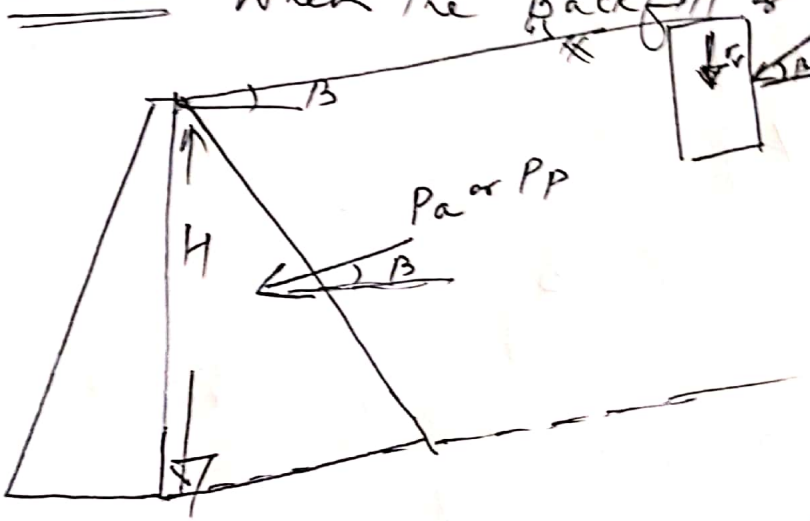
Department of Civil Engineering
Katihar Engineering College, Katihar

Subject: Soil and Rock Mechanics
TOPIC: Lateral Earth Pressure Theory
Instructor: Prof. RASHID MUSTAFA
Lecture No: 04

Case V When the Backfill or Ground Surface is inclined



Active Earth Pressure (P_a) = $k_a \gamma H$

Active Thrust (P_a) = $\frac{1}{2} k_a \gamma H^2$

Where k_a = Active Earth Pressure Coefficient.

$$K_a = \cos\beta \left[\frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}} \right]$$

When Ground Surface is horizontal ($\beta = 0$)

$$k_a = \cos 0 \left[\frac{\cos 0 - \sqrt{\cos^2 0 - \cos^2\phi}}{\cos 0 + \sqrt{\cos^2 0 - \cos^2\phi}} \right]$$

$$k_a = \frac{1 - \sin\phi}{1 + \sin\phi}$$

Passive Thrust (P_p) = $\frac{1}{2} k_p \gamma H^2$ —

$$k_p = \cos\beta \left[\frac{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}} \right]$$

When Ground surface is horizontal ($\beta = 0$)

