Accepted Practices for Post-Frame Building Construction: Framing Tolerances

NFBA NATIONAL FRAME BUILDING ASSOC.

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1 Purpose and scope

1.1 The purpose of this document is to provide recommended tolerances for construction of wood framing in post-frame buildings. Field experience indicates that adherence to these guidelines will help produce finished buildings that are functional, structurally sound and aesthetically pleasing.

1.2 The scope of this document is limited to the primary and secondary framing of a post-frame building.

1.3 This document is superseded by all contract documents (this includes building plans and specifications) and applicable building codes. Special jobsite conditions may require alteration of the building plans and specifications. These alterations should only be made after approval of all parties involved.

1.4 Frame measurements will vary over time as: (1) wood absorbs and desorbs moisture, resulting in changes in the size and shape of members, (2) anticipated and unanticipated loads temporarily and/or permanently deform the structure, and (3) changes occur in unstable or nonconsolidated soils. For these reasons, frame measurements made to determine the accuracy of construction should be taken immediately after building completion. The greater the elapsed time between construction and field measurements, the more difficult it is to separate deviations associated with normal structural use and aging from those associated with initial component placement.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this document. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this document are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Standards organizations maintain registers of currently valid standards.

ANSI/ASAE EP484.2, *Diaphragm Design of Metal-Clad, Wood-Frame Rectangular Buildings*

ANSI/ASAE EP486.2, Shallow *Post and Pier Foundation Design*

ANSI/ASAE EP559.1, *Design Requirements and Bending Properties for Mechanically Laminated Wood Assemblies*

ANSI/ASABE S618, *Post Frame Building System Nomenclature*

SBCA/TPI *Building Component Safety Information (BCSI) Guide to Good Practice for Handling, Installing, Restraining & Bracing of Metal Plate Connected Wood Trusses.* 2013 Edition, Updated 2015

ANSI/AWC National Design Specification for Wood Construction with Commentary, 2012 Edition

AWC, ASD/*LRFD Manual for Engineered Wood Construction*, 2012 Edition

AWPA U1-15*, Use Category System: User Specification for Treated Wood*

U. S. Department of Commerce, PS 20-15, *American Softwood Lumber Standard*

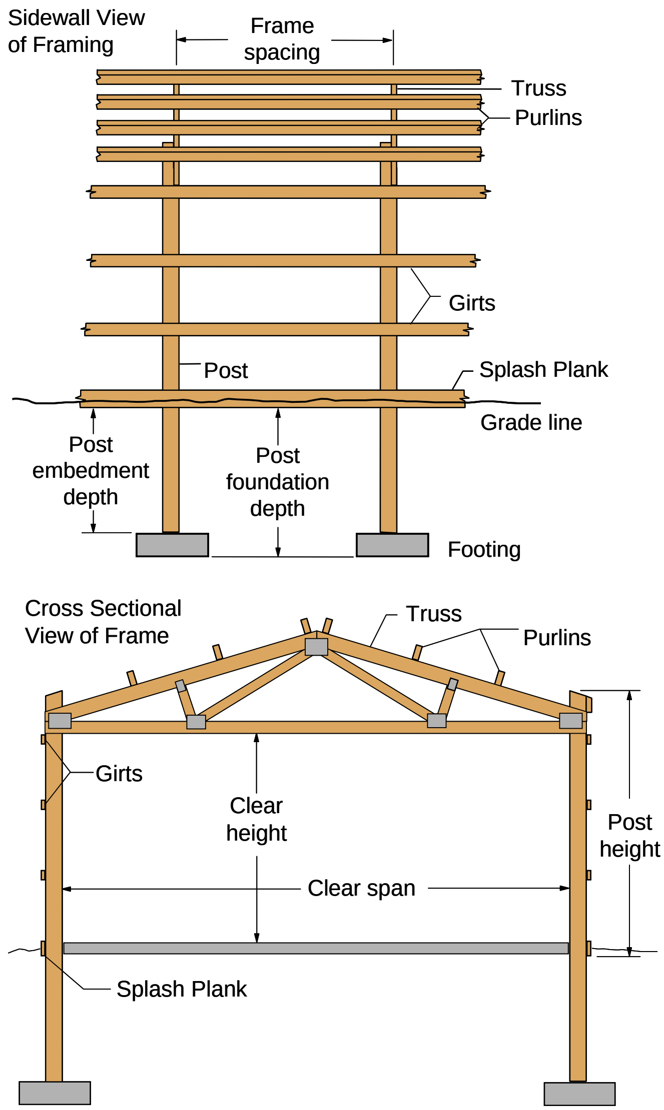


Figure 1 – Post-frame building terminology.

3 Definitions (see Figures 1 and 2)

3.1 bearing height: Vertical distance between a pre-defined baseline (generally the grade line) and the bearing point of a component.

3.2 bearing point: The point at which a component is supported.

3.3 board: Wood member less than two (2) nominal inches in thickness and one (1) or more nominal inches in width.

3.4 check: Separation of the wood that usually extends across growth rings (i.e., a split perpendicular-to-growth rings). Commonly results from stresses that build up in wood during seasoning.

3.5 cladding: The exterior and interior coverings fastened to framing.

3.6 clear height: Vertical distance between the finished floor and the lowest part of a truss, rafter, or girder.

3.7 clear span: Horizontal distance from the face of one support to the face of the opposite support.

3.8 dimension lumber: Wood members from two (2) nominal inches to but not including five (5) nominal inches in thickness, and 2 or more nominal inches in width.

3.9 frame spacing: On-center horizontal spacing of primary frames. Frame spacing may vary within a building. Also known as, bay width.

3.10 girder: A large, generally horizontal, beam. Commonly used in post-frame buildings to support trusses whose bearing points do not coincide with a post.

3.11 girt: A member attached (typically at a right angle) to posts. Girts laterally support posts and transfer load between any attached wall sheathing and the posts.

