Lecture 09

Design of Wall and Column Footings

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Introduction

• The substructure, or foundation, is the part of a structure that is usually placed below the surface of the ground and that transmits the load to the underlying soil or rock.

• Function of a foundation is to transfer the structural loads from a building safely into the ground.

• Foundation is regarded as the most important component of engineered systems.
Types of Foundations

- Foundations can be divided into two broad categories depending on the depth of foundation;

1. Shallow Foundations
   - Load transfer occur at shallower depths.
   - Isolated, Wall, Combined, Mat footings.

2. Deep Foundations
   - Load transfer occur at deeper depths.
   - Piles, drilled piers, drilled caissons

Types of Foundations

- Shallow Foundations
  1. Isolated Column Footing
     - Isolated column footing carrying a single column is usually called spread footing.
Types of Foundations

- Shallow Foundations
  1. Isolated Column Footing
     - Sometimes spread footings are stepped, or are tapered to save materials.

![Spread Footing (Tapered)](image1)  ![Spread Footing (Stepped)](image2)

2. Wall Footing (Strip Footing)
   - Wall footings or strip footings display essentially one-dimensional action, cantilevering out on each side of the wall.
Types of Foundations

• Shallow Foundations

3. Combined Footing
   • A combined footing is a type of footing supporting two or more than two columns. There are two common configurations of combined footings:
     1. Two Column Footing
        • Such a footing is often used when one column is close to a property line.

2. Column Strip or Multiple Column Footing
   • A combined footing may also be used if the space between adjoining isolated footings is small.
Types of Foundations

• Shallow Foundations

4. Mat Footing
   • A mat or raft foundation transfers the loads from all the columns in a building to the underlying soil.
   • Mat foundations are used when excessive loads are supported on a limited area or when very weak soils are encountered.
   • Mat footings are essentially inverted slabs and hence they have as much configurations as typical slab systems have.

Types of Foundations

• Shallow Foundations

5. Mat Footing

Mat Footing with Beams

Mat Footing without Beams
Types of Foundations

- **Shallow Foundations**
  5. Mat Footing

![Mat Footing with Drop Panels](image1)
![Mat Footing with Column Capitals](image2)

- **Deep Foundations**
  6. Pile Foundation
  - This type of foundation is essential when the supporting ground consists of structurally unsound layers of materials to large depths.
  - The piles may be either end bearing, skin friction, or both.
Types of Foundations

- **Choice of Foundation**
  - The choice of foundation type is selected in consultation with geotechnical engineer.
  - Factors to be considered are:
    - Soil strength
    - Soil type
    - Variability of soil type over the area and with increasing depth
    - Susceptibility of the soil and the building to deflections.
    - Construction methods

Following types of footing will be discussed in detail in the next slides:

1. Wall Footing
2. Isolated Column Footing
1. Wall Footing

General

- Behavior:
  - A wall footing behaves similarly to a cantilever beam, where the cantilever extends out from the wall and is loaded in an upward direction by the soil pressure.
**General**

- **Behavior:**
  - The wall footing has bending in only one direction, it is generally designated in much the same manner as a one way slab, by considering a typical 12-in. wide strip along the wall length.
  - The simple principles of beam action apply to wall footings with only minor modifications.

![Deflected shape of footing](image)

- **Reinforcement:**
  - Main reinforcement for flexure is placed at the bottom of the footing perpendicular to the wall along the short direction, as shown.
  - Temperature reinforcement is placed at the bottom of the footing parallel to the wall along the long direction.

![Main reinforcement and plan of wall footing](image)
ACI Recommendations

- **ACI Chapter 13**
  - ACI section 13.3 contains provisions for shallow foundations.

**Required Footing Area**

- Footing bearing area is calculated based on unfactored forces or service loads (ACI 13.3.1.1)
- **Bearing Area,** $A_{req} = \frac{\text{Service Load}}{q_e}$
  - Where Effective bearing capacity, $q_e = q_a - W$
  - ($W = \text{Weight of fill} + \text{weight of concrete}$)

- **Bearing pressure for strength design of footing,** $q_u$:
  - $q_u = \frac{\text{Factored load on column}}{A_{req}}$
ACI Recommendations

Design Considerations in Flexure

- The maximum factored moment is calculated at critical section.

