780 CMR 23.00

WOOD

780 CMR 23.00 is Unique to Massachusetts

780 CMR 2301.0 GENERAL

2301.1 Scope. The provisions of 780 CMR 23.00 shall govern the materials, design, construction, and quality of wood members, systems, and structures, and their fasteners.

2301.2 General Requirements. Except as otherwise provided in 780 CMR 23.00, the design and construction of wood components, systems, and structures shall be in accordance with the following listed standards for allowable stress design (ASD) or the following listed standards:

1. ANSI/AF&PA NDS
2. AF&PA SDPWS Panel Supplement

780 CMR 2302.0 DEFINITIONS

2302.1 General. The following definitions shall apply to the provisions of 780 CMR 23.00.

ACCREDITATION BODY. An approved, third-party organization that is independent of the grading and inspection agencies and the lumber mills, and that initially accredits and subsequently monitors, on a continuing basis, the competency and performance of a grading or inspection agency related to carrying out specific tasks.

BOUNDARY ELEMENT. Diaphragms and shear wall boundary members to which sheathing transfers forces. Boundary elements include chords and drag struts at diaphragm and shear wall perimeters, interior openings, discontinuities and re-entrant corners.

COLLECTOR. A horizontal diaphragm element parallel and in line with the applied force that collects and transfers diaphragm shear forces to the vertical elements of the lateral-force-resisting system and/or distributes forces within the diaphragm.

CONVENTIONAL LIGHT-FRAME WOOD CONSTRUCTION. A type of construction whose primary structural elements are formed by a system of repetitive wood-framing members.

CRIPPLE WALL. A framed stud wall extending from the top of the foundation to the underside of floor framing for the lowest occupied floor level.

DIAPHRAGM. A horizontal or nearly horizontal system acting to transmit lateral forces to the vertical-resisting elements. When the term "diaphragm" is used, it includes horizontal bracing systems.

DIAPHRAGM, BLOCKED. A diaphragm in which adjacent sheathing edges not occurring over framing are supported on and fastened to common blocking members.

DIAPHRAGM, BOUNDARY. A location where shear is transferred into or out of the diaphragm sheathing. Transfer is either to a boundary element or to another force-resisting element.

DIAPHRAGM, CHORD. A diaphragm boundary element perpendicular to the applied load that is assumed to take axial stresses due to the diaphragm moment.

DIAPHRAGM, UNBLOCKED. A diaphragm that has edge nailing at supporting members only. Blocking between supporting structural members at panel edges is not included. Diaphragm panels are field nailed to supporting members.

DRAG STRUT. See "Collector."

FIBERBOARD. A fibrous, homogeneous panel made from lignocellulosic fibers (usually wood or cane) and having a density of less than 31 pounds per cubic foot (497 kg/m^3) but more than ten pounds per cubic foot (160 kg/m^3).

GLUED BUILT-UP MEMBER. A structural element, the section of which is composed of built-up lumber, wood structural panels or wood structural panels in combination with lumber, all parts bonded together with structural adhesives.

GRADE (LUMBER). The classification of lumber in regard to strength and utility in accordance with DOC PS 20 and the grading rules of an approved lumber rules writing agency.

HARDBOARD. A fibrous-felted, homogeneous panel made from lignocellulosic fibers consolidated under heat and pressure in a hot press to a density not less than 31 pounds per cubic foot (497 kg/m^3).

NAILING, BOUNDARY. A special nailing pattern required by design at the boundaries of diaphragms.

NAILING, EDGE. A special nailing pattern required by design at the edges of each panel within the assembly of a diaphragm or shear wall.

NAILING, FIELD. Nailing required between the sheathing panels and framing members at locations other than boundary nailing and edge nailing.

NATIVE LUMBER. Native lumber is wood processed in the Commonwealth of Massachusetts by a mill registered in accordance with 780 CMR 110.R4. Such wood may be ungraded but is stamped or certified in accordance with the requirements of 780 CMR110.R4.

NATURALLY DURABLE WOOD. The heartwood of the following species with the exception that an occasional piece with corner sapwood is permitted if 90% or more of the width of each side on which it occurs is heartwood.

Decay Resistant. Redwood, cedar, black locust and black walnut.

Termite Resistant. Redwood and Eastern red cedar.

NOMINAL SIZE (LUMBER). The commercial size designation of width and depth, in standard sawn lumber and glued laminated lumber grades; somewhat larger than the standard net size of dressed lumber, in accordance with DOC PS 20 for sawn lumber and in accordance with the NDS for glued laminated lumber.

PARTICLEBOARD. A generic term for a panel primarily composed of cellulosic materials (usually wood), generally in the form of discrete pieces or particles, as distinguished from fibers. The cellulosic material is combined with synthetic resin or other suitable bonding system by a process in which the interparticle bond is created by the bonding system under heat and pressure.

PERFORATED SHEAR WALL. A section of shear wall with full-height sheathing that meets the height-to-width ratio limits of 780 CMR 2305.3.3.

PERFORATED SHEAR WALL SEGMENT. A section of shear wall with full-height sheathing that meets the aspect ratio limits of 780 CMR 2305.3.3.

PRESERVATIVE-TREATED WOOD. Wood (including plywood) pressure-treated with preservatives in accordance with 780 CMR 2303.1.8.

SHEAR WALL. A wall designed to resist lateral forces parallel to the plane of a wall.

STRUCTURAL GLUED LAMINATED TIMBER. Any member comprising an assembly of laminations of lumber in which the grain of all laminations is approximately parallel longitudinally, in which the laminations are bonded with adhesives.

SUBDIAPHRAGM. A portion of a larger wood diaphragm designed to anchor and transfer local forces to primary diaphragm struts and the main diaphragm.

TIE-DOWN (HOLD-DOWN). A device used to resist uplift of the chords of shear walls.

TREATED WOOD. Wood impregnated under pressure with compounds that reduce their susceptibility to flame spread or to deterioration caused by fungi, insects, or marine borers.

WOOD SHEAR PANEL. A wood floor, roof, or wall component sheathed to act as a shear wall or diaphragm.

WOOD STRUCTURAL PANEL. A panel manufactured from veneers; or wood strands or wafers; or a combination of veneer and wood strands or wafers; bonded together with waterproof synthetic resins or other suitable bonding systems. Examples of wood structural panels are:

Composite Panels. A structural panel that is made of layers of veneer and wood-based material;

Oriented Strand Board (OSB). A wood structural panel that is a mat-formed product composed of thin rectangular wood strands or wafers arranged in oriented layers; and

Plywood. A wood structural panel comprised of plies of wood veneer arranged in cross-aligned layers.

780 CMR 2303.0 SUPPLEMENTAL REQUIREMENTS

2303.1 General. 780 CMR 2303.0 supplements the requirements in the referenced standards of 780 CMR 2301.2.

2303.2 Lumber.

2303.2.1 Standard. Lumber and lumber grading shall comply with DOC PS 20

2303.2.2 Alternate Grading. In lieu of a grade mark on lumber as required by DOC PS 20, a certificate of inspection as to species and grade issued by a lumber grading or inspection agency meeting the requirements of DOC PS 20 may be accepted for precut, remanufactured, or rough-sawn lumber, and for sizes larger than three inches (76 mm) nominal thickness.

2303.2.3 Native Lumber. Native lumber shall be acceptable for use in one and two story dwellings, barns, sheds, agricultural and accessory structures. Native lumber shall also be acceptable for use in other one and two story structures as columns when the design loads are 25% greater than required in 780 CMR 16.00; as joists, principal beams, and girders in floor constructions when the design loads are 15% greater than required in 780 CMR 16.00; and as other elements when the design loads are as required in 780 CMR 16.00.

Each piece of native lumber produced shall be stamped with the name and registration number of the producer in accordance with 780 CMR 110.R4. In addition, all native lumber shall bear an approved mark identifying the species of wood. In lieu of the stamp bearing the name and registration number and species identification, a certification bearing the same information may be provided by the producer for precut or re-manufactured lumber in accordance with 780 CMR 110.R4. When native lumber is used, it shall be subject to the following requirements:

1. Sizing Criteria. For lumber, sized in accordance with the DOC PS-20, figures for maximum fiber stress and modulus of elasticity for framing grade No. 2 shall be used in establishing span and spacing characteristics for all structural members.

2. Stress criteria: Lumber which is sized in excess of the dimensions established by the DOC PS-20 for the given nominal size referenced shall be allowed to have a maximum fiber stress increase above that provided in 780 CMR 2303.2.3, Item 1 in proportion to the increased bearing capacity of the cross section as provided in Table 2303.2 or as calculated.

TABLE 2302.3 NATIVE LUMBER - ALLOWABLE STRESSES

Nominal Size	Actual Lumber Size Closest size which does not exceed the size shown) Actual Size (thickness x width)	Multiplier factor based on lumber width	Factor to be added to multiplier factor for lumber oversized in thickness	
			Thickness increase of ¼" to ½"	Thickness increase of over ½" to 1"
3 x 8	2½ x 7½ 2½ x 7¾ 2½ x 8	1.0 x Fs 1.07 1.14	+0.10	+0.20
3 x 10	2½ x 9½ 2½ x 9 1¾ 2½ x 10	1.0 1.05 1.11	+0.10	+0.20
3 x 12	2½ x 11½ 2½ x 11 1¾ 2½ x 12	1.0 1.04 1.09	+0.10	+0.20
3 x 14	2½ x 13½ 2½ x 13 1¾ 2½ x 14	1.0 1.04 1.07	+0.10	+0.20
4 x 10	3½ x 9½ 3½ x 9¾ 3½ x 10	1.0 1.05 1.11	+0.07	+0.14
4 x 12	3½ x 11½ 3½ x 11¾ 3½ x 12	1.0 1.04 1.09	+0.07	+0.14
4 x 14	3½ x 13½ 3½ x 13¾ 3½ x 14	1.0 1.04 1.08	+0.07	+0.14

2303.3 Prefabricated Wood I-joists. Prefabricated wood I-joists shall conform to ASTM D 5055.

2303.4 Structural Glued Laminated Timber. Glued laminated timbers shall be manufactured and identified as required in AITC A190.1, and ASTM D3737.

2303.5 Wood Structural Panels

2303.5.1 Wood structural panels, when used structurally (including those used for siding, roof and wall sheathing, subflooring, diaphragms, and built-up members), shall conform to the requirements for its type in DOC PS 1 or DOC PS 2. Each panel or member shall be identified for grade and glue type by the trademarks of an approved testing and grading agency. Wood structural panel components shall be identified by the trademarks of an approved testing and inspection agency indicating conformance with the applicable standard.

2303.5.2 Wood structural panels when permanently exposed in outdoor applications shall be of exterior type, except that wood structural panel roof sheathing exposed to the outdoors on the underside may be interior type bonded with exterior glue, Exposure 1.

2303.5.3 In NDS, Section 9.2.1.1, the phrase "an approved source" shall be taken to mean "AF&PA ASD Panel Supplement."

2303.5.4 In ASCE 16-95, Section 8.3.1 substitute the following for the first paragraph: "Panel stiffness and factored reference resistance shall be used in structural - use panel design and shall be

in accordance with AF&PA LRFD Panel Supplement - 1996, or shall be determined by test in accordance with DOC PS 1 or DOC PS 2."

2303.6 Fiberboard. Fiberboard for its various uses shall conform to ANSI/AHA A194.1 or ASTM C 208. Fiberboard sheathing, when used structurally, shall be so identified by an approved agency as conforming to ANSI/AHA A194.1 or ASTM C 208.

2303.6.1 Jointing. To ensure tight fitting assemblies, edges shall be manufactured with square, ship-lapped, beveled, tongue-and-groove, or U-shaped joints.

2303.1.5.2 Exposure to Weather. Fiberboard shall not be used for an structural application, such as floor or roof deck or wall sheathing, where it will be exposed to the weather.

2303.7 Hardboard. Hardboard siding used structurally shall be identified by an approved agency conforming to AHA A135.6. Hardboard underlayment shall meet the strength requirements of $^{7}/_{32}$-inch (5.6 mm) or ¼-inch (6.4 mm) service class hardboard planed or sanded on one side to a uniform thickness of not less than 0.200 inch (5.1 mm). Pre-finished hardboard paneling shall meet the requirements of AHA A135.5. Other basic hardboard products shall meet the requirements of AHA A135.4. Hardboard products shall be installed in accordance with manufacturer's recommendations, and shall not be exposed to the weather.

2303.8 Particleboard. Particleboard shall conform to ANSI A208.1. Particleboard shall be identified by the grade mark or certificate of inspection issued by an approved agency. Particleboard shall not be utilized for applications other than indicated in 780 CMR 2303.8.

2303.8.1 Floor Underlayment. Particleboard floor underlayment shall conform to Type PBU of ANSI A208.1. Type PBU underlayment shall not be less than ¼-inch (6.4 mm) thick and shall be installed in accordance with the installation instructions of the Composite Panel Association.

2303.9 Preservative-treated Wood. Lumber, timber, plywood, piles and poles supporting permanent structures required by 780 CMR 2304.6 to be preservative-treated shall conform to the requirements of the applicable AWPA Standard C1, C2, C3, C4, C9, C14, C15, C16, C22, C23, C24, C28, C31, C33 and M4, for the species, product, preservative and end use. Preservatives shall conform to AWPA P1/P13, P2, P5, P8 and P9.

2303.9.1 Identification. Wood that is preservative-treated shall bear the quality mark of an inspection agency that maintains continuing supervision, testing and inspection over the quality of the preservative-treated wood. Inspection agencies for preservative treated wood shall be listed by an accreditation body that complies with the requirements of the American Lumber Standards Treated Wood Program, or equivalent. The quality mark shall be on a stamp or label affixed to the preservative-treated wood. The quality mark shall include the following information:

1. Identification of treating manufacturer.
2. Type of preservative used.
3. Minimum preservative retention (pef).
4. End use for which the product is treated.
5. AWPA standard to which the product was treated.
6. Identity of the accredited inspection agency.

2303.9.2 Moisture Content. Where preservative-treated wood is used in enclosed locations where drying in service cannot readily occur, such wood shall be at a moisture content of 19% or less for lumber and 15% or less for wood structural panels before being covered with insulation, interior wall finish, floor covering or other materials.

2303.10 Fire-retardant-treated Wood. Fire-retardant-treated wood is any wood product which, when impregnated with chemical by a pressure process or other means during manufacture, shall have, when tested in accordance with ASTM E 84, a listed flame spread index of 25 or less and show no evidence of significant progressive combustion when the test is continued for an additional 20-minute period. In addition, the flame front shall not progress more than 10.5 feet (3200 mm) beyond the centerline of the burners at any time during the test.

2303.10.1 Labeling. Fire-retardant-treated lumber and wood structural panels shall be labeled. The label shall contain the following items:

1. The identification mark of an approved agency
2. Identification of the treating manufacturer.
3. The name of the fire-retardant treatment.
4. The species of wood treated.
5. Flame spread and smoke-developed index.
6. Method of drying after treatment.
7. Conformance with appropriate standards in accordance with 780 CMR 2303.10.2 through 2303.10.5.
8. For fire-retardant-treated wood exposed to weather, damp or wet locations, include the words "No increase in the listed classification when subjected to the Standard Rain Test" (ASTM D 2898).

