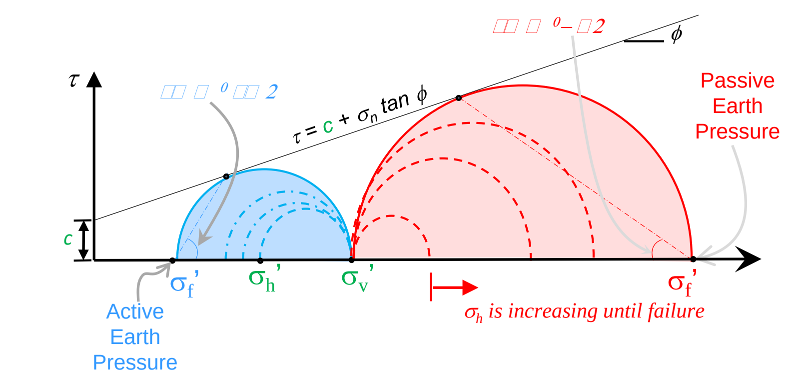
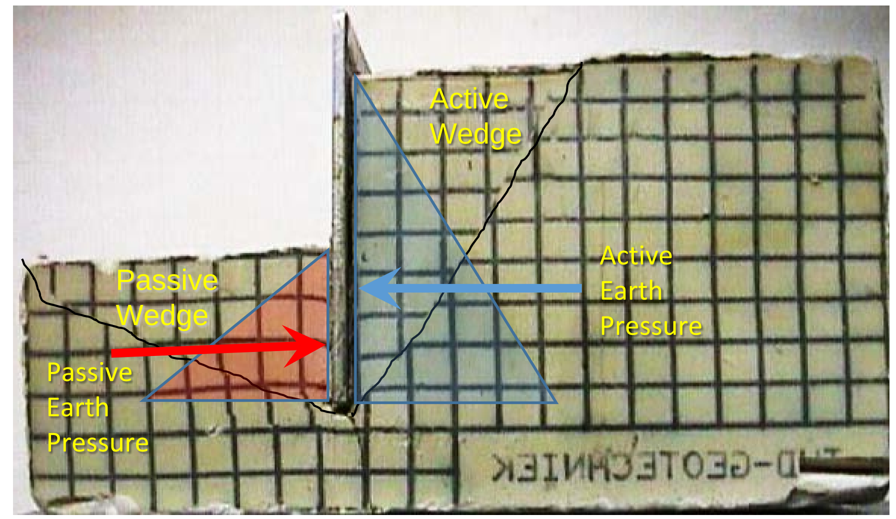
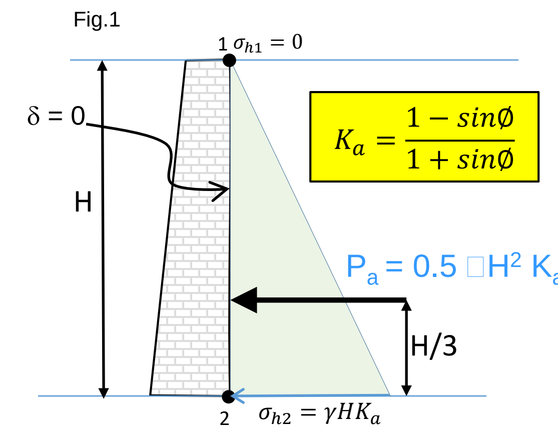
Rankine's Earth Pressure Method for (c- ϕ) Soil

Rankine's Active and Passive Earth Pressure in (c- f) Soil



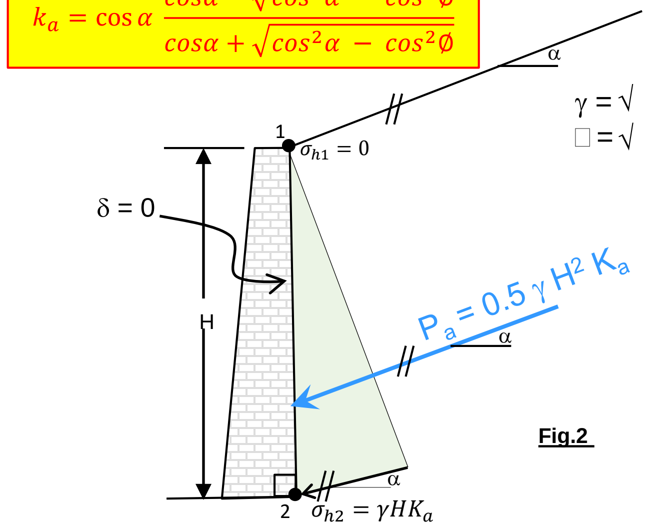


Rankine's Active Earth Pressure in (ϕ) Soil



Rankine's Active Earth Pressure in (ϕ) Soil with inclined backfill

$$k_a = \cos\alpha \frac{\cos\alpha - \sqrt{\cos^2\alpha - \cos^2\emptyset}}{\cos\alpha + \sqrt{\cos^2\alpha - \cos^2\emptyset}}$$



Active Earth Pressure

$$\sigma_f' = \sigma_V' \tan^2\left(45^o - \frac{\emptyset}{2}\right) + 2\,c\,\tan\left(45^o - \frac{\emptyset}{2}\right)$$

Or

$$\sigma_f' = \sigma_V' K_a - 2\,c\,\sqrt{K_a}$$

$$K_a = \tan^2\left(45^o - \frac{\emptyset}{2}\right) = \frac{1 - \sin\emptyset}{1 + \sin\emptyset}$$

Coefficient of active earth pressure

Passive Earth Pressure

$$\sigma_f' = \sigma_V' \tan^2\left(45^o + \frac{\emptyset}{2}\right) + 2\,c\,\tan\left(45^o + \frac{\emptyset}{2}\right)$$

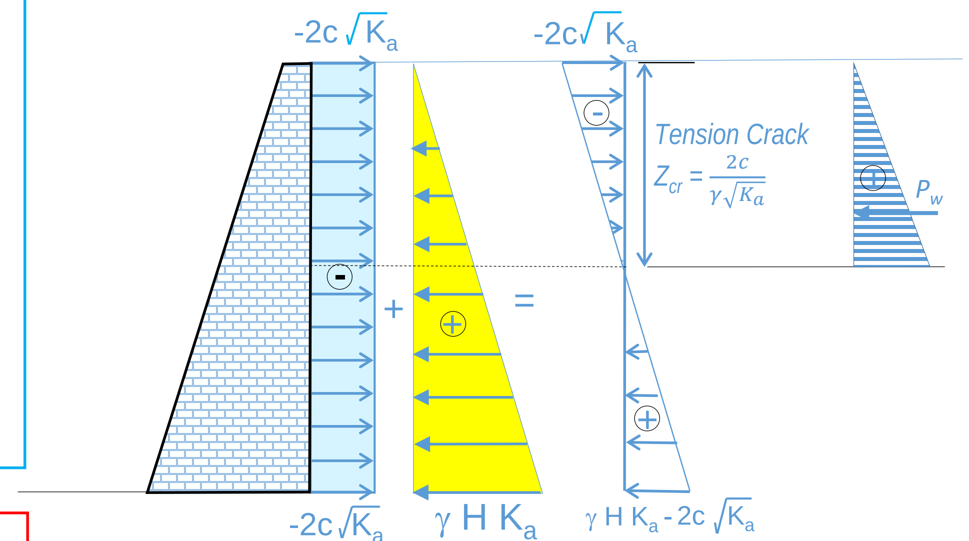
Or

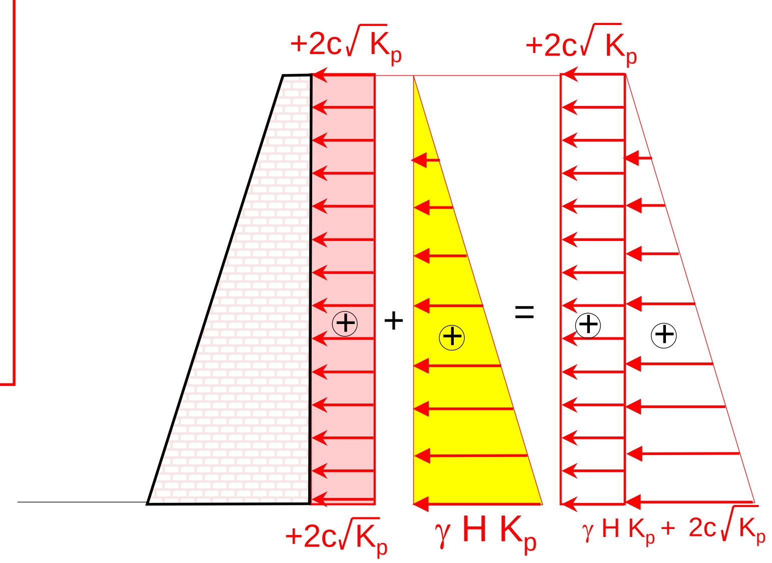
$$\sigma_f' = \sigma_V' K_p + 2\,c\,\sqrt{K_p}$$

$$K_p = \tan^2\left(45^o + \frac{\emptyset}{2}\right) = \frac{1 + \sin\emptyset}{1 - \sin\emptyset}$$

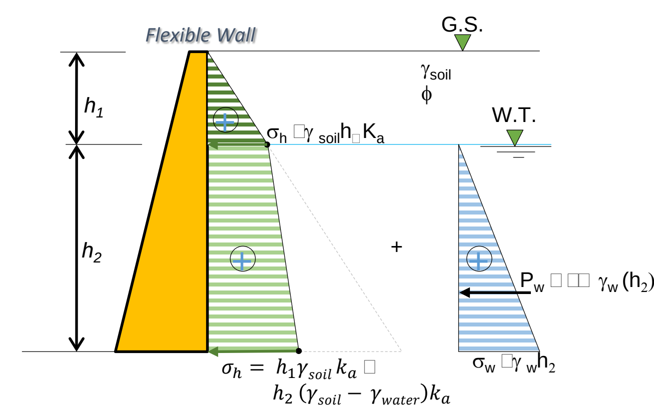
Coefficient of passive earth pressure

Effect of Cohesion of the Rankine's Active and Passive Earth Pressure

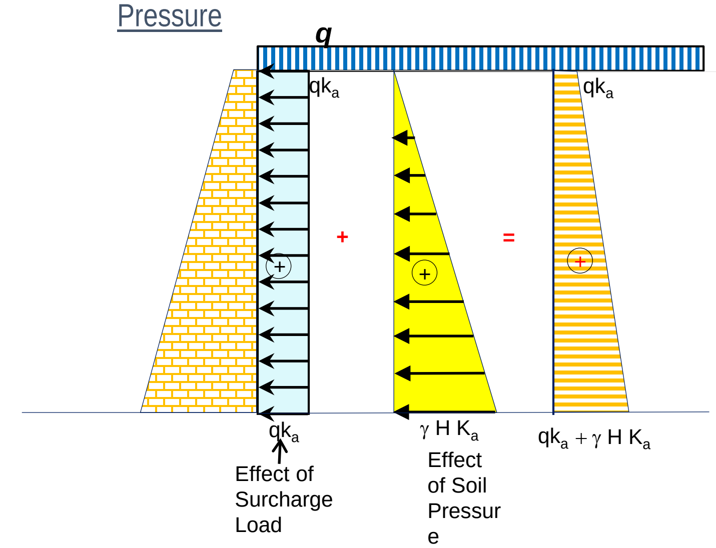




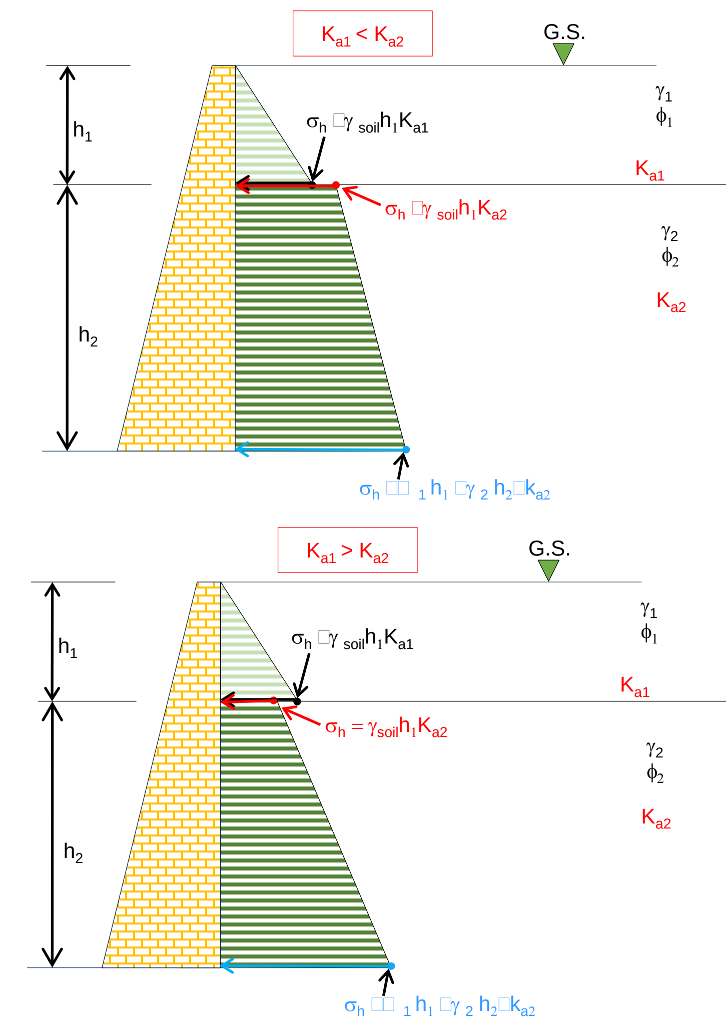
Rankine's Active Earth Pressure in f - Soil & Water Table



