Southwest
New Brunswick
Service Commission

Rafter framing

Although there are all kinds of styles of roofing styles and subystems (mansard, gambrel, gable, gable dormer, barn dormer), in the end, when it comes to most residential roofs, there are just two kinds of systems: rafters and trusses. The two systems have similarities – and differences.

Here's the critical difference: in order for a building inspector to certify a truss as Code-compliant, it has to be certified by an engineer as suitable for the snow loads in the area. All of the local truss manufacturing companies do this.

Or, in simpler terms, a carpenter or contractor can build a truss – but it can't be deemed Code-compliant.

On the other hand, a carpenter or contractor can build a rafter system, and as long as it's done right, rafter systems can meet the requirements of the National Building Code of Canada.

Here then, is some critical information to know about rafters.

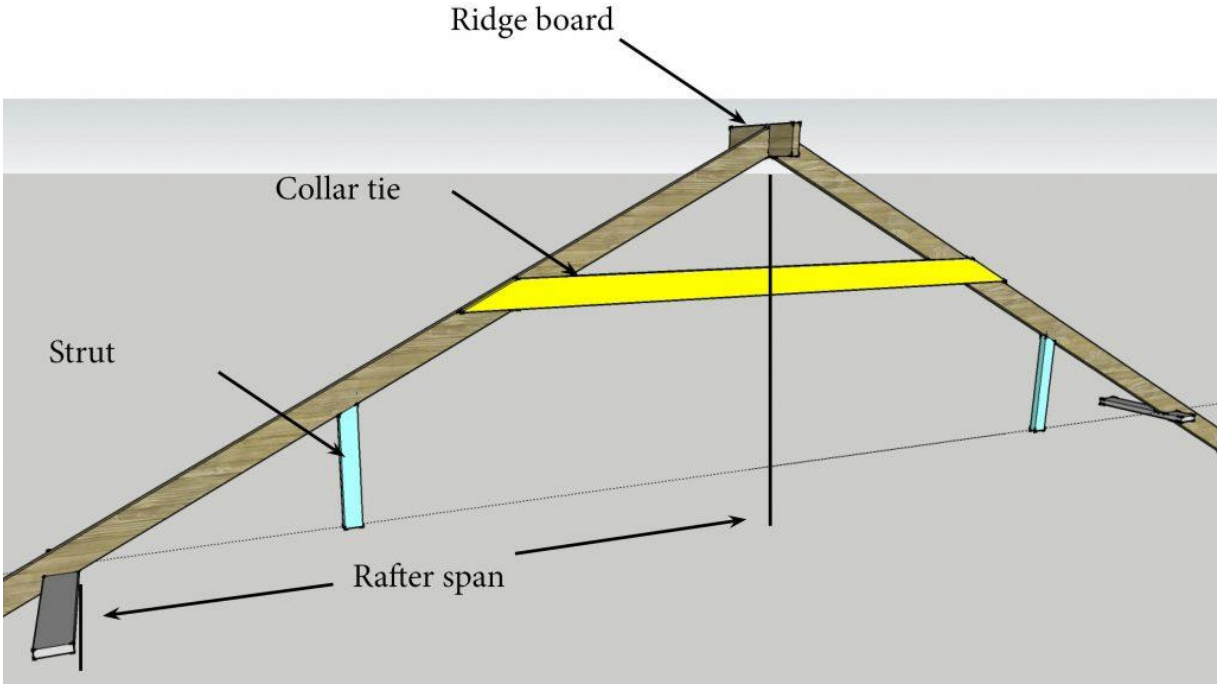

Illustration of some typical rafter elements. Note that in this drawing, some of the

outlined elements may not be necessary; they are included purely for explanatory purposes.

Definitions

Collar tie: a section of wood that ties two opposite rafters together. This is often used to reduce the rafter span.

Dwarf wall: a small wall, built with a top and bottom plate (and doubled top plate if the rafters do not land directly over vertical studs) that is built to support rafters partway up the slope. (Usually constructed fairly close to the wall - think "Cape Cod" style roofing.)

Rafter span: this is the distance between the supporting wall and the centre of the roof measured horizontally. The span is NOT the distance between the supporting wall and the peak of the roof measured along the diagonal.

Rafter: This is the lumber that runs from the centre (peak) to the supporting wall.