3.12 grade line (grade level): The line of intersection between the building exterior and the finished ground surface and/or top of the pavement in contact with the building exterior.

3.13 grain. The direction, size, arrangement, appearance, or quality of the fibers in wood or lumber.

3.14 manufactured component. A component that is assembled in a manufacturing facility. The wood trusses and laminated columns used in post-frame buildings are generally manufactured components.

3.15 plumbness: The orientation of a line or element relative to a truly vertical plane or line. An element that is off plumb or out-of-plumb will tend to lean to one side.

3.16 post: A structural wood column. Functions as a major foundation element when it is embedded in the soil. Post-frame building posts include solid-sawn posts, structural composite lumber posts, glulam posts, mechanically-laminated lumber posts, and poles.

3.17 post embedment depth: Vertical distance from the grade line to the bottom of the embedded post. Equal to foundation depth when the post does not bear on a footing or other foundation element.

3.18 post foundation: A foundation consisting of an embedded post and all attached below-grade elements, which may include a footing, uplift resistance system, and collar.

3.19 post foundation depth: Vertical distance from the ground surface to the bottom of a post or pier foundation. Typically the vertical distance from the ground surface to the base of the footing.

3.20 post-frame: A structural building frame consisting of a wood roof truss or rafters connected to vertical timber posts or sidewall posts.

3.21 post-frame building: A building system whose primary framing system is principally comprised of post-frames.

3.22 post height: The length of the non-embedded portion of a post.

3.23 post tilt: A post can be out-of-plumb in two directions, that is, there can be out-of-plane and/or in-plane tilt.

> **3.23.1 post tilt - out-of-plane:** Tilting of a post inward or outward from the plane of the wall or building envelope. Post movement that causes a wall to buckle in or out.
>
> **3.23.2 post tilt - in-plane:** Tilting of a post in a direction parallel to the wall containing the post. A post with in-plane tilt is leaning toward or away from an adjacent post in the same wall.

3.24 primary framing: The main structural framing members in a building. The primary framing members in a post-frame building include the posts, roof trusses/rafters, and any girders that transfer load between roof trusses/rafters and posts.

3.25 purlin: A member attached (typically at a right angle) to roof trusses/rafters. Purlins laterally support trusses/rafters and transfer load between roof sheathing and roof trusses/rafters.

3.26 seam (or stitch) fasteners: An edge fastener that connects two structural sheathing panels thereby adding in-plane shear continuity between the panels.

3.27 secondary framing: Structural framing members used to transfer load between exterior sheathing and primary framing members, and/or to laterally brace primary framing members. Secondary framing members in a post-frame building include girts, purlins, eave struts and any structural wood bracing.

3.28 shake: Separation of annual growth rings (splitting parallel-to-growth rings). Usually considered to have occurred in the standing tree or during felling.

3.29 splash plank: Any decay and corrosion resistant girt that is in soil contact or located near the soil surface, that remains visible from the building exterior upon building completion, and is 2 to 4 inches in nominal thickness.

3.30 timber: Wood members five or more nominal inches in the least dimension.

3.31 truss: A structural framework, generally two-dimensional. An engineered structural component, assembled from wood members, metal connector plates and/or other mechanical fasteners, designed to carry its own weight and superimposed design loads. The truss members form a semi-rigid structural framework and are assembled such that the members form triangles.

3.32 wane: Bark, or lack of wood from any cause, on the edge or corner of a piece.

3.33 warp: Any variation from a true plane surface. Warp includes bow, crook, cup, and twist, or any combination thereof.

3.33.1 bow (see Figure 2): Deviation, in a direction perpendicular to the wide face, from a straight line drawn between the ends of a piece of lumber.

3.33.2 crook (see Figure 2): Deviation, in a direction perpendicular to the narrow edge, from a straight line drawn between the ends of a piece of lumber.

3.33.3 cup: Deviation, in the wide face of a piece of lumber, from a straight line drawn from edge to edge of the piece.

3.33.4 twist: A curl or spiral of a piece of lumber along its length. Measured by laying lumber on a flat surface such that three corners contact the surface. The amount of twist is equal to the distance between the flat surface and the corner not contacting the surface.

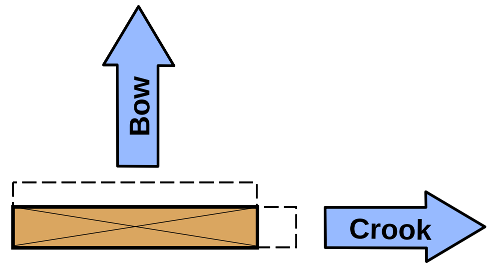


Figure 2 – Lumber warping terminology: bow versus crook as viewed from end of wood member.

4 Lumber selection

4.1 Lumber for manufactured components. Selection of lumber for manufactured components shall be in accordance with all applicable standards.

4.2 Lumber for non-manufactured components.

4.2.1 Warp. Lumber should be selected such that warp does not interfere with component placement and/or prevent placement of the lumber within recommended tolerances.

4.2.1.1 Bow (see Figure 2). Bow in dimension lumber can generally be removed during placement.

4.2.1.2 Crook (see Figure 2). Crook is difficult to remove during component placement. Lumber with crook greater than 0.6% of the member length should not be used for girts or purlins.

4.2.1.3 Twist. Lumber with twist greater than1% of the member length should not be used for girts or purlins.

4.2.2 Splits. A split results when a check or shake extends entirely through a piece of lumber. Splits shorter than one-half the width of the wide face of the lumber are generally acceptable. Longer splits may be acceptable.

4.2.3 Wane. Wane is acceptable when in accordance with applicable grading rules.

5 Post foundations

5.1 Minimum depth. Post foundation depth should be a minimum of 90% of the specified depth.

5.2 Maximum depth. A post foundation can be located deeper than specified. Where laminated posts are preservative-treated on one end but not the other, deeper embedment will bring the non-treated portion of the post closer to grade. ANSI/ASAE EP559.1 requires that preservative treatment extend a minimum of 16 inches above the exterior grade line.

