CONSTRUCTIONCALC™
We Empower The Building Industry
SOFTWARE, ENGINEERING & SEMINARS

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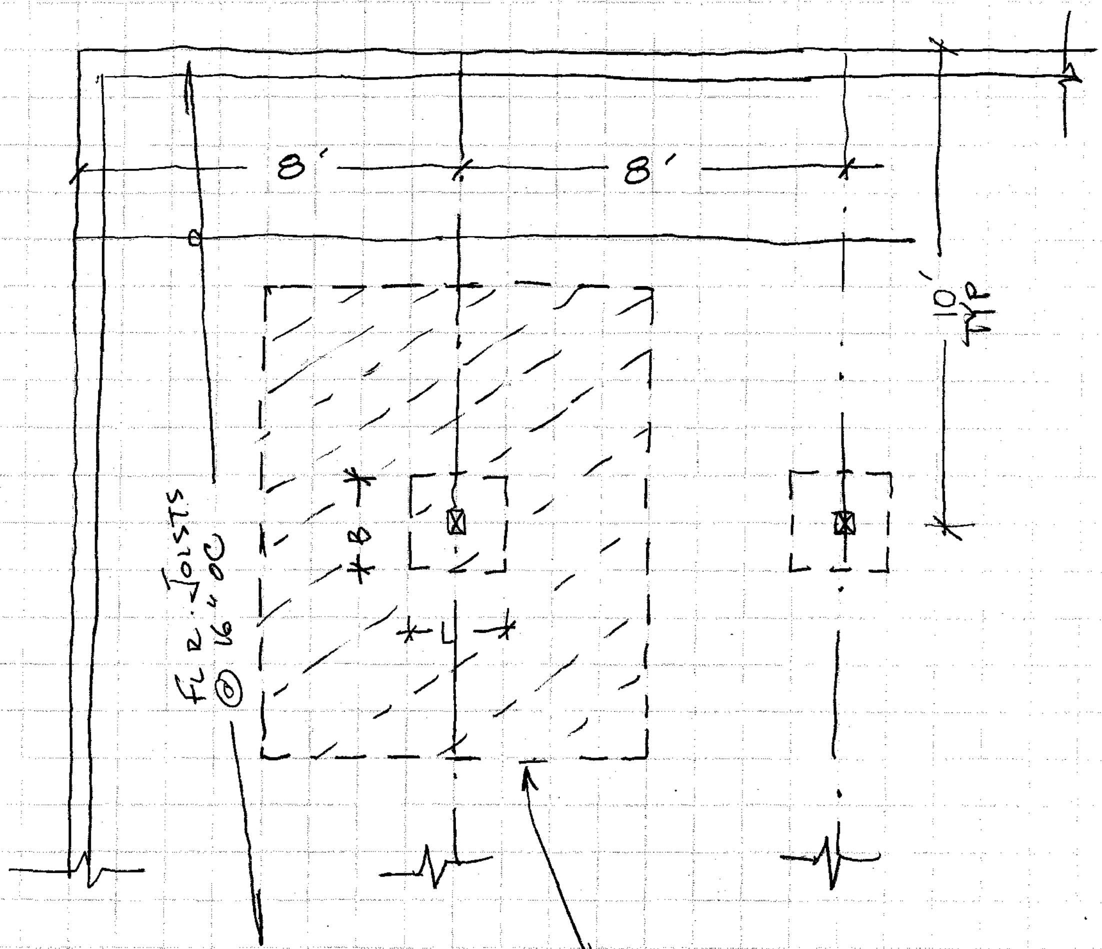
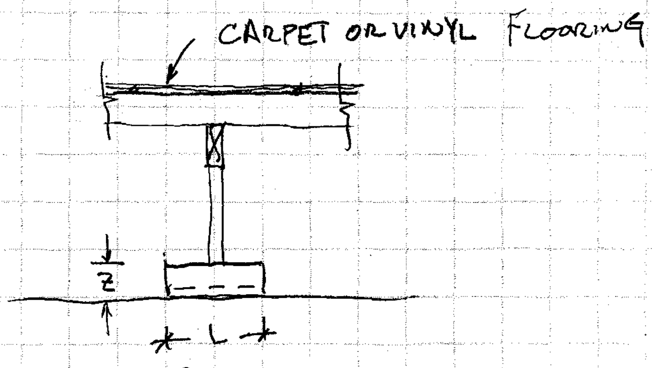


TRIB AREA $= \left(\frac{8}{2}+\frac{8}{2}\right)\left(\frac{10}{2}+\frac{10}{2}\right)$
$= (4+4)(5+5)$
$= (8)(10) = 80$ sf.



