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Understanding Roof Framing Systems in Vermont & New Hampshire Homes

How Roofs Are Framed, Why Issues Occur, And What To Know Before Making Changes

Why Roof Framing Matters

Roofs do more than keep the weather out. Structurally, they must:

- Support their own weight and heavy snow loads
- Control outward forces that can push walls apart
- Transfer loads safely down to the walls and foundation

How a roof is framed plays a major role in how it behaves over time — and how it responds to changes or renovations.

Why This Is Especially Important In Vermont & New Hampshire

Homes in this region face conditions that are different from many other parts of the country:

- **Higher snow loads** that place significant demands on roof framing
- **Older housing stock**, often built when design standards were lower
- **Changes over time**, including renovations, added finishes, or new loads

As a result, it is not uncommon to see roof framing that is undersized by modern standards or stressed by how the home has evolved.

What This Document Will Help You Understand

This guide explains:

- The most common roof framing systems found in homes in this region
- How these systems work structurally
- Common issues that occur with each system
- Why certain renovations often require structural review
    - Examples include dormers, vaulted ceilings, skylights, and rooftop solar installations.

What This Document Is — and Is Not

This document is:

- An educational overview
- A way to better understand what you see in your home
- A tool to help you ask informed questions

This document is not:

- An analysis of your specific roof
- A diagnosis of structural adequacy
- A substitute for a professional assessment

Every home is different, and roof performance depends on geometry, materials, connections, snow exposure, site context, local climatic patterns, and how loads are transferred through the building.

Mass Timber Advisors
Residential Structural Engineering
Woodbury, VT | Serving Vermont & New Hampshire

Clarity Enables Action

The goal of this guide is to provide **context and clarity** — so you can better understand how your roof works, why issues may arise, and when it makes sense to consult a structural engineer.

Common Roof Framing Systems In Vermont And New Hampshire Homes

This guide explains the four following common roof framing systems:

- **Rafter-based systems**: sloped rafters and horizontal ceiling ties create stiff triangular framing
- **Ridge / valley / hip beam systems:** Sloped rafters are supported on structural beams and posts
- **Historic timber trusses:** homemade style trusses often using 2x4 and 2x6 framing with plywood gusset plates
- **Modern metal plate connected trusses:** prefabricate offsite, designed for project-specific loading, spans and configurations

Rafter-Based Roof Systems

THE MOST COMMON ROOF FRAMING FOUND IN VERMONT & NEW HAMPSHIRE HOMES

Common Rafter & Ceiling Tie Systems

Many homes in Vermont and New Hampshire are framed using **sloped rafters** that run from the roof ridge down to the exterior walls. In this system, it is common for **ceiling ties** to connect opposing rafters at the top of the exterior walls.

How this system works:

- Rafters carry the vertical weight of the roof and snow
- Ridge connection of opposing rafters creates a "hinge" effect, resulting in **outward thrust** which is resisted by ceiling ties
- Together, the rafters and ceiling ties form a **stiff triangular system**
- This triangle helps prevent exterior walls from spreading outward while transferring snow and gravity loads to load bearing elements (walls, beams, etc.)

When properly sized and connected, this is an effective and economical roof framing system.

Common Issues With Rafter & Ceiling Tie Systems

Issues often arise when:

- Rafters are **undersized**, especially in older homes
- Ceiling ties are missing, altered, or removed
- Additional loads have been added over time (roofing layers, finishes, snow)

These conditions can lead to roof sag, wall movement, or interior cracking.

Total building widths at which rafter and tie systems work are generally limited to approximately 32 to 34 feet. Wider buildings and longer spans will typically require alternative roof framing systems.

Knee Walls In Older Homes (A Common Northern New England Condition)

In many older homes—especially those with **balloon-framed exterior walls**—the roof does not bear directly at the attic floor level. Instead, to maximize the amount of livable space on the home's uppermost story, the roof intersects the exterior wall **1 to 4 feet above the floor**, creating a short wall known as a **knee wall**.