$$k_p = \frac{1+\sin\phi}{1-\sin\phi}$$

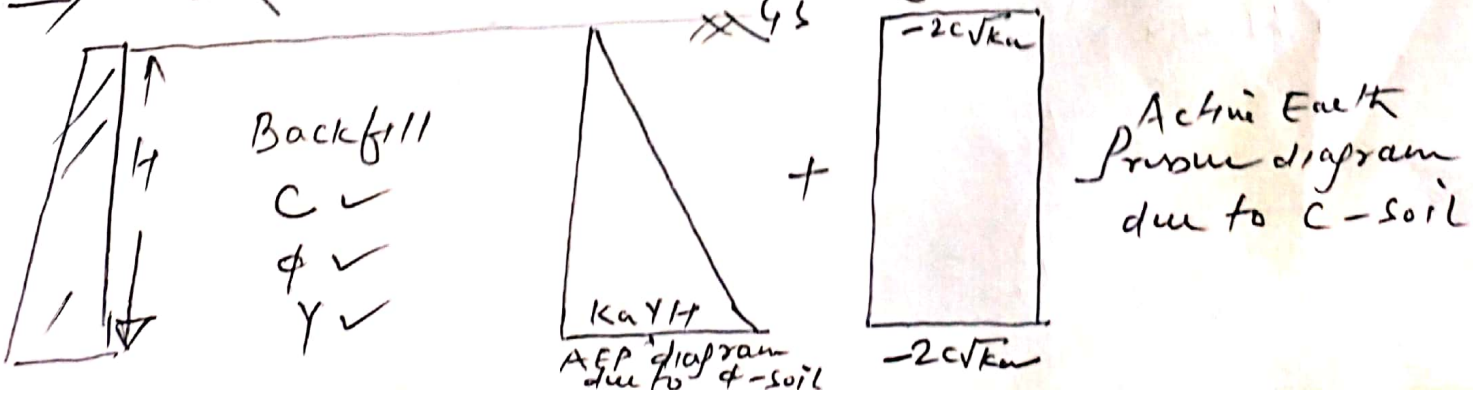
$$k_a \cdot k_p = \cos^2\beta$$

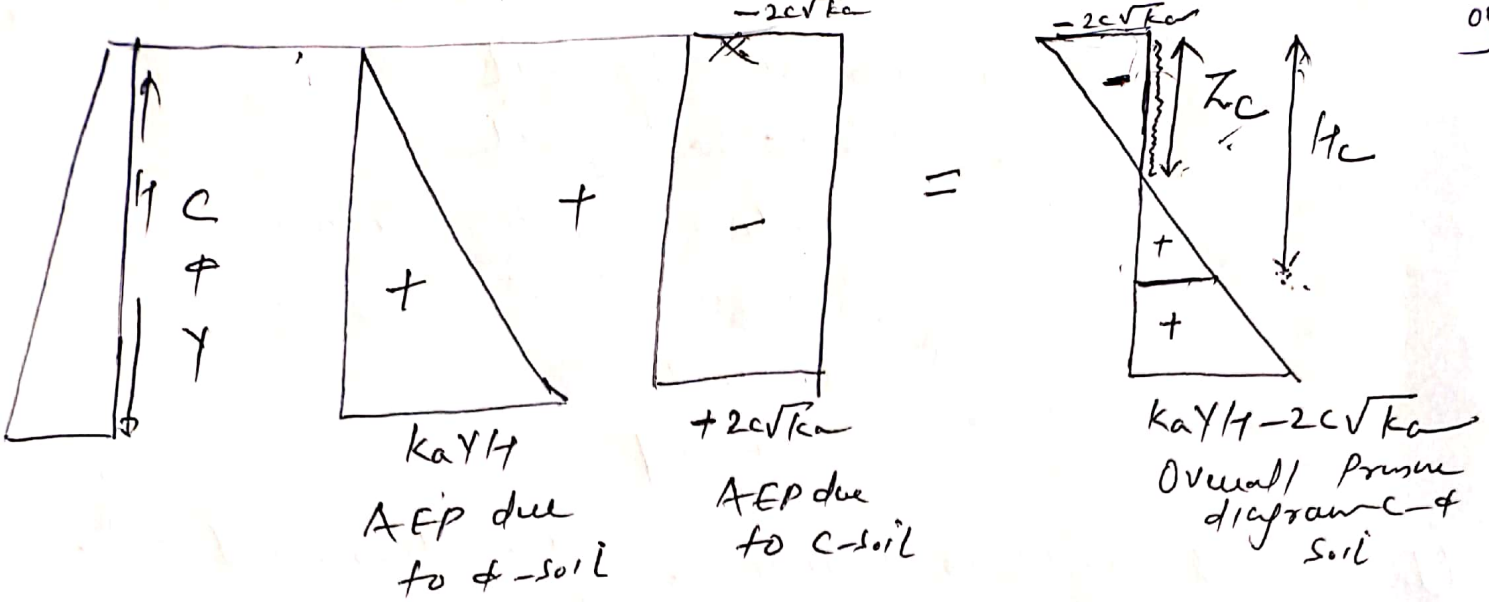
→ ⇒ Active and Passive Earth Pressure when soil backfill is c–ϕ

→ Active Condition

The Effect of cohesion in active Earth Pressure was estimated by Resal & Bell. It is also called Resal & Bell Theory.

⇒ Resal & Bell Theory.





