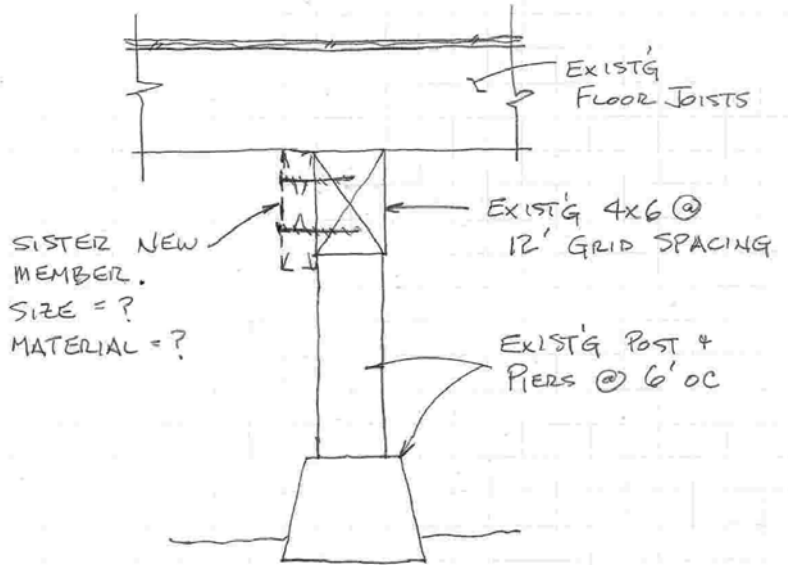


## Example Sistered Floor Beam Design Using ConstructionCalc ProBeam v5.0 Software

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.** This is from an old house which failed a building inspection because the floor beams are undersized. Rather than replace the beams a simpler fix would be to sister another member to the side of the beam. The question is what size and material should that sistered member be? Here is a sketch of the typical beam.



- 2) Open **ConstructionCalc ProBeam** from Microsoft Excel: File – Open.
- 3) **Part 1** – General Input. Here is a screenshot of Part 1 input.

**YOUR COMPANY, INC**

**Important:** Top and bottom must be laterally supported at supports and at 4-ft max. intervals  
2009 - 2003 IBC. All designs should be checked by a competent professional. All users shall con

**Job Name:** Sistered Floor Beam Example

**Beam I.D.:** Typical floor beam

**Other Info.:** tkg, 5/26/2010

Main Span, L = 6.00 ft

Main Span Max. Allowed Live Defl: L / 360 = 0.20 in

Main Span Max. Allowed Total Defl: L / 240 = 0.30 in

Cantilever (Overhang) Exists? No

Pitch if Sloped: 0.0 :12

Load Duration Live: 1.00

Loads From Continuous Member? Yes

Add Self Wt.?  Yes  No

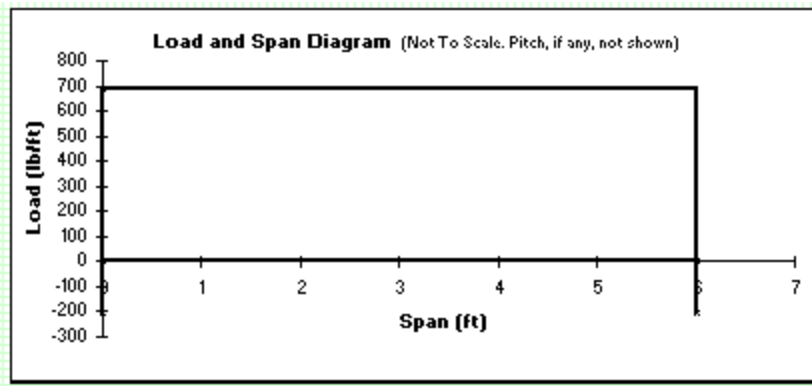
Sawn Member Repetitive Use? No

- 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 post to post, in our case, 6'. 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 only floor load, so select Live: 1.0. See red triangle note for more.
  - g) **Loads From Continuous Member?:** The floor joists ARE continuous (i.e. not spliced) over this beam, so Yes. Even if some of the joists were spliced over this beam I would select Yes because that is always conservative.
  - 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.** The only load our beam sees is from the floor joists. Note, unused loads are hidden via the **Hide / Show / Print** button at the top of screen.
- a) **Uniform Loads Over the Full Length of Member:** Our beam supports floor load over its entire length, thus this section applies.