2303.10.2 Strength Adjustments. Design values for untreated lumber and wood structural panels shall be adjusted for fire-retardant-treated wood. Adjustments to design values shall be based on a method of investigation that takes into consideration the effects of the anticipated temperature and humidity to which the fire-retardant-treated wood will be subjected, the type of treatment and re-drying procedures.

2303.10.2.1 Wood Structural Panels. The effect of treatment and the method of redrying after treatment, and exposure to high temperatures and high humidities on the flexure properties of fire-retardant-treated softwood plywood shall be determined in accordance with ASTM D 5516. The test data developed by ASTM D 5516 shall be used to develop adjustment factors, maximum loads and spans, or both, for untreated plywood design values in accordance with ASTM D 6305. Each manufacturer shall publish the allowable maximum loads and spans for service as floor and roof sheathing for its treatment.

2303.10.2.2 Lumber. For each species of wood treated, the effect of the treatment and the method of redrying after treatment and exposure to high temperatures and high humidities on the allowable design properties of fire-retardant-treated lumber shall be determined in accordance with ASTM D 5664. The test data developed by ASTM D 5664 shall be used to develop modification factors for use at or near room temperature and at elevated temperatures and humidity in accordance with an approved method of investigation. Each manufacturer shall publish the modification factors for service at temperatures of not less than 80°F (26.7°C) and for roof framing. The roof framing modification factors shall take into consideration the climatological location.

2303.10.3 Exposure to Weather, Damp or Wet Locations. Where fire-retardant-treated wood is exposed to weather, or damp or wet locations, it shall be identified as "Exterior" to indicate there is no increase in the listed flame spread index as defined in 780 CMR 2303.10 when subjected to ASTM D 2898.

2303.10.4 Interior Applications. Interior fire-retardant-treated wood shall have moisture content of not over 28% when tested in accordance with ASTM D 3201 procedures at 92% humidity. Interior fire-retardant-treated wood shall be tested in accordance with 780 CMR 2303.10.2.1 or 2303.10.2.2. Interior fire-retardant-treated wood designated as Type A shall be tested in accordance with the provisions of 780 CMR 2303.10.

2303.10.5 Moisture Content. Fire-retardant-treated wood shall be dried to a moisture content of 19% or less for lumber and 15% or less for wood structural panels before use. For wood kiln dried after treatment (KDAT), the kiln temperatures shall not exceed those used in kiln drying the lumber and plywood submitted for the tests described in 780 CMR 2303.10.2.1 for plywood and 780 CMR 2303.10.2.2 for lumber.

2303.10.6 Type I and II Construction Applications. See780 CMR 603.1 for limitations on the use of fire-retardant-treated wood in buildings of Type I or II construction.

2303.11 Hardwood Plywood. Hardwood and decorative plywood shall be manufactured and identified as required in HPVA HP-1.

2303.12 Trusses. Metal plate connected wood trusses shall be manufactured as required by TPI 1. Each manufacturer of trusses using metal plate connectors shall retain an approved agency to make nonscheduled inspections of truss manufacturing and delivery operations. The inspection shall cover all phases of truss operations, including lumber storage, handling, cutting fixtures, presses and rollers, manufacturing, bundling, and banding.

2303.12.1 Truss Design and Erection Documents. Truss design and erection documents shall be prepared by a registered design professional experienced in structural engineering. A copy of the final truss design and erection documents shall be provided to the Building Official. Truss design and erection documents shall be provided with the shipments of trusses delivered to the job site. Truss design and erection documents shall include, at a minimum, the information specified in 780 CMR 2303.12.1, items 1. through 13.

1. Slopes, depths, spans, and spacings;
2. Locations and details of joints and field splices;
3. Required bearing widths for each load combination;
4. Design loads (uniformly distributed, concentrated, and moments), including, but not limited to, dead loads, live loads, snow loads (basic, drifting, and sliding), wind loads (external and internal pressures and suctions), seismic loads, impact loads, and hanging loads, individually for top chords, bottom chords, and web members for each load combination;
5. Adjustments to lumber and metal connector plate design values for conditions of use;
6. Reaction forces and directions at each support for each load combination;
7. Metal connector plate types, sizes, thicknesses or gauges, and the dimensioned locations of each metal connector plate;
8. Lumber size, species, and grade for each member;
9. Connection requirements and details for:
   15.1. Truss-to-support (truss girders, beams, walls, etc.); and
   15.2. Truss ply-to-ply.
10. Calculated deflection ratios and/or maximum deflection values for each load case and load combination;
11. Stresses (bending and/or axial) in <u>each</u> truss member for each load combination. Note members where stress reversals occur.

12. Required truss member bracing to account for member slenderness effects. Detail the types (continuous, "T", "L", etc.), sizes, locations, connections, and end terminations for continuous bracing. Truss member bracing requirements to account for member slenderness effects shall be indicated on the truss erection drawings and the truss design drawings.
13. Required truss member reinforcing and/or bracing for out-of-plane wind loading.

2303.13 Joist Hangers and Similar Metal Connectors. The vertical load-bearing capacity, torsional moment capacity, and deflection characteristics of joist hangers and similar connectors shall be determined in accordance with ASTM D 1761, using lumber having a specific gravity of 0.49 or greater, but not greater than 0.55.

2303.13.1 Vertical Load Capacity for Joist Hangers. The vertical load capacity for the joist hanger shall be determined by testing three joist hanger assemblies as specified in ASTM D 1761. If the ultimate vertical load for any one of the tests varies more than 20% from the average ultimate vertical load, at least three additional tests shall be conducted. The allowable vertical load for a normal duration of loading of the joist hanger shall be the lowest value determined from the following:

1. The lowest ultimate vertical load from any test divided by three (where three tests are conducted and each ultimate vertical load does not vary more than 20% from the average ultimate vertical load).
2. The average ultimate vertical load for all tests divided by six (where six or more tests are conducted).
3. The vertical load at which the vertical movement of the joist with respect to the header is 0.125 inch (3.2 mm) in any test.
4. The allowable design load for nails or other fasteners utilized to secure the joist hanger to the wood members.
5. The allowable design load for the wood members forming the connection.

2303.13.2 Torsional Moment Capacity for Joist Hangers. The torsional moment capacity for the joist hanger shall be determined by testing at least three joist hanger assemblies as specified in ASTM D 1761. The allowable torsional moment for normal duration of loading of the joist hanger shall be the average torsional moment at which the lateral movement of the top or bottom of the joist with respect to the original position of the joist is 0.125 inch (3.2 mm).

2303.13.3 Design Value Modifications for Joist Hangers. For species of wood other than that used in the tests, the allowable design values for joist hangers shall be adjusted for specific gravity where failure is controlled by dowel type fasteners (such as nails or bolts), and shall be adjusted for the bearing strength of the wood where failure is controlled by bearing on the wood. Allowable design values for joist hangers that are determined by 780 CMR 2303.13.1, Item 4. or 5. shall be permitted to be modified by the appropriate duration of loading factors as specified in AFPA NDS. Allowable design values determined by 780 CMR 2303.13.1, Item 1., 2. or 3. shall not be modified by duration of loading factors.

2303.14 Nails and Staples. Nails and staples shall conform to requirements of ASTM F 1667. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as follows: 80 ksi (551 MPa) for shank diameters larger than 0.177 inch (4.50 mm), but not larger than 0.254 inch (6.45 mm); 90 ksi (620 MPa) for shank diameters larger than 0.142 inch (3.61 mm), but not larger than 0.177 inch (4.50 mm); and 100 ksi (689 MPa) for shank diameters of 0.142 inch (3.61 mm) or less.

780 CMR 2304.0 GENERAL CONSTRUCTION REQUIREMENTS

2304.1 Framing Around Flues and Chimneys. Combustible framing shall be a minimum of two inches (51 mm), but shall not be less than the distance specified in 780 CMR 2111.0 and 2113.0 and the *International Mechanical Code*, from flues, chimneys and fireplaces, and six inches (152 mm) away from flue openings.

2304.2 Wall Sheathing.

2304.2.1 Wall Sheathing. Except as provided for in 780 CMR 1405.0 for weather boarding or where stucco construction that complies with 780 CMR 2510.0 is installed, enclosed buildings shall be sheathed with one of the materials of the nominal thickness specified in Table 2304.2.

2304.2.1.1 Wood Structural Panel Sheathing. Where wood structural panel sheathing is used as the exposed finish on the exterior of outside walls, it shall have an exterior exposure durability classification. Where wood structural panel sheathing is used on the exterior of outside walls but not as the exposed finish, it shall be of a type manufactured with exterior glue (Exposure 1 or Exterior). Where wood structural panel sheathing is used elsewhere, it shall be of a type manufactured with intermediate or exterior glue.

TABLE 2304.2 MINIMUM THICKNESS OF WALL SHEATHING

SHEATHING TYPE	MINIMUM THICKNESS	MAXIMUM WALL STUD SPACING
Wood boards	5/8 inch	24 inches on center
Fiberboard	½ inch	16 inches on center
Wood structural panel	In accordance with Tables 2308.9.3(2) and 2308.9.3(3)	—
M-S "Exterior Glue" and M-2 "Exterior Glue" Particleboard	In accordance with Tables 2306.4.3 and 2308.9.3(5)	—
Gypsum sheathing	½ inch	16 inches on center
Gypsum wallboard	½ inch	24 inches on center
Reinforced cement mortar	1 inch	24 inches on center

For SI: 1 inch - 25.4 mm

2304.2.2 Interior Paneling. Softwood wood structural panels used for interior paneling shall conform with the provisions of 780 CMR 8.00. Panels shall comply with DOC PS 1 or PS 2. Prefinished hardboard paneling shall meet the requirements of AHA A135.5. Hardwood plywood shall conform to HPVA HP-1.

2304.3 Structural Floor and Roof Sheathing. The maximum spans for floor and roof sheathing shall comply with Tables 2304.3(1), 2304.3(2), 2304.3(3), 2304.3(4) or 2304.3(5), as applicable. Wood structural panel roof sheathing shall be bonded by exterior glue.

TABLE 2304.3(1) ALLOWABLE SPANS FOR LUMBER FLOOR AND ROOF SHEATHING

SPAN (inches)	MINIMUM NET THICKNESS (inches) OF LUMBER PLACED			
	Perpendicular to supports		Diagonally to supports	
	Surfaced dry[a]	Surfaced unseasoned	Surfaced dry[c]	Surfaced unseasoned
Floors				
24	¾	25/32	¾	25/32
16	5/8	11/16	5/8	11/16
Roofs				
2	5/8	11/16	¾	25/32

For SI: 1 inch - 25.4 mm

a. Maximum 19% moisture content

TABLE 2304.3(2) SHEATHING LUMBER, MINIMUM GRADE REQUIREMENTS: BOARD GRADE

SOLID FLOOR OR ROOF SHEATHING	SPACED ROOF SHEATHING	GRADING RULES
Utility	Standard	NLGA, WCLIB, WWPA
4 common or utility	3 common or standard	NLGA, WCLIB, WWPA, NSLB or NELMA
No. 3	No. 2	SPIB
Merchantable	Construction common	RIS

TABLE 2304.3(3) ALLOWABLE SPANS AND LOADS FOR WOOD STRUCTURAL PANEL SHEATHING AND SINGLE-FLOOR GRADES CONTINUOUS OVER TWO OR MORE SPANS WITH STRENGTH AXIS PERPENDICULAR TO SUPPORTS[a, b]

SHEATHING GRADES		ROOF[c]				FLOOR[d]
Panel span rating roof/floor span	Panel thickness (inches)	Maximum span (inches)		Load[e] (psf)		Maximum span (inches)
		With edge support[f]	Without edge support	Total load	Live load	
12/0	5/16	12	12	40	30	0
16/0	5/16, 3/8	16	16	40	30	0
20/0	5/16, 3/8	20	20	40	30	0
24/0	3/8, 7/16, 1/2	24	20[g]	40	30	0
24/16	7/16, 1/2	24	24	50	40	16
32/16	15/32, 1/2, 5/8	32	28	40	30	16[h]
40/20	19/32, 5/8, 3/4, 7/8	40	32	40	30	20[h,i]
48/24	23/32, 3/4, 7/8	48	36	45	35	24
54/32	7/8, 1	54	40	45	35	32
60/32	7/8, 1 1/8	60	48	45	35	32
SINGLE FLOOR GRADES		**ROOF[c]**				**FLOOR[d]**
Panel span rating	Panel thickness (inches)	Maximum span (inches)		Load[e] (psf)		Maximum span (inches)
		With edge support[f]	Without edge support	Total load	Live load	
16 o.c.	1/2, 19/32, 5/8	24	24	50	40	16[h]
20 o.c.	19/32, 5/8, 3/4	32	32	40	30	20[h,i]
24 o.c.	23/32, 3/4	48	36	35	25	24
32 o.c.	7/8, 1	48	40	50	40	32
48 o.c.	1 3/32, 1 1/8	60	48	50	40	48

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m^2.

a. Applies to panels 24 inches or wider.
b. Reserved.
c. Uniform load deflection limitations $^1/_{180}$ of span under live load plus dead load, $^1/_{240}$ under live load only.
d. Panel edges shall have approved tongue-and-groove joints or shall be supported with blocking un less ¼-inch minimum thickness underlayment or 1½ inches of approved cellular or lightweight concrete is placed over the subfloor, or finish floor is ¾-inch wood strip. Allowable uniform load based on deflection of $^1/_{360}$ of span is 100 pounds per square foot except the span rating of 48 inches on center is based on a total load of 65 pounds per square foot.
e. Allowable load at maximum span.
f. Tongue-and-groove edges, panel edge clips (one midway between each support, except two equally spaced between supports 48 inches on center), lumber blocking or other. Only lumber blocking shall satisfy blocked diaphragm requirements.
g. For $^1/_2$-inch panel, maximum span shall be 24 inches.
h. Span is permitted to be 24 inches on center where ¾-inch wood strip flooring is installed at right angles to joist.
i. Span is permitted to be 24 inches on center for floors where 1½ inches of cellular or lightweight concrete is applied over the panels.

TABLE 2304.3(4) ALLOWABLE SPANS FOR WOOD STRUCTURAL PANEL COMBINATION SUBFLOOR-UNDERLAYMENT (SINGLE FLOOR)[a]
(Panels Continuous over Two or More Spans and Strength Axis Perpendicular to Supports)

IDENTIFICATION	MAXIMUM SPACING OF JOISTS (inches)				
	16	20	24	32	48
Species group[c]	Thickness (inches)				
1	1/2	5/8	3/4	-	-
2, 3	5/8	3/4	7/8	-	-
4	3/4	7/8	1	-	-
Single floor span rating[d]	16 o.c.	20 o.c.	24 o.c.	32 o.c.	48 o.c.

