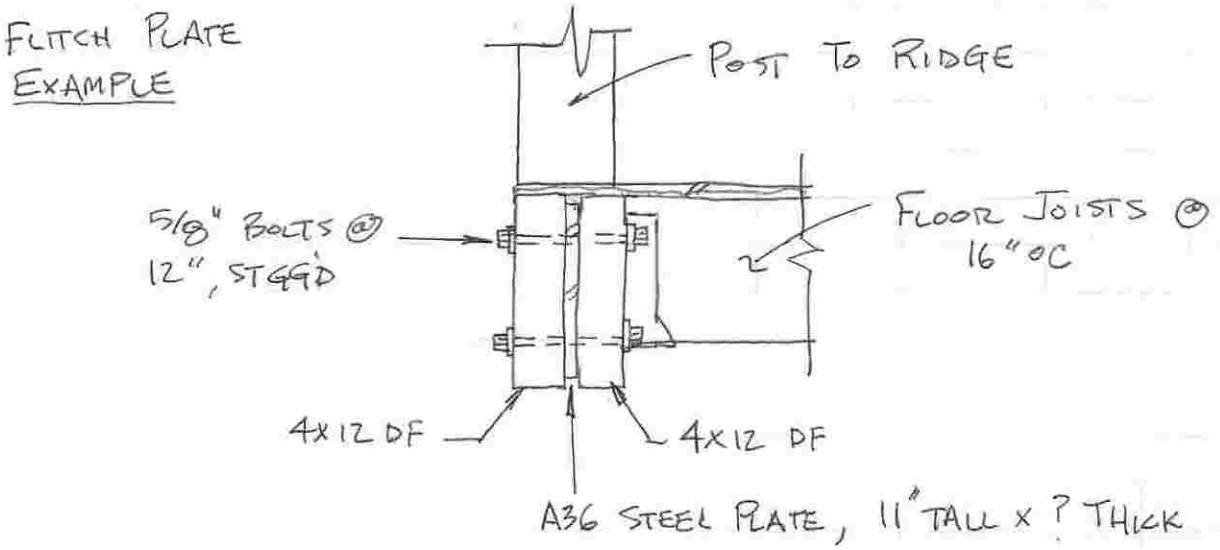
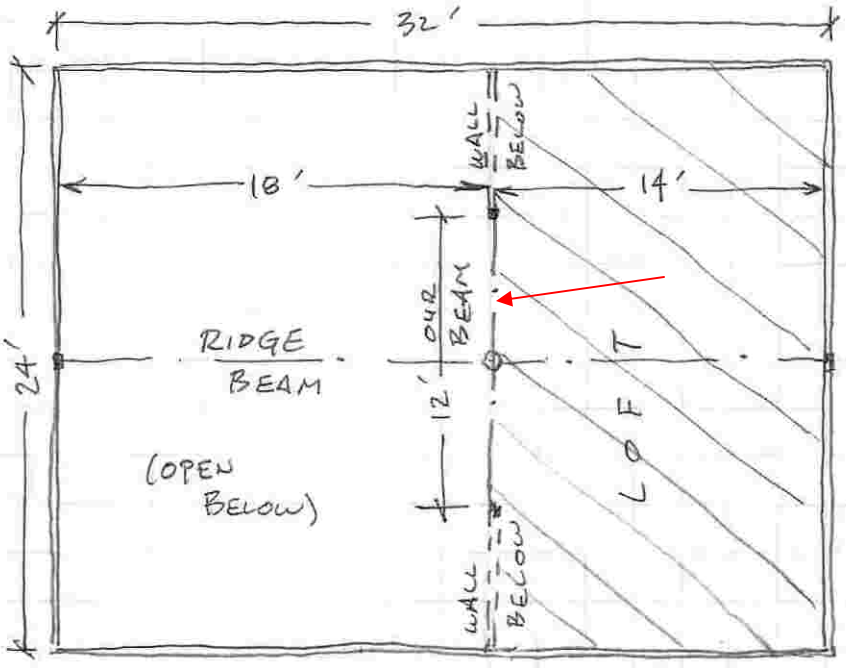
Example Flitch Plate Beam Design Using ConstructionCalc ProBeam v5.0 Software

Note: The following example assumes you are a beginner. You should expect this to go slowly at first. However, with a little practice, getting solutions with ConstructionCalc is about a one minute job.