Effect of Surcharge (q) Load on Active Earth Pressure

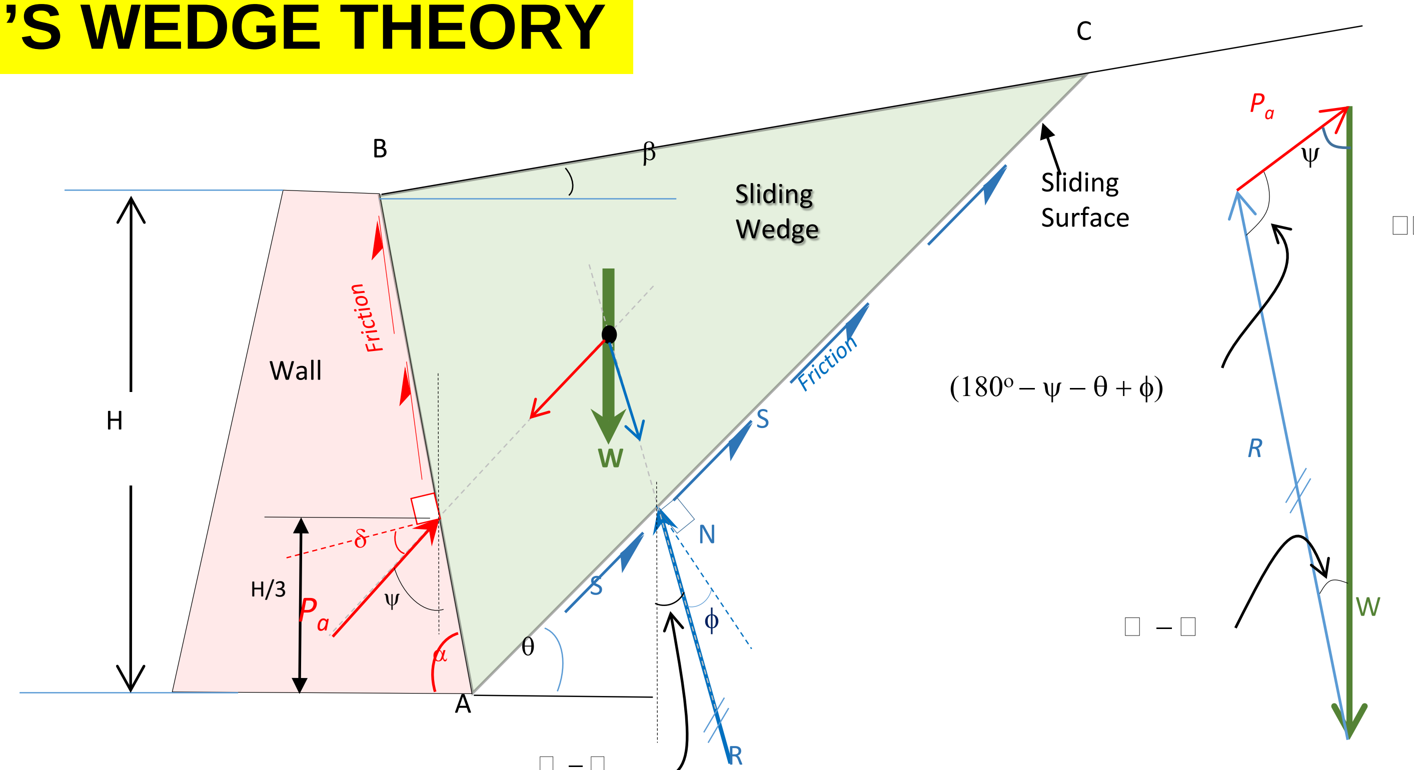


Effect of Two Soil Layers on Active Earth Pressure



Kamal Tawfiq

COULOMB'S WEDGE THEORY

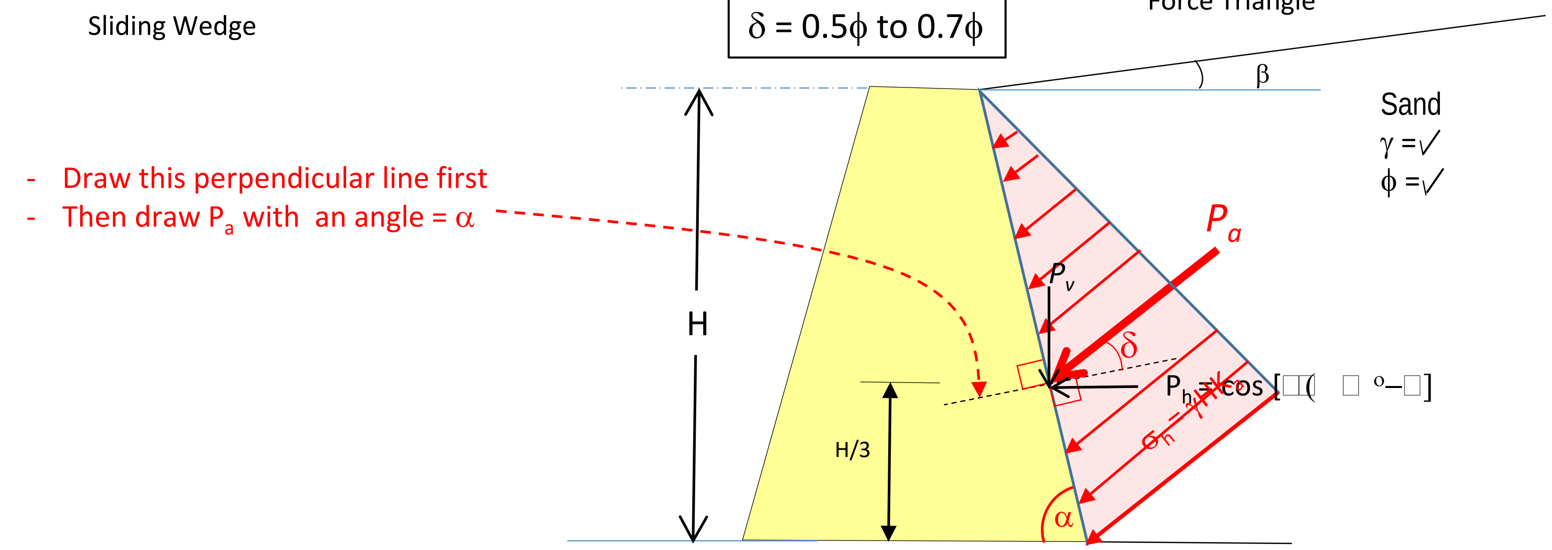


Sliding Wedge

Force Triangle

W = weight of the soil wedge
R = resultant of the shear and normal forces on the failure surface BC
P$_a$ = the active force per unit length of the wall. The direction of Pa is inclined at an angle □to the normal drawn and the face of the wall that supports the soil
δ = the angle of friction between the soil and the wall

δ = 0.5ϕ to 0.7ϕ



W = g (area of wedge *ABC*)

From the triangles of forces,

$$\frac{P_a}{\sin(\theta-\emptyset)} = \frac{W}{\sin(180^o-\psi-\theta+\phi)}$$

$$P_a = \frac{W\sin(\theta-\emptyset)}{\sin(180^o-\psi-\theta+\phi)}$$

Substituting for *W*,

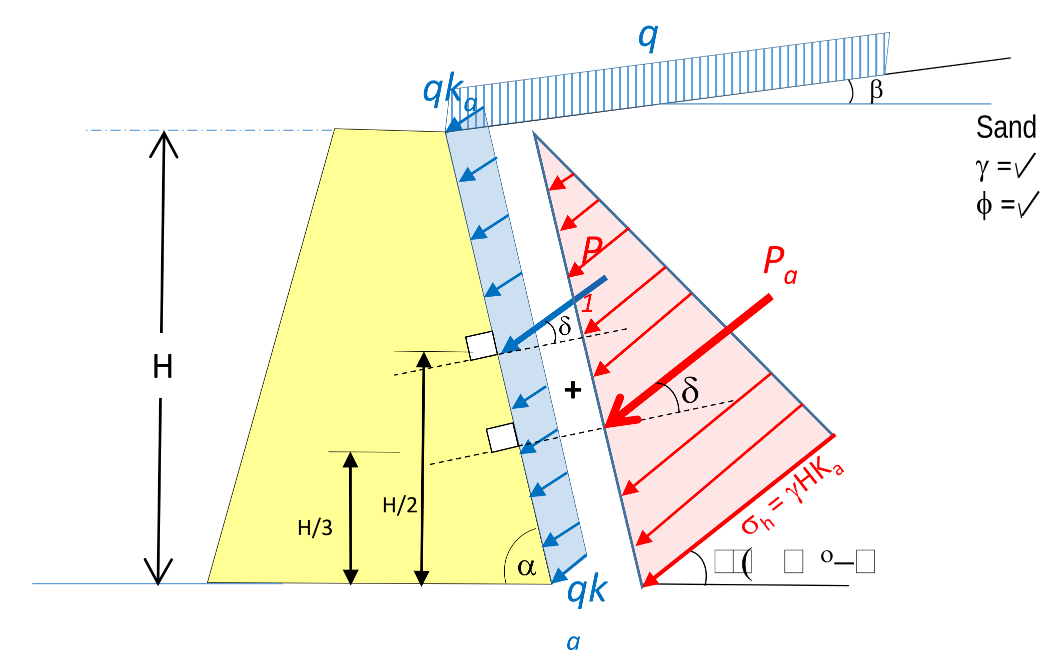
$$P_a = \frac{1}{2}.\frac{\gamma H^2}{\sin^2\alpha}.\frac{\sin(\theta-\emptyset)}{\sin(180^o-\psi-\theta+\phi)}.\frac{\sin(\theta+\alpha).\sin(\alpha+\beta)}{\sin(\theta-\beta)}$$

The maximum value of *Pa* is obtained by equating the first derivative of *Pa* with respect to θ to zero; or

$(\partial P_a)/\partial$□ = 0, and substituting the corresponding value of θ.

