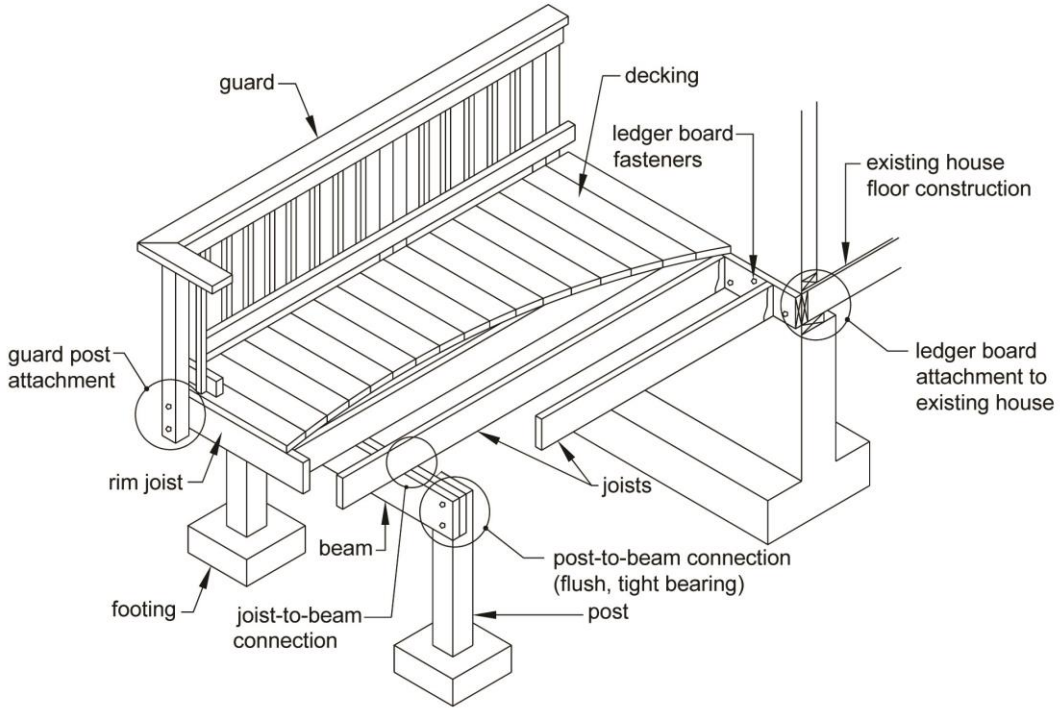
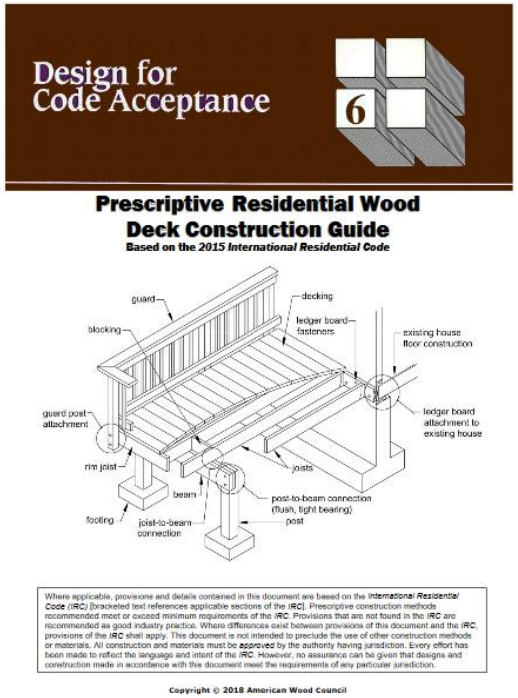
AMERICAN WOOD COUNCIL





Deck Construction: Code, Design, and DCA6-15

Matt Hunter, BCO
Manager, Northeast Region

ICC PREFERRED EDUCATION PROVIDER

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Course Description

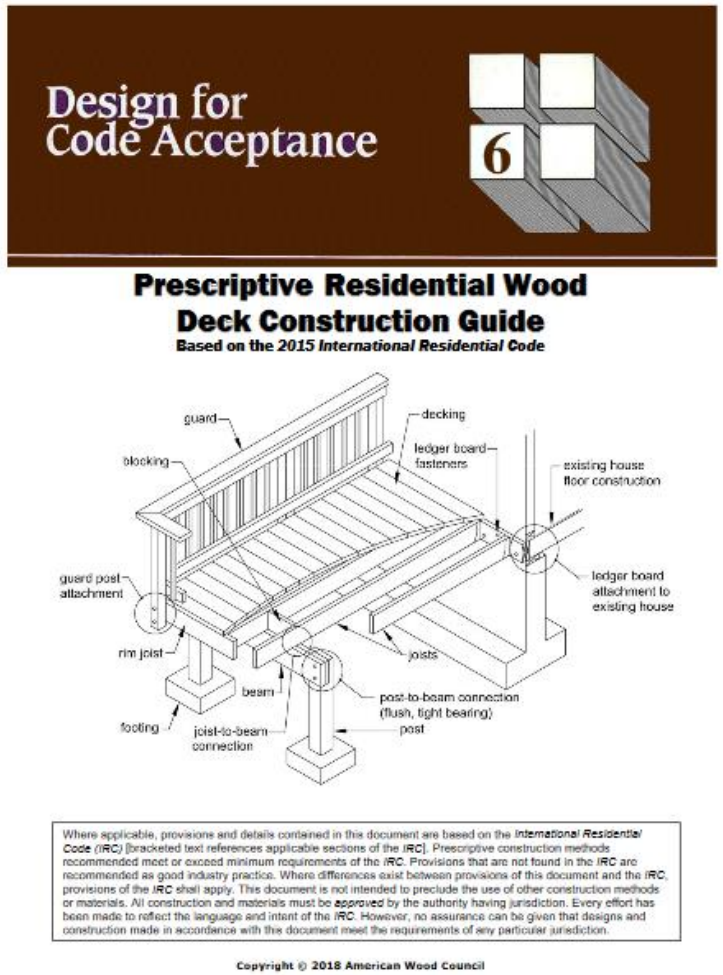
- **Hundreds of wood decks get built every year and some without the proper guidance for designing or constructing a safe deck. However, AWC DCA-6, which has been recently updated, includes guidance on provisions for the 2015 International Residential Code (IRC) pertaining to single level residential wood deck construction. Provisions contained in this document that are not included in the IRC are considered good practice recommendations.**

Learning Objectives

- Identify a typical deck load path
- Give the history of the relationship between the IRC deck codes and DCA6
- Identify how applicable each requirement of DCA6-15 is to the 2015 IRC based on the differences and similarities for individual deck components
- Cite other resources available for deck construction, permit review, and inspection

Outline

- How Decks Work – Load Path
- Quick History of Deck Codes and DCA6
- Parts of the Deck
  - 2015 IRC
  - DCA6-12, 15
  - Future Ideas
- Other Resources
- Questions



Who am I and Who is the AWC?

- AWC's NE Regional Manager
- Licensed Building Code Official-PA
- A classically trained draftsman & landscape designer
- 15 years experience in civil/site/land development/inspt.
- Framed over 50 wood decks & 20 houses, and worked in the trades as a framer, not a carpenter!
- A believer in honest discussion
- Army veteran and Eagle Scout
- Aspiring BBQ Pitmaster & future member of Operation BBQ Relief

- Represents 75-80% of wood industry
- Engages in the consensus based model code development (IRC, IBC, IFC, IECC, etc.)
- Writes structural wood standards (NDS, SDPWS, WFCM, etc.)
- Participates in other standards (ASCE, ASTM, ICC-ES, ASHRAE, etc.)
- Develops technical papers and design aids (DCA6, TR12, etc.)
- ICC/AIA Preferred Provider of Continuing Education

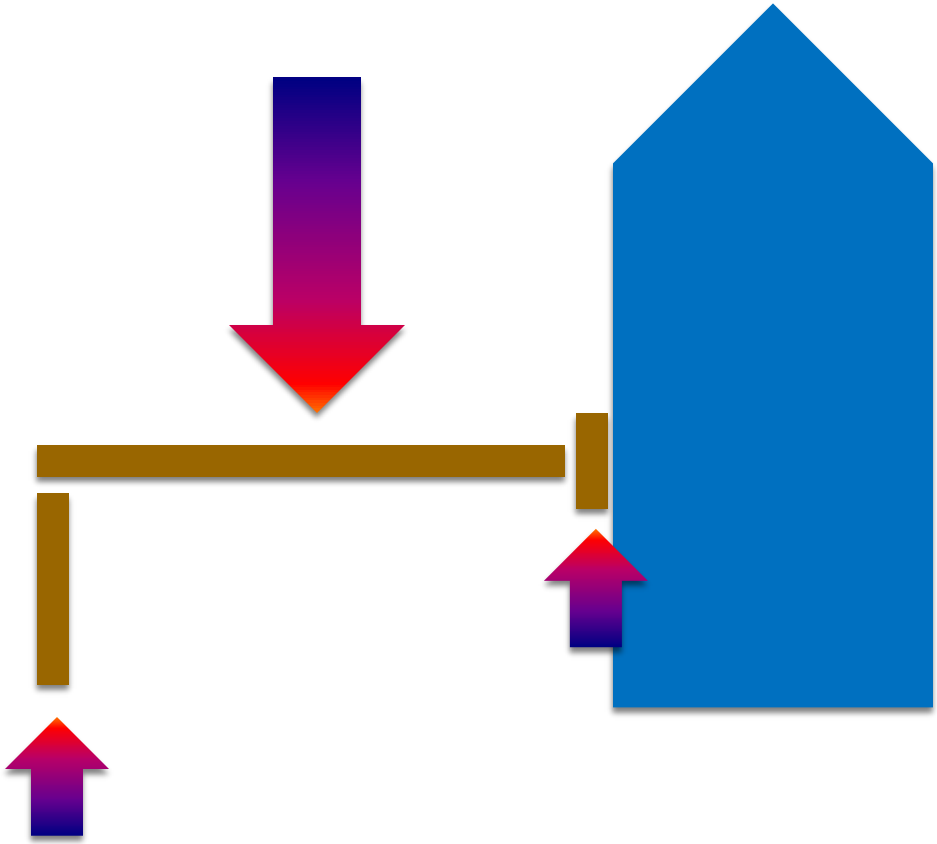
Why is this Important?

- **Deck & Porch Injury Study www.buildingonline.com/news/pdfs/Outdoor-Deck-and-Porch-Injury-Study.pdf**
  - **Nearly 15% of all deck-related injuries resulted from structural failure**
  - **60% of structural failures are the deck connection to the house**
  - **33% are the railing**

"Except for hurricanes and tornadoes, more injuries may be connected to deck failures than all other wood building components and loading cases combined!"
Dr. Frank Woeste, P.E.

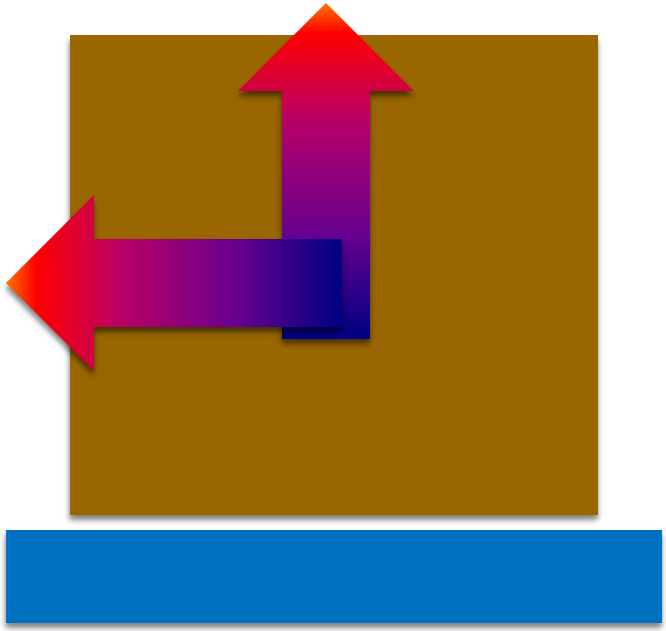
How Do Decks Work: Load Path

Elevation View



Vertical Load

Plan View



Lateral Load

How Do Decks Work: Load Path

For a 12’ x 12’ deck the lateral load would be…

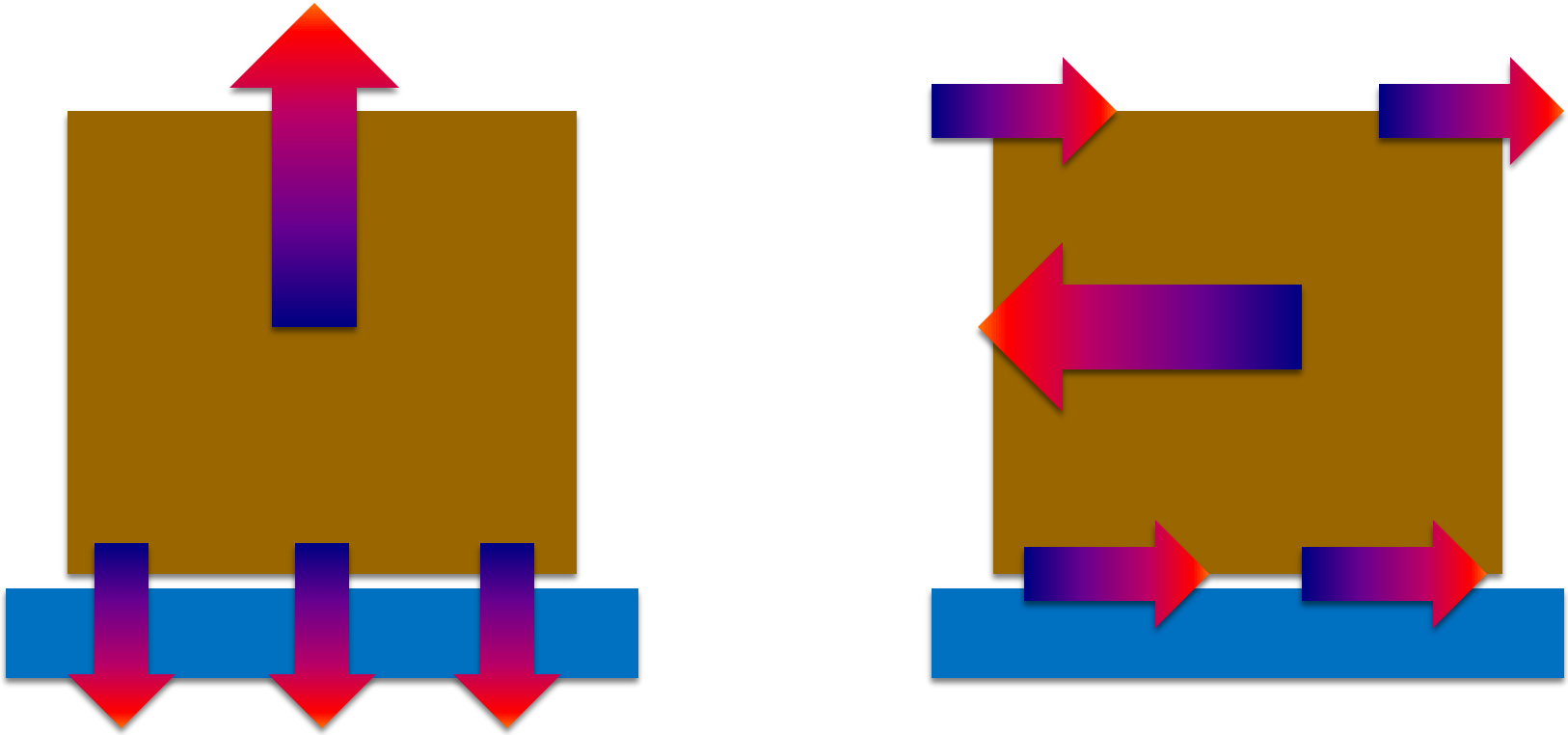
- On tip of Florida (Hurricane) - 9 psf.
- On the coast of California (Seismic) - 4 psf.
- Anywhere it can be highly occupied - 12 psf.

Realistic?

Source:
Wood Design Focus,
Volume 23,
Number 2

How Do Decks Work: Load Path

Plan View



Lateral Load

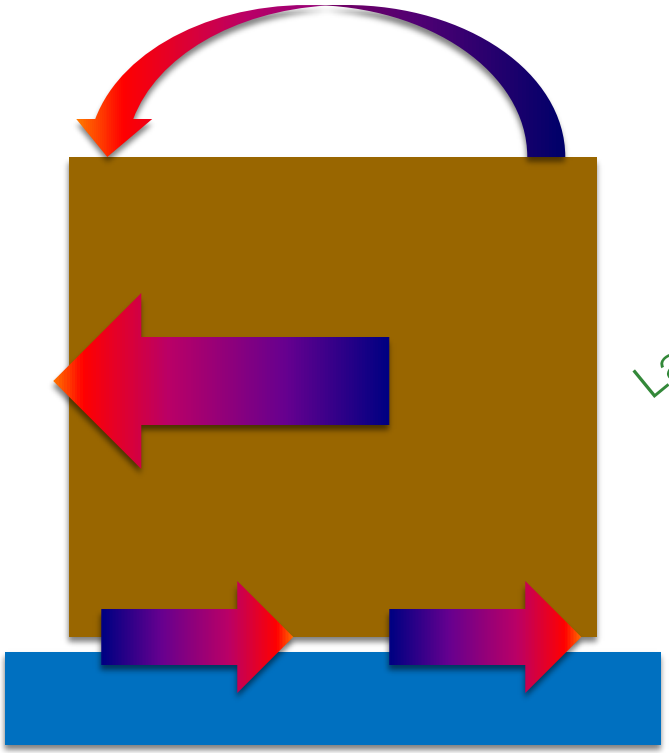
How Do Decks Work: Load Path

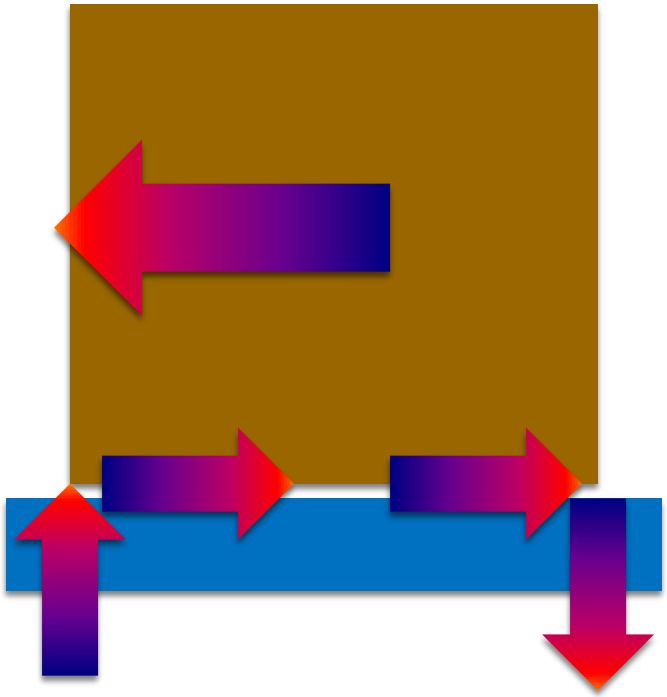
Diagonal Brace for a 12’ x 12’ Deck: (12’x12’x12psf)/2=864 lb
864 lb x 1.4 because of 45 angle / 2 braces = 605 lb per brace
Code requires 1/2” Hardware/Bolts (about 620 lb capacity) NDS requires 7d end and edge distance... (0.5” x 7d=3.5”) Nom 6x6-5.5”
So, it doesn’t work! Could it though? What types of fasteners?

How Do Decks Work: Load Path

Plan View

Lateral Load Connectors are NOT belts and suspenders for the LEDGER!





Lateral Load…why does the Code Commentary suggest to install the lateral load connectors near each edge of the deck?

Quick History of Deck Codes

- **2000 IRC – One Subsection on Decks**
  - **Design for vertical and lateral**
  - **Don't attach to house with nails in withdrawal**
  - **Cantilevers have to resist uplift**
- **2003 IRC – No Change**
- **2006 IRC – No Change**
- **2009 IRC – Five new Subsections**
  - **Lateral Load Device Requirement**
  - **Deck ledger connection**
  - **Don't support ledger with veneer**
- **DCA6 is published to give guidance (by AWC, previously AF&PA)**
- **2012 IRC – Dedicated Section (R507)**
- **2015 IRC – Incorporation parts of DCA6 plus new lateral option**

History of DCA6 - Cooperators

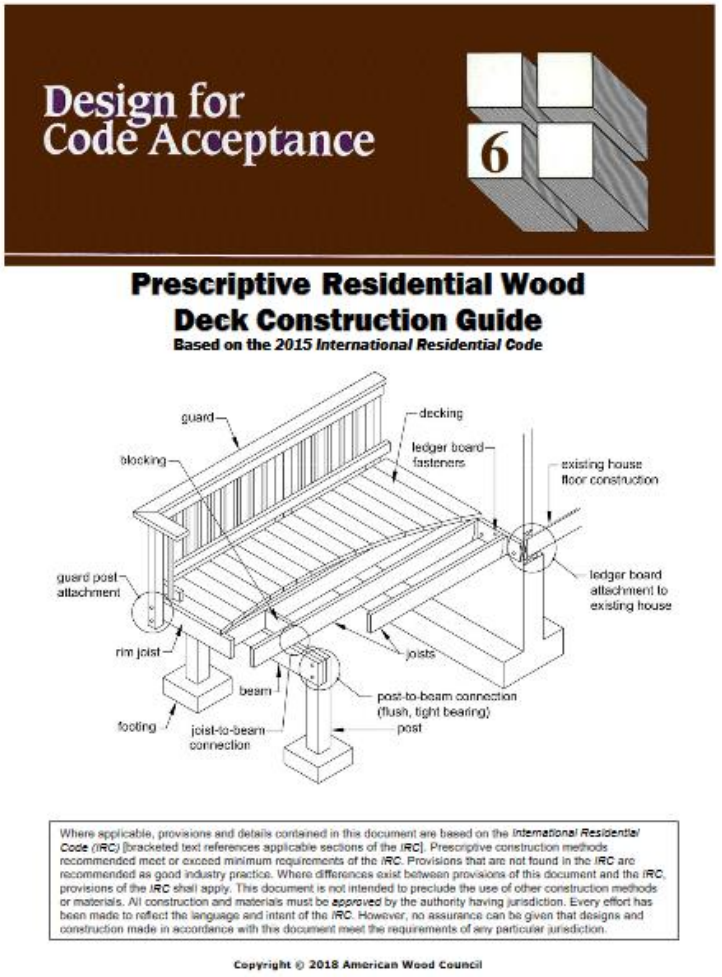
- **Prescriptive Residential Wood Deck Construction Guide – Design for Code Acceptance No. 6 (DCA 6)**

AMERICAN WOOD COUNCIL

- **Primary Cooperators**
  - **American Wood Council**
  - **International Code Council**
  - **Fairfax County, Virginia**

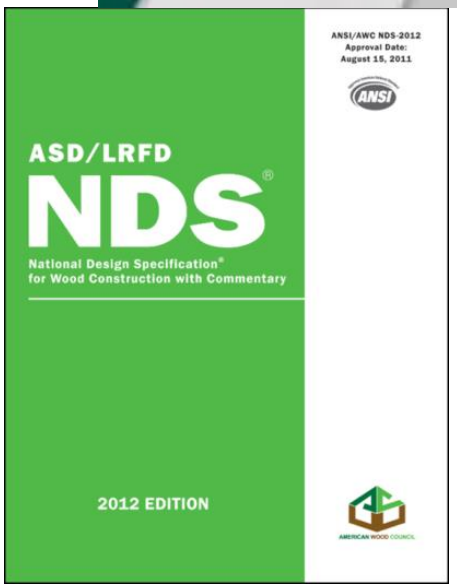
History of DCA6 - Cooperators

- **Additional Cooperators**
  - APA-The Engineered Wood Association
  - National Association of Home Builders
  - Simpson Strong-Tie Company
  - Southern Forest Products Association
  - Southern Pine Inspection Bureau
  - Stairway Manufacturers' Association
  - Virginia Polytechnic Institute and State University
  - Washington State University
  - NADRA – North American Deck and Railing Association
  - WIJMA – Wood I-Joist Manufacturers Association



History of DCA6 - Code Basis

- **Basis and Applicability**
  - 2015 International Residential Code (IRC)
  - bracketed text shows reference to applicable IRC sections ex. [R317 and R318].
  - Recommended prescriptive construction methods meet or exceed IRC minimum requirements
  - Provisions not included in IRC are considered good practice recommendations
  - Where differences exist, IRC applies
  - Not intended to preclude use of other construction methods or materials
  - All construction and materials approved by the authority having jurisdiction



Parts of a Deck

- Wood, Fasteners, and Weather
- Decking
- Joists
- Joist Connections
- Rim Joists
- Beams
- Posts
- Post Connections
- Footings
- Ledgers and Connection
- Lateral Load Devices
- Guards
- Stairs, Treads, and Handrails
- Chimneys or Bay Windows

Wood, Fasteners, and Weather

- **Lumber**
  - **American Lumber Standards Committee (ALSC) approved grade mark**
  - **Naturally durable**
    - Redwood or Western Cedar
  - **Preservative treated**
    - American Wood Protection Association (AWPA)
    - Ground contact (UC4A-C)

From DCA6-15

Table 1. Common Species and Use Categories for Decay Resistance. [a]

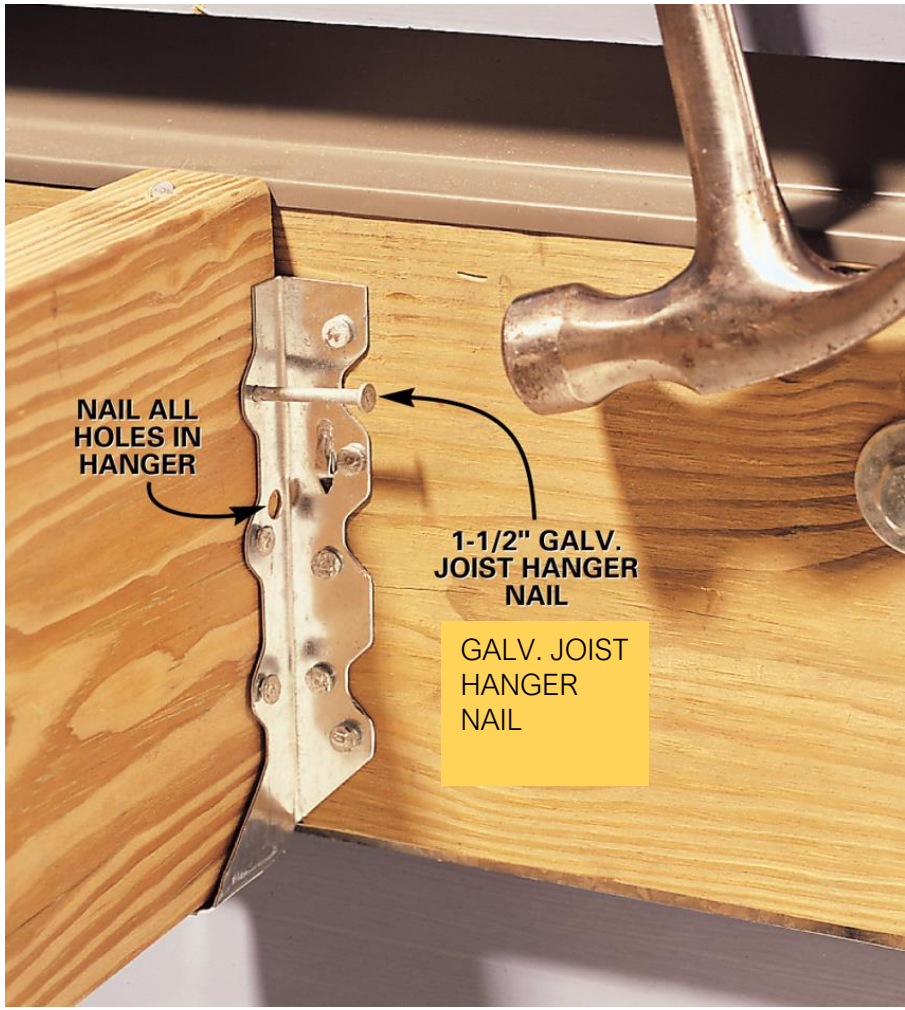
	Species	Above Ground	Ground Contact
Preservative-Treated[b]	Southern Pine	X	X
	Douglas Fir-Larch	X	X
	Hem-Fir	X	X
	SPF	X	
	Ponderosa Pine	X	X
	Red Pine	X	X
	Redwood	X	X
	Western Cedars	X	
Naturally Durable[c]	Redwood	X	
	Western Cedars	X	

Wood, Fasteners, and Weather

- **Fasteners**
  - **Nails – ASTM F 1667**
    - Threaded nails as stated in DCA6 include helical (spiral) and annular (ring-shank) nails.
  - **Screws – ANSI/ASME B18.6.1**
  - **Bolts/Lags – ANSI/ASME B18.2.1**
- **½" bolts and lag screws prescribed extensively in both IRC and DCA6**
  - **Edge distance and spacing based on diameter**
  - **Need to adjust for larger or smaller fasteners**

Wood, Fasteners, and Weather

- **Corrosion Resistance 2015 IRC R317.3**
  - **Screws, bolts, nails**
    - Hot-dipped galvanized
    - Stainless
    - Silicon bronze
    - Copper
  - **Hangers and anchors**
    - Galvanized
    - Stainless
  - **Saltwater exposure – DCA6**
    - Stainless
  - **Other fasteners/hardware**
    - Approved by building official
  - **Flashing**
    - Nominal 0.019” min.



