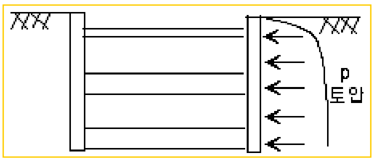
# 11장 토 압

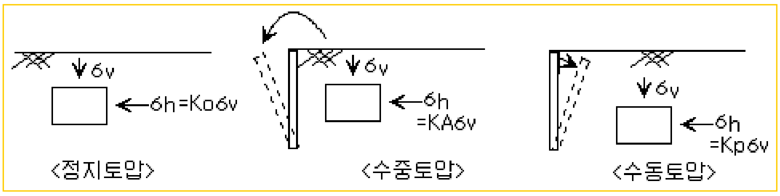
·흙막이 구조물에 작용하는 하중을 계산하기 위한 수평방향의 하중이다.

ex) 옹벽, (가설)흙막이벽, 지중지하벽



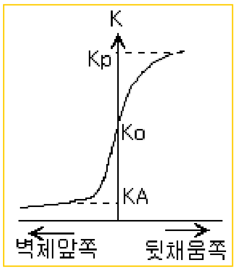

## 11.2 토압의 종류

①정지 토압=Ko
②주동 토압=Ka
③수동 토압=Kp




·토압계수

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

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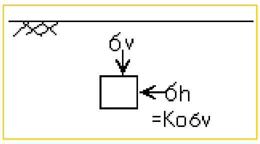
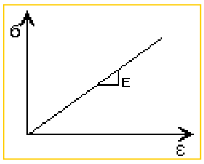
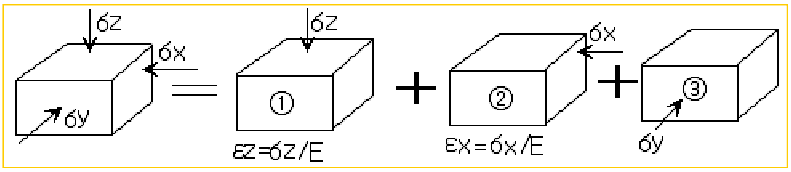
## 11.3 정지 토압계수




-지반을 탄성체로 가정→Hook's law를 따른다.




-중첩의 원리 적용가능




※포이송비

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

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

$$\varepsilon z=\frac{\sigma z}{E}\sigma \qquad \varepsilon x=\frac{\sigma x}{E} \qquad \varepsilon y=\frac{\sigma y}{E}$$

$$\varepsilon x=-\mu\varepsilon z=(-\mu\cdot\frac{\sigma z}{E}) \qquad \varepsilon y=-\mu\cdot\frac{\sigma x}{E} \qquad \varepsilon x=-\mu\cdot\frac{\sigma y}{E}$$

$$\varepsilon y=-\mu\varepsilon z=-\mu\cdot\frac{\sigma z}{E} \qquad \varepsilon t=-\mu\cdot\frac{\sigma x}{E} \qquad \varepsilon z=-\mu\cdot\frac{\sigma y}{E}$$

$$\rightarrow \varepsilon x=\frac{1}{E}[\sigma x-\mu(\sigma y+\sigma z)]$$

$$\rightarrow \varepsilon y=\frac{1}{E}[\sigma y-\mu(\sigma x+\sigma z)]$$

$$\rightarrow \varepsilon z=\frac{1}{E}[\sigma z-\mu(\sigma x+\sigma y)]$$

·정지토압조건

→εx=εy=0인 조건에 해당

윗식에 대입

$\sigma x=\mu(\sigma y+\sigma z)$

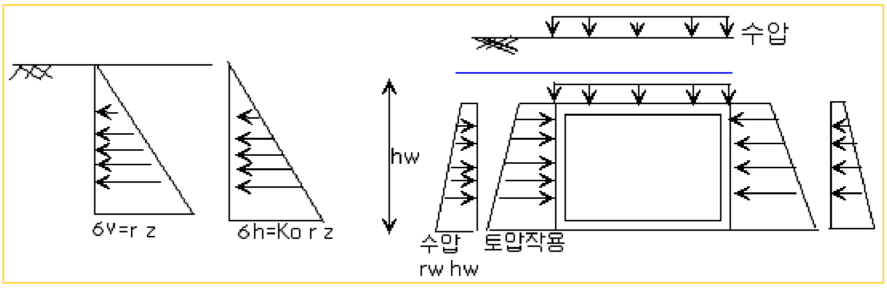
$\sigma y=\mu(\sigma x+\sigma z)$ 위 식에대입 $\rightarrow \sigma x=\frac{(1+\mu)\mu}{1-\mu^2}\cdot\sigma z$

$$\therefore \sigma x=\frac{\mu}{1-\mu}\cdot\sigma z \qquad \therefore Ko=\frac{\mu}{1-\mu}$$

