REQUIRED:

$S_{service}$: Calculated elastic settlement using the empirical Hough Method (inches)

DESIGN PARAMETERS (AASHTO LRFD [2017] SECTION 10.6.2.4.2 AND FIGURE 10.6.2.4-1

γ = unit weight of soil (pcf) $\gamma := 135 \cdot \dfrac{lb}{ft^3}$

q_u = applied footing load (ksf) $q_u := 10\ ksf$

H_C = initial height of layer (ft) $H_C := 10\ ft$

B = design footing width (ft) $B := 15\ ft$

ΔH_i = elastic settlement of layer i (ft)

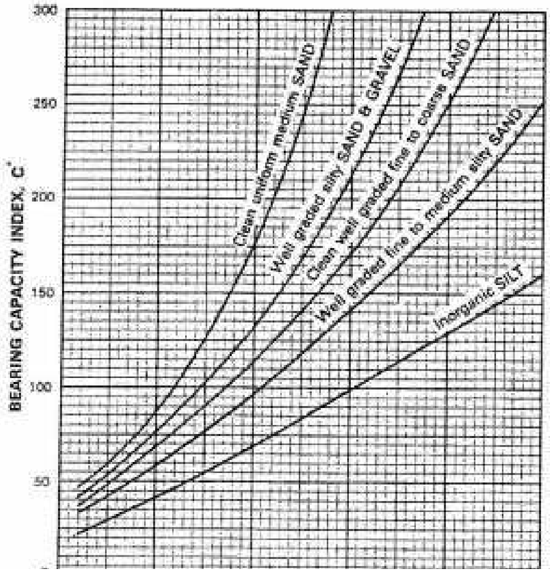
σ'_0 = initial vertical effective stres at the midpoint of layer i (ksf)

$\Delta\sigma_v$ = increase in vertical stress at the midpoint of layer i (ksf)

AASHTO C10.6.2.4.2: *The subsurface soil profile should be subdivided into layers based on stratigraphy to a depth of about three times the footing width. The maximum layer thickness should be about 10 feet.*

The design footing width, B***, is*** $15\ feet$***; therefore the total analysis depth should be approximately*** $D_a := 3 \cdot B = 45\ ft$.

C = Bearing Capacity Index from AASHTO Figure 10.6.2.1.2-1. (see figure below) (Limited to 300 for Well graded silty SAND & GRAVEL with N1 (N1 shall be taken as $(N1_{60})$) greater than 80 blows per foot.)

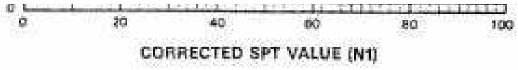


$N1 := 90$

From Figure 10.6.2.4.2-1 at the left: $C' := 300$

NOTE: The Hough method is applicable to cohesionless deposits. The "Inorganic Silt" curve should generally not be applied to soils that exhibit plasticity. The settlement characteristics of cohesive soils that exhibit plasticity should be investigated using undisturbed samples and laboratory consolidation tests as prescribed in Article 10.6.2.4.3.

In Figure 10.6.2.4.2-1, (N1) shall be taken as $N1_{60}$, Standard Penetration Resistance, N (blows/ft), corrected



Reference: Hough, "Compressibility as a Basis for Soil Bearing Value" ASCE 1959

Figure 10.6.2.4.2-1—Bearing Capacity Index versus Corrected SPT (modified from Cheney and Chassie, 2000, after Hough, 1959)

for overburden pressure as specified in Article 10.4.6.2.4

$n_{soil} := \dfrac{D_a}{H_C}$ $\quad n_{soil} = 4.5$ Number of soil layers to be used in the analysis

d_i = depth to midpoint of layer i.

