CHAPTER 6
MATERIALS AND GENERAL DESIGN CONSIDERATIONS

6.1 GENERAL

6.1.1 Installation

Metal plate connected wood trusses are planar structural components. Structural design and performance depends on trusses being positioned vertically (unless designed for non-vertical orientation), in-plane, at a specific spacing, properly braced, and with bearings according to place diagram dimensions. Truss designs in accordance with this standard apply to trusses with the following characteristics, unless otherwise specified by the Truss Designer:

6.1.1.1 The maximum allowable overall bow in any chord, or bow in any panel or web, shall not exceed 3/4 in. or L/200, whichever is greater. In no case shall any bow exceed 2 in. L is the span of the truss or chord, web, or panel length in inches or mm. (See Figure 6.1-1)

6.1.1.2 Trusses do not exhibit a variation from plumb (vertical tolerance) at any point along the length of the truss from top to bottom chords which exceeds the lesser of 1/50 of the depth of the truss at that point (D/50), or 2 in. (50 mm). (See Figure 6.1-2)

6.1.1.3 The location of trusses along the bearing support are within 1/4 in. (6 mm) of plan dimensions. Special hangers or supports are located to support trusses within 1/4 in. (6 mm) of plan dimensions. Trusses shall be located at the spacing specified by the truss design drawing. Where there are obstructions that do not allow the exact spacing to be used, contact the Truss Designer to determine the change in load carrying capacity due to the specific truss movement required at the site, and to determine any reinforcement required to accommodate the changes to the applied load on all affected trusses.

6.1.1.4 Top chord bearing parallel chord trusses do not exceed a maximum gap of 1/2 in. (13 mm) between the inside of the bearing and the first diagonal or vertical web, as shown in Figure 6.1-3.

This Section shall not be interpreted to apply to metal plate connected wood trusses at the time of manufacture, delivery, storage, or any other time before they are positioned and braced.

6.1.2 Serviceability

6.1.2.1 The Building Designer shall specify if strong-backing is required and, if so, any further guidance desired beyond that given in Section 7.5.2.4.

6.1.2.2 Any camber requirements for load induced deflection shall be specified by the Building Designer.

6.1.2.3 Building Designers shall include the initial dead load deflection and in-service creep deflection when establishing roof design loads for flat roofs having a potential for ponding.

6.1.3 Truss Design Information

For each truss design drawing, the Truss Designer shall set forth, as a minimum, the following:

6.1.3.1 Slope or depth, span, and spacing;

6.1.3.2 Location of all joints;

6.1.3.3 Required bearing widths;

6.1.3.4 Design loads as applicable:

6.1.3.4.1 Top chord live load (including snow loads);
6.1.3.4.2 Top chord dead load;
6.1.3.4.3 Bottom chord live load;
6.1.3.4.4 Bottom chord dead load;
6.1.3.4.5 Concentrated loads and their points of application; and
6.1.3.4.6 Controlling wind and earthquake loads expressed in units of force per unit area or unit length;

6.1.3.5 Adjustments to lumber and metal connector plate design values for conditions of use;

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BOW

L (in)	Max. Bow	L (ft)
≤ 150"	3/4"	12.5'
175"	7/8"	14.6'
200"	1"	16.7'
225"	1-1/8"	18.8'
250"	1-1/4"	20.8'
275"	1-3/8"	22.9'
300"	1-1/2"	25.0'
350"	1-3/4"	29.2'
≥ 400"	2"	33.3'

PLUMB

D (in)	D/50	D (ft)
12"	1/4"	1'
24"	1/2"	2'
36"	3/4"	3'
48"	1"	4'
60"	1-1/4"	5'
72"	1-1/2"	6'
84"	1-3/4"	7'
96"	2"	8'
≥ 96"	≥ 2"	≥ 8'

