

## Section 507 Timber Structures

### 507.1 Description

- (1) This section describes furnishing, framing, treating, delivering, erecting, and painting if required, treated lumber and timber required for timber bridges and other timber structures, or lumber and timber parts of other bridges or structures.

### 507.2 Materials

#### 507.2.1 General

- (1) Furnish hardware required to erect the lumber and timber. Furnish materials conforming to the following:
  - Structural steel.....[506.2](#)
  - Miscellaneous metals .....[506.2](#)
  - Paint and painting.....[517](#)

#### 507.2.2 Lumber and Timber

##### 507.2.2.1 General

- (1) If ordering lumber and timber in multiple lengths, grade them after cutting to length.
- (2) The engineer will only accept sound pieces free from decay. The engineer will reject pieces exceptionally light in weight.
- (3) There is no heartwood requirement for lumber and timber treated with a preservative and no limit on the quantity of sapwood it can contain. Preservative treatment of lumber and timber shall conform to [507.2.2.6](#).
- (4) Ensure that there are no unsound knots or knot holes. Also ensure that there are no tight knots of a diameter exceeding one-quarter of the greater dimension at the point where they occur. Measure a knot by taking its diameter at right angles to the length of the timber. Ensure that the sum of sizes of all knots in any one-foot length does not exceed 2 times the size of the largest allowed single knot. The engineer will treat cluster knots as if they were a single knot. A cluster knot is 2 or more knots grouped together, with the fibers of the wood deflected around the entire unit.

##### 507.2.2.2 Wood Species

- (1) Furnish one of the following species for treated structural lumber and timber:
  - Douglas Fir-Coastal
  - Southern Pine
  - Hem-Fir

##### 507.2.2.3 Manufacture

- (1) Ensure structural lumber and timber are straight, sawed square at the ends, and have opposite surfaces parallel.
- (2) Saw rough structural lumber and timber to the nominal dimensions specified in [507.2.2.3\(4\)](#). Occasional slight variation is permissible, however, ensure that the specified minimum dressed dimensions are met everywhere along the length.
- (3) The manufacturer may surface structural lumber and timber ordered rough, if thicker than specified, to a rough stock thickness.
- (4) Manufacture lumber and timber according to the nominal and minimum dimensions in the following table:

**AMERICAN STANDARD SIZES FOR STRESS-GRADED & NON-STRESS-GRADED CONSTRUCTION LUMBER<sup>[1]</sup>**

ITEM	THICKNESS			FACE WIDTH		
	NOMINAL inches	MINIMUM DRESSED		NOMINAL inches	MINIMUM DRESSED	
		DRY inches	GREEN inches		DRY inches	GREEN inches
BOARDS	1	3/4	25/32	2	1 1/2	1 9/16
	1 1/4	1	1 1/32	3	2 1/2	2 9/16
	1 1/2	1 1/4	1 9/32	4	3 1/2	3 9/16
				5	4 1/2	4 5/8
				6	5 1/2	5 5/8
				7	6 1/2	6 5/8
				8	7 1/4	7 1/2
				9	8 1/4	8 1/2
				10	9 1/4	9 1/2
				11	10 1/4	10 1/2
				12	11 1/4	11 1/2
				14	13 1/4	13 1/2
				16	15 1/4	15 1/2
DIMENSION	2	1 1/2	1 9/16	2	1 1/2	1 9/16
	2 1/2	2	2 1/16	3	2 1/2	2 9/16
	3	2 1/2	2 9/16	4	3 1/2	3 9/16
	3 1/2	3	3 1/16	5	4 1/2	4 5/8
	4	3 1/2	3 9/16	6	5 1/2	5 5/8
	4 1/2	4	4 1/16	8	7 1/4	7 1/2
				10	9 1/4	9 1/2
				12	11 1/4	11 1/2
				14	13 1/4	13 1/2
			16	15 1/4	15 1/2	
TIMBERS	5 and thicker	1/2 less than nominal	1/2 less than nominal	5 and wider	1/2 less than nominal	1/2 less than nominal

<sup>[1]</sup> This table uses nominal sizes for convenience. They do not represent actual sizes.

