Rekayasa Pondasi II

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Introduction

- UTS
  - Shallow Foundation
  - Lateral Earth Pressure
- UAS
  - Retaining Wall

Lateral Earth Pressure

Introduction

Kemiringan mendekati vertikal biasanya akan ditopang oleh *Retaining wall, cantilever sheet-pile walls, sheet-pile with anchore,* atau struktur lainnya. Desain dari struktur ini memerlukan perkiraan tegangan tanah lateral (*lateral earth pressure*), yang terdiri atas beberapa fungsi faktor seperti :

(a) Tipe pergerakan struktur
(b) Parameter kuat geser tanah
(c) Berat satuan tanah
(d) Kondisi air tanah di timbunan

Lateral Earth Pressure

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Lateral Earth Pressure

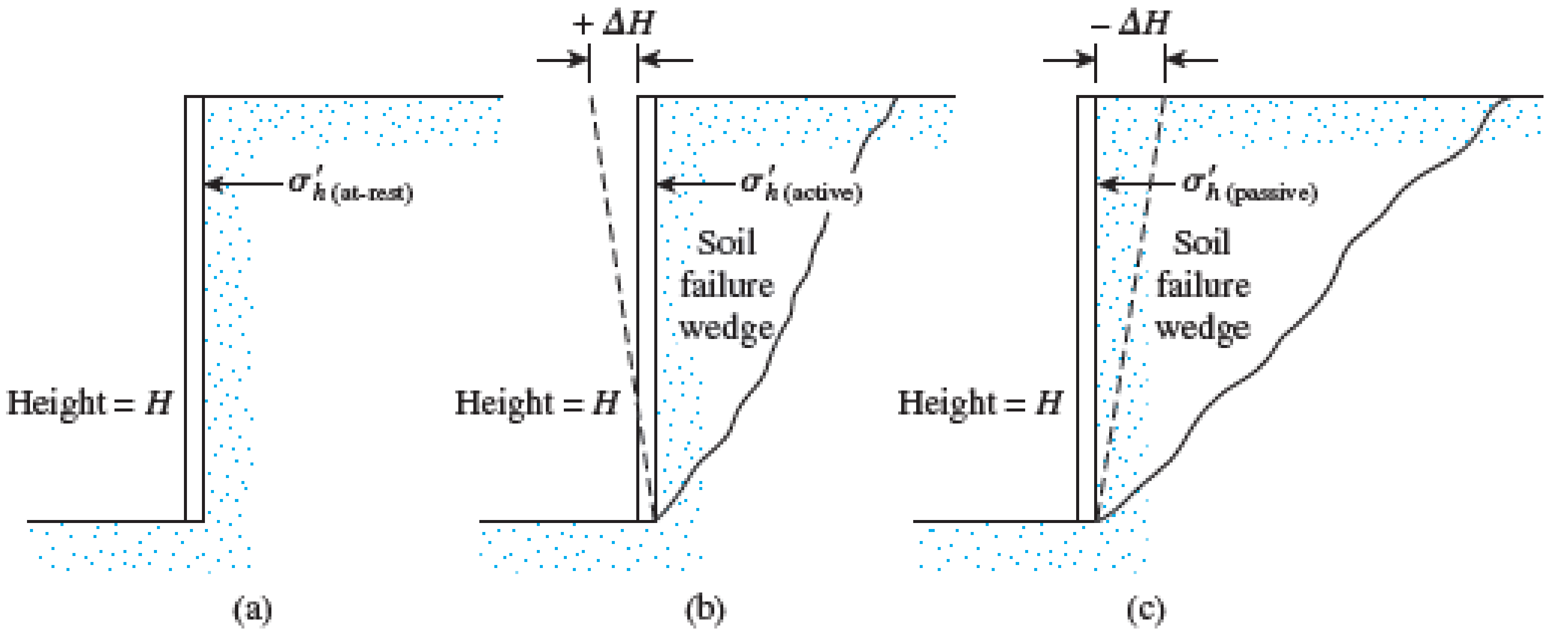


Figure 12.1 Nature of lateral earth pressure on a retaining wall

(a) ***At-rest earth pressure*** : Tidak dizinkan mengalami pergerakan lateral.

(b) ***Active earth pressure*** : Dinding miring menjauhi tanah tertahan. Area irisan segitiga kemungkinan akan mengalami *fail*.

(c) ***Passive earth pressure*** : Dinding terdorong menuju tanah yang tertahan yang cukup membuat pergerakan di dinding. Irisan tanah segitiga ini akan *fail* juga.

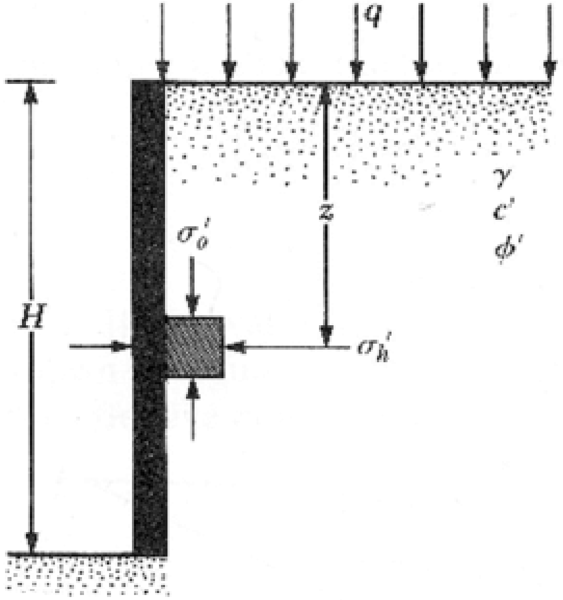
Lateral Earth Pressure at Rest

Lateral Earth Pressure at Rest

If the wall is at rest and is not allowed to move at all, either away from the soil mass or into the soil mass, the lateral pressure at a depth z is:

$$\sigma_h = K_o \sigma'_o + u$$

where u = pore water pressure
K_o = coefficient of at-rest earth pressure



For normally consolidated soil, the relation for K_o (Jaky, 1944):

$$K_o \approx 1 - \sin\phi'$$

where ϕ' = drained peak friction angle

For normally consolidated clay, the coefficient of earth pressure at rest can be approximated (Broker and Ireland, 1965) as:

$$K_o \approx 0.95 - \sin\phi'$$

$$K_o = 0.4 + 0.007\,(PI) \quad \text{(for PI between 0 and 40)}$$

$$K_o = 0.64 + 0.001\,(PI) \quad \text{(for PI between 40 and 80)}$$

Lateral Earth Pressure at Rest

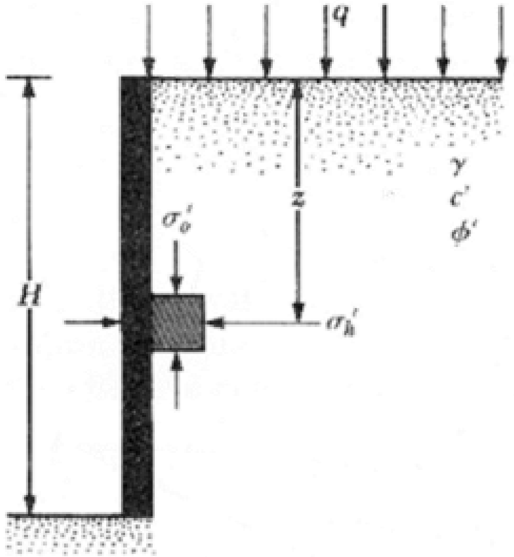
For overconsolidated clays: $K_{o(\text{overconsolidated})} \approx K_{o(\text{normally consolidated})}\sqrt{\text{OCR}}$

