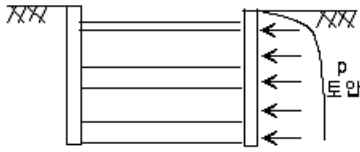


11장 토 압

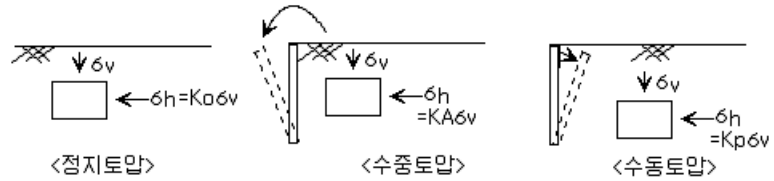
~흙막이 구조물에 작용하는 하중을 계산하기 위한 수평방향의 하중이다.

ex) 옹벽, (가설)흙막이벽, 지중지하벽



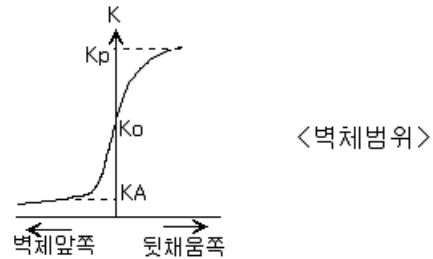
11.2 토압의 종류

- ① 정지 토압 = K_0
- ② 주동 토압 = K_a
- ③ 수동 토압 = K_p



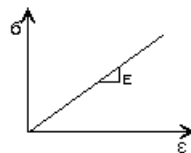
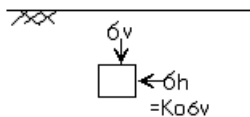
· 토압계수

$$K = \frac{\sigma_h}{\sigma_v}$$

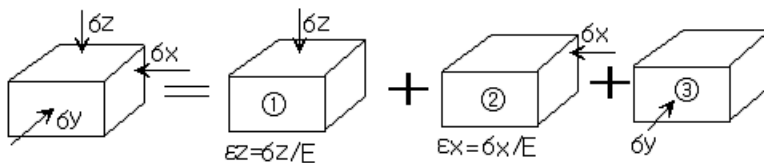


11.3 정지 토압계수

- 지반을 탄성체로 가정 → Hook's law를 따른다.



- 중첩의 원리 적용가능



※ 포이송비

Hook's law: $\sigma = E\epsilon_a$ 여기서, $\epsilon_a = \frac{dl}{l}$

$\mu = -\frac{\epsilon_l(\text{횡변형율})}{\epsilon_a(\text{축변형율})}$ (정의) → $\epsilon_l = -\mu\epsilon_a = -\mu\frac{\sigma}{E}$

$$\varepsilon_z = \frac{\sigma_z}{E}$$

$$\varepsilon_x = \frac{\sigma_x}{E}$$

$$\varepsilon_y = \frac{\sigma_y}{E}$$

$$\varepsilon_x = -\mu \varepsilon_z = \left(-\mu \cdot \frac{\sigma_z}{E}\right)$$

$$\varepsilon_y = -\mu \cdot \frac{\sigma_x}{E}$$

$$\varepsilon_x = -\mu \cdot \frac{\sigma_y}{E}$$

$$\varepsilon_y = -\mu \varepsilon_z = -\mu \cdot \frac{\sigma_z}{E}$$

$$\varepsilon_z = -\mu \cdot \frac{\sigma_x}{E}$$

$$\varepsilon_z = -\mu \cdot \frac{\sigma_y}{E}$$

$$\rightarrow \varepsilon_x = \frac{1}{E} [\sigma_x - \mu(\sigma_y + \sigma_z)]$$

$$\rightarrow \varepsilon_y = \frac{1}{E} [\sigma_y - \mu(\sigma_x + \sigma_z)]$$

$$\rightarrow \varepsilon_z = \frac{1}{E} [\sigma_z - \mu(\sigma_x + \sigma_y)]$$