-Jacky 공식 (경험공식)

for 사질토 → $Ko=1-\sin\phi'$

for 점성토 → $Ko=(1-\sin\phi')\sqrt{O.C.R}$ $\quad (O.C.R=\frac{\sigma_c'}{\sigma_{v0}'})$

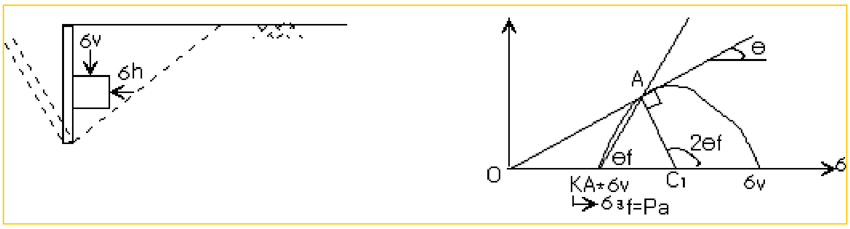



11.4 Rankine의 토압이론

→벽면 마찰각을 무시한 토압이론

사질토(c=0) 인 경우

ⅰ)주동 토압

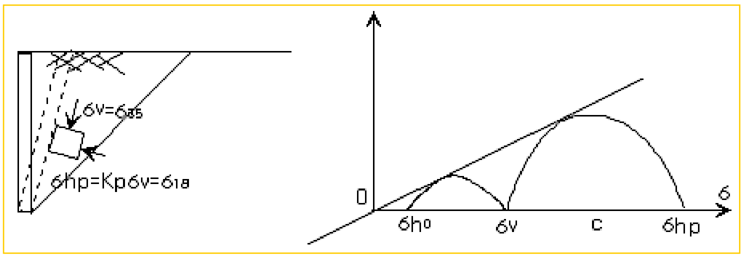



$$\sin\phi = \frac{CA}{OC} = \frac{\frac{(\sigma_v - \sigma_{ha})}{2}}{\frac{(\sigma_v + \sigma_{ha})}{2}} \rightarrow \frac{\sigma_{ha}}{\sigma_v} = \frac{1-\sin\phi}{1+\sin\phi} = \tan^2(45° - \frac{\phi}{2}) = K_a$$

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

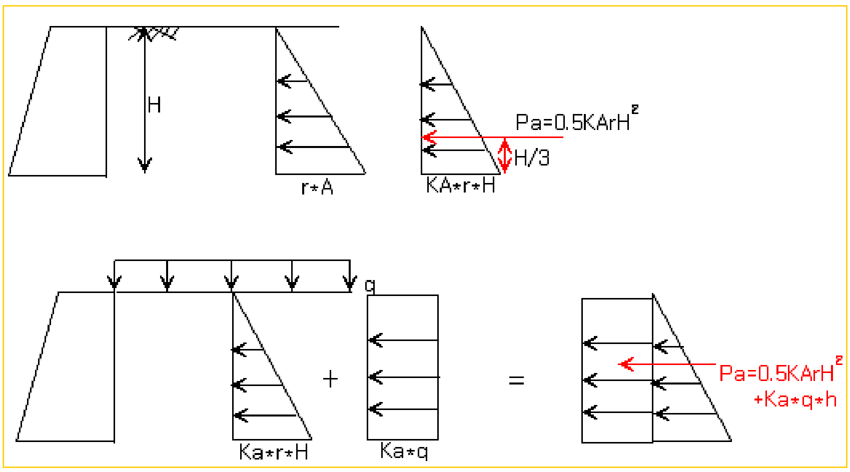
$$2\Theta_f = 90° + \phi \rightarrow \theta_f = 45 + \frac{\phi}{2}$$

ii) 수동 토압

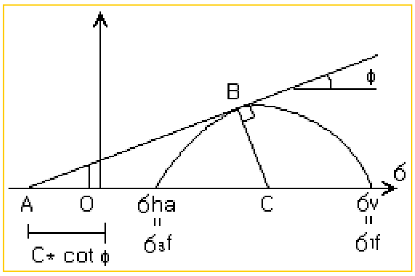



$$Kp = \frac{\sigma_{hp}}{\sigma_v} = \frac{1+\sin\phi}{1-\sin\phi} = \tan^2(45° + \frac{\phi}{2}) = \frac{1}{K_a}$$

