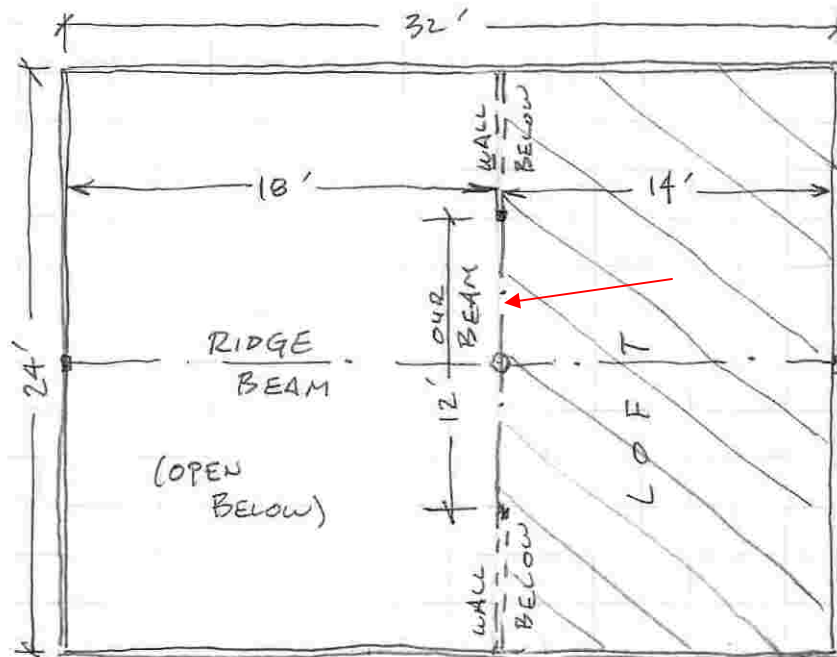
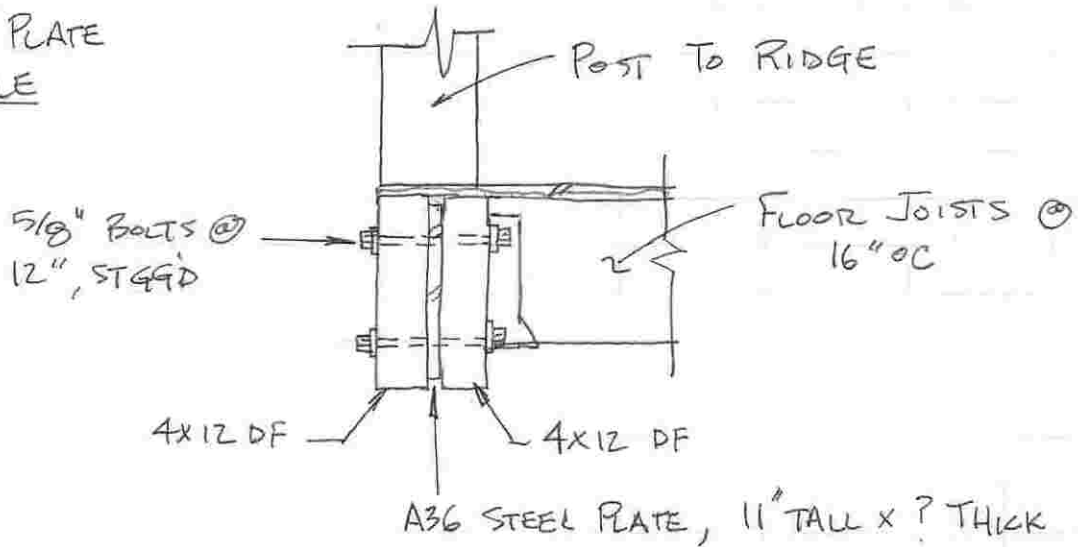


Example Flitch Plate Beam Design Using ConstructionCalc ProBeam v5.0 Software

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.