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m^2.

a. Spans limited to value shown because of possible effects of concentrated loads. Allowable uniform loads based on deflection of $^1/_{360}$ of span is 100 pounds per square foot except allowable total uniform load for 1⅛-inch wood structural panels over joists spaced 48 inches on center is 65 pounds per square foot. Panel edges shall have approved tongue-and-groove joints or shall be supported with blocking, unless ¼-inch minimum thickness underlayment or 1½ inches of approved cellular or lightweight concrete is placed over the subfloor, or finish floor is ¾-inch wood strip.
b. Reserved.
c. Applicable to all grades of sanded exterior-type plywood. See DOC PS 1 for plywood species groups.
d. Applicable to Underlayment grade, C-C (Plugged) plywood, and Single Floor grade wood structural panels.

TABLE 2304.3(5) ALLOWABLE LOAD (PSF) FOR WOOD STRUCTURAL PANEL ROOF SHEATHING CONTINUOUS OVER TWO OR MORE SPANS AND STRENGTH AXIS PARALLEL TO SUPPORTS
(Plywood Structural Panels Are Five-ply, Five-layer Unless Otherwise Noted)[b]

PANEL GRADE	THICKNESS (inch)	MAXIMUM SPAN (inches)	LOAD AT MAXIMUM SPAN (psf)	
			Live	Total
Structural I sheathing	7/16	24	20	30
	15/32	24	35[c]	45[c]
	½	24	40[c]	50[c]
	19/32, 5/8	24	70	80
	23/32, ¾	24	90	100
Sheathing, other grades covered in DOC PS 1 or DOC PS 2	7/16	16	40	50
	15/32	24	20	25
	1/2	24	25	30
	19/32	24	40[c]	50[c]
	5/8	24	45[c]	55[c]
	23/32, ¾	24	60[c]	65[c]

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m^2 .

a. Reserved.

b. Uniform load deflection limitations 1/180 of span under live load plus dead load, 1/240 under live load only. Edges shall be blocked with lumber or other approved type of edge supports.

c. For composite and four-ply plywood structural panel, load shall be reduced by 15 pounds per square foot.

2304.4 Mechanically Laminated Floors and Decks. A laminated lumber floor or deck built up of wood members set on edge, when meeting the following requirements, is permitted to be designed as a solid floor or roof deck of the same thickness, and continuous spans are permitted to be designed on the basis of the full cross section using the simple span moment coefficient.

Nail lengths shall not be less than two and one-half times the net thickness of each lamination. Where deck supports are four feet (1219 mm) on center or less, side nails shall be spaced not more than 30 inches (762 mm) on center alternately near top and bottom edges, and staggered one-third of the spacing in adjacent laminations. Where supports are spaced more than four feet (1219 mm) on center, side nails shall be spaced not more than 18 inches (457 mm) on center alternately near top and bottom edges, and staggered ⅓ of the spacing in adjacent laminations. Two side nails shall be used at each end of butt-jointed pieces.

Laminations shall be toe-nailed to supports with 20d or larger common nails. Where the supports are four feet (1219 mm) on center or less, alternate laminations shall be toe-nailed to alternate supports; where supports are spaced more than four feet (1219 mm) on center, alternate laminations shall be toe-nailed to every support. A single-span deck shall have all laminations full length. A continuous deck of two spans shall not have more than every fourth lamination spliced within quarter points adjoining supports. Joints shall be closely butted over supports or staggered across the deck but within the adjoining quarter spans. No lamination shall be spliced more than twice in any span.

2304.5 Connections and Fasteners.

2304.5.1 Nails. The number and size of nails connecting wood members shall not be less than that set forth in Table 2304.5.

2304.5.2 Sheathing Fasteners. Sheathing nails or similar fasteners shall be driven so that their head or crown is flush with the surface of the sheathing.

2304.5.3 Fasteners in Preservative-treated and Fire-retardant-treated Wood. Fasteners for preservative-treated and fire-retardant-treated wood shall be of hot-dipped zinc coated galvanized steel, stainless steel, silicon bronze, or copper.

2304.5.4 Columns and Posts. Wood columns and posts shall be framed to provide full end bearing. Alternatively, column-and-post end connections shall be designed to resist the full compressive loads. Column and post end connections shall be fastened to resist lateral and net induced uplift forces.

TABLE 2304.5 FASTENING SCHEDULE

CONNECTION	FASTENING[a,m]	LOCATION
1. Joist to sill or girder	3 - 8d common 3 - 3" x 0.13 1" nails 3 - 3" 14 gage staples	toenail
2. Bridging to joist	2 - 8d common 2 - 3" x 0.13 1" nails 2 - 3"14 gage staples	toenail each end
3. 1" x 6" subfloor or less to each joist	2 - 8d common	face nail
4. Wider than 1" x 6" subfloor to each joist	3 - 8d common	face nail
5. 2" subfloor to joist or girder	2 - 16d common	blind and face nail
6. Sole plate to joist or blocking Sole plate to joist or blocking at braced wall panel	16d at 16" o.c. 3" x 0.13 1" nails at 8" o.c. 3" 14 gage staples at 12" o.c. 3 - 16d at 16" 4 - 3" x 0.13 1" nails at 16" 4 - 3" 14 gage staples per 16"	typical face nail braced wall panels
7. Top plate to stud	2 - 16d common 3 - 3" x 0.131" nails 3 - 3" 14 gage staples	end nail
8. Stud to sole plate	4 - 8d common 4 - 3" x 0.131" nails 3 - 3" 14 gage staples 2 - 16d common 3 - 3" x 0.131" nails 3 - 3" 14 gage staples	toenail end nail
9. Double studs	16d at 24" o.c. 3" x 0.13 1" nail at 8" o.c. 3" 14 gage staple at 8" o.c.	face nail
10. Double top plates Double top plates	16d at 16" o.c. 3" x 0.13 1" nail at 12" o.c. 3" 14 gage staple at 12" o.c. 8-16d common 12 - 3" x 0.131" nails 12 - 3" 14 gage staples	typical face nail lap splice
11. Blocking between joists or rafters to top plate	3 - 8d common 3 - 3" x 0.13 1" nails 3 - 3" 14 gage staples	toenail
12. Rim joist to top plate	8d at 6" o.c. 3" x 0.13 1" nail at 6" o.c. 3" 14 gage staple at 6" o.c.	toenail
13. Top plates, laps and intersections	2 - 16d common 3 - 3" x 0.131" nails 3 - 3" 14 gage staples	face nail
14. Continuous header, two pieces	16d common	16" o.c. along edge
15. Ceiling joists to plate	3 - 8d common 5 - 3" x 0.131" nails 5 - 3" 14 gage staples	toenail
16. Continuous header to stud	4 - 8d common	toenail
17. Ceiling joists, laps over partitions (see 780 CMR 2308.10.4.1, Table 2308.10.4.1)	3 - 16d common minimum, Table 2308.10.4.1 4 - 3" x 0.131" nails 4 - 3" 14 gage staples	face nail
18. Ceiling joists to parallel rafters (see 780 CMR 2308.10.4.1, Table 2308.10.4.1)	3 - 16d common minimum, Table 2308.10.4.1 4 - 3" x 0.131" nails 4 - 3" 14 gage staples	face nail
19. Rafter to plate (see 780 CMR 2308.10.1, Table 2308.10.1)	3 - 8d common 3 - 3" x 0.131" nails 3 - 3" 14 gage staples	toenail
20. 1" diagonal brace to each stud and plate	2 - 8d common 2 - 3"x 0.131"nails 2 - 3" 14 gage staples	face nail
21. 1" x 8" sheathing to each bearing	2 - 8d common	face nail
22. Wider than 1"x 8" sheathing to each bearing	3 - 8d common	face nail

TABLE 2304.5 - continued

CONNECTION	FASTENING[a,m]	LOCATION
23. Built-up corner studs	16d common 3" x 0.131" nails 3" 14 gage staples	24" o.c. 16" o.c. 16" o.c.
24. Built-up girder and beams	20d common 32" o.c 3" x 0.131" nail at 24" o.c. 3" 14 gage staple at 24" o.c. 2 - 20d common 3 - 3" x 0.13 1" nails 3 - 3" 14 gage staples	face nail at top and bottom staggered on opposite sides face nail at ends and at each splice
25. 2" planks	16d common	at each bearing
26. Collar tie to rafter	3 - 10d common 4 - 3"x 0.131"nails 4 - 3" 14 gage staples	face nail
27. Jack rafter to hip	3 - 10d common 4 - 3" x 0.13 1"nails 4 - 3" 14 gage staples 2 - 16d common 3 - 3"x 0.131"nails 3 - 3" 14 gage staples	toenail face nail
28. Roof rafter to 2-by ridge beam	2 - 16d common 3 - 3" x 0.131" nails 3 - 3" 14 gage staples 2 - 16d common 3 - 3"x 0.131"nails 3 - 3" 14 gage staples	toenail face nail
29. Joist to band joist	3 - 16d common 5 - 3"x 0.131"nails 5 - 3" 14 gage staples	face nail
30. Ledger strip	3 - 16d common 4 - 3^ × 0.131" nails 4 - 3^ 14 gage staples	face nail
31. Wood structural panels and particleboard:[b] Subfloor, roof and wall sheathing (to framing): Single Floor (combination subfloor-underlayment to framing):	½" and less 19/32" to ¾" ⅝" to 1" 1⅛" to 1¼" ¾" and less ⅞" to 1" 1⅛" to 1¼"	6d[c,l] 2⅜" × 0.113" nail[n] 1¾" 16 gage[o] 8d[d] or 6d[e] 2 ⅜^ × 0.113" nail[p] 2" 16 gage[p] 8d[c] 10d[d] or 8d[e] 6d[e] 8d[e] 10d[d] or 8d[e]	
32. Panel siding (to framing)	½" or less ⅝"	6d[f] 8d[f]	
33. Fiberboard sheathing:[g]	½" 25/32" 	No. 11 gage roofing nail[h] 6d common nail No. 16 gage staple[i] No. 11 gage roofing nail[h] 8d common nail No. 16 gage staple[i]	
34. Interior paneling	¼" ⅜"		4d[j] 6dk

For SI: 1 inch = 25.4 mm.

a. Common or box nails are permitted to be used except where otherwise stated.

b. Nails spaced at six inches on center at edges, 12 inches at intermediate supports except 6 inches at supports where spans are 48 inches or more. For nailing of wood structural panel and particleboard diaphragms and shear walls, refer to 780 CMR 2305.0. Nails for wall sheathing are permitted to be common, box or casing.

c. Common or deformed shank.

d. Common.

e. Deformed shank.

f. Corrosion-resistant siding or casing nail.

g. Fasteners spaced three inches on center at exterior edges and six inches on center at intermediate supports.

h. Corrosion-resistant roofing nails with 7/16-inch-diameter head and 1½-inch length for ½-inch sheathing and 1¾-inch length for 25/32-inch sheathing.

i. Corrosion-resistant staples with nominal 7/16-inch crown and 1⅛-inch length for ½-inch sheathing and 1½-inch length for 25/32-inch sheathing. Panel supports at 16 inches (20 inches if strength axis in the long direction of the panel, unless otherwise marked).

j. Casing or finish nails spaced six inches on panel edges, 12 inches at intermediate supports.
k. Panel supports at 24 inches. Casing or finish nails spaced six inches on panel edges, 12 inches at intermediate supports.
l. For roof sheathing applications, 8d nails are the minimum required for wood structural panels.
m. Staples shall have a minimum crown width of $^{7}/_{16}$ inch.
n. For roof sheathing applications, fasteners spaced four inches on center at edges, eight inches at intermediate supports.
o. Fasteners spaced four inches on center at edges, eight inches at intermediate supports for subfloor and wall sheathing and three inches on center at edges, six inches at intermediate supports for roof sheathing.
p. Fasteners spaced four inches on center at edges, eight inches at intermediate supports.

2304.6 Protection Against Decay and Termites.

2304.6.1 General. Where required by 780 CMR 2304.6, protection from decay and termites shall be provided by the use of naturally durable or preservative-treated wood.

2304.6.2 Wood Used above Ground. Wood installed above ground in the locations specified in 780 CMR 2304.6.2.1 through 2304.6.2.6 shall be naturally durable wood or preservative-treated wood that uses water-borne preservatives, and shall be treated in accordance with AWPA C2 or C9 or applicable AWPA standards for above-ground use.

2304.6.2.1 Joists, Girders, and Subflooring. Where wood joists or the bottom of a wood structural floor without joists are closer than 18 inches (457 mm), or wood girders are closer than 12 inches (305 mm), to the exposed ground in crawl spaces or unexcavated areas located within the perimeter of the building foundation, the floor assembly (including posts, girders, joists and subfloor) shall be of naturally durable or preservative-treated wood.

2304.6.2.2 Framing. Wood framing members, including wood sheathing, which rest on exterior foundation walls and are less than 8 inches (203 mm) from exposed earth shall be of naturally durable or preservative-treated wood. Wood framing members and furring strips attached directly to the interior of exterior masonry or concrete walls below grade shall be of approved naturally durable or preservative-treated wood.

2304.6.2.3 Sleepers and Sills. Sleepers and sills on a concrete or masonry slab that is in direct contact with earth shall be of naturally durable or preservative-treated wood.

2304.6.2.4 Girder Ends. The ends of wood girders entering exterior masonry or concrete walls shall be provided with a ½-inch (12.7 mm) air space on top, sides and end, unless naturally durable or preservative-treated wood is used.

2304.6.2.5 Wood Siding. Clearance between wood siding and earth on the exterior of a building shall not be less than six inches (152 mm) except where siding, sheathing and wall framing are of naturally durable or preservative-treated wood.

2304.6.2.6 Posts or Columns. Posts or columns supporting permanent structures and supported by a concrete or masonry slab or footing that is in direct contact with the earth shall be of naturally durable or preservative-treated wood.

Exceptions:

1. Posts or columns that are either exposed to the weather or located in basements or cellars, supported by concrete piers or metal pedestals projected at least one inch (25 mm) above the slab or deck and six inches (152 mm) above exposed earth, and are separated there from by an impervious moisture barrier.
2. Posts or columns in enclosed crawl spaces or unexcavated areas located within the periphery of the building, supported by a concrete pier or metal pedestal at a height greater than eight inches (203 mm) from exposed ground, and are separated there from by an impervious moisture barrier.

2304.6.3 Laminated Timbers. The portions of glued laminated timbers that form the structural supports of a building or other structure and are exposed to weather and not properly protected by a roof, eave or similar covering shall be pressure treated with preservative, or be manufactured from naturally durable or preservative treated wood.

2304.6.4 Wood in Contact with the Ground or Fresh Water. Wood in contact with the ground (exposed earth) that supports permanent structures shall be of naturally durable (species for both decay and termite resistant) or preservative-treated wood using water-borne preservatives and shall be treated in accordance with AWPA C2, C9 or other applicable AWPA standard for soil or fresh water contact, where used in the locations specified in 780 CMR 2304.6.4.1 and 2304.6.4.2.

