Engineering Tripos Part IIA 2009 Module 3D2 Answers

1 (a) 250 kPa and 138 kPa (taking $\gamma_w = 10$ kN/m^3)

(b) $q = 20$ kPa, $p = 166$ kPa, $p' = 86$ kPa

(c) (i) 13 kPa (ii) 60 kPa

(d) the clay in the excavation will soften as time passes, and drainage takes place

2 (c) 5.5 mm

3 (b) (i) $\dfrac{\tau_{u,ult}}{\sigma'_o} = \tan\phi_{crit}\left[\dfrac{\sigma'_c}{2.72\,\sigma'_o}\right]^{1-\kappa/\lambda}$

(ii) Find $\dfrac{\tau_y}{\sigma'_o} = \tan\phi_{crit}\,\ln\left[\dfrac{\sigma'_c}{\sigma'_o}\right]$. Then $\dfrac{\tau_{u,\max}}{\sigma'_o}$ = the greater of $\dfrac{\tau_y}{\sigma'_o}$ and $\dfrac{\tau_{u,ult}}{\sigma'_o}$.

(iii) $\dfrac{\tau_{d,ult}}{\sigma'_o} = \tan\phi_{crit}$

(iv) $\dfrac{\tau_{d,\max}}{\sigma'_o}$ = the greater of $\dfrac{\tau_y}{\sigma'_o}$ and $\dfrac{\tau_{d,ult}}{\sigma'_o}$

For OCR = 1: 0.24, 0.24, 0.45, 0.45

For OCR = 10: 1.00, 1.02, 0.45, 1.02

(c) For OCR = 1, mud slumps to far below its critical state angle.

For OCR = 10, stiff clay initially stands steeply, but it can soften to its residual friction angle, about half its critical state angle, on slip surfaces.

4 (b) 3950 kPa and 2470 kPa (taking $\sigma'_c = 15000$ kPa)

(c) 40.6° and 10.8°; 49.3° and 21.6°

(d) Linear fit: $c' = 13$ kPa, $\phi' = 39.5°$

Power law fit: $\beta = 0.86$ correctly passes through the origin and the critical state.

MDB 16/6/2009