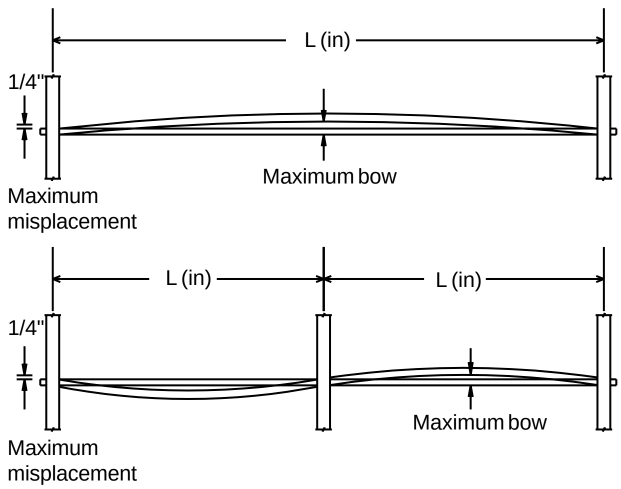

Figure 6.1-1 Out-of-Plane Tolerances

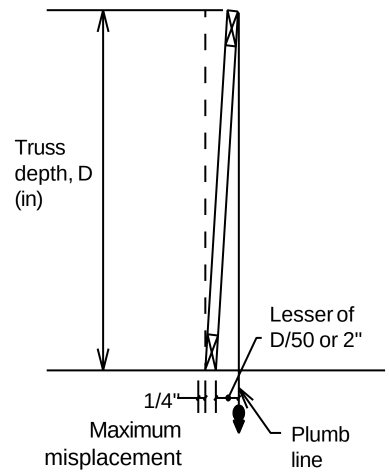

Figure 6.1-2 Out-of-Plumb Tolerances

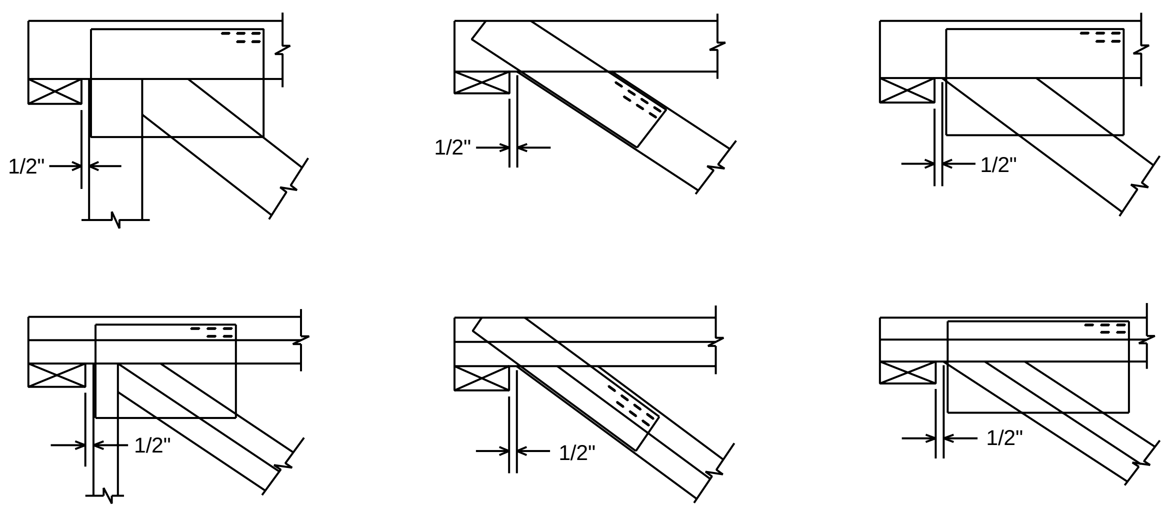

Figure 6.1-3 Placement tolerances for top chord bearing parallel chord trusses (single and double-member top chords).

