## 6. Lateral Earth Pressure & Earth Retaining Structures

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- Pressure distributions
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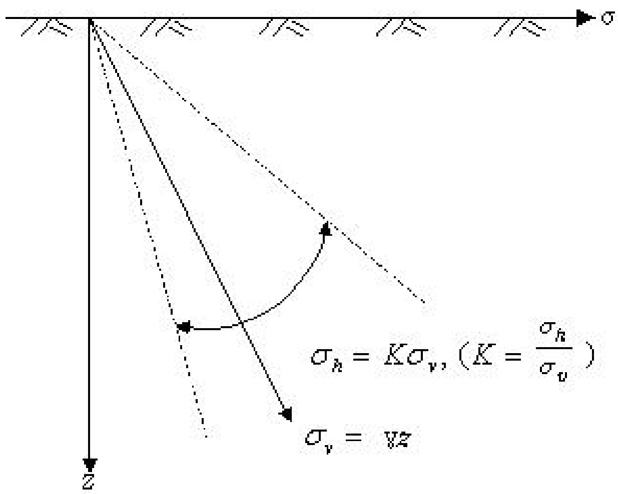
- Reinforced earth

## 6.1 Preliminaries

1)




2) Geostatic case ( at-rest condition )

$K \rightarrow K_0$ : the coefficient of lateral stress at rest

assumptions i ) ground surface horizontal

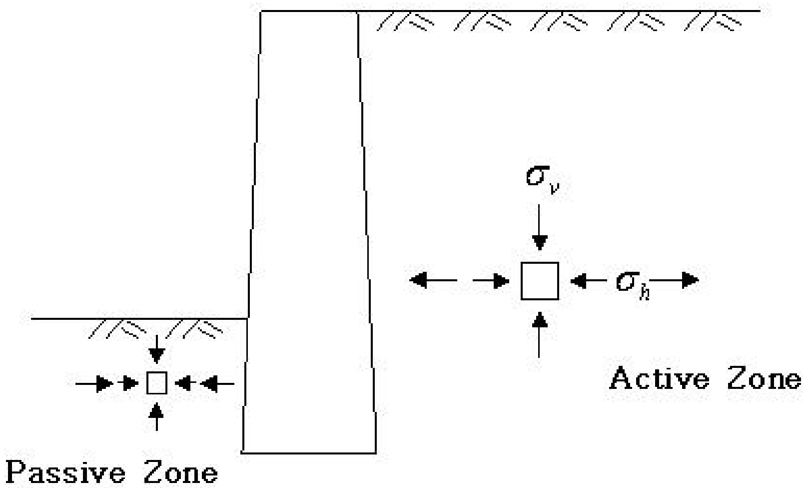
ii ) homogeneous soil

$$K_0 = \frac{\mu}{1-\mu} \qquad \left( \because \sigma_h = \frac{\mu}{1-\mu}\sigma_v \right)$$

