



# MetroWest Building Officials Association

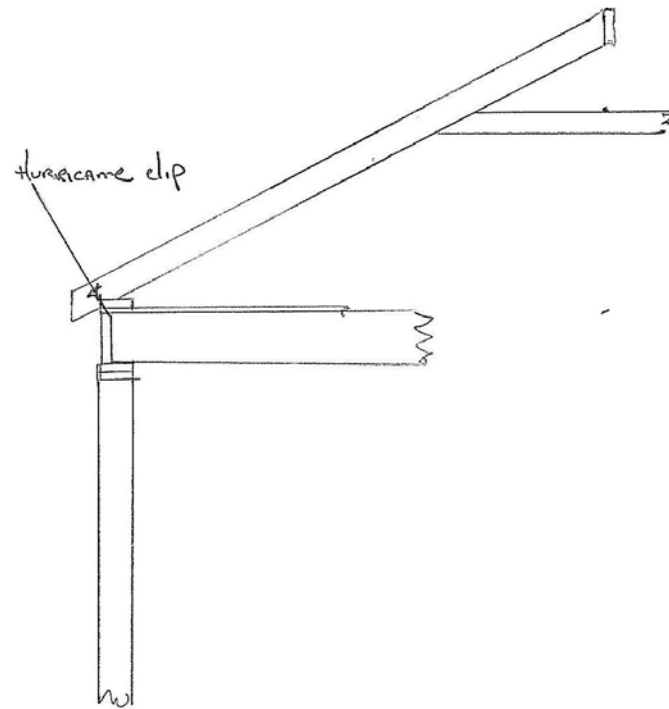
Building Code Workshop &  
Discussion  
March 2013

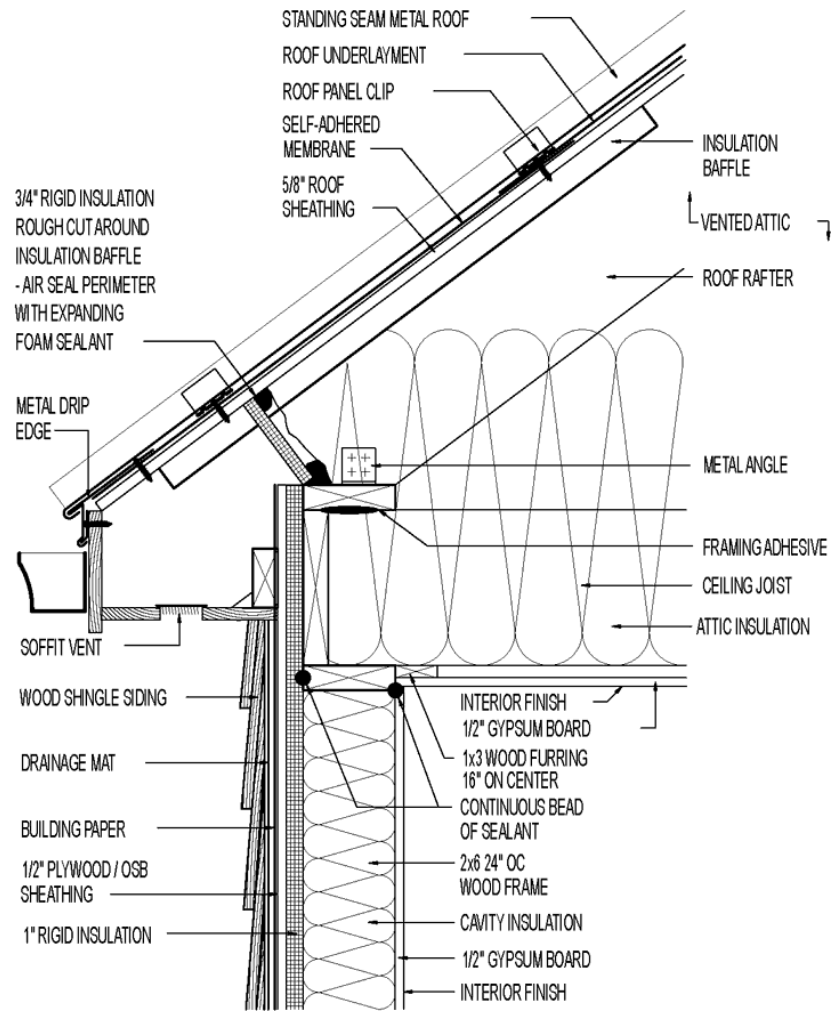
Presented by Robert Berger, CBO  
& Tin Htway, CBO

Is this rafter connection code compliant?



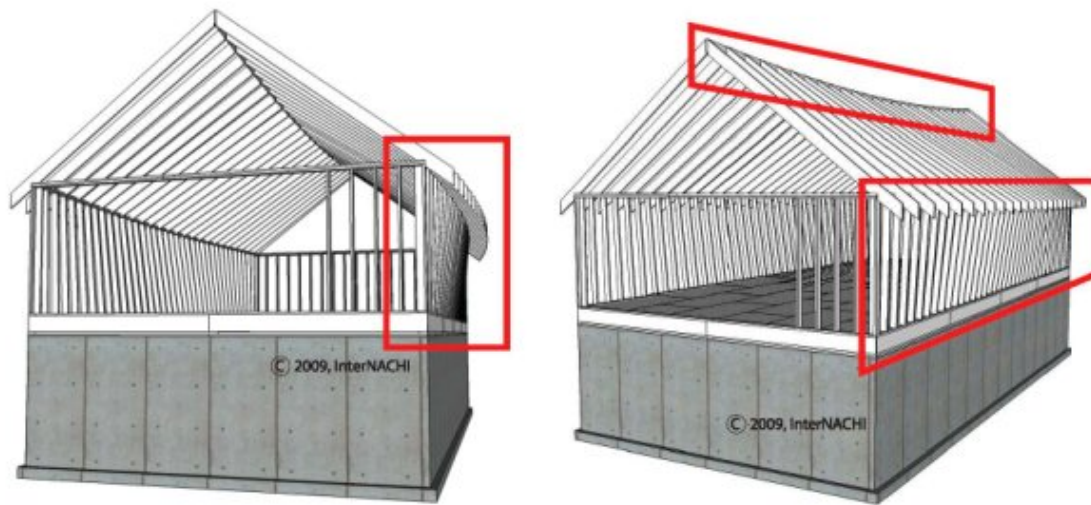
# Typical Section showing a Raised Rafter Detail





