

**Name** \_\_\_\_\_

**Practice of Structural Engineering**

**14.508**

**Take-home Exam #1**

**Problem # 1:** \_\_\_\_\_/5

**Problem # 2:** \_\_\_\_\_/5

**Problem # 3:** \_\_\_\_\_/5

**Problem # 4:** \_\_\_\_\_/5

**Total:** \_\_\_\_\_/20

### Problem #1

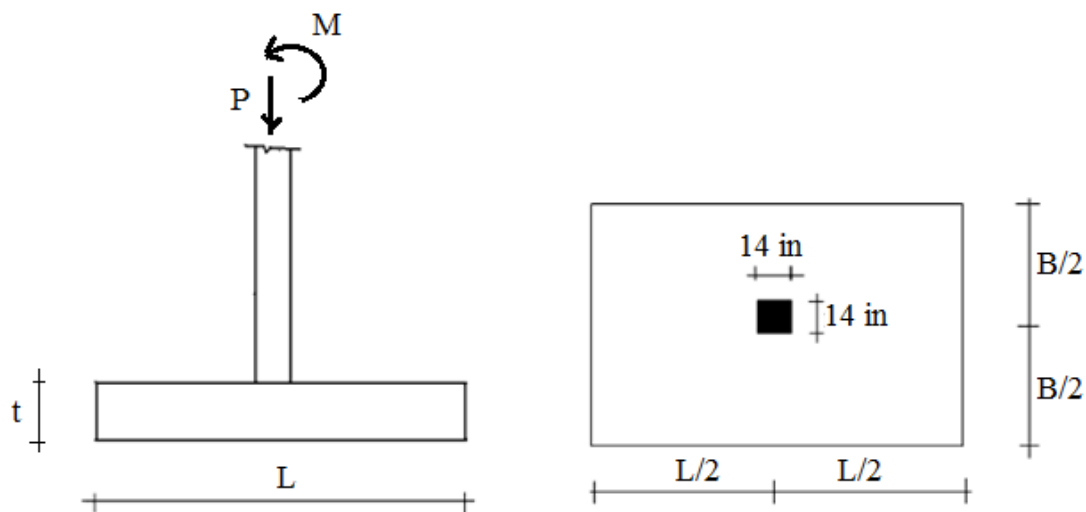
A square/rectangular footing supporting a square column is shown below.

- (a) Determine the footing dimensions  $L$  and  $B$ . Use 3 inch increments
- (b) Determine the required  $t$ . Use 2 inch increments.
- (c) Determine the required reinforcing. Use #8 bars. Show the reinforcing arrangements.

Assume:

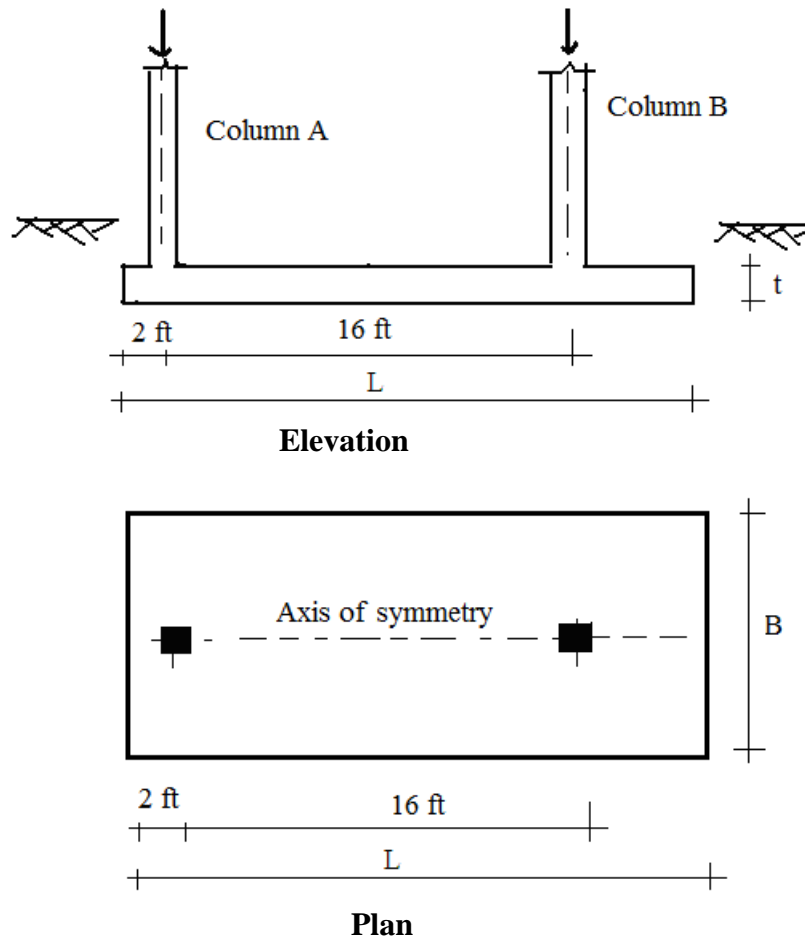
$$f'_c = 4000 \text{ psi} \quad f_y = 60,000 \text{ psi} \quad q_e = 4.5 \text{ kip/ft}^2$$

