ASDIP Foundation
STRUCTURAL ENGINEERING SOFTWARE

Spread Footing Verification Example

Reference: Reinforced Concrete – Mechanics and Design, 5th Edition, by Wright and MacGregor, Prentice Hall, 2009. Example 15-2.

A square spread footing supports an 18-in square supporting a service dead load of 400 kips and a service live load of 270 kips. The column is built with 5000-psi concrete and has 8 #9 longitudinal bars with fy = 60 ksi. Design the footing to be constructed using 3000-psi concrete. The top of the footing is covered with 6-in of fill with a density of 120 pcf and a 6-in basement floor with a load of 100 psf. The allowable pressure of the soil is 6000 psf.

U = 1.4 D = 1.4 x 400 = 560 kips

U = 1.2 D + 1.6 L = 1.2 x 400 + 1.6 x 270 = 912 kips (controls)

- Try an 11'-2" x 32" thick footing (d = 28"). Check punching shear.

Factored net soil pressure = $912/11.17^2$ = 7.31 ksf

The critical shear perimeter is a square which side is 18" + 28" = 46"

$V_u = 7.31[11.17^2 – (46/12)^2] = 805$ kips

$\phi V_c = 0.75 \times 4 \sqrt{3000} \times 46 \times 4 \times 28 = 847$ kips > V_u OK

- Check one-way shear.

$V_u = 7.31[11.17 \times (30/12)] = 204$ kips

$\phi V_c = 0.75 \times 2 \sqrt{3000} \times 134 \times 28 = 308$ kips > V_u OK

- Design the flexural reinforcement.

$M_u = 7.31[11.17 \times (58/12)^2 / 2] = 954$ kips

Try 11 #8 bars each way ($A_s = 8.69$ in^2)

a = 8.69 x 60 / (0.85 x 3 x 134) = 1.53 in (tension controlled)

$\phi M_n = 0.9 \times 8.69 \times 60 (28 – 1.53/2) = 1065$ k-ft > M_u OK

- Check the development.

The clear spacing exceeds $2d_b$ and the clear cover exceeds d_b, therefore

$L_d = 60000/(20 \sqrt{3000}) d_b = 54.8 \times 1" = 54.8"$ OK

- Design the column-footing joint.

The allowable bearing on the footing is $0.85 \times 0.65 \times 3 \times 18^2 \times 2 = 1070$ kips

The allowable bearing on the base of the column is $0.85 \times 0.65 \times 5 \times 18^2 = 895$ kips (controls)

Area of dowels required = $(912 - 895)/(0.65 \times 60) = 0.44$ in^2

Area of dowels minimum = $0.005 \times 18^2 = 1.62$ in^2 (controls)

Use 4 #6 dowels. Extend dowels 25" into column.

ASDIP Foundation 2.5.5 **SPREAD FOOTING DESIGN** *www.asdipsoft.com*

GEOMETRY

Footing Length (X-dir)	11.17	ft	
Footing Width (Z-dir)	11.17	ft	
Footing Thickness	32.0	in	OK
Soil Cover	0.50	ft	
Column Length (X-dir)	18.0	in	
Column Width (Z-dir)	18.0	in	
Offset (X-dir)	0.0	in	OK
Offset (Z-dir)	0.0	in	OK
Pedestal Height	N. A.	ft	

SOIL PRESSURES (Comb: D+L)

Gross Allow. Soil Pressure ..	6.00	ksf
Soil Pressure at Corner 1	5.89	ksf
Soil Pressure at Corner 2	5.83	ksf
Soil Pressure at Corner 3	5.77	ksf
Soil Pressure at Corner 4	5.83	ksf
Bearing Pressure Ratio	0.98	OK
Ftg. Area in Contact with Soil ...	100.0	%
X-eccentricity / Ftg. Length	0.00	OK
Z-eccentricity / Ftg. Width	0.00	OK

APPLIED LOADS

	Dead	Live	RLive	Snow	Wind	Seismic	
Axial Force P	400.0	270.0	0.0	0.0	0.0	0.0	kip
Moment about X Mx ..	0.0	0.0	0.0	0.0	0.0	0.0	k-ft
Moment about Z Mz ..	0.0	0.0	0.0	0.0	0.0	0.0	k-ft
Shear Force Vx	0.0	0.0	0.0	0.0	0.0	0.0	kip
Shear Force Vz	0.0	0.0	0.0	0.0	0.0	0.0	kip

OVERTURNING CALCULATIONS (Comb: 0.6D+1W)

