TEARING OUT WALLS

I'm doing a remodel which requires the removal of an interior wall. Can I do this? Is it safe?

Don Gorgis
Sonora, CA

Dear Don,

I was once told by a remodeler that if I would answer this very question and post it to my blog, it would be the hottest thing on the internet. Somehow I doubt that, but I'm glad to shed some light on an oft misunderstood and underestimated topic. Thank you for asking.

Following are the four main steps involved in demo'ing a wall or a part of one. Please understand that there are many ways of doing things – what I discuss below may or may not be exactly applicable to every situation. If in doubt, be safe: call in an expert.

STEP 1: DETERMINE IF THE WALL BEARS LOAD, I.E. IS "LOAD BEARING"

There are two types of loads that walls carry: *lateral*, sideways-acting loads from wind and earthquake; and *gravity*, from the downward weight of things above.

Lateral Loads. With residential construction, *interior* walls generally are not shear walls, i.e. those designed to take lateral (wind and earthquake) loads. But there are exceptions. *Exterior* walls generally are shear walls. How to tell? Here are several characteristics that can apply to interior or exterior shear wall walls:

- If it's constructed with plywood or OSB sheathing on one or both sides. This is an almost sure-fire indicator of a shear wall. However, drywall-covered walls may be shear walls too, particularly if any of the following holds true.
- If the top of the wall (interior wall) extends beyond the ceiling to the roof diaphragm (the plywood portion of the roof.)
- If the bottom of the wall is connected to the floor or foundation with a high number of nails or bolts.
- If there are holdowns at any location along the wall.
- If there are hurricane clips or other metal hardware connecting the top of wall to ceiling or roof framing.

If your wall has one or more of the above it's likely a shear wall and you should get an engineer involved. It is possible to remove parts of a shear wall if there is enough capacity in what's left, or if the lost capacity can be picked up elsewhere. To determine this requires engineering knowledge of wind and seismic design – something that should be undertaken only by a licensed engineer.

If you're sure your wall is not a shear wall, great, no concern there. Let's move to the next item.

Gravity Loads. Most *exterior* walls are load bearing and must be temporarily supported per Step 2, below.

Some *interior* walls are load bearing and some are not. Those that are must be temporarily supported per Step 2, below. If your interior wall carries no gravity load from above and it is not a shear wall, terrific! You can go ahead and demo it without worry. Of course, pay attention to plumbing, HVAC, and electrical embedded in the wall – you'll have to reroute or otherwise deal with those.

You can be 99% sure that an *interior* wall is non-load-bearing if it is parallel to the framing immediately above it. For example, if there are roof trusses above and they run parallel to your wall, your wall is most likely non-load-bearing. As another example, if the framing immediately above your interior wall is a 2nd floor, and those floor joists are parallel to your wall, it's probably non-load-bearing.

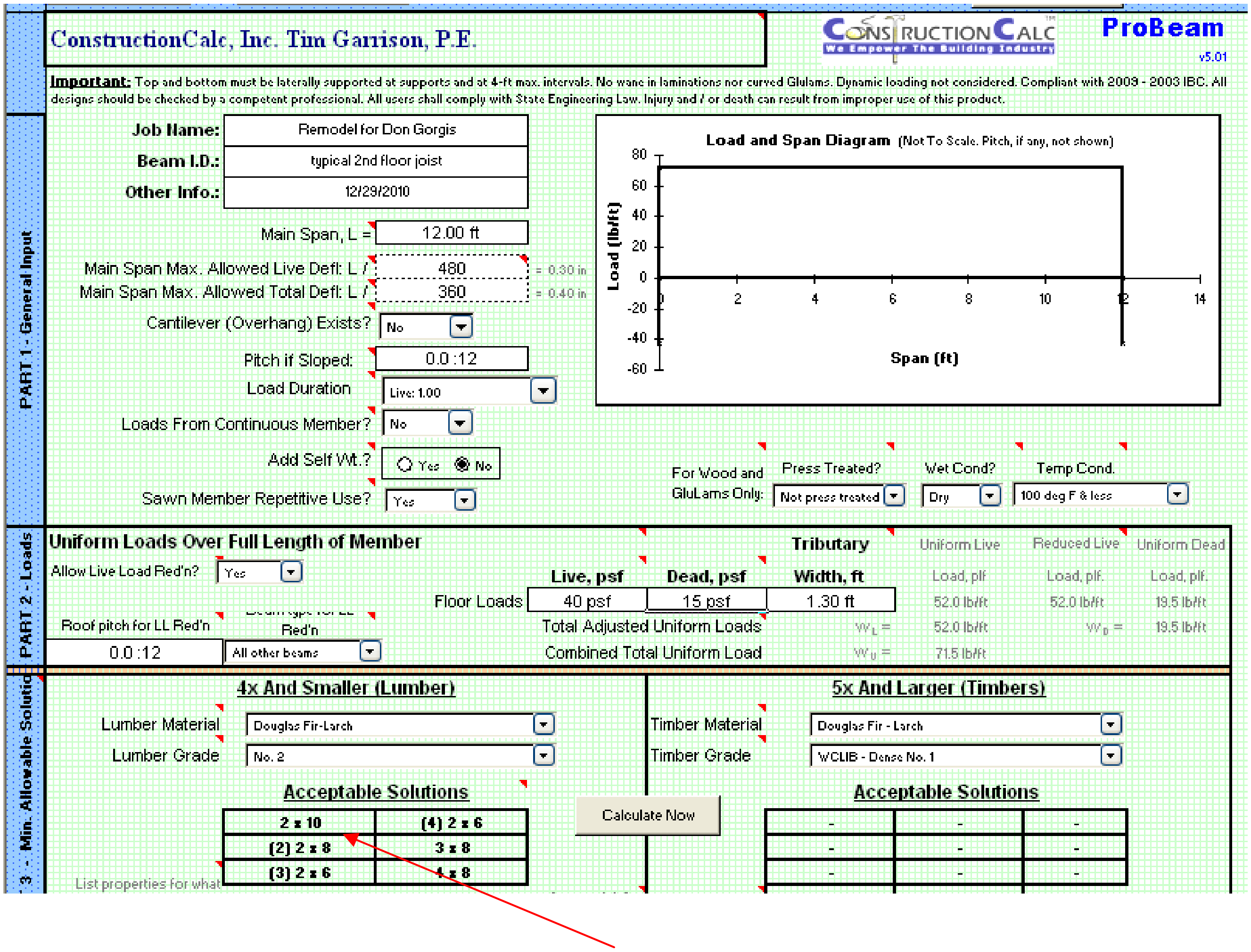
But beware! Sometimes even with non-load-bearing walls, a concentrated load, a.k.a. point load, may be brought down from above and bear on your wall. Such a load can come from a beam above, a post above, or a door header above. If the framing above is an upper floor, generally, but not always, there will be solid blocking in the floor cavity directly under any point load between the subfloor and the top plate of your wall. Regardless of where the point load comes from, it must be supported by a new beam you install to replace the demo'd wall (see Step 3, below.)