SECTION

FootingCalc v3.0 Example:

Typical Post and Pier Footing.

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 takes only a few minutes.

1) General. In all ConstructionCalc programs you can type a name of the item you're designing, job name, date, etc. in the three cells at the top. Or you can leave them blank if you wish.
2) Select B and L Directions.
   a) We know that our footing will be square and that the only applied loads will be gravity (downward). So the B-dimension will equal the L-dimension.
   b) Make a sketch of the footing (see SK1, attached). It doesn't matter which side you choose as B or L.
   c) Also make a cross section sketch showing depth, Z, and depth of bury, if any.
3) Soil Information
   a) We've been given soil type from a geotechnical engineer. It is Type 4, with bearing capacity of 2,000 psf. Select this from the dropdown and pertinent soil properties from the IBC automatically populate the white dashed cells below. We can use these values or type new ones over them if the geotechnical engineer so directs. We'll use the default values.
   b) There will be no soil over the footing, so zero.
   c) Our footing will sit on the surface of the excavated crawlspace so depth of bury is zero.
   d) Density of soil over footing doesn't matter because there is no soil over the footing. Leave blank or zero.
4) Concrete and Rebar
   a) Concrete compressive strength. We will use the minimum allowed: 2,500 psi.
   b) Rebar grade. We'll use grade 40.
5) Loads – General (IMPORTANT, PLEASE READ)
   a) The only loads on typical post and pier footings are gravity loads from the floor system. Lateral loads are typically taken out by exterior shear walls and their continuous footings. This means that we can clear and hide all but gravity loads using the grey Hide / Show / Print button in the upper right. Do that now.
6) Lateral Loads From?

a) Our footing will not resist lateral loads so select No lateral loads.

7) Applied Gravity Loads

a) We have a floor framing diagram so we can easily determine our footing loads using unit weights ("psf" loading) and tributary area.

b) Roof pitch. This input is only applicable for roof loads. Our footing only resists floor loads so we leave this zero or blank.

c) Live load reduction. We could select Yes here if we wanted to try for a reduction in live load based on tributary area. But most likely for this small tributary area this will have no effect.

d) Loads from continuous member? This option increases "psf + tributary area" loads 15%, due to member continuity over their supports. Since we don't know how the framer will build this floor system we will assume that either the floor joists are continuous (not spliced) over the floor beam or the floor beam is continuous (not spliced) over the post / pier, or both. We select Yes. If in doubt, select Yes – it is always conservative.

If we were to select No, the applied load to the footing would be less than if we selected Yes, but we would be saying that every floor joist will be spliced over the floor beam and every floor beam will be spliced over its post / pier. This is possible but unlikely. Usually floor joists are very long TJIs without splices over supports. If floor beams are PSL or other engineered wood, 20' lengths would not be uncommon.

e) We'll use the row labeled Floor 1 Loads.

i) Live: Enter 40. If you didn't know that residential floor live load is 40 psf, check the red triangle pop up note at the top of this Live, psf column.

ii) Dead: This floor is a typical stick-framed system with carpet or vinyl covering. We'll use 15. Again, check the red triangle pop up note for help. Actually 15 psf is a bit heavy since there is no gyp ceiling on the underside. But I don't mind being conservative – it leaves a little extra factor of safety in case the future residents have a lot of book shelves or water beds or other unusual live loads.

iii) x Length: This is one of the two tributary area dimensions. Our footings are arranged at 8' centers in the L-direction and 10' centers in the B-direction. So the tributary area is 8 x 10 (see SK1). See pop up note for more on this topic. We will enter 8 in this cell, though we could enter 10 if we wished.

iv) x Width: This is the other part of our tributary area. Enter 10. (If we had entered 10 in the previous step we would enter 8 here.)

f) That's it for loading. Very simple.

8) Plinth, Hairpin, and Anchor Bolts.

a) These are typically applicable to metal building footings and industrial applications. We will not use them so clear and hide using the Hide / Unhide / Print gray button.

