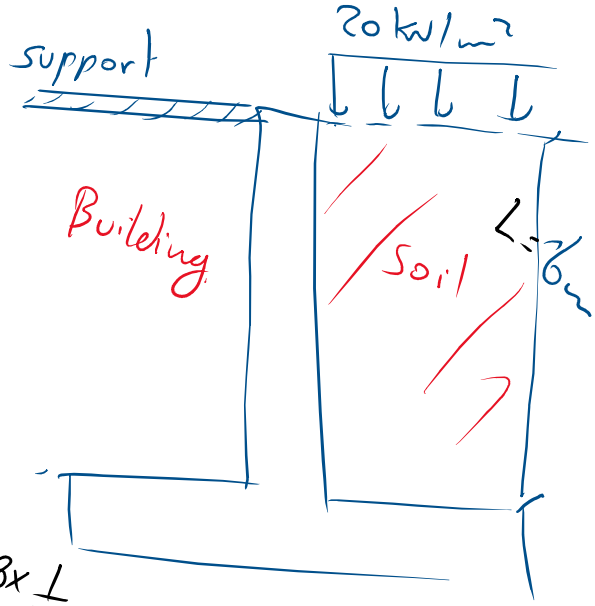
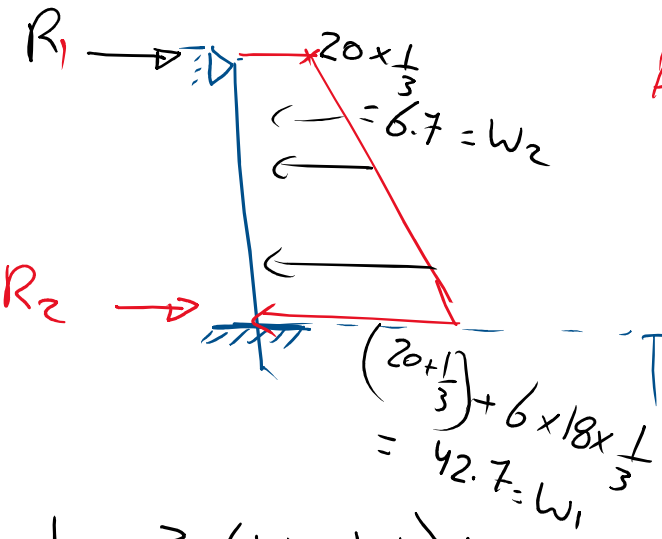
Example Basement Wall

Design the Basement Wall shown, assume $f'_c = 28$ MPa.

$f_y = 420$ MPa $\quad \gamma_s = 18$ kN/m^3

$q_{wall} = 240$ kN/m $\quad k_o = \frac{1}{3}$





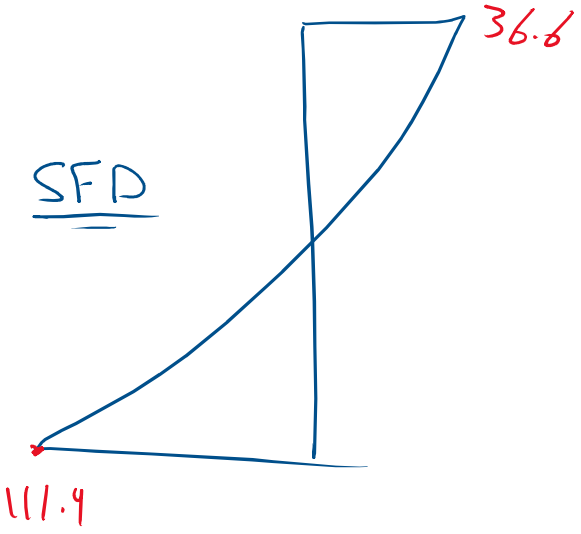
For 1 story.

