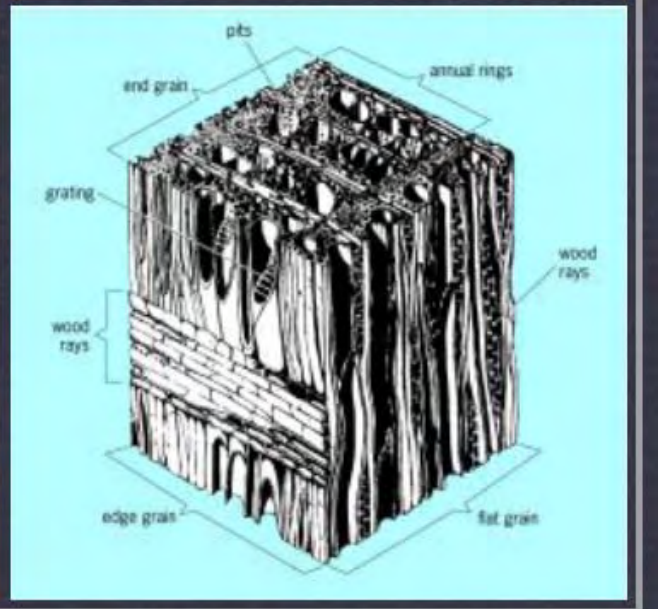
Mouldings, Paneling,
Furniture, Finish
Flooring, Finish
Carpentry, veneers



WOOD

softwood structure and grain pattern

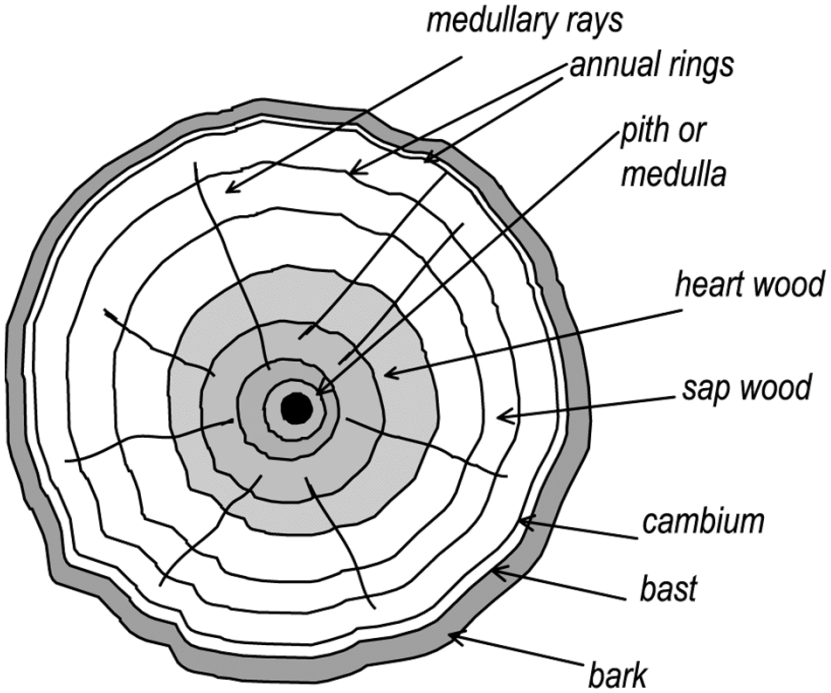
courtesy of PROF. J. Montgomery



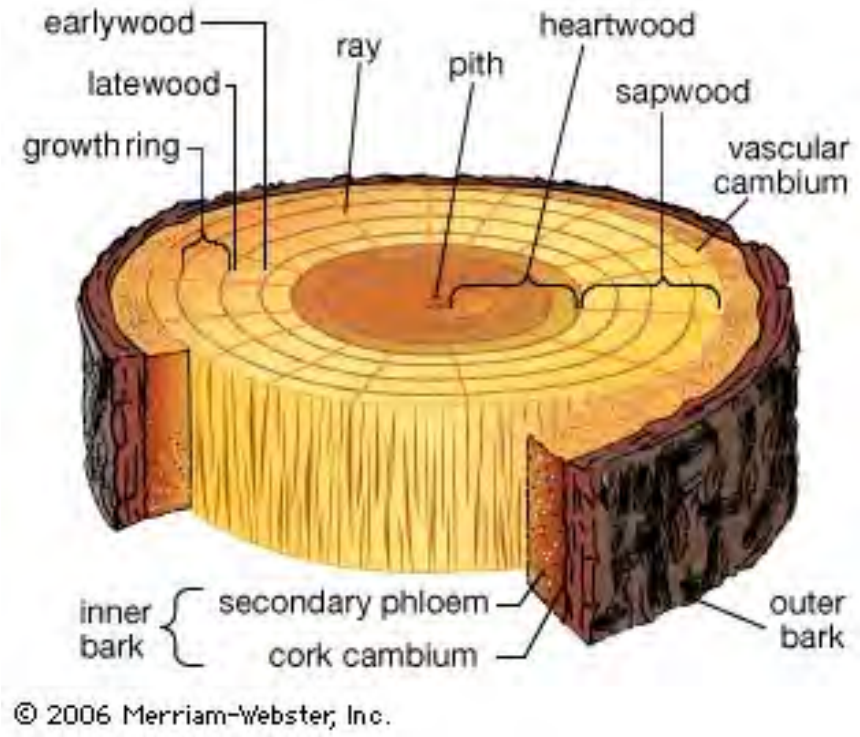
WOOD

hardwood structure and grain pattern

courtesy of PROF. J. Montgomery



The tree trunk showing growth rings

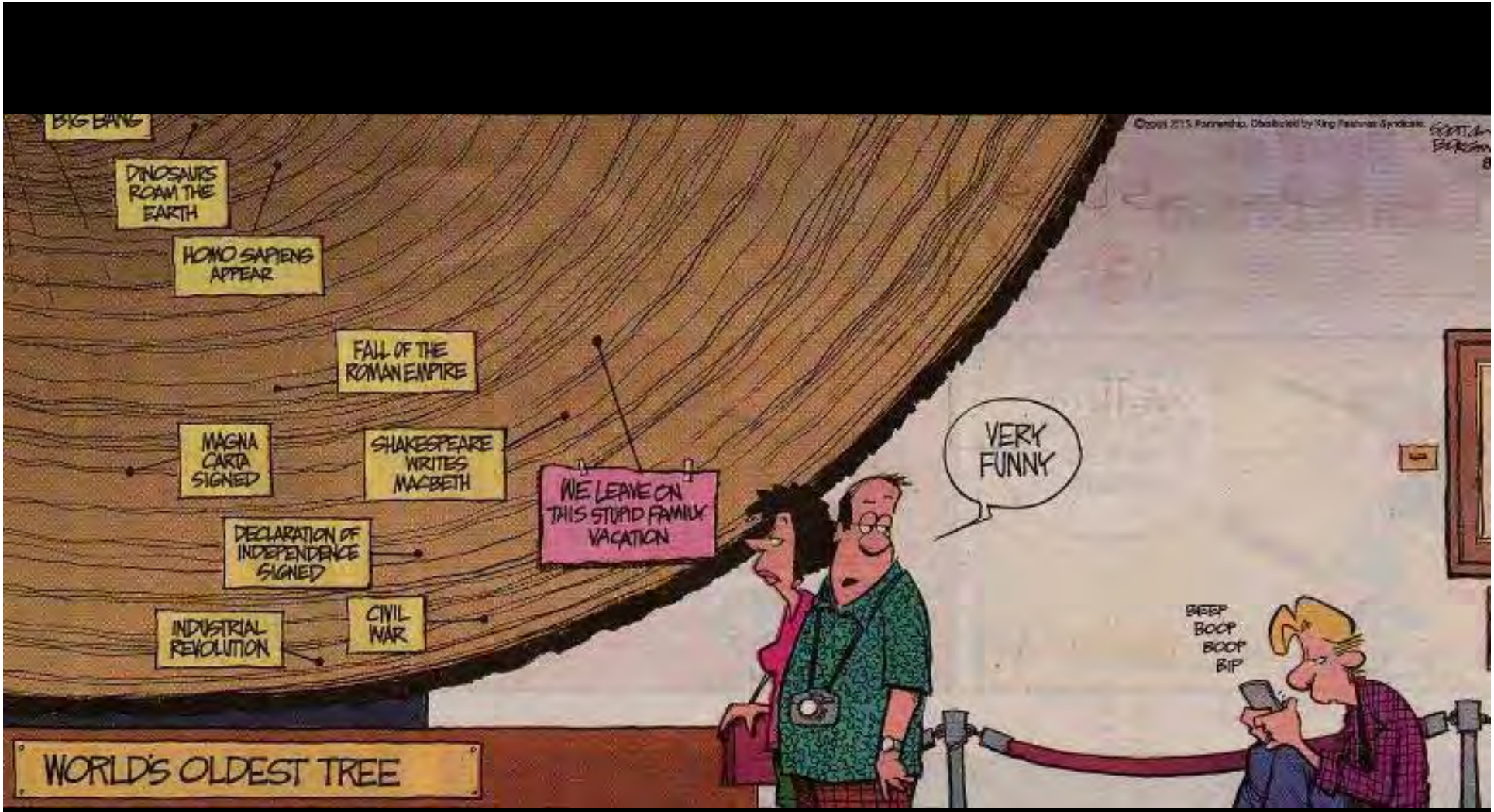


BARK (alive and dead)
CAMBIUM (creates new bark)
SAPWOOD (the distribution system)
HEARTWOOD (contributes to the trees strength)
PITH (the center of the tree)

RATE AND CONDITIONS OF GROWTH

Faster growth (less strong) = Springwood
Slower growth (denser and stronger) = Summerwood

courtesy of PROF. S. VAIDYA



courtesy of PROF. S. VAIDYA

WOOD

harvesting wood

courtesy of PROF. J. Montgomery

- clear cut forest
- destruction of habitat
- erosion problems
- recovery takes time

WOOD

forest management

courtesy of PROF. J. Montgomery

- maintain biodiversity and habitat
- selective harvesting
- confirm origin of wood products used in projects

WOOD

FSC + forest stewardship council

courtesy of PROF. J. Montgomery

HOW LUMBER IS CUT

Sawing:

The problem: How much lumber can be obtained from a tree vs. the quality of the lumber.

