Spring'14 Soil Mechanics Homework 6 Solution

1. If the wall moves into the excavation, it moves towards A, and away from B. This means if the wall movement is large enough to yield the soil, A has passive failure and B has active failure. Point C is not affected by the excavation, therefore the soil there does not have lateral strain, indicating K_o condition.

$$K_a = \frac{1-\sin\phi'}{1+\sin\phi'} = \frac{1-\sin 20^o}{1+\sin 20^o} = 0.49 \qquad K_p = 1/K_a = 2.04 \qquad K_o = (1-\sin\phi')\sqrt{OCR} = 0.658$$

At point A; $\sigma_v' = \sigma_v - u = (1x17+1x20) - 10 = 27$ kPa

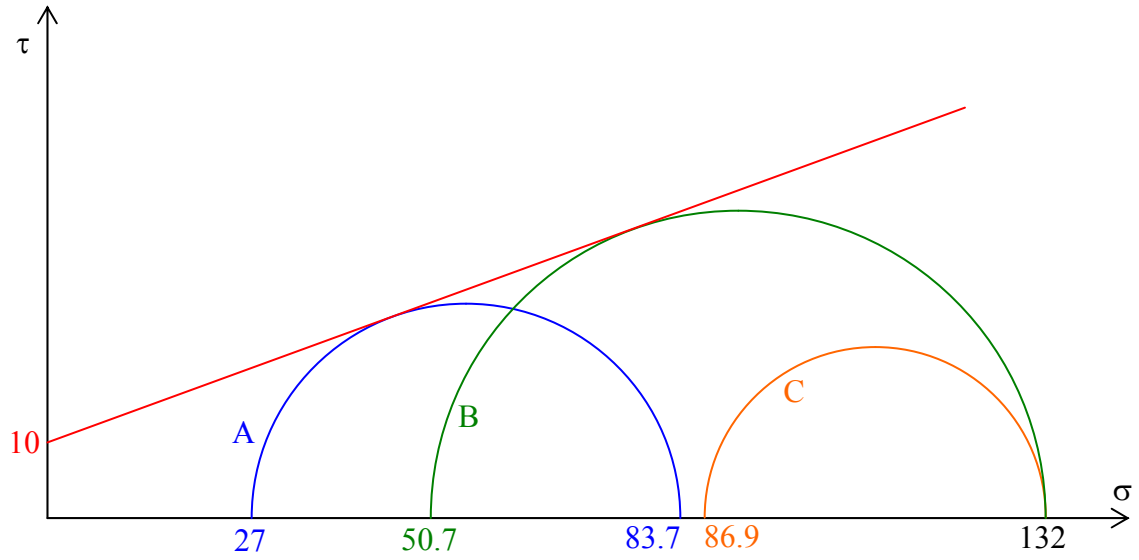
$\sigma_{hp}' = \sigma_v'.K_p + 2c'\sqrt{K_p} = 27x2.04 + 2x10x\sqrt{2.04} = 55.1+28.6 = 83.7$ kPa

At point B; $\sigma_v' = \sigma_v - u = (20+6x17+1x20) - 10 = 132$ kPa

$\sigma_{ha}' = \sigma_v'.K_a - 2c'\sqrt{K_a} = 132x0.49 - 2x10x\sqrt{0.49} = 64.7-14 = 50.7$ kPa

At point C; $\sigma_v' = 132$ kPa

$\sigma_h' = \sigma_v'.K_o = 132x0.658 = 86.9$ kPa (assuming normally consolidated)



2. Tension crack occurs on the active (right) side. At the bottom of a tension crack horizontal (effective for drained alanysis, total for undrained analysis) stres shall be zero.,

$\sigma_{ha}' = \sigma_v'.K_a - 2c'\sqrt{K_a}$

$0 = (20+17.z)\ 0.49 - 2x10x\sqrt{0.49} = 9.8 + 8.33\ z - 14 = 8.33\ z - 4.2$

$\Rightarrow\ z = 4.2/8.33 =$ ***<u>0.5 m</u>***

3. Active side: groundwater level: $\sigma_v' = \sigma_v - u = (20+6x17) - 0 = 122$ kPa

$\sigma_{ha}' = \sigma_v'.K_a - 2c'\sqrt{K_a} = 122x0.49 - 2x10x\sqrt{0.49} = 59.8-14 = 45.8$ kPa