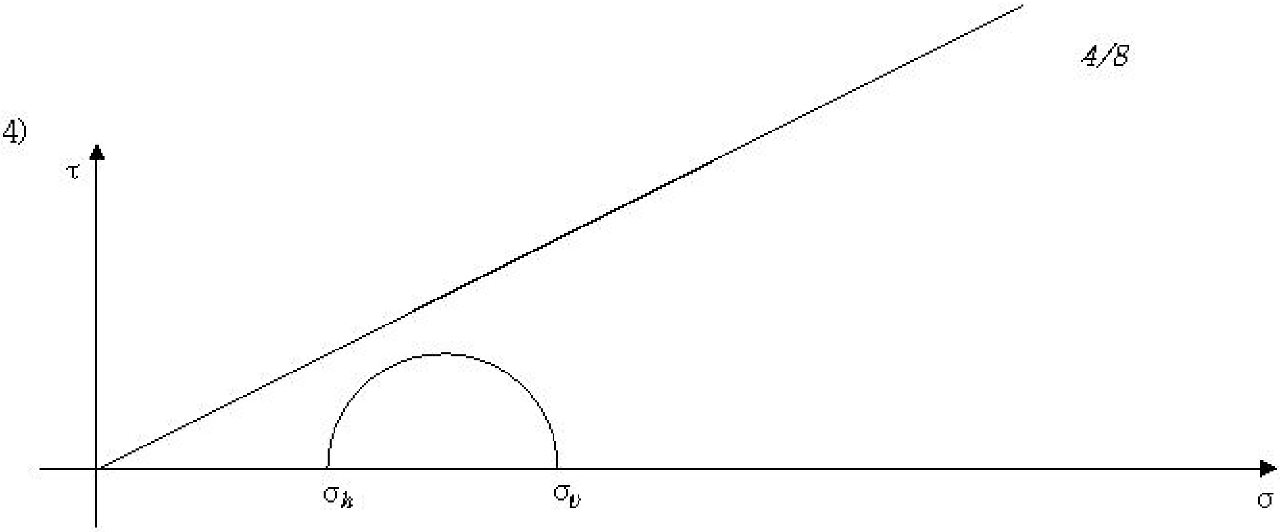
or empirically

$$K_0 = 1 - \sin\phi \qquad (\text{Jaky})$$

3)



4)

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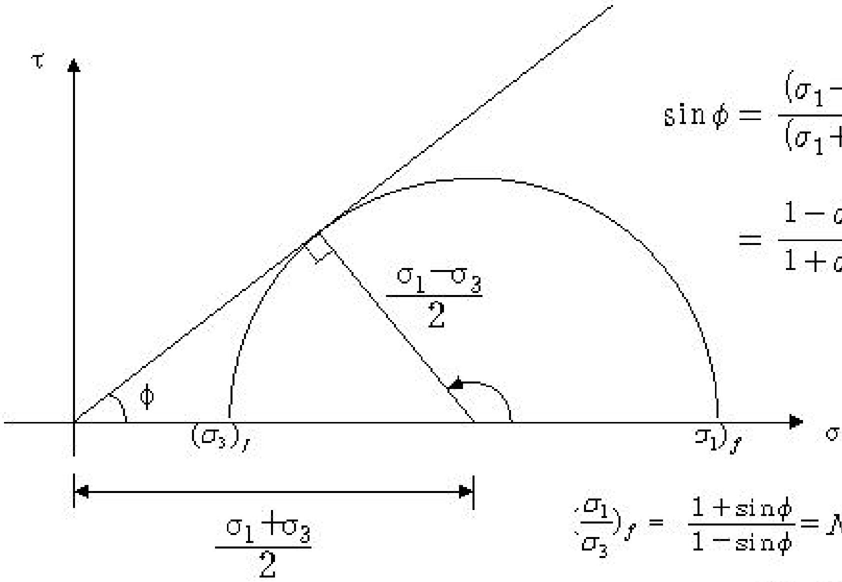



$$\sin\phi = \frac{(\sigma_1-\sigma_3)/2}{(\sigma_1+\sigma_3)/2}$$

$$= \frac{1-\sigma_3/\sigma_1}{1+\sigma_3/\sigma_1}$$

$$\left(\frac{\sigma_1}{\sigma_3}\right)_f = \frac{1+\sin\phi}{1-\sin\phi} = N_\phi(flow\ factor)$$

