Example 1

Column footings (12'x12') for a proposed building carry a stress of 4 tsf. They are to be located 1ft away from the edge of the footings of an existing building which are 10' by 10' in plan. The centerlines of columns of the two buildings coincide.

What would be the increase in stress at 6' depth?

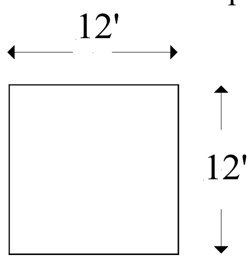
Below the corner of proposed footing

Below the middle of proposed footing

Below the middle of existing footing.

Solution (Example 1)

a. Corner of proposed footing

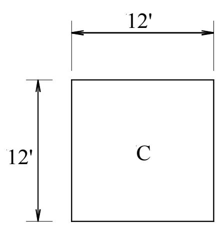


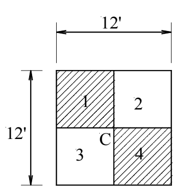
m = n = B/z = L/z = 12/6 = 2

I = 0.23247

$\Delta\sigma = 0.23247 \times 4\text{tsf} = 0.93$ tsf

b. Middle of proposed footing





m = n = B/z = L/z = 6/6 = 1

I = 0.17522

$\Delta\sigma = 0.17522 \times 4 \times 4 = 2.804$ tsf

[1]c. Middle of existing footing

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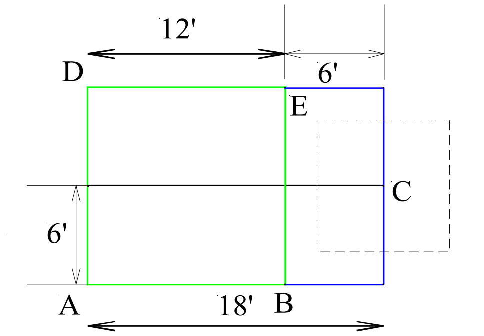
[1]*Note we can only find stress increase under a corner. Using superposition we must construct the stresses so that the point of interest can be brought under a corner.*



2 × stress from area (AC- BC)

AC: m = (12+1+5)/6 = 3 n = 6/6 = 1

I= 0.20341

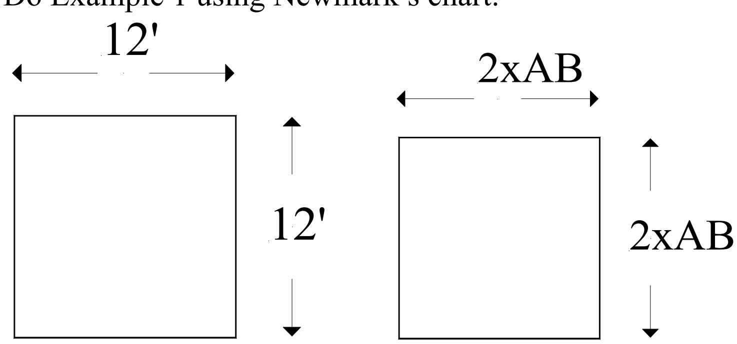
BC: m = (1+5)/6 = 1 n = 6/6

I_{BC} = 0.17522

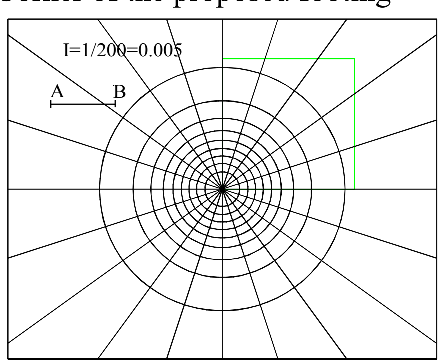
$\Delta\sigma = 2\times4\times(0.20341-0.17522) = 0.226$ tsf

Example 2

Do Example 1 using Newmark's chart.

