2021 International Residential Code
Structural Review

Pilot Presentation by Russell Thornburg

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Shining Light On Code

Background:
Building Contractor
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Field Inspector
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Code Development Committee
Code Trainer
Code Consultant

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Field Issue vs. Plan Details

Field Issue

- Connections.
- Bridging.
- Floor and roof sheathing.
- Drilling and notching.
- Concrete covers.

Plan details

- Foundation and framing plans.
- Materials specifications.
- Wall bracing.
- Wall framing.

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Class Assumptions

- Typical wood-framed construction.
- Typical CMU or concrete foundation construction.
- Guidance and "rules of thumb" are given for the review of non-prescriptive elements, (i.e.) steel beams, LVLs.
- I am not a P.E. or AIA of any degree, just a simple plans examiner in the back corner.

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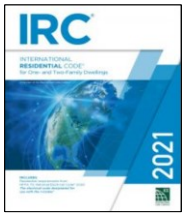
International Residential Code

- Prescriptive Code.
- "Cookbook" with ingredients.
- Limits.
- It is the worst possible house you can build by law!



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Structural Review

- Objective:
  Perform and Recognize
  International Residential Code
  Structural Review & Field

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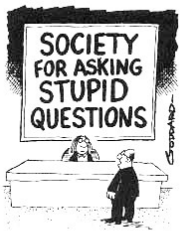
Questions?

SURE– Go ahead and ask your question!

There are no stupid questions!

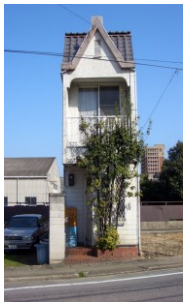


"Excuse me, but is this The Society for Asking Stupid Questions?"

8

Basic Understanding

- Types of loads
- Applying the code
- Tributary width, area
- Load path
- Modulus of Elasticity
- Calculating loads
- Use span tables



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Objectives

- Determine the difference between plan details and field issues.
- Define prescriptive code.
- Complete a simple interpolation.
- Identify steps to take when a design falls outside IRC limits.
- Identify typical wood species and wood products seen on the plan.

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Types of Loads

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Types of Loads

Application	Dead loads	Live loads
Vertical loads		
Horizontal loads		

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Definitions

Dead load:

Weight of all materials of construction, including walls, floors, ceilings, stairways, built-in partitions, finishes, cladding, and fixed services (HVAC, etc)

Live load:

Loads produced by the occupants using the building, or environmental loads.

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Applying the code

Table R301.2

Climatic criteria

Table R301.2
Climate and Geographic Design Criteria

GROUND SNOW LOAD[a]	WIND DESIGN				SEISMIC DESIGN CATEGORY[f]	SUBJECT TO DAMAGE FROM			ICE BARRIER UNDERLAYMENT REQUIRED[h]	FLOOD HAZARDS[i]	AIR FREEZING INDEX[j]	MEAN ANNUAL TEMP[k]
	Speed[d] (mph)	Topographic effects[k]	Special wind region[l]	Windborne debris zone[m]		Weathering[a]	Frost line depth[b]	Termite[c]				

Table R301.5

Live loads

Tables R301.5
Minimum Uniformly Distributed Live Loads (in pounds per square foot)

USE	UNIFORM LOAD (psf)	CONCENTRATED LOAD (lb)
Uninhabitable attics without storage[b]	10	—
Uninhabitable attics with limited storage[b, g]	20	—
Habitable attics and attics served with fixed stairs	30	—
Balconies (exterior) and decks[e]	40	—
Fire escapes	40	—
Guards	—	200[a, i]
Guard in-fill components[i]	—	50[j]
Handrail[j]	—	200[j]
Passenger vehicle garages[n]	50[a]	2,000[j]
Areas other than sleeping areas	40	—
Sleeping areas	30	—
Stairs	40[f]	300[f]

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Types of Loads

Dead loads

- **Vertical loads**
  - Self weight of the building components
    - Concrete, wood
    - MEP systems
    - Finishes, etc

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Section R301.4

Dead loads

Self weight of members

- **Joists**
- **Sheathing**

- **Rule of thumb**

10 PSF

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Table R301.2

Dead loads

- **Interior wall loads**

- **Rule of thumb**
  5 # / foot
  of vertical height

or 50 PLF

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Table R301.2

Dead loads

- Exterior wall loads - wood

•Rule of thumb
8 # / foot
of vertical height

or **80 PLF**

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Table R301.2

Dead loads

- Exterior wall loads -masonry

•Rule of thumb

40 PLF/foot

Example:
6' tall brick = 240PLF

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Types of Loads

Live loads

- Vertical loads
  - Snow
  - People
  - Moveable "things"
- Horizontal loads
  - Wind
  - Seismic

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Table R301.2

Live loads

- "Ground Snow Load"

20 PLF

Table R301.2
Climate and Geographic Design Criteria

GROUND SNOW LOAD[a]	WIND DESIGN				SEISMIC DESIGN CATEGORY[f]	SUBJECT TO DAMAGE FROM			ICE BARRIER UNDERLAYMENT REQUIRED[h]	FLOOD HAZARDS[i]	AIR FREEZING INDEX[j]	MEAN ANNUAL TEMP[k]
	Speed[d] (mph)	Topographic effects[k]	Special wind region[l]	Windborne debris zone[m]		Weathering[a]	Frost line depth[b]	Termite[c]				

Types of Loads

Live loads

- Vertical loads (Interior)
  - People
  - Moveable things
    - Furniture
    - Storage

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Table R301.5

Live loads (psf)

- Bedrooms

30 PSF

Tables R301.5
Minimum Uniformly Distributed Live Loads (in pounds per square foot)

USE	UNIFORM LOAD (psf)	CONCENTRATED LOAD (lb)
Uninhabitable attics without storage[b]	10	—
Uninhabitable attics with limited storage[b, g]	20	—
Habitable attics and attics served with fixed stairs	30	—
Balconies (exterior) and decks[e]	40	—
Fire escapes	40	—
Guards	—	200[f, i]
Guard in-fill components[i]	—	50[j]
Handrail[i]	—	200[j]
Passenger vehicle garages[a]	50[a]	2,000[c]
Areas other than sleeping areas	40	—
Sleeping areas	30	—
Stairs	40[c]	300[c]

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Table R301.5

Live loads (psf)

- Rooms - other than sleeping rooms

40 PSF

Tables R301.5
Minimum Uniformly Distributed Live Loads (in pounds per square foot)

USE	UNIFORM LOAD (psf)	CONCENTRATED LOAD (lb)
Uninhabitable attics without storage[b]	10	—
Uninhabitable attics with limited storage[b, g]	20	—
Habitable attics and attics served with fixed stairs	30	—
Balconies (exterior) and decks[e]	40	—
Fire escapes	40	—
Guards	—	200[f, i]
Guard in-fill components[i]	—	50[j]
Handrail[i]	—	200[j]
Passenger vehicle garages[a]	50[a]	2,000[c]
Areas other than sleeping areas	40	—
Sleeping areas	30	—
Stairs	40[c]	300[c]

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Table R301.5

Live loads (psf)

- Attics – very limited storage (a hatch)

10 PSF

Tables R301.5
Minimum Uniformly Distributed Live Loads (in pounds per square foot)

USE	UNIFORM LOAD (psf)	CONCENTRATED LOAD (lb)
Uninhabitable attics without storage[b]	10	—
Uninhabitable attics with limited storage[b, g]	20	—
Habitable attics and attics served with fixed stairs	30	—
Balconies (exterior) and decks[e]	40	—
Fire escapes	40	—
Guards	—	200[f, i]
Guard in-fill components[i]	—	50[j]
Handrail[i]	—	200[j]
Passenger vehicle garages[a]	50[a]	2,000[c]
Areas other than sleeping areas	40	—
Sleeping areas	30	—
Stairs	40[c]	300[c]

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Table R301.5

Live loads (psf)

- Attics –limited storage (a pull down ladder)

20 PSF

Tables R301.5
Minimum Uniformly Distributed Live Loads (in pounds per square foot)

USE	UNIFORM LOAD (psf)	CONCENTRATED LOAD (lb)
Uninhabitable attics without storage[b]	10	—
Uninhabitable attics with limited storage[b, g]	20	—
Habitable attics and attics served with fixed stairs	30	—
Balconies (exterior) and decks[e]	40	—
Fire escapes	40	—
Guards	—	200[c, i]
Guard in-fill components[i]	—	50[f]
Handrail[f]	—	200[f]
Passenger vehicle garages[a]	50[a]	2,000[a]
Areas other than sleeping areas	40	—
Sleeping areas	30	—
Stairs	40[d]	300[f]

Table R301.5

Live loads (psf)

- Attics – with fixed stair (bedroom)

30 PSF

Tables R301.5
Minimum Uniformly Distributed Live Loads (in pounds per square foot)

USE	UNIFORM LOAD (psf)	CONCENTRATED LOAD (lb)
Uninhabitable attics without storage[b]	10	—
Uninhabitable attics with limited storage[b, g]	20	—
Habitable attics and attics served with fixed stairs	30	—
Balconies (exterior) and decks[e]	40	—
Fire escapes	40	—
Guards	—	200[c, i]
Guard in-fill components[i]	—	50[f]
Handrail[f]	—	200[f]
Passenger vehicle garages[a]	50[a]	2,000[a]
Areas other than sleeping areas	40	—
Sleeping areas	30	—
Stairs	40[d]	300[f]

Table R301.5

Live loads (psf)

- Attics – with fixed stair (habitable space)

40 PSF

Tables R301.5
Minimum Uniformly Distributed Live Loads (in pounds per square foot)

USE	UNIFORM LOAD (psf)	CONCENTRATED LOAD (lb)
Uninhabitable attics without storage[b]	10	—
Uninhabitable attics with limited storage[b, g]	20	—
Habitable attics and attics served with fixed stairs	30	—
Balconies (exterior) and decks[e]	40	—
Fire escapes	40	—
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Guard in-fill components[i]	—	50[f]
Handrail[f]	—	200[f]
Passenger vehicle garages[a]	50[a]	2,000[a]
Areas other than sleeping areas	40	—
Sleeping areas	30	—
Stairs	40[d]	300[f]

Table R301.5

Live loads (psf)

- Attics – with fixed stair (potentially habitable space)

40 PSF

Tables R301.5
Minimum Uniformly Distributed Live Loads (in pounds per square foot)

USE	UNIFORM LOAD (psf)	CONCENTRATED LOAD (lb)
Uninhabitable attics without storage[b]	10	—
Uninhabitable attics with limited storage[b, g]	20	—
Habitable attics and attics served with fixed stairs	30	—
Balconies (exterior) and decks[e]	40	—
Fire escapes	40	—
Guards	—	200[c, i]
Guard in-fill components[i]	—	50[f]
Handrail[f]	—	200[f]
Passenger vehicle garages[a]	50[a]	2,000[a]
Areas other than sleeping areas	40	—
Sleeping areas	30	—
Stairs	40[d]	300[f]

Table R301.5

Live loads (psf)

- Decks

40 PSF

Tables R301.5
Minimum Uniformly Distributed Live Loads (in pounds per square foot)

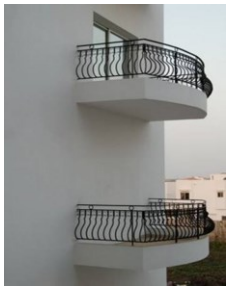
USE	UNIFORM LOAD (psf)	CONCENTRATED LOAD (lb)
Uninhabitable attics without storage[b]	10	—
Uninhabitable attics with limited storage[b, g]	20	—
Habitable attics and attics served with fixed stairs	30	—
Balconies (exterior) and decks[e]	40	—
Fire escapes	40	—
Guards	—	200[f, i]
Guard in-fill components[i]	—	50[j]
Handrail[i]	—	200[j]
Passenger vehicle garages[a]	50[a]	2,000[a]
Areas other than sleeping areas	40	—
Sleeping areas	30	—
Stairs	40[c]	300[c]

Table R301.5

Live loads (psf)

- Exterior balconies

40 PSF



Tables R301.5
Minimum Uniformly Distributed Live Loads (in pounds per square foot)

USE	UNIFORM LOAD (psf)	CONCENTRATED LOAD (lb)
Uninhabitable attics without storage[b]	10	—
Uninhabitable attics with limited storage[b, g]	20	—
Habitable attics and attics served with fixed stairs	30	—
Balconies (exterior) and decks[e]	40	—
Fire escapes	40	—
Guards	—	200[f, i]
Guard in-fill components[i]	—	50[j]
Handrail[i]	—	200[j]
Passenger vehicle garages[a]	50[a]	2,000[a]
Areas other than sleeping areas	40	—
Sleeping areas	30	—
Stairs	40[c]	300[c]

Types of Loads

Live loads

- Horizontal loads
  - Wind

Varies around the state

Table R301.2
Climate and Geographic Design Criteria

GROUND SNOW LOAD[a]	WIND DESIGN				SEISMIC DESIGN CATEGORY[f]	SUBJECT TO DAMAGE FROM			ICE BARRIER UNDERLAYMENT REQUIRED[h]	FLOOD HAZARDS[i]	AIR FREEZING INDEX[j]	MEAN ANNUAL TEMP[k]
	Speed[d] (mph)	Topographic effects[k]	Special wind region[l]	Windborne debris zone[m]		Weathering[a]	Frost line depth[b]	Termite[c]				

Wind Design R301.2

- **Updated Wind Speed maps match IBC and ASCE 7 maps with a large portion of the country having wind speeds less than 115 mph.**

Wind Design R301.2

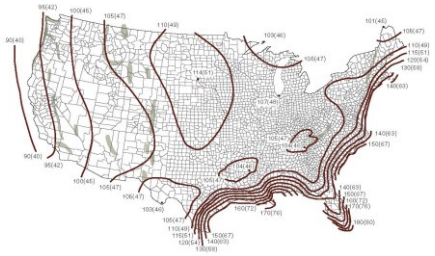
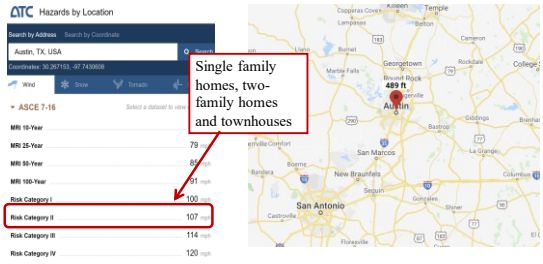


FIGURE R301.2(2)
ULTIMATE DESIGN WIND SPEEDS

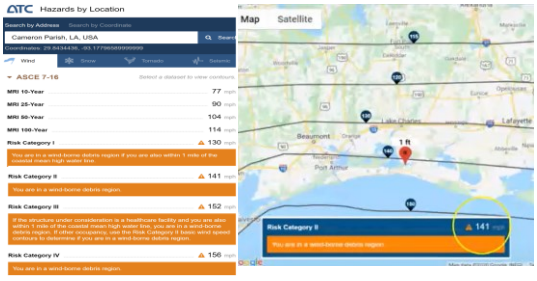
Code Change No: RB32-19

Wind – https://hazards.atcouncil.org

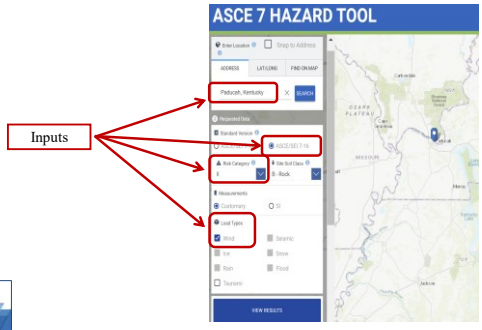


Wind Hazardous

ATC Hazards Locations
https://hazards.atcouncil.org



https://asce7hazardtool.online



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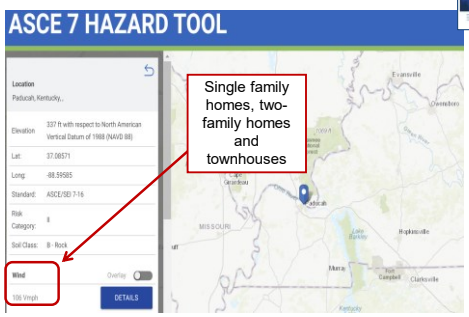

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Types of Loads

Live loads

- Horizontal loads
  - Seismic

For the most part, MT has all SDC A-D levels

Table R301.2
Climate and Geographic Design Criteria

GROUND SNOW LOAD[a]	WIND DESIGN				SEISMIC DESIGN CATEGORY[f]	SUBJECT TO DAMAGE FROM			ICE BARRIER UNDERLAYMENT REQUIRED[h]	FLOOD HAZARDS[i]	AIR FREEZING INDEX[j]	MEAN ANNUAL TEMP[k]
	Speed[d] (mph)	Topographic effects[k]	Special wind region[l]	Windborne debris zone[m]		Weathering[a]	Frost line depth[b]	Termite[c]				

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Types of Loads

Live loads

- Horizontal loads
  - Floods (water surge)

Refer to Section R324 for flood-resistant construction

Table R301.2
Climate and Geographic Design Criteria

GROUND SNOW LOAD[a]	WIND DESIGN				SEISMIC DESIGN CATEGORY[f]	SUBJECT TO DAMAGE FROM			ICE BARRIER UNDERLAYMENT REQUIRED[h]	FLOOD HAZARDS[i]	AIR FREEZING INDEX[j]	MEAN ANNUAL TEMP[k]
	Speed[d] (mph)	Topographic effects[k]	Special wind region[l]	Windborne debris zone[m]		Weathering[a]	Frost line depth[b]	Termite[c]				

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Complete Q1 on the worksheet

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Q1: Fill in the blanks

Live load – all spaces except bedrooms	40	psf
Live load - bedroom	30	psf
Live load – attics with light storage (pull down)	20	psf
Live load - attics without storage (hatch)	10	psf
Dead load – floors	10	psf
Dead load - exterior walls	80	PLF
Dead load – interior walls,	50	PLF
Deck live load	40	psf
Balcony live load	40	psf
Snow load (horizontal projection)	20	psf

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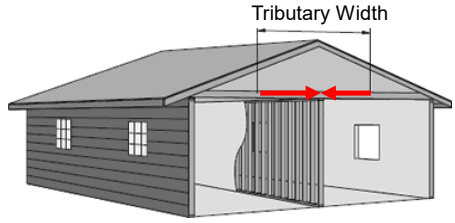
How loads are distributed

Tributary loads

Tributary width (length)

is the portion of the span that is supported by a structural member.