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6.1.3.6 Each reaction force and direction;

6.1.3.7 Metal connector plate type, size, thickness or gauge, and the dimensioned location of each metal connector plate except where symmetrically located relative to the joint interface;

6.1.3.8 Lumber size, species or species group, and grade for each member;

6.1.3.9 Connection requirements for: (a) truss to truss girder; (b) truss ply to ply; and (c) field assembly of trusses;

6.1.3.10 Calculated deflection ratio or maximum deflection for live and total load;

6.1.3.11 Maximum axial compression forces in the truss members to enable the Building Designer to design the size, connections, and anchorage of the permanent continuous lateral bracing;

6.1.3.12 The approximate location for continuous lateral permanent bracing of truss members subject to buckling due to compression forces;

6.1.3.13 The quality control factor (Cq), per Section 6.4.11; and

6.1.3.14 Any specific joint inspection requirements

6.1.4 Truss Design Data

The following truss design data shall be available from the Truss Designer:

(a) Comprehensive design calculations, including the load combinations and conditions considered, along with the axial forces and moments resulting from these conditions;

(b) The required number of effective teeth for lateral resistance in each joint member contact area as determined in accordance with Section 8.4 using lateral strength design values derived per Section 5.2.9.2; and

(c) The JSI for each joint, as calculated per Section 8.12.3.

6.2 LOADS AND STRUCTURAL ANALYSIS

6.2.1 Buildings or other structures, and all parts thereof, shall be designed by the Building Designer to safely support all loads, including dead loads, that are expected to affect the structure during its service life. These loads shall be as stipulated by the governing building code or, in the absence of such a code, the loads, forces, and combinations of loads shall be in accordance with accepted engineering practice for the geographical area under consideration. In the absence of a governing building code, the appropriate sections of ASCE 7 shall be used.

6.2.2 The following loading conditions shall apply to the design of metal plate connected wood trusses.

6.2.2.1 The weight of non-bearing partitions shall be permitted to be ignored for truss design purposes given the following conditions; if the following conditions do not exist, the Building Designer shall specify in the structural design documents the non-bearing partition loads that need to be applied to the trusses:

(a) Trusses are not spaced over 24 inches (610 mm) on centers;

(b) Top chord panel length of supporting trusses does not exceed 30 inches (760 mm);

(c) Design live load of supporting trusses results from a residential occupancy and is not less than 40 psf (1920 Pa);

(d) Partition weight does not exceed 60 pounds per linear foot (875 N/m); and

(e) When partitions parallel to supporting trusses are not located on or immediately adjacent to a truss, the sub-floor shall be of adequate strength and stiffness to support the partition load, or other provisions shall be made by the Building Designer to distribute the partition weight to the supporting trusses.

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6.2.2.2 Attic live loads, other than floor live loads, that are applied to the entire length of the bottom chord shall not be required to be applied concurrently with other live loads.

6.2.2.3 When dead loads are specified on a projected horizontal area basis, the effect of the pitch shall be taken into account.

6.2.2.4 The dead load used in determining wind uplift shall not exceed the minimum expected actual weight of the materials, or 0.6 times the nominal design dead load if the minimum expected actual weight of the materials is not known.

6.2.2.5 Live load on floor trusses shall be considered for both cases of full-length loading and partial-length loading, where partial-length loading shall exclude the floor live load over the truss in the area between a non-triangulated panel (a/k/a open chase) and the nearest bearing.

6.2.3 Truss member axial forces, bending moments, and effective buckling lengths shall be based on a mathematical model of the truss that closely approximates the geometry and properties of the truss members and connections.

6.2.4 An accepted structural analysis method for analyzing statically indeterminate structures, such as the matrix stiffness method, shall be used to determine the design moments and axial forces for each truss member.

Table 6.4-1 Flat Use Factor (C_{fu}) for Lumber 2" Thick

Width (inches)	C_{fu}
2" & 3"	1.0
4"	1.1
5"	1.1
6"	1.15
8"	1.15
10" & wider	1.2

6.3 DESIGN VALUES

6.3.1 Design Values For Solid Sawn Lumber

6.3.1.1 Design values (E, F_b, F_c, $F_{c\perp}$, F_t, and F_v) for solid-sawn lumber and approved, grade stamped, finger-jointed lumber shall be in accordance with the published values of lumber rules writing agencies approved by the Board of Review of the American Lumber Standards Committee. Design values for F_g shall be in accordance with ANSI/AF&PA NDS-1997.