주동 토압의 분포와 합력의 위치



## 2 점성토의 주동 및 수동토압($c \neq 0$인 경우)



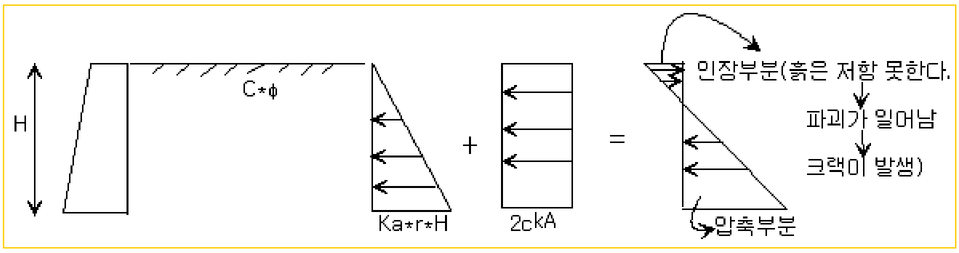

$$\sin\phi = \frac{CB}{AO + OC}$$

$$= \frac{(\sigma_v - \sigma_{ha})/2}{c \cdot \cot\phi + (\sigma_v + \sigma_{ha})/2}$$

$$\sigma_{ha} = \left(\frac{1-\sin\phi}{1+\sin\phi}\right)\sigma_v - 2 \cdot c\frac{\cos\phi}{1+\sin\phi}$$

$$= K_a \cdot \gamma \cdot z - 2c\sqrt{K_a}$$

-토압분포




-인장깊이 선정

бha=0인 시점

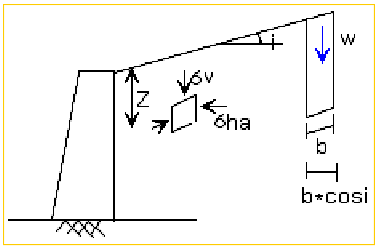
$$\sigma_{ha} = K_a \cdot \gamma \cdot Z_0 - 2C\sqrt{K_a} = 0$$

$$\therefore Z_c = \frac{2C}{\gamma} \cdot \frac{1}{\sqrt{Kp}} = \frac{2C}{\gamma} \cdot \sqrt{Kp}$$

-수동토압계수

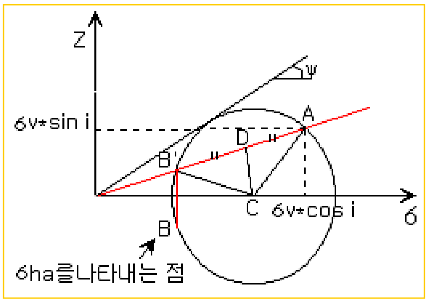
$$\sigma_{hp} = K_p \cdot \gamma \cdot Z + 2C\sqrt{K_p} \qquad \left(Kp = \frac{1+\sin\phi}{1-\sin\phi}\right)$$

-지표면이 경사진 경우에 대한 토압




6v=W/b=Z*b′*cosi*ɣ/b′

=ɣZ*cosi




$$Ka=\frac{6ha}{6v}$$

$OA^2$=6v² • cos²i+6v² • sin²i=6v²(cos²i+sin²i)

OA=6v

OB=6ha

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

OD=OC • cos I

AD= $\sqrt{AC^2-CD^2}$ (AC=OC • sinψ, CD=OC • sin I)

$$\therefore Ka=\frac{OC\cdot\cos i-\sqrt{OC^2\cdot\sin^2\phi+OC^2\cdot\sin^2 i}}{OC\cdot\cos i+\sqrt{OC^2\cdot\sin^2\phi-OC^2\cdot\sin^2 i}}=\frac{\cos i-\sqrt{\sin^2\phi-\sin^2 i}}{\cos i+\sqrt{\sin^2\phi-\sin^2 i}}$$

$$=\frac{\cos i-\sqrt{\cos^2 i-\cos^2\phi}}{\cos i+\sqrt{\cos^2 i-\cos^2\phi}}=\frac{1}{Kp}$$

