Department of Civil Engineering
Katihar Engineering College, Katihar

Subject: Soil and Rock Mechanics
Topic: Earth Pressure Theory
Lecture: 07
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(1)

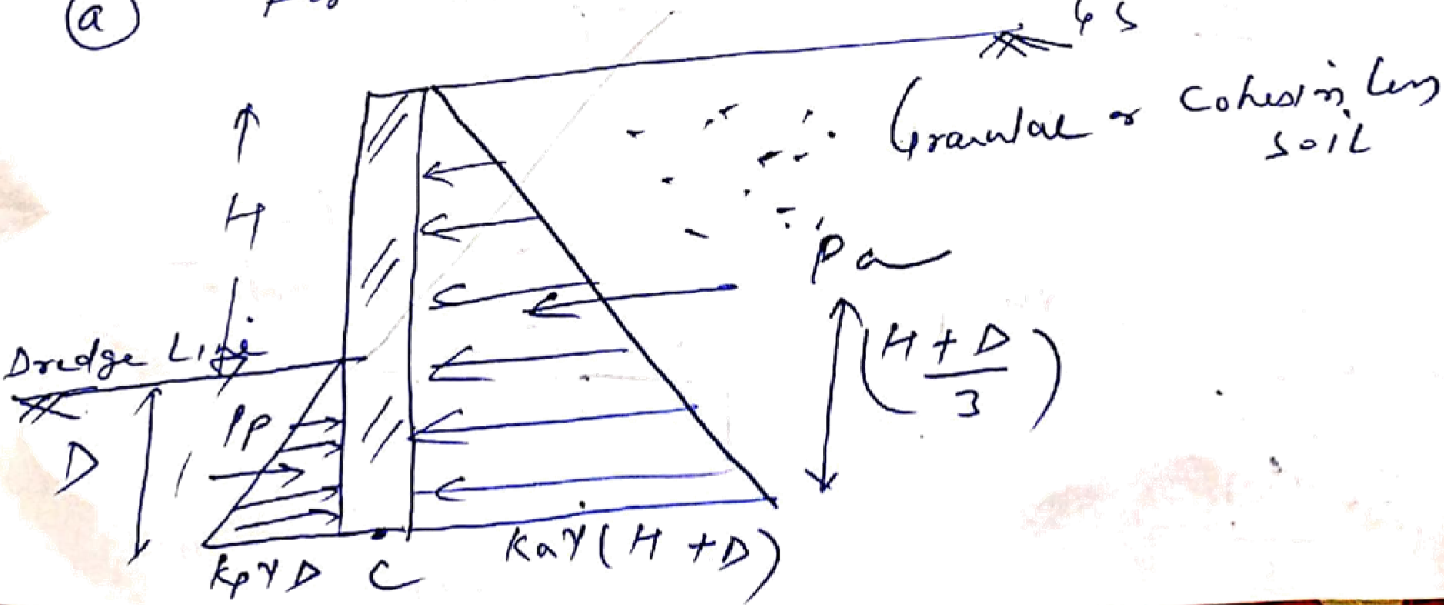
Sheet Pile Wall: Sheet pile consist of number of sheet piles driven side by side to form continuous vertical wall into the medium which is used to retain earth mass.

→ used in water front structure, temporary construction to prevent failure below the gravity dam

Types → Cantilever sheet pile
→ Anchored sheet pile

Cantilever sheet pile

(a) For cohesionless soil



In order to ensure safety against overturning the minm depth of embedment can be calculated as

$$\Sigma M_c = 0$$

$$P_a \times \left(\frac{H+D}{3}\right) - P_p \times \frac{D}{3} = 0$$

$$\frac{1}{2} K_a \gamma (H+D)^2 \times \left(\frac{H+D}{3}\right) - \frac{1}{2} K_p \gamma D^2 \times \frac{D}{3} = 0$$

$$\frac{1}{2} K_a \gamma \frac{(H+D)^3}{3} = \frac{1}{2} K_p \frac{\gamma D^3}{3}$$

