Foundations
- Types
- Soil Pressures
- Kern
- Limit States
- A required
- Design of Footings
- Soil Failure
- One-Way Slab
- 2way Shear
- Flexure
- Bearing/Load Transfer

→ Purpose of foundations

To safely transmit load from the Structure to the ground without unsafe differential settlement

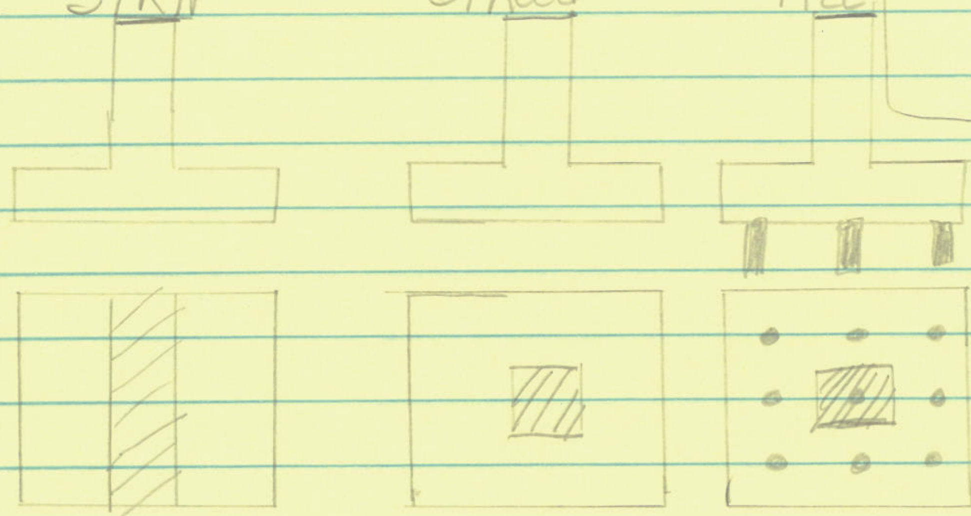
→ What if settlement?

EVEN → Not huge deal (Mexico City)

UNEVEN → BIG DEAL (Los Vegas Casino, Leaning Tower of Pizza)