FLITCH PLATE
EXAMPLE



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. See 2003 IBC. All designs should be checked by a competent professional. All users shall comply with

Job Name:	Flitch Plate Example
Beam I.D.:	Loft Beam
Other Info.:	tkg, 5/26/2010
Main Span, L =	12.00 ft
Main Span Max. Allowed Live Defl: L /	360 = 0.40 in
Main Span Max. Allowed Total Defl: L /	240 = 0.60 in
Cantilever (Overhang) Exists?	No
Pitch if Sloped:	0.0 :12
Load Duration	Snow: 1.15
Loads From Continuous Member?	No
Add Self Wt.?	<input checked="" type="radio"/> Yes <input type="radio"/> No
Sawn Member Repetitive Use?	No

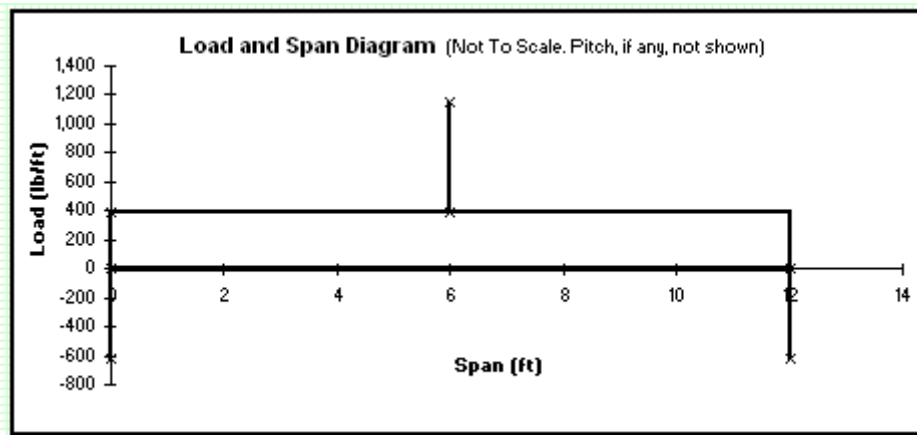
- General.** With all ConstructionCalc programs you can type in a name of the member you're designing, job name, date, etc. in the three cells at the top. Also, you can type in your company name at the very top of the sheet.
 - Span:** Main span is the beam's horizontal distance from bearing wall to bearing wall, in our case, 12'. Note: only enter numbers, no symbols, spaces, or units – the program does that for you.
 - 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.
 - Cantilever Exists?** No, no overhang.
 - Pitch if Sloped:** Our beam is horizontal, so No.
 - Load Duration:** Our beam supports a generous portion of roof snow load, so select Snow: 1.15.
 - Loads From Continuous Member?:** The floor joists are not continuous over this beam, they butt into it, so No.
 - 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.
 - 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.

Uniform Loads Over Full Length of Member			Tributary	Uniform Live	Reduced Live	Uniform Dead
	Live, psf	Dead, psf	Width, ft	Load, plf	Load, plf	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		

Concentrated (Point) Loads			Trib. Length		Live, lbs	Dead, lbs	Location, ft
	Live Load, psf	Dead Load, psf	Trib. Width, ft	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.
- Live Load:** Check the red popup note under Live, psf and you'll see "Residential floor, deck, and storage: 40 psf".
 - 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.
 - 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 previously 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.
- Live Load:** Ridge beam's live load comes from snow, which in our example is 25 psf.
 - 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.
 - 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.
 - 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.
 - 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 above, 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.

4x And Smaller (Lumber)

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

Acceptable Solutions

-	-
-	-
-	-

List properties for what size lumber? 4 x 12 *
Fb=1139 Fv=207 Fcp=625 E=1600000 Sif Wt=10.07

5x And Larger (Timbers)

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

Acceptable Solutions

-	12 x 16	-
6 x 22	14 x 16	-
8 x 20	16 x 16	-
10 x 18	-	-

List properties for what size? 6 x 18 * Fb=967 Fv=196 Fcp=625 E=1300000 Sif Wt=24.26

Glued Laminated Members

Glulam Grade: 24F-V4 (DF/DF)

Acceptable Solutions

2.5" x 18"	5.125" x 13.5"
3" x 16.5"	6.75" x 12"
3.125" x 16.5"	8.75" x 10.5"
5" x 13.5"	-

List glu lam properties for what size glulam? 3.125" x 10.5" *
Fb=2760 Fv=276 Fcp=748 E=1800000 Fbt=2127.5 Self Wt=8.18

1.9E Microllam LVL

List properties for what size LVL? (3) 1-3/4" x 11-7/8"
(2) 1-3/4" x 16"
(2) 1-3/4" x 16" Fb=2390 Fv=327.75 Fcp=750 E=1900000 Sif Wt=16.4