5.3 Soil. Footings should only be placed on a smooth surface of well compacted or undisturbed soil.

5.4 Centering (see Figure 3). Unless design dictates otherwise, a post should be located on a cast-in-place or precast footing such that some portion of the post cross-section is located over the center of the footing. Additionally, no portion of the post should extend past the edge of the footing.

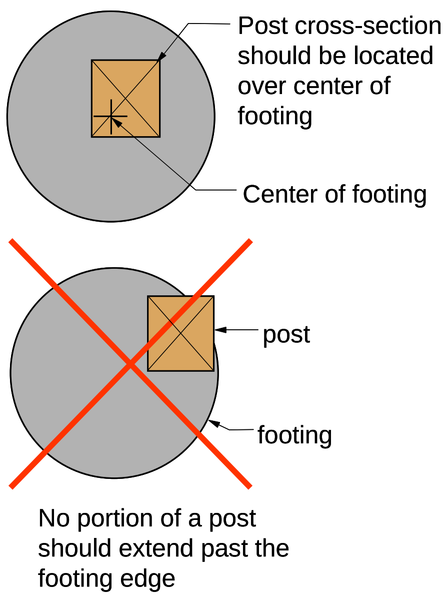


Figure 3 - Guidelines for post placement on footing.

6 Post placement

6.1 Plumbness. At the time of placement, no portion of a post should deviate from a plumb line (extending upward from the base of the post) more than 1% of the post height, nor should any surface of the post have a slope greater than 1.5% (see Figure 4). These requirements apply to both in- and out-of-plane post tilt. A post specifically designed to be installed out-of-plumb should be positioned so that no portion of the post deviates from its specified location an amount greater than 1% of the post height.

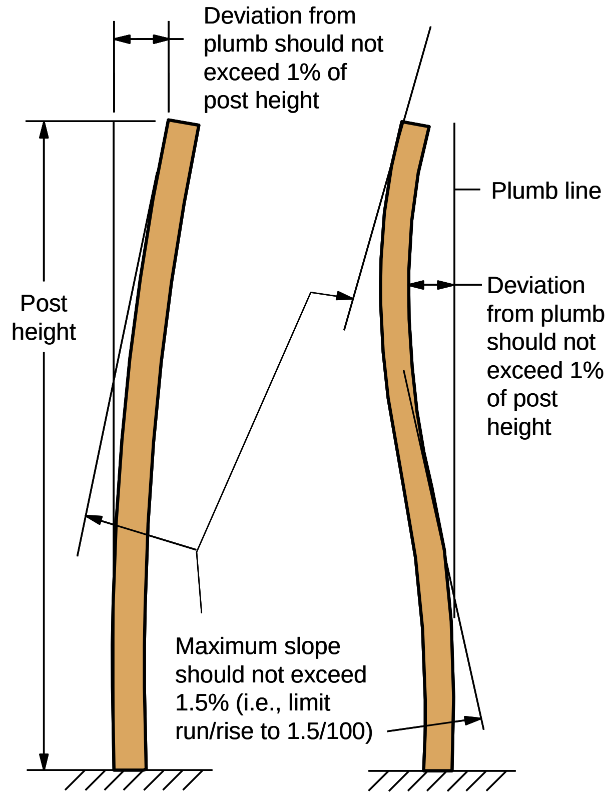
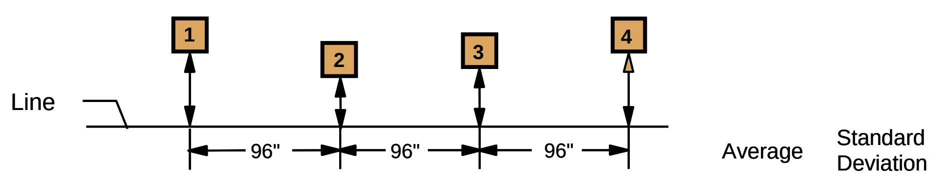


Figure 4 - Post plumbness criteria.

6.2 Spacing. On-center spacing of the base of adjacent posts should be within two inches of the specified spacing.

6.3 Alignment. Posts within a given wall are considered properly aligned if a line can be drawn along the wall such that (1) the distance between any one post and the line does not deviate from the average post-to-line distance by no more than 3/4 of an inch, and (2) the post-to-line distance of any two adjacent posts does not differ by more than 0.8% of the distance between the two posts. Generally, alignment is checked using a line that is equal distance from the corner posts (see example in Figure 5). Post alignment should be checked at both the base and top of each wall.



	1		2		3		4	Average	Standard Deviation
Distance from post to line, in.	10.0		8.5		9.0		10.0	9.375	0.75
Deviation from average, in.	+0.625		-0.875*		-0.375		+0.625		
Difference between adjacent posts, in.		1.50**		0.5		1.0**			

* Exceeds recommended maximum of 0.75 inches
** Exceeds recommended maximum of post spacing x 0.008 = 0.77 inches

Figure 5 - Checking alignment of posts 1, 2, 3 and 4 with a line equal distant from each corner post.

6.4 Wall length. In rectangular buildings, the overall length of opposing walls should not differ by more than 2.0 inches.

6.5 Diagonal measurements. Corner-to-corner diagonal measurements should be taken at the finished floor and compared to determine the squareness of a rectangular area. These diagonal measurements should not deviate from each other by more than 2 inches or 0.5% of the length of the shortest side of the rectangle, whichever is greater (see Figure 6). For example, when checking the *overall* squareness of a building that is 40 by 100 feet, 0.5% of the length of the shortest side would be 40 feet x 0.005 or 0.2 feet. Since this equals 2.4 inches, the allowable difference in diagonal measurements would be increased from 2 to 2.4 inches. If the squareness of an individual bay in the same building is being checked, and the post spacing is 8 feet, then the rectangular area would be 8 by 40 feet, and 0.5% of the length of the shortest side of this rectangle would equal 8 feet x 0.005 or 0.04 feet (1/2 inch). Since this is less than 2 inches, the allowable difference in diagonal measurements would be increased to 2 inches.