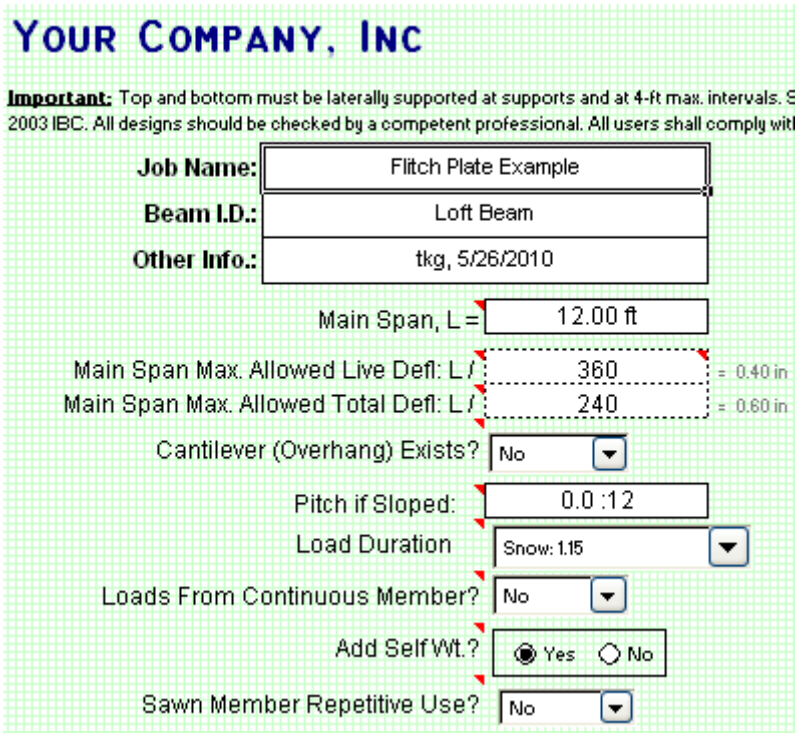
1) **General**. Here is a sketch of the beam and the cabin from which it comes.





2) Open **ConstructionCalc ProBeam** from Microsoft Excel: File – Open.

3) **Part 1 –** General Input. Here is a screenshot of Part 1 input.



a) **General.** With all ConstructionCalc programs you can type in a name of the member you're designing, job name, date, etc. in the three cells at the top. Also, you can type in your company name at the very top of the sheet.

b) **Span**: Main span is the beam's horizontal distance from bearing wall to bearing wall, in our case, 12'. Note: only enter numbers, no symbols, spaces, or units – the program does that for you.

c) **Maximum Allowed Deflection**: This is the amount of deflection (sag) we're willing to allow. (See red triangle note for more.) Let's use the default values of L/360 for live load deflection and L/240 for total deflection.

d) **Cantilever Exists?** No, no overhang.

e) **Pitch if Sloped**: Our beam is horizontal, so No.

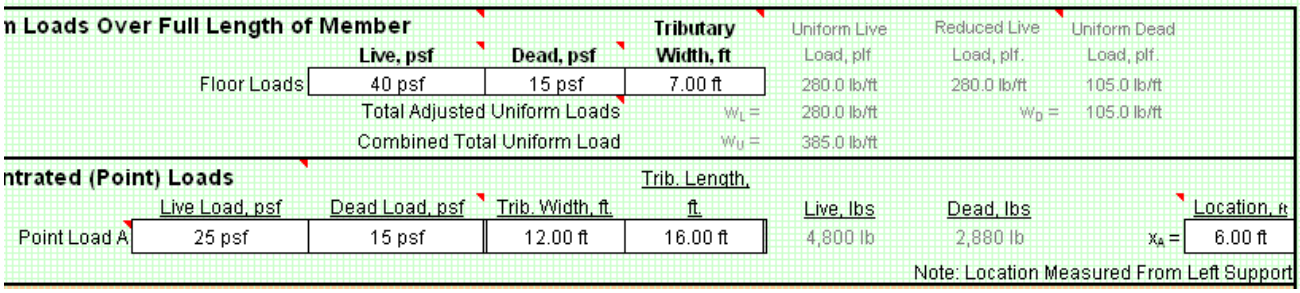
f) **Load Duration**: Our beam supports a generous portion of roof snow load, so select Snow: 1.15.