Decking

2015 IRC

TABLE R507.4
MAXIMUM JOIST SPACING

MATERIAL TYPE AND NOMINAL SIZE	MAXIMUM ON-CENTER JOIST SPACING	
	Perpendicular to joist	Diagonal to joist[a]
$1^{1}/_{4}$-inch-thick wood	16 inches	12 inches
2-inch-thick wood	24 inches	16 inches
Plastic composite	In accordance with Section R507.3	In accordance with Section R507.3

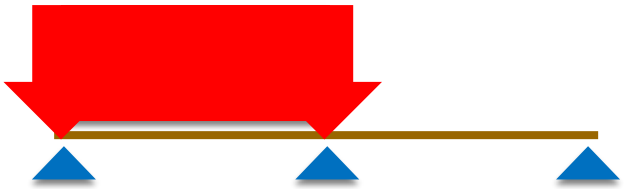
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 degree = 0.01745 rad.

a. Maximum angle of 45 degrees from perpendicular for wood deck boards

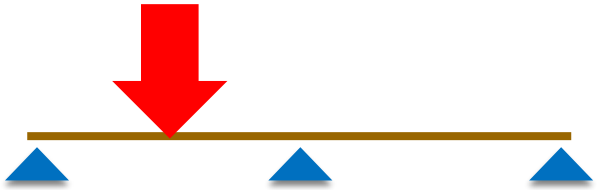
Dimension lumber (2" nominal) or Span rated decking

ALSC decking policy

70psf

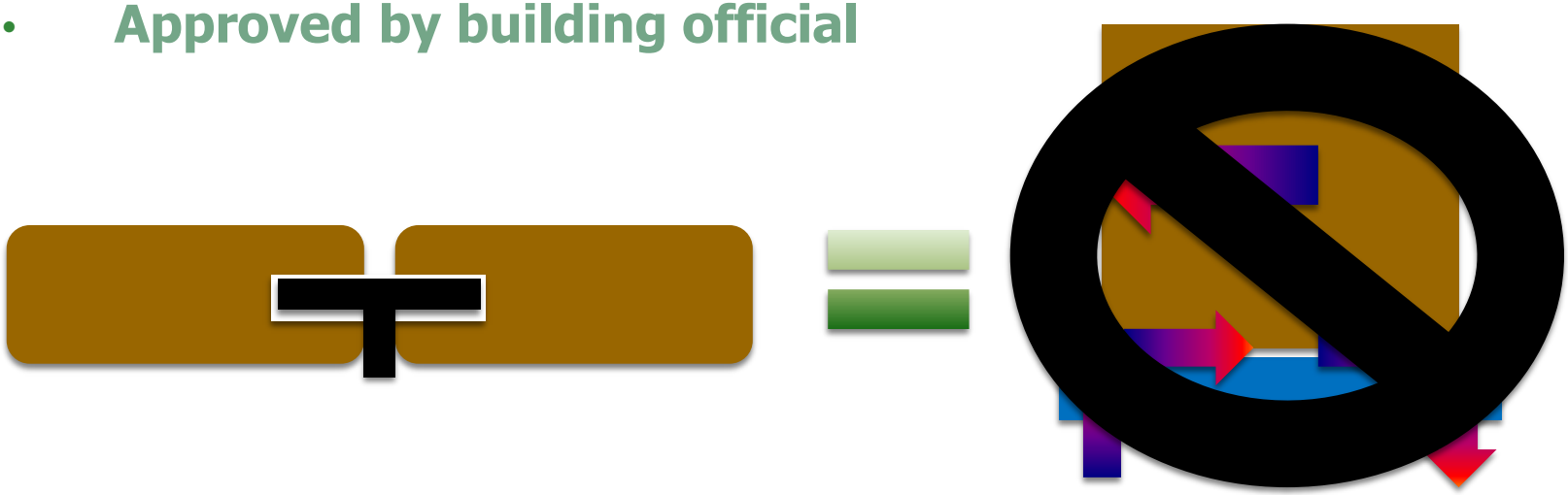


220 lb



Decking – DCA6-12

- **Attachment**
  - 2-8d commons
  - 2-#8 screws
- **Spacing 1/8”**
- **Perpendicular or 45°**
- **Bear on 3 joists minimum**
- **Substitution**
  - Approved by building official



Joists

2015 IRC

TABLE R507.5
DECK JOIST SPANS FOR COMMON LUMBER SPECIES[f] (ft. - in.)

SPECIES[a]	SIZE	SPACING OF DECK JOISTS WITH NO CANTILEVER[b] (inches)			SPACING OF DECK JOISTS WITH CANTILEVERS[c] (inches)		
		12	16	24	12	16	24
Southern pine	2 × 6	9-11	9-0	7-7	6-8	6-8	6-8
	2 × 8	13-1	11-10	9-8	10-1	10-1	9-8
	2 × 10	16-2	14-0	11-5	14-6	14-0	11-5
	2 × 12	18-0	16-6	13-6	18-0	16-6	13-6

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound = 0.454 kg.

a. No. 2 grade with wet service factor.
b. Ground snow load, live load = 40 psf, dead load = 10 psf, L/Δ = 360.
c. Ground snow load, live load = 40 psf, dead load = 10 psf, L/Δ = 360 at main span, L/Δ = 180 at cantilever with a 220-pound point load applied to end.
d. Includes incising factor.
e. Northern species with no incising factor
f. Cantilevered spans not exceeding the nominal depth of the joist are permitted.

From R507.5: “Deck joists shall be permitted to cantilever not gr eater than one-fourth of the actual, adjacent joist span.” Emphasis added.

Joists

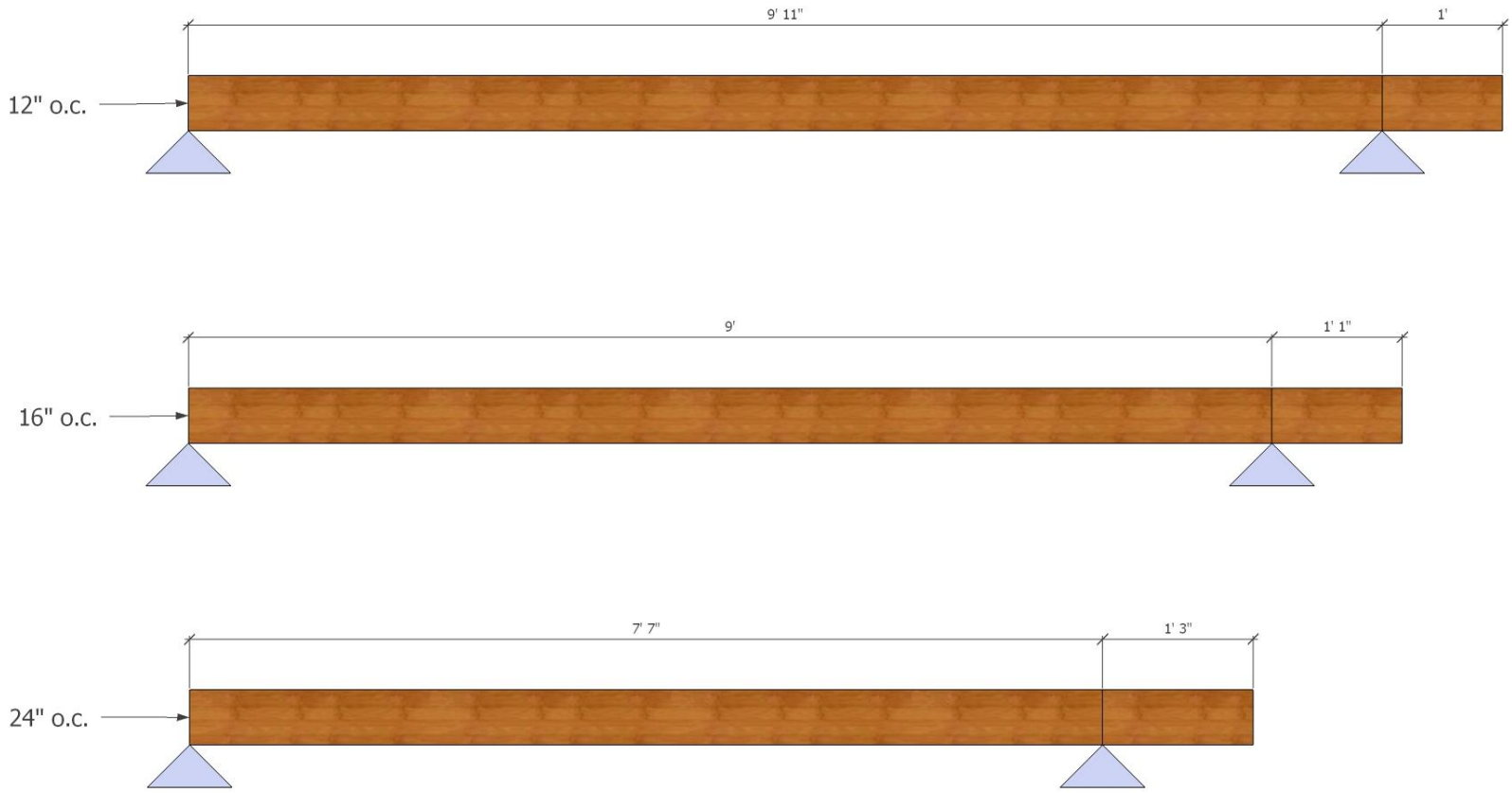
DCA6-15

Table 2. Maximum Joist Spans and Overhangs

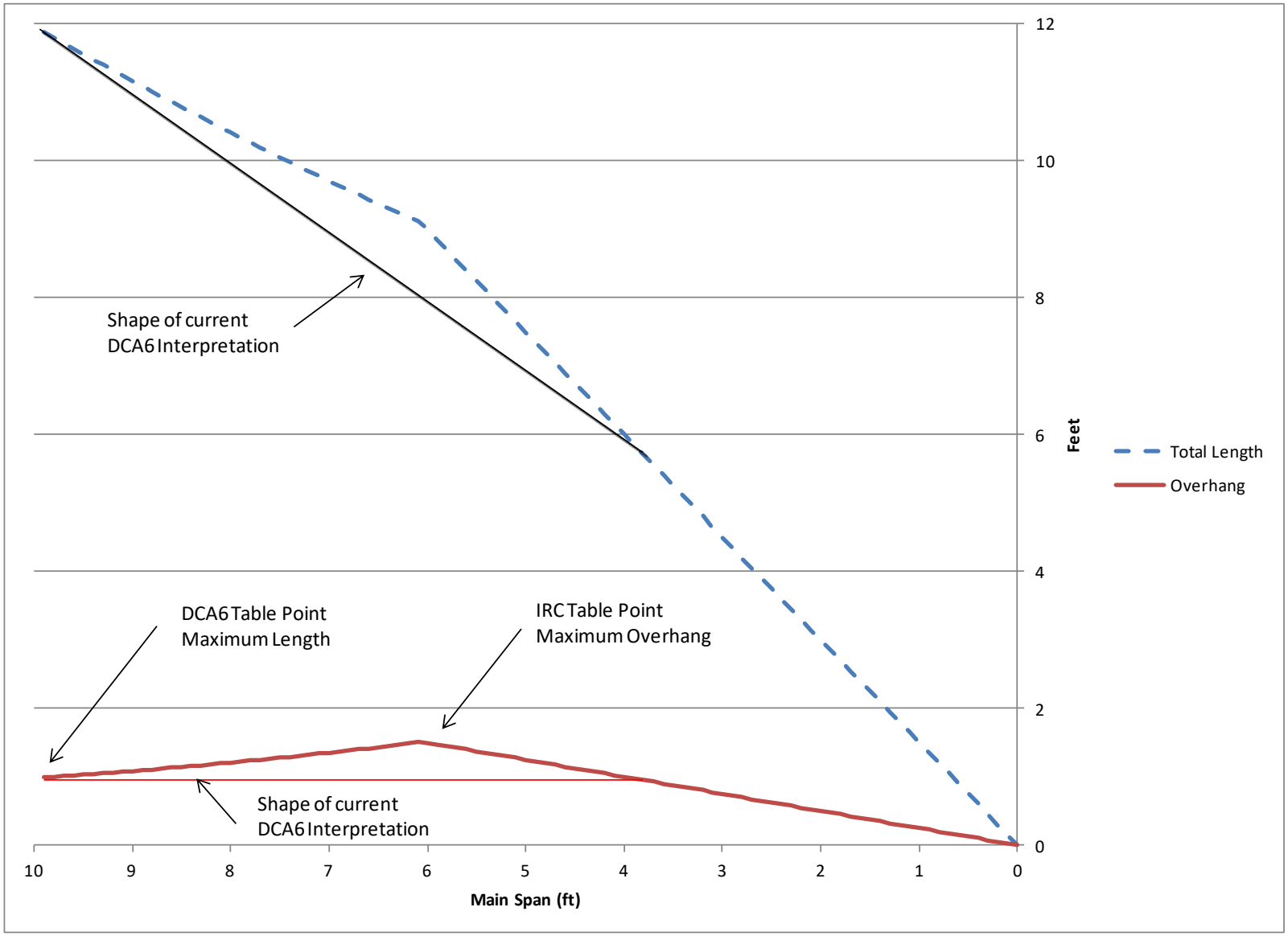
Species	Size	Joist Spacing (o.c.)[1] Allowable Span[2] (L_J) 12"	16"	24"	Allowable Overhang[3] (L_O) 12"	16"	24"
Southern Pine	2x6[6]	9' - 11"	9' - 0"	7' - 7"	1' - 0"	1' - 1"	1' - 3"
	2x8	13' - 1"	11' - 10"	9' - 8"	1' - 10"	2' - 0"	2' - 4"
	2x10	16' - 2"	14' - 0"	11' - 5"	3' - 1"	3' - 5"	2' - 10"
	2x12	18' - 0"[7]	16' - 6"	13' - 6"	4' - [illegible]	4' - 2"	3' - 4"

Footnote 6: Ledger shall be a minimum of 2x8 nominal. Where guards are required, outside joists and rim joists shall be a minimum of 2x8 Nominal. See anything odd here?

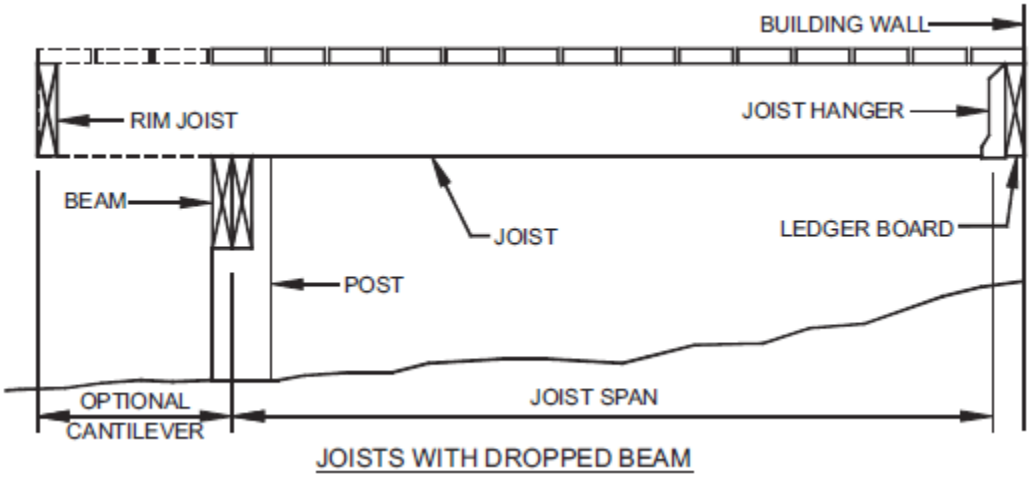
Joists



Joists

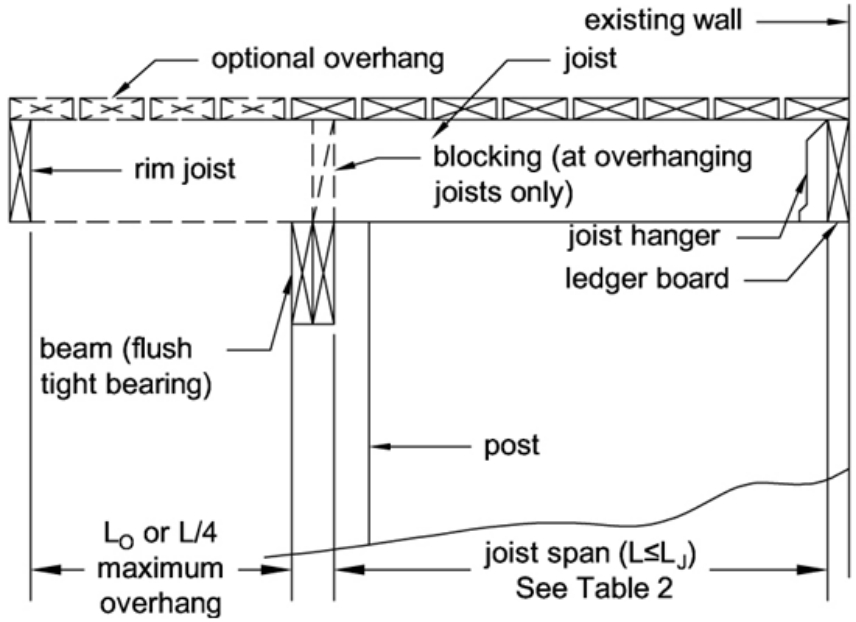

12
10
8
6
4
2
0
Feet
Total Length
Overhang
Shape of current
DCA6 Interpretation
DCA6 Table Point
Maximum Length
IRC Table Point
Maximum Overhang
Shape of current
DCA6 Interpretation
10
9
8
7
6
5
4
3
2
1
0
Main Span (ft)

Joists



JOISTS WITH DROPPED BEAM

2015 IRC



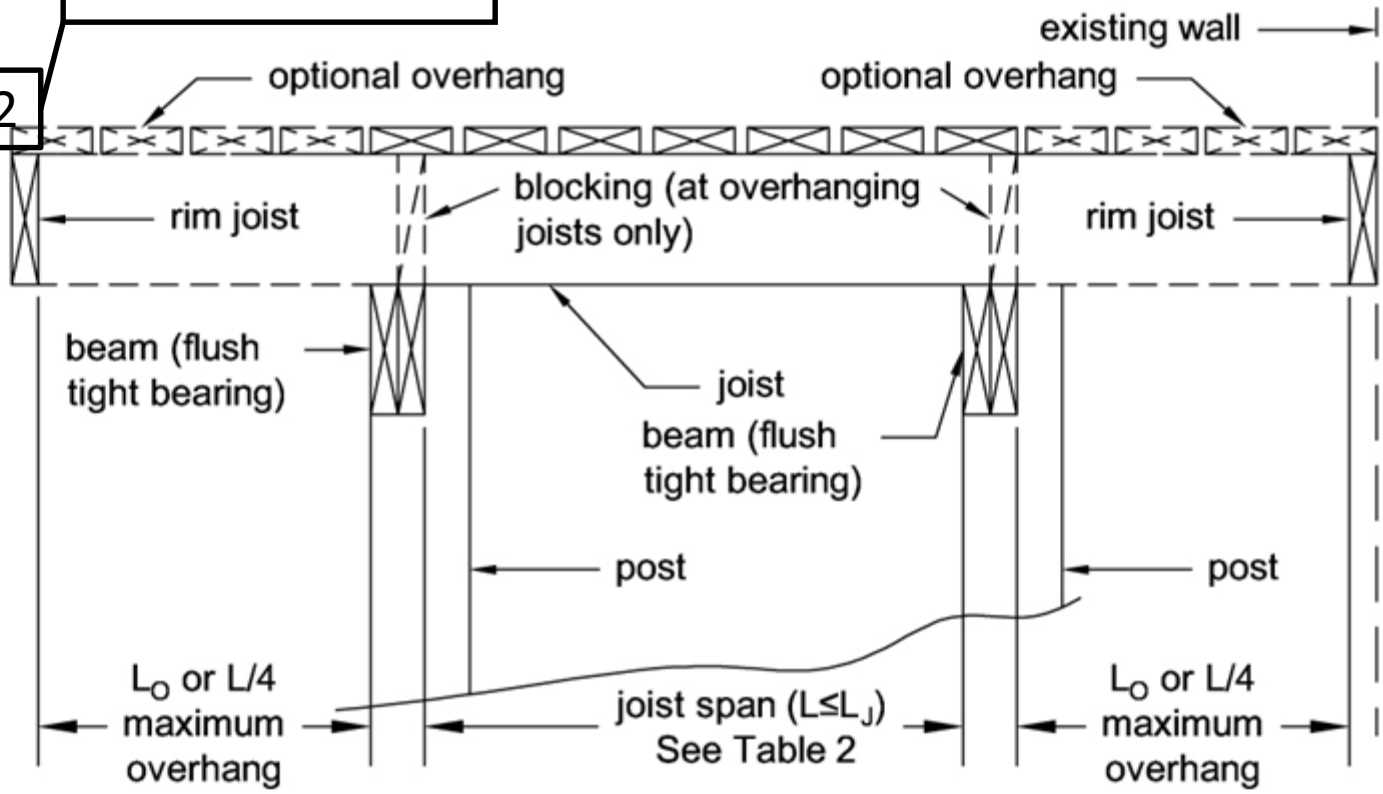
DCA6-15

3” Subtracted from Allowed Overhang

Joists

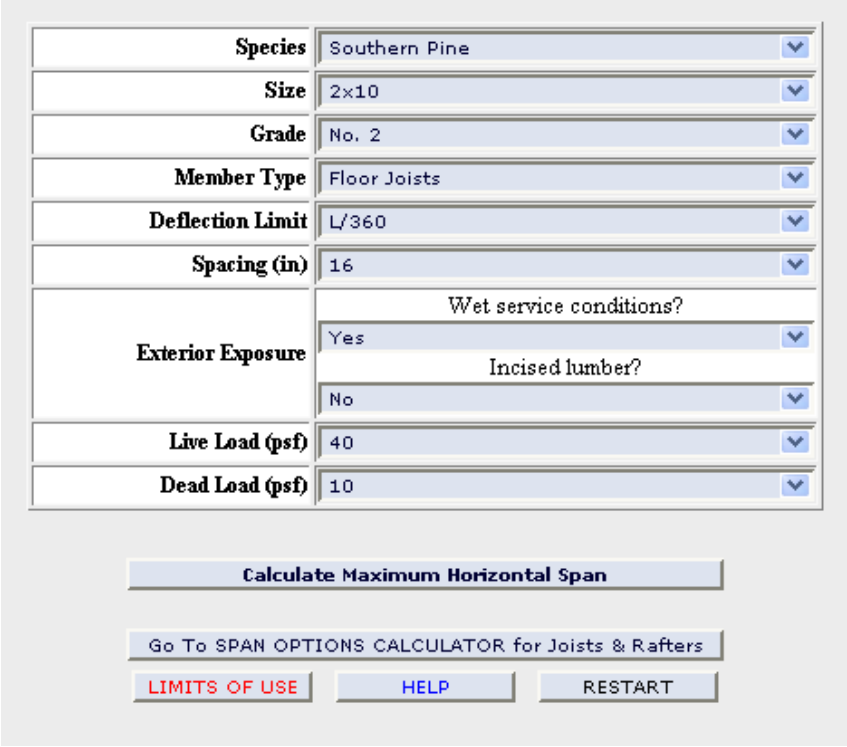
Figure 2: Joist Span – Non-Ledger Deck

New to DCA6-12



*Non-Ledger Decks are vertically independent of the primary structure but still rely on the primary structure to resist lateral loads. Free-standing decks are both vertically and laterally independent.

Joists



- AWC Online Span Calculator
  - Simple spans (no cantilever)
  - Uniform loads
  - Wet service conditions
  - Incising factor
  - 18’-0” MAX (DCA 6)
  - Free at www.awc.org

Apps – not free

The Maximum Horizontal Span is:

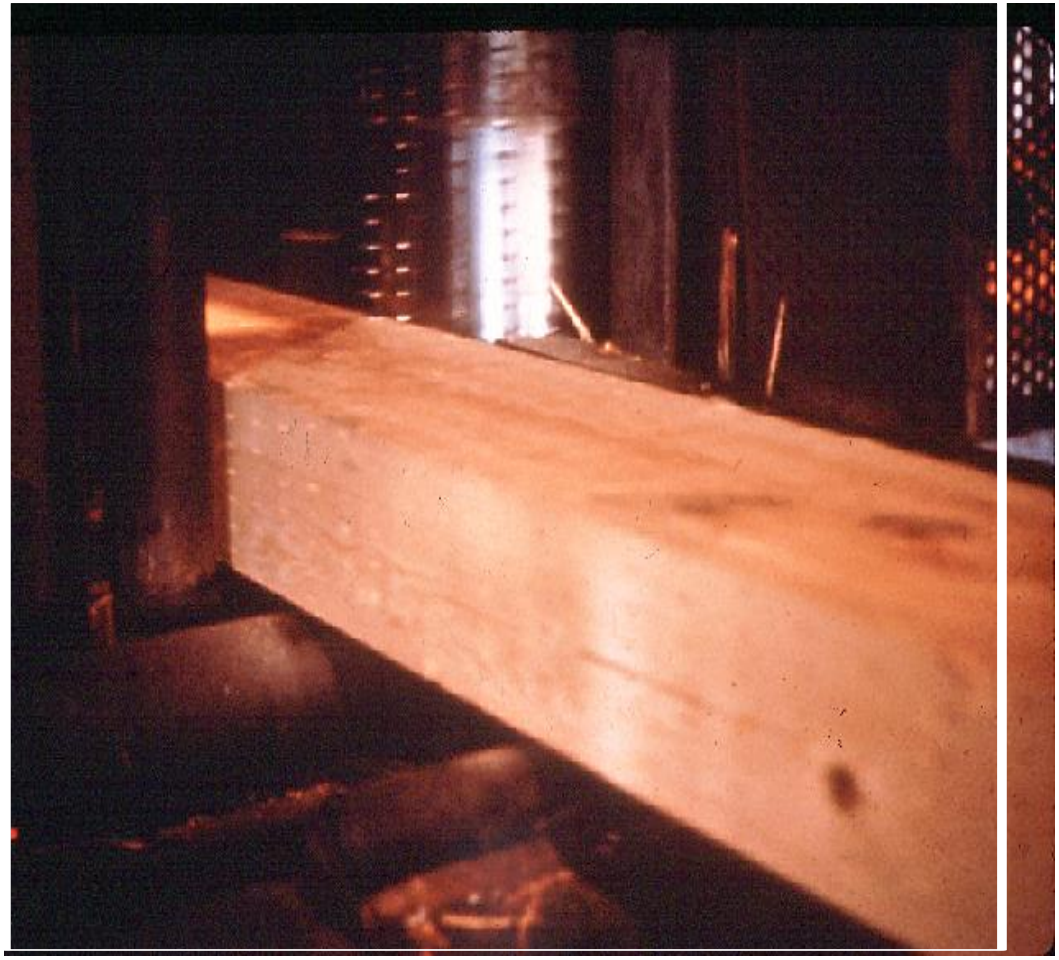
15 ft. 10 in.

with a minimum bearing length of **0.93 in.** required at each end of the member.