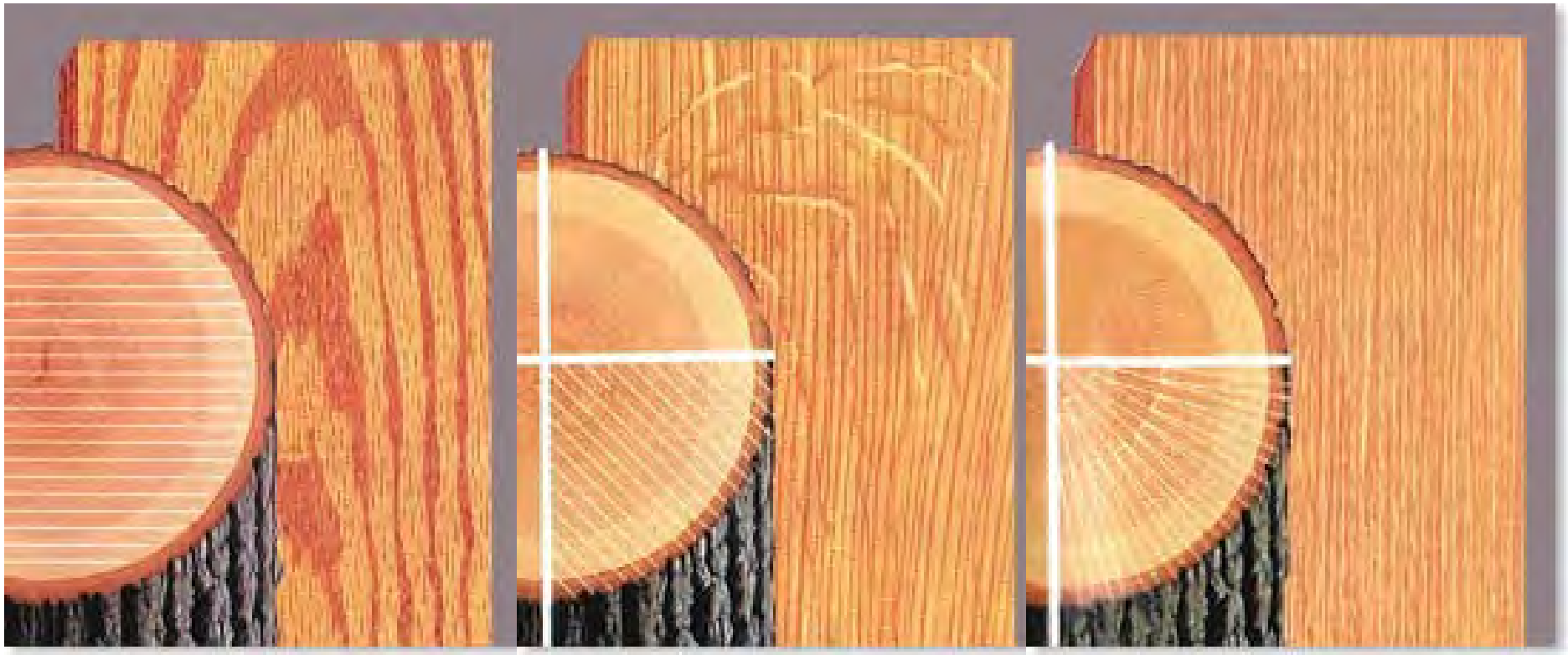
Plainsawing: the greatest yield (and greatest distortions during seasoning)

Quartersawing: Less yield (least warping)

The Lumber Yard/ Saw Mill:

http://www.youtube.com/watch?v=r2cDKZnlf2Y&NR=1

courtesy of PROF. S. VAIDYA



PLAIN SAWN **QUARTER SAWN** **RIFT SAWN**

courtesy of PROF. S. VAIDYA

SEASONING :

Removing moisture from green lumber
(from 32% to about 19%)
Unseasoned lumber: dimensionally unstable
Seasoned lumber: stronger and more stable.
Season too much:
Lumber will re-absorb moisture and swell up.

SEASONING METHODS:

Air-drying: takes months
Kiln drying: more control

SEASONING :

Shrinkage and swelling

Volume change is not equal in all directions.

Shrinkage will occur most in the direction (A) tangential (perpendicular) to the growth rings [5-10%]

(B) Shrinkage radially (parallels the grain) [2-6%]

(C) Least Shrinkage longitudinal (in the direction of tree growth) [.1-.3%]

SHRINKAGE AND WARPING

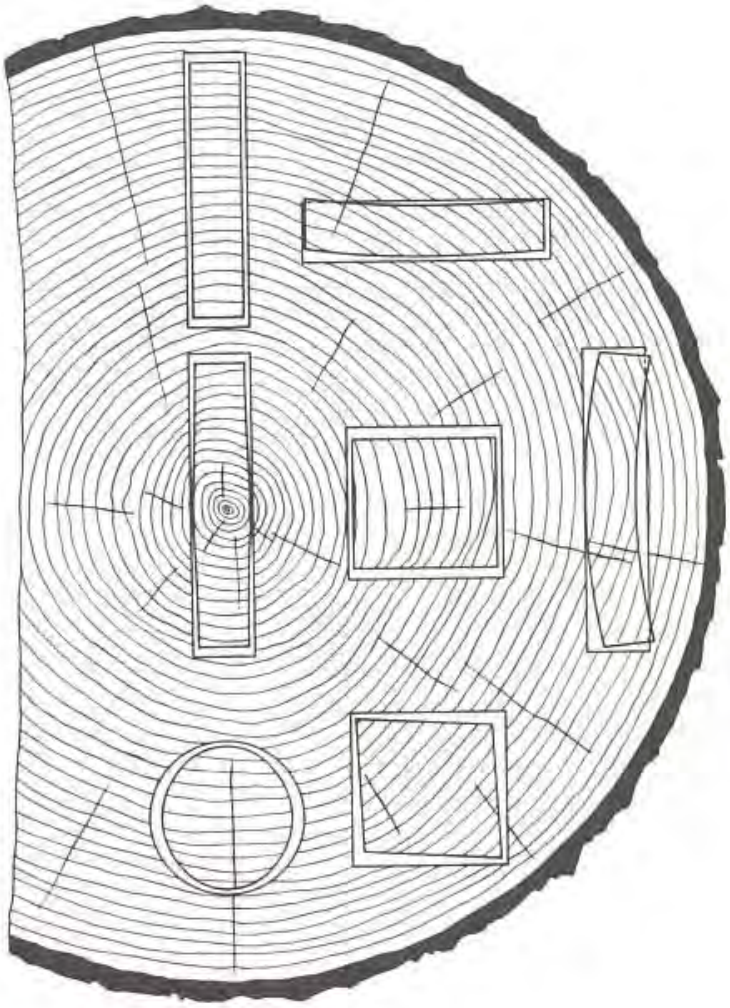


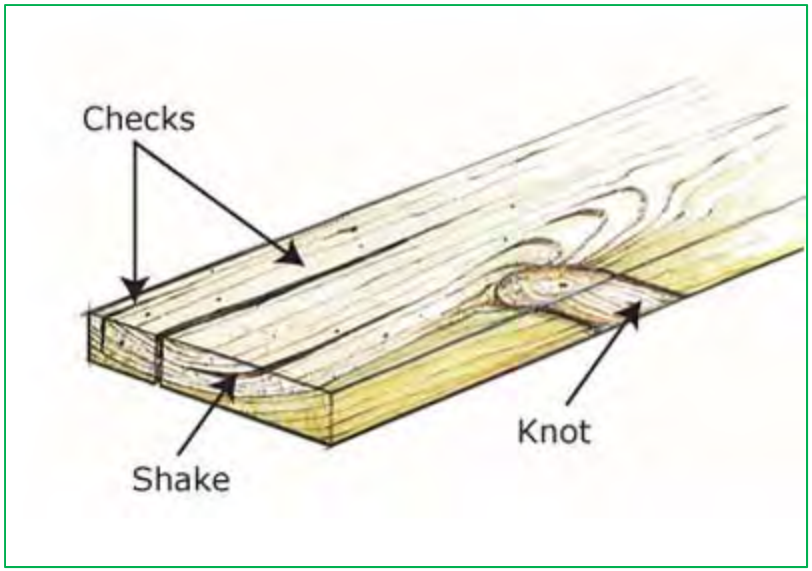
FIGURE 3.14
The difference between tangential and radial shrinkage also produces seasoning distortions in lumber. The nature of the distortion depends on the position the piece of lumber occupied in the tree. The distortions are the most pronounced in plainsawed lumber (upper right, extreme right, lower right). (*Courtesy of Forest Products Laboratory, Forest Service, USDA*)

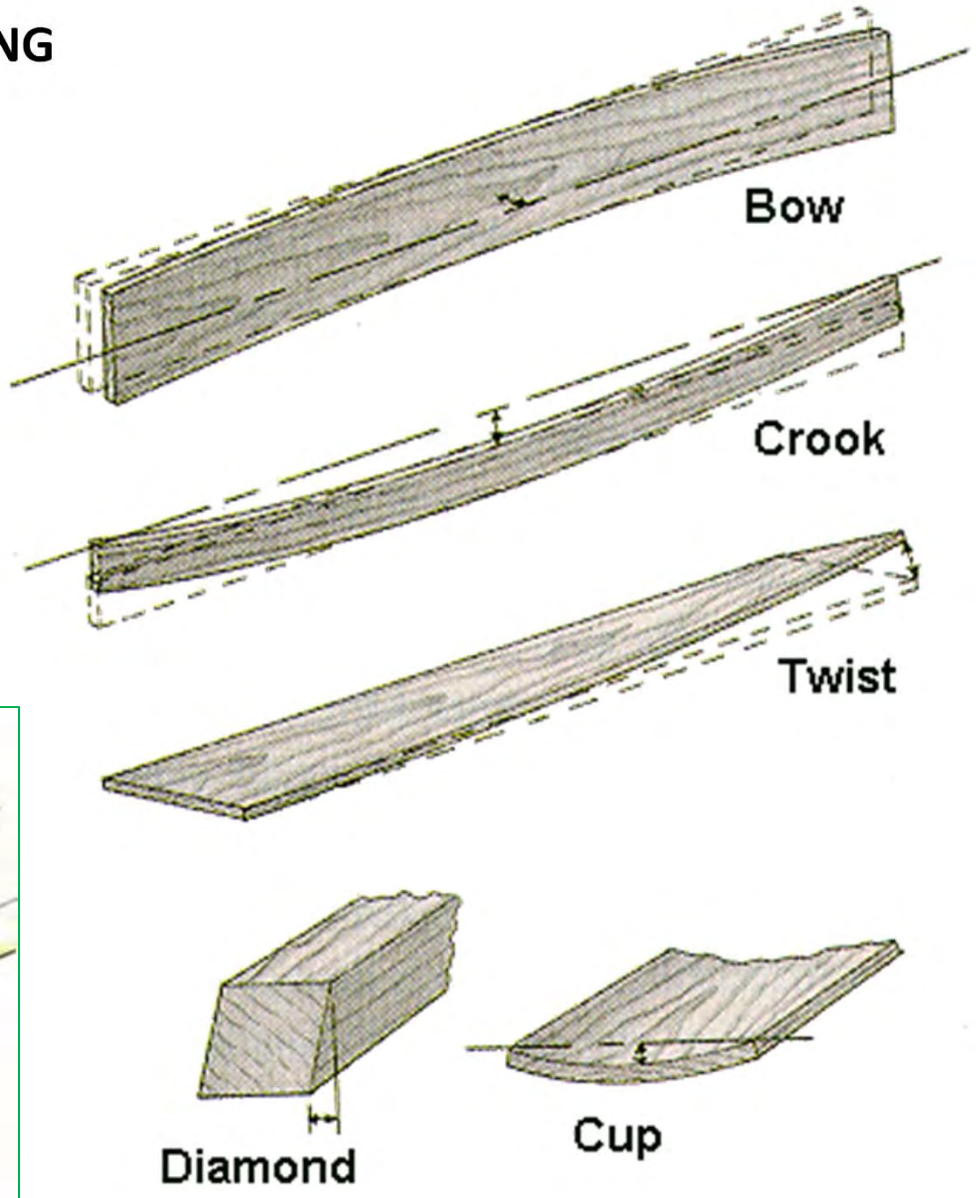
DEFECTS, SHRINKAGE AND WARPING

- Knots: places where branches joined the trunk.