Exception. Untreated wood is permitted where such wood is continuously and entirely below the ground water level or submerged in fresh water.

2304.6.4.1 Posts or Columns. Posts and columns supporting permanent structures that are embedded in concrete in direct contact with the earth or embedded in concrete exposed to

the weather, or in direct contact with the earth, shall be of preservative-treated wood.

2304.6.4.2 Wood Structural Members. Wood structural members that support moisture-permeable floors or roofs that are exposed to the weather, such as concrete or masonry slabs, shall be of naturally durable or preservative-treated wood unless separated from such floors or roofs by an impervious moisture barrier.

2304.6.5 Supporting Member for Permanent Appurtenances. Naturally durable or preservative-treated wood shall be utilized for those portions of wood members that form the structural supports of buildings, balconies, porches, or similar permanent building appurtenances where such members are exposed to the weather without adequate protection from a roof, eave, overhead or other covering to prevent moisture or water accumulation on the surface or at joints between members.

2304.6.6 Wood Used in Retaining Walls and Cribs. Wood installed in retaining or crib walls shall be of preservative-treated wood treated in accordance with AWPA C2 or C9 for soil and fresh water contact.

2304.7 Wood Supporting Masonry or Concrete. Wood members shall not be used to permanently support the dead load of any masonry or concrete.

Exceptions:

1. Masonry or concrete nonstructural floor or roof surfacing not more than four inches (102 mm) thick is permitted to be supported by wood members.
2. Any structure is permitted to rest upon wood piles constructed in accordance with the requirements of 780 CMR 18.00.
3. Glass unit masonry having an installed weight of 20 pounds per square foot (0.96 kN/m^2) or less is permitted to be installed in accordance with the provisions of 780 CMR 21.00. The wood construction supporting the glass unit masonry shall be designed to support the additional weight of the glass unit masonry plus any other loads and designed to limit deflection and shrinkage to the smaller of $^1/_{600}$ of the span of the supporting members *or* 0.3 inches.

2304.8 Wood Construction in Foundations. Wood construction is not permitted for basement walls and foundations of buildings, except for piles and poles.

2304.9 Shrinkage. Consideration shall be given in design to the possible effect of cross-grain dimensional changes considered vertically which may occur in lumber fabricated in a green condition.

2304.9.1. Wood walls and bearing partitions shall not support more than two floors and a roof unless an analysis satisfactory to the building official shows that shrinkage of the wood framing will not have adverse effects on the structure or any plumbing, electrical or mechanical systems, or other equipment installed therein due to excessive shrinkage or differential movements caused by shrinkage. The analysis shall also show that the roof drainage system and the foregoing systems or equipment will not be adversely affected or, as an alternate, such systems shall be designed to accommodate the differential shrinkage or movements.

780 CMR 2305.0 GENERAL DESIGN REQUIREMENTS FOR LATERAL-FORCE-RESISTING SYSTEMS

23305.1 General. Structures using wood shear walls and diaphragms to resist wind, seismic and other lateral loads, shall be designed and constructed in accordance with the provisions of 780 CMR 2305.0 and 2306.0. Alternatively, compliance with the AF&PA SDPWS shall be permitted, except that the determination of shear capacity as described in the second sentence of AF&PA SDPWS, section 4.1.2 shall not be permitted.

2305.1.1 Framing. Boundary elements shall be provided to transmit tension and compression forces. Perimeter members at openings shall be provided and shall be detailed to distribute the shearing stresses. Diaphragm and shear wall sheathing shall not be used to splice boundary elements. Diaphragm chords and collectors shall be placed in, or tangent to, the plane of the diaphragm framing unless it can be demonstrated that the moments, shears, and deformations, considering eccentricities resulting from other configurations can be tolerated without exceeding the adjusted resistance and drift limits.

2305.1.1.1 Framing Members. Framing members shall be at least two-inch (51 mm) nominal width. In general, adjoining panel edges shall bear and be attached to the framing members and butt along their center lines. Nails shall be placed not less than ⅜ inch (9.5 mm) from the panel edge, not more than 12 inches (305 mm) apart along intermediate supports, and 6 inches (152 mm) along panel edge bearings, and shall be firmly driven into the framing members.

2305.1.3 Openings in Shear Panels. Openings in shear panels that materially affect their strength shall be fully detailed on the plans, and shall have their edges adequately reinforced to transfer all shearing stresses.

2305.1.4 Shear Panel Connections. Positive connections and anchorages, capable of resisting the design forces, shall be provided between the shear panel and the attached components. Toenails shall not be used to

transfer lateral forces in excess of 150 pounds per foot (2189 N/m) from diaphragms to shear walls, drag struts (collectors) or other elements, or from shear walls to other elements.

2305.1.5 Wood Members Resisting Horizontal Seismic Forces Contributed by Masonry and Concrete. Wood shear walls, diaphragms, horizontal trusses and other members shall not be used to resist horizontal seismic forces contributed by masonry or concrete construction in structures over one story in height.

Exceptions:

1. Wood floor and roof members are permitted to be used in horizontal trusses and diaphragms to resist horizontal seismic forces contributed by masonry or concrete construction provided such forces do not result in torsional force distribution through the truss or diaphragm.

2. Wood structural panel sheathed shear walls are permitted to be used to provide resistance to seismic forces contributed by masonry or concrete construction in two-, three-, and four story structures of masonry or concrete construction, provided the following requirements are met:

2.1. Story-to-story wall heights shall not exceed 12 feet (3658 mm).

2.2. Diaphragms shall not be designed to transmit lateral forces by rotation. Diaphragms shall not cantilever past the outermost supporting shear wall.

2.3. Combined deflections of diaphragms and shear walls shall not permit story drift of supported masonry or concrete walls to exceed the limit of Table 9.5.2.8 of ASCE 7.

2.4 Wood structural panel sheathing in diaphragms shall have unsupported edges blocked. Wood structural panel sheathing for all stories of shear walls shall have unsupported edges blocked and, for the lowest story, shall have a minimum thickness of $^{15}/_{32}$ inch (11.9 mm).

2.5. There shall be no out-of-plane horizontal offsets between the first and second stories of wood structural panel shear walls.

2.6 Concrete and masonry shear walls shall be continuous to the foundation.

2305.1.6 Wood Members Resisting Seismic Forces from Non-structural Concrete or Masonry. Wood members shall be permitted to resist horizontal seismic forces from non-structural concrete, masonry veneer or concrete floors.

2305.2 Design of Wood Diaphragms.

2305.2.1 General. Wood diaphragms are permitted to be used to resist horizontal forces provided the deflection in the plane of the diaphragm, as determined by calculations, tests, or analogies drawn therefrom, does not exceed the permissible deflection of attached distributing or resisting elements. Connections shall extend into the diaphragm a sufficient distance to develop the force transferred into the diaphragm.

2305.2.2 Deflection. Permissible deflection shall be that deflection up to which the diaphragm and any attached distributing or resisting element will maintain its structural integrity under design load conditions, such that the resisting element will continue to support design loads without danger to occupants of the structure. Calculations for diaphragm deflection shall account for the usual bending and shear components as well as any other factors, such as nail deformation, which will contribute to deflection.

The deflection (D) of a blocked wood structural panel diaphragm uniformly nailed throughout is permitted to be calculated by the use of the following formula. If not uniformly nailed, the constant 0.188 (For SI: 1/1627) in the third term must be modified accordingly.

EQUATION 23-1

$$\Delta = \frac{5vL^3}{8EAb} + \frac{vL}{4Gt} + 0.188Le_n + \frac{\sum(\Delta_c X)}{2b}$$

For SI:

$$\Delta = \frac{0.052vL^3}{EAb} + \frac{vL}{4Gt} + \frac{Le_n}{1627} + \frac{\sum(\Delta_c X)}{2b}$$

where:

A = Area of chord cross section, in square inches (mm^2).

b = Diaphragm width, in feet (mm).

E = Elastic modulus of chords, in pounds per square inch (N/mm^2).

e_n = Nail or staple deformation, in inches (mm). (See Table 2305.2.2(2))

Gt = Panel ridgidity through the thickness, in pounds per inch (N/mm) of panel width or depth. (See Table 2305.2.2(1)).

L = Diaphragm length, in feet (mm).

v = Maximum shear due to design loads in the direction under consideration, in pounds per lineal foot (plf) (N/mm).

Δ = The calculated deflection, in inches (mm).

$\sum(\Delta_c X)$ = ***Sum of individual chord-splice slip values on both sides of the diaphragm, each multiplied by its distance to the nearest support.***

TABLE 2305.2.2(1) e_n VALUES (INCHES) FOR USE IN CALCULATING DIAPHRAGM DEFLECTION DUE TO FASTENER SLIP (STRUCTURAL I)[a,d]

LOAD PER FASTENER[c] (pounds)	FASTENER DESIGNATIONS[b]			
	6d	8d	10d	14-Ga staple x 2 inches long
60	0.012	0.008	0.006	0.011
80	0.020	0.012	0.010	0.018
100	0.030	0.018	0.013	0.028
120	0.045	0.023	0.018	0.04
140	0.068	0.031	0.023	0.053
160	0.102	0.041	0.029	0.068
180	-	0.056	0.037	-
200	-	0.075	0.470	-
220	-	0.096	0.060	-
240	-	-	0.077	-

For SI: 1 inch - 25.4 mm, 1 foot = 305 mm, 1 pound = 4.448 N

a. Increase "e_n" values 20% for plywood grades other than Structural I.
b. Nail values apply to common wire nails or staples identified,
c. Load per fastener = maximum shear per foot divided by the number of fasteners per foot at internor panel edges.
d. Decrease e_n values 50% for seasoned lumber (moisture content < 19%).

TABLE 2305.2.2(2) VALUES OF G*t* FOR USE ON CALCULATING DEFLECTION OF WOOD STRUCTURAL PANEL SHEAR WALLS AND DIAPHRAGMS

PANEL TYPE	SPAN RATING	VALUES OF G*t* (lb./in. panel depth or width)							
		OTHER				STRUCTURAL			
		3-ply plywood	4-ply plywood	5-ply plywood	OSB	3-ply plywood	4-ply plywood	5-ply plywood[a]	OSB
SHEATHING	24/0	25000	32500	37500	77500	32500	42500	41500	77500
	24/16	27000	35000	40500	83500	35000	45500	44500	83500
	32/16	27000	35000	40500	83500	35000	45500	44500	83500
	40/20	28500	37000	43000	88500	37000	48000	47500	88500
	48/24	31000	40500	46500	96000	40500	52500	51000	96000
Single Floor	16 O.C	27000	35000	40500	8.500	35000	45500	44500	83500
	20 O.C	28000	36500	42000	87000	36500	47500	46000	87000
	24 O.C	30000	39000	45000	93000	39000	50500	49500	93000
	32 O.C	26000	47000	54000	110000	47000	61000	59500	110000
	48 O.C	50500	65500	76000	155000	65500	85000	83500	155000

		Other			Structural I		
	Thickness (in.)	A-A, A-C	Marine	All Other Grades	A-A, A-C	Marine	All Other Grades
Sanded Plywood	¼	24000	31000	24000	31000	31000	31000
	11/32	25500	33000	25500	33000	33000	33000
	38054	26000	34000	26000	34000	34000	34000
	15/32	3800	49500	38000	49500	49500	49500
	½	38500	50000	38500	50000	50000	50000
	19/32	49000	63500	49000	63500	63500	63500
	⅝	49500	64500	49500	64500	64500	64500
	23/32	50500	65500	50500	65500	65500	65500
	¾	51000	66500	51000	66500	66500	66500
	⅞	52500	68500	52500	68500	68500	68500
	1	73500	95500	73500	95500	95500	95500
	1⅛	75000	97500	75000	97500	97500	97500

For SI: 1 inch = 25.4 mm, 1 pound/inch - 0.1751 N/mm.
a. Applies to plywood with five or more layers; for five ply/three layer plywood, use values for four ply.

2305.2.3 Diaphragm Aspect Ratios. Size and shape of diaphragms shall be limited as set forth in Table 2305.2.3.

TABLE 2305.2.3 MAXIMUM DIAPHRAGM DIMENSION RATIOS HORIZONTAL AND SLOPED DIAPHRAGM

TYPE	MAXIMUM LENGTH - WIDTH RATIO
Wood structural panel, nailed all edges	4:1
Wood structural panel, blocking omitted at intermediate joints	3:1
Diagonal sheathing, single	3:1
Diagonal sheathing, double	4:1

2305.2.4 Construction. Shear panels shall be constructed of wood structural panels, manufactured with exterior glue, not less than four by eight feet (1219 mm by 2438 mm), except at boundaries and changes in framing. Boundary elements shall be connected at corners. Wood structural panel thickness for horizontal diaphragms shall not be less than set forth in 780 CMR 2301.2.1(2) or 2301.2.2(5) for corresponding joist spacing and loads, except that ¼-inch (6.4 mm) is permitted to be used where perpendicular loads permit. Sheet-type sheathing shall be arranged so that the width of a sheet in a shear wall shall not be less than two feet (610 mm).

2305.2.5 Rigid Diaphragms. Design of structures with rigid diaphragms shall conform to the structure configuration requirements and the horizontal shear distribution requirements of 780 CMR 1615.0.

Open front structures with rigid wood diaphragms resulting in torsional force distribution are permitted provided the length, *l*, of the diaphragm normal to the open side does not exceed 25 feet (7620 mm), the diaphragm sheathing conforms to 780 CMR 2305.2.4, and the *l/w* ratio (as shown in Figure 2305.2.5(1)) is less than 1.0 for one-story structures or 0.67 for structures over one story in height.

Exception. Where calculations show that diaphragm deflections can be tolerated, the length, *l*, normal to the open end is permitted to be increased to a *l/w* ratio not greater than 1.5 where sheathed in conformance with 780 CMR 2305.2.4 or to 1.0 where sheathed in conformance with 780 CMR 2306.3.4 or 2306.3.5.

Rigid wood diaphragms are permitted to cantilever past the outermost supporting shear wall (or other vertical-resisting element) a length, *l*, of not more than 25 feet (7620 mm) or two-thirds of the diaphragm width, *w*, whichever is the smaller. Figure 2305.2.5(2) illustrates the dimensions of *l* and *w* for a cantilevered diaphragm.

Structures with rigid wood diaphragms having a torsional irregularity in accordance with Table 1616.5.1, Item 1, shall meet the following requirements: The *l/w* ratio shall not exceed 1.0 for one-story structures or 0.67 for structures over one story in height, where *l* is the dimension parallel to the load direction for which the irregularity exists.

Exception. Where calculations demonstrate that the diaphragm deflections can be tolerated, the width is permitted to be increased and the *l/w* ratio is permitted to be increased to 1.5 where sheathed in conformance with 780 CMR 2305.2.4 or 1.0 where sheathed in conformance with 780 CMR 2306.3.4 or 2306.3.5.