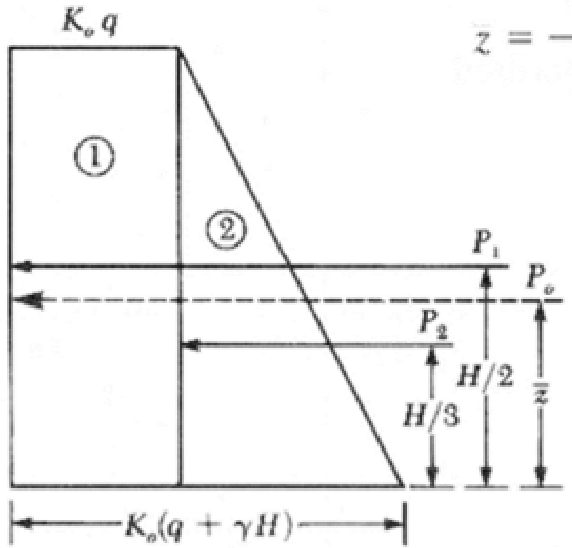
where OCR = overconsolidation ratio

The total force, Po, per unit length of the wall can be obtained from the area of the pressure diagram: $P_o = P_1 + P_2 = qK_oH + \frac{1}{2}\gamma H^2 K_o$

The location of the line of action of resultant force, Po, can be obtained by taking moment about the bottom of the wall:

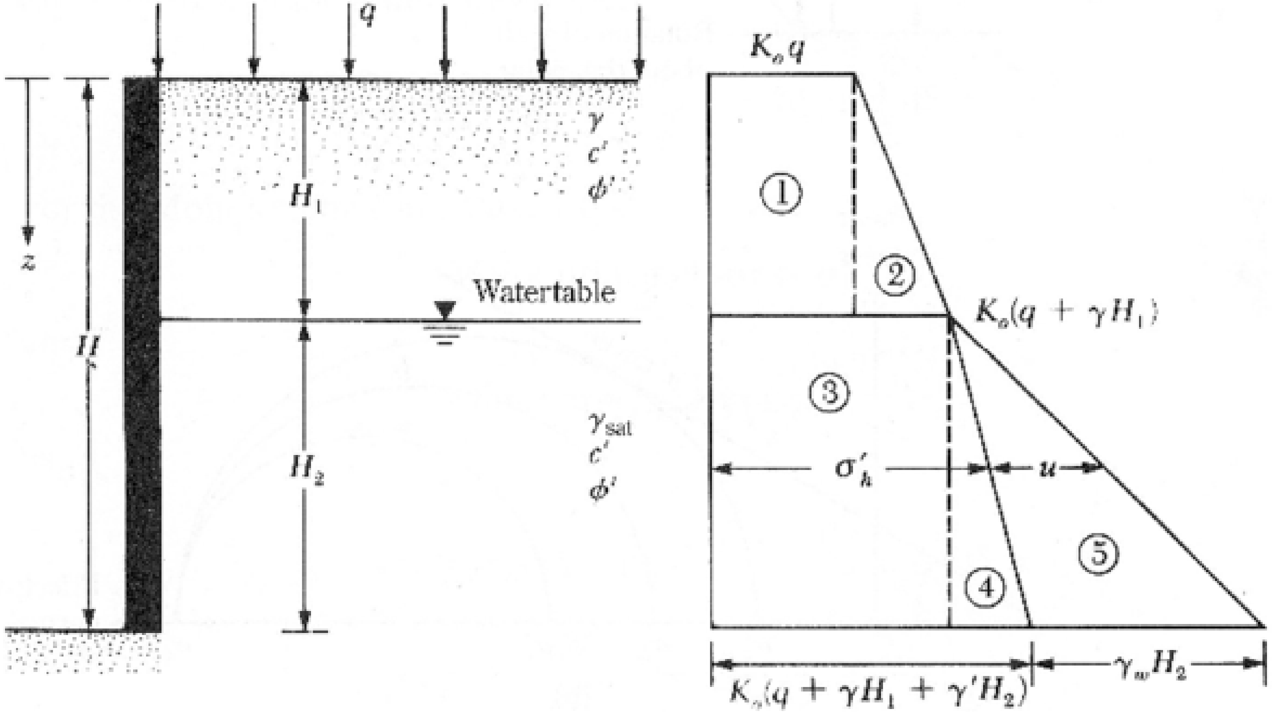
$$\bar{z} = \frac{P_1\left(\frac{H}{2}\right) + P_2\left(\frac{H}{3}\right)}{P_o}$$





Lateral Earth Pressure at Rest

If the water table is located at a depth z < H, the at rest pressure diagram:



Specifically,

$$P_o = A_1 + A_2 + A_3 + A_4 + A_5$$

$$P_o = K_o q H_1 + \tfrac{1}{2} K_o \gamma H_1^2 + K_o (q + \gamma H_1) H_2 + \tfrac{1}{2} K_o \gamma' H_2^2 + \tfrac{1}{2} \gamma_w H_2^2$$