Property	Value
Species	Southern Pine
Grade	No. 2
Size	2x10
Modulus of Elasticity (E)	1440000 psi
Bending Strength (F_b)	1207.5 psi
Bearing Strength (F_{cp})	378.55 psi
Shear Strength (F_v)	169.75 psi

Joists

- Incising factor
  - Refractory species
  - DFL, HF, SPF
  - Reduces strength and stiffness



Joists

Species	Douglas Fir-Larch
Size	2x10
Grade	No. 2
Member Type	Floor Joists
Deflection Limit	L/360
Spacing (in)	16
Exterior Exposure	Wet service conditions? Yes Incised lumber? Yes
Live Load (psf)	40
Dead Load (psf)	10

Calculate Maximum Horizontal Span

Go To SPAN OPTIONS CALCULATOR for Joists & Rafters

LIMITS OF USE | HELP | RESTART

Incising factor

The Maximum Horizontal Span is:

13 ft. 11 in.

with a minimum bearing length of **0.74 in.** required at each end of the member.

Property	Value
Species	Douglas Fir-Larch
Grade	No. 2
Size	2x10
Modulus of Elasticity (E)	1368000 psi
Bending Strength (F_b)	910.8 psi
Bearing Strength (F_{cp})	418.75 psi
Shear Strength (F_v)	139.68 psi

Joist Connections

R507.7 – Deck joist and deck beam bearing

1-1/2” for bearing on wood or metal

R507.5.1 – Lateral restraint at supports

Joist hangers or blocking depth ≥ 60% joist depth

DCA6-12

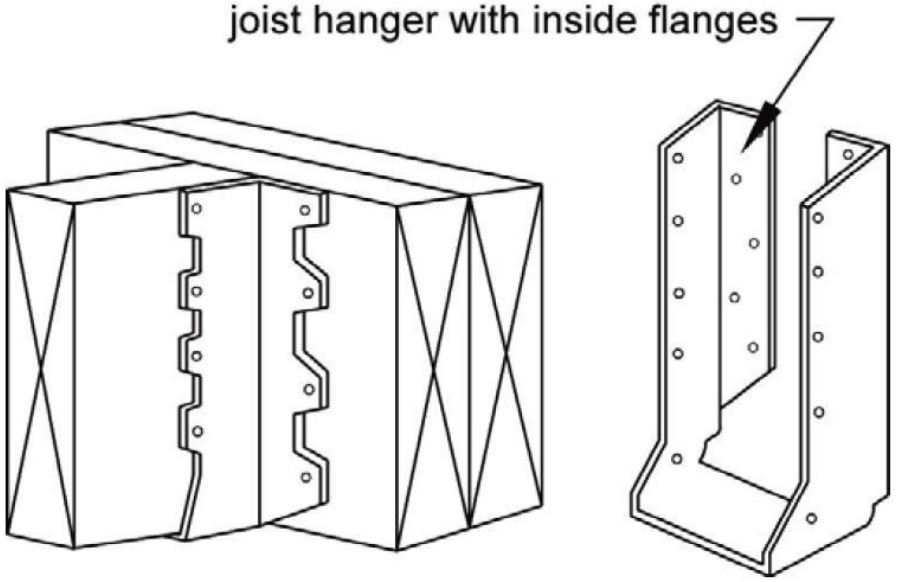
- **Joist Hangers**
- **Capacity per DCA6 Table 3A**
- **No clips/brackets**

Table 3A: Joist Hanger Vertical Capacity

Joist Size	Minimum Capacity, lbs
2x6	400
2x8	500
2x10	600
2x12	700

DCA6-12

Figure 7: Typical Joist Hangers



Joist Connections

- Options
  - Toe-nails
  - Hurricane clip
  - Joist hanger

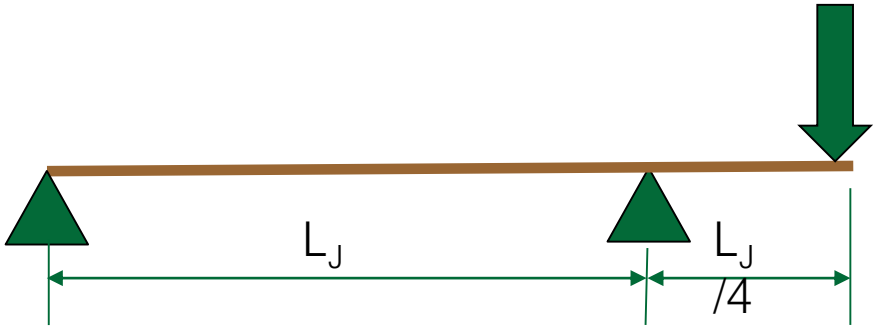
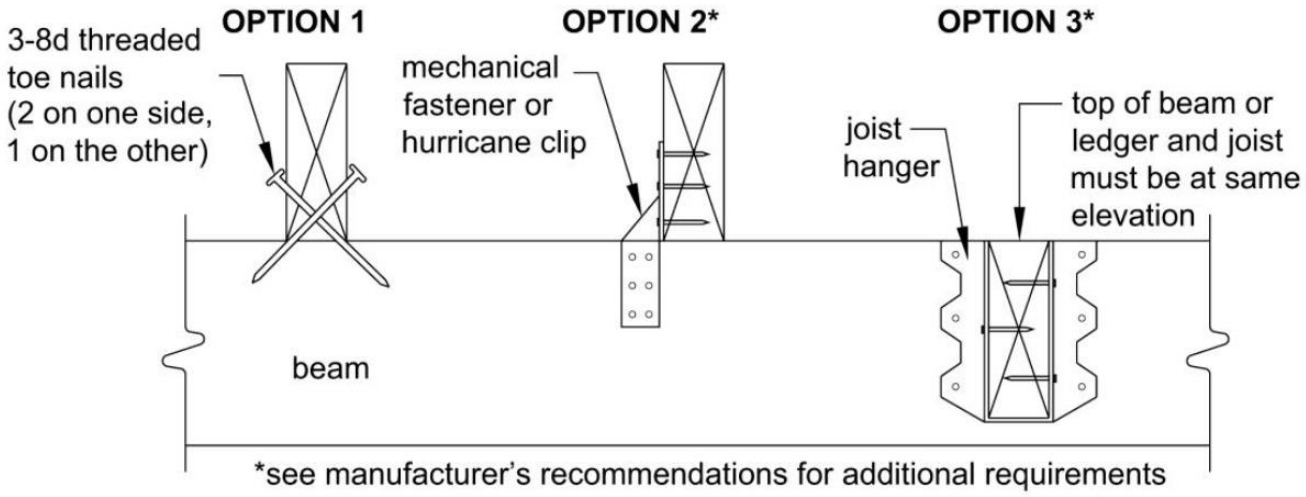


Figure 6. Joist-to-Beam Detail.

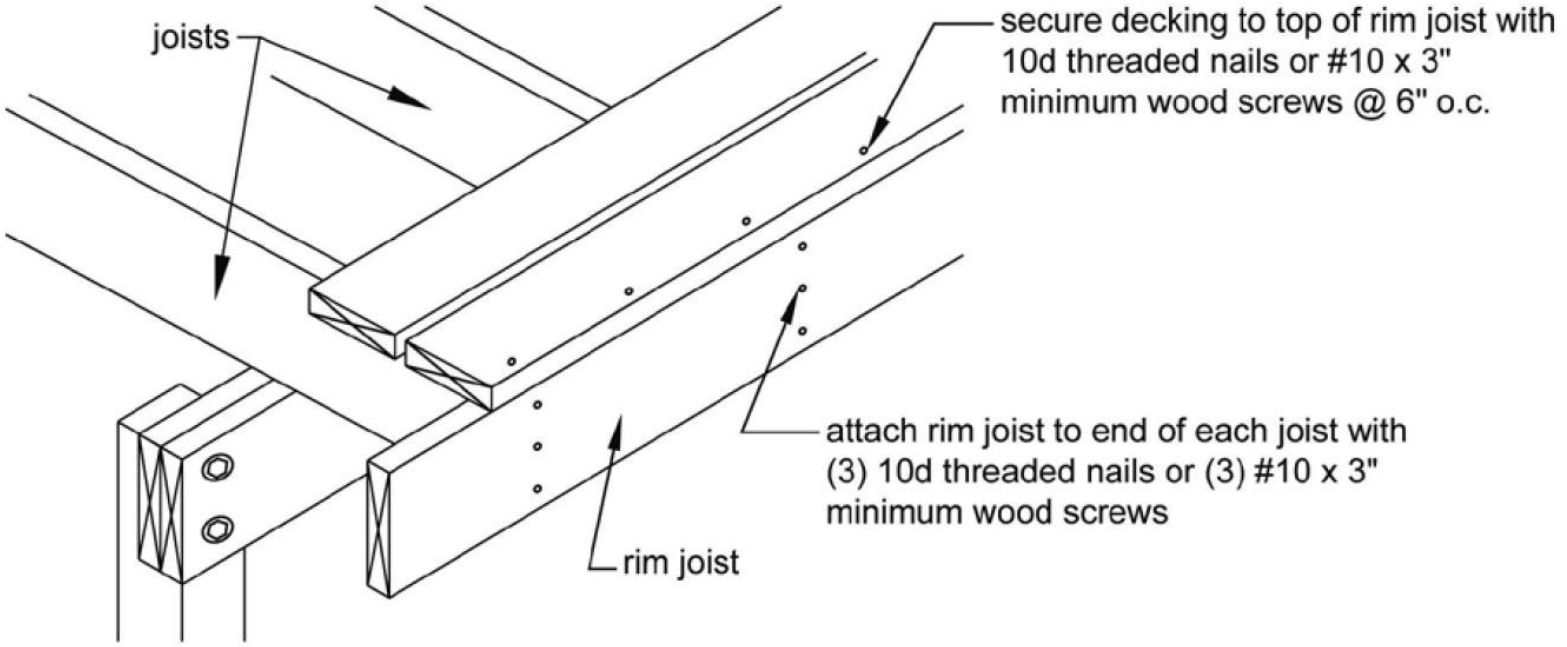


Rim Joist

2015 IRC & DCA6-15

- Decking attachment
  - #10 x 3″ min. wood screws @ 6″ o.c.
  - 10d @ 6″ o.c.
- Joist attachment
  - (3) #10 x 3″ min. wood screws
  - (3) 10d nails

Figure 11. Rim Joist Connection Details



Beams

2015 IRC

TABLE R507.6
DECK BEAM SPAN LENGTHS[a, b] (ft. - in.)

SPECIES[c]	SIZE[d]	DECK JOIST SPAN LESS THAN OR EQUAL TO: (feet)						
		6	8	10	12	14	16	18
Southern pine	2 – 2 × 6	6-11	5-11	5-4	4-10	4-6	4-3	4-0
	2 – 2 × 8	8-9	7-7	6-9	6-2	5-9	5-4	5-0
	2 – 2 × 10	10-4	9-0	8-0	7-4	6-9	6-4	6-0
	2 – 2 × 12	12-2	10-7	9-5	8-7	8-0	7-6	7-0
	3 – 2 × 6	8-2	7-5	6-8	6-1	5-8	5-3	5-0
	3 – 2 × 8	10-10	9-6	8-6	7-9	7-2	6-8	6-4
	3 – 2 × 10	13-0	11-3	10-0	9-2	8-6	7-11	7-6
	3 – 2 × 12	15-3	13-3	11-10	10-9	10-0	9-4	8-10

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound = 0.454 kg.

a. Ground snow load, live load = 40 psf, dead load = 10 psf, L/Δ = 360 at main span, L/Δ = 180 at cantilever with a 220-pound point load applied at the end.

b. Beams supporting deck joists from one side only.

c. No. 2 grade, wet service factor.

R507.6

- Beams can cantilever up to ¼ of actual beam span
- Splices at interior posts, 50 lbs. design load CONTROLS.

Beams

- **Spans limited to 18′ due to footer sizes**
- **3″ Subtracted because of Definition of Span**

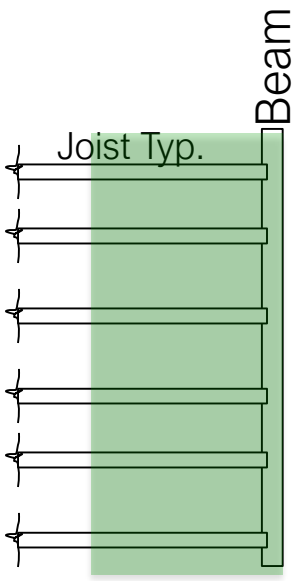
DCA6-15

Table 3B. Glued Laminated Timber Beam Spans (L_B)[1] for Joists Framing from One Side Only.

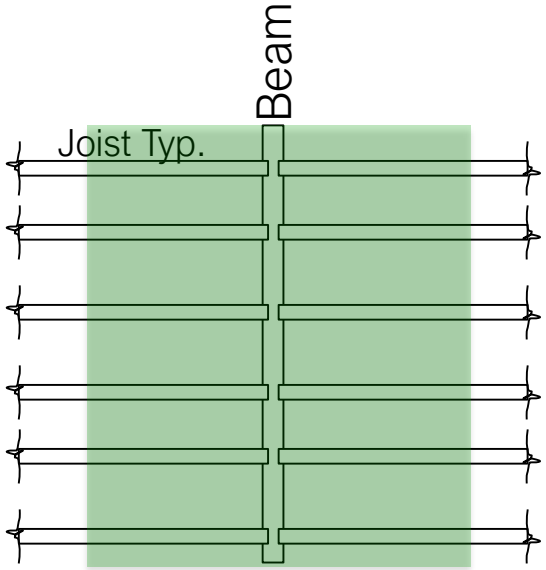
Stress Class[2]	Width[3]	Depth[4]	Joist Spans (L) Less Than or Equal to: 6'	8'	10'	12'	14'	16'	18'
Balanced or Unbalanced 20F-1.5E And Higher Grade Cedar	3-1/2"	9-1/2"	12'-2"	10'-6"	9'-4"	8'-6"	7'-10"	7'-4"	6'-11"
		11-7/8"	15'-2"	13'-1"	11'-8"	10'-8"	9'-10"	9'-2"	8'-8"
		14"	17'-10"	15'-5"	13'-9"	12'-7"	11'-7"	10'-10"	10'-2"
	5-1/4"	11-7/8"	18'-0"[5]	16'-8"	14'-10"	13'-7"	12'-6"	11'-8"	11'-0"
		14"	18'-0"[5]	18'-0"[5]	17'-6"	15'-11"	14'-9"	13'-9"	13'-0"
		16"	18'-0"[5]	18'-0"[5]	18'-0"[5]	18'-0"[5]	16'-10"	15'-9"	14'-10"
Unbalanced 24F-1.8E Douglas Fir-Larch or Southern Pine	3-1/2"	9-1/2"	13'-11"	12'-1"	10'-9"	9'-10"	9'-1"	8'-6"	8'-0"
		11-7/8"	17'-5"	15'-1"	13'-5"	12'-3"	11'-4"	10'-7"	10'-0"
		14"	18'-0"[5]	17'-9"	15'-10"	14'-5"	13'-4"	12'-6"	11'- 9"
	5-1/4"	11-7/8"	18'-0"[5]	18'-0"[5]	17'-1"	15'-7"	14'-5"	13'-6"	12'-8"
		14"	18'-0"[5]	18'-0"[5]	18'-0"[5]	18'-0"[5]	17'-0"	15'-10"	14'-11"
		16"	18'-0"[5]	18'-0"[5]	18'-0"[5]	18'-0"[5]	18'-0"[5]	18'-0"[5]	17'-0"
Balanced 24F-1.8E Douglas Fir-Larch or Southern Pine	3-1/2"	9-1/2"	13'-11"	12'-7"	11'-8"	11'-0"	10'-5"	9'-11"	9'-7"
		11-7/8"	17'-5"	15'-10"	14'-8"	13'-9"	13'-1"	12'-6"	12'-0"
		14"	18'-0"[5]	18'-0"[5]	17'-4"	16'-3"	15'-5"	14'-9"	14'-2"
	5-1/4"	11-7/8"	18'-0"[5]	18'-0"[5]	17'-4"	16'-3"	15'-5"	14'-9"	14'-2"
		14"	18'-0"[5]	18'-0"[5]	18'-0"[5]	18'-0"[5]	18'-0"[5]	17'-6"	16'-9"
		16"	18'-0"[5]	18'-0"[5]	18'-0"[5]	18'-0"[5]	18'-0"[5]	18'-0"[5]	18'-0"[5]

Beams

Joists on one side vs. Joists on two sides



½ Joist Length

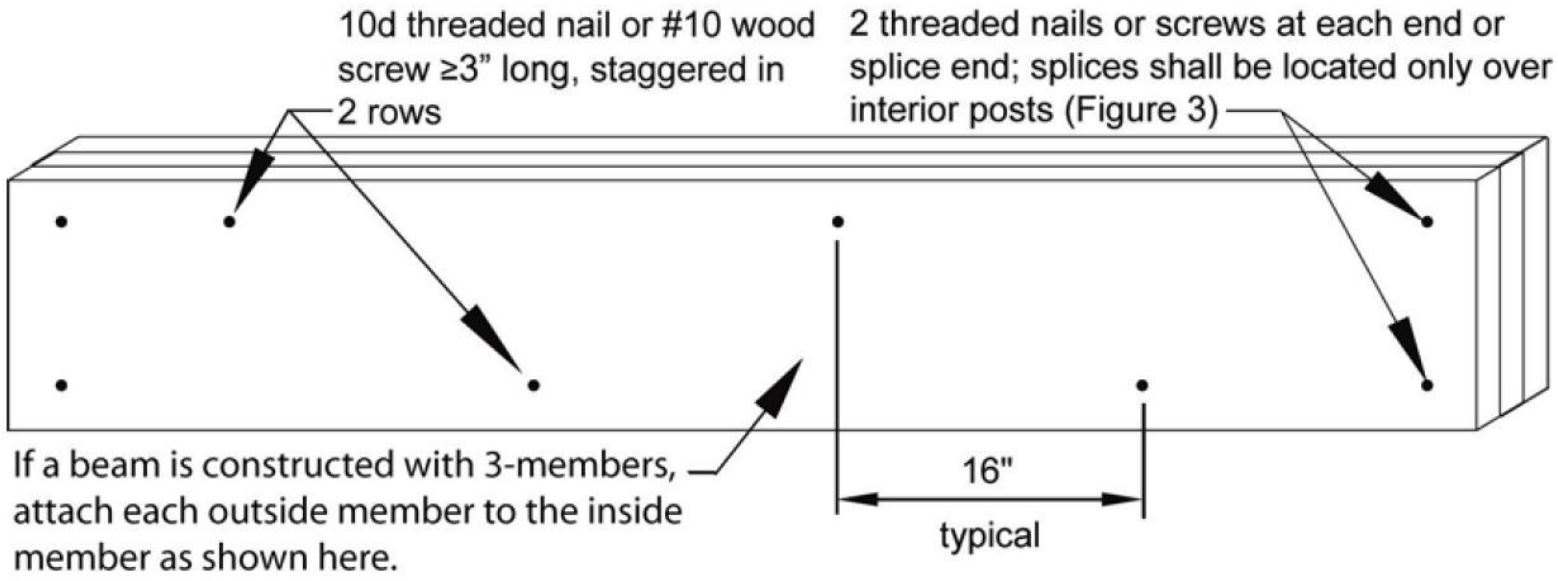


2 x ½ Joist Length
= Full Joist Length

Beams

- Assembly
  - For built-up beams
  - 10d threaded or #10 wood screws
  - 16” o.c. staggered

Figure 4. Beam Assembly Details



Posts

2015 IRC

TABLE R507.8
DECK POST HEIGHT[a]

DECK POST SIZE	MAXIMUM HEIGHT[a]
4 × 4	8'
4 × 6	8'
6 × 6	14'

For SI: 1 foot = 304.8 mm.

a. Measured to the underside of the beam.

R507.8

- Only applies to single-level, wood-framed decks with 18’ beam span by 18’ single joist span assumption.

Posts

DCA6-15

Table 4. Post Height for 6x6 and Footing Sizes for all Posts

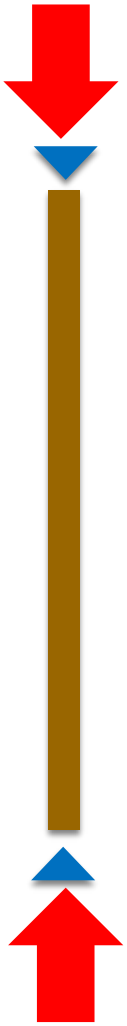
Beam Span, L_B	Joist Span L_J	Post Heights[1]				
		Southern Pine	Douglas Fir-Larch[3]	Hem-Fir[3], Western Cedars	Redwood	Ponderosa Pine, Red Pine, SPF[3]
6'	<10'	14'	14'	14'	14'	14'
	<14'	14'	14'	14'	14'	14'
	<18'	14'	14'	12'	14'	11'
8'	<10'	14'	14'	14'	14'	14'
	<14'	14'	14'	14'	14'	11'
	<18'	14'	13'	11'	12'	8'

DCA6-12

- Always 6x6 (unless commentary is used)
- Less allowed height than 2015 IRC

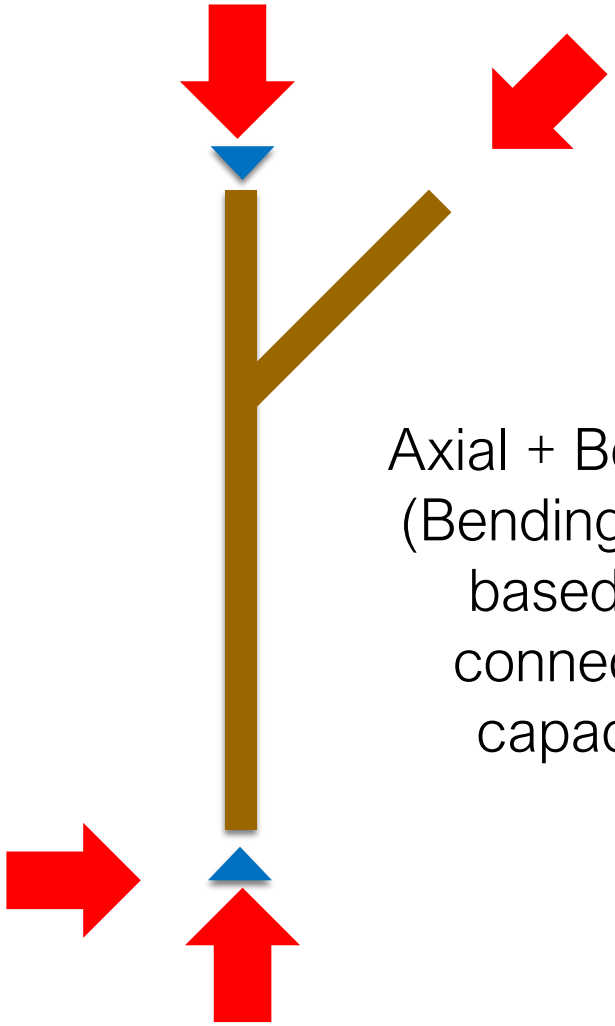
Posts

2015 IRC



Pure Axial

DCA6-15



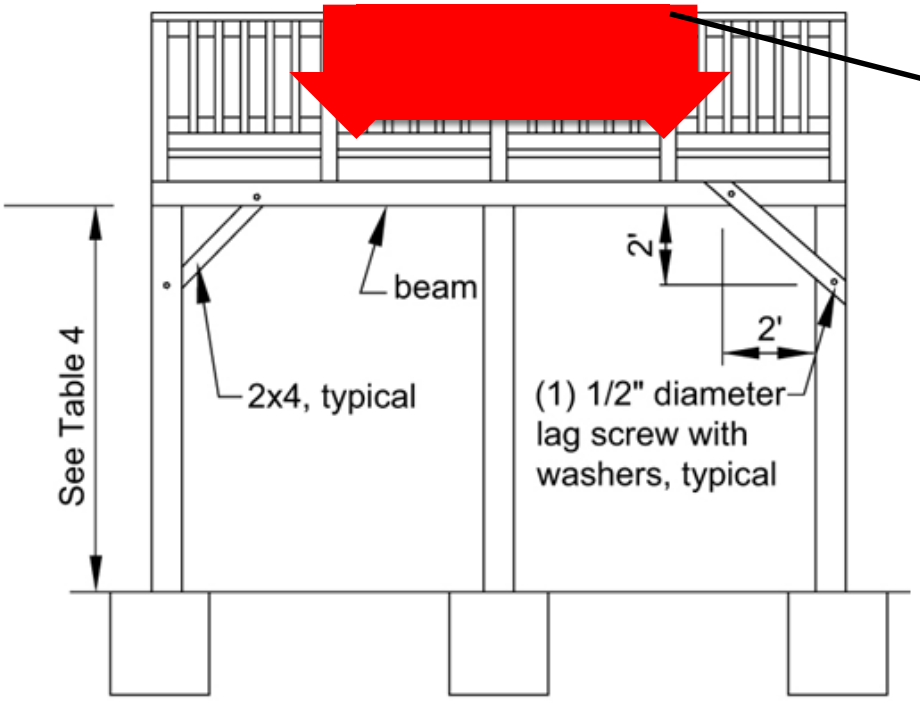
Axial + Bending (Bending force based on connection capacity)

Posts – DCA6-15

- Decks > 2′ above grade
  - require diagonal bracing

- Parallel to beam
  - Lag Screw to beam and post
- Perpendicular to beam
  - Bracing not required

Figure 10: Diagonal Bracing



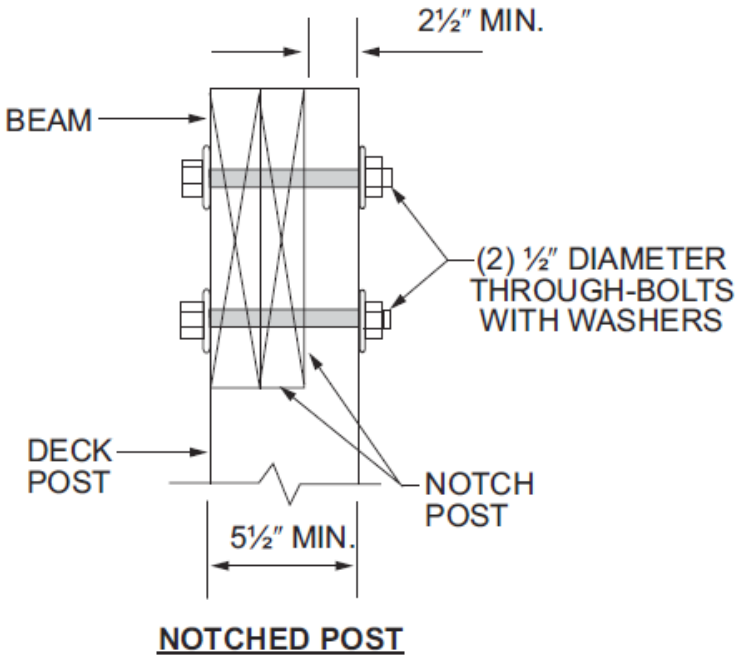
DIAGONAL BRACING PARALLEL TO BEAM

New DCA6-12

*Diagonal bracing is never installed on center posts

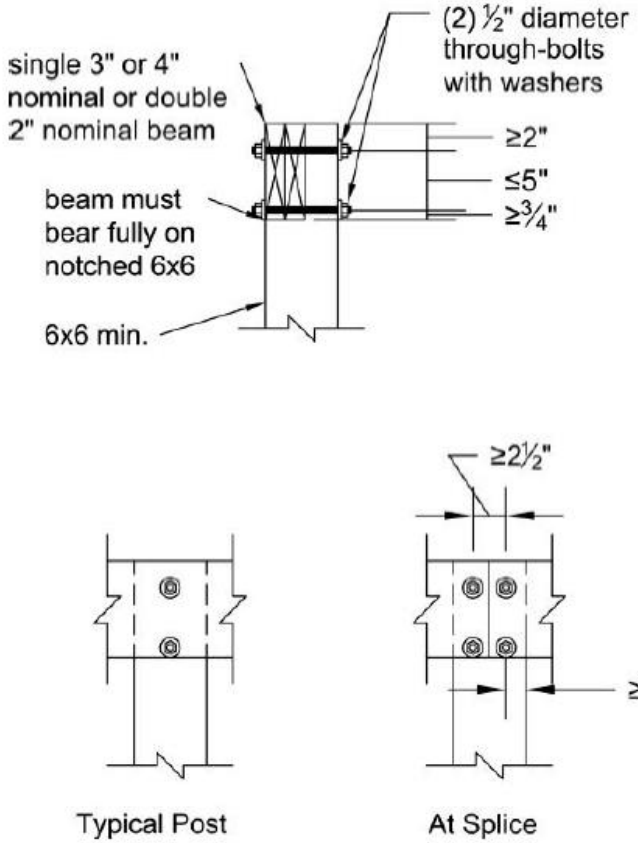
Post Connections

2015 IRC



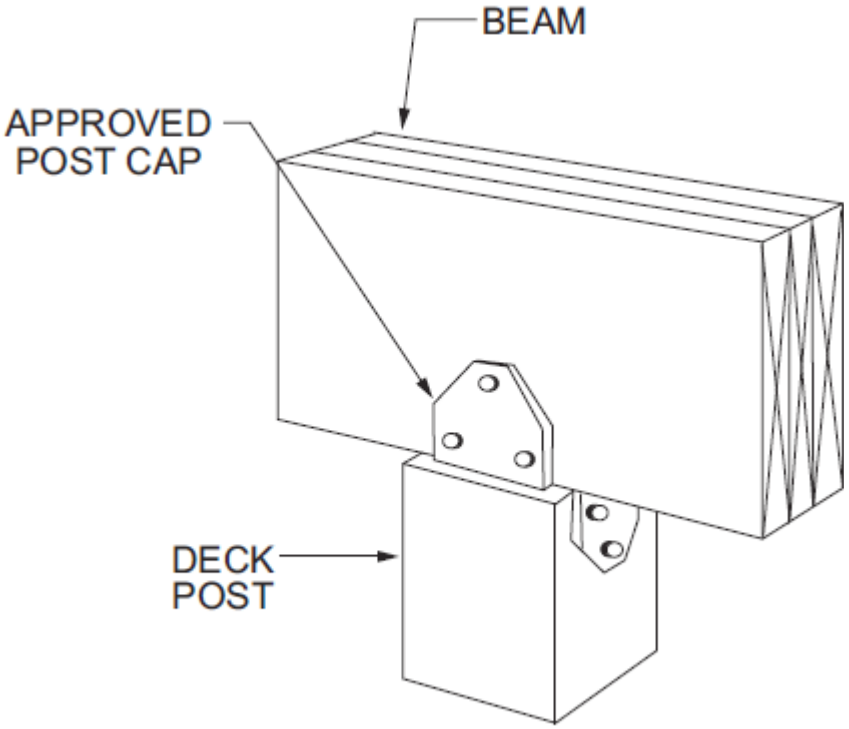
NOTCHED POST

DCA6-15



Post Connections

- Centered on footings
- Cut ends field treated
  - Copper naphthenate
  - [R402.1.2]