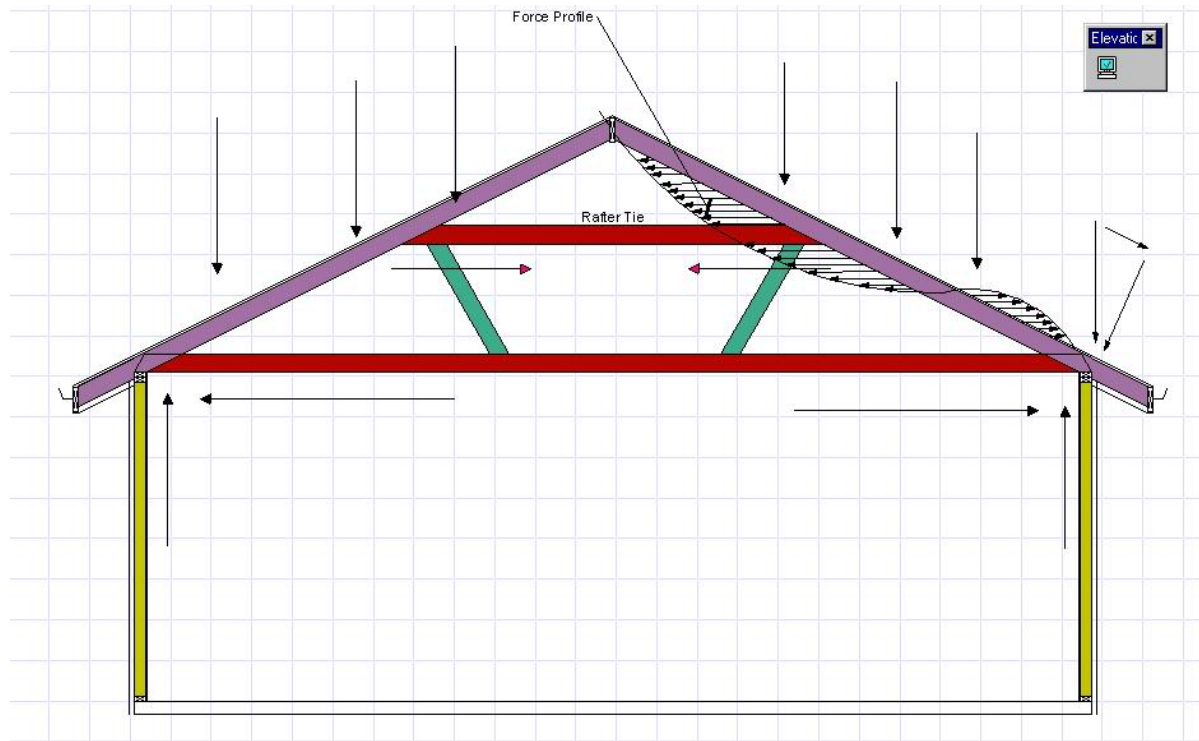
# Inadequate or missing rafter ties

Sagging Ridge due to Inadequate/missing Rafter Ties



\*\*note: studs left out on nearest wall for clarity

# Force Profile on Roofing System



# 2009 IRC – Section 802.3.1 Ceiling joist and rafter connections

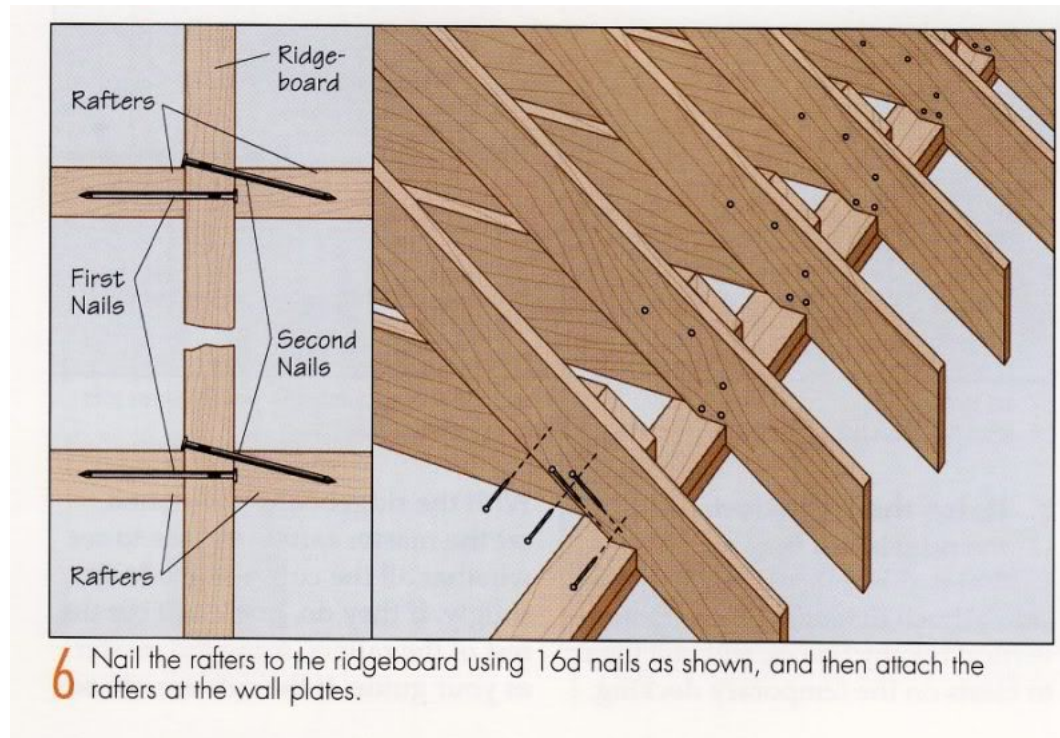
- **R802.3.1 Ceiling joist and rafter connections.** Ceiling joists and rafters shall be nailed to each other in accordance with Table R802.5.1(9), and the rafter shall be nailed to the top wall plate in accordance with Table R602.3(1). Ceiling joists shall be continuous or securely joined in accordance with Table R802.5.1(9) where they meet over interior partitions and are nailed to adjacent rafters to provide a continuous tie across the building when such joists are parallel to the rafters.
- Where ceiling joists are not connected to the rafters at the top wall plate, joists connected higher in the *attic* shall be installed as rafter ties, or rafter ties shall be installed to provide a continuous tie. Where ceiling joists are not parallel to rafters, rafter ties shall be installed. Rafter ties shall be a minimum of 2-inch by 4-inch (51 mm by 102 mm) (nominal), installed in accordance with the connection requirements in Table R802.5.1(9), or connections of equivalent capacities shall be provided. Where ceiling joists or rafter ties are not provided, the ridge formed by these rafters shall be supported by a wall or girder designed in accordance with accepted engineering practice.
- Collar ties or ridge straps to resist wind uplift shall be connected in the upper third of the *attic* space in accordance with Table R602.3(1).
- Collar ties shall be a minimum of 1-inch by 4-inch (25 mm by 102 mm) (nominal), spaced not more than 4 feet (1219 mm) on center.

## R802.3.1 Ceiling joist and rafter connections (con't).

- Ceiling joists and rafters shall be nailed to each other in accordance with Table R802.5.1(9), and the rafter shall be nailed to the top wall plate in accordance with Table R602.3(1). Ceiling joists shall be continuous or securely joined in accordance with Table R802.5.1(9) where they meet over interior partitions and are nailed to adjacent rafters to provide a continuous tie across the building when such joists are parallel to the rafters.



## R802.3.1 Ceiling joist and rafter connections (con't).



# R802.3.1 Ceiling joist and rafter connections (con't).

Collar ties or ridge straps to resist wind uplift shall be connected in the upper third of the *attic* space in accordance with Table R602.3(1).