$\sigma_{ha} = \sigma_{ha}' + u = 45.8 + 0 = 45.8$ kPa

tip of the wall: $\sigma_v' = \sigma_v - u = (20+6x17+2x20) - 20 = 142$ kPa

$\sigma_{ha}' = \sigma_v'.K_a - 2c'\sqrt{K_a} = 142x0.49 - 2x10x\sqrt{0.49} = 69.6-14 = 55.6$ kPa

$\sigma_{ha} = \sigma_{ha}' + u = 55.6 + 20 = 75.6$ kPa

Passive side : ground surface : $\sigma_v' = 0$

$\sigma_{hp}' = \sigma_v'.K_p + 2c'\sqrt{K_p} = 0x2.04 + 2x10x\sqrt{2.04} = 28.6$ kPa $= \sigma_{hp}$

groundwater level : $\sigma_v' = \sigma_v - u = (1x17) - 0 = 17$ kPa

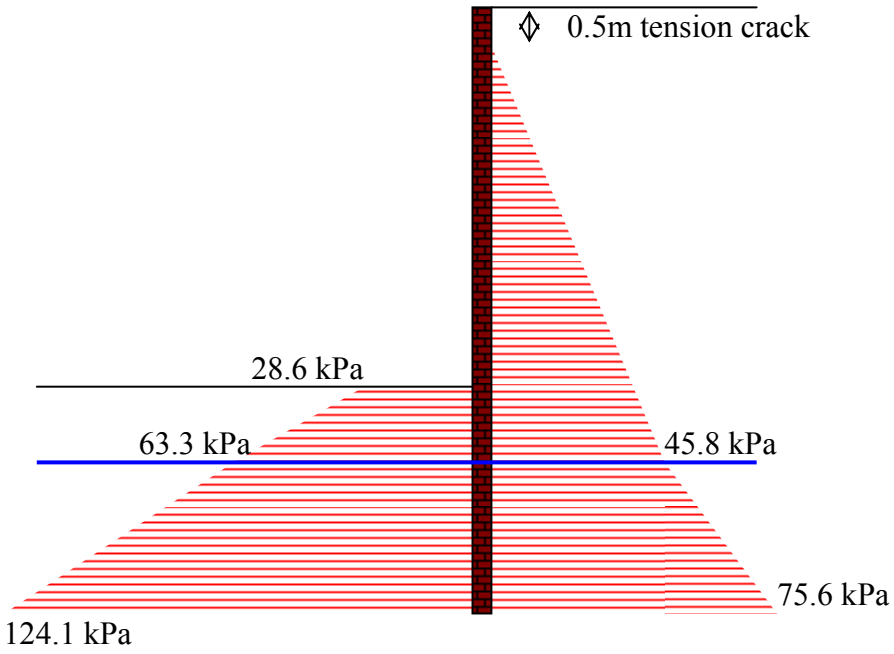
$\sigma_{hp}' = \sigma_v'.K_p + 2c'\sqrt{K_p} = 17x2.04 + 2x10x\sqrt{2.04} = 34.7+28.6 = 63.3$ kPa

$\sigma_{hp} = \sigma_{hp}' + u = 63.3 + 0 = 63.3$ kPa

tip of the wall: $\sigma_v' = \sigma_v - u = (1x17+2x20) - 20 = 37$ kPa

$\sigma_{hp}' = \sigma_v'.K_p + 2c'\sqrt{K_p} = 37x2.04 + 2x10x\sqrt{2.04} = 75.5+28.6 = 104.1$ kPa

$\sigma_{hp} = \sigma_{hp}' + u = 104.1 + 20 = 124.1$ kPa



4. Total Active Force = $\frac{45.8\times5.5}{2} + 2\cdot\frac{45.8+75.6}{2} = 247.35$ kN/m

Total Passive Resistance = $\frac{28.6+63.3}{2} + 2\cdot\frac{63.3+124.1}{2} = 233.35$ kN/m

required support force to stabilize the wall = 247.35 – 233.35 = 14 kN/m

supports are every 4 m $\Rightarrow$ each support carries 4x14 = ***56 kN***

5. No horizontal displacement means we want to have zero horizontal strain, which is the K_o condition. So if you make stresses on each side equal to K_o stresses, you will eliminate horizontal movement. (Note that the excavation side will be over-consolidated due to removal of soil, even though the soil was initially normally consolidated)