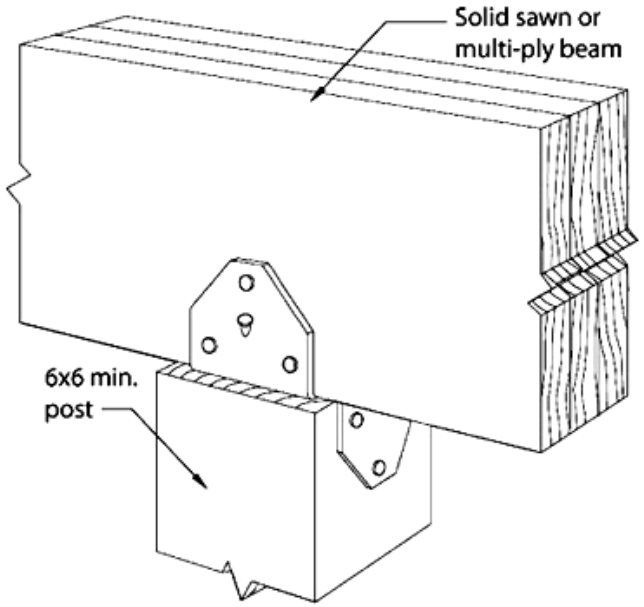


POST CAP

2015 IRC

DCA6-15

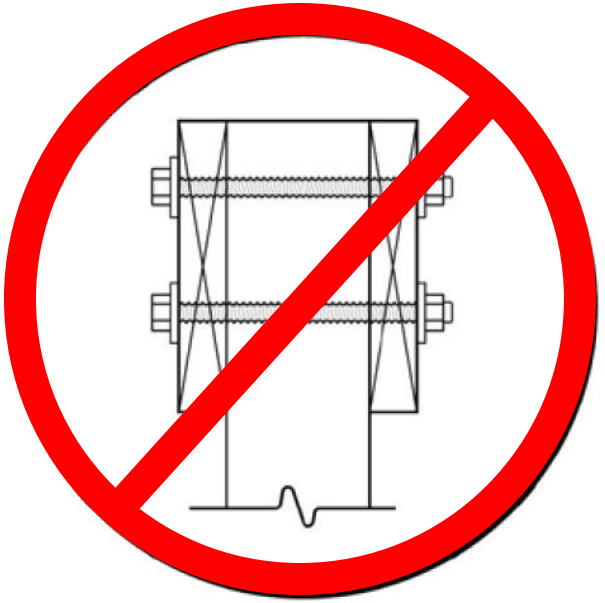
Figure 8B: Alternate *Approved* Post-to-Beam Post Cap Attachment



Post Connections – DCA6-15

- Prohibited connection
  - Beam to side of post
  - Ensures wood-to-wood bearing
  - Avoids potential issues with non-compliant fasteners
  - *Bolts in wet service environments have reduced capacity!*

Figure 9. Prohibited Post-to-Beam Attachment Condition



Bearing is about 10 times stronger than (2) ½" bolts!

Footings – 2015 IRC

- Per Section R403
  - Size?
- Prevent lateral displacement at bottom
  - Manufactured connector
  - 12” embedment in soil or concrete

2015 IRC

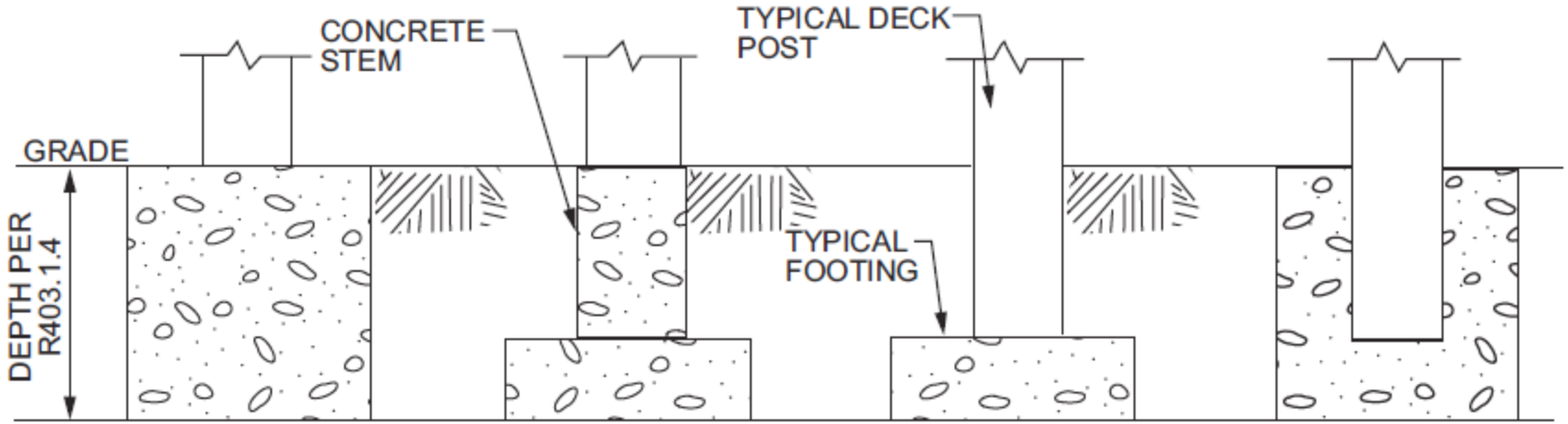
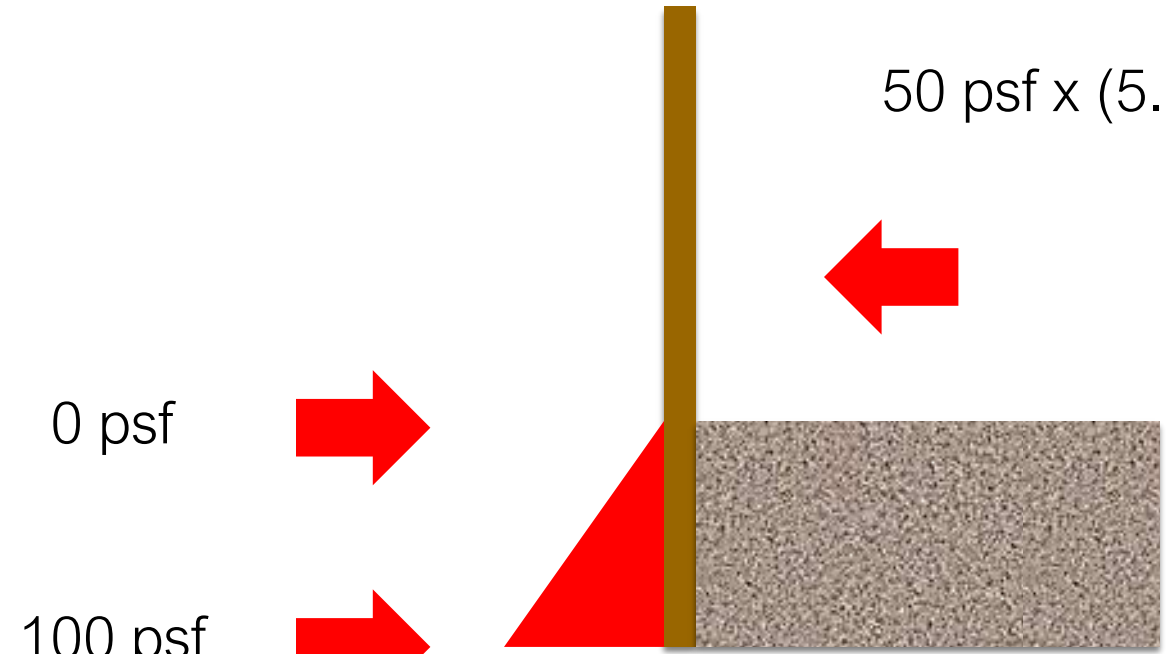


FIGURE R507.8.1
TYPICAL DECK POSTS TO DECK FOOTINGS

Footings

Per IBC Table 1806.2, clay, sandy clay, silty clay, clayey silt, and silt sandy silt have Lateral Bearing Pressure values of 100 psf/ft. (Worst Case)

R507.8.1 Requires 12” minimum post embedment in ground.



50 psf x (5.5”) x (12”) / 144 (ft^2/in^2)

= 23 lbs

Footings

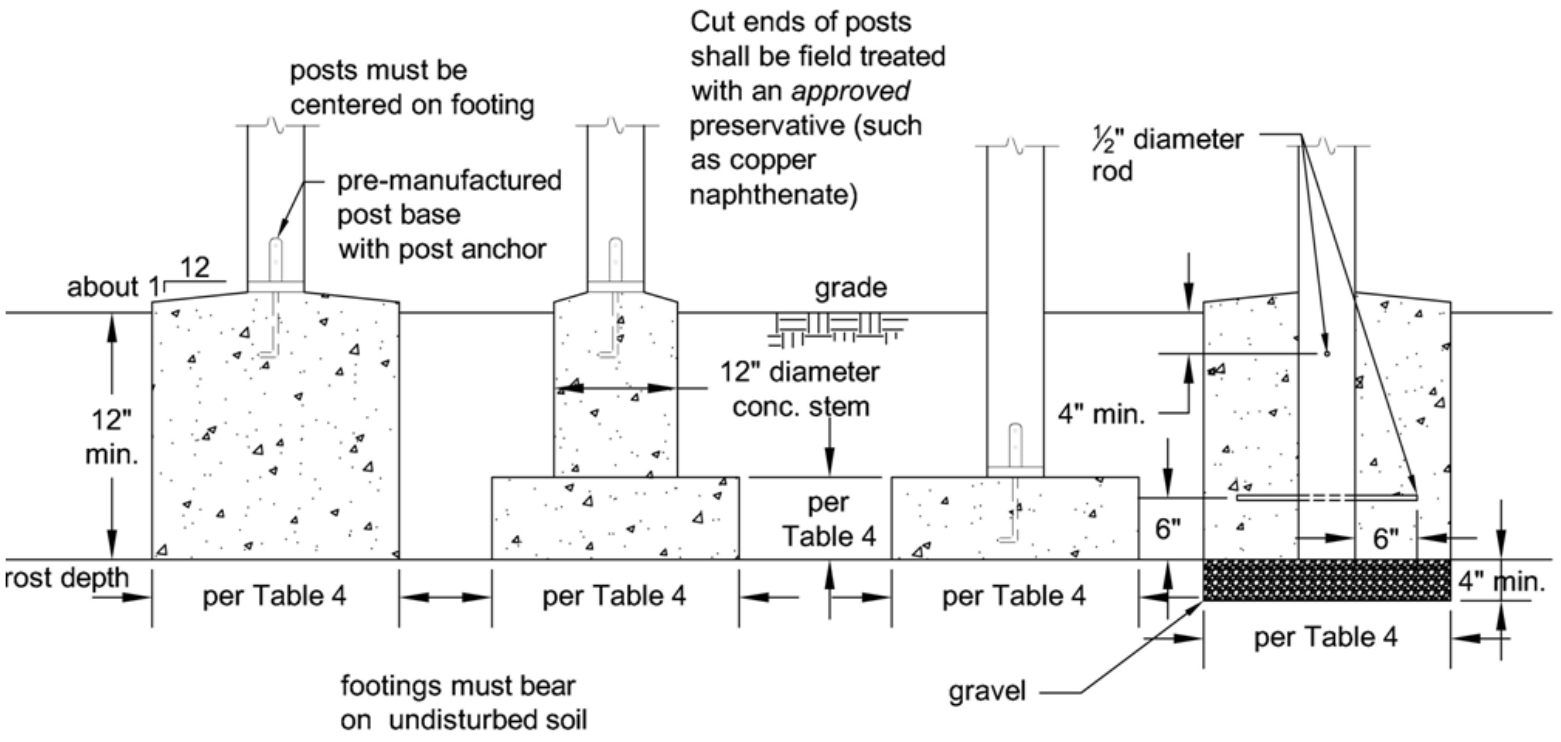
Soil Type	Lateral Pressure (psf/ft)	Capacity w/ 1’ Depth	Capacity w/ 2’ Depth
Sedimentary Rock	400	92 lbs	183 lbs
Sandy Gravel	200	46 lbs	92 lbs
Sand and Gravel	150	34 lbs	69 lbs
Clay and Silt	100	23 lbs	46 lbs

Post Base ≈ 500 to 700 lbs.

Footings - DCA6-15…different from IRC

- Depth $\geq$ 12” or frost line
- Soil 1,500 psf bearing capacity

Figure 12: Typical Footing Options



Footing Sizes and Post Heights

Table 4. Post Height for 6x6 and Footing Sizes for all Posts

Beam Span, L_B	Joist Span L_J	Post Heights[1]	Footing Sizes[2]		
			Round Footing Diameter	Square Footing	Footing Thickness[4]
6'	<10'		18"	16"x16"	7"
	<14'		21"	18"x18"	8"
	<18'		24"	21"x21"	10"
8'	<10'		20"	18"x18"	8"
	<14'		24"	21"x21"	10"
	<18'		27"	24"x24"	11"

2 Assumes 1,500 psf soil bearing capacity and 150 pcf concrete. Value may be multiplied by 0.9 for corner posts.

DCA6-15

Ledger

- Minimum 2x8 nominal No. 2
  - No concentrated loads (DCA6-15: slight exception)
  - No support from veneer
- Fasteners and Spacing per Tables (galvanized or stainless)
- Attached to nominal 2x solid-sawn or 1” dimensional LVL Band Joist
  - Requires Full Support

2015 IRC

TABLE R507.2
DECK LEDGER CONNECTION TO BAND JOIST[a, b]
(Deck live load = 40 psf, deck dead load = 10 psf, snow load ≤ 40 psf)

CONNECTION DETAILS	JOIST SPAN						
	6′ and less	6′1″ to 8′	8′1″ to 10′	10′1″ to 12′	12′1″ to 14′	14′1″ to 16′	16′1″ to 18′
	On-center spacing of fasteners						
1/2-inch diameter lag screw with 1/2-inch maximum sheathing[c, d]	30	23	18	15	13	11	10
1/2-inch diameter bolt with 1/2-inch maximum sheathing[d]	36	36	34	29	24	21	19
1/2-inch diameter bolt with 1-inch maximum sheathing[e]	36	36	29	24	21	18	16

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. Ledgers shall be flashed in accordance with Section R703.8 to prevent water from contacting the house band joist.

b. Snow load shall not be assumed to act concurrently with live load.

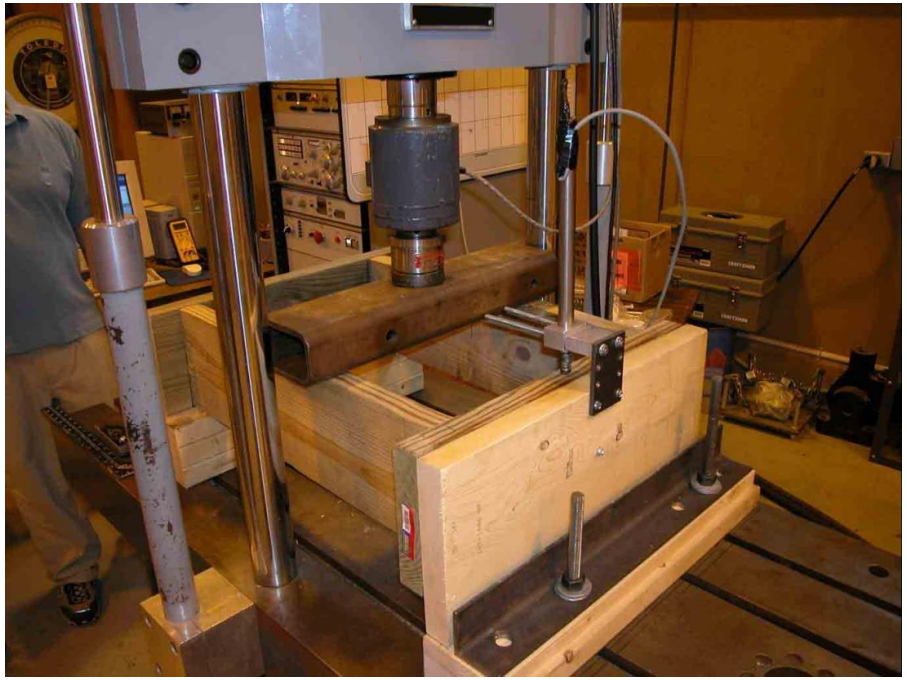
c. The tip of the lag screw shall fully extend beyond the inside face of the band joist.

d. Sheathing shall be wood structural panel or solid sawn lumber.

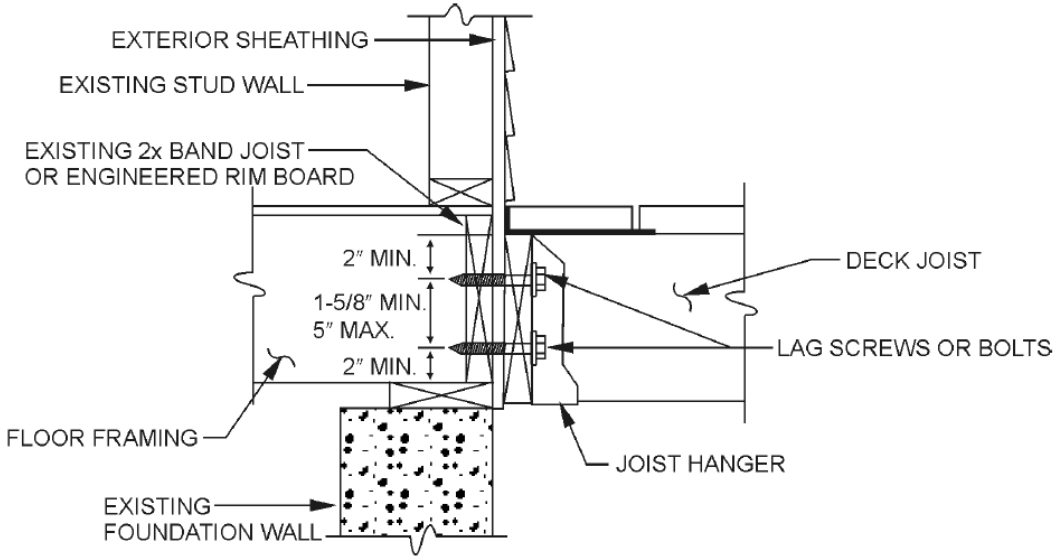
e. Sheathing shall be permitted to be wood structural panel, gypsum board, fiberboard, lumber or foam sheathing. Up to 1/2-inch thickness of stacked washers shall be permitted to substitute for up to 1/2 inch of allowable sheathing thickness where combined with wood structural panel or lumber sheathing.

Ledger

- Virginia Tech & Washington State University
- 3 common conditions
- ½″ diameter lag screws & bolts
- Fastener spacing values limited to:
  - Deck LL=40 psf and DL=10 psf
  - Band joist lumber G ≥ 0.42
  - Composite rim board with thickness ≥ 1″ and equivalent G ≥ 0.50
  - PPT deck ledger lumber with G ≥ 0.43
  - Deck ledger can be incised and wet
  - Proper installation including flashing
  - No decay present
  - No fastener corrosion

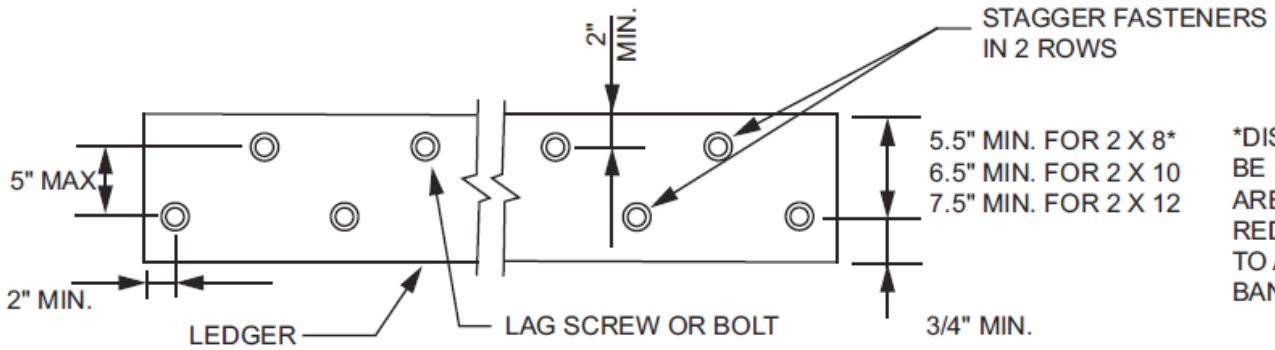


Ledger – 2015 IRC



For SI: 1 inch = 25.4 mm.

FIGURE R507.2.1(2)
PLACEMENT OF LAG SCREWS AND BOLTS IN BAND JOISTS

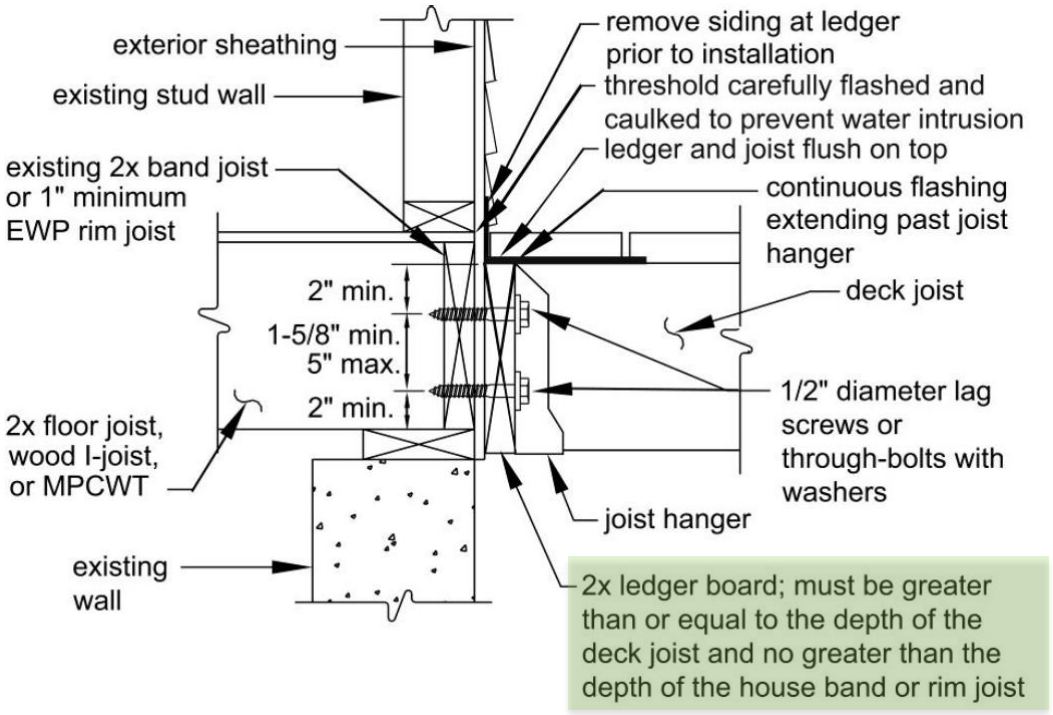


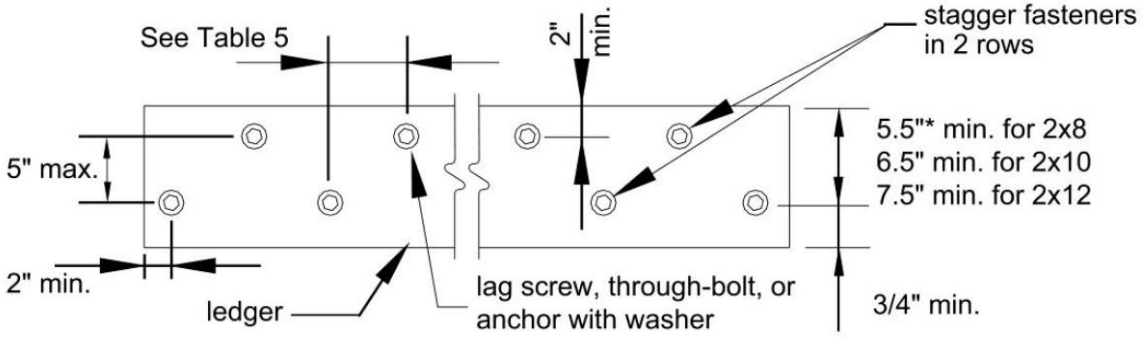
*DISTANCE SHALL BE PERMITTED TO BE REDUCED TO 4.5" IF LAG SCREWS ARE USED OR BOLT SPACING IS REDUCED TO THAT OF LAG SCREWS TO ATTACH 2 X 8 LEDGERS TO 2 X 8 BAND JOISTS.

For SI: 1 inch = 25.4 mm.

