

6. Lateral Earth Pressure & Earth Retaining Structures

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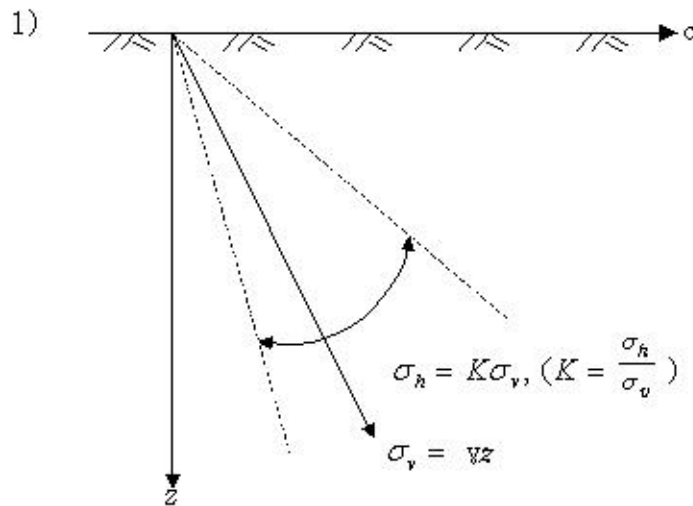
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6.1 Preliminaries



2) Geostatic case (**at-rest condition**)

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

assumptions i) ground surface horizontal

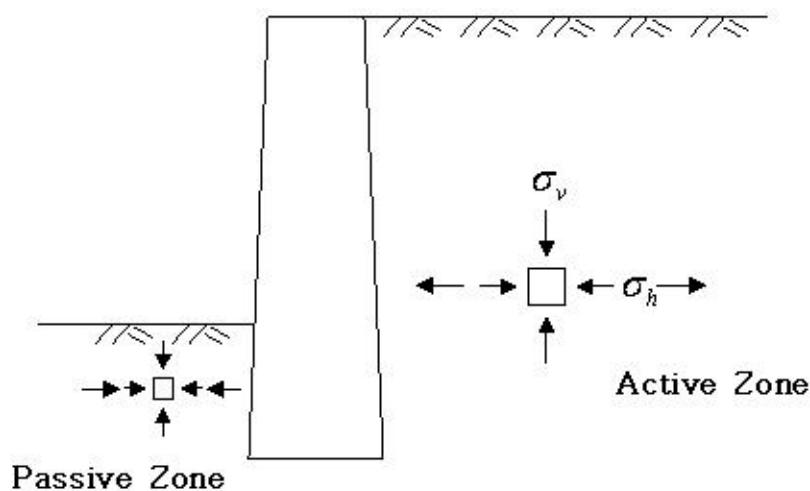
ii) homogeneous soil

$$K_0 = \frac{\mu}{1 - \mu} \quad (\because \sigma_h = \frac{\mu}{1 - \mu} \sigma_v)$$