Rafter span: this is the distance between the supporting wall and the centre of the roof measured horizontally. The span is NOT the distance between the supporting wall and the peak of the roof measured along the diagonal.

Ridge beam: If the roof has a shallow slope, then the load of the roof must be supported at the peak by a beam that runs the length of the peak, and is supported by a system that eventually leads directly to the foundation of the structure, or a similar set of load-bearing elements. This is usually only required with slopes of 1:3 (4:12 pitch) or more.

Ridge board: In some cases, a ridge board may be required. A ridge board is nothing more than a solid element of wood that runs the length of the peak.

Slope: In construction, the slope – or angle – of the roof, is measured as a function of the increase in height (rise) over a 12-foot horizontal distance (run).

1 / 12	4.76 °
2 / 12	9.46 °
3 / 12	14.04 °
4 / 12	**18.43 °**
5 / 12	22.62 °
6 / 12	**26.57 °**
7 / 12	30.26 °
8 / 12	33.69 °
9 / 12	36.37 °
10 / 12	39.81 °
11 / 12	42.51 °
12 /12	**45 °**
13 / 12	47.29 °
14 / 12	49.4 °
15 / 12	51.34 °
16 / 12	53.13 °
17 / 12	54.78 °
18 / 12	56.31 °
19 / 12	57.72 °
20 / 12	59.04 °

Note that roofs with an angle of 60 degrees or more are treated as walls for the purpose of the Code – with the exception of the exterior sheathing and roofing material.

Strut: a vertical support element. Usually placed near the outside edge, but can also be used on the interior peak. Must be at no more than a 45-degree angle (from horizontal) and bear onto a load-bearing element.

Rafter construction

Rafters for roofs with a slope 1:3 or less

If the slope of a roof is 1:3 (4:12 pitch), then two key elements come into play.

- 1) The centre of the peak must be supported by one of two things:

    - Either a ridge beam supported at the ends (and/or middle, as required), or
    - A ridge board of standard dimensional lumber, with a height equal to or greater than the surface of the rafter; supported at distances no greater than 1.2 metres (4') by a loadbearing wall or by 2x6 lumber struts supported by suitable load-bearing elements. [9.23.14.8(3)]
- 2) The rafters, where they meet the top plate of the supporting wall, must be cross-braced with ceiling joists at both ends; or, alternately, tie rods. [9.23.14.8 (5)]

Rafters for roofs with a slope of 1:3 or more

Rafter systems for steeper roof pitches are a little less stringent. For one, if the lower ends of the rafters "are adequately tied to prevent outward movement" [9.23.14.8(4)], there is no need for a ridge board. In this case, ceiling joists or a floor system usually serve as the lateral ties.

Collar ties

Collar ties can be used used to reduce rafter span – they essentially provide intermediate support for the rafter, but only for roofs with a pitch of more than 1:3. They cannot be assumed to provide support for a splice, however (see below).

Splicing rafters

In cases where the diagonal length of lumber exceeds the readily available 16' lengths, rafters must be spliced over supports (strut or wall) that extend to suitable bearing. [9.23.14.1(1)] Struts may be set diagonally, as long as they are no less than 45 degrees to the horizontal. [9.23.17.14(4)]

Connection at the peak

Rafters may be offset by 1-1/2", as shown here, if a ridge board is used.

If a ridge board is required, then the rafters may be offset by 1-1/2". This allows for a little easier nailing.

Otherwise, the rafters must naturally be connected at the ridge. A gusset plate may be used to connect rafters at the peak where no ridge board is required. Code does

not specify the nature of a gusset plate - which means a section of plywood may be used - as long as the connectors are nails (not ordinary wood screws!) the construction will be acceptable.

Sizing rafters

Sizing rafters is based on four variables: the size of the lumber, the span of the rafter, the spacing of the rafter, and the calculated snow load.
We've done a little number crunching and provided two tables to help determine the lumber needed for the two key climactic zones in our area: York County and Charlotte County. Note that this is for a 41 psf (2kpa) snowload, and in some cases, lesser snowloads can be assumed: as always, call us for guidance.