g) **Loads From Continuous Member?**: The floor joists are not continuous over this beam, they butt into it, so No.

h) **Add Self-Weight?** This beam's self weight will not be included in any uniform dead load we input later, we need to add it now, so Yes.

i) **Sawn Member Repetitive Use?** This beam acts alone, i.e. it doesn't have other beams helping it share the load, so No.

4) **Part 2 – Loads Input**. Our beam sees load from the ridge beam post and from the loft joists. Note, unused loads can be hidden via the **Hide / Show / Print** button at the top of screen.



n Loads Over Full Length of Member

	Live, psf	Dead, psf	Tributary Width, ft	Uniform Live Load, plf	Reduced Live Load, plf.	Uniform Dead Load, plf.
Floor Loads	40 psf	15 psf	7.00 ft	280.0 lb/ft	280.0 lb/ft	105.0 lb/ft
Total Adjusted Uniform Loads			w_L =	280.0 lb/ft	w_D =	105.0 lb/ft
Combined Total Uniform Load			w_U =	385.0 lb/ft		

ntrated (Point) Loads

	Live Load, psf	Dead Load, psf	Trib. Width, ft.	Trib. Length, ft.	Live, lbs	Dead, lbs	Location, ft
Point Load A	25 psf	15 psf	12.00 ft	16.00 ft	4,800 lb	2,880 lb	x_A = 6.00 ft

Note: Location Measured From Left Support

a) **Uniform Loads Over the Full Length of Member**: Our beam supports loft floor load over its entire length, thus this section applies.

   i) **Live Load**: Check the red popup note under Live, psf and you'll see "Residential floor, deck, and storage: 40 psf".

   ii) **Dead Load**: Dead load for a wood floor system with carpet or vinyl on the top and gyp on the bottom is usually 15 psf. See the popup note under Dead, psf.

   iii) **Tributary width:** This is the width perpendicular to our member, from which load is applied. Our beam carries half the span of the floor joists. They're 14' long so half that is 7.

b) **Concentrated (Point) Loads:** Our beam carries a point load from a post supporting the ridge beam. If we had previous designed the ridge beam, we'd get this from its reactions. But since we haven't done that yet we need to determine the ridge beam's point load using tributary area.

   i) **Live Load:** Ridge beam's live load comes from snow, which in our example is 25 psf.

   ii) **Dead Load:** Check the Dead Load red triangle pop up note for comp roof or metal roof systems with gyp ceiling and you'll see it is 15 psf.

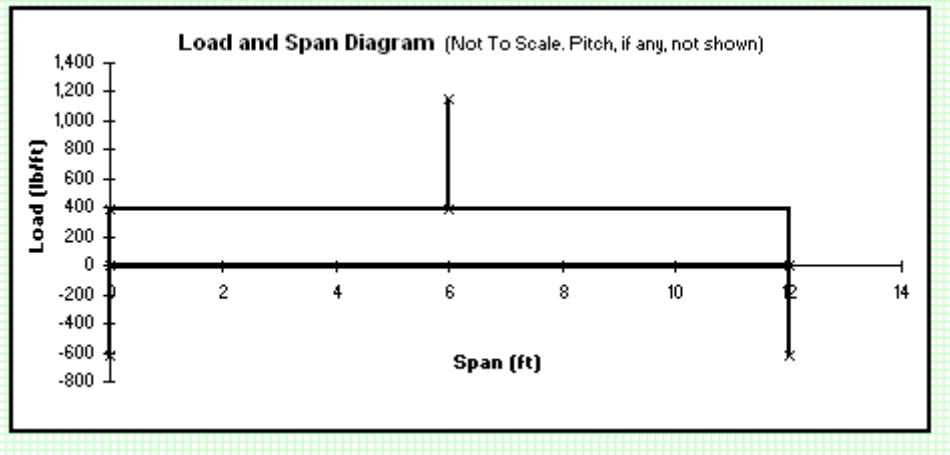
   iii) **Trib Width**: This is half the span of the rafters that the ridge beam supports. There are 12' long rafters on each side of the ridge so the tributary width on the ridge beam =12/2+12/2 which equals 12. You could type that into the cell and Excel would do the math for you.