Active Earth Pressure due to ϕ-soil $(p_{a1}) = k_a \gamma H$

Active thrust due to ϕ-soil $(P_{a1}) = \frac{1}{2} k_a \gamma H^2$ acting at H/3 from base of the wall.

Active Earth Pressure due to c-soil $(p_{a2}) = -2c\sqrt{k_a}$

→ Total Active thrust Befor tension Crack and after tension Crack

⇒ Depth of tension Crack (Z_c): The depth at which active pressure is zero.

$$(k_a \gamma Z_c - 2c\sqrt{k_a}) = 0$$

$$k_a \gamma Z_c = 2c\sqrt{k_a}$$

$$Z_c = \frac{2c\sqrt{k_a}}{k_a \cdot \gamma}$$

$$\boxed{Z_c = \frac{2c}{\gamma\sqrt{k_a}}}$$

Where $c \rightarrow$ Cohesion of soil

$\gamma \rightarrow$ Unit wt of soil

$k_a \rightarrow$ Active Earth Pressure Coefficient.

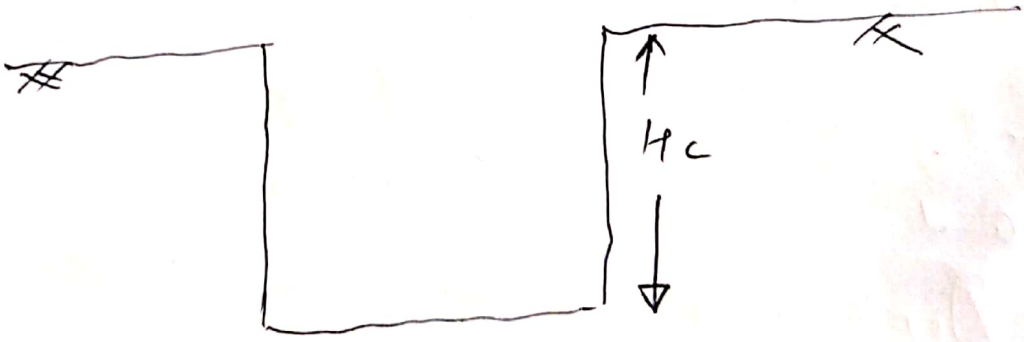
$$k_a = \frac{1-\sin\phi}{1+\sin\phi}$$

Unsupported height or Critical height (H_c): Total net Earth is zero.

$$H_c = 2 Z_c$$

$$= 2 \times \frac{2c}{\gamma\sqrt{k_a}}$$

$$\boxed{H_c = \frac{4c}{\gamma\sqrt{k_a}}}$$



$\Rightarrow$ Active Earth ~~Pressure~~ Thrust before the tension crack.

$$P_a = \int_0^H (p_a)\, dz$$

$$\boxed{P_a = \int_0^H (k_a \gamma z - 2c\sqrt{k_a})\, dz}$$

↳ Before tension crack

Active thrust after the tension Crack (P_a) $= \int_{z_c}^{H} p_a \cdot dz$

Active thrust after the tension crack (P_a) $= \int_{z_c}^{H} (k_a \gamma z - 2c\sqrt{k_a})\, dz$