**507.2.2.4 Stress Grading Requirements**

- (1) Furnish structural lumber and timber conforming to the stress grade the plans, specifications, or contract shows.
- (2) Grade lumber and timber required to conform to a specific stress grade according to AASHTO M168.
- (3) Ensure that lumber and timber required to conform to a specific stress grade shows a copyrighted stamp on each piece designating the inspecting agency, inspector, or mill and grade, or furnish a certificate of inspection to the engineer for untreated material, or to the department inspector at the treating plant for treated material. Include the kind and grade of material and the name of the grading agency.

**507.2.2.5 Structural Purposes**

- (1) If the plan or contract does not designate a required stress grade, conform to the minimum stress grade, and associated allowable unit stress, for lumber and timber used for various structural components as follows:

**STRESS RATING AT 19 PERCENT MAXIMUM MOISTURE**

**USE 1750 psi  $f_b$  STRUCTURAL JOIST AND PLANK GRADE FOR:**

- |                           |                              |
|---------------------------|------------------------------|
| Joists; 4 inches or less. | Floor planks, wearing.       |
| Sidewalk railing posts.   | Rails.                       |
| Bulkhead planks.          | Laminated or strip flooring. |

**USE 1750 psi  $f_b$  STRUCTURAL BEAM AND STRINGER GRADE FOR:**

- |                              |        |
|------------------------------|--------|
| Stringers; 5 inches or more. | Sills. |
| Roadway railing posts.       | Caps.  |

**USE 1200 psi  $f_b$  STRUCTURAL JOIST AND PLANK GRADE FOR:**

- |                                   |                     |
|-----------------------------------|---------------------|
| Nailing strips; 4 inches or less. | Subfloor planks.    |
| Bracing; sway and longitudinal.   | Subfloor sheathing. |
| Cross bridging.                   | Retaining pieces.   |
| Cleats.                           | Scupper blocks.     |
| Fire stops.                       | Sidewalks.          |

**USE 1200 psi  $f_b$  STRUCTURAL BEAM AND STRINGER GRADE FOR:**

- |                                   |           |
|-----------------------------------|-----------|
| Nailing strips; 5 inches or more. | Grillage. |
| Mud Sills.                        |           |

**USE 1200 psi  $f_c$  STRUCTURAL POST AND TIMBER GRADE FOR:**

- |                               |               |
|-------------------------------|---------------|
| Posts with longitudinal load. | Wheel guards. |
|-------------------------------|---------------|

**USE THE ENGINEER-DESIGNATED STRESS GRADE FOR ALL OTHER LUMBER AND TIMBER.**

**507.2.2.6 Preservative Treatments**

**507.2.2.6.1 General**

- (1) Use the pressure process to apply preservative treatment to structural lumber and timber, unless specified otherwise in the contract or special provisions, according to AASHTO M133.
- (2) Unless the contract specifies otherwise, furnish structural lumber and timber treated with one of the preservatives specified in [507.2.3](#), except as follows:
  - Do not treat coastal Douglas fir with chromated copper arsenate.
  - If using pentachlorophenol, use a solution with 5 percent pure pentachlorophenol, by weight, of the total solution. Use the heavy petroleum solvent, except if painting the treated surface then use the light petroleum solvent.

**507.2.2.6.2 Treatment Preparation**

- (1) If possible, sort the material into one kind, or designated group of kinds of wood, and into pieces approximately equal in size, moisture, and sapwood content; and separate to ensure the treating medium contacts all surfaces.
- (2) If possible, perform adzing, boring, chamfering, framing, gaining, mortising, surfacing, etc., before treatment.

**507.2.2.6.3 Preservative Quantity**

- (1) Unless the proposal or the plans specify otherwise, use at least the minimum quantity of preservative material retained, and at least the minimum penetration specified in AWPA Standards U1 and T1 for use category UC4A for the species furnished.
- (2) Determine the minimum net retention according to AWPA Standard M2.

**507.2.3 Wood Preservatives**

- (1) Use oil-soluble wood preservatives conforming to the following standards:
 

Creosote-coal tar solution.....	AWPA P2
Pentachlorophenol.....	AWPA P35
Petroleum solvents used in pentachlorophenol solutions .....	AWPA P9
Petroleum solvents used in copper naphthenate solutions.....	AWPA P9
Copper naphthenate solution.....	AWPA P36
- (2) Use waterborne wood preservatives conforming to the following standards:
 

Chromated copper arsenate solution type C .....	AWPA P23
Ammoniacal copper zinc arsenate solution .....	AWPA P22
Alkaline copper quat solution type D.....	AWPA P29

Copper azole type C .....	AWPA P48
Copper naphthenate solution.....	AWPA P34

**507.2.4 (Vacant)**

**507.2.5 Timber Connectors**

- (1) Zinc coat connectors for timber structures, except malleable iron connectors, by hot-dipping according to [ASTM A653](#).

