36.1

$$k = soil\ charecteristc(when\ unknown\ use\ the\ following) = 0.3$$

$$w = soil\ density = 100\frac{lb}{ft^3}$$

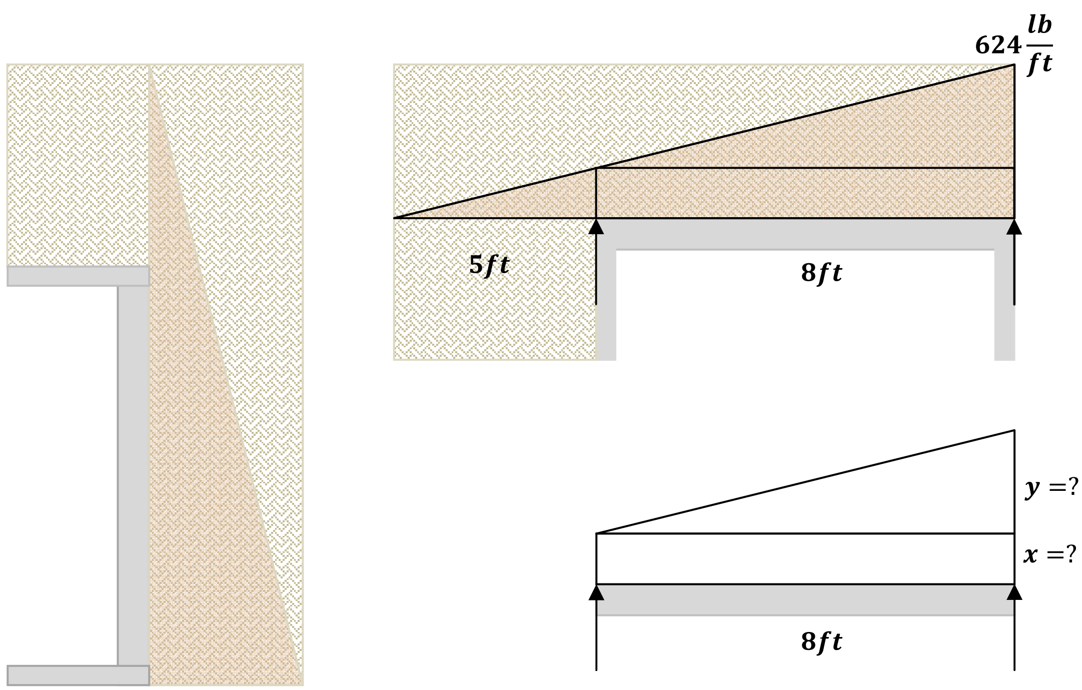
$$h_c = height\ of\ wall = 13ft$$

$$P_e = max\ lateral\ fuid\ pressure = kwh_c = (0.3)\left(100\frac{lb}{ft^3}\right)(13ft) = 390\frac{lb}{ft^2}$$

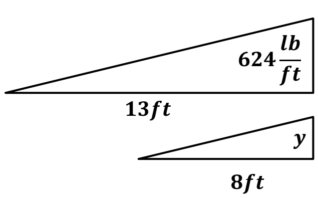
Furthermore, to simplify the problem, we will consider a 1ft wide section of the wall.
*See concrete wall diagram.*
This will simplify our units to $390\frac{lb}{ft}$. However this value must still be factored for LRFD.

$$1.6\left(390\frac{lb}{ft}\right) = \mathbf{624\frac{lb}{ft}}$$

The load and span, shear and moment diagram can be visualized as a beam.




Use similar triangles to find the pressure distribution value at the second end of the simplified diagram.




$$\frac{(13ft)}{624\frac{lb}{ft}} = \frac{8ft}{y}$$

$$13ft(y) = 8ft\left(624\frac{lb}{ft}\right)$$

$$y = \frac{8ft\left(624\frac{lb}{ft}\right)}{13ft} = 384\frac{lb}{ft}$$

$$x = 624\frac{lb}{ft} - y = \left(624\frac{lb}{ft}\right) - \left(384\frac{lb}{ft}\right) = 240\frac{lb}{ft}$$

To simplify the problem, analyze the loading as a rectangle and a square.