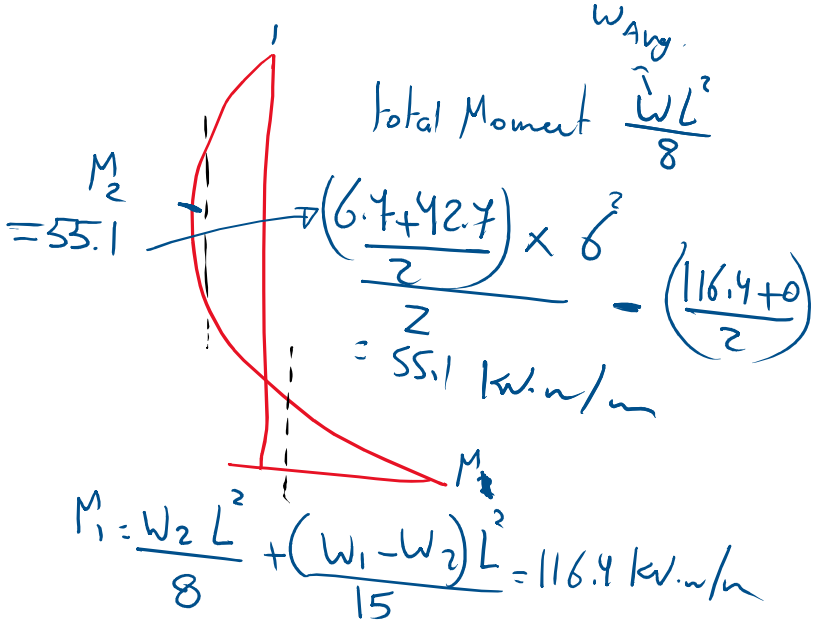
$$R_1 = 0.1 W_2 L + \frac{3}{8}(W_1 - W_2)L$$

$$R_1 = (42.7 - 6.7)\,0.1 \times 6 + 6.7 \times 6 \times \frac{3}{8} = 36.6 \text{ kN/m}$$

$$\Sigma F_y = 0 \rightarrow R_2 = \frac{42.7 + 6.7}{2} \times 6 - 36.6 = 111.4 \text{ kN/m}$$

SFD





$$M_1 = \frac{W_2 L^2}{8} + \frac{(W_1 - W_2)L^2}{15} = 116.4 \text{ kN.m/m}$$

$\Rightarrow \underbrace{V_u}_{\text{assume}} = P_u = 111.4 \times 1.6 = \underline{\underline{\text{F.S}}}$

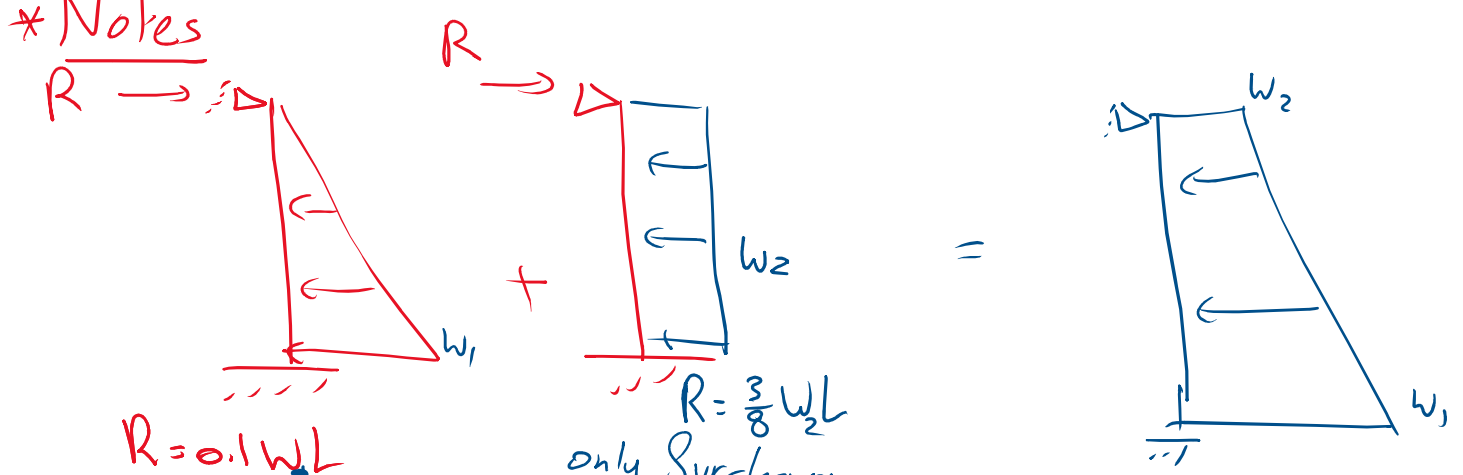
$\phi V_c = V_u$

$$0.75 \times (0.166)\sqrt{28} \times \underbrace{1000}_{b} \times d = 1.6 \times 111.4 \quad (V_u)$$