Why knee walls can be problematic:

- Roof rafters still exert outward thrust at the **top of the knee wall**
- The floor system below acts as a tie, but at a **lower elevation**
- This difference in height causes bending in the knee wall studs

Common signs homeowners notice:

- Knee walls bowing outward
- Cracking where knee walls meet ceilings or floors
- Sloped ceilings near the eaves and/or generally sag of the roof ridgeline, particularly near the middle of the roof's length

Raised Ceiling Tie Systems

A variation of the ceiling tie system is the **raised ceiling tie**, often used to create more headroom or a partially vaulted ceiling. As the name implies, the system still utilizes rafters and ceiling ties, but rather than ceiling ties intersecting rafters at the exterior walls, the ties are raised in elevation, meeting the rafters within their span.

How raised ceiling ties behave structurally

- The portion of the roof **above the ceiling tie** still acts as a stiff triangle
- The portion **below the ceiling tie** behaves like a spanning rafter
- The system is **no longer a full triangle from wall to ridge**

Why tie height matters

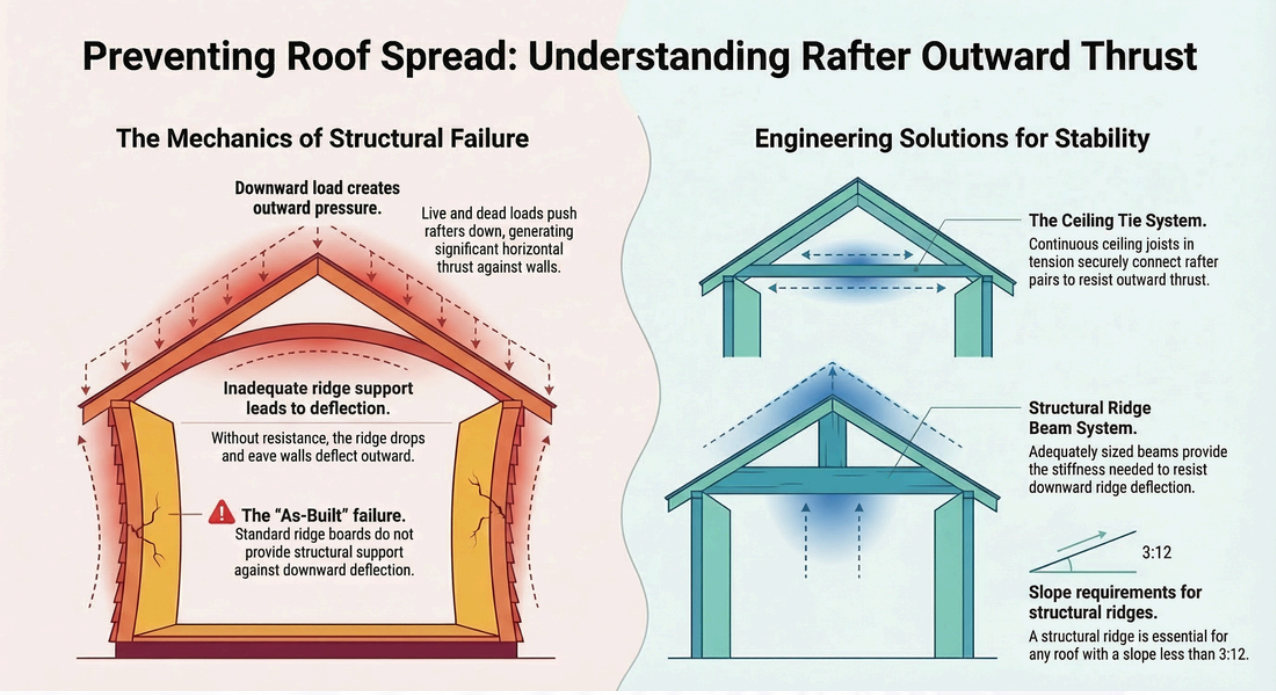
- The higher the ceiling tie, the more bending stress is introduced into the rafters
- Excessively high ceiling ties can overstress rafters, potentially leading to rafter cracking or significant roof sag

Connections Matter

Ceiling ties must be **properly connected** to rafters:

- Members typically overlap
- Adequate nailing or fastening is critical

Poor or missing connections can significantly reduce the effectiveness of the system.



Structural Ridge Beams, Hips & Valleys

WHEN ROOFS RELY ON STRUCTURAL BEAMS INSTEAD OF TIES

Structural Ridge Beam Systems

In some homes, the roof is framed using a **structural ridge beam** rather than ceiling ties.