1.3E Timberstrand LSL

List properties for what size LSL? -
3-1/2" x 4-3/8" * Fb=2185 Fv=172.5 Fcp=680 E=1300000 Sif Wt=4.5

2.0E Parallam PSL

-	5-1/4" x 11-1/4"
2-11/16" x 16"	7" x 11-1/4"
3-1/2" x 14"	-

List properties for what size? 3-1/2" x 9-1/2" * Fb=3335 Fv=333.5 Fcp=750 E=2000000 Sif Wt=10.4

I-Level, T,JI

Web: -
Stiffeners? No

1.55E Timberstrand LSL

List properties for what size? (3) 1-3/4" x 14"
(2) 1-3/4" x 16"
1-3/4" x 14" * Fb=2674 Fv=356.5 Fcp=800 E=1550000 Sif Wt=7.5

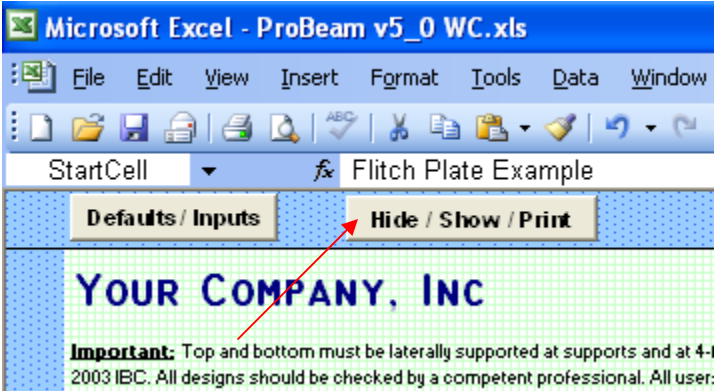
b) We could select any member listed – they all calc and meet code. However, we’re designing a fitch plate beam so we move on.

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.

Structural Steel Tubes				Structural Steel W-Shapes (I-Beams)																					
-	HSS10x2x1/4	HSS10x2x3/8		Steel Type? A392, Fy=50 ksi																					
-	HSS9x3x1/4	HSS8x3x3/8	HSS7x3x1/2	Web Stiffeners? <input type="button" value="No"/> <table border="1"> <tr><td>-</td><td>W14X22</td><td>-</td></tr> <tr><td>-</td><td>W16X26</td><td>-</td></tr> <tr><td>W6X20</td><td>W18X35</td><td>-</td></tr> <tr><td>W8X18</td><td>W21X44</td><td>-</td></tr> <tr><td>W10X15</td><td>-</td><td>-</td></tr> <tr><td>W12X14</td><td>-</td><td>-</td></tr> </table>				-	W14X22	-	-	W16X26	-	W6X20	W18X35	-	W8X18	W21X44	-	W10X15	-	-	W12X14	-	-
-	W14X22	-																							
-	W16X26	-																							
W6X20	W18X35	-																							
W8X18	W21X44	-																							
W10X15	-	-																							
W12X14	-	-																							
-	HSS8x4x1/4	HSS7x4x3/8	HSS7x4x1/2																						
-	HSS9x5x1/4	HSS7x5x3/8	HSS7x5x1/2																						
-	HSS8x6x1/4	HSS6x6x3/8	HSS6x6x1/2																						
Welded End Plate Caps? <input type="button" value="No"/>	-	-	HSS7x7x1/2																						
	-	-	-																						
	-	-	-																						
	-	-	-																						
	-	-	-																						

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

The image shows a dialog box titled 'Hide/Show/Print'. It contains several sections with radio buttons for 'Hide' and 'Show' options:

- Uniform Loads:** Clear and Hide, Show, Hide Unused.
- Pont Loads:** Clear and Hide, Show, Hide Unused.
- Uniform Loads On Cantlvr:** Clear and Hide, Show.
- Part'l Uniform Loads:** Clear and Hide, Show.
- Wedge Loads:** Clear and Hide, Show.
- Timber and Lumber:** Hide, Show.
- Glu-lam, PSL, LVL, I-Joist, LSL:** Hide, Show.
- Steel:** Hide, Show.
- Show All Member Types:** A button.
- Custom Member:** Hide, Show, Clear. A red arrow points to the 'Show' radio button.
- Report Detail:** Hide, Show.