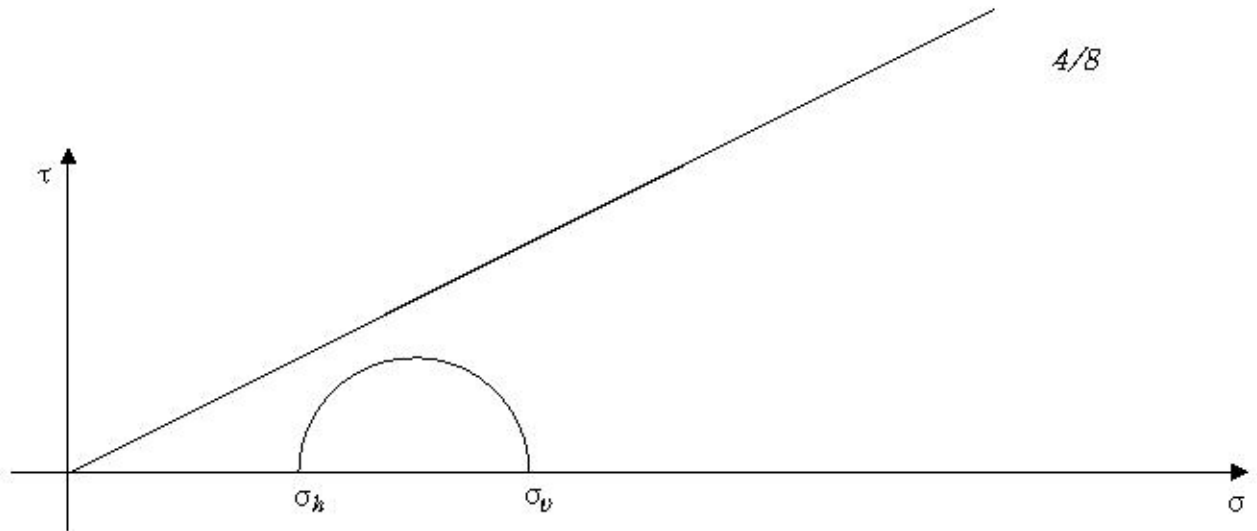
or empirically

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

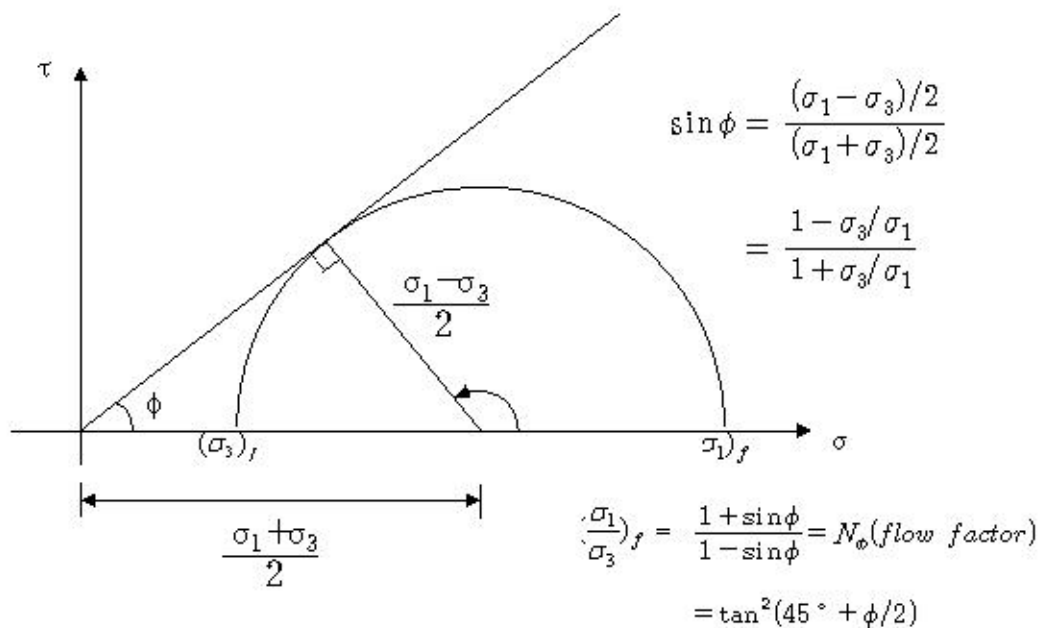
3)



4)



5)

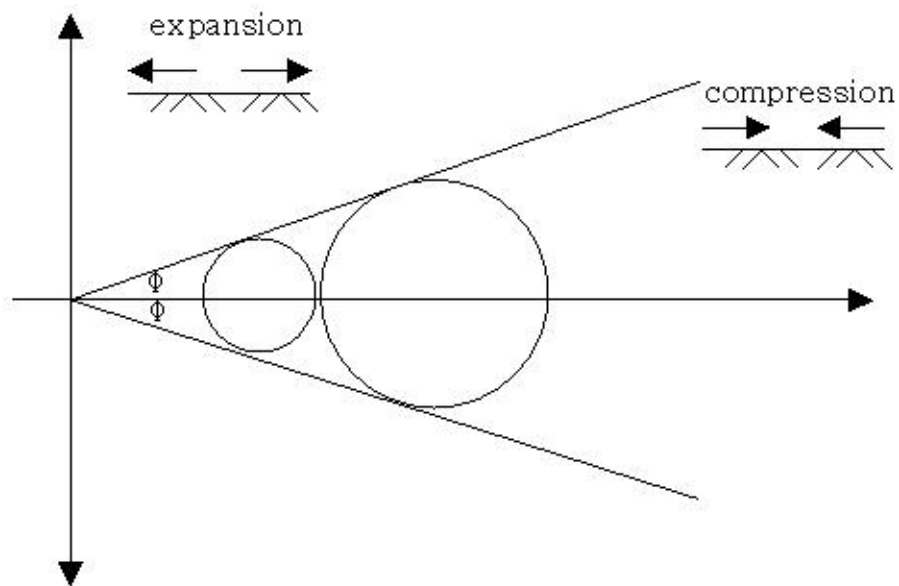


6) $K_a = \frac{(\sigma_h)_A}{\sigma_v} = \left(\frac{\sigma_3}{\sigma_1}\right)_f = \frac{1 - \sin \phi}{1 + \sin \phi} = \tan^2(45^\circ - \phi / 2) : \text{Coefficient of Active Stress}$