FIGURE R507.2.1(1)
PLACEMENT OF LAG SCREWS AND BOLTS IN LEDGERS

Ledger – DCA6-15





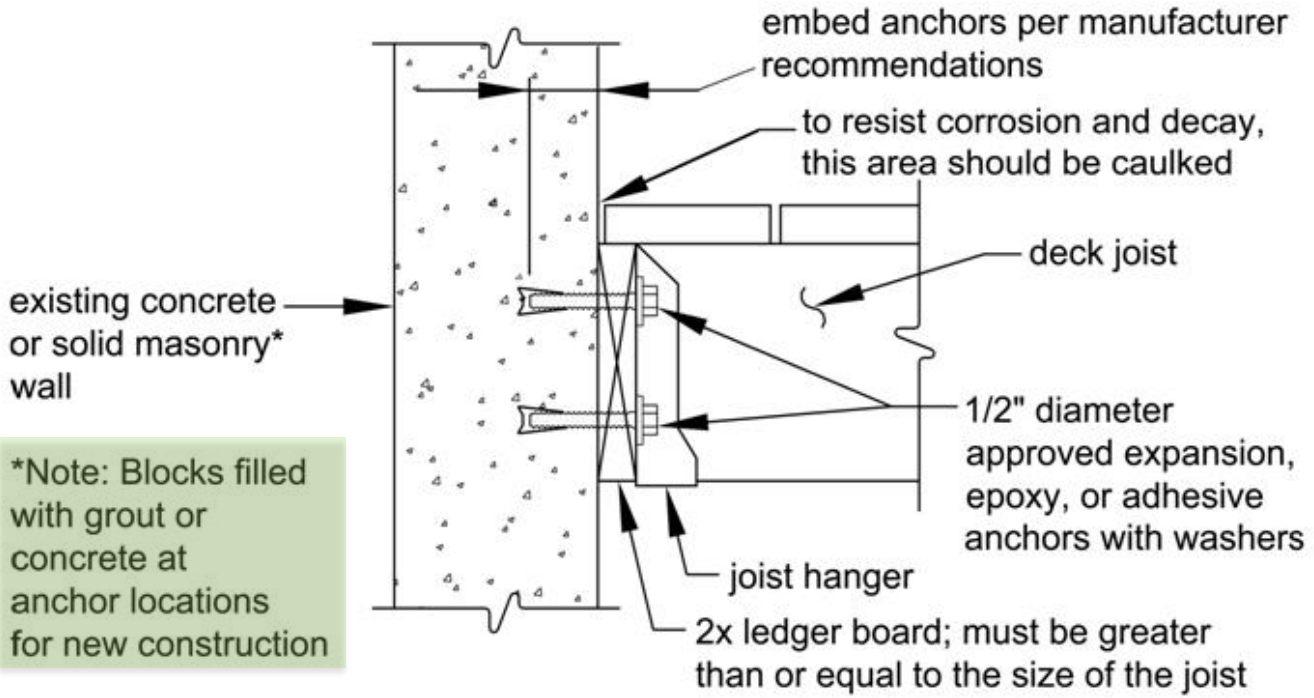
See Figure 14 for rim joist fastener spacing

*Distance can be reduced to 4.5" if lag screws are used or bolt spacing is reduced to that of lag screws to attach 2x8 ledgers to 2x8 band joists (1/2" stacked washers not permitted)

Ledger – DCA6-15

- Ledger board to foundation wall
  - Concrete or solid masonry
  - ½″ approved anchors

Figure 15: Attachment of Ledger Board to Foundation Wall (Concrete or Solid Masonry)



Ledger – DCA6-15

- I-joists
  - 1″ or thicker EWP rim joist
    - OSB
    - SCL including LVL
  - <1″ rim joist
    - Non-ledger deck
    - Full plan submission
- Trusses
  - 2x4 ribbon
    - No deck attachment
  - Requirements
    - Standard details
    - Non-ledger deck
    - Full plan submission
    - SBCA tech note

Figure 13A. Wood I-Joist Profile

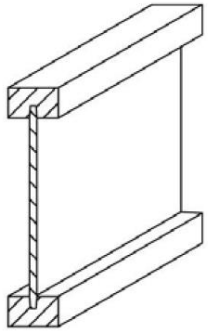
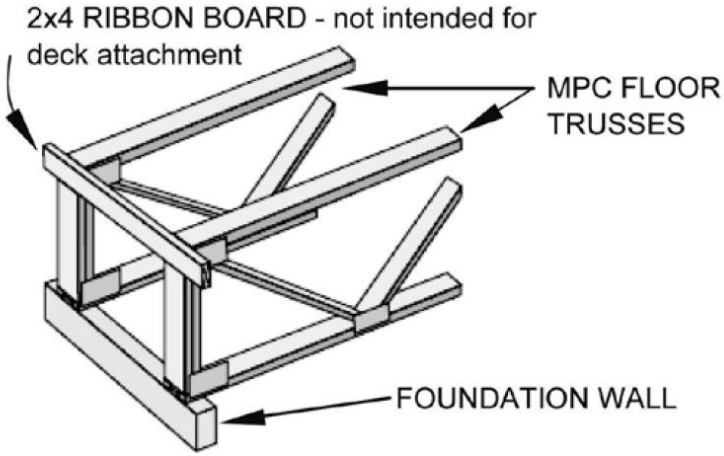


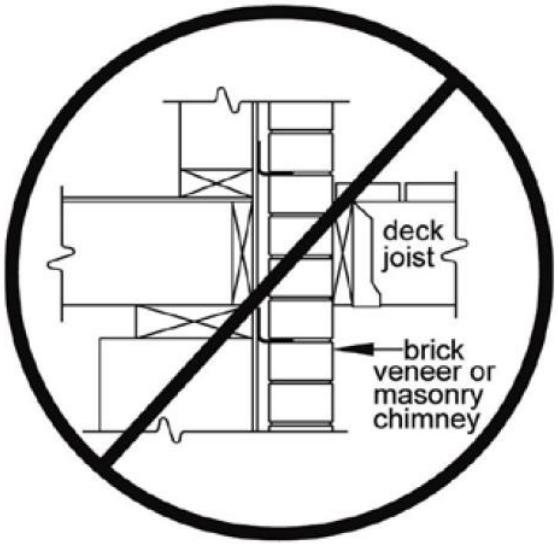
Figure 13B. Metal Plate Connected (MPC) Wood Floor Trusses with a 2x4 Lumber "Ribbon" at the Ends of the Trusses



Ledger

- Exterior veneers
  - Brick
  - Masonry
  - Stone
- Requires non-ledger deck

Figure 17. No Attachment to or Through Exterior Veneers (Brick, Masonry, Stone)



DCA6-12

Ledger – DCA6-15

- Cantilevered floors
- Bay windows
- Requires non-ledger deck

Figure 18. No Attachment to House Overhang

Lateral Load Devices

2015 IRC

R507.1 – "…Where supported by attachment to an exterior wall, decks shall be positively anchored to the primary structure and designed for both vertical and lateral loads."

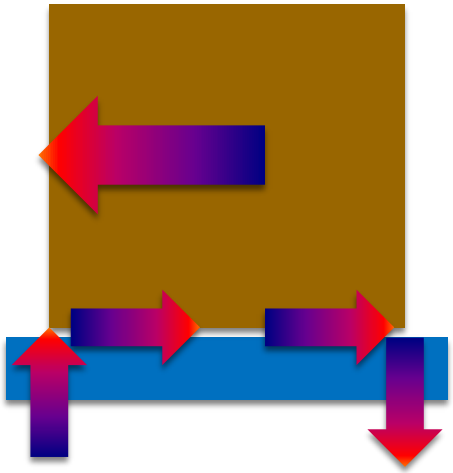
R507.2.4 – "The lateral load connection require by Section 507.1 shall be permitted to be in accordance with Figure R507.2.3(1) or Figure R507.2.3(2)…"

Figure R507.2.3(1) – Previous Solution

- 1,500 lbs
- Two locations at ends (within 24")

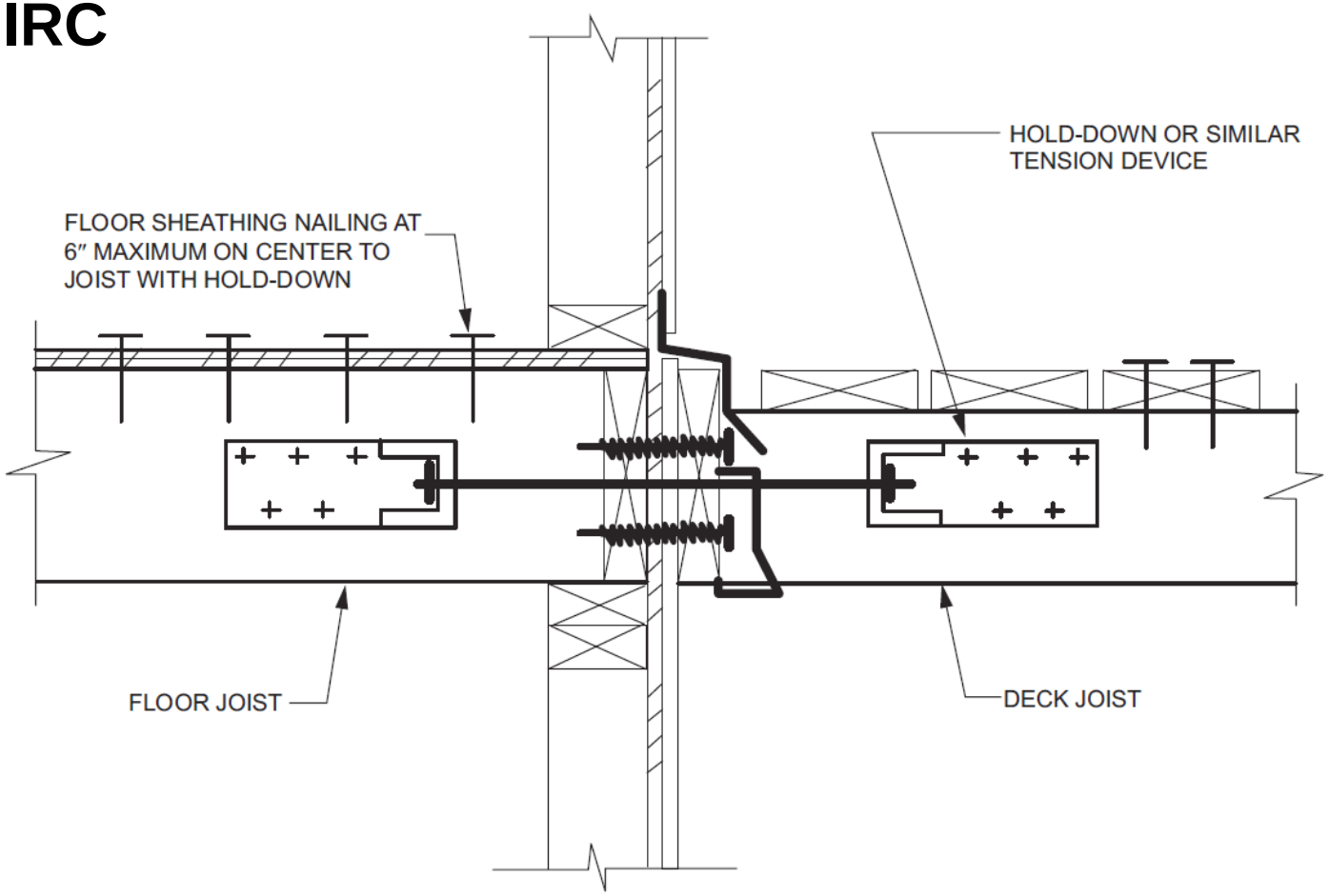
Figure R507.2.3(2) – Washington State Solution

- 750 lbs
- Four locations



Lateral Load Devices

2015 IRC

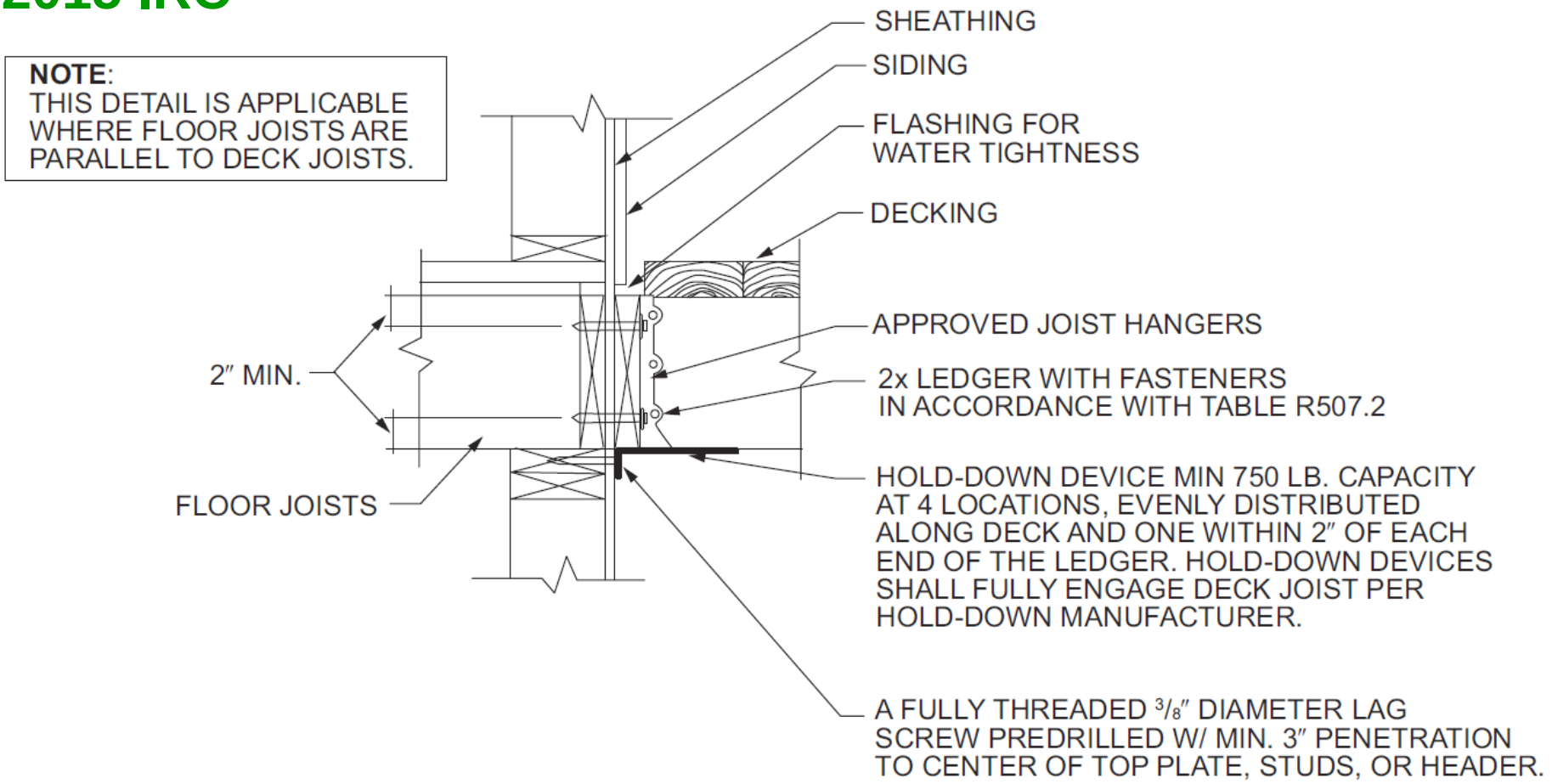


For SI: 1 inch = 25.4 mm.

FIGURE 507.2.3(1)
DECK ATTACHMENT FOR LATERAL LOADS

Lateral Load Devices=LESS HEARTBURN!

2015 IRC



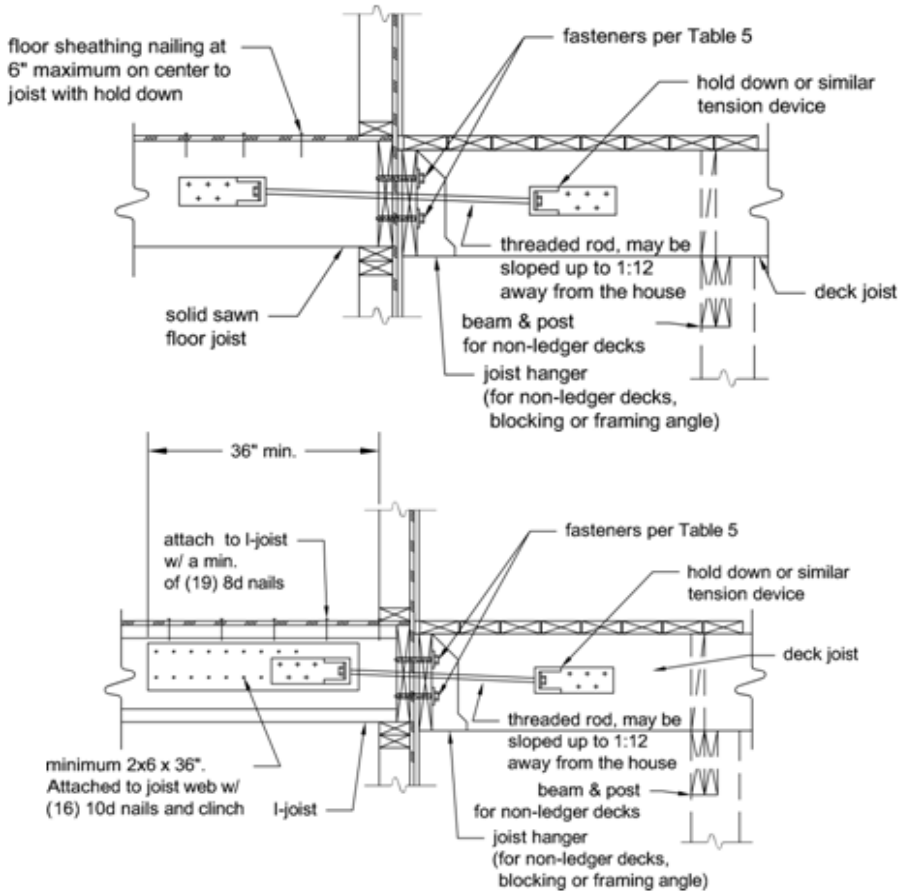
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

FIGURE R507.2.3(2)
DECK ATTACHMENT FOR LATERAL LOADS

Lateral Load Devices – DCA6-15

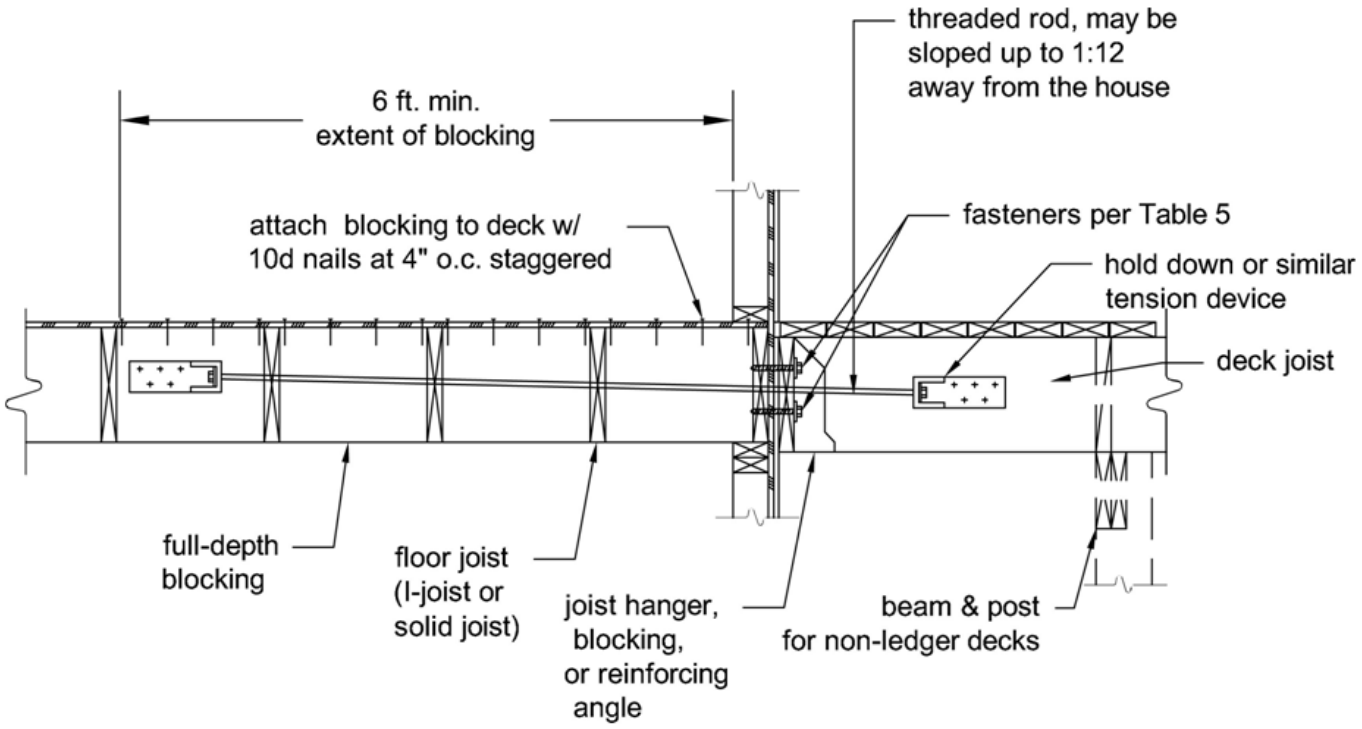
- Attachment to House
  - Lateral attachment to house floor system
  - *2012 IRC*
  - 2 locations per deck
  - 1500 lb capacity
  - Always required

Figure 22 Lateral Load Device with Joists Parallel to Deck Joists



Lateral Load Devices – DCA6-15

Figure 23: Lateral Load Device with Joists Perpendicular to Deck Joists



Guards

36″ height, min.– Changed in 2015 IRC. Seating areas did not factor into the 36″ min. guard height

2012 IRC-OK

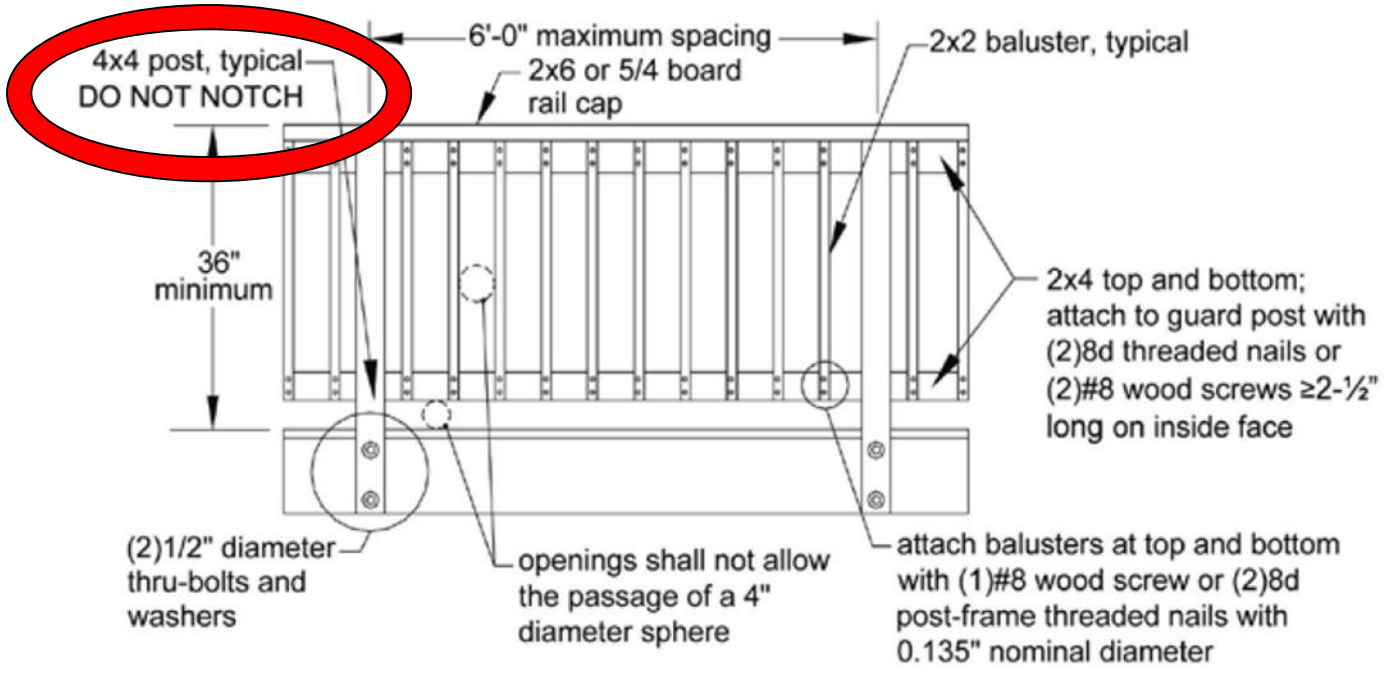
DCA6-15

Guards

- **Guard requirements**
  - **Deck height > 30”**
  - **Guard Required**

DCA6-15

Figure 24. Example Guard Detail



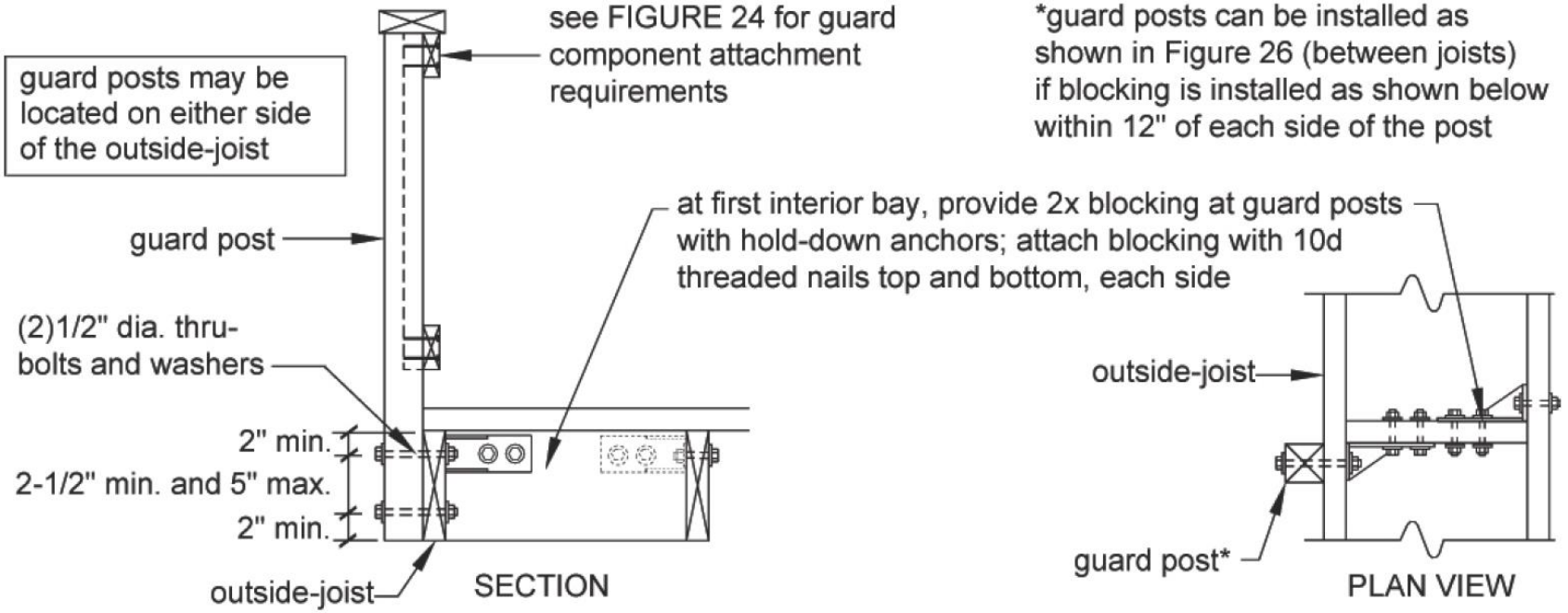
Guards

- IBC/IRC require guard rails to resist 200 lb concentrated load [Table R301.5]
- ***Tests require 2.5 safety factor per IBC [1709.3.1] 500 lbs.!***
- Virginia Tech Research
  - Typical ½" bolt or lag screw connections failed
  - Commercial hold down passed

Guards – DCA6-15

- Minimum 4x4 post
- Bending design value ≥ 1,100 psi
  - All No.2 species shown in Table 2
  - $C_M = 0.85$, $C_i = 0.80$, $C_D = 1.6$

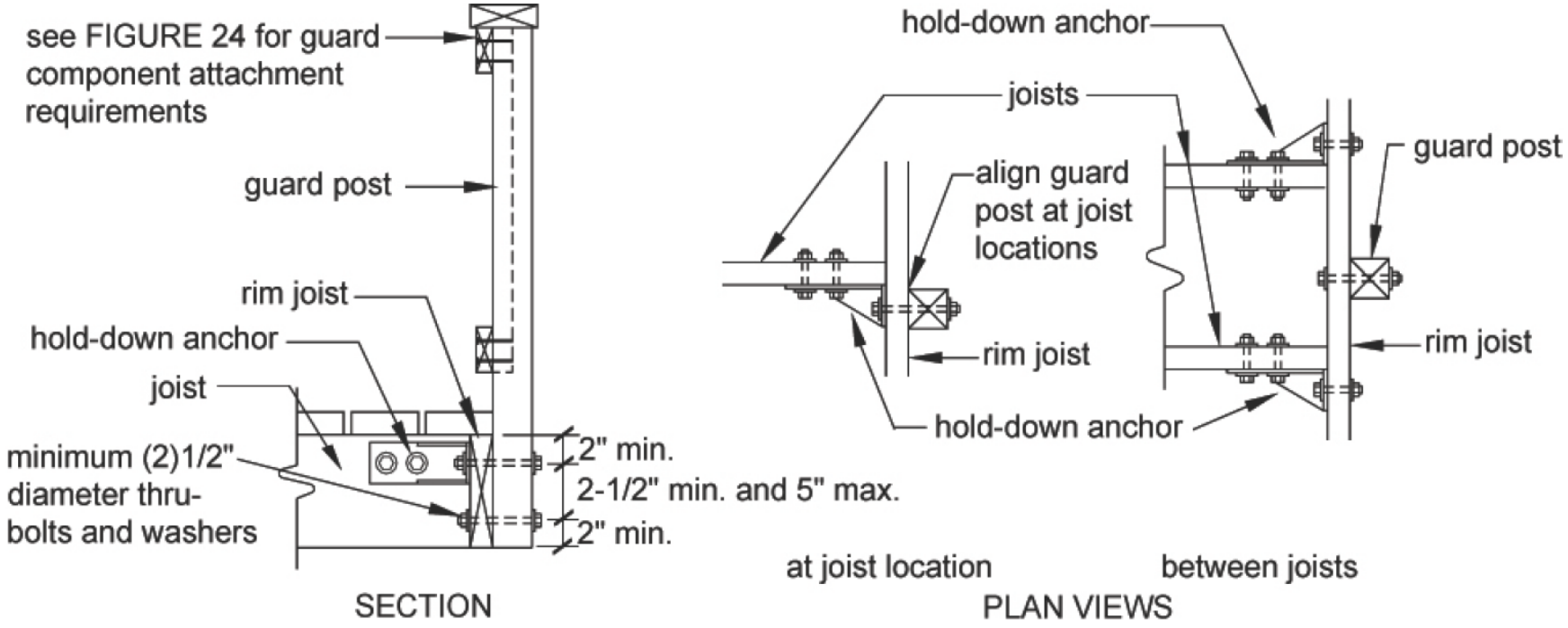
Figure 25. Guard Post to Outside Joist Example



Guards – DCA6-15

- Guard Post to Rim Joist
  - Hold down anchors
  - Minimum of two ½" bolts

Figure 26. Guard Post to Rim Joist Example



Guards – 2015 IRC and beyond?