→ Types of Foundation

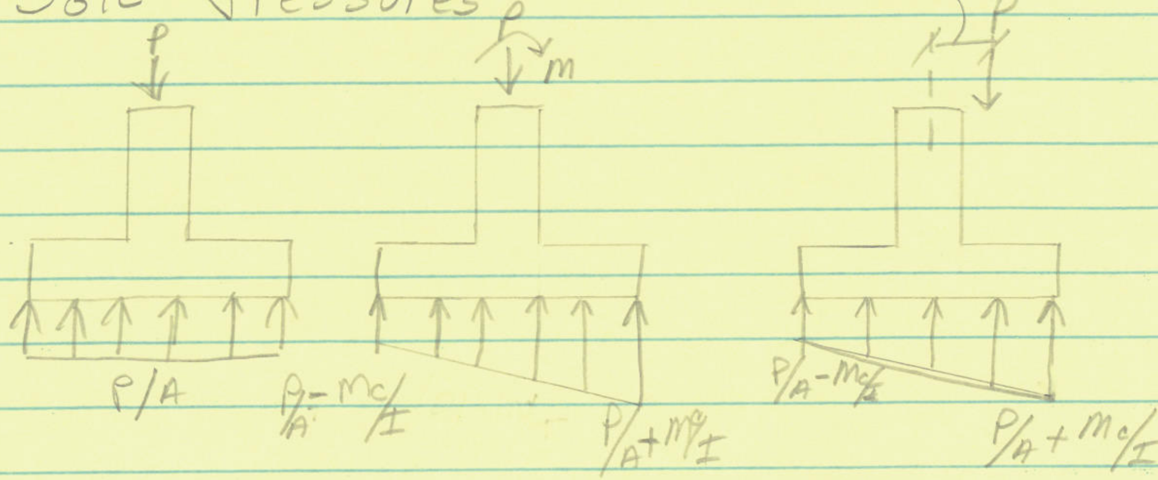
STRIP SPRead PILE



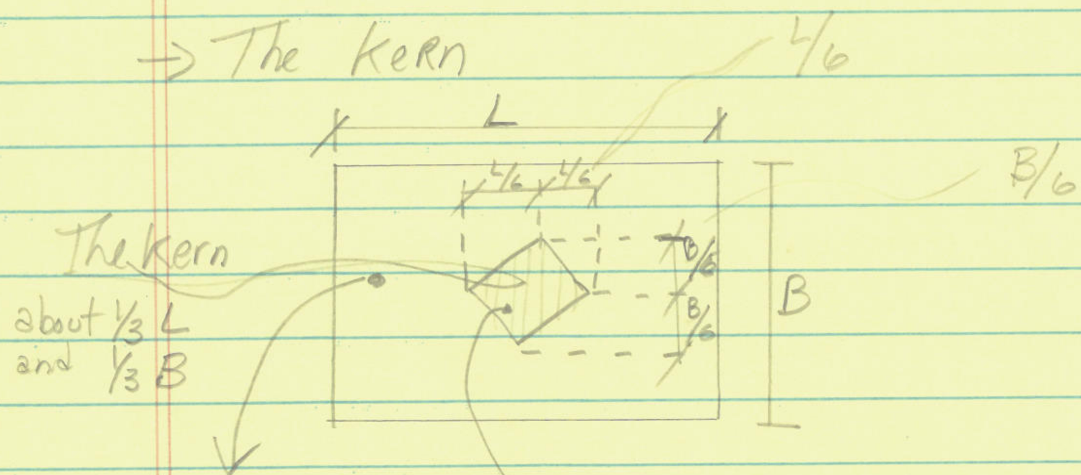
→ Raft or Mat

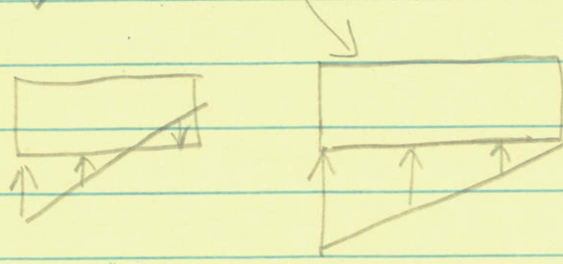
Large foundation under entire structure

→ Soil Pressures



→ The Kern





* Load must fall in the kern of the footing

→ Soil Limit

- Soil bearing failure

$q_{act} < q_{allow} = \dfrac{q_{ultimate}}{FS}$

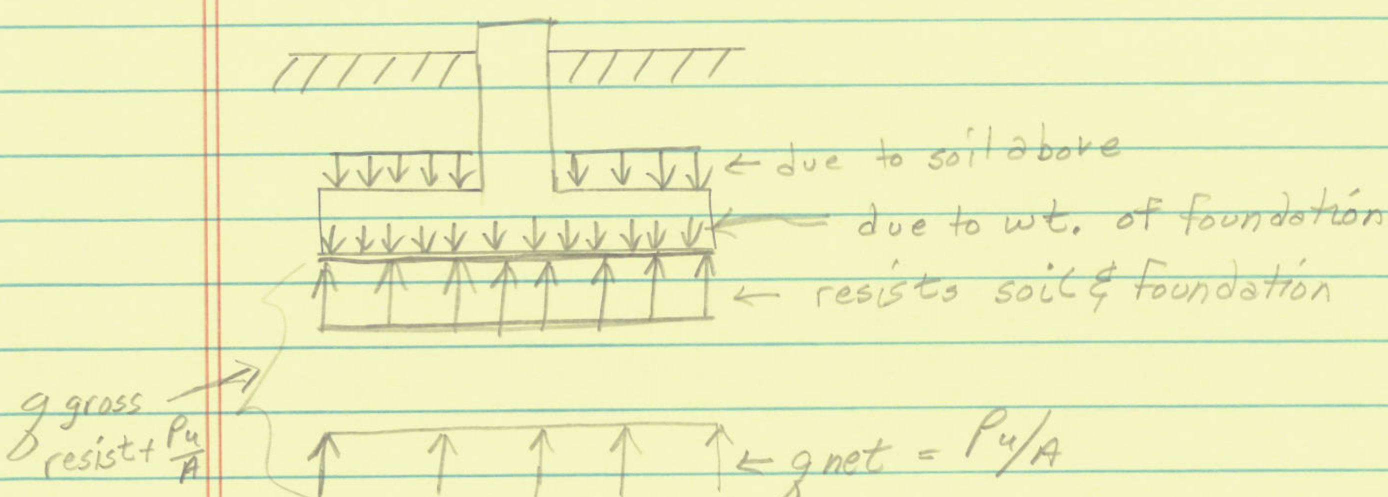
q_{act} ↑ From service loads

$q_{ultimate}$ ↙ From geo tech

FS ↖ usually 2.5 – 3.0

- differential settlement
- excessive settlement

→ Calculations of Soil Pressure



→ A required of Spread footing

Soil Capacity $q_{gross} \le q_{all}$

$$A_{req'd} = \frac{D\left\{\begin{array}{l}\text{structure}\\ \text{footing}\\ \text{over burden}\end{array}\right\} + L}{q_{allowed}}$$

