TIMBER FRAMING:
Applications in Commercial Construction

The attributes and range of timber framing in a commercial context in the use of high design heavy timber as expressive structure.

Mack Magee, MS
Principal, Fire Tower Engineered Timber
President, Timber Framers Guild

Disclaimer: This presentation was developed by a third party and is not funded by WoodWorks or the Softwood Lumber Board.

Course Description

Designed to answer questions about use of heavy timber as both structural material and exposed architectural feature in commercial construction, this presentation will cover topics such as specification, structural design, joinery, code compliance paths, and fire resistance. The role of the architect and structural engineer in heavy timber design and specification will be discussed, and case studies will be presented to illustrate a range of applications. Traditional and modern joinery options will be explored with an emphasis on aesthetics, structural capacity, and design routes. Heavy timber’s role as a building material in the International Building Code, AWC’s National Design Specification® for Wood Construction, and Timber Frame Engineering Council’s (TFEC) Engineering Standards & Loading Criteria will also be covered.

Learning Objectives

1. Review species, appearance grade, and material options for heavy timber applications in commercial construction.
2. Discuss heavy timber’s inherent fire-resistant characteristics and review its role as a fire-resistant material in the context of code requirements.
3. Based on case study examples, highlight possibilities for heavy timber’s use as a structural material and exposed architectural finish in commercial construction.
4. Explore heavy timber’s role as a building material in current codes and discuss steps for structural load resistance of members and connections.
TIMBER FRAMING:
A modern alternative, craft approach for high quality, sustainable, non-residential construction

“Wood is universally beautiful to man, and the most humanly intimate of all building materials.”
Frank Lloyd Wright

Special Note: The photos and images used in this presentation were generously provided by members of the Timber Framers Guild from across North America and beyond.

Agenda
- Introduction
- Expressive structure
- 3D modeling
- Design options
- Specifying timber
- Code considerations
INTRODUCTION

JAMES “MACK” MAGEE

CURRENTLY:
• Principal, Fire Tower Engineered Timber
• President, Timber Framers Guild

FORMERLY:
• VP Sales & Marketing Fraserwood Industries
• General Manager, Cascade Joinery, Bellingham, Washington
• Manager Civil Engineering Projects Worldwide, Owens Corning
• Director of Operations, Riverbend Timber Framing, Michigan

EDUCATION:
• Masters Of Science Civil Engineering, Stanford, 1986
• Bachelors Of Science, Civil Engineering, Stanford, 1985

Why use Timber as a structural material?

Because it brings drama...

...and visual interest...

Denver Public Library’s Western Reading Room
Courtesy of Bensonwood (bensonwood.com)

Denver Public Library’s Western Reading Room
Courtesy of Fire Tower Engineered Timber (ftet.com)
Reciprocal roof framing and is the most sustainable structural material. Great East Hall of Foquang Temple ca. 857

Heddal Stave Church, Notodden Norway circa 1250 A.D.

Centuries Old Mixed Use Timber Frames in Europe
EdgeMatched™ Douglas Fir Glulam
Broktorpsgarden, Halmstad, Sweden ca 1700
Courtesy of Fire Tower Engineered Timber (ftet.com)

Timber Framing
• Historically, all wood joinery by necessity
• Characterized as pegged mortise & tenon joinery
• Revival in 70’s began with this traditional approach
• Cultural pressures forced modern accommodations
• Now, industry embraces innovation

Demonstrating this is today’s purpose

Timber in Design
Design choices
• Species
• Sawing options
• Solid sawn
• Round log
• Turned & pressure washed
• Mechanically & glue laminated
• Straight & curved
• Small or large members
• Framing styles
• Joinery styles
• Surfacing
• Finishing
• Shaping
• Carving
• Embellishments

Agenda
• Introduction
• Expressive structure
• 3D modeling
• Design options
• Specifying timber
• Code considerations
SentryWorld Golf Course Porte Cochere, Stevens Point, WI
Courtesy of FraserWood Industries (fraserwoodindustries.com)