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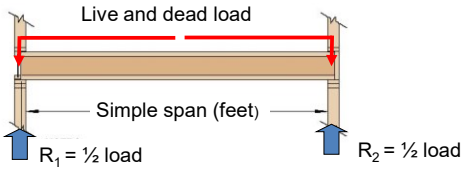
How loads are distributed

Tributary width (length)

is half the distance between adjacent walls (single span).



Example: 10' span = 5' tributary width`

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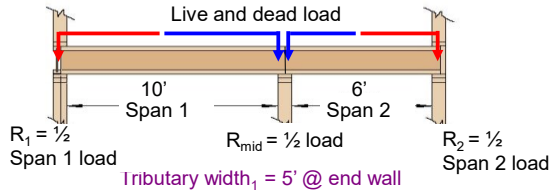
How loads are distributed

Tributary width

or half of the distance between adjacent walls (multiple span)



Tributary $width_1$ = 5' @ end wall

Tributary $width_2$ = 3' @ end wall

Tributary width $_{mid}$ = 8' @ middle wall

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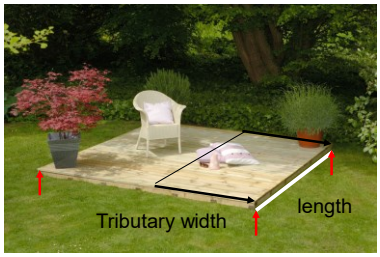
How loads are distributed

Tributary area

Tributary width x length



Tributary area carried by this girder

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Worksheet handout Q2-Q5

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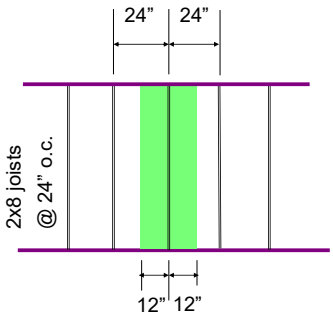
Q2. A floor system under a kitchen is made up of 2x8 @ 24" o.c. What is the tributary width of a single floor joist member?

24 inches



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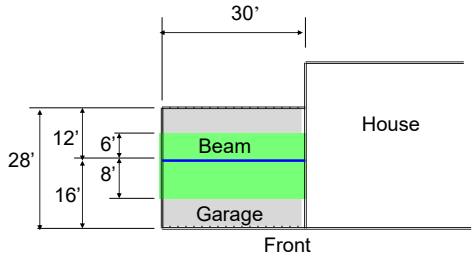
Q3. The floor over a garage is supported by a beam and the perimeter walls. If the joists are 16" o.c.:

1. What is the tributary width on the beam? **14'** ft
2. What is the tributary width on the front wall? **8'** ft
3. What is the tributary width on the rear wall? **6'** ft
4. If the joists are 12" o.c.? **Doesn't make any difference**



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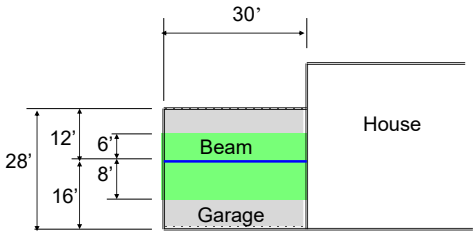
Q4. What is the tributary area carried by the beam in Q3?

420 sqft



Tributary width x length of the beam
14' x 30' = 420 sqft

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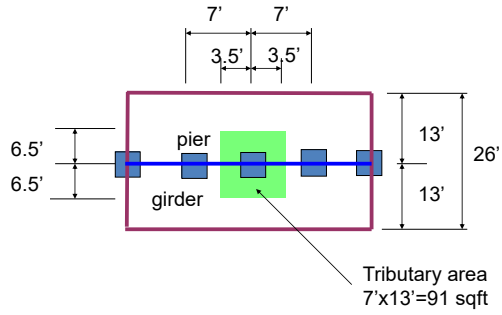
Q5. The crawl space girder is supported on piers spaced 7' o.c. What is the tributary area carried by one of the middle girders?

91 sqft



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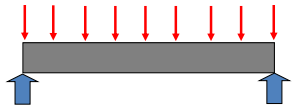
How loads are applied

Uniform load

is a load spread over some or all portion(s) of the structural member



Note: the load is expressed in PLF

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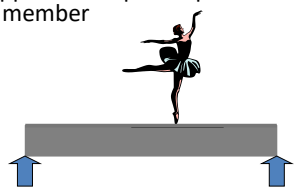
How loads are applied

Concentrated (point) load

is a load applied to a specific place on the structural member



Note: the load is expressed in # (lbs)

"Kip" = one "kilo" pound = 1000# = 1K

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How loads are applied

Axial load

is a point load applied at the end of a structural member

Note: the load is expressed in #

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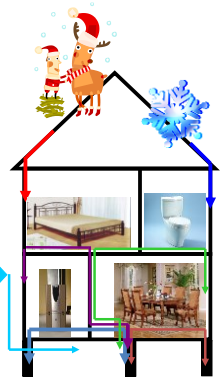
Load Path

Load path

is the path by which loads get from the origination to the foundation.



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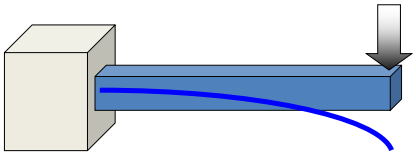
Modulus of Elasticity

Modulus of Elasticity (Young's Modulus)

is the measure of the stiffness of a given material.

In layman's terms: the amount of load (weight) that can be placed on a structural member before it will permanently deform

(in millions of pounds per square inch (example E=2.0))



56

Quantifying the loads

3 step procedure to quick check structural integrity:

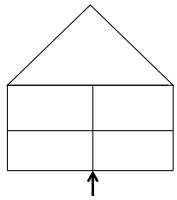
1. Identify all loads
2. Quantify loads into "PLF"
3. Look them up in a span table, or use engineering software like StruCalc®

57

Quantifying the loads

Procedure

1. Identify design loads



Example #1: Crawl space girder

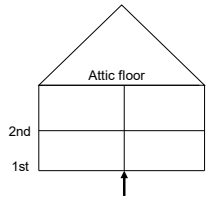
- **First floor load**
- **Interior wall load**
- **Second floor load**
- **Interior wall load**
- **Attic floor load**

58

Quantifying the loads

Procedure

1. Identify design loads
2. Quantify "PLF"



Example #1: Crawl space girder

- **First floor load** [40 psf (LL) + 10 psf (DL)] x 10 ft (trib width) = 500 PLF
- **Interior wall load** = 50 PLF
- **Second floor load** [30 psf (LL) + 10 psf (DL)] x 10 ft (trib width) = 400 PLF
- **Interior wall load** = 50 PLF
- **Attic floor load** [40 psf (LL) + 10 psf (DL) x 10 ft (trib width) = 500 PLF

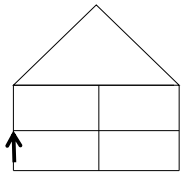
Total load 1500 PLF

59

Quantifying the loads

Procedure

1. Identify design loads
2. Quantify "PLF"



Example #2: Door header

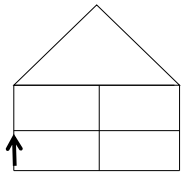
- **Second floor load**
- **Exterior wall load**
- **Roof load**

60

Quantifying the loads

Procedure

1. Identify design loads
2. Quantify "PLF"



Example #2: Door header

- **Second floor load** [30 psf (LL) + 10 psf (DL)] x 5 feet (trib width) = 200 PLF
- **Exterior wall load** = 80 PLF
- **Truss load** 1200 # @ 2' o.c. = 600 PLF

Total load 880 PLF

61

Quantifying the loads

Procedure

1. Identify design loads
2. Quantify "PLF"

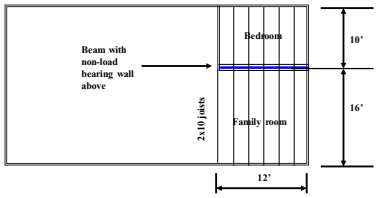
Complete Q6, of the worksheet.

62

Q6: What is the total uniform loading (plf) on the following LVL beam? List and quantify the loads.

- 12' long LVL beam above the basement,
- carrying 2x10 floor joists spanning 16' for family room (above) on one side
- and 10' on the other side supporting a bedroom,
- plus a non-load bearing interior wall

650 PLF



Family room	[40psf (LL) + 10psf (DL)] x 8'	= 400 plf
Bedroom	[30psf (LL) + 10psf (DL)] x 5'	= 200 plf
Interior wall		= 50 plf
	Total uniform load	650 plf

63

Span table

Procedure

1. Identify design loads
2. Quantify "PLF"
3. Look them up in a span table
   - 2x joist span tables (table 1)
   - I-joist span tables (table 2)
   - 2x beam span tables (table 3)
   - LVL beam span tables (table 4)
   - Column load tables (tables 5-6)

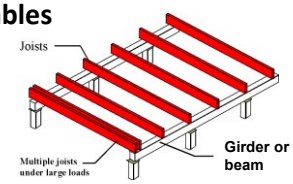
64

Span table

Procedure

1. Identify design loads
2. Quantify "PLF"
3. Look in a span table
   - 2x joist span tables

Table 1:
- Species,
- Depth of member,
- Live load
- Spacing,
- Span length



65

Table 1
Span Table for Floors - Ceilings - Rafters

	Southern Pine #2						
	APPLICABLE CODE SECTION	IRC R802.5.1(1)	IRC R802.5.1(2)	IRC R502.3.1(1)	IRC R502.3.1(2)	IRC R802.4.1(1)	IRC R802.4.1(2)
	Spacing (inches)	Ceiling Joists w/o storage access hole LL 10 DL 5 L/240	Ceiling Joists w/ pull down stair LL 20 DL 10 L/240	Floor Joists sleep areas LL 30 DL 10 L/360	Floor Joists living areas LL 40 DL 10 L/360	Raters w/o ceiling living areas LL 20 DL 10 L/180	Rafters w/ ceiling living areas LL 20 DL 10 L/240
2x4	12	11-10	9-3			10-4	9-5
	16	10-9	8-0			9-0	8-7
	19.2	10-2	7-4			8-2	8-1
	24	9-3	6-7			7-4	7-4
2x6	12	18-8	13-11	11-3	10-3	15-7	14-9
	16	16-11	12-0	10-3	9-4	13-6	13-5
	19.2	15-7	11-0	9-6	8-6	12-3	12-3
	24	13-11	9-10	8-6	7-7	11-0	11-0
2x8	12	24-7	17-7	14-11	13-6	19-8	19-6
	16	21-7	15-3	13-3	11-10	17-1	17-1
	19.2	19-8	13-11	12-1	10-10	15-7	15-7
	24	17-7	12-6	10-10	9-8	13-11	13-11
2x10	12	>26-0	20-11	18-1	16-2	23-5	23-5
	16	25-7	18-1	15-8	14-0	20-3	20-3
	19.2	23-5	16-6	14-4	12-10	18-6	18-6
	24	20-11	14-9	12-10	11-5	16-6	16-6
2x12	12			21-4	19-2	>26-0	>26-0
	16			18-6	16-6	23-10	23-10
	19.2			16-10	15-1	21-9	21-9
	24			15-1	13-6	19-6	19-6

** length usually not available
** already takes into account ***repetitive members factor*** of 115%
(based on values from various tables in IRC)

66

Q7. What is the max span length of a 2x8, @16" o.c. for kitchen? **_11'-10"_ ft**

Kitchen live load = 40 psf.

Table 1
Span Table for Floors - Ceilings - Rafters

	Southern Pine #2						
	APPLICABLE CODE SECTION	IRC R802.5.1(1)	IRC R802.5.1(2)	IRC R502.3.1(1)	IRC R502.3.1(2)	IRC R802.4.1(1)	IRC R802.4.1(2)
	Spacing (inches)	Ceiling Joists w/o storage access hole LL 10 DL 5 L/240	Ceiling Joists w/ pull down stair LL 20 DL 10 L/240	Floor Joists sleep areas LL 30 DL 10 L/360	Floor Joists living areas LL 40 DL 10 L/360	Raters w/o ceiling living areas LL 20 DL 10 L/180	Rafters w/ ceiling living areas LL 20 DL 10 L/240
2x4	12	11-10	9-3			10-4	9-5
	16	10-9	8-0			9-0	8-7
	19.2	10-2	7-4			8-2	8-1
	24	9-3	6-7			7-4	7-4
2x6	12	18-8	13-11	11-3	10-3	15-7	14-9
	16	16-11	12-0	10-3	9-4	13-6	13-5
	19.2	15-7	11-0	9-6	8-6	12-3	12-3
	24	13-11	9-10	8-6	7-7	11-0	11-0
2x8	12	24-7	17-7	14-11	13-6	19-8	19-6
	16	21-7	15-3	13-3	11-10	17-1	17-1
	19.2	19-8	13-11	12-1	10-10	15-7	15-7
	24	17-7	12-6	10-10	9-8	13-11	13-11
2x10	12	>26-0	20-11	18-1	16-2	23-5	23-5
	16	25-7	18-1	15-8	14-0	20-3	20-3
	19.2	23-5	16-6	14-4	12-10	18-6	18-6
	24	20-11	14-9	12-10	11-5	16-6	16-6
2x12	12			21-4	19-2	>26-0	>26-0
	16			18-6	16-6	23-10	23-10
	19.2			16-10	15-1	21-9	21-9
	24			15-1	13-6	19-6	19-6

** length usually not available
** already takes into account ***repetitive members factor*** of 115%
(based on values from various tables in IRC)

68

Q8. What is the max spacing (tributary width) for bedroom if using 2x8 floor joists, spanning 15'? **_None__ oc**

Bedroom live load = 30 psf.

Table 1
Span Table for Floors - Ceilings - Rafters

	Southern Pine #2						
	APPLICABLE CODE SECTION	IRC R802.5.1(1)	IRC R802.5.1(2)	IRC R502.3.1(1)	IRC R502.3.1(2)	IRC R802.4.1(1)	IRC R802.4.1(2)
	Spacing (inches)	Ceiling Joists w/o storage access hole LL 10 DL 5 L/240	Ceiling Joists w/ pull down stair LL 20 DL 10 L/240	Floor Joists sleep areas LL 30 DL 10 L/360	Floor Joists living areas LL 40 DL 10 L/360	Raters w/o ceiling living areas LL 20 DL 10 L/180	Rafters w/ ceiling living areas LL 20 DL 10 L/240
2x4	12	11-10	9-3			10-4	9-5
	16	10-9	8-0			9-0	8-7
	19.2	10-2	7-4			8-2	8-1
	24	9-3	6-7			7-4	7-4
2x6	12	18-8	13-11	11-3	10-3	15-7	14-9
	16	16-11	12-0	10-3	9-4	13-6	13-5
	19.2	15-7	11-0	9-6	8-6	12-3	12-3
	24	13-11	9-10	8-6	7-7	11-0	11-0
2x8	12	24-7	17-7	14-11	13-6	19-8	19-6
	16	21-7	15-3	13-3	11-10	17-1	17-1
	19.2	19-8	13-11	12-1	10-10	15-7	15-7
	24	17-7	12-6	10-10	9-8	13-11	13-11
2x10	12	>26-0	20-11	18-1	16-2	23-5	23-5
	16	25-7	18-1	15-8	14-0	20-3	20-3
	19.2	23-5	16-6	14-4	12-10	18-6	18-6
	24	20-11	14-9	12-10	11-5	16-6	16-6
2x12	12			21-4	19-2	>26-0	>26-0
	16			18-6	16-6	23-10	23-10
	19.2			16-10	15-1	21-9	21-9
	24			15-1	13-6	19-6	19-6

** length usually not available
** already takes into account ***repetitive members factor*** of 115%
(based on values from various tables in IRC)

69

Q9. What is the min. size roof rafter (with an attached ceiling), if the rafters are 24"o.c. and span 16'? **___2_x_10_**

Roof rafters with ceilings (L/240)

Table 1
Span Table for Floors - Ceilings - Rafters

	Southern Pine #2						
	APPLICABLE CODE SECTION	IRC R802.5.1(1)	IRC R802.5.1(2)	IRC R502.3.1(1)	IRC R502.3.1(2)	IRC R802.4.1(1)	IRC R802.4.1(2)
	Spacing (inches)	Ceiling Joists w/o storage access hole LL 10 DL 5 L/240	Ceiling Joists w/ pull down stair LL 20 DL 10 L/240	Floor Joists sleep areas LL 30 DL 10 L/360	Floor Joists living areas LL 40 DL 10 L/360	Raters w/o ceiling living areas LL 20 DL 10 L/180	Rafters w/ ceiling living areas LL 20 DL 10 L/240
2x4	12	11-10	9-3			10-4	9-5
	16	10-9	8-0			9-0	8-7
	19.2	10-2	7-4			8-2	8-1
	24	9-3	6-7			7-4	7-4
2x6	12	18-8	13-11	11-3	10-3	15-7	14-9
	16	16-11	12-0	10-3	9-4	13-6	13-5
	19.2	15-7	11-0	9-6	8-6	12-3	12-3
	24	13-11	9-10	8-6	7-7	11-0	11-0
2x8	12	24-7	17-7	14-11	13-6	19-8	19-6
	16	21-7	15-3	13-3	11-10	17-1	17-1
	19.2	19-8	13-11	12-1	10-10	15-7	15-7
	24	17-7	12-6	10-10	9-8	13-11	13-11
2x10	12	>26-0	20-11	18-1	16-2	23-5	23-5
	16	25-7	18-1	15-8	14-0	20-3	20-3
	19.2	23-5	16-6	14-4	12-10	18-6	18-6
	24	20-11	14-9	12-10	11-5	16-6	16-6
2x12	12			21-4	19-2	>26-0	>26-0
	16			18-6	16-6	23-10	23-10
	19.2			16-10	15-1	21-9	21-9
	24			15-1	13-6	19-6	19-6

** length usually not available
** already takes into account ***repetitive members factor*** of 115%
(based on values from various tables in IRC)

70

Q10. Can a 10'-6" wide deck be constructed with 2x6 joists?
Yes / No No

Dry

Deck live load = 40 psf.