Collar ties shall be a minimum of 1-inch by 4-inch (25 mm by 102 mm) (nominal), spaced not more than 4 feet (1219 mm) on center.

❖ The requirements of this section describe connections to resist horizontal thrust from gravity loads and ridge uplift from wind loads. Ceiling joists or rafter ties are the framing members used to resist the horizontal thrust from gravity loads. A ceiling joist or rafter tie is required at every rafter. Collar ties or ridge straps are used to resist the ridge uplift caused by the wind load. Collar ties or ridge straps must be spaced not further than every 4 feet (1219 mm) on center.

Ceiling joists located at the top plate and parallel to the rafters must be connected as shown in Commentary Figure R802.3.1(1). The connection must be in accordance with Table R802.5.1(9).

Ceiling joists located at the top plate and parallel to the rafters must be continuous or lap joined as shown in Commentary Figures R802.3.1(3) and R802.3.2(1). The lap splice connection must be in accordance with Table R802.5.1(9), Note e.

Where ceiling joists or rafter ties are located above the top plate or the ceiling joists are not parallel to the rafters, as shown in Commentary Figure R802.3.1(2), the connections must be in accordance with Table R802.5.1(9).

Cathedral ceilings (where ceiling joists or rafter ties are not installed) must be designed so the wall or ridge beam carries the full load of the roof. This would require the walls to be supported by a continuous foundation and/or beams and girders. The ridge beam must also be capable of supporting the full load exerted by the tributary area of the rafters. The ridge beam must be stiff enough to minimize the deflection

from the rafter loads so that rafter thrust does not displace the walls.

Collar ties or ridge straps must be located in the upper one-third of the attic space, be a minimum of 1 inch by 4 inches (25 mm by 102 mm), be spaced not more than 4 feet (1219 mm) on center and connected in accordance with Table R602.3(1). The minimum prescriptive connections in Table R602.3(1) for collar ties and ridge straps are based on minimum connection requirements using the 2001 *Wood Frame Construction Manual* for slopes greater than 3:12, at a wind speed of 100 mph (45 m/s) or less, for a roof span of 36 feet (10 973 mm) or less [see Commentary Figures R802.3.1(2) and R802.3.1(3)].