At the bottom, there are three buttons: 'Calculate Now', 'Print Preview', and 'Okay'.

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

Custom Member

Member Type: Multi-Ply (use lower section) **a**

Single Member

Single Member Material: [Input Your Own]

Width, b =

Height, d =

Area, A = 0.00 in²

Section Modulus, S = 0.00 in³

Mom. of Inertia, I = 0.00 in⁴

Bending Strength, F_b =

Shear Strength, F_v =

Comp Perp to Grain F_{cp} =

Modulus of Elasticity, E =

Self Weight =

Custom Member Results

2 plies 3.5-in x 11.25-in DF 2 + 1 ply 0.5-in x 11-in Steel, 36ksi

Bending Overdesign: -4.5%

Shear Overdesign: 819.3%

Deflection Overdesign: 123.7%

Custom Mem. FAILS by: 4.5% **i**

Multi-Ply Side-By-Side Member

Mem. 1 Material: [Input Your Own] **c**

Reduce Strength For Bolt Holes: 15% - Medium bolts

Bearing: Only Mem 1 Bears

Mem 1, No. of Plies: 2.00 plies **d**

Mem 1, Ply Width, b = 3.50 in

Mem 1, Ply Height, d = 11.25 in

Mem 2 Material: Steel, 36ksi **e**

Mem 2, No. of Plies: 1.00 plies

Mem 2, Ply Width, b = 0.50 in **f**

Mem 2, Ply Height, d = 11.00 in

Multi-Ply Member 1

Material: DF 2 **b3**

Bending Strength, F_b = 1,139 psi

Shear Strength, F_v = 207 psi

Comp Perp to Grain F_{cp} = 625 psi

Modulus of Elasticity, E = 1,600,000 psi

Self Weight = 10.1 lb/ft

Multi-Ply Member 2

Material: Steel, 36ksi

Bending Strength, F_b = 24,000 psi

Shear Strength, F_v = 14,500 psi

Comp Perp to Grain F_{cp} = 21,160 psi

Mod of Elas., psi, E = 29,000,000

Self Weight = 15.9 lb/ft

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

4x And Smaller (Lumber)

Lumber Material: Douglas Fir-Larch

Lumber Grade: No. 2

Acceptable Solutions

-	-
-	-
-	-

List properties for what size lumber? 4 x 12 *

F_b=1139 F_v=207 F_{cp}=625 E=1600000 Slf Wt=10.07

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

- We select 4x12 from the drop down.
 - 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.
 - 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.
 - 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.
- Here is where we input our two plies of 4x12.
 - The actual size of a 4x12 is 3.5 x 11.25.
 - 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		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	
Final Member:	Custom Member			Bending Overdesign:	9.3%
Material Library:	.			Shear Overdesign:	1006.4%
Final Size:	2 plies 3.5-in x 11.25-in DF 2 + 1 ply 0.63			Deflection Overdesign:	153.7%
Min. Bearing Lengths:	= 1.50 in. (Left) = 1.50 in. (Right)	Use Conditions Selected:		Bearing / Buckling Overdsgrn:	N/A
Vert Diff (approx):	0.00 ft	True Len (approx):	a	Final member OK by:	9.3%
Actual Member Size:	3.50" x 11.25"	12.00 ft		Controlling criteria is:	Bending
Reactions			Final Member Additional Information		
Maximums	R _a -Left	R _a -Right	Max. Positive Moment:	30,509 ft-lb	6.00 ft Main Span
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 _a -Right	Cant. Down Defl. (Live / Tot):	N/A	N/A
Live Load:	0 lb	0 lb	Cant. Up Defl. (Live / Tot):	N/A	N/A
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
Net Reaction:	1,242 lb	1,242 lb	Approx. Self Weight:	29.95 plf	Approx. Tot. Wt.: 359 lb
Live Case Causing Min:	N/A	N/A	Min. Calc'd Bearing Lengths:	= 1.45 in (Left) = 1.45 in (Right)	
			Bracing Req'd For Full Strength: Lateral bracing required only at supports		
			W/O Mid-Bracing: Bending Fed'n: 0%		
			Allowed Moment: 33,340 ft-lb		

- 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.