How do you tell if an *interior* wall supports gravity load? Here are several indicators:

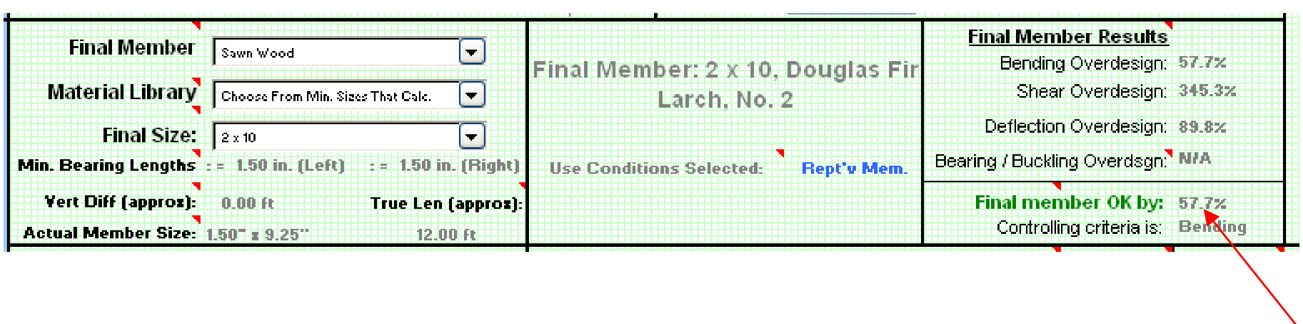
- If the framing above is an upper floor and the floor joists run perpendicular to your wall. If said floor joists are spliced or end over your wall, for sure your wall is load bearing.

  If the floor joists are continuous (i.e. not spliced) over your wall it is possible that your wall is not intended to support said joists. In this case, you'll have to calc the floor joists above to determine if they're stout enough for their span once your wall is removed. ConstructionCalc ProBeam™ is ideal for this.

  Here's an example. Let's say the floor joists above your wall are 2x10 Doug Fir #2 at 16" spacing. And let's say that when your wall is removed, the joists will span 12'. Here is the input and solution that checks the typical floor joist. Toward the bottom of this screen shot you can see that a 2x10 is acceptable:



With ProBeam™ we can now select that 2x10 and see how close it is to meeting code.



This 2x10 joist makes it by 57%, a very comfortable margin of safety. Thus, in this case we can demo our wall and not worry about installing a beam to replace it.

If the floor joists above were TJI I-joists instead of 2x10, ProBeam™ could just as easily check them because the entire Trus Joist MacMillan library of I-joists is included in its database.

Here are more ways to tell if an *interior* wall is a bearing wall.

- If the framing above is from roof trusses and they run perpendicular to your wall *and* there are truss webs that come together directly over your wall. This isn't always a sure indicator because roof trusses generally are designed to span from exterior wall to exterior wall; so if a wall below just happens to fall where webs come together it doesn't necessarily mean said wall is supposed to bear. But sometimes when the truss span is long, say greater than 30-feet, a truss designer will use an interior wall for support. In such cases, almost always there will be webs joining the bottom chord over the bearing wall. Also, girder trusses (a truss that carries other trusses) will occasionally use an interior wall for bearing. The best way to know whether roof trusses bear on interior walls is to get a copy of the original truss engineering.

- If the framing over your wall is a stick-framed roof and there are kickers or struts down to your wall, or kickers / struts to ceiling joists perpendicular to your wall, within a couple or few feet of your wall.

- If there is a foundation under your wall.

- If there is a heavy beam under your wall.

- If there is a post above bearing on your wall.

If your wall has one or more of the above, it's likely a bearing wall. Which brings us to Step 2.

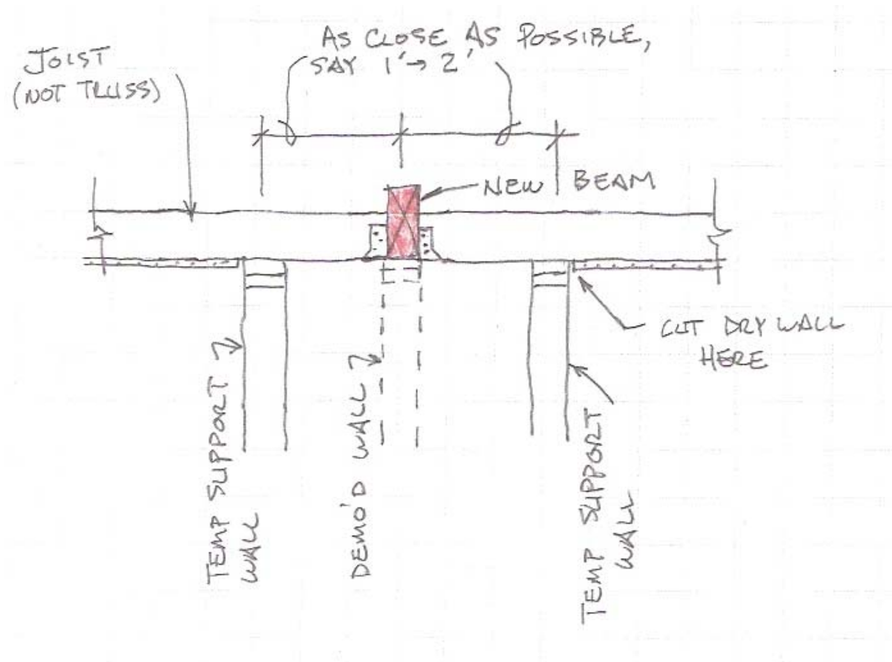
STEP 2 – INSTALL TEMPORARY SUPPORT TO CEILING

Now that we've determined that your wall bears load from above we have to provide support to the ceiling before we demo the wall. There are two scenarios: the joists above are spliced or will be cut and the ends hung on the new beam (not applicable to trusses); or the joists above are continuous and will not be cut and will bear on top of the new beam (i.e. the beam will be positioned below the joists, extending into the room.)