   iv) **Trib Length:** This is half the span of the ridge beam on each side of the post. In other words the post supports half the ridge beam's length on one side plus half the ridge beam's length on the other side. We can do the math right in the cell like so =18/2+14/2. Type that, hit tab and you'll see 16 displayed in the cell.

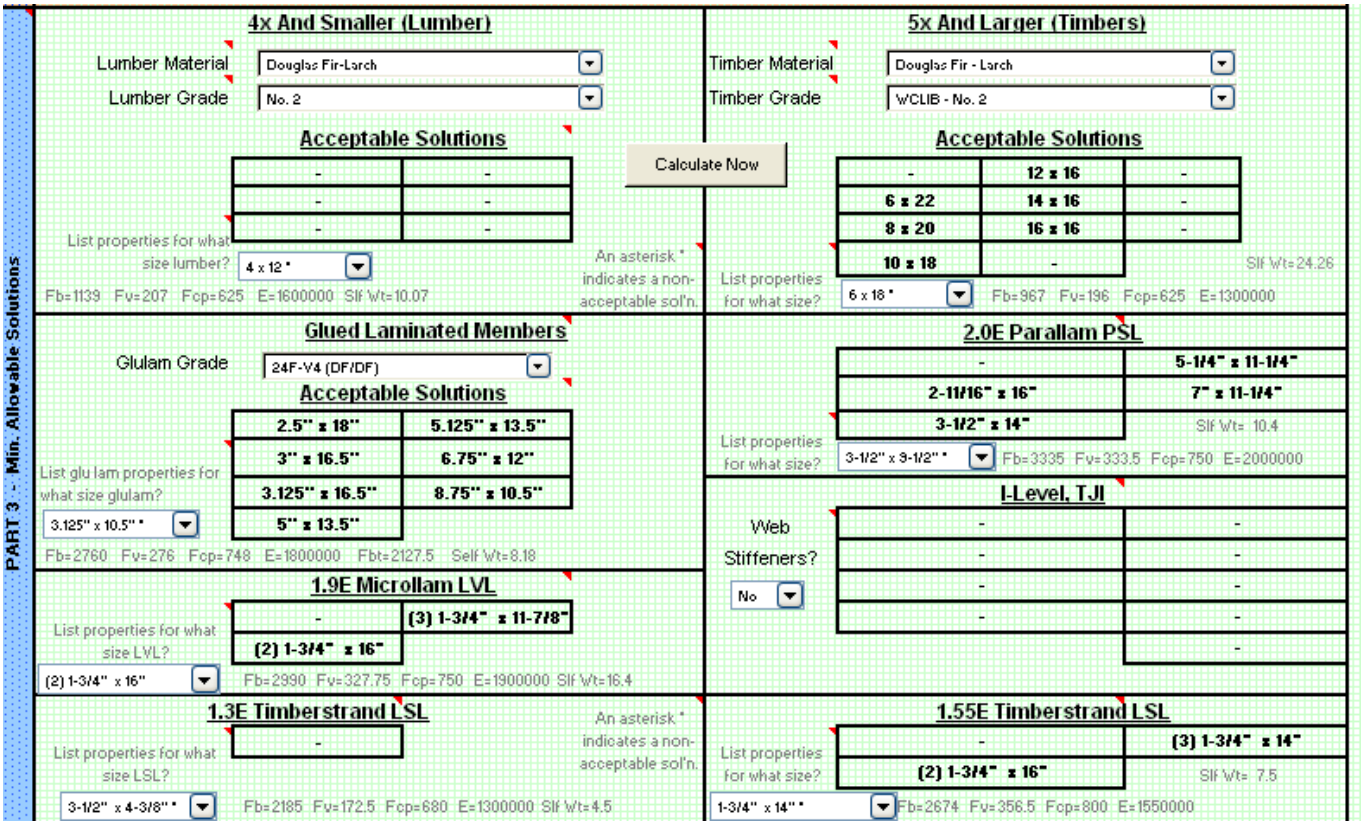
   v) **Location**: You must tell ProBeam where along our beam the point load falls. It is at midspan, 6' from the left support.