Table 1
Span Table for Floors - Ceilings - Rafters

		Southern Pine #2					
	APPLICABLE CODE SECTION	IRC R802.5.1(1)	IRC R802.5.1(2)	IRC R502.3.1(1)	IRC R502.3.1(2)	IRC R802.4.1(1)	IRC R802.4.1(2)
	Spacing (inches)	Ceiling Joists w/o storage access hole LL 10 DL 5 L/240	Ceiling Joists w/ pull down stair LL 20 DL 10 L/240	Floor Joists sleep areas LL 30 DL 10 L/360	Floor Joists living areas LL 40 DL 10 L/360	Raters w/o ceiling living areas LL 20 DL 10 L/180	Rafters w/ ceiling living areas LL 20 DL 10 L/240
2x4	12	11-10	9-3			10-4	9-5
	16	10-9	8-0			9-0	8-7
	19.2	10-2	7-4			8-2	8-1
	24	9-3	6-7			7-4	7-4
2x6	12	18-6	15-11	11-5	10-3	15-7	14-9
	16	16-11	12-0	10-3	9-4	13-6	13-5
	19.2	15-7	11-0	9-6	8-6	12-3	12-3
	24	13-11	9-10	8-6	7-7	11-0	11-0
2x8	12	24-7	17-7	14-11	13-6	19-8	19-6
	16	21-7	15-3	13-3	11-10	17-1	17-1
	19.2	19-8	13-11	12-1	10-10	15-7	15-7
	24	17-7	12-6	10-10	9-8	13-11	13-11
2x10	12	>26-0	20-11	18-1	16-2	23-5	23-5
	16	25-7	18-1	15-8	14-0	20-3	20-3
	19.2	23-5	16-6	14-4	12-10	18-6	18-6
	24	20-11	14-9	12-10	11-5	16-6	16-6
2x12	12			21-4	19-2	>26-0	>26-0
	16			18-6	16-6	23-10	23-10
	19.2			16-10	15-1	21-9	21-9
	24			15-1	13-6	19-6	19-6

** length usually not available
** already takes into account ***repetitive members factor*** of 115%
(based on values from various tables in IRC)

71

Q10. Can a 10'-6" wide deck be constructed with 2x6 joists?
Yes / No NOPE

Deck live load = 40 psf.

Wet

Table R507.6
Maximum Deck Joist Spans

LOAD[a](psf)	JOIST SPECIES[b]	JOIST SIZE	ALLOWABLE JOIST SPAN[b, c, f] (feet-inches) Joist spacing (inches) 12	16	24	MAXIMUM CANTILEVER[d, f] (feet-inches) Joist back span[e] (feet) 4	6	8	10	12	14	16	18
40 live load	Southern pine	2 × 6	9-11	9-0	7-7	1-0	1-6	1-5	NP	NP	NP	NP	NP
		2 × 8	13-1	11-10	9-8	1-0	1-6	2-0	2-6	2-3	NP	NP	NP
		2 × 10	16-2	14-0	11-5	1-0	1-6	2-0	2-6	3-0	3-4	3-4	NP
		2 × 12	18-0	16-6	13-6	1-0	1-6	2-0	2-6	3-0	3-6	4-0	4-1
	Douglas fir-larch[g]	2 × 6	9-6	8-4	6-10	1-0	1-6	1-4	NP	NP	NP	NP	NP
	Hem-fir[g]	2 × 8	12-6	11-1	9-1	1-0	1-6	2-0	2-3	2-0	NP	NP	NP
		2 × 10	15-8	13-7	11-1	1-0	1-6	2-0	2-6	3-0	3-3	NP	NP
	Spruce-pine-fir[g]	2 × 12	18-0	15-9	12-10	1-0	1-6	2-0	2-6	3-0	3-6	3-11	3-11
	Redwood[f]	2 × 6	8-10	8-0	6-10	1-0	1-4	1-1	NP	NP	NP	NP	NP
	Western cedars[f]	2 × 8	11-8	10-7	8-8	1-0	1-6	2-0	1-11	NP	NP	NP	NP
	Ponderosa pine[f]	2 × 10	14-11	13-0	10-7	1-0	1-6	2-0	2-6	3-0	2-9	NP	NP
	Red pine[f]	2 × 12	17-5	15-1	12-4	1-0	1-6	2-0	2-6	3-0	3-6	3-8	NP

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Span table

Procedure

1. Identify design loads
2. Quantify "PLF"
3. Look in a span table
   - **I-joist span tables**

Table 2:
- **Manufacturer's series #**
- **Depth**
- **Spacing,**
- **Span length**
- **Simple or multiple span**

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Table 2 I- joist span table

Truss Joist 40 psf Live + 10 psf Dead (L/360)									
		SINGLE SPAN				MULTI-SPAN			
Depth	SERIES	12"	16"	19.2"	24"	12"	16"	19.2"	24"
9-1/2	110	18-2	16-7	15-3	13-8	17-8	15-3	13-11	12-5
	210	19-1	17-5	16-6	15-0				
	230	19-7	17-11	16-11	15-9	19-7	17-8	16-1	14-5
11-7/8	110	21-7	18-11	17-3	15-5	19-11	17-3	15-8	14-0
	210	22-8	20-8	18-11	16-10				
	230	23-3	21-3	19-11	17-9	23-0*	19-11	18-2	16-3
	360	25-4	23-2	21-10	20-4	25-4*	23-2*	21-0*	17-10
	560	28-10	26-3	24-9	23-0	28-10*	26-3*	24-9*	20-11
14	110	23-9	20-6	18-9	16-9	21-8	18-9	17-1	14-7
	210	25-8	22-6	20-7	18-4				
	230	26-4	23-9	21-8	19-4	25-0*	21-8	19-9	17-1
	360	28-9	26-3	24-9	21-5	28-9*	26-3*	22-4	17-10
	560	32-8	29-9	28-0	25-2	32-8*	29-9*	26-3*	20-11
16	210	27-10	24-1	22-0	19-5				
	230	29-2	25-5	23-2	20-7	26-9*	23-2	21-2	17-1
	360	31-10	29-0	26-10	21-5	31-10*	26-10	22-4	17-10
	560	36-1	32-11	31-0	25-2	36-1*	36-1*	26-3	20-11
18	360		31-9	26-10	21-5		24-9	20-7	16-6
	560		35-11	31-6	25-2		29-1*	24-2	19-4

Spans are manufacturer-specific, and should be verified periodically. Span figures may change from time to time.

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Span table

Using Table 2, complete Q11-Q12

Truss Joist 40 psf Live + 10 psf Dead (L/360)									
		SINGLE SPAN				MULTI-SPAN			
Depth	SERIES	12"	16"	19.2"	24"	12"	16"	19.2"	24"
9-1/2	110	18-2	16-7	15-3	13-8	17-8	15-3	13-11	12-5
	210	19-1	17-5	16-6	15-0				
	230	19-7	17-11	16-11	15-9	19-7	17-8	16-1	14-5
11-7/8	110	21-7	18-11	17-3	15-5	19-11	17-3	15-8	14-0
	210	22-8	20-8	18-11	16-10				
	230	23-3	21-3	19-11	17-9	23-0*	19-11	18-2	16-3
	360	25-4	23-2	21-10	20-4	25-4*	23-2*	21-0*	17-10
	560	28-10	26-3	24-9	23-0	28-10*	26-3*	24-9*	20-11
14	110	23-9	20-6	18-9	16-9	21-8	18-9	17-1	14-7
	210	25-8	22-6	20-7	18-4				
	230	26-4	23-9	21-8	19-4	25-0*	21-8	19-9	17-1
	360	28-9	26-3	24-9	21-5	28-9*	26-3*	22-4	17-10
	560	32-8	29-9	28-0	25-2	32-8*	29-9*	26-3*	20-11
16	210	27-10	24-1	22-0	19-5				
	230	29-2	25-5	23-2	20-7	26-9*	23-2	21-2	17-1
	360	31-10	29-0	26-10	21-5	31-10*	26-10	22-4	17-10
	560	36-1	32-11	31-0	25-2	36-1*	36-1*	26-3	20-11
18	360		31-9	26-10	21-5		24-9	20-7	16-6
	560		35-11	31-6	25-2		29-1*	24-2	19-4

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Q11. What is the max span length of a TJI-110, 9-1/2" @ 16" o.c. for Livingroom? **16'-7"** ft

Truss Joist 40 psf Live + 10 psf Dead (L/360)									
		SINGLE SPAN				MULTI-SPAN			
Depth	SERIES	12"	16"	19.2"	24"	12"	16"	19.2"	24"
9-1/2	110	18-2	16-7	15-3	13-8	17-8	15-3	13-11	12-5
	210	19-1	17-5	16-6	15-0				
	230	19-7	17-11	16-11	15-9	19-7	17-8	16-1	14-5
11-7/8	110	21-7	18-11	17-3	15-5	19-11	17-3	15-8	14-0
	210	22-8	20-8	18-11	16-10				
	230	23-3	21-3	19-11	17-9	23-0*	19-11	18-2	16-3
	360	25-4	23-2	21-10	20-4	25-4*	23-2*	21-0*	17-10
	560	28-10	26-3	24-9	23-0	28-10*	26-3*	24-9*	20-11
14	110	23-9	20-6	18-9	16-9	21-8	18-9	17-1	14-7
	210	25-8	22-6	20-7	18-4				
	230	26-4	23-9	21-8	19-4	25-0*	21-8	19-9	17-1
	360	28-9	26-3	24-9	21-5	28-9*	26-3*	22-4	17-10
	560	32-8	29-9	28-0	25-2	32-8*	29-9*	26-3*	20-11
16	210	27-10	24-1	22-0	19-5				
	230	29-2	25-5	23-2	20-7	26-9*	23-2	21-2	17-1
	360	31-10	29-0	26-10	21-5	31-10*	26-10	22-4	17-10
	560	36-1	32-11	31-0	25-2	36-1*	36-1*	26-3	20-11
18	360		31-9	26-10	21-5		24-9	20-7	16-6
	560		35-11	31-6	25-2		29-1*	24-2	19-4

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Q12. What is the maximum spacing allowed if using Georgia Pacific, Series WI-40, 11-7/8", spanning 17'-0"? **19.2"** o.c.

Georgia Pacific 40 psf Live + 10 psf Dead (L/480)									
		SINGLE SPAN				MULTI-SPAN			
Depth	Series	12"	16"	19.2"	24"	12"	16"	19.2"	24"
9-1/2	GPI 40	18-0	16-6	15-7	14-6	19-8	18-0	16-6	14-9
	WI-40	18-0	16-5	15-6	14-1	19-7	17-2	15-8	14-0
11-7/8	GPI 40	21-6	19-8	18-7	17-1	23-6	20-10	19-0	17-0
	WI-40	21-5	19-7	18-2	16-3	23-0	19-11	18-2	16.2
	WI-60	22-7	20-8	19-6	18-2	24-8	22-6	21-2	19-1
	WI 80	24-11	22-8	21-4	19-11	27-1	24-8	23-3	21-7
14	GPI 40	24-4	22-3	21-0	18-11	26-8	23-1	21-1	18-10
	WI 40	24-4	22-1	20-2	18-0	25-6	22-1	20-1	18-0
	WI 60	25-9	23-6	22-2	20-8	28-0	25-7	23-8	19-9
	WI 80	28-3	25-9	24-3	22-7	30-10	28-0	26-5	23-11
16	WI 60	28-6	26-0	24-7	22-10	31-1	28-1	24-9	19-9
	WI 80	31-4	28-6	26-10	25-0	34-2	31-1	29-3	23-11

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Span table

Procedure

1. Identify design loads
2. Quantify "PLF"
3. Look in a span table
   - **2x beam table**

Table 3:
- **Species,**
- **Depth of member,**
- **Span length**
- **Quantity of members**

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Table 3 2x Members Used as Beams

Old Table

SYP#2 ALLOWABLE UNIFORM BEAM LOADING (PLF)	5'	6'	7'	8'	9'	10'	11'	12'	13'	14'	15'	16'	17'	18'	19'	20'
(1) 2x4	109	75	54	35	24											
(2) 2x4	218	150	108	71	49	35										
(3) 2x4	376	260	162	107	74	53	39									
(4) 2x4	502	347	217	143	99	71	52	39								
(1) 2x6	224	155	113	86	68	54	44	37								
(2) 2x6	449	311	227	173	136	109	89	74								
(3) 2x6	776	537	393	299	235	189	155	122	95							
(4) 2x6	1036	717	524	399	314	252	207	163	126	99						
(1) 2x8	375	260	190	145	114	91	75	63	53							
(2) 2x8	750	520	381	290	228	183	151	126	106	91	78	68				
(3) 2x8	1298	899	658	502	395	318	262	218	185	158	137	116				
(4) 2x8	1730	1198	878	669	527	424	349	291	246	211	182	154				
(1) 2x10	535	371	271	207	163	131	108	90	76	65	56	49	43	38	34	30
(2) 2x10	1071	741	543	414	326	263	216	180	152	130	113	98	86	76	68	60
(3) 2x10	1850	1281	939	716	564	455	374	312	265	227	196	170				
(4) 2x10	2465	1709	1252	955	751	606	499	416	353	302	262	228				
(1) 2x12	736	510	373	285	224	181	148	124	105	90	78	68	60	53	47	42
(2) 2x12	1472	1020	747	570	449	362	297	248	210	180	156	135	120	106	94	84
(3) 2x12	2542	1761	1291	986	776	626	515	431	365	313	271	236				
(4) 2x12	3386	2300	1722	1314	1035	835	687	574	487	417	361	316				

Based on 2009 IRC and 2005 NDS. Chart was developed from StruCalc – Uniform Loaded Floor Beams.

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Span table

Using Table 3, complete Q13-Q14

Old Table

SYP#2 ALLOWABLE UNIFORM BEAM LOADING (PLF)	5'	6'	7'	8'	9'	10'	11'	12'	13'	14'	15'	16'	17'	18'	19'	20'
(1) 2x4	109	75	54	35	24											
(2) 2x4	218	150	108	71	49	35										
(3) 2x4	376	260	162	107	74	53	39									
(4) 2x4	502	347	217	143	99	71	52	39								
(1) 2x6	224	155	113	86	68	54	44	37								
(2) 2x6	449	311	227	173	136	109	89	74								
(3) 2x6	776	537	393	299	235	189	155	122	95							
(4) 2x6	1036	717	524	399	314	252	207	163	126	99						
(1) 2x8	375	260	190	145	114	91	75	63	53							
(2) 2x8	750	520	381	290	228	183	151	126	106	91	78	68				
(3) 2x8	1298	899	658	502	395	318	262	218	185	158	137	116				
(4) 2x8	1730	1198	878	669	527	424	349	291	246	211	182	154				
(1) 2x10	535	371	271	207	163	131	108	90	76	65	56	49	43	38	34	30
(2) 2x10	1071	741	543	414	326	263	216	180	152	130	113	98	86	76	68	60
(3) 2x10	1850	1281	939	716	564	455	374	312	265	227	196	170				
(4) 2x10	2465	1709	1252	955	751	606	499	416	353	302	262	228				
(1) 2x12	736	510	373	285	224	181	148	124	105	90	78	68	60	53	47	42
(2) 2x12	1472	1020	747	570	449	362	297	248	210	180	156	135	120	106	94	84
(3) 2x12	2542	1761	1291	986	776	626	515	431	365	313	271	236				
(4) 2x12	3386	2300	1722	1314	1035	835	687	574	487	417	361	316				

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Q13. How many 2x8s @ 13' long are required if carrying 165plf?