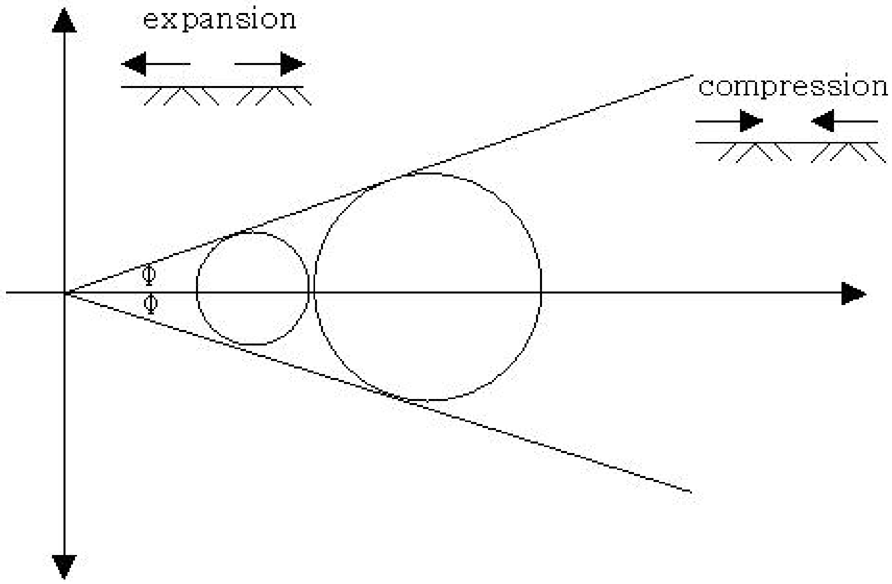
$$= \tan^2(45° + \phi/2)$$

6) $K_a = \frac{(\sigma_h)_A}{\sigma_v} = \left(\frac{\sigma_3}{\sigma_1}\right)_f = \frac{1-\sin\phi}{1+\sin\phi} = \tan^2(45° - \phi/2)$ : ***Coefficient of Active Stress***

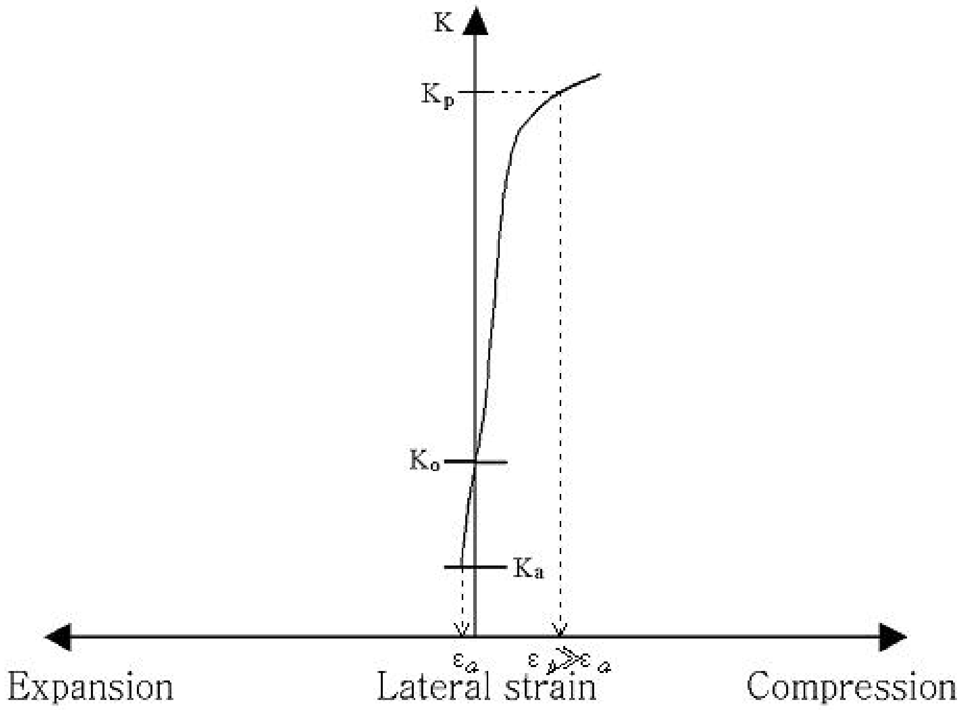
$K_p = \frac{(\sigma_h)_P}{\sigma_v} = \left(\frac{\sigma_1}{\sigma_3}\right)_f = \frac{1+\sin\phi}{1-\sin\phi} = \tan^2(45° + \phi/2)$ : ***Coefficient of Passive Stress***