9) Footing Dimensions

a) General. I recommend starting with the size of footing you'd like, then go back and fine tune until an optimal solution is obtained.

b) Footing length, L. Let's start with 1.5.

c) Footing width, B. We want this to be a square footing so let's set the B dimension equal to the L dimension. In this cell, input: =L. Now when you change L, B will change automatically. Cool! Of course you could also input a number, like 1.5.

d) Footing depth, Z. Input the minimum for a reinforced pad footing: 9.

e) Bearing plate dimensions. We know that the post which bears on this footing will be a 4x4. So our bearing area dimensions will be 3.5 x 3.5.

f) Load eccentricity. If our post were not centered on the footing we would have eccentricity which would be input here. However, our post will be located on the middle of our footing, so leave these two cells blank (zero eccentricity).

10) GENERAL RESULTS

a) General. Now we fine tune the footing size.

b) Look at the Unity column. We see that the Max soil pressure under our footing exceeds the allowed. Unity is a red number, 1.18. This indicates that the footing is 18% undersized. Let's try 1.67' (20") square. Just change the L input to 1.67. The B dimension updates automatically and we see that now Unity is less than 1 and we're okay.

c) Everything else in the General Results section is okay so we proceed to Footing Reinforcement.

11) Footing Reinforcement

a) All bars the same size? This is a helpful feature that presets all footing rebar to the same size. Note that whatever you select in the subsections below overrides this dropdown. We'll select #4 here.

b) Cover, bottom bars. Code minimum is 3-inches so let's use that.

c) Bottom bars. Let's guess 2 in each the L and B directions.

   i) Immediately to the right we see the spacing between bars is 6.7" and is okay.

d) Top bars. Since our footing has no uplift we don't need top bars. Leave the number of bars blank.

12) FOOTING RESULTS, L-DIRECTION

a) Glancing at the Unity results we see everything is okay.

b) The only red warning is that we do not have enough development length of the bottom L-bars. We have a choice now: either use a larger footing; or bend the ends of the L-bars. Bending the bars is cheaper than making a larger footing, so we'll do that.

13) FOOTING RESULTS, B-DIRECTION

a) Because our footing is symmetric, our B-direction footing results are nearly identical to the L-Direction results. Okay as-is, though we need to bend the ends of the B-bars to get adequate development length like we did with the L-bars.

14) Results.

a) The bottom two sections show controlling load combinations, maximum and minimum loads, eccentricities, etc.

b) The final results are restated at the bottom right. Since everything is Okay (in green) we know our design is acceptable.

15) Print a copy.

a) The best way to print is to use the Hide / Unhide / Print button in the upper right. We've already hidden the sections that don't apply. We could also hide the Summary of Applied Loads and Eccentricities section if we wish.

b) Once we've hidden (or not) the sections that weren't used we click Print Preview. Now we can adjust the print settings just like any other Excel spreadsheet. And then Print.

16) Saving the file.

a) We could Save As and give the program a new name if we wanted to save this design. However, that uses over 1 meg of disk space because it saves the entire program. I usually avoid this and just save the paper copy. If I ever need to recreate the design it's a snap to re-input using the paper copy to remind myself of what the inputs were.

17) Next problem. To start a new problem, it is recommended to first clear inputs via the gray Clear Values button in the upper right.

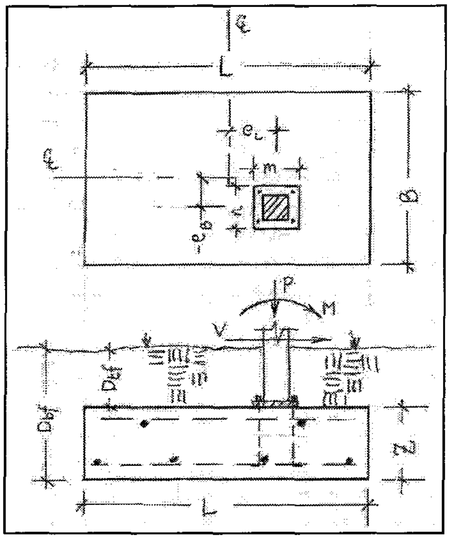
PP 1

ConstructionCalc, Inc.

FootingCalc
v3.0

Disclaimer: All users of this software shall comply with State Engineering Law which specifies who may perform engineering and defines the practice of engineering. See "About" tab, below, for assumptions.

