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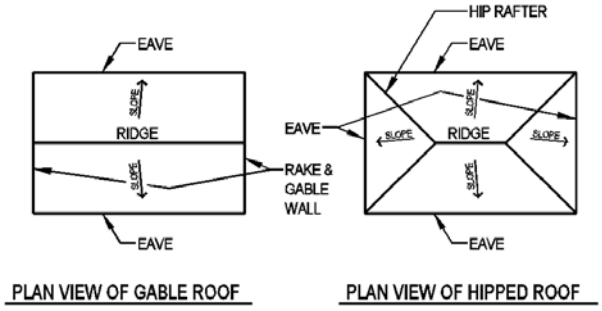
Conventionally Framed Roofs - Part 3
The Hipped Roof

Introduction:

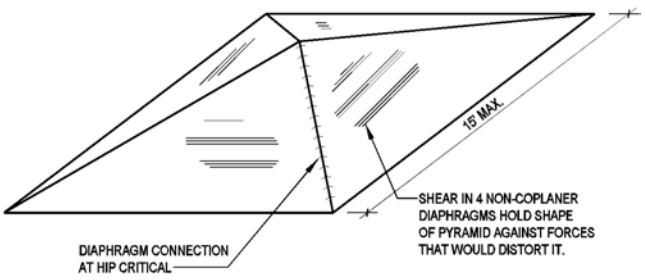
In Part 1 of this technical bulletin series we discussed the conventionally framed gable roof and its basic structural requirements, while in Part 2 we discussed problems and solutions of the gabled roof when not properly designed or constructed. In this technical bulletin, we will discuss a common variation of the "A" framed roof, the hipped roof.

On a simple hipped roof, the roof slopes upwards to the ridge from all four sides. However on a simple gable-style roof, the roof slope is only on two opposing sides, and the ends of the roof are closed off with a triangular gable wall. We frequently encounter hipped roofs that are constructed as self-supporting assemblies (i.e. no interior support). While this is possible for modest hipped roofs, there are certain structural requirements to make a hipped roof self-supporting. In the following bulletin we will discuss the mechanisms required to make a hipped roof self-supporting and show why it is generally better to provide support at the hip rafters.

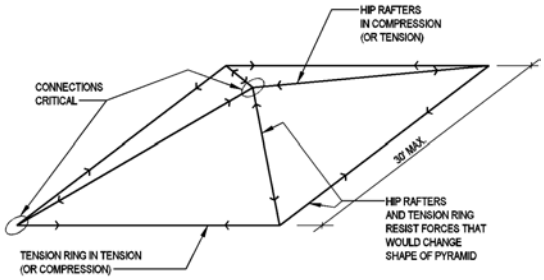


The Folded Plate Mechanism for Hipped Roofs Up to 15 Feet:

The simplest hipped roof is a pyramid shape. A small pyramid-shaped roof can be constructed out of basic wood framing and can be supported on walls or posts without any mechanism to resist thrust. The "folded plate" of the four connected, non-co-planar diaphragms prevents the roof from changing shape. The size of pyramid constructed in this fashion is limited by the ability of the plywood diaphragms; in particular, the ability of the connection between the diaphragms at the hip rafters to resist the 'tear apart' forces at the corners. It is difficult to get a strong connection between the plywood diaphragms and the hip rafters; therefore, this 'folded plate" mechanism is limited to small hipped roofs, about15 feet maximum total span.



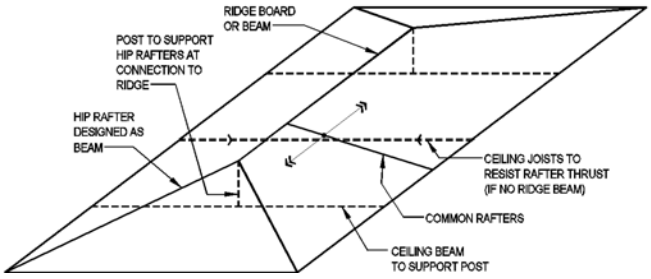
The Tension Ring Mechanism for Hipped Roofs up to 30 Feet:



Another mechanism available to construct a self-supporting pyramid is to provide a "tension ring" around the perimeter and design the hip rafters as compression struts/beams. In this case, the basic frame consisting of hip rafters and the 'perimeter ring' is statically determinant. The rafters and sheathing are simply cladding applied to this frame. Using typical wood framing methods and materials, "tension ring" pyramids can be constructed spanning up to 30 feet. Transforming the simple pyramid to a hipped roof with a rectangular plan complicates matters a little but the structural mechanism is essentially the same.

Typical Supported Hipped Roofs:

While it is possible to design and construct unsupported hipped roofs of modest proportions (such as a 25' by 50' ranch), the detailing for such a roof is elaborate. The connections between the hip rafters and the bearing at the corners are critical. The *International Residential Code* (IRC) does not address the requirements for such a roof and instead requires that hip (and valley) rafters be supported at the ridge by a "brace to a bearing partition" (paragraph R802.3). Essentially a post must be provided from the intersection of the hip rafters and the ridge to a supporting element below. The problem is that this roof feature seldom coincides with a supporting structure (bearing partition) below. One solution often employed by framers is a 'strong back'. This is usually nothing more than a 2x laid flat, installed on top of the ceiling joist to distribute the reaction from the post onto several ceiling joist. This solution does not comply with code and is inadequate. The load from the post is substantial, (as much as 5,000 lbs for a 30 foot hip), and the 'strong back' and ceiling joists usually have not been adequately sized to support the full reaction without excessive deflection and/or sustaining structural damage.



A better solution is to extend the post down to a ceiling beam designed to support the reaction from the hips. We found that a typical 25' to 30' hipped roof post should be constructed of three-2x4's nailed together (if the intersection of the hip rafters is no more than 6'-6" above the ceiling or four-2x6's if this intersection is less than 11' high). The post should be supported on a ceiling beam designed to support the reaction from the post. Typically beams constructed of three plys of the next size 2x from that used for the ceiling joist will work (i.e. if the ceiling joists are 2x8's the beam should be three-2x10's). Each end of this ceiling beam should bear fully on adequate supports. If an unsupported hipped roof is desired such as with a cathedral ceiling, special design of that roof is required by a Structural Engineer employing one of the mechanisms described in this Technical Bulletin.

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