The value of P_a so obtained is written as

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



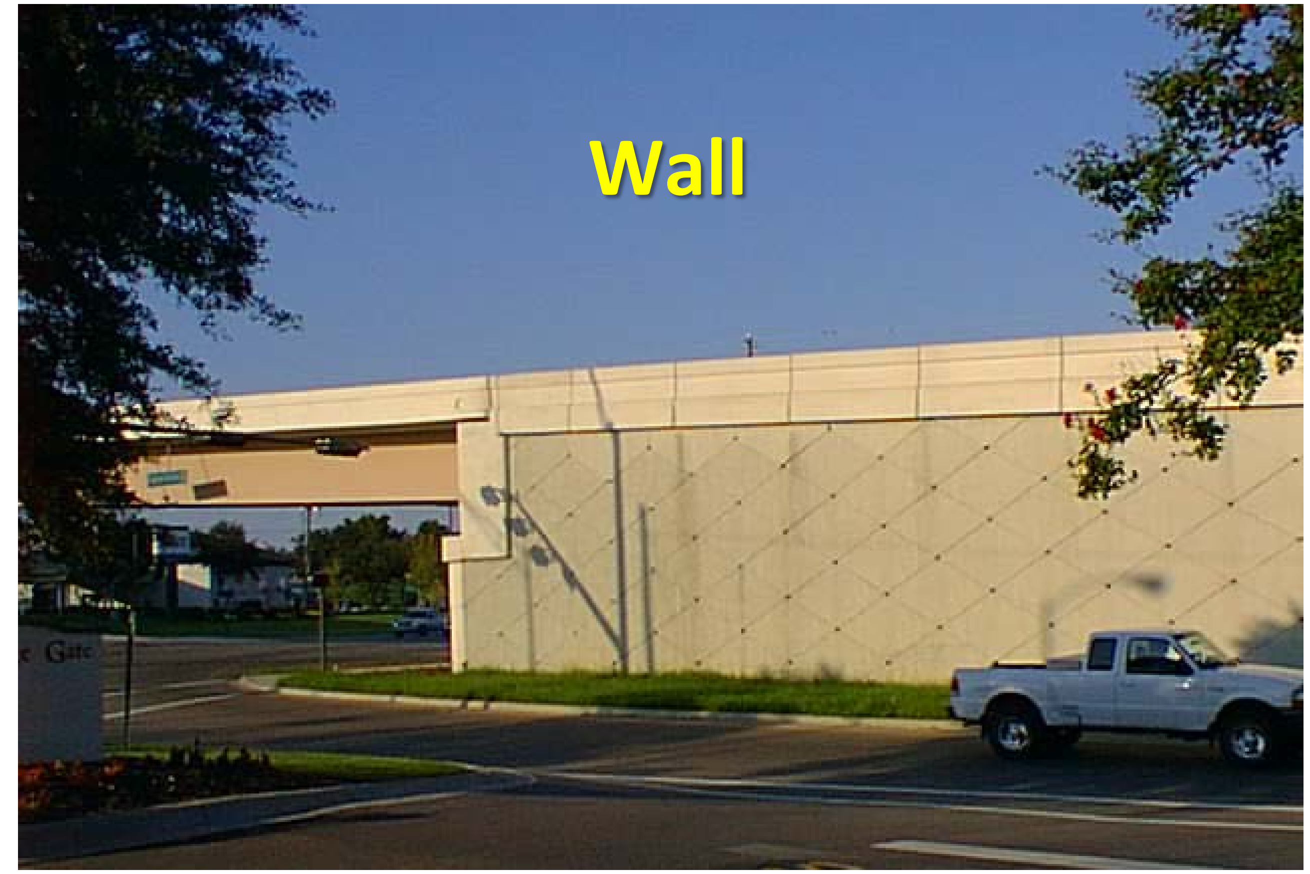
This is usually written as

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

Where K_a being the coefficient of active earth pressur $= \dfrac{sin^2(\alpha+\phi)}{sin^2\alpha\ sin(\alpha-\delta)\left[1+\sqrt{\frac{\sin(\emptyset+\delta)\sin(\emptyset-\beta)}{\sin(\alpha-\delta)\sin(\alpha+\beta)}}\right]^2}$

Kamal Tawfiq

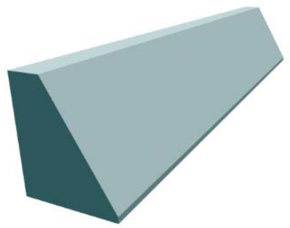
Earth Retaining Walls

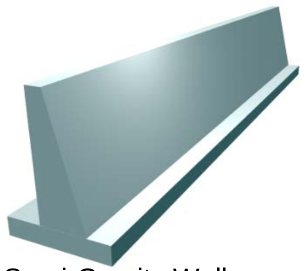


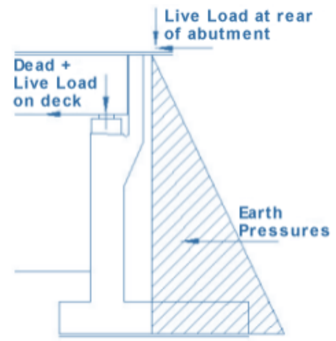
Design of Retaining Wall

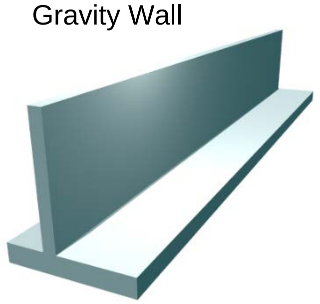
Types of Earth Retaining Walls

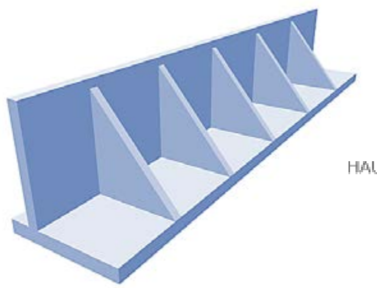
I- Permanent Walls

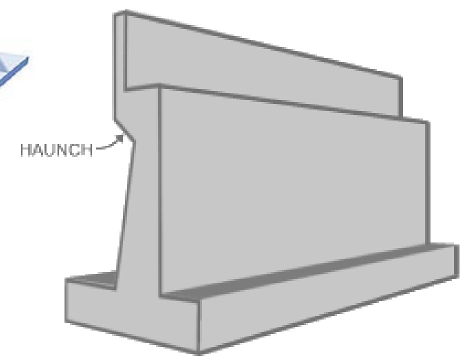

Gravity Wall

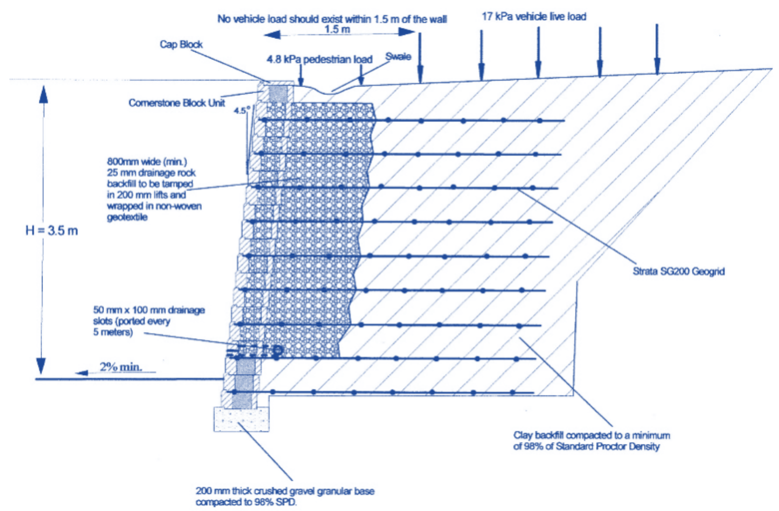

Semi-Gravity Wall




Cantilever Wall


Counterfort wall

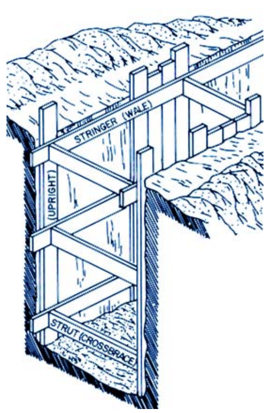




Segmental Walls


MSE Walls

II- Temporary Walls



Braced cuts


Sheet pile wall

Design of Retaining Wall

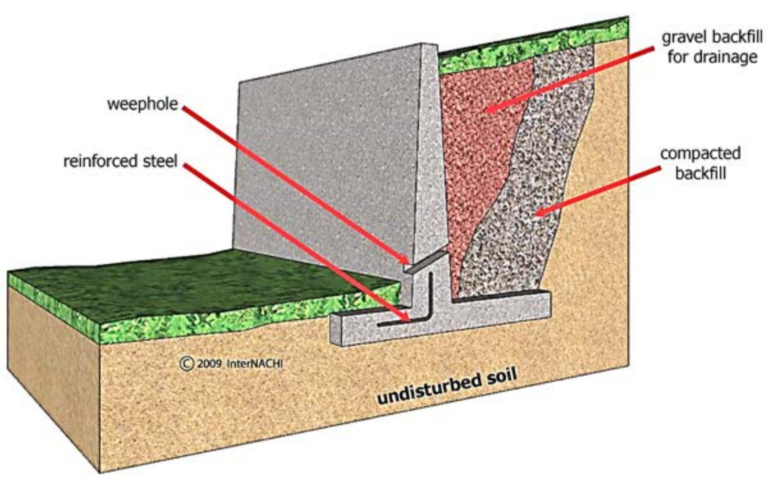
By Kamal Tawfiq, Ph.D., P.E

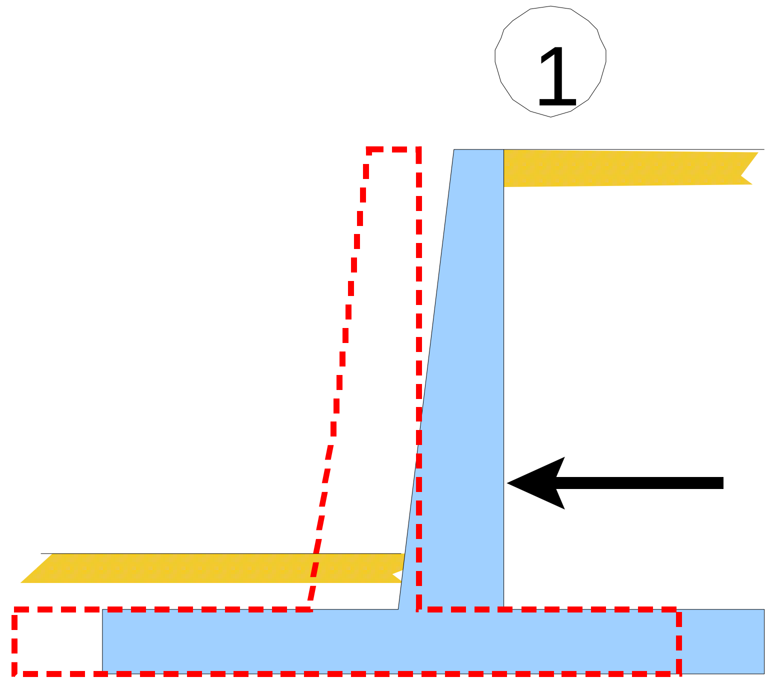
1- External Stability
2- Internal Stability

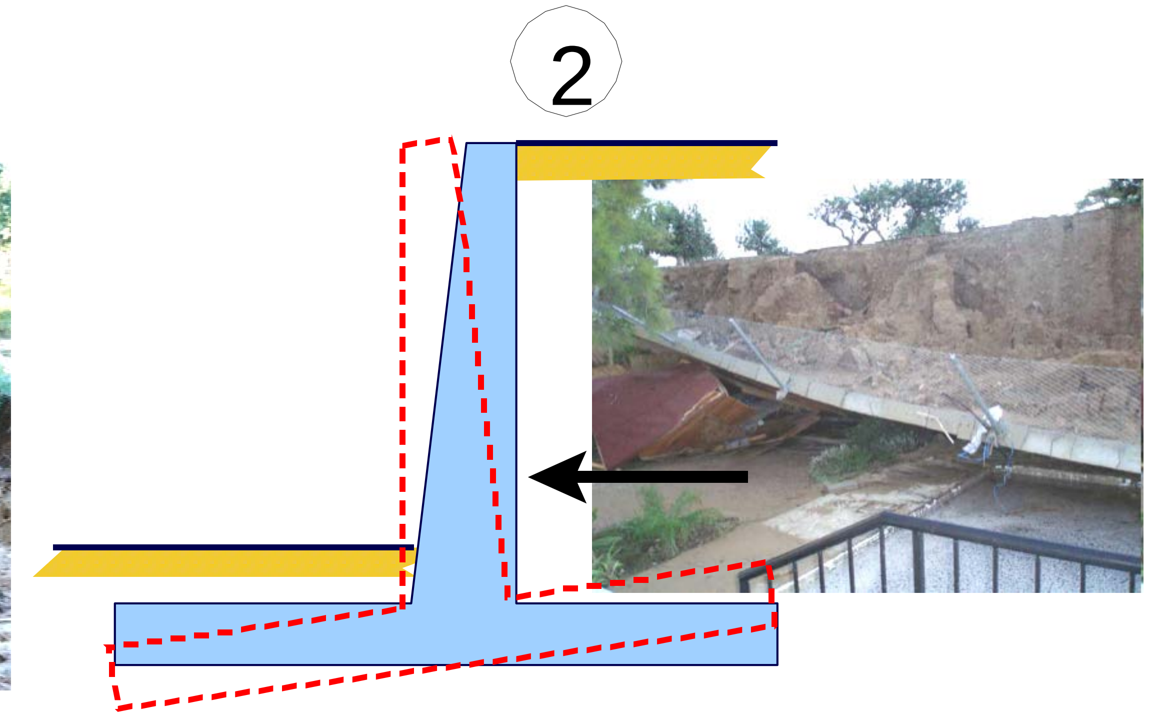
1. External Stability

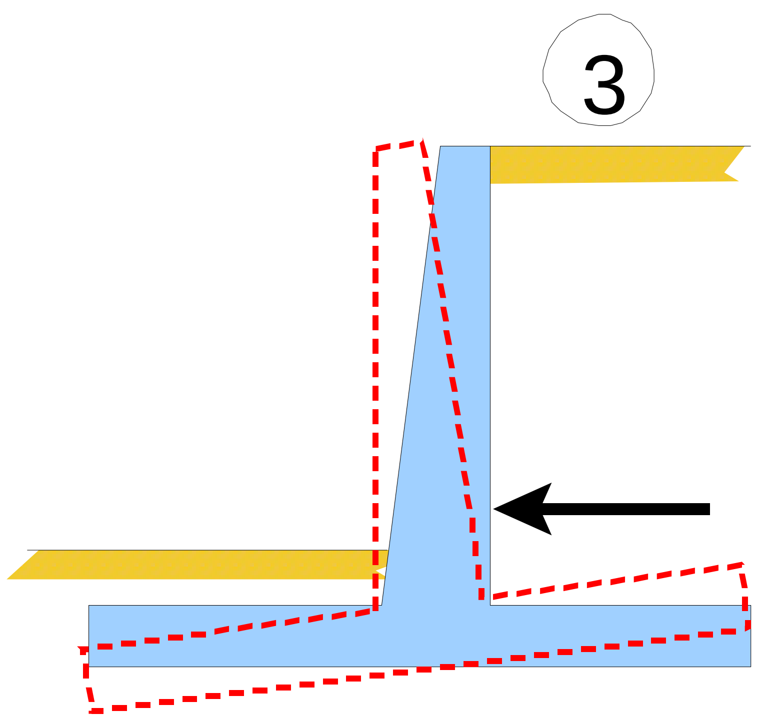
1- Sliding
2- Overturning
3- Settlement
4- Overall Failure