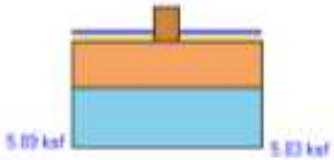
OVERTURNING

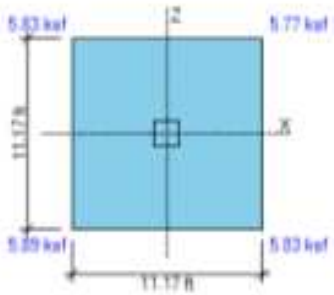
	Force	Arm	Moment
- About X-X	kip	ft	k-ft
Moment Mx	---	---	0.0
Shear Force Vz	0.0	2.67	0.0
Rh =	0.0	OTM =	0.0
- About Z-Z			
Moment Mz	---	---	0.0
Shear Force Vx	0.0	2.67	0.0
Rh =	0.0	OTM =	0.0

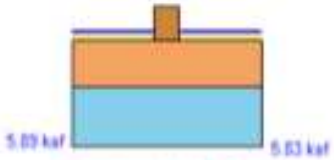
	X-X	Z-Z	
Arm of Vertical Resultant =	5.59	5.59	ft
Overturning Safety Factor =	99.99	99.99	> 1.5 OK

RESISTING

	Force	Arm	Moment
- About X-X	kip	ft	k-ft
Footing Weight ..	29.9	5.59	167.2
Column Weight ..	0.0	5.59	0.0
Soil Cover	4.4	5.59	24.6
Axial Force P	240.0	5.59	1340.4
Rv =	274.4	RM =	1532.3
- About Z-Z			
Footing Weight ..	29.9	5.59	167.2
Column Weight ..	0.0	5.59	0.0
Soil Cover	4.4	5.59	24.6
Axial Force P	240.0	5.59	1340.4
Rv =	274.4	RM =	1532.3







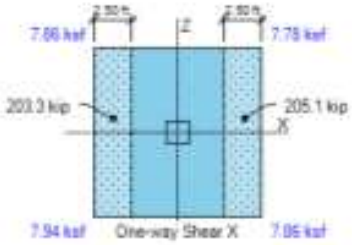
Controlling Load Comb: D+L

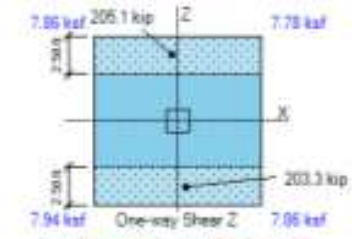
SLIDING (Comb. 0.6D+1W)

Footing-Soil Friction Coeff.	0.45		
Friction Force at Base	123.5	kip	
Passive Pressure Coeff. Kp	2.77		
	X-X	Z-Z	
Passive Force @ Ftg ...	18.2	18.2	kip
Horiz. Resisting Force	141.6	141.6	kip
Horiz. Sliding Force	0.0	0.0	kip
Sliding Safety Factor ...	99.99	99.99 > 1.5	OK

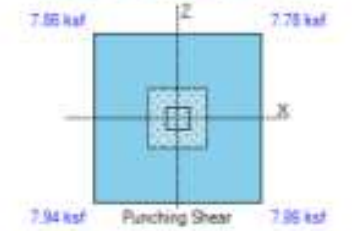
UPLIFT CALCS (Comb: 0.6D+0.7E)

Uplift Force P	0.0	kip
Pedestal Selfweight	0.0	kip
Footing Selfweight	29.9	kip
Soil Cover Weight	4.4	kip
Downward Force W	34.4	kip
Uplift Safety Factor	99.99 > 1.0	OK





Controlling Load Comb: 1.2D+1.6L+0.5S



Controlling Load Comb: 1.2D+1.6L+0.5S

PUNCHING SHEAR (Comb: 1.2D+1.6L+0.5S)

Unbalanced Moment Factor γ_{vx} ...	0.40	
Unbalanced Moment Factor γ_{vz} ...	0.40	
Punching Shear due to Axial	178.4	psi
Punching Shear due to Mx	0.0	psi
Punching Shear due to Mz	0.0	psi
Punching Shear Stress Vu	178.4	psi
Effective Perimeter bo	184.0	in
Average Effective Depth d	28.0	in
Column Location Factor α_s	40 (Interior)	
Column Aspect Ratio β	1.00	
Punching Shear Strength ϕV_c ..	332.2	psi
Punching Shear Ratio $V_u/\phi V_c$	0.54	OK

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ONE-WAY SHEAR (Comb: 1.2D+1.6L+0.5S)