Epic Farm Campus Garden Bridge, Verona, WI
Courtesy of FraserWood Industries (fraserwoodindustries.com)
EdgeMatched™ Douglas Fir Glulam
Kinsol Trestle Bridge, Vancouver Island, BC
Courtesy of MacDonald&Lawrence (macdonaldandlawrence.ca)

Birdseye Cove Event Barn
Courtesy of MacDonald&Lawrence (macdonaldandlawrence.ca)

Swimming Pool Cabana
Courtesy of MoreSun Woodworking (moresunwoodworking.com)
Mohonk Barn Museum, New Paltz, NY
Courtesy of New Energy Works (newenergyworks.com)

Lautenberg Visitors Center, Sterling Forest, NY
Courtesy of New Energy Works (newenergyworks.com)

Lyons National Bank, Canandaigua, NY
Courtesy of New Energy Works (newenergyworks.com)

Deerfield Country Club, Brockport, NY
Courtesy of New Energy Works (newenergyworks.com)
EdgeMatched™ Douglas Fir Glulam
Chicago Horizon Pavilion, Chicago, IL
Courtesy of Trillium Dell Timberworks (trilliumdell.com)

EdgeMatched™ Douglas Fir Glulam
Location of catspaw
Writers Theater, Chicago, IL
Courtesy of Trillium Dell Timberworks (trilliumdell.com)
Catspaw
- At lower plate
- Supports walkway from upper plate
- All wood joinery
- Notched into plate
- Developed for this project

Writers Theater, Chicago, IL
Courtesy of Trillium Dell Timberworks (trilliumdell.com)

Manufacturing Facility
Bensonwood Manufacturing Facility, Walpole, NH
Courtesy of Bensonwood Homes (bensonwood.com)

Commercial
Winchendon School, Massachusetts
William Noah Allyn Headquarters, Skaneateles, NY

Institutional
Ashton Gardens Wedding Chapel, Corinth, TX
Courtesy of Texas Timber Frames
Kituwah Immersion Language Academy, Asheville, NC

YMCA, Yorktown, PA

YMCA, Yorktown, PA

Alpine Orthopedic Clinic, Franconia, NH
Commercial

Alpine Orthopedic Clinic, Franconia, NH

Northstar Trading Post, Toledo, OH
Courtesy of Riverbend Timber Framing (riverbendtf.com)

Commercial

Northstar Trading Post, Toledo, OH
Courtesy of Riverbend Timber Framing (riverbendtf.com)

Nanaimo Shipping Center, Nanaimo, BC
Organic Form in Architecture

O’Siem Pavilion, Squamish, British Columbia
Courtesy of FraserWood Industries (fraserwoodindustries.com)

Organic Structural Form in Architecture

Structural Form in Architecture

O’Siem Pavilion, Squamish, British Columbia
Courtesy of FraserWood Industries (fraserwoodindustries.com)
Structural Form in Architecture

Organic Structural Form in Architecture

Agenda

- Introduction
- Expressive structure
- 3D modeling
- Design options
- Specifying timber
- Code considerations
3D Modeling

Quinnipiac University, Hamden, CT
Courtesy of Fire Tower Engineered Timber (ftet.com)

3D Modeling

3D Modeling

3D Modeling

3D Modeling

Courtesy of Mike Beganyi Design and Consulting, LLC
3D Modeling
Round Barn in NY
Courtesy of fire Tower Engineered Timbr (ftet.xom)

Agenda

• Introduction
• Expressive structure
• 3D modeling
• Design options
• Specifying timber
• Code considerations
Agenda

• Design options
• Framing styles
• Joinery approaches
• Surfacing & finishing
• Embellishment

Cruck Frames

Ancient Leigh Court Tithe Barn, UK

Modern

Rustic Treen Framing
Fresh Air Fund Camp in Fishkill, NY

Round Log Timber Framing
Round Log Timber Framing

Log Timber Framing

Combined Log & Timber Framing
Agenda

- Design options
- Framing styles
- Joinery approaches
- Surfacing & finishing
- Embellishment

Joinery Types

- All wood joinery
- Hidden steel
- Exposed steel
- Wood & steel

A structure is a collection of connections held together by the members.