c) **Done**. Click on **Calculate Now** and let's check our results.

5) **Check the span and loading**: First, we want to make sure our span and loading were input correctly, so at the upper right of the screen is a graphic showing both. You can see the span is 12', the uniform floor load matches 4a abvoe, and the concentrated load is at midspan. Yep, it's right.

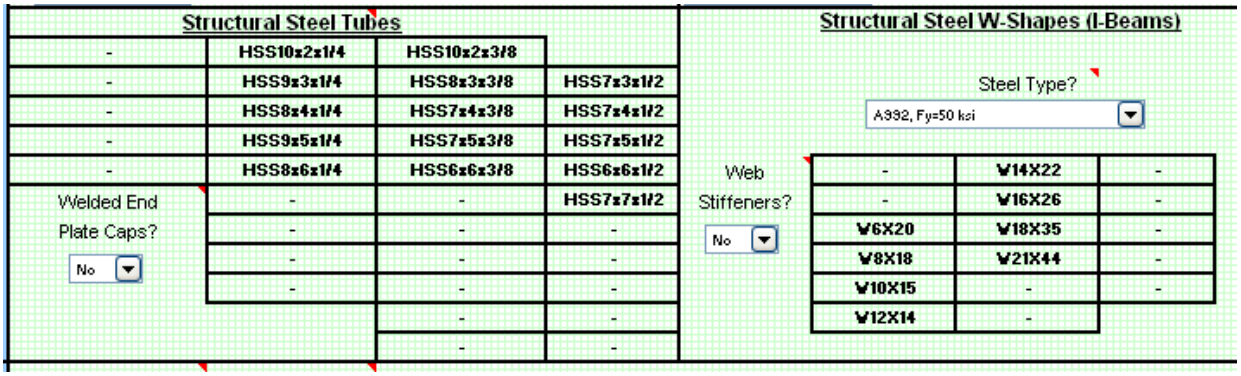


a) **Part 3 - Allowable Solutions:** This section shows all the types and sizes of members that will work. Here are the sawn lumber and engineered lumber alternatives.



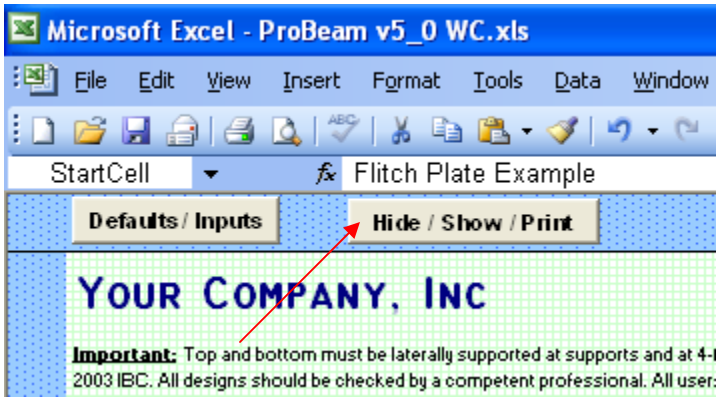
b) We could select any member listed – they all calc and meet code. However, we're designing a flitch plate beam so we move on.

c) But wait, what about a steel beam? If the owner wasn't opposed to it a steel beam might not be a bad choice.