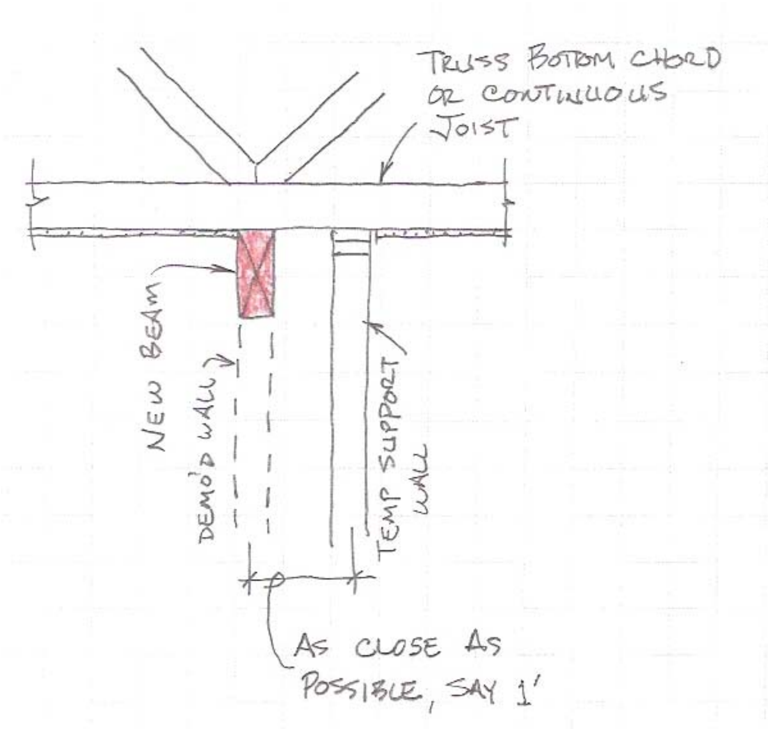
Scenario 1 – Joists Above Are Spliced or Will Be Cut. First and foremost, if the framing above consists of trusses, you CAN NOT use this method. NEVER cut the bottom chord, or any other member of any truss. Doing so ruins its ability to carry load and creates an extremely dangerous condition.

You can use this method only if the framing above consists of simple floor joists or ceiling joists, not truss members. Before demoing or cutting you'll have to build temporary support on *both sides* of the subject wall.

Here is what this might look like:



Scenario 2 – Joists or Truss Bottom Chord Above Is Continuous and Will Not Be Cut. In this case your new beam will be under the joists, extending into the room. You should need to build only one temporary support wall. Like so:



Temporary Wall Construction. Temporary walls for residential applications can be stick-framed with 2x4s at 16" or 24" spacing. No drywall or other sheathing is necessary. I suggest a double top plate if the temporary studs do not line up with the joists they're supporting. If the studs do line up a single top plate can be used. If you're worried that the temporary wall might rack, nail a 1x4 diagonal to it, top plate to bottom plate.

What about the bottom of temporary support walls? Can they safely bear on the floor below? In most cases yes they can.

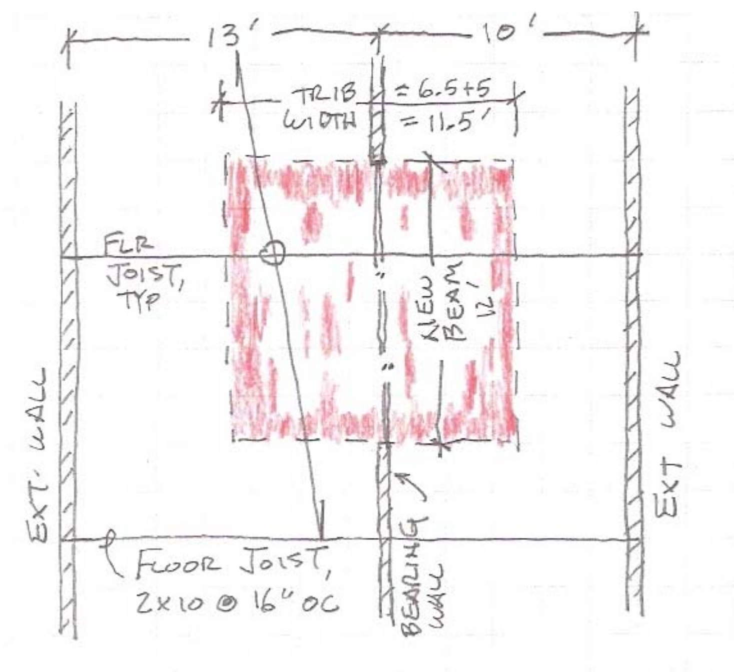
But here is a WARNING. Take most of the live load off the roof / floor above before starting the job. For example, if there is a waterbed in the 2nd floor bedroom above where you're demoing a wall, empty the waterbed. If there's a safe or filing cabinet up there, move them to another room. If there is only roof above, do not start your job when there's snow up top. And don't pick the same time as a reroofing project which might have a pallet of asphalt shingles stacked up there.

If you're in doubt about the floor *below* your temporary wall, install temporary support under it too. Or call in your friendly local engineer to have a look.

