TOPIK BAHASAN 9

TEGANGAN LATERAL TANAH

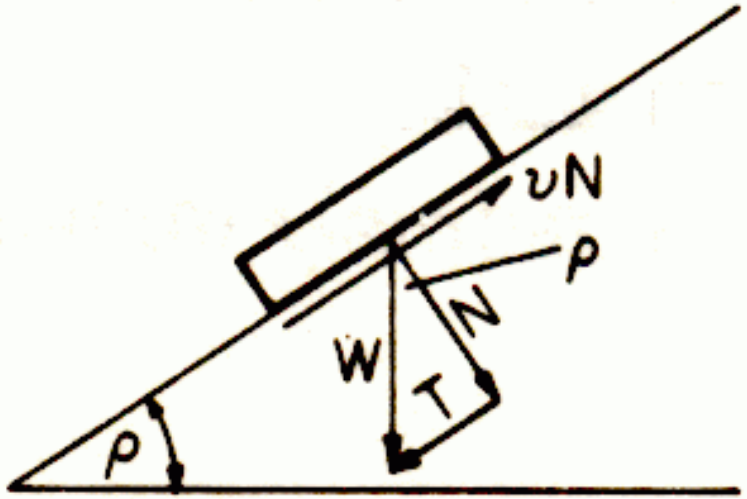
PERTEMUAN 19 – 20

TEGANGAN LATERAL TANAH

- merupakan tegangan tanah pada arah horisontal dan fungsi dari tegangan vertikal
- dapat disebabkan oleh massa tanah dan atau beban luar
- Ada 3 kondisi
  - Tegangan lateral saat diam (at rest)
  - Tegangan lateral aktif
  - Tegangan lateral pasif

TEGANGAN LATERAL TANAH

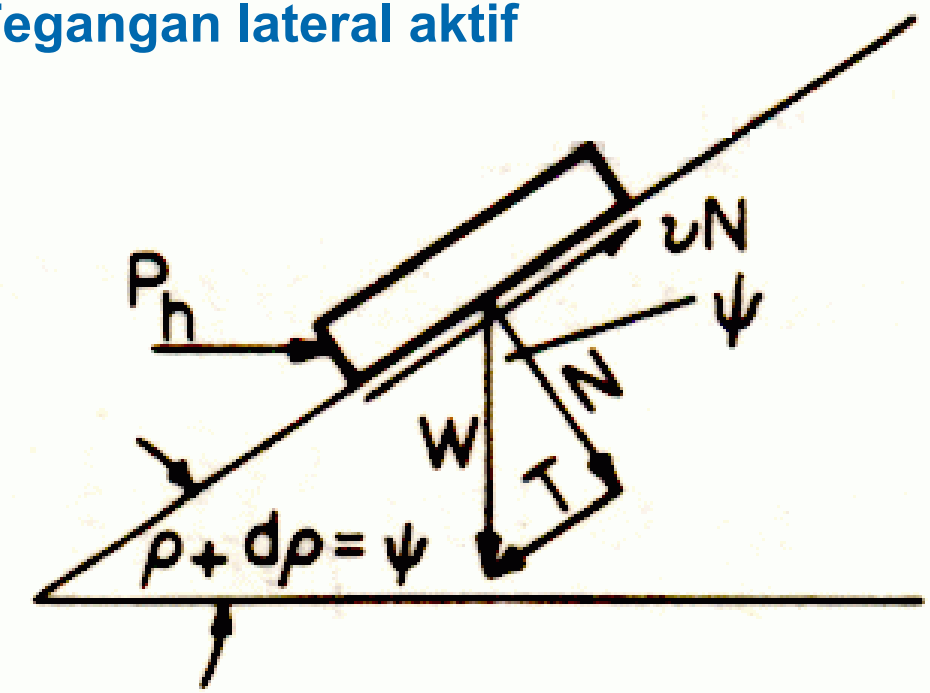
Tegangan lateral saat diam (at rest)



Kasus I

TEGANGAN LATERAL TANAH

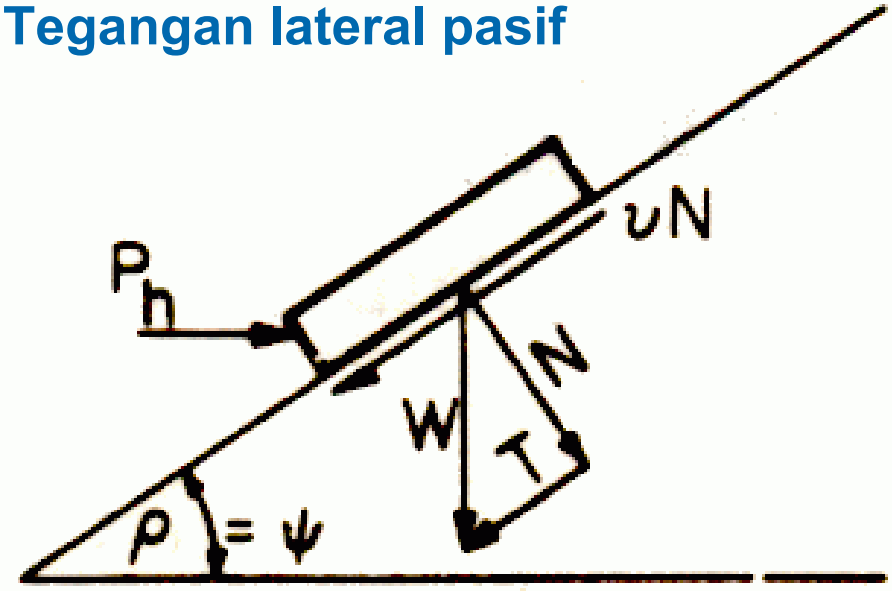
Tegangan lateral aktif



Kasus II

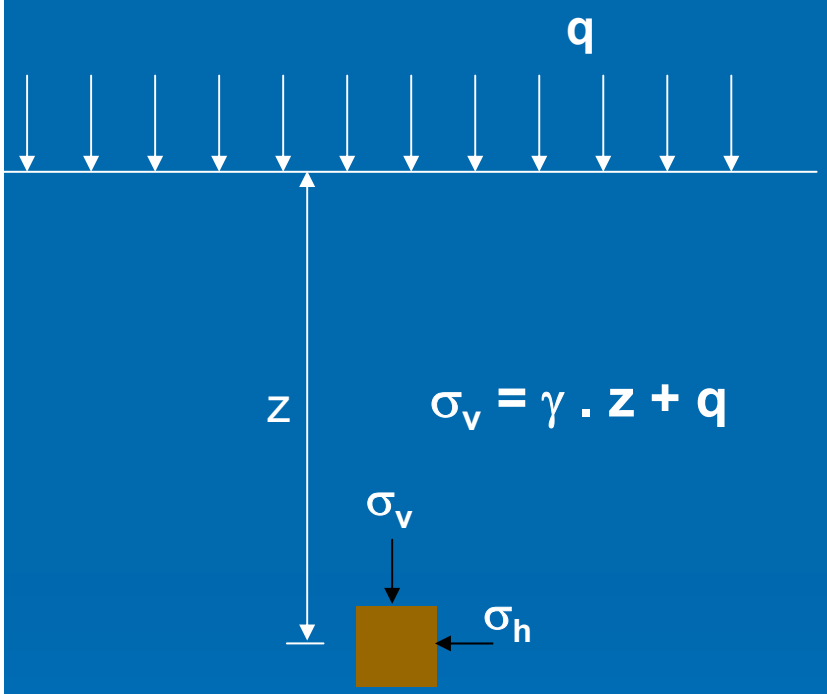
TEGANGAN LATERAL TANAH

Tegangan lateral pasif



Kasus III

TEGANGAN LATERAL TANAH



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

At rest, $K = K_o$

Jaky, Broker dan Ireland → $K_o = M - \sin \phi'$

Pasir, lempung terkonsolidasi normal → M = 1

Lempung dengan OCR > 2 → M = 0,95

Broker dan Ireland

$K_o = 0{,}40 + 0{,}007\ PI\ ,\ 0 \leq PI \leq 40$

$K_o = 0{,}64 + 0{,}001\ PI\ ,\ 40 \leq PI \leq 80$

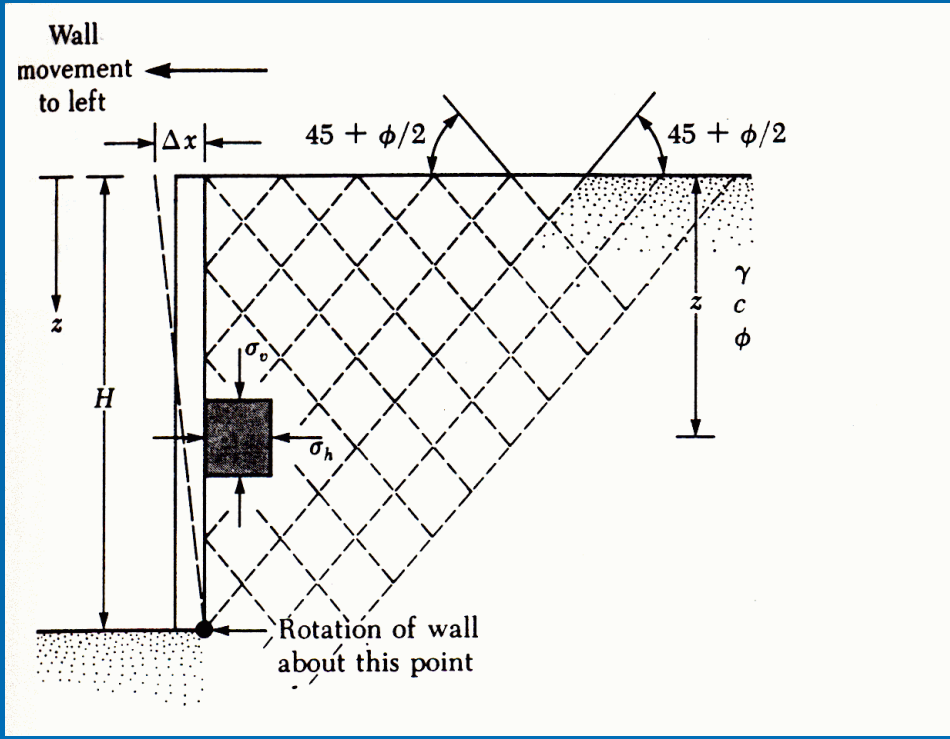
Sherif dan Ishibashi → $K_o = \lambda + \alpha\ (OCR - 1)$

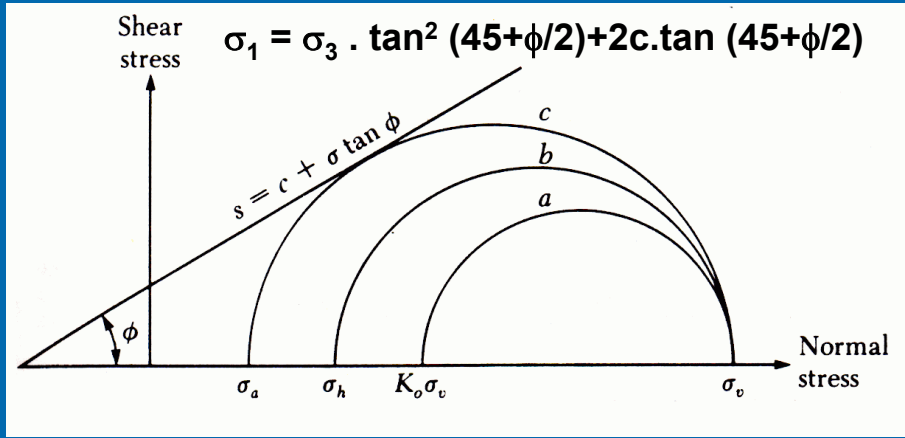
$\lambda = 0{,}54 + 0{,}00444\ (LL - 20)$

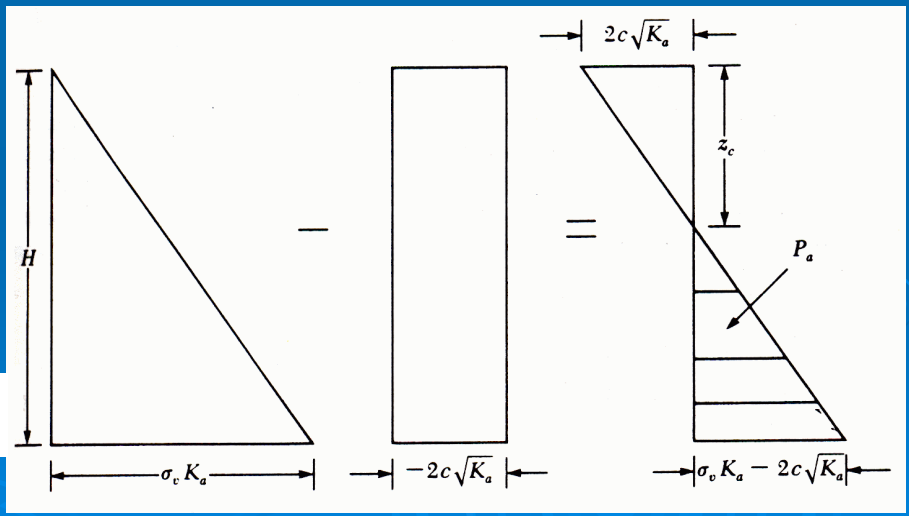
$\alpha = 0{,}09 + 0{,}00111\ (LL - 20)$