Lateral Active Earth Pressure

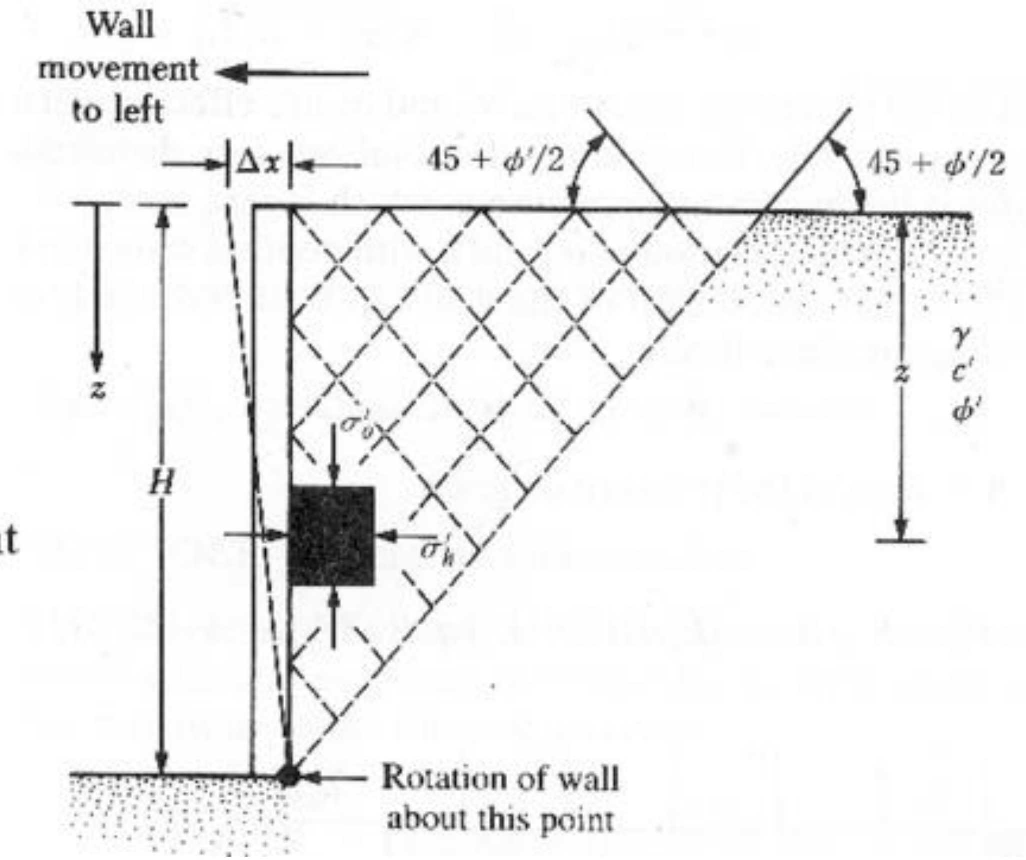
The rankine active pressure σ_a':

$$\sigma'_a = \sigma'_o \tan^2\left(45 - \frac{\phi'}{2}\right) - 2c' \tan\left(45 - \frac{\phi'}{2}\right)$$

$$= \sigma'_o K_a - 2c'\sqrt{K_a}$$

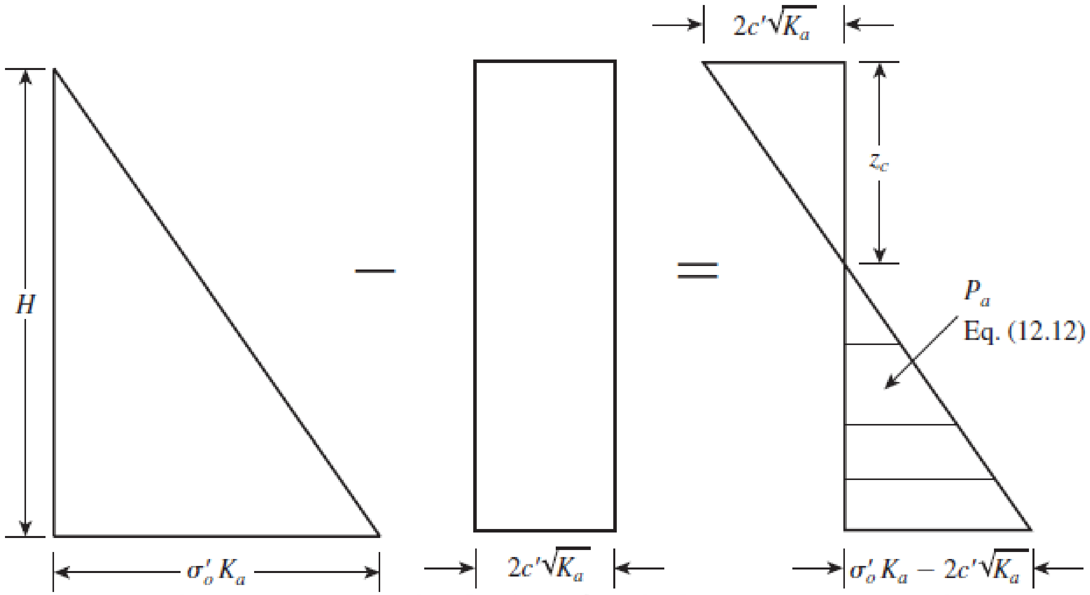
where $K_a = \tan^2(45 - \phi'/2)$

= Rankine active pressure coefficient



Lateral Active Earth Pressure

The variation of the active pressure with depth for the wall shown in figure:



The pressure indicating a tensile stress that decrease with depth and becomes zero at a depth z = z_c or: $\gamma z_c K_a - 2c'\sqrt{K_a} = 0$ ⇨ $z_c = \dfrac{2c'}{\gamma\sqrt{K_a}}$

The depth zc is usually referred to as the depth of tensile crack, because the tensile stress in the soil will eventually cause a crack along the soil-wall interface.

Lateral Active Earth Pressure

Rankine Active Earth Pressure

The total Rankine active force per unit length of the wall before the tensile crack occurs:

$$P_a = \tfrac{1}{2}\gamma H^2 K_a - 2c' H\sqrt{K_a}$$

After the tensile crack appears, the force per unit length on the wall will caused only by the pressure distribution between depth z = z_c and z = H. This force may be expressed as:

$$P_a = \tfrac{1}{2}(H - z_c)(\gamma H K_a - 2c'\sqrt{K_a})$$

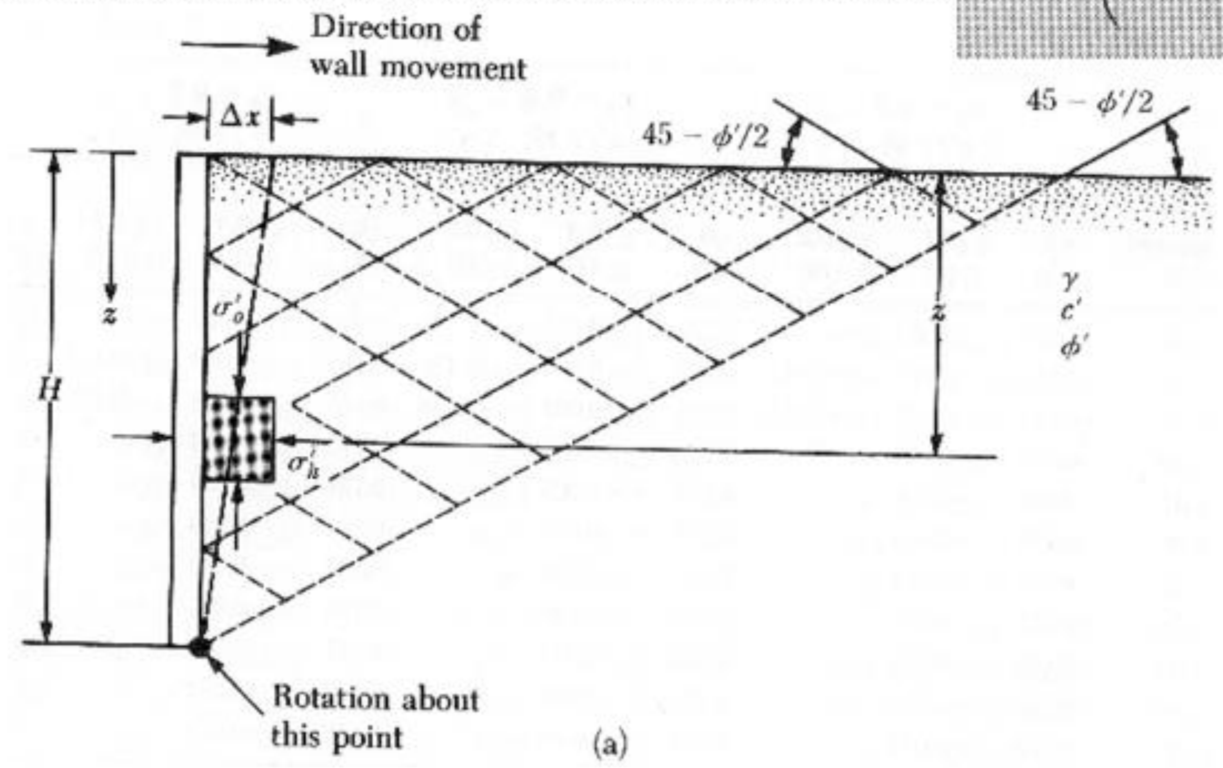
$$P_a = \frac{1}{2}\left(H - \frac{2c'}{\gamma\sqrt{K_a}}\right)\left(\gamma H K_a - 2c'\sqrt{K_a}\right)$$