2305.3 Design of Wood Shear Walls.

2305.3.1 General. Wood shear walls are permitted to resist horizontal forces in vertical distributing or resisting elements, provided the deflection in the plane of the shear wall, as determined by calculations, tests, or analogies drawn therefrom, does not exceed the more restrictive of the permissible deflection of attached distributing or resisting elements or the drift limits of ASCE 7, Section 9.5.2.8. Shear wall sheathing other than wood structural panels shall not be permitted.

Exception. Buildings of conventional light-frame wood construction may have shear wall sheathing of diagonal wood sheathing, metal lath and plaster, gypsum lath, gypsum sheathing, gypsum board, hardboard, or particleboard providing all of the following conditions are met:

1. The building shall not be more than 35 feet in height.
2. The shear walls shall not provide lateral load resistance for more than three framed levels (floors or roof). In this context, a pitched roof shall be considered a "level." Where attics are habitable, the pitched roof and attic floor shall be considered separate levels.
3. The location of the shear walls shall be limited to exterior walls, fire walls or fire partitions.
4. The building is not in Seismic Use Group III.
5. The dead load of each level (floor or roof), supported laterally by the shear walls, shall not be more than 25 psf. Where attics are not habitable, the dead load of a pitched roof shall include the dead load of the attic floor.

FIGURE 2305.2.5(1) DIAPHRAGM LENGTH AND WIDTH FOR PLAN VIEW OF OPEN FRONT BUILDING

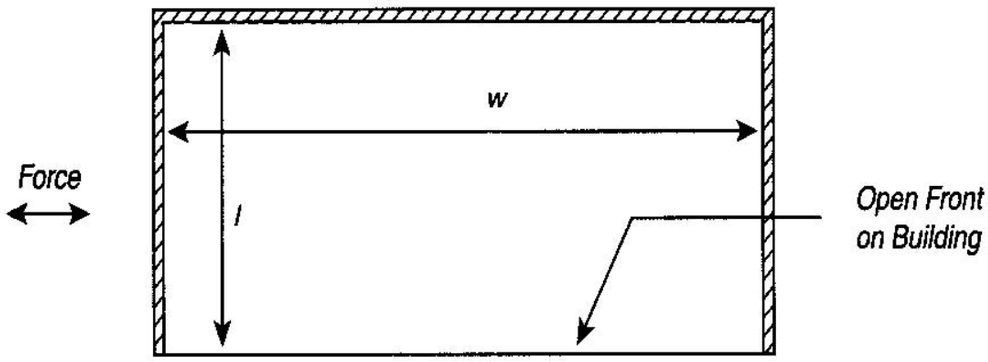
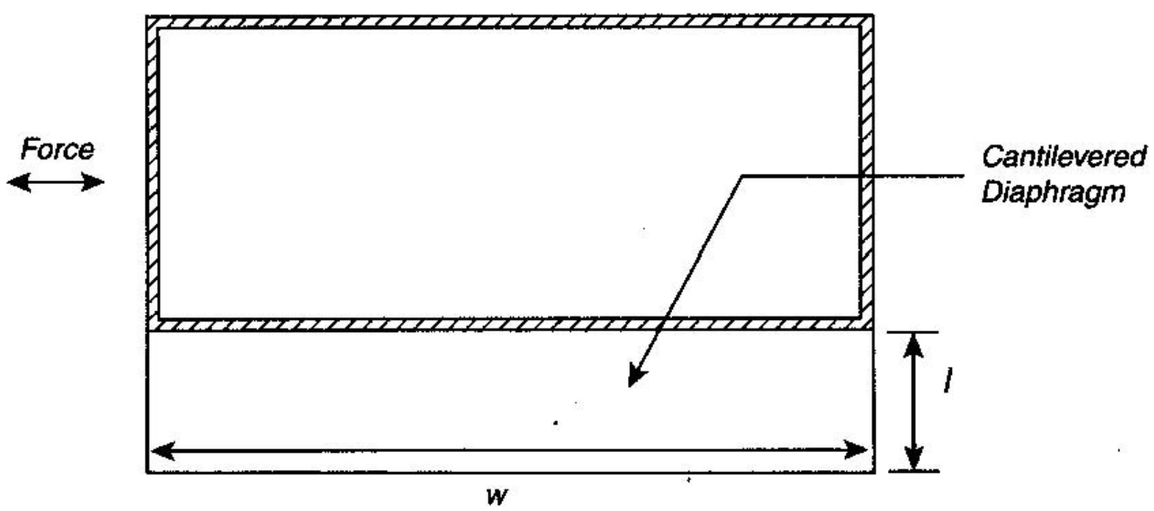


FIGURE 2305.2.5(2) DIAPHRAGM LENGTH AND WIDTH FOR PLAN VIEW OF CANTILEVERED DIAPHRAGM



2305.3.2 Deflection. Permissible deflection shall be that deflection up to which the shear wall and any attached distributing or resisting element will maintain its structural integrity under design load conditions, *i.e.*, continue to support design loads without danger to occupants of the structure.

The deflection (Δ) of a blocked wood structural panel shear wall uniformly fastened throughout is permitted to be calculated by the use of the following equation:

EQUATION 23-2

$$\Delta = \frac{8vh^3}{EAb} + \frac{vh}{Gt} + 0.75he_n\, d_a$$

For SI: $\Delta = \frac{vh^3}{3EAb} + \frac{vh}{Gt} + \frac{he_n}{406.7} + d_a$

where:

A = Area of boundary element cross section in square inches ($mm^{2)}$ (vertical member at shear wall boundary).

b = Wall width, in feet (mm).

d_a = Vertical elongation of overturning anchorage (including fastener slip, device elongation, anchor rod elongation, etc.) at the design shear load (v).

E = Elastic modulus of boundary element (vertical member at shear wall boundary), in pounds per square inch (N/mm^2).

e_n = Deformation of mechanically fastened connections, in inches (mm^2). (See Table 2305.2.2(1).)

Gt = Panel rigidity through the thickness, in pounds per inch (N/mm) of panel width or depth. (See Table 2305.2.2(2).)

h = Wall height, in feet (mm).

v = Maximum shear due to design loads at the top of the wall, in pounds per lineal foot (N/mm).

Δ = The calculated deflection, in inches (mm).

2305.3.3 Shear Wall Aspect Ratios. Size and shape of shear walls, perforated wall shear wall segments within perforated shear walls and wall piers within shear walls with openings designed for force transfer around openings shall be limited as set forth in Table 2305.3.3. The height, *h*, and the width, *w*, shall be determined in accordance with 780 CMR 2305.3.4 through 2305.3.4.2 and 780 CMR 2305.3.5 through 2305.3.5.2, respectively.

TABLE 2305.3.3 MAXIMUM SHEAR WALL ASPECT RATIOS

TYPE	MAXIMUM HEIGHT WIDTH RATIO
Wood structural panels or particleboard, nailed edges	For other than seismic: 3½ For seismic: 2:1[a]
Diagonal sheathing, single	2:1
Fiberboard, gypsum board, gypsum lath, cement plaster	1½:1[b]

a. For design to resist seismic forces, shear wall aspect ratios greater than 2:1 but not exceeding 3½:1, are permitted provided that the factored shear resistance values in 780 CMR 2306.4.1 are multiplied by 2w/h.

b. Ratio shown is for unblocked construction. Height-to-width ratio is permitted to be 2:1 where the wall is installed as blocked construction in accordance with 780 CMR 2306.4.5.1.2.

2305.3.4 Shear Wall Height Definition. The height of a shear wall, *h*, shall be defined as:

1. The maximum clear height from top of foundation to bottom of diaphragm framing above; or
2. The maximum clear height from top of diaphragm to bottom of diaphragm framing above. (See Figure 2305.3.4(a).)

2305.3.4.1 Perforated Shear Wall Segment Height Definition. The height of a perforated shear wall segment, h, shall be defined as specified in 780 CMR 2305.3.4 for shear walls.

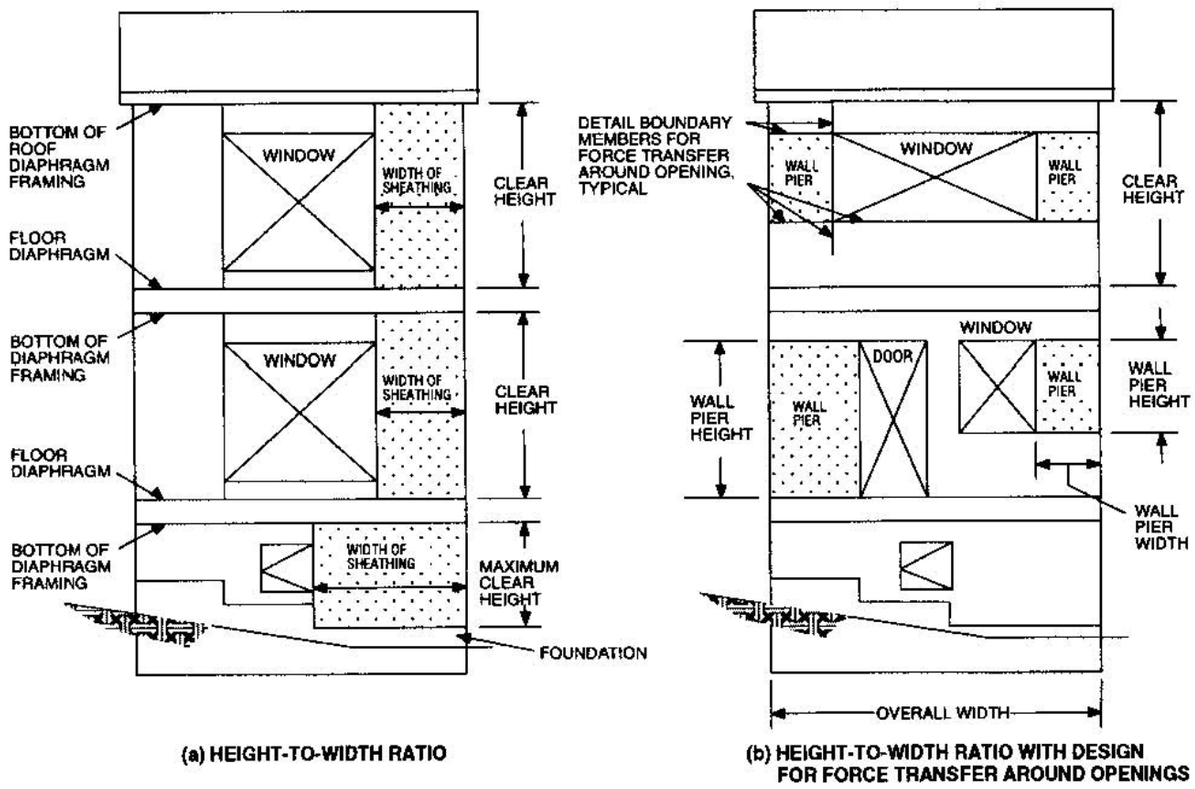
2305.3.4.2 Force Transfer Shear Wall Pier Height Definition. The height, *h*, of a wall pier in a shear wall with openings designed for force transfer around openings shall be defined as the clear height of the pier at the side of an opening [See Figure 2305.3.4(b)].

2305.3.5 Shear Wall Width Definition. The width of a shear wall, *w*, shall be defined as the sheathed dimension of the shear wall in the direction of application of force. (See Figure 2305.3.4(a).)

2305.3.5.1 Perforated Shear Wall Segment Width Definition. Shear wall segment width definition. The width of a perforated shear wall segment, w, shall be defined as the width of full height sheathing adjacent to openings in the perforated shear wall (See Figure 2305.3.4(a).)

2305.3.5.2 Force Transfer Shear Wall Pier Width Definition. The width, *w*, of a wall pier in a shear wall with openings designed for force transfer around openings shall be defined as the sheathed width of the pier at the side of an opening (See Figure 2305.3.4(b).)

FIGURE 2305.3.4 GENERAL DEFINITION OF SHEAR WALL HEIGHT, WIDTH AND HEIGHT -TO-WIDTH RATIO



2305.3.6 Overturning Restraint. Where the dead load stabilizing moment in accordance with 780 CMR 16.00 design load combinations is not sufficient to prevent uplift due to overturning moments on the wall, an anchoring device shall be provided. Anchoring devices shall maintain a continuous load path from the roof to the foundation.

2305.3.7 Shear Walls with Openings. The provisions of 780 CMR 2305.3.7 shall apply to the design of shear walls with openings. Where framing and connections around the openings are designed for force transfer around the openings, the provisions of 780 CMR 2305.3.7.1 shall apply. Where framing and connections around the opening are not designed for force transfer around the openings, the provisions of 780 CMR 2305.3.7.2 shall apply.

2305.3.7.1 Force Transfer Around Openings. Where shear walls with openings are designed for force transfer around the openings, the limitations of Table 2305.3.3 shall apply to the overall shear wall including openings and to each wall pier at the side of an opening. Design for force transfer shall be based on a rational analysis. Detailing of boundary elements around the opening shall be provided in accordance with the provisions of 780 CMR 2305.3.7.1 (See Figure 2305.3.4(b).)

2305.3.7.2 Perforated Shear Walls. The provisions of 780 CMR 2305.3.7.2 shall be permitted to be used for the design of perforated shear walls. For the determination of the height and width of perforated shear wall segments, see 780 CMR 2305.3.4.1 and 2305.3.5.1, respectively.

2305.3.7.2.1 Limitations. The following limitations shall apply to the use of 780 CMR 2305.3.7.2:

1. A perforated shear wall segment shall be located at each end of a perforated shear wall. Openings shall be permitted to occur beyond the ends of the perforated shear wall; however, the width of such openings shall not be included in the width of the perforated shear wall.
2. The allowable shear set forth in Table 2306.4.1 shall not exceed 490 plf (7150 N/m).
3. Where out-of-plane offsets occur, portions of the wall on each side of the offset shall be considered as separate perforated shear walls.
4. Collectors for shear transfer shall be provided through the full length of the perforated shear wall.
5. A perforated shear wall shall have uniform top of wall and bottom of wall elevations. Perforated shear walls not having uniform elevations shall be designed by other methods.
6. Perforated shear wall height, *h*, shall not exceed 20 feet (6096 mm).

2305.3.7.2.2 Perforated Shear Wall Resistance. The resistance of a perforated shear wall shall be calculated in accordance with the following:

1. The percent of full-height sheathing shall be calculated as the sum of the widths of perforated shear wall segments divided by the total width of the perforated shear wall including openings.
2. The maximum opening height shall be taken as the maximum opening clear height. Where areas above and below an opening remain unsheathed, the height of opening shall be defined as the height of the wall.
3. The unadjusted shear resistance shall be the allowable shear set forth in Table 2306.4.1 for height-to-width ratios of perforated shear wall segments that do not exceed 2:1 for seismic forces and 3½:1 for other than seismic forces. For seismic forces, where the height-to-width ratio of any perforated shear wall segment used in the calculation of the sum of the widths of perforated shear wall segments, ΣL_i is greater than 2:1 but not exceeding 3½:1, the unadjusted shear resistance shall be multiplied by two w/h.
4. The adjusted shear resistance shall be calculated by multiplying the unadjusted shear resistance by the shear resistance adjustment factors of Table 2305.3.7.2. For intermediate percentages of full height sheathing, the values in Table 2305.3.7.2 are permitted to be interpolated.
5. The perforated shear wall resistance shall be equal to the adjusted shear resistance times the sum of the widths of the perforated shear wall segments.