- For a footing supporting masonry wall, critical section is located between the edge and the middle of the wall. (ACI 13.2.7.1)
  \[ M_u = \frac{q_u (k + b/4)^2}{2} \]

- For a footing supporting concrete wall, critical section is located at the face of the wall. (ACI 13.2.7.1)
  \[ M_u = \frac{q_u k^2}{2} \]
ACI Recommendations

• Design Considerations in Flexure
  • Minimum reinforcement Requirement, $A_{\text{min}}$ (ACI 7.6.1.1):
    • For less than Grade 60, $A_{\text{min}} = 0.0020 \ bh$
    • For Grade 60, $A_{\text{min}} = 0.0018 \ bh$
  • Maximum spacing requirement
    • Maximum spacing = 3h or 18”
  • Clear cover
    • Minimum 3” clear cover must be provided to protect the bars from corrosion.

ACI Recommendations

• Distribution of Reinforcement
  • ACI 13.3.2.2 states that in one-way footings, reinforcement shall be distributed uniformly across entire width of footing.

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ACI Recommendations

• Design Considerations in Shear
  • The behavior of footings in shear is similar to beams.
  • Only one-way shear or beam shear is significant in wall footing. Hence determining critical shear at critical section which is at a distance “d” from the face of support.

ACI Recommendations

• Design Considerations in Shear
  • Calculation of Critical shear at distance ‘d’

\[ V_u = q_u b(k - d) \]

Where \( b \) is unit width equal to 1 foot

![Diagram of wall footing with labels k and d]
ACI Recommendations

- Design Considerations in Shear
  - Beam shear capacity ($\Phi V_c$)
    \[ \Phi V_c = \Phi 2 \sqrt{f'c} \cdot b \cdot d \]
    Where $b$ is unit width equal to 1 foot

  If $\Phi V_c < V_u$, the depth of footing is increased instead of providing any shear reinforcement.

Design Procedure

- The design involves the following steps:
  - Step # 01: Estimate the thickness of footing, $h$
    Assume thickness $h$ of the footing which must satisfy the shear requirements. (Min. thickness of footing on soil = 9 in.).
  - Step # 02: Calculate weight of fill + weight of concrete, $W$
    \[ W = W_{\text{conc}} + W_{\text{fill}} \]
  - Step # 03: Calculate effective bearing capacity, $q_e$
    \[ q_e = q_a - W \] (Allowable bearing capacity of soil)
  - Step # 04: Calculate bearing area, $A_{\text{req}}$
    \[ A_{\text{req}} = \text{service load} / q_e \]
Design Procedure

• The design involves the following steps:
  
  • Step # 05: Calculate design pressure on base of footing due to factored loads, \( q_u \)
    \[
    q_u = \frac{\text{Factored load}}{\text{Bearing area}}
    \]
  
  • Step # 06: Calculate the critical shear, \( V_u \)
    \[
    V_u = q_u b (k - d)
    \]
  
  • Step # 07: Check the shear capacity, \( \Phi V_c \)
    \[
    \Phi V_c = \Phi 2 \sqrt{f'_c bd}
    \]
    \( \Phi V_c \) shall be equal to or greater than \( V_u \), if \( \Phi V_c < V_u \), increase thickness of footing.

  • Step # 08: Calculate maximum moment, \( M_u \)
    \[
    M_u = \frac{q_u (k + \frac{b}{2})^2}{2} \quad (\text{Masonry wall}) \\
    M_u = \frac{q_u k^2}{2} \quad (\text{Concrete wall})
    \]
    where; \( b = \text{wall thickness} \)

  • Step # 09: Calculate steel area, \( A_s \)
    \[
    A_s = M_u / \Phi f_y (d - a/2), \quad a = 0.2h
    \]
    By trial and success method, find \( A_s \)
Design Procedure

- The design involves the following steps:
  - **Step # 10: Minimum reinforcement and maximum spacing check**
    - $A_{smin} = 0.0020 \ bh$ For less than Grade 60
    - $A_{smin} = A_{dist} = 0.0018 \ bh$ For Grade 60
    - Maximum spacing = 3h or 18" 
  - **Step # 11: Bars Spacing/Placement**
    - Main Bars: Spacing = $A_b \times 12 / A_s$
    - Distribution Bars: Spacing = $A_b \times 12 / A_s$

- **Step # 12: Drafting**

Example 9.1

- Design Example: Wall Footing
  - A 12-in thick concrete wall carries a service dead load of 10 kips/ft and a service live load of 12.5 kips/ft. The allowable soil pressure, $q_a$, is 5000 psf at the level of the base of the footing, which is 5 ft below the final ground surface. Design a wall footing using $f'_c = 3000$ psi and $f_y = 60,000$ psi. The density of soil is 120 lb/ft$^3$. 