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SYP#2 ALLOWABLE UNIFORM BEAM LOADING (PLF)	5'	6'	7'	8'	9'	10'	11'	12'	13'	14'	15'	16'	17'	18'	19'	20'
(1) 2x4	109	75	54	35	24											
(2) 2x4	218	150	108	71	49	35										
(3) 2x4	376	260	162	107	74	53	39									
(4) 2x4	502	347	217	143	99	71	52	39								
(1) 2x6	224	155	113	86	68	54	44	37								
(2) 2x6	449	311	227	173	136	109	89	74								
(3) 2x6	776	537	393	299	235	189	155	122	95							
(4) 2x6	1036	717	524	399	314	252	207	163	126	99						
(1) 2x8	375	260	190	145	114	91	75	63	53							
(2) 2x8	750	520	381	290	228	183	151	126	106	91	78	68				
(3) 2x8	1298	899	658	502	395	318	262	218	185	158	137	116				
(4) 2x8	1730	1198	878	669	527	424	349	291	246	211	182	154				
(1) 2x10	535	371	271	207	163	131	108	90	76	65	56	49	43	38	34	30
(2) 2x10	1071	741	543	414	326	263	216	180	152	130	113	98	86	76	68	60
(3) 2x10	1850	1281	939	716	564	455	374	312	265	227	196	170				
(4) 2x10	2465	1709	1252	955	751	606	499	416	353	302	262	228				
(1) 2x12	736	510	373	285	224	181	148	124	105	90	78	68	60	53	47	42
(2) 2x12	1472	1020	747	570	449	362	297	248	210	180	156	135	120	106	94	84
(3) 2x12	2542	1761	1291	986	776	626	515	431	365	313	271	236				
(4) 2x12	3386	2300	1722	1314	1035	835	687	574	487	417	361	316				

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Q14. Will (3) 2x10x10' carrying 400plf pass/fail? **PASS**

SYP#2 ALLOWABLE UNIFORM BEAM LOADING (PLF)	5'	6'	7'	8'	9'	10'	11'	12'	13'	14'	15'	16'	17'	18'	19'	20'
(1) 2x4	109	75	54	35	24											
(2) 2x4	218	150	108	71	49	35										
(3) 2x4	376	260	162	107	74	53	39									
(4) 2x4	502	347	217	143	99	71	52	39								
(1) 2x6	224	155	113	86	68	54	44	37								
(2) 2x6	449	311	227	173	136	109	89	74								
(3) 2x6	776	537	393	299	235	189	155	122	95							
(4) 2x6	1036	717	524	399	314	252	207	163	126	99						
(1) 2x8	375	260	190	145	114	91	75	63	53							
(2) 2x8	750	520	381	290	228	183	151	126	106	91	78	68				
(3) 2x8	1298	899	658	502	395	318	262	218	185	158	137	116				
(4) 2x8	1730	1198	878	669	527	424	349	291	246	211	182	154				
(1) 2x10	535	371	271	207	163	131	108	90	76	65	56	49	43	38	34	30
(2) 2x10	1071	741	543	414	326	263	216	180	152	130	113	98	86	76	68	60
(3) 2x10	1850	1281	939	716	564	455	374	312	265	227	196	170				
(4) 2x10	2465	1709	1252	955	751	606	499	416	353	302	262	228				
(1) 2x12	736	510	373	285	224	181	148	124	105	90	78	68	60	53	47	42
(2) 2x12	1472	1020	747	570	449	362	297	248	210	180	156	135	120	106	94	84
(3) 2x12	2542	1761	1291	986	776	626	515	431	365	313	271	236				
(4) 2x12	3386	2300	1722	1314	1035	835	687	574	487	417	361	316				

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Span table

Procedure

1. Identify design loads
2. Quantify "PLF"
3. Look in a span table
   - **LVL beam table**

Table 4:
- **Manufacturer,**
- **E value**
- **Number of plies,**
- **Depth of member,**
- **Span**

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Table 4 LVL beam span table

Truss Joist 2 ply – PLF (E=1.9) 100%								
7-1/4	9-1/4	9-1/2	11-1/4	11-7/8	14	16	18	20	SPAN
1,525	2,055	2,125	2,648	2,848	3,589	3,917	3,917	3,917	6
1,307	1,889	1,959	2,444	2,625	3,295	3,659	3,671	3,671	6.5
1,089	1,723	1,794	2,239	2,402	3,002	3,401	3,425	3,425	7
870	1,557	1,628	2,035	2,179	2,708	3,143	3,178	3,178	7.5
652	1,391	1,462	1,830	1,956	2,414	2,885	2,932	2,932	8
545	1,255	1,319	1,693	1,827	2,255	2,688	2,777	2,777	8.5
439	1,119	1,177	1,555	1,699	2,096	2,491	2,621	2,621	9
332	983	1,034	1,418	1,570	1,937	2,294	2,466	2,466	9.5
270	883	932	1,279	1,415	1,817	2,147	2,342	2,342	10
235	793	840	1,181	1,306	1,696	2,038	2,244	2,244	10.5
199	702	748	1,082	1,197	1,575	1,928	2,145	2,145	11
164	612	655	984	1,088	1,454	1,819	2,047	2,047	11.5
128	521	563	885	979	1,333	1,709	1,948	1,948	12
113	473	512	810	906	1,244	1,595	1,852	1,878	12.5
97	425	460	736	832	1,154	1,481	1,756	1,808	13
82	377	409	661	759	1,062	1,367	1,659	1,737	13.5
66	329	357	586	685	975	1,253	1,563	1,667	14
	303	329	541	632	917	1,182	1,474	1,607	14.5
	277	301	496	580	859	1,111	1,386	1,546	15
	252	273	450	527	800	1,039	1,297	1,486	15.5
	226	**245**	**405**	**475**	**742**	**968**	**1,209**	**1,425**	**16**
	200	217	360	422	684	897	1,120	1,365	16.5
	185	201	334	391	635	850	1,062	1,294	17
	170	185	307	361	586	804	1,004	1,224	17.5
	155	168	281	330	537	757	945	1,153	18

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Span table

Using the four Table 4s, complete Q15-Q16

Truss Joist 2 ply – PLF (E=1.9) 100%								
7-1/4	9-1/4	9-1/2	11-1/4	11-7/8	14	16	18	20	SPAN
1,525	2,055	2,125	2,648	2,848	3,589	3,917	3,917	3,917	6
1,307	1,889	1,959	2,444	2,625	3,295	3,659	3,671	3,671	6.5
1,089	1,723	1,794	2,239	2,402	3,002	3,401	3,425	3,425	7
870	1,557	1,628	2,035	2,179	2,708	3,143	3,178	3,178	7.5
652	1,391	1,462	1,830	1,956	2,414	2,885	2,932	2,932	8
545	1,255	1,319	1,693	1,827	2,255	2,688	2,777	2,777	8.5
439	1,119	1,177	1,555	1,699	2,096	2,491	2,621	2,621	9
332	983	1,034	1,418	1,570	1,937	2,294	2,466	2,466	9.5
270	883	932	1,279	1,415	1,817	2,147	2,342	2,342	10
235	793	840	1,181	1,306	1,696	2,038	2,244	2,244	10.5
199	702	748	1,082	1,197	1,575	1,928	2,145	2,145	11
164	612	655	984	1,088	1,454	1,819	2,047	2,047	11.5
128	521	563	885	979	1,333	1,709	1,948	1,948	12
113	473	512	810	906	1,244	1,595	1,852	1,878	12.5
97	425	460	736	832	1,154	1,481	1,756	1,808	13
82	377	409	661	759	1,062	1,367	1,659	1,737	13.5
66	329	357	586	685	975	1,253	1,563	1,667	14
	303	329	541	632	917	1,182	1,474	1,607	14.5
	277	301	496	580	859	1,111	1,386	1,546	15
	252	273	450	527	800	1,039	1,297	1,486	15.5
	226	**245**	**405**	**475**	**742**	**968**	**1,209**	**1,425**	**16**
	200	217	360	422	684	897	1,120	1,365	16.5
	185	201	334	391	635	850	1,062	1,294	17
	170	185	307	361	586	804	1,004	1,224	17.5
	155	168	281	330	537	757	945	1,153	18

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Q15. What is the max allowable uniform load for a TJ, E=1.9, 100%, (2ply) 14" @ 13'? __1154___ plf

Truss Joist 2 ply – PLF (E=1.9) 100%								
7-1/4	9-1/4	9-1/2	11-1/4	11-7/8	14	16	18	20	SPAN
1,525	2,055	2,125	2,648	2,848	3,589	3,917	3,917	3,917	6
1,307	1,889	1,959	2,444	2,625	3,295	3,659	3,671	3,671	6.5
1,089	1,723	1,794	2,239	2,402	3,002	3,401	3,425	3,425	7
870	1,557	1,628	2,035	2,179	2,708	3,143	3,178	3,178	7.5
652	1,391	1,462	1,830	1,956	2,414	2,885	2,932	2,932	8
545	1,255	1,319	1,693	1,827	2,255	2,688	2,777	2,777	8.5
439	1,119	1,177	1,555	1,699	2,096	2,491	2,621	2,621	9
332	983	1,034	1,418	1,570	1,937	2,294	2,466	2,466	9.5
270	883	932	1,279	1,415	1,817	2,147	2,342	2,342	10
235	793	840	1,181	1,306	1,696	2,038	2,244	2,244	10.5
199	702	748	1,082	1,197	1,575	1,928	2,145	2,145	11
164	612	655	984	1,088	1,454	1,819	2,047	2,047	11.5
128	521	563	885	979	1,333	1,709	1,948	1,948	12
113	473	512	810	906	1,244	1,595	1,852	1,878	12.5
97	425	460	736	832	1,154	1,481	1,756	1,808	13
82	377	409	661	759	1,062	1,367	1,659	1,737	13.5
66	329	357	586	685	975	1,253	1,563	1,667	14
	303	329	541	632	917	1,182	1,474	1,607	14.5
	277	301	496	580	859	1,111	1,386	1,546	15
	252	273	450	527	800	1,039	1,297	1,486	15.5
	226	**245**	**405**	**475**	**742**	**968**	**1,209**	**1,425**	**16**
	200	217	360	422	684	897	1,120	1,365	16.5
	185	201	334	391	635	850	1,062	1,294	17
	170	185	307	361	586	804	1,004	1,224	17.5
	155	168	281	330	537	757	945	1,153	18

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Q16. How much more weight (plf) will a TJ, (3) 11-7/8" @ 15' carry if you change from E=1.9 to a E=2.0? **46** plf

TJI LVL, 3 ply (E=1.9)								
7-1/4	9-1/4	9-1/2	11-1/4	11-7/8	14	16	18	20	SPAN
2,287	3,083	3,188	3,972	4,273	5,384	5,875	5,875	5,875	6
1,960	2,834	2,939	3,665	3,939	4,943	5,488	5,508	5,508	6.5
1,633	2,585	2,691	3,359	3,604	4,503	5,102	5,137	5,137	7
1,305	2,335	2,442	3,052	3,270	4,062	4,715	4,768	4,768	7.5
978	2,086	2,193	2,745	2,935	3,621	4,328	4,399	4,399	8
818	1,883	1,979	2,540	2,742	3,383	4,033	4,166	4,166	8.5
658	1,678	1,765	2,333	2,547	3,143	3,736	3,932	3,932	9
498	1,475	1,551	2,128	2,354	2,905	3,441	3,699	3,699	9.5
406	1,325	1,398	1,919	2,123	2,725	3,221	3,513	3,513	10
353	1,189	1,260	1,771	1,960	2,544	3,057	3,365	3,365	10.5
300	1,053	1,121	1,623	1,796	2,363	2,892	3,218	3,218	11
246	917	983	1,475	1,633	2,181	2,728	3,070	3,070	11.5
193	781	844	1,327	1,469	2,000	2,563	2,922	2,922	12
170	709	767	1,215	1,359	1,866	2,392	2,778	2,817	12.5
147	638	690	1,103	1,249	1,732	2,222	2,634	2,711	13
123	566	612	991	1,138	1,597	2,051	2,489	2,606	13.5
100	494	535	879	1,028	1,463	1,880	2,345	2,500	14
89	455	493	811	949	1,376	1,773	2,212	2,410	14.5
77	416	451	743	870	1,288	1,666	2,079	2,319	15

3 PLY (E=2.0)							
9-1/4	9-1/2	11-1/4	11-7/8	14	16	18	SPAN
2,204	2,275	2,792	2,985	3,683	4,400	4,400	8
2,008	2,090	2,617	2,796	3,441	4,100	4,167	8.5
1,810	1,905	2,440	2,605	3,197	3,800	3,933	9
1,614	1,720	2,265	2,416	2,955	3,500	3,700	9.5
1,395	1,505	2,130	2,271	2,772	3,276	3,514	10
1,252	1,351	1,959	2,113	2,634	3,109	3,366	10.5
1,109	1,197	1,788	1,955	2,496	2,942	3,219	11
965	1,042	1,617	1,797	2,358	2,774	3,071	11.5
822	888	1,446	1,639	2,220	2,607	2,923	12
747	807	1,316	1,500	2,075	2,484	2,815	12.5
671	726	1,186	1,361	1,930	2,360	2,707	13
596	644	1,055	1,221	1,784	2,237	2,598	13.5
520	563	925	1,082	1,639	2,113	2,490	14
479	519	854	999	1,527	1,993	2,371	14.5
438	475	782	916	1,415	1,873	2,252	15

916 plf – 870 plf = 46 plf

87

Span table

Procedure

1. Identify design loads
2. Quantify "PLF"
3. Look in a span table
   - **2x columns**

Table 5:
- **Species**
- **Height**
- **Number of studs ganged together**

88

Span table

Table 5
Stud capacity in sheathed walls

BRACED SYP#2
Allowable Axial Capacity for Columns (lbs)
for use with stud walls
(sheathed on at least one side)

	5'	6'	7'	8'	9'	10'	11'	12'
(1) 2x4	5,930	4,750	3,758	3,000	2,426	2,000	1,665	1,408
(2) 2x4		9,500	7,515	6,000	4,800	4,000	3,300	2,800
(3) 2x4		14,000	11,250	9,000	7,280	6,000	5,000	4,200
(4) 2x4		19,000	15,000	12,000	9,700	8,000	6,600	5,600
(5) 2x4			18,600	15,000	12,200	10,000	8,300	70,000

89

Span table

Try Q17 using table 5

BRACED SYP#2
Allowable Axial Capacity for Columns (lbs)
for use with stud walls
(sheathed on at least one side)

	5'	6'	7'	8'	9'	10'	11'	12'
(1) 2x4	5,930	4,750	3,758	3,000	2,426	2,000	1,665	1,408
(2) 2x4		9,500	7,515	6,000	4,800	4,000	3,300	2,800
(3) 2x4		14,000	11,250	9,000	7,280	6,000	5,000	4,200
(4) 2x4		19,000	15,000	12,000	9,700	8,000	6,600	5,600
(5) 2x4			18,600	15,000	12,200	10,000	8,300	70,000

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Q17. How many 2x4 x 10' studs are required to carry 6,600#?

4

BRACED SYP#2
Allowable Axial Capacity for Columns (lbs)
for use with stud walls
(sheathed on at least one side)

	5'	6'	7'	8'	9'	10'	11'	12'
(1) 2x4	5,930	4,750	3,758	3,000	2,426	2,000	1,665	1,408
(2) 2x4		9,500	7,515	6,000	4,800	4,000	3,300	2,800
(3) 2x4		14,000	11,250	9,000	7,280	6,000	5,000	4,200
(4) 2x4		19,000	15,000	12,000	9,700	8,000	6,600	5,600
(5) 2x4			18,600	15,000	12,200	10,000	8,300	70,000

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Span table

Procedure

1. Identify design loads
2. Quantify "PLF"
3. Look in a span table
   - **PSL columns**

Table 6:
- **Manufacturer**
- **Height of column**
- **Number of studs ganged together**

92

Span table

Table 6
Manufactured columns

	TJ - PSL loads (#) (E=1.8)					Steel	
Effective column length (ft)	**3.5 x 3.5**	**3.5 x 5.55**	**3.5 x 7.25**	**5.25 x 5.25**	**5.25 x 7.25**	**3" dia steel**	**3.5" dia**
6	**10600**	**15900**	**21200**	**33300**			
7	**8700**	**13100**	**17500**	**30000**			
8	**7300**	**10900**	**14500**	**26600**	**35500**		
9	**6100**	**9200**	**12200**	**23500**	**31300**		
10	**5200**	**7800**	**10400**	**20700**	**27500**	**30000**	**35000**
12	**3900**	**5800**	**7800**	**16200**	**21600**		

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Span table

Try Q18 using Table 6

	TJ - PSL loads (#) (E=1.8)					Steel	
Effective column length (ft)	3.5x3.5	3.5x5.55	3.5x7.25	5.25x5.25	5.25x7.25	3" dia steel	3.5" dia
6	10600	15900	21200	33300			
7	8700	13100	17500	30000			
8	7300	10900	14500	26600	35500		
9	6100	9200	12200	23500	31300		
10	5200	7800	10400	20700	27500	30000	35000
12	3900	5800	7800	16200	21600		

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Q18. How much weight will a TJ 3-1/2 x 7-1/4 x 10' PSL carry?
10400 #

	TJ - PSL loads (#) (E=1.8)					Steel	
Effective column length (ft)	3.5 x 3.5	3.5 x 5.55	3.5 x 7.25	5.25 x 5.25	5.25 x 7.25	3" dia steel	3.5" dia
6	10600	15900	21200	33300			
7	8700	13100	17500	30000			
8	7300	10900	14500	26600	35500		
9	6100	9200	12200	23500	31300		
10	5200	7800	10400	20700	27500	30000	35000
12	3900	5800	7800	16200	21600		

95

Calculating footing size (no table)

Procedure

Footing size

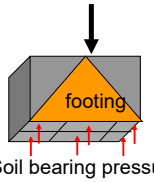
Size is a function of:
- **Load (#)**
- **Soil bearing pressure (psf)**

96

Calculating footing size (no table)

Procedure

Footing size



Load gets spread @ 45°

Soil bearing pressure (psf)

- Soil bearing pressure = $\frac{\text{Load (\#)}}{\text{Area (sqft)}}$
- Area required = $\frac{\text{Load (\#)}}{\text{Soil bearing pressure (psf)}}$

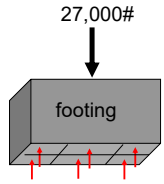
97

Calculating footing size (no table)

Try Q19

98

Q19. If the soil bearing pressure is 3,000 psf, what size square footing is required to carry 27,000# **__3__(ft) x _3__ (ft)**



Soil bearing pressure
3,000 (psf)

Area = Load (27,000#) / Bearing pressure (3,000 psf) = 9 sqft = 3' x '3

99

Interpolation

- IRC allows interpolation in many tables.
- No extrapolation.

TABLE R602.10.5.2
PARTIAL CREDIT FOR BRACED WALL PANELS LESS THAN 48 INCHES IN ACTUAL LENGTH

ACTUAL LENGTH OF BRACED WALL PANEL (inches)	CONTRIBUTING LENGTH OF BRACED WALL PANEL (inches)[a]	
	8-foot Wall Height	9-foot Wall Height
48	48	48
42	36	36
36	27	N/A

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.
N/A = Not Applicable.
a. Linear interpolation shall be permitted.

Show notes

100

How to Interpolate

Making the most of IRC tables

- Step 1: Using the starting value, x, identify upper and lower limits from your table.

x_u	y_u
x_l	y_l

- Step 2: Solve for unknown value, *y*:

$$y = \frac{(x - x_l) \times (y_u - y_l)}{(x_u - x_l)} + y_l$$

101

For Example

- Step 1: For an actual length of 39", what is the contributing length for an 8 ft. wall?
- From Table R602.10.5.2, the starting value, *x* is equal to 39, and the upper and lower limits are shown below.

