# Lecture-06, Final-Term,

## Page-01, 17-06-2020

**Pb-02:** A column 18" square with $f'_c = 4ksi$ reinforced with 8 #8 bars of $f_y = 60 ksi$, supported a D.L of 220k and a L.L of 175K. The allowable soil pressure, $q_a = 5 k/ft^2$. Design a square footing with base 5' below grade. Using $f'_c = 4ksi$, $f_y = 60ksi$ and $\gamma_{soil} = 110 Pcf$.

**Sol:** **Step-01:** Let $h = 24"$

**Step-02:** Total Weight = Wt. of Soil + Wt. of R.C

$$= 3 * 110 + 2 * 150 = 630 \text{ Psf}$$
$$= 0.630 \text{ Psf}$$

**Step-03:** Effective Bearing Capacity:

$$q_e = q_a - W = 5 - 0.630$$
$$q_e = 4.37 \text{ ksf}$$

**Step-04:** Required Area for foundation;

$$A_{req} = \frac{\text{Service load}}{q_e} = \frac{220+175}{4.37} = 90.40 ft^2.$$

**Step-05:** Since foundation is square

$$A_{req} = B * B = 90.40 \Rightarrow B \cong 9'-6"$$

# Page - 02;

**Step-06:** Upward Bearing Capacity of Soil

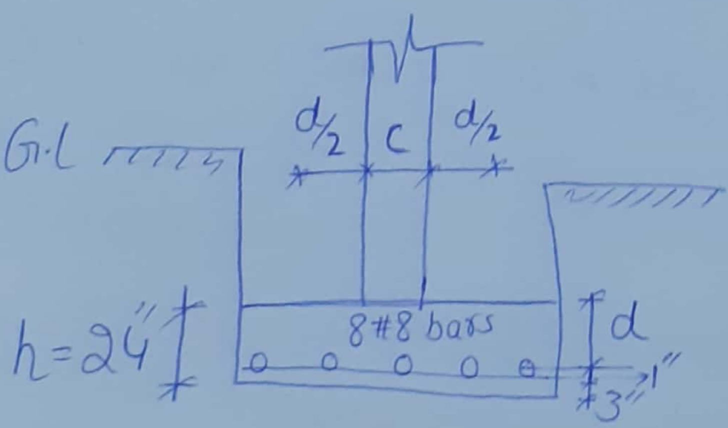
$$q_{up} = \frac{\text{Factored load}}{(B)^2} = \frac{1.2 * 220 + 1.6 * 175}{(9.5)^2}$$

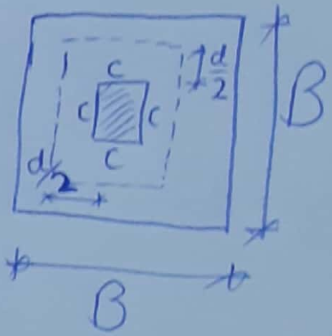
$$q_{up} = 6.03 \; K/ft^2 .$$

**Step-07:** Punching Shear OR, Two Way Shear

$$b_0 = 4 * (c + d)$$

c → Column dimension; d → Effective depth




$$d = h - \text{Clear cover} - \text{dia. of bar} - \frac{1}{2} * d_b$$

$$= 24 - 3 - 1 - \frac{1}{2} * 1 = 19.5''$$

$$b_0 = 4 * (18 + 19.5) = 150''$$

**Step-08:** $V_{u_2} = q_{up} * [B^2 - (c+d)^2] = 6.03 * [9.5^2 - (\frac{18+19.5}{12}$

$$\therefore V_{u_2} = 485.32K$$

# Page-03:

**Step-09:** $\phi V_{c/p} = \phi * 4 * \sqrt{f'_c} * b_o * d$

$$= \frac{0.75 * 4 * \sqrt{4000} * 150 * 19.5}{1000}$$

$$= 554.98K \quad \text{Okay}$$

**Step-10:** Beam Shear/One Way Shear Check

$$V_{u_1} = q_{up} * B * \left[\frac{B}{2} - \frac{c}{2} - d\right]$$

$$V_{u_1} = 6.03 * 9.5 * \left[\frac{9.5}{2} - \frac{18/12}{2} - \frac{19.5}{12}\right]$$

$$V_{u_1} = 136 \text{ K}$$

**Step-11:** Self Shear Capacity:

$$\phi V_c = \phi * 2 * \sqrt{f'_c} * B * d$$

$$= \frac{0.75 * 2 * \sqrt{4000} * (9.5 * 12) * 19.5}{1000}$$

$$= 210.89K > V_{u_1} \Rightarrow O.K$$

**Step-12:** Ultimate Moment.

$$M_u = \frac{q_{up} * B}{8} * (B-C)^2 = \frac{6.03 * 9.5}{8} * \left(9.5 - \frac{18}{12}\right)^2$$

$$M_u = 458.28K' = 5499.36K''$$

# Page-04:

**Step-13:** Area of steel for main bars by Trial & Repeat method.

**Trial-01:** Let $a = 0.2 * h = 0.2 * 24 = 4.8''$

$$A_s = \frac{M_u}{\phi * f_y * (d - \frac{a}{2})} = \frac{5499.36}{0.90 * 60 * (19.5 - \frac{4.8}{2})} = 5.96 \ in^2$$

**Trial-02:**

$$a = \frac{A_s * f_y}{0.85 * f_c' * B} = \frac{5.96 * 60}{0.85 * 4 * (9.5 * 12)} = 0.92''$$

$$A_s = \frac{M_u}{\phi * f_y * (d - \frac{a}{2})} = 5.35 \ in^2.$$

0.82

**Trial-03:** $a = 0.82''$

$A_s = 5.33 \ in^2$

**Trial-04:**

$a = 0.82''$

$A_s = 5.33 \ in^2$

**Step-14:** Check the minimum reinforcement by the following 03 methods;

a- $As_{min} = 0.0018 * B * h = 0.0018 * (9.5 * 12) * 24$

$As_{min} = 4.92 \ in^2$

# Page - 05:

b- $As_{min} = \frac{200}{fy} * B * d$

$As_{min} = \frac{200}{60000} * (9.5*12) * 19.5 = 7.41\ in^2$

C- $As_{min} = \frac{3*\sqrt{f'_c}}{fy} * B * d$

$As_{min} = \frac{3*\sqrt{4000}}{60000} * (9.5*12) * (19.5) = 7.03\ in^2$

Note: From above 03 conditions, greater value will be selected.

**Step-15:** Using #8 bars:

$Ab = 0.785\ in^2$

No. of bars $= \frac{As}{Ab} = \frac{7.41}{0.785} \approx 10$ bars in each direction.