Find the total load W:

$$Area\ of\ a\ Triange = \frac{1}{2}(base)height$$

$$W_T = \frac{1}{2}(8ft)384\frac{lb}{ft} = 1536lb$$

$$Area\ of\ a\ rectangle = (base)height$$

$$W_S = (8ft)240\frac{lb}{ft} = 1920lb$$

Find Shear Max V:

$$Max\ shear\ of\ a\ triangular\ load\ = \frac{2}{3}W_T$$

$$V_T = \frac{2}{3}(1536lb) = 1024\ lb$$

$$Max\ shearof\ a\ rectangular\ load = \frac{1}{2}W_S$$

$$V_S = \frac{1}{2}(1920lb) = 960\ lb$$

Find the Total Shear

$$V_u = V_T + V_S = 1024\ lb\ ft + 960\ lb\ ft = \mathbf{1984lb}$$

Find Max Moment M:

$$Max\ moment\ of\ a\ rectangular\ load = 0.1283W_TL$$

$$M_T = \frac{2}{3}(1536lb) = 1576\ lb\ ft$$

$$Max\ moment\ of\ a\ \ rectangular\ load = \frac{W_SL}{8}$$

$$M_S = \frac{1}{2}(1920lb) = 1920lb\ ft$$

Find the Total Moment

$$M_u = M_T + M_S = 1576lb\ ft + 1920\ lb\ ft = 3496lbft\left(\frac{12in}{1ft}\right) = 41952lbin = \mathbf{42k\ in}$$

**To determine if a 8in wall will be adequate find the following:**

1. **Find the depth required for the maximum moment**

$$d_m = \sqrt{\frac{M_u}{\Phi R b}}$$

2. **Find the depth required for the maximum shear**

$$V_{crit} = V_u - (P_e)d_v$$

$$f_v' = \frac{V_{crit}}{A}$$

3. **Find the code required depth**

4in or L/25

Proceed with the following conditions:

$f_c' = 3000psi$

$F_y = 60000psi$

$\rho_{rec} = 0.0080psi\ (from\ table\ A.4)$

$R = required\ reinforcement = 434.7psi\ (from\ table A.7)$

$b = 12in\ (one\ foot\ section\ of\ the\ wall)$

$M_u = 42k\ in$

$\phi = 0.9$

$P_e(at\ 13ft\ and\ factored\ ) = \ max\ lateral\ fuid\ pressure = kwh_c = 624\frac{lb}{ft}$

$f_v' = 82.2psi\ (table\ 31.1)$

$V_u = 1984lb$

**Find the depth required for the maximum moment**

$$d_m = \sqrt{\frac{M_u}{\Phi R b}} = \sqrt{\frac{42k\ in}{(0.9)(434.7)(12in)}} = \mathbf{2.99in}$$

**Find the depth required for the maximum shear**

$$V_{crit} = V_u - (P_e)d_v$$

$$f_v' = \frac{V_{crit}}{A}$$

Combine the equations:

$$f_v' = \frac{V_u - (P_e)d_v}{b(d_v)}$$

Rearrange:

$$f_v'(b)(d_v) = V_u - (P_e)d_v$$

$$f_v'(b)(d_v) + (P_e)(d_v) = V_u$$

Factor:

$d_v(f_v'b + P_e) = V_u$

$$d_v = \frac{V_u}{(f_v'b + P_e)} = \frac{1984lb}{\left(82.2psi(12in) + 624\frac{lb}{ft}\left(\frac{1ft}{12in}\right)\right)} = \frac{1984lb}{1038.4\frac{lb}{in}} = \mathbf{1.91in}$$

**<u>Find the code required depth</u>**

Code requires 4in or L/25:

$$\frac{L}{25} = \frac{8ft\left(\frac{12in}{ft}\right)}{25} = 3.84in$$

Since $3.84in < 4in$

$\boldsymbol{d_c = 4in}$

**<u>Summarize conclusions:</u>**

$\boldsymbol{d_m = 2.99in}$

$\boldsymbol{d_v = 1.91in}$

$\boldsymbol{d_c = 4in}$

**Since they are all less than 8in the wall depth will be sufficient.**

**<u>Size steel for the 8in wall depth:</u>**

$b = 12in$

$d = 8in - 2in = 6in\ (2in\ is\ the\ concrete\ cover\ over\ the\ steel)$

$$d_m = \sqrt{\frac{M_u}{\Phi R b}}$$

Rearrange to find the actual required reinforcement value R:

$$R = \frac{M_u}{\Phi d^2 b} = \frac{42k\ in}{0.9(6in)^2(12in)} = 0.108ksi = 108psi$$

Use table A.8 to find R (however, the value is off the chart so use the minimum value of $\rho_g(aka\ \rho_{min}) = 0.033$

$$A_s = \rho_{min}A_c = (0.033)12in(6in) = 0.24in^2\ per\ one\ foot\ of\ spacing$$

Try #4 bar: Area= $0.2in^2$

$$\frac{0.24in^2}{12in} = \frac{0.2in^2}{spacing}$$

**Spacing = 10in with #4 bar**