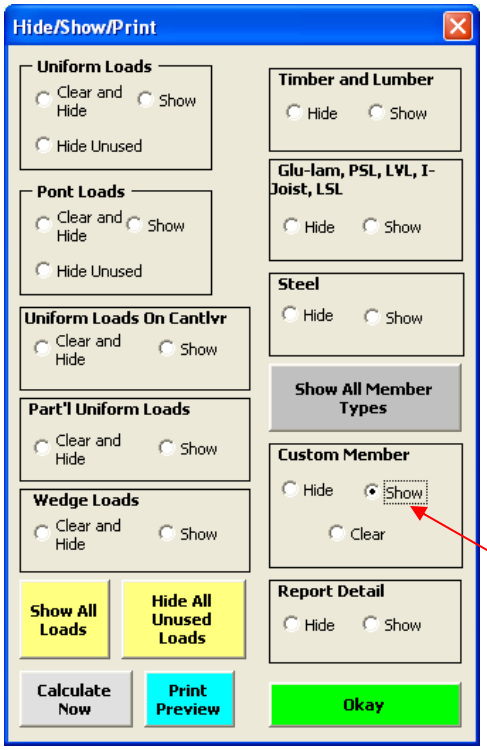


There are lots of choices in tubes or wide-flange shapes. I'd probably go with a W12x14 (12" tall and 14 lbs per foot) – a very efficient choice.

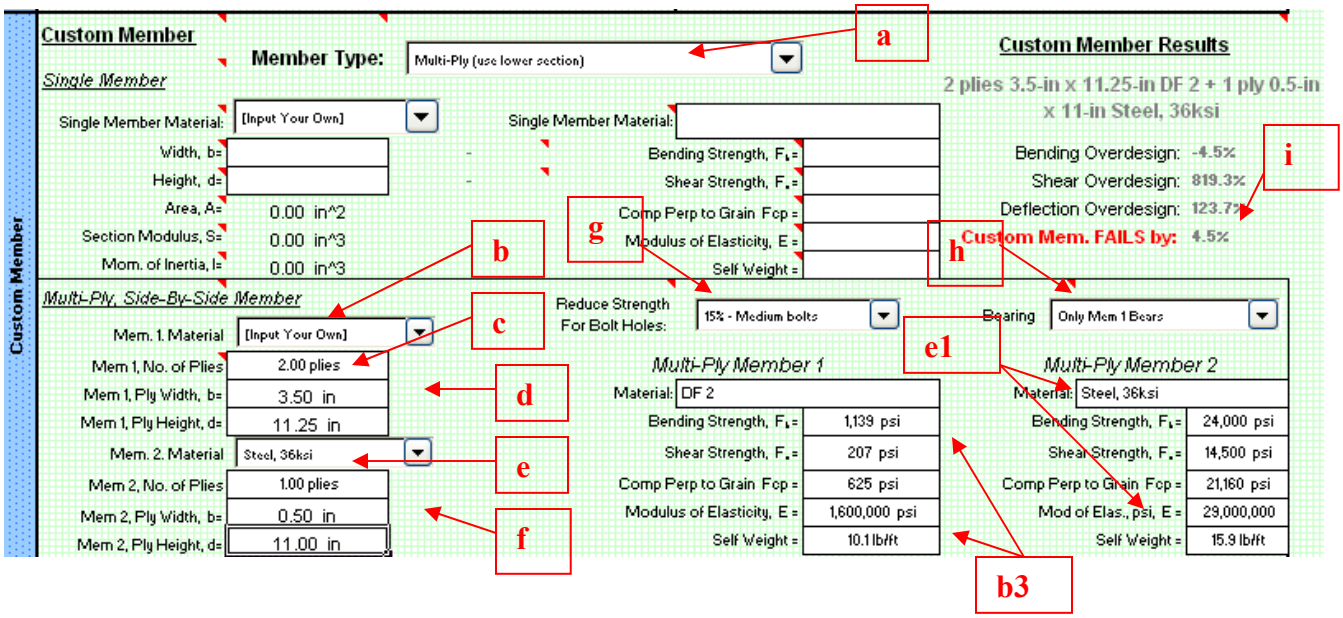
6) **Custom Member**: Now let's get to the gist of our example, a flitch plate beam. The home owner told us that he wants to use 4x12s on each side with a steel plate in the middle. See the sketch at the beginning of this example. To access the Custom Member section of ProBeam, click on this button.