How this system works:

- Rafters are supported by a ridge beam instead of pushing against each other
- The ridge beam carries the roof load vertically
- Loads are transferred through **posts** down to the foundation
- There is **no outward thrust** on exterior walls

When Structural Ridge Beams Are Commonly Used

Structural ridge beams are often the best solution when:

- Vaulted ceilings are desired
- Dormers are added
- Roof geometry is complex
- A consistent ceiling tie elevation is not possible

Tradeoffs to understand

- Structural ridge beams are typically more expensive
- Posts and foundations must be designed to carry the added load (often in the interior of the building rather than along exterior walls)

Hips, Valleys, and Roof Direction Changes

Many homes have roofs that include **hips, valleys, and intersecting roof planes**.

Key roof terms

- **Gable:** Triangular end of a roof
- **Hip:** Roof slopes in two directions down from a common diagonal plane
- **Valley:** Intersection of two roof planes to a low plane
- **Valley beam:** Structural member carrying concentrated roof loads along a valley
- **Eave:** Lower edge of the roof

Structural Considerations In Complex Roofs

- Valleys concentrate roof loads into fewer members
- Ceiling framing often runs parallel to rafters at hips
- Changes in roof direction must still resist outward thrust and transfer loads properly

Poorly understood or modified hip and valley framing is a common source of structural issues.

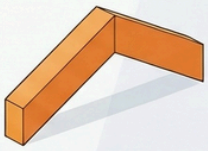
A Guide to Residential Roof Styles and Support

Common Roof Styles

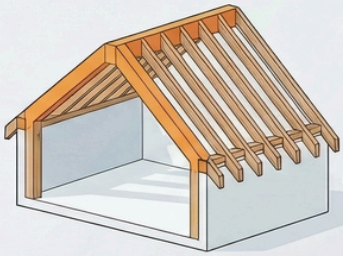
Gable and Hipped Roofs
The most common styles featuring two or four sloping sides meeting at a ridge.

Shed Roof
A modern, functional style consisting of a single sloping roof surface.

Dutch Gables and Valleys
Complex styles combining hipped sections with small gable ends or intersecting roof planes.



Ridge Beam Structural Requirements



Use in Cathedral Ceilings
Required when ceiling joists or rafter ties do not provide continuous structural ties.

Full Load Bearing
The ridge beam must be capable of supporting the entire load of the rafters.

Prevents Wall Displacement
High stiffness is required to stop rafter thrust from pushing walls outward.

Structural Compliance Reference
(Inspired by 2021 IRC R802.3)

Ridge Beam:
Must support full load of rafters.

Beam Support:
Must be supported at each end by a wall or column.

Deflection:
Must be minimized to prevent rafter thrust.

Roof Trusses (Old & Modern)

SYSTEMS DESIGNED TO ACT AS A WHOLE

Style 1: Older “Homemade” Trusses

Some older homes use **site-built trusses**, often constructed from 2×4 or 2×6 lumber with plywood gusset plates to connect truss members together.

Common characteristics:

- Built on site by the original builder
- Variable quality and consistency
- Often not designed for modern snow loads

Common issues:

- Aging or deteriorated connections
- Undersized members
- Inadequate bracing
- Limited flexibility for modification

Style 2: Modern Prefabricated Roof Trusses

Many newer homes use **engineered, factory-built trusses** connected with metal plates.