LL > 110% → $\lambda = 1{,}0$; $\alpha = 0{,}19$

TEGANGAN LATERAL TANAH AKTIF





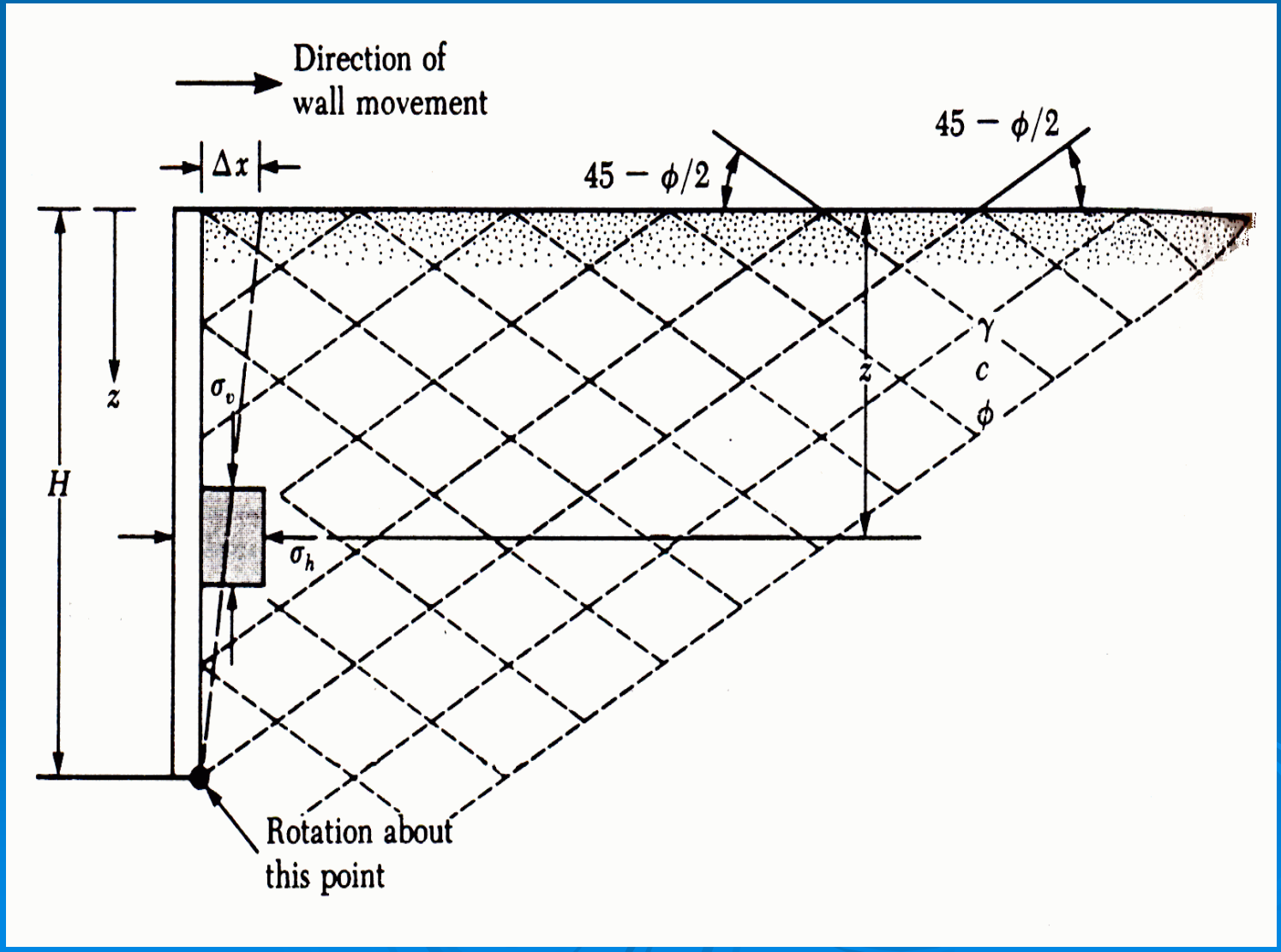


$\sigma_a = \sigma_v \cdot \tan^2(45-\phi/2) - 2c \cdot \tan(45-\phi/2)$

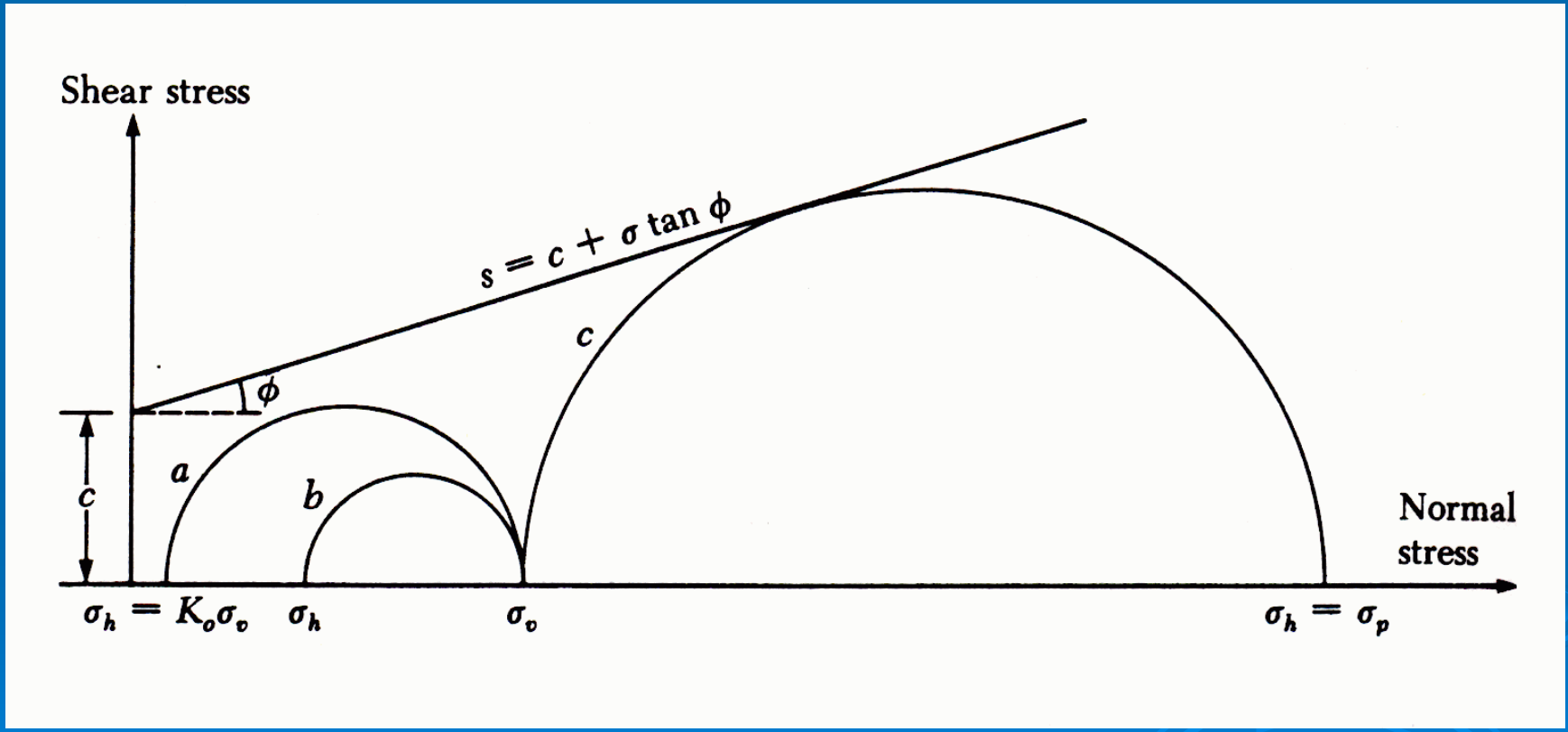
$\sigma_a = \sigma_v \cdot Ka - 2c\sqrt{Ka}$