	- Side	+ Side		
One-way Shear Vux ...	203.3	205.1	kip	
One-way Shear Vuz ...	203.3	205.1	kip	
Under-strength ϕ Factor		0.75		
One-way Shear Strength ϕVcx		302.8	kip	OK
One-way Shear Strength ϕVcz		313.9	kip	OK
Max. One-way Shear Ratio Vu/ϕVc ..		0.68		OK

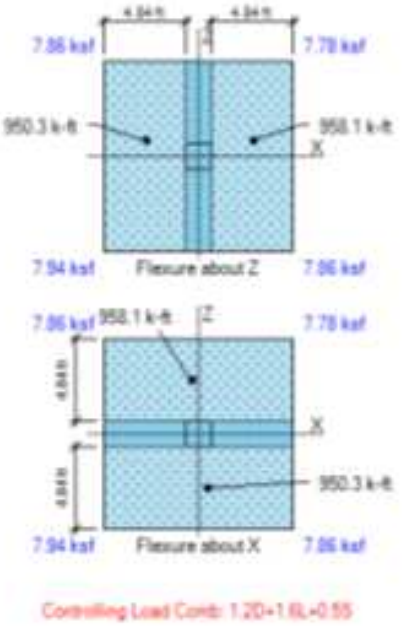
FLEXURE (Comb: 1.2D+1.6L+0.5S)

- Top Bars -	- Side	+ Side		
Bending Moment -Mux ...	0.0	0.0	k-ft	
Bending Moment -Muz ...	0.0	0.0	k-ft	
No Top Reinforcement Provided at the Footing				
Use Plain Concrete Flexural Strength at Top				
X-Bars Development Length Ratio ..		N.A.		
Z-Bars Development Length Ratio ..		N.A.		
Min. Top Steel Area Ratio		N.A.		
Under-strength ϕ Factor		0.55		
Bending Strength -ϕMnx		287.1	k-ft	OK
Bending Strength -ϕMnz		287.1	k-ft	OK
Max. Bending Ratio -Mu/ϕMn		0.00		OK

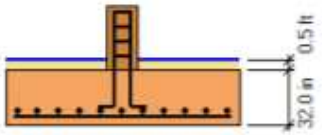
- Bottom Bars -	- Side	+ Side		
Bending Moment +Mux ...	950.3	958.1	k-ft	
Bending Moment +Muz ...	950.3	958.1	k-ft	
Use 11 #6 Bars Parallel to X (Bot) , d = 27.5 in				
Use 11 #6 Bars Parallel to Z (Bot) , d = 28.5 in				
X-Bars Development Length Ratio ..		0.59		OK
Z-Bars Development Length Ratio ..		0.59		OK
Min. Bottom Steel Area Ratio		0.89		OK
Under-strength ϕ Factor		0.90		
Bending Strength +ϕMnx		1084.6	k-ft	OK
Bending Strength +ϕMnz		1045.5	k-ft	OK
Max. Bending Ratio +Mu/ϕMn		0.92		OK

TRANSFER (Comb: 1.2D+1.6L+0.5S)

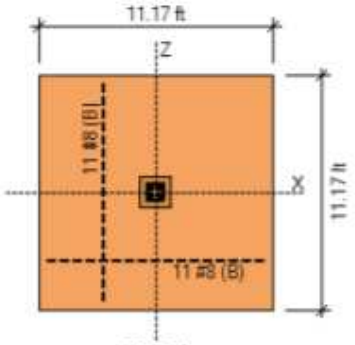
Bearing Under-strength ϕ Factor	0.65		
Use 4 #6 x 2.00 ft hooked dowels , As = 1.76 in2			
Compressive Stress Pu	2.8	ksi	
Column Bearing Strength ϕPn ...	3.0	ksi	OK
Footing Bearing Strength ϕPn ...	3.5	ksi	OK
Shear Force Transfer Vu	0.0	kip	
Shear Friction Strength ϕVn	47.5	kip	OK
Min. Steel Area As = 0.005 A1 ...	1.62	in2	OK
Develop. Length Ratio at Column	0.64		OK
Develop. Length Ratio at Footing	0.31		OK



Controlling Load Comb: 1.2D+1.6L+0.5S



ELEVATION



PLAN

DESIGN CODES

Concrete Design	ACI 318-08
Load Combinations	ASCE 7-05

MATERIALS

Column Concrete f'c	5.0	ksi
Column Dowels fy	60.0	ksi
Column Ties fy	60.0	ksi
Footing Concrete f'c	3.0	ksi
Footing Rebars fy	60.0	ksi
Soil Cover Density	120.0	pcf