· 정지토압조건

→ $\varepsilon_x = \varepsilon_y = 0$ 인 조건에 해당

윗식에 대입

$$\sigma_x = \mu(\sigma_y + \sigma_z)$$

$$\sigma_y = \mu(\sigma_x + \sigma_z) \text{ 위 식에 대입 } \rightarrow \sigma_x = \frac{(1+\mu)\mu}{1-\mu^2} \cdot \sigma_z$$

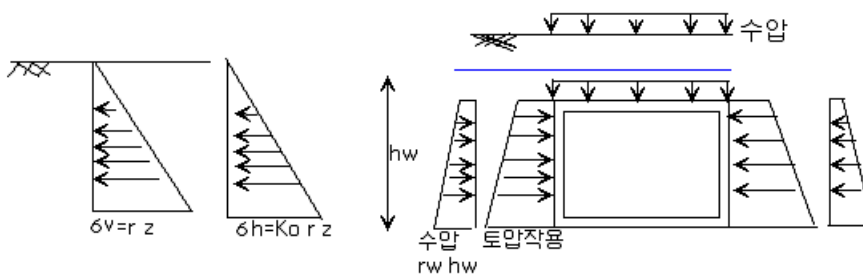
$$\therefore \sigma_x = \frac{\mu}{1-\mu} \cdot \sigma_z$$

$$\therefore K_o = \frac{\mu}{1-\mu}$$

-Jacky 공식 (경험 공식)

for 사질토 → $K_o = 1 - \sin \phi'$

for 점성토 → $K_o = (1 - \sin \phi') \sqrt{O.C.R.}$ ($O.C.R. = \frac{\sigma'_c}{\sigma'_{v0}}$)

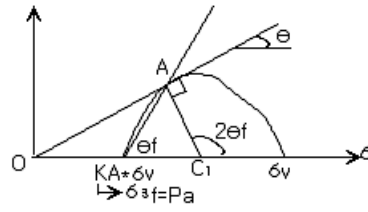


11.4 Rankine의 토압이론

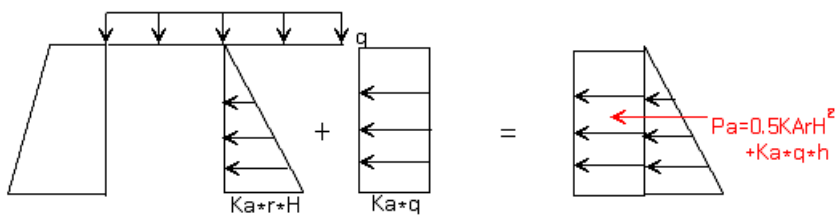
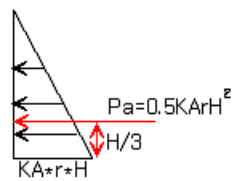
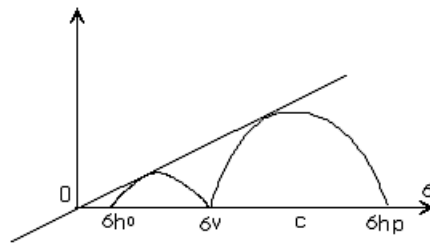
→ 벽면 마찰각을 무시한 토압이론

