Design of Pier, for Harrington, Garage, and Truss Bridge

Calculate Resultant Force R, Using Known F_x, F_y, and F_z values.

$$R_{xy} = \sqrt{x^2 + y^2}$$

$$R = \sqrt{R_{xy}^2 + z^2}$$

Known Values

Compressive Strength of Concrete

$$f'c = 4000\ psi$$

Allowable Soil Pressure

$$q_a = 8000\ psi$$

Concrete Self weight

$$w_c = 150\ pcf$$

Soil Pressure

$$w = 120\ pcf$$

Calculate Effective Bearing Capacity to Carry Column Load

(Minimum Depth Cover for column is 4ft)

$$q_e = q_a - w_c \times 4ft$$

Calculate the Area Required

$$A_{req} = \frac{R}{q_e}$$

After Calculating Area required, solve for a Base, b, value that will meet the Area required.

For Strength Design, Upward pressure caused by column load is the Resulstant divided by Base, B

$$q_u = \frac{R}{b}$$

Based on the Base, b, and A req, find a column side length, lc, and d value.

Footing Depth is determined by punching shear on critical perimeter abcd, length of critical perimeter is bo

$$b_o = 4(L_c + d)$$

The punching Shear force acting on this perimeter is equal to total upward pressure minus that acting within the perimeter abcd

$$V_{u1} = q_u(b^2 - \left(\frac{L_c + d}{12}\right)^2$$

Corresponding nominal shear strength is Vc

$$V_c = 4\lambda\sqrt{4000}b_o(d \times 2)$$

$$\phi V_c = 0.75 \times V_c$$

If design strength exceeds factored shear V_{u1}, depth value, d, is adequate for punching shear.

The selected value d will now be checked for beam shear.

$$V_{u2} = q_u b \times (d2)$$

Nominal shear strength

$$V_c = 2\lambda\sqrt{4000}b \times 12 \times d$$

Design Shear Strength

$$\phi V_c = 0.75 \times V_c$$

If design shear strength is larger than factored shear Vu2 then d will be adequate for one-way shear.

Solve for the moment Mu

$$M_u = q_u b \left(\frac{a^2}{2}\right) * 12$$

Using Mu value, the required area of steel is

$$A_s = \frac{M_u}{.9 \times f_y \times (d - 1)}$$

Checking the minimum reinforcement ratios

$$A_{smin} = \frac{3\sqrt{f'c}}{f_y} \times 114 \times d$$

Steel reinforcement cannot be less than

$$A_{smin} = \frac{200}{f_y} \times 114 \times d$$

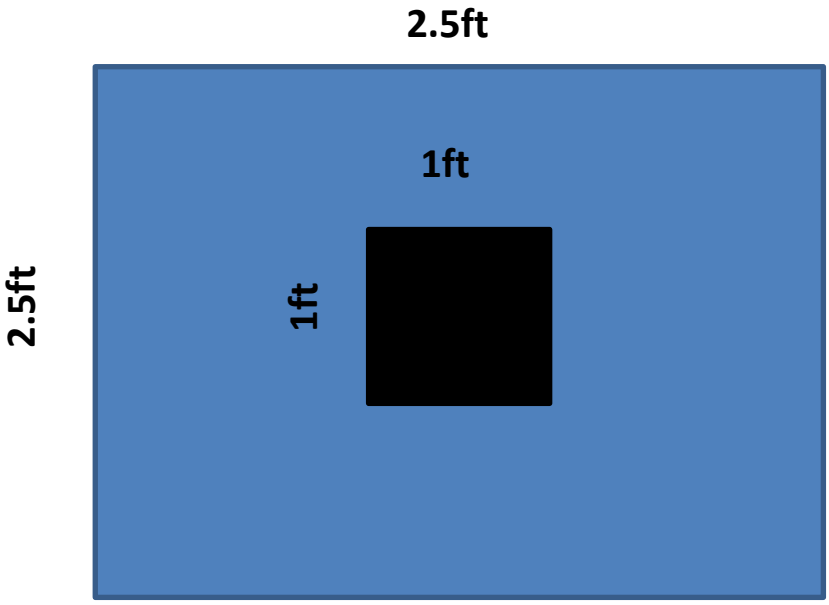
Selecting an economical Bar, such as #7rebar, calculate required numbers of rebar, and spacing.