Example 9.1

- Design Example: Wall Footing
Example 9.1

- Design Example: Wall Footing

- Step # 01: Estimate the thickness of footing, $h$
  - Assuming a trial thickness, $h = 12$ in.
  - Effective depth, $d = 12 - 3$ in. cover – $\frac{1}{2}$ (bar diameter) ≈ 8.5 in.

- Step # 02: Calculate weight of fill and weight of concrete, $W$
  - $W = W_{\text{conc}} + W_{\text{fill}} = 1 \times 0.15 + 4 \times 0.12 = 0.63 \text{ ksf}$

- Step # 03: Calculate effective bearing capacity, $q_e$
  - $q_e = q_a - W$
    - $q_e = 5 - 0.63 = 4.37 \text{ ksf}$
Example 9.1

**Step # 04: Calculate bearing area, \( A_{req} \)**
- \( A_{req} = \text{service load} / q_e \)
  - Service load = 10 + 12.5 = 22.5 kips/ft
  - \( A_{req} = 22.5 / 4.37 = 5.15 \text{ ft}^2 \) per foot of length
- Trying a footing 5 ft 2 in. wide

**Step # 05: Calculate design pressure on base of footing due to factored loads, \( q_u \)**
- \( q_u = \text{Factored load} / \text{Bearing area} \)
  - Factored loads = 1.2(10) + 1.6(12.5) = 32 kips
  - \( q_u = 32 / 5.17 = 6.19 \text{ ksf} \)

**Step # 06: Calculate the critical shear, \( V_u \)**
- Only one-way shear is significant in wall footing, hence determining critical shear at distance \( d \) from the face of support.
  - \( d = 12 - 3 \text{ in. cover} - \frac{1}{2} (\text{bar diameter}) = 8.5 \text{ in.} \)
  - \( V_u = q_u b (k - d) \)
  - \( V_u = 6.19 \times 1 \times \frac{(25 - 8.5)}{12} \)
  - \( V_u = 8.51 \text{ kips/ft} \)
Example 9.1

- **Step # 07: Check the shear capacity, $\Phi V_c$**
  - **Check the Thickness for Shear**
    - Shear capacity, $\phi V_c = \phi 2 \sqrt{f'_c bd}$
      \[ = \left(0.75 \times \sqrt{3000}\right) \times 12 \times 8.5 \right) / 1000 \]
      \[ \phi V_c = 9.50 \text{ kips} \]
    - Since $V_u < \phi V_c$, the footing depth is OK. If $V_u$ is larger or considerably smaller than $\phi V_c$ then chose a new thickness and repeat the previous steps.
    - Using 12 in thick and 5 ft 2 in wide footing.

- **Step # 08: Calculate maximum moment, $M_u$**
  \[ M_u = \frac{4uk^2}{2} = 6.19((25/12)^2 \times 1)/2 \]
  \[ = 13.43 \text{ ft-kips/ft of length} \]

- **Step # 09: Calculate steel area, $A_s$**
  - Now, using trial and success method for determining $A_s$,
    \[ A_s = M_u / \Phi f_y (d - a/2), \quad a = 0.2h \]
  - $A_s = 0.390 \text{ in}^2 / \text{per foot}$. 
Example 9.1

Step # 10: Minimum reinforcement and maximum spacing check

- Min reinforcement
  \[ A_{s,\text{min}} = 0.0018bh = 0.0018 \times 12 \times 12 = 0.26 \text{ in}^2/\text{ft} \]
  \[ A_s > A_{s,\text{min}} \text{ O.K} \]
- Max spacing = 3h or 18\( \frac{\text{in}}{\text{c}} \) = 3(12) = 36\( \frac{\text{in}}{\text{c}} \) or 18\( \frac{\text{in}}{\text{c}} \) (OK)