$Ka = \tan^2(45 - \phi/2)$

TEGANGAN LATERAL TANAH PASIF

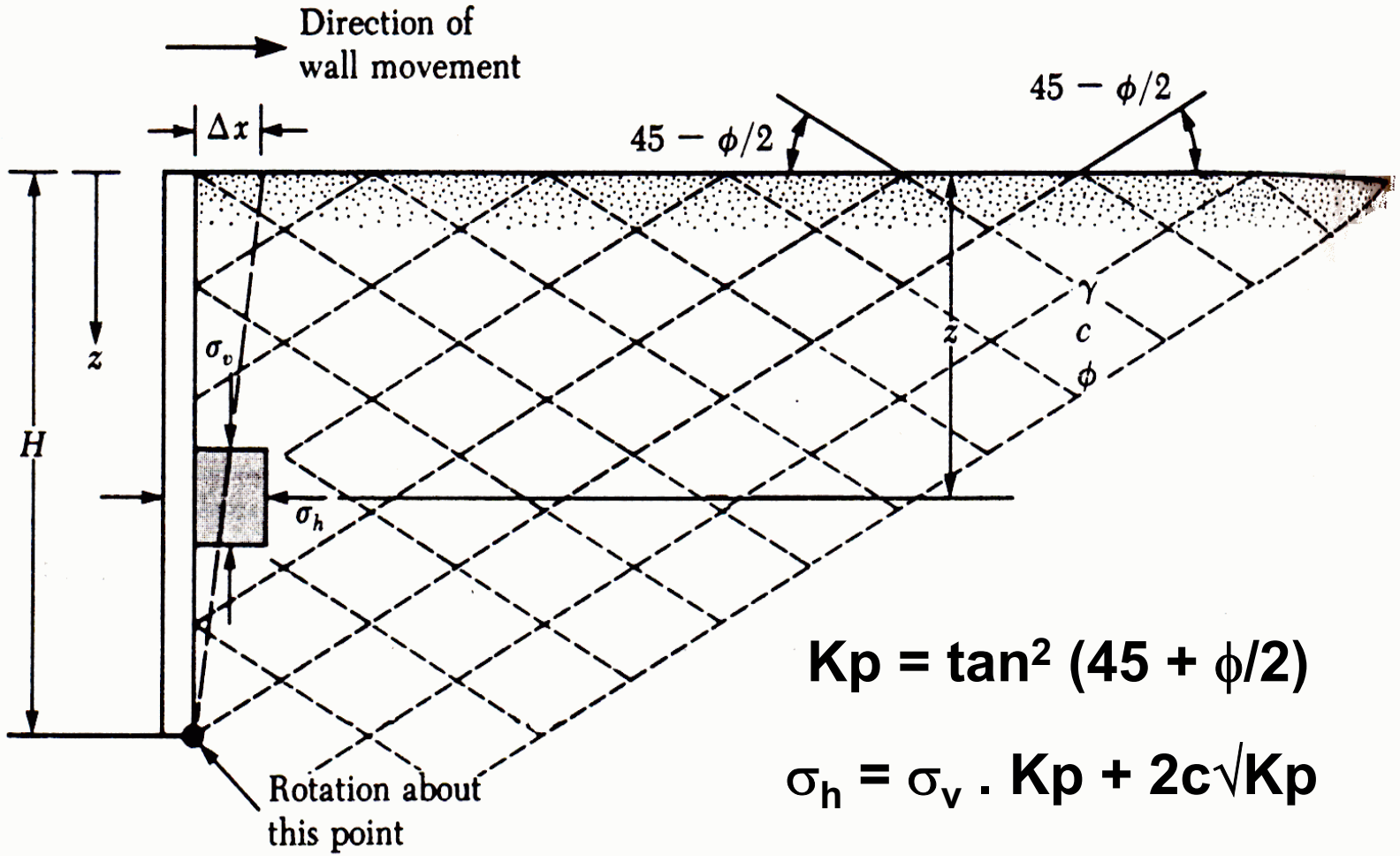


TEGANGAN LATERAL TANAH PASIF



$$\sigma_p = \sigma_v \cdot \tan^2(45+\phi/2) + 2c \cdot \tan(45+\phi/2)$$

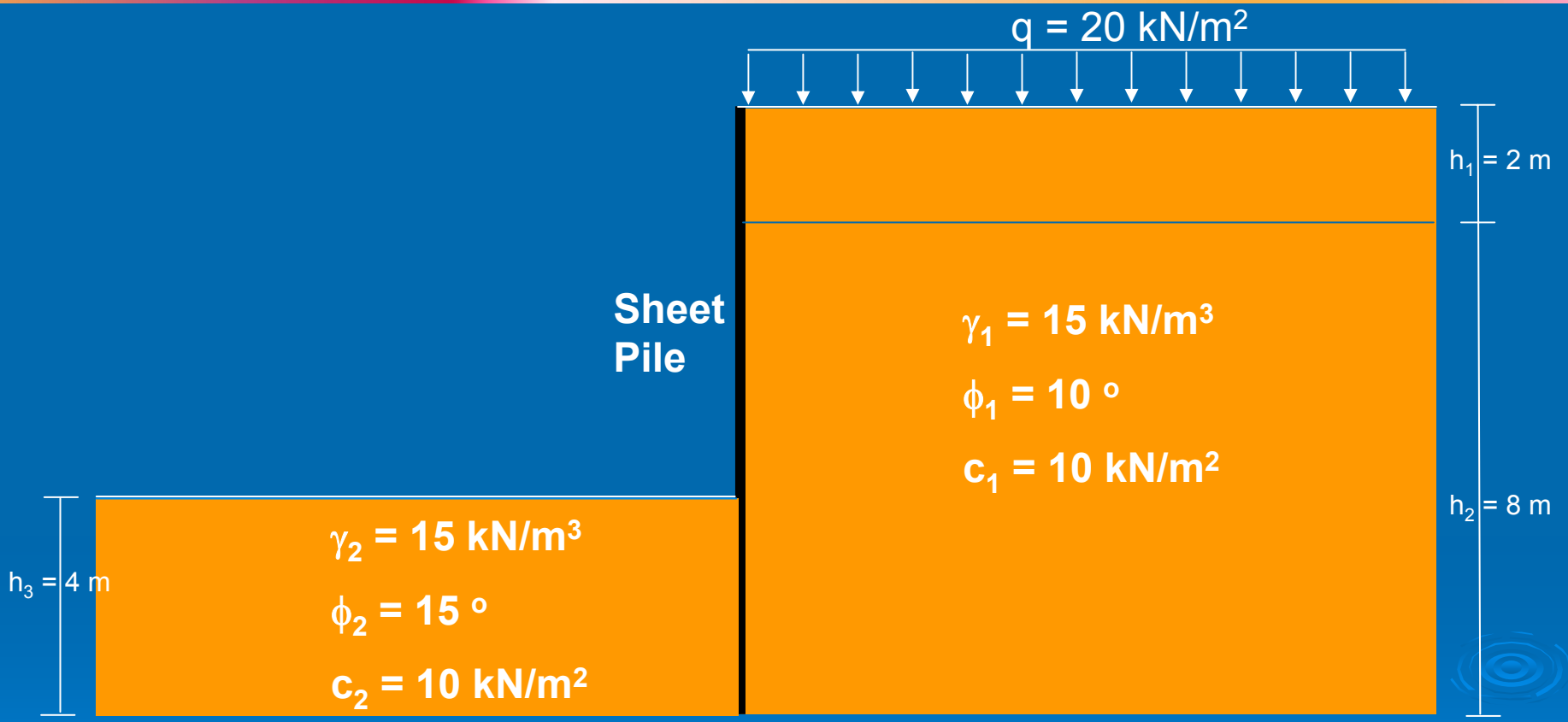
TEGANGAN LATERAL TANAH PASIF



$$Kp = \tan^2 (45 + \phi/2)$$

$$\sigma_h = \sigma_v \,.\, Kp + 2c\sqrt{Kp}$$

CONTOH SOAL



Pertanyaan :

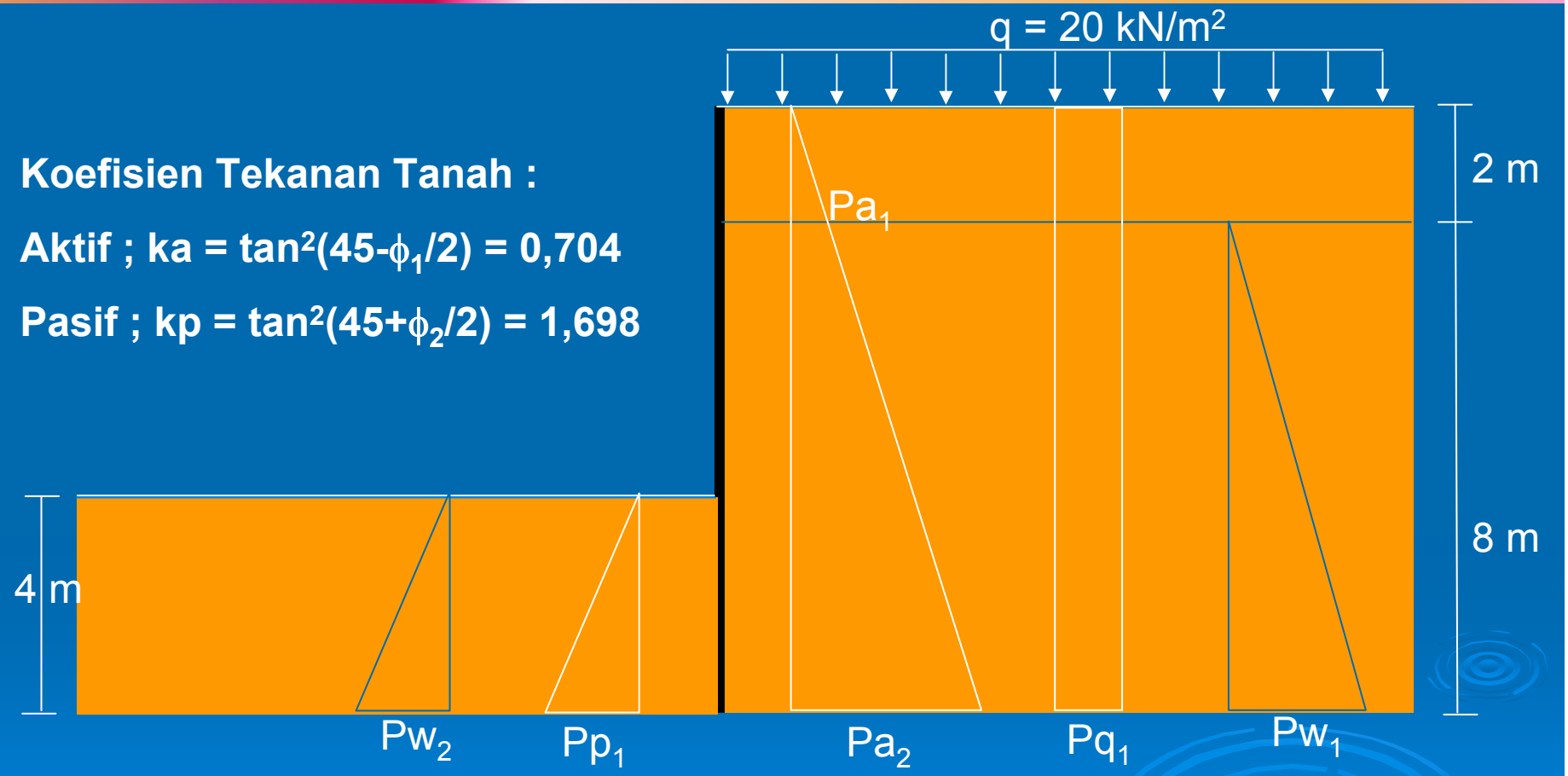
1. **Hitung tegangan dan tegangan tanah aktif dan pasif yang dialami oleh sheet pile**
2. **Hitung kestabilan guling dan geser dari sheet pile**

PENYELESAIAN

Koefisien Tekanan Tanah :

Aktif ; ka = $\tan^2(45-\phi_1/2)$ = 0,704

Pasif ; kp = $\tan^2(45+\phi_2/2)$ = 1,698



Tekanan Tanah Aktif

$Pa_1 = ka \cdot \gamma_1 \cdot h_1 - 2 \cdot c \cdot \sqrt{ka} = 0{,}704 \cdot 15 \cdot 2 - 2 \cdot 10 \cdot \sqrt{0{,}704} = 4{,}34$ kN/m²

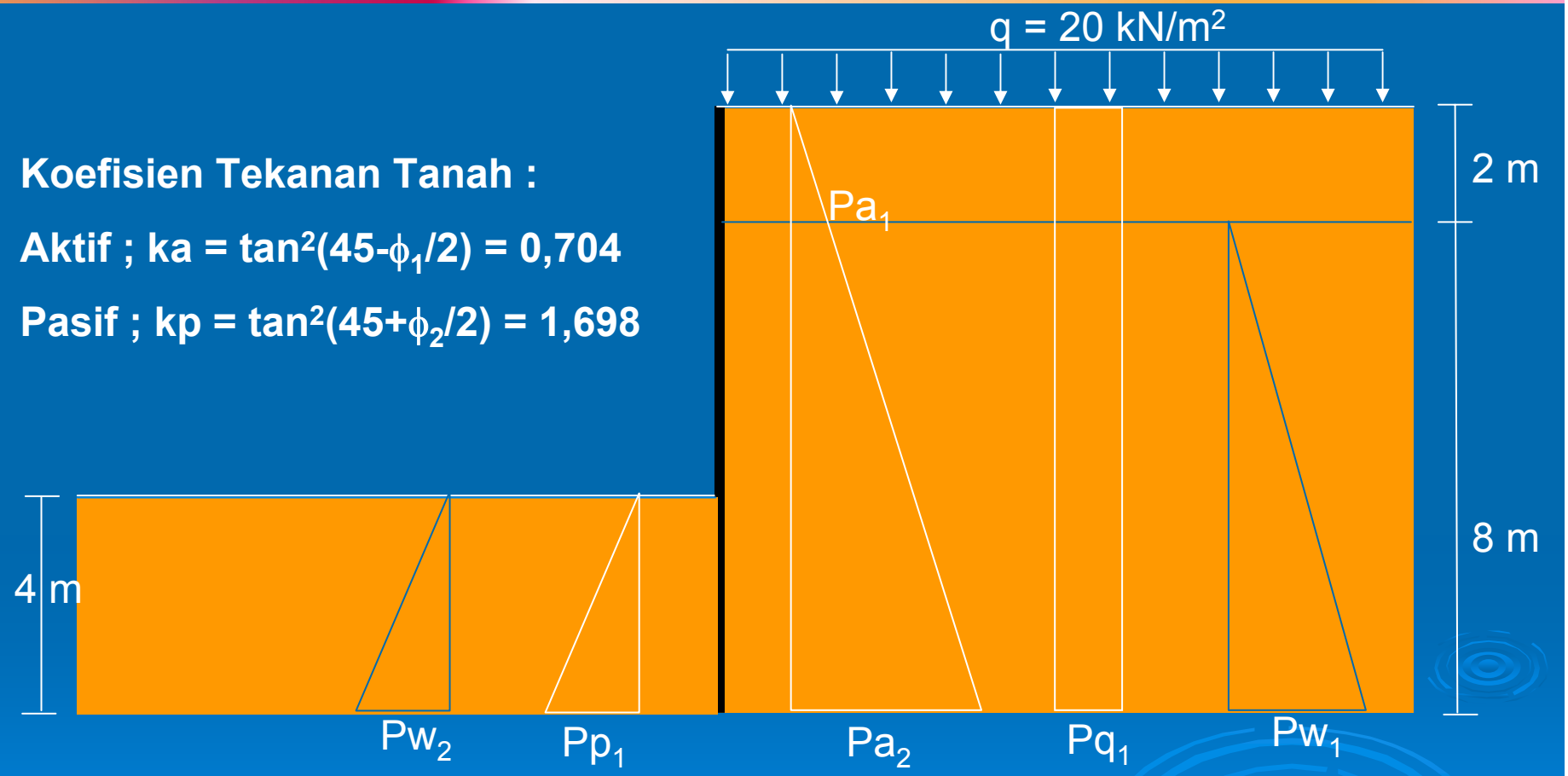
$Pa_2 = ka \cdot (\gamma_1 \cdot h_1 + \gamma_1' \cdot h_2) - 2 \cdot c \cdot \sqrt{ka} = 32{,}5$ kN/m²

PENYELESAIAN

Koefisien Tekanan Tanah :

