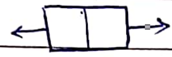
Hoang Thu Minh

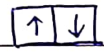
NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

CV2013 Date 19-20 S1 No.

1\.

(a) - Divergent plate boundaries: plates moving apart from each other
e.g. Mid-Atlantic Ridge 

- Convergent plate boundaries: plates moving towards each other
e.g. the Himalayan border with India 

- Transform-fault boundaries: plates sliding along each other
e.g. San Andreas Fault 

(b) (i) - Rock mass is a matrix consisting of rock materials and discontinuity

- Rock material is the intact rock within the framework of discontinuities

- Rock structure is ~~the individual, contrasted, larger-scale features of rocks~~ The nature & distribution of structural features within the rock mass

- Discontinuity is any separation in the rock continuum having effectively zero tensile strength ~~and is used with~~

(ii) - Persistency
- Roughness
- Stiffness
- Block size

(c) (i) - Weathering is the general process by which rocks are broken down on Earth's surface to produce sediment particles

- Physical weathering are mechanical processes which fragment solid rocks

- Chemical weathering refers to processes by which the minerals in a rock are chemically altered or dissolved.

(ii) Residual soil is formed by weathering of rocks and with little or no movement from the origin of the soil. Downward from the ground surface, progressively lesser degrees of rock weathering occurs

Transported soil is also formed by weathering of rocks, then transported by natural agents to a different location. During transportation, the size and shape of particles can undergo change

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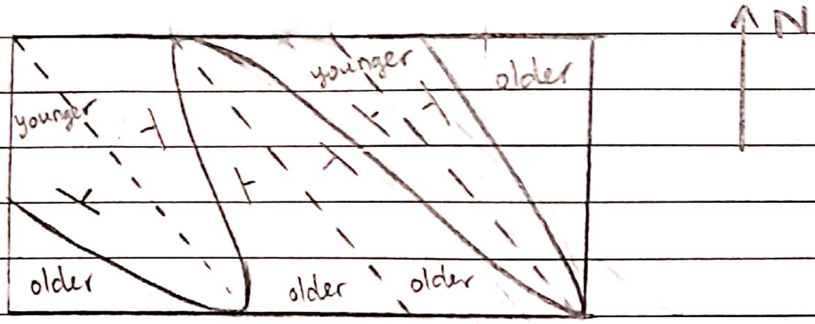
(d)



3.

(a)

(i) Darcy's law for 1-dimensional flow:

$$q = k i A$$

where q = discharge volume (m³/s) over unit time
k = permeability coefficient (m/s)
i = hydraulic gradient (m/m) $= \Delta H / L$
ΔH = ~~change in~~ head loss over the length L of soil
A = Cross-sectional area

(ii) Since $q_A = q_B \Rightarrow k_A i_A A = k_B i_B A \Rightarrow k_A i_A = k_B i_B$
~~$i_A = \frac{\Delta h_A}{L_A} = \frac{h_3 - h_1}{2}$~~ $\Rightarrow v_A = v_B$

(iii) Since $q_A = q_B \Rightarrow k_A i_A A = k_B i_B A$

$$\Rightarrow (2.0 \times 10^{-5}) \frac{h_3 - h_1}{2} = (1.0 \times 10^{-5}) \left(\frac{h_1 - h_0}{1} \right)$$

$$\Rightarrow h_3 - h_1 = h_1 - h_0$$

$$\Rightarrow h_1 = \frac{1}{2}(h_3 + h_0)$$

$h_3 = 4\,m$, $h_0 = 0\,m$ $\Rightarrow h_1 = \frac{1}{2}(4+0) = 2\,m$

(iv) $q = k_A i_A A = (2.0 \times 10^{-5}) \left(\frac{4-2}{2} \right) (2.0) = 4.0 \times 10^{-5}\ m^3/s$

$v_A = v_B = k_A i_A = (2.0 \times 10^{-5}) \left(\frac{4-2}{2} \right) = 2.0 \times 10^{-5}\ m/s$

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(b) (i) $N_d = 16$ $h = 5 - 1 = 4$ m

$N_f = 5$

Discharge below the dam $q = kh\frac{N_f}{N_d} = (6\times10^{-6})(4)\left(\frac{5}{16}\right) = 7.5\times10^{-6}$ m³/s per m

(ii) $\Delta h = \frac{h}{N_d} = \frac{4}{16} = 0.25$ m

Total head at B: $h_B = 1 + 6(0.25) = 2.5$ m

Elevation at B: $z_B = -1.4 - 1 = -2.4$ m

$\therefore$ Pore water pressure at B: $h_B - z_B = 4.9$ m

$\therefore u_B = (4.9\text{m})(9.81\text{ kN/m}^3) = 48.07$ kPa

(iii) $h_P = 5 - 0.25 = 4.75$ m

$z_P = -1 - 2 = -3$ m

$\therefore u_P = (h_P - z_P)\gamma_w = (7.75\text{m})(9.81\text{ kN/m}^3) = 76.03$ kPa