Step # 11: Bars Spacing/Placement

- Main Bars: Spacing = \( A_b \times 12 / A_s \)
  - Using #5 bars, spacing = \( 0.31 \times 12 / 0.390 = 9.53 \approx 9 \text{ in. c/c} \)
- Distribution Bars:
  \[ A_{st} = 0.0018bh = 0.0018 \times 12 \times 12 = 0.26 \text{ in}^2 \]
  - Using #5 bars, spacing = \( 0.31 \times 12 / 0.26 = 14.3 \text{ c/c} \)
  - We will use 5 #5 bars at equal spacing in the total footing width of 62 in. – 3 in. cover on one side – 3 in. cover on other side = 56\( \frac{\text{in}}{\text{c}} \)
Example 9.1

- Step # 12: Drafting

Example 9.2

- Design Example: Wall Footing
  - A 12-in thick concrete wall carries a service dead load of 15 kips/ft and a service live load of 10 kips/ft. The allowable soil pressure, $q_a$, is 5000 psf at the level of the base of the footing, which is 5 ft below the final ground surface. Design a wall footing using $f'_c = 3500$ psi and $f_y = 50,000$ psi. The density of soil is 120 lb/ft$^3$. 
2. Isolated Column Footing

General

- **Shape:**
  - Individual column footings are generally square in plan.
  - Rectangular shapes are sometimes used where dimensional limitations exists.
General

• Behavior:
  • The footing is a slab that directly supports a column.
  • Isolated footings display essentially two-dimensional action, cantilevering out on both orthogonal sides of the column.
  • The footing is loaded in an upward direction by the soil pressure.
  • Tensile stresses are induced in each direction in the bottom of the footing.

General

• Reinforcement:
  • A spread footing will typically have reinforcement in two orthogonal directions at the bottom of the footing for flexure.
**General**

- **Required Footing Area**
  - Bearing Area, \( A_{req} = (B \times L) = \text{Service Load/} q_e \)

- \( q_u \) (bearing pressure for strength design of footing):
  - \( q_u = \text{factored load on column/} A_{req} \)

**ACI Recommendations**

- **Design Considerations in Flexure**
  - The maximum factored moment is calculated at critical section.
    - For an isolated footing, critical section is located at the face of the column.
    - \( M_i = q_u B k^2/2 \), where \( k = (B - C)/2 \)
ACI Recommendations

- Design Considerations in Flexure
  - Minimum Reinforcement ($A_{\text{min}}$):
    - $A_{\text{min}} = 0.005B_d^{\text{avg}}$
  - Maximum Spacing Requirement (ACI 7.7.2.3):
    - Least of $3h$ or $18''$

ACI Recommendations

- Distribution of Reinforcement
  - *ACI* 13.3.3.2 states that in two-way square footings, reinforcement shall be distributed uniformly across entire width of footing.
ACI Recommendations

- **Design Considerations in Shear**
  - The footing thickness (depth) is generally established by the shear requirement.
  - The footing is subjected to two-way action. The two-way shear is commonly termed Punching shear, since the column or pedestal tends to punch through the footing, induces stresses around the perimeter of the column.
  - Beam shear is not usually a problem in a isolated footing.

ACI Recommendations

- **Design Considerations in Shear**
  - Two-Way Shear (Punching Shear)
    - The critical section for this two-way shear is taken at d/2 from the face of the column.
ACI Recommendations

• Design Considerations in Shear
  • Calculation of Critical shear at distance ‘d/2’
    
    \[ V_{up} = q_u B^2 - q_u (c + d_{avg})^2 \]
    
    \[ V_{up} = q_u \left( B^2 - (c + d_{avg})^2 \right) \]

ACI Recommendations

• Design Considerations in Shear
  • Punching shear capacity \((\Phi V_{cp})\)
    
    \[ \Phi V_{cp} = \Phi 4 \sqrt{f'c b_o d_{avg}} \]
    
    Where \(b_o\) is Critical Shear Parameter, \(b_o = 4 x (c + d_{avg})\)
ACI Recommendations

- Design Considerations in Shear

\( \Phi V_{cp} \) should be equal to or greater than \( V_{up} \). If \( \Phi V_{cp} < V_{up} \), the depth of footing is increased instead of providing any shear reinforcement.

Design Procedure

- The design involves the following steps:
  - **Step # 01: Estimate the thickness of footing, \( h \)**
    
    Assume thickness \( h \) of the footing which must satisfy the shear requirements. (Min. thickness of footing on soil = 6 in.). Also find ‘d’.
  