← service loads

→ other structural elements

$q_{net} = \frac{\text{Max factored Load}}{A_{footing}}$

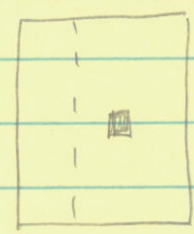
usually $1.2D_L + 1.6_{LL}$

→ Spread Footing Limit State (Things we need to check)

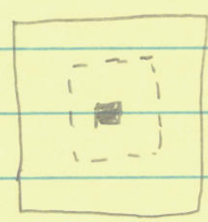
Soil Failure $q_{act} \leq q_{allowed}$

Shear

1 way →



2 way →

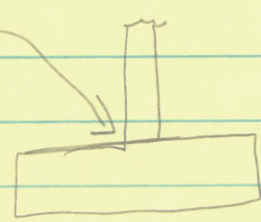


→ Flexure $\phi M_n \geq M_u$

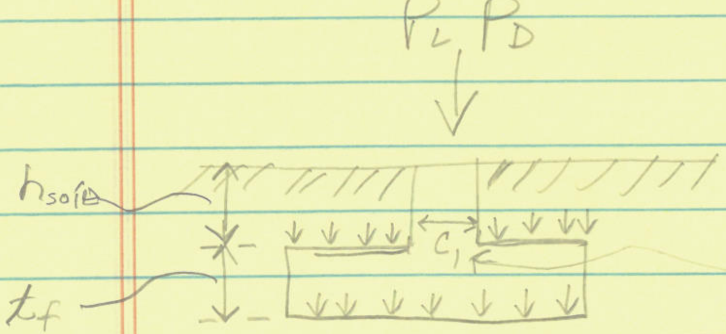
l_d

→ Bearing / Load transfer

@ joint →



Soil Failure



h_{soil} = depth of surcharge
t_f = thickness of footing
rule of thumb $\approx 1.5 C_1$

$q_{actual} \leq q_{allowed}$ (ASD)

$q_{act} = \gamma_{soil} (x) h_{soil} + W_c t_f + \frac{P_D + P_L}{A_{required}}$

($W_c t_f$: weight of footing)

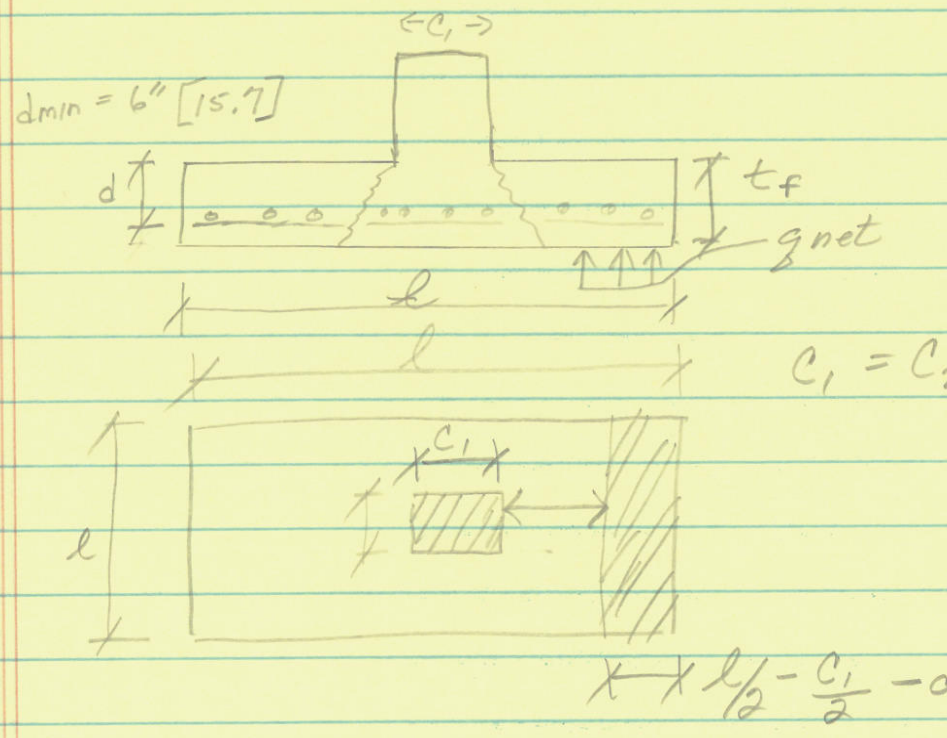
$\frac{P_D + P_L}{A_{req}} \leq q_{allowed} - \gamma_s h_s - W_c t_f$

