Calculating Loads on Beams & Headers

by Paul Fisette

Most builders install built-up dimension lumber headers over standard window and door openings without worrying about the loads. You just put in the same-size double 2x10 or 2x12 headers throughout the house — not only will they carry standard residential loads, but they also automatically keep the window and door heads at a uniform height.

You can't beat sawn lumber for most small window headers, but as spans and loads increase, stronger materials are a better choice. Sawn lumber limits design potential and in some cases just doesn't work. LVL (laminated veneer lumber), Parallam, Timberstrand, and Anthony Power Beam are all good alternatives for longer-span and heavily loaded beams.

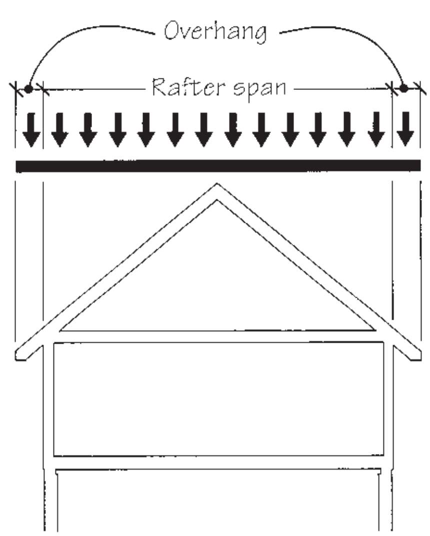
In this two-part article, I'll compare how sawn lumber and these engineered materials measure up as headers and beams. Regardless of the material you choose, you've got to accurately calculate the loads the beam will carry — that's the subject of this article. In Part II, I'll compare the performance and cost of solid-sawn beams to the alternatives mentioned above.

Following the Load Path

The job of headers and beams is simple: They transfer loads from above to the foundation below through a network of structural elements. The idea behind sizing headers and beams is straightforward: Add together all the live loads and dead loads that act on the member and then choose a material that can support the load. The beam must be strong enough in bending (its *Fb* value) so that it doesn't break and stiff enough (its *E* value) so that it doesn't deflect excessively under the load.

Engineered lumber beams are typically sized using span tables that match the span to pounds per linear foot (plf) of beam. So to use the tables in the manufacturers' design guides, you have to translate the load on a beam into pounds per linear foot.

Uniform vs. point loads. Loads are considered to be either uniformly distributed or point loads. A layer of sand spread evenly over a surface is an example of a pure uniformly distributed load. Each square foot of the surface feels the same load. Live and dead loads listed in the building code for roofs and floors are approximations of distributed loads, and are stated in pounds per square foot (psf).



Uniform roof loads are based upon the horizontal footprint area of the roof, not the sloped area of the roof.

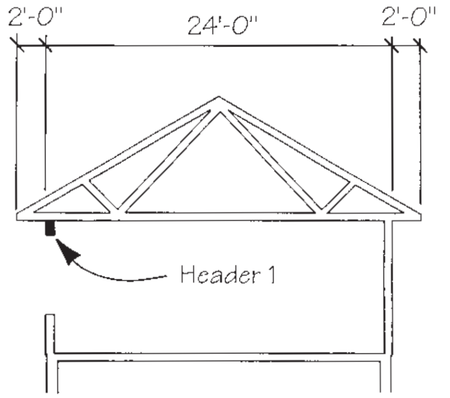
Point loads occur when a weight bears on one spot in a structure, the way a column imposes its load at the base. The load is not shared equally by the supporting structure. Analysis of point loading is best left to engineers. In this article, we'll consider only uniformly distributed loads.

Some Examples

Let's trace distributed loads for several different houses. Assume that all are located in the same climate, but have different loading paths because of the way they are built. These examples illustrate how distributed loads are assigned to structural elements. Our sample homes are in an area where the snow load is 50 pounds per square foot of roof area (treat snow as live load). In a warmer climate, of course, the snow load would be less, so you need to check your code book for live loads and dead loads in your region. All loads are listed as pounds per square foot of horizontal projection (footprint area), as in the illustration at left.

Header 1: One Story, Truss Roof

Here, each square foot of roof system delivers 50 pounds of live load and 15 pounds of dead load (an average weight for a roof built with trusses), or a total load of 65 psf, to the structural support system. Remember, these loads are distributed uniformly over the entire surface of the roof. Each exterior wall (and any headers within) will carry all loads from the center of the house to the outside, including the roof overhang. This distance, the "trib-



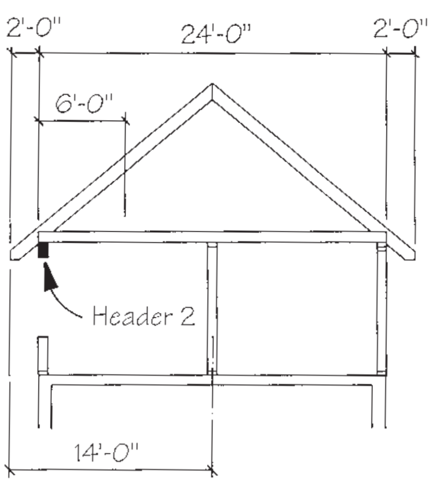
utary" width, is 14 feet (12 feet + 2 feet). So each linear foot of wall must carry the loads imposed by a 1-foot-wide strip 14 feet long. Thus, each lineal foot of wall supports

live load (snow): 50 psf x 14 ft. = 700 plf
roof dead load: 15 psf x 14 ft. = 210 plf
total load: 910 plf

It is important to list live load, dead load, and total load separately because live load is used to compute stiffness and total load is used to calculate strength.