6ha=KA • 6v=KA • ɣ • z • cos i

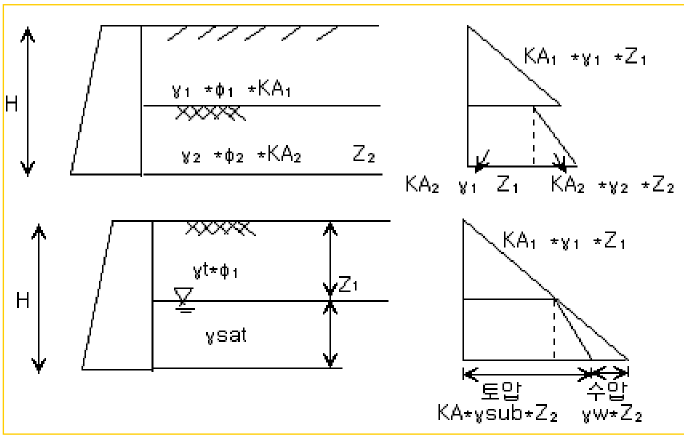
$$\therefore Pa=\frac{1}{2}KA\cdot ɣ\cdot H^2\cdot\cos I$$

11.4 뒤채움이 이층이거나 지하수위가 있는 경우

-주동토압

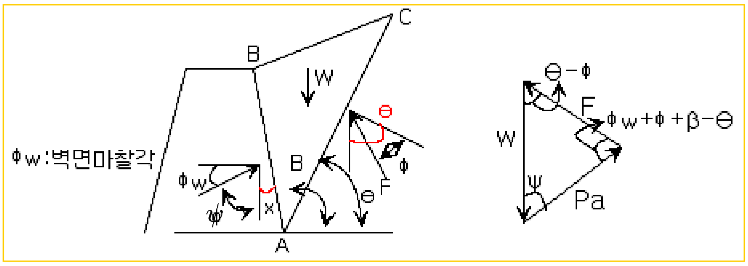
ɣsub=ɣsat−ɣw

$$=\frac{Gs-1}{1+e}ɣ_W$$



## 11.5 Coulomb의 토압이론 :~벽면에 마찰각을 고려한 토압이론

①c=0인 경우




x=90-(180-β)=β-90°

∴ψ=90-ϕw-(β-90)

=180-(β+ϕw)

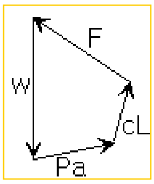
$$\frac{Pa}{\sin(\Theta-\phi)}=\frac{W}{\sin(\phi+\phi w+\beta-\Theta)}$$

$$\therefore\quad PA=W\cdot\frac{\sin(\Theta-\phi)}{\sin(\phi+\phi w+\beta-\Theta)}$$

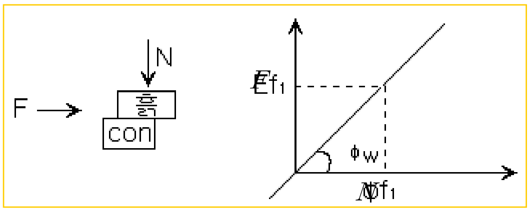
$\frac{dPA}{d\Theta}=0$일때의 Θ값 추정

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

②C≠0인 경우




-벽면 마찰각( ϕw)



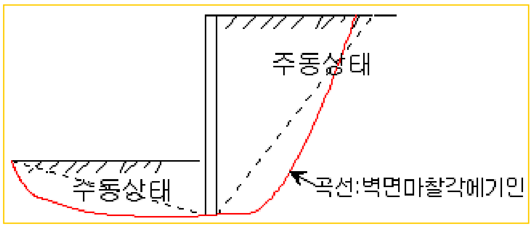

∴일반적으로는 $\phi w \fallingdotseq \frac{2}{3}\phi$로 가정

## 11.6실제 활동면의 현상

-수동토압의 경우 $\phi w>\frac{\phi}{3}$ 이면

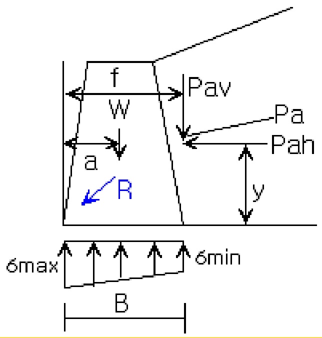
실제 수동토압과 현저한 차이발생

→직선파괴가정=수동토압의 크기를 실제 보다 크게 평가




## 11.7 옹벽의 안정

### 1.안정조건




①수평활동에 대한 안정

$$Fs = \frac{\text{수평저항렬}}{\text{수평활동력}} = \frac{Ff}{Rh} = Rv \cdot \frac{\tan\phi w}{Rh} > 1.5$$