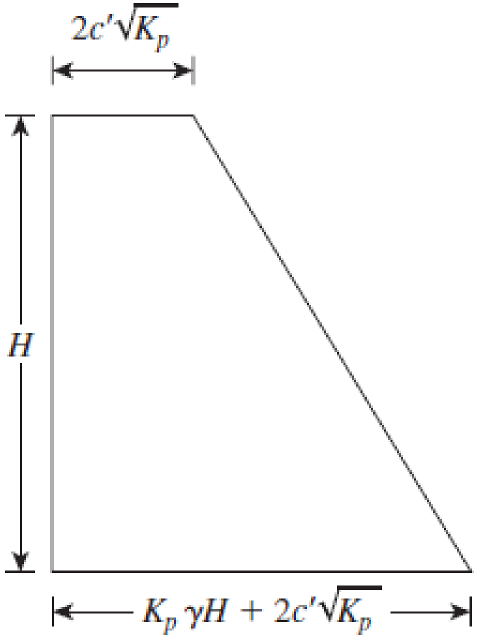
Lateral Passive Earth Pressure

The rankine passive pressure σ_p': $\sigma'_p = \sigma'_o K_p + 2c'\sqrt{K_p}$

$$\sigma'_p = \gamma H K_p + 2c'\sqrt{K_p}$$

K_p = Rankine passive earth pressure coefficient $= \tan^2\left(45 + \frac{\phi'}{2}\right)$