$\sigma_P = 5(9.81) + 2(20) = 89.05$ kN/m²

$\Rightarrow \sigma'_P = \sigma_P - u_P = 89.05 - 76.03 = 13.02$ kPa

(iv) $i_Q = \frac{\Delta h}{L} = \frac{0.25\text{m}}{0.8\text{ m}} = 0.3125$ m/m

~~$v_Q = ki_Q = (6\times10^{-6})(0.358) = 2.148\times10^{-6}$ m/s~~

$v_Q = ki_Q = (6\times10^{-6})(0.3125) = 1.875\times10^{-6}$ m/s

4

(a) (i) Objectives of soil compaction

1. Reduce detrimental settlement of structures built on filled ground
2. Increase shear strength to improve slope stability
3. Improved bearing capacity of pavement subgrade
4. Control undesirable volume changes
5. Reduce permeability to minimize seepage

- Role of water: The degree of compaction is measured in terms of dry density ρ_d. Since $\rho_d = \rho/(1+w)$, with ρ is the total density of soil and w is the water content, changes in water content affects ρ_d value. ρ_d reaches maximum at optimal water content, ~~w_{op}~~

(ii) – Increase shear strength
– Reduce permeability
– ~~Increase~~ Reduce soil compressity

(b) (i) Before placement of the fill:

– Total stress $\sigma_{v0} = 1(18) + 4(20) + 2(16) = 130$ kPa

– Pore water pressure $u_0 = 9.81(2+4) = 58.86$ kPa

– Effective stress $\sigma'_{v0} = \sigma_{v0} - u_0 = 130 - 58.86 = 71.14$ kPa

– Preconsolidation pressure $\sigma'_p = OCR \times \sigma'_{v0} = 1.2 \times 71.14 = 85.37$ kPa

(ii) $\Delta q = 20 \times 3 = 60$ kPa

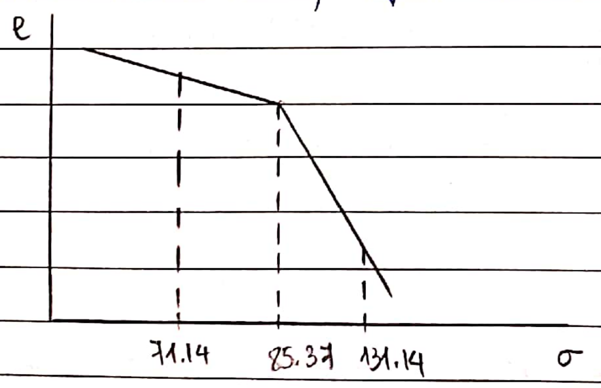
Immediately after placement $u_e = \Delta q = 60$ kPa

$\sigma_v = \sigma_{v0} + \Delta q = 130 + 60 = 190$ kPa

$u = u_0 + u_e = 58.86 + 60 = 118.86$ kPa

$\sigma'_v = \sigma'_{v0} = 71.14$ kPa

(iii) At $t = \infty$, $\sigma'_v = 71.14 + 60 = 131.14$ kPa



$$S_c = \frac{H}{1+e_0}\left(C_r \log \frac{\sigma'_p}{\sigma'_0} + C_c \log \frac{\sigma'_2}{\sigma'_p}\right)$$

$$= \frac{4}{1+1.2}\left(0.04 \log \frac{85.37}{71.14} + 0.8 \log \frac{131.14}{85.37}\right)$$

$$= 0.277 \text{ m}$$

(iv) $U = \frac{S(t)}{S_c} = \frac{1}{2} = 0.5 \Rightarrow T_v = 0.197$

$d = 4/2 = 2$ m (double drainage)

$T_v = \frac{C_v t}{d^2} \Rightarrow t = \frac{T_v d^2}{C_v} = \frac{0.197 \times 2^2}{1.25} = 0.6304$ year

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(v) ~~$U_{avg} = 90\%$, $\frac{z}{d} = \frac{2}{2} = 1$~~ } ~~$\Rightarrow T_v =$~~ $U_{avg} = 90\%$

$T_v = 0.848$

~~$\Rightarrow \frac{z}{d} = 0.45$ m~~ $\Rightarrow z = 0.9$ m

For $\frac{z}{d} = 1 \Rightarrow U_z = 0.84$

$U_z = 1 - \frac{u_e}{u_i} \Rightarrow 0.84 = 1 - \frac{u_e}{60} \Rightarrow u_e = 9.6$ kPa

$\Rightarrow u = u_e + u_o = 9.6 + 58.86 = 68.46$ kPa

$\Rightarrow h_w = \frac{u}{\gamma_w} = \frac{68.46}{9.81} = 6.98$ m

4✓

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