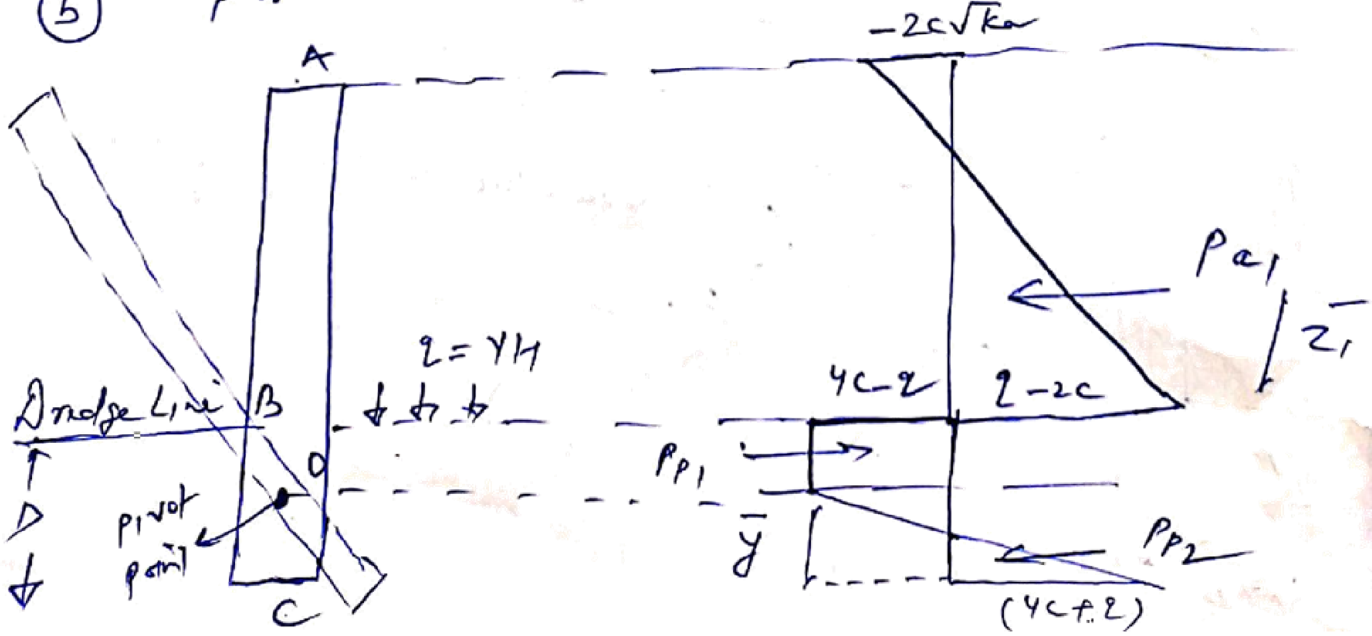
$$K_a (H+D)^3 = K_p (D)^3$$

$$D = \checkmark$$

If factor of safety is not given then increase D by 30 %.

∴ **Depth of embedment = 1.3 D**

(b) For Cohesive Soil



Above dredge Line

Right hand side (Active Condition)

$$p_a = k_a \gamma z - 2c\sqrt{k_a}$$

For Pure clay ($\phi = 0$, $k_a = 1$)

$$p_a = \gamma z - 2c$$

At $z = 0$, Point A, $p_a = -2c$

At $z = H$, Point B, $p_a = \gamma H - 2c$

$= q - 2c (\leftarrow)$

At Point B. (Right hand side) Active

$$p_a = q - 2c \ (\leftarrow)$$

Left hand side (Passive)

$$p_p = k_p \gamma z + 2c\sqrt{k_p} \quad \begin{bmatrix} k_p = 1 \\ z = 0 \end{bmatrix}$$

$$p_p = 2c \ (\rightarrow)$$

Resultant Earth Pressure

$$p = \underset{(\rightarrow)}{p_p} - \underset{\leftarrow}{(p_a)}$$

$$= 2c - (q - 2c) = \underset{\rightarrow}{(4c - q)}$$

Below the dredge Line at depth z.

RHS, Active, $k_a \sigma_v - 2c\sqrt{k_a}$

$= k_a(q + \gamma z) - 2c\sqrt{k_a}$

$$p_a = q + \gamma z - 2c \ (\leftarrow)$$

Resultant Earth Pressure

$$p = p_p - p_a$$

$(\rightarrow)$ $(\leftarrow)$

$$= \gamma z + 2c - (q + \gamma z - 2c)$$

$$p = (4c - q)$$

At the base point C

RHS, (Passive)

$$p_p = K_p \sigma_v + 2c\sqrt{K_p}$$

$$= K_p(q + \gamma D) + 2c\sqrt{K_p}$$

$$= q + \gamma D + 2c \; (\leftarrow)$$

LHS. Active

$$p_a = K_a \sigma_v - 2c\sqrt{K_a}$$

$$= K_a \gamma D - 2c\sqrt{K_a}$$

$$= \gamma D - 2c \; (\rightarrow)$$

Resultant Earth Pressure

$$p = p_p - p_a$$

$$= (q + \gamma D + 2c) - (\gamma D - 2c)$$

$$= q + 4c \; (\leftarrow)$$

For stability

$$\Sigma F_H = 0, \quad \Sigma M_C = 0$$

$$\Sigma F_H = 0$$

$$P_{p1} - P_{p2} - P_{a1} = 0$$

$$(4c-q)\times D - \frac{1}{2}\left[4c+q+4c-q\right)\times\bar{y} - Pa_1 = 0 \quad \text{--- (1)}$$