$x = 39$	x_u=42	y_u=36
	x_l=36	y_l=27

102

For Example

- Step 2: Solve for unknown value, *y*:

$$\text{unknown} = \frac{(39-36)\times(36-27)}{(42-36)} + 27 = 31.5$$

- **Remember the sequence of operations in a formula:**

  Please Excuse My Dear Aunt Sally

  parentheses > exponent > multiply > divide > add > subtract

103

How to Interpolate

Step 1: Identify upper and lower limits of table values.

For example, for a actual length of 39", what is the contributing length?

	Known	Unknown
Upper limit:	42"	36"
Desired value:	39"	?
Lower limit:	36"	27"

TABLE R602.10.5.2
PARTIAL CREDIT FOR BRACED WALL PANELS LESS THAN 48 INCHES IN ACTUAL LENGTH

Actual Length of Braced Wall Panel (in)	Contributing Length of Braced Wall Panel (in) [a]	
	8 ft Wall Height	9 ft Wall Height
48	48	48
42	36	36
36	27	N/A

For SI: 1 inch = 25.4mm
a. Linear interpolation shall be permitted.

104

How to Interpolate

Step 2: Find the difference between the upper limits and lower limits for the known values.

	Known	Unknown
Upper limit:	42"	36"
Lower limit:	-36"	-27"
	6	9

105

How to Interpolate

Step 3: Divide the known-difference into the unknown-difference.

	Known	Unknown
Upper limit:	42"	36"
Lower limit:	36"	27"
	6	9

9 ÷ 6 = 1.5

106

How to Interpolate

Step 4: Find the difference between the known-desired value and the known-lower limits.

Known

Upper limit:
Desired value: 39”
Lower limit: - 36”
3

107

How to Interpolate

Step 5: Multiply the difference in Step 4 with the quotient of Step 3.

Known

Upper limit:
Desired value: 39”
Lower limit: -36”
3

3 x 1.5 = 4.5

108

How to Interpolate

Step 6: Add the product from Step 5 to the unknown-lower limit.

	Known	Unknown
Upper limit:	42”	36”
Desired value:	39”	**31.5**
Lower limit:	36”	27”

27 + 4.5 = **31.5**

109

You Try It

Find the Maximum Cantilever Span for a 2 x 8 and a ground snow load of 45 psf.

TABLE R502.3.3(2)
CANTILEVER SPANS FOR FLOOR JOISTS SUPPORTING EXTERIOR BALCONY[a, b, e, f]

MEMBER SIZE	SPACING	MAXIMUM CANTILEVER SPAN (uplift force at backspan support in lb)[c, d]		
		Ground Snow Load		
		≤ 30 psf	50 psf	70 psf
2 × 8	12"	42" (139)	39" (156)	34" (165)
2 × 8	16"	36" (151)	34" (171)	29" (180)
2 × 10	12"	61" (164)	57" (189)	49" (201)
2 × 10	16"	53" (180)	49" (208)	42" (220)
2 × 10	24"	43" (212)	40" (241)	34" (255)
2 × 12	16"	72" (228)	67" (260)	57" (268)
2 × 12	24"	58" (279)	54" (319)	47" (330)

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

a. Spans are based on No. 2 Grade lumber of Douglas fir-larch, Southern pine, hem-fir, and spruce-pine-fir for repetitive (three or more) members.
b. Ratio of backspan to cantilever span shall be not less than 2:1.
c. Connections capable of resisting the indicated uplift force shall be provided at the backspan support.
f. Linear interpolation shall be permitted for ground snow loads other than shown.

110

Solution

Step 1: Identify upper and lower limits of table values.

	Known	Unknown
Upper limit:	50 psf	39”
Desired value:	45 psf	**?**
Lower limit:	30 psf	42”

111

Solution

Step 2: Find the difference between the upper limits and lower limits for the known values.

	Known	Unknown
Upper limit:	50 psf	39”
Lower limit:	-30 psf	-42”
	6	- 3

112

Solution

Step 3: Divide the known-difference into the unknown-difference.

	Known	Unknown
Upper limit:	42”	39”
Lower limit:	36”	42”
	6	- 3

- 3 ÷ 6 = -0.5

113

Solution

Step 4: Find the difference between the known-desired value and the known-lower limits.

	Known
Upper limit:	
Desired value:	45 psf
Lower limit:	-30 psf
	5 psf

114

Solution

Step 5: Multiply the difference in Step 4 with the quotient of Step 3.

	Known
Upper limit:	
Desired value:	45 psf
Lower limit:	-30 psf
	5 psf

5 x -0.5 = -2.5

115

Solution

Step 6: Add the product from Step 5 to the unknown-lower limit.

	Known	Unknown
Upper limit:	50 psf	39”
Desired value:	45 psf	**40.5**
Lower limit:	30 psf	42”

42 + -2.5 = 40.5

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Design Criteria

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Design Criteria

Buildings shall be constructed to safely support all loads, including dead loads, live loads, roof loads, snow loads, wind loads and seismic loads … in accordance with the provisions of this code …

… shall result in a system that provides a complete load path … for the transfer of all loads from their point of origin through the load-resisting elements to the foundation.

Alternate material?
ZipSystem

R301.1

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Alternative Provisions

- Don't want to use the IRC?
- Use the prescriptive provisions in the following:
  - *Wood Frame Construction Manual.*
  - *Standard for Cold-Formed Steel Framing.*
  - *Standard on the Design and Construction of Log Structures.*

R301.1.1

119

Design Criteria

The International Residential Code is a prescriptive code.

The AWC (American Wood Council) National Design Specification (NDS) is an engineering standard for design of wood structures. The (AWC) Wood Frame Construction Manual (WFCM) is a "how to do it" prescriptive manual, based on engineering.

Both of these documents are referred to in the IRC as alternate provisions in a usable format this is beneficial to the engineer, builder and building official, especially for situations not addressed in the IRC.

R301.1.1

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Design Criteria

Chapter 44 Referenced Standards

AWC

American Wood Council
222 Catoctin Circle SE, Suite 201
Leesburg, VA 20175

ANSI/AWC NDS—2018	National Design Specification (NDS) for Wood Construction—with 2018 Supplement R404.2.2, R502.2, Table R503.1, R507.2.1, R602.3, R608.9.2, R608.9.3, Table R703.15.1, Table R703.15.2, R802.2
ANSI/AWC PWF—2021:	Permanent Wood Foundation Design Specification R317.3.2, R401.1, R404.2.3
ANSI/AWC WFCM—2018	Wood Frame Construction Manual for One- and Two-family Dwellings R301.1.1, R301.2.1.1, R602.10.8.2, Figure R608.9(9), R608.9.2, R608.9.3, R608.10
AWC STJR—2021:	Span Tables for Joists and Rafters R502.3, R802.4.1, R802.5.1

TPI

Truss Plate Institute
2670 Crain Highway, Suite 203
Waldorf, MD 20601

TPI 1—2014	National Design Standard for Metal Plate Connected Wood Truss Construction R502.11.1, R802.10.2

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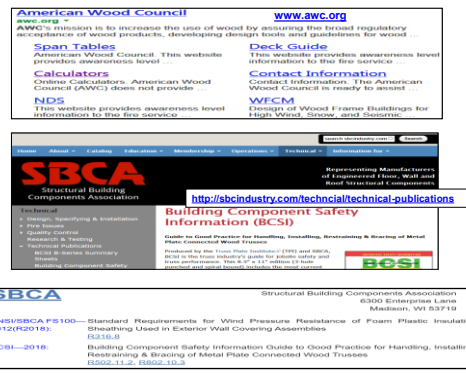
R502 & R802

Design Criteria



SBCA	Structural Building Components Association 6300 Enterprise Lane Madison, WI 53719
ANSI/SBCA FS100—2012(R2018):	Standard Requirements for Wind Pressure Resistance of Foam Plastic Insulating Sheathing Used in Exterior Wall Covering Assemblies R316.8
BCSI—2018:	Building Component Safety Information Guide to Good Practice for Handling, Installing, Restraining & Bracing of Metal Plate Connected Wood Trusses R502.11.2, R602.10.3

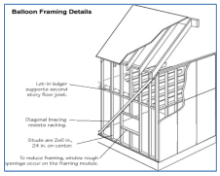
122

Design Criteria

Construction systems.

The requirements of this code are based on platform and balloon-frame construction …

Other framing systems must have equivalent detailing to ensure force transfer, continuity and compatible deformations.



R301.1.2, comment R602.9

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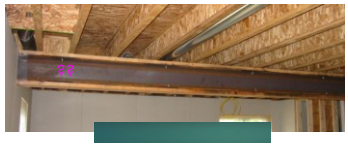
Design Criteria



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Design Criteria

Engineered design.
When …a building… contains structural elements exceeding the limits of section R301 … these elements shall be designed in accordance with accepted engineering practice.

Although not defined in the code, accepted engineering practice means the engineering analysis is based on well established principles of mechanics and conforms to accepted principles, tests or standards of nationally recognized technical or scientific authorities.

The building official has the authority to require the plan to be designed and certified by qualified an architect or engineer.

www.asce.org/asce-7

www.awc.org/sdpws-2015

www.iccsafe.org

R301.1.3

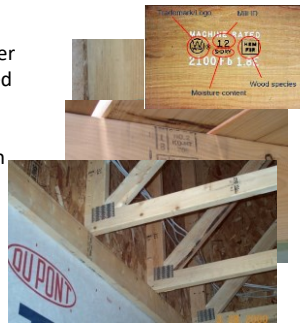
125

Conventional Construction

126

Floors, Walls, Ceilings & Roofs Construction

- All dimension lumber for shall be identified by a grade mark, certification or approved inspection agency.



R502.1, 602.1. 802.1 Identification

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Floors, Walls, Ceilings & Roofs Construction

Lumber Grade

- **Blocking: floors & rafters – utility**
- **Floor joist- SS - #3**
- **Girders/Headers- # 2**
- **Studs - # 3 or NLB Utility**
- **Cantilever floor joist #2**
- **Rafters – SS - # 3**

R502.1, 602.2. 802

128

Stud Wall Species and Grades

BETTER

NOT AS GOOD

SELECT STRUCTURAL

#1

#2

#3

STUD

CONSTRUCTION

STANDARD

UTILITY

R602.2

129 129

Stud - Size, Height, Spacing

Table R602.3(5)
Size, Height and Spacing of Wood Studs [a]

STUD SIZE (inches)	BEARING WALLS: Laterally unsupported stud height[a] (feet)	BEARING WALLS: Maximum spacing supporting a roof[illegible] assembly or a habi[illegible] assembly, only [illegible]	BEARING WALLS: Maximum spacing where supporting one floor height[b] (inches)	NONBEARING WALLS: Laterally unsupported stud height[a] (feet)	NONBEARING WALLS: Maximum spacing (inches)
2 × 3[c]	—	—	—	10	16
2 × 4	10	24[c]	24	14	24
3 × 4	10	24	24	14	24
2 × 5	10	24	24	16	24
2 × 6	10	24	24	20	24

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

a. Laterally unsupported stud heights are distances between points of lateral support placed [illegible] stud. Increases in unsupported height are permitted where in compli[illegible]

b. Shall not be used in exterior walls.

c. A habitable attic assembly supported by 2 × 4 studs is limited to a [illegible]

[illegible]ing shall be installed not greater than 4 feet apart measured vertically from either end of the [illegible]

[illegible]studs shall be designed in accordance with accepted engineering practice.

130

Stud - Size, Height, Spacing

11'-7" MAX FLOOR - FLOOR HT

12-0" MAX STUD HT

UNLESS

R301.3 Story height.

The wind and seismic provisions of this code shall apply to buildings with story heights not exceeding the following:

1. For wood wall framing, the story height shall not exceed 11' 7" and the laterally unsupported bearing wall stud height permitted by Table R602.3(5).

   Exception: A story height not exceeding 13' 7" is permitted provided that the maximum wall stud clear height does not exceed 12', the wall studs are in accordance with **Exception 2 or 3** of **Section R602.3.1** or an engineered design is provided for the wall framing members, and wall bracing for the building is in accordance with Section R602.10. Studs shall be laterally supported at the top and bottom plate in accordance with Section R602.3.

2. Where ground snow loads are less than or equal to 25 lb. psf, and the ultimate design wind speed is less than or equal to 130 mph, 2" x 6" studs supporting a roof load with not more than 6' of tributary length shall have a maximum height of 18' where spaced at 16" o.c., or 20' where spaced at 12" o.c. Studs shall be No. 2 grade lumber or better.
3. Exterior load-bearing studs not exceeding 12' in height provided in accordance with Table R602.3(6). The minimum number of full-height studs adjacent to openings shall be in accordance with Section R602.7.5. The building shall be located in Exposure B, the roof live load shall not exceed 20 psf, and the ground snow load shall not exceed 30 psf. Studs and plates shall be No. 2 grade lumber or better.

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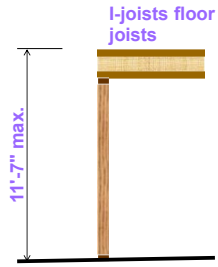
R301.3 Story Height

- Maximum story height = 11'-7" - **Unless**



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Stud - Size, Height, Spacing

Changed 2009 Table into 2012 and Again

R602.3.1Stud size, height and spacing.

The size, height and spacing of studs shall be in accordance with Table R602.3(5).

Exceptions:

1. Utility grade studs shall not be spaced more than 16" o.c., shall not support more than a roof and ceiling, and shall not exceed 8' in height for exterior walls and load-bearing walls or 10' for interior nonload-bearing walls.
2. Where ground snow loads are less than or equal to 25 lb. psf, and the ultimate design wind speed is less than or equal to 130 mph, 2" x 6" studs supporting a roof load with not more than 6' of tributary length shall have a maximum height of 18' where spaced at 16" o.c., or 20' where spaced at 12" o.c. Studs shall be No. 2 grade lumber or better.
3. Exterior load-bearing studs not exceeding 12' in height provided in accordance with Table R602.3(6). The minimum number of full-height studs adjacent to openings shall be in accordance with Section R602.7.5. The building shall be located in Exposure B, the roof live load shall not exceed 20 psf, and the ground snow load shall not exceed 30 psf. Studs and plates shall be No. 2 grade lumber or better.

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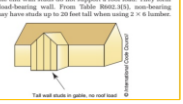
2015 IRC Significant Changes

Example—Prescriptive Tall Walls

In the following three cases, tall walls meeting the IRC's limits are illustrated.

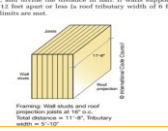
Case 1: 2 × 6 Continuous Studs Used in an 18-Foot Gable End Wall

The gable end wall studs do not support a roof load. They form a non-load-bearing wall. From Table R602.3(5), non-bearing walls may have studs up to 20 feet tall when using 2 × 6 lumber.



Example—Prescriptive Tall Walls (Continued)

What is a roof load tributary width? Tributary width describes the width of the roof surface that will transfer live or snow loads to nearby walls. To determine tributary width in a roof, measure the total distance between roof supports, typically walls in residential construction, and divide the distance in half. If walls supporting the roof are 12 feet apart or less (a roof tributary width of 6 feet), Exception 2 limits are met.



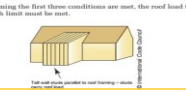
Framing: Wall studs and roof projection joists at 16" o.c.
Total distance = 11'-8", Tributary width = 5'-10"

Case 2: 2 × 6 Continuous Studs Used in a 20-Foot Tall Wall Supporting a Projection (Roof Framing Parallel to Wall)

The studs used for a two-story projection where the roof framing runs parallel to the wall will carry a roof load. If the studs can meet all the limits of Section R602.3.1, Exception 2, then no engineering of the wall is required. The following four limits must be met:

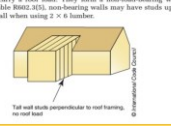
1. Snow load ≤25 psf
2. Wind speed ≤130 mph
3. 2 × 6 construction
4. Roof load tributary width ≤6 feet

Assuming the first three conditions are met, the roof load tributary width limit must be met.



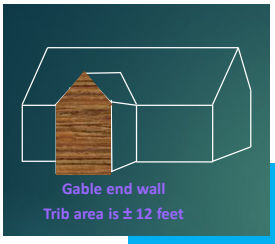
Case 3: 2 × 6 Continuous Studs Used in a Variable-Height Wall Supporting a Projection (Roof Framing Perpendicular to Wall)

The studs where the roof framing runs perpendicular to the wall do not carry a roof load. They form a non-load-bearing wall. From Table R602.3(5), non-bearing walls may have studs up to 20 feet tall when using 2 × 6 lumber.



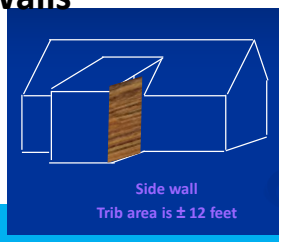
134

Tall Walls



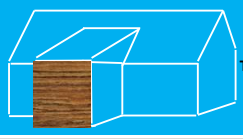
Gable end wall

Trib area is ± 12 feet



Side wall

Trib area is ± 12 feet



End wall

Trib area is ≤12 feet

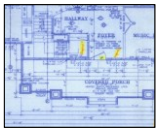
135

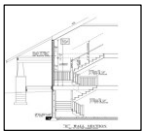
R602.3.1 Stud size, Height and Spacing -- Exceptions

Exceptions:

1. Utility grade studs shall not be spaced more than 16" oc, shall not support more than a roof and ceiling, and shall not exceed 8' in height for exterior walls and load-bearing walls or 10' for interior nonload-bearing walls.

2. Where snow loads are ≤ 25 lbs psf, and the ultimate design wind speed is ≤ 130 mph, 2x6" studs supporting a roof load with not more than 6' of tributary length shall have a maximum height of 18' where spaced at 16" o.c., or 20' where spaced at 12" on center. Studs shall be minimum No. 2 grade lumber.





136

Tall Walls

- What if the tall walls are carrying more than 6' of tributary area?