- Splits and checks: caused by the stresses of seasoning

- Warping: crooking, bowing, twisting and cupping; due to the lumber shrinking unevenly.





courtesy of PROF. S. VAIDYA

DEFECTS, SHRINKAGE AND WARPING

crook

cup

bow

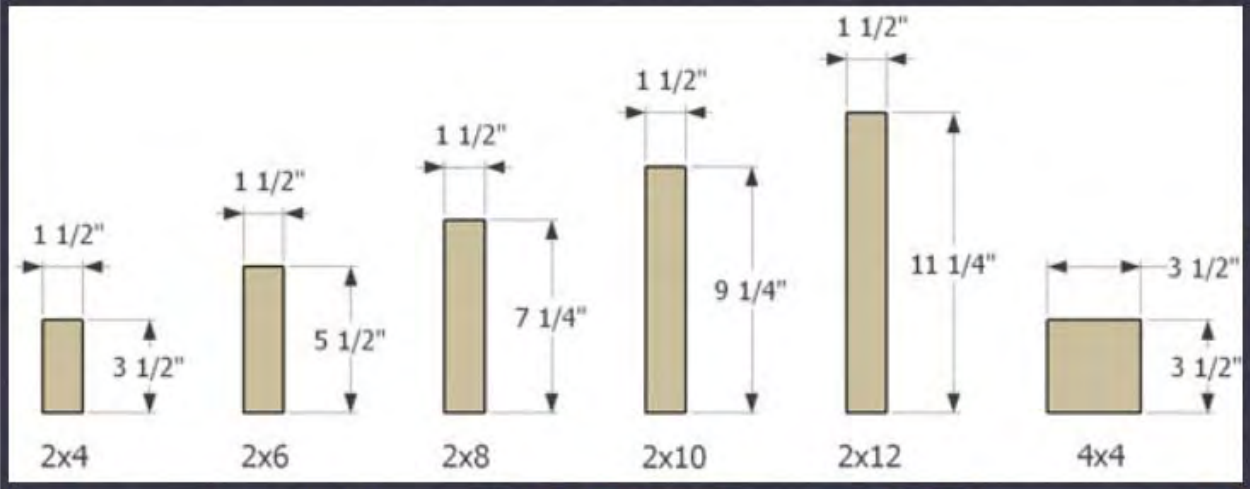
twist

Defects

Bark pocket

Knot: cut longitudinally

Knot: cut crosswise



Nominal Dimension	Actual Dimension
1" x 2"	3/4" x 1-1/2"
1" x 3"	3/4" x 2-1/2"
1" x 4"	3/4" x 3-1/2"
1" x 5"	3/4" x 4-1/2"
1" x 6"	3/4" x 5-1/2"
1" x 7"	3/4" x 6-1/4"
1" x 8"	3/4" x 7-1/4"
1" x 10"	3/4" x 9-1/4"
1" x 12"	3/4" x 11-1/4"
2" x 4"	1-1/2" x 3-1/2"
2" x 6"	1-1/2" x 5-1/2"
2" x 8"	1-1/2" x 7-1/4"
2" x 10"	1-1/2" x 9-1/4"
2" x 12"	1-1/2" x 11-1/4"
3" x 6"	2-1/2" x 5-1/2"
4" x 4"	3-1/2" x 3-1/2"
4" x 6"	3-1/2" x 5-1/2"

LUMBER

dimensional lumber

courtesy of PROF. J. Montgomery

NOMINAL VS ACTUAL

Nominal dimensions: 2x4 2x6 2x8……

Actual dimensions: After dressing : 1 ½ x 3 ½ …..

Nominal Dimension	Actual Dimension
1″	¾″ (19 mm)
2″	1½″ (38 mm)
3″	2½″ (64 mm)
4″	3½″ (89 mm)
5″	4½″ (114 mm)
6″	5½″ (140 mm)
8″	7¼″ (184 mm)
10″	9¼″ (235 mm)
12″	11¼″ (286 mm)
over 12″	¾″ less (19 mm less)

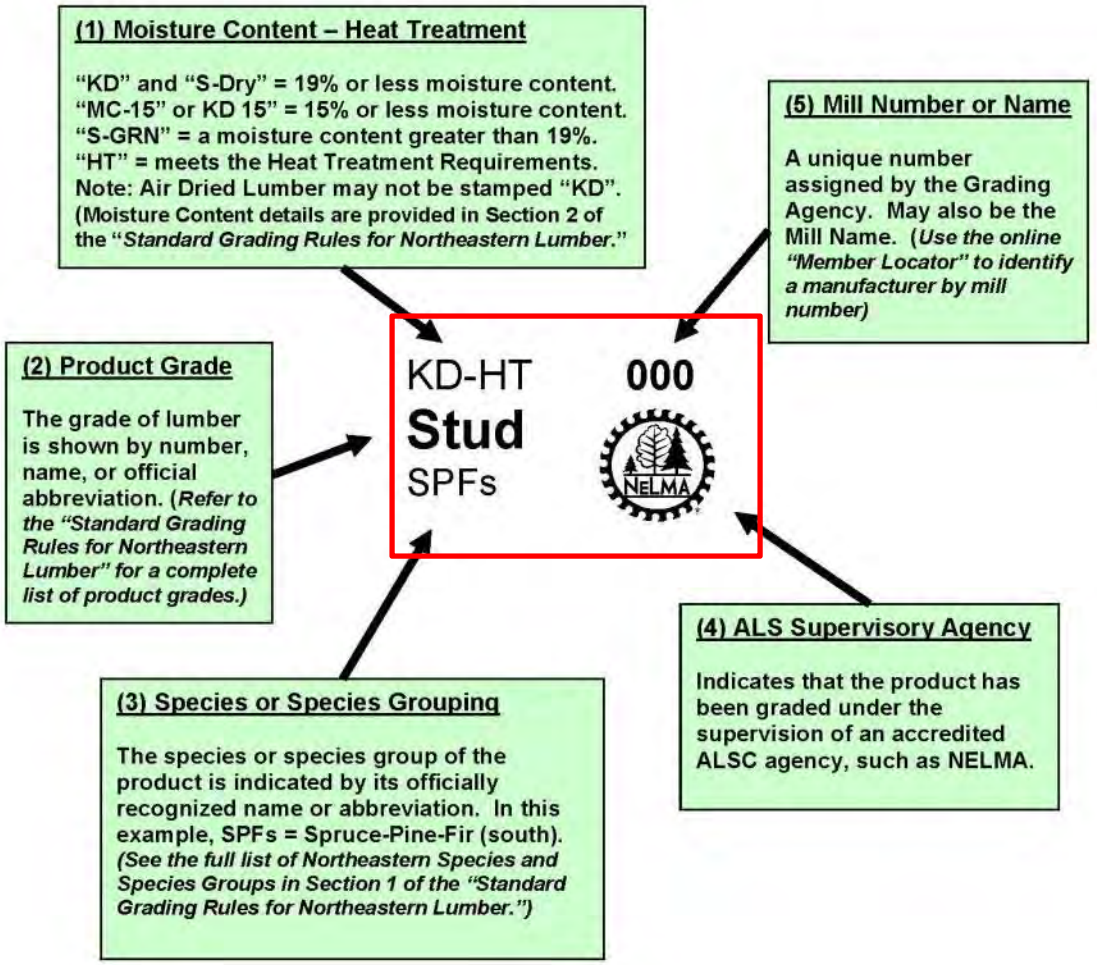
Basic material comparative properties

material	working strength in tension	working strength compression	density	modulus of elasticity
would (framing lumber)	300-1000 psi	600-1700 psi	30 pcf	1,000,000-1,900,000 psi
(including order, on reinforced)	0	250-13,000 psi	120 pcf	700,000-3,700,000 psi
structural steel	25,000-43,000 psi	25,000-43,000 psi	490 pcf	29,000,000 psi
concrete (unreinforced)	0	1,000-4,000 psi	145 pcf	3,000,000-4,500,000 psi

SURFACING GRADESTAMP

S-DRY: Lumber was surfaced after seasoning (smoothes out warping caused by seasoning)

S-GRN: Planed when green



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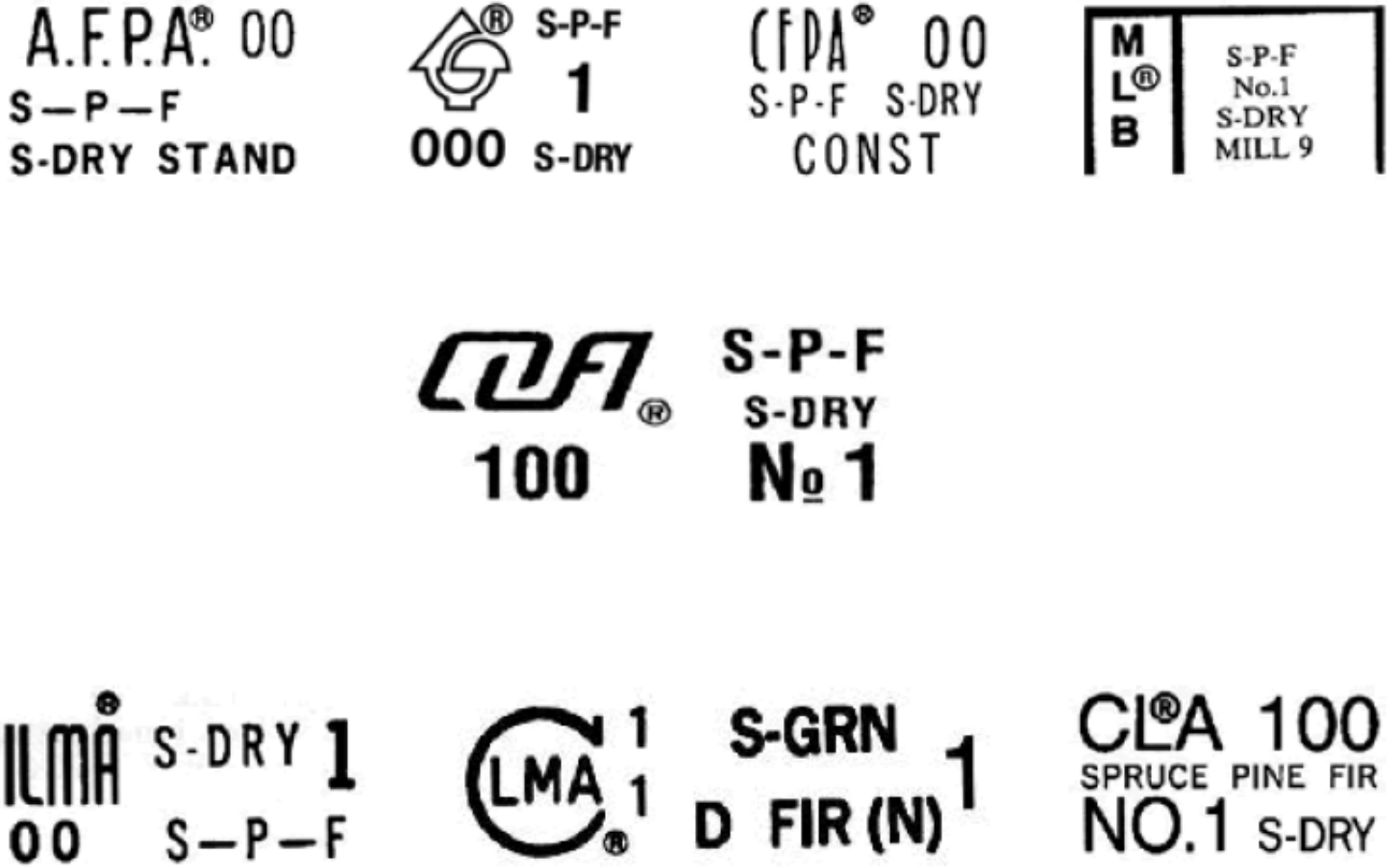
SURFACING GRADESTAMP



WOOD STRENGTH

- Wood is stronger parallel to the grain than it is perpendicular to the grain.
- Wood is stronger in compression than it is in tension.