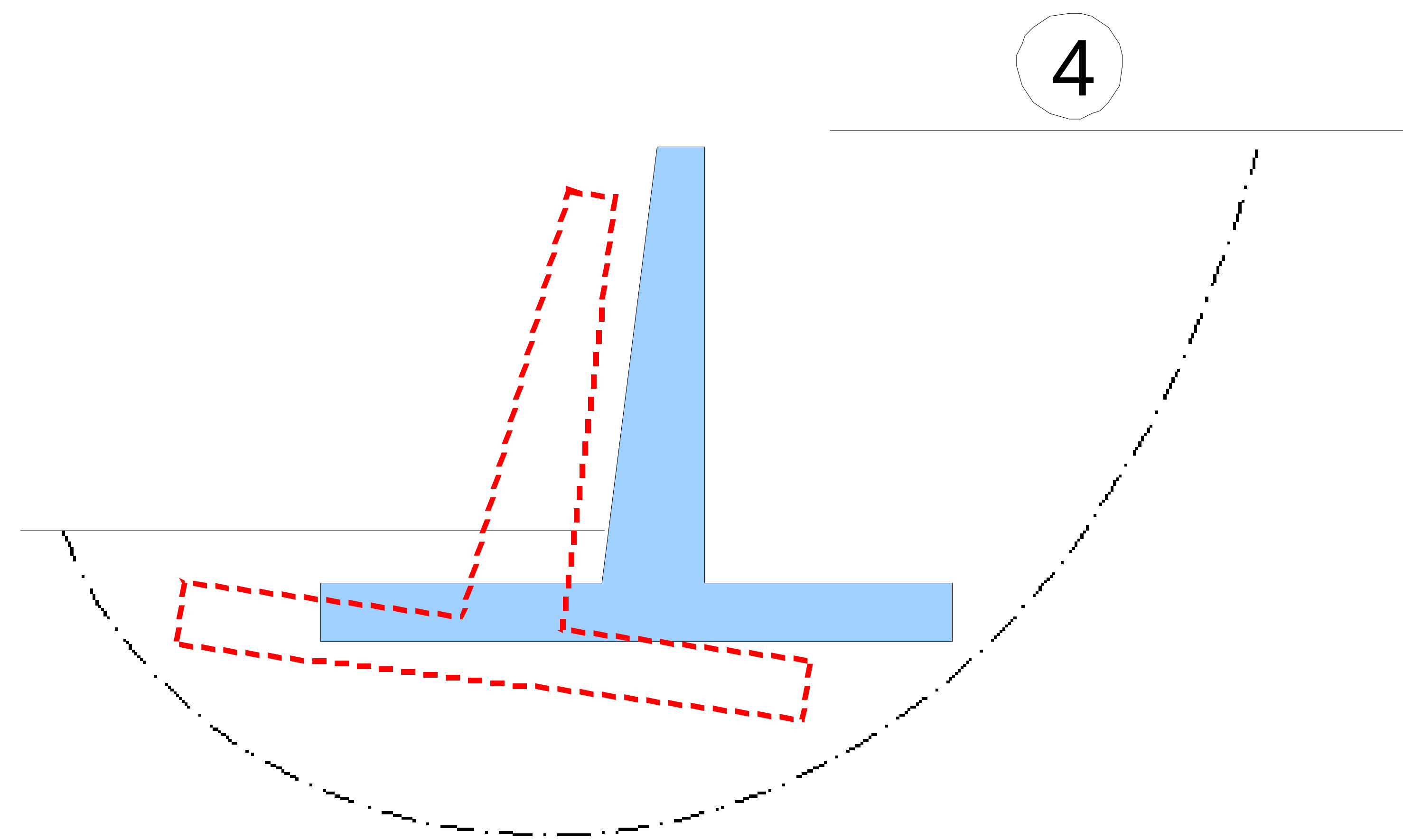
Cantilevered Concrete Retaining Wall

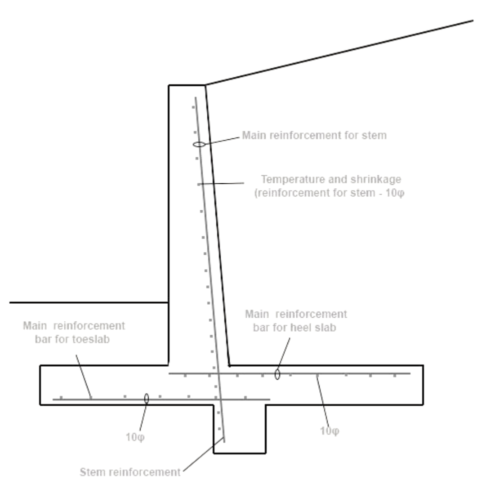






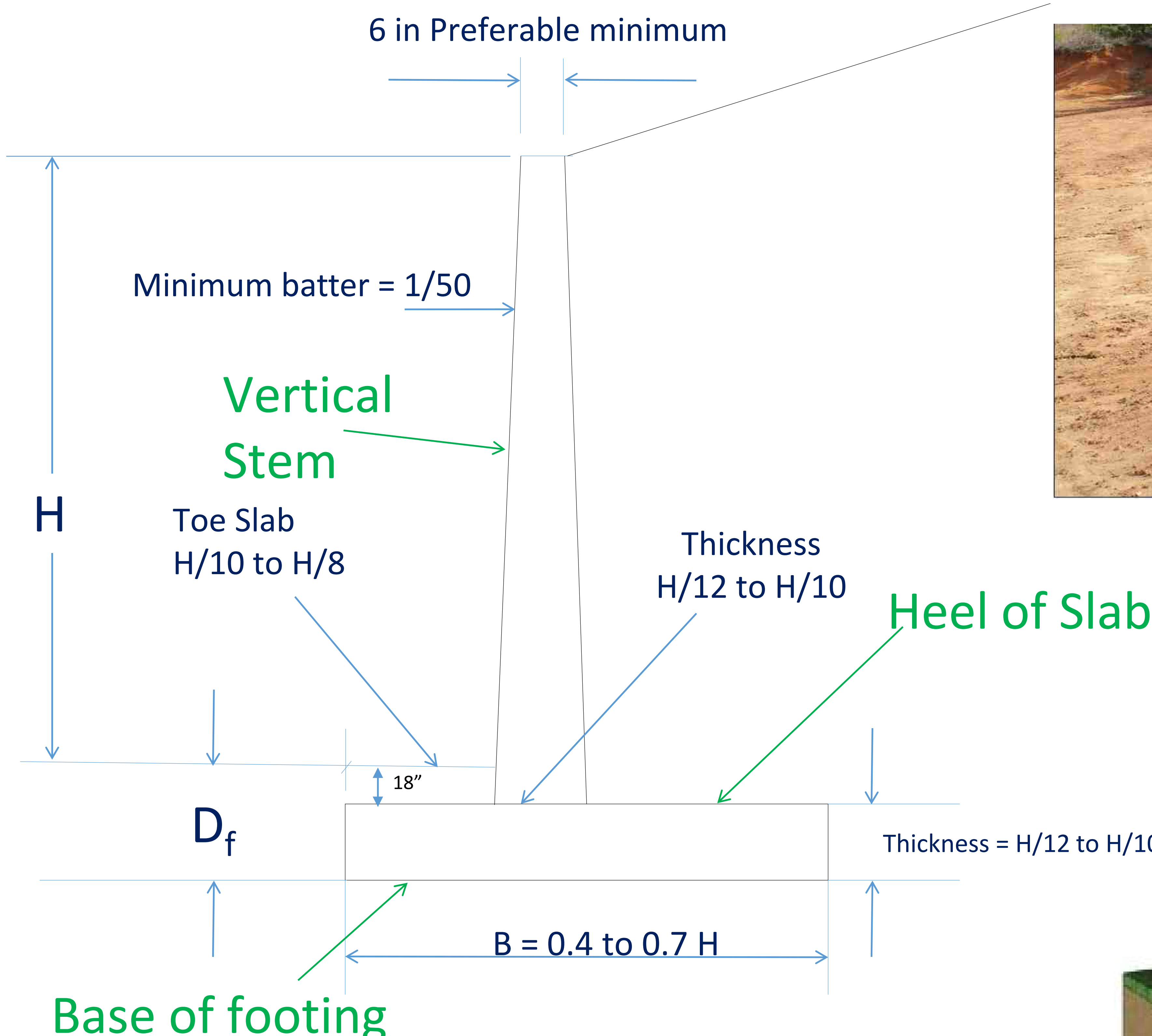


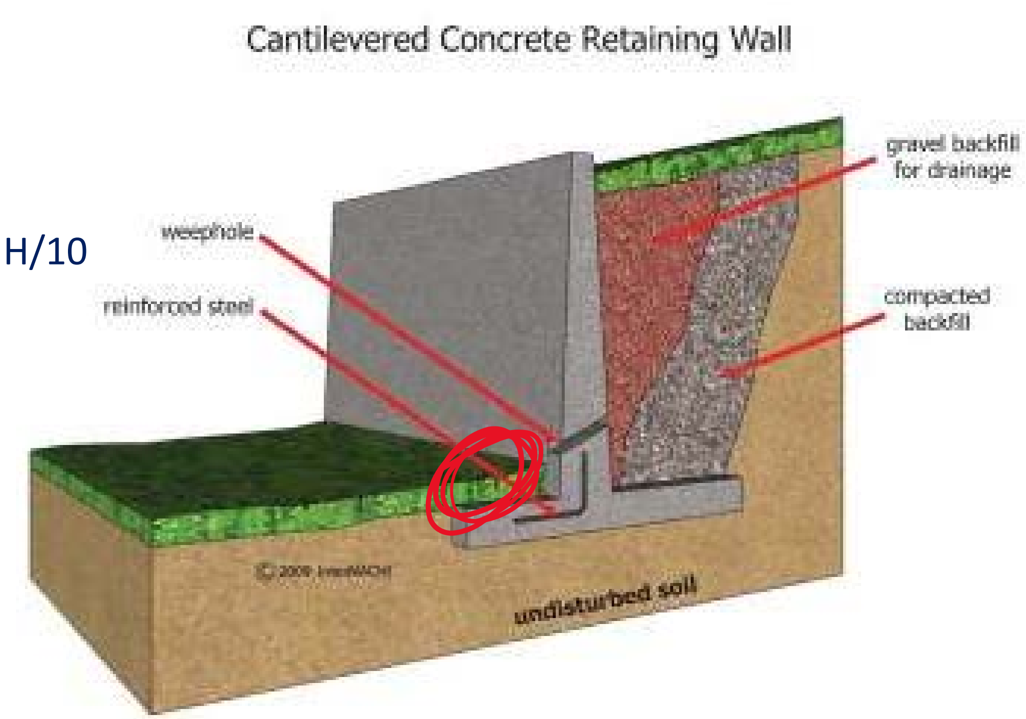




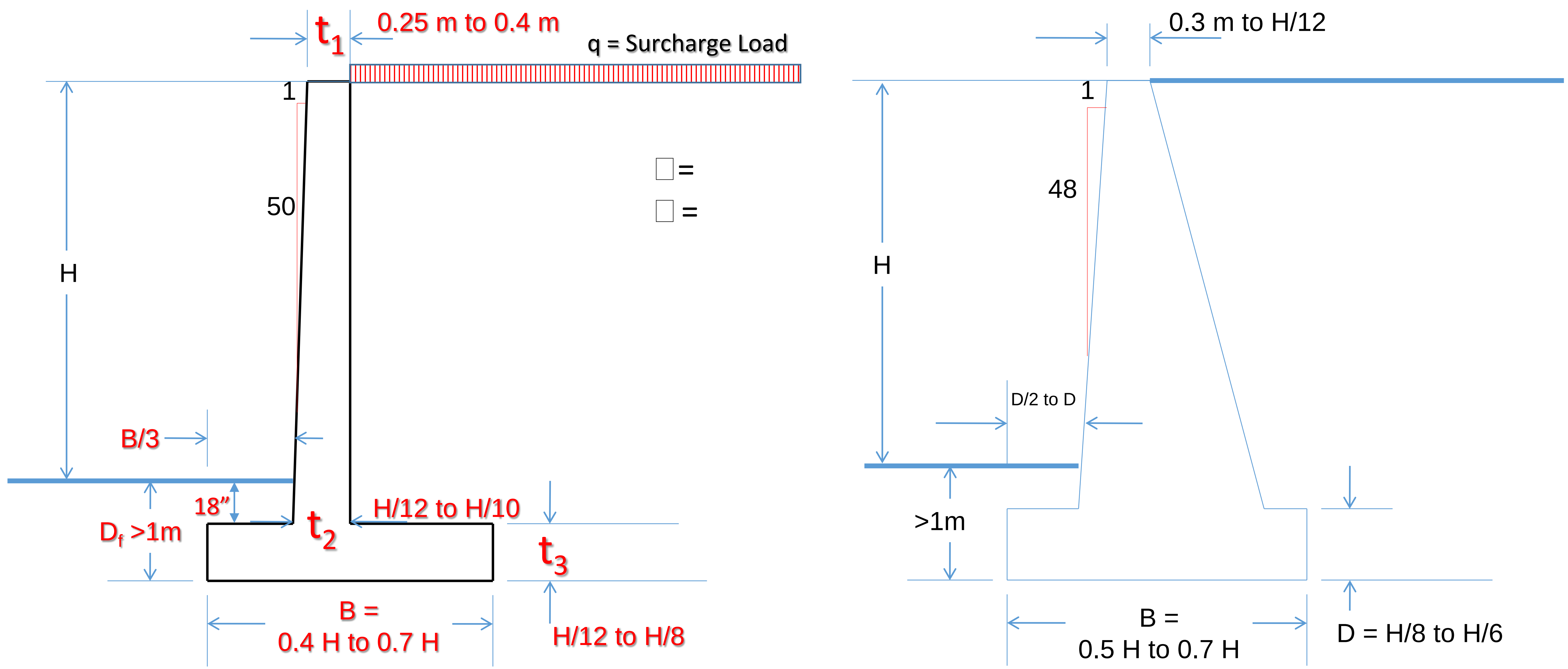
Internal Stability
Steel Reinforcement and Thicknesses