$$\Sigma M_c = 0$$

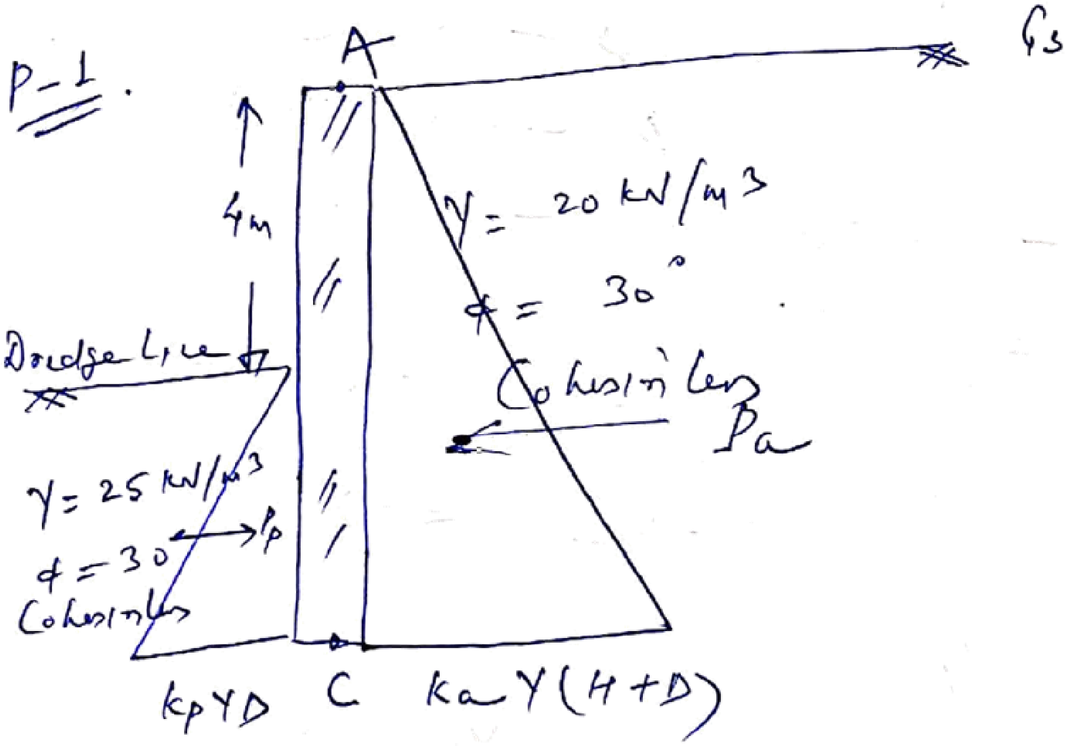
$$(4c-q)\times D\times\frac{D}{2} - \frac{1}{2}(4c+q+4c-q)\times\bar{y}\times\frac{\bar{y}}{3} - Pa_1(D+\bar{z}_1) = 0 \quad \text{--- (2)}$$

Solve eqn (1) & (2)

$D = \checkmark$ and $\bar{y}$

Provide depth of embedment = 1.3 D

P-1.



For Active Condition

$$ka = \frac{1-\sin 30}{1+\sin 30} = 1/3$$

$$Kp = \frac{1+\sin 30}{1-\sin 30} = 3$$

$P_a = \frac{1}{2} k_a \gamma (H+D)^2$ acting at $\left(\frac{H+D}{3}\right)$ from base.

$= \frac{1}{2} \times \frac{1}{3} \times 20 \, (H+D)^2$

$P_a = \frac{20}{6} (H+D)^2$ acting at $\left(\frac{H+D}{3}\right)$

$P_p = \frac{1}{2} k_p \gamma D^2$ acting at $\frac{D}{3}$ from base

$= \frac{1}{2} \times 3 \times 25 \times D^2$ acting at $\frac{D}{3}$ from base

$= \frac{75}{2} D^2$ acting at $\frac{D}{3}$ from base

$\sum M_c = 0$

$P_a \times \left(\frac{H+D}{3}\right) - P_p \times \frac{D}{3} = 0$

$\Rightarrow \frac{20}{6} (H+D)^2 \times \frac{(H+D)}{3} = \frac{75}{2} D^2 \times \frac{D}{3}$

$\Rightarrow \frac{10}{3} (H+D)^3 = 37.5 D^3$

$\Rightarrow 3.33 (4+D)^3 = 37.5 D^3$

$D = 3.22$ m

Factor of safety is not given in the problem, so increase the value of D by 30%.

Depth of embedment $= 1.3 D = 1.3 \times 3.22$

$= 4.2$ m

HAPPY AND SAFE LEARNING