사질토 ($c=0$) 인 경우

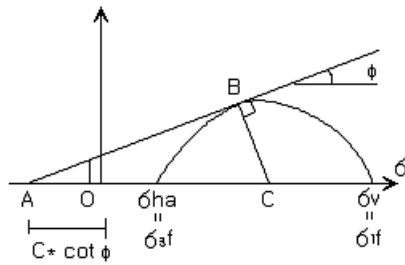
i) 주동 토압



$$\therefore K_a = \frac{1 - \sin \phi}{1 + \sin \phi}$$

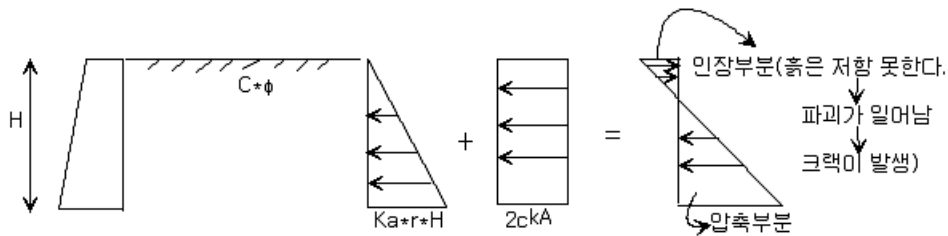


2 점성토의 주동 및 수동토압(c≠0인 경우)



$$\begin{aligned}\sin \phi &= \frac{CB}{AO + OC} \\ &= \frac{(\sigma_v - \sigma_{ha})/2}{c \cdot \cot \phi + (\sigma_v + \sigma_{ha})/2} \\ \sigma_{ha} &= \left(\frac{1 - \sin \phi}{1 + \sin \phi} \right) \sigma_v - 2 \cdot c \cdot \frac{\cos \phi}{1 + \sin \phi} \\ &= K_a \cdot \gamma \cdot z - 2c \sqrt{K_a}\end{aligned}$$

- 토압분포



- 인장깊이 선정

$\sigma_{ha}=0$ 인 시점

$$\sigma_{ha} = K_a \cdot \gamma \cdot Z_0 - 2C \sqrt{K_a} = 0$$

$$\therefore Z_0 = \frac{2C}{\gamma} \cdot \frac{1}{\sqrt{K_p}} = \frac{2C}{\gamma} \cdot \sqrt{K_p}$$

- 수동토압계수

$$\sigma_{hp} = K_p \cdot \gamma \cdot Z + 2C \sqrt{K_p} \quad (K_p = \frac{1 + \sin \phi}{1 - \sin \phi})$$

-지표면이 경사진 경우에 대한 토압

$$\begin{aligned}\delta v &= W/b = Z \cdot b' \cdot \gamma \cdot \cos i / b' \\ &= \gamma Z \cdot \cos i\end{aligned}$$

$$K_a = \frac{\delta h a}{\delta v}$$

$$OA^2 = \delta v^2 \cdot \cos^2 i + \delta v^2 \cdot \sin^2 i = \delta v^2 (\cos^2 i + \sin^2 i)$$

$$OA = \delta v$$

$$OB = \delta h a$$

$$K_a = \frac{OB}{OA} = \frac{OB - AD}{OD + AD}$$

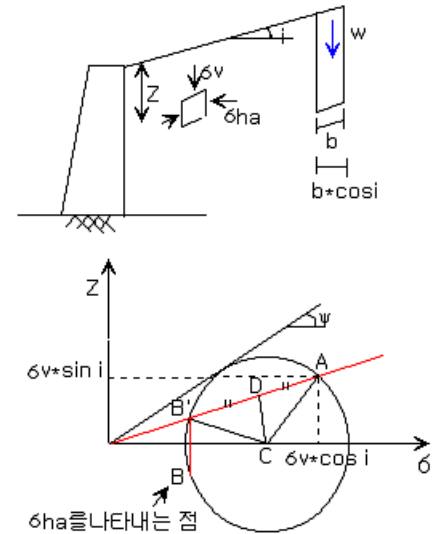
$$OD = OC \cdot \cos I$$

$$AD = \sqrt{AC^2 - CD^2} \quad (AC = OC \cdot \sin \psi, CD = OC \cdot \sin I)$$