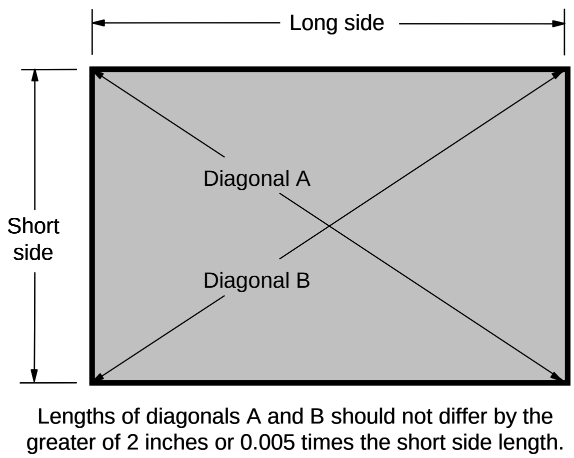


Figure 6 - Criteria for acceptable degree of squareness.

7 Truss placement

7.1 Bearing height. The actual bearing height should not deviate from the specified bearing height by more than 1/2 inch (see Figure 7).

7.2 Vertical Offset. The difference in the bearing heights of adjacent trusses should not exceed 0.5% of the spacing between the trusses (see Figure 7). This specification does not apply to adjacent trusses specifically designed to bear at different elevations.

7.3 Bow. Table B1-3 of the SBCA/TPI *Building Component Safety Information* guide requires that trusses not be installed with an overall bow or bow in any chord or panel which exceeds the lesser of L/200 or two inches. L is the span of the truss or chord or panel length in inches (see Figure 8).

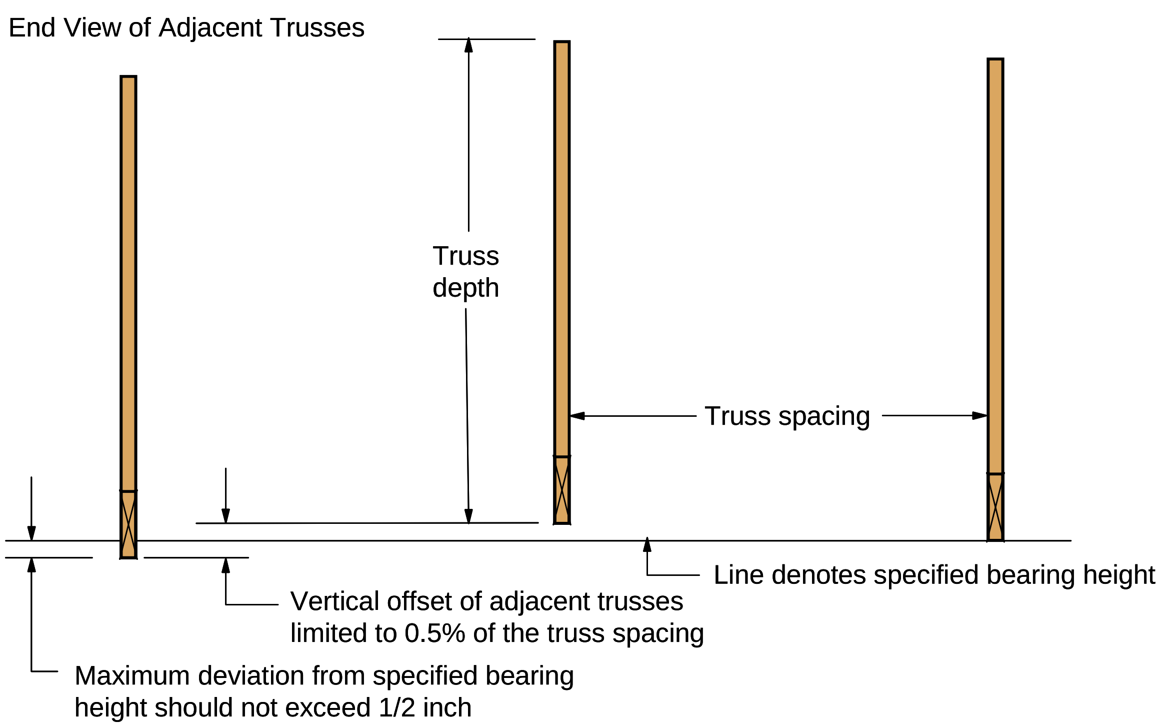


Figure 7 – Truss bearing height tolerances.