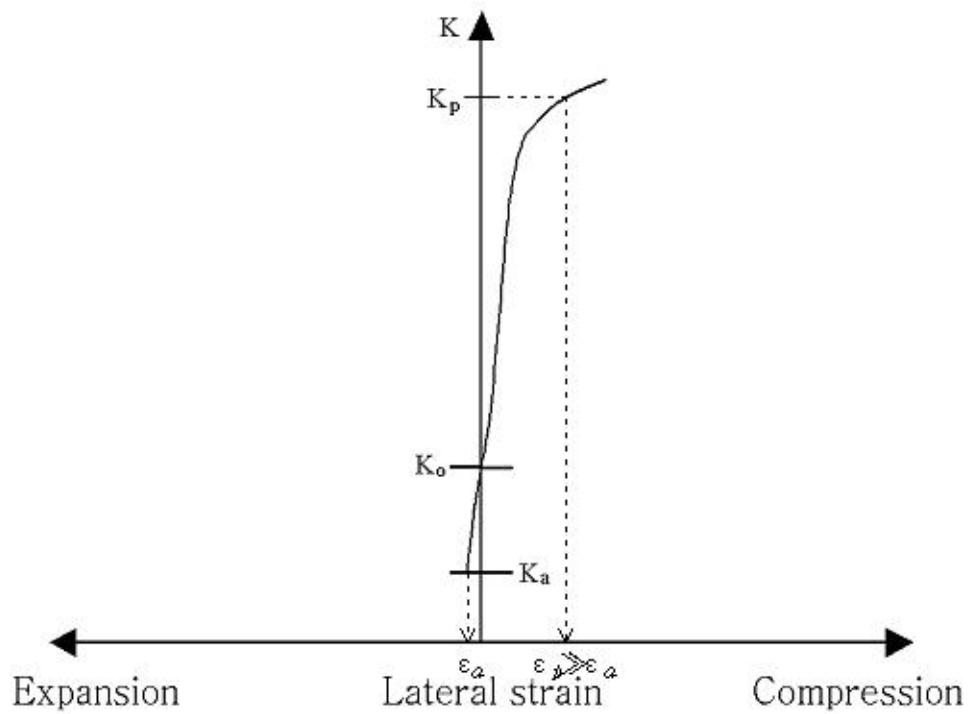
$K_p = \frac{(\sigma_h)_P}{\sigma_v} = \left(\frac{\sigma_1}{\sigma_3}\right)_f = \frac{1 + \sin \phi}{1 - \sin \phi} = \tan^2(45^\circ + \phi / 2) : \text{Coefficient of Passive Stress}$

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

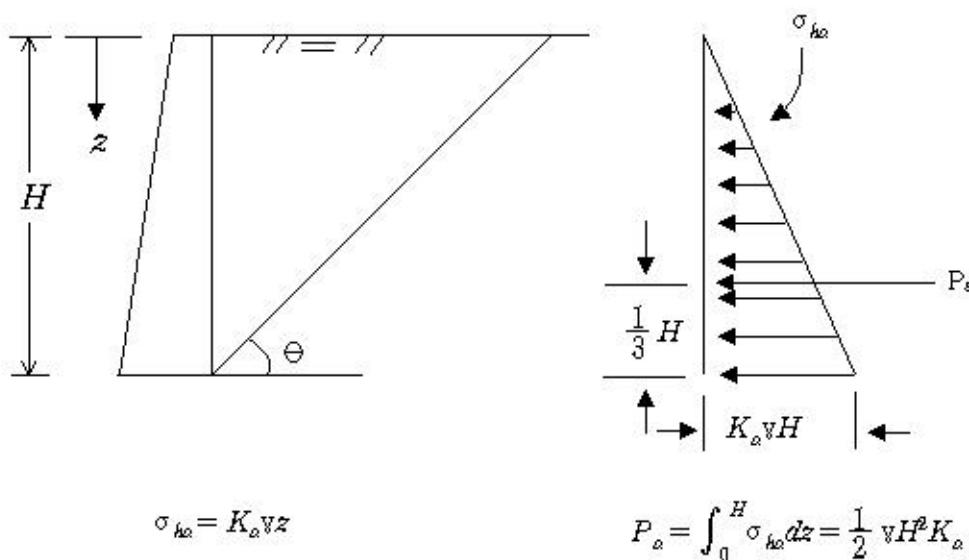
1) Assumptions :

