3D2 Geotechnical Engineering
Exam answers 2006

Question 1: Cylindrical cavity collapse analysis of tunneling-induced settlement

(a) Proof

(b) $$\varepsilon_{\gamma,a} = -\frac{2\rho_a}{a}\ ,\ \varepsilon_\gamma = -\frac{2\rho_a a}{r^2} = -2\varepsilon_{\gamma,a}\frac{a^2}{r^2}$$

(c) $$\frac{2\rho_b}{b\varepsilon_{\gamma,f}} = \left[\frac{\gamma}{c_u}\beta\frac{b-a}{\left\{\left(\frac{b}{a}\right)^{2\beta}-1\right\}}\right]^{1/\beta}$$

(d) $\rho_b = 6.25$ mm

Question 2: Stress paths in clay, collapse of a vertical cut

(a) A′: $\sigma'_h = 121.8$ kPa, $p' = 147.9$ kPa, $q = 78.2$ kPa
B′: $\sigma'_h = 58.5$ kPa, $p' = 55.6$ kPa, $q = -8.5$ kPa

$K_a = 0.44$, $K_p = 2.28$

(b) C′: $q = 65$ kPa, $p' = 55.6$ kPa, $\sigma'_h = 33.9$ kPa, $\sigma'_v = 98.9$ kPa
D′: $q = 70$ kPa, $p' = 78.9$ kPa, $\sigma'_h = 55.3$ kPa, $\sigma'_v = 125.3$ kPa

(c) B: $q = -8.5$ kPa, $p = 45.6$ kPa, $\sigma_h = 48.5$ kPa, $\sigma'_v = 40$ kPa
E: $q = 40$ kPa, $p' = 20$ kPa, $\sigma_h = 0$ kPa, $\sigma_v = 40$ kPa

Question 3: Combined V-H loading of a two-footing structure

(a) $H = 3blc_u/2$

(b) $H = 2blc_u$

(c) $V = 2bl\,(2+\pi)\,d_c c_u + \gamma' b/2$

Question 4: Stability of a cantilever gravity wall in dry sand

(a) $M_{overturning} = 801$ kNm/m

(b) $M_{restoring} = 3651$ kNm/m , FoS = 4.56

(c) $B' = B - 2e = B - 2(M/V) = 4.6$ m

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