6.3.1.2 Design of lumber chord and web members shall be based on dressed sizes as set forth by the U.S. Department of Commerce, PS-20-94. If other sizes or materials are used, the net dressed size shall be stated in the design and used in the design calculations.

6.3.2 Design Values For Structural Composite Lumber

Design values for structural composite lumber shall be approved by the authorities having jurisdiction.

6.3.3 Design Values For Fasteners Other Than Metal Connector Plates

Design values for fasteners other than metal connector plates shall be in accordance with the ANSI/AF&PA NDS. Other fasteners shall be permitted when approved by the authorities having jurisdiction.

6.4 ADJUSTMENTS TO DESIGN VALUES

6.4.1 Load Duration Factor (C_D)

6.4.1.1 Design values shall be permitted to be adjusted for load duration conditions in accordance with this section, unless otherwise specified by local

Table 6.4-2 Wet Service Factor (C_M)

F_b	F_t	F_v		F_c	E	V_{LR}
0.85	1.0	0.97	0.67	0.8	0.9	0.8

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Table 6.4-3 Temperature Factor, C_t

Design Values	In Service Moisture Conditions	C_t		
			$100^{\circ}F < T \le 125^{\circ}F$	$125^{\circ}F < T \le 150^{\circ}F$
F_t, E	Wet or Dry	1.0	0.9	0.9
F_b,F_v,F_c, and	Dry	1.0	0.8	0.7
	Wet	1.0	0.7	0.5

code requirements. The Building Designer shall be permitted to reduce the load duration factor when the expected load durations are greater than the assumed durations in Section 6.4.1.3.

6.4.1.2 Adjustments for load duration apply to all lumber and plate lateral resistance (tooth holding) design values, with the exception of modulus of elasticity (E) and compression perpendicular to grain ($F_{c\perp}$).

6.4.1.3 The adjustment for load duration shall be accomplished by multiplying the design value by the appropriate C_D factor as follows:

$T F_{c\perp} \le 100^{\circ}F$

Permanent	0.90
Normal - 10 Years duration	1.00
Snow - 2 Months duration	1.15
Construction - 7 Days duration	1.25
Wind & Earthquake - 5-10 minutes	1.60
Impact*	2.0

*For FRT and pressure-preservative lumber and all connections subject to an impact load, the duration of load factor shall not exceed 1.6.

6.4.1.4 For combinations of loads with different durations, the load duration factor, C_D, for the shortest duration load that is part of that load combination shall apply for that entire load combination.

6.4.2 Repetitive Member Increase (C_r)

6.4.2.1 Repetitive member design values that are listed in the recognized lumber grading rules, or a 15 percent increase to F_b and 10 percent increase to F_c and F_t for solid sawn lumber members to which structural wood sheathing is mechanically attached, or a 10 percent increase to F_b, F_c, and F_t for solid sawn lumber members to which structural wood sheathing is not attached, shall only apply to chord members where three or more trusses are positioned side by side, are in contact, or are spaced no more than 24 inches (610 mm) on center and are joined by roof sheathing, flooring, gypsum, or other load distributing elements attached directly to the chords.

6.4.2.2 Single-ply and two-ply girder trusses are not permitted to use the repetitive member increases outlined in Section 6.4.2.1.

Table 6.4-4 Shear Stress Factor, C_H[1]

Length of split on wide face of 2" (nominal) lumber		Length of split on wide face of 3" (nominal) and thicker lumber		Size of shake in 2" (nominal) and thicker lumber	
no split	2.00	no split	2.00	no shake	2.00
1/2 x wide face	1.67	1/2 x narrow face	1.67	1/6 x narrow face	1.67
3/4 x wide face	1.50	3/4 x narrow face	1.50	1/4 x narrow face	1.50
1 x wide face	1.33	1 x narrow face	1.33	1/3 x narrow face	1.33
1-1/2 x wide face	1.00	1-1/2 x narrow face or more	1.00	1/2 x narrow face or more	1.00 1.00

1. Shear stress factor shall not be applied to shear stress values determined in accordance with ASTM D245-99.

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6.4.3 Flat Use Factor (C_{fu})

Flat use factor for lumber, C_{fu}, as stated in Table 6.4-1, shall be permitted to be applied to the bending design value, F_b, when the member is subjected to bending about its weak axis. Otherwise, C_{fu} shall be taken as unity.

