

The UWA method

1. UWA method for clay

Unit skin friction f_{si} in layer i is :

$$f_{si} = \tau_f = 0.055q_t \left[\max \left(\frac{h}{R^*}, 1 \right) \right]^{-0.2}$$

$$f_{si} = \tau_f = \frac{0.23q_t \left[\max \left(\frac{h}{R^*}, 1 \right) \right]^{-0.2}}{(q_t/\sigma'_v)^{0.15}}$$

where

$$R^* = (R^2 - R_i^2)^{0.5}$$

2. UWA method for sand

Unit skin friction f_{si} in layer i is :

$$f_{si} = \tau_f = \sigma'_{rf} \cdot \tan \delta_{cv} = \frac{f}{f_c} (\sigma'_{rc} + \Delta\sigma'_{rd}) \tan \delta_{cv}$$

$$\sigma'_{rc} = 0.03 \cdot q_c (A_{rs}^*)^{0.3} \left[\max \left(\frac{h}{D_{out}}, 2 \right) \right]^{-0.5}$$

$$A_{rs}^* = 1 - IFR \left(\frac{D_{in}^2}{D_{out}^2} \right)$$

$$IFR_{avg} = \min \left[1, \left(\frac{D_{in}}{1.5m} \right)^{0.2} \right]$$

$$\Delta\sigma'_{rd} = 4G \cdot \frac{\Delta r}{D_{out}}$$

$$\frac{G}{q_c} = 185 \cdot q_{c1N}^{-0.75} \quad , \quad \text{with} \quad q_{c1N} = \frac{q_c/Pa}{(\sigma'_{v0}/Pa)^{0.5}}$$

where

σ'_{rf} = radial effective stress at failure

σ'_{rc} = radial effective stress after installation and equalization

$\Delta\sigma'_{rd}$ = change/increase in radial stress due to loading stress path (dilation)

δ_{cv} = constant volume interface friction angle

$\frac{f}{f_c} = 1$ for compression and 0.75 for tension

q_c = cone resistance

A_{rs}^* = effective area ratio

IFR = incremental filling ratio

h = relative distance above the pile tip (= pile length – depth)

Δr = the interface dilation, assumed for analyses=0.02mm, as for ICP-05

P_a = a reference stress equal to 100 kPa

Unit end bearing q_b is :

$$q_b = (0.15 + 0.45A_{rb}^*)\overline{q_c}$$

$$A_{rb}^* = 1 - FFR \left(\frac{D_{in}^2}{D_{out}^2} \right)$$

$$FFR = \min \left[1, \left(\frac{D_{in}}{1.5m} \right)^{0.2} \right]$$