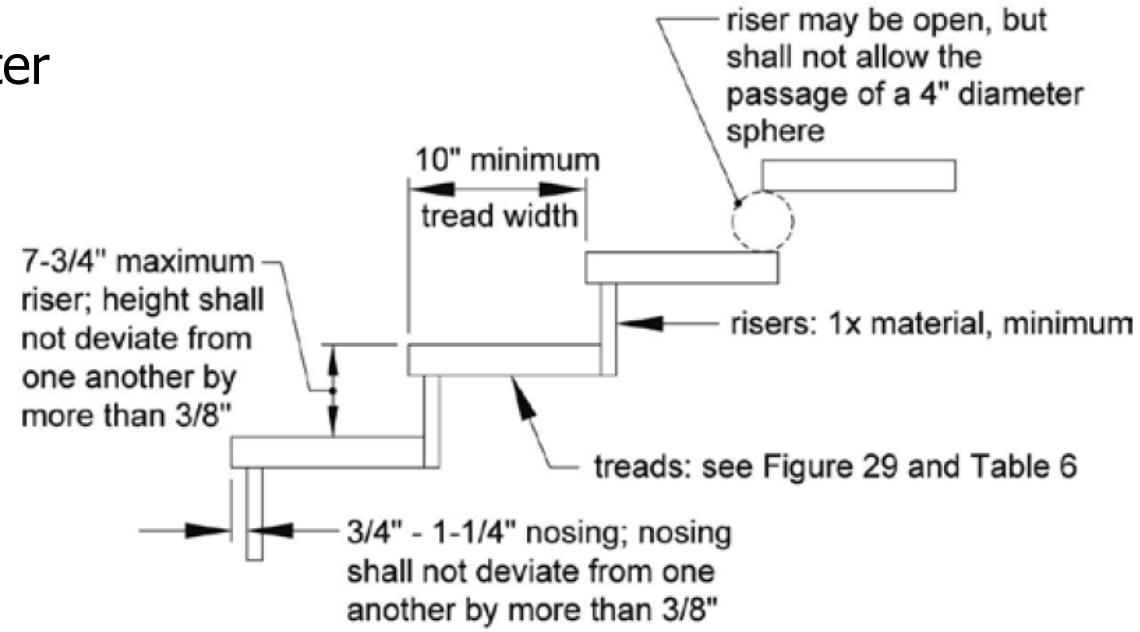
- Nothing Specific to Decks
  - Gives requirements in Table R301.5 and R312
- Deck Code Coalition proposed changes for the 2018 IRC- APPROVED
  - Generically strengthen deck structure
  - Provide wood and mechanical hold-down / commodity solutions
  - Simplify load direction

Guards[h, i]	200# outward 200# downward 50# inward 50# upward

Stairs – DCA6-15

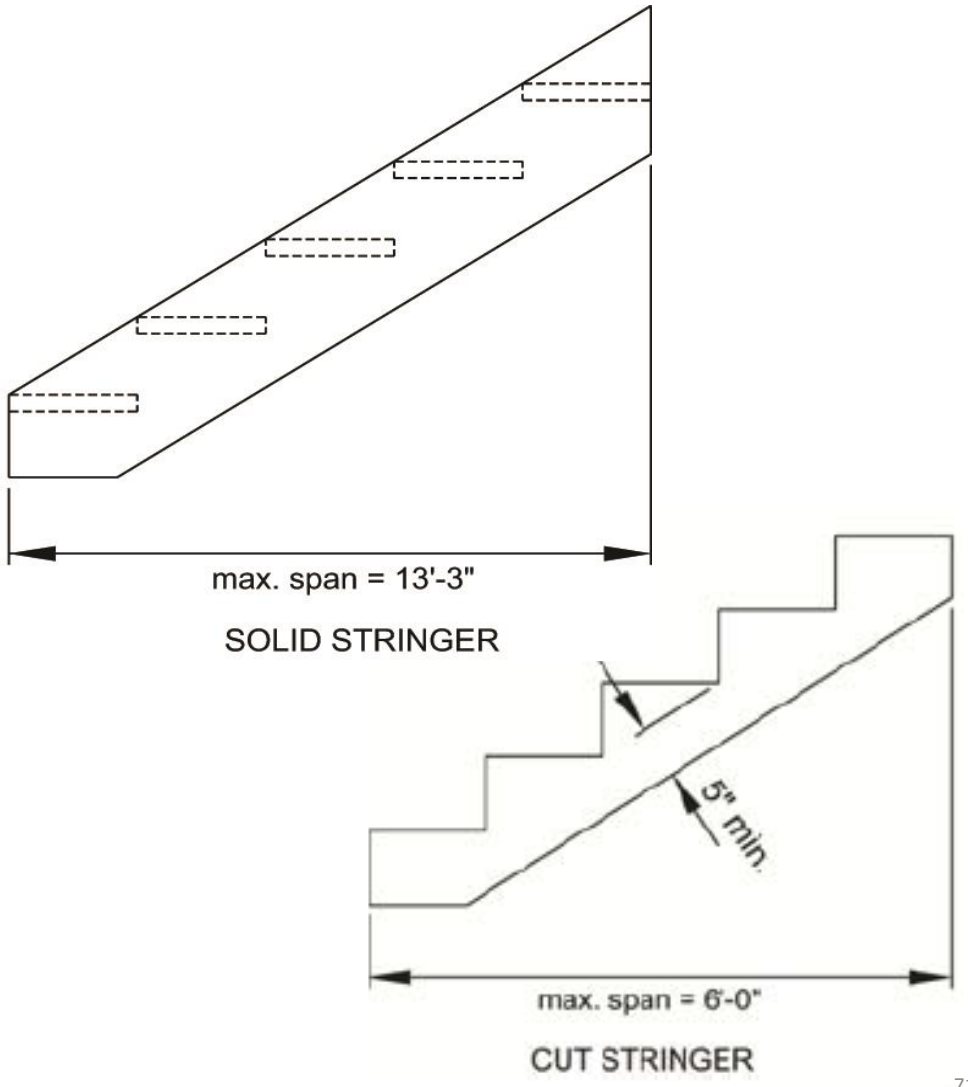
- Treads and Risers
  - 7-3/4″ rise & 10″ run
  - Except where amended
  - 1x risers
  - Treads per Table 6
  - Openings < 4″ diameter sphere

Figure 27. Tread and Riser Detail



Stairs – DCA6-15

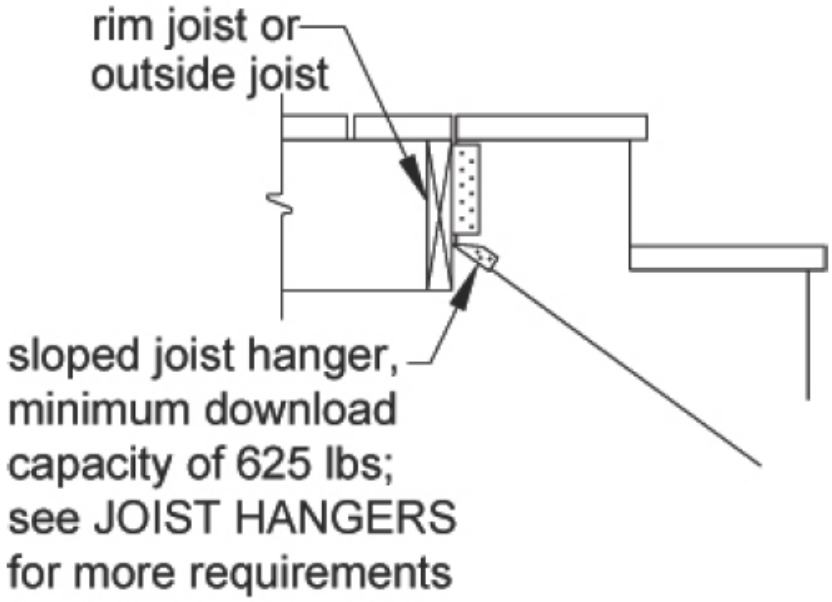
- Stringers
  - Minimum 2x12
  - Spans per Figure 28
  - Intermediate landings permitted



Stairs – DCA6-15

- Stringer Attachment
  - Hangers
    - Sloped joist hanger
    - Per manufacturer

Figure 31. Stair Stringer Attachment Detail

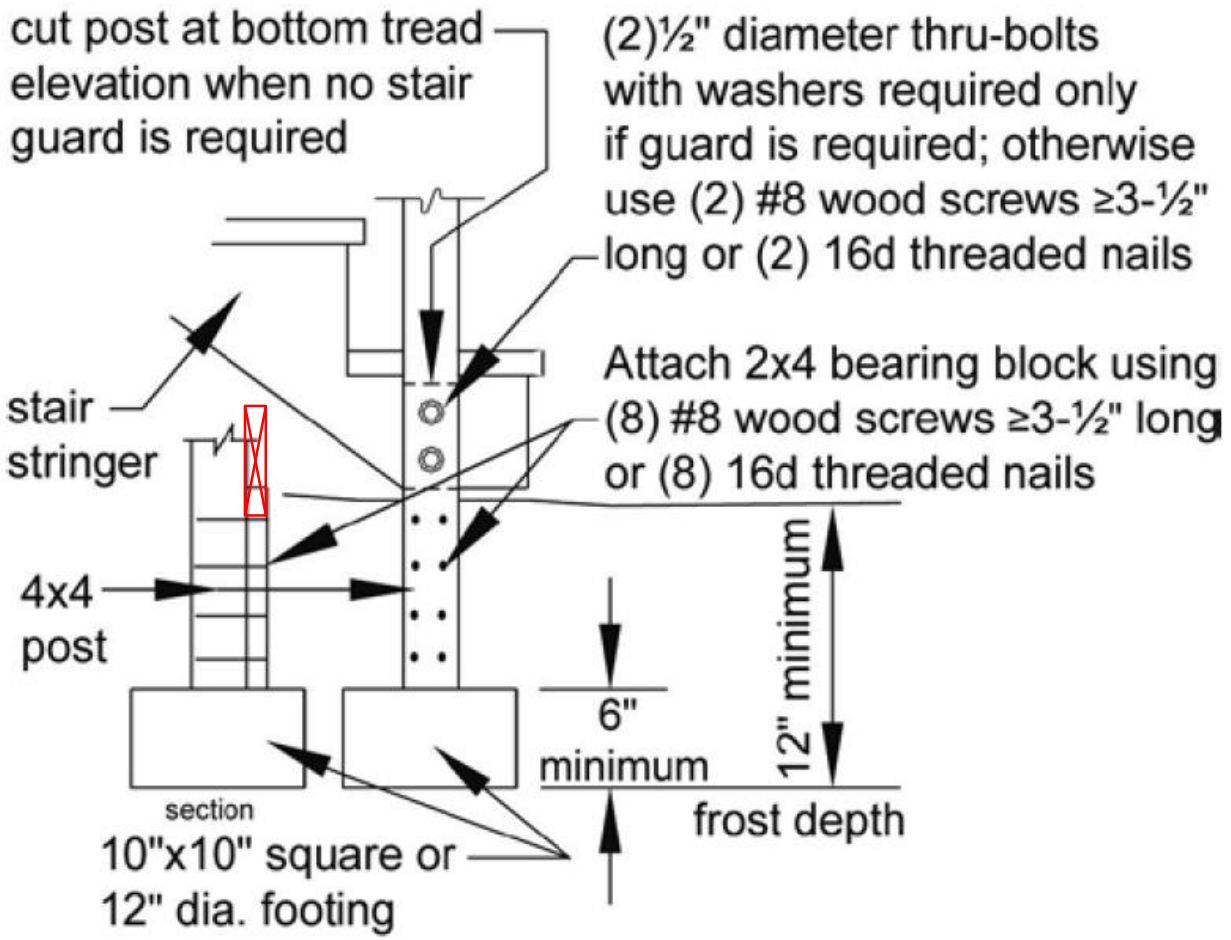


ATTACHMENT WITH HANGERS

Stairs – DCA6-15

- Lighting
  - Top landing
  - Illuminate all landings
  - Light switch inside the house

Figure 34. Stair Footing Detail

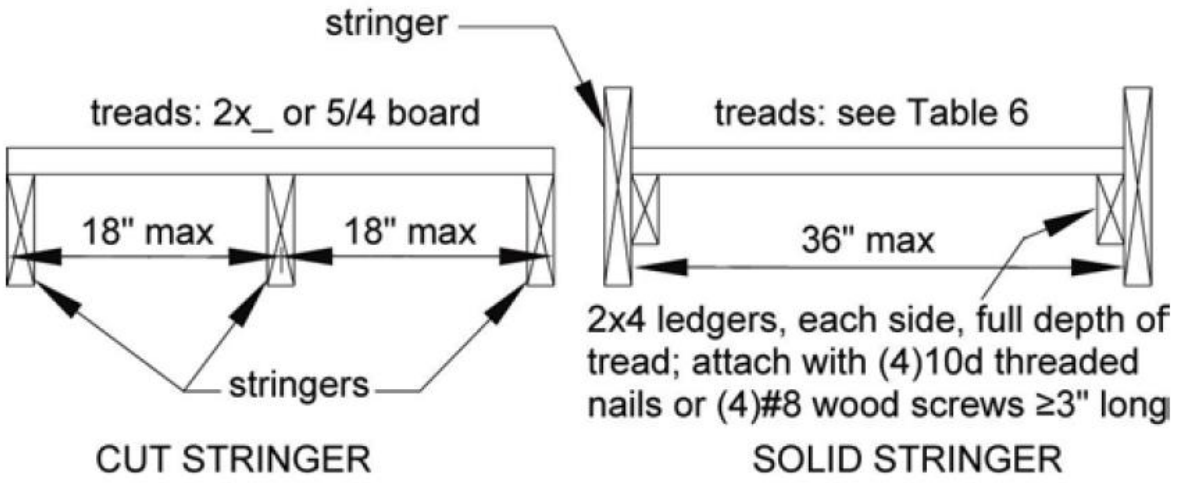


Stringers and Treads – DCA6-15

- Stringers
  - Cut ≤ 18″ o.c.
  - Solid ≤ 36″ o.c.
- Treads
  - Sizes per Table 6
  - Connections per Fig 29

Figure 29. Tread Connection Requirements

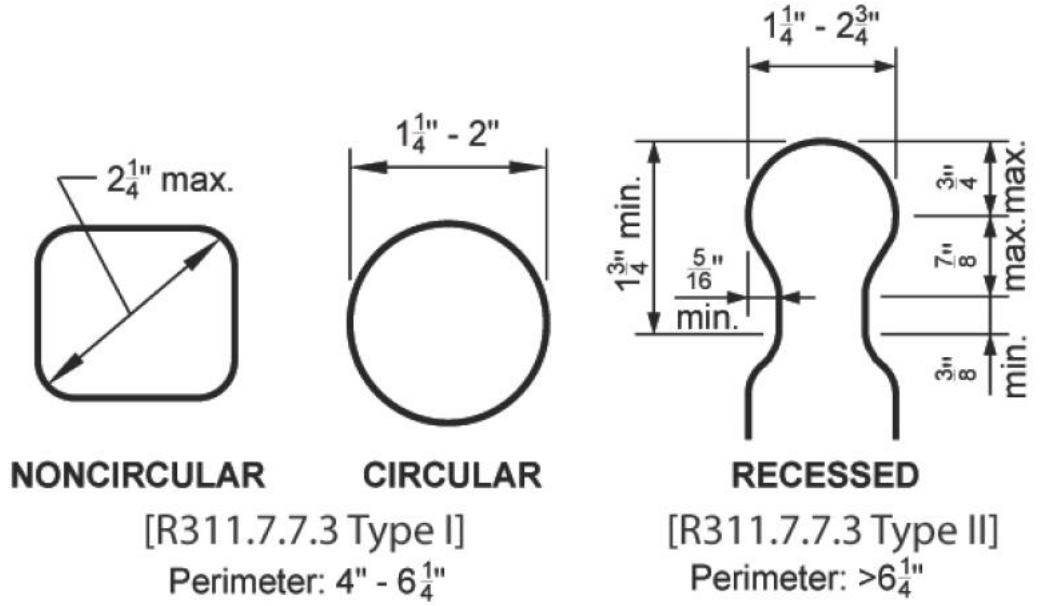
Attachment per tread at each stringer or ledger:
2x_ or 5/4 treads - (2)8d threaded nails or (2)#8 screws ≥2-1/2" long
3x_ treads - (2)16d threaded nails or (2)#8 screws ≥3-1/2" long



Handrails – DCA6-15

- Handrails
  - Type I: 4″ – 6¼″ perimeter
    - Circular
      - 1¼″ – 2″ diameter
    - Noncircular
      - Max. cross section 2¼″
  - Type II: >6¼″ perimeter
    - Graspable recess

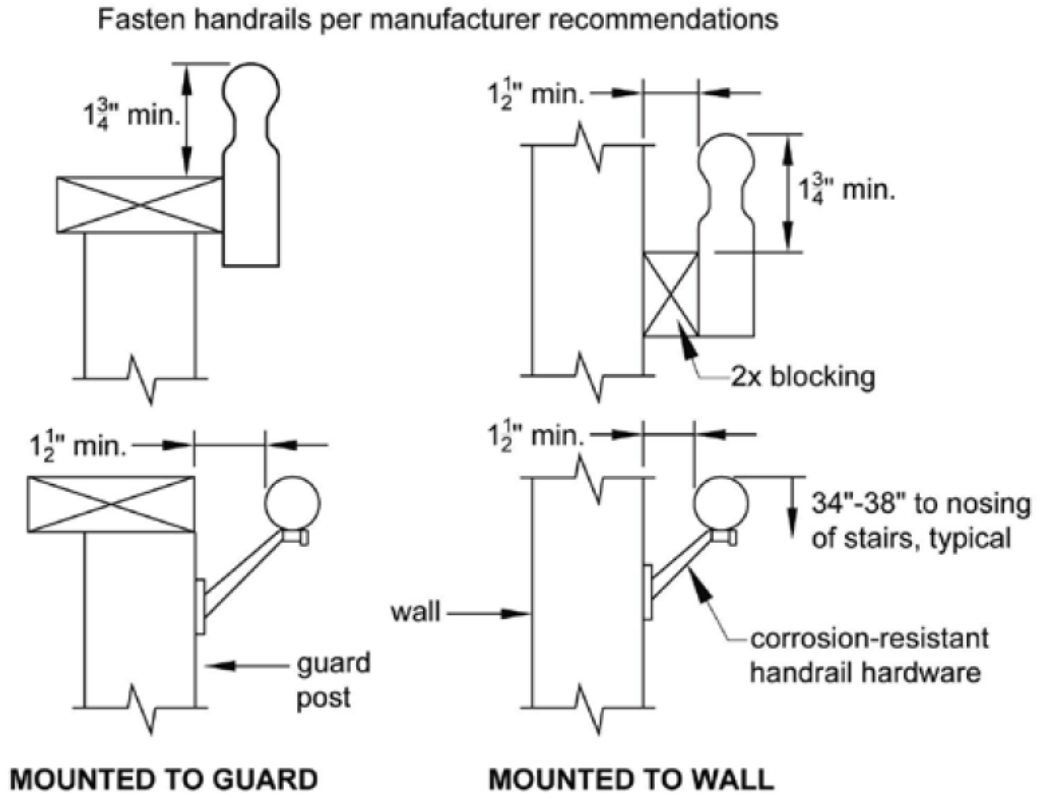
Figure 32B. Handrail Grip Size



Handrails – DCA6-15

- Handrails
  - Required for stairs with 4 or more treads
  - Height 34″ – 38″

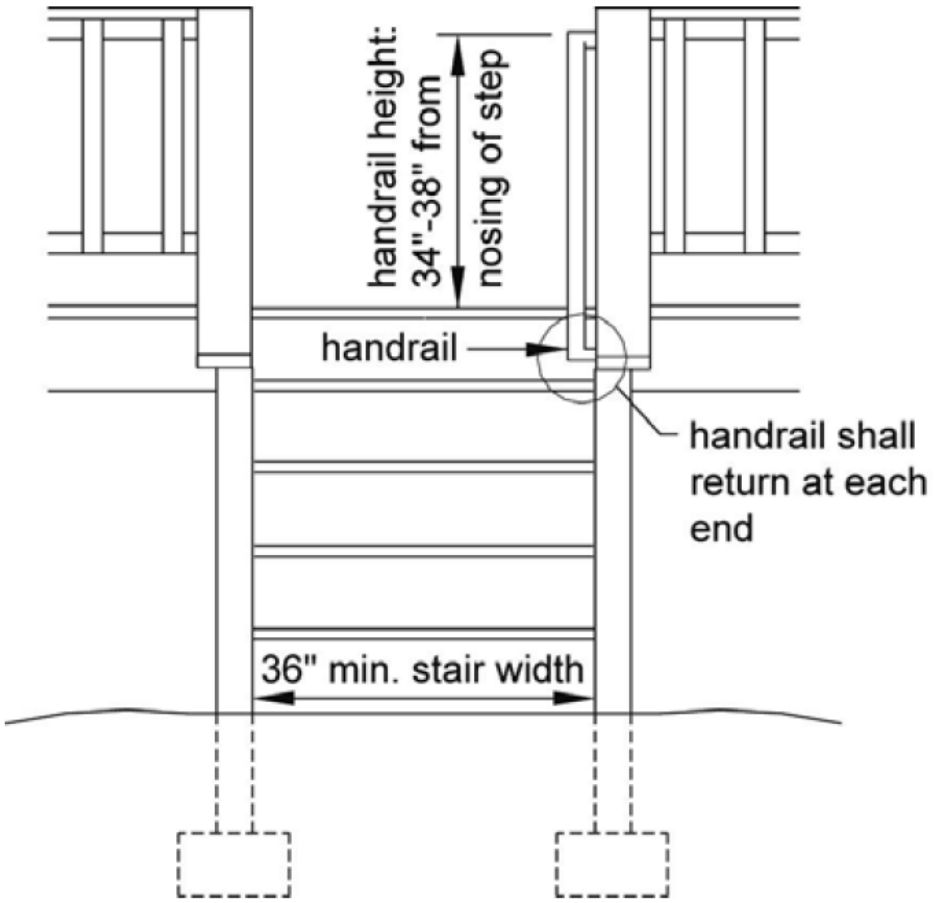
Figure 32A. Handrail Mounting Examples



Handrails – DCA6-15

- Handrails
  - Continuous from lowest to highest riser
  - Return to guard at each end
  - May be interrupted by guard at turn

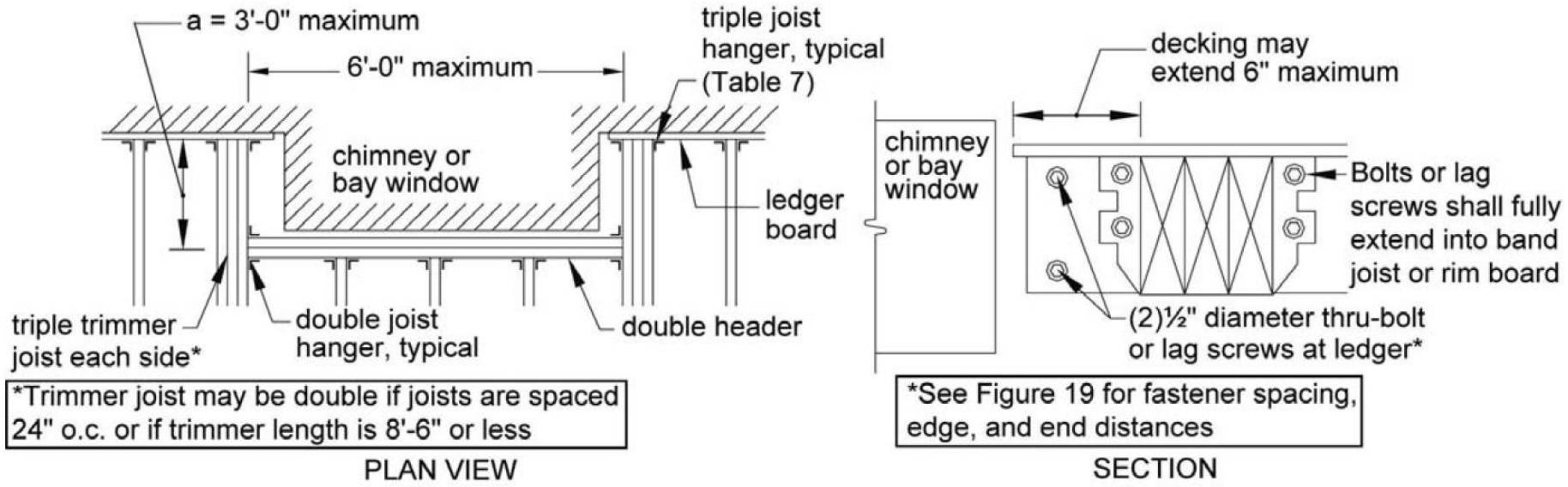
Figure 33. Miscellaneous Stair Requirements



Chimney or Bay Window – DCA6-15

- Headers 6′ maximum span
  - Use 6x6 post to reduce spans to ≤6′
  - >6′ span requires plan submission

Figure 35: Detail for Framing Around a Chimney or Bay Window



Chimney or Bay Window – DCA6-15

- Trimmers
  - Triple
    - 12"-16" joist spacing
    - Spans > 8'-6"
  - Double
    - 24" joist spacing
    - Spans ≤ 8'-6"
  - "a" ≤ 3'

Table 7: Trimmer Joist Hanger Vertical Capacity

Joist Size	Minimum Capacity, lbs
2x6	870
2x8	1155
2x10	1420
2x12	1575

Other Recourses

- DCA6 Commentary and Appendixes
- AWC.org (calculators, helpdesk)
- Wood Structural Design Database (member sizing)
- National Design Specification for Wood Construction (almost everything)
- Wood Design Focus (specific, deck-related topics)

DCA 6 Commentary

- Background information
- Example calculations
- Alternative provisions

Table C2. Conditions Where Deflection Controls Overhang Length*.

