Tekanan Efektif

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Tanah

Udara/gas		
Air		
Partikel	Partikel	Partikel
Tanah (3- fasa)	Tanah jenuh (2-fasa)	Tanah kering (1-fasa)

Proses pemadatan
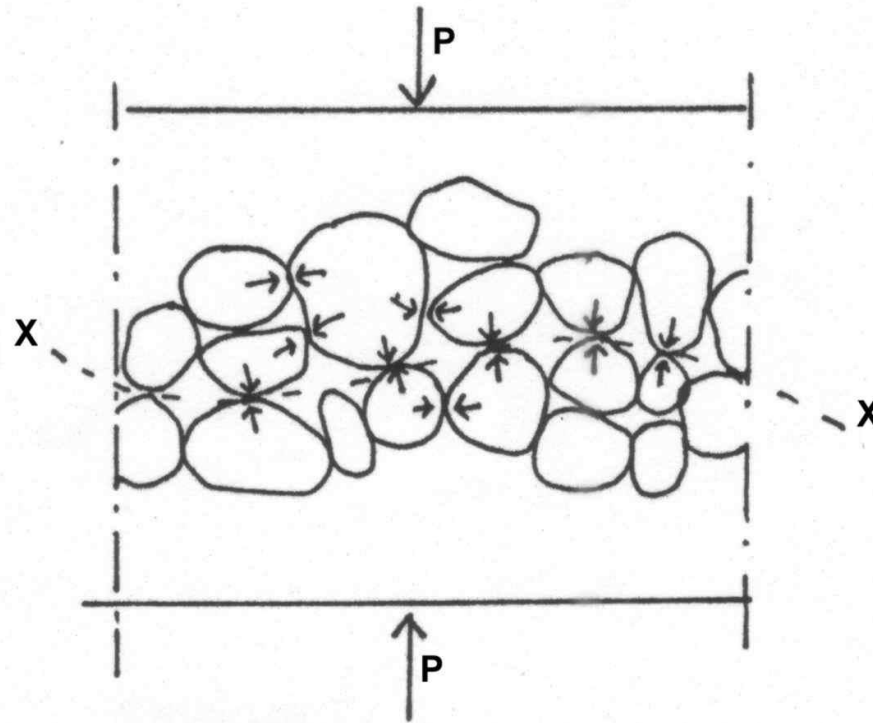
Proses pemampatan
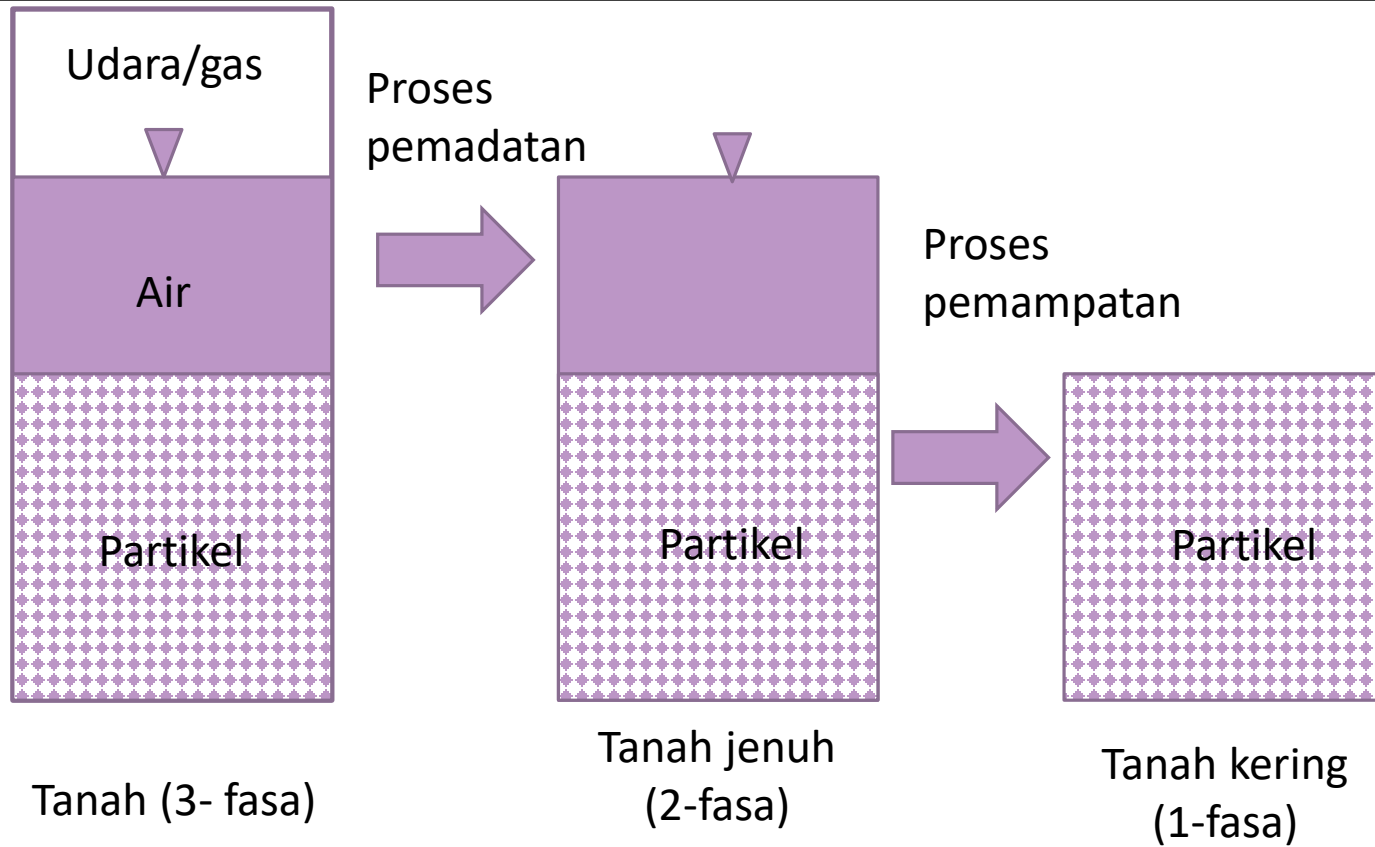
Tekanan dalam tanah