Rafter table (general)

	2x4	2x6	2x8	2x10	2x12
12" OC	8'1	12'9"	16'9"	21'5"	25'7"
16" OC	7'4"	11'7"	15'3"	19'1"	22'2"
24" OC	6'5"	10'1"	12'9"	15'7"	18'1"

Sizing ridge beams

If a ridge beam is necessary, then do note it must be constructed out of three-, four-, or five-ply lumber of 2x8 size or greater. Call us for the specifications.

Nailing rafters There are some specific requirements for rafter/top plate connections - here are the nailing tables to aid in construction.

Construction Detail	Minimum Length of Nails, mm	Length required, inches	Minimum Number or Maximum Spacing of Nails
Roof rafter, roof truss or roof joist to plate – toe nail	82	3.23	3
Rafter plate to each ceiling joist	101	3.98	2
Rafter to joist (with ridge supported)	76	2.99	3
Rafter to joist (with ridge unsupported)	76	2.99	See table 9.23.14.8 below
Gusset plate to each rafter at peak	57	2.24	4
Rafter to ridge board – toe nail – end nail	82	3.23	3
Collar tie to rafter – each end	76	2.99	3
Collar tie lateral support to each collar tie	57	2.24	2
Jack rafter to hip or valley rafter	82	3.23	2
Roof strut to rafter	76	2.99	3
Roof strut to loadbearing wall – toe nail	82	3.23	2

Table 9.23.14.8.
Rafter-to-Joist Nailing (Unsupported Ridge)
Forming Part of Sentences 9.23.14.8.(5) and (6)

Roof Slope	Rafter Spacing, mm	Minimum Number of Nails not less than 76 mm Long											
		Rafter Tied to every Joist						Rafter Tied to Joist every 1.2 m					
		Building Width up to 8 m			*Building* Width up to 9.8 m			*Building* Width up to 8 m			*Building* Width up to 9.8 m		
		Roof Snow Load, kPa			Roof Snow Load, kPa			Roof Snow Load, kPa			Roof Snow Load, kPa		
		1.0 or less	1.5	2.0 or more	1.0 or less	1.5	2.0 or more	1.0 or less	1.5	2.0 or more	1.0 or less	1.5	2.0 or more
1 in 3	400	4	5	6	5	7	8	11	—	—	—	—	—
	600	6	8	9	8	—	—	11	—	—	—	—	—
1 in 2.4	400	4	4	5	5	6	7	7	10	—	9	—	—
	600	5	7	8	7	9	11	7	10	—	—	—	—
1 in 2	400	4	4	4	4	4	5	6	8	9	8	—	—
	600	4	5	6	5	7	8	6	8	9	8	—	—
1 in 1.71	400	4	4	4	4	4	4	5	7	8	7	9	11
	600	4	4	5	5	6	7	5	7	8	7	9	11
1 in 1.33	400	4	4	4	4	4	4	4	5	6	5	6	7
	600	4	4	4	4	4	5	4	5	6	5	6	7
1 in 1	400	4	4	4	4	4	4	4	4	4	4	4	5
	600	4	4	4	4	4	4	4	4	4	4	4	5

Insulating spaces below rafters

If the space below a rafter-style roof is an unheated attic, then insulation is simply a matter of bringing the attic insulation up to the R50 required for attics.

If the space beneath a rafter system is heated, then the diagonal elements of the rafter must be insulated, and treated as a cathedral ceiling. In this case, that assembly is required to be R26.

If the space above collar ties is treated as an unheated attic, then an attic hatch is required, and the insulation must meet R50 standards.The requirement for R26 in a cathedral ceiling may impose some design considerations upon the builder/homeowner.

Fortunately, the space can be considered “confined,” for the purposes of whether cellulose and other loose-fill insulation can be used [9.25.2.4(2)], but cellulose and fibreglas generally have an R-value of 3.5 per inch of thickness, which presents a problem when insulating rafters.R 3.5/inch means only R19.5 for a standard 2x6 rafter and 25.3 for a 2x8 rafter. Now, other materials – sheathing, vapour barrier, drywall – will add a little, but factor in the thermal bridging of the lumber and even a 2x8 rafter assembly will still not meet code using fibreglas or cellulose infill. The solutions include moving to a 2x10 rafter, or adding a layer of foam insulation (usually on the roof-deck side) to meet the required R-value. The other option, and one used in renovations of many existing rafter-style roofs in older buildings, is site-applied closed-cell foam, which averages about R7 per inch.