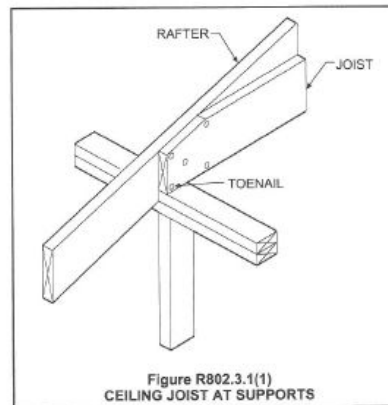


TABLE R802.5.1(9)  
**RAFTER/CEILING JOIST HEEL JOINT CONNECTIONS<sup>a, b, c, d, e, f, h</sup>**

RAFTER SLOPE	RAFTER SPACING (inches)	GROUND SNOW LOAD (psf)															
		20 <sup>a</sup>				30				50				70			
		Roof span (feet)															
		12	20	28	36	12	20	28	36	12	20	28	36	12	20	28	36
Required number of 16d common nails <sup>a, b</sup> per heel joint splices <sup>c, d, e, f</sup>																	
3:12	12	4	6	8	10	4	6	8	11	5	8	12	15	6	11	15	20
	16	5	8	10	13	5	8	11	14	6	11	15	20	8	14	20	26
	24	7	11	15	19	7	11	16	21	9	16	23	30	12	21	30	39
4:12	12	3	5	6	8	3	5	6	8	4	6	9	11	5	8	12	15
	16	4	6	8	10	4	6	8	11	5	8	12	15	6	11	15	20
	24	5	8	12	15	5	9	12	16	7	12	17	22	9	16	23	29
5:12	12	3	4	5	6	3	4	5	7	3	5	7	9	4	7	9	12
	16	3	5	6	8	3	5	7	9	4	7	9	12	5	9	12	16
	24	4	7	9	12	4	7	10	13	6	10	14	18	7	13	18	23
7:12	12	3	4	4	5	3	3	4	5	3	4	5	7	3	5	7	9
	16	3	4	5	6	3	4	5	6	3	5	7	9	4	6	9	11
	24	3	5	7	9	3	5	7	9	4	7	10	13	5	9	13	17
9:12	12	3	3	4	4	3	3	3	4	3	3	4	5	3	4	5	7
	16	3	4	4	5	3	3	4	5	3	4	5	7	3	5	7	9
	24	3	4	6	7	3	4	6	7	3	6	8	10	4	7	10	13
12:12	12	3	3	3	3	3	3	3	3	3	3	3	4	3	3	4	5
	16	3	3	4	4	3	3	3	4	3	3	4	5	3	4	5	7
	24	3	4	4	5	3	3	4	6	3	4	6	8	3	6	8	10

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

a. 40d box nails shall be permitted to be substituted for 16d common nails.

b. Nailing requirements shall be permitted to be reduced 25 percent if nails are clinched.

c. Heel joint connections are not required when the ridge is supported by a load-bearing wall, header or ridge beam.

d. When intermediate support of the rafter is provided by vertical struts or purlins to a loadbearing wall, the tabulated heel joint connection requirements shall be permitted to be reduced proportionally to the reduction in span.

e. Equivalent nailing patterns are required for ceiling joist to ceiling joist lap splices.

f. When rafter ties are substituted for ceiling joists, the heel joint connection requirement shall be taken as the tabulated heel joint connection requirement for two-thirds of the actual rafter-slope.

g. Applies to roof live load of 20 psf or less.

h. Tabulated heel joint connection requirements assume that ceiling joists or rafter ties are located at the bottom of the attic space. When ceiling joists or rafter ties are located higher in the attic, heel joint connection requirements shall be increased by the following factors:

$H_C/H_R$	Heel Joint Connection Adjustment Factor
1/3	1.5
1/4	1.33
1/5	1.25
1/6	1.2
1/10 or less	1.11

where:

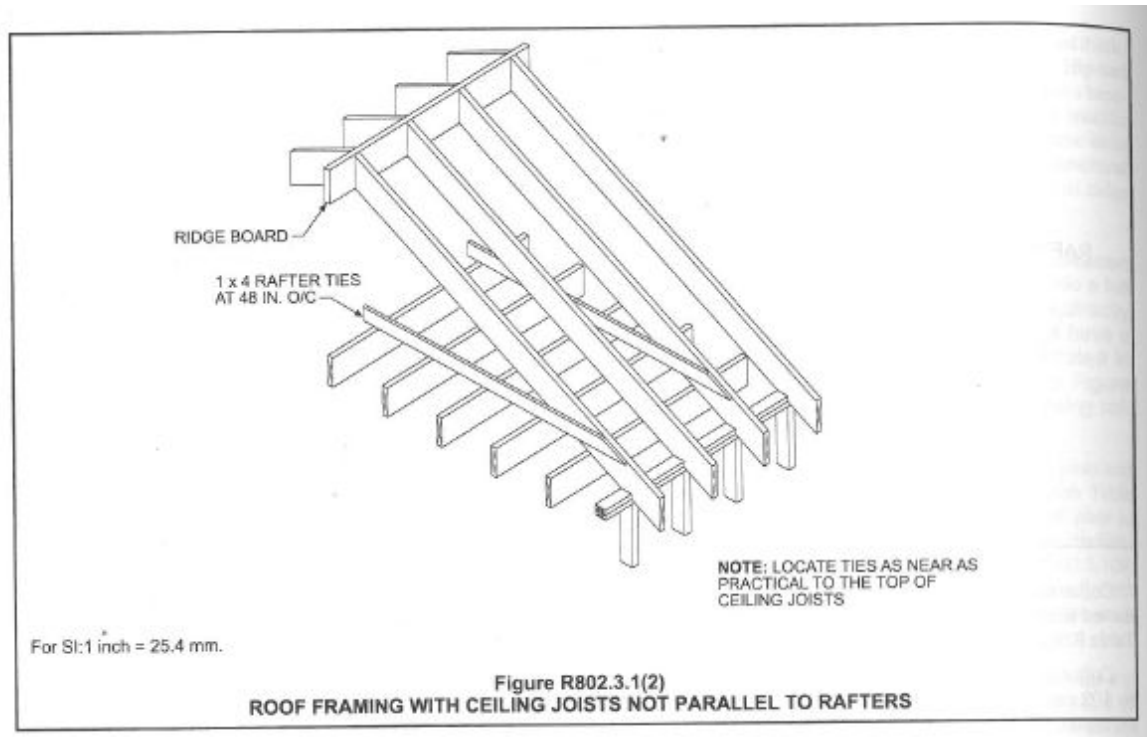
$H_C$  = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.