137

Headers

138

Headers

- Table R602.5(1) exterior bearing walls
- Table R602.5(2) interior bearing walls

139

Headers

Exterior walls

Girder Spans[a] and Header Span[a] for Exterior Bearing Walls
Table R602.7(1)
(Maximum spans for DF-larch, H-fir, SP and SPFb & required number of jack studs)

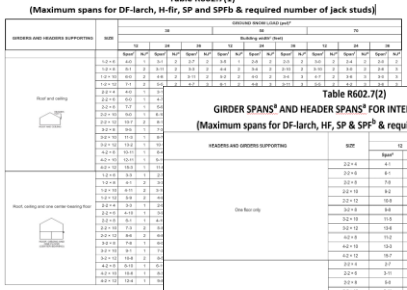


Table R602.7(2)
GIRDER SPANS[a] AND HEADER SPANS[a] FOR INTERIOR BEARING WALLS
(Maximum spans for DF-larch, HF, SP & SPF[b] & required number of jack studs)

Interior walls

140

Headers

- What size SP#2 header and number of jacks:
  - Interior wall on first floor of a two story house

9’

24’

141

Headers - answer

Supports one floor

Table R602.7(2)
GIRDER SPANS[a] AND HEADER SPANS[a] FOR INTERIOR BEARING WALLS
(Maximum spans for DF-larch, HF, SP & SPF[b] & required number of jack studs)

HEADERS AND GIRDERS SUPPORTING	SIZE	BUILDING Width[c] (feet) 12 Span[e]	12 NJ[f]	24 Span[e]	24 NJ[f]	36 Span[e]	36 NJ[f]
One floor only (HEADER, TYP; ONE FLOOR ONLY)	2-2 × 4	4-1	1	2-10	1	2-4	1
	2-2 × 6	6-1	1	4-4	1	3-8	1
	2-2 × 8	7-6	1	5-5	1	4-8	2
	2-2 × 10	9-2	1	6-6	2	5-3	2
	2-2 × 12	10-9	1	7-7	2	6-3	2
	3-2 × 8	9-8	1	6-10	1	5-7	1
	3-2 × 10	11-9	1	8-1	1	6-7	2
	3-2 × 12	13-8	1	9-6	2	7-9	2
	4-2 × 8	11-2	1	7-11	1	6-5	1
	4-2 × 10	13-3	1	9-4	1	7-8	1
	4-2 × 12	15-7	1	11-0	1	9-0	2
Two floors (TWO FLOORS)	2-2 × 4	2-7	1	1-11	1	1-7	1
	2-2 × 6	3-11	1	2-11	2	2-5	2
	2-2 × 8	5-0	1	3-8	2	3-1	2
	2-2 × 10	5-11	2	4-4	2	3-7	2
	2-2 × 12	6-11	2	5-2	2	4-3	3
	3-2 × 8	6-3	1	4-7	2	3-10	2
	3-2 × 10	7-5	1	5-6	2	4-8	2
	3-2 × 12	8-6	2	6-5	2	5-4	2
	4-2 × 8	7-2	1	5-4	1	4-5	2
	4-2 × 10	8-6	1	6-4	2	5-3	2
	4-2 × 12	10-1	1	7-5	2	6-2	2

142

Header

- **What size header do I need:**
  - **One-story, 36’ wide house in DeGray Resort, Arkansas**
  - **Header supports a roof and ceiling only**
  - **Window is 36” wide x 62 tall”**
  - **SP#2**

143

Header - answer

- **One-story, 36’ wide house Owatonna, MN**
- **Header supports a roof and ceiling only**
- **Window is 36” wide x 62 tall”**
- **SP#2**

Table R602.7(1)

Girder Spans[a] and Header Span[a] for Exterior Bearing Walls

(Maximum spans for DF-larch, H-fir, SP and SPFb & required number of jack studs)

GIRDERS AND HEADERS SUPPORTING	SIZE	GROUND SNOW LOAD (psf)											
		30				50				70			
		Building width[b] (feet)											
		12		24		36		12		24		36	
		Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]
Roof and ceiling	1-2 × 6	4-0	1	3-1	2	2-7	2	3-6	1	2-8	2	2-3	2
	1-2 × 8	5-1	2	3-11	2	3-3	2	4-4	2	3-4	2	2-10	2
	1-2 × 10	6-0	2	4-8	2	3-11	2	5-2	2	4-0	2	3-4	2
	1-2 × 12	7-1	2	5-5	2	4-7	3	6-1	2	4-8	3	3-11	3
	2-2 × 4	4-0	1	3-1	1	2-7	1	3-5	1	2-7	1	2-2	1
	2-2 × 6	6-0	1	4-7	1	3-10	1	5-1	1	3-11	1	3-3	2
	2-2 × 8	7-7	1	5-9	1	4-10	2	6-5	1	5-0	2	4-2	2
	2-2 × 10	9-0	1	6-10	2	5-9	2	7-8	2	5-11	2	4-11	2
	2-2 × 12	10-7	2	8-1	2	6-10	2	9-0	2	6-11	2	5-10	2
	3-2 × 8	9-5	1	7-3	1	6-1	1	8-1	1	6-3	1	5-3	2
	3-2 × 10	11-3	1	8-7	1	7-3	2	9-7	1	7-4	2	6-2	2
	3-2 × 12	13-2	1	10-1	2	8-6	2	11-3	2	8-6	2	7-4	2
	4-2 × 8	10-11	1	8-4	1	7-0	1	9-4	1	7-2	1	6-0	[illegible]
	4-2 × 10	13-11	1	9-11	1	8-4	1	11-1	1	8-6	1	7-2	[illegible]
	4-2 × 12	15-3	1	11-6	1	9-10	2	13-0	1	10-0	2	8-6	[illegible]

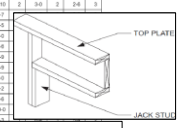


FIGURE R602.7.1(1)

144

Headers for Porches

SUPPORTING

Roof

Floor

TABLE R602.7(3) GIRDER AND HEADER SPANS[a] FOR OPEN PORCHES (Maximum span for Douglas fir-larch, hem-fir, Southern pine and spruce-pine-fir[e])

SIZE	SUPPORTING ROOF						SUPPORTING FLOOR	
	Ground Snow Load (psf)							
	30		50		70			
	Depth of Porch[c] (feet)							
	8	14	8	14	8	14	8	14
2-2 × 6	7-6	5-8	6-2	4-8	5-4	4-0	6-4	4-9
2-2 × 8	10-1	7-7	8-3	6-2	7-1	5-4	8-5	6-4
2-2 × 10	12-4	9-4	10-1	7-7	8-9	6-7	10-4	7-9
2-2 × 12	14-4	10-10	11-8	8-10	10-1	7-8	11-11	9-0

145

Headers for Porches

- Size the header and girder for this porch that extends 8’ from the house

146

Headers for Porches - answer

- Size the header and girder for this porch that is 8’ from the house

TABLE R602.7(3) GIRDER AND HEADER SPANS[a][b]FOR OPEN PORCHES (Maximum span for Douglas fir-larch, hem-fir, Southern pine and spruce-pine-fir[c])

SIZE	SUPPORTING ROOF						SUPPORTING FLOOR	
	Ground Snow Load (psf)							
	30		50		70			
	Depth of Porch[f] (feet)							
	8	14	8	14	8	14	8	14
2-2 × 6	7-6	5-8	6-2	4-8	5-4	4-0	6-4	4-9
2-2 × 8	10-1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8-5	6-4
2-2 × 10	12-4	9-4	10-1	7-7	8-9	6-7	10-4	7-9
2-2 × 12	14-4	10-10	11-8	8-10	10-1	7-8	11-11	9-0

Table R602.7(3)

147

Header & Girder

- **What size header and girder:**
  - **Porch measures 6’x15’**
  - **Rafters run in opposite direction as deck joists**
  - **Columns are 5’ apart.**

Table R602.7(3)

148

Header - answer

- **Porch measures 6’x15’**
- **Rafters run in opposite direction as deck joists**
- **Columns are 5’ apart.**

TABLE R602.7(3) GIRDER AND HEADER SPANS[a][b]FOR OPEN PORCHES (Maximum span for Douglas fir-larch, hem-fir, Southern pine and spruce-pine-fir[c])

SIZE	SUPPORTING ROOF						SUPPORTING FLOOR	
	Ground Snow Load (psf)							
	30		50		70			
	Depth of Porch[f] (feet)							
	8	14	8	14	8	14	8	14
2-2 × 6	7-6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6-4	4-9
2-2 × 8	10-1	7-7	8-3	6-2	7-1	5-4	8-5	6-4
2-2 × 10	12-4	9-4	10-1	7-7	8-9	6-7	10-4	7-9
2-2 × 12	14-4	10-10	11-8	8-10	10-1	7-8	11-11	9-0

149

Wall Header

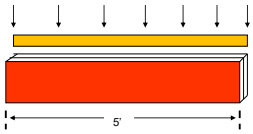
16 spaces @ 19.2” (16 x 1.6 = 25.6)

8’ + 10’ x 50 = 900

150

Roof Truss 2' oc

Reaction load 2222 lbs
per truss= **1111plf.**
2 – 2x10 Hem-Fir
F_b 850



Formula: use the uniform load formula: [plf x l x l x 12[÷ [8 x fb]=s³
l=Length in feet

[1111 x 5 x 5 x 12] ÷ [8 x 850] = 49s³
49 x .85 (snow load reduction) = 41.65s³

Formula 2 x 10 (H x H x W : 6)

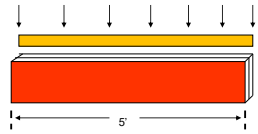
Uniform load -Continues

(9.25 x 9.25 x 1.5) / 6 = 21.39s³
2 x 21.39 = 42.78s³ (passes)

151

Roof Truss 2' o.c.

Reaction load 2222 lbs
per truss= **1111plf.**
2 – 2x12 SPF
F_b 850



Formula: use the uniform load formula: [plf x l x l x 12] ÷ [8 x fb]=s³
l=Length in feet

[1111 x 5 x 5 x 12] ÷ [8 x 850] = 49s³
49 x .85 (snow load reduction) = 41.65s³

Formula 2 x 12 (H x H x W ÷ 6)

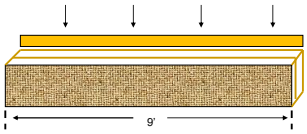
Uniform load -Continues

(11.375 x 11.375 x 1.5) ÷ 6 = 32s³
2 x 32 = 64s³ (pass)

152

Roof Truss 2' oc

Single Car Garage



Reaction load 2222 lbs per
truss= **1111plf.**
2 – 1.75 x 11.25 LVL
Louisiana Pacific Ganglam
F_b 2400

Formula: use the uniform load formula: [plf x l x l x 12[÷ [8 x fb]=s³
l=Length in feet

[1111 x 9 x 9 x 12] ÷ [8 x 2400] = 56.24s³
56.24 x .85 (snow load reduction) = 47.8s³

Formula 1.75 x 11.25 (H x H x W ÷ 6)

Uniform load -Continues

(11.25 x 11.25 x 1.75) ÷ 6 = 36.9s³
2 x 36.9 = 73.8s³ (passes)

153

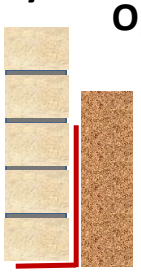
Lintels

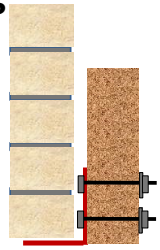
Brick support above opening

Brick support above roof

154

Masonry Veneer Supported Above Opening





1. Lintel is independent of the wood header
2. Lintel is connected to wood beam

155

Masonry Veneer Supported Above Opening

- Sizing steel lintel:
- Two options
  - Option 1:
    Use Table R703.8.3.1
  - Option 2:
    R703.8.3.2 – prescriptive

156

Masonry Veneer Supported Above Opening - Option 1

- Size header:
  - Masonry veneer lintel over 8 foot garage door
  - Supporting gable wall only

157

Masonry Veneer Supported Above Opening Option 1 - answer

- Size header:
  - Masonry veneer lintel over 8 foot garage door
  - Supporting gable wall only

TABLE R703.8.3.1 ALLOWABLE SPANS FOR LINTELS SUPPORTING MASONRY VENEER[a, b, c, d]

SIZE OF STEEL ANGLE[a, c, d] (inches)	NO STORY ABOVE	ONE STORY ABOVE	TWO STORIES ABOVE	NO. OF 1/2-INCH OR EQUIVALENT REINFORCING BARS IN REINFORCED LINTEL[b, d]
3 × 3 × 7/16	6'-0"	4'-6"	3'-0"	1
4 × 3 × 7/16	8'-0"	6'-0"	4'-6"	1
5 × 3 1/2 × 5/16	10'-0"	8'-0"	6'-0"	2
6 × 3 1/2 × 5/16	14'-0"	9'-6"	7'-0"	2
2-6 × 3 1/2 × 5/16	20'-0"	12'-0"	9'-6"	4

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

a. Long leg of the angle shall be placed in a vertical position.
b. Depth of reinforced lintels shall be not less than 8 inches and all cells of hollow masonry lintels shall be grouted solid. Reinforcing bars shall extend not less than 8 inches into the support.
c. Steel members indicated are adequate typical examples; other steel members meeting structural design requirements shall be permitted to be used.
d. Either steel angle or reinforced lintel shall span opening.

158

Lintel

- Size header using option 1:
  - Masonry veneer lintel over 16 foot garage door
  - Room trusses for second floor

159

Lintel - answer

- Size header:
  - 16 foot garage door
  - Supporting gable wall only

TABLE R703.8.3.1 ALLOWABLE SPANS FOR LINTELS SUPPORTING MASONRY VENEER[a, b, c, d]

SIZE OF STEEL ANGLE[a, c, d] (inches)	NO STORY ABOVE	ONE STORY ABOVE	TWO STORIES ABOVE	NO. OF 1/2-INCH OR EQUIVALENT REINFORCING BARS IN REINFORCED LINTEL[b, d]
3 × 3 × 1/4	6'-0"	4'-6"	3'-0"	1
4 × 3 × 1/4	8'-0"	6'-0"	4'-6"	1
5 × 3 1/2 × 5/16	10'-0"	8'-0"	6'-0"	2
6 × 3 1/2 × 5/16	14'-0"	9'-6"	7'-0"	2
2-6 × 3 1/2 × 5/16	20'-0"	12'-0"	9'-6"	4

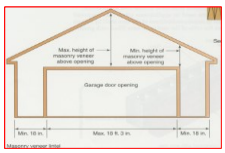
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

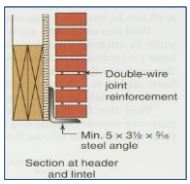
a. Long leg of the angle shall be placed in a vertical position.
b. Depth of reinforced lintels shall be not less than 8 inches and all cells of hollow masonry lintels shall be grouted solid. Reinforcing bars shall extend not less than 6 inches into the support.
c. Steel members indicated are adequate typical examples; other steel members meeting structural design requirements shall be permitted to be used.
d. Either steel angle or reinforced lintel shall span opening.

160

Brick Veneer Lintels – option 2

- Prescriptive
  - Max header span: 18'-3"
  - 18" masonry on sides
  - Min L 5 x 3½ x $^{5}/_{16}$
  - Double wire joint reinforcement
  - Table R703.8.3.2





161

Brick Veneer Lintels – option 2

- Size header using option 2

162

Brick Veneer Lintels – answer

- Size header using option 2

TABLE R703.8.3.2 HEIGHT OF MASONRY VENEER ABOVE OPENING

MINIMUM HEIGHT OF MASONRY VENEER ABOVE OPENING (inches)	MAXIMUM HEIGHT OF MASONRY VENEER ABOVE OPENING (feet)
13	< 5
24	5 to < 12
60	12 to height above support allowed by Section R703.8

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

Brick Support Above Roof

- How to support brick above roof:
  - Option 1: Brick supported by wall studs
  - Option 2: Brick supported by rafters

Brick Support Above Roof

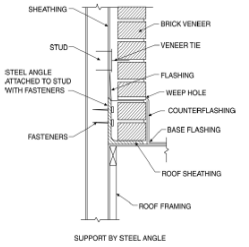


Figure R703.8.2.1
Exterior Masonry Veneer Support by Steel Angles

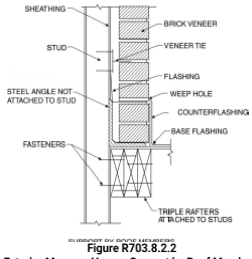
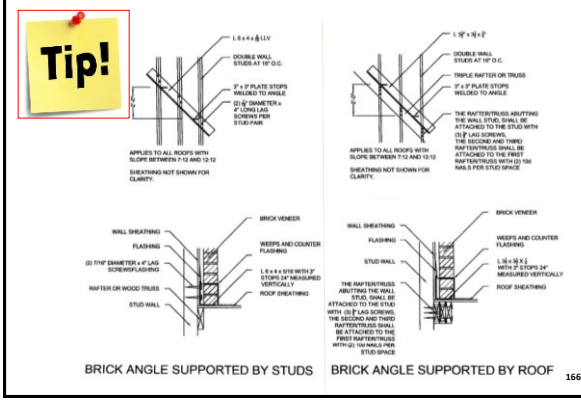


Figure R703.8.2.2
Exterior Masonry Veneer Support by Roof Members
EXTERIOR MASONRY VENEER SUPPORT BY ROOF MEMBERS