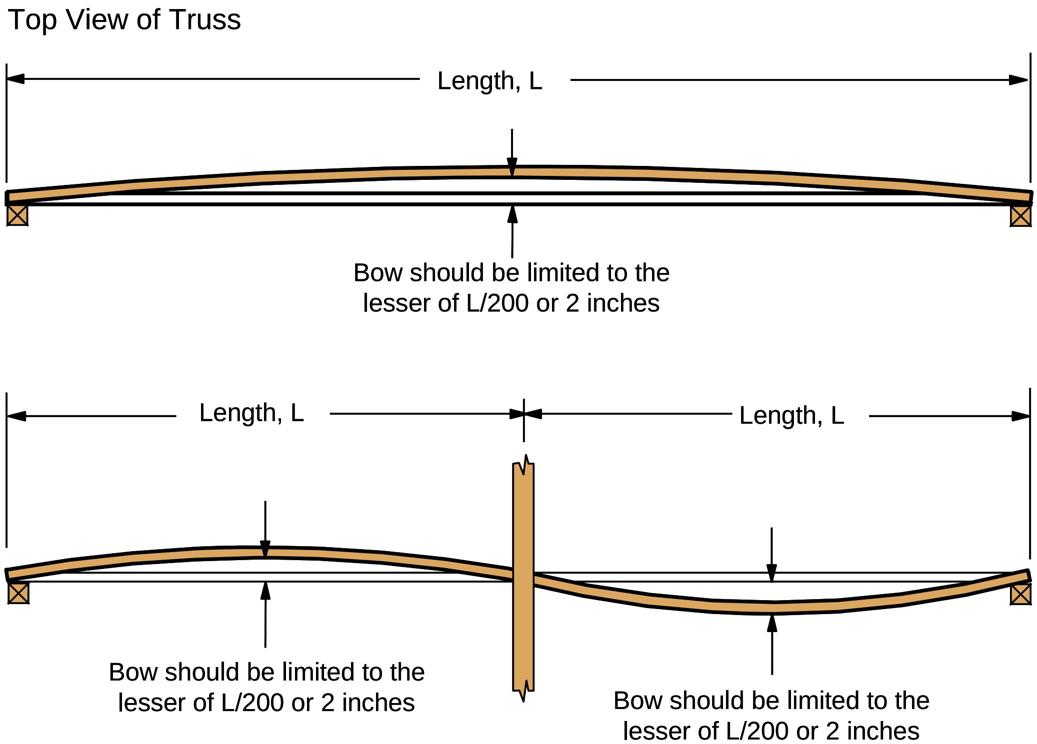


Figure 8 – Restrictions on overall truss bow and bow in truss members

7.4 Plumbness. Table B1-2 of the SBCA/TPI BCSI guide requires that trusses not be installed with a variation from plumb at any point along the length of the truss from top to bottom chords which exceed 2% of the depth of the truss at that point (D/50) or two inches, whichever is less (see Figure 9). This specification does not apply to trusses specifically designed to be installed out of plumb.

8 Girder placement

8.1 Bearing height. The actual bearing height should not deviate from the specified bearing height by more than 1/2 inch.

8.2 Horizontal alignment. The difference in height of adjacent girder bearing points should not exceed 0.5% of the distance between the bearing points (i.e., 1/200 of the bearing point spacing). This specification does not apply to girders specifically designed to be installed out-of-level.

9 Girt placement

9.1 Alignment. To check girt alignment, a line should be drawn along the top, bottom, or centerline of the girt row (if girts were originally aligned using their bottom edge, then the line should be drawn along the bottom edge, etc.). Individual girts can be considered properly aligned if at every girt attachment point, the girt does not deviate from the line more than 3/8 inch (see Fig. 10). Any vertical offset between the butting ends of two girts that is not due to variation in lumber size should not exceed 1/4 inch (see Fig. 10).

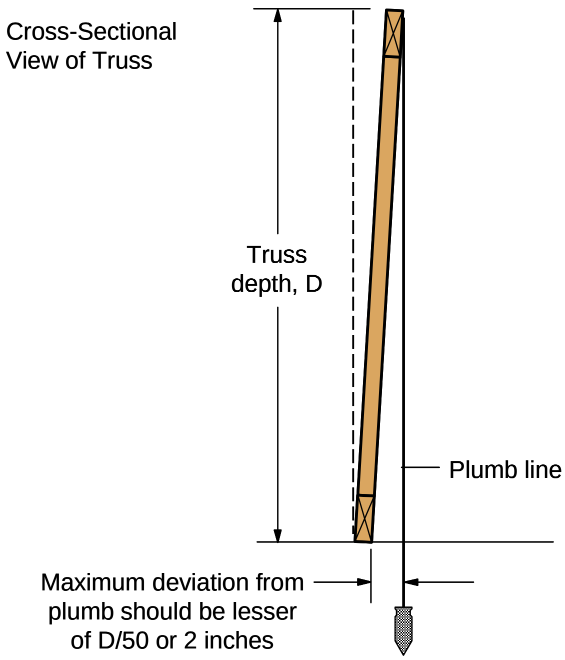


Figure 9 - Requirements for truss plumbness.

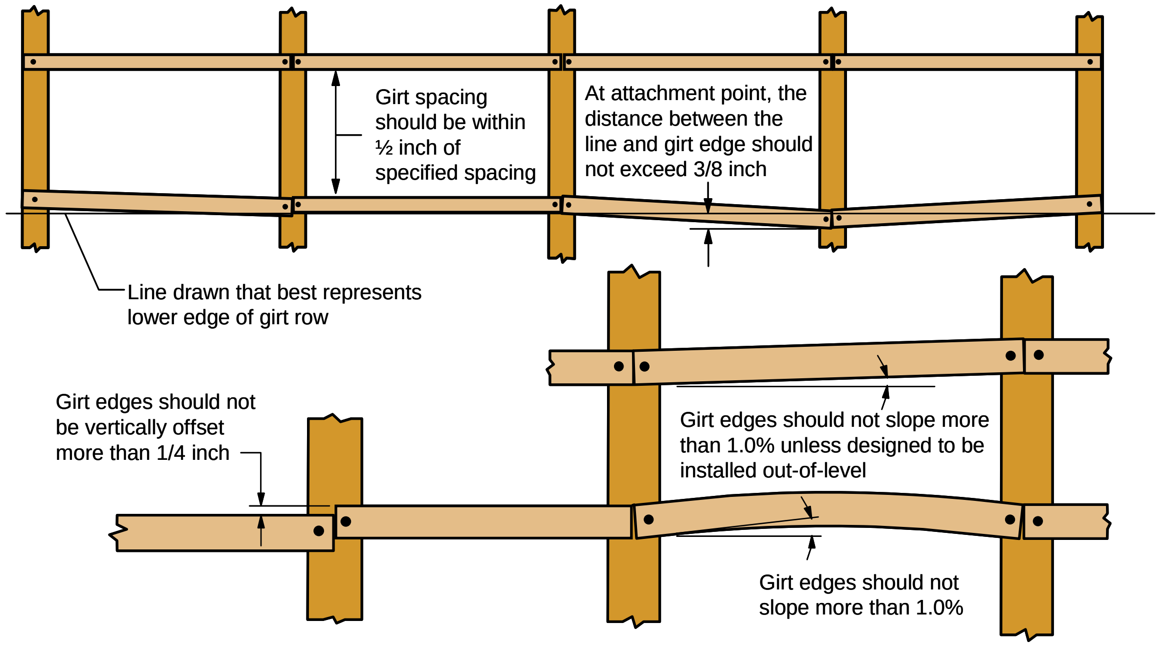


Figure 10 – Girt placement criteria

9.2 Slope. Individual girts should not slope more than 1.0% unless specifically designed to be installed out-of-level (see Figure 10).