All Wood Joinery

Splines (free tenons) & Wedged Through Tenon Spline

All Wood Joinery

Through Tenons
All Wood Joinery
Scarf Joints

Hidden Steel Connections
Hidden Steel Connections
Exposed Steel Connections

Exposed Steel Connections

Exposed Steel Connections

Exposed Steel Connections
Agenda

- Design options
- Framing styles
- Joinery approaches
- Surfacing & finishing
- Embellishment

Combination of Wood & Steel Joinery

Adzed Surface
Hewn

Rough Sawn with Band Saw

Rough Sawn with a Band Saw

Rough Sawn with a Circular Saw
Walnut Blasted to Age the Timber

Planed Smooth with a Stained Finish

Stained Finish

Agenda

• Design options
  • Framing styles
  • Joinery approaches
  • Surfacing & finishing
  • Embellishment
Shape Embellishments: Chamfers

Shape Embellishments: Finials
Shape & Carving Embellishments

Agenda

- Introduction
- Expressive structure
- 3D modeling
- Design options
- Specifying timber
- Code considerations

Agenda

- Specifying timber
  - Timber
    - Solid sawn—commercial species
    - Glue-laminated
    - Specialty glue laminated
    - Mechanically laminated
  - Grades
  - Dry timber

Boxed Heart
Boxed Heart

Free of Heart Center (FOHC)

Common species
- Douglas Fir √
- Spruce √
- Port Orford cedar √
- Yellow cedar √
- Hemlock √
- Southern Pine √

Other species
- Red & White Oak
- Eastern White Pine
- Cypress

Glulam timber (✓=glulam species)
Agenda

- Specifying timber
  - Timber
  - Solid sawn—commercial species
  - Glue-laminated
  - Specialty glue laminated
  - Mechanically laminated
- Grades
- Dry timber
Agenda

• Specifying timber
  • Timber
  • Solid sawn—commercial species
  • Glue-laminated
  • Specialty glue laminated
  • Mechanically laminated
  • Grades
  • Dry timber
Agenda

• Specifying timber
  • Timber
  • Solid sawn—commercial species
  • Glue-laminated
  • Specialty glue laminated
  • Mechanically laminated
• Grades
• Dry Timber
Mechanically Laminated Posts

Agenda

• Specifying timber
  • Timber
    • Solid sawn—commercial species
    • Glue-laminated
    • Specialty glue laminated
    • Mechanically laminated
  • Grades
  • Dry lumber

Grading Agencies & Rules

Slope of Grain

• West Coast Lumber Inspection Bureau
• Log Scaling & Grading Bureau
• National Lumber Grading Authority
• National Hardwood Lumber Association
• Western Wood Products Association
• Northeastern Lumber Manufacturers Association
• Southern Pine Inspection Bureau
• Pacific Lumber Inspection Bureau
Agenda

- Specifying timber
  - Timber
    - Solid sawn—commercial species
    - Glue-laminated
    - Specialty glue laminated
    - Mechanically laminated
  - Grades
  - Dry timber

Antique Timber (Barn & House)
Industrial Salvage

Forest Salvage/Standing Dead

Reclaimed ships timbers or timbers from bottom of rivers or canals

Radio Frequency Kiln Dried Timber
Agenda

- Introduction
- Expressive structure
- 3D modeling
- Design options
- Specifying timber
- Code considerations

National Design Specifications for Wood Construction

- Code considerations
  - National Design Specifications for Wood Construction
  - TFEC-1
  - IBC: Type IV heavy timber
  - Fire resistance

TFEC - 1
Standard for Design of Timber Frame Structures
Agenda

- Code considerations
  - National Design Specifications for Wood Construction
  - TFEC-1
  - IBC: Construction types for fire
  - Fire resistance

Code Considerations

- Type I – non-combustible
- Type II – non-combustible
- Type III – combustible framing
  - non-combustible exterior walls
- Type IV – heavy timber
- Type V – wood construction