**507.2.5.1 Split Ring Connectors**

- (1) Manufacture split rings of 2 1/2 inch and 4 inch inside diameter from hot-rolled low carbon steel conforming to AASHTO M169 grade 1010. Each ring shall form a closed, true circle with the principal axis of the cross-section of the ring metal parallel to the geometric axis of the ring. Bevel the metal section from the central portion toward the edges to a thickness less than midsection. Provide one tongue and slot cut in the perimeter.

**507.2.5.2 Shear Plates**

- (1) Use hot-rolled low carbon steel conforming to AASHTO M169 Grade 1010 for pressed-steel shear plates.
- (2) Cast malleable-iron shear plates from malleable iron conforming to [ASTM A47](#).

**507.2.6 Hardware**

- (1) For machine bolts, timber bolts, drift bolts, lag screws, dowels, rods, and spikes longer than 6 inches left in the finished work, conform to the material specifications for structural steel or miscellaneous metals specified in [507.2.1](#).
- (2) Provide square heads and nuts for machine bolts unless specified otherwise. Ensure the threads on bolts are U.S. Standard and not less than 2 1/2 times the diameter of the bolt in length.
- (3) Provide gray or malleable iron casting washers, or cut them from steel plates. Use washers with holes not more than 1/8 inch larger than the bolt diameter. Use ogee type gray iron washers with a diameter at least 3 1/2 times the bolt diameter, and a thickness equal to the bolt diameter. Use malleable iron washers with properly proportioned ribs to develop the bolt's full strength. The malleable iron washer diameter shall at least equal 3 1/2 times the bolt diameter, and have a thickness equal to 1/2 the bolt diameter. Use plate washers with a diameter at least 3 1/2 times the bolt diameter and, unless specified otherwise, a thickness of at least 1/4 inch.
- (4) Provide gray or malleable iron casting packing spools or separators, or cut them from steel plates. Ensure the hole diameter is not more than 1/8 inch larger than the packing bolt diameter.
- (5) Use oval-headed barbed car nails or ring shank nails for nails and spikes up to and including 60d. For spikes over 60d, use the type and size specified. Unless specified otherwise, use nails no shorter than 2 1/2 times the thickness of the material being driven through. If clinching nails, ensure they project at least one inch before clinching.
- (6) Zinc coat hardware unless specified otherwise. The zinc coating shall conform to the quality and weight in [ASTM A153](#).

**507.3 Construction**

**507.3.1 Quality**

- (1) Ensure first class product quality throughout. Drive nails and spikes with just sufficient force to set the heads flush with the wood surface. Ensure that wood surfaces are free from deep or frequent hammer marks.
- (2) The product quality on metal parts shall conform to the requirements specified in [506](#) for steel bridges.

**507.3.2 Storage**

- (1) Store lumber and timber in neat piles, on suitable blocking or supports, and above the ground. Clear the ground underneath and near piles of weeds and rubbish.
- (2) Close-stack treated material to prevent long timbers, or those of small cross-section, from sagging or becoming crooked. If anticipating an extended storage period and the material merits protection from the direct sunlight or possible fire hazard, cover the top of the pile with a layer of tar paper, or equal, and spread not less than one inch of sand or earth over the cover.

**507.3.3 Handling**

- (1) Handle treated lumber and timber carefully to avoid breaking through the treated portions and exposing untreated wood. Do not use chains, peaveys, cant hooks, pickaroons, timber dogs, pike poles, or other pointed tools on treated lumber and timber, use padded or non-metallic slings instead.

### **507.3.4 Framing and Boring**

#### **507.3.4.1 General**

- (1) Cut and frame lumber and timber to a close fit. If possible, cut, frame, and bore treated timbers before treatment.

#### **507.3.4.2 Holes for Bolts, Dowels, Rods, and Lag Screws**

- (1) Bore the holes for round drift bolts and dowels with a bit 1/16 inch less in diameter than the bolt or dowel used. Ensure that the diameter of holes for square drift bolts or dowels equals the bolt or dowels least dimension.
- (2) Bore the holes for machine bolts with a bit the same diameter as the bolt.
- (3) Bore the holes for rods with a bit 1/16 inch greater in diameter than the rod.
- (4) Bore the holes for lag screws with a bit not larger than the body of the screw at the thread base.

