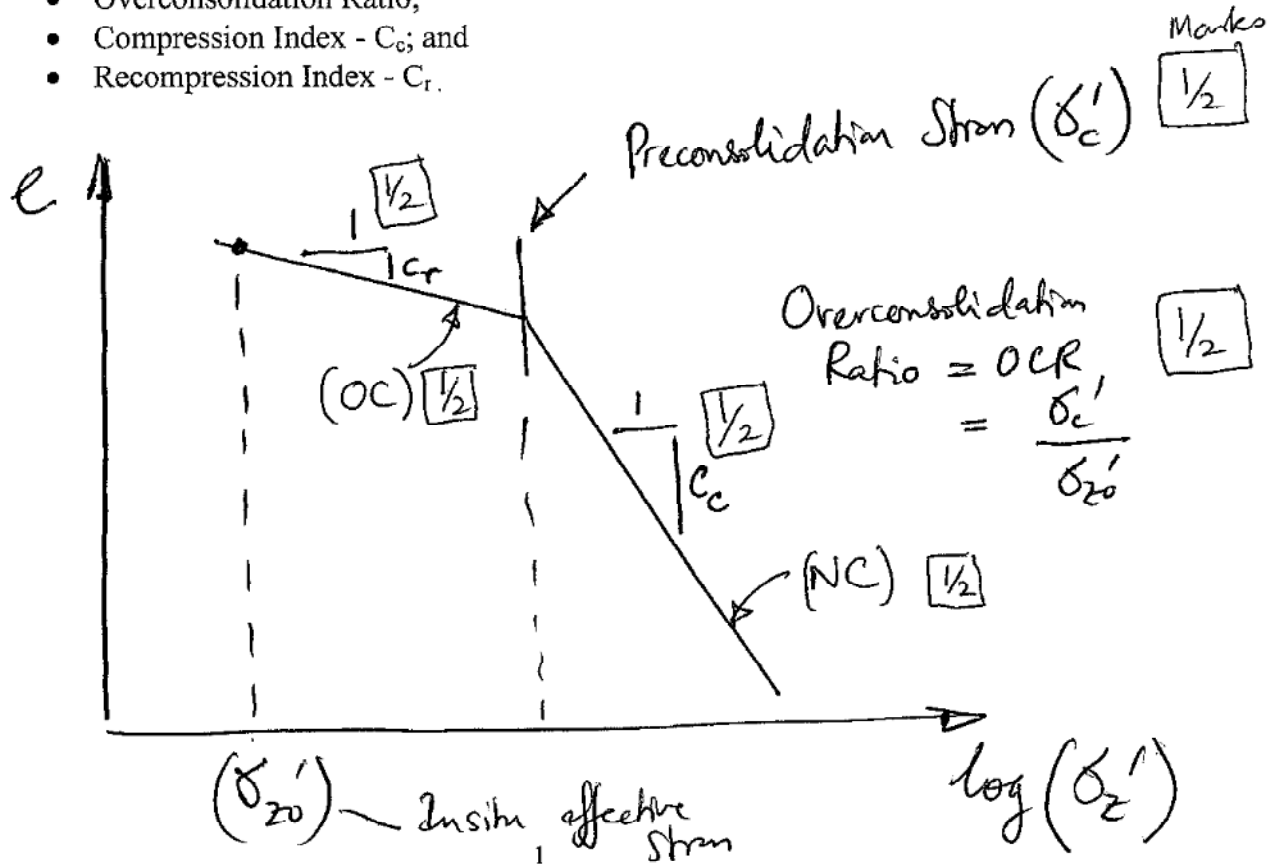
• CIVL 311 Mid-term I - 2012

Question 1

(a) Using the space below, draw a schematic plot of void ratio - e vs. log (vertical effective stress, σ'_z) for a clayey soil, and use the diagram to illustrate/express the definitions for the following **(3 Marks out of 22)**:

- Preconsolidation stress (σ'_c);
- Virgin consolidation (NC) part of the e vs. log (σ'_z) curve;
- Recompression part of the e vs. log (σ'_z) curve;
- Overconsolidation Ratio;
- Compression Index - C_c; and
- Recompression Index - C_r.



- **CIVL 311 Mid-term I - 2012**
- **Answers to Q2**

- **Primary Consolidation**
  - Excess water pressure dissipates (water drains out)
  - Effective stress increases
  - Soil skeleton volume decreases
  - Time dependent

1

- **Secondary compression**
  - Creep
  - Constant effective stress
  - Skeleton volume decreases
  - Fabric changes