Common Proportions of Cantilever Wall





Approximate Dimensions



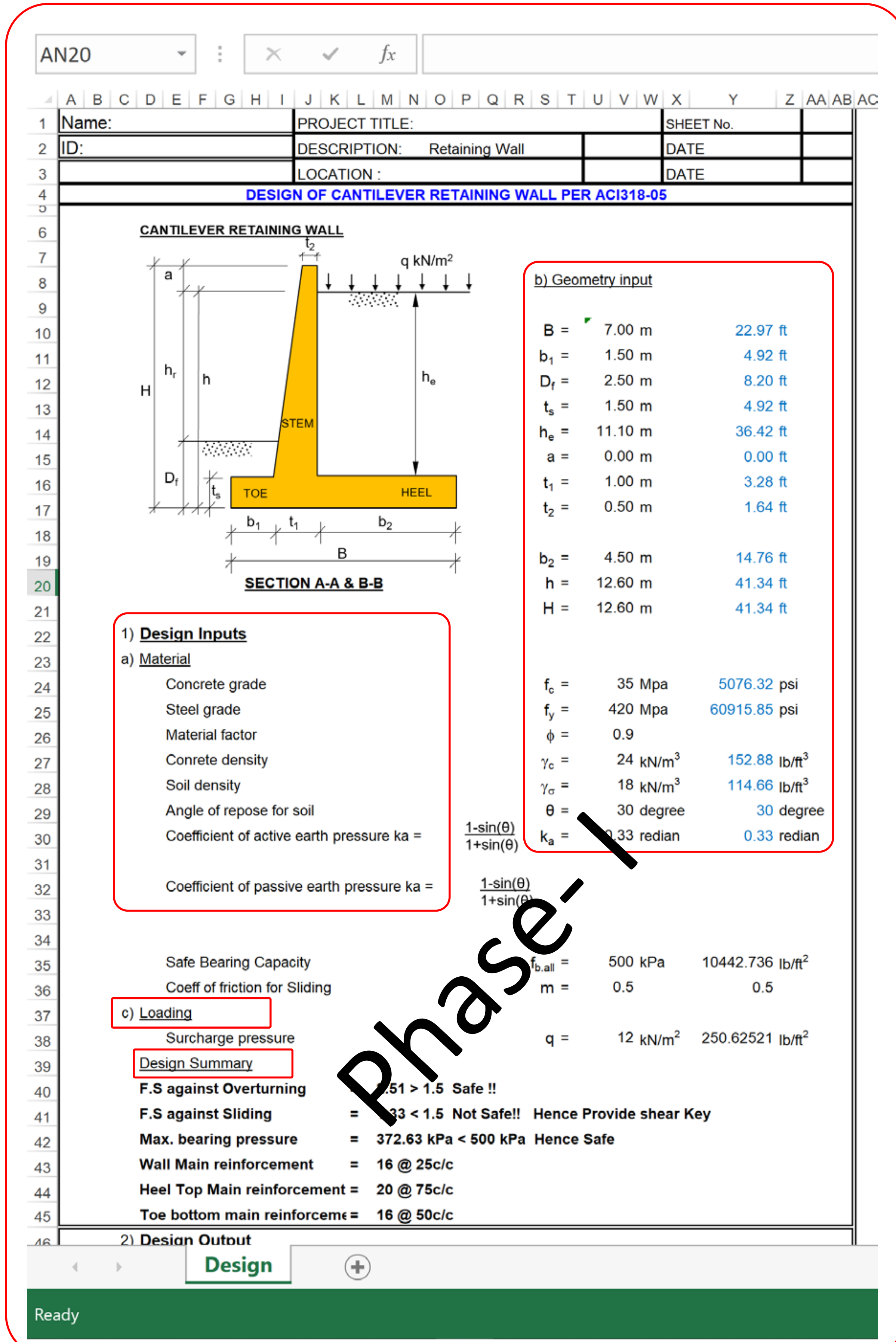
Cantilever Retaining Wall

Gravity Retaining Wall

Kamal Tawfiq Ph.D., P.E., F.ASCE

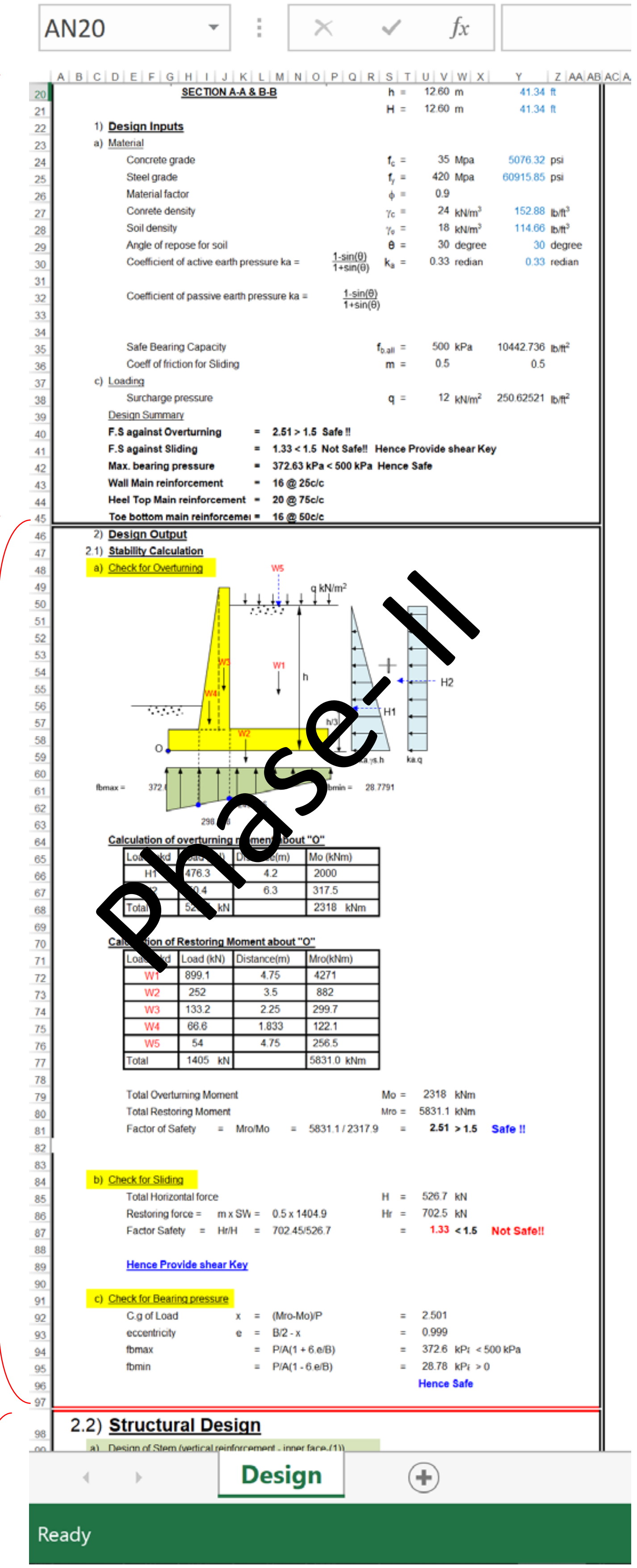
Sample of Excel Spreadsheet Analysis and Deign of Cantilever Retaining Walls