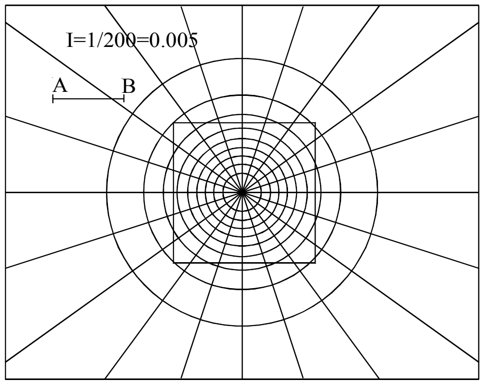


Corner of the proposed footing



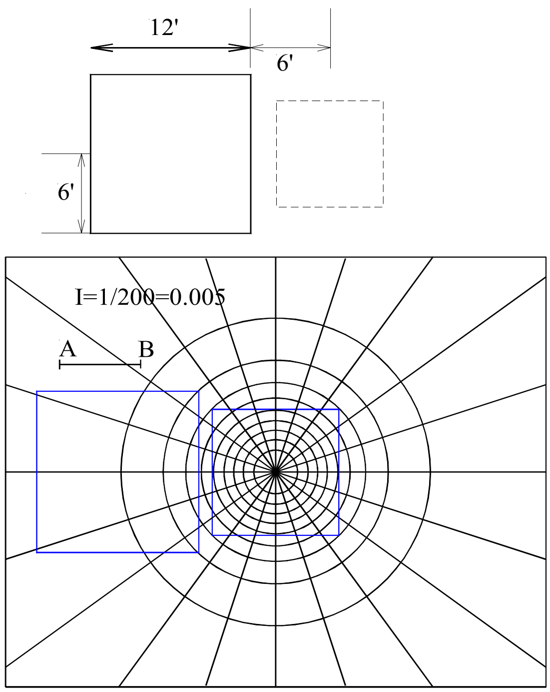
$\Delta\sigma = 0.005\times4\times45 = 0.90$ tsf

b. Middle of proposed footing



$\Delta\sigma = 0.005\times4\times144 = 2.88$ tsf

c. Middle of existing footing



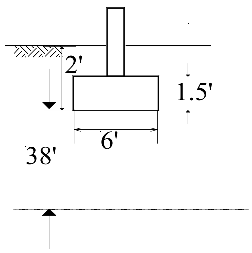
$\Delta\sigma = 0.005\times4\times12 = 0.24$ tsf

Example 3

A 6’×6’ column footing is 1.5’ thick and is located 2’ below ground in a silty clay 40 ft thick with $c_u = 1.5$ tsf, and $\gamma = 115$ pcf. Column load is 110 tons. Determine its elastic settlement.

Solution

$E_s = 350\times1.5 = 525$ tsf



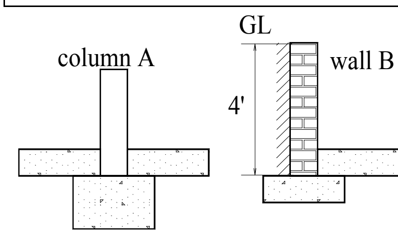
$q_0 = 110/6\times6 + 1.5\times150/2000 + 0.5\times115/2000 = 3.2$ tsf
$D_f/B = 2/6 = 0.33$
$H/B = (40\text{-}2)/6 = 6.3$
[2]$A_2 = 0.97$ $\qquad$ $A_1 = 0.68$

$$S_e = 0.97\times0.68\frac{3.2\times6}{525} = 0.024' = 0.29''$$

Example 4

Design footings for the foundation arrangement shown. Floor slab thickness = 6″ and unit weight of underlying sand is $\gamma = 120$ pcf. No ground water was detected.

	LL	DL
Column A	60 T	170 T
Wall B	4 T/ft	2.2 T/ft



Solution (Example 4)

depth, ft	N_F	σ′, tsf	$C_N = (1/\sigma')^{0.5}$	N_{cor}	[3]N_{avg}
5	12	0.3	1.826	21	21
7.5	15	0.45	1.491	22	22
10	18	0.6	1.291	23	22
12.5	19	0.75	1.155	22	22
15	23	0.9	1.054	24	23
20	25	1.2	0.913	23	23

Footing A:

Total load = 60+170=230 tons

Average $N_{avg} = 22$,

$$q_{all} = \frac{N_{avg}}{10} = \frac{22}{10} = 2.2\text{tsf}$$

Try

$q_{net(all)}$ tsf= $0.125\, N_{cor}\times F_d\times(1 + 1 / B)^2 \times S$ for B > 4 ft