$$d_i := 5, 15 .. 45 = \begin{bmatrix} 5 \\ 15 \\ 25 \\ 35 \\ 45 \end{bmatrix}$$

σ_{0_i} = initial vertical effective stress at the midpoint of layer i (ft)

$$\sigma_{0\_i} := \gamma \cdot d_i \cdot ft \cdot g \quad \sigma_{0\_i} = \begin{bmatrix} 0.7 \\ 2 \\ 3.4 \\ 4.7 \\ 6.1 \end{bmatrix} \frac{kip}{ft^2}$$

Δq_u = change in the vertical effective stress using the Boussinesq Vertical Stress Contours (AASHTO Figure 10.6.2.4.1-1) (dimensionless)

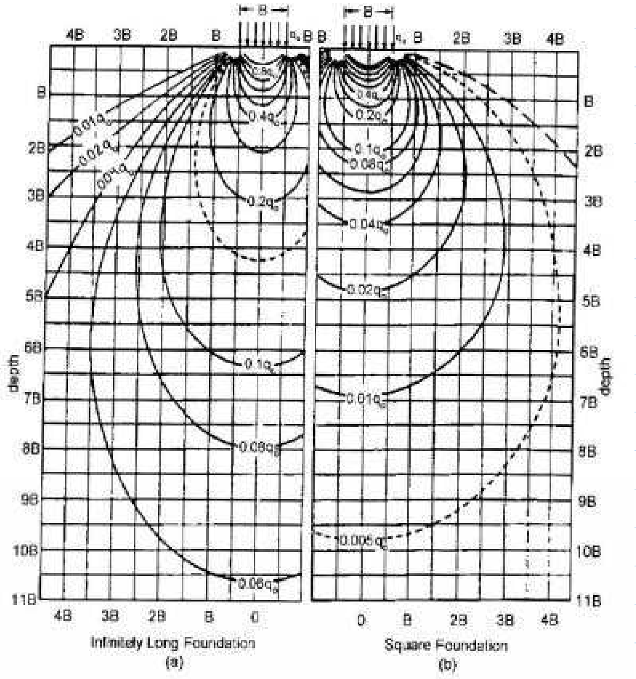


Figure 10.6.2.4.1-1—Boussinesq Vertical Stress Contours for Continuous and Square Footings Modified after Sowers (1979)

Δq_u is the change in verical effective stress using the Boussinesq Vertical Stress Contours (AASHTO Figure 10.6.2.1.1-1) (dimensionless). Since the median barrier retaining wall is 672 to 885 feet in length, use the values for the infinitely long foundation.

$$B = 15\ ft$$

$$\frac{d_i}{B} = \begin{bmatrix} 0.333 \\ 1 \\ 1.667 \\ 2.333 \\ 3 \end{bmatrix} \frac{1}{ft}$$

With the $\frac{d_i}{B}$ values shown above, from Figure 10.6.2.4.1-1:

$$\Delta_{qu\_i} := \begin{bmatrix} 0.9 \\ 0.55 \\ 0.36 \\ 0.27 \\ 0.22 \end{bmatrix}$$

$\Delta\sigma_{v\_i}$ = the increase in vertical stress at the midpoint of layer i (psf)

$$\Delta\sigma_{v\_i} := \Delta_{qu\_i} \cdot q_u$$

$$\Delta\sigma_{v\_i} = \begin{bmatrix} 9 \\ 5.5 \\ 3.6 \\ 2.7 \\ 2.2 \end{bmatrix} ksf$$

CALCULATIONS (AASHTO LRFD [2012] EQUATION 10.6.2.4.2-3

ΔH_i = elastic settlement of layer i (ft):

$$\Delta H_i := H_C \cdot \left(\frac{1}{C'}\right) \cdot \log\left(\frac{\left(\sigma_{0\_i} + \Delta\sigma_{v\_i}\right)}{\sigma_{0\_i}}\right)$$

$$\Delta H_i = \begin{bmatrix} 0.463 \\ 0.228 \\ 0.126 \\ 0.079 \\ 0.054 \end{bmatrix} in$$

values should be ~
0.46
0.22
0.13
0.08
0.03