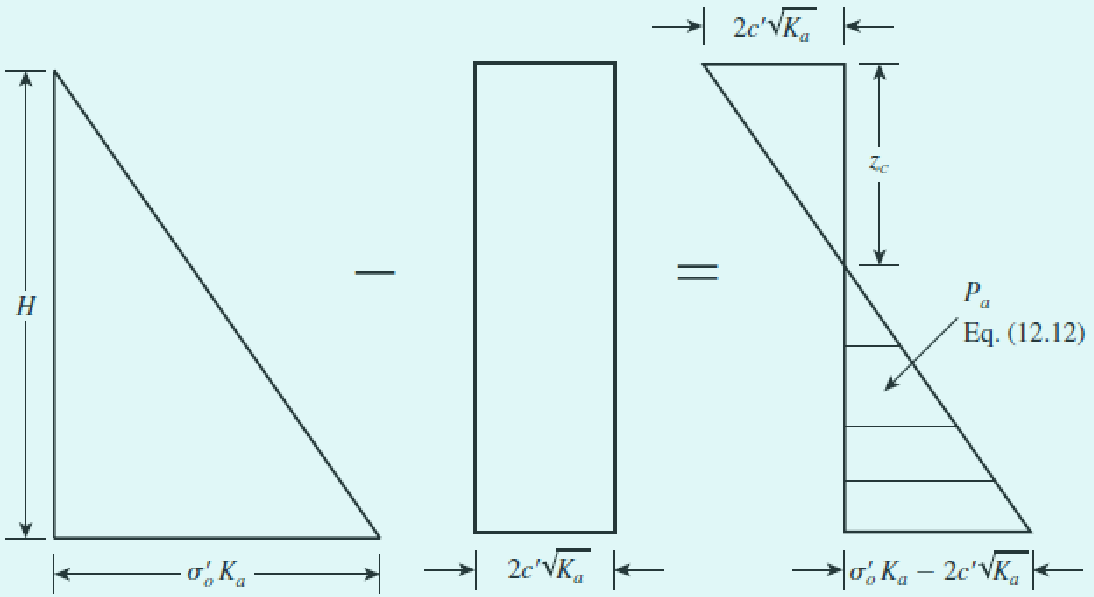




Comparation

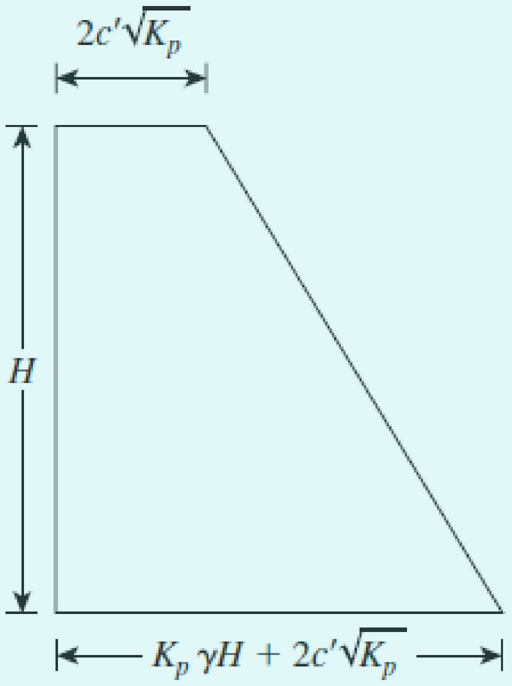
Active Earth Pressure

$$K_a = tan^2\left(45 - \frac{\emptyset'}{2}\right)$$



Passive Earth Pressure

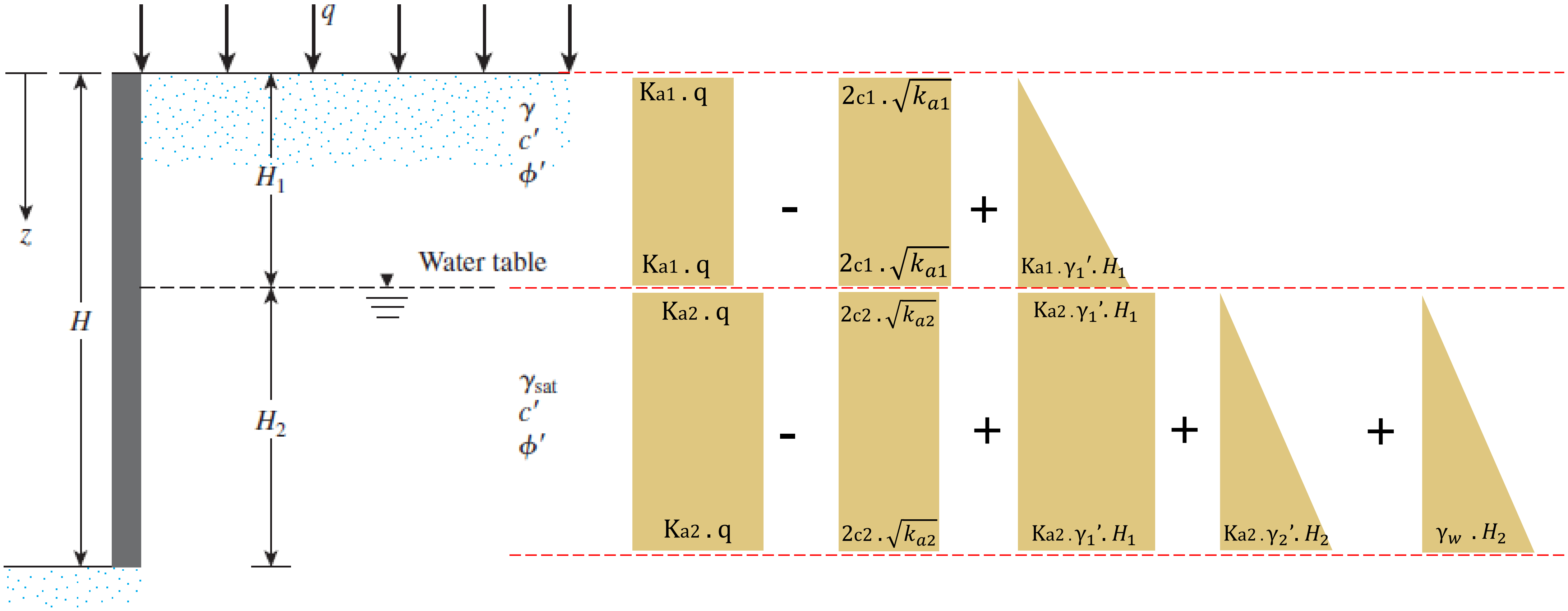
$$K_p = tan^2\left(45 + \frac{\emptyset'}{2}\right)$$



Lateral Active Earth Pressure

Active Earth Pressure

$$K_a = tan^2\left(45 - \frac{\emptyset'}{2}\right)$$



In condition :