2305.3.7.2.3 Anchorage and Load Path. Design of perforated shear wall anchorage and load path shall conform to the requirements of 780 CMR 2305.3.7.2.4 through 2305.3.7.2.8, or shall be calculated using principles of mechanics. Except as modified by 780 CMR 2305.3.7.2.4 through 2305.3.7.2.8, wall framing, sheathing, sheathing attachment and fastener schedules shall conform to the requirements of 780 CMR 2305.2.4 and Table 2306.4.1.

2305.3.7.2.4 Uplift Anchorage at Perforated Shear Wall Ends. Anchorage for uplift forces due to overturning shall be provided at each end of the perforated shear wall. The uplift anchorage shall conform to the requirements of 780 CMR 2305.3.6 except that for each story the minimum tension chord uplift force, T, shall be calculated in accordance with the following:

EQUATION 23-3

$$T = Vh/\Sigma C_o L_i$$

where:
T = Tension chord uplift force, pounds (N).
V = Shear force in perforated shear wall, pounds (N).
h = Perforated shear wall height, feet (mm).
C_o = Shear resistance adjustment factor from Table 2305.3.7.2.
ΣL_i = Sum of widths of perforated shear wall segments, feet (mm).

2305.3.7.2.5 Anchorage for In-plane Shear. The unit shear force, v, transmitted into the top of a perforated shear wall, out of the base of the perforated shear wall at full-height sheathing, and into collectors (drag struts) connecting shear wall segments, shall be calculated in accordance with the following:

EQUATION 23-4

$$v = V/C_o \Sigma L_i$$

where:
v = Unit shear force, pounds per lineal feet (N/m).
V = Shear force in perforated shear wall, pounds (N).
C_o = Shear resistance adjustment factor from Table 2305.3.7.2.
ΣL_i = Sum of widths of perforated shear wall segments, feet (mm).

2305.3.7.2.6 Uplift Anchorage Between Perforated Shear Wall Ends. In addition to the requirements of 780 CMR 2305.3.7.2.4, perforated shear wall bottom plates at full-height sheathing shall be anchored for a uniform uplift force, t, equal to the unit shear force, v, determined in 780 CMR 2305.3.7.2.5.

2305.3.7.2.7 Compression Chords. Each end of each perforated shear wall segment shall be designed for a compression chord force, C, equal to the tension chord uplift force, T, calculated in 780 CMR 2305.3.7.2.4.

2305.3.7.2.8 Load Path. A load path to the foundation shall be provided for each uplift force, T and t, for each shear force, V and v, and for each compression chord force, C. Elements resisting shear wall forces contributed by multiple stories shall be designed for the sum of forces contributed by each story.

2305.3.7.2.9 Deflection of Shear Walls with Openings. The controlling deflection of a blocked shear wall with openings uniformly nailed throughout shall be taken as the maximum individual deflection of the shear wall segments calculated in accordance with 780 CMR 2305.3.2, divided by

the appropriate shear resistance adjustment factors of Table 2305.3.7.2.

TABLE 2305.3.7.2 SHEAR RESISTANCE FACTOR, C_o

WALL HEIGHT, H	MAXIMUM OPENING HEIGHT[a]				
	H/3	H/2	2H/3	5H/6	H
8' wall	2'-8"	4'-0"	5'-4"	6'-8"	8'-0"
10' wall	3'-4"	5'-0"	6'-8"	8'-4"	10'-0"
Percentage full-height sheathing[b]	Shear resistance adjustment factor				
10%	1.00	0.69	0.53	0.43	0.36
20%	1.00	0.71	0.56	0.45	0.38
30%	1.00	0.74	0.59	0.49	0.42
40%	1.00	0.77	0.63	0.53	0.45
50%	1.00	0.8	0.67	0.57	0.5
60%	1.00	0.83	0.71	0.63	0.56
70%	1.00	0.87	0.77	0.69	0.63
80%	1.00	0.91	0.83	0.77	0.71
90%	1.00	0.95	0.91	0.87	0.83
100%	1.00	1.00	1.00	1.00	1.00

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. See 780 CMR 2305.3.7.2.2, Item 2.

b. See 780 CMR 2305.3.7.2.2, Item 1.

2305.3.8 Summing Shear Capacities. The shear values for shear panels of different capacities applied to the same side of the wall are not cumulative except as allowed in Table 2306.4.1.

The shear values for material of the same type and capacity applied to both faces of the same wall are cumulative. Where the material capacities are not equal, the allowable shear shall be either two times the smaller shear capacity or the capacity of the stronger side, whichever is greater.

Summing shear capacities of dissimilar materials applied to opposite faces or to the same wall line is not allowed.

Exception. For wind design of structures described in the Exception to 780 CMR 2305.3.1, the allowable shear capacity of shear wall segments sheathed with a combination of wood structural panels and gypsum wall board on opposite faces shall equal the sum of the sheathing capacities of each face separately.

2305.3.9 Adhesives. Adhesive attachment of shear wall sheathing is not permitted as a substitute for mechanical fasteners, and shall not be used in shear wall strength calculations alone, or in combination with mechanical fasteners.

2305.3.10 Sill Plate Size and Anchorage. Two inch (51 mm) nominal wood sill plates for shear walls shall include steel plate washers, a minimum of $^3/_{16}$ inch by two inches by two inches (4.76 mm by 51 mm by 51 mm) in size, between the sill plate and nut. Sill plates resisting a design load greater than 490 plf (LRFD) (7154 N/m) or 350 plf (ASD) (5110 N/m) shall not be less than a three inch (76 mm) nominal member. Where a single three inch (76 mm) nominal sill plate is used, 2-20d box end nails shall be substituted for 2-16d common end nails found in line 8 of Table 2304.5.

Exception. In shear walls where the design load is less than 840 plf (LRFD) (12 264 N/m) or 600 plf (ASD) (8760 N/m), the sill plate is permitted to be a two inch (51 mm) nominal member if the sill plate is anchored by two times the number of bolts required by design and $^3/_{16}$ inch by two inches by two inches (4.76 mm by 51 mm by 51 mm) plate washers are used.

780 CMR 2306.0 CAPACITY AND CONSTRUCTION OF LATERAL FORCE RESISTING SYSTEMS

2306.1 General Criteria. The capacities given in this section are for ASD. For LRFD (strength design), the nominal strength (reference resistance) is equal to the allowable shear capacities given in 780 CMR 2306.0 times 2.0. The factored resistance is the nominal strength multiplied by the resistance factor, ϕ, equal to 0.65.

2306.1.1 Adjustment of Design Values. The values in the tables of 780 CMR 2306.1are for the Temperature Factor, C_t, equal 1.0 and the Wet Service factor, C_M, equal 1.0. The values in the tables shall be adjusted for conditions when these factors are less than 1.0. The values in the tables have been adjusted for load duration; no further adjustments are permitted.

2306.2 Wind Provisions for Walls.

2306.2.1 Wall Stud Bending Stress Increase. The NDS fiber stress in bending (F_b) design values for wood studs resisting out of plane wind load can be increased by the factors in Table 2306.2.1, in lieu of the 1.15 repetitive member factor, to take into consideration the load sharing and composite actions provided by the wood structural panels as defined in 780 CMR 2302.1, where the studs are spaced no more than

16 inches (406 mm) on center, covered on the inside with a minimum of ½ inch (12.7 mm) gypsum board fastened in accordance with Table 2306.4.5, and sheathed on the exterior with a minimum of ⅜ inch (9.5 mm) wood structural panel sheathing that is attached to the studs using a minimum of 8d common nails spaced a maximum of six inches on center (152 mm) at panel edges and 12 inches on center (305 mm) in the field of the panels.

TABLE 2306.2.1 WALL STUD BENDING STRESS INCREASE FACTORS

STUD SIZE	SYSTEM FACTOR
2 x 4	1.5
2 x 6	1.4
2 x 8	1.3
2 x 10	1.2
2 x 12	1.15

2306.3 Wood Diaphragms.

2306.3.1 Shear Capacities Modifications. The allowable shear capacities in Tables 2306.3.1, 2306.3.1a, and 2306.3.1b for horizontal wood structural panel diaphragms shall be increased 40% for wind design.

2306.3.2 Wood Structural Panel Diaphragms. Structural panel diaphragms with wood structural panels are permitted to be used to resist horizontal forces not exceeding those set forth in Tables 2306.3.1, 2306.3.1a, 2306.3.1b or 2306.3.2.

2306.3.3 Diagonally Sheathed Lumber Diaphragms. Diagonally sheathed lumber diaphragms shall be nailed in accordance with Table 2306.3.3.

2306.3.4 Single Diagonally Sheathed Lumber Diaphragms. Single diagonally sheathed lumber diaphragms shall be constructed of minimum one-inch (25 mm) thick nominal sheathing boards laid at an angle of approximately 45 degrees (0.78 radians) to the supports. The shear capacity for single diagonally sheathed lumber diaphragms of southern pine or Douglas fir-larch shall not exceed 300 pounds per linear foot (4378 N/m) of width. The shear capacities shall be adjusted by reduction factors of 0.82 for framing members of species with a specific gravity equal to or greater than 0.42 but less than 0.49 and 0.65 species with a specific gravity of less than 0.42, as contained in the NDS.

2306.3.4.1 End Joints. End joints in adjacent boards shall be separated by at least one stud or joist space and there shall be at least two boards between joints on the same support.

2306.3.4.2 Single Diagonally Sheathed Lumber Diaphragms. Single diagonally sheathed lumber diaphragms made up of two-inch (51 mm) nominal diagonal lumber sheathing fastened with 16d nails shall be designed with the same shear capacities as shear panels using one-inch (25 mm) boards fastened with 8d nails, provided there are not splices in adjacent boards on the same support and the supports are not less than four inch (102 mm) nominal depth or three inch (76 mm) nominal thickness.

2306.3.5 Double Diagonally Sheathed Lumber Diaphragms. Double diagonally sheathed lumber diaphragms shall be constructed of two layers of diagonal sheathing boards at 90 degrees (1.57 rad) to each other on the same face of the supporting members. Each chord shall be considered as a beam with uniform load per foot equal to 50% of the unit shear due to diaphragm action. The load shall be assumed as acting normal to the chord in the plan of the diaphragm in either direction. The span of the chord or portion thereof shall be the distance between framing members of the diaphragm, such as the joists, studs, and blocking that serve to transfer the assumed load to the sheathing. The shear capacity of double diagonally sheathed diaphragms of southern pine or Douglas fir-larch shall not exceed 600 pounds per linear foot (8756 kN/m) of width. The shear capacity shall be adjusted by reduction factors of 0.82 for framing members of species with a specific gravity equal to or greater than 0.42 but less than 0.49 and 0.65 for species with a specific gravity of less than 0.42, as contained in the NDS. Nailing of diagonally sheathed lumber diaphragms shall be in accordance with Table 2306.3.3.

2306.3.6 Gypsum Board Diaphragm Ceilings. Gypsum board diaphragm ceilings shall be in accordance with 780 CMR 2508.5, but may only be used for ceilings below attics without floor diaphragms.

2306.4 Shear Walls. See 780 CMR 2305.3.1 for limitations on shear wall bracing materials. Panel sheathing joints in shear walls shall occur over studs or blocking. Adjacent panel sheathing joints shall occur over and be nailed to common framing members.

2306.4.1 Wood Structural Panel Shear Walls. Wood structural panels shall be fastened directly to wood framing; fastening through other sheathing materials is not permitted. The allowable shear capacities for wood structural panel shear walls shall be in accordance with Tables 2306.4.1, 2306.4.1a, and 2304.1b. These capacities are permitted to be increased 40% for wind design.

2306.4.2 Lumber Sheathed Shear Walls. Single and double diagonally sheathed lumber diaphragms shall be in accordance with the construction and allowable load provisions of

780 CMR 2306.3.4 and 2306.3.5.

2306.4.3 Particleboard Shear Walls. The design shear capacity of particleboard shear walls shall be in accordance with Table 2306.4.3. Shear panels shall be constructed with particleboard sheets not less than four by eight feet (1219 by 2438 mm), except at boundaries and changes in framing. Particleboard panels shall be designed to resist shear only, and chords, collector members, and boundary elements shall be connected at all corners. Panel edges shall be backed with two-inch (51 mm) nominal or wider framing. Sheets are permitted to be installed either horizontally or vertically. For ⅜-inch (9.5 mm) particleboard sheets installed with the long dimension parallel to the studs spaced 24 inches (610 mm) on center along intermediate framing members. For all other conditions, nails of the same size shall be spaced at 12 inches (305 mm) on center along intermediate framing members. Particleboard panels less than 12 inches (305 mm) wide shall be blocked.

2306.4.4 Fiberboard Shear Walls. The design shear capacity of fiberboard shear walls shall be in accordance with Table 2308.9.3(4). The fiberboard sheathing shall be applied vertically or horizontally to wood studs not less than two-inch (51 mm) nominal thickness spaced 16 inches (406 mm) on center. Blocking not less than two-inch (51 mm) nominal in thickness shall be provided at horizontal joints.

2306.4.5 Shear Walls Sheathed with Other Materials. Shear capacities for walls sheathed with lath and plaster, and gypsum board shall be in accordance with Table 2306.4.5. Shear walls sheathed with lath, plaster and gypsum board shall be constructed in accordance with 780 CMR 25.00 and 780 CMR 2306.4.5.1.

2306.4.5.1 Application of Gypsum Board or Lath and Plaster to Wood Framing.

2306.4.5.1.1 Joint Staggering. End joints of adjacent courses of gypsum board shall not occur over the same stud.

2306.4.5.1.2 Blocking. Where required in Table 2306.4.5, wood blocking having the same cross-sectional dimensions as the studs shall be provided at joints that are perpendicular to the studs.

2306.4.5.1.3 Nailing. Studs, top and bottom plates and blocking shall be nailed in accordance with Table 2304.9.1.

2306.4.5.1.4 Fasteners. The size and spacing of nails shall be set forth in Table 2306.4.5. Nails shall be spaced not less than ⅜ inch (9.5 mm) from edges and ends of gypsum boards or sides of studs, blocking and top and bottom plates.

2306.4.5.1.5 Gypsum Lath. Gypsum lath shall be applied perpendicular to the studs. Maximum allowable shear values shall be set forth in Table 2306.4.5.