Note:
Assume the Bearing Capacity of the Foundation, q_{all} = 3000 psf



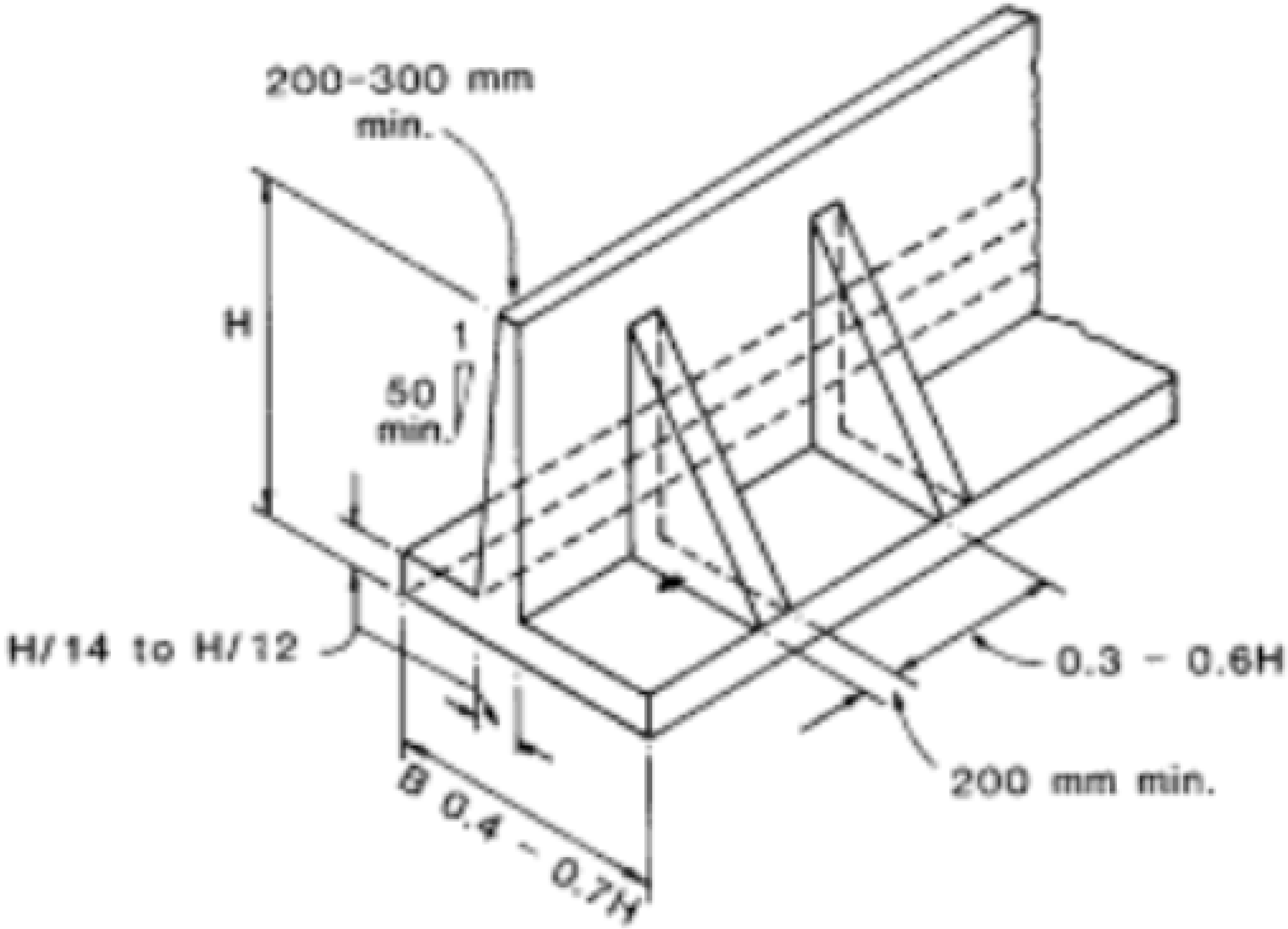
Page 1
Design Input

Page 2
Design Output
(External Stability)
REQUIRED



Page 3
Design Output
(Internal Stability)
NOT REQUIRED
IN THIS PROPJECT

Counterfort Retaining Wall



Internal Stability

Structural Design
Steel Reinforcement and Thicknesses — Structural Design

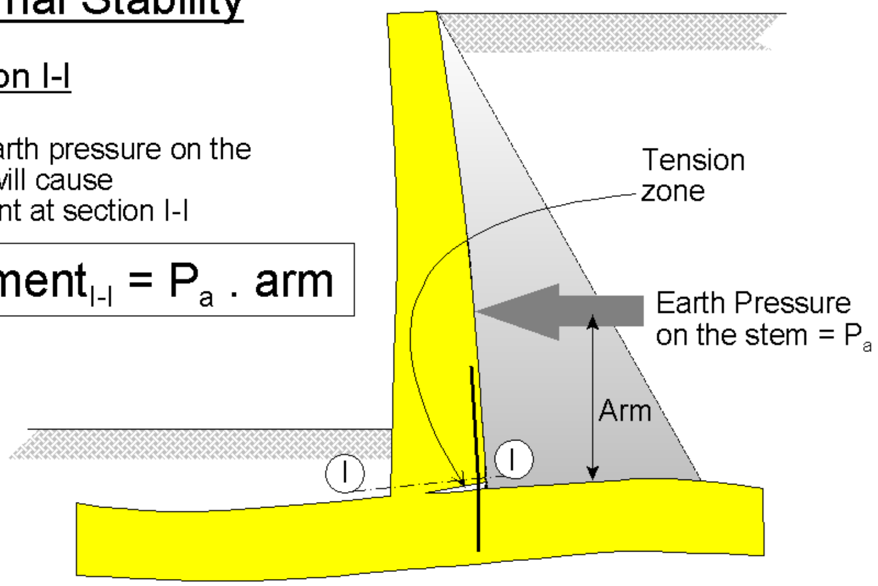
2-

Internal Stability

Section I-I

The earth pressure on the stem will cause moment at section I-I

$$Moment_{I-I} = P_a \cdot arm$$

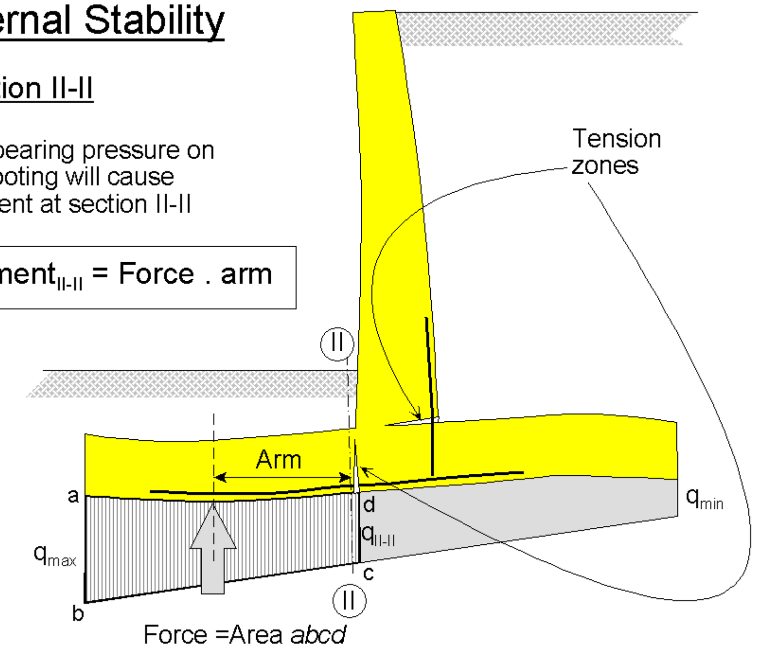


Internal Stability

Section II-II

The bearing pressure on the footing will cause moment at section II-II

$$Moment_{II-II} = Force \cdot arm$$

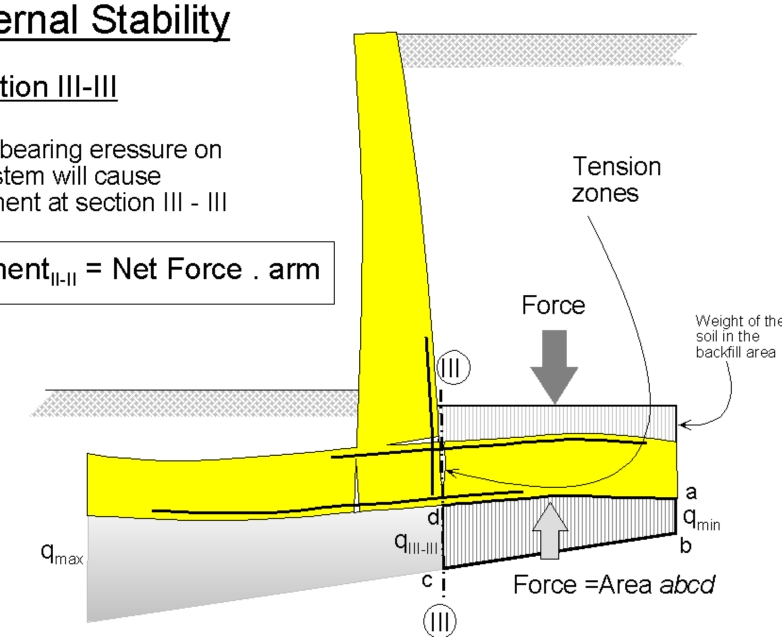


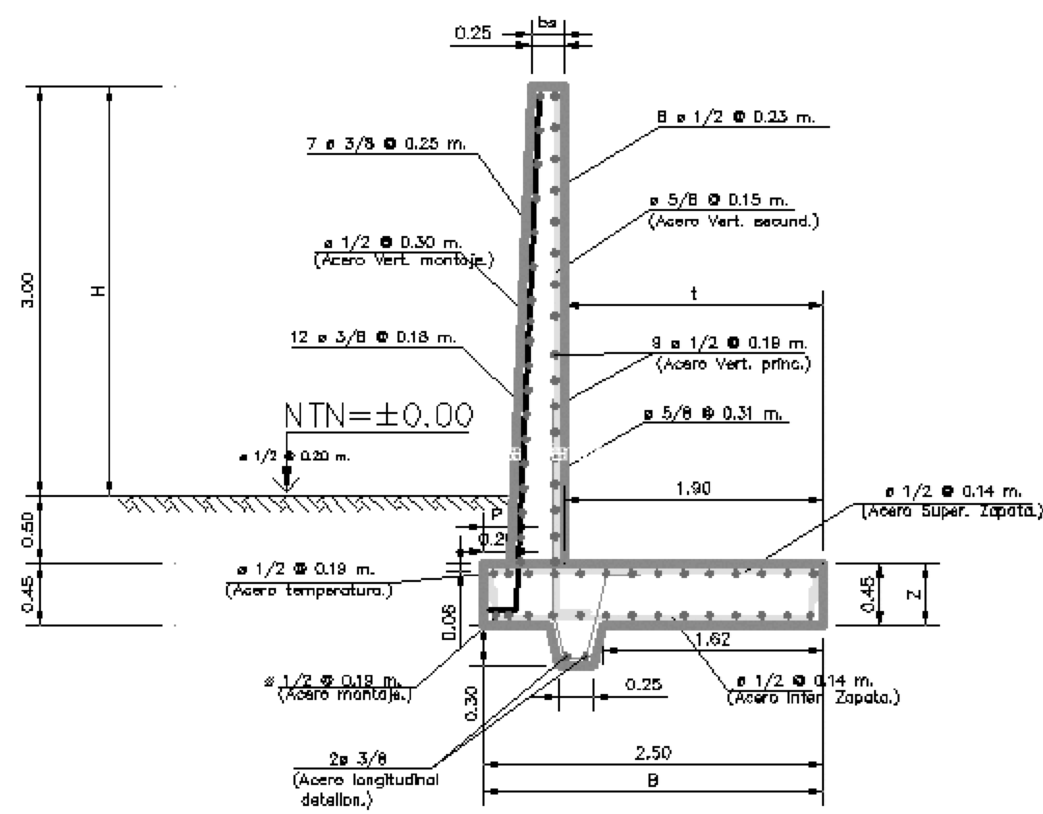
Internal Stability

Section III-III

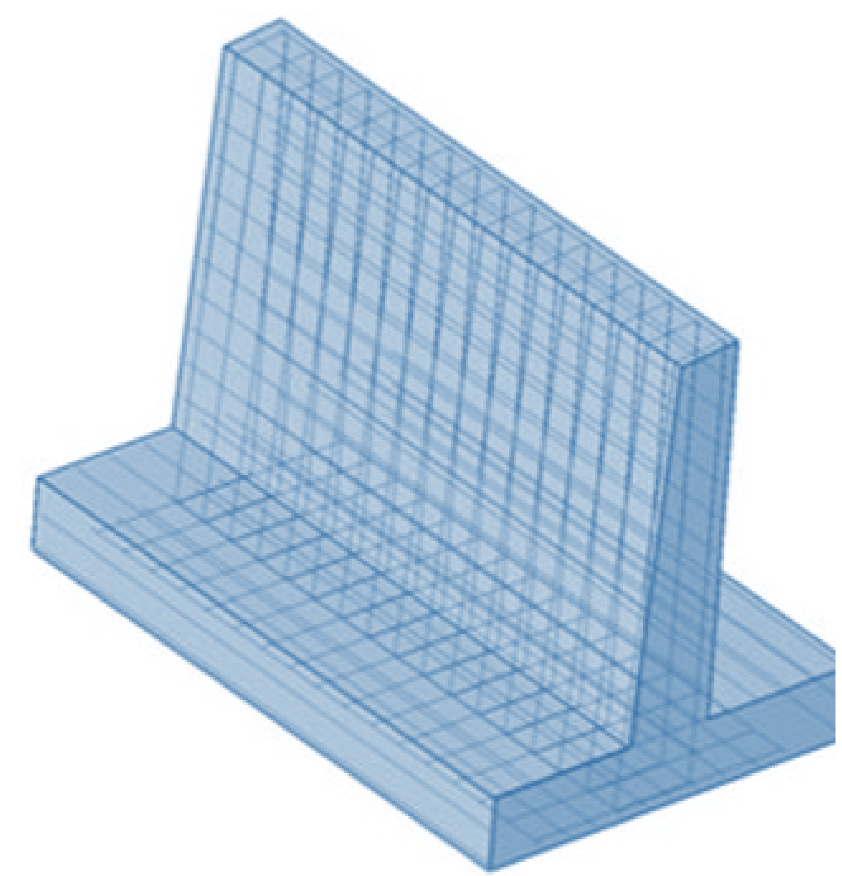
The bearing eressure on the stem will cause moment at section III - III