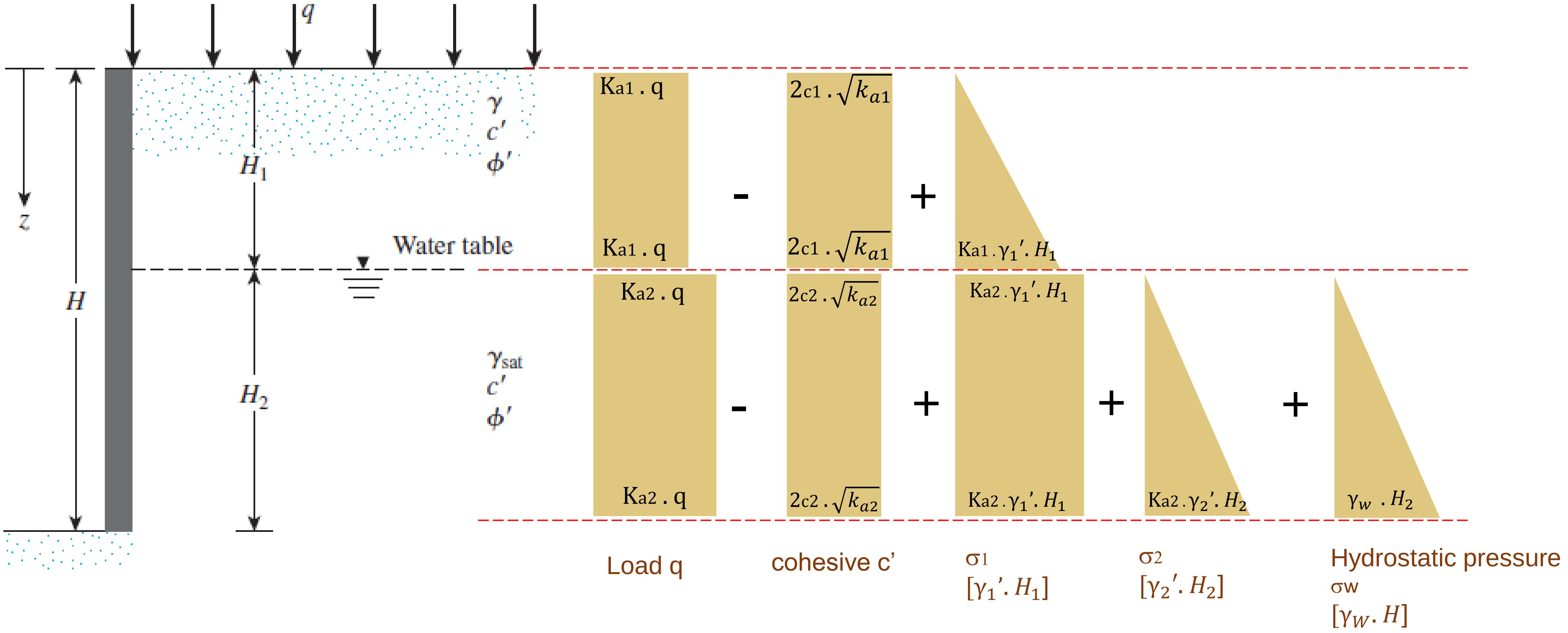
ϕ_1 is greater than ϕ_2

c_1 is greater than c_2

Lateral Active Earth Pressure

Active Earth Pressure

$$K_a = tan^2\left(45 - \frac{\varnothing'}{2}\right)$$



Lateral Active Earth Pressure

Active Earth Pressure

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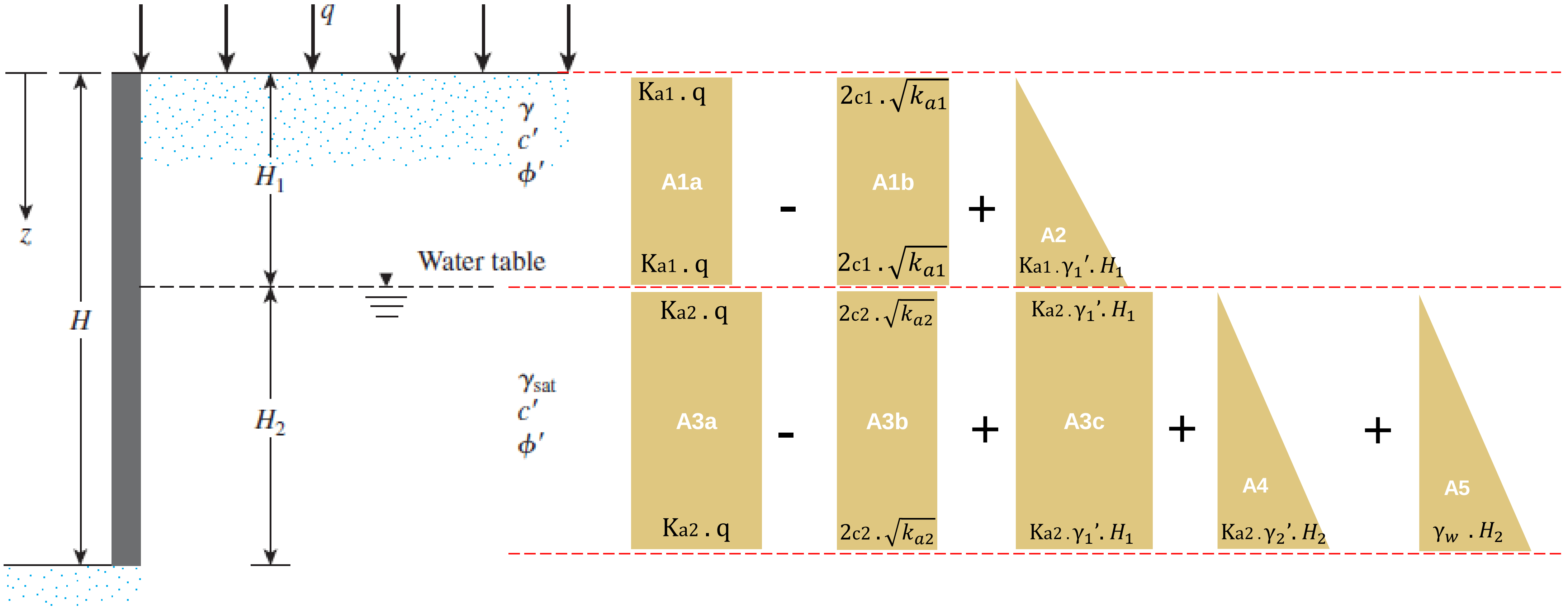
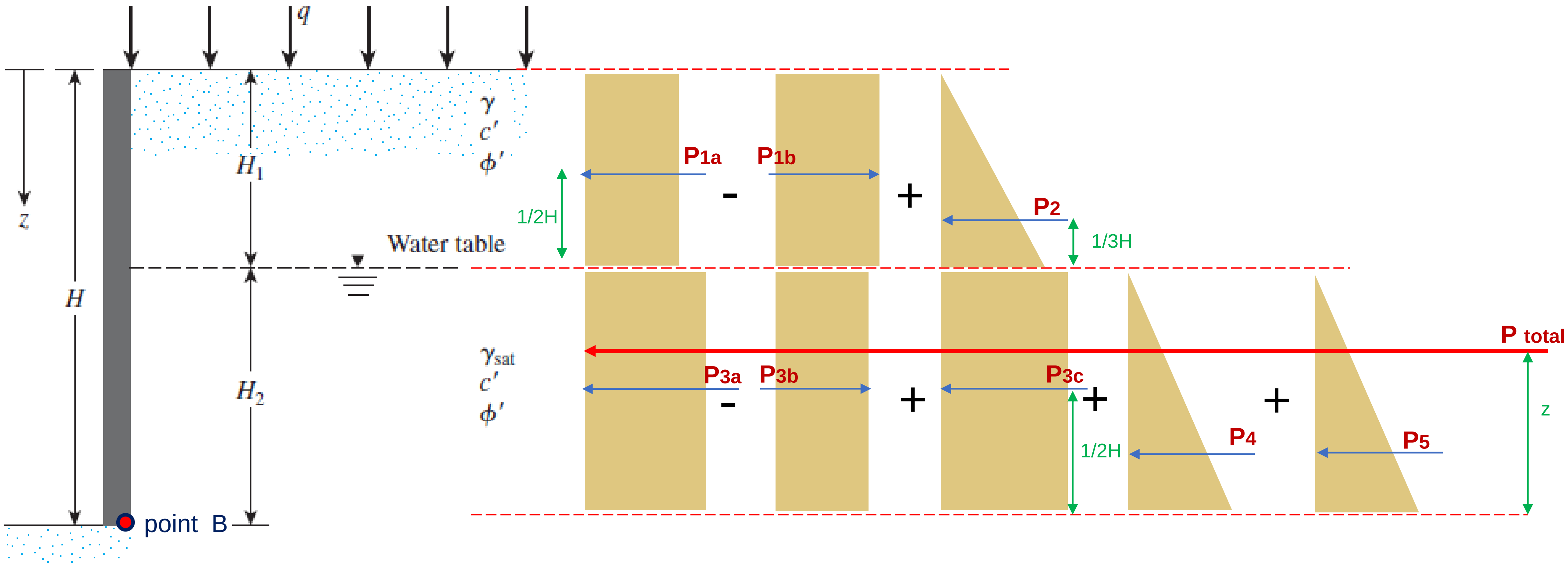


For summation of the horizontal force :

P total = A1ab + A2 + A3abc + A4 + A5

P total = $H_1 . \left(k_{a1} . q \; - \; 2c_1\sqrt{k_{a1}}\right)$ + ½ $H_1 . (K_{a1} . \gamma_1' . H_1)$ + $H_2 . \left(k_{a2} . q \; - \; 2c_2\sqrt{k_{a2}} + K_{a2} . \gamma_1' . H_1\right)$ + ½ $H_2 . (K_{a2} . \gamma_2' . H_2)$ + ½ $H_2 . (\gamma_w . H_2)$