Aktif ; ka = $\tan^2(45-\phi_1/2)$ = 0,704

Pasif ; kp = $\tan^2(45+\phi_2/2)$ = 1,698



<u>Tekanan Tanah Aktif</u>

$Pq_1 = ka \cdot q = 0{,}704 \cdot 20 = 14{,}08\ kN/m^2$

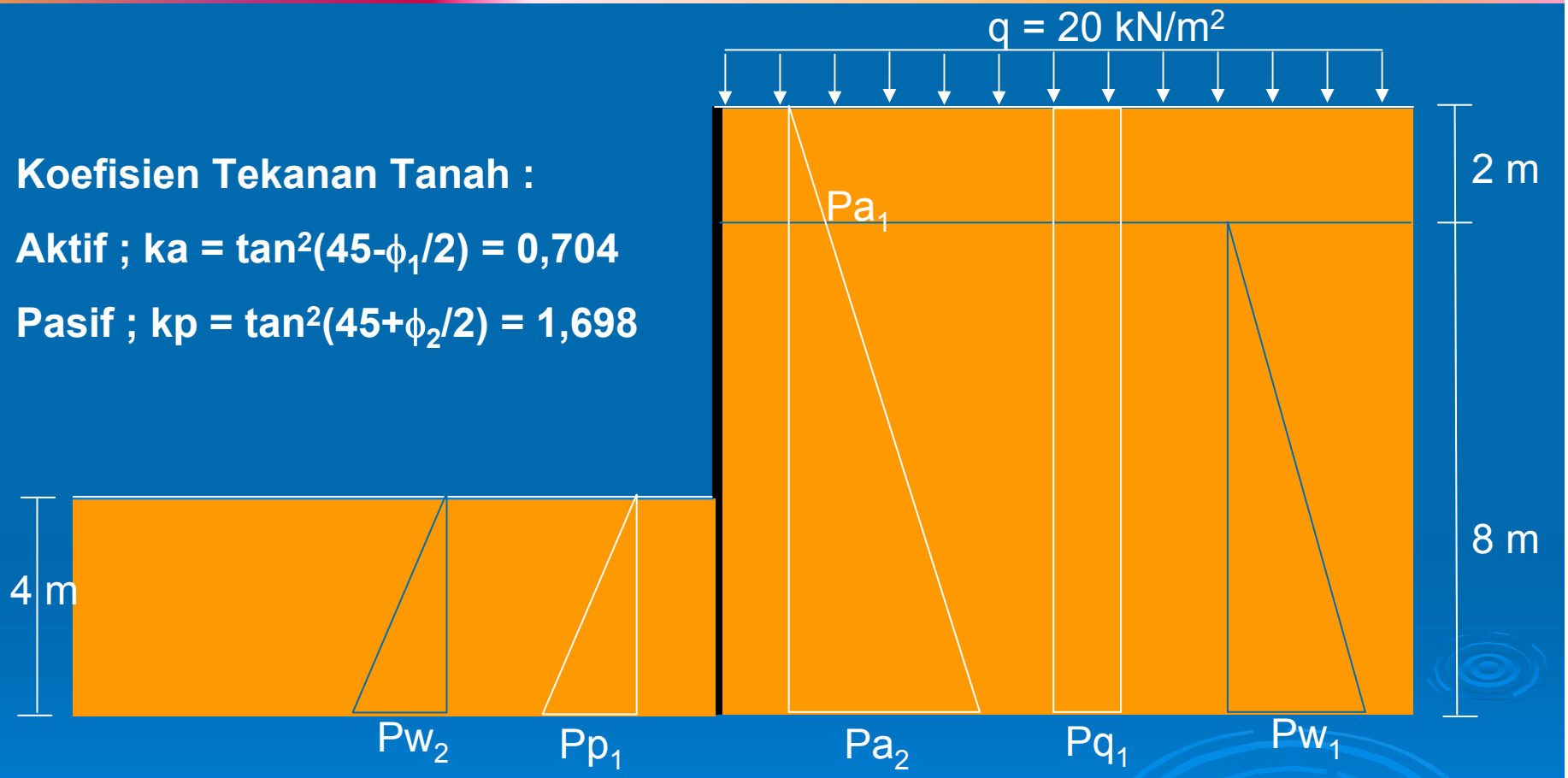
$Pw_1 = kw \cdot \gamma_w \cdot h_2 = 1 \cdot 10 \cdot 8 = 80\ kN/m^2$

PENYELESAIAN

Koefisien Tekanan Tanah :

Aktif ; ka = $\tan^2(45-\phi_1/2)$ = 0,704

Pasif ; kp = $\tan^2(45+\phi_2/2)$ = 1,698



Tekanan Tanah Pasif

$Pp_1 = kp \cdot \gamma_2' \cdot h_3 + 2 \cdot c \cdot \sqrt{kp} = 1{,}698 \cdot 5 \cdot 4 + 2 \cdot 10 \cdot \sqrt{1{,}698} = 60{,}02\ kN/m^2$

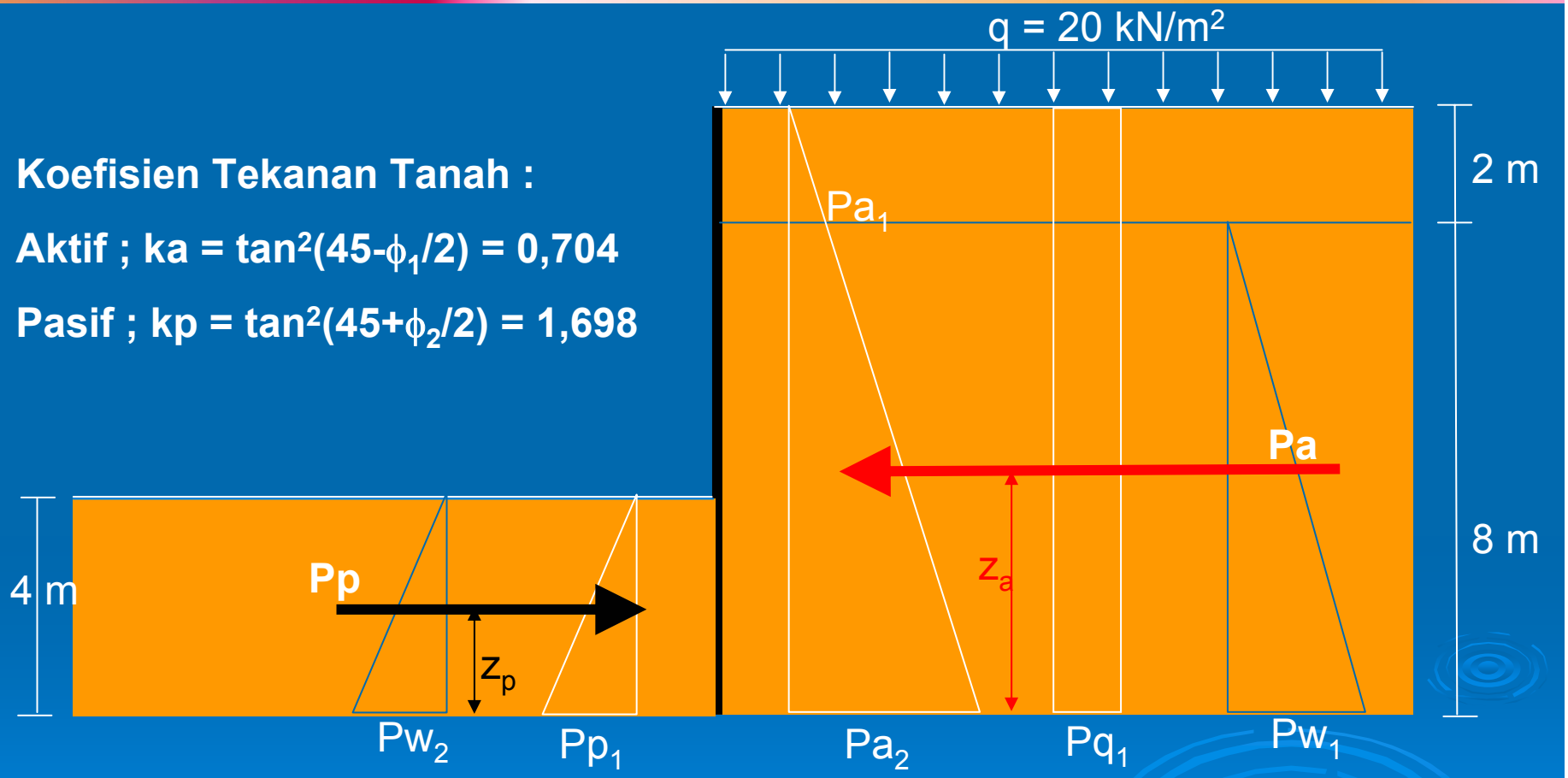
$Pw_2 = kw \cdot \gamma_w \cdot h_3 = 1 \cdot 10 \cdot 4 = 40\ kN/m^2$

PENYELESAIAN

Koefisien Tekanan Tanah :

Aktif ; ka = $\tan^2(45-\phi_1/2)$ = 0,704

Pasif ; kp = $\tan^2(45+\phi_2/2)$ = 1,698



Gaya Tanah Aktif

$Pa = 0,5 \cdot Pa_1 \cdot h_1 + (Pa_1+Pa_2)/2 \cdot H_2 + Pq_1 \cdot (h_1+h_2) + 0,5 \cdot Pw_1 \cdot h_2 = 612,5$ kN/m

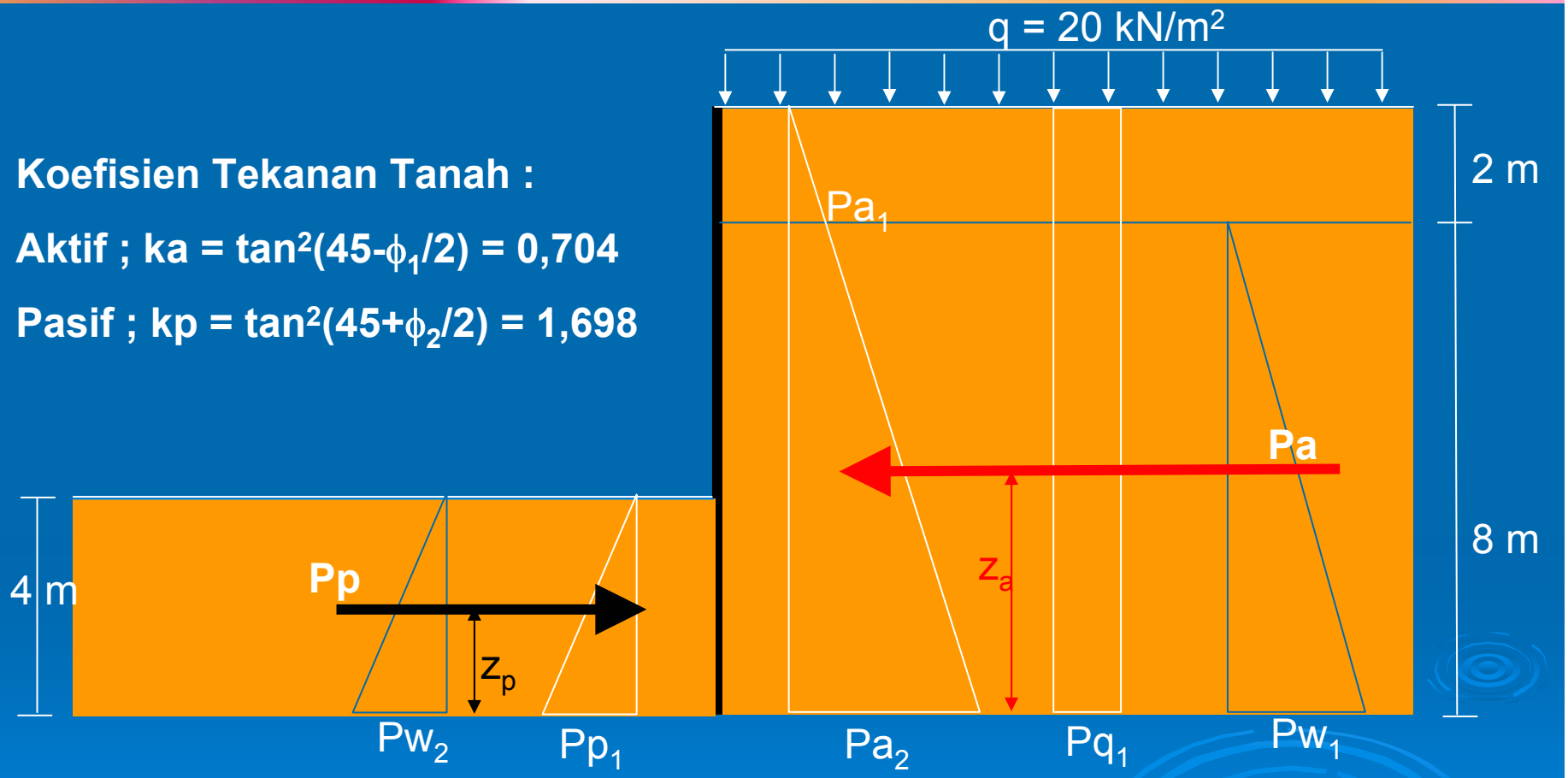
$z_a = 3,32$ m

PENYELESAIAN

Koefisien Tekanan Tanah :