$H_R$  = Height of roof ridge measured vertically above the top of the rafter support walls.

## R802.3.1 Ceiling joist and rafter connections (con't).

- Where ceiling joists are not connected to the rafters at the top wall plate,
- joists connected higher in the *attic* shall be installed as rafter ties,
- or rafter ties shall be installed to provide a continuous tie.

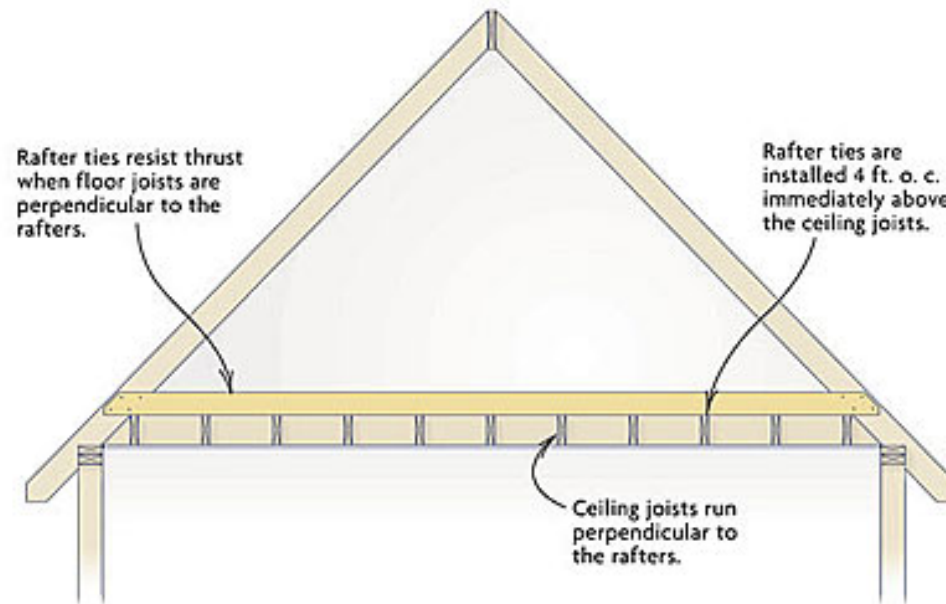
# R802.3.1 Ceiling joist and rafter connections (con't).



## R802.3.1 Ceiling joist and rafter connections (con't).

- Where ceiling joists are not parallel to rafters, rafter ties shall be installed. Rafter ties shall be a minimum of 2-inch by 4-inch (51 mm by 102 mm) (nominal), installed in accordance with the connection requirements in Table R802.5.1(9), or connections of equivalent capacities shall be provided. Where ceiling joists or rafter ties are not provided, the ridge formed by these rafters shall be supported by a wall or girder designed in accordance with accepted engineering practice