> *"Defect free wood is comparable to steel on a strength-per-unit-weight basis, but with the ordinary run of defects, an average piece of lumber is inferior…"*

- Wood strengths varies according to the species
- "Allowable strength" varies according to the species and grade of the lumber.

ALLOWABLE STRENGTH*: the amount of stress you are permitted to apply to the lumber (this figure includes safety factors.)*

courtesy of PROF. S. VAIDYA

WOOD STRENGTH & GRADING

- Used where strength is critical use:
  - Douglas fir
  - Southern pine

- Used where strength is less critical
  - Eastern hemlock
  - Spruce-pine-fir

- Within each species there are strength grades
- Graded for appearance or structural strength.
- Strength is dependent on species and grade.
- Higher the grade, higher the price

WOOD STRENGTH & GRADING

DIMENSION LUMBER GRADES Table **2.1**

Product	Grades	WWPA Western Lumber Grading Rules Section Reference	Uses
Structural Light Framing (SLF) 2″ to 4″ thick 2″ to 4″ wide	SELECT STRUCTURAL NO.1 NO.2 NO.3	(42.10) (42.11) (42.12) (42.13)	Structural applications where highest design values are needed in light framing sizes.
Light Framing (LF) 2″ to 4″ thick 2″ to 4″ wide	CONSTRUCTION STANDARD UTILITY	(40.11) (40.12) (40.13)	Where high-strength values are not required, such as wall framing, plates, sills, cripples, blocking, etc.
Stud 2″ to 4″ thick 2″ and wider	STUD	(41.13)	An optional all-purpose grade designed primarily for stud uses, including bearing walls.
Structural Joists and Planks (SJ&P)	SELECT STRUCTURAL NO.1 NO.2 NO.3	(62.10) (62.11) (62.12) (62.13)	Intended to fit engineering applications for lumber 5″ and wider, such as joists, rafters, headers, beams, trusses, and general framing.

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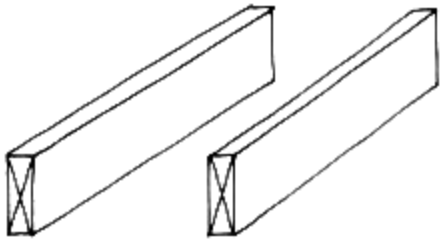
FRAMING

LUMBER CUT FOR HORIZONTAL USE

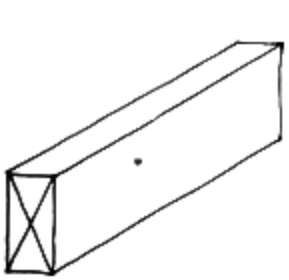
Joists: Usually 2" (nominal) in thickness used to directly support floor or ceiling, and supported in turn by a larger horizontal member (beam or girder) or a bearing wall. Joists are generally spaced at small, regular intervals, such as 12", 16", or 24" on center.



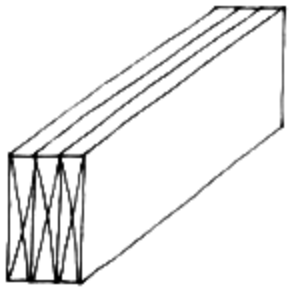
JOISTS

Beams: Larger (in cross section, not necessarily in length) than joists. Used to support joists and transfer their loads to vertical supports (or to girders).

Girders: Similar to beams, only larger in cross section.

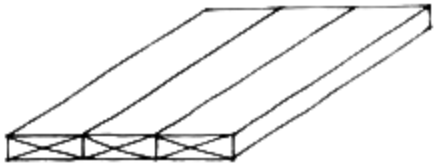


BEAM



BUILT-UP GIRDER

Planks: 2" in thickness (could be 3" or 4"). Used as flooring, roofing, or decking, directly over and supported by beams.



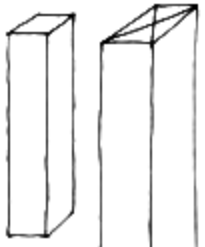
PLANKS

LUMBER CUT FOR VERTICAL USE

Posts: Vertical supports, usually short.

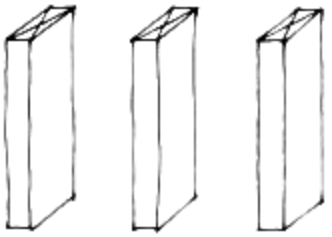
Columns: Vertical supports, longer than posts. Used to transfer horizontal loads down to the foundations.

Studs: Mini-columns. A series of slender structural members placed at small, regular intervals as the supporting elements in load-bearing wood walls and partitions.



POST

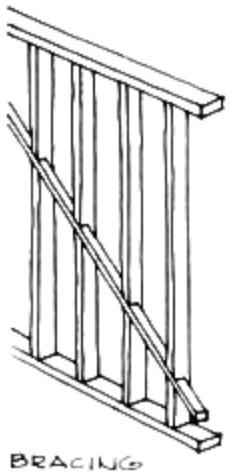
COLUMN



STUDS

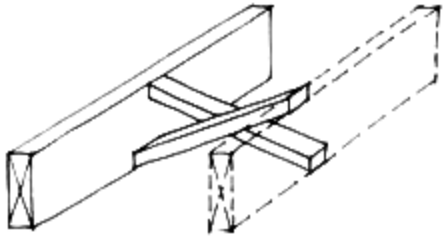
LUMBER CUT FOR DIAGONAL USE

Bracing: A piece of lumber applied to the frame on the diagonal to stiffen the structure.



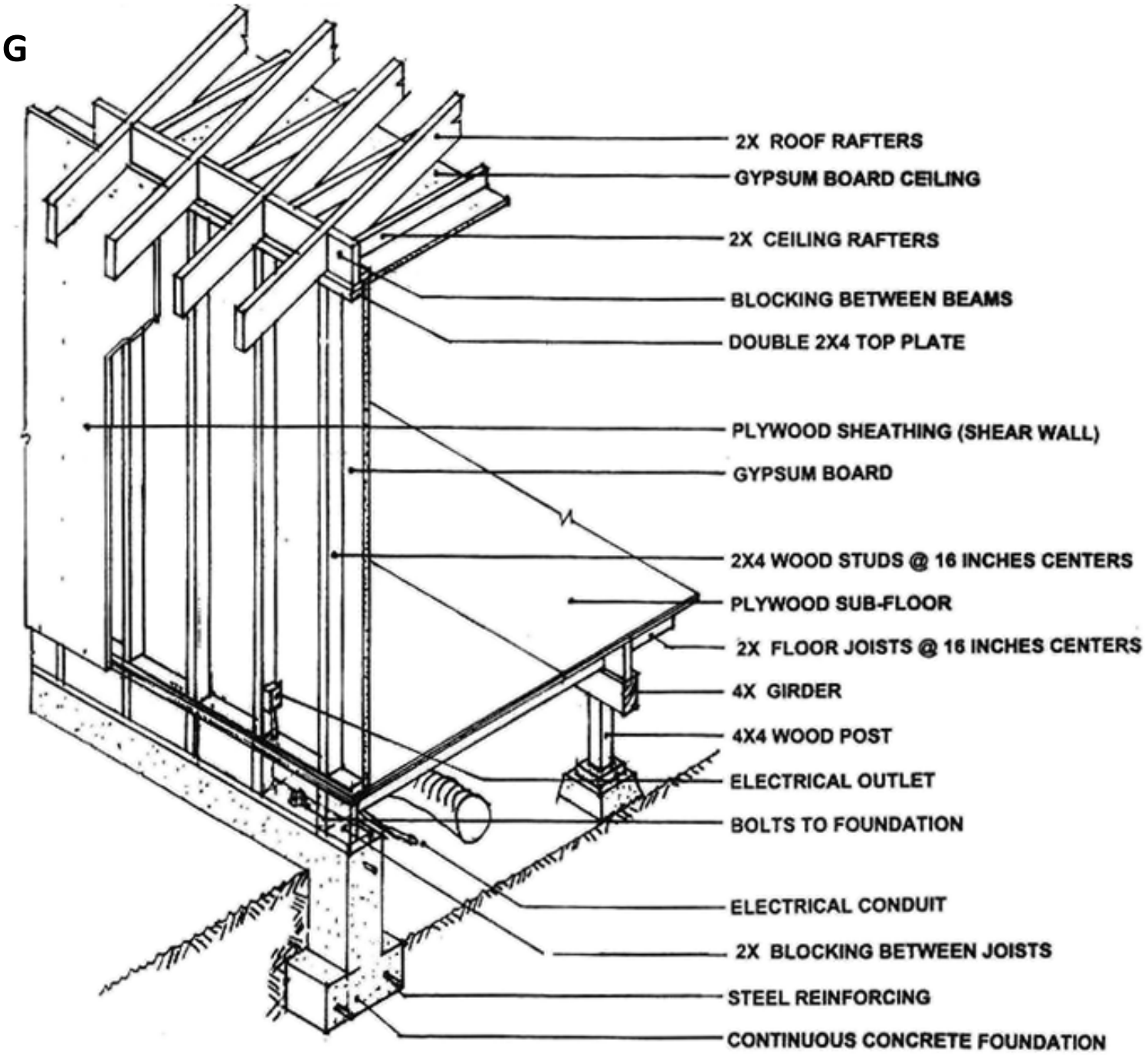
BRACING

Bridging: Used in an "X" pattern between the joists to stiffen the floor.



BRIDGING

FRAMING



courtesy of PROF. S. VAIDYA

FRAMING: *WOOD PRODUCTS*

- Need:

(a) To produce any desired shape in wood

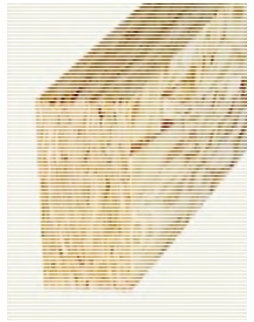
(b) To reduce wastage of wood when members are reduced to required size

FRAMING: *WOOD PRODUCTS*

- GLUE LAMINATED WOOD: GLULAM

  Engineered wood components made up of wood laminations, or "lams" that are glued together with waterproof adhesives.