Header 2: One Story, Stick Roof

This house is identical to our first example except it is stick-built. As a result, the live load, dead load, and distribution of forces are different. Unlike

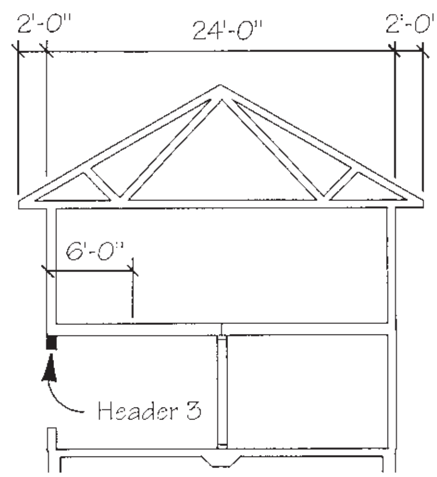


the trussed roof, live load and dead load of the rafters and ceiling joists must be accounted for as separate systems. Since it is possible to use the attic for storage, the live load of the attic floor is set at 20 psf according to code. So each lineal foot of header supports

live load (snow): 50 psf x 14 ft. = 700 plf
roof dead load: 10 psf x 14 ft. = 140 plf
ceiling live load: 20 psf x 6 ft. = 120 plf
ceiling dead load: 10 psf x 6 ft. = 60 plf
total load: 1,020 plf

Header 3: Two Story, Truss Roof

Again, this house has the same width dimension, but it has two levels. Loads are contributed to the lower header by the roof, upper walls, and second floor. For second-story floor loads, code usually gives a live load of 30 psf and a dead load



of 10 psf. *Architectural Graphic Standards* lists the weight of an exterior 2x6 wall as 16 pounds per square foot. So an 8-foot-tall wall weighs 128 plf (8 ft. x 16 psf). The loads delivered to the header are

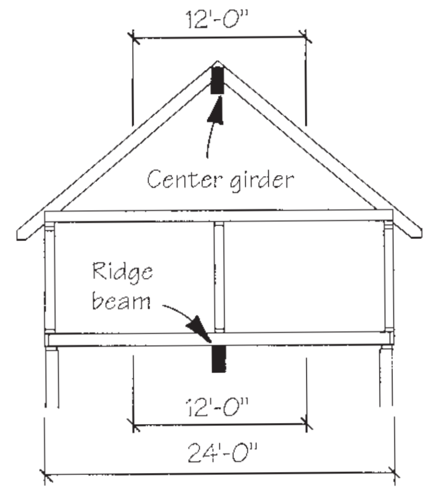
live load (snow): 50 psf x 14 ft. = 700 plf
roof dead load: 15 psf x 14 ft. = 210 plf
upper level wall: 16 psf x 8 ft. = 128 plf
2nd floor live load: 30 psf x 6 ft. = 180 plf
2nd floor dead load: 10 psf x 6 ft. = 60 plf
total load: 1,278 plf

Ridge Beam & Center Girder

This figure illustrates two structural elements: a structural ridge beam and a center girder. Each has a tributary width of 12 feet. The load per foot of beam is determined the same way as for headers. For the ridge beam, the load is

live load (snow): 50 psf x 12 ft. = 600 plf
roof dead load: 10 psf x 12 ft. = 120 plf
total load: 720 plf

Center girder. The center beam carries half the floor load, the weight of the



partition wall, and half the second-floor load (an attic treated as living space). Code load for first-story rooms is 40 psf live and 10 psf dead. *Graphic Standards* lists the weight of a 2x4 partition as 10 pounds per square foot. So the load on this girder is

1st floor live load: 40 psf x 12 ft. = 480 plf
1st floor dead load: 10 psf x 12 ft. = 120 plf
8-foot-tall partition: 10 psf x 8 ft. = 80 plf
2nd floor live load: 30 psf x 12 ft. = 360 plf
2nd floor dead load: 10 psf x 12 ft. = 120 plf
total load: 1,160 plf

In Summary

These examples are typical of the kind of calculations you will have to do to figure the uniform load on a beam. Armed with this information, you can size a dimension lumber beam, as long as you can confidently wade through the necessary formulas. Or you can go to the engineered lumber design guides and safely choose a beam that will carry the load for the span in question. In the next article, we'll look at cost and performance of some engineered beams versus sawn lumber.

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Curious about the forces that hold a building together — or cause it to fall apart? Address your questions to Practical Engineering, *JLC*, RR 2, Box 146, Richmond, VT 05477.