$$Moment_{II-II} = Net\ Force \cdot arm$$





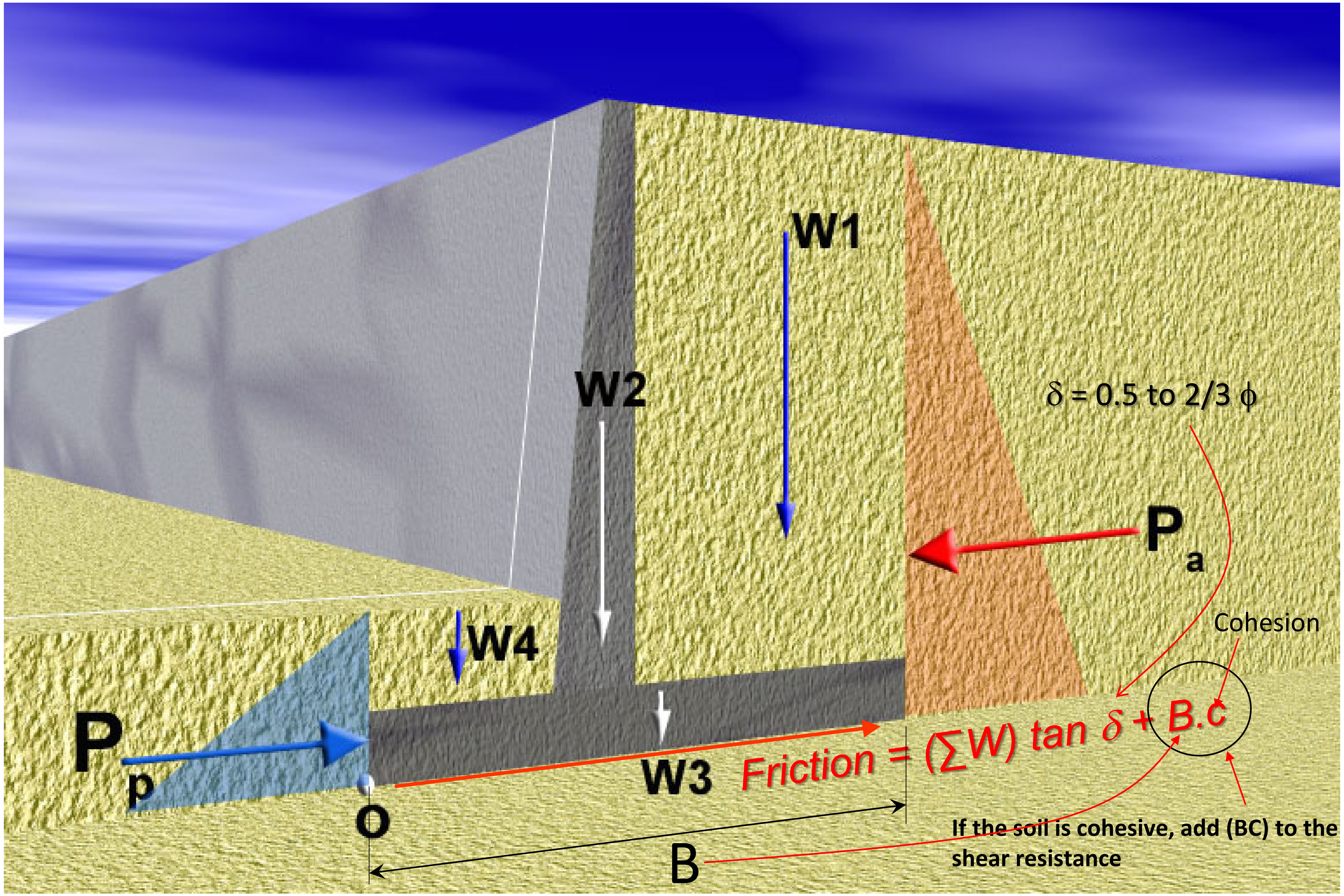
DETALLES DE MURO DE CONTENCION



I. External Stability

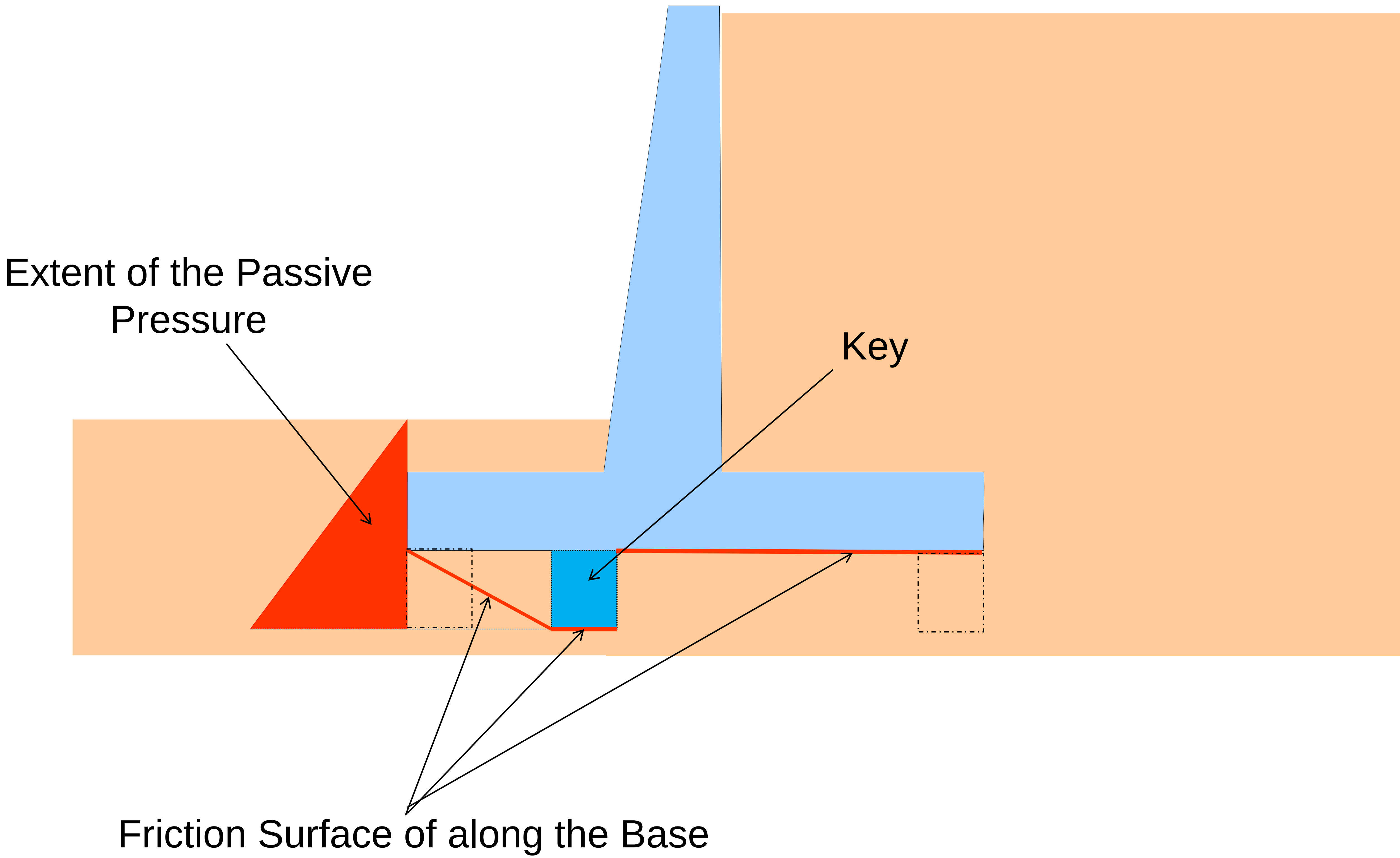
1- Sliding

$$\text{Factor of Safety Against Sliding} = \frac{\text{Resisting Force}}{\text{Driving Force}} = \frac{F_R}{F_D}$$

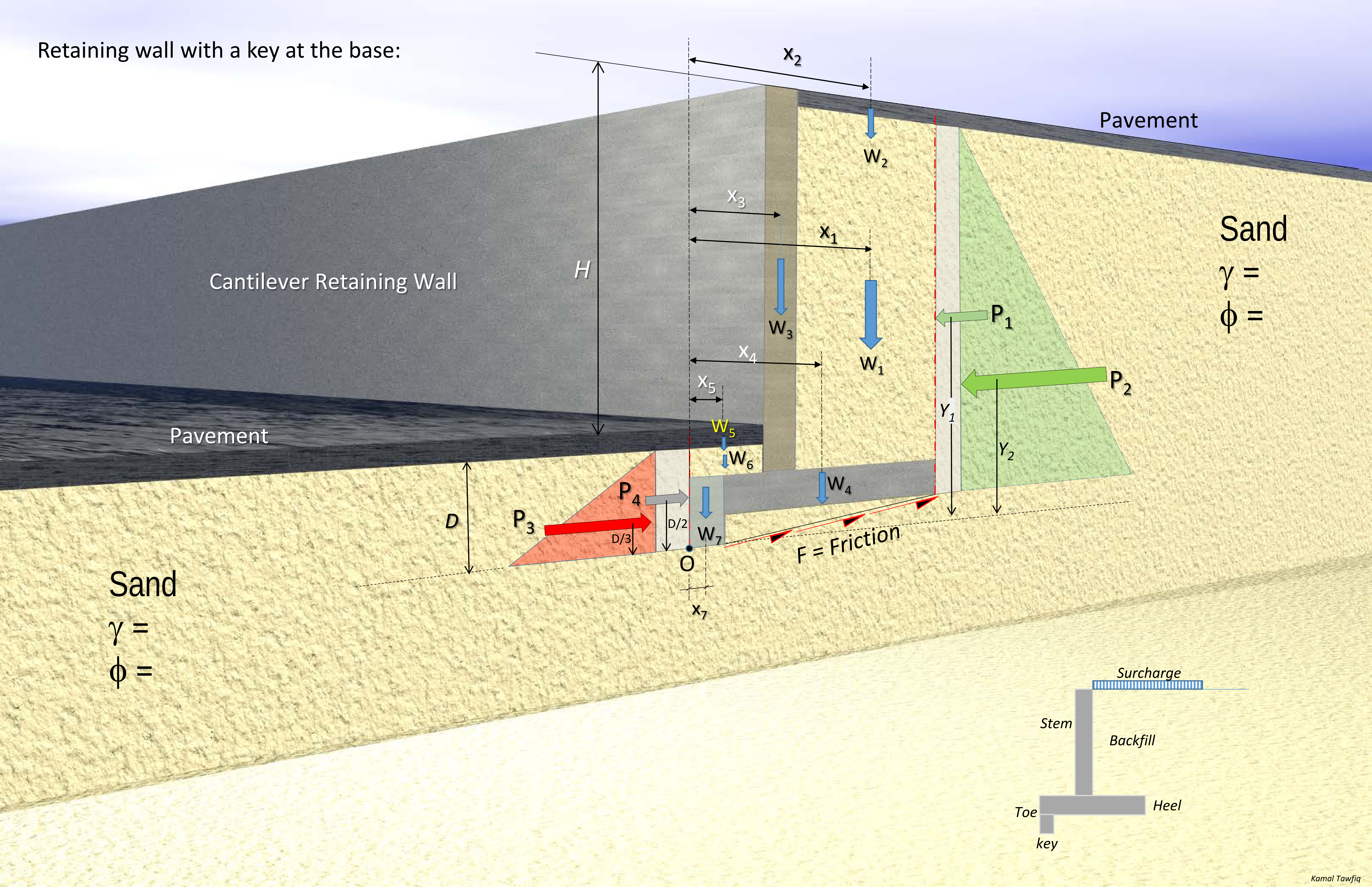


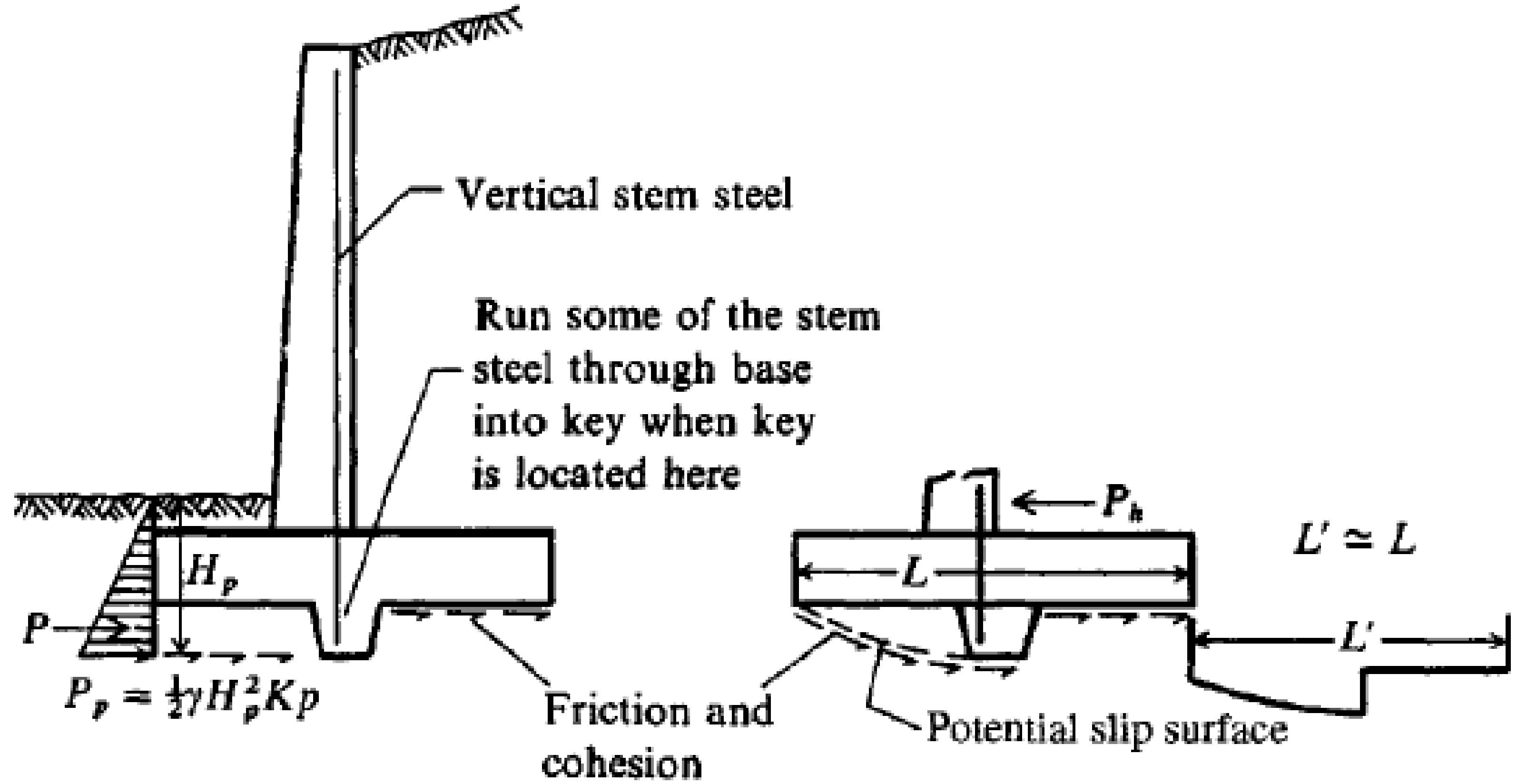
$$F_D = P_a \qquad\qquad F_R = P_p + \text{Friction}$$

