Project

"Bakery City Creamery Floor Upgrade"

$Latitude := 44.7752$ $Longitude := -117.8283$

$City :=$ "Baker City"

$State :=$ "Oregon" $ZipCode := 97814$

Relevant Codes

ASCE 7-10

IBC 2012

NDS 2012

ACI 318-08

Oregon Structural Specialty Code (OSSC) 2014

Site Criteria and Loads

Wind:

N/A - No Lateral Calculations Required
For the Scope of this work

Seismic:

N/A - No Lateral Calculations Required
For the Scope of this work

Snow:

N/A - No Snow Load Analysis Required
For the Scope of this work

Project Geometry

$beam_{length} := 22\ ft$ $beam_{span\_type} :=$ "Two Span Continuous"

$joist_{length} := 12.5\ ft$ $joist_{span\_type} :=$ "Simple"

$Post_{height} := 8\ ft$

Dead Load

$D := 20\ psf$ Includes Subfloor, Floor Joists, + 10 psf floor finishing

Live Load

$L := 100\ psf$ ASCE 7-10 Table 4.1-Distributed Load for "Stores: Retail"

$L_p := 1000\ lbf$ ASCE 7-10 Table 4.1-Point Load for "Stores: Retail"

Snow Load

$S := 0\ psf$ Snow Load Not Applicable to Interior Calculations

Determine Controlling Load Case for First Floor

$w_1 := D = 20\ psf$

$$w_{1mod} := \frac{D}{0.9} = 22.22\ psf$$

$w_2 := D + L = 120\ psf$

$$w_{2mod} := \frac{D + L}{1.0} = 120\ psf$$

$w_3 := D + S = 20\ psf$

$$w_{3mod} := \frac{D + S}{1.15} = 17.39\ psf$$

$w_4 := D + 0.75 \cdot L + 0.75 \cdot S = 95\ psf$

$$w_{4mod} := \frac{D + 0.75 \cdot L + 0.75 \cdot S}{1.15} = 82.61\ psf$$

$w_5 := D = 20\ psf$

$$w_{5mod} := \frac{D}{0.9} = 22.22\ psf$$

$w_{6a} := D + 0.75 \cdot L + 0.75 \cdot S = 95\ psf$

$$w_{6amod} := \frac{D + 0.75 \cdot L + 0.75 \cdot S}{1.15} = 82.61\ psf$$

$w_{6b} := D + 0.75 \cdot L + 0.75 \cdot S = 95\ psf$

$$w_{6bmod} := \frac{D + 0.75 \cdot L + 0.75 \cdot S}{1.15} = 82.61\ psf$$

$w_7 := 0.6 \cdot D = 12\ psf$

$$w_{7mod} := \frac{0.6 \cdot D}{0.9} = 13.33\ psf$$

$w_8 := 0.6 \cdot D = 12\ psf$

$$w_{8mod} := \frac{0.6 \cdot D}{0.9} = 13.33\ psf$$

$$w_{control} := \max\left(w_{1mod}, w_{2mod}, w_{3mod}, w_{4mod}, w_{5mod}, w_{6amod}, w_{6bmod}, w_{7mod}, w_{8mod}\right) = 120\ psf$$

$w_{control} := w_2 = 120\ psf$ Determined to be controlling loading combined with applicable duration factor given in NDS 2012

Determine size and spacing of lower floor joists

$S := 16\ in$ — O.C. Spacing of Joists

$M_{dist} := \frac{w_{control} \cdot S \cdot joist_{length}^{2}}{8} = 3125\ lbf \cdot ft$ — Max Moment per joist w/ uniform live load

$M_{point} := \frac{D \cdot S \cdot joist_{length}^{2}}{8} + \frac{L_p \cdot joist_{length}}{4} = 3645.83\ lbf \cdot ft$ — Max Moment per joist w/ point live load

$M_{max} := \max\left(M_{dist}, M_{point}\right) = 3645.83\ lbf \cdot ft$ — Controlling Max Moment