- i) backfill horizontal
- ii) vertical walls
- iii) no friction on the walls

2) Active pressures

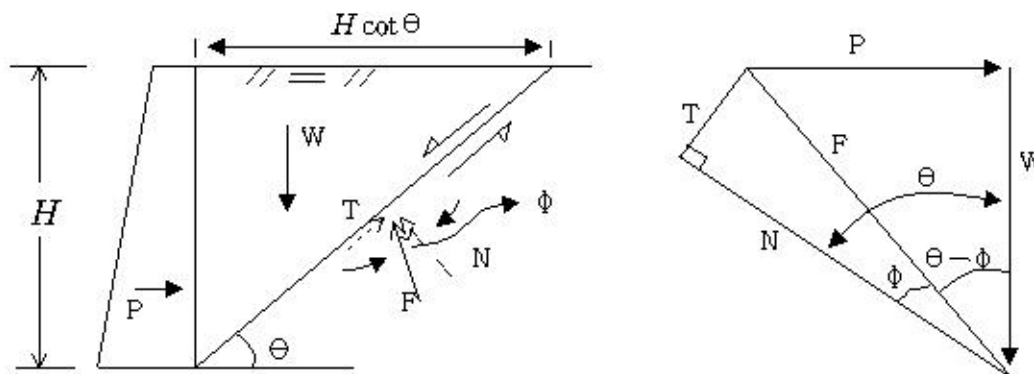
i) Rankine

- The active thrust zone is assumed to be
(**triangle**)
- Location of failure surface is known
(**$\theta = 45^\circ + \phi/2$**)



ii) Trial wedge

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



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

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

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

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

* Find θ_{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 $(\cos(2\theta - \phi)) = 0$

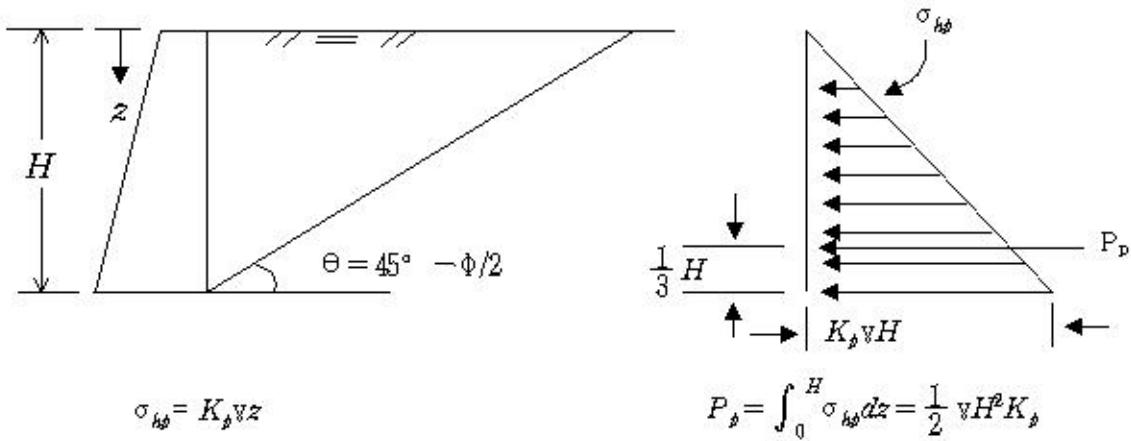
$$\rightarrow \theta = 45^\circ + \phi/2$$

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

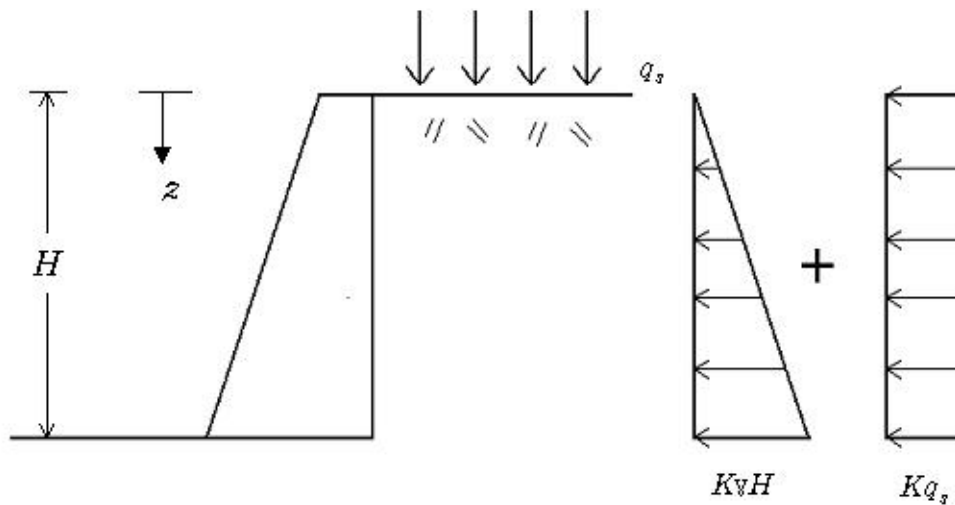
$$= \frac{1}{2} \gamma H^2 \cot(45^\circ + \phi/2) \tan(45^\circ - \phi/2)$$

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

3) Passive resistance σ_{hp}



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



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

$$\sigma_h = K\sigma_v = (q_s + \gamma z)K$$

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

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