Calculate height of footer

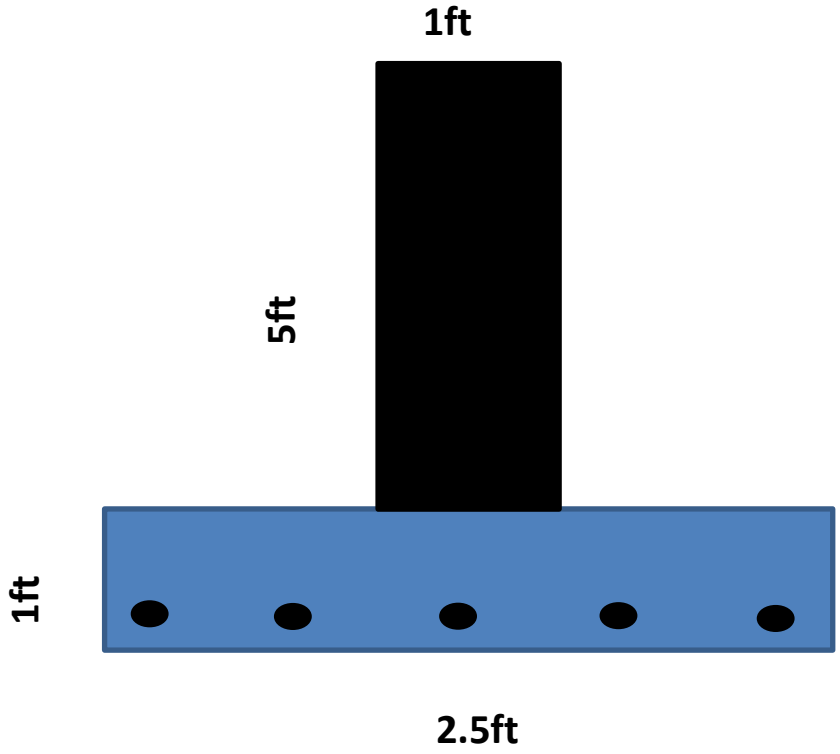
$$H = D + 1.5 \times 1 + 3$$

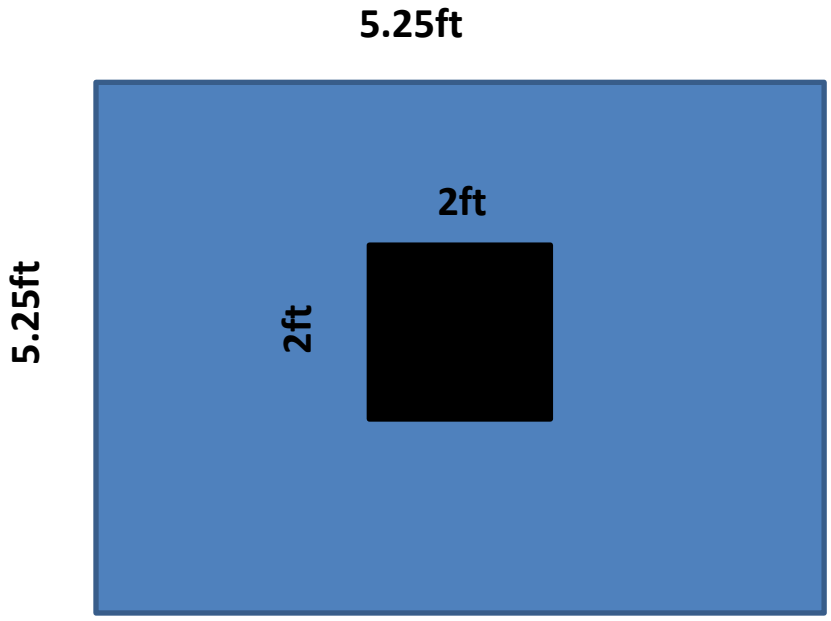
Make Final Recommendations based on calculations

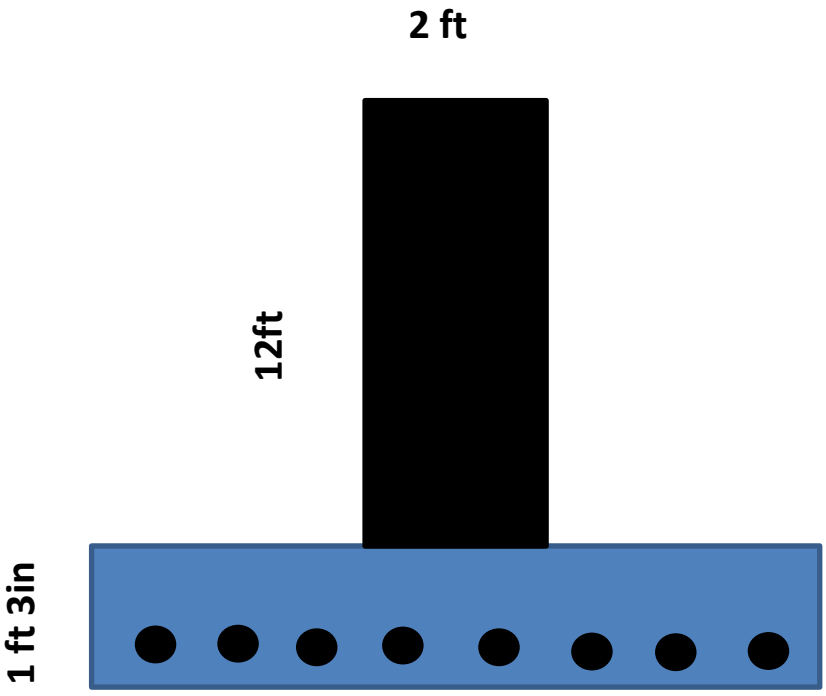
Pier Harrington and Parking Garage Top View



Pier Harrington and Parking Garage Side View







5.25 ft

#7 Rebar o.c.