②전도에 대한 안정

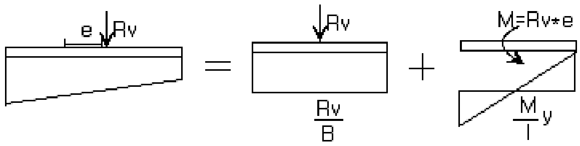
$$Fs = \frac{Mr(\text{저항모멘트})}{Mo(\text{활동모멘트})} = \frac{W \cdot a + Pav \cdot f}{Pah \cdot y} > 1.5$$

### ③허용지지력 검토

$$Fs = \frac{qu}{\sigma \max} > 3.0$$

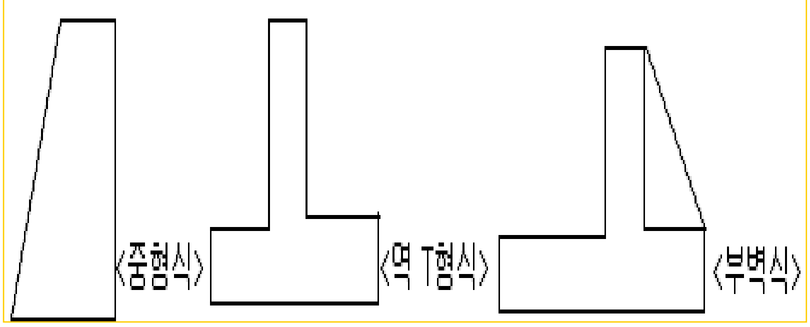
*편심

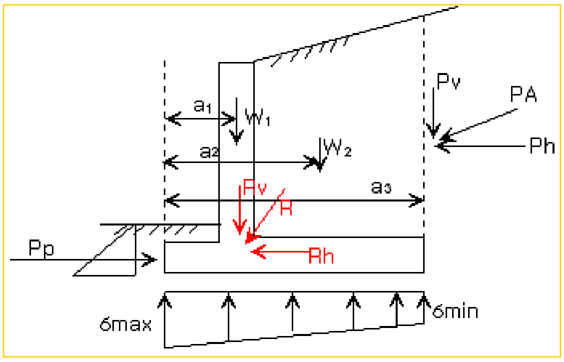
$$\frac{M}{I} \cdot y = \frac{Rv \cdot e}{\frac{1 \cdot B^3}{12}} \cdot \left(\frac{B}{2}\right) = \frac{6Rv \cdot e}{B^2}$$




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

### -옹벽의 종류






(가상벽면에 토압작용)

Rankine 토압이론을 적용

①옹벽의 수평활동안정

$$Fs = \frac{Rv \cdot \tan\phi w}{Rh(=Ph)} > 1.5$$

②전도활동에 대한 안정

$$Fs = \frac{\text{저항모멘트}}{\text{활동모멘트}} = \frac{W_1 a_1 + W_2 a_2}{P_h y - P_v a_3} > 1.5$$

③허용지지력에 대한 안정

$$Fs = \frac{qu}{\sigma\max} > 3$$

$$\left( qa(\text{허용지지력}) = \frac{qu}{3}(\text{극한지지력}) \right)$$

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

-6min=0인 조건에서

$$\rightarrow 1 - \frac{6 \cdot e}{B} = 0\text{인 지점} \quad \rightarrow \quad e = \frac{B}{6}$$

6min값이 -값이 되면 인장력 발생

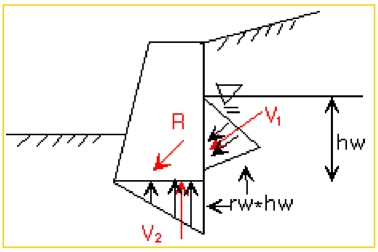
지반 반력에서 인장력이 발생하지 않도록 하기위한 최대편심 거리는 B/6이다.

(편심이 B/3안에 존재해야 한다. )

2.지하수위가 옹벽의 안정에 끼치는 영향

-활동에 대한 안전율

$$Fs = \frac{(Rv - V_2)\tan\phi w}{Rh + V_{1_h}} > 1.5$$




3.옹벽에 작용하는 간이 토압분포

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

$$Ph = \frac{1}{2} Kn \cdot H^2$$

$$Pv = \frac{1}{2} Kv \cdot H^2 \ \ (\text{i=0이면} \rightarrow \text{Pv=0}) \rightarrow \text{Kv=0}$$

<도표이용>