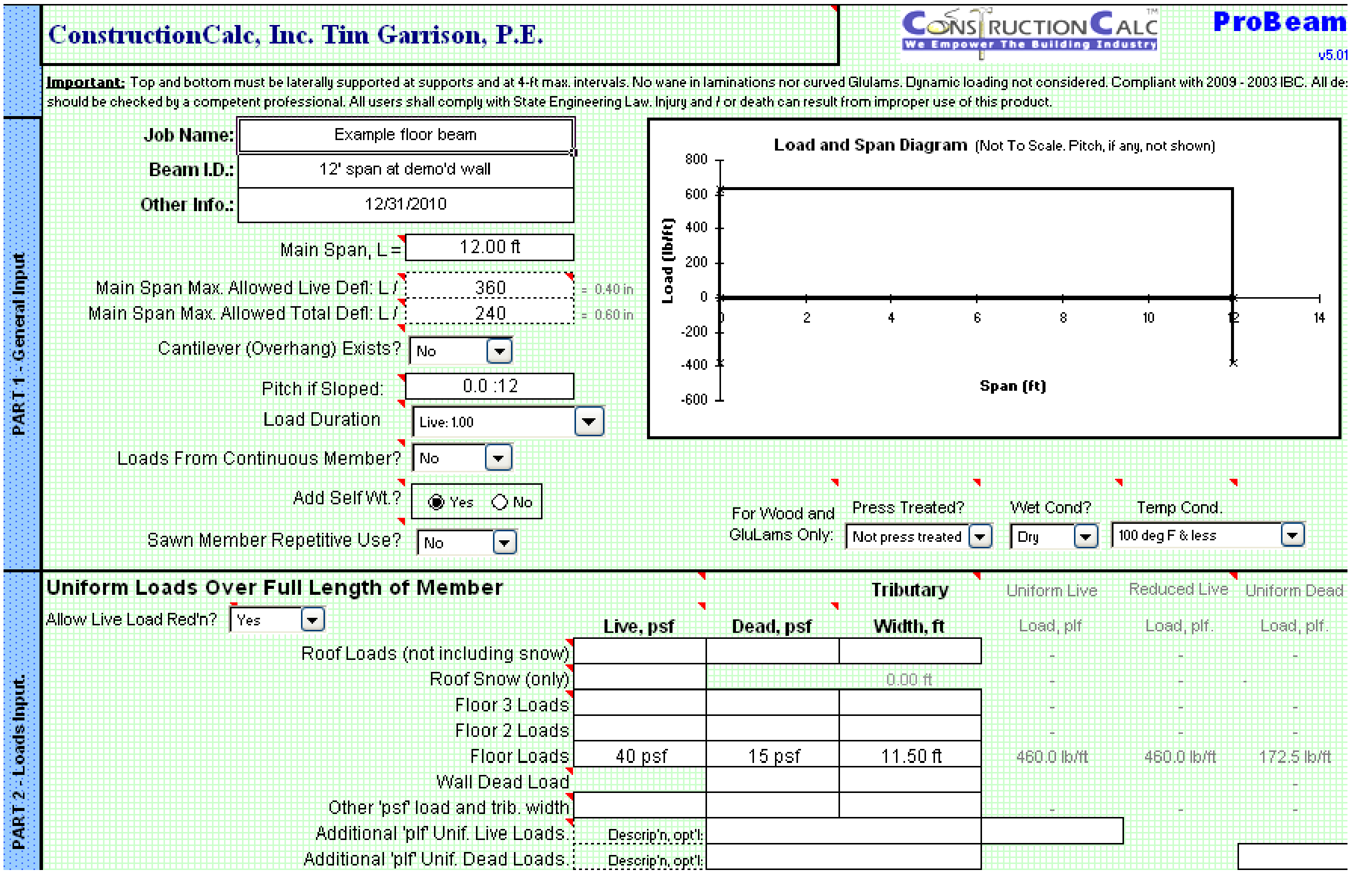
<u>STEP 3 – SIZE THE NEW BEAM</u>

This is my favorite step because it involves design. It is simple enough that most non-engineers can do it with the aid of good software. ConstructionCalc, ProBeam™ is such a product. As with any other part of the job, if you're in doubt, check your design with a professional.

Example 1. Let's say our beam will support 2nd floor joists that were supported by the wall we're demo'ing. We're blowing a 12' long hole in the wall which means our new beam will span 12'. And let's say the floor joists above span 10' to the exterior wall on one side, and 13' to the exterior wall on the other side. Here is a sketch of what this floor framing might look like. I didn't show the temporary support walls to keep the clutter down, but they're there. The shaded area illustrates the tributary (i.e. "loaded") width.

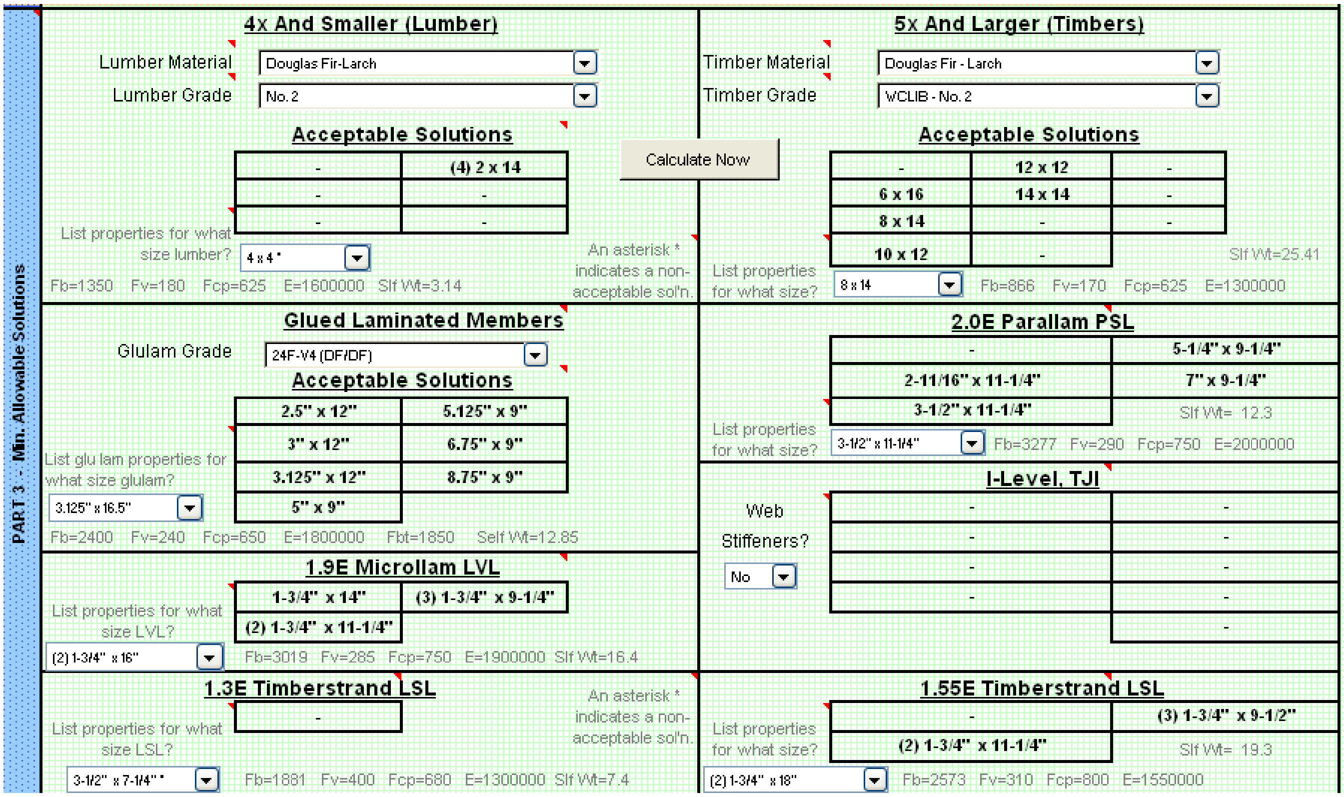


Now let's go to ProBeam™ and design our beam. (For more information and education on the inputs, there are many solved examples with detailed explanation of each input at http://www.constructioncalc.com/blog/solved-examples/. Here is our input:

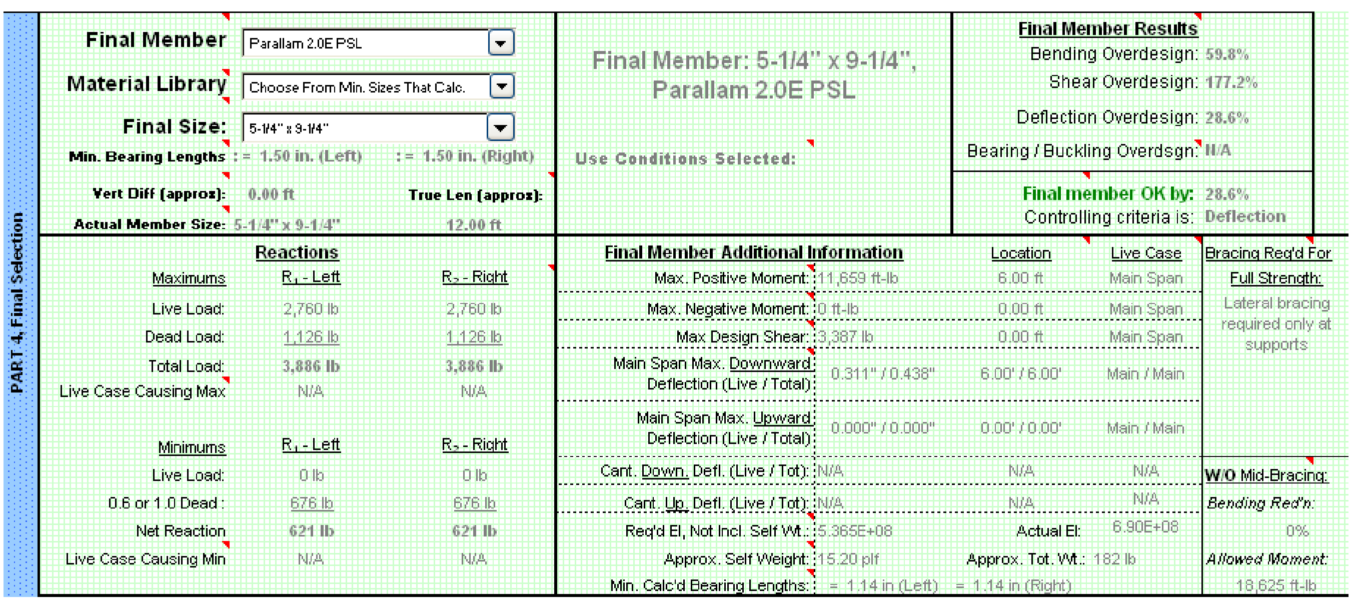


Note that the only load was from the floor immediately above. ProBeam™ allows for many more loads to be added if applicable. For example, if a point load from a roof happened to also come down on our beam it's a very simple matter to add it to the design. Again, see the solved examples at www.ConstructionCalc.com for more.

Here are the solutions. Anything shown in these tables is acceptable.

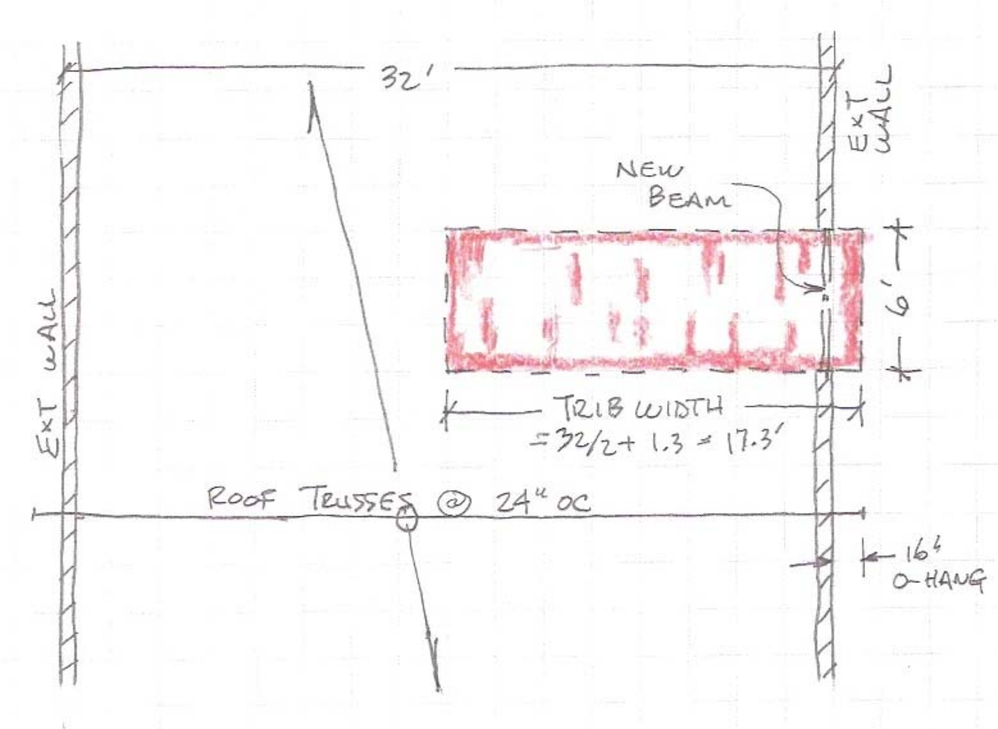


We see that the smallest Doug Fir is a 6x16, probably not realistic. We'd likely select a glulam or PSL. Let's say we like PSLs and will use one. But which one? Any shown in the PSL table meets code. The final choice will probably depend mostly on its height. Let's say we want our beam to fit in the floor cavity. The existing floor joists are 2x10s, which are actually 9.25" tall. It would be best if we select a beam that is exactly 9.25" tall, too. We see that the 5.25x9.25 PSL fits perfectly. So let's select that and see how efficient it is. Here is the final design info:

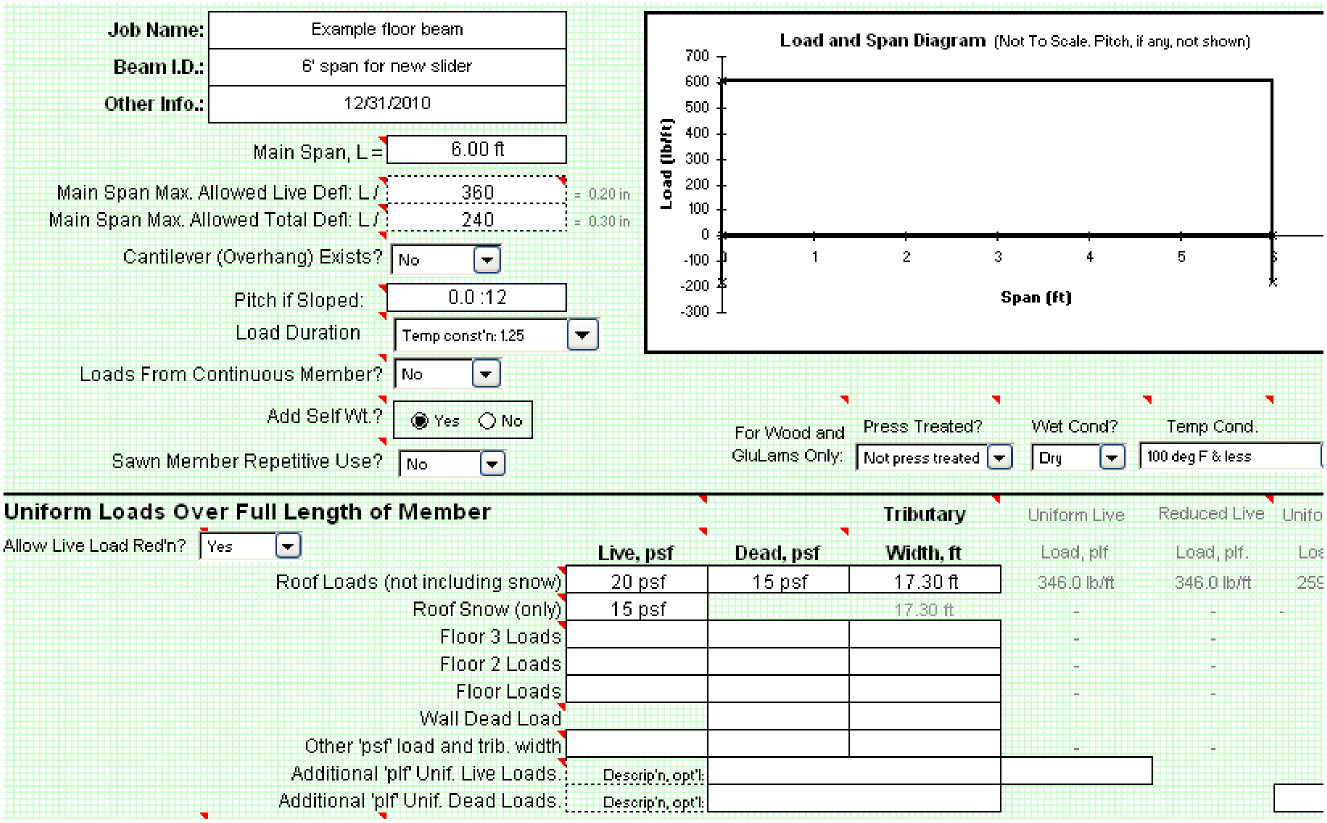


Our PSL makes it by 28%, plenty safe and fairly efficient. Also shown in this section are the reactions, i.e. the forces at the ends of the beam that must be supported by a post or trimmer and a foundation below. We'll get to those in the next step.

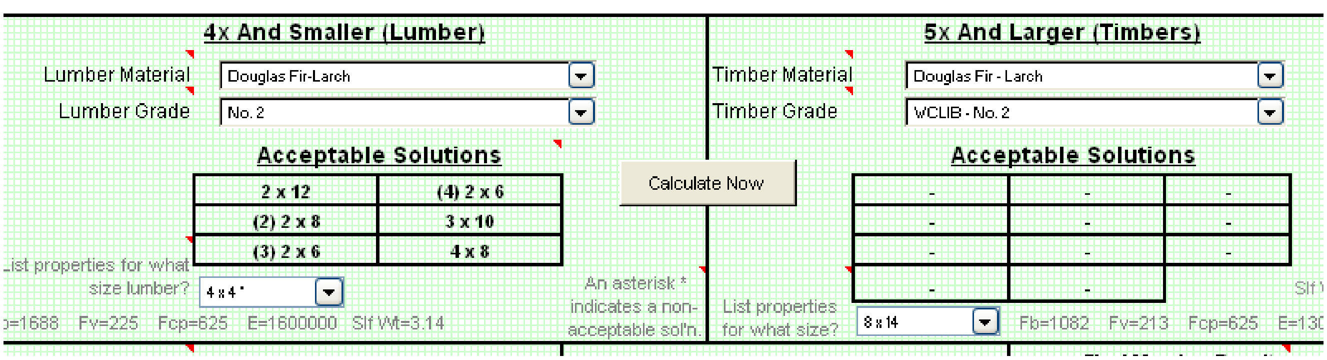
Example 2. Let's design one more example beam, this time one supporting roof trusses. Let's say we're blowing a 6' hole in an exterior wall for a new sliding glass door. Here is what this might look like. Again, I didn't show the temporary support wall but it's there, about 1' inside of the wall we're demo'ing. The shaded area is the tributary (i.e. "loaded") area.