$$P_D = 140 \text{ kip} \quad P_L = 160 \text{ kip} \quad M_D = 60 \text{ kip ft} \quad M_L = 80 \text{ kip ft}$$



## Problem #2

A combined footing supports two square columns. Column A is 14 inches x 14 inches and carries a dead load of 140 kip and a live load of 220 kip. Column B is 16 inches x 16 inches and carries a dead load of 260 kip and a live load of 300 kip. The effective soil pressure is  $q_e = 4.0 \text{ kip/ft}^2$ . Assume the soil pressure distribution is uniform.



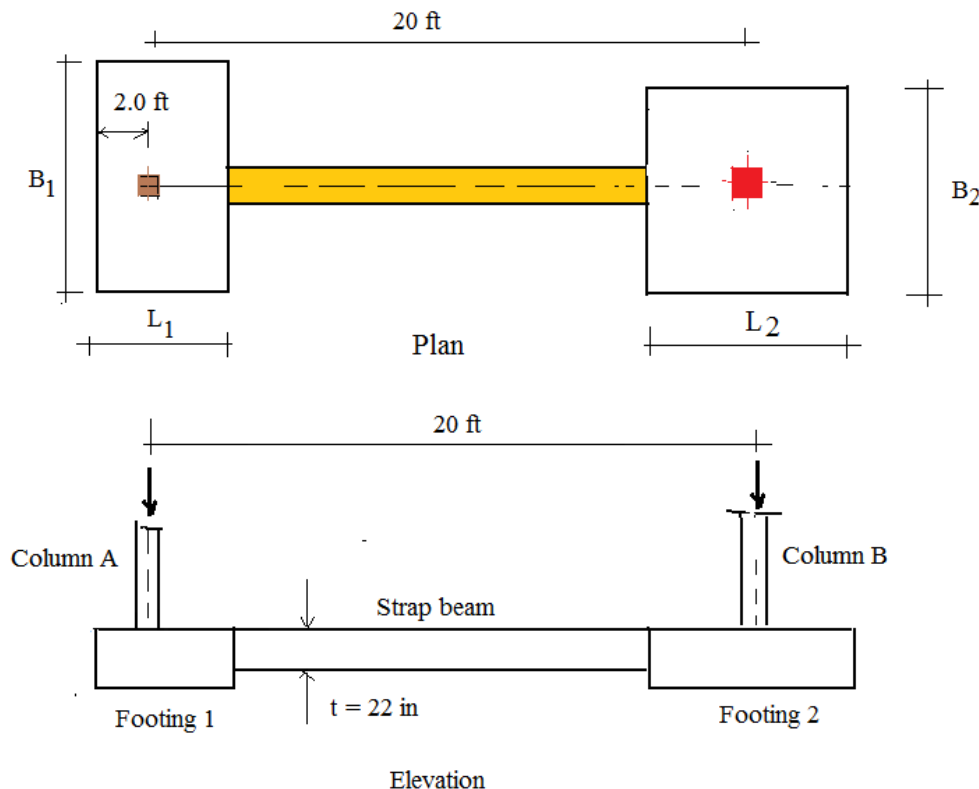
- (a) Determine the footing dimensions  $L$  and  $B$ . Use 3 inch increments.
- (b) Establish the shear and moment diagrams corresponding to the factored loading,  $P_u = 1.2 P_D + 1.6 P_L$ .
- (c) Determine the required  $t$ . Use 2 inch increments.
- (d) Determine the required reinforcing. Use #9 bars. Show the reinforcing arrangements.

Assume:  $f'_c = 4000 \text{ psi}$  and  $f_y = 60,000 \text{ psi}$ .

### Problem #3

Column A is 14 inches x 14 inches and carries a dead load of 160 kip and a live load of 140 kip. The interior column B is 18 inches x 18 inches and carries a dead load of 230 kip and a live load of 200 kip. The distance between the center lines of the columns is 18 ft. A strap footing is used to support the columns. The center line of column A is 2.0 ft. from the property line. Assume the strap is placed such that it does not bear directly on the soil. Assume  $f'_c = 4000$  psi and  $f_y = 60,000$  psi.