$\Downarrow$

$A_{req} = \frac{P_D + P_L}{q_{allowed} - \gamma_s h_s - W_c t_f}$

max allowed − soil − footing

⇉ One Way Shear



$c_1 = c_2 = c$ for square

$$V_u = l\left(\frac{l}{2} - \frac{c}{2} - d\right) q_{net}$$

$$V_c = 2\sqrt{f'_c}\; l d \qquad \phi = 0.75$$

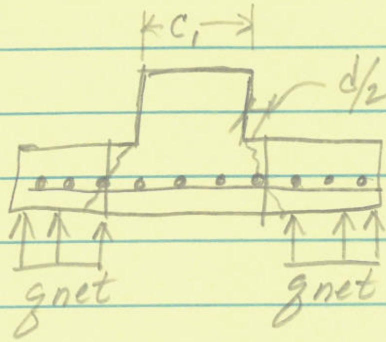
[11.4.5.1]

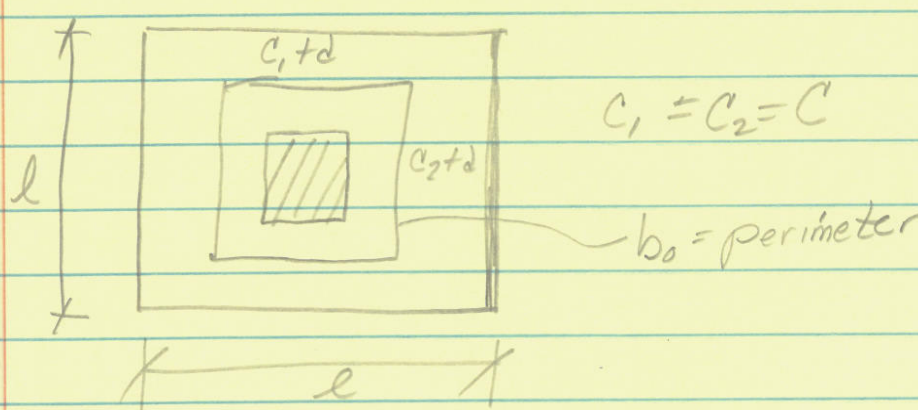
If $\phi V_c > V_u \rightarrow$ No shear required

If Shear problems

- Increase t_F
- Use Shear reinforcing

Two Way Shear





$$V_u = [\ell^2 - (c+d)^2]\, q_{net}$$

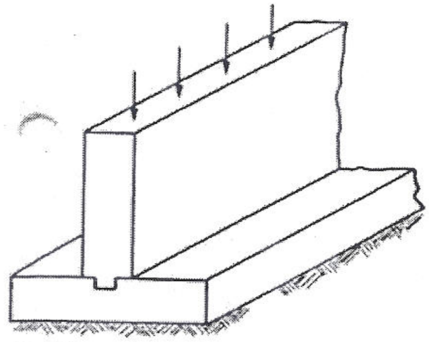
$$V_c = \min \begin{cases} \left(2 + \frac{4}{\beta}\right)\sqrt{f'_c}\, b_o d \\ \left(\frac{\alpha_s d}{b_o} + 2\right)\sqrt{f'_c}\, b_o d \\ 4\sqrt{f'_c}\, b_o d \end{cases}$$

β = ratio long side to short side

α_s = 40 interior column
30 edge column
20 corner column

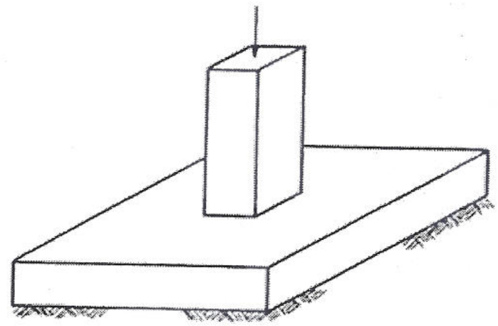
If $\phi V_c \geq V_u$, no shear reinf. needed

Footings
ENCE 4359 Structural Concrete Design
Dr. Lamanna

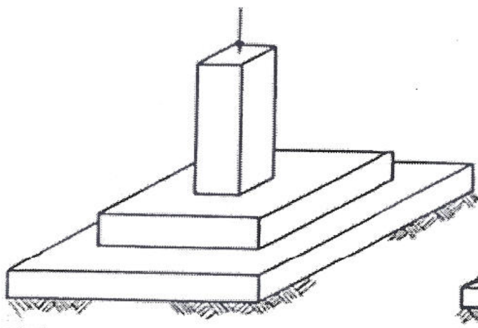


(a) Strip or wall footing.