Job Name	Example post and pier footing.
Footing I.D.	Typical interior pad ftg.
Other Info	4/27/2009



Soil Information

Soil Type: Class 4: Sand, silty sand, clayey sand, silty gravel and clayey gravel

Soil bearing capacity, unfactored	2,000 psf
Soil lateral bearing capacity, unfactored	150 psf
Soil coefficient of friction	0.250
Soil lateral sliding resistance, Cl. 5 only.	130 psf
Depth of soil over top of footing, Dtf, ft.	0.00 ft
Depth to bottom of footing, Dbf, ft.	0.00 ft
Density of soil over top of footing, pcf	0 pcf

Concrete and Rebar

Concrete Compressive Strength, psi — f'c = 2,500 psi

Rebar grade — Grade 40

Lateral Loads From?

No lateral loads

Soil bearing capacity, factored — qs = 2,000 psf

Applied Gravity Loads, "P" (unfactored)

Roof Pitch

Allow Live Load Reduction? No

Loads From Continuous Members? Yes

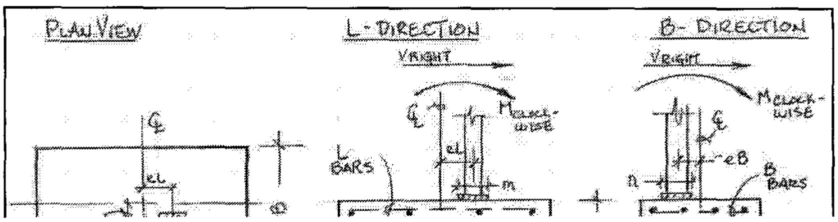
	Live, psf	Dead, psf	x Length, ft	x Width, ft.	Live Load, lbs	Reduced Live Load, lbs.	Dead Load, lbs	Snow Load, lbs
Roof (no snow)					0 lb	0 lb	0 lb	
Roof Snow (only)			-	-				0 lb
Floor 3 Loads					0 lb	0 lb	0 lb	
Floor 2 Loads					0 lb	0 lb	0 lb	
Floor 1 Loads	40 psf	15 psf	8.00 ft	10.00 ft	3,680 lb	3,680 lb	1,380 lb	
Wall Dead Load							0 lb	
Other 'psf' load and trib. area.					0 lb	0 lb	0 lb	
Other gravity loads, lbs.		Descrip'n, opt'l:						
Other gravity loads, lbs.		Descrip'n, opt'l:						
Subtotals gravity loads, unfactored:					**3,680 lb**		**1,380 lb**	**0 lb**
Adjusted for inclination					**3,680 lb**		**1,380 lb**	**0 lb**

Footing Dimensions

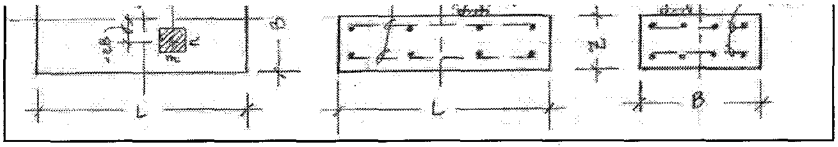
Footing length, L, ft	L =	1.67 ft		
Footing width, B, ft.	B =	1.67 ft	Vol of conc:	
Footing depth, Z, inches	Z =	9.00 in	**0.08 cy**	
Bearing plate length in 'L' direction, inches	m =	3.50 in		
Bearing plate width in 'B' direction, inches	n =	3.50 in	Resl't Ecc:	
Load eccentricity in 'L' direction, inches	eL =	0.00 in	**0.00 in**	
Load eccentricity in 'B' direction, inches	eB =	0.00 in	**0.00 in**	

General Results

	Max allowed	Unity check	
Max Soil press, q:	Max allowed	Unity check	
1,927 psf	**2,000 psf**	**0.96**	**ok**
Sliding force, L-dir	Max allowed		
0 lb	**0 lb**	**-**	**ok**
Sliding force, B-dir	Max allowed		
0 lb	**0 lb**	**-**	**ok**
Ult two-way shear	Max allowed		
6,233 lb	**27,563 lb**	**0.23**	**ok**
Ult conc bearing pressure	Max allowed		
616 psi	**1,381 psi**	**0.45**	**ok**
Ult net uplift	Max allowed		
0 lb	**282 lb**	**-**	**ok**