Species	Size	Joist Spacing (o.c.) 12"	16"	24"
		Allowable Overhang[3] (L_O)		
Southern Pine	2x6[6]	1' - 0"	1' - 1"	1' - 3"
	2x8	1' - 10"	2' - 0"	2' - 4"
	2x10	3' - 1"	3' - 5"	2' - 10"
	2x12	4' - 6"	4' - 2"	3' - 4"
Douglas Fir-Larch, Hem-Fir, Spruce-Pine-Fir[4]	2x6[6]	0' - 11"	1' - 0"	1' - 2"
	2x8	1' - 8"	1' - 10"	2' - 2"
	2x10	2' - 10"	3' - 2"	2' - 9"
	2x12	4' - 4"	3' - 11"	3' - 3"
Redwood, Western Cedars, Ponderosa Pine[5], Red Pine[5]	2x6[6]	0' - 9"	0' - 10"	0' - 11"
	2x8	1' - 5"	1' - 7"	1' - 9"
	2x10	2' - 5"	2' - 7"	2' - 8"
	2x12	3' - 7"	3' - 9"	3' - 1"

* Shading indicates overhang is deflection controlled. See Table 2 for footnotes.

DCA 6 Commentary

- Helpful Guidance
  - Ex: Joists framing into 2 sides of the same beam
    - 8′-0″ joists from opposite sides
    - Use 16′-0″ joist spans for equivalent tributary area

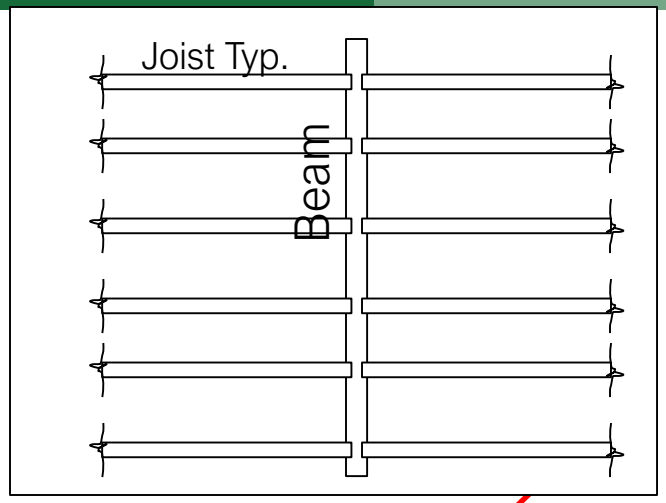


Table 3A. Dimension Lumber Deck Beam Spans (L_B)[1] for Joists Framing from One Side Only.

Species	Size[4]	Joist Spans (L) Less Than or Equal to: 6'	8'	10'	12'	14'	16'	18'
Southern Pine	2-2x6	6' - 8"	5' - 8"	5' - 1"	4' - 7"	4' - 3"	4' - 0"	3' - 9"
	2-2x8	8' - 6"	7' - 4"	6' - 6"	5' - 11"	5' - 6"	5' - 1"	4' - 9"
	2-2x10	10' - 1"	8' - 9"	7' - 9"	7' - 1"	6' - 6"	6' - 1"	5' - 9"
	2-2x12	11' - 11"	10' - 4"	9' - 2"	8' - 4"	7' - 9"	7' - 3"	6' - 9"
	3-2x6	7' - 11"	7' - 2"	6' - 5"	5' - 10"	5' - 5"	5' - 0"	4' - 9"
	3-2x8	10' - 7"	9' - 3"	8' - 3"	7' - 6"	6' - 11"	6' - 5"	6' - 1"
	3-2x10	12' - 9"	11' - 0"	9' - 9"	8' - 9"	8' - 3"	7' - 8"	7' - 3"
	3-2x12	15' - 0"	13' - 0"	11' - 7"	10' - 6"	9' - 9"	9' - 1"	8' - 7"

DCA 6 Commentary

- Alternate prescriptive provisions
  - Ex: 4x4 Posts

Table C4a. 4x4 Post Heights

Beam Span, L_B	Joist Span L_J	Post Heights[1]				
		Southern Pine	Douglas Fir-Larch[3]	Hem-Fir[3], Western Cedars	Redwood	Ponderosa Pine, Red Pine, SPF[3]
6'	<10'	4'	2'	3'	4'	3'
	<14'	3'	2'	2'	3'	2'
	<18'	2'	2'	2'	2'	2'
8'	<10'	3'	2'	2'	4'	2'
	<14'	2'	2'	2'	3'	2'
	<18'	2'	2'	2'	2'	2'
10'	<10'	3'	2'	2'	3'	2'
	<14'	2'	2'	2'	2'	2'
	<18'	2'	2'	2'	2'	2'

DCA 6 Commentary

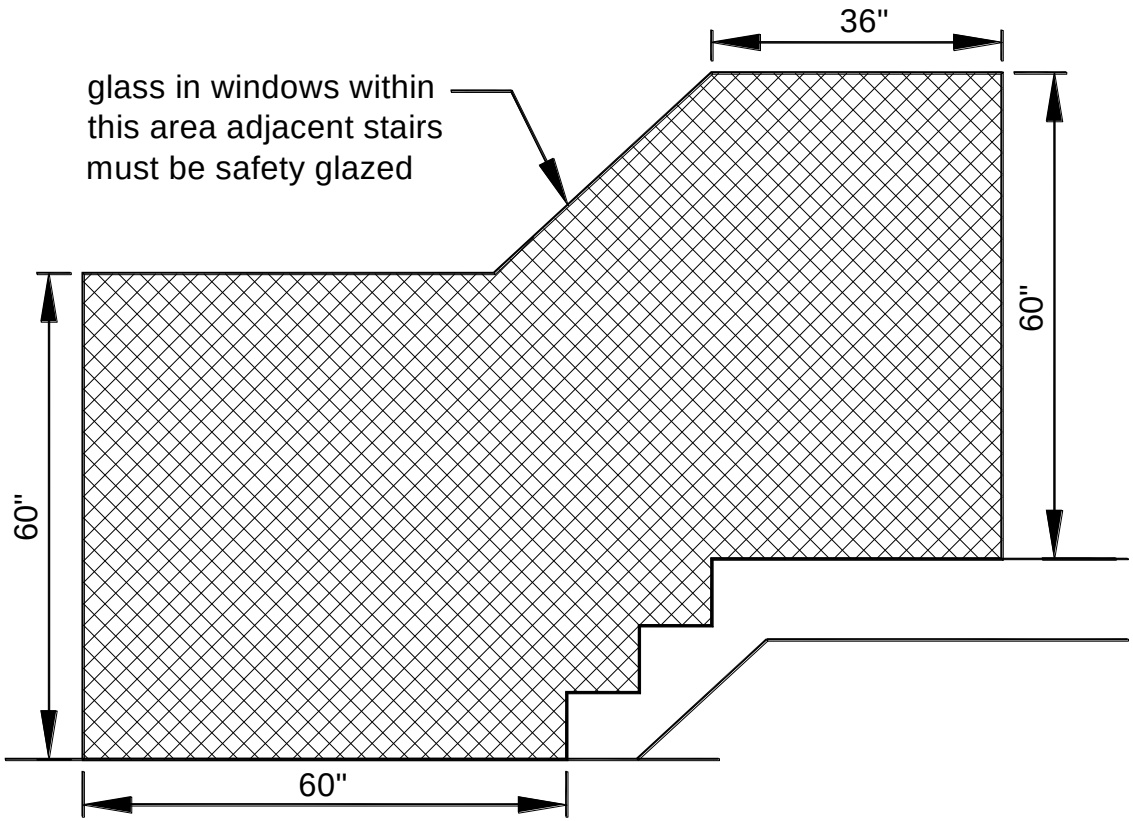
- Alternate prescriptive provisions
  - Ex: Soil Bearing Capacities

Table C4b. Footing Sizes for Higher Soil Bearing Capacities

Beam Span, L_B	Joist Span L_J	2000 psf			2500 psf			3000 psf		
		Round Footing Diameter	Square Footing	Footing Thickness[4]	Round Footing Diameter	Square Footing	Footing Thickness[4]	Round Footing Diameter	Square Footing	Footing Thickness[4]
6'	≤10'	15"	13"x13"	6"	14"	12"x12"	6"	12"	11"x11"	6"
	≤14'	18"	16"x16"	7"	16"	14"x14"	6"	15"	13"x13"	6"
	≤18'	20"	18"x18"	8"	18"	16"x16"	7"	16"	15"x15"	6"
8'	≤10'	17"	15"x15"	6"	16"	14"x14"	6"	14"	13"x13"	6"
	≤14'	21"	18"x18"	8"	18"	16"x16"	7"	17"	15"x15"	6"
	≤18'	23"	21"x21"	9"	21"	18"x18"	8"	19"	17"x17"	7"
10'	≤10'	19"	17"x17"	7"	17"	15"x15"	6"	16"	14"x14"	6"
	≤14'	22"	21"x21"	9"	20"	18"x18"	8"	19"	17"x17"	7"
	≤18'	26"	23"x23"	11"	23"	21"x21"	9"	21"	19"x19"	8"

DCA 6 Commentary – Appendix A

- Safety glazing provisions



DCA 6 Commentary – Appendix B

- Tributary area provisions

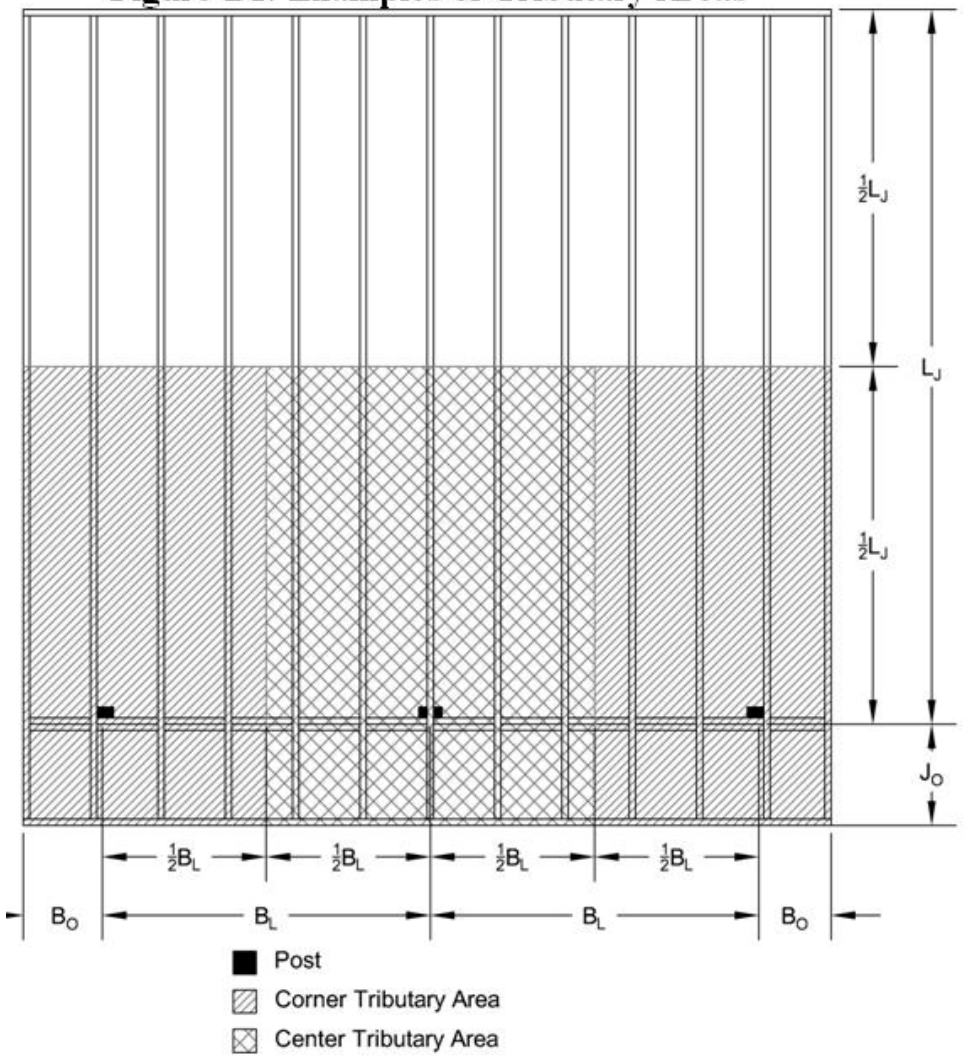
$$A_{CenterPost} = \left(\frac{1}{2}J_L + J_O\right)(B_L) \qquad \text{Eq. B-1}$$

$$A_{CornerPost} = \left(\frac{1}{2}J_L + J_O\right)\left(\frac{1}{2}B_L + B_O\right) \qquad \text{Eq. B-2}$$

Where:

A is tributary area (ft^2)
J_L is length of joist (ft)
J_O is length of joist overhang (ft)
B_L is the length of the beam span (ft)
B_O is the length of the beam overhang (ft)

Figure B1. Examples of Tributary Areas



DCA 6 Commentary – Appendix B

- Tributary area provisions: Post Height

Table B1. Post Heights Based[1,3] on Tributary Area for Corner Posts.

Tributary Area (sq. ft.)	6x6 Post Height (ft.)					4x4 Post Height (ft.)				
	Southern Pine	Douglas Fir-Larch[2]	Hem-Fir[2], Western Cedars	Redwood	Ponderosa Pine, Red Pine, SPF[2]	Southern Pine	Douglas Fir-Larch[2]	Hem-Fir[2], Western Cedars	Redwood	Ponderosa Pine, Red Pine, SPF[2]
10	14	14	14	14	14	9	7	7	11	8
20	14	14	14	14	14	6	4	5	7	5
30	14	14	14	14	14	5	3	4	6	4
40	14	14	14	14	14	4	3	3	5	3
50	14	14	14	14	14	4	2	3	4	3
60	14	14	14	14	14	3	2	2	4	2
70	14	14	14	14	13	3	2	2	3	2
80	14	14	13	14	12	2	2	2	3	2
90	14	14	12	14	10	2	2	2	2	2
100	14	14	11	13	9	2	2	2	2	2

DCA 6 Commentary – Appendix B

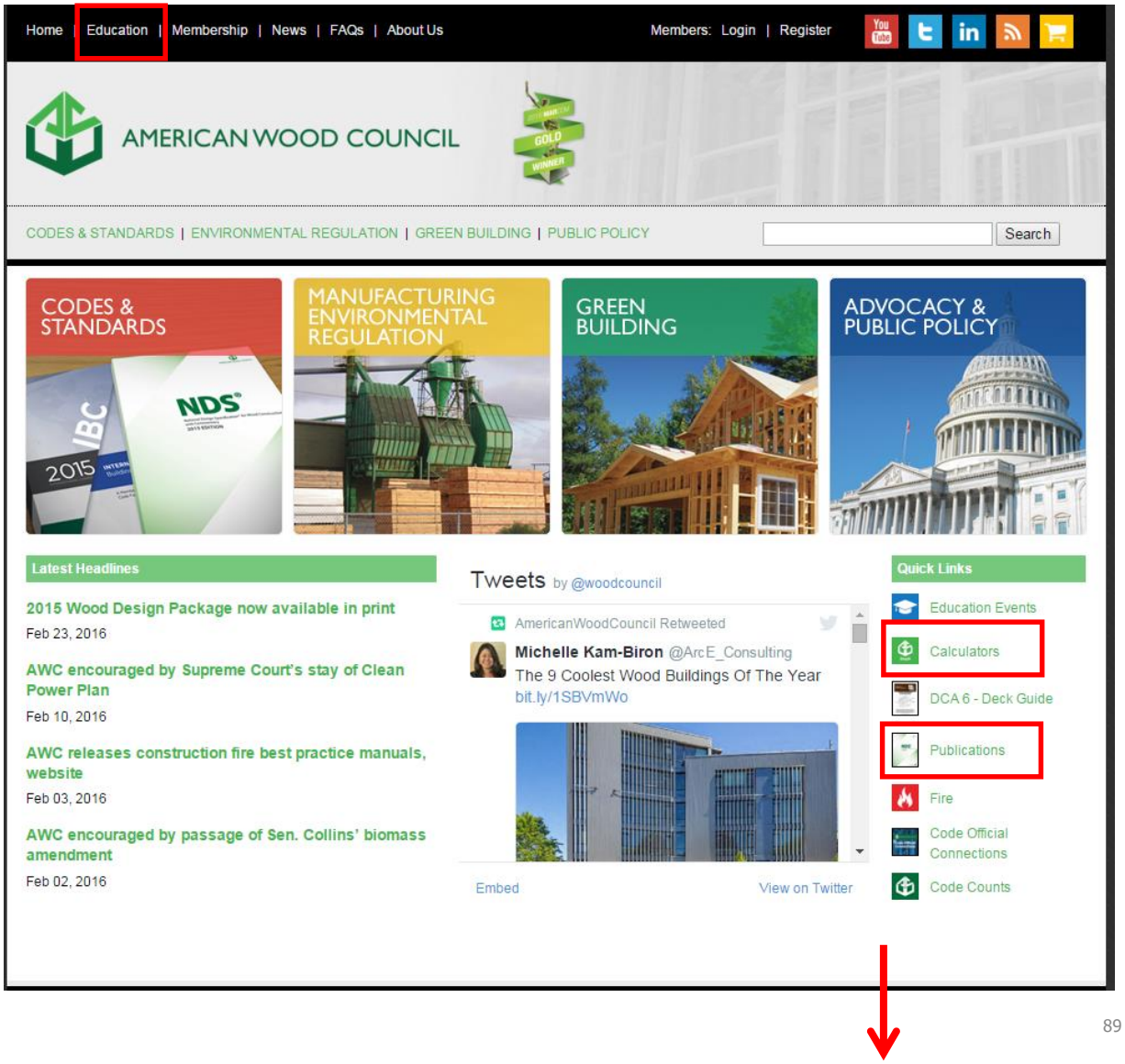
- Tributary area provisions: Footing Size

Table B3. Footing Sizes[1] Based on Tributary Area for Various Soil Capacities.

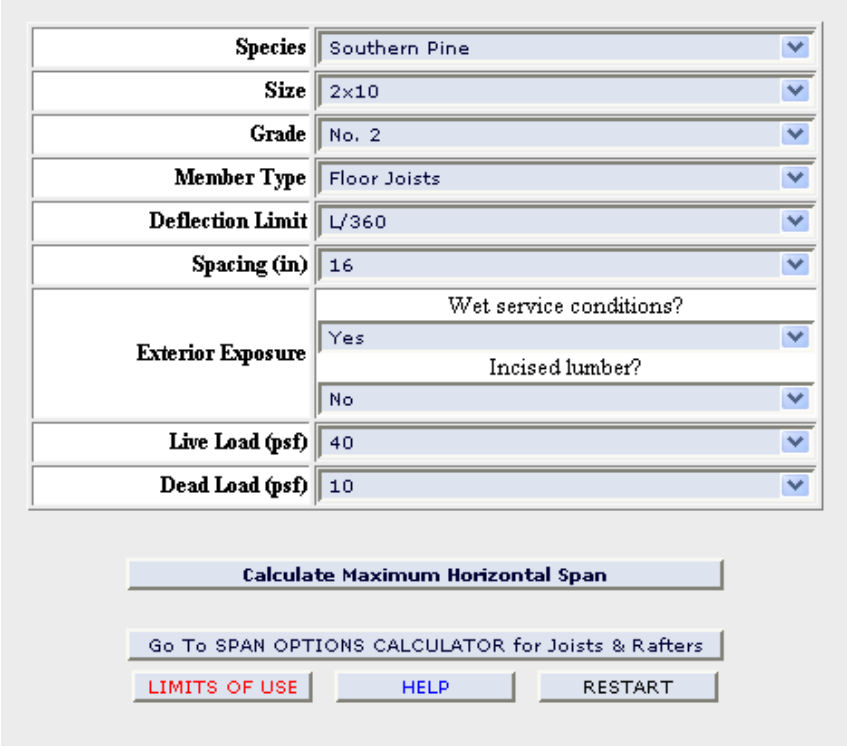
Tributary Area[2] (sq. ft.)	Soil Bearing Capacity											
	1500 psf			2000 psf			2500 psf			3000 psf		
	Round Footing Diameter (in.)	Square Footing (in.)	Footing Thickness (in.)	Round Footing Diameter (in.)	Square Footing (in.)	Footing Thickness (in.)	Round Footing Diameter (in.)	Square Footing (in.)	Footing Thickness (in.)	Round Footing Diameter (in.)	Square Footing (in.)	Footing Thickness (in.)
10	8	7	6	7	7	6	7	6	6	6	5	6
20	12	10	6	10	9	6	9	8	6	8	7	6
30	14	13	6	12	11	6	11	10	6	10	9	6
40	16	15	6	14	13	6	13	11	6	12	10	6
50	18	16	7	16	14	6	14	13	6	13	12	6
60	20	18	8	17	15	6	16	14	6	14	13	6
70	22	19	9	19	17	7	17	15	6	15	14	6
80	23	21	9	20	18	8	18	16	7	16	15	6
90	25	22	10	21	19	8	19	17	7	17	15	6
100	26	23	11	23	20	9	20	18	8	18	16	7

AWC.org

- Span Calculator
- Connection Calculator
- Helpdesk
- Publications
- Education



Span Calculator



- AWC Online Span Calculator
  - Simple spans (no cantilever)
  - Uniform loads
  - Wet service conditions
  - Incising factor
  - 18’-0” MAX (DCA 6)
  - Free at www.awc.org

Apps – not free

The Maximum Horizontal Span is:

15 ft. 10 in.

with a minimum bearing length of **0.93 in.** required at each end of the member.

Property	Value
Species	Southern Pine
Grade	No. 2
Size	2x10
Modulus of Elasticity (E)	1440000 psi
Bending Strength (F_b)	1207.5 psi
Bearing Strength (F_{cp})	378.55 psi
Shear Strength (F_v)	169.75 psi

Connection Calculator

Design Method	Allowable Stress Design (ASD)
Connection Type	Lateral loading
Fastener Type	Bolt
Loading Scenario	Single Shear - Wood Main Member
	Submit Initial Values

Main Member Type	Southern Pine
Main Member Thickness	5.5 in.
Main Member: Angle of Load to Grain	0
Side Member Type	Southern Pine
Side Member Thickness	1.5 in.
Side Member: Angle of Load to Grain	0
Fastener Diameter	1/2 in.
Load Duration Factor	C_D = 1.0
Wet Service Factor	C_M = 0.7
Temperature Factor	C_t = 1.0

Apps – not free

- AWC Online Connection Calculator
  - Single Fastener (No Group Action)
  - Yield Mode Equations
  - Wet service conditions
  - Load duration

Free at www.awc.org

Connection Yield Modes

Im	2960 lbs.
Is	807 lbs.
II	1099 lbs.
IIIm	1270 lbs.
IIIs	461 lbs.
IV	525 lbs.

Adjusted ASD Capacity	461 lbs.

Helpdesk and Education

- Helpdesk
  - info@awc.org
- Education
  - Webinars
  - Presentations
  - Self Study
  - ICC, AIA, NCSEA credits

Free at www.awc.org

THURSDAY, APRIL 14, 2016

2015 WFCM Significant Changes and Introduction to High Wind Guides (STD333)
4/14/2016
Location: *Webinar* ***Time:*** *From 1:55pm until 3pm EST. Education credits awarded.*
Export to Your Calendar Register

THURSDAY, MAY 05, 2016

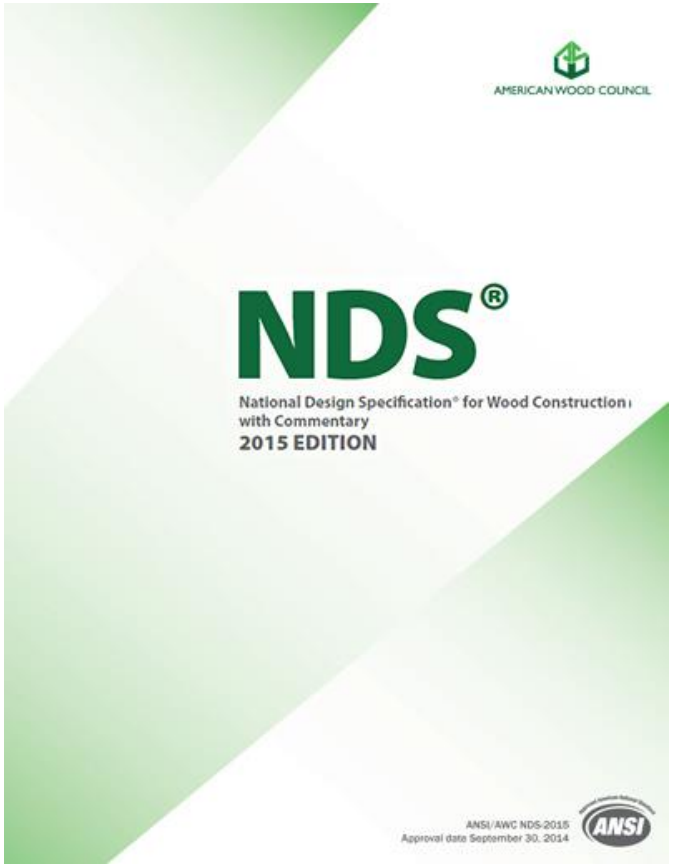
Disaster Resistant Wood Frame Construction Example using 2015 WFCM - Part 1: Loads (STD340-1)
5/5/2016
Location: *Webinar* ***Time:*** *From 1:55pm until 3pm EST. Education credits awarded.*
Export to Your Calendar Register

THURSDAY, MAY 12, 2016

Disaster Resistant Wood Frame Constr Example using 2015 WFCM - Part 2: Roof Story Design (STD340-2)
5/12/2016
Location: *Webinar* ***Time:*** *From 1:55pm until 3pm EST. Education credits awarded.*
Export to Your Calendar Register

Additional Resources

- **2015 National Design Specification® (NDS®) for Wood Construction**
  - **Structural lumber**
    - Design values
  - **Column design**
  - **Beam design**
  - **Connection design**
- **Footing design**
  - **Per engineering mechanics**



Design Values

- **Design values are assigned to predict strength and stiffness properties to meet engineering design requirements**

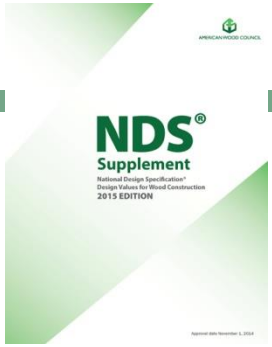


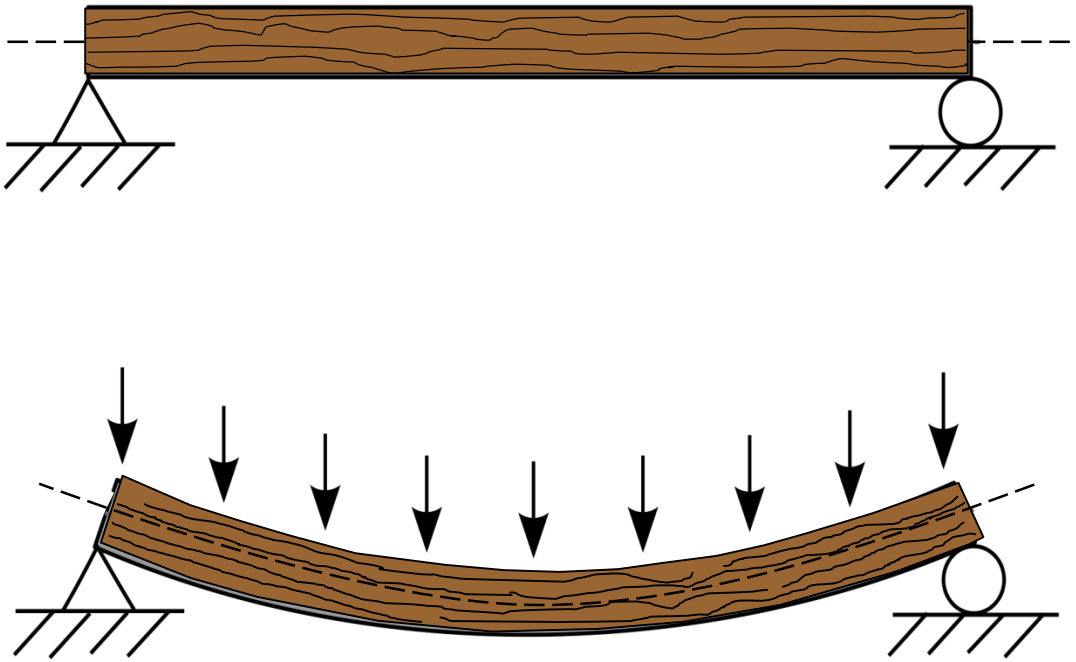
Table 4A (Cont.) Reference Design Values for Visually Graded Dimension Lumber (2" – 4" thick)[1,2,3]

(All species except Southern Pine—see Table 4B) (Tabulated design values are for normal load duration and dry service conditions. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