**6.2 Rankine's active and passive state**

1) Failure surfaces




2) Lateral displacements at the critical state of Rankine



## 6.3 Lateral earth pressures on simple retaining walls

1) Assumptions :

i) backfill horizontal

ii) vertical walls

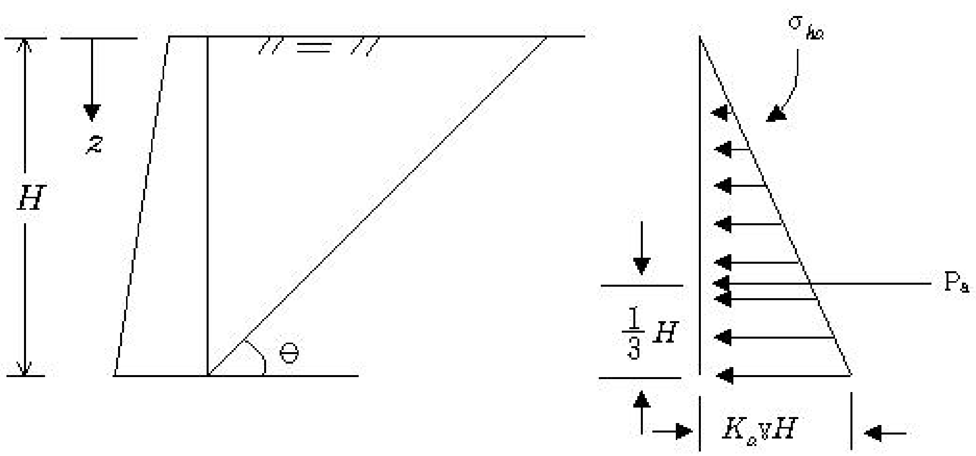
iii) no friction on the walls

2) Active pressures

i) Rankine

- The active thrust zone is assumed to be
( triangle )

- Location of failure surface is known
( $\theta = 45^\circ + \phi/2$ )

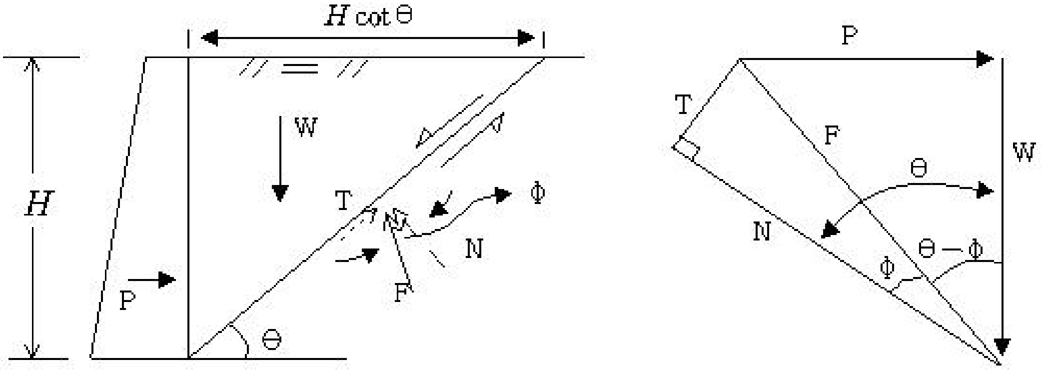



$\sigma_{ha} = K_a \gamma z$

$P_a = \int_0^H \sigma_{ha} dz = \frac{1}{2} \gamma H^2 K_a$

ii) Trial wedge

- Assume triangular wedge
- but failure surface not known ( Θ)




$$\Sigma F_V = 0 \quad : \quad F = \frac{W}{\cos(\Theta - \phi)} \quad (\because W = F\cos(\Theta - \phi))$$

$$\Sigma F_H = 0 \quad : \quad P = F\sin(\Theta - \phi)$$

$$= \frac{W}{\cos(\Theta - \phi)}\sin(\Theta - \phi) = W\tan(\Theta - \phi)$$

$$= \frac{1}{2}\gamma H^2 \cot\Theta \cdot \tan(\Theta - \phi)$$

* Find $\Theta_{cr}$ for the trial wedge $\left(\frac{\partial P}{\partial \theta} = 0\right)$

$$\frac{\partial P}{\partial \Theta} = \frac{1}{2}\gamma H^2 \left[ -\frac{\tan(\Theta - \phi)}{\sin^2\Theta} + \frac{\cot\Theta}{\cos^2(\Theta - \phi)} \right]$$

:

$$= \frac{1}{2}\gamma H^2 \frac{\sin\phi\cos(2\Theta - \phi)}{[\sin\Theta\cos(\Theta - \phi)]^2}$$