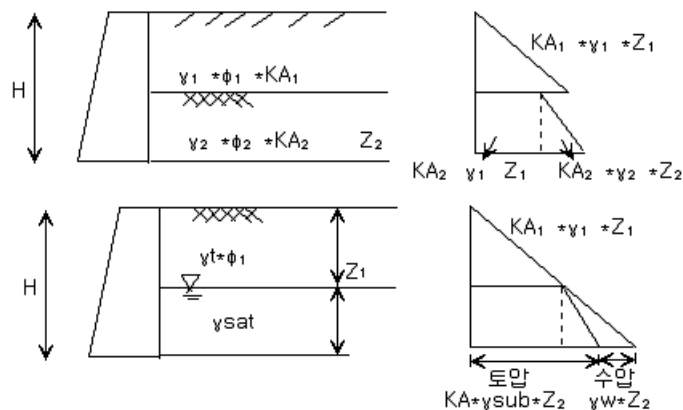
$$\begin{aligned}\therefore K_a &= \frac{OC \cdot \cos i - \sqrt{OC^2 \cdot \sin^2 \phi + OC^2 \cdot \sin^2 i}}{OC \cdot \cos i + \sqrt{OC^2 \cdot \sin^2 \phi - OC^2 \cdot \sin^2 i}} = \frac{\cos i - \sqrt{\sin^2 \phi - \sin^2 i}}{\cos i + \sqrt{\sin^2 \phi - \sin^2 i}} \\ &= \frac{\cos i - \sqrt{\cos^2 i - \cos^2 \phi}}{\cos i + \sqrt{\cos^2 i - \cos^2 \phi}} = \frac{1}{K_p}\end{aligned}$$

$$\delta h a = K_a \cdot \delta v = K_a \cdot \gamma \cdot z \cdot \cos i$$

$$\therefore P_a = \frac{1}{2} K_a \cdot \gamma \cdot H^2 \cdot \cos I$$



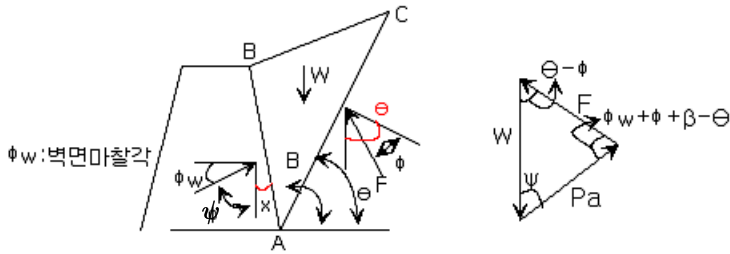
11.4 뒤채움이 이층이거나 지하수위가 있는 경우
-주동토압



$$\begin{aligned}\gamma_{sub} &= \gamma_{sat} - \gamma_w \\ &= \frac{Gs - 1}{1 + e} \gamma_w\end{aligned}$$

11.5 Coulomb의 토압이론 : ~벽면에 마찰각을 고려한 토압이론

① $c=0$ 인 경우



$$x = 90 - (180 - \beta) = \beta - 90^\circ$$

$$\begin{aligned} \therefore \psi &= 90 - \phi_w - (\beta - 90) \\ &= 180 - (\beta + \phi_w) \end{aligned}$$

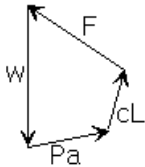
$$\frac{Pa}{\sin(\theta - \phi)} = \frac{W}{\sin(\phi + \phi_w + \beta - \theta)}$$

$$\therefore PA = W \cdot \frac{\sin(\theta - \phi)}{\sin(\phi + \phi_w + \beta - \theta)}$$

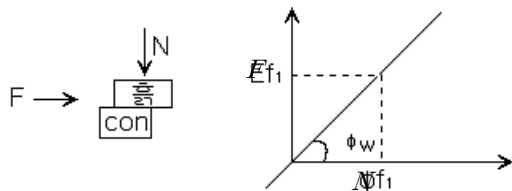
$$\frac{dPA}{d\theta} = 0 \text{ 일 때의 } \theta \text{ 값 추정}$$

$$PA = \frac{\gamma H^2}{2} \left[\frac{\sin(\beta - \phi) \csc \beta}{\sqrt{\sin(\beta + \phi_w)} + \sqrt{\frac{\sin(\phi + \phi_w) \cdot \sin(\phi - i)}{\sin(\beta - i)}}} \right]^2$$