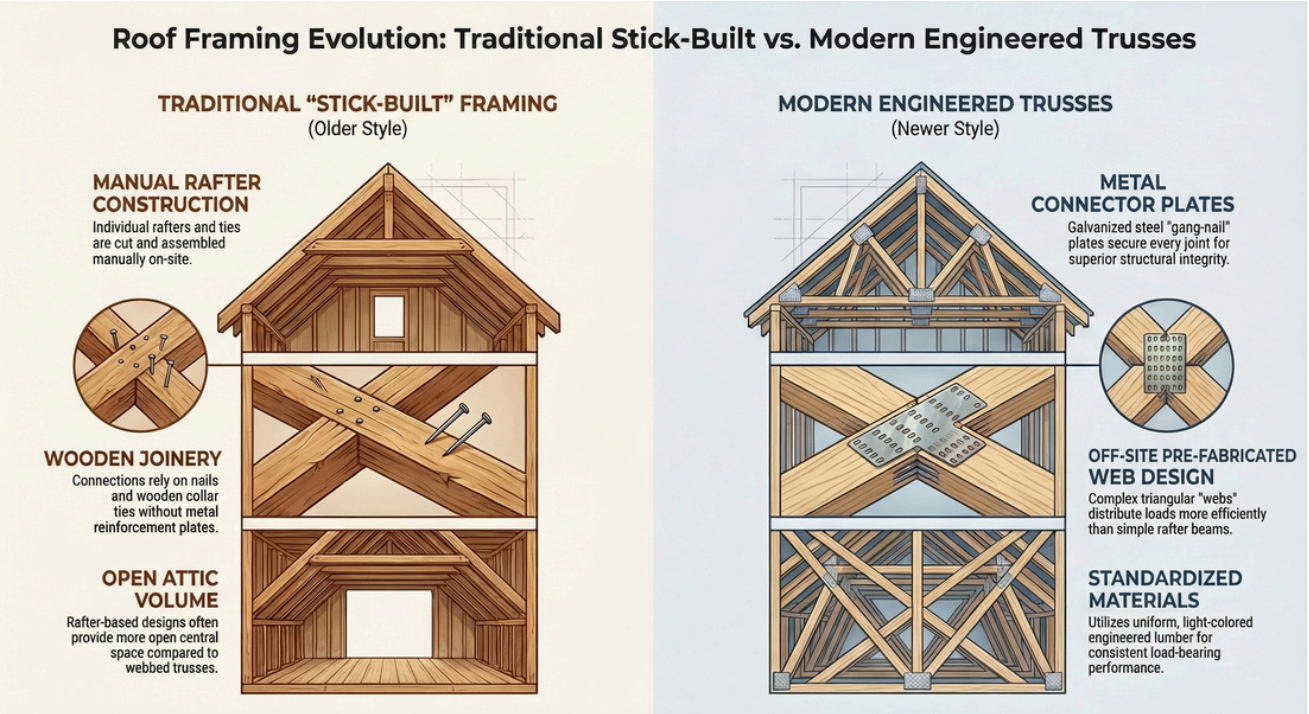
How modern trusses work

- Designed as a complete structural system
- Each member and connection is critical
- Loads are distributed through the entire truss
- Structural efficiency gained by leveraging each member in tension or compression rather than bending

Important renovation implications

- Trusses should **not be cut or modified** without engineering review
- Removing webs or adding loads affects the entire system
- Vaulted ceilings, storage areas, or dormers often require significant analysis and reinforcement

Trusses offer efficiency and strength—but limited flexibility.



Style 1: Older "Homemade" Trusses

Style 2: Modern Prefabricated Roof Trusses

Snow Loads, Renovations & When to Call an Engineer

PUTTING IT ALL TOGETHER

Snow Load And Roof Slope

Snow loads are typically the controlling factor in roof design in Vermont and New Hampshire.

Key considerations

- NH and VT Building Codes dictate required design snow loads by town (VT & NH) and by site specific elevation (NH only)
- Steeper roofs tend to shed snow more effectively
- Building codes allow snow load reductions when:
  - Roof slopes are sufficiently steep
  - Roof surfaces are unobstructed and slippery (i.e. metal not shingles)
  - Features such as dormers or snow guards are absent

Small changes to roof geometry can significantly affect snow loading.

Renovations That Commonly Trigger Structural Review

Structural evaluation is often recommended when homeowners consider:

- Adding dormers, skylights or snowguards
- Converting flat ceilings to vaulted ceilings
- Removing ceiling or collar ties
- Changing metal roofs to shingles
- Adding rooftop solar panels
- Modifying trusses or roof framing
- Altering interior bearing walls or posts supporting roof framing

Understanding Load Paths

- Most roof loads are transferred to **exterior walls**
- Structural ridge beams introduce **interior posts**
- Interior posts must be supported all the way to the foundation
- Moving or removing posts can affect roof capacity

When To Contact A Structural Engineer

It may be time to seek professional input if you observe:

- Persistent roof sag or deflection
- Cracking at ceilings or walls near the roof
- Planned roof modifications or added loads
- Uncertainty about how your roof is framed

Final Note

This guide is educational, not diagnostic. Every home is unique, and roof performance depends on many interacting factors.

A structural assessment provides clarity specific to **your roof and your home**.

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