Correct depth factor as in the class

$$q_u = c N_c + \bar{q} N_q + 0.5 \gamma B N_\gamma$$

$$q_u = c' N_c F_{cs} F_{cd} F_{ci} + q N_q F_{qs} F_{qd} F_{qi} + \tfrac{1}{2} \gamma B N_\gamma F_{\gamma s} F_{\gamma d} F_{\gamma i}$$

$$q_u = 1.3 c' N_c + q N_q + 0.3 \gamma B N_\gamma$$

$$N_q = \frac{e^{2(3\pi/4 - \phi'/2)\tan\phi'}}{2\cos^2\left(45 + \frac{\phi'}{2}\right)}$$

$$N_\gamma = \frac{1}{2}\left(\frac{K_{p\gamma}}{\cos^2\phi'} - 1\right)\tan\phi'$$

$$N_c = \cot\phi'\left[\frac{e^{2(3\pi/4 - \phi'/2)\tan\phi'}}{2\cos^2\left(\frac{\pi}{4} + \frac{\phi'}{2}\right)} - 1\right] = \cot\phi'(N_q - 1)$$

$$K_{p\gamma} = \tan^2(45 + \phi'/2)$$

$$q_u = 1.3 c N_c + \bar{q} N_q + 0.4 \gamma B N_\gamma$$

$$FS = \frac{Q_{ult}}{Q} \qquad FS = q'_u / q_{max}$$

$$\bar{\gamma} = \gamma' + (\gamma - \gamma')\frac{d}{B}$$

$$N_q = e^{\pi \tan\phi'} \tan^2(45^\circ + \phi'/2)$$

$$N_c = (N_q - 1)\cot\phi' \qquad N_\gamma = 2(N_q + 1)\tan\phi'$$

$$q_{all} = \frac{q_{ult}}{FS}$$

$$c'' = 0.67c$$
$$\phi'' = \tan^{-1}(0.67 \tan\phi)$$

$$F_{cs} = 1 + \frac{B}{L}\frac{N_q}{N_c} \qquad F_{qs} = 1 + \frac{B}{L}\tan\phi \qquad F_{\gamma s} = 1 - 0.4\frac{B}{L}$$

$$e = \frac{M}{Q} \qquad q_{min} = \frac{Q}{BL}\left(1 - \frac{6e}{B}\right)$$

$$F_{cd} = 1 + 0.4\frac{D_f}{B} \qquad F_{qd} = 1 + 2\tan\phi(1 - \sin\phi)^2\frac{D_f}{B} \qquad F_{\gamma d} = 1$$

$$q_{max} = \frac{Q}{BL} + \frac{6M}{B^2 L} \qquad q_{max} = \frac{Q}{BL}\left(1 + \frac{6e}{B}\right)$$

$$F_{cd} = 1 + 0.4\tan^{-1}\left(\frac{D_f}{B}\right) \qquad F_{qd} = 1 + 2\tan\phi(1 - \sin\phi)^2\tan^{-1}\frac{D_f}{B} \qquad F_{\gamma d} = 1$$

$$q_{min} = \frac{Q}{BL} - \frac{6M}{B^2 L}$$

$$L' = L - 2e_x$$

$$B' = B - 2e_y$$

$$F_{ci} = F_{qi} = \left(1 - \frac{\beta^o}{90^o}\right)^2 \qquad F_{\gamma i} = \left(1 - \frac{\beta}{\phi}\right)^2$$

$$q_u = q_b + \left(1 + \frac{B}{L}\right)\left(\frac{2c_a H}{B}\right) + \gamma_1 H^2\left(1 + \frac{B}{L}\right)\left(1 + \frac{2D_f}{H}\right)\left(\frac{K_s \tan\phi_1}{B}\right) - \gamma_1 H < q_t$$

$$q_b = c_2 N_{c(2)} F_{cs(2)} + \gamma_1 (D_f + H) N_{q(2)} F_{qs(2)} + \frac{1}{2}\gamma_2 B N_{\gamma(2)} F_{\gamma s(2)}$$

$$q_t = c_1 N_{c(1)} F_{cs(1)} + \gamma_1 D_f N_{q(1)} F_{qs(1)} + \frac{1}{2}\gamma_1 B N_{\gamma(1)} F_{\gamma s(1)}$$

the bearing-capacity factors for sound rock are approximately

$$N_q = \tan^6\left(45^\circ + \frac{\phi}{2}\right) \qquad N_c = 5\tan^4\left(45^\circ + \frac{\phi}{2}\right) \qquad N_\gamma = N_q + 1$$

$$q'_{ult} = q_{ult}(\text{RQD})^2 \qquad \phi' = \sqrt{20(N_1)_{60}} + 20$$

$$\Delta\sigma'_v = \frac{q_o(B \times 1)}{(B + Z)} \qquad \Delta\sigma'_v = \frac{q_o(B \times B)}{(B + Z)(B + Z)} \qquad \Delta\sigma'_v = \frac{q_o(B \times L)}{(B + Z)(L + Z)}$$

$$S_t = C_\alpha H \log(t/t_P)$$

$$S_T = S_d + S_c + S_t \qquad S_d = A_1 A_2 \frac{qo}{E_u} B$$

$$S_e = C_1 C_2(\bar{q} - q)\sum_0^{z_2}\frac{I_z}{E_s}\Delta z \qquad C_1 = 1 - 0.5\left(\frac{q}{q' - q}\right) \qquad C_2 = 1 + 0.2\log\left(\frac{t}{0.1}\right)$$

$E_s = 2.5 q_c$ for square foundations ($L/B = 1$)

$E_s = 3.5 q_c$ for long foundations (L/B ...)

$$S_c = \frac{Cc}{1 + e_o} H \log\left(\frac{\sigma'_f}{\sigma'_o}\right) \qquad S_c = \frac{Cr}{1 + e_o} H \log\left(\frac{\sigma'_f}{\sigma'_o}\right)$$

$$E_s = \beta q_c \qquad S_c = \frac{Cr}{1 + e_o}$$

$$\frac{E_s}{p_a} = \alpha N_{60}$$

where

p_a = atmospheric pressure ≈ 100 kN/m² (≈ 2000 lb/ft²)

$$\alpha = \begin{cases} 5 \text{ for sands with fines} \\ 10 \text{ for clean normally consolidated sand} \\ 15 \text{ for clean overconsolidated sand} \end{cases}$$