$w_{equivalent} := \frac{M_{max} \cdot 8}{joist_{length}^{2}} = 186.67\ plf$

Select BCI 90 2.0 3-1/2" Flange, 11-7/8" depth from BCI Allowable Uniform Floor Load Tables, maximum load of 207 plf

Calculate Bottom Floor Beam Size

Design note: Beam Size to be a minimum 12" depth min, to match joist size

$length_{trib} := 12.5\ ft$ Tributary Floor Length

$$M_{max} := \frac{w_{control} \cdot length_{trib} \cdot \left(\frac{beam_{length}}{2}\right)^2}{8} = 22687.5\ lbf \cdot ft$$

$C_D := 1.0$ $C_M := 1.0$ $C_t := 1.0$ $C_L := 1.0$

$L := \frac{beam_{length}}{ft} = 22$ $d := 12$

$x := 10$ $b := 3.5$

$$C_V := \left(\frac{21}{L}\right)^{\frac{1}{x}} \cdot \left(\frac{12}{d}\right)^{\frac{1}{x}} \cdot \left(\frac{5.125}{b}\right)^{\frac{1}{x}} = 1.03$$

$C_{fu} := 1.0$ $C_c := 1.0$

$F_b := 2400\ psi$ 24F-V4 DF/DF GLULAM BEAM NDS Table 5A

$$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_L \cdot C_V \cdot C_{fu} \cdot C_c = 2481.72\ psi$$

Determine the applied bending stress

$S := 132\ in^3$

$$f_b := \frac{M_{max}}{S} = 2062.5\ psi$$

$f_b = 2062.5\ psi$ **<** $F'_b = 2481.72\ psi$ **OK**

Check Maximum Deflection

$I := 792\ in^4$ $l := \frac{beam_{length}}{2} = 11\ ft$ $w := w_{control} \cdot length_{trib} = 1500\ plf$

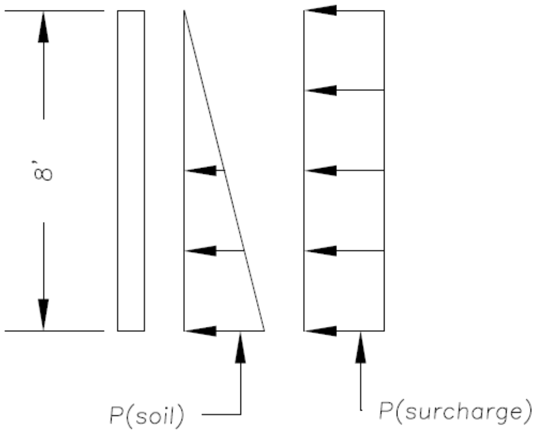
$\frac{l}{240} = 0.55\ in$ $E := 0.88 \cdot 10^6\ psi = 880000\ psi$

$$\Delta_{max} := \frac{w \cdot l^4}{185 \cdot E \cdot I} = 0.29\ in$$ **OK**

Use Glulam 24F-V4 5-1/2"x12" Beam for floor support between posts

Design Basement Retaining Wall

Design note: Basement Wall is Designed to resist active earth pressure as if the existing building foundation were non-existent. The Basement Wall is **NOT** Designed to resist vertical load originating from the building envelope.



Consider Active Condition w/ surcharge live load of 40 psf

$q_{sur} := 50\ plf$ Live Load

$\gamma_{soil} := 120\ pcf$

$\phi := 31\ deg$

$H_{wall} := 8\ ft$

$L_{wall} := 1\ ft$ Design Per Foot

$\gamma_{conc} := 150\ pcf$

$1.2 \cdot D + 1.6 \cdot L$ Controlling LRFD Design Equation

$$K_a := \tan\left(45\ deg - \frac{\phi}{2}\right)^2 = 0.32$$

$$P_{soil} := K_a \cdot H_{wall} \cdot \gamma_{soil} \cdot L_{wall} \cdot 1.2 = 368.75\ plf$$