Code Considerations

Type I & II Non-Combustible Construction

- Non-combustible floor framing and columns
- Heavy Timber permitted for roof framing only
- SIPs not permitted

Code Considerations

Type III Combustible/Non-Combustible Construction

- Exterior walls non-combustible
- Light frame wood allowed for floor and roof framing
- Roof deck – SIPs permitted
**Code Considerations**

Type IV Heavy Timber Construction
- Exterior walls non-combustible
- No concealed spaces
- Columns 8x8 supporting floor & roof
- 6x8 supporting roof only
- Floor beams 6x10 minimum
- Roof beams 4x6 minimum
- Flooring 1” T&G over 3” T&G with material laid so no continuous joints
- Roof deck 2” T&G – SIPs not permitted

Type V Combustible Construction
- Light frame wood permitted for walls, floor and roof framing
- SIPs permitted
- No minimum timber sizes

**Agenda**

- Code considerations
  - National Design Specifications for Wood Construction
  - TFEC-1
  - IBC: Type IV heavy timber
  - Fire resistance

**Fire Resistance**
- Timber is naturally resistant
- The outside surfaces char at a steady rate
- Insulates the timber inside the char layer
- Note the timber is still supporting the steel
Code Considerations

Fire Resistance

• First & second floor collapsed into the basement
• Heavy timber roof remained
• Miata engine block puddled

Fire Resistance

• Posts supported steel beams
• Beams became plastic (melted) & collapsed
• Posts charred; still stand

Wood is the most humanly sympathetic of all building materials because it affects so many of our senses...it may even be that our appreciation of proportion comes from the natural dimensions of trees.

Peter Davey, Editor, The Architectural Review
THANK YOU.

QUESTIONS?

Mack Magee
m@ftet.com
401.441.5217

Fire Tower Engineered Timber
Providence, RI  C  Calliht, MI  C  Laramie, WY

www.ftet.com

Timber Framers Guild
360.746.6571
www.tfguild.org

THANK YOU.

QUESTIONS?

Mack Magee
m@ftet.com
401.441.5217

Fire Tower Engineered Timber
Providence, RI  C  Calliht, MI  C  Laramie, WY

www.ftet.com

Timber Framers Guild
360.746.6571
www.tfguild.org
SECTION 06130: TIMBER FRAMING MASTER SPECIFICATION (VERSION 8/24/2011)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including general and supplementary conditions and Division 1 specification sections, apply to this section.

1.2 WORK INCLUDED

[Note to Specifier: Clarify whether timber frame Contractor is responsible for design of gravity load support and lateral stability of timber frame structure and whether other rough carpentry, SIPs, etc., are to be provided and installed as part of work of this section.]

A. Work includes furnishing labor, materials, and equipment to design, furnish, and install structural and architectural timber framing as detailed in drawings or specified, including structural design of timber frame system, joinery, and connections not provided in drawings, and supplying associated fasteners to complete system and connect timber framing members to structural supports.

B. Types of timber construction specified in this section include the following:

1. Beams, girders, plates, sills, girts, purlins and joists.
2. Columns and posts, braces and bolsters.
3. Timber trusses.
4. Solid wood decking.

1.3 RELATED WORK

A. The following sections are related to work of this section:

[Note to Specifier: Delete sections not applicable to project.]

1. Section 06100 Rough Carpentry.
2. Section 06071 Pressure-Treated Wood Products.
3. Section 06180 Glue-Laminated Timbers.
4. Section 06200 Finish Carpentry.

B. The following sections specify products to be installed as part of work of this section:

1. Section 06120 Structural Insulated Panels.
1.4 DEFINITIONS

[Note to Specifier: Eliminate inspection agencies indicated below not applicable to project.]

A. Inspection Agencies and abbreviations used to reference them include the following:

1. NELMA - Northeastern Lumber Manufacturers Association.
2. NHLA - National Hardwood Lumber Association.
3. NLGA - National Lumber Grades Authority.
4. SPIB - Southern Pine Inspection Bureau.
5. WCLIB - West Coast Lumber Inspection Bureau.
6. WWPA - Western Wood Products Association.
7. AWPA – American Wood Protection Association

1.5 DELIVERY, STORAGE, AND HANDLING

A. Schedule timber delivery and installation to avoid extended on-site storage.

B. Keep timber members dry during delivery and storage. Cover timber with weathertight tarps. Do not store members in areas of high or low relative humidity.