  - **Step # 02: Calculate weight of fill + weight of concrete, \( W \)**
    
    \[ W = W_{conc} + W_{fill} \]
  
  - **Step # 03: Calculate effective bearing capacity, \( q_e \)**
    
    \[ q_e = q_a - W \quad (q_a = \text{Allowable bearing capacity of soil}) \]
  
  - **Step # 04: Calculate bearing area, \( A_{req} \)**
    
    \[ A_{req} = \text{service load} / q_e \]
Design Procedure

- The design involves the following steps:
  - Step # 05: Calculate critical shear parameter, \( b_o \)
    
    Critical Perimeter, \( b_o = 4 \times (c + d_{avg}) \)
  
  - Step # 06: Calculate design pressure on base of footing due to factored loads, \( q_u \)
    
    \( q_u = \text{Factored load} / \text{Bearing area} \)
  
  - Step # 07: Calculate the punching shear force, \( V_{up} \)
    
    \[ V_{up} = q_u \left( B^2 - (c + d_{avg})^2 \right) \]
  
  - Step # 08: Check the punching shear capacity, \( \Phi V_{cp} \)
    
    \[ \Phi V_{cp} = \Phi 4 \sqrt{f'_c b_o d_{avg}} \quad \boxed{\Phi V_{cp} \geq V_{up}} \]
    
    \( \Phi V_{cp} \) shall be equal to or greater than \( V_{up} \), if \( \Phi V_{cp} < V_{up} \), increase thickness of footing
  
  - Step # 09: Calculate maximum moment, \( M_u \)
    
    \[ M_u = q_u B k^2 \quad \text{where; } k = (B - C)/2 \]
  
  - Step # 10: Calculate steel area, \( A_s \)
    
    \[ A_s = M_u / \Phi f_y \left( d - a/2 \right) \quad \text{By trial and success method, find } A_s \]

(Continued on next page...)

Design Procedure (continued)

- The design involves the following steps (continued):
  
  - Step # 08: Check the punching shear capacity, \( \Phi V_{cp} \)
    
    \[ \Phi V_{cp} = \Phi 4 \sqrt{f'_c b_o d_{avg}} \quad \boxed{\Phi V_{cp} \geq V_{up}} \]
    
    \( \Phi V_{cp} \) shall be equal to or greater than \( V_{up} \), if \( \Phi V_{cp} < V_{up} \), increase thickness of footing
  
  - Step # 09: Calculate maximum moment, \( M_u \)
    
    \[ M_u = q_u B k^2 \quad \text{where; } k = (B - C)/2 \]
  
  - Step # 10: Calculate steel area, \( A_s \)
    
    \[ A_s = M_u / \Phi f_y \left( d - a/2 \right) \quad \text{By trial and success method, find } A_s \]
Design Procedure

- The design involves the following steps:
  - Step #11: Minimum reinforcement check, $A_{smin}$
    \[ A_{smin} = 0.005B_{davg} \]
  - Step #12: Bars Placement
  - Step #13: Drafting

Example 9.3

- Design of a square column footing

A column 18" square with $f'_c = 3$ ksi reinforced with 8 #8 bars of $f_y = 40$ ksi, supports a service load of 81.87 kips (factored load = 103.17 kips). The allowable soil pressure is 2.204 k/ft². Design a square footing with base 5’ below surface. Take unit weight of soil as 100 psf.
Example 9.3

- **Data Given:**
  - Column size = 18" × 18"
  - $f'_c = 3$ ksi
  - $f_y = 40$ ksi
  - $q_a = 2.204$ k/ft²
  - Factored load on column = 103.17 kips (Reaction at the support)
  - Service load on column = 81.87 kips (Reaction at the support due to service load)

- **Step # 01: Estimate the thickness of footing, h**
  - Assume $h = 15$ in.
  - $d_{avg} = h – \text{clear cover} – \text{one bar dia} = 15 – 3 – 1(\text{for #8 bar}) = 11$ in.

- **Step # 02: Calculate overburden pressure, W**
  - Assume depth of the base of footing from ground level ($z$) = 5'
  - Weight of fill and concrete footing, $W = W_{\text{conc}} + W_{\text{fill}}$
    
    $W = \gamma_{\text{fill}}(z - h) + \gamma_c h = 100 \times (5 - 1.25) + 150 \times (1.25)$
    
    $W = 562.5$ psf = 0.5625 ksf
Example 9.3

- **Step # 03: Calculate effective bearing capacity, \( q_e \)**
  - Effective bearing capacity, \( q_e = q_a - W \)
  - \( q_e = 2.204 - 0.5625 = 1.642 \) ksf

- **Step # 04: Calculate bearing area, \( A_{req} \)**
  - Bearing area, \( A_{req} = \frac{\text{Service Load}}{q_e} \)
  - \( A_{req} = 81.87 / 1.642 = 49.86 \) ft²
  - \( A_{req} = B \times B = 49.86 \) ft²
  - \( B = 7 \) ft.