Aktif ; ka = $\tan^2(45-\phi_1/2)$ = 0,704

Pasif ; kp = $\tan^2(45+\phi_2/2)$ = 1,698

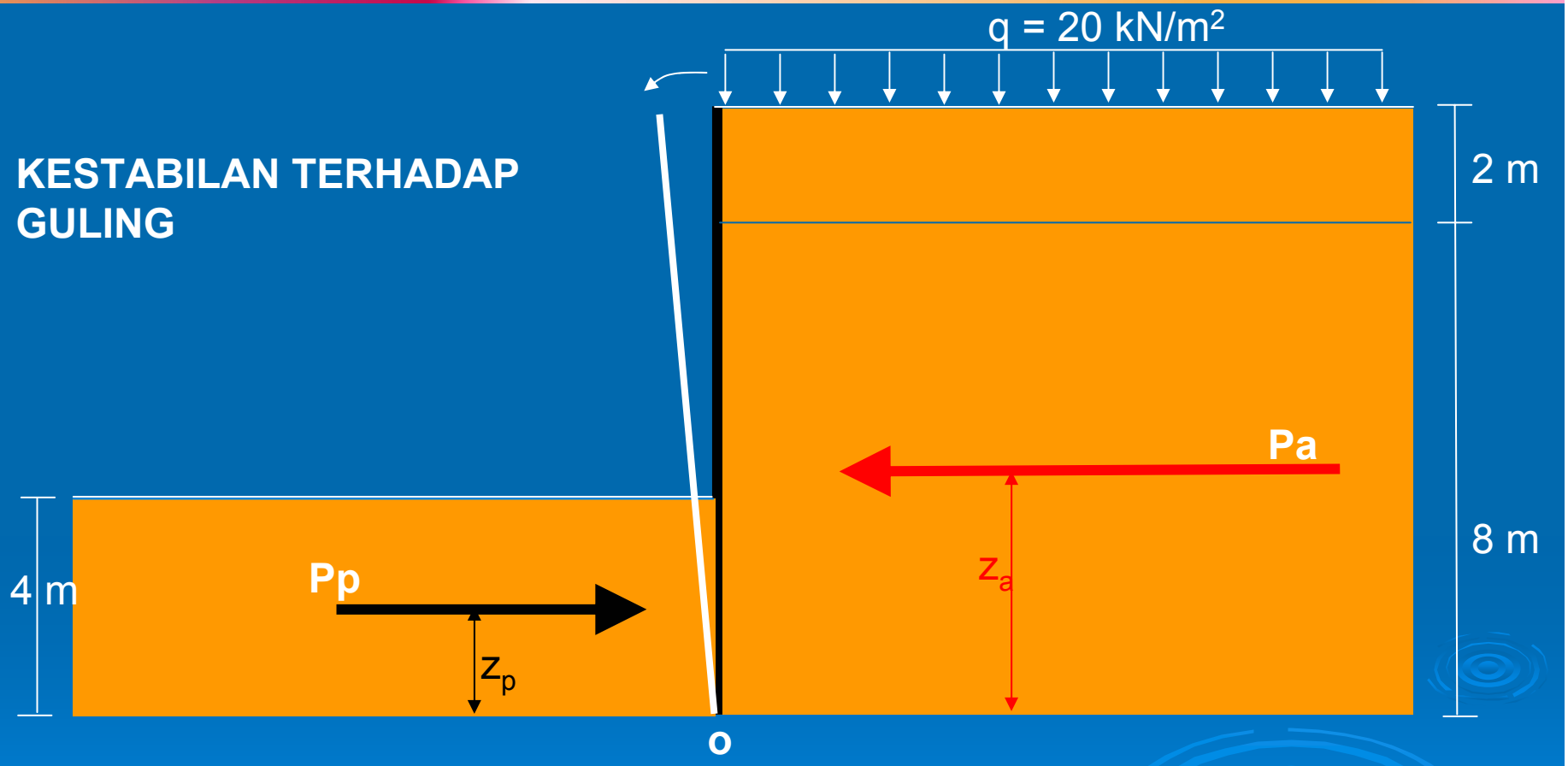


Gaya Tanah Pasif

$Pp = 0,5 \cdot Pp_1 \cdot h_3 + 0,5 \cdot Pw_2 \cdot h_3 = 200,04$ kN/m

$z_p = 4/3$ m

PENYELESAIAN

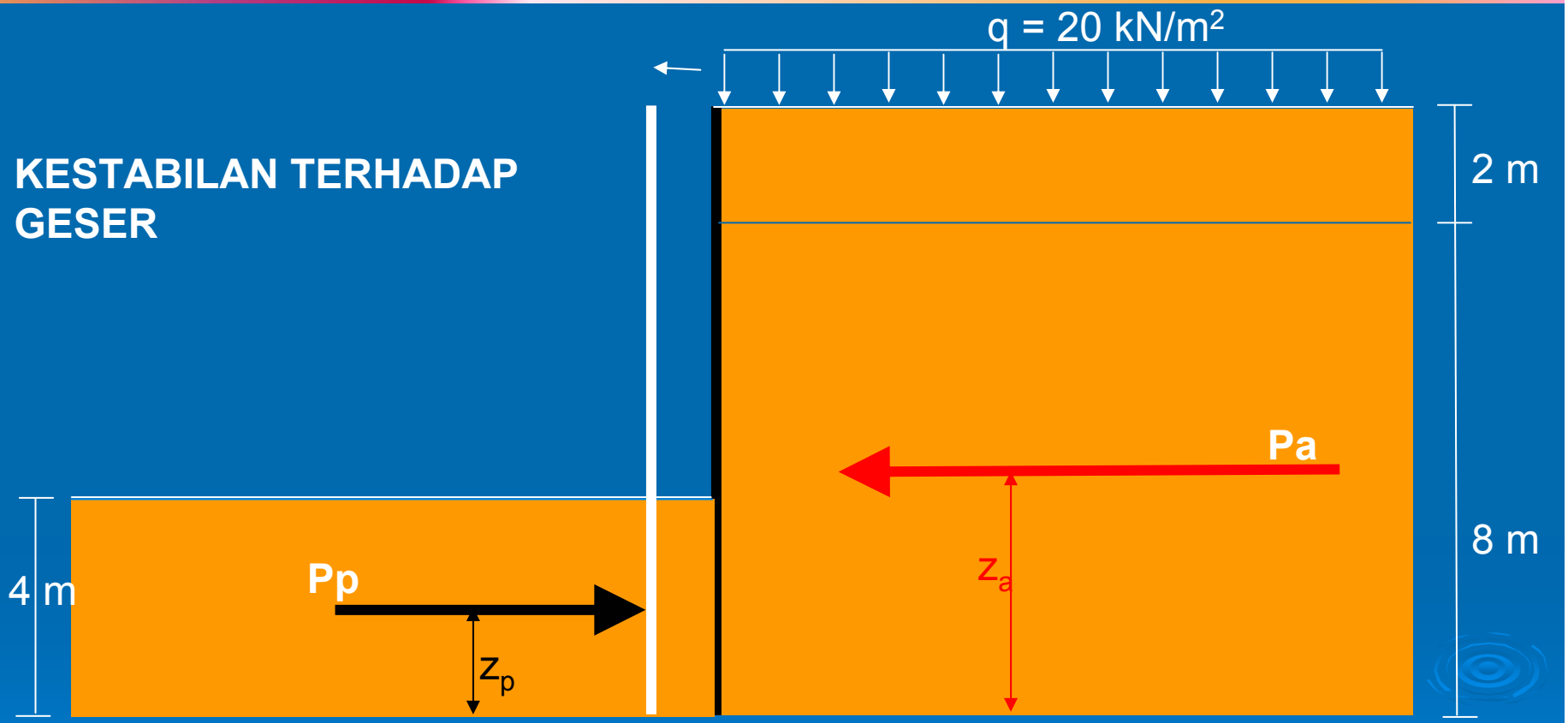


Faktor Keamanan

FK = Pp . z_p / Pa . z_a = (200,04 . 4/3) / (612,5 . 3,32) = 0,13

PENYELESAIAN

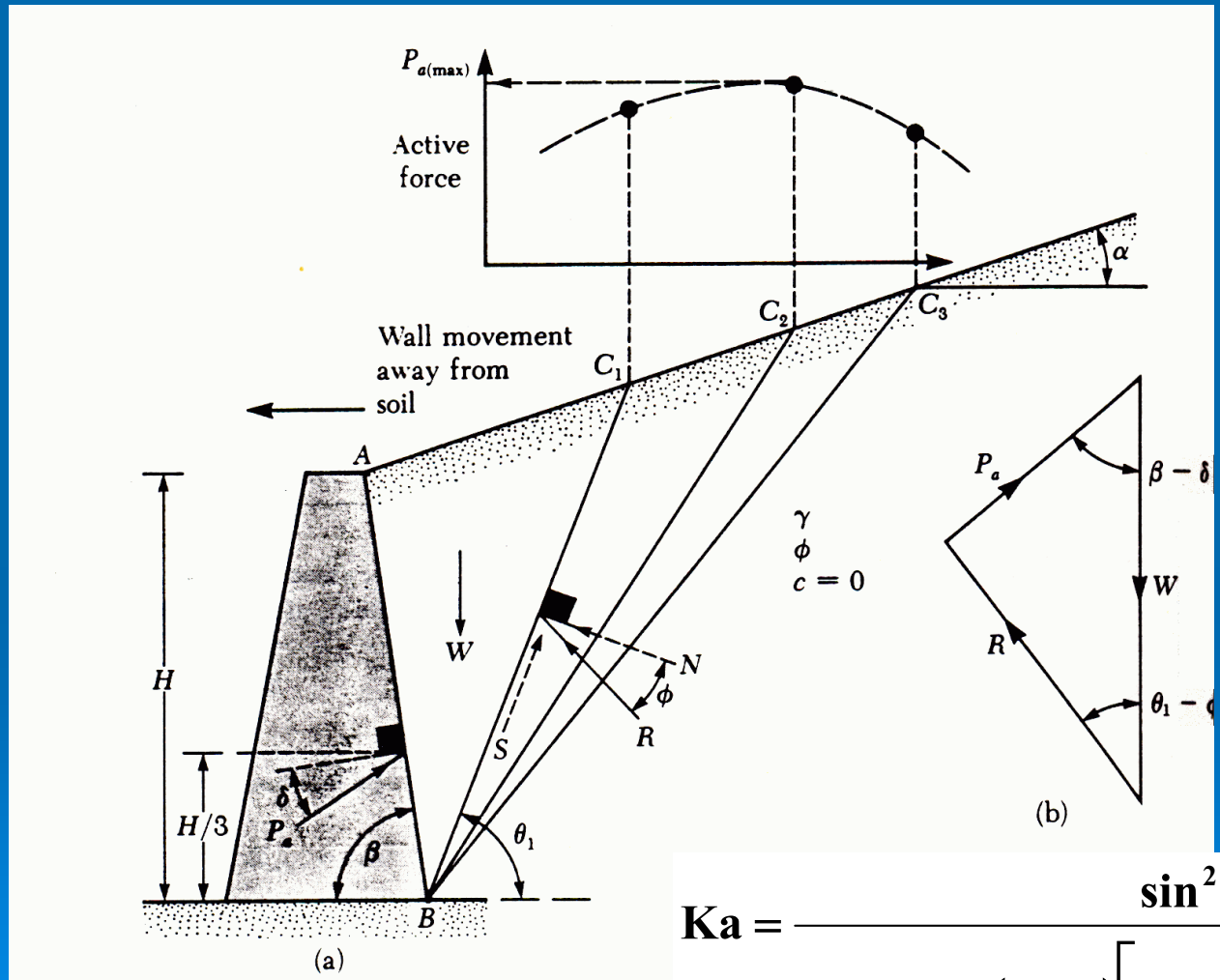
KESTABILAN TERHADAP GESER



Faktor Keamanan

FK = Pp / Pa = 200,04 / 612,5 = 0,33

TEGANGAN LATERAL TANAH AKTIF



Asumsi :

-Tanah timbunan berupa tanah granular

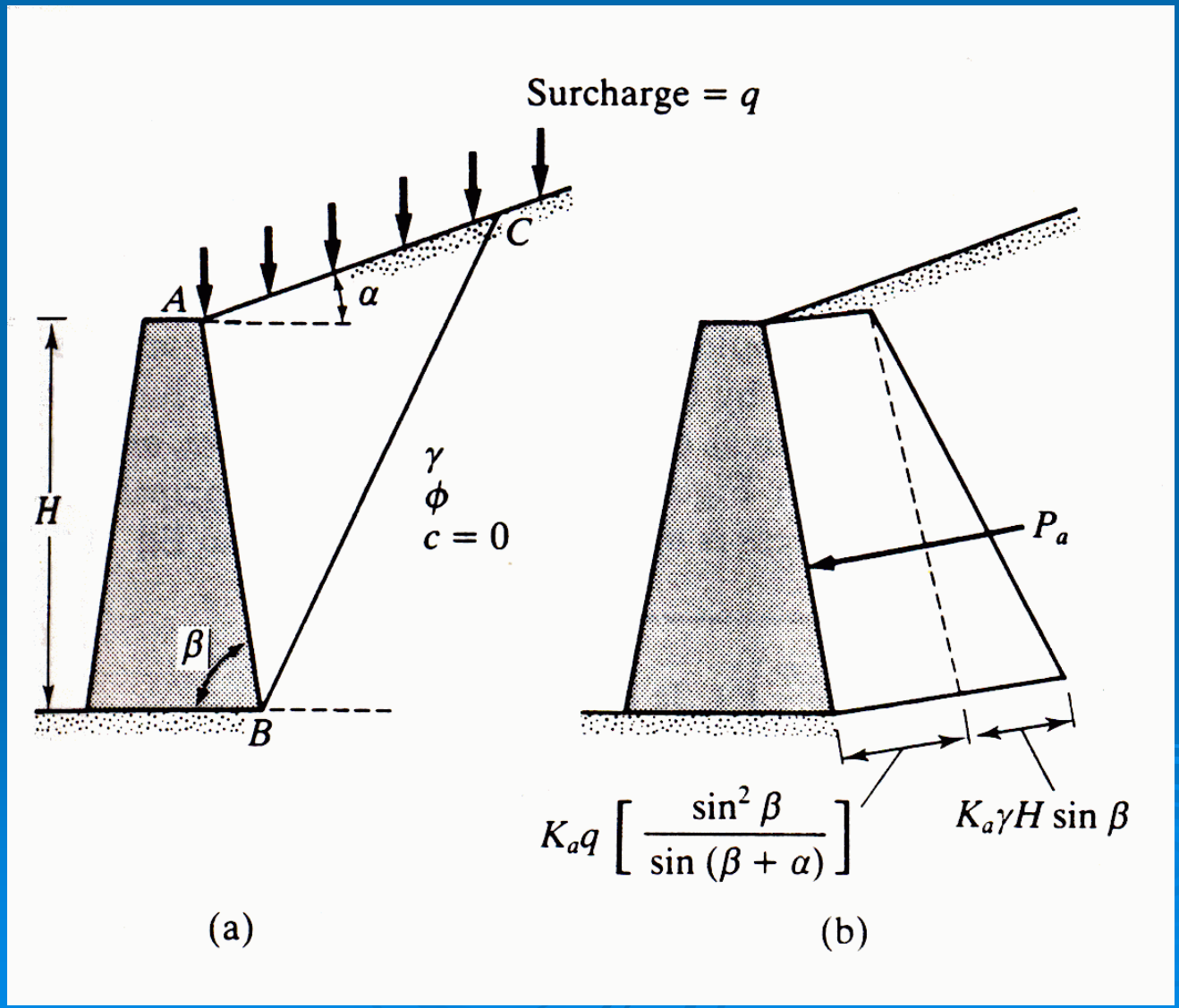
- Gesekan antar dinding dan timbunan diperhitungkan