C. Cut and stack timber so as not to encourage growth of sap-stain fungi, mold, carpenter ants, borers, etc.

D. Stack timbers with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

1.6 SUBMITTALS

A. Shop Drawings: Submit for review shop drawings signed and sealed by a Structural Engineer registered in state where project is located. Show design loads, material properties, full dimensions of each member, and layout of timber frame system. Show large-scale details of joints and connections. Provide hardware cut sheets and design values for fasteners.

B. Samples: Full width and depth, 24 inches long, showing range of variation expected in appearance, including surface texture and finish of wood products.

C. Provide manufacturer’s certification of moisture content.

[Note to Specifier: Specify whether certification of timber grading is to be submitted and whether certification of moisture content at time of fabrication or delivery is to be submitted.]

1.7 QUALITY ASSURANCE

[Note to Specifier: Edit or delete paragraph below as required by project.]
A. Fabricator and Erector of timber framing shall not have less than [##] years experience in fabrication and erection of timber framing.

B. Timbers shall be graded by lumber grading agency certified by American Lumber Standards Committee.

C. Locate grade stamp on timber surfaces not exposed to view in completed work. Grade certification can be submitted in lieu of grade stamping material.

PART 2 - PRODUCTS

2.1 GENERAL

[Note to Specifier: Edit or delete paragraphs below as required by project.]

A. General: Comply with PS 20 and grading rules of lumber grading agencies certified by American Lumber Standards Committee Board of Review as applicable.

1. Factory mark each item of timber with grade stamp of grading agency.
2. For exposed timber indicated to receive stained or natural finish, apply grade stamps to surfaces not exposed to view, or omit grade stamps and provide certificates of grade compliance issued by grading agency.

B. Preservative Treatment:

1. For sawn products, pressure treat timbers as required in architectural and structural drawings and within this section with preservative treatment to comply with AWPA U1-04 Use Category System, Commodity Specification A, Sawn Products. See Section 06071 for treatments and related requirements.
   a. List products to be treated.
   b. Products to be treated [before] [after] fabrication.
   c. Specify conditioning (air dry, kiln dry, etc.), packaging, and handling after treating.
   d. Specify treatment for post-treating fabrication.
2. For posts, pressure treat poles as required in architectural and structural drawings and this section with preservative treatment to comply with AWPA U1-04 Use Category System, Commodity Specification B, Posts. See Section 06071 for treatments and related requirements.
   a. List products to be treated.
   b. Products to be treated [before] [after] fabrication.
   c. Specify conditioning (air dry, kiln dry, etc.), packaging, and handling after treating.
   d. Specify treatment for post-treating fabrication.
3. For fire-retardant timber, pressure treat material as required in architectural and structural drawings and this section with treatment to comply with AWPA U1-04 Use Category System, Commodity Specification H, Fire Retardants. See Section 06071 for treatments and related requirements.
2.2 TIMBER

[Note to Specifier: Use Paragraph A, B, or both to specify timber and performance requirement.]

A. Timber Species and Grade: [Species]; [Select Structural] [No. 1] [No. 2].

B. Timber performance requirements. Species and grade that comply with required structural properties for moisture content provided.

1. Allowable Stress Ratings for 12 inches (305 mm) Depth: [Fb 1500 psi (10.3 MPa) and E 1,500,000 psi (10 340 MPa)] [Fb 1300 psi (9.0 MPa) and E 1,300,000 psi (8 960 MPa)] <Insert values> [As indicated in drawings].

[Note to Specifier: Edit grading rules based on applicability to species used.]

C. Grading Rules: [NELMA, NHLA, NLGA, SPIB, WCLIB, or WWPA].

D. For large ([10] inch or greater maximum dimension) members, use box heart timbers. For small (less than [10] inch maximum dimension) members, use free of heart center timbers. Do not use timber with excessive reaction wood.