$d = 269$ mm $\rightarrow$ $h = 350$ mm

$d \geq 270$ mm

* Notes



$R = 0.1 WL$

no surcharge load

$R = \frac{3}{8} W_2 L$

only Surcharge load.

or liquid load.

$R = 0.1WL + \frac{3}{8} W_2 L$

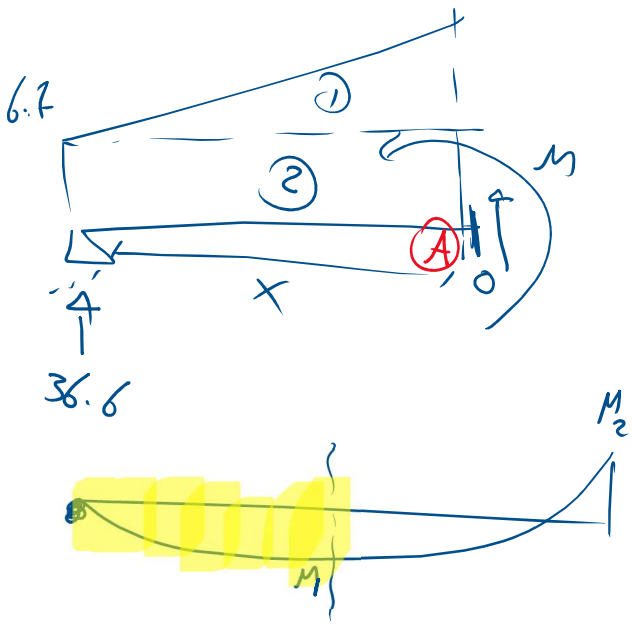
$(W_1 - W_2)$

$\Sigma F_o = 0$

$$36.6 = \left(\frac{\left(\frac{42.7 - 6.7}{6}\right)x + 6.7}{2} + 6.7 \right) x$$

$x = 2.55$

$\Sigma M_A = 0 \rightarrow \underline{\underline{M_1 = 55.1}}$



$$\frac{wL^2}{8} = M_1 + \left(\frac{M_2}{2}\right)$$

$$M_2 = 2\left(\frac{wL^2}{8} - M_1\right)$$

$M = 116.4$

$M_u = 1.6 \times 116.4 \Rightarrow 186.24 \text{ kN.m/m}$

$\rho = 7.21 \times 10^{-3} \rightarrow A_s = 1945 \text{ mm}^2 > A_{s\min} = 900 \text{ mm}^2/\text{m}$

$\hookrightarrow d = 270$ $\quad \rightarrow$ use $8\phi 18/\text{m}$

$b = 1000$

$0.0033 \times 1000 \times 270 = 900$

$\rightarrow M_2 = 55.1$

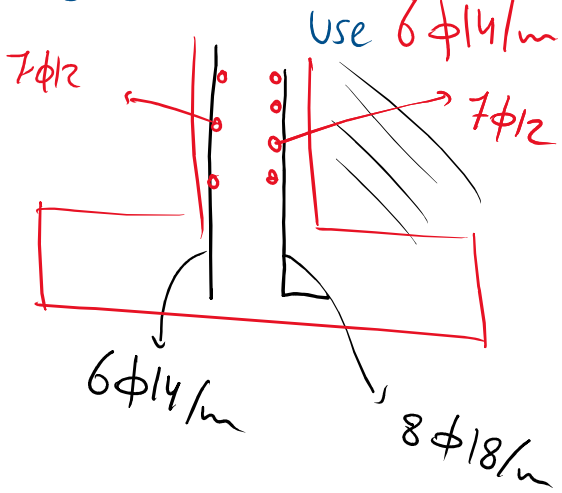
$M_u = 1.6 \times 55.1 = 89.1 \rightarrow A_s = \frac{89.1}{186.24} \times 1945 \rightarrow 920 \text{ mm}^2/\text{m} > A_{s\min}$ (ratio)