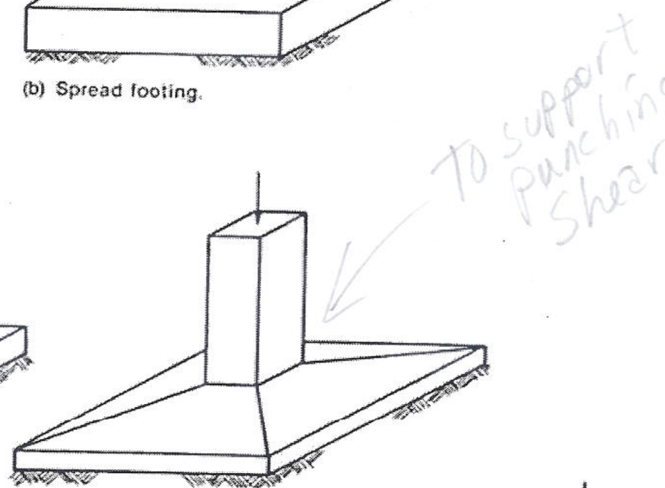
Chain Wall



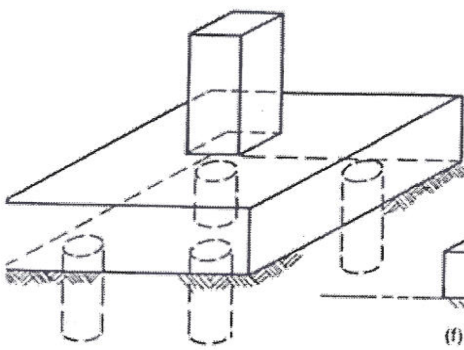
(b) Spread footing.



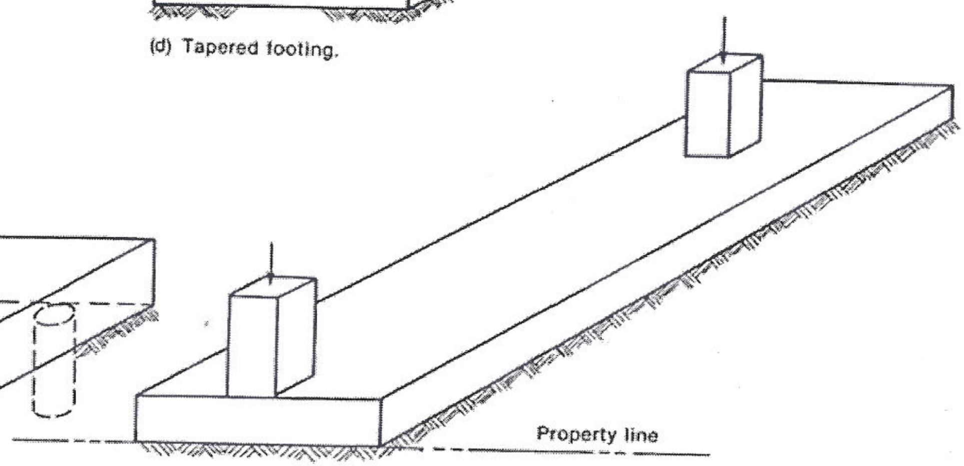
(c) Stepped footing.



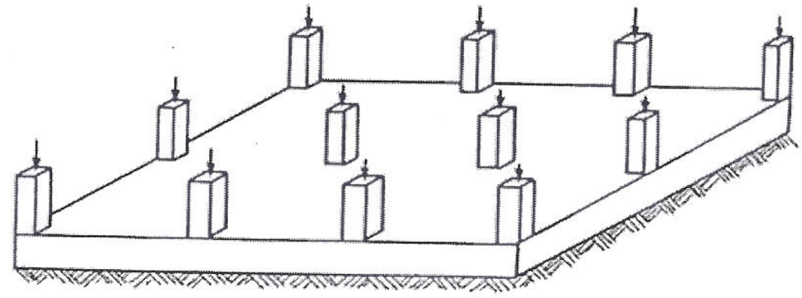
(d) Tapered footing.



(e) Pile cap.



(f) Combined footing.



(g) Mat or raft footing.