② $C \neq 0$ 인 경우



-벽면 마찰각(ϕ_w)



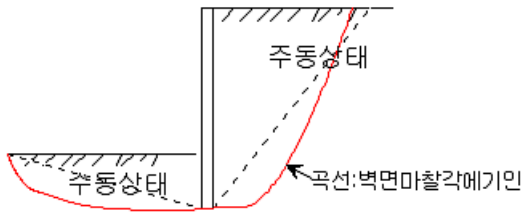
\therefore 일반적으로는 $\phi_w = \frac{2}{3} \phi$ 로 가정

11.6 실제 활동면의 현상

-수동토압의 경우 $\phi_w > \frac{\phi}{3}$ 이면

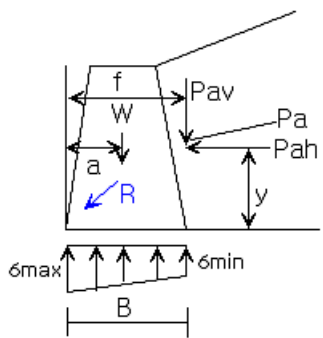
실제 수동토압과 현저한 차이발생

→ 직선 파괴가정 = 수동토압의 크기를 실제 보다 크게 평가



11.7 옹벽의 안정

1. 안정조건



①수평활동에 대한 안정

$$F_s = \frac{\text{수평저항력}}{\text{수평활동력}} = \frac{Ff}{Rh} = Rv \cdot \frac{\tan \phi_w}{Rh} > 1.5$$

②전도에 대한 안정

$$F_s = \frac{M_r(\text{저항모멘트})}{M_o(\text{활동모멘트})} = \frac{W \cdot a + Pav \cdot f}{Pah \cdot y} > 1.5$$

③허용지지력 검토

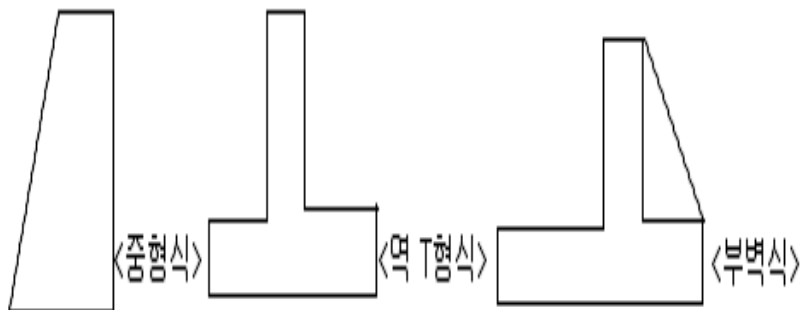
$$F_s = \frac{qu}{\sigma_{\max}} > 3.0$$

*편심

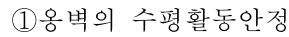
$$\frac{M}{I} \cdot y = \frac{Rv \cdot e}{\frac{1}{12} \cdot B^3} \cdot \left(\frac{B}{2}\right) = \frac{6Rv \cdot e}{B^2}$$

$$\therefore \sigma = \frac{Rv}{B} \left(1 \pm \frac{6e}{B}\right)$$

-옹벽의 종류



- Rankine 토압이론을 적용



②전도활동에 대한 안정

③허용지지력에 대한 안정

-6min=0인 조건에서

6min값이 -값이 되면 인장력 발생

지반 반력에서 인장력이 발생하지 않도록 하기위한 최대편심 거리는 $B/6$ 이다.

2. 지하수위가 옹벽의 안정에 끼치는 영향

-활동에 대한 안전을

3. 옹벽에 작용하는 간이 토압분포

-by Terzoghi , Peck (단, 옹벽높이가 6m이내일 때)

<도표이용>