Brick supported by wall studs

Brick supported by triple rafters

Brick Support Above Roof

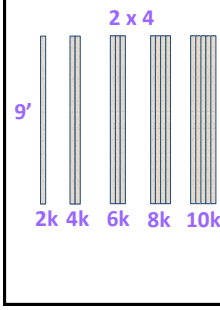


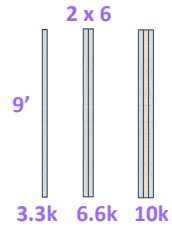
Columns

167

Columns

Rule of thumb





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Columns

> 10k use manufactured lumber

Allowable Axial Loads (lbs) for 1.3E TimberStrand® LSL

Column Bearing Type	Effective Column Length	Column Size 3½" x 3½" 100%	3½" x 3½" 115%	3½" x 3½" 125%	3½" x 4½" 100%	3½" x 4½" 115%	3½" x 4½" 125%	3½" x 5½" 100%	3½" x 5½" 115%	3½" x 5½" 125%	3½" x 7½" 100%	3½" x 7½" 115%	3½" x 7½" 125%	3½" x 9¼" 100%	3½" x 9¼" 115%	3½" x 9¼" 125%
On Column Base	2'	12,845	15,845	14,625	15,220	17,580	16,290	19,120	22,470	22,900	25,205	28,320	30,290	29,900	33,600	36,025
	4'	10,945	13,830	12,490	13,415	16,790	15,030	16,885	19,590	20,025	22,260	24,505	25,870	26,400	29,155	30,780
	6'	9,528	9,650	10,215	11,469	12,265	12,760	14,155	15,420	16,850	18,895	20,325	21,155	22,480	24,160	25,125
	8'	7,950	7,985	8,225	9,660	9,980	10,290	11,860	12,550	12,945	15,640	16,545	17,060	18,610	19,680	20,290
	9'	6,210	6,325	6,695	7,795	8,160	8,370	9,800	10,255	10,520	12,915	13,520	13,870	15,360	16,085	16,500
	10'	5,095	5,460	5,610	6,400	6,790	6,890	8,080	8,480	8,690	10,705	11,185	11,450	12,790	13,365	13,695
	12'	4,375	4,525	4,610	5,465	5,655	5,765	6,970	7,110	7,265	9,060	9,370	9,550	10,775	11,150	11,360
	14'	3,705	3,840	3,905	4,605	4,795	4,880	5,850	6,050	6,150	7,755	7,950	8,085	9,275	9,460	9,620
	16'	2,765	2,855	2,895	3,440	3,545	3,615	4,375	4,485	4,545	5,770	5,910	5,985	6,860	7,000	7,130
	18'	2,010	2,260	2,225	2,685	2,750	2,780	3,385	3,450	3,495	4,465	4,565	4,610	5,330	5,435	5,495
On Wood Plate(1,2)	2'–2'	5,365	5,365	5,365	7,065	7,065	7,065	8,760	8,760	8,760	10,780	10,785	10,785	12,830	12,830	12,830
	4'	5,295	5,400	5,515	6,890	6,290	6,895	8,360	8,685	8,820	10,255	10,395	10,390	12,290	12,830	12,830
	6'	4,575	4,525	4,610	5,465	5,655	5,765	6,970	7,110	7,265	9,060	9,370	9,550	10,775	11,150	11,360
	8'	3,705	3,840	3,905	4,605	4,795	4,880	5,850	6,050	6,150	7,755	7,950	8,085	9,275	9,460	9,620
	10'	2,765	2,855	2,895	3,440	3,545	3,615	4,375	4,485	4,545	5,770	5,910	5,985	6,860	7,000	7,130
	14'	2,010	2,260	2,225	2,685	2,750	2,780	3,385	3,450	3,495	4,465	4,565	4,610	5,330	5,435	5,495

(1) Wood plate bearing is based on compression perpendicular-to-grain stress of 425 psi adjusted per the NDS®, 3.10.4.
(2) See connection details below.

Allowable Axial Loads (lbs) for 1.8E Parallam® PSL

Column Bearing Type	Effective Column Length	Column Size 3½" x 3½" 100%	3½" x 3½" 115%	3½" x 3½" 125%	3½" x 5½" 100%	3½" x 5½" 115%	3½" x 5½" 125%	3½" x 7" 100%	3½" x 7" 115%	3½" x 7" 125%	3½" x 9½" 100%	3½" x 9½" 115%	3½" x 9½" 125%	3½" x 11½" 100%	3½" x 11½" 115%	3½" x 11½" 125%
On Column Base	2'	13,595	17,700	17,540	19,890	21,570	21,570	22,185	25,225	25,225	28,770	30,980	30,980	34,000	40,000	40,000
	4'	8,770	9,180	9,370	11,100	11,710	12,000	12,470	13,280	13,280	16,275	16,905	17,245	19,280	20,345	20,800
	6'	7,355	7,550	7,725	10,905	11,225	11,570	12,280	13,280	13,280	16,275	16,905	17,245	19,280	20,345	20,800
	8'	4,175	4,290	4,350	5,305	5,455	5,535	6,145	6,315	6,405	7,535	7,745	7,855	8,745	8,985	9,110
	9'	3,260	3,350	3,445	3,900	4,015	4,130	4,370	4,495	4,620	5,370	5,525	5,680	6,010	6,185	6,360
	10'	2,840	2,900	2,960	3,400	3,470	3,540	3,805	3,885	3,965	4,675	4,775	4,875	5,235	5,345	5,455
	12'	1,600	1,685	1,810	2,500	2,595	2,695	2,800	2,895	3,000	3,440	3,555	3,670	3,850	3,980	4,110
	14'							2,070	2,135	2,200	2,545	2,630	2,715	2,850	2,945	3,040
	16'							1,585	1,635	1,685	1,945	2,010	2,075	2,175	2,245	2,315
	18'							1,250	1,290	1,330	1,535	1,585	1,635	1,715	1,770	1,825
	20'							1,010	1,045	1,080	1,245	1,285	1,325	1,390	1,435	1,480
	22'							835	865	895	1,030	1,065	1,100	1,150	1,185	1,225
	24'							700	725	750	865	895	925	965	995	1,025

Timberstrand ratio exceeds 50

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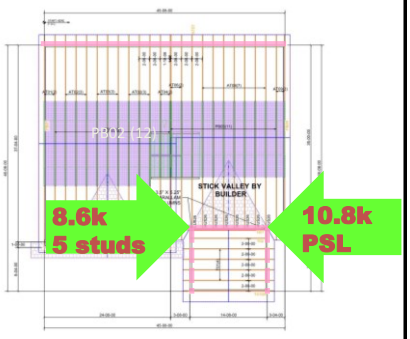
Columns

- What size posts would I expect?

170

Columns - answer

- What size posts would I expect?
  - 9' column



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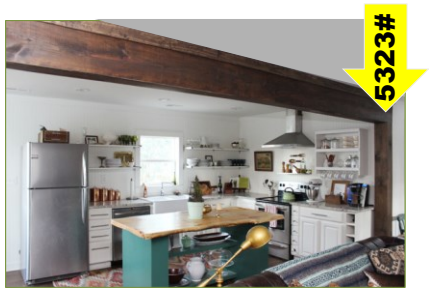
Columns

- **How many 2x4 jack studs would I need under this beam?**



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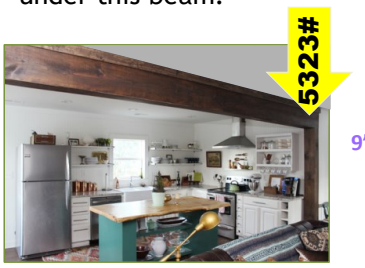
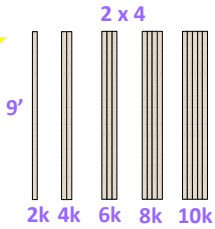
Columns - answer

- How many 2x4 jack studs would I need under this beam?





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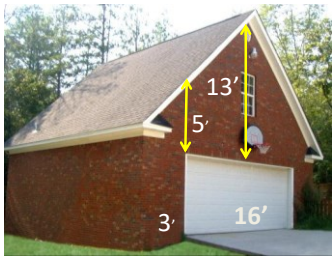
Lintel

- **What is the minimum steel header**
  - **The garage has a truss roof.**



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Steel Lintel -answer

- What is the minimum steel header
  - The garage has a truss roof.

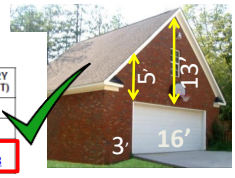

TABLE R703.8.3.2
HEIGHT OF MASONRY VENEER ABOVE OPENING

MINIMUM HEIGHT OF MASONRY VENEER ABOVE OPENING (INCH)	MAXIMUM HEIGHT OF MASONRY VENEER ABOVE OPENING (FEET)
13	< 5
24	5 to < 12
60	12 to height above support allowed by Section R703.8

TABLE R703.8.3.1
ALLOWABLE SPANS FOR LINTELS SUPPORTING MASONRY VENEER[a, b, c, d]

SIZE OF STEEL ANGLE[c, e, f] (inches)	NO STORY ABOVE	ONE STORY ABOVE	TWO STORIES ABOVE	NO. OF 1/2-INCH OR EQUIVALENT REINFORCING BARS IN REINFORCED LINTEL[c, e]
3 × 3 × 1/4	6'-0"	4'-6"	3'-0"	1
4 × 3 × 1/4	8'-0"	6'-0"	4'-6"	1
5 × 3 1/2 × 5/16	10'-0"	8'-0"	6'-0"	2
6 × 3 1/2 × 5/16	14'-0"	9'-6"	7'-0"	2
2-6 × 3 1/2 × 5/16	20'-0"	12'-0"	9'-6"	4

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.
a. Long leg of the angle shall be placed in a vertical position.
b. Depth of reinforced lintels shall not be less than 8 inches and all cells of hollow masonry lintels shall be grouted solid. Reinforcing bars shall extend not less than 8 inches into the support.
c. Steel members indicated are adequate typical examples; other steel members meeting structural design requirements may be used.
d. Either steel angle or reinforced lintel shall span opening.

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Header

- What is the minimum size header over the window?
  - House is 36' wide
  - The 2nd floor joists center wall
  - 25 psf snow load
  - Window is 8'wide

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Exterior Header -answer

Table R602.7(1)
Girder Spans[a] and Header Span[a] for Exterior Bearing Walls
(Maximum spans for DF-larch, H-fir, SP and SPFb & required number of jack studs)

GIRDERS AND HEADERS SUPPORTING	SIZE	GROUND SNOW LOAD (psf)[b] 30						50						70					
		Building width[c] (feet) 12		24		36		12		24		36		12		24		36	
		Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]	Span[f]	NJ[d]
Roof and ceiling	2-2 × 4	4-0	1	3-1	1	2-7	1	3-5	1	2-7	1	2-3	1	3-0	1	2-4	1	2-0	1
	2-2 × 6	6-1	1	4-7	1	3-10	1	5-1	1	3-11	1	3-3	1	4-4	1	3-4	1	2-10	1
	2-2 × 8	7-7	1	5-10	1	4-10	1	6-5	1	5-0	1	4-2	1	5-6	1	4-3	1	3-6	1
	2-2 × 10	9-1	1	6-11	1	5-7	1	7-7	1	5-11	1	4-11	1	6-6	1	5-1	1	4-2	1
	2-2 × 12	10-4	1	8-0	1	6-5	1	8-8	1	6-8	1	5-6	1	7-5	1	5-8	1	4-8	1
	2-3 × 4	3-8	1	2-9	1	2-4	1	3-2	1	2-4	1	2-0	1	2-11	1	2-2	1	1-9	1
	2-3 × 6	5-6	1	4-3	1	3-5	1	4-8	1	3-7	1	3-0	1	4-0	1	3-1	1	2-6	1
	2-3 × 8	6-11	1	5-3	1	4-3	1	5-10	1	4-6	1	3-8	1	5-0	1	3-10	1	3-2	1
	2-3 × 10	8-3	1	6-4	1	5-2	1	7-0	1	5-4	1	4-5	1	6-0	1	4-7	1	3-9	1
	2-3 × 12	9-5	1	7-3	1	5-11	1	8-0	1	6-2	1	5-1	1	6-11	1	5-3	1	4-3	1
	4-2 × 6	5-0	1	3-10	1	3-1	1	4-3	1	3-3	1	2-8	1	3-11	1	3-0	1	2-5	1
	4-2 × 8	6-2	1	4-7	1	3-8	1	5-2	1	4-0	1	3-3	1	4-5	1	3-5	1	2-9	1
	4-2 × 10	7-4	1	5-6	1	4-6	1	6-3	1	4-8	1	3-9	1	5-4	1	4-1	1	3-3	1
	4-2 × 12	8-4	1	6-4	1	5-2	1	7-1	1	5-4	1	4-4	1	6-2	1	4-8	1	3-9	1
Roof, ceiling and one center-bearing floor	2-2 × 4	3-3	1	2-6	1	2-2	1	2-11	1	2-2	1	1-9	1	2-8	1	2-0	1	1-6	1
	2-2 × 6	4-10	1	3-9	1	3-3	2	4-5	1	3-6	1	2-11	1	3-9	1	3-0	1	2-6	1
	2-2 × 8	6-1	1	4-10	2	4-1	2	5-7	2	4-5	1	3-6	1	4-11	1	3-9	1	3-1	1
	2-2 × 10	7-3	2	5-9	2	4-10	2	6-8	2	5-3	1	4-3	1	5-11	1	4-6	1	3-8	1
	2-2 × 12	8-6	2	6-8	2	5-8	2	7-10	2	6-2	1	5-0	1	6-11	1	5-3	1	4-3	1
	2-3 × 6	7-6	1	6-0	1	5-1	2	7-0	1	5-6	1	4-6	1	6-2	1	4-9	1	3-9	1
	2-3 × 8	9-1	1	7-2	2	6-1	2	8-4	1	6-7	1	5-5	1	7-5	1	5-8	1	4-7	1
	2-3 × 10	10-8	2	8-5	2	7-2	2	9-10	2	7-6	1	6-2	1	8-8	1	6-8	1	5-4	1
	2-3 × 12	12-4	2	9-8	2	8-3	2	11-4	2	8-7	2	7-1	1	9-11	1	7-8	1	6-2	1
	4-2 × 6	6-10	1	5-4	1	4-5	1	6-1	1	4-7	1	3-8	1	5-2	1	4-0	1	3-2	1
	4-2 × 8	8-10	1	6-11	1	5-11	1	8-1	1	6-4	1	5-5	2	7-6	1	5-11	1	5-0	2
	4-2 × 10	10-8	1	8-3	2	7-0	2	9-8	1	7-7	2	6-5	2	8-10	1	7-0	2	6-0	2
	4-2 × 12	12-4	1	9-8	2	8-3	2	11-4	2	8-11	2	7-7	2	10-4	2	8-3	2	7-0	2

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Roof Construction

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Objectives

- Identify three roof system types and their components.
- Review plans, using IRC tables, ceiling joists and rafters.
- Review typical wood truss shop drawings.

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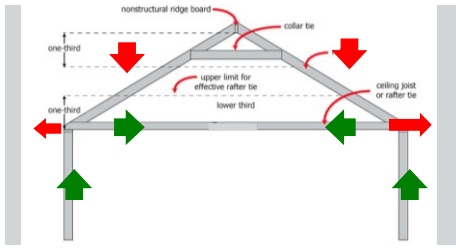
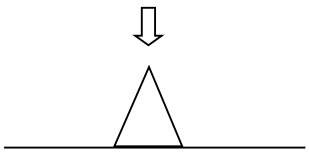
Rafter/Ceiling Joist System



180

Activity

- Fold some paper in half.
- Place it on your table/desk.
- Press downward at the peak.
- What happens?



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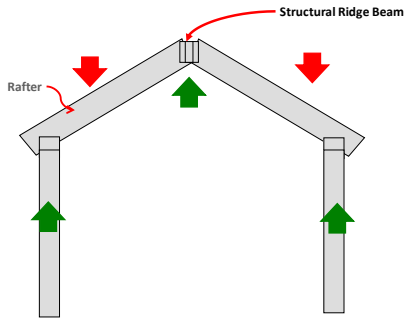
Rafter/Ridge Beam System



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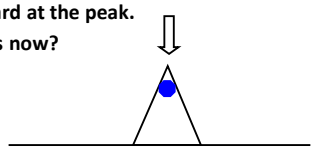
Activity

- Fold piece of paper in half.
- Place it on the table/deck.
- Place a pencil at the peak.
- Press downward at the peak.
- What happens now?



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Ridge Beam Load Path

- Follow ridge beam load path.
- Ensure columns, multi-ply studs support beam.
- Materials:
  - Large dimensioned lumber.
  - LVL, microlam.
  - Steel.
  - Flitch beam.

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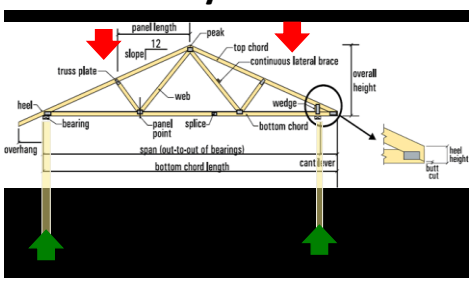
Manufactured Truss System



R802.10.1
R802.10.2.1

185

Ceiling Joist Design Check

- Table R802.5.1(1) for no storage.
- Table R802.5.1(2) for limited storage.
- Known values:
  - Ceiling joist size and spacing.
  - Lumber species and grade.
  - Attic dead load.
  - Deflection limit.