Now Click Here

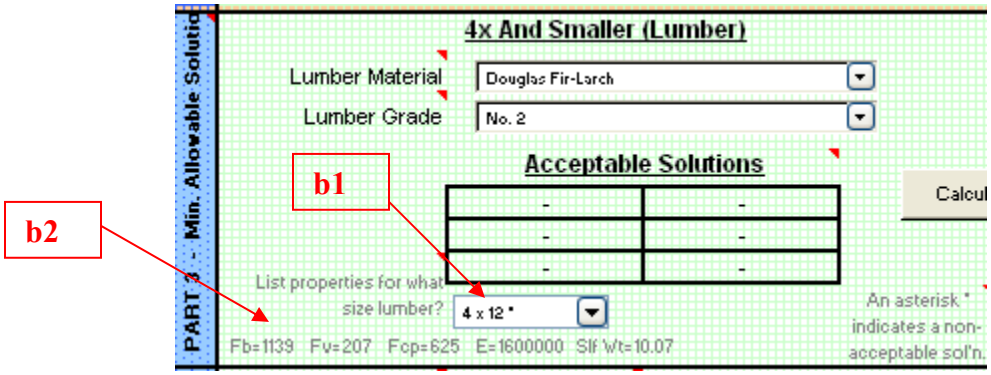


7) Here is our Multi-Ply Custom Beam input.



a) The first step is to select Multi-Ply member type.

b) Let's make Member 1 the Doug Fir 4x12s. Note that Member 1 can be any number of side-by-side plies of the same material. Looking at the Mem. 1 Material drop down menu we don't find regular old Doug Fir. There's Doug Fir T&G, and Doug Fir used in a flat orientation, but not regular Doug Fir used as a beam or joist. *Why not?* Because all the sawn material strength values are available to us in the section above. Here:



b1. We select 4x12 from the drop down.

b2. Just below in gray are the numbers we need. We don't care about the asterisk – we just want the allowable stresses for a 4x12 Doug Fir No. 2.

b Getting back to our Mem 1. Material drop down selection, we must select [Input Your Own]. Doing this clears the allowable stresses in the Multi-Ply Member 1 section to the right.

b3. Now Let's input those allowable stresses. We start at the top and type DF 2 or something similar. The cells below correspond to the numbers in gray from step b2, above. We manually type those numbers.

c) Here is where we input our two plies of 4x12.

d) The actual size of a 4x12 is 3.5 x 11.25.

e) Now for Member 2, the steel flitch plate. We select 36 ksi steel because that is the most common grade of plate steel.

e1. When we do that the allowable stresses for 36 ksi steel are automatically supplied.

f) We now input the number of steel plies, 1, and the size. We don't know the width, so let's guess 0.5. For height let's use 11".

g) Since our multi-ply beam is bolted together there will be some strength reduction for the material lost at the bolt holes. ProBeam allows you to easily estimate this. We select 15% reduction.

h) Our beam will bear on multiple studs at its ends and we need to know the minimum bearing length on those studs. Because the steel portion is less tall than the 4x12s only the 4x12s will actually bear. So we select Only Mem 1 Bears. ProBeam assumes all the plies of Mem 1 bear.

i) Let's check the results to the right. We see that our beam fails by 4.5% and the controlling criteria is bending. No good. We need a thicker flitch plate. Let's try 5/8". In Mem 2 width, type =5/8 and you'll see that .63 is placed in the cell. Click Calculate Now and we find:

Custom Member Results

2 plies 3.5-in x 11.25-in DF 2 + 1 ply 0.63-in x 11-in Steel, 36ksi

Bending Overdesign:	9.3%
Shear Overdesign:	1006.4%
Deflection Overdesign:	153.7%
Custom Mem. OK by:	9.3%

Yes, this beam calcs.