9.3 Spacing. The spacing between girt rows should not deviate from the specified spacing by more than 1/2 inch. Specific types of insulation and interior finishes may dictate less than a 1/2 inch deviation (see Figure 10).

9.4 Sag. Sag may be visible in girts that are placed with the wide face horizontal. This sag should not exceed 0.6% of the girt span. Temporary braces can be used to support long girts at midspan until cladding is attached.

10 Purlin placement

10.1 Spacing. The spacing between purlin rows should not deviate from the specified spacing by more than 1/2 inch.

11 Equivalency Table

11.1 Equivalency Table. Allowable deviations are typically expressed as a percent (e.g., maximum slope should not exceed 1.5%) or as a ratio of some dimension (e.g., midspan displacement should not exceed L/200 where L is the distance between member supports). Table 1 can be used to help convert these percentages and ratios to actual deviations.

11.1.1 Example 1. According to Section 6.1 no portion of a post should deviate from a plumb line (extending upward from the base of the post) more than 1% of the post height. From Table 1, a 1.0% deviation for a 10-foot high post is 1-3/16 inches.

11.1.2 Example 2. According to Section 6.1, no surface of a post should have a slope greater than 1.5%. From Table 1, a 1.5% slope is equivalent to a deviation of 17/32 inches in 3 feet or 23/32 inches in 4 feet. Consequently, when a 4 foot level is used to check post plumbness, the space between the post and the end of the level (i.e., the end of the level not in contact with the post) should not exceed 23/32 inches.

Table 1 – Equivalency Table

Allowable deviation		Allowable deviation in inches when L is:				
		2 ft	3 ft	4 ft	8 ft	10 ft
0.5%	L/200	1/8	3/16	1/4	1/2	19/32
0.6%	L/167	5/32	7/32	9/32	9/16	23/32
0.8%	L/125	3/16	9/32	3/8	25/32	31/32
1.0%	L/100	1/4	3/8	15/32	31/32	1-3/16
1.5%	L/67	3/8	17/32	23/32	1-3/32	1-13/16
2.0%	L/50	1/2	23/32	31/32	1-15/16	2-13/32

COMMENTARY

Accepted Practices for Post-Frame Building Construction: Framing Tolerances

1 Purpose and Scope

All building components are assumed to have specific dimensions, and the locations of the components are dimensioned on drawings to a theoretically exact position either relative to each other or relative to one or more datum points. In reality, all component dimensions and positions vary somewhat. The acceptable amount of this variation is the *tolerance* of the component dimension or installed position.

This document contains tolerances for the position/placement of footings, posts, trusses, girders, girts, and purlins in a post-frame building. Together, these components form the building frame. When combined with the exterior cladding, this frame forms a unique and efficient load-resisting system that characterizes post-frame buildings.

The tolerances contained in this document are based primarily on field measurements reported by Begel and Bohnhoff (1997).

This document is intended as one in a series of documents on accepted practices for post-frame building construction. Possible companion documents include: cladding requirements and placement tolerances, truss bracing, excavation, grading and backfilling, fire resistive assemblies, thermal insulation, etc.

2 Normative references

Documents referenced in this section are those that through one or more of their provisions: (1) help define post-frame building terminology, (2) influence post-frame building component selection, and/or (3) contain tolerances appropriate to post-frame building construction.

3 Definitions

This section is primarily based on definitions given in ANSI/ASABE S618 Post Frame Building System Nomenclature, and the American Softwood Lumber Standard (PS 20-15).

4 Lumber selection

Placing limits on framing tolerances begins with placing tolerances on the raw materials used in construction. When lumber is considerably warped, it becomes increasingly more difficult to hold framing tolerances.

Warp of dimension lumber produced in the U.S. is controlled at the time of grading by the National Grading Rule (NGR). In the NGR, allowable bow, crook, and twist for a specific lumber grade is dependent on the actual length and the nominal face width of the lumber. The cup of a specific grade is only dependent on nominal face width.

In Section 4.2.1, crooks and twists of non-manufactured components used in post-frame buildings are limited to 0.6% and 1% of the member length, respectively (L/167 and L/100, respectively), and no restrictions are placed on bows and cups. These provisions were based on the following observations/considerations:

1. Warp can be expected to worsen as lumber absorbs and desorbs moisture after grading, consequently allowable warping should not be less than those established by the NGR.
2. Lumber used for primary and secondary framing is typically of No.2 grade or better. Lumber used for secondary framing is typically 4 or 6 nominal inches wide.
3. Establishing allowable warps that are a function of three different variables (lumber length, width, and grade) is not practical for everyday use.
4. Bows in nominal 2-inch thick dimension lumber (the lumber typically used in post-frame buildings) can be removed during construction.
5. Cupping of lumber is not perceived to be a problem with the dimension lumber used for non-manufactured components in post-frame buildings.
6. Allowances for warping must leave room for placement tolerances.

Splits are addressed in Section 4.2.2. The actual permissible length for a split in a structural member is dependent on assumptions made when assigning allowable shear stresses to the member during building design. Consequently, the building designer must generally be contacted for information about permissible split length.