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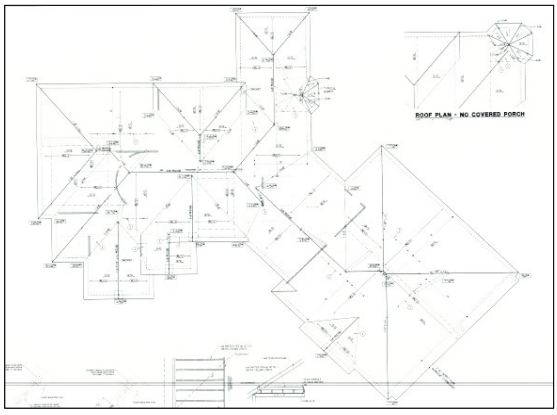

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Ceiling Joist Design Check

Table R802.5.1(2)
Ceiling Joist Spans for Common Lumber Species
(Uninhabitable attics with limited storage, live load = 20 psf, L/D = 240)

CEILING JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf			
			2 × 4	2 × 6	2 × 8	2 × 10
			Maximum ceiling joist spans			
			(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
24	Douglas fir-larch	SS	8-3	13-0	17-2	21-3
	Douglas fir-larch	#1	7-8	11-2	14-2	17-4
	Douglas fir-larch	#2	7-3	10-8	13-6	16-5
	Douglas fir-larch	#3	5-7	8-1	10-3	12-7
	Hem-fir	SS	7-10	12-3	16-2	20-6
	Hem-fir	#1	7-7	11-1	14-0	17-1
	Hem-fir	#2	7-1	10-4	13-1	16-0
	Hem-fir	#3	5-5	7-11	10-0	12-3
	Southern pine	SS	8-1	12-9	16-10	21-6
	Southern pine	#1	7-8	11-5	14-6	16-11
	Southern pine	#2	6-7	9-10	12-6	14-9
	Southern pine	#3	5-1	7-5	9-5	11-5
	Spruce-pine-fir	SS	7-8	12-0	15-10	19-5
	Spruce-pine-fir	#1	7-2	10-6	13-3	16-3
	Spruce-pine-fir	#2	7-2	10-6	13-3	16-3
	Spruce-pine-fir	#3	5-5	7-11	10-0	12-3

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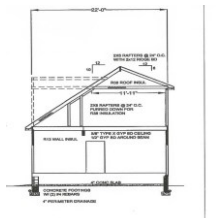
You Try It

- Lets look at this plan.
- What size and spacing of ceiling joists in the garage roof comply?
- Width of garage is 22’0”



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Solution

- Use Table R802.5.1(2) for limited storage and 10 PSF dead load.
- Maximum span = 12’- 06” < 11’-11”, OK!

Table R802.5.1(2)—continued
Ceiling Joist Spans for Common Lumber Species
(Uninhabitable attics with limited storage, live load = 20 psf, L/D = 240)

CEILING JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf			
			2 × 4	2 × 6	2 × 8	2 × 10
			Maximum ceiling joist spans			
			(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
24	Douglas fir-larch	SS	8-3	13-0	17-2	21-3
	Douglas fir-larch	#1	7-8	11-2	14-2	17-4
	Douglas fir-larch	#2	7-3	10-8	13-6	16-5
	Douglas fir-larch	#3	5-7	8-1	10-3	12-7
	Hem-fir	SS	7-10	12-3	16-2	20-6
	Hem-fir	#1	7-7	11-1	14-0	17-1
	Hem-fir	#2	7-1	10-4	13-1	16-0
	Hem-fir	#3	5-5	7-11	10-0	12-3
	Southern pine	SS	8-1	12-9	16-10	21-6
	Southern pine	#1	7-8	11-5	14-6	16-11
	Southern pine	#2	6-7	9-10	12-6	14-9
	Southern pine	#3	5-1	7-5	9-5	11-5
	Spruce-pine-fir	SS	7-8	12-0	15-10	19-5
	Spruce-pine-fir	#1	7-2	10-6	13-3	16-3
	Spruce-pine-fir	#2	7-2	10-6	13-3	16-3
	Spruce-pine-fir	#3	5-5	7-11	10-0	12-3

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Rafter Design Check

- Table R802.4.1(1) – (8) for various live load or ground snow load.
- Known values:
  - Roof live load (when ground snow load ≤ 30 PSF).
  - Ground snow load (when > 30 PSF).
  - Dead load.
  - Rafter size and spacing.
  - Lumber species and grade.
  - Span length.
  - Finish material on rafters (deflection).

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Rafter Design Check

Table R802.4.1(3)
Rafter Spans for Common Lumber Species
(Ground snow load = 30 psf, ceiling not attached to rafters, L/D = 180)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf						DEAD LOAD = 20 psf			
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans*									
			(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
24	Douglas fir-larch	SS	8-0	12-6	16-2	19-9	22-10	7-10	11-6	14-6	17-8	20-5
	Douglas fir-larch	#1	7-1	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
	Douglas fir-larch	#2	6-9	9-10	12-6	15-3	17-9	6-0	8-10	11-2	13-8	15-10
	Douglas fir-larch	#3	5-2	7-7	9-7	11-8	13-6	4-7	6-9	8-7	10-5	12-1
	Hem-fir	SS	7-6	11-10	15-7	19-1	22-1	7-6	11-0	13-11	17-0	19-9
	Hem-fir	#1	7-0	10-3	13-0	16-11	18-6	6-3	9-2	11-6	14-3	16-6
	Hem-fir	#2	6-7	9-7	12-2	14-10	17-3	5-10	8-7	10-10	13-3	15-5
	Hem-fir	#3	5-0	7-4	9-4	11-5	13-2	4-6	6-7	8-4	10-2	11-10
	Southern pine	SS	7-10	12-3	16-2	20-0	23-7	7-10	11-10	15-0	17-11	21-2
	Southern pine	#1	7-1	10-7	13-5	15-9	18-8	6-4	9-6	12-0	14-4	16-8
	Southern pine	#2	6-1	9-2	11-7	13-9	16-5	5-6	8-2	10-9	12-3	14-6
	Southern pine	#3	4-8	6-11	8-8	10-7	12-6	4-2	6-2	7-10	9-6	11-2
	Spruce-pine-fir	SS	7-4	11-7	14-9	18-0	20-11	7-1	10-5	13-2	16-1	18-8
	Spruce-pine-fir	#1	6-8	9-9	12-4	15-1	17-6	5-11	8-8	11-0	13-6	15-7
	Spruce-pine-fir	#2	6-8	9-9	12-4	15-1	17-6	5-11	8-8	11-0	13-6	15-7
	Spruce-pine-fir	#3	5-0	7-4	9-4	11-5	13-2	4-6	6-7	8-4	10-2	11-10

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Rafter Span Adjustment

- **Raise ceiling joist/rafter tie.**
- **Maximum 1/3 height of rafter.**
- **H_C = height of rafter tie above bearing point.**
- **H_R = height of rafter above bearing.**
- **Use table to determine adjustment.**
- **Multiply tabular span length with adjustment.**

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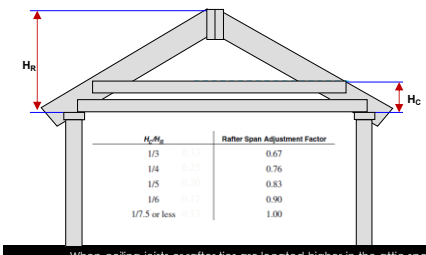
Rafter Span Adjustment



H_C/H_R	Rafter Span Adjustment Factor
1/3	0.67
1/4	0.76
1/5	0.83
1/6	0.90
1/7.5 or less	1.00

Rafter Span Tables

When ceiling joists or rafter ties are located higher in the attic space, these rafter spans shall be multiplied by the following factors:

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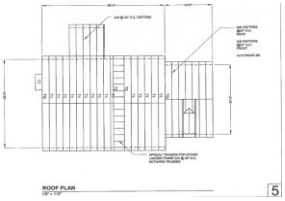
You Try It

- Look at these plans.
- Do the rafters in the sunroon



Solution – Tabular Span

Table R802.4.1(1)—continued
Rafter Spans for Common Lumber Species
(Roof live load = 20 psf, ceiling not attached to rafters, L/D = 180)

RAFTER SPACING (inches)	SPECIES AND GRADE	DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
		2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
		Maximum rafter spans[a]									
		(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
24	Douglas fir-larch	SS	9-1	14-4	18-10	23-9	Note b	9-1	13-3	16-10	20-7	23-10
	Douglas fir-larch	#1	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
	Douglas fir-larch	#2	8-2	11-11	15-1	18-5	21-4	7-0	10-4	13-0	15-11	18-6
	Douglas fir-larch	#3	6-2	9-1	11-6	14-1	16-3	5-4	7-10	10-0	12-2	14-1
	Hem-fir	SS	8-7	13-6	17-10	22-9	Note b	8-7	12-10	16-3	19-10	23-0
	Hem-fir	#1	8-0	12-4	15-8	19-2	22-2	7-4	10-9	13-7	16-7	19-3
	Hem-fir	#2	7-11	11-7	14-8	17-10	20-8	6-10	10-0	12-8	15-6	17-11
	Hem-fir	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9
	Southern pine	SS	8-11	14-1	18-6	23-6	Note b	8-11	13-10	17-6	20-10	24-8
	Southern pine	#1	8-7	12-9	16-2	19-11	22-6	7-5	11-1	14-0	16-5	19-6
	Southern pine	#2	7-8	11-0	13-11	16-6	19-6	6-4	9-6	12-1	14-4	16-10
	Southern pine	#3	5-8	8-4	10-6	12-9	15-1	4-11	7-3	9-1	11-0	13-1
	Spruce-pine-fir	SS	8-5	13-3	17-5	21-8	25-2	8-4	12-2	15-4	18-9	21-9
	Spruce-pine-fir	#1	8-0	11-9	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Spruce-pine-fir	#2	7-11	11-6	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Spruce-pine-fir	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9

Solution - Adjustment

- Actual span = 5’-2”.
- Span from table = 7’-11”.
- H_C/H_R = 1/3.
- Adjustment = 0.67.
- Adjusted value = 7.9167’ x 0.67 = 5.28’
- 5.28’ > 5.167’ (5’-2”), OK!

Rafter Opposing

- Does the IRC require rafters to be directly opposing one another when framed to the ridge board?
- **A:** Yes. Section R802.3 requires the rafters to be framed to each other (directly opposing) with a gusset plate or framed to a ridge board.
- In the picture is this a ridge board or ridge beam?

R802.3

Collar tie??

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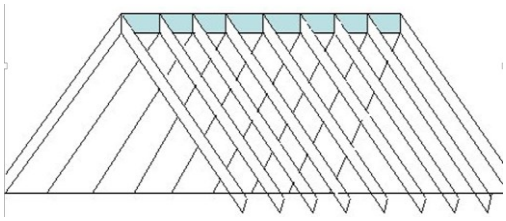
Ridge must be designed as a beam: R802.3.1:
Given: 14 foot ridge for a roof that is 22 feet wide:
Plf=(35+10) x 11 = 495 Use LP-LVL at 2,400 fb
[495 x 14 x 14 x 12] ÷ [8 x 2,400] = S^3
Snow load reduction .85 x 279 = 60.6S^3 required

Assume 2 – 11.25 x 1.75
[11.25 x 11.25 x 1.75 x 2] ÷ 6 = 73.8S^3 provided ok



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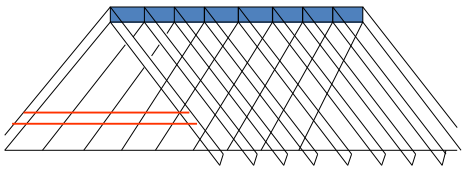
Beam 14' long Rafters are 24 inches on center
Room 22' wide
Pitch 10/12



Rafter tie has been raised 2 x 10 @ 24 inches.
Ridge height is 11 x 10 = 110 inches.
Ratio equals 24/110=.21>.20 so use ¼ adjustment=.76
Table 802.5.1(6) span for DFL #2 = 12-4
12.3 x .76 = 9.3 foot span (fails)

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Framing Details

- Minimum nominal thickness of 2"
- Minimum depth equal to rafter cut
- Must be designed as beams for >3:12 slope.

R802.4.3,
R802.4.4

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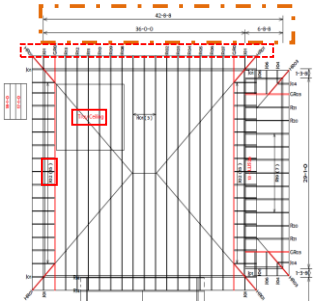
Truss Layout



- Section R802.10.1
- Dimensions: span, spacing of trusses.
- Truss identification.
- Girder truss identification.
- Ceiling requirements.

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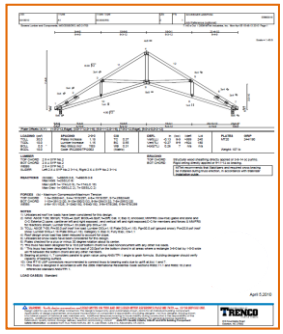
Truss Specs



- Sections R802.10.1 and R802.10.2.
- Submitted prior to erection/installation or with permit application.
- Design and signed/sealed by RDP.
- Minimum requirements for drawings.

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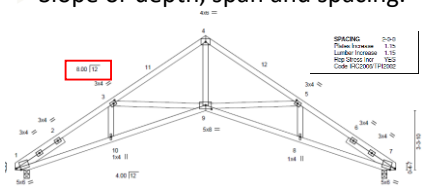
Truss Shop Drawings

- Slope or depth, span and spacing.



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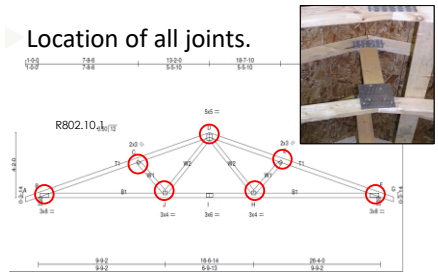
Truss Shop Drawings

- Location of all joints.



R802.10.1

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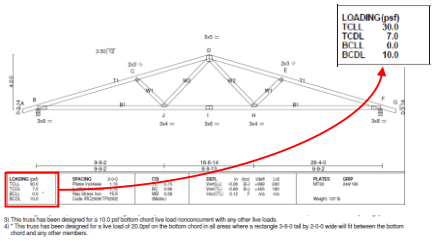
Truss Shop Drawings

- Loading of all chords.



3) This truss has been designed for a 10.0 psf bottom chord live load nonconcurrent with any other live loads.
4) * This truss has been designed for a live load of 20.0psf on the bottom chord in all areas where a rectangle 3-6-0 tall by 2-0-0 wide will fit between the bottom chord and any other members.

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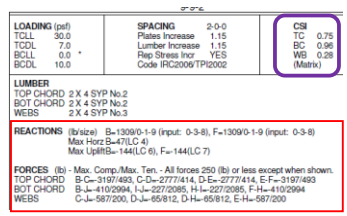
Truss Shop Drawings

- **Reactions and forces.**



R802.10.1

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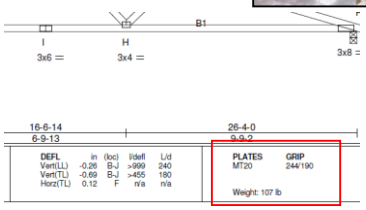
Truss Shop Drawings

- Joint connector (proprietary product).



R802.10.1

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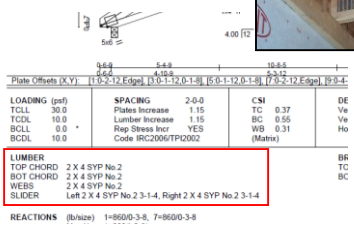
Truss Shop Drawings

- Lumber size, species and grade.



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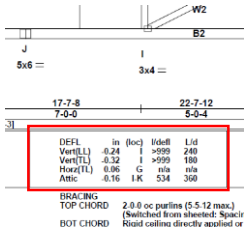
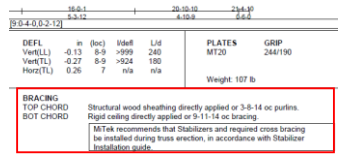
Truss Shop Drawings

- Calculated deflection.



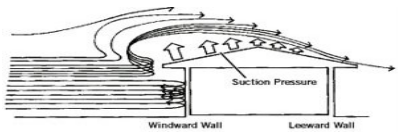
Truss Shop Drawings

- **Permanent bracing locations.**
- **Permanent bracing responsibility of building designer.**
- **Temporary bracing responsibility of truss designer.**



Roof Tie-down

- **At truss/rafter-to-wall connection.**
- **Prescribed connection strength per Table R802.11.**
- **Show connection on plans?**
- **Required when uplift pressure ≥ 200 psi?**



R802.11.1

Roof Tie-down

Table R802.11—continued

Rafter or Truss Uplift Connection Forces from Wind (ASD) (Pound PER Connection) a, b, c, d, e, f, g, h

RAFTER OR TRUSS SPACING	ROOF SPAN (feet)	EXPOSURE C									
		Ultimate Design Wind Speed V_{ULT} (mph)									
		110		115		120		130		140	
		Roof Pitch		Roof Pitch		Roof Pitch		Roof Pitch		Roof Pitch	
		< 5:12	≥ 5:12	< 5:12	≥ 5:12	< 5:12	≥ 5:12	< 5:12	≥ 5:12	< 5:12	≥ 5:12
24" o.c.	12	190	176	220	204	252	236	322	302	396	372
	18	242	222	282	262	326	302	416	390	514	484
	24	296	272	346	320	400	370	512	478	634	596
	28	332	304	390	358	450	416	578	538	716	670
	32	368	336	432	398	498	462	642	598	796	746
	36	404	370	474	438	548	508	706	658	876	822
	42	458	420	538	496	624	578	804	750	998	936
	48	512	468	604	556	698	646	900	840	1120	1048

Uplift

R602.3.5 Braced wall panel uplift load path.

Braced wall panels located at exterior walls that support roof rafters or trusses (including stories below top story) shall have the framing members connected in accordance with one of the following:

1. Fastening in accordance with Table R602.3(1) where:
   1.1. The ultimate design wind speed does not exceed 115 mph (51 m/s), the wind exposure category is B, the roof pitch is 5:12 or greater, and the roof span is 32 feet (9754 mm) or less.
   1.2. The net uplift value at the top of a wall does not exceed 100 plf (146 N/mm). The net uplift value shall be determined in accordance with Section R802.11 and shall be permitted to be reduced by 60 plf (86 N/mm) for each full wall above.
2. Where the net uplift value at the top of a wall exceeds 100 plf (146 N/mm), installing *approved* uplift framing connectors to provide a continuous load path from the top of the wall to the foundation or to a point where the uplift force is 100 plf (146 N/mm) or less. The net uplift value shall be as determined in Item 1.2.
3. Wall sheathing and fasteners designed to resist combined uplift and shear forces in accordance with accepted engineering practice.

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Congratulations

You are the *GREATEST!*

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