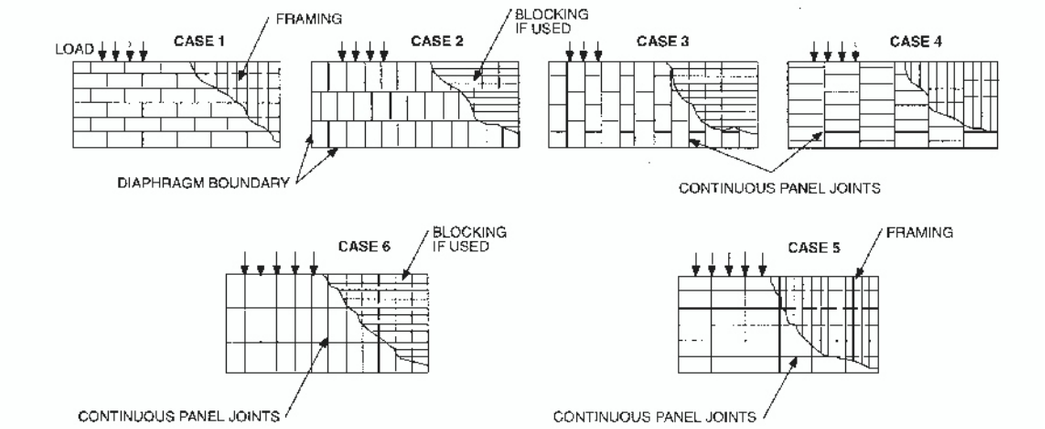
2306.4.5.1.6 Gypsum Sheathing. Four-foot-wide (1219 mm) pieces of gypsum sheathing shall be applied parallel or perpendicular to studs. Two-foot-wide (610 mm) pieces of gypsum sheathing shall be applied perpendicular to the studs. Maximum allowable shear values shall be as set forth in Table 2306.4.5.

2306.4.5.1.7 Other Gypsum Boards. Gypsum board shall be applied parallel or perpendicular to studs. Maximum allowable shear values shall be set forth in Table 2306.4.5.

TABLE 2306.3.1 RECOMMENDED SHEAR (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL DIAPHRAGMS WITH FRAMING OF DOUGLAS-FIR-LARCH, OR SOUTHERN PINE[a] FOR WIND OR SEISMIC LOADING

PANEL GRADE	COMMON NAIL SIZE OR STAPLE[f] LENGTH AND GAGE	MINIMUM FASTENER PENETRATION IN FRAMING (inches)	MINIMUM NOMINAL PANEL THICKNESS (inch)	MINIMUM NOMINAL WIDTH OF FRAMING MEMBER (inches)	BLOCKED DIAPHRAGMS				UNBLOCKED DIAPHRAGMS	
					fastener spacing (inches) at diaphragm boundaries (all Cases) at continuous panel edges parallel to load (Cases 3, 4), and at all panel edges (Cases 5 and 6)[b]				Fasteners spaced at 6" max. at supported edges[b]	
					6	4	2½[c]	2[c]	Case 1 (no unblocked edges or continuous joints parallel to load)	All other configurations (Cases 2, 3, 4, 5 and8)
					Fastener spacing (inches) at other panel edges (Cases 1, 2, 3 and 4)[b]					
					6	6	4	3		
Structural 1 Grades	6d[e] (2" x 0.113")	1¼	5/16	2 3	185 210	250 180	375 420	420 475	165 185	125 140
	1½ 16 Gage	1		2 3	155 175	205 230	310 345	350 390	135 155	105 115
	8d (2½" x 0.131")	1⅜	⅜	2 3	270 300	360 400	530 300	600 675	240 265	180 200
	1½ 16 Gage	1		2 3	175 200	235 265	350 395	400 450	155 175	115 130
	10d[d] (3" x 0.148")	1½	15/32	2 3	320 360	425 480	640 720	7730 820	285 320	215 240
	1½ 16 Gage	1		2 3	175 200	235 265	350 395	400 450	155 175	120 130
Sheathinig, Single Floor and Other Grades Covered in DOC PS1 and PS2	6d[e] (2" x 0.113")	1¼	5/16	2 3	170 190	225 250	335 380	380 430	150 170	110 125
	1½ 16 Gage	1		2 3	140 155	185 205	275 310	315 350	125 140	90 105
	6d[e] (2" x 0.113")	1¼	⅜	2 3	185 210	250 280	375 420	420 475	165 185	125 140
	8d (2½" x 0.131")	1⅜		2 3	240 270	320 360	480 540	545 610	215 240	160 180
	1½ 16 Gage	1		2 3	160 180	210 235	315 355	360 400	140 260	105 120
	8d (2½" x 0.131")	1⅜	7/16	2 3	255 285	340 380	505 570	575 645	230 255	170 190
	1½ 16 Gage	1		2 3	165 190	225 250	335 375	380 425	150 165	110 125
	8d (2½" x 0.131")	1⅜	15/32	2 3	270 300	360 400	430 600	600 675	240 265	180 200
	10d[d] (3" x 0.148")	1½		2 3	290 325	385 430	575 650	655 735	255 290	190 215
	1½ 16 Gage	1		2 3	160 180	210 235	315 355	360 405	140 160	105 120
	10d[d] (3" x 0.148")	1½	19/32	2 3	320 360	425 480	640 720	730 820	285 320	215 240
	1¾ 16 Gage	1		2 3	175 200	235 265	350 395	400 450	155 175	115 130

TABLE 2306.3.1 RECOMMENDED SHEAR (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL DIAPHRAGMS WITH FRAMING OF DOUGLAS-FIR-LARCH, OR SOUTHERN PINE[a] FOR WIND OR SEISMIC LOADING - continued



For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

a. For framing of other species: (1) Find specific gravity for species of lumber in AFPA National Design Specification. (2) For staples find shear value from table above for Structural I panels (regardless of actual grade) and multiply value by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other spe cies. (3) For nails find shear value from table above for nail size for actual grade and multiply value by the following adjustment factor: Specific Gravity Ad justment Factor = [1-(0.5 - SG)], where SG = Specific Gravity of the framing lumber. This adjustment factor shall not be greater than 1.
b. Space fasteners maximum 12 inches o.c. along intermediate framing members (6 inches o.c. where supports are spaced 48 inches o.c.).Framing at adjoining panel edges shall be 3 inches nominal or wider, and nails shall be staggered where nails are spaced two inches o.c. or 2½ inches o.c.
c. Framing at adjoining panel edges shall be three inches nominal or wider, and nails shall be staggered where both of the following conditions are met: (1) 10d nails having penetration into framing of more than 1½ inches and (2) nails are spaced three inches o.c. or less.
d. 8d is recommended minimum for roofs due to negative pressures of high winds.
e. Staples shall have a minimum crown width of $^{7}/_{16}$ inch.
f. Staples shall have a minimum crown width of $^{7}/_{16}$ inch, and shall be installed with their crowns parallel to the long dimension of the framing members.
g. The minimum nominal width of framing members not located at boundaries or adjoining panel edges shall be two inches.

TABLE 2306.3.1a RECOMMENDED SHEAR (POUNDS PER FOOT) FOR NAILED WOOD STRUCTURAL PANEL DIAPHRAGMS WITH FRAMING OF SPRUCE-PINE-FIR (SPECIFIC GRAVITY = 0.42) FOR WIND OR SEISMIC LOADING

PANEL GRADE	MINIMUM NOMINAL PANEL THICKNESS (inch)	COMMON NAIL SIZE OR STAPLE[f] LENGTH AND GAGE	MINIMUM FASTENER PENETRATION IN FRAMING (inches)	MINIMUM NOMINAL WIDTH OF FRAMING MEMBER (inches)	BLOCKED DIAPHRAGMS				UNBLOCKED DIAPHRAGMS	
					fastener spacing (inches) at diaphragm boundaries (all Cases) at continuous panel edges parallel to load (Cases 3, 4), and at all panel edges (Cases 5 and 6)[b]				Fasteners spaced at 6" max. at supported edges[b]	
					6	4	2½[c]	2[c]	Case 1 (no unblocked edges or continuous joints parallel to load)	All other configurations (Cases 2, 3, 4, 5 and8)
					Fastener spacing (inches) at other panel edges (Cases 1, 2, 3 and 4)[b]					
					6	6	4	3		
Structural I Grades	5/16	6d[e] (2" x 0.113")	1¼	2 3	170 190	230 255	345 385	385 435	150 170	115 125
	3/8	8d (2½" x 0.131")	1⅜	2 3	245 275	330 365	485 550	550 620	220 240	165 180
	15/32	10d[d] (3" x 0.148")	1½	2 3	290 330	390 440	585 660	670 750	260 290	195 220
Sheathinig, Single Floor and Other Grades Covered in DOC PS1 and PS2	5/16	6d[e] (2" x 0.113")	1¼	2 3	155 170	205 230	305 345	345 395	135 155	100 115
	3/8	6d[e] (2" x 0.113")	1¼	2 3	170 190	230 255	345 385	385 435	150 170	115 125
		8d (2½" x 0.131")	1⅜	2 3	220 245	290 330	440 495	500 560	195 220	145 165
	7/16	8d (2½" x 0.131")	1⅜	2 3	230 260	310 345	460 520	525 590	210 230	155 170
	15/32	8d (2½" x 0.131")	1⅜	2 3	245 275	330 365	485 550	550 620	220 240	165 180
		10d[d] (3" x 0.148")	1½	2 3	265 295	350 395	525 595	600 675	230 265	170 195
	19/32	10d[d] (3" x 0.148")	1½	2 3	290 330	390 440	585 660	670 750	260 290	195 220

For Sl: 1 inch 25.4 mm, 1 pound per foot = 14.5939 N/m.
For foot notes, see Table 2306.3.1

TABLE 2306.3.1b RECOMMENDED SHEAR (POUNDS PER FOOT) FOR STAPLED WOOD STRUCTURAL PANEL DIAPHRAGMS WITH FRAMING OF SPRUCE-PINE-FIR (SPECIFIC GRAVITY = 0.42) FOR WIND OR SEISMIC LOADING

PANEL GRADE	MINIMUM NOMINAL PANEL THICKNESS (inch)	STAPLE[f] LENGTH AND GAGE	MINIMUM FASTENER PENETRA-TION IN FRAMING (inches)	MINIMUM NOMINAL WIDTH OF FRAMING MEMBER (inches)	BLOCKED DIAPHRAGMS				UNBLOCKED DIAPHRAGMS	
					fastener spacing (inches) at diaphragm boundaries (all Cases) at continuous panel edges parallel to load (Cases 3, 4), and at all panel edges (Cases 5 and 6)[b]				Fasteners spaced at 6" max. at supported edges[b]	
					6	4	2½[c]	2[c]	Case 1 (no unblocked edges or continuous joints parallel to load)	All other configurations (Cases 2, 3, 4, 5 and8)
					Fastener spacing (inches) at other panel edges (Cases 1, 2, 3 and 4)[b]					
					6	6	4	3		
Structural I Grades	5/16	1½ 16 Gage	1	2 3	125 140	165 185	250 280	285 315	110 125	85 90
	⅜	1½ 16 Gage)	1	2 3	140 160	190 215	285 320	325 365	125 140	90 105
	15/32	1½ 16 Gage	1	2 3	140 160	190 215	285 320	325 365	125 140	95 105

For Sl: 1 inch 25.4 mm, 1 pound per foot = 14.5939 N/m.
For foot notes, see Table 2306.3.1

TABLE 2306.3.2 ALLOWABLE SHEAR IN POUNDS PER FOOT FOR HORIZONTAL BLOCKED DIAPHRAGMS UTILIZING MULTIPLE ROWS OF FASTENERS (HIGH LOAD DIAPHRAGMS) WITH FRAMING OF DOUGLAS FIR, LARCH OR SOUTHERN PINE[a] FOR WIND OR SEISMIC LOADING[b]

PANEL GRADE[c]	FASTENER AND SIZE	MINIMUM FASTENER PENETRATION IN FRAMING (inches)	MINIMUM NOMINAL PANEL THICKNESS (inch)	MINIMUM NOMINAL WIDTH OF FRAMING MEMBER[e] (inches)	LINES OF FASTENERS	BLOCKED DIAPHRAGMS					
						Cases 1 and 2[d]					
						Fastener Spacing Per Line at Boundaries (inches)					
						4		2½		2	
						Fastener Spacing Per Line at Other Panel Edges (inches)					
						6	4	4	3	3	2
Structural 1 grades	10d common nails	1½	15/32	3	2	605	815	875	1150	—	—
				4	2	700	915	1005	1290	—	—
				4	3	875	1220	1285	1395	—	—
			19/32	3	2	670	880	965	1255	—	—
				4	2	780	990	1110	1440	—	—
				4	3	965	1320	1405	1790	—	—
			23/32	3	2	730	955	1050	1365	—	—
				4	2	855	1070	1210	1565	—	—
				4	3	1050	1430	1525	1800	—	—
	14 gage staples	2	15/32	3	2	600	600	860	960	1060	1200
				4	3	860	900	1160	1295	1295	1400
			19/32	3	2	600	600	875	960	1075	1200
				4	3	875	900	1175	1440	1475	1795
Sheathing single floor and other grades covered in DOC PS 1 and PS 2	10d common nails	1 1/2	15/32	3	2	525	725	765	1010	—	—
				4	2	605	815	875	1105	—	—
				4	3	765	1085	1130	1195	—	—
			19/32	3	2	650	860	935	1225	—	—
				4	2	755	965	1080	1370	—	—
				4	3	935	1290	1365	1485	—	—
			23/32	3	2	710	935	1020	1335	—	—
				4	2	825	1050	1175	1445	—	—
				4	3	1020	1400	1480	1565	—	—
	14 gage staples	2	15/32	3	2	540	540	735	865	915	1080
				4	3	735	810	1005	1105	1105	1195
			19/32	3	2	600	600	865	960	1065	1200
				4	3	865	900	1130	1430	1370	1485
			23/32	4	3	865	900	1130	1490	1430	1545

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

a. For framing of the other species: (1) Find specific gravity for species of framing lumber in AFPA National Design Specification, (2) Find shear value from Table 2306.3.2 for nail size of actual grade, and (3) Multiply value by the following adjustment factor = [1 -(0.5- *SG)*], where *SG* = Specific gravity of the framing lumber. This adjustment factor shall not be greater than 1.

b. Fastening along intermediate framing members: Space nails 12 inches on center, except 6 inches on center for spans greater than 32 inches.

c. Panels conforming to PS 1 or PS 2.

d. Table 2306.3.2 gives shear values for Cases 1 and 2 as shown in Table 2306.3.1. The values shown are applicable to Cases 3, 4, 5 and 6 as shown in Table 2306.3.1, pro viding fasteners at all continuous panel edges are spaced in accordance with the boundary fastener spacing.

e. The minimum depth of framing members shall be three inches.