horizontal Steel

$A_{s\min} = 0.002 \times 350 \times 1000$

$= 700 \text{ mm}^2/\text{m}$

$\rightarrow 7\phi 12/\text{m}$

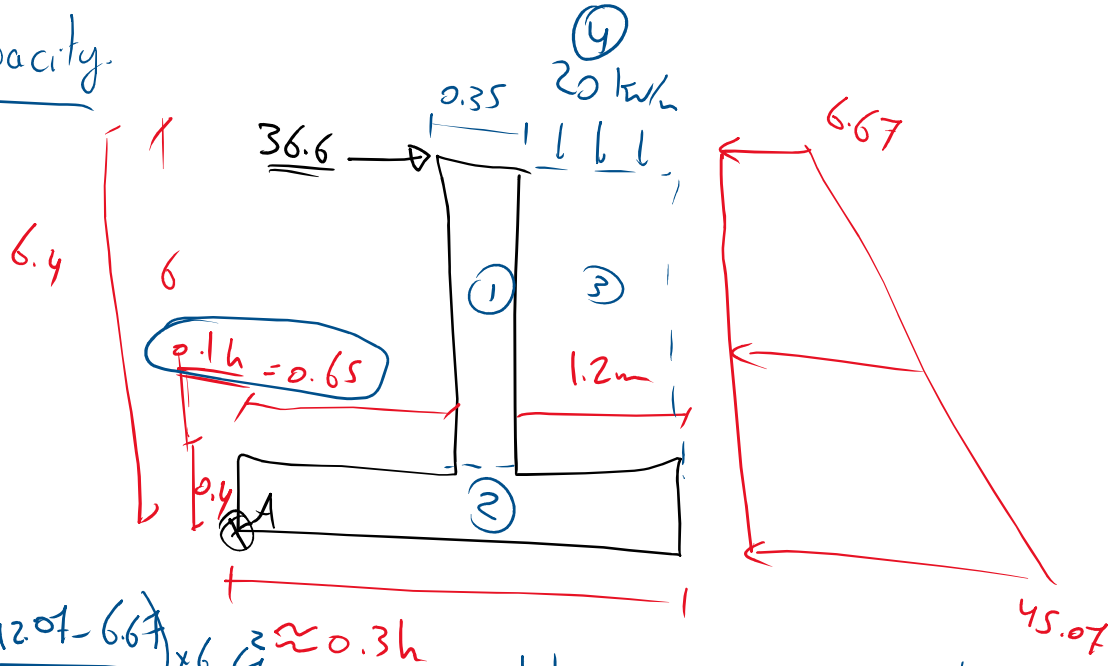


Stability Check

① O.T ✓

② Sliding ✓

③ Bearing Capacity.



$$M_{OT} = 6.67 \times \frac{6.4^2}{2} + \frac{(42.07 - 6.67)}{2} \times 6.67^2 \approx 0.3h$$

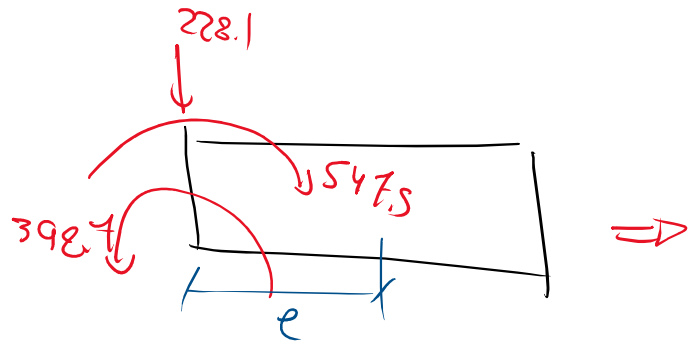
$$= 398.7 \text{ kN.m/m}$$

$$M_R = 313.3 + 6.4 \times 36.6$$

$$= 547.5 \text{ kN.m/m}$$

$$P_V = 228.1 \text{ kN.m}$$

	W	arm	M_{arm}
①	52.5	0.825	43.3
②	129.6	1.6	207.4
③	22	1.1	24.2
④	24	1.6	38.4
	228.1		313.3