This is zero if ( $\cos(2\theta - \phi)$ ) = 0

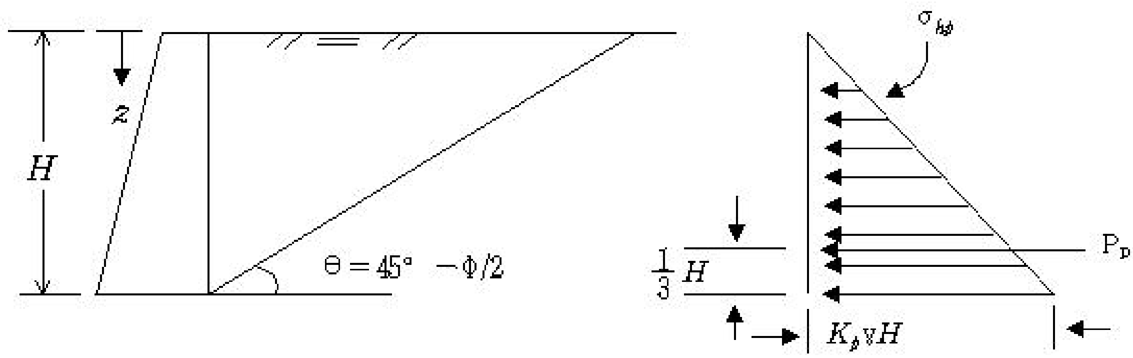
$$\rightarrow \Theta = 45° + \phi/2$$

Then, $P = \frac{1}{2}\gamma H^2 \cot\Theta \cdot \tan(\Theta - \phi)$

$$= \frac{1}{2}\gamma H^2 \cot(45° + \phi/2)\tan(45° - \phi/2)$$

$$= \frac{1}{2}\gamma H^2 K_a$$

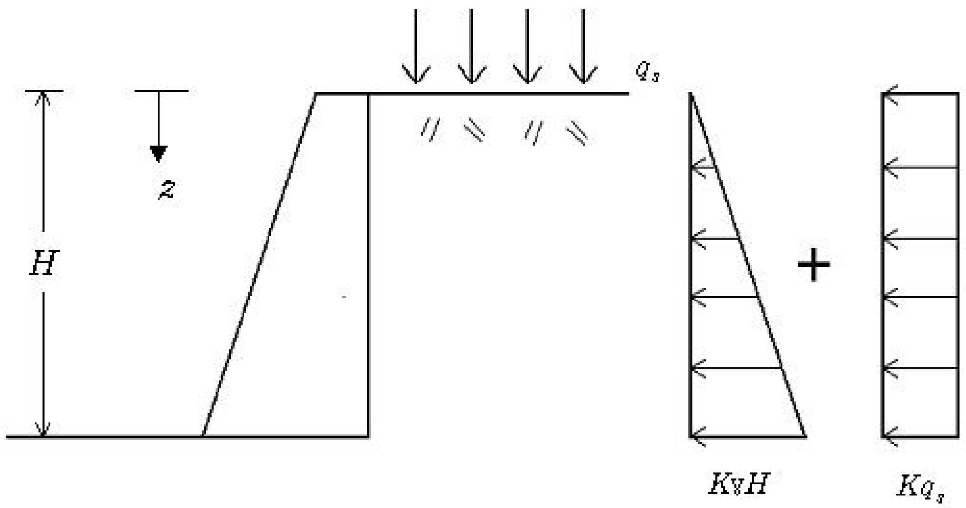
3) Passive resistance $\sigma_{hp}$




$\sigma_{hp} = K_p\gamma z$

$$P_p = \int_0^H \sigma_{hp} dz = \frac{1}{2}\gamma H^2 K_p$$

4) Active & Passive thrusts with uniform surcharge in the backfill




$$\sigma_v = q_s + \gamma z$$

$$\sigma_h = K\sigma_v = (q_s + \gamma_z)K$$

$$P_a = \int_0^H \sigma_{ha} dz = \frac{1}{2}\gamma H^2 K_a + q_s H K_a$$

$$P_p = \int_0^H \sigma_{hp} dz = \frac{1}{2}\sigma H^2 K_p + q_s H K_p$$