6.4.4 Buckling Stiffness Factor (C_T)

6.4.4.1 The buckling stiffness factor, C_T, shall be applied to E, and shall be determined using Section 6.4.4.2 when the following conditions in (a)-(d) are met:

(a) The member size is 2x4 (38 x 89 mm) or smaller;

(b) Continuous 3/8 inch (9.5 mm) or thicker wood structural panel sheathing is attached to the chord with fasteners of the type, size, and spacing as required by the Building Designer or authorities having jurisdiction;

(c) The member is subjected to combined bending and axial compression; and

(d) The trusses are used under dry service conditions.

If these conditions are not met, C_T shall be taken as unity.

6.4.4.2 When permitted in accordance with Section 6.4.4.1, the buckling stiffness factor (C_T) shall be determined as follows:

$$C_T = 1 + \frac{2300L'}{kE} \qquad \text{(E6.4-1)}$$

for wood seasoned to a moisture content of 19 percent or less at the time the plywood is applied to the chord, or as:

$$C_T = 1 + \frac{1200L'}{kE} \qquad \text{(E6.4-2)}$$

for wood that is unseasoned or partially seasoned at the time of plywood attachment, where:

L' = effective buckling length in inches, but not greater than 96 inches (2440 mm)

and

k = 0.82 for $COV_E \le 0.11$ for machine stress rated lumber;

k = 0.75 for $COV_E \le 0.15$ for machine evaluated lumber; or

k = 0.59 for $COV_E \cong 0.25$ for visually graded lumber

6.4.5 Wet Service Factor (C_M)

6.4.5.1 When dimension lumber is used where moisture content will exceed 19 percent for an extended time period, design values shall be multiplied by the appropriate wet service factors in Table 6.4-2, except as specified in Section 6.4.5.2.

6.4.5.2 C_M shall be taken as unity for F_b or F_c if the following conditions are met:

If $(F_b)(C_{fu})$ 1150 psi, C_M = 1.0 for F_b

If (F_c) 750 psi, C_M = 1.0 for F_c

6.4.5.3 Metal connector plates installed in lumber having a moisture content greater than 19 percent at the time of truss fabrication shall have the lateral resistance value (V_{LR}) multiplied by C_M.

6.4.6 Temperature Factor (C_t)

For structural members that will experience sustained exposure to elevated temperatures up to 150 degrees Fahrenheit, the tabulated design values shall be multiplied by the temperature factors in Table 6.4-3.

6.4.7 Shear Stress Factor (C_H)

6.4.7.1 When the length of a split or shake of a member is known not to exceed the specified limits (maximum length assumed in the tabulated shear design values), and is not anticipated to ever exceed the limits, a shear stress factor, C_H, per ASTM D245-88 provisions, shall be permitted to be applied to the tabulated shear design value. C_H is equal to 2.0 for members with no splits or shakes. The shear stress factors for other known lengths of splits and shakes are shown in Table 6.4-4.

6.4.7.2 The shear stress factor shall not be applied to shear stress values determined in accordance with ASTM D245-99.

6.4.8 Incising Factor (C_i)

6.4.8.1 Tabulated design values shall be multiplied by the incising factor, C_i, per the current edition of ANSI/AF&PA NDS, when structural sawn lumber is incised to increased penetration of preservatives with incisions cut parallel to grain, a maximum depth of , a maximum length of , and a maximum density of incisions of 357/ft^2. Incising factors shall be determined by test for

3/8" incising patterns exceeding these limits.