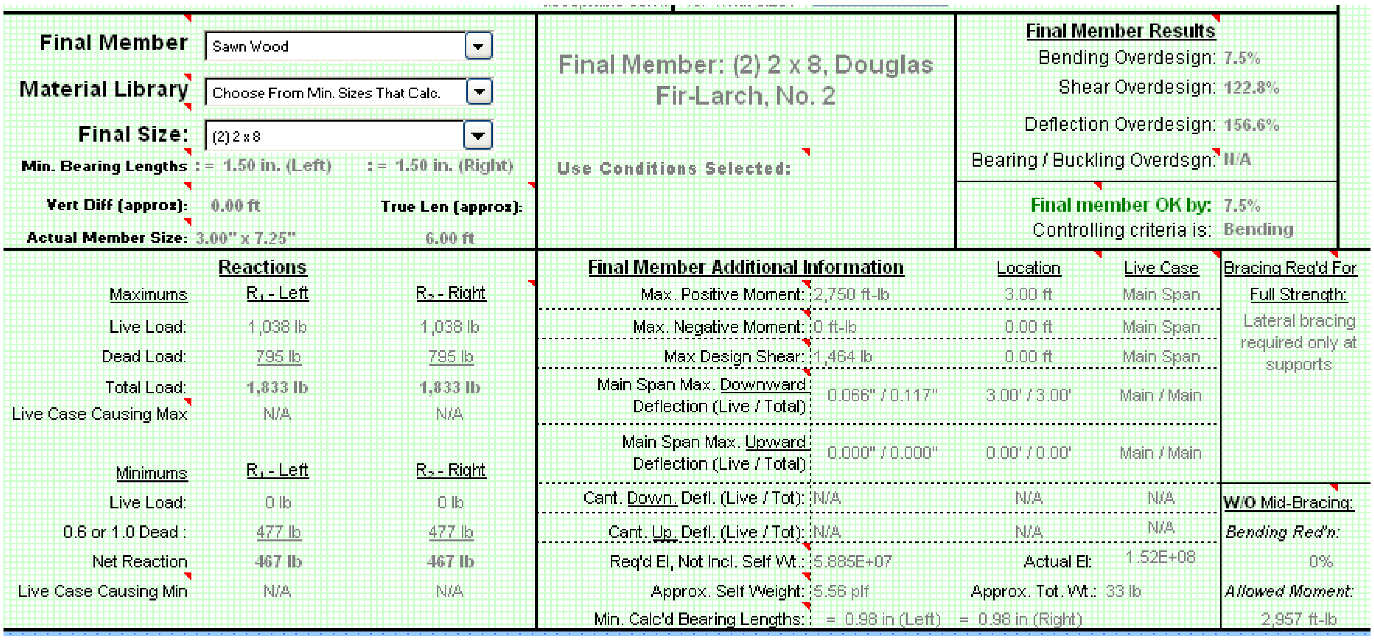
Here is the input. I assumed that this roof is not in heavy snow country, so code-prescribed live load of 20 psf controls over snow.



And here are the allowable solutions. Note that I hid the engineered lumber section (via the Hide/Show/Print button in the upper left) which is handy when printing so that the output fits on a single page.



This time we see that sawn Doug Fir works. The best choices are probably the 2, 2x8s or the 4x8. Let's select the 2, 2x8s and see how efficient they are.



They make it by 7.5%, very efficient. An excellent choice.

Now that our new beam is correctly sized we're ready for the fourth and final step.

STEP 4 – SUPPORT THE NEW LOADS AT THE ENDS OF THE BEAM

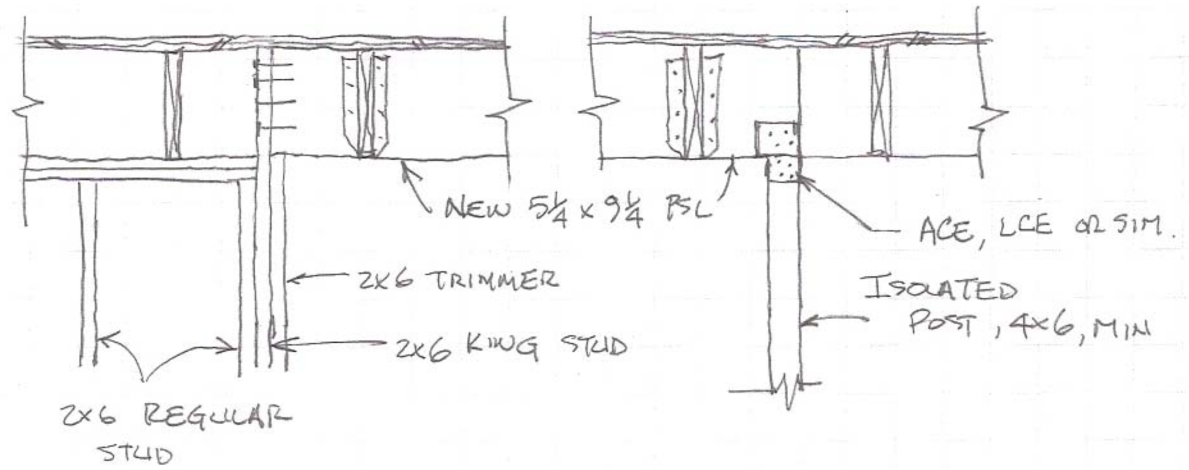
When we install our new beam and take out the temporary support walls all of the load from above our beam will be brought down to its ends to create point loads, aka concentrated loads, to the floor below. It is critical that we properly support those point loads or we'll wind up with a crater in our floor.

The first thing to decide is how big a post should be placed under each end of our beam? We could use software to determine this, ConstructionCalc, Wood Column Calculator™ being an excellent choice. I'll save you the time, however, with the following table that I generated from Wood Column Calculator™.

Post or trimmer size	Allowable load (reaction)
2x4	1900 lbs
2x6	4,500 lbs
2, 2x4	3,800 lbs
2, 2x6	10,000 lbs
4x4	4,400 lbs
4x6	12,500 lbs

IMPORTANT! The above table assumes that the post / trimmer is no more than 9' tall; and that it is sheathed on both sides with drywall, OSB, or plywood – i.e. it is not an isolated post in the middle of the room. If either of those assumptions are untrue the allowable loads are less.

For our first example, the total reaction is 3,886 lbs at each end of the new beam (see above ProBeam™ printout.) So we look in the above table and see that a 2x6 or 4x4 or anything larger works. I like to design green whenever possible, so I use the code minimum if it fits – in this case a 2x6. But remember, that 2x6 works only if it is sheathed on both sides. Here is a sketch (left hand side) of what it might look like.

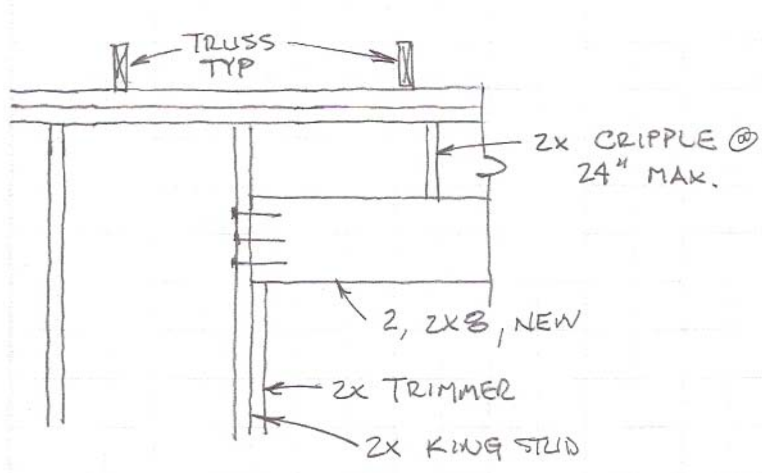


Note that I run a king stud up the end of our new beam. This provides positive connection of the beam end to the wall. There are other ways to frame this but what's important is that the end of the beam is held from moving sideways, rotating, or sliding off.