Uniform Loads Over Full Length of Member			Tributary	Uniform Live	Reduce
	Live, psf	Dead, psf	Width, ft	Load, plf	Load
Floor Loads	40 psf	10 psf	12.00 ft	480.0 lb/ft	480.0
	Total Adjusted Uniform Loads		$w_L =$	552.0 lb/ft	
	Combined Total Uniform Load		$w_U =$	690.0 lb/ft	

- 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 no gyp on the bottom is usually 10 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 on one side plus half the span of the joists on the other side. The spacing from our beam to the next one on either side is 12'. So the trib width  $= 12/2 + 12/2 = 12$ . You could type that equation into the trib width cell and Excel would do the math for you.
- b) **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 6' and the uniform floor load matches the input in 4a, above. Yep, it's right.



a) **Part 3 - Allowable Solutions:** If we were designing a new floor beam we'd be interested in this section – it shows all the types and sizes of members that will work. Looking just at the sawn options we see that this beam should have been a 4x10 or 6x8. This confirms that our 4x6 is way too small.

**4x And Smaller (Lumber)**

Lumber Material: Douglas Fir-Larch  
Lumber Grade: No. 2

**Acceptable Solutions**

-	(4) 2 x 8
(2) 2 x 10	3 x 12
(3) 2 x 8	4 x 10

List properties for what size lumber? 4 x 6 \*

Fb=1170 Fv=180 Fcp=625 E=1600000 Sif Wt=4.93

**5x And Larger (Timbers)**

Timber Material: Douglas Fir - Larch  
Timber Grade: WCLIB - No. 2

**Acceptable Solutions**

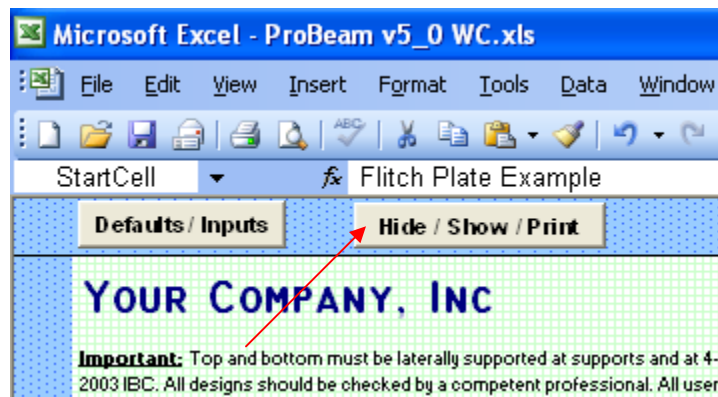
-	-
6 x 8	-
-	-
-	-

List properties for what size? 6 x 18 Fb=841 Fv=170 Fcp

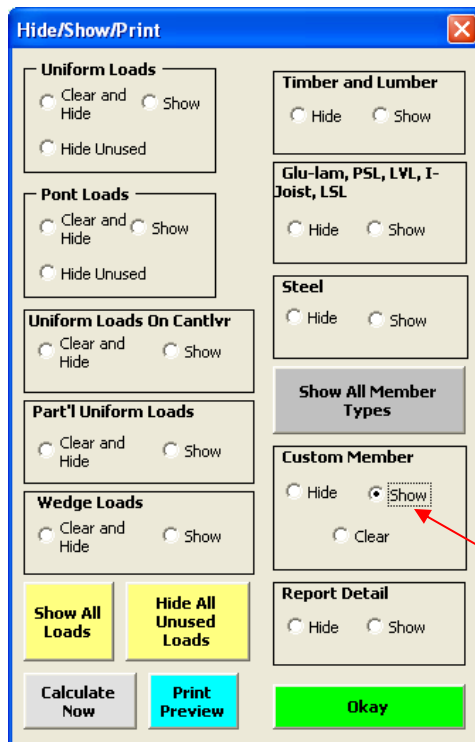
Calculate Now

An asterisk \* indicates a non-acceptable sol'n

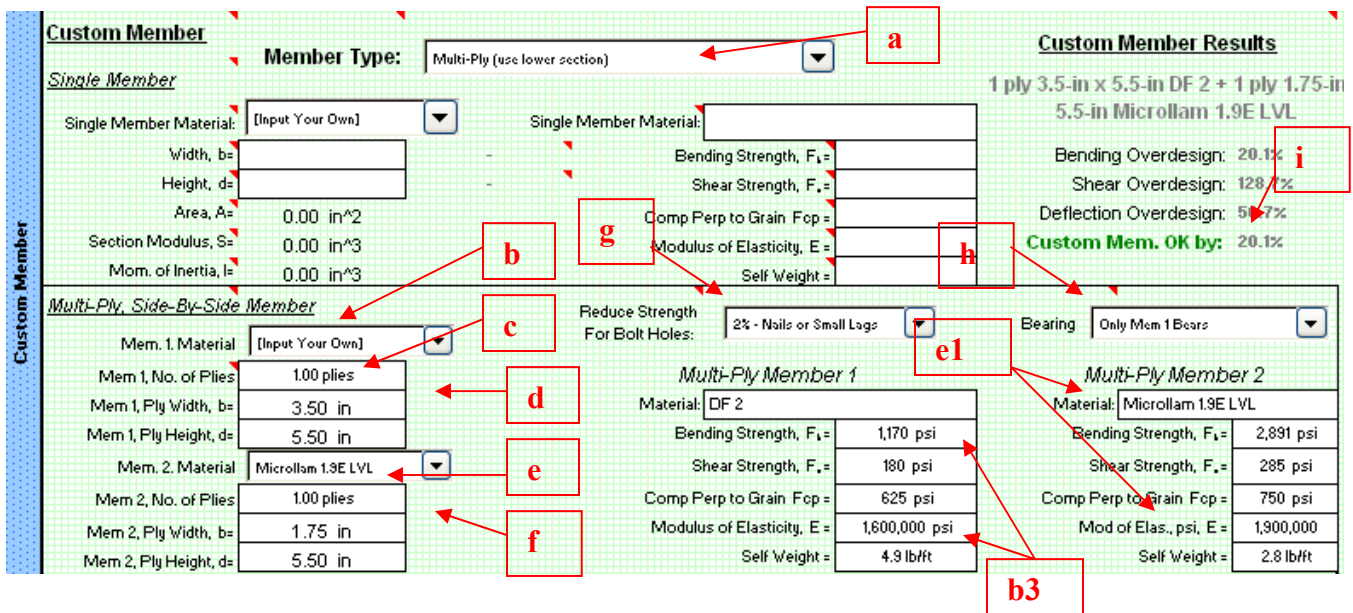
6) **Custom Member:** Now let's get to the gist of our example, a new member sistered to the existing 4x6. See the sketch at the beginning of this example. To access the Custom Member section of ProBeam, click on this button.



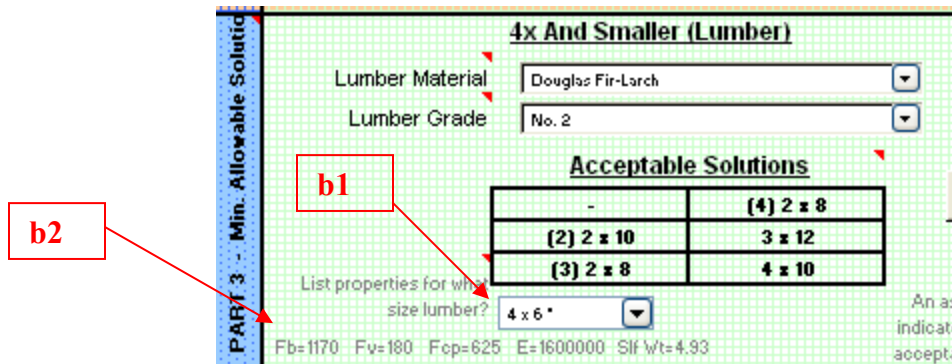
Now Click Here and the Custom Member section unhides.