  The grain of all laminations run parallel with the length of the member. Individual lams typically are less than 2" inches thick. Glulam products range in net widths from 2 1/2 to 10 3/4 inches, although nearly any member width can be produced



- STRUCTURAL COMPOSITE LUMBER OR ENGINEERED LUMBER:
  - LSL = LAMINATED STRAND LUMBER
  - OSL = ORIENTED STRAND LUMBER

  (rim boards and short span headers)

  - LVL = LAMINATED VENEER LUMBER
  - PSL = PARALLEL STRAND LUMBER (*stronger*)

(commonly used for longer span headers & floor beams)

  - WPC = WOOD PLASTIC COMPOSITE

courtesy of PROF. S. VAIDYA

FRAMING: *WOOD PRODUCTS: GLULAM*

- Allows for usage as a beam or column
- Exposed to view appearance grades available
- Camber can be manufactured into the beam for long term deflection considerations
- Versatile in all light commercial and industrial applications
- Custom curved and other complex shapes available
- Glulams can be fabricated to achieve a one hour fire resistant rating in an exposed to view condition.

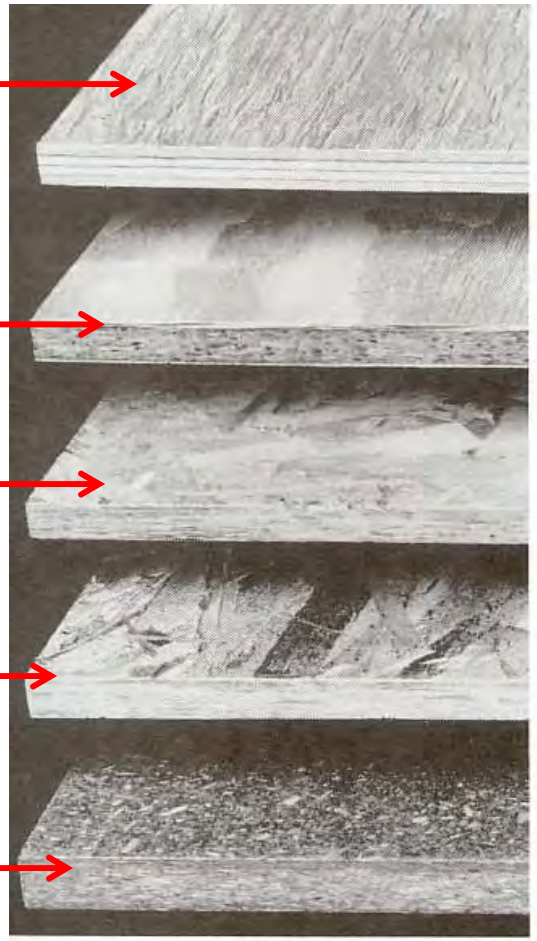
courtesy of PROF. S. VAIDYA

FRAMING: *WOOD PRODUCTS: GLULAM*

2009 RAIC Awards of Excellence
Richmond Olympic Oval

FRAMING: *WOOD PANEL PRODUCTS*

- STRUCTURAL WOOD PANELS
  - PLYWOOD
  - COMPOSITE PANEL
  - WAFER BOARD (FLAKE BOARD)
  - OSB = ORIENTED STRAND BOARD
  - PARTICLE BOARD
  - FIBERBOARD (MDF)



PLYWOOD PRODUCTION

http://www.youtube.com/watch?v=njoXy8HZC9I&feature=related

courtesy of PROF. S. VAIDYA

FRAMING: *WOOD PANEL PRODUCTS - GRADESTAMPS*

1 Panel grade
2 Span Rating
3 Tongue-and-groove
4 Bond classification
5 Product Standard
6 Thickness
7 Mill number
8 APA's performance rated panel standard
9 Siding face grade
10 Species group number
11 HUD recognition
12 Panel grade, Canadian standard
13 Panel mark – Rating and end-use designation per the Canadian standard
14 Canadian performance rated panel standard
15 Panel face orientation indicator

FRAMING: *WOOD PRODUCTS*

Laminated Veneer Lumber (**LVL**):
uses veneers in sheets and looks like a plywood with no cross-bands

Parallel Strand Lumber (**PSL**):
Veneers are sliced into narrow strands, coated with adhesive, oriented longitudinally and pressed into rectangular cross sections.

FRAMING: *WOOD PRODUCTS: GLULAM*

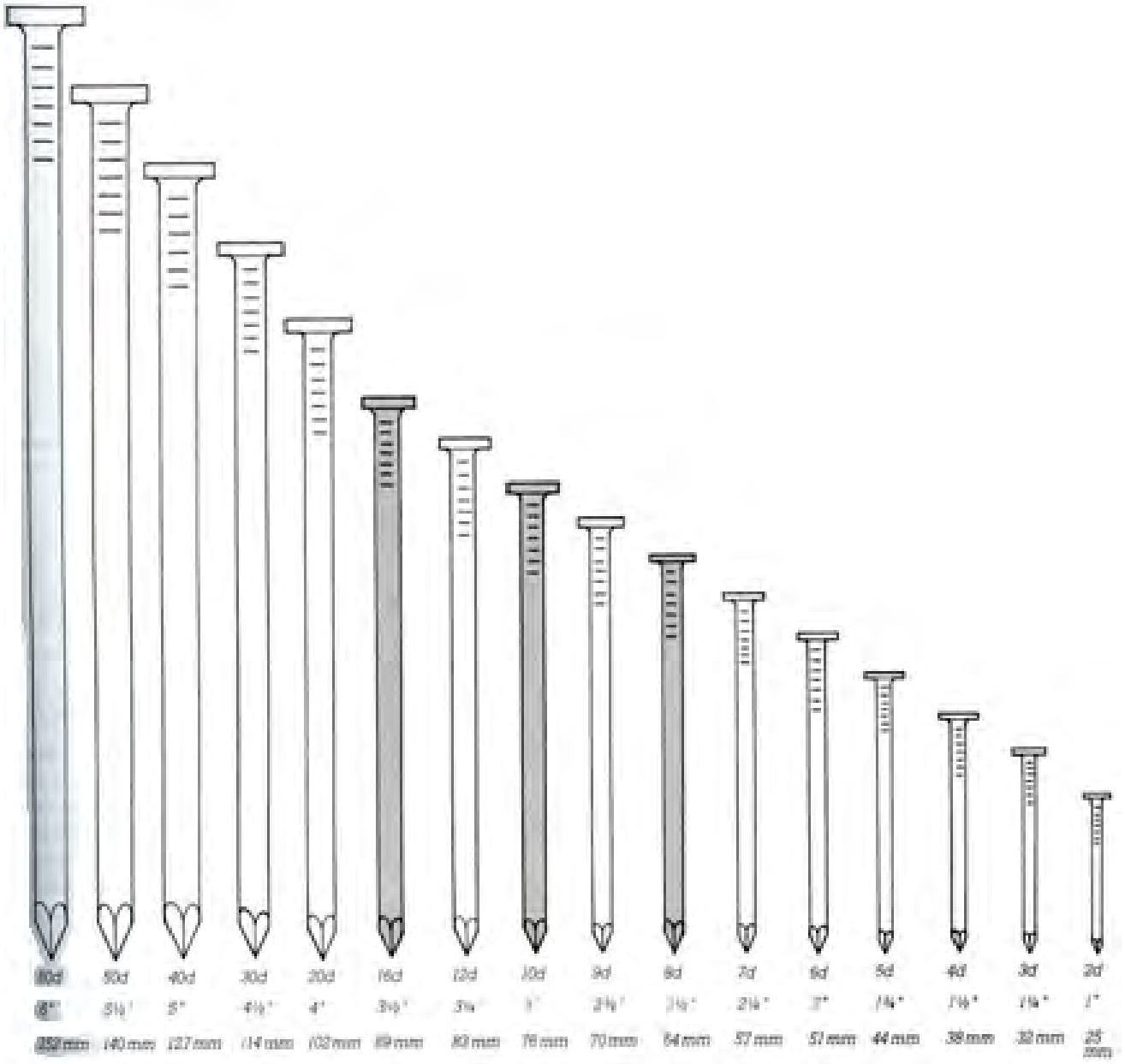
courtesy of PROF. S. VAIDYA

FRAMING: FASTENERS & *JOINERY*

- Fasteners are **the weakest links** in wooden construction
- **Earlier mortised and pegged joints** were weak due to material removal
- In today's construction, **nails, screws, bolts, toothed plates & adhesives** are used to develop full strength of joined members.
- Since most of the **joints depend primarily on the bearing strength** of joints, simple fasteners are found to be sufficient
- **Nails:** Sharpened metal pins driven into wood with a hammer or mechanical gun - Should have corrosion resistance: **Hot-dip galvanized** - Type of nails: **Common nails** (flat head); used for most structural purposes - **Box nails:** made of lighter gauge wires; less holding power - **Casing nails, finish nails and brad nails:** virtually headless, used for attaching finish components of a building - **Deformed shank nails:** used for attaching gypsum wall boards and floor under-layment - **Hardened concrete nail:** provides proper holding power to soft roofing tiles - **Methods of fastening:** Face nail, End nail, Toe nail.

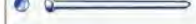
FRAMING: FASTENERS & *JOINERY*

- NAILS
- SCREWS
- NAILING PLATES
- TOOTHED PLATES
- SHEET METAL CONNECTORS
- BOLTS
- GLUES
- TRADITIONAL JOINERY



FRAMING: FASTENERS & *JOINERY*

Commonly Used Nails

Flat Head/Wire Nail	
	For rough carpentry work: large ugly head ensures a firm grip. Liable to split wood. Blunting the point can help to avoid this.
Bullet Head/Oval Brad	
	Commonly used in carpentry. Oval cross section makes it unlikely to split wood if the long axis follows the grain.
Lost Head	
	General carpentry nail. Head can be punched below surface and the hole filled. Called a "finish nail" in the U.S.
Panel Pin	
	Small nail for securing light pieces of wood ; usually used in conjunction with glue. Called a "brad" in the U.S.
Clout	
	Large headed for fixing roofing felt, sash cords, wire fencing to wood. Galvanized for outdoor work. Called a "roofing nail" in the U.S.
Flooring Brad/Cut Nail	
	Used to hold down floorboards. Good holding power and unlikely to split wood. Good fixing for lightweight insulation block.
Glazing Brad	
	Headless: used to hold glass into picture frames, window sashes and lino to floorboards. Will not grip if driven too far in.
Masonry Nail	
	Hardened steel nail for fixing wood to soft brick, breeze block and concrete.
Hardboard Pin	
	Special head shape countersinks itself in hardboard and can be filled over.