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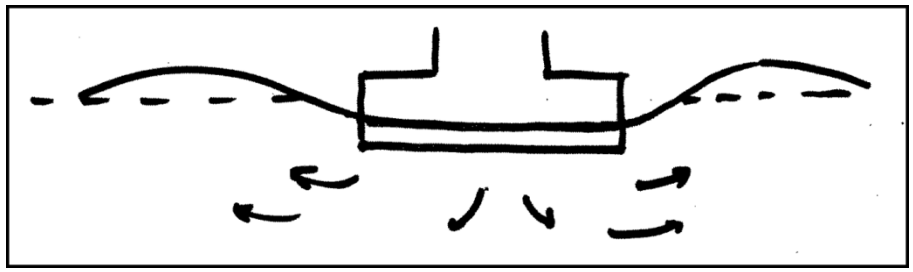
- **Distortion**
  - Shear deformation of soil under undrained conditions
  - Distortional
  - Time dependent



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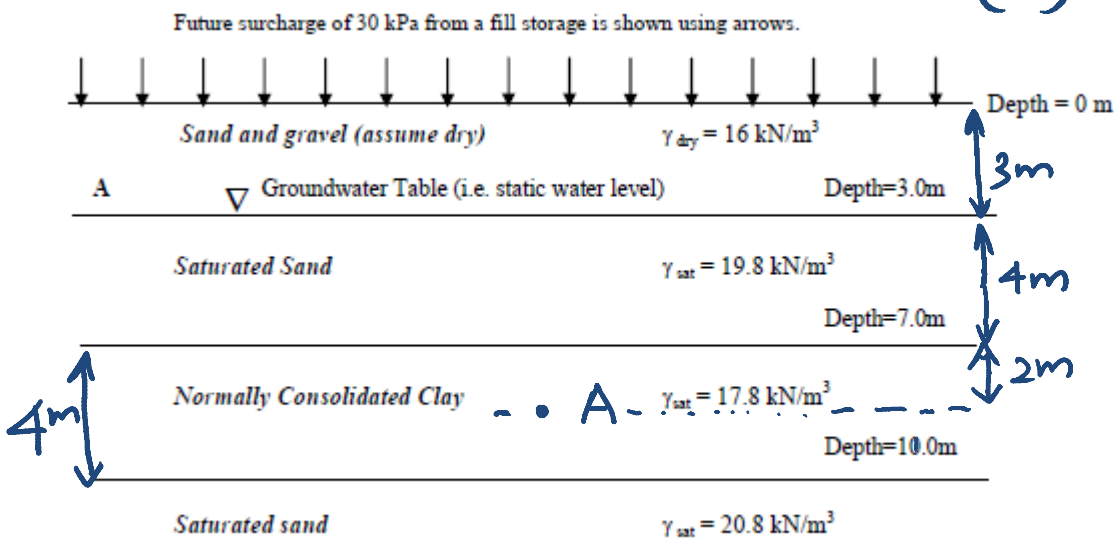

(i) • Compute initial vertical effective stress (σ_{vo}') at A:

$\sigma_{vo} = 16.0 \times 3 + 19.8 \times 4 + 17.8 \times 2$ [1]

$= \underline{162.8 \text{ kPa}}$

$u = 9.8 \times 6 = \underline{58.8 \text{ kPa}}$ [1]

$(\sigma_{vo}')_A = 162.8 - 58.8 = \underline{104 \text{ kPa}}$ [1]

• In situ void ratio e_o prior to loading $e_o = 1.00 - 0.35 \log\left(\frac{104}{100}\right)$

$= \underline{0.994}$ [1]

- $\Delta\sigma_z = 30\ kPa.$ $H_o = 4\ m$ [1]

$C_c = 0.35$ [1]

Primary consolidation settlement due to $\Delta\sigma_z$

$$\rho_c = \rho_{pc}$$

$$\rho_{pc} = \frac{C_c}{1+e_o} \cdot \log\left(\frac{\sigma_{zo}' + \Delta\sigma_z}{\sigma_{zo}'}\right) \cdot H_o$$

$$= \left(\frac{0.35}{1+0.994}\right) \log\left(\frac{104+30}{104}\right) \cdot 4$$ [2]

$$= 0.1755 \times 0.11007 \times 4$$

$$= 0.077\ m = \underline{77\ mm} \leftarrow$$ [2]

(ii) $\dfrac{C_v t_{90}}{H_{dr}^2} = 0.848$ $\quad C_v = 5\times10^{-8}\ m^2/s$

Clay layer in double drainage.

$\therefore \dfrac{5\times10^{-8}\times t_{90}}{(2)^2} = 0.848 \Rightarrow H_{dr} = 2\ m$ [1] [1]

$\therefore t_{90} = \dfrac{0.848\times 2^2}{5\times10^{-8}}$ sec

$= \dfrac{67840000}{3600\times24\times365}$ yrs

$= 2.15$ yrs [1]

(iii) Clay layer underlain by impermeable bedrock

$$H_{dr} = 4\text{ m}$$ 1

$$\frac{C_v t_{50}}{H_{dr}^2} = 0.196$$

$$t_{50} = \frac{0.196 \times 4^2}{(5 \times 10^{-8})}\ \text{sec}$$ 1

$$= \frac{62720000}{3600 \times 24 \times 365}\ \text{yrs}$$

$$= 1.99\ \text{yrs}$$ 1