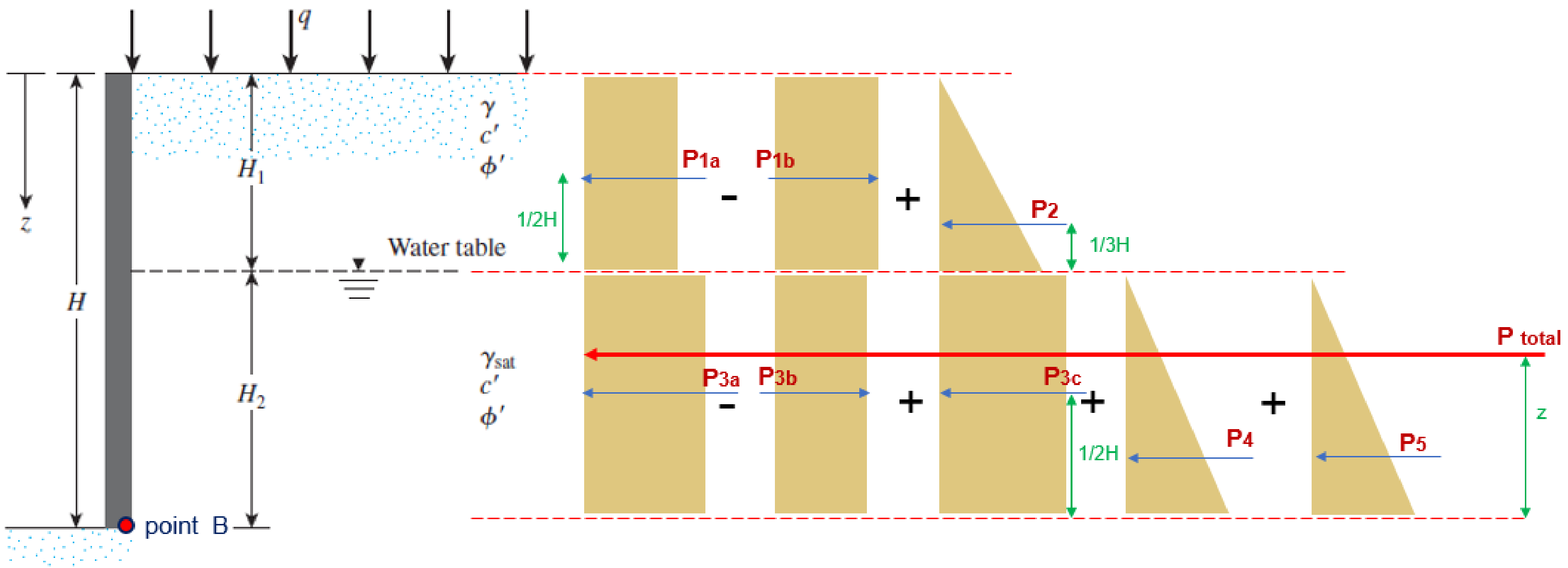
Lateral Active Earth Pressure



For summation of the horizontal force : P total = A1ab + A2 + A3abc + A4 + A5

Summing the moment of all the force about point B (P total) x Z = P1ab + P2 + P3abc + P4 + P5

Lateral Active Earth Pressure



For summation of the horizontal force :

$$P_{total} = A_{1ab} + A_2 + A_{3abc} + A_4 + A_5$$

$$P_{total} = H_1 \,.\, \left(k_{a1} \,.\, q - 2c_1\sqrt{k_{a1}}\right) + \tfrac{1}{2} H_1 \,.\, \left(K_{a1} \,.\, \gamma_1' \,.\, H_1\right) + H_2 \,.\, \left(k_{a2} \,.\, q - 2c_2\sqrt{k_{a2}} + K_{a2} \,.\, \gamma_1' \,.\, H_1\right) + \tfrac{1}{2} H_2 \,.\, \left(K_{a2} \,.\, \gamma_2' \,.\, H_2\right) + \tfrac{1}{2} H_2 \,.\, \left(\gamma_w \,.\, H_2\right)$$

The distance of the line of action of the resultant force from the bottom of the wall can be determined by taking the moments about the bottom of the wall (point B) and is

$$(P_{total}) \,.\, z = [(\tfrac{1}{2} H_1 + H_2) \,.\, (A_{1ab})] + [(\tfrac{1}{3} H_1 + H_2) \,.\, (A_2) + (\tfrac{1}{2} H_2) \,.\, (A_{3abc})] + [(\tfrac{1}{3} H_2)(A_4) + (\tfrac{1}{3} H_2) \,.\, (A_5)]$$

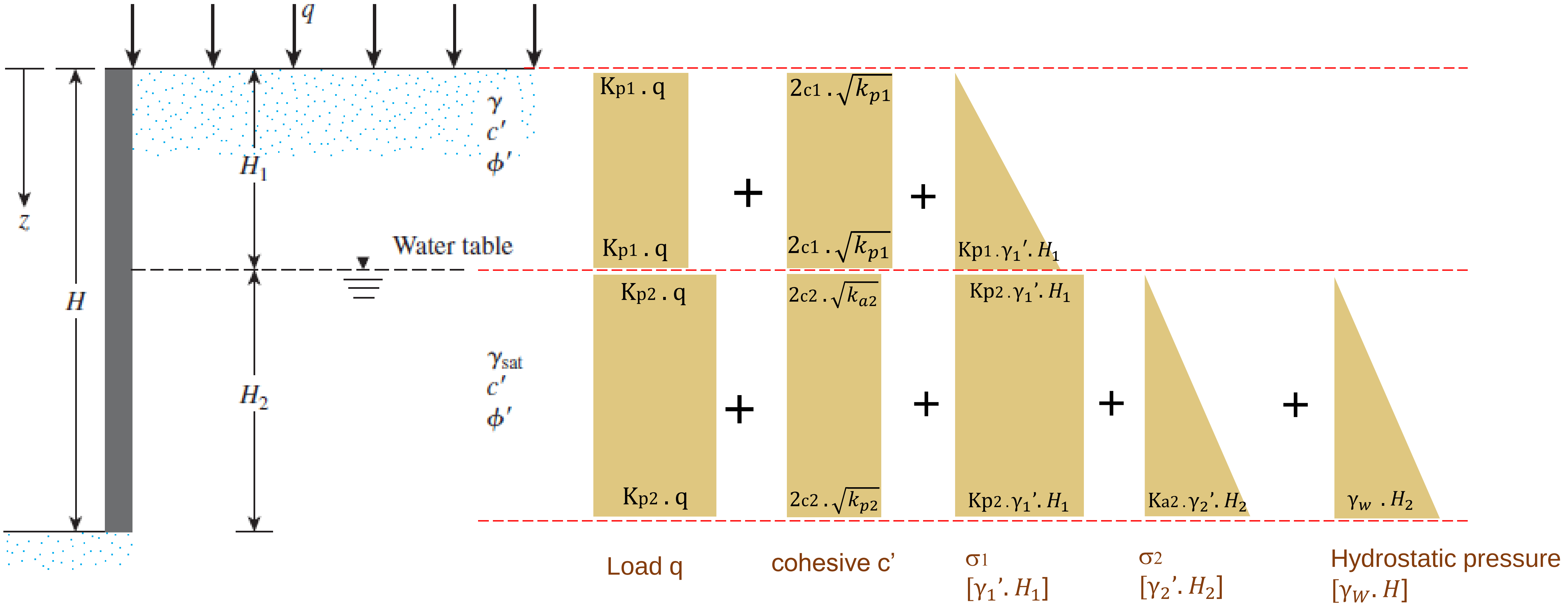
So the distance of resultant force from B is

$$Z = \frac{[(\tfrac{1}{2} H_1 + H_2) \,.\, (A_{1ab})] + [(\tfrac{1}{3} H_1 + H_2) \,.\, (A_2) + (\tfrac{1}{2} H_2) \,.\, (A_{3abc})] + [(\tfrac{1}{3} H_2)(A_4) + (\tfrac{1}{3} H_2) \,.\, (A_5)]}{P\ total}$$