Special Purpose Fixings

Carpet Nail	
	Small nail with broad head. For fixing carpets and fabrics to wood or floorboards.
Annular Ring Nail	
	For fixing plywood, fibreboard and other sheet materials. Very strong grip but difficult to remove.
Roofing Nail	
	For securing corrugated iron or asbestos roofing to wooden rafters. Galvanized for outside work. Called a "spiral nail" in the U.S.
Pipe Nail	
	Used to fix guttering and other rainwater hardware directly onto masonry or brick.
Wire Staple	
	Used to secure wire fencing, upholstery springs and similar hardware to wood. Galvanized for outside work.
Wood Cleat (corrugated fastener)	
	For butt or mitre joining wood, quickly and easily. For light duty work.
Sealing Roof Nail	
	Used on corrugated metal roofing. Has a plastic or lead washer under the head. Drive through the high part of the corrugation.
Duplex Nail	
	Used for assembling concrete boxing or formwork. Lower head grips the timber; upper head facilitates removal.
Flooring Nail	
	Used to nail floorboards to diagonal sub-floors. Holds like a screw, but easier to drive.

http://www.diyinfo.org/wiki/Wood_Nails-Screws,Types-Uses_Explained

FRAMING: FASTENERS & *JOINERY*

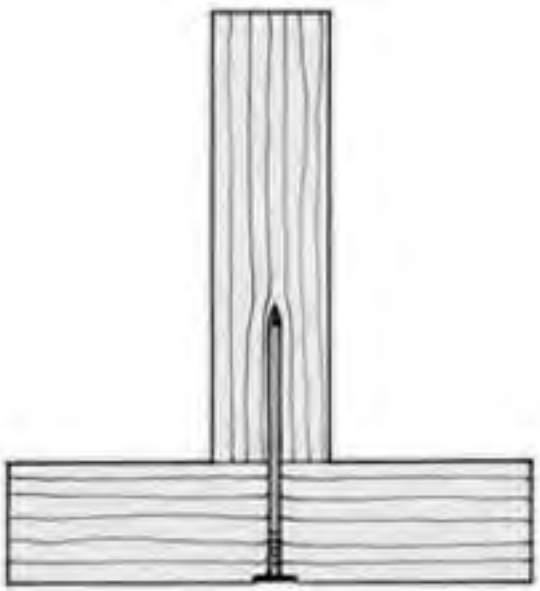
Commonly Used Screws

Flat Head Screw (Counter Sunk)	
	Used for general woodwork. The head sinks in flush with or slightly below the wood surface.
Cross Head/Pozi Drive Screw (Counter Sunk)	
	Used for general woodwork, but needs a special screwdriver which does not slip from the head. Called a "Phillips Head" screw in the U.S.
Round Head Screw (Counter Sunk)	
	Used for fixing door-handle plates and other decorative fittings with countersunk holes. The head is designed to be seen.
Round Head Screw	
	Used for fixing hardware fittings without countersunk holes. The head protrudes from the work.
Mirror Screw	
	Used for fixing mirrors and ' bathroom fittings. The chromed cap threads into the screw head to hide the screw. Do not over tighten.
Nut Head/Coach Screw	
	Used for fixing heavy constructions together and heavy equipment to timbers. Tighten with a spanner. Called a "lag screw" in the U.S.
Invisible Screw/Dowel Screw	
	Used for invisible joining of two pieces of timber.
Panel Screw	
	Used for fixing thin sheets of metal and plastic. Cuts its own thread as it is screwed in. Various types of head are available.
Chip or Custom Board Screw	
	Used for securing chipboard and its derivatives. Various types of heads are available.
Handrail Bolt	
	Used for jointing sections of handrails together. A screwdriver is used to turn the nut.

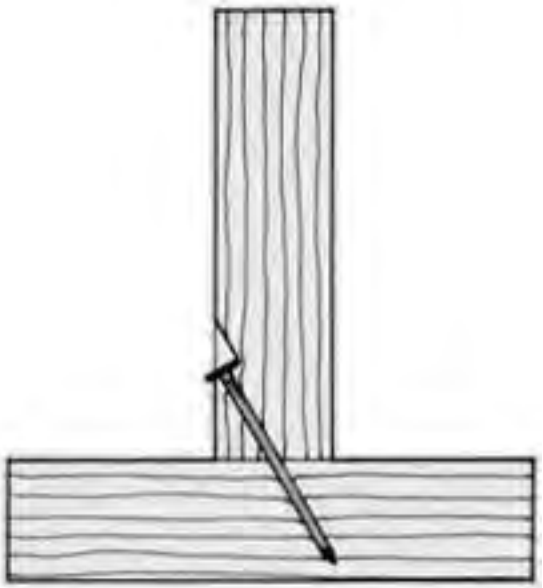
http://www.diyinfo.org/wiki/Wood_Nails-Screws,Types-Uses_Explained

FRAMING: FASTENERS & *JOINERY-Nails*

FACE NAIL



END NAIL

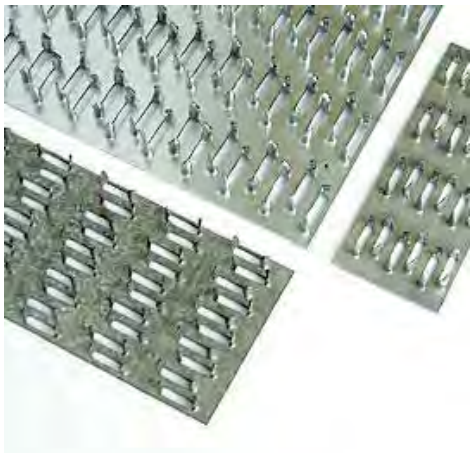


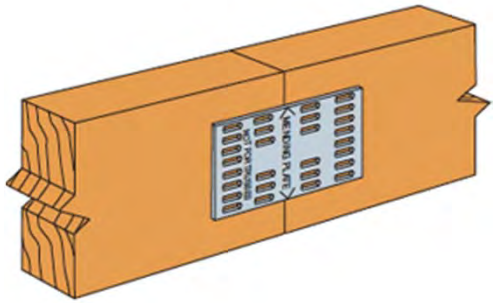
TOE NAIL

FRAMING: FASTENERS & *JOINERY-Nails*

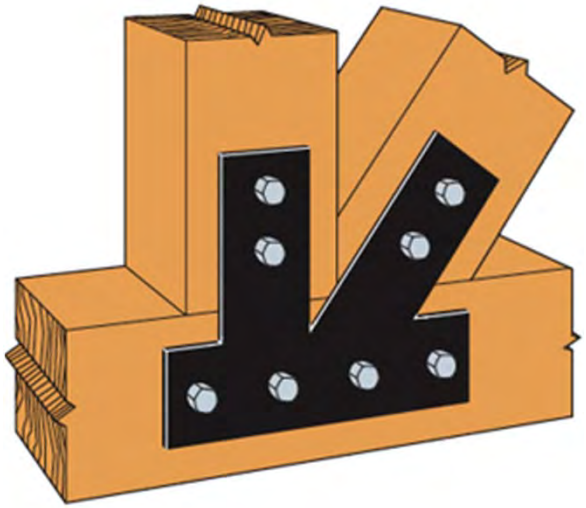
courtesy of PROF. S. VAIDYA

FRAMING: FASTENERS & *JOINERY*-*Nailing Plates, Toothed Plates, Sheet Metal Connectors*