5 Post foundations

Section 5.1 states that post foundation depth should be a minimum of 90% of the specified depth. This tolerance was based on the following observations/considerations:

1. Although a 10% reduction in embedment depth will reduce a post's capacity to resist lateral loads, the reduction is more than compensated for by the conservativeness of the allowable lat-

eral soil pressures typically used in embedment depth calculations.
2. The tolerance on embedment depth should be a percentage of the embedment depth and not a fixed amount. Whereas a fixed tolerance, such as 6 inches, may be safe for embedment depths around 4 feet, such a tolerance may be too excessive for 2-foot embedment depths (i.e., where 6-inches is 25% of the specified depth).
3. When the specified foundation depth is at the frost line, a 10% reduction in embedment depth will only minutely increase frost heave potential. Frost heave is typically not an issue with most post-frame building systems as heaving of individual posts is controlled by: (1) good surface drainage, (2) placement of footings on well-drained soils, (3) backfilling with soils not susceptible to frost heave, and (4) a building system that resists upward movement of an individual post.
4. Fully 10% of the posts in the Begel and Bohnhoff study (1997) were found to have an embedment depth one foot less than their plan specified value.

Section 5.4, which requires that some portion of the post cross-section be located over the footing center, is intended to minimize the effects of eccentric loading on soil bearing pressures. In establishing this section, it is recognized that the contact pressure between the post and footing is never uniform due to surface irregularities and overall position of the post relative to the footing. Originally, the contact between a post and footing is likely to be a *line of contact* that eccentrically loads the footing resulting in non-uniform soil pressures (see Figure 11a). These uneven soil pressures result in differential settlement. This, in turn, changes the area of contact between the post and footing resulting in reduced load eccentricity and more uniform soil pressures (see Figure 11b). It is important to note that the latter is not always true unless some portion of the post cross-section is always located over the footing center.

6 Post placement

The tolerances for post placement are primarily based on the research by Begel and Bohnhoff (1997).

Post plumbness tolerances serve two purposes; they ensure that posts are fairly vertical and that they aren't substantially bowed or crooked.

The tolerance on post spacing is fixed at two inches. Consideration was given to equating the tolerance to some percentage of the specified post spacing. This was not done because: (1) post spacing tolerance is actually a reflection of how accurately each individual post is positioned, and this accuracy is not a function of the specified post spacing, and (2) when tolerances are a function of post spacing, the tolerance must be recalculated every time the specified post spacing changes. Although a 2 inch tolerance on post spacing may seem excessive, 6% of the measured post spacings in the Begel and Bohnhoff study deviated from the specified spacing by more than 2 inches. It should be noted that whether the specified spacing is 10 feet or 4 feet, a 2 inch variation from the specified spacing is virtually impossible for the human eye to detect.

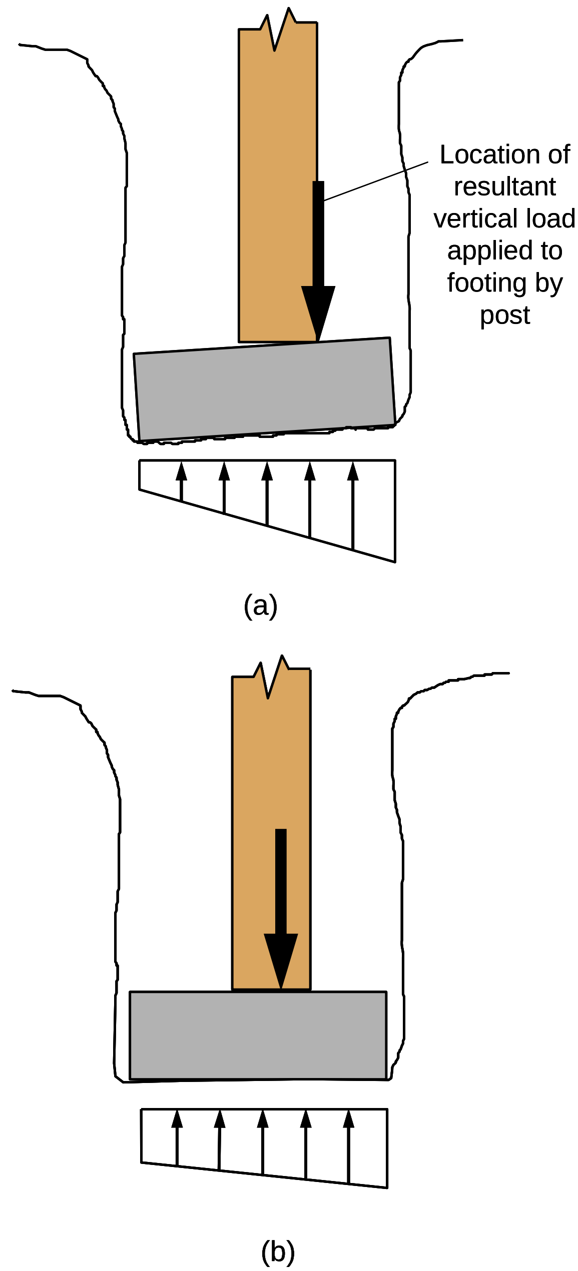
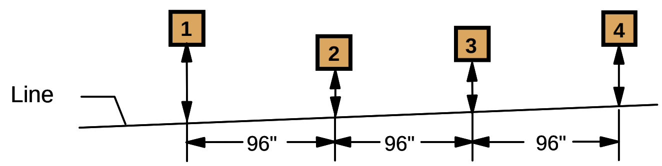


Figure 11 – Soil pressures and post load eccentricity at (a) time of placement and (b) after settlement.

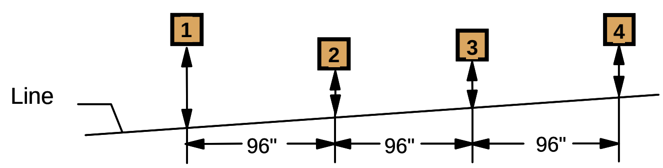
Section 6.3 states that posts can be considered properly aligned if it is possible to position the line such that the distance between any one post and the line does not deviate from the calculated average by more than 3/4 inches in either direction. In the Begel and Bohnhoff study, 97% of the posts were within 3/4 inches of a “best fit” post line. Note that if two adjacent posts both deviate 3/4 inches from a “best fit” post line but in opposite directions, the total offset between the two posts would be 1.5 inches. More than likely, this would not be acceptable. Unlike post spacing, deviations in post alignment are much easier for the human eye to detect, and become more noticeable as the spacing between posts decreases. For this reason, an extra stipulation is placed on post alignment, that is, the post-to-line distance of any two adjacent posts should not differ by more than 0.8% of the distance between the two posts. This is equivalent to 3/4 inches for an 8 foot post spacing. When three posts are in a row, and the middle post is offset from the outside two by a displacement equal to the post spacing x 0.008, the offset of the middle post is equal to L/250, where L is the distance between the outer posts.