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 existing Doug Fir 4x6. Note that Member 1 can be any number of side-by-side plies of the same material. In our case there is just a single existing 4x6, so 1 ply. Looking at the Mem. 1 Material dropdown 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:



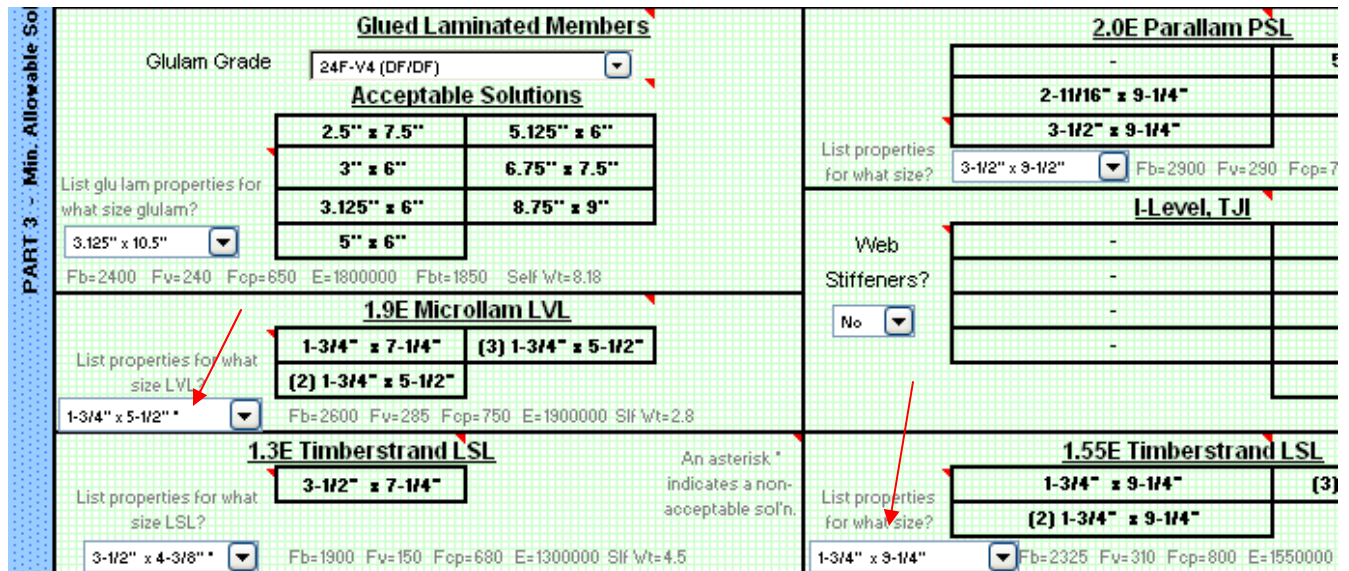
b1. We select 4x6 from the drop down.

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 4x6 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 1 ply 4x6.
- d) The actual size of a 4x6 is 3.5 x 5.5.
- e) Now for Member 2. It would be nice if we could use a single member approximately the same depth as our 4x6, and also one that is fairly narrow that we can nail or screw to the side of our 4x6. I don't want to use through bolts – too difficult in this cramped crawl space and drilling all those holes weakens the existing member too much. I tried a 2x6 DF No. 2 and it didn't even come close. What about an engineered lumber material? Are there any such materials that are less than 2" wide and about 5.5" tall? A quick way to find out is to check ProBeam's on-board library for each of the engineered lumber types shown in Part 3. Here's how.



Each dropdown shows the entire library of that material type. I first tried a 1.55E LSL and found that the smallest one is 1.75 x 9.25, too tall. I then checked the 1.9E LVL library and found the smallest one is 1.75 x 5.5. Perfect!

Back to the Custom Member section, I now select Microlam 1.9E LVL for my Mem 2 Material.

e1. When I do that the allowable stresses for that material are automatically supplied.