## R802.3.1 Ceiling joist and rafter connections (con't).

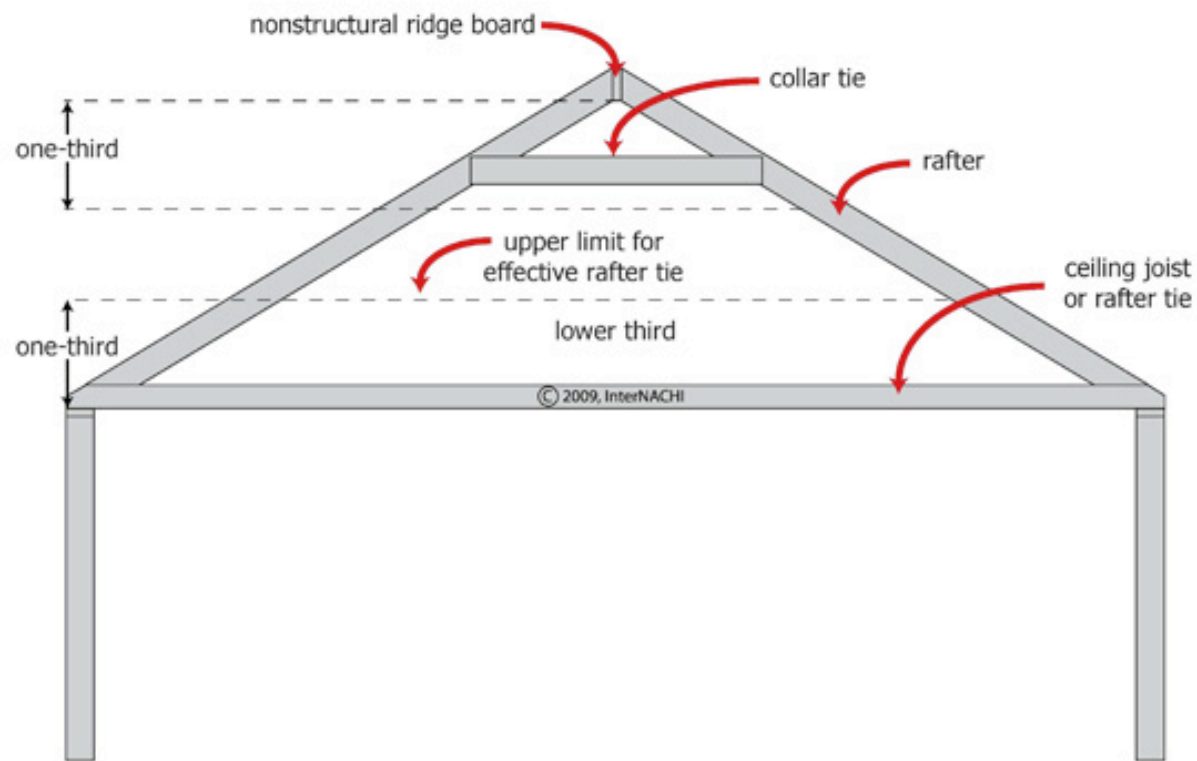


## R802.3.1 Ceiling joist and rafter connections (con't).

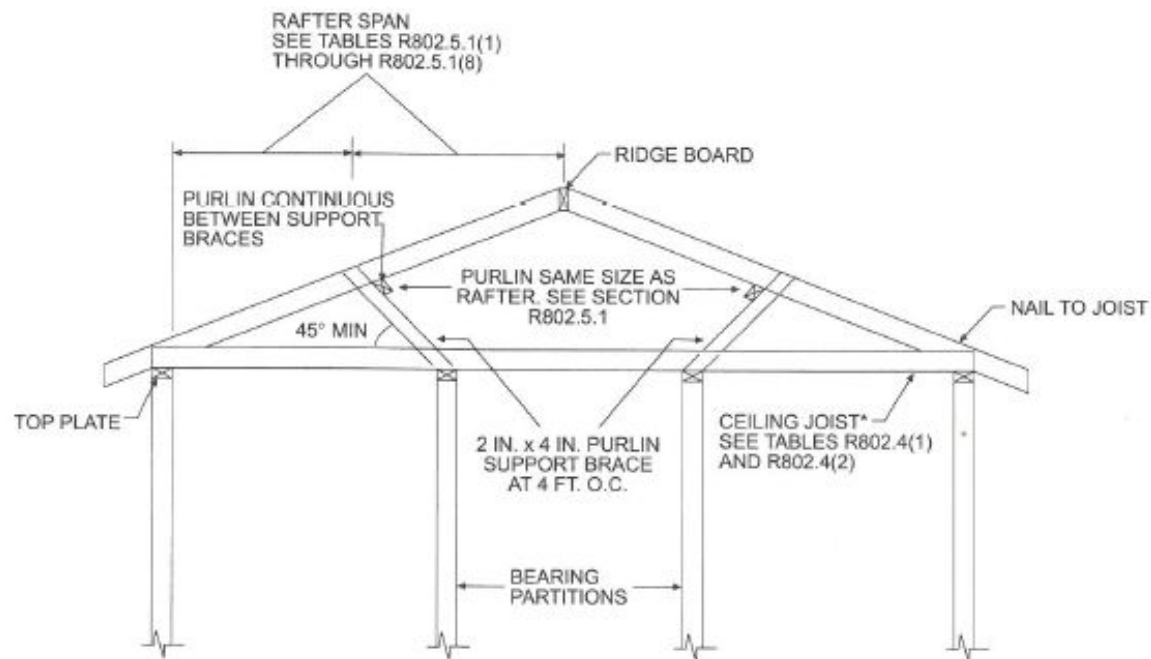
- Collar ties or ridge straps to resist wind uplift shall be connected in the upper third of the *attic* space in accordance with Table R602.3(1).
- Collar ties shall be a minimum of 1-inch by 4-inch (25 mm by 102 mm) (nominal), spaced not more than 4 feet (1219 mm) on center.



# R802.3.1 Ceiling joist and rafter connections (con't).



# IRC 2009 – Braced Rafter Construction



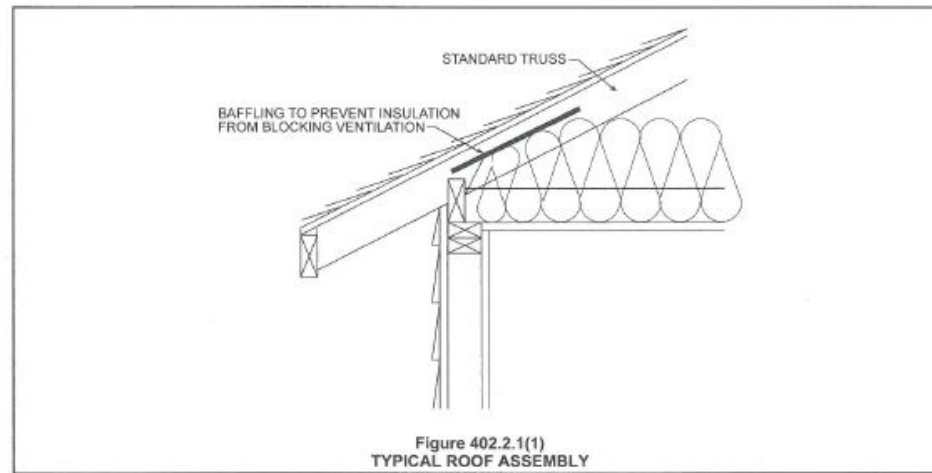
For SI: 1 inch = 25.4 mm, 1 foot = 305 mm, 1 degree = 0.018 rad.