#### **507.3.4.3 Countersinking**

- (1) Perform countersinking if smooth faces are required.

#### **507.3.4.4 Connectors**

- (1) If using timber connectors, use the type and size the plans show. Install split ring connectors in precut grooves to form a snug fit, or as the manufacturer recommends.

#### **507.3.5 Temporary Attachment**

- (1) If attaching forms or temporary braces to treated timber with nails or spikes, with the engineer's approval, fill the holes by driving zinc coated nails or spikes flush with the surface, or by plugging as required for bolt holes.

#### **507.3.6 Bolts and Washers**

- (1) Use a washer the size and type specified under all bolt heads, except timber bolts or bolts with button-type heads, and also under lag screws and nuts that would otherwise come in contact with wood.

#### **507.3.7 Treating Cuts, Abrasions, and Holes in Treated Lumber and Timber**

- (1) Carefully trim and cover abrasions, holes, and cuts made in treated lumber and timber with a compatible preservative material. Use preservatives and application methods specified in AWPA Standard M4. Apply the preservative in 3 applications; wait at least 2 hours between applications.
- (2) Carefully trim and then fill holes made in treated material with preservative so that the solution saturates the entire area surrounding the hole. Use copper naphthenate solution containing 2 percent or more copper metal and conforming to [507.2.3](#) or with another preservative allowed for field applications under AWPA M4.
- (3) Treat unfilled holes in treated lumber and timber, except for countersinking recesses, as specified above and then plug with treated plugs.
- (4) Fill countersinking recesses that form pockets that might retain water with a copper naphthenate solution containing 2 percent or more copper metal after placing the bolt or screw.

#### **507.3.8 Framed Bents**

##### **507.3.8.1 Mudsills**

- (1) Firmly, and evenly bed mudsills to solid bearing and tamp in place.

##### **507.3.8.2 Concrete Pedestals**

- (1) Finish the concrete pedestals for supporting framed bents so the sills or posts bear evenly on them. In casting them, set dowels in them of not less than 3/4 inch diameter and projecting at least 6 inches above the tops of the pedestals, for anchoring the sills or posts.

##### **507.3.8.3 Sills**

- (1) Ensure that sills bear true and even on mudsills, piles, or pedestals. Drift bolt the sills to mudsills or piles with bolts at least 3/4 inch in diameter and extending into the mudsills or piles at least 6 inches. If possible, remove earth from contact with sills so air circulates freely around them.

##### **507.3.8.4 Posts**

- (1) Ensure that posts bear evenly on cap and sill. Fasten posts to pedestals with dowels at least 3/4 inch in diameter and extending at least 6 inches into the posts.
- (2) Fasten posts to sills by one of the following methods, as the plans show:
  - With dowels not less than 3/4 inch diameter extending at least 6 inches into posts and sills.
  - With drift bolts not less than 3/4 inch diameter driven diagonally through the base of the post and extending at least 9 inches into the sill.

### **507.3.9 Caps**

- (1) Place the timber caps so the ends align, to secure an even and uniform bearing over the tops of the supporting posts or piles. Secure caps with drift bolts at least 3/4 inch in diameter and extending at least 9 inches into the posts or piles. Place the drift bolts approximately in the center of the post or pile.

### **507.3.10 Bracing**

- (1) Ensure that bracing bears firmly against the pile or cap that it is bolted. Provide and place shims as necessary to avoid bending the bracing more than one inch out of line after drawing the bracing bolts tight. Furnishing and placing shims are incidental to this work. If the opening between the bracing and the cap or pile is less than one inch, there is no need for shims. If the opening between the bracing and the cap or pile is from one to 2 inches, place 2 ogee washers with their narrow faces together on each bolt that passes through the opening. If the opening between the bracing and the cap or pile is over 2 inches, use wooden shims of the proper thickness. Use wooden shims made of untreated white oak, or the treated material used in the structure. Do not use built-up wooden shims. Ensure each wooden shim is a single piece of lumber at least 4 inches wide and at least as long as the bracing is wide, measured along the cap or pile.
- (2) The contractor shall not adze, trim, or cut otherwise any treated member to avoid using the above-described shims.