- f) We now input the number of LVL plies, 1, and the size.
- g) Since our multi-ply beam will be nailed or screwed (small lag screws) together there will be some strength reduction for the material lost at the nail / screw penetrations. ProBeam allows you to easily estimate this. We select 2% reduction.
- h) Our beam currently bears on a post. We won't modify that. Does the new beam have to bear on a post too? It could but it doesn't have to, because the existing 4x6 has plenty of shear capacity which is the main stress at a beam's support. We can quickly and easily verify this by dropping down to Part 4 – Final Selection and make the following selections.

**Final Member**: Sawn Wood  
**Material Library**: Choose From All Sizes Of Beam Type  
**Final Size**: 4 x 6"  
**Bearing Lengths**: = 1.50 in. (Left) = 1.50 in. (Right)  
**Vert Diff (approx)**: 0.00 ft  
**True Len (approx)**: 6.00 ft  
**Actual Member Size**: 3.50" x 5.50"

**Final Member Results**  
 Bending Overdesign: -45.0%  
 Shear Overdesign: 30.8%  
 Deflection Overdesign: -3.5%  
 Bearing / Buckling Overdsgr: N/A  
**Final member FAILS by: 45.0%**  
 Controlling criteria is: Bending

We see that the existing 4x6, while failing in bending and deflection has 30.8% overdesign in shear. Thus we know that our sistered LVL doesn't need its own post, it can use the 4x6s shear capacity and its post.

So we'll select Only Member 1 Bears.

i) Let's check the results to the right. We see that our multi-ply beam easily makes it, by over 20%.

- 8) **Part 4 - Final Selection.** We could stop at this point knowing our sistered LVL + DF 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 7i, above.

**Final Member**: Custom Member  
**Material Library**: -  
**Final Size**: 1 ply 3.5-in x 5.5-in DF 2 + 1 ply 1.75-in x 5.5-in  
**Min. Bearing Lengths**: = 1.50 in. (Left) = 1.50 in. (Right)  
**Vert Diff (approx)**: 0.00 ft  
**True Len (approx)**: 6.00 ft  
**Actual Member Size**: 3.50" x 5.50"

**Final Member Results**  
 Bending Overdesign: 20.1%  
 Shear Overdesign: 128.7%  
 Deflection Overdesign: 50.7%  
 Bearing / Buckling Overdsgr: N/A  
**Final member OK by: 20.1%**  
 Controlling criteria is: Bending

Reactions			Final Member Additional Information			Location	Live Case	Bracing Req
Maximums	R <sub>s</sub> -Left	R <sub>s</sub> -Right	Max. Positive Moment:	3,140 ft-lb	3.00 ft	Main Span	Full Stre	
Live Load:	1,656 lb	1,656 lb	Max. Negative Moment:	0 ft-lb	0.00 ft	Main Span	Lateral br	
Dead Load:	437 lb	437 lb	Max. Design Shear:	1,773 lb	0.00 ft	Main Span	required c	
Total Load:	2,093 lb	2,093 lb	Main Span Max. Downward Deflection (Live / Total):	0.133" / 0.168"	3.00' / 3.00'	Main / Main	suppo	
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 <sub>s</sub> -Left	R <sub>s</sub> -Right	Cant. Down. Defl. (Live / Tot):	N/A	N/A	N/A	<b>W/O Mid-E</b>	
Live Load:	0 lb	0 lb	Cant. Up. Defl. (Live / Tot):	N/A	N/A	N/A	<b>Bending Fa</b>	
0.6 or 1.0 Dead:	262 lb	262 lb	Req'd EI, Not Incl. Self Wt.:	8.048E+07	Actual EI:	1.21E+08		
Net Reaction:	248 lb	248 lb	Approx. Self Weight:	7.68 plf	Approx. Tot. Wt.:	46 lb	<b>Allowed/Wt</b>	
Live Case Causing Min:	N/A	N/A	Min. Calc'd Bearing Lengths:	= 0.96 in (Left) = 0.96 in (Right)			3,769 f	

- a) **Min. Bearing Lengths:** Here we see that our Mem 1 must bear on at least 1.5" of support post. The support post is a 4x4 so as long as our beam end (beam splice assumed) sits on at least half of the post, we're good.

- b) **Reactions.** We see that each end of the beam brings 2,093 lbs to its post and footing below. We could check the design of 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.