Let's say the other end of our beam has no adjacent wall – it must be supported on a stand-alone post, as shown in the sketch, above right. The table above shows a 4x6 is good for 12,500 lbs but that assumes it's sheathed on both sides to prevent bowing (buckling). Our stand-alone post won't have that sheathing. I checked its capacity in this case using Wood Column Calculator™ and it is 6,500 lbs, still way more than 3,886, so we're okay. It's interesting to note, however, that the capacity of the 4x6 is about HALF when it has no lateral bracing, i.e. when it can bow. This concept is described in detail in my book BASIC STRUCTURAL CONCEPTS FOR THE NON-ENGINEER, available at www.ConstructionCalc.com.

The post / beam connector is a cheap Simpson™ model, just something that won't allow the beam to slip off. The post and beam can not rack or tilt because the beam is connected to floor joists which are connected to the floor diaphragm above, a laterally stable element. The ceiling, when reinstalled, also will add lateral stability.

For the second example, the total reaction was 1,833, so we could use a 2x4 or 2x6. Here's a sketch:

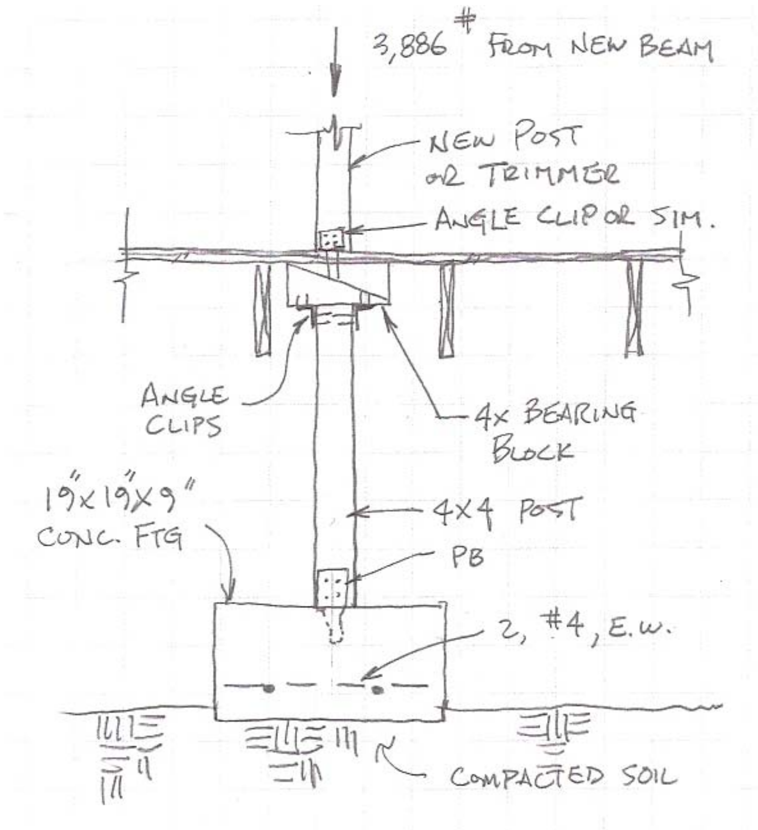


Concrete Floors. If our beam bears on trimmers or posts which bear on a concrete slab-on-grade floor, we have to determine if the floor is thick enough to support the loads. If there's an existing thickened slab or footing under said trimmers / posts, with residential loads, there's nothing to check – it's fine. The rub comes when the loads are applied to a 4" unreinforced slab, a common situation.

A concrete slab distributes load through itself at about a 45-degree angle. If the post base is, say, 4" square, projected through a 4" slab, the load is applied to the soil below over an area of about 1-foot square. Average soil can support about 1,500 lbs per square foot (psf), so in this case we could apply a load of 1,500 lbs to the 4" slab without much worry that it would crack. If the load is greater, as in our first example (3,886 lbs), to be sure we don't crack the slab, we would have to cut out a chunk of slab and replace it with a thicker chunk, a.k.a. a footing. But how big a footing? We could turn to ConstructionCalc, FootingCalc™ for an easy answer, but I'll save you the time an tell you that a footing 19"x19"x9" with 2, #4 rebars each way would do the trick. This assumes the soil underneath is at least of average bearing capacity.

Wood Floors. If our post / trimmer bears on a wood floor we have to make sure that there is sufficient capacity directly underneath to take the new load. In cases where there is an exterior footing below, like in our example 2, there's generally nothing to worry about. The trimmers bear on the edge of a wood subfloor which has a continuous rim joist or continuous rim blocking below which bears on a mud sill which is bolted to a continuous concrete footing. Said footings are almost always large enough to take residential point loads.

However, in example 1 where the point loads come down in the middle of a floor, in most cases there is no footing or beam below. So additional capacity must be added. Installing pad footings under each end of our new beam is usually the simplest approach. As discussed above, FootingCalc™ is an easy way to calc the required footing. I did this previously for example 1 and found that a footing 19"x19"x9" with 2, #4 rebars each way works. Here is a sketch:



I use a 4x bearing block so that the posts above and below have something substantial to attach to. If this were my home, I would also use a permanent screw jack (Simpson JP44 or similar) connected to the top of the 4x4 post so that when the soil below the new footing settles, and it will settle at least a little, you can relevel the floor with the twist of a nut rather than jacking and shimming.

When this step is done, only then can you take down the temporary supports installed in Step 2, above.

To summarize, tearing out walls or blowing big holes in them is, more often than not, a complicated project. It requires knowledge of how loads come down through a structure, and sometimes how wind and earthquake loads are resisted. Attention to load path, i.e. the path through which loads flow, including through connectors, from point of application to the ground, is paramount. Any load bearing element that loses support, even for 1 second, must have adequate temporary support installed prior. New permanent beams, posts, and footings must be designed to meet current building code. There are several good brands of reasonably-priced software available to assist with this, ConstructionCalc™ being one.

Probably the most important thing to remember is this: if you're in doubt, call in a professional. The money you spend will be well-worth your safety and your peace of mind.

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