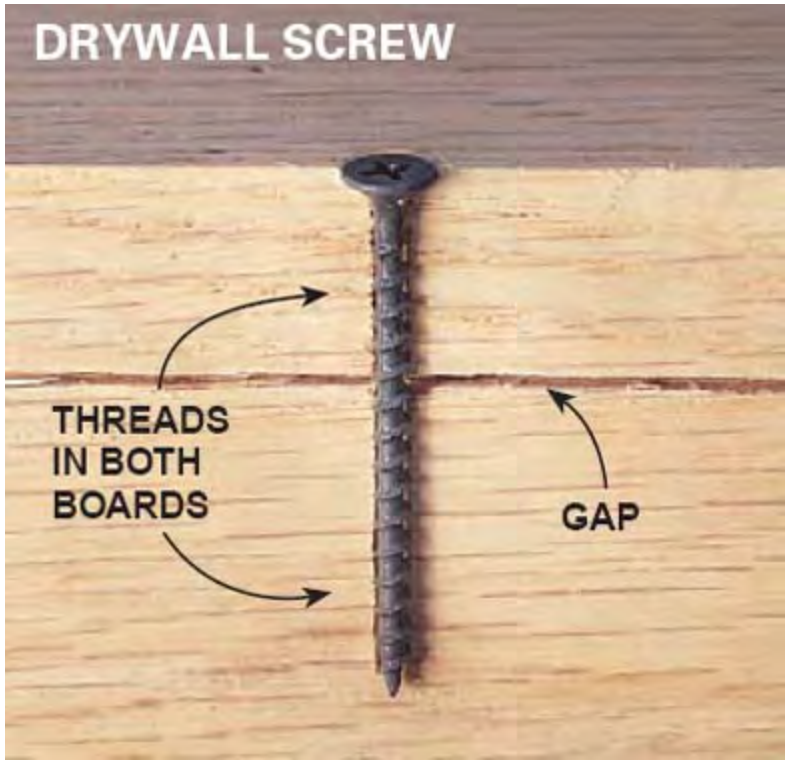
Timber Connectors

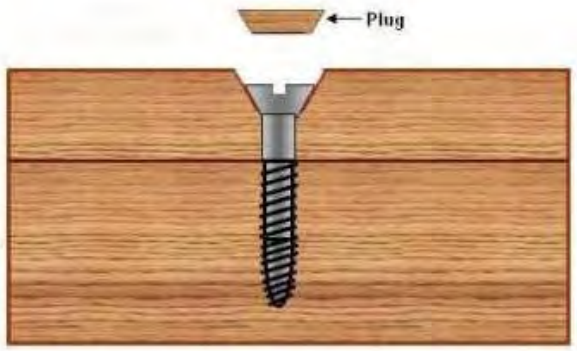


http://www.strongtie.com/index.html?source=topnav

courtesy of PROF. S. VAIDYA

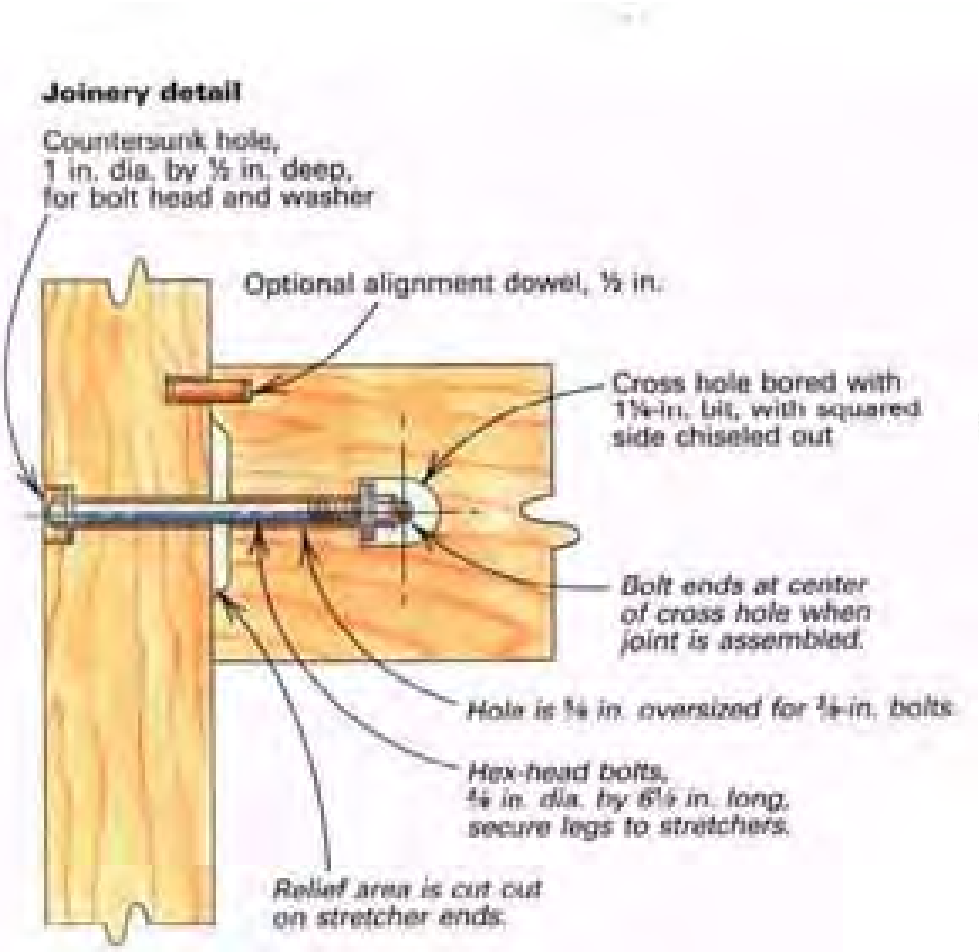
FRAMING: FASTENERS & *JOINERY-Screws*

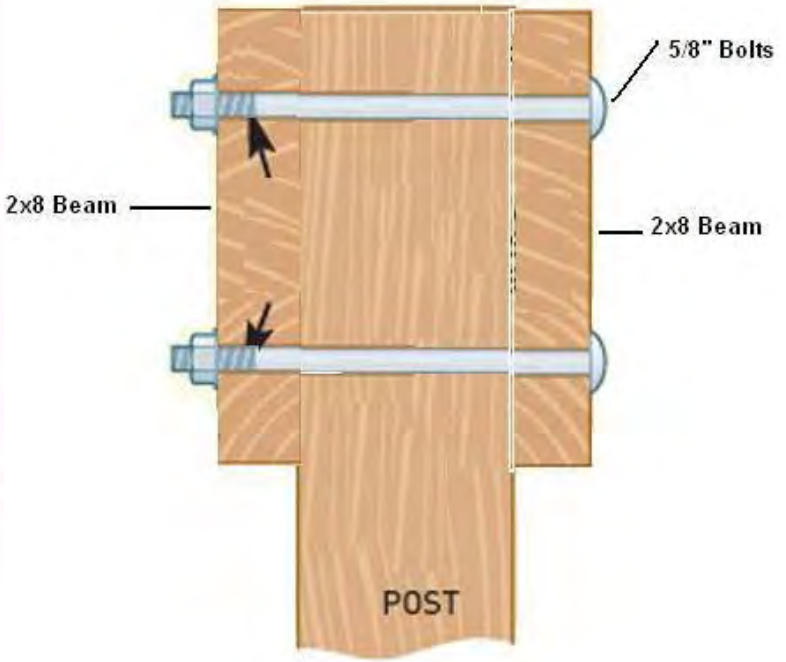




courtesy of PROF. S. VAIDYA

FRAMING: FASTENERS & *JOINERY-Bolts*

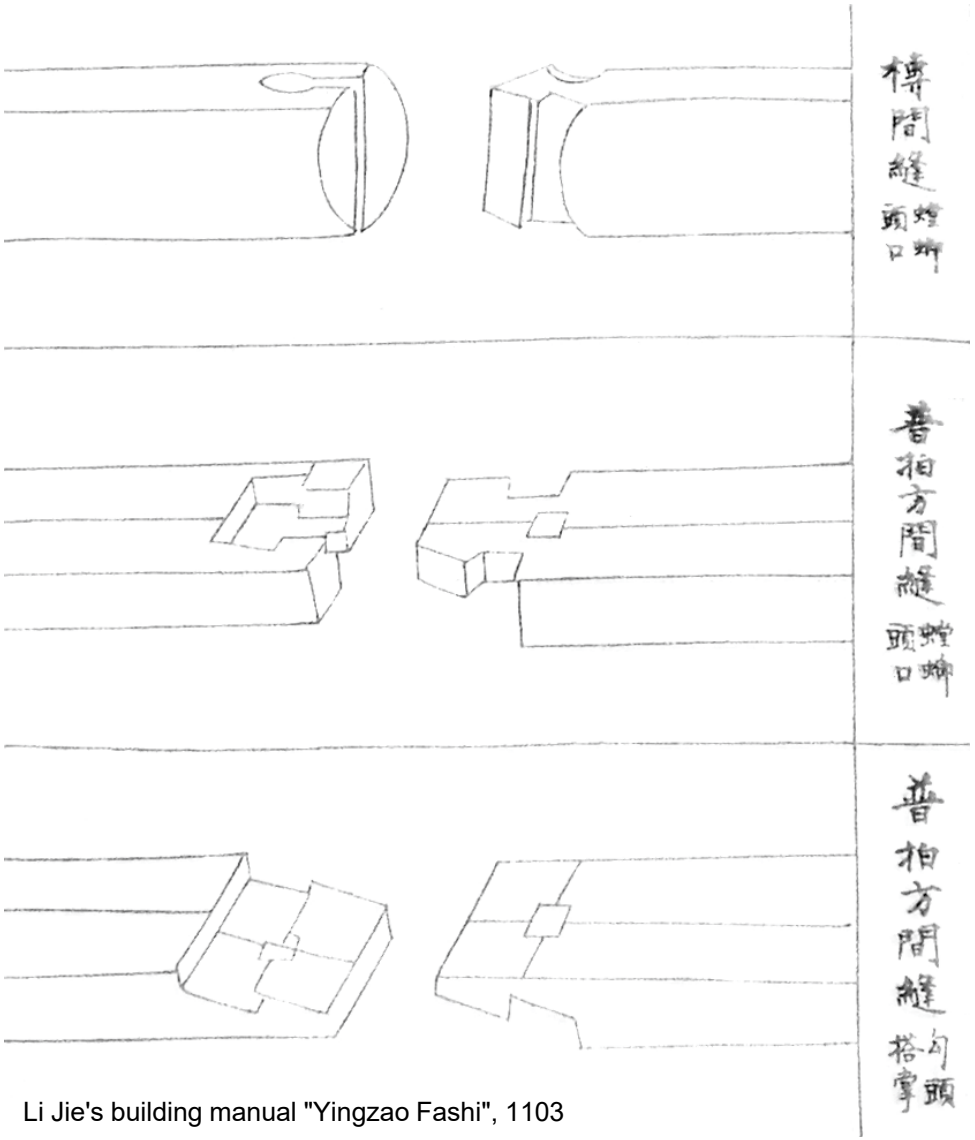




courtesy of PROF. S. VAIDYA

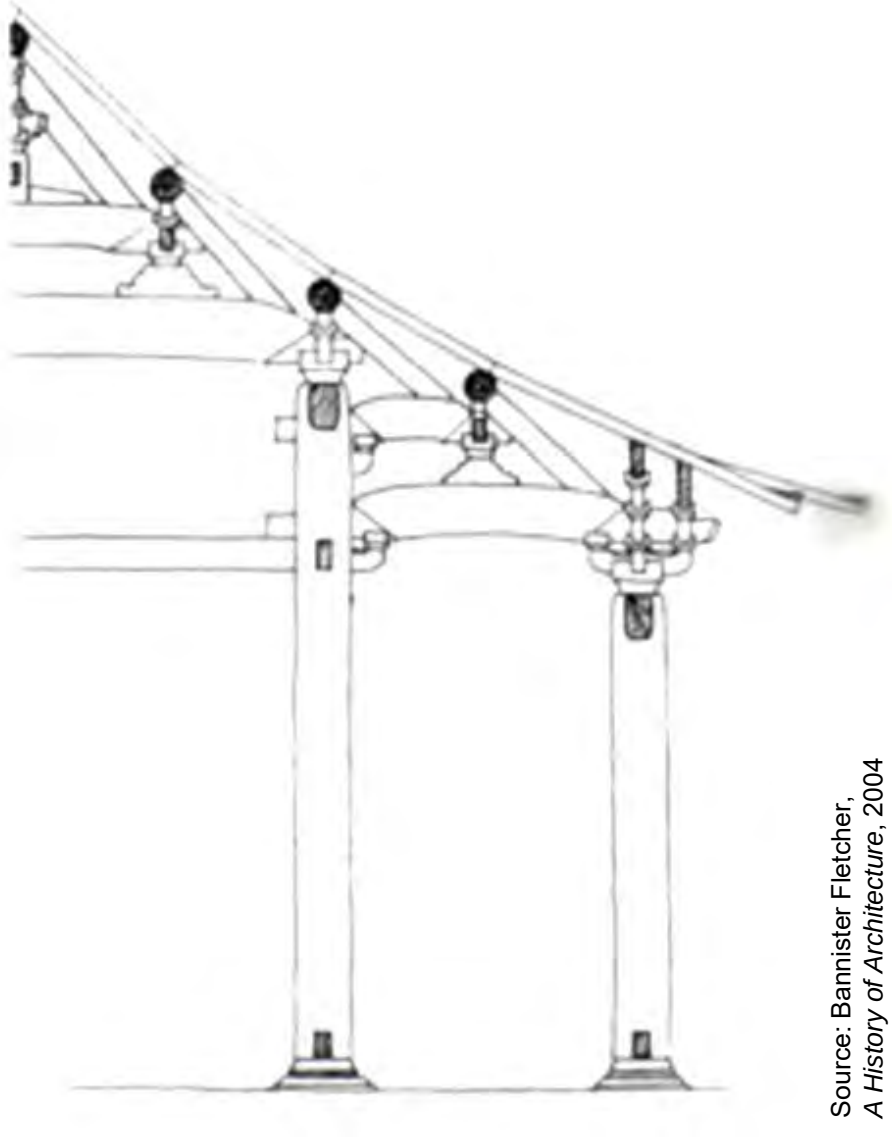
Chinese Timber Construction, Traditional