$F_d = 1+0.33(3/10.25) = 1.097$

Let S = 1",

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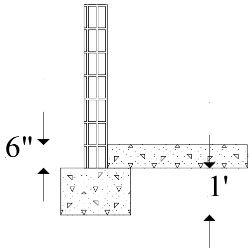
[2] *From Fig. 4.21*

[3] *running average*



$q_{net(all)}$ tsf= 0.125 ×22×1.097×(1 + 1 /10.25)^2×1

$q_{net(all)}$ tsf = 3.63tsf

$$B = \sqrt{\frac{230}{3.63}} = 7.96$$

Revised, Try 8' × 8'

Assume footing thickness as 2'-6".

Check soil pressure

Source	Stress computations	tsf
Column loads	230/8×8	3.59
floor slab + footing	(0.5+2.5) ×150/2000	0.225
surcharge, slab + soil	-(0.5×150 +2.5x120)/2000	-0.188[4]
Total stress		3.63

Hence footing width is OK.

Wall footing B

Assume footing thickness = 1', D_f=1'-6"

As first trial use q_a determined for column footing A

6.2/3.63= 1.707, try 1'-9" by 1'-9"

$q_{net(all)}$ tsf= 0.2 N_{cor}×F_d×S for B ≤ 4 ft

F_d = 1+0.33(1.5/1.75) = 1.282

q_a = 0.2×22×1.282×1 = 5.64tsf

B = 6.2/5.64 = 1.09' Try 1' 3" by 1' 3"

F_d = 1+1.5/1.25 = 1.396 > 1.33, use 1.33

q_a = 0.2×22×1.33×1 = 5.85tsf

Check soil pressure

Source	Computations	tsf
Wall load	6.2/1.25	4.96
floor slab + footing	(1.0+0.5)×150/2000	0.113
surcharge, slab + soil	-(0.5×150 +1×120)/2000	-0.098
Total		4.97

1' 3" wide footing is OK (Note: Bearing capacity controls)

Example 5

Plate load test data for two plates are as follows:

Dia, m	Stress, kPa	Settlement, mm
0.305	400	7.75
0.762	400	13

[4] *difference between these two is thickness of footing times difference in unit weight of soil and concrete, i.e., 2.5(0.15-0.12)/2 = 0.038 tsf.*

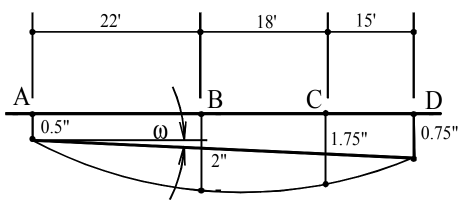
Determine settlement of a 1.5m×1.5m footing with a stress of 400 kPa.
If load-settlement curve is linear determine maximum footing load if settlement is not to exceed 13mm.
Solution
a. $13 = 7.75\left(\frac{0.762}{0.305}\right)^{n}$ → n = 0.565

$$S_F = 13\left(\frac{1.5}{0.762}\right)^{0.565} \rightarrow \quad = 19.06 \text{ mm}$$

Maximum footing load

$$\frac{13}{19.06} \times 400 \times 1.5 \times 1.5 = 614 \text{ kN}$$

Example 6
In a reinforced structure, columns A-D have spacing of 22', 18', and 15'. Estimated column settlements are 0.50", 2.0", 1.75" and 0.75".
a. Is this structure acceptable for 1955 USSR code?
Would first crack appear in panel wall (Wahls, 1981)?
Solution:



$$\omega = \frac{0.75 - 0.5}{12(22 + 18 + 15)} = 0.0004$$

$$\eta_{AB} = \frac{2.0 - 0.5}{12 \times 22} - 0.0004 = 0.0053 > 0.002 \quad \rightarrow \text{NG}$$

$$\eta_{BC} = \frac{2.0 - 1.75}{12 \times 18} - 0.0004 = 0.0008 < 0.002 \rightarrow OK$$

$$\eta_{CD} = \frac{1.75 - 0.75}{12 \times 15} - 0.0004 = 0.00516 > 0.002 \rightarrow NG$$

1/300 = 0.0033 < 0.00516 first cracks will occur between AB & CD