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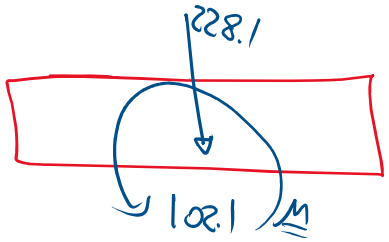
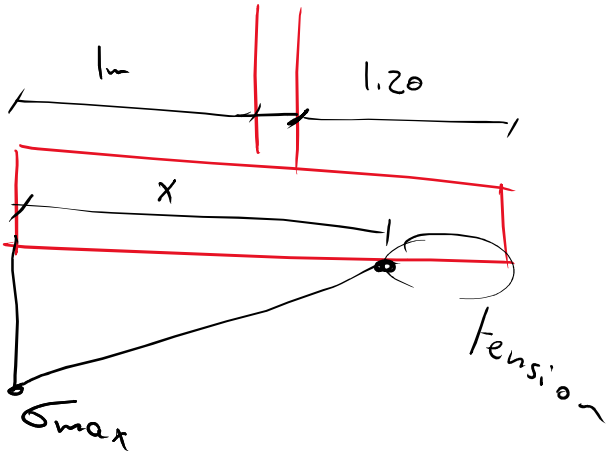


$$e = \frac{M}{P} = \frac{102.1}{228.1} = 0.448 > \frac{b}{6} = \frac{2.2}{6} = 0.36$$ Large Eccnt

$$X = \left(\frac{L}{2} - e\right) \times 3 = \left(\frac{2.2}{2} - 0.448\right) \times 3 = 1.96\,m$$

$$\sigma_{max} = \frac{P}{B \times L}\left(1 + \frac{6e}{L}\right)$$

$$\frac{228.1}{1 \times 2.2}\left(1 + \frac{6 \times 0.448}{2.2}\right) = 230.1\ kN/m^2$$

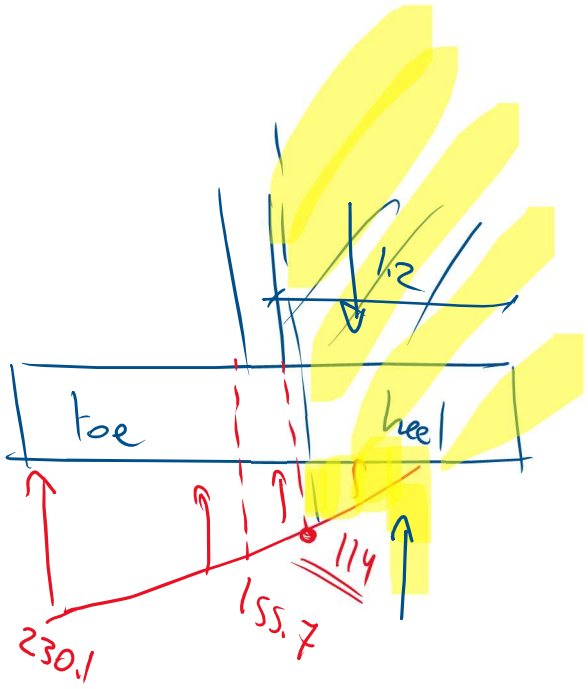


$\sigma_{max} < q_{all} = 240\ kN/m^2$ ok

Bearing Check ok

Heel Design

$$V_u = 1.6\left(128 \times 1.2\right) + \left(0.4 \times 25 \times 1.2\right) \times 1.2$$
$$- 114\,\frac{(1.96 - 1)}{2} \times 1.6$$
$$= 149.6\ kN/m$$



$$\phi V_c = 0.75\left(\frac{1}{6}\right)\sqrt{28} \times \frac{b}{1000} \times 320 = 211.7\ kN > V_u\ ok.$$