[Note to specifier: Typical levels of moisture content in the industry are Green, 23%, 19% and 12%. Typical moisture meter pin lengths range between 1.25 inches and 3 inches which provide a reasonable method of verifying the dry condition. If the material is dry to specified level when dressed, it will likely be as dry or drier when fabricated or installed.]

E. Moisture Content: Provide timber with [xx] percent maximum moisture content x inches from surface at time of [dressing][fabrication][installation]

F. Dressing: Provide [dressed timber (S4S)] [timber that is rough sawn (Rgh)] unless otherwise indicated.

1. Round columns shall be hand peeled (shaved) from nominal S4S timbers. The minimum dressed diameter shall not be more than [1/2 inch] under nominal size indicated in drawings.

G. Incising: To be performed by [treater] [timber supplier] [timber framer] for [specify] treated products.

H. End Sealer: Manufacturer's standard, transparent, colorless wood sealer effective in retarding transmission of moisture at cross-grain cuts and compatible with finish.

I. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer compatible with finish.

J. Cut members indicated as curved in drawings from stock having similar natural curves. Cross grain deviation greater than 1 in 10 is not permitted unless member is identified in the drawings as decorative only.
2.3 PEGS

A. Use straight grain peg material with slope of grain not greater than 1:15, [clear hardwood][clear hardwood with minimum specific gravity of 0.57] [white oak] [other].

B. Pegs shall be [tapered a minimum one-third their length and at least 4 inches longer than thickness of timber in which they are driven] [uniform dowels with chamfered edges][octagon dowels with chamfered edges] [turned round pegs] [sawed octagonal pegs] [driven round] [square and shaved with draw knife (historical)].

2.4 WEDGES

[Note to Specifier: Detail wedge size and slope in drawing or indicate below.]

A. Use straight-grain wedge material with slope of grain not greater than 1:15. Wedge material shall be [clear hardwood with minimum specific gravity of 0.57] [white oak] [other].

2.5 FASTENERS

A. General: Provide fasteners of size and type complying with requirements specified for material and manufacture.

1. Where fasteners are exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide [Type 304 stainless steel] [hot-dip galvanized] [other].


[Note to Specifier: Edit proprietary fasteners indicated below as required for project.]

C. Proprietary Fasteners:

1. RSS structural screws by GRK or accepted equivalent.
2. Timberlok fasteners by FastenMaster or accepted equivalent.
3. Strong Drive screws (SDS) by Simpson Strong-tie or accepted equivalent.
4. WFC/WFR/WFD fasteners by SFS intec or accepted equivalent.

D. Lag Bolts: ASME B18.2.1.

[Note to Specifier: Verify washer requirements and edit paragraph 2.5E where bearing requirements are critical. Consider use of timber washers (ASTM A47) or plate washers versus structural steel washers (ASTM F 436)]

E. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.

G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing in accordance ASTM E 488, performed by a qualified independent testing and inspecting agency.


H. Other proprietary connectors:

1. Timberlinx steel connectors by Timberlinx, Division of Michael Preston Distributors Limited or accepted equivalent.
2. Other.

2.6 STEEL CONNECTION MATERIALS

A. Unless otherwise indicated, fabricate steel connection materials and steel elements from the following materials:

1. Structural-steel shapes, plates, and flat bars complying with ASTM A 36.
2. Round steel bars complying with ASTM A 575, Grade M 1020.
3. Hot-rolled steel sheet complying with ASTM A 1011, Structural Steel, Type SS, Grade 33.
4. Stainless steel plate and flat bars complying with ASTM A 666, Type [304] [316].
5. Stainless steel bars and shapes complying with ASTM A 276, Type [304] [316].
6. Stainless steel sheet complying with ASTM A 666, Type [304] [316].

B. Fabricate tie rods from round steel bars with upset threads connected with forged-steel turnbuckles complying with ASTM A 668/A 668M.