**Note:** Where ceiling joists run perpendicular to the rafters, rafter ties shall be nailed to each rafter near the top of the ceiling joist.

**FIGURE R802.5.1  
BRACED RAFTER CONSTRUCTION**

# Energy Conservation Compliance

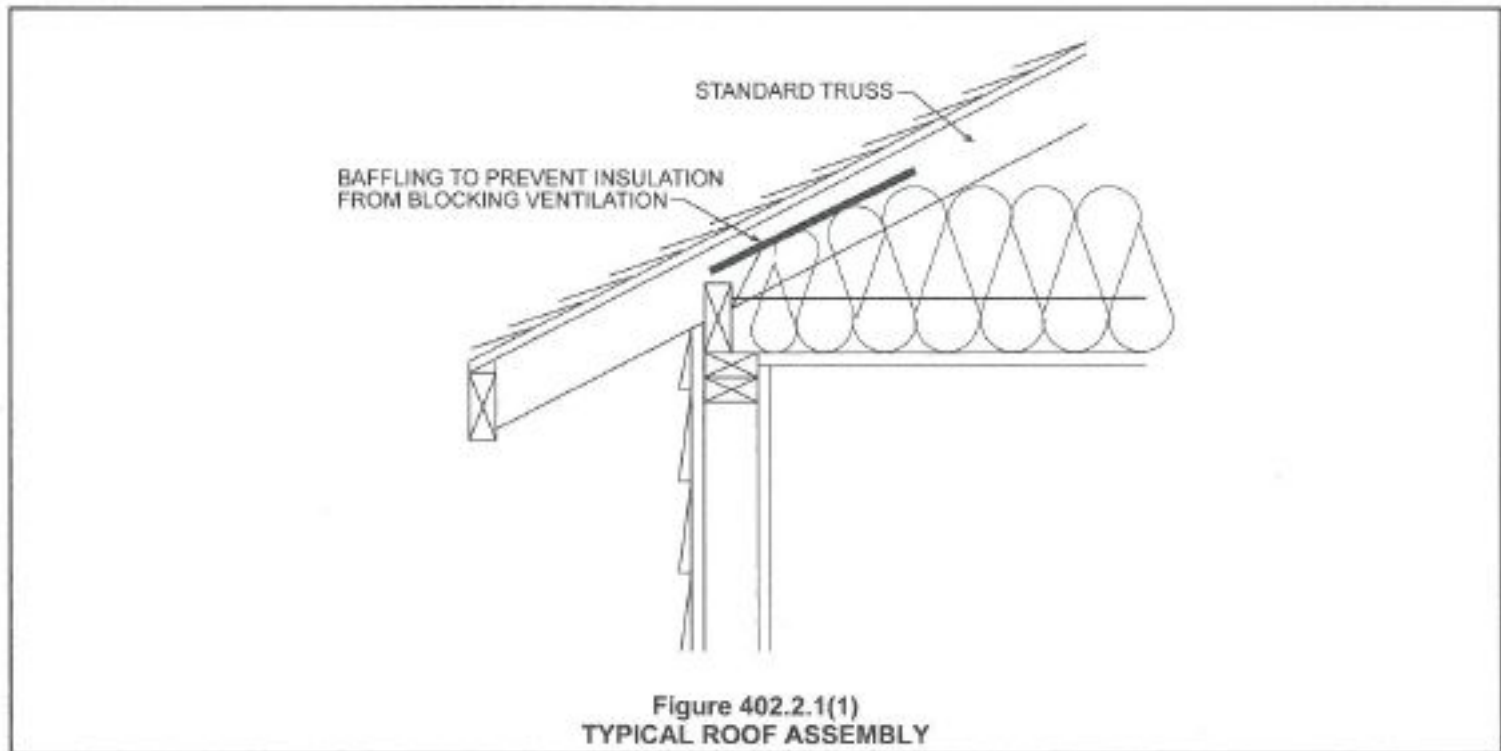
- How do we achieve energy conservation compliance and still maintain building code compliance?

