CIE 444 – SOIL MECHANICS

Lebanese American University – Fall 2010
Prof. Grace Abou-Jaoude Estephan

HOMEWORK#7

Out Friday Dec 10, 2010
Due Friday Dec 17, 2010, IN CLASS

Solve problems **9.2, 9.4, 9.7, 9.35, and 9.38** in the textbook:
"Geotechnical Engineering: Principles and Practices", **2nd Edition**, by Coduto et al.

Problem 9.2

Vertical normal strain

$$E = \frac{\sigma}{\varepsilon_{\|}} \rightarrow \varepsilon_{\|} = \frac{\sigma}{E} = \frac{320\,\text{kPa}}{27{,}000\,\text{kPa}} = 0.012$$

Vertical deformation

$$\varepsilon_{\|} = \frac{dL}{L} \rightarrow dL = \varepsilon_{\|} L = (0.012)(0.2\,\text{m}) = -0.0024\,\text{m} = 2.4\,\text{mm}$$

Horizontal strain

$$\nu = \frac{\varepsilon_{\perp}}{\varepsilon_{\|}} \rightarrow \varepsilon_{\perp} = \nu\varepsilon_{\|} = (0.3)(0.012) = 0.0036$$

Horizontal deformation

$$\varepsilon = -\frac{dL}{L} \rightarrow dL = -\varepsilon_{\perp} L = -(0.0036)(0.10\,\text{m}) = -0.00036\,\text{m} = 0.36\,\text{mm}$$

Problem 9.4

(a)

$$\sigma_1 = \frac{\sigma_x + \sigma_z}{2} + \sqrt{\left[\frac{\sigma_x - \sigma_z}{2}\right]^2 + \tau_{xz}^2}$$

$$= \frac{210 + 375}{2} + \sqrt{\left[\frac{210 - 375}{2}\right]^2 + 75^2}$$

$$= 404 \text{ lb/ft}^2$$

$$\sigma_3 = \frac{\sigma_x + \sigma_z}{2} - \sqrt{\left[\frac{\sigma_x - \sigma_z}{2}\right]^2 + 75^2}$$

$$= \frac{210 + 375}{2} - \sqrt{\left[\frac{210 - 375}{2}\right]^2 + 75^2}$$

$$= 181 \text{ lb/ft}^2$$

(b)

$$\tau_{\max} = \frac{\sigma_1 - \sigma_3}{2} = \frac{404 - 181}{2} = 111 \text{ kPa}$$

The maximum shear stress acts at an angle of 21 + 45 = 66° clockwise and 21 – 45 = 24° counterclockwise from the horizontal.

(c)

$$\theta = 55 - 21 = 34°$$

$$\sigma = \frac{\sigma_1 + \sigma_3}{2} + \frac{\sigma_1 - \sigma_3}{2}\cos 2\theta$$

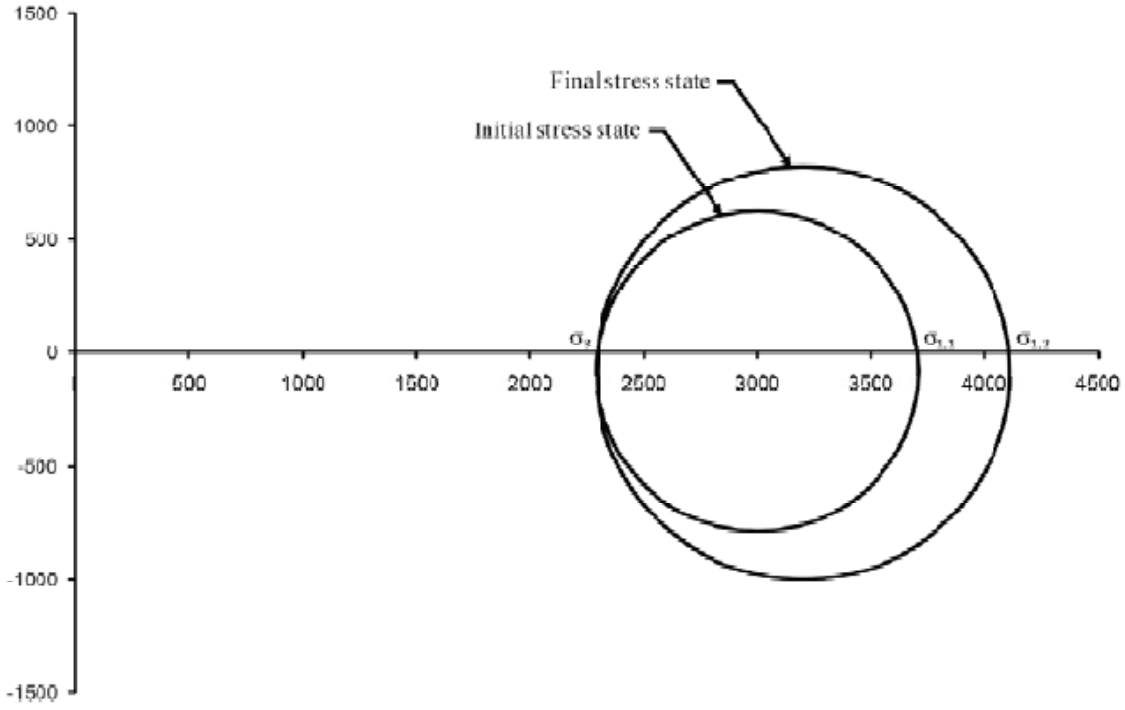
$$= \frac{404 + 181}{2} + \frac{404 - 181}{2}\cos(2(34))$$

$$= 334 \text{ kPa}$$

$$\tau = \frac{\sigma_1 - \sigma_3}{2}\sin 2\theta = \frac{404 - 181}{2}\sin(2(34)) = -103 \text{ kPa}$$

Problem 9.7

$$\sigma_{1,2} = \sigma_3 + \sigma_d = 2{,}300 + 1{,}800 = 4{,}100 \text{ lb/ft}^2$$



Problem 9.35

If we computed the effective stress from each source, then combined them by superposition, we would implicitly by subtracting the pore water pressure for each source, rather than only once. This would be incorrect. Therefore, we must combine the total stresses by superposition, and then subtract the pore water pressure to find the effective stress.

Problem 9.38

(a) $$\sigma_z = \gamma H = (120)(2) = 240 \text{ lb/ft}^2$$

(b) $$P/\text{tire} = \frac{18{,}000 \text{ lb}}{4} = 4500 \text{ lb}$$

The induced stresses from the right wheels are small and will be neglected.

	$\sigma_{z,\text{induced}}$					
	Rear Axle		Front Axle			
x (ft)	Outside wheel	Inside Wheel	Outside wheel	Inside Wheel	Sum	Total
0	10	4	2	1	17	257
1	28	10	4	2	44	284
2	95	28	6	4	133	373
3	307	95	9	6	417	657
4	537	307	10	9	863	1103
5	307	537	9	10	863	1103
6	95	307	6	9	417	657

(c)