C. Use shear plates [2 5/8 inches] [4 inches] in diameter, complying with ASTM D 5933.

D. Finish:

1. Where not exposed to weather, finish steel assemblies and fasteners with rust-inhibitive primer, 2-mil dry film thickness.
2. Where exposed to weather, hot-dip galvanize steel assemblies and fasteners after fabrication to comply with ASTM A 123/A 123M or ASTM A 153/A 153M.
2.7 FABRICATION

A. Shop fabricate members by cutting and restoring exposed surfaces to match specified surfacing. Predrill for fasteners and assembly of units.

1. Finish exposed surfaces to provide smooth finish. Surface texture shall be equivalent to that produced by [machine sanding with No. 120 grit sandpaper] [other requirement].

[Note to Specifier: Delete subparagraph below if treated timber is not required.]

2. Where preservative-treated members are specified, fabricate before treatment to greatest extent possible. Where fabrication must be done after treatment, apply field-treatment preservative to comply with AWPA M4.
   a. Use inorganic boron treatment for members not in contact with ground and continuously protected from water.
   b. Use copper naphthenate treatment for members in contact with ground or not continuously protected from water.

B. Camber: Fabricate horizontal members and inclined members with slope of less than 1:1 with natural convex bow (crown) up to provide camber.

C. Seal Coat: After fabricating and surfacing each unit, apply saturation coat of [penetrating sealer] [tung oil] [landark finish] on surfaces of each unit except for treated wood where treatment included water repellent.

D. Timber sizes are [nominal] [actual] dimensions [prior to shrinkage] [at the time of fabrication] [at the time of installation]. Plane, adze, or otherwise dress timber to square, uniform dimension at joinery locations. Dressed dimensions shall not be [more than [1/2 inch under size indicated in drawings] [less than dimensions indicated in Product Standard PS20] [other].

E. Waney edges are [permitted provided they do not exceed [1/8] of a face. Remove bark and spokeshave or plane smooth waney edge] [not permitted].

F. Timbers with moderate bow are permitted where their intended use will straighten them. Place crowns up for spanning members. Do not use severely bowed timbers or timbers bowed in more than one direction.

G. Remove staining from soil, oil, or grease.

H. Chamfer exposed edges of beams and posts with ski tip stops.

I. Cut mortise and tenon joints so there is 1/4-inch-minimum clearance between tendon end and mortise bottom to allow for shrinkage.

J. Cut 1/4-inch chamfers on tenons on end grain edges.

K. Cut joints accurately to make neat, snug fit.
L. Drill peg holes to produce a tight fit at final assembly. When their location is not indicated in drawings, locate center line of hole [2 inches] from face of mortise.

M. Offset peg holes on tenon from those in mortise, or drawbore, so that by driving a tapered peg through the offset holes, joint will be drawn tightly together, or drawpinned. Offset shall be [1/8 inch] for softwood timbers and [3/32 inch] for hardwood timber.

N. Layout marks and identification marks shall not be visible on completed frame.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. General: Erect heavy timber construction true and plumb. Provide temporary bracing to maintain lines and levels until permanent supporting members are in place.

B. Handle and temporarily support heavy timber construction to prevent surface damage, compression, and other effects that might interfere with indicated finish. Tools used to drive or pull joints together shall not mar finished surface of timber.

C. Framing adjacent to masonry: Provide 1/2-inch clearance at tops, sides, and ends of members adjacent to masonry unless otherwise indicated.

D. Cutting: Avoid extra cutting after fabrication. Where field fitting is unavoidable, comply with finish and preservative treatment requirements for shop fabrication.

E. Saw off pegs protruding on exterior of frame flush. Leave interior pegs protruding. Cut off pegs with mushroomed heads below damaged area.

3.2 STRUCTURAL TESTS AND INSPECTIONS

A. Notify Special Inspector when structural framing is complete. Timber framing shall be inspected and approved prior to enclosing walls, floors, roofs, or ceilings.
3.3  ADJUSTING AND CLEANING

A. Repair damaged surfaces and finishes after completing erection. Replace damaged heavy timber construction if repairs are not approved by Architect.

END OF SECTION 06130