- Selubung keruntuhan berbentuk bidang datar (BC_1, BC_2 …)

$$Pa = \tfrac{1}{2}\, Ka \,.\, \gamma \,.\, H^2$$

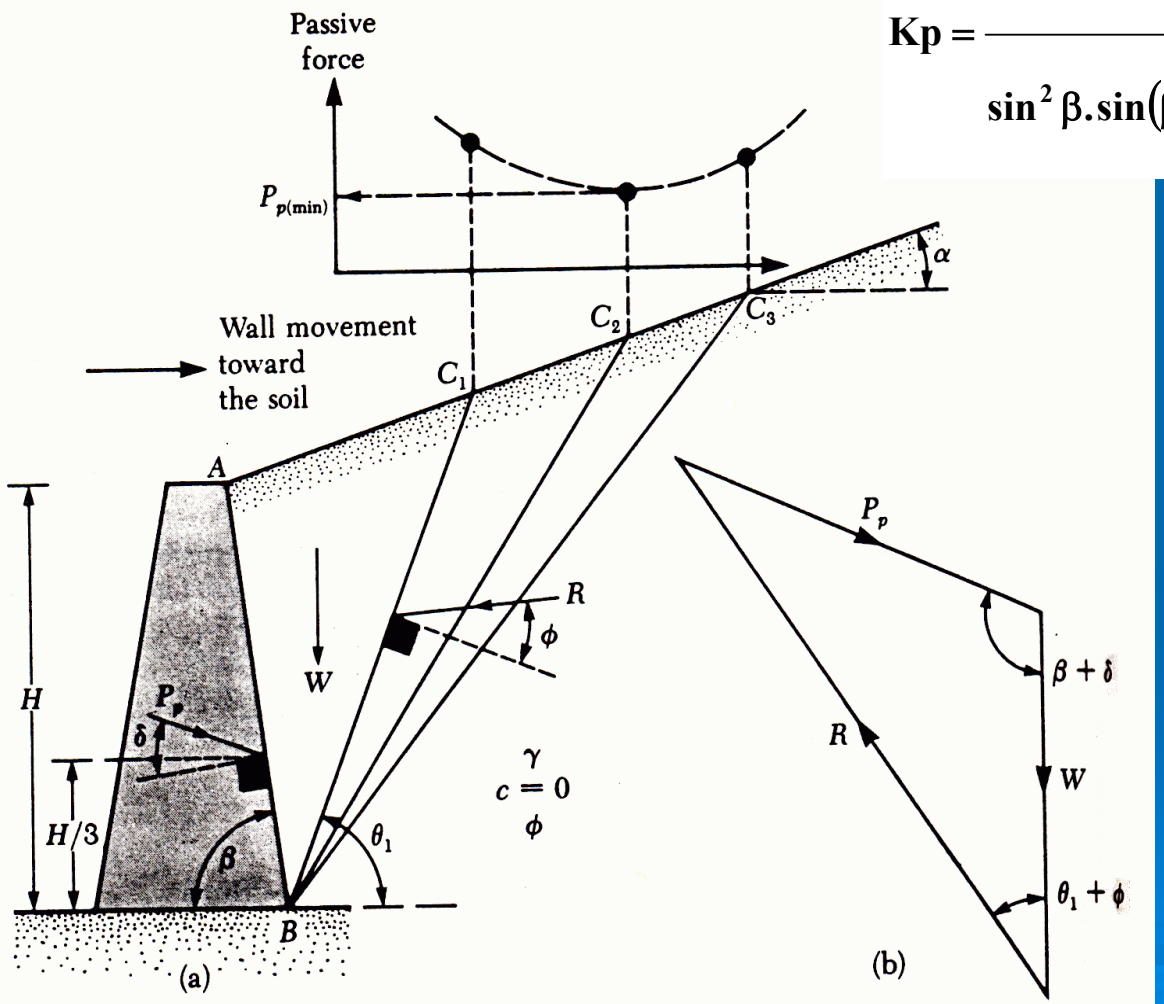
$$Ka = \frac{\sin^2(\beta+\phi)}{\sin^2\beta.\sin(\beta-\delta)\left[1+\sqrt{\dfrac{\sin(\phi+\delta).\sin(\phi-\alpha)}{\sin(\beta-\delta).\sin(\beta+\alpha)}}\right]^2}$$

TEGANGAN LATERAL TANAH AKTIF



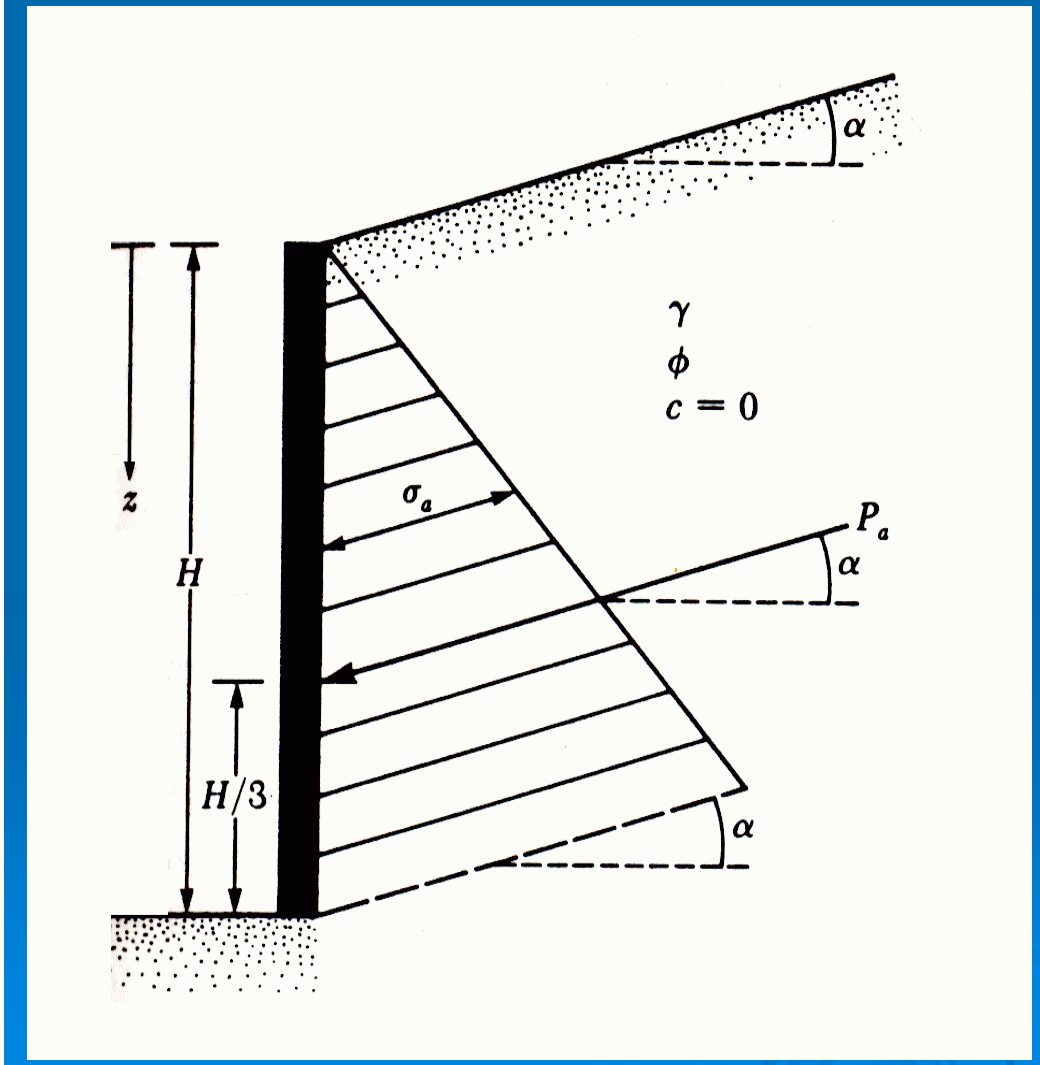
TEGANGAN LATERAL TANAH PASIF

$$Kp = \frac{\sin^2(\beta - \phi)}{\sin^2\beta . \sin(\beta + \delta)\left[1 + \sqrt{\frac{\sin(\phi + \delta).\sin(\phi + \alpha)}{\sin(\beta + \delta).\sin(\beta + \alpha)}}\right]^2}$$



$$Pp = \tfrac{1}{2}\, Kp \,.\, \gamma \,.\, H^2$$

TEGANGAN LATERAL MATERIAL GRANULAR



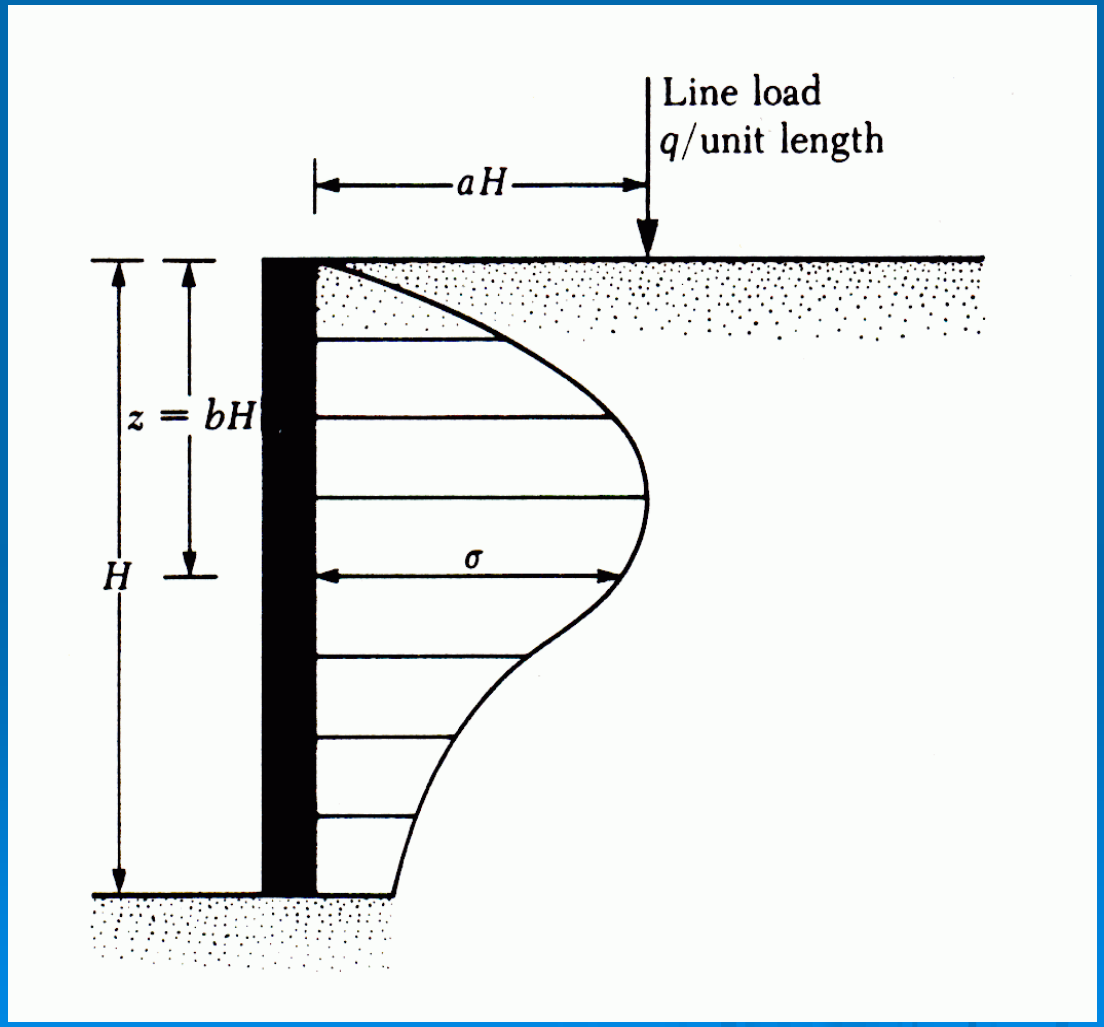
$$Ka = \cos\alpha \frac{\cos\alpha - \sqrt{\cos^2\alpha - \cos^2\phi}}{\cos\alpha + \sqrt{\cos^2\alpha - \cos^2\phi}}$$