TABLE 2306.3.3 DIAGONALLY SHEATHED LUMBER DIAPHRAGM NAILING SCHEDULE

SHEATHING NOMINAL DIMENSION	NAILING TO INTERMEDIATE AND END-BEARING STUDS		NAILING AT THE SHEAR PANEL BOUNDARIES	
	Type, size and number of nails per board			
	Common nails	Box nails	Common nails	Box nails
1 × 6	two - 8d	three - 8d	three - 8d	five - 8d
1 × 8	three - 8d	four - 8d	four - 8d	six - 8d
2 × 6	two - 16d	three - 16d	three - 16d	five - 16d
2 × 8	three - 16d	four - 16d	four - 16d	six - 16d

TABLE 2306.4.1 ALLOWABLE SHEAR (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL SHEAR WALLS WITH FRAMING OF DOUGLAS-FIR-LARCH, OR SOUTHERN PINE[a] FOR WIND OR SEISMIC LOADING [b, h. I, j]

PANEL GRADE	MINIMUM NOMINAL PANEL THICKNESS (inches)	MINIMUM FASTENER PENETRATION IN FRAMING (inches)	PANELS APPLIED DIRECT TO FRAMING				
			Nail (common or galvanized box) or staple size[k]	Fastener spacing at panel edges (inches)			
				6	4	3	2[e]
Structural 1 Sheathing	5/16	1¼	6d (2" x 0.113" common, 2" - 0.099" galvanized box)	200	300	390	510
		1	1½ 16 Gage	165	245	325	415
	⅜	1⅜	8d (2½" x 0.131" common, 2½" - 0.113" galvanized box)	230[d]	360[d]	460[d]	610[d]
		1	1½ 16 Gage	155	235	315	400
	7/16	1⅜	8d (2½" x 0.131" common, 2½" - 0.113" galvanized box)	255[d]	395[d]	505[d]	670[d]
		1	1½ 16 Gage	170	260	345	440
	15/32	1⅜	8d (2½" x 0.131" common, 2½" - 0.113" galvanized box)	280	430	550	730
			10d (3" x 0.148" common, 3" - 0.128" galvanized box)	850	280	375	475
		1	1½ 16 Gage	340	510	665[f]	870
Sheathing, Plywood Siding except Group 5 Species	5/16 or ¼[c]	1¼	6d (2" x 0.113" common, 2" - 0.099" galvanized box)	180	270	350	450
		1	1½ 16 Gage	145	220	295	375
	⅜	1¼	6d (2" x 0.113" common, 2" - 0.099" galvanized box)	200	300	390	510
		1 ⅜	8d (2½" x 0.131" common, 2½" - 0.113" galvanized box)	220[d]	320[d]	410[d]	530[d]
		1	1½ 16 Gage	140	210	280	360
	7/16	1 ⅜	8d (2½" x 0.131" common, 2½" - 0.113" galvanized box)	240[d]	350[d]	450[d]	585[d]
		1	1½ 16 Gage	155	230	310	395
	15/32	1 ⅜	8d (2½" x 0.131" common, 2½" - 0.113" galvanized box)	260	380	490	640
		1½	10d (3" x 0.148" common, 3" - 0.128" galvanized box)	310	460	600[f]	770
		1	1½ 16 Gage	170	255	335	430
	19/32	1½	10d (3" x 0.148" common, 3" - 0.128" galvanized box)	340	510	665[f]	870
		1	1½ 16 Gage	185	280	375	475
			Nail size (ga;vanized casing)				
	5/16[c]	1¼	6d (2" - 0.099")	140	210	275	360
	⅜	1 ⅜	8d (2½" - 0.113")	160	40	310	410

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

a. For framing of the other species: (1) Find specific gravity for species of lumber in NDS. (2) For staples find shear value from Table 2306.4.1 for Structural 1 panels (regardless of actual grade) and multiply value by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other species. (3) For nails find shear value from Table 2306.4.1 for nail size for actual grade, and multiply value by the following adjustment factor: Specific Gravity Adjustment Factor = [1 -(0.5- *SG)*], where *SG* = Specific gravity of the framing lumber. This adjustment factor shall not be greater than 1.

b. panel edges backed with two-inch nominal or wider framing. Instal; panels either horizontally or vertically. Space nails maximum six inches o.c. along intermediate framing members for ⅜-inch and 7/16-inch panels installed on studs spaced 24 inches o.c. For other conditions and panel thickness, space nails maximum 12 o.c. on intermediate supports..

c. ⅜-inch or siding 16 inches o.c. is minimum recommended where applied direct to framing as exterior siding.

d. Allowable shear values are permitted to be increased to values shown for 15/32-inch sheathing with same nailing provided (a) studs are spaced at a maximum of 16 inches o.c., or (b) if panels are applied with long dimension across studs.

e. Framing at adjoining panel edges shall be three-inch nominal or wider, and nails shall be staggered where nails are spaces two-inches.

f. Framing at adjoining panel edges shall be three-inch nominal or wider, and nails shall be staggered where both of the following conditions are met: (1) 10d (3" x 0.148") nails having penetration into framing of more than 1½ inches and (2) nails are spaces three inches o.c.

g. Values apply to all-veneer plywood. Thickness at point of nailing on panel edges governs shear values.

h. Where panels are applied on both faces of a wall and nail spacing is less than six inches o.c. on either side, panel joists shall be offset to fail on different framing members, or framing shall be three-inch nominal or thicker at adjoining panel edges and nails on each side shall be staggered.
i. In Seismic Design Category D, E, or F, where shear design values exceed 490 pounds per lineal foot (LRFD) or 350 pounds per lineal foot (ASD) all framing members receiving edge nailing from abutting panels shall not be less that a single three-inch nominal member, or two-inch nominal members fastened together in accordance with 780 CMR 2307.1 (LFRD) or 780 CMR 2308.1 (ASD) to transfer the design shear value between framing members. Plywood joint and sill plate nailing shall be staggered in all cases. Dee 780 CMR 2305.3.10 for sill plate size and anchorage requirements.
j. Galvanized nails shall be hot-dipped or tumbled.
k. Staples shall have a minimum crown width of $^{7}/_{16}$inch, and shall be installed with their growns parallel to the long dimension of the framing members.

TABLE 2306.4.1a ALLOWABLE SHEAR (POUNDS PER FOOT) FOR NAILED WOOD STRUCTURAL PANEL SHEAR WALLS WITH FRAMING OF SPRUCE-PINE-FIR (SPECIFIC GRAVITY = 0.42) FOR WIND OR SEISMIC LOADING [b, h. I, j]

PANEL GRADE	MINIMUM NOMINAL PANEL THICKNESS (inches)	MINIMUM FASTENER PENETRATION IN FRAMING (inches)	PANELS APPLIED DIRECT TO FRAMING				
			Nail (common or galvanized box)	Fastener spacing at panel edges (inches)			
				6	4	3	2[e]
Structural 1 Sheathing	$^{5}/_{16}$	1¼	6d (2" x 0.113" common, 2" - 0.099" galvanized box)	180	275	355	465
	⅜	1⅜	8d (2½" x 0.131" common, 2½" - 0.113" galvanized box)	210[d]	330[d]	420[d]	560[d]
	$^{7}/_{16}$	1⅜	8d (2½" x 0.131" common, 2½" - 0.113" galvanized box)	230[d]	360[d]	460[d]	615[d]
	$^{15}/_{32}$	1⅜	8d (2½" x 0.131" common, 2½" - 0.113" galvanized box)	255	395	505f	670
			10d (3" x 0.148" common, 3" - 0.128" galvanized box)	310	465	610f	800
Sheathing, Plywood Siding except Group 5 Species	$^{5}/_{16}$ or ¼[c]	1¼	6d (2" x 0.113" common, 2" - 0.099" galvanized box)	165	245	320	410
	⅜	1¼	6d (2" x 0.113" common, 2" - 0.099" galvanized box)	180	275	355	465
		1⅜	8d (2½" x 0.131" common, 2½" - 0.113" galvanized box)	200[d]	290[d]	375[d]	485[d]
	$^{7}/_{16}$	1⅜	8d (2½" x 0.131" common, 2½" - 0.113" galvanized box)	220[d]	320[d]	410[d]	535[d]
	$^{15}/_{32}$	1⅜	8d (2½" x 0.131" common, 2½" - 0.113" galvanized box)	235	345	450[f]	585
		1½	10d (3" x 0.148" common, 3" - 0.128" galvanized box)	285	420	550[f]	705
	$^{19}/_{32}$	1½	1 10d (3" x 0.148" common, 3" - 0.128" galvanized box)	310	465	610[f]	800
			Nail size (ga;vanized casing)				
	$^{5}/_{16}$[c]	1¼	6d (2" - 0.099")	125	190	250	330
	⅜	1⅜	8d (2½" - 0.113")	145	220	285[f]	375

For SI: I inch = 25.4 turn, I pound per foot = 14.5939 N/m.
For footnotes, see Table 2306.4.1

TABLE 2306.4.1b ALLOWABLE SHEAR (POUNDS PER FOOT) FOR STAPLED WOOD STRUCTURAL PANEL SHEAR WALLS WITH FRAMING OF SPRUCE-PINE-FIR (SPECIFIC GRAVITY = 0.42) FOR WIND OR SEISMIC LOADING[b, h, I, j]

PANEL GRADE	MINIMUM NOMINAL PANEL THICKNESS (inches)	MINIMUM FASTENER PENETRATION IN FRAMING (inches)	PANELS APPLIED DIRECT TO FRAMING				
			STAPLE LENGTH AND GAGE[k]	Fastener spacing at panel edges (inches)			
				6	4	3	2[e]
All Sheathing and Plywood Siding[g] except Group 5 Species	5/16	1	1½ 16 Gage	135	200	265	340
	3/8	1	1½ 16 Gage	125	190	255	325
	7/16	1	1½ 16 Gage	135	210	280	360
	15/32	1	1½ 16 Gage	150	225	305	385

For SI: 1 inch = 25.4 turn, 1 pound per foot = 14.5939 N/m.
For footnotes, see Table 2306.4.1

TABLE 2306.4.3 ALLOWABLE SHEAR FOR PARTICLEBOARD SHEAR WALL SHEATHING[b]

PANEL GRADE	MINIMUM NOMINAL PANEL THICKNESS (inch)	MINIMUM NAIL PENETRATION IN FRAMING (inches)	PANELS APPLIED DIRECT TO FRAMING				
			Nail size (common or galvanized box)	Allowable shear (pounds per foot) nail spacing at panel edges (inches)[a]			
				6	4	3	2
M-S "Exterior Glue" and M-2 "Exterior Glue"	3/8	1 ½	6d	120	180	230	300
	3/8	1 ½	8d	130	190	240	315
	½			140	210	270	350
	½	1⅝	10d	185	275	360	460
	⅝			200	305	395	520

For SI: 1 inch = 25.4 turn, 1 pound per foot = 14.5939 N/m.
a. Values are not permitted in Seismic Design Category D, E, or F.
b Galvanized nails shall be hot-dipped or tumbled.

TABLE 2306.4.5 ALLOWABLE SHEAR FOR WIND OR SEISMIC FORCES FOR SHEAR WALLS OF LATH AND PLASTER OR GYPSUM BOARD WOOD FRAMED WALL ASSEMBLIES

TYPE OF MATERIAL	THICKNESS OF MATERIAL	WALL CONSTRUCTION	FASTENER SPACING[b] MAXIMUM (inches)	SHEAR VALUE[a,e] (plf)	MINIMUM FASTENER SIZE[c, d, j, k]
1. Expanded metal or woven wire lath and portland cement plaster	7/8"	Unblocked	6	180	No. 11 gage 1½" long, 7/16" head 16 Ga. Galv. Staple, 7/8 legs
2. Gypsum lath, plain or perforated	3/8" lath and ½" plaster	Unblocked	5	100	No. 13 gage, 1⅛" long, 19/64" head, plasterboard nail 16 Ga. Galv. Staple, 1⅛" long 0.120" Nail, min. 3/8" head, 1¼" long
3. Gypsum sheathing	½" x 2' x 8'	Unblocked	4	75	No. 11 gage, 1¾" long, 7/16" head, diamond-point, galvanized 16 Ga. Galv. Staple, 1¾" long
	½" × 4'	Blocked[f]	4	175	
		Unblocked	7	100	
	5/8" × 4'	Blocked	4^ edge/ 7^ field	200	6d galvanized 0.120" Nail, min. 3/8" head, 1¾" long
4. Gypsum board, gypsum veneer base, or water-resistant gypsum backing board	½"	Unblocked[f]	7	75	5d cooler (1⅝" x 0.086") or wallboard 0.120" Nail, min. 3/8" head, 1½" long 16 Gage Staple, 1½" long
		Unblocked[f]	4	110	
		Unblocked	7	100	
		Unblocked	4	125	
		Blocked[g]	7	125	
		Blocked[g]	4	150	
		Unblocked	8/12[h]	60	No. 6-1¼" screws[i]
		Blocked[g]	4/16[h]	160	
		Blocked[g]	4/12[h]	155	
		Blocked[f, g]	8/12[h]	70	
		Blocked[g]	6/12[h]	90	
	5/8"	Unblocked[f]	7	115	6d cooler (1⅞" x 0.092") or wallboard 0.120" Nail, min. 3/8" head, 1¾" long 16 Gage Staple, 1½" legs, 1⅝" long
			4	145	
		Blocked[g]	7	145	
			4	175	
		Blocked[g] Two-ply	Base ply: 9 Face ply: 7	250	Base ply—6d cooler (1⅞" x 0.092") or wallboard 1¾" × 0.120" Nail, min. 3/8" head 1⅝" 16 Ga. Galv. Staple Face ply—8d cooler (2⅜" x 0.113") or wallboard 0.120" Nail, min. 3/8" head, 2⅜" long 15 Ga. Galv. Staple, 2¼" long
		Unblocked	8/12[h]	70	No. 6-1¼" screws[i]
		Blocked[g]	8/12[h]	90	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per foot = 14.5939 N/m.

a. These shear walls shall not be used to resist loads imposed by masonry or concrete construction (see 780 CMR 2305.1.5). Values shown are for short-term loading due to wind or seismic load. Walls resisting seismic loads shall be subject to the limitations in 780 CMR 1617.6. Values shown shall be reduced 25% for normal loading.
b. Applies to nailing at studs, top and bottom plates and blocking.
c. Alternate nails are permitted to be used if their dimensions are not less than the specified dimensions. Drywall screws are permitted to be substituted for the 5d, 6d (cooler) nails listed above. 1¼ inches Type S or W, No. 6 for 6d (cooler) nails.
d. For properties of cooler nails, see ASTM C 514.
e. Except as noted, shear values are based on a maximum framing spacing of 16 inches on center.
f. Maximum framing spacing of 24 inches on center.
g. All edges are blocked, and edge nailing is provided at all supports and all panel edges.
h. First number denotes fastener spacing at the edges; second number denotes fastener spacing in the field.
i. Screws are Type W or S.
j. Staples shall have a minimum crown width of 7/16 inch, measured outside the legs.
k. Staples for the attachment of gypsum lath and woven-wire lath shall have a minimum crown width of ¾ inch, measured outside the legs.