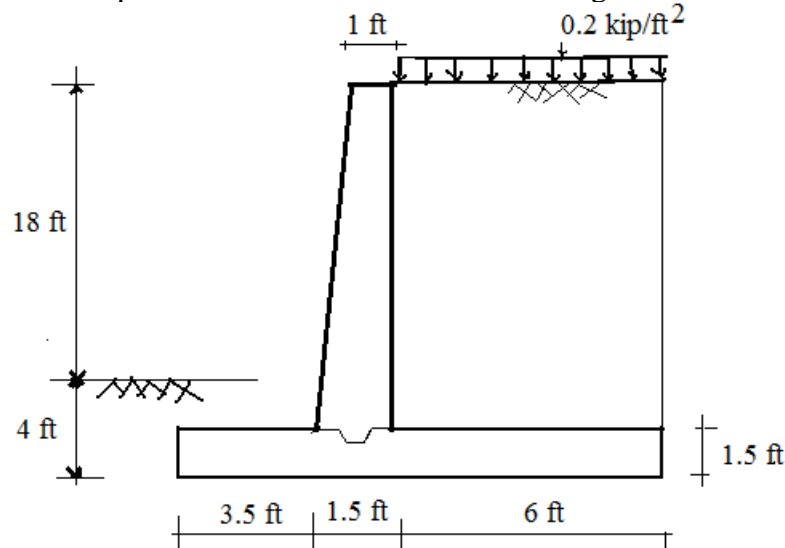
- Determine the dimensions  $L_1$ ,  $B_1$ ,  $B_2$  and  $L_2$  for the pad footings that will result in a uniform effective soil pressure not exceeding  $4.5 \text{ kip/ft}^2$  under each pad footing. Use  $\frac{1}{4}$  ft. increments.
- Establish the shear and moment diagrams corresponding to the factored loading,  $P_u = 1.2 P_D + 1.6 P_L$ .
- Design the strap beam (i.e., determine the required width and reinforcing). Use #8 bars. Show the reinforcing arrangements.
- Determine the soil pressure profile under the footings determined in part (a) when an additional loading, consisting of an uplift force of 90 kip at the exterior column and an uplift force of 40 kip at the interior column, is applied to the factored loads.



### Problem # 4

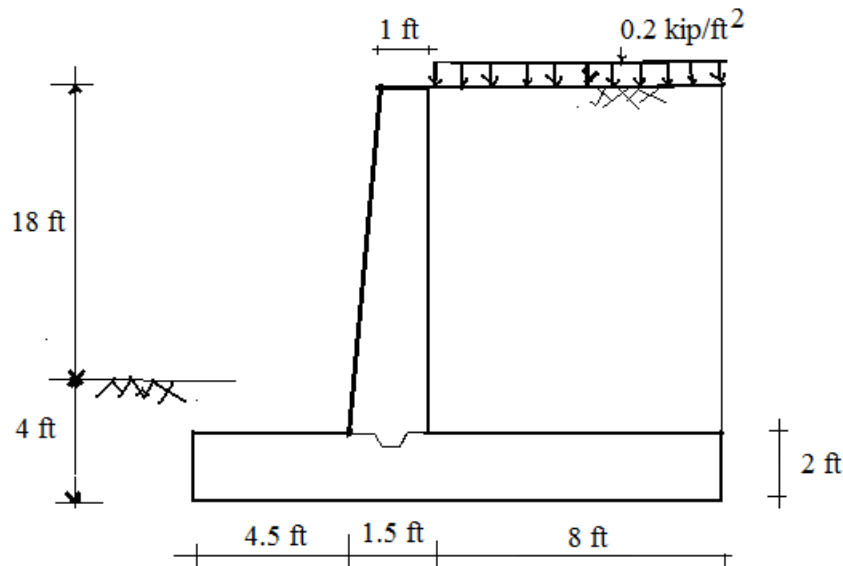
(a) For the cantilever retaining wall shown below, determine the following:

- The soil pressure acting on the wall
- The factor of safety for overturning
- The factor of safety for sliding
- The soil pressure distribution under the footing



(b) To improve the soil pressure distribution under the footing, the footing size is increased as shown below. Select the reinforcing and show the reinforcing details. Use #8 or #4 bars.

Assume: Allowable soil pressure = 4.5 kip/ft<sup>2</sup>,  $f'_c = 4000$  psi,  $f_y = 60,000$  psi,  $\gamma_{\text{soil}} = 0.12$  kip/ft<sup>3</sup>,  $\gamma_{\text{concrete}} = 0.15$  kip/ft<sup>3</sup>,  $k_a = 1/3$ , and  $\mu = .58$



(c) Are the dimensions of the stem and base appropriate for optimal design? What is your suggestion?