Posts are originally aligned using string lines attached to batter boards or corner posts. In a similar manner, string lines can be used to check post alignment after placement. Typically, a string line is stretched along a wall so that it is equal distance from the two posts that define the ends of the wall (i.e., the corner posts). Note that when this is done, misalignment of a corner post can make it more difficult to properly assess the alignment of other posts within the wall. A slightly more accurate (but more involved) procedure for assessing post alignment is to first establish the “*most parallel line*” (i.e., the line that is most parallel to the wall). The *most parallel line* is the line position that minimizes the standard deviation of the post-to-line measurements. In Figure 5, this value is 0.750 inches. Figure 12 shows two slightly different line positions for the wall shown in Figure 5. These different line positions were obtained by maintaining the 10 inch distance between the line and post 4, but increasing the distance between the line and post 1 from 10.0 inches to 10.15, and then to 10.3 inches. The standard deviation associated with these new line positions are 0.747 and 0.750 inches, respectively. Of these three line positions, the one associated with the lower standard deviation of 0.747 would be considered the most parallel to the wall. An alternative to this method of obtaining the *most parallel line* is to take one set of measurements and use linear least squares regression (along with post spacing information) to remove any "error" due to line placement.



					Average	Standard Deviation
Distance from post to line, in.	10.15	8.60	9.05	10.00	9.45	0.747
Deviation from average, in.	+0.70	-0.85*	-0.40	+0.55		
Difference between adjacent posts, in.		1.55**	0.45	0.95**		

* Exceeds recommended maximum of 0.75 inches
** Exceeds recommended maximum of post spacing x 0.008 = 0.77 inches



					Average	Standard Deviation
Distance from post to line, in.	10.30	8.70	9.10	10.0	9.525	0.75
Deviation from average, in.	+0.775	-0.825*	-0.425	+0.475		
Difference between adjacent posts, in.		1.60**	0.40	0.90**		

* Exceeds recommended maximum of 0.75 inches
** Exceeds recommended maximum of post spacing x 0.008 = 0.77 inches

Figure 12 – Repositioning of string line (from that shown in Figure 5) results in slightly different post-to-line deviations. The line in the top figure is considered most parallel to the wall because it has the lowest standard deviation for post-to-line distances (i.e., 0.747 inches).

Section 6.4 states that the overall length of opposing walls should not differ by more than 2.0 inches. The fixed value of 2.0 inches is consistent with the post spacing requirement.

Section 6.5 helps control the squareness of the building, individual bays, and any other rectangular areas formed by posts within the building. To control the squareness of a rectangular area, the section requires that diagonal measurements not deviate from each other by more than 2 inches or 0.5% of the length of the shortest side of the rectangle, whichever is greater (see Figure 6). The fixed value of 2 inches ensures that the tolerance on the difference in diagonal measurements is not less than the post spacing tolerance (Section 6.2) or the tolerance on the difference in length between opposing walls (Section 6.4). The provision that the tolerance be no less than 0.5% of the length of the shortest side of the rectangle (i.e., the shortest leg) allows for increases in the 2 inch tolerance for larger rectangular areas. Specifically, it allows for increases whenever the length of the shortest leg exceeds 33 feet. It is important to note that when the length of the shortest leg exceeds 33 feet, a tolerance equal to *0.005 x shortest leg length* ensures that the deviation from 90 degrees of any one corner of the rectangle will not exceed 0.3 degrees.

7 Truss placement

Truss placement tolerances include bearing height, horizontal alignment, bow, and plumbness. Bow and plumbness provisions are identical to those published by the Structural Building Components Association (SBCA) and Truss Plate Institute (TPI) in their Building Component Safety Information (BCSI) guide and are not discussed here.

Deviations from the specified truss bearing height are limited by Section 7.1 to ± 1/2 inch. It is important to realize that truss bearing height controls building clear height when posts are installed *after* finished flooring (e.g., on a slab-on-grade). When finish flooring is installed after frame erection, it is the sole responsibility of those installing the floor to meet specifications controlling clear height.

Section 7.2 limits the amount of vertical offset between adjacent trusses to 0.5% of the truss spacing. Without this requirement, a 1 inch vertical offset between adjacent trusses would be permissible under Section 7.1 (i.e., one truss could be 1/2 inch high and the other 1/2 inch low). For typical truss spacings, a 1 inch offset between adjacent trusses may be noticeable when viewing the eave of the building.

Limiting the offset of adjacent trusses to 0.5% of the truss spacing is analogous to a deflection limitation of L/400. For example, when the middle of three trusses spaced 10 foot on center is offset from each outer truss the maximum amount of 0.60 inches (120 inches x 0.005), the 0.60 offset between the outer two trusses is 1/400 of the distance between the outer trusses.

8 Girder placement

Girder placement tolerances for bearing height and horizontal alignment are identical to those for truss placement.

9 Girt placement

Girt placement tolerances include alignment, slope, spacing and sag. Specific tolerances are based on the results of the Begel and Bohnhoff study and unless specifically stated, take into account variations in lumber size and shape.

10 Purlin Placement

The only tolerance on purlin placement is a spacing tolerance of ± 1/2 inch. This tolerance was selected to be consistent with the girt spacing tolerance. Unlike girts, purlins are less visible and generally speaking, their placement does not control or influence interior finishing.

References

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Credits

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