$$P_{sur} := 1.6 \cdot q_{sur} \cdot K_a = 25.61\ plf$$

$$R_{sur} := P_{sur} \cdot H_{wall} = 204.86\ lbf$$

$$H_{sur} := 4\ ft$$

$$A_{footing} := 6.7\ ft^2$$

$$R_{soil} := P_{soil} \cdot \frac{H_{wall}}{2} = 1475.015\ lbf$$

$$B := 36\ in$$

$$H_{soil} := \frac{H_{wall}}{3} = 2.67\ ft$$

$$t_{wall} := 12\ in$$

Sum moments at bottom of wall to determine tension force in steel per foot of wall:

$$\Sigma M_a = 0 = \gamma_{conc} \cdot t_{wall} \cdot H_{wall} \cdot L_{wall} \cdot \frac{t_{wall}}{2} - R_{soil} \cdot H_{soil} - R_{sur} \cdot H_{sur} + T_{steel} \cdot \frac{t_{wall}}{2}$$

$$T_{steel} := \frac{R_{soil} \cdot H_{soil} + R_{sur} \cdot H_{sur} - t_{wall} \cdot H_{wall} \cdot \frac{t_{wall}}{2} \cdot L_{wall} \cdot \gamma_{conc}}{\frac{t_{wall}}{2}} = 8305.655\ lbf$$

$$\sigma_{steel} := 0.9 \cdot 60\ ksi = 54\ ksi$$

$A_{steel} := \frac{T_{steel}}{\sigma_{steel}} = 0.15\ in^2$ Total of area of steel per foot required

$A_{\#5bar} := 0.31\ in^2$

$S := 1.5$ Bar Spacing Provided in feet

$A_{provided} := \frac{A_{\#5bar}}{S} = 0.2067\ in^2$ **>** $A_{steel} = 0.1538\ in^2$

Use #5 Bars @ 18 inches on center

Check Wall Overturning, Assume Footing width to be the length from outside of wall to the end of the thickened footing

$D_{concwall} := 150\ pcf \cdot 8\ ft \cdot 12\ in \cdot 1\ ft = 1200\ lbf$

$D_{footing} := B \cdot 16\ in \cdot 150\ pcf \cdot 1\ ft = 600\ lbf$

$D := (D_{concwall} + D_{footing}) = 1800\ lbf$

$w := 30\ in$

$1.4 \cdot D$ Controlling LRFD Design Equation

$P_{soil} := K_a \cdot H_{wall} \cdot \gamma_{soil} \cdot L_{wall} \cdot 1.4 = 430.21\ plf$

$D_{top} := D = 1800\ lbf$ $d := 6\ in$

$M_R := (D_{concwall}) \cdot (w - d) + D_{footing} \cdot \frac{w}{2} = 3150\ lbf \cdot ft$

$M_o := \left(P_{soil} \cdot (H_{soil} + 7\ in) + P_{sur} \cdot \left(\frac{H_{wall}}{2} + 7\ in\right)\right) \cdot 1\ ft = 1515.56\ lbf \cdot ft$

$FS_{overturn} := \frac{M_R}{M_o} = 2.08$ **Ok**

Determine minimum Horizontal wall steel

$\rho_{tmin} := 0.0020$

$\rho_t = \frac{A_{steel}}{A_{conc}}$ $A_{bar} := A_{\#5bar} = 0.31\ in^2$

$A_{steel} = A_{bar} \cdot N$ $A_{conc} := 12\ in \cdot 8\ ft = 8\ ft^2$

$N := \frac{\rho_{tmin} \cdot A_{conc}}{A_{bar}} = 7.43$ Use (8) #5 bars for 8' wall

Determine Required Hook Development Length (ACI 318 Section 12.5)

$\lambda := 1.0$ $\Psi_e := 1.0$ $F_y := 60000$ $F'_c := 3000$ $d_b := 0.5\ in$

$$l_{dh} := \frac{0.02 \cdot \Psi_e \cdot F_y}{\lambda \cdot \sqrt{F'_c}} \cdot d_b = 10.954\ in$$

but not less than:

$8\ d_b = 4\ in$ *or* $6\ in$