PP2



Footing Reinforcement

All bars the same size? All # 4

Bottom Bars:

Cover, bottom rebar, inches	cov =	3.00 in		
L-Bars, Bottom. Rebar parallel to L dimension:		# 4	Bar Spacing:	Max allowed
L-Bars, Bottom. No. of bars	nL =	2.0	**6.7 in**	18.0 in
B-Bars, Bottom. Rebar parallel to B dimension:		# 4	**(ok)**	
B-Bars, Bottom. No. of bars	nB =	2.0	**6.7 in**	

Top Bars: **(ok)**

L-Bars, Top		# 4
L-Bars, Top. No. of bars	nLt =	0.0
B-Bars, Top		# 4
B-Bars, Top. No. of bars	nBt =	0.0

Footing Results, L-Direction

Ult Moment, L dir:	Max allowed	Unity check
1,126 '-#	**6,675 '-#**	**0.17 ok**
L-steel provided	Min allowed	
0.40 in^2	**0.36 in^2**	**0.90 ok**
L bottom bars, development length check		
-10.6-in.	N.G. Hook ends of L-bars 6-in. or adjust design	
Ult Shear L dir:	Max allowed	
996 lb	**8,642 lb**	**0.12 ok**
Top L steel provided	Min suggested	
0.00 in^2	**0.00 in^2**	**- ok**

Footing Results, B-Direction

Ult Moment, B dir:	Max allowed	Unity check
1,126 '-#	**6,075 '-#**	**0.19 ok**
B steel provided	Min allowed	
0.40 in^2	**0.36 in^2**	**0.90 ok**
B bottom bars, development length check		
-10.6-in.	N.G. Hook ends of B-bars 6-in. or adjust design	
Ult Shear B dir:	Max allowed	
1,194 lb	**7,891 lb**	**0.15 ok**
Top B steel provided	Min suggested	
0.00 in^2	**0.00 in^2**	**- ok**

Summary of Applied Loads and Eccentricities

Totals, Unfactored: Self-Weight: **314 lb** Dead: **1,380 lb** Live: **3,680 lb** Snow: **0 lb**

	P, Maximum:	**5,374 lb**	**D+L+S**				Sliding resisted by:
Totals, Factored, Soil Design (ASD):	V, Max., L-dir.:	**0 lb**		V, Max, B-dir.:	**0 lb**		**L-dir: N.A.**
	M, Max.,L-dir.:	**0 '-#**		M, Max, B-dir.:	**0 '-#**		**B-dir: N.A.**
	Resultant eccentricity, L-dir.:	**0.00 in**		Resultant ecc., B-dir.:	**0.00 in**		
	P, Maximum:	**7,921 lb**	**1.2D+1.6L+.5S**	P, Minimum:	**1,524 lb**	**.9D+1.6W**	
Totals, Factored, Concrete Design (strength design):	V, Max., L-dir.:	**0 lb**		V, Max, B-dir.:	**0 lb**		
	M, Max.,L-dir.:	**0 '-#**		M, Max, B-dir.:	**0 '-#**		
	Resultant eccentricity, L-dir.:	**0.00 in**		Resultant ecc., B-dir.:	**0.00 in**		

Controlling Load Combinations

Soil bearing (ASD method)	**D+L+S**
Sliding resistance, L-direction (ASD method)	**D+L+S**
Sliding resistance, B-direction (ASD method)	**D+L+S**
Concrete bending and 1-way shear, L-dir:	**1.2D+1.6L+.5S**
Concrete bending and 1-way shear, B-dir:	**1.2D+1.6L+.5S**
Two-way shear	**1.2D+1.6L+.5S**
Bearing pressure, brng plate on conc.	**1.2D+1.6L+.5S**
Uplift	**.9D+1.6W**

Final Design		
Conc f'c: **2500 psi**	**Footing Size: LxBxZ = 1.67-ft x 1.67-ft x 9-in**	**Okay**
Rebar: **Grade 40**	**L-Direction Rebar: 2, # 4 bottom + 0, # 4 top**	**Okay**
	B-Direction Rebar: 2, # 4 bottom + 0, # 4 top	**Okay**
Soil Brng Cap. **2000 psf**	**No Plinth**	
Inclined Load:	**No Hairpin**	
0 deg. (no incl'n)	**No Anchor Bolts**	