Lateral Passive Earth Pressure

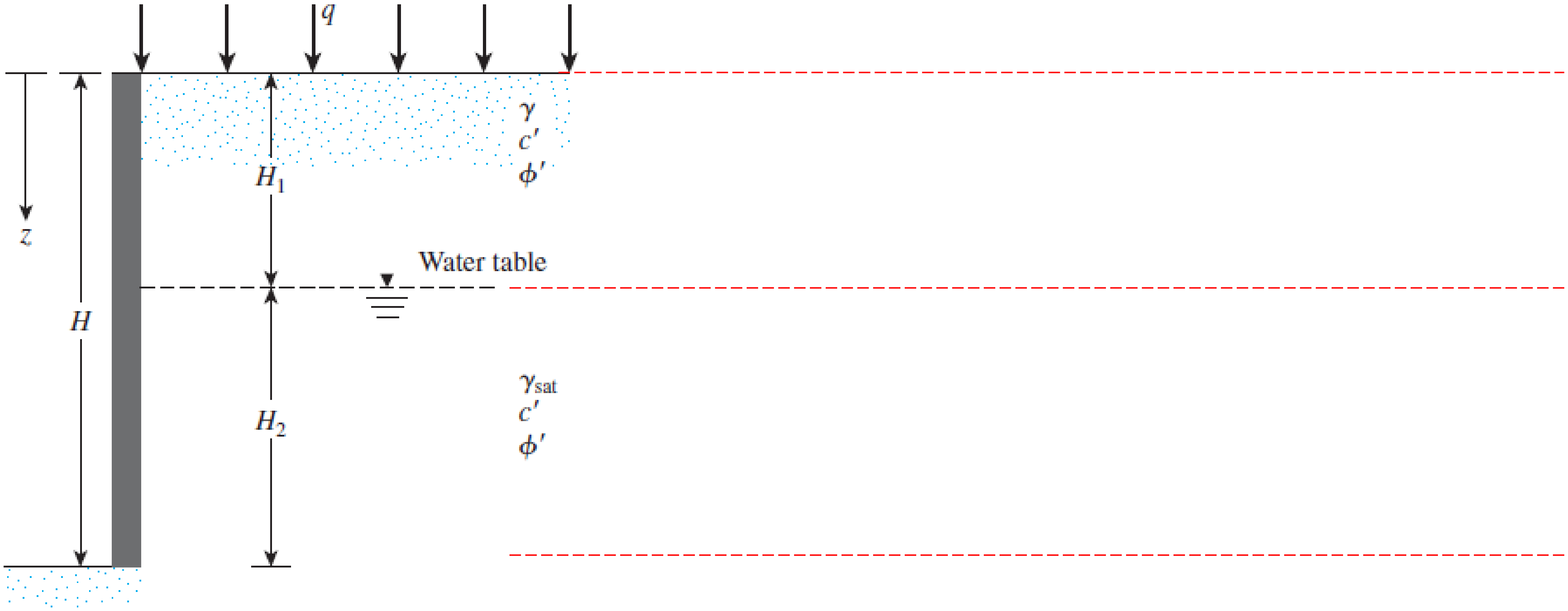
Passive Earth Pressure

$$K_p = tan^2\left(45 + \frac{\varnothing'}{2}\right)$$



Problem No 2

In figure 2, let H_1 = 3, 4, 5 m, H_2 = 3, 4, 5 m. γ_1 = 16, 17, 18 kN/m^3, q = 0, ϕ'_1 = 33°, 34°, 35°.c'_1 = 0, γ_2 = 16.5, 17.5, 18.5 kN/m^3, ϕ'_2 = 24°, 25°, 26°.c'_2 = 10, 12.5, 15 kN/m^2. Determine the **Rankine active force** per unit length of the wall.



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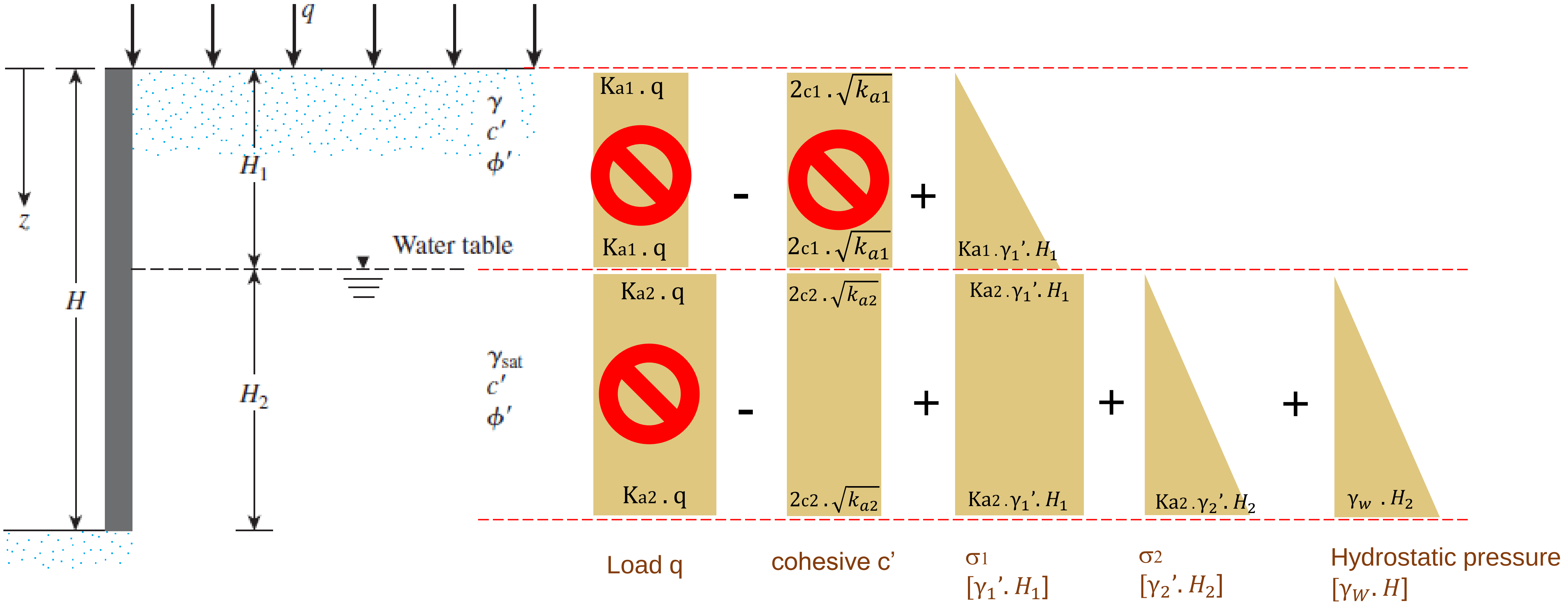

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