$$Pa = \tfrac{1}{2}.\gamma.H^2.Ka$$

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

$$Pp = \tfrac{1}{2}.\gamma.H^2.Kp$$

TEGANGAN LATERAL AKIBAT BEBAN



$$\sigma = \frac{2q}{nH} \cdot \frac{a^2 b}{\left(a^2 + b^2\right)^2}$$

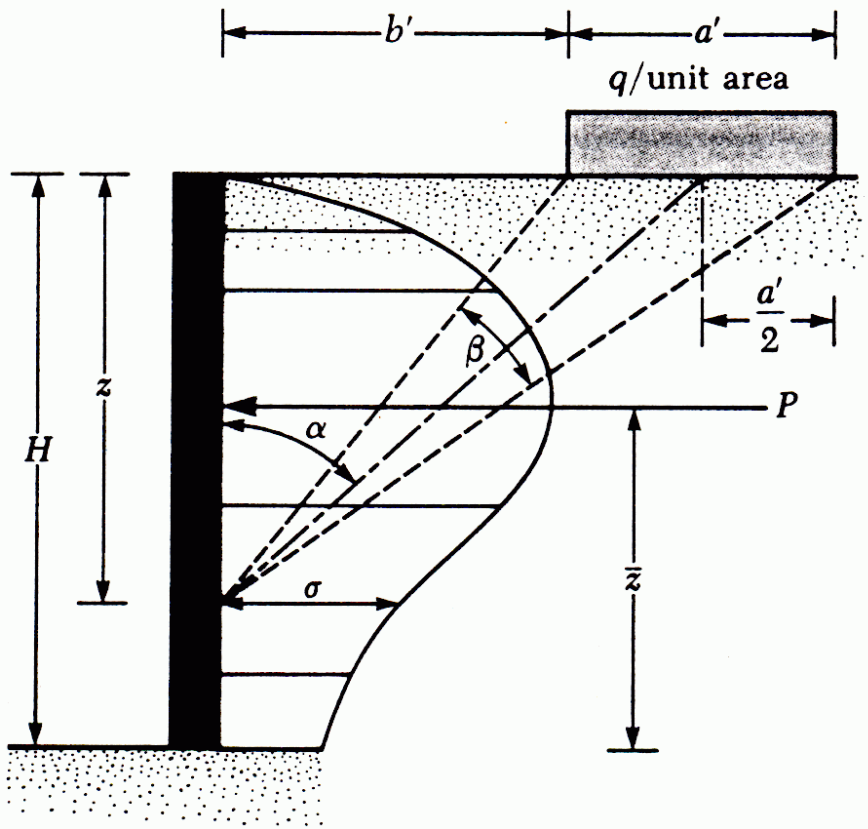
a > 0,4

$$\sigma = \frac{4q}{nH} \cdot \frac{a^2 b}{\left(a^2 + b^2\right)^2}$$

a ≤ 0,4

$$\sigma = \frac{q}{H} \cdot \frac{0{,}203 b}{\left(0{,}16 + b^2\right)^2}$$

TEGANGAN LATERAL AKIBAT BEBAN



$$\sigma = \frac{q}{H}\left(\beta - \sin\beta.\cos 2\alpha\right)$$

$$P = \frac{q}{90}\left(H\left(\theta_2 - \theta_1\right)\right)$$

$$\theta_1 = \tan^{-1}\left(\frac{b'}{H}\right)$$

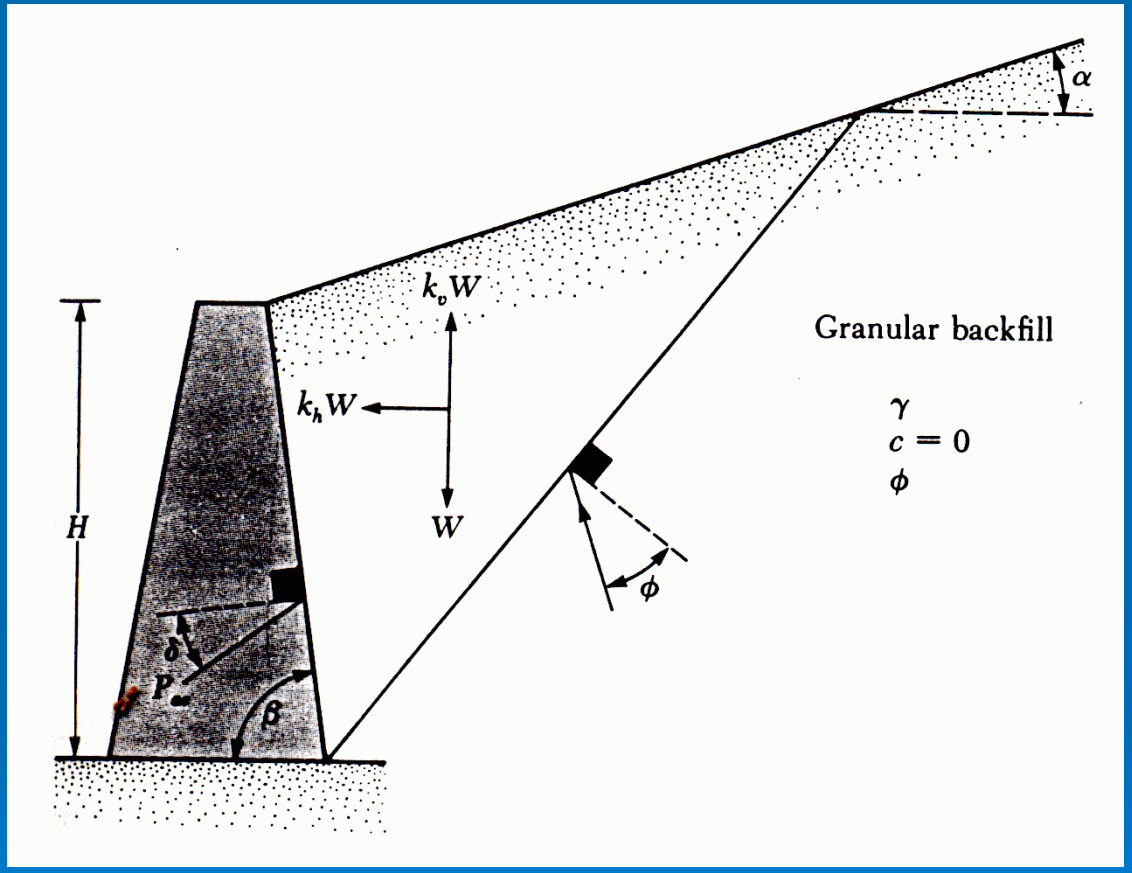
$$\theta_2 = \tan^{-1}\left(\frac{a'+b'}{H}\right)$$

$$\bar{z} = \frac{H^2\left(\theta_2 - \theta_1\right) - \left(R - Q\right) + 57{,}30a'H}{2H\left(\theta_2 - \theta_1\right)}$$

$$R = \left(a'+b'\right)^2\left(90 - \theta_2\right)$$

$$Q = b'^2\left(90 - \theta_1\right)$$

TEGANGAN LATERAL AKIBAT GEMPA

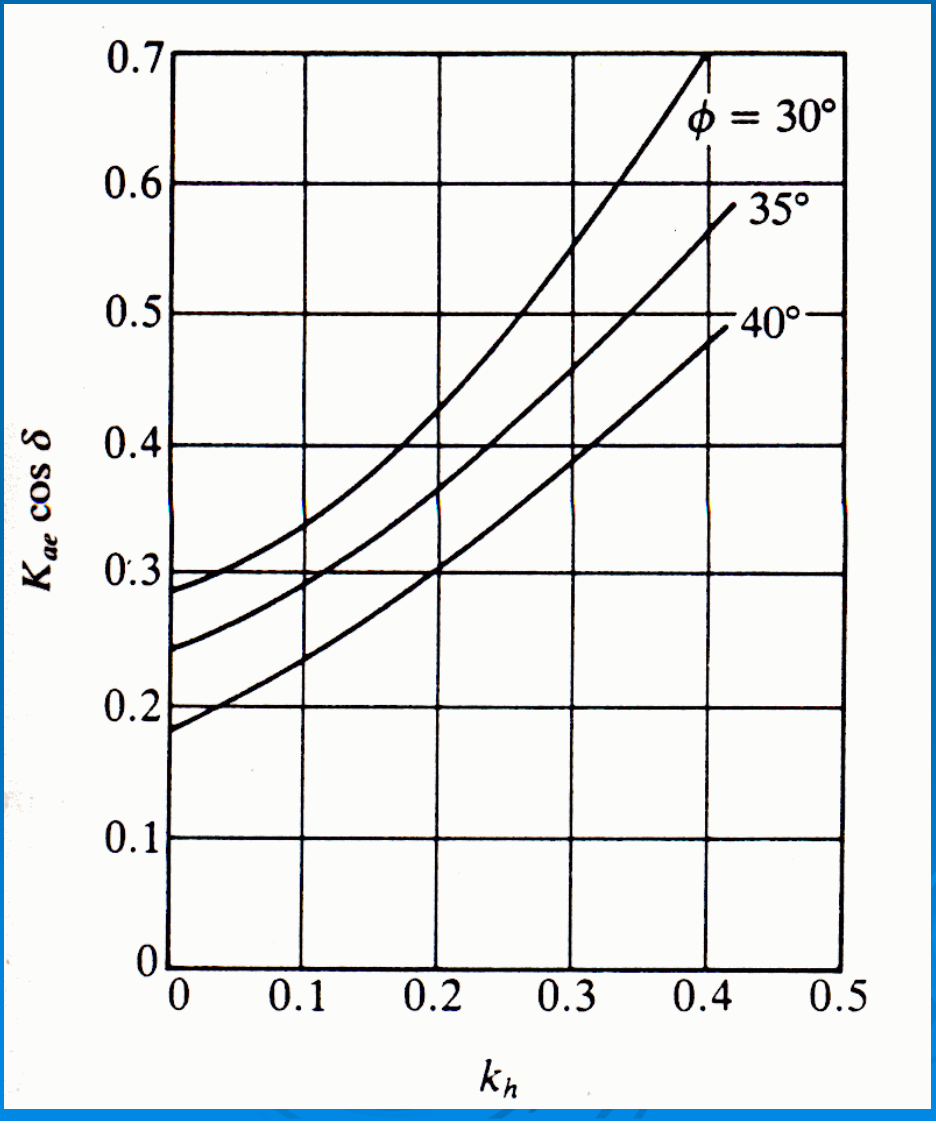


$$P_{ae} = \tfrac{1}{2}.\gamma.H^2(1-k_v)K_{ae}$$

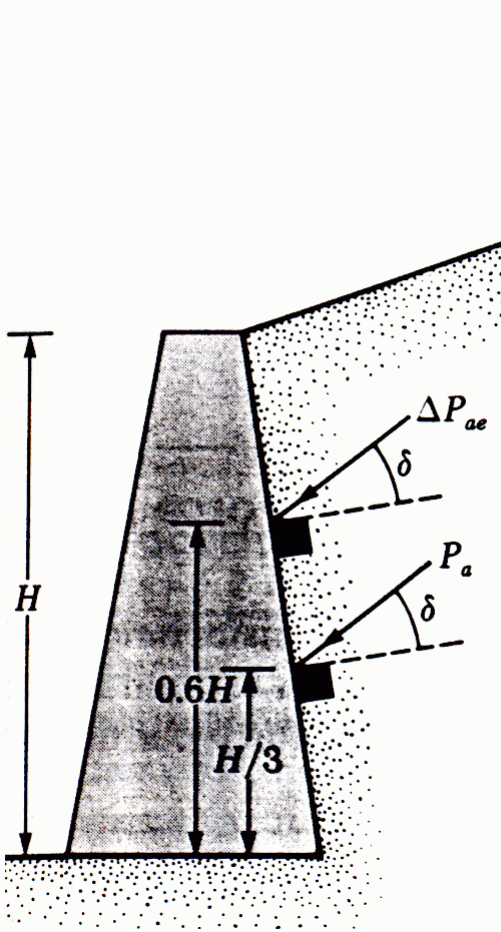
$$\theta' = \tan^{-1}\left[\frac{k_h}{1-k_v}\right]$$

$$K_{ae} = \frac{\sin^2(\phi+\beta-\theta')}{\cos\theta'.\sin^2\beta.\sin(\beta-\theta'-\delta)\left[1+\sqrt{\frac{\sin(\phi+\delta)\sin(\phi-\theta'-\alpha)}{\sin(\beta-\delta-\theta')\sin(\alpha+\beta)}}\right]^2}$$