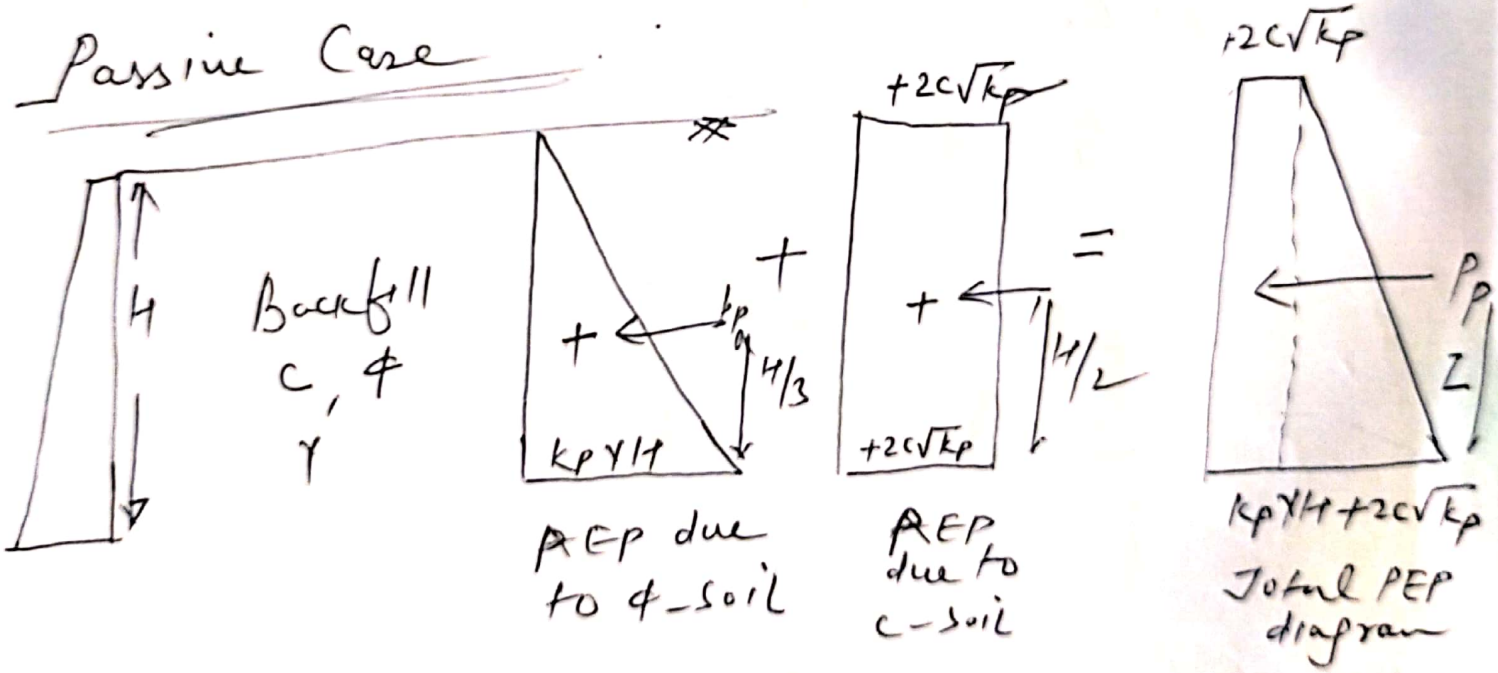
Where $z_c \rightarrow$ Depth of tension crack

$$z_c = \frac{2c}{\gamma\sqrt{k_a}}$$

$c \rightarrow$ cohesion of soil.

Note: Cohesion decreases the active Earth Pressure by $-2c\sqrt{k_a}$

Passive Case



Passive Earth Pressure due to ϕ-soil $(p_{p_1}) = k_p \gamma H$

Total Passive thrust due to ϕ-soil $(P_{p_1}) = \frac{1}{2} k_p \gamma H^2$ acting at a height of H/3 from base

Passive Earth pressure to c-soil $(p_{p_2}) = +2c\sqrt{k_p}$

Total Passive thrust due to c-soil $(P_{p_2}) = (2c\sqrt{k_p} \cdot H)$ acts at a height of $H/2$ from base.

Let P_p be the total Passive thrust due to c-ϕ soil

$$\boxed{P_p = P_{p_1} + P_{p_2}}$$

Let z be the Line of action

$$P_p \times z = P_{p_1} \times z_1 + P_{p_2} \times z_2$$

$$z = \frac{P_{p_1} \times z_1 + P_{p_2} \times z_2}{P_p}$$

$$\boxed{z = \frac{\frac{1}{2} k_p \gamma H^2 \times \frac{H}{3} + 2c\sqrt{k_p} \cdot H \times H/2}{\frac{1}{2} k_p \gamma H^2 + 2c\sqrt{k_p} H}}$$

Note: Cohesion increases the Passive Earth pressure by the magnitude of $+2c\sqrt{k_p}$

<Happy Learning>