8) **Part 4 - Final Selection**. We could stop at this point knowing our flitch plate beam works, but let's continue and gather some more information. We select Custom Beam in the Final Member dropdown and our beam shows up in the cells to the right. Nothing new there, it's a repeat of the above.

Final Member	Custom Member	Final Member: 2 plies 3.5-in x 11.25-in DF 2 + 1 ply 0.63-in x 11-in Steel, 36ksi,	**Final Member Results**
Material Library	-		Bending Overdesign: 9.3%
Final Size:	2 plies 3.5-in x 11.25-in DF 2 + 1 ply 0.63		Shear Overdesign: 1006.4%
Min. Bearing Lengths	: = 1.50 in. (Left) = 1.50 in. (Right)	Use Conditions Selected:	Deflection Overdesign: 153.7%
Vert Diff (approx):	0.00 ft **True Len (approx):**	a	Bearing / Buckling Overdsgn: N/A
Actual Member Size:	3.50" x 11.25" 12.00 ft		**Final member OK by:** 9.3%
			Controlling criteria is: **Bending**

Reactions			**Final Member Additional Information**			**Bracing Req'd For Full Strength:**
Maximums	R_A - Left	R_B - Right	Max. Positive Moment:	30,509 ft-lb	6.00 ft Main Span	Lateral bracing required only at supports
Live Load:	4,080 lb	4,080 lb	Max. Negative Moment:	0 ft-lb	0.00 ft Main Span	
Dead Load:	2,250 lb	2,250 lb	Max Design Shear:	5,949 lb	0.00 ft Main Span	
Total Load:	**6,330 lb**	**6,330 lb**	Main Span Max. Downward Deflection (Live / Total):	0.151" / 0.237"	6.00' / 6.00' Main / Main	
Live Case Causing Max	N/A	N/A	Main Span Max. Upward Deflection (Live / Total):	0.000" / 0.000"	0.00' / 0.00' Main / Main	
Minimums	R_A - Left	R_B - Right	Cant. Down. Defl. (Live / Tot):	N/A	N/A N/A	**W/O** Mid-Bracing:
Live Load:	0 lb	0 lb	Cant. Up. Defl. (Live / Tot):	N/A	N/A N/A	*Bending Req'd:*
0.6 or 1.0 Dead:	1,350 lb	1,350 lb	Req'd EI, Not Incl. Self Wt.:	1.096E+09	Actual EI: 2.84E+09	0%
Net Reaction	**1,242 lb**	**1,242 lb**	Approx. Self Weight:	29.95 plf	Approx. Tot. Wt.: 359 lb	*Allowed Moment:*
Live Case Causing Min	N/A	N/A	Min. Calc'd Bearing Lengths:	= 1.45 in (Left)	= 1.45 in (Right)	33,340 ft-lb

b

a) **Min**. **Bearing Lengths**: Here we see that our beam must bear on at least 1.5" of support post (or studs). This assumes full width bearing on both plies of Member 1. If that's not possible because the post isn't 3.5+3.5+.63 = 7.63" wide, longer bearing length will be required.

b) **Reactions**. We see that each end of the beam brings 6,330 lbs to its post and footing below. We could design those with other ConstructionCalc products if we wished.

c) **Final Member Additional Information**. This section shows a bunch of extra information that may or may not be of interest.

d) **Printout**. You may want to print this design. Because this ConstructionCalc product is nothing more than a fancy Excel spreadsheet, you have lots of printing options via File, Page Setup. Also, you can hide various parts of the display and access Print Preview via the ConstructionCalc **Hide / Show / Print** button at the top of the page.