Using Key at the Base to Improve Sliding Resistance



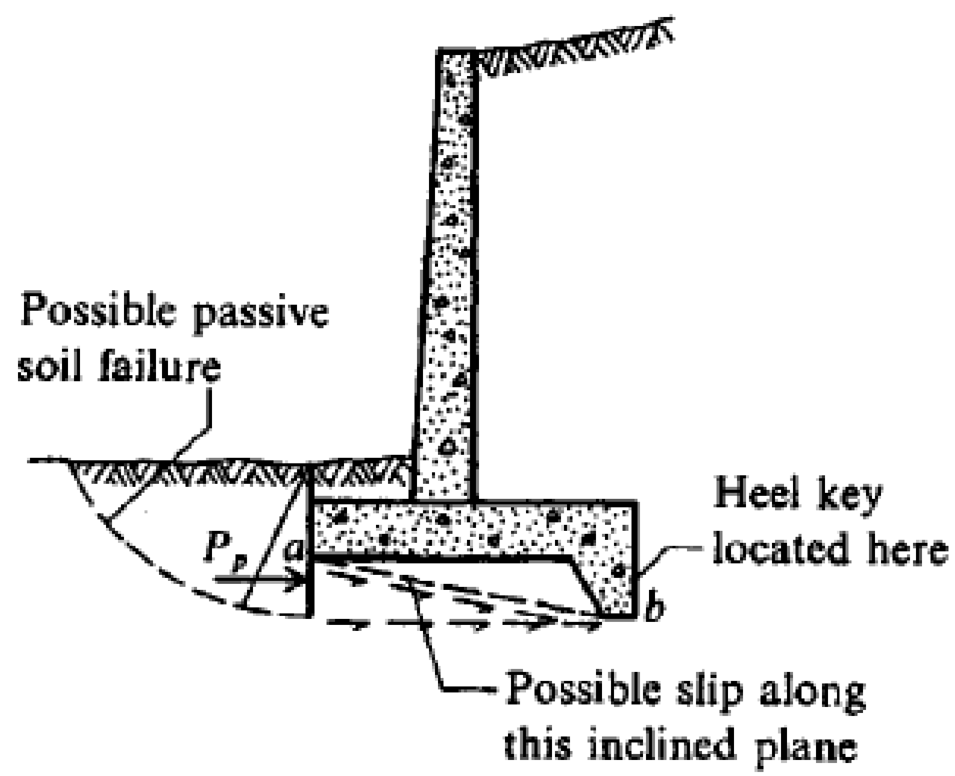
Retaining wall with a key at the base:





(a) Base key near stem so that stem steel may be extended into the key without additional splicing or using anchor bends.

(b) Potential sliding surface using the key location of a. There may be little increase in sliding resistance from this key, if the slip surface develops as shown.



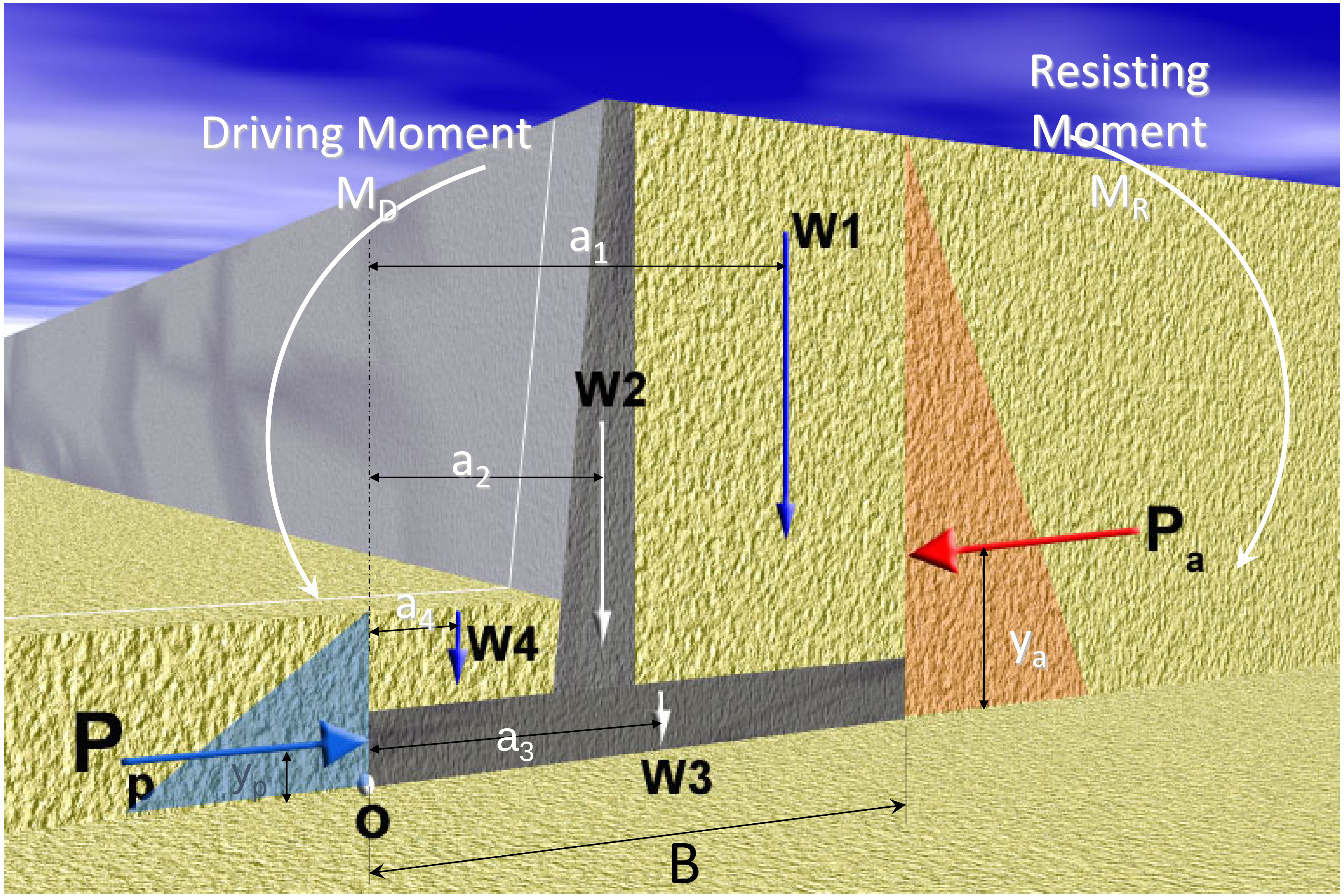
(c) Possible sliding modes when using a heel key.

Figure 12-14 Stability against sliding by using a base key.

I. External Stability

2- Overturning

$$\text{Factor of Safety Against Overturning} = \frac{\text{Resisting Moment}}{\text{Driving Moment}} = \frac{M_R}{M_D}$$



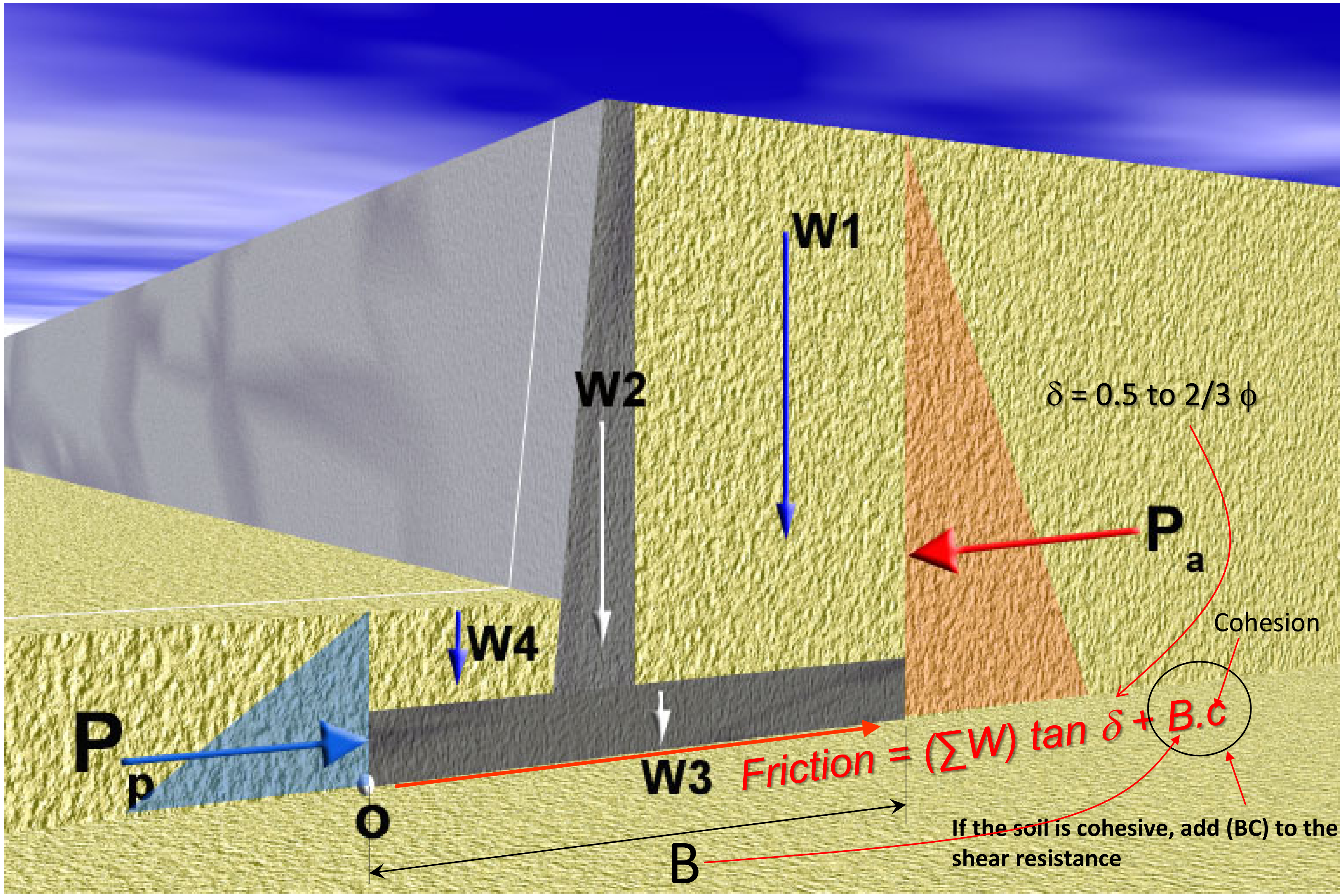
Moment About o $\quad M_D = P_a \cdot y_a \quad M_R = P_p . y_p + W_1 a_1 + W_2 a_2 + W_3 a_3 + W_4 a_4$

Session Ended 9/30/2020 at 6:15 PM

I. External Stability

1- Sliding

$$\text{Factor of Safety Against Sliding} = \frac{\text{Resisting Force}}{\text{Driving Force}} = \frac{F_R}{F_D}$$



$$F_D = P_a \qquad F_R = P_p + \text{Friction}$$