- **Step # 05: Calculate critical shear parameter, \( b_o \)**
  - Critical Perimeter, \( b_o = 4 \times (c + d_{avg}) \)
  - \( b_o = 4 \times (18 + 11) = 116 \) in

- **Step # 06: Calculate design pressure on base of footing due to factored loads, \( q_u \)**
  - \( q_u = \frac{\text{factored load on column}}{A_{req}} \)
  - \( q_u = 103.17 / (7 \times 7) = 2.105 \) ksf
Example 9.3

Step # 07: Calculate the punching shear force, $V_{up}$

- $V_{up} = q_u \left( B^2 - (c + d_{avg})^2 \right)$
- $V_{up} = q_u B^2 - q_u (c + d_{avg})^2$
- $V_{up} = 2.105 \left[ 7^2 - \left( \frac{18+11}{12} \right)^2 \right]$
  $= 90.85 \text{ kip}$

Step # 08: Check the punching shear capacity, $\Phi V_{cp}$

- $V_{up} = 90.85 \text{ kip}$

Punching shear capacity ($\Phi V_{cp}$)

$\Phi V_{cp} = \Phi 4 \sqrt{f'c} b_d d_{avg}$

$\Phi V_{cp} = 0.75 \times 4 \times \sqrt{3000} \times 116 \times 11/1000$

$\Phi V_{cp} = 209.66 \text{ k} > V_{up}, \text{ O.K}$
Example 9.3

- **Step # 09: Calculate maximum moment, M_u**
  - \( M_u = q_u B k^2 / 2 \)
  - \( k = (B - C) / 2 = (7 \times 12 - 18) / 2 \)
    - \( = 33 \text{ in} = 2.75' \)
  - \( M_u = 2.105 \times 7 \times 2.75 \times 2.75 / 2 \)
    - \( = 55.72 \text{ ft-k} \)
    - \( = 668.60 \text{ in-kip} \)

- **Critical Section**

Example 9.3

- **Step # 10: Calculate steel area, A_s**
  - \( M_u = 668.60 \text{ kip-in} \)
  - \( a = 0.2 d_{avg} = 0.2 \times 11 = 2.2'' \)
  - \( A_s = M_u / (\Phi f_y (d_{avg} - a/2)) = 668.60 / (0.9 \times 40 \times (11 - 2.2/2)) \)
    - \( = 1.87 \text{ in}^2 \)
  - \( a = A_s f_y / (0.85 f'_c B) = 1.83 \times 40 / (0.85 \times 3 \times 7 \times 12) \)
    - \( = 0.35'' \)
  - After trials, \( A_s = 1.71 \text{ in}^2 \)
Example 9.3

Step # 11: Minimum reinforcement check, $A_{smin}$

$$A_{smin} = 0.005 B d_{avg} = 4.62 \text{ in}^2$$

$A_{smin} = 4.62 \text{ in}^2$ so $A_{smin}$ governs.

Step # 12: Bars Placement

- Now, the spacing can be calculated as follows:
- Using #8 bars: No. of bars = $4.62 / 0.79$ 
  $\approx 6$ bars.
- Spacing = $6.5 \times 12 / 5 = 15$ in. c/c
- Hence 6 bars can be provided in the foundation if they are placed 15 in. c/c (Max. spacing should not exceed 3h or 18 in.)
Example 9.3

- Step # 13: Drafting

Example 9.4

- Design of a square column footing

A column 18" square with $f'_c = 3$ksi reinforced with 8 #8 bars of $f_y = 60$ ksi, supports a dead load of 220 kips and live load of 175 kips. The allowable soil pressure is 5 k/ft². Design a square footing with base 5’ below surface. Take unit weight of soil equal to 100 psf.
Assignment # 04

- Submit Example # 9.4 of Lecture 09-Design of Column and Wall Footings in the next class.

References

- Design of Concrete Structures 14th/15th edition by Nilson, Darwin and Dolan.
- ACI 318-14