TEGANGAN LATERAL AKIBAT GEMPA



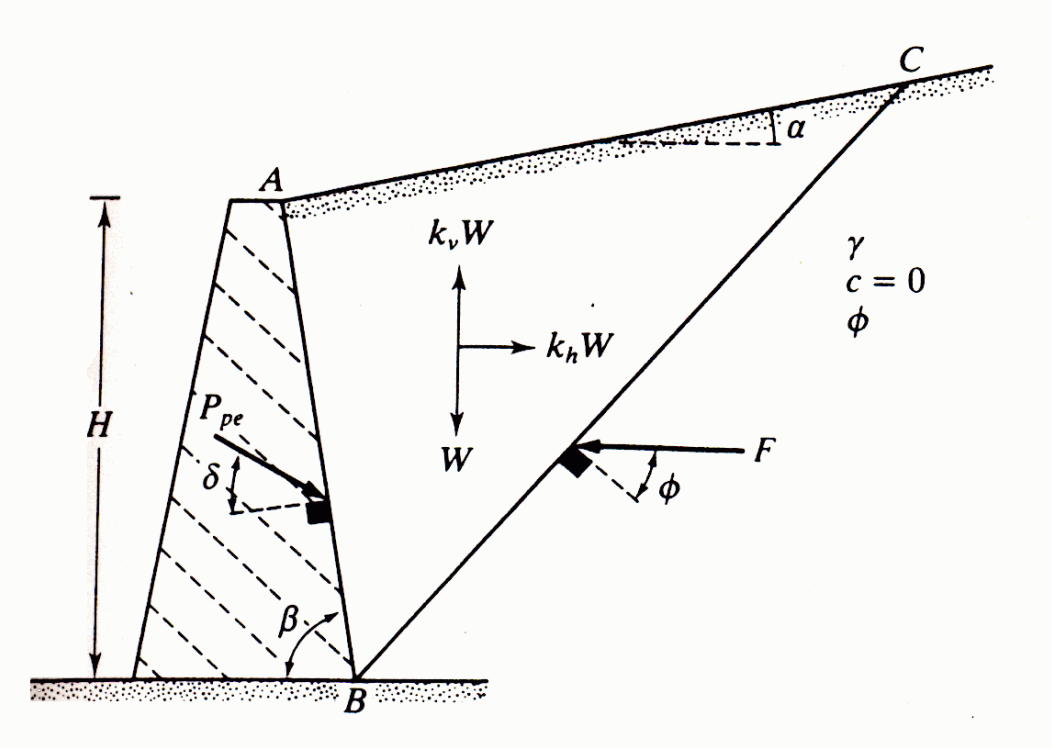
TEGANGAN LATERAL AKIBAT GEMPA



$$\bar{z} = \frac{(0{,}6H)(\Delta P_{ae}) + \left(\frac{H}{3}\right)Pa}{P_{ae}}$$

$$\Delta P_{ae} = P_{ae} - Pa$$

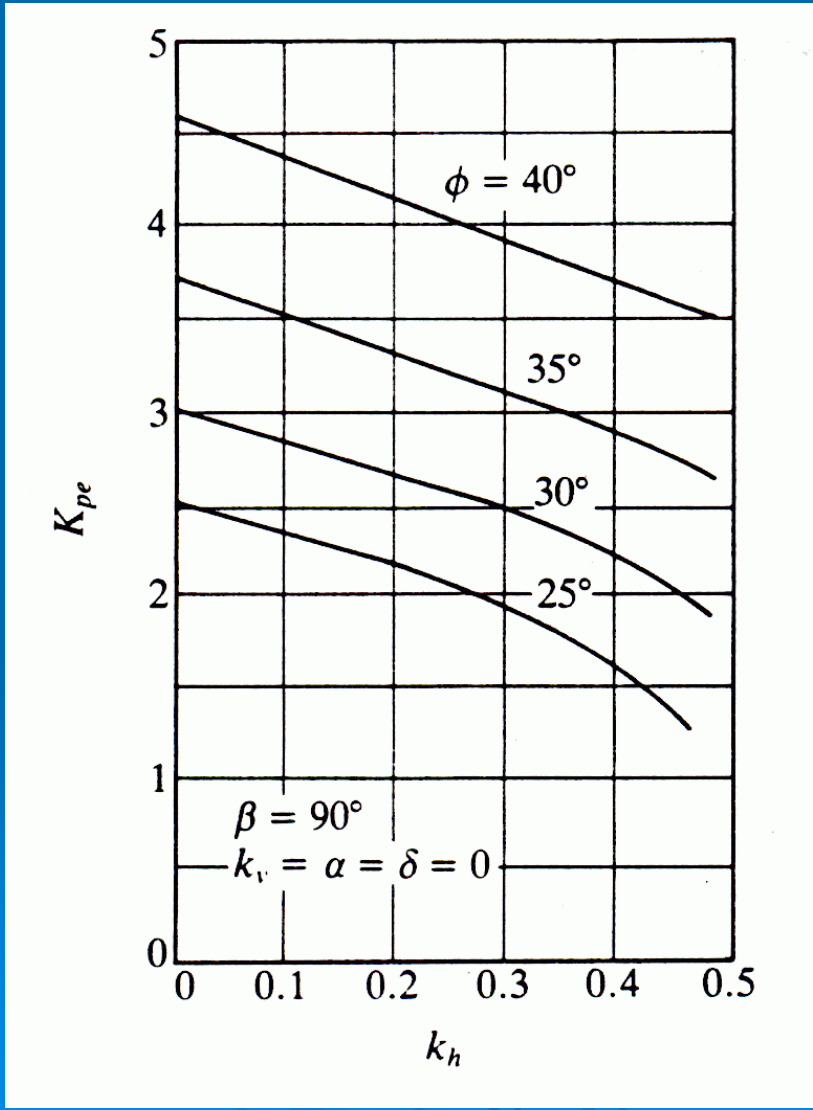
TEGANGAN LATERAL AKIBAT GEMPA



$$P_{pe} = \tfrac{1}{2}.\gamma.H^2\left(1-k_v\right)K_{pe}$$

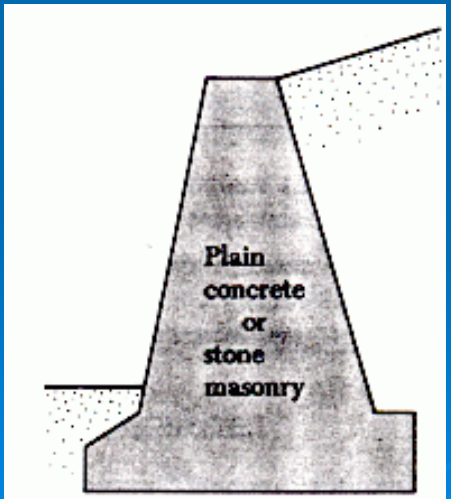
$$K_{pe} = \frac{\sin^2\left(\beta+\theta'-\phi\right)}{\cos\theta'.\sin^2\beta.\sin\left(\delta+\beta+\theta'-90\right)\left[1-\sqrt{\frac{\sin\left(\phi+\delta\right)\sin\left(\phi+\alpha-\theta'\right)}{\sin\left(\beta+\delta+\theta'\right)\sin\left(\alpha+\beta\right)}}\right]^2}$$

TEGANGAN LATERAL AKIBAT GEMPA

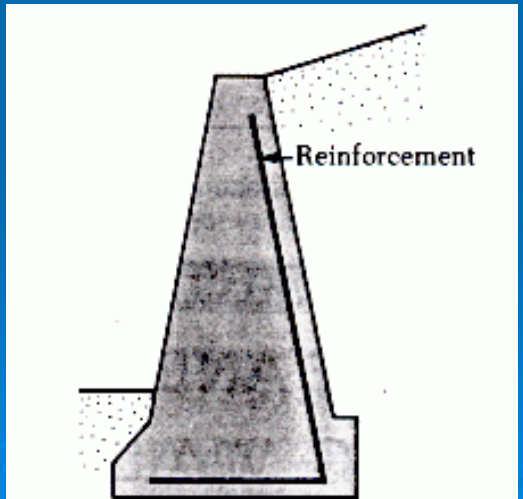


APLIKASI TEGANGAN LATERAL

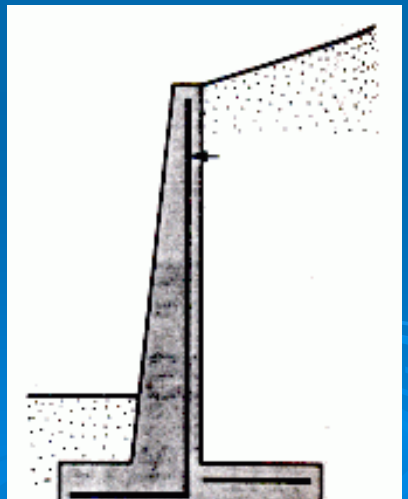
- ANALISA STABILITAS DINDING PENAHAN TANAH
  - GESER
  - GULING



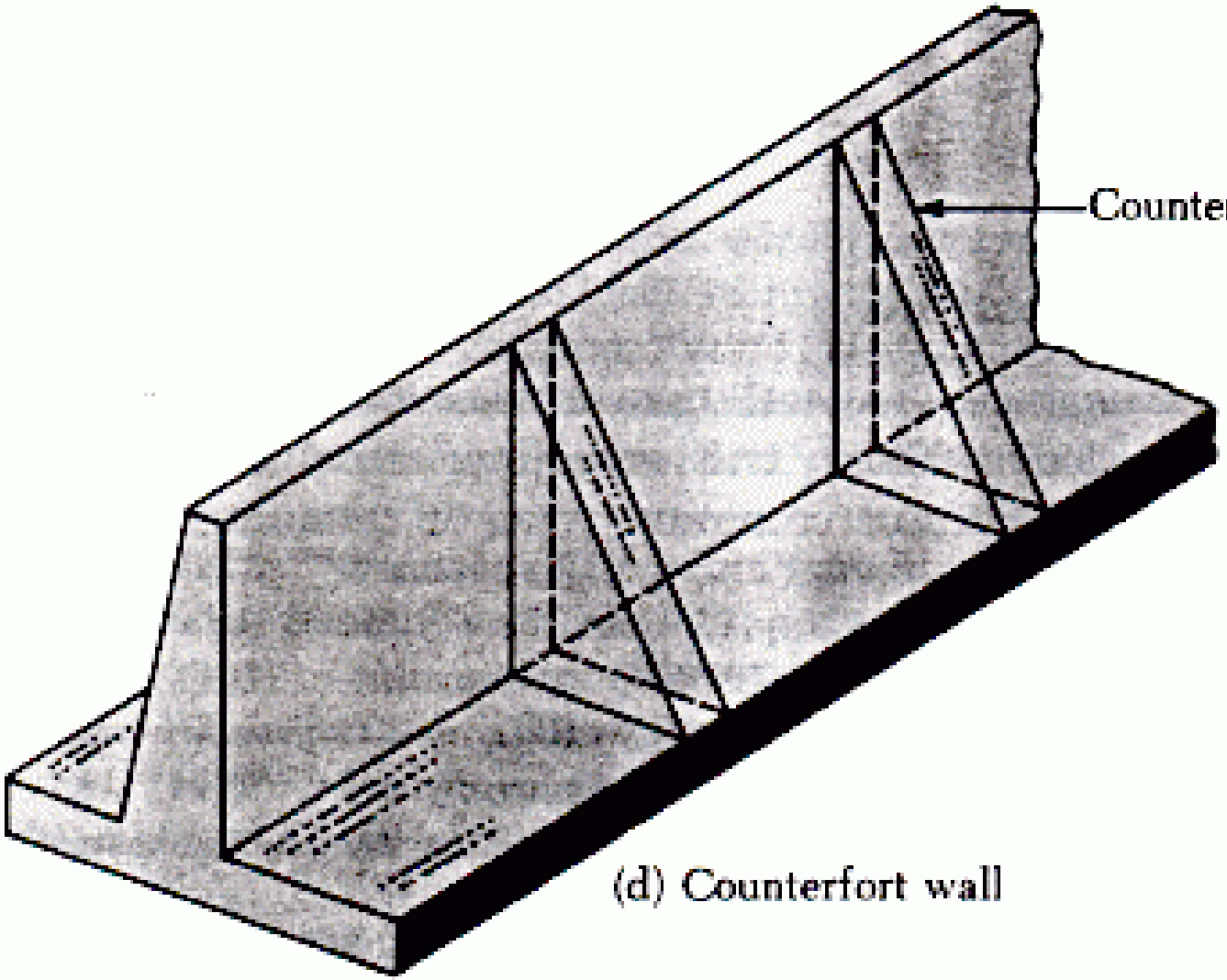
(a) Gravity wall



(b) Semigravity wall


(c) Cantilever wall

APLIKASI TEGANGAN LATERAL



(d) Counterfort wall

APLIKASI TEGANGAN LATERAL