USE WITH TABLE 4A ADJUSTMENT FACTORS

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							Specific Gravity[4]	Grading Rules Agency
		Bending	Tension parallel to grain	Shear parallel to grain	Compression perpendicular to grain	Compression parallel to grain	Modulus of Elasticity			
		F_b	F_t	F_v	$F_{c\perp}$	F_c	E	E_{min}	G	
REDWOOD										
Clear Structural		1,750	1,000	160	650	1,850	1,400,000	510,000	0.44	
Select Structural		1,350	800	160	650	1,500	1,400,000	510,000	0.44	
Select Structural, open grain		1,100	625	160	425	1,100	1,100,000	400,000	0.37	
No. 1		975	575	160	650	1,200	1,300,000	470,000	0.44	
No. 1, open grain	2" & wider	775	450	160	425	900	1,100,000	400,000	0.37	
No. 2		925	525	160	650	950	1,200,000	440,000	0.44	
No. 2, open grain		725	425	160	425	700	1,000,000	370,000	0.37	RIS
No. 3		525	300	160	650	550	1,100,000	400,000	0.44	
No. 3, open grain		425	250	160	425	400	900,000	330,000	0.37	
Stud	2" & wider	575	325	160	425	450	900,000	330,000	0.44	
Construction		825	475	160	425	925	900,000	330,000	0.44	
Standard	2" - 4" wide	450	275	160	425	725	900,000	330,000	0.44	
Utility		225	125	160	425	475	800,000	290,000	0.44	

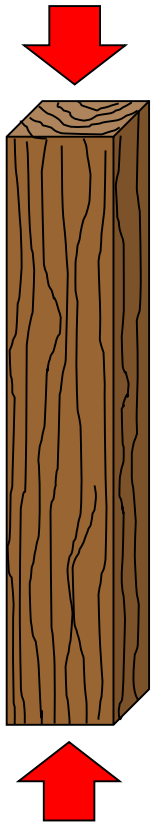
Design Properties - Bending



Fiber Stress in Bending F_b

Design Properties - Compression

Compression
Parallel to Grain
$F_{c||}$



Lumber Adjustment Factors

Most common adjustment factors for decks

Beams/Joists

Columns

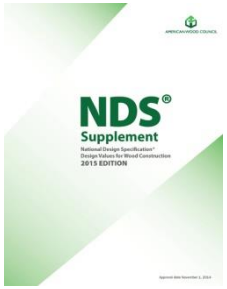


Table 4.3.1 Applicability of Adjustment Factors for Sawn Lumber

		ASD only	ASD and LRFD										LRFD only		
		Load Duration Factor	Wet Service Factor	Temperature Factor	Beam Stability Factor	Size Factor	Flat Use Factor	Incising Factor	Repetitive Member Factor	Column Stability Factor	Buckling Stiffness Factor	Bearing Area Factor	Format Conversion Factor	Resistance Factor	Time Effect Factor
													K_F	ϕ	
$F_b' = F_b$	x	C_D	C_M	C_t	C_L	C_F	C_{fu}	C_i	C_r	-	-	-	2.54	0.85	λ
$F_t' = F_t$	x	C_D	C_M	C_t	-	C_F	-	C_i	-	-	-	-	2.70	0.80	λ
$F_v' = F_v$	x	C_D	C_M	C_t	-	-	-	C_i	-	-	-	-	2.88	0.75	λ
$F_c' = F_c$	x	C_D	C_M	C_t	-	C_F	-	C_i	-	C_P	-	-	2.40	0.90	λ
$F_{c\perp}' = F_{c\perp}$	x	-	C_M	C_t	-	-	-	C_i	-	-	-	C_b	1.67	0.90	-
$E' = E$	x	-	C_M	C_t	-	-	-	C_i	-	-	-	-	-	-	-
$E_{min}' = E_{min}$	x	-	C_M	C_t	-	-	-	C_i	-	-	C_T	-	1.76	0.85	-

Load Duration Factors

Assumption for decks is occupancy live load

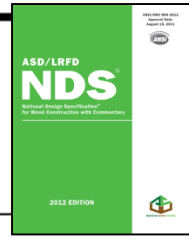


Table 2.3.2 Frequently Used Load Duration Factors, C_D[1]

Load Duration	C_D	Typical Design Loads
Permanent	0.9	Dead Load
Ten years	1.0	Occupancy Live Load
Two months	1.15	Snow Load
Seven days	1.25	Construction Load
Ten minutes	1.6	Wind/Earthquake Load
Impact[2]	2.0	Impact Load

1. Load duration factors shall not apply to reference modulus of elasticity, E, reference modulus of elasticity for beam and column stability, E_{min}, nor to reference compression perpendicular to grain design values, $F_{c\perp}$, based on a deformation limit.
2. Load duration factors greater than 1.6 shall not apply to structural members pressure-treated with water-borne preservatives (see Reference 30), or fire retardant chemicals. The impact load duration factor shall not apply to connections.

Repetitive Member Factor, C_r

- **2"- 4" dimension lumber**
- **24" o.c. or less**
- **3 or more members**
- **Load distributing element**
- **Applies to F_b**

- **For decks**
  - **Joists**
  - **Built-up beams**

$C_r = 1.15$

Wet Service Factor, C_M

F_b	F_t	F_v	$F_{c\perp}$	F_c	E and E_{min}
0.85*	1.0	0.97	0.67	0.8**	0.9

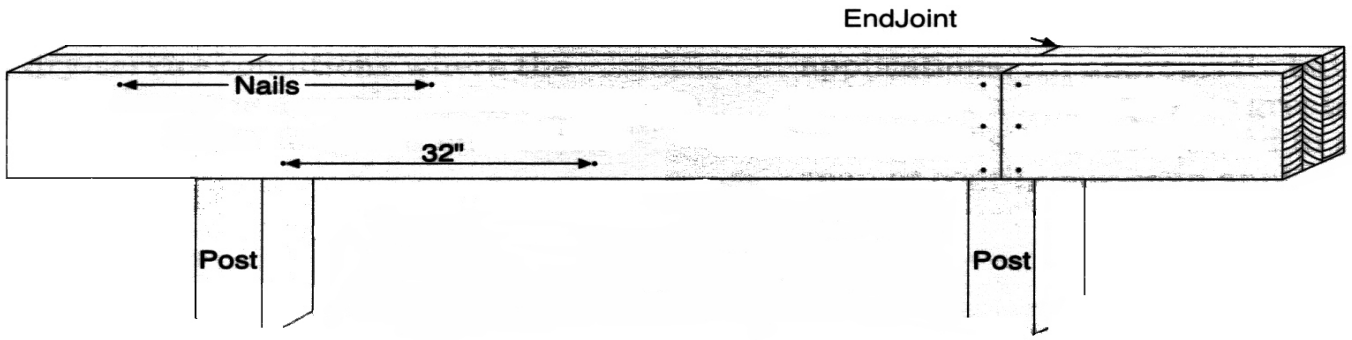
* when $(F_b)(C_F) \leq 1{,}150$ psi, $C_M = 1.0$
** when $(F_c)(C_F) \leq 750$ psi, $C_M = 1.0$

Note the adjustment is unity if:

$F_b C_F \leq 1150$ psi

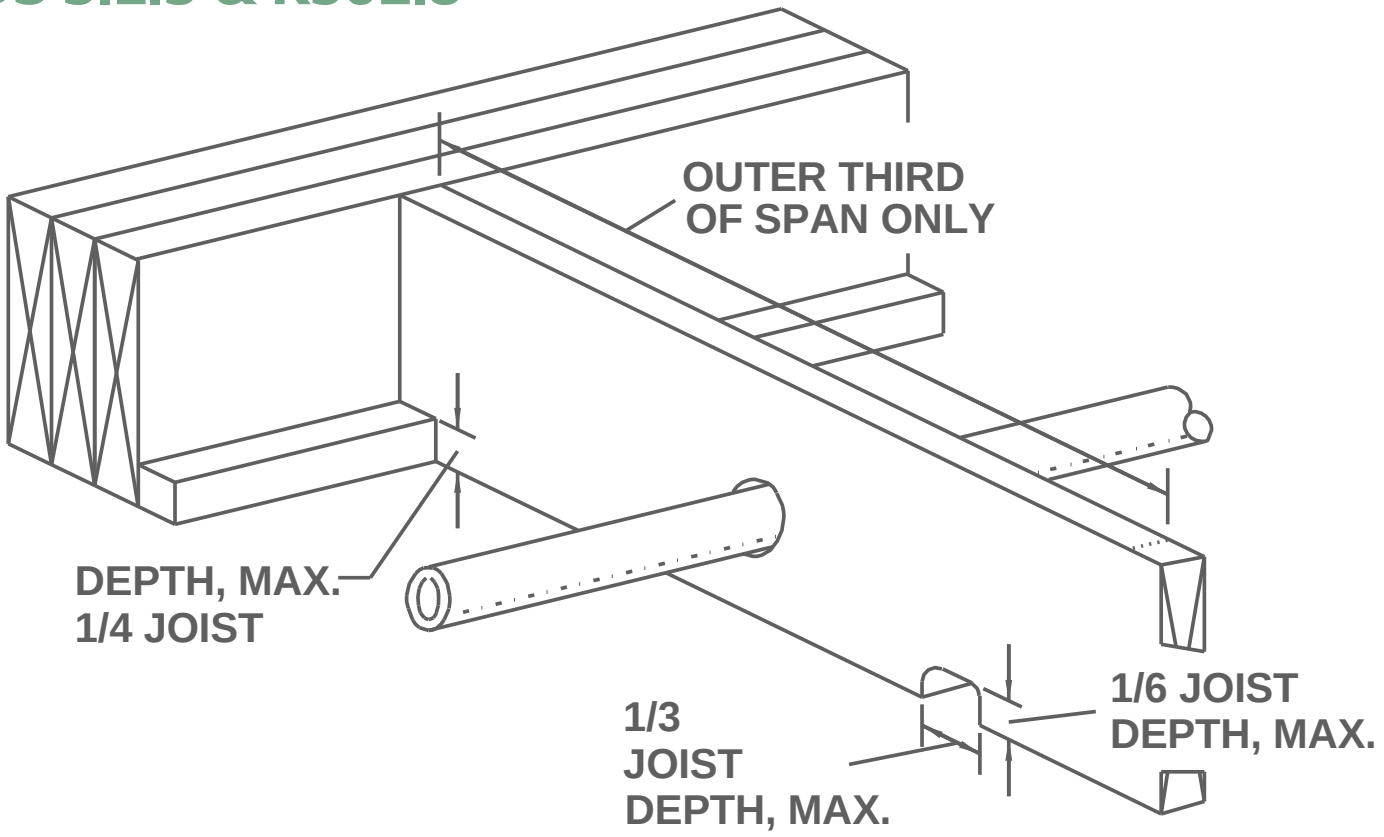
Beam/Joist Design

- **Beam/Joist Spans are based on**
  - **Species and grade of lumber**
  - **Cross-sectional size of beam**
  - **Tributary load it supports**
- **Design Considerations**
  - **Bending**
  - **Shear**
  - **Deflection**
  - **Bearing**

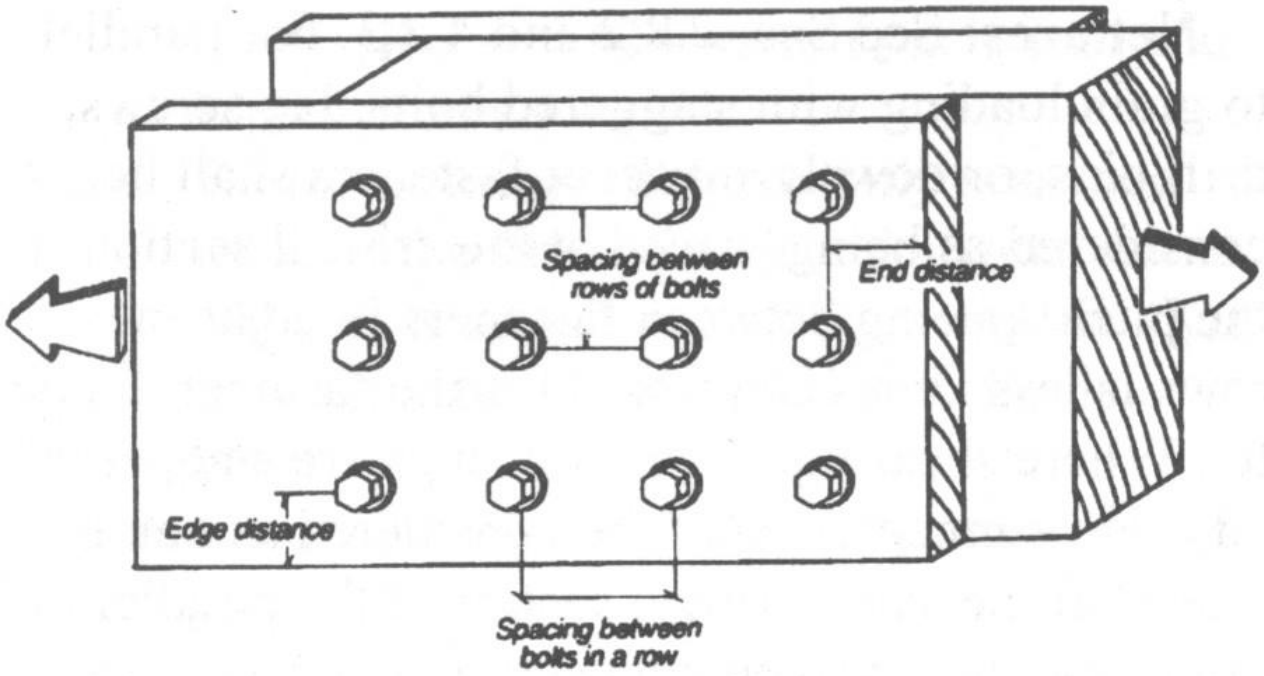


Joist/Beam Design - Notches

- **Notching Provisions – Sawn Lumber**
  - **NDS 3.2.3 & R502.8**



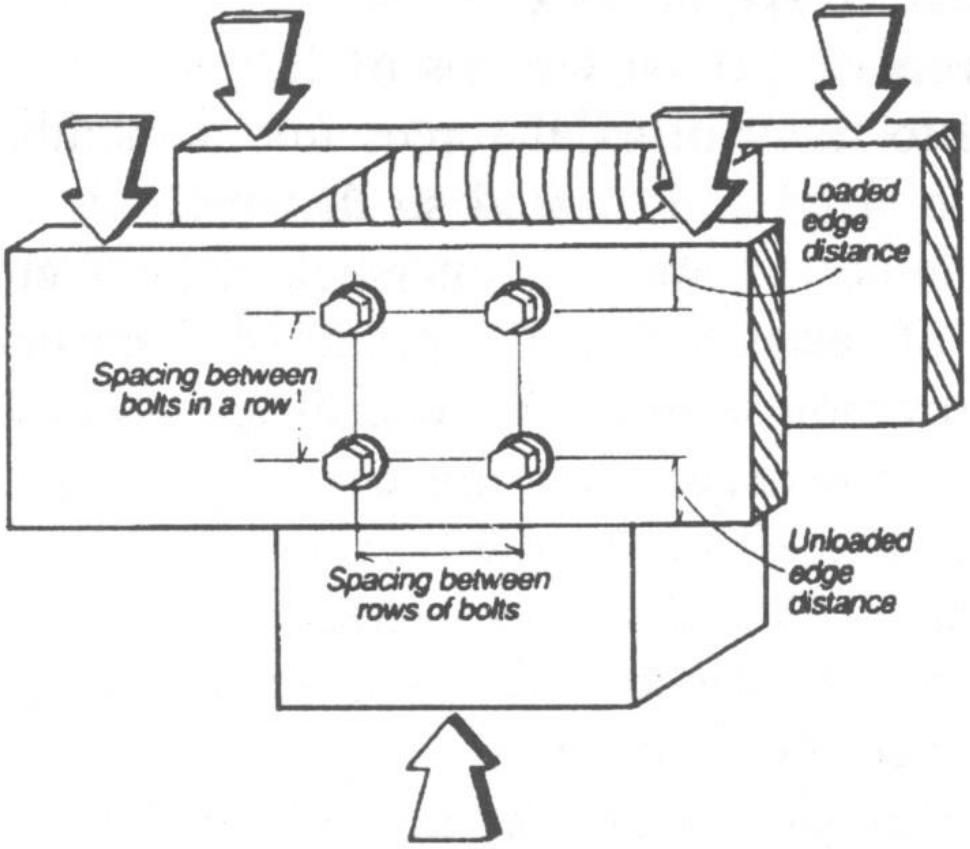
Spacing, End, & Edge Distances



Parallel to grain loading

Parallel to Grain

Spacing, End, & Edge Distances

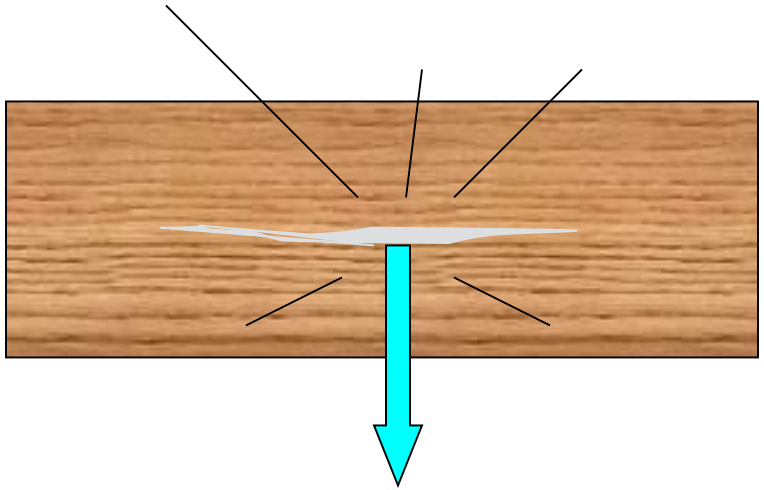


Perpendicular to grain loading

Perpendicular to Grain

Connecting Wood

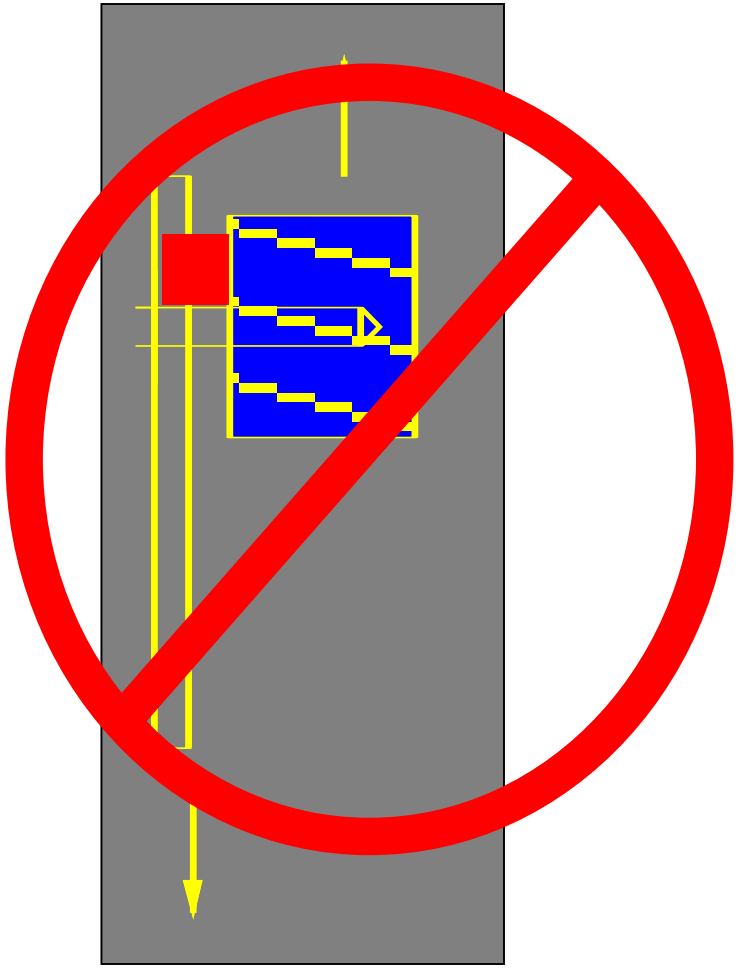
- **Tension perpendicular to grain**
  - ***Achilles heel of wood connections!***



Initiators:

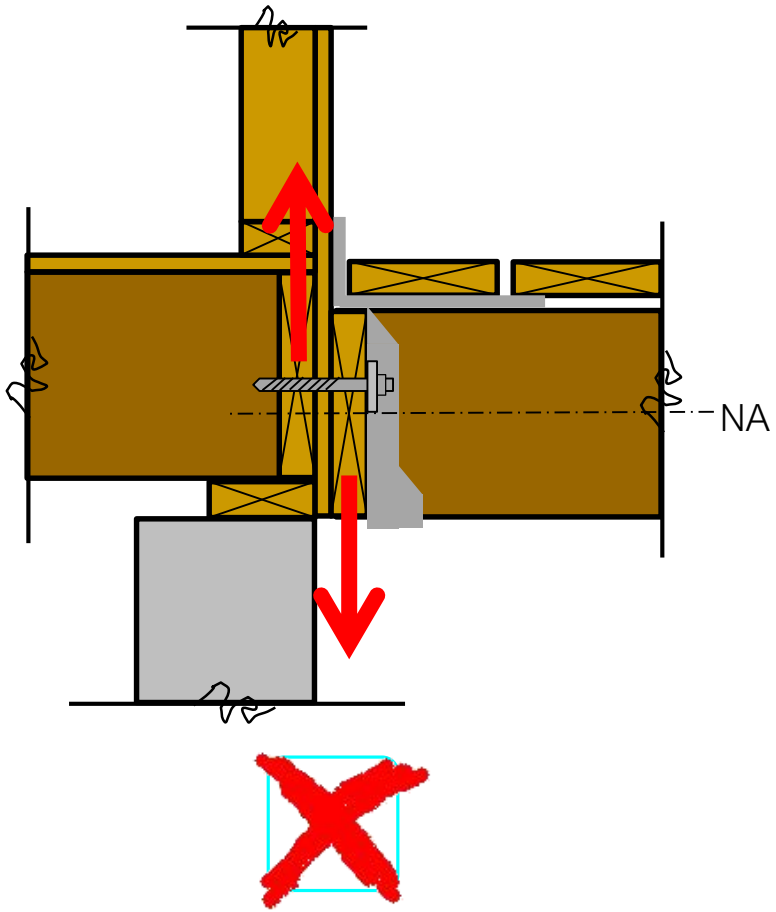
- **notches**
- **large diameter fasteners**
- **hanging loads**
- **shrinkage**

Tension Perpendicular-to-Grain



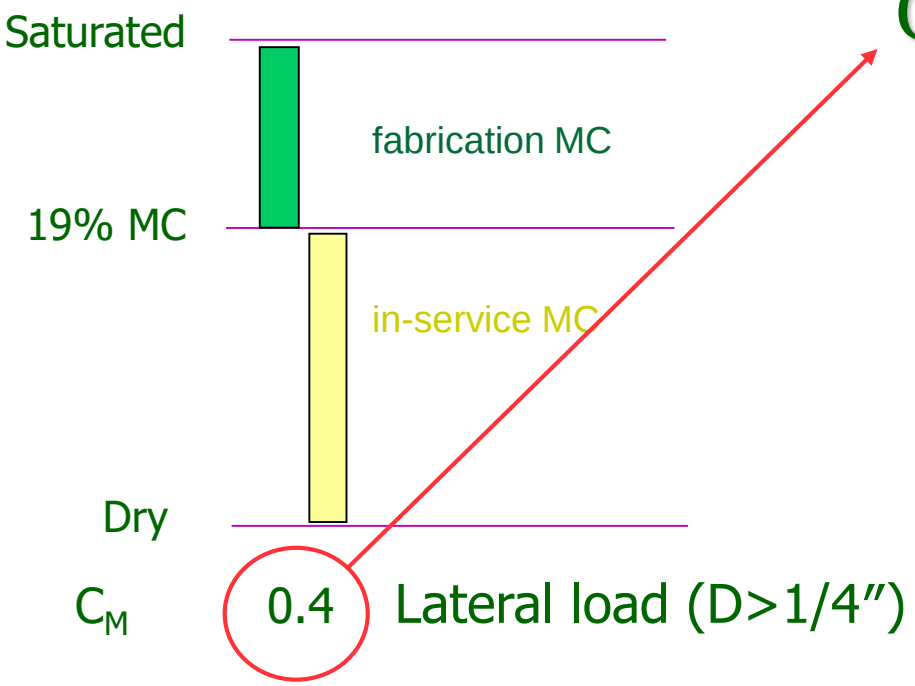
- **NDS Table 11.5.1C**
  - **Footnote 2**
  - **Restricts loading the tension zone**
  - **Applies to ledgers if constructed with a single row of fasteners as shown**

Tension Perpendicular-to-Grain



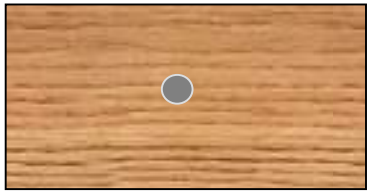
- **NDS Table 11.5.1C**
  - **Footnote 2**
  - **Restricts loading the tension zone**
  - **Applies to ledgers if constructed with a single row of fasteners as shown**

Wet Service Factor, C_M

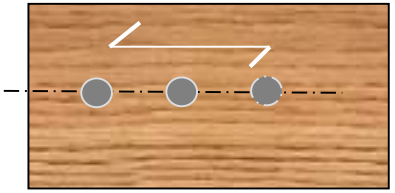


$C_M = 1.0$ if:

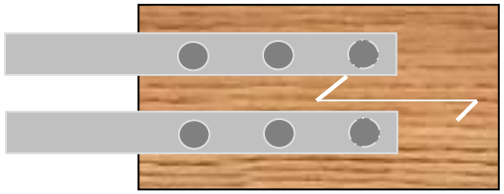
1 fastener



2+ fasteners



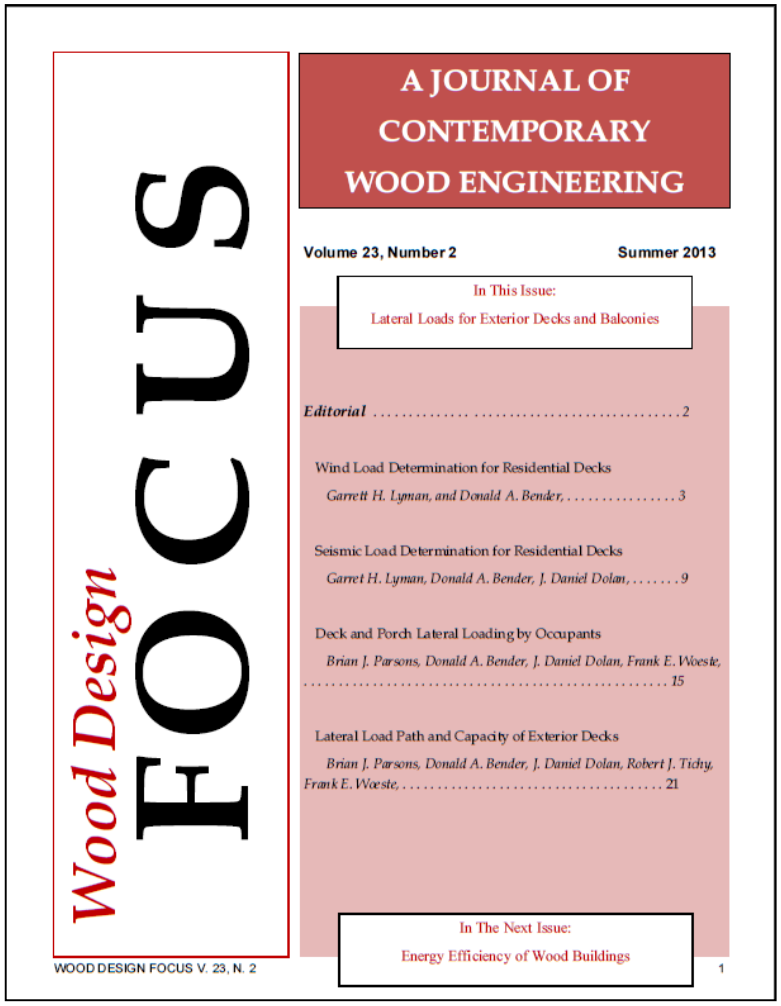
split splice plates



Wood Design Focus

- Wood Design Focus
  - Deck Issue
  - www.forestprod.org/
  - Summer 2013

Figure 2. Cyclic Loading Caused by Occupants Swaying Side to Side in Unison



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A JOURNAL OF CONTEMPORARY WOOD ENGINEERING

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