6.4.8.2 Appropriate reduction factors shall be used for design of metal connector plates installed in incised lumber.

6.4.9 Chemically Treated Lumber

6.4.9.1 Fire Retardant Treated Wood (FRTW)

6.4.9.1.1 All fire retardant treated lumber used in trusses shall be redried after treatment to 19 percent maximum moisture content at temperatures not to exceed 160° F (71° C). FRTW lumber design values shall be developed from approved test methods and procedures that consider potential strength-reduction characteristics, including effects of elevated temperature and moisture, and design values shall be approved by the authorities having jurisdiction.

6.4.9.1.2 Metal connector plates installed in lumber pressure-impregnated with fire retardant chemicals shall have the reductions for lateral resistance values specified by the FRT chemical manufacturer. The quality mark shall indicate that the design value adjustments are in accordance with either the FRT manufacturer's specifications or based upon an approved method of investigation which takes into consideration the effects of the anticipated temperature and humidity of which the fire retardant treated wood will be subjected.

6.4.9.2 Preservative Treated Wood

All preservative treated lumber used in trusses redried after treatment shall be redried to a 19 percent maximum moisture content at temperatures not to exceed 160° F (71° C). Design values for preservative treated lumber used in trusses shall be developed from approved test methods and procedures that consider potential strength-reduction characteristics, including incising marks. Design values shall be approved by the authorities having jurisdiction.

6.4.10 Wind/Seismic Load Factors

Allowable shear and tension design values for metal connector plates shall be permitted to be increased by 33-1/3 percent for load cases including wind or earthquake loads, in accordance with ASCE 7.

6.4.11 Quality Control Factor

6.4.11.1 The quality control factor (C_q) shall only apply to plate lateral resistance design values (V_{LR}).

6.4.11.2 The Truss Manufacturer's value of C_q shall not exceed 1.00 for plates embedded into lumber faces wider than 2 inches, and 1.11 for plates embedded into lumber faces less than or equal to 2 inches, except as permitted by the Truss Manufacturer's quality assurance program in accordance with Section 3.2. C_q shall not exceed 1.25 in any case.

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6.4.11.3 The Truss Designer shall be permitted, as part of the Truss Manufacturer's quality assurance program, to increase C_q above the Truss Manufacturer's value on a joint-by-joint basis where necessary to meet the design requirements for that joint. In such cases, the truss design drawing shall indicate that inspection of these joints requires the Tooth Count Method (TCM) in Annex A3.

6.412. Other Adjustment Factors

Wood design stresses for dry lumber shall be permitted to be used for green lumber when the following three conditions are met:

(a) Trusses shall be stored after fabrication and installed in an exposure with equilibrium moisture content conditions of 19 percent or less.

(b) Appropriate reduction factors (C_M) shall be used for design of fasteners installed prior to the drying of the lumber, including truss plates, nails, joist hangers, and similar fasteners.

(c) Typical conditions in that geographical area permit drying of the lumber to 19% moisture content or less prior to the closing in of the structure.

6.5 CORROSIVE ENVIRONMENTS

6.5.1 The following coatings are recognized as providing increased corrosion protection to metal connector plates:

(a) Epoxy-Polyamide Primer (SSPC-Paint 22)

(b) Coal-Tar Epoxy-Polyamide Black or Dark Red Paint (SSPC-Paint 16)

(c) Basic Zinc Chromate-Vinyl Butyral Wash Primer (SSPC-Paint 27) and cold applied Asphaltic Mastic (Extra Thick Film) Paint (SSPC-Paint 12)

(d) Post-plate-manufacture hot dip galvanizing per ASTM A153

6.5.2 Embedded metal connector plates shall be free of dirt and oil prior to coating application. If the coating is damaged prior to, or during truss installation, such damage shall be alleviated before accessibility is impeded.

6.5.3 Metal connector plates, including Types 304 and 316 stainless steel plates, shall not be exposed to swimming pool environments unless adequate provision is made to prevent stress corrosion cracking. In lieu of use of a stainless steel that is not susceptible to stress corrosion cracking (see commentary), trusses shall be separated from the pool environment by a vapor barrier and shall be separately ventilated from the pool environment.