Forms of Jointing



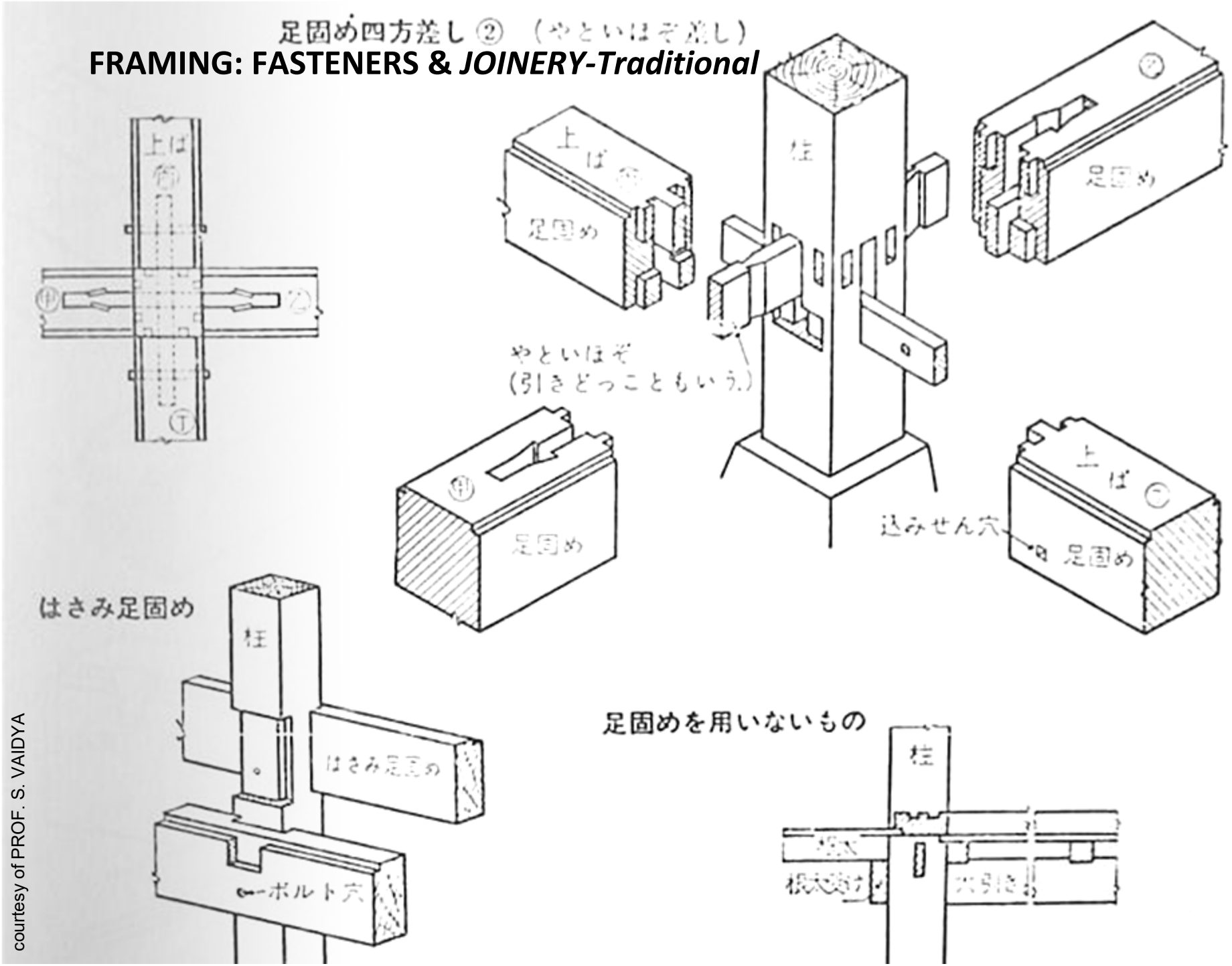
Li Jie's building manual "Yingzao Fashi", 1103

Section Bracket



Source: Bannister Fletcher, *A History of Architecture*, 2004

FRAMING: FASTENERS & *JOINERY-Traditional*



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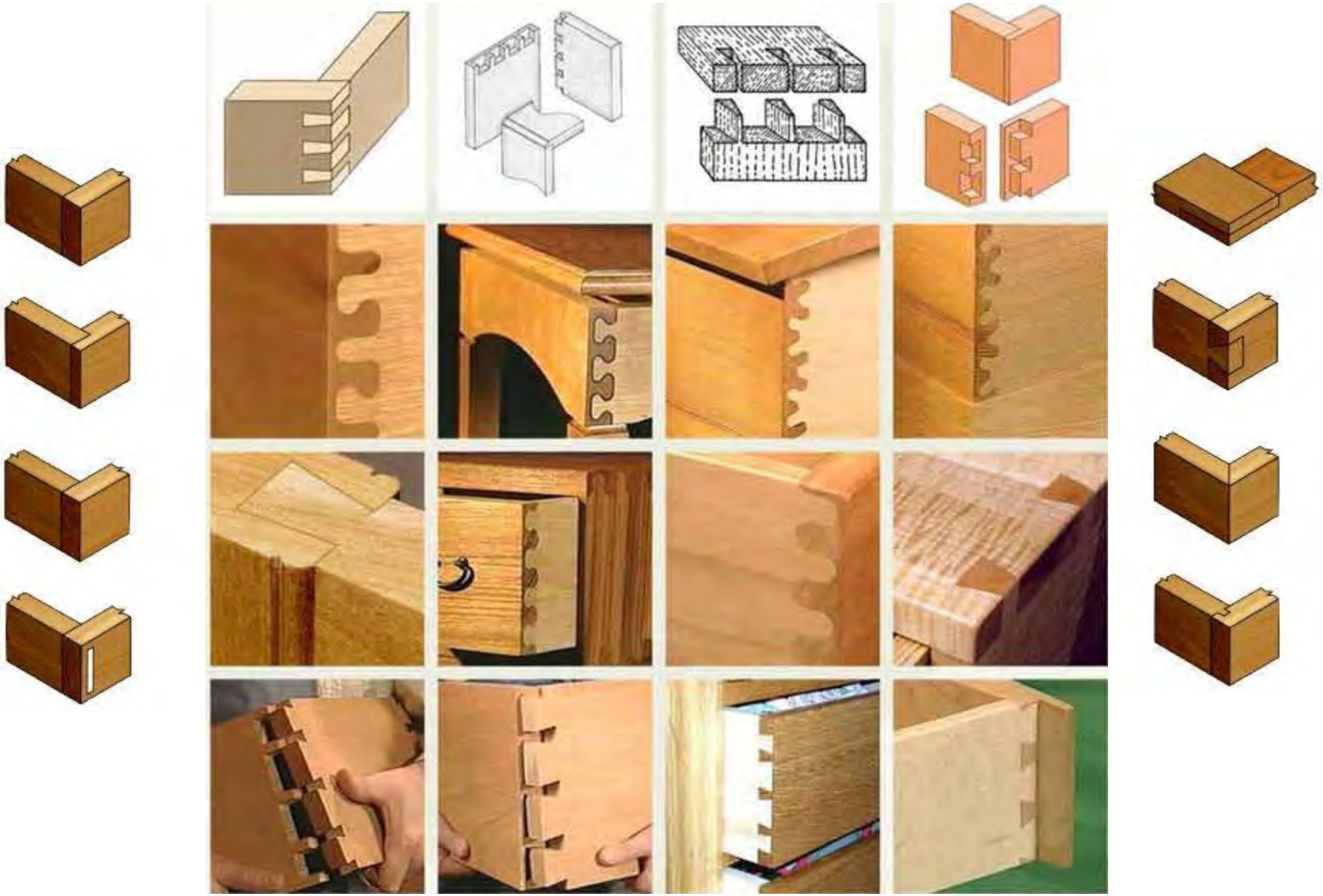

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Bohlin Cywinski Jackson

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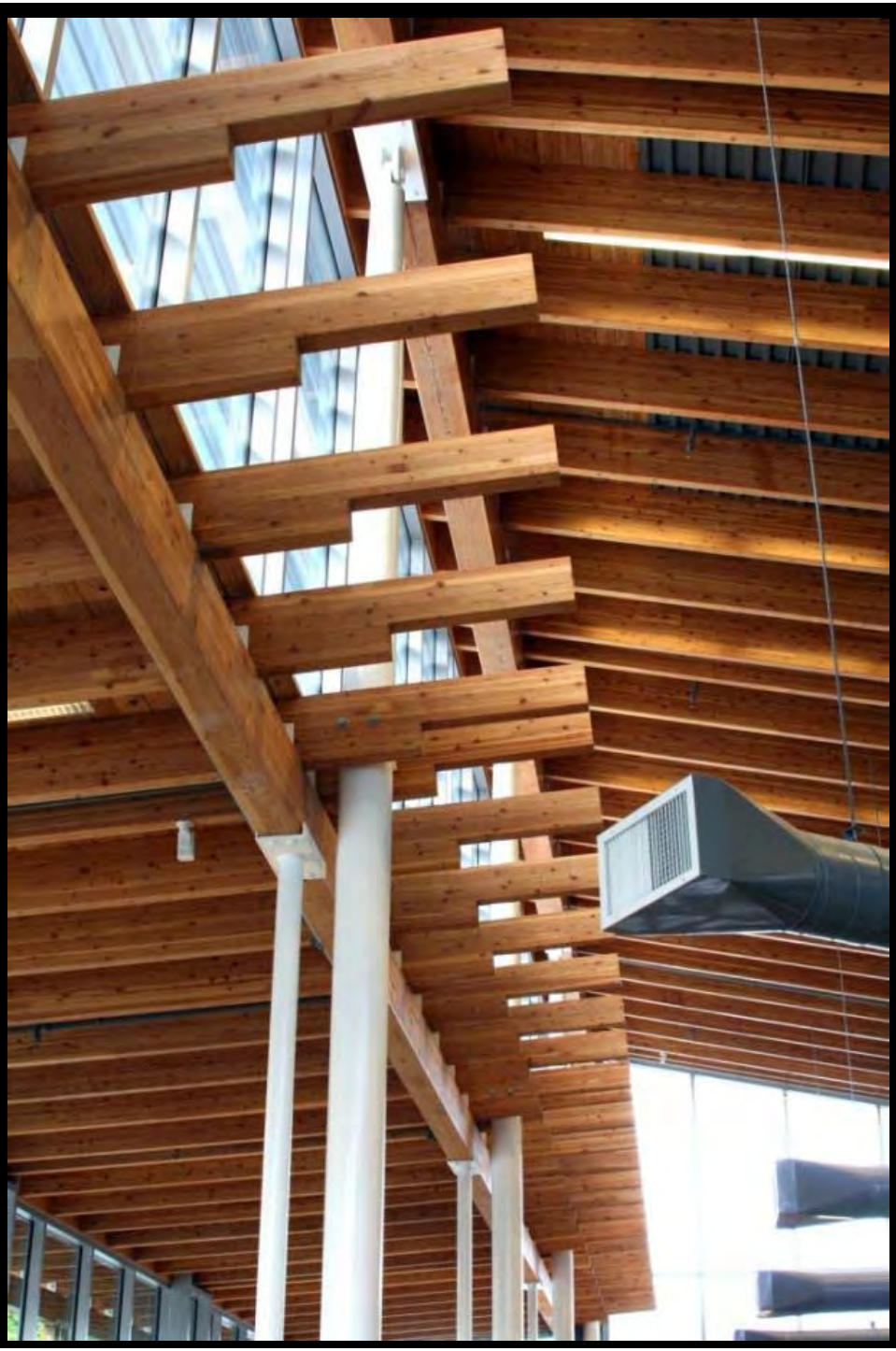

Bohlin Cywinski Jackson

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Readings: Chapter 3, Pages 84 - 127,
Fundamentals of Building Construction / Materials & Methods
By Edward Allen & John Wiley (5th Edition)