### **507.3.11 Stringers**

- (1) Size the stringers at bearings and position so that knots near edges are in the top of the stringers.
- (2) Outside stringers may have butt joints but, lap interior stringers to take bearing over the full width of the floor beam or cap at each end. Separate the lapped ends of stringers by at least 1/2 inch for air circulation and securely fasten by drift bolting if specified. If stringers are 2 panels in length, stagger the joints.
- (3) Neatly and accurately frame cross bridging between stringers, and securely toe nail with at least 2 nails in each end. Ensure cross bridging members bear at each end against the sides of stringers. Unless specified otherwise in the contract, place cross bridging at the center of each span.

### **507.3.12 Plank Floors**

- (1) Use treated lumber and timber in plank floors.
- (2) Single plank floors consist of a single thickness of plank supported by stringers or joists. Use planks surfaced on one side and one edge (S1S1E). Lay the planks with the surfaced side down and with close joints. Spike each plank securely to each joist. Lay planks at right angles to the centerline of roadway. Grade the thickness of the planks carefully and lay them so that no 2 adjacent planks vary by more than 1/16 inch.
- (3) Two-ply plank floors consist of 2 layers of flooring supported by stringers or joists. Use planks surfaced on one side and on one edge (S1S1E). Lay the planks with the surfaced side down and with close joints. Lay the top course diagonally or parallel to the centerline of roadway, as specified, and fasten each floor plank securely to the lower course or to the joist. Grade the thickness of the planks carefully and lay them so that no 2 adjacent planks vary by more than 1/16 inch. Stagger joints by at least 3 feet. If placing the top flooring parallel to the centerline of the roadway, take care to securely fasten the end of the flooring. At each end of the bridge, bevel the upper course of planks.
- (4) Spike side and retaining pieces at one-foot intervals and bolt at 3-foot intervals unless the plans show otherwise. Fasten scupper blocks to the retaining pieces by spikes and bolts through the wheel guards. Bolt the wheel guards in place as the plans show. Lay side retaining pieces and wheel guards true to line, parallel to the centerline of roadway, and flush with the edge of the subflooring.

### **507.3.13 Laminated or Strip Floors**

- (1) Use 3-inch or thinner strips, surfaced to a uniform thickness (S1S) and, if specified, to a uniform width (S1S1E).
- (2) Place the strips of lumber on edge and at right angles to the centerline of roadway. Spike each strip to the adjacent strip at 2-foot intervals with spikes that stagger 8 inches with those in adjacent strips. Use spikes of sufficient length to pass through 2 strips and at least halfway through the third. Additionally, toe nail the strips to the stringers or nailing strips with 20d spikes, and stagger the nailing of successive strips to space spikes at least 6 inches along each stringer or nailing strip. Keep each strip vertical and tight against the preceding one with even bearing on all the supports. If the plans show, attach the strips securely to steel supports by department-approved zinc coated metal clips.

### **507.3.14 Wheel Guards and Railings**

- (1) Unless specified otherwise, furnish wheel guards surfaced on one side and one edge (S1S1E) and rails and rail posts surfaced on 4 sides (S4S).

- (2) Lay the wheel guards in sections not less than 12 feet long.

**507.3.15 Fire Stops**

- (1) Provide fire stops in the intervals as the plans show. They consist of wood diaphragms at least as thick as the flooring or sidewalk, are located over caps, and fill the openings between the joists completely.

**507.3.16 Painting Lumber and Timber**

- (1) Paint lumber and timber as specified under [517.3.2](#) unless the contract provides otherwise.
- (2) Painting lumber and timber is incidental to furnishing and erecting the lumber and timber.

**507.4 Measurement**

- (1) The department will measure Treated Lumber and Timber by the thousand feet board measure (MBM) acceptably completed. The department will compute quantities from the nominal sizes and from the lengths as framed and erected. The department will not make any allowance for waste.
- (2) The department will only measure lumber and timber that is a part of the completed work. The department will not measure falsework, forms, bracing, sheeting, or other lumber and timber used for erection purposes.

**507.5 Payment**

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
507.0200	Treated Lumber and Timber	MBM

- (2) Payment for Treated Lumber and Timber is full compensation for providing, framing, treating, placing, and painting; and for materials and hardware required for erecting the lumber and timber.