- Tekanan akibat berat sendiri tanah (In-situ stress)
  - Tekanan Total
  - Tekanan efektif

- Tekanan akibat beban luar
  - Berat Bangunan
  - Aliran air dalam tanah
  - Angin
  - dll

Konsep Tekanan efektif

Explain

Konsep tekanan efektif penting karena:
- Tekanan hanya dapat disalurkan melalui kontak anatar butiran tanah
- Kekuatan tanah berasal dari kontak antar butiran tanah
- Keberadaan air hanya menambah tekanan dalam tanah tapi tidak memberikan kotribusi dalam kekuatan geser tanah

Tekanan Total = Tekanan Effective + Tekanan air pori

$$\sigma = \sigma' + \mu$$

- Total stress (σ) on a plane in soil mass is the force per unit area transmitted in the normal direction across the plane assuming the soil to be a solid material

- Pore water pressure (μ) is the pressure of the water filling the void space between the solid particles

- Effective stress (σ') on the plane, representing the stress transmitted through the soil skeleton only.

Terzaghi (1923) Principal of Effective Stress

explain

Tekanan akibat berat sendiri (in-situ stress)

$$\sigma_o = \sigma'_o + \mu$$

$$\mu = (H_1+H)\ \gamma_w \ ; \quad \sigma_o' = H\ \gamma' \ ; \quad \sigma_o = H_1\gamma_w + H\ \gamma_{sat}$$
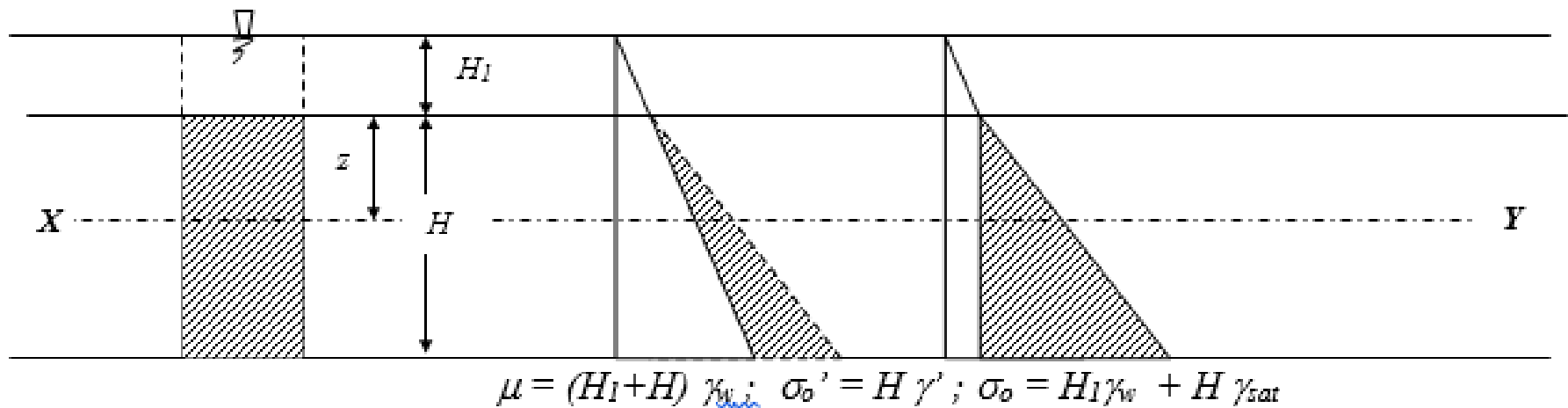
The effective stress along *XY* is as follows:

Pore-water pressure: $\quad \mu = (H_1 + z)\ \gamma_w$

Effective stress: $\quad \sigma'_o = z\ (\gamma_{sat} - \gamma_w) = z\ \gamma'$

Total stress: $\quad \sigma_o = H_1\ \gamma_w + z\ \gamma_{sat}$

Example Problem 2.1

A soil profile consists of a surface layer of loose sand 3.5 m thick overlying a layer of stiff clay as shown in Figure P2.1. Unit weight of sand is 16.5 kN/m³ while the saturated unit weight of stiff clay is 18.5 kN/m³. Draw the distribution of total, effective and pore water pressure in the soil and calculate the stresses at depth of – 3.5 and – 5.5 m from surface. Take γ_w = 9.8 kN/m³.
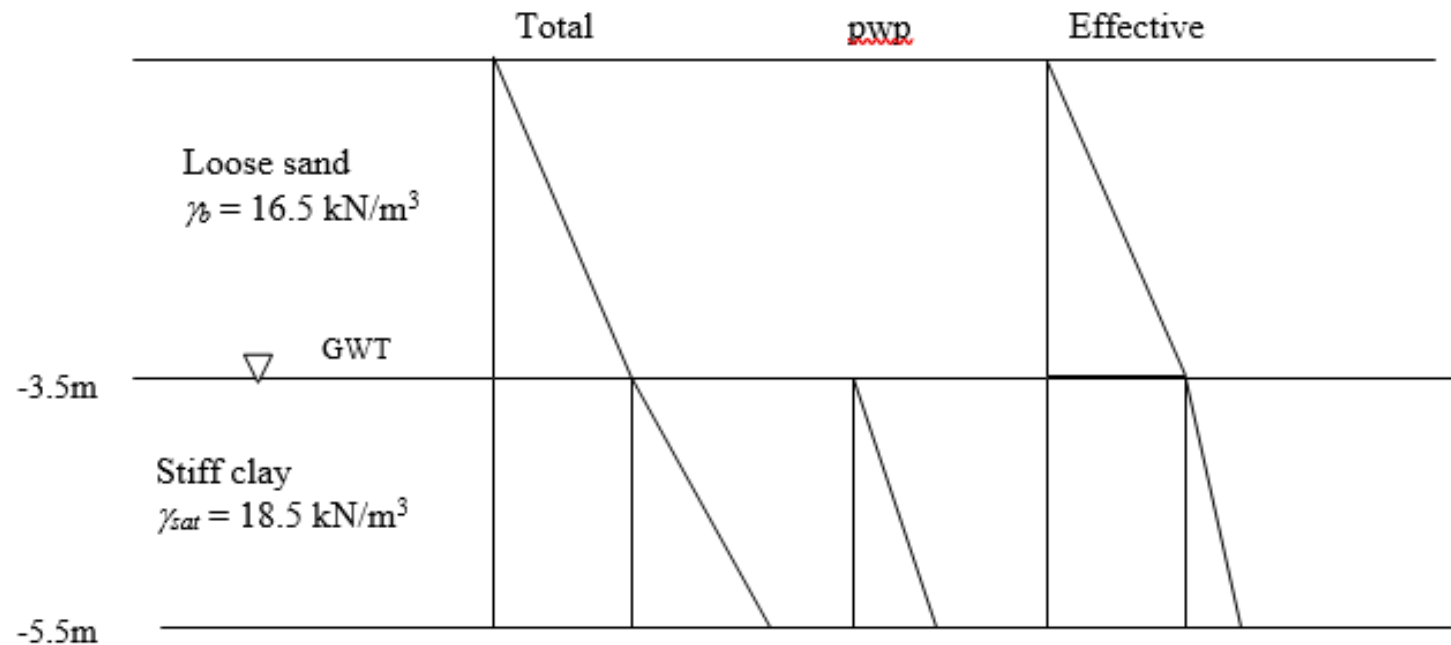
Solution:

Figure P2.1

At depth of – 3.5 m (GWT)

Total stress: $\qquad \sigma_o = 16.5 \times 3.5 = 57.75 \ \text{kN/m}^3$

Pore-water pressure: $\qquad \mu = 0$

Effective stress: $\qquad \sigma_o' = 57.75 - 0 = 57.75 \quad \text{kN/m}^3$

At depth of –5.5 m

Total stress: $\qquad \sigma_o = (16.5 \times 3.5) + (18.5 \times 2) = 94.75 \ \text{kN/m}^3$

Pore-water pressure: $\qquad \mu = 2 \times 9.8 = 19.6 \ \text{kN/m}^3$

Effective stress: $\qquad \sigma_o' = 94.75 - 19.6 = 75.15 \ \text{kN/m}^3$

Example Problem 2.2

Calculate the effective stress at 5 m below a river bed which consist of sand with saturated unit weight of 20 kN/m³. The depth of the water in the river was 2 m. Take $\gamma_w = 9.8$ kN/m³.

Solution:

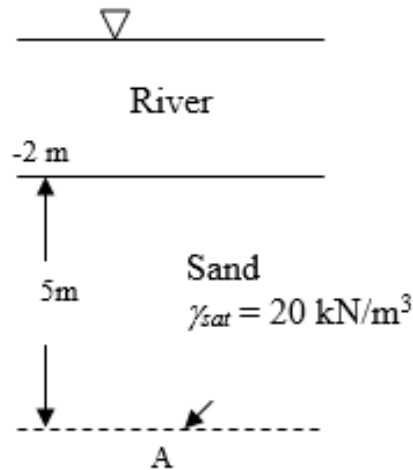River

-2 m

Sand
5m
$\gamma_{sat} = 20$ kN/m³

Figure P2.2

A

At point A

Total stress: $\sigma_o = 2 \times \gamma_w + 5 \times \gamma_{sat} = 119.6$ kN/m³

Pore water pressure $\mu = \gamma_w (2 + 5) = 68.6$ kN/m³

Effective stress $\sigma'_o = \sigma_o - \mu$

                                    $= 119.6 - 68.6$

                                    $= 51$ kN/m³

Aplikasi Konsep Tekanan Tanah Efektif

Kekuatan geser tanah (Daya dukung pondasi)

Konsolidasi (Penurunan Tanah)

Tekanan Tanah Lateral (Tanggul)

Aliran air Tanah

Kondisi Quick dan Uplift (Tek ke atas)