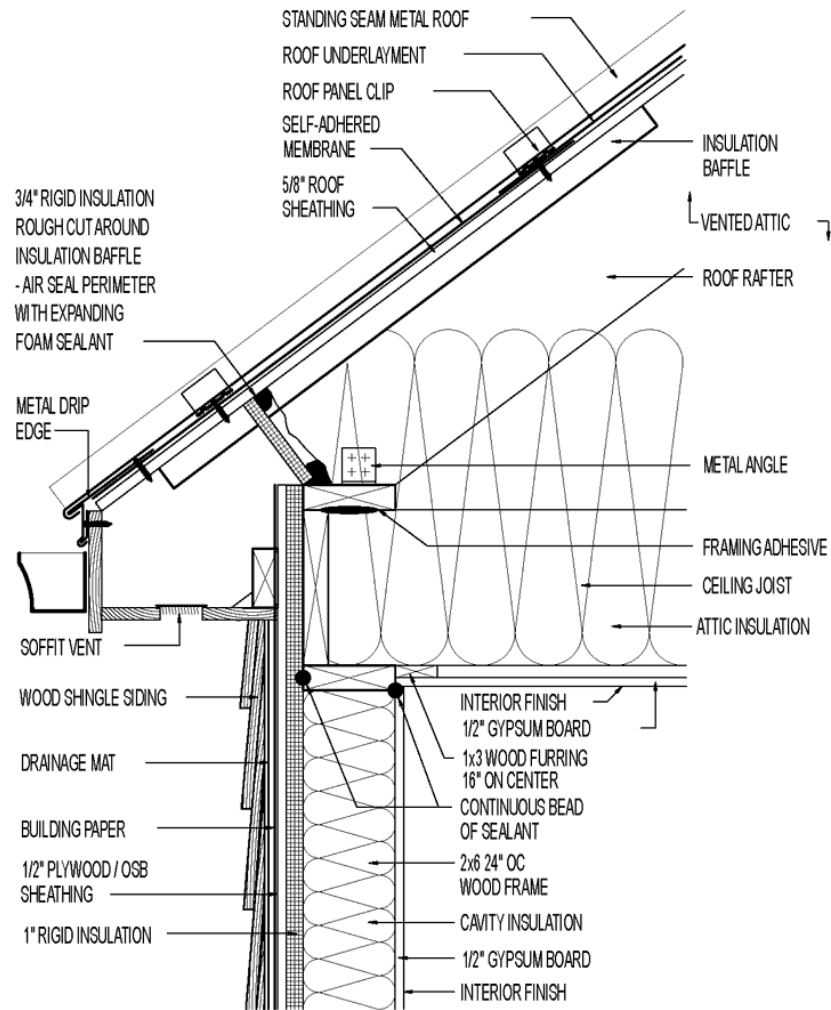


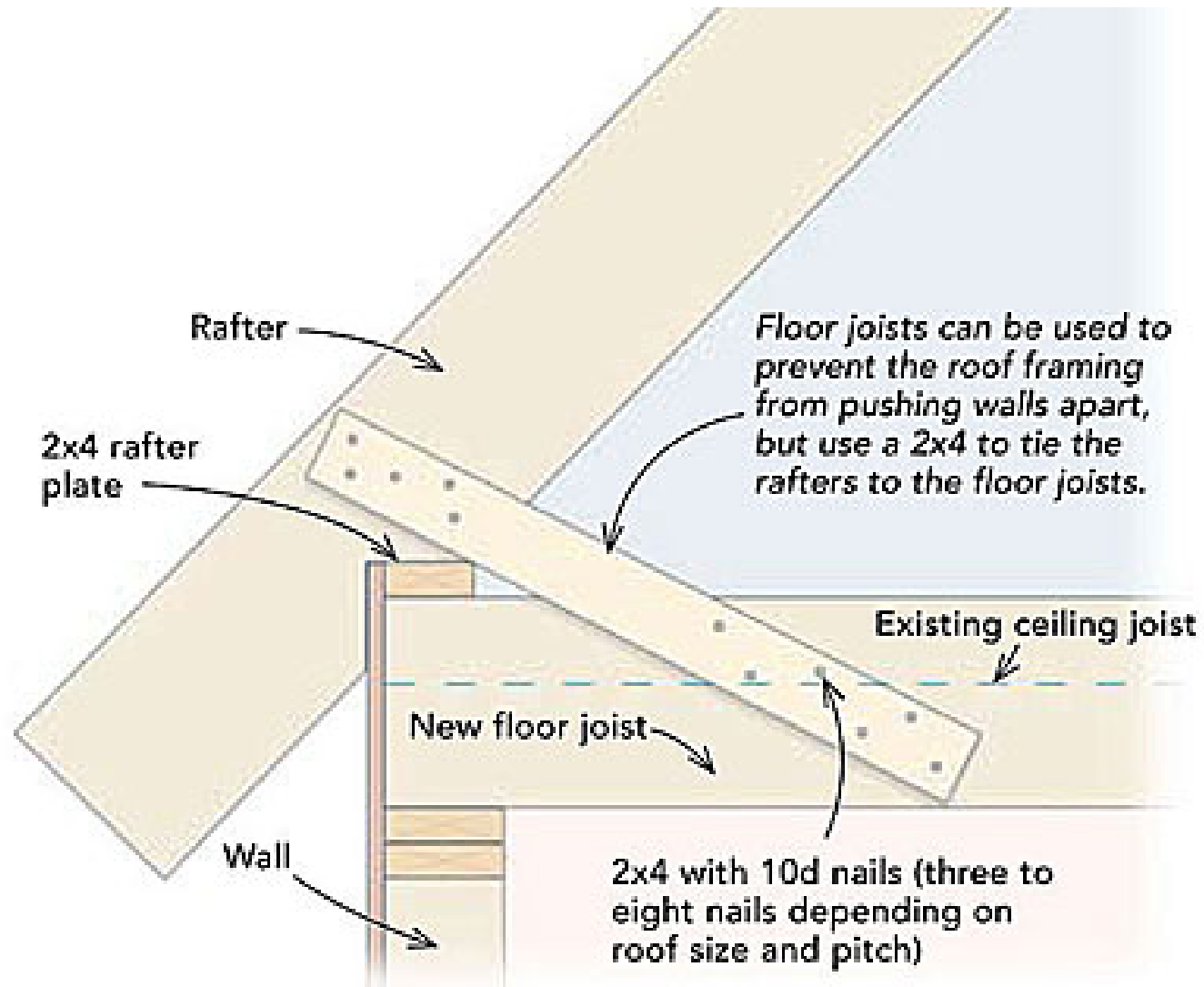
## 402.2 Specific insulation requirements (Prescriptive).

- **402.2.1 Ceilings with attic spaces.** When Section 402.1.1 would require R-38 in the ceiling, R-30 shall be deemed to satisfy the requirement for R-38 wherever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves. Similarly, R-38 shall be deemed to satisfy the requirement for R-49 wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves. This reduction shall not apply to the *U*-factor alternative approach in Section 402.1.3 and the total UA alternative in Section 402.1.4.

# IECC 2009 – 402.2.1 permissible reduction in R-value rating









# Thank you

- Questions & Answers