# Addis Ababa University
# Addis Ababa Institute of Technology
# School of Civil and Environmental Engineering

## Fundamentals of Geotechnical Engineering III (CEng3143) - Test 2

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| Name | |
| ID No. | |
| Signature | |
| Section | |
| Exam Date: | 16.12.2019 |

Instruction:

1) Cheating is strictly forbidden.
2) The time allowed for this exam is 1 hour.
3) Please read the questions carefully and make sure you understand the facts before you begin answering. Write as legibly and concisely as possible.
4) Use the provided space properly to present you answer.

| Question # | Weight [marks] | Score [marks] |
|---|---|---|
| 1 | 40 % | |
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| 2 | 60 % | |
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## SECTION 1: Shear Strength of Soils [40%]

1.1 What are the parameters that are responsible to the shear strength of a soil element? Indicate for which type of soils that their behavior dominates in contributing to shearing strength. **(5 points)**

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1.2 Explain, with the help of a neat sketch, the difference in the respective responses of loose and dense sands that are under shearing action. **(5 points)**

1.3 What are the different corrections that are applied to a measured SPT number on site? Explain the rationales (reasons) for application of these corrections and how they affect the recorded SPT number. **(10 points)**

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1.4 Explain the two-phase process of loading and drainage condition for consolidated-undrained (CU) triaxial test. **(10 points)**

1.5 In a consolidated-drained CD triaxial compression test on a soil sample the confining pressure was kept at 300 kPa. The failure plane was inclined at $50^0$ with the horizontal plane. If the cohesion of the soil was 60 kPa, determine the shear and normal stresses on the failure plane and the deviator stress at the time of failure. **(10 points)**

## SECTION 2: Lateral Earth Pressure of Soils [60%]

2.1 State the assumptions made by Rankine while developing his theory of lateral earth pressure. **(5 points)**

2.2 Describe the three lateral earth pressure conditions with respect to wall movement. Indicate how the lateral earth pressure coefficient varies with wall movement using a rough sketch. **(10 points)**

2.3 Derive the following Rankine expressions for active and passive lateral earth pressure coefficients for a homogenously cohesionless soil based on his failure theory by sketching respective Mohr's circles and failure envelopes. **(10 points)**

i) $k_a = \frac{1-\sin\phi}{1+\sin\phi}$

ii) $k_p = 1/k_a$

where, $\phi$ is friction angle of the soil.

2.4 A six-meter retaining wall retains a horizontal, two-layered soil as shown in the Figure below. A 3 m by 3 m reinforced-concrete ($\gamma_{conc}$ = 25 kN/m$^3$) isolated footing of 0.8 m thickness carrying a factored column load of 400 kN can be seen to have been constructed near the retaining wall. Neglecting any embedment effect by the foundation,

i) plot the different lateral pressure distributions of the system;
ii) calculate the magnitude and location of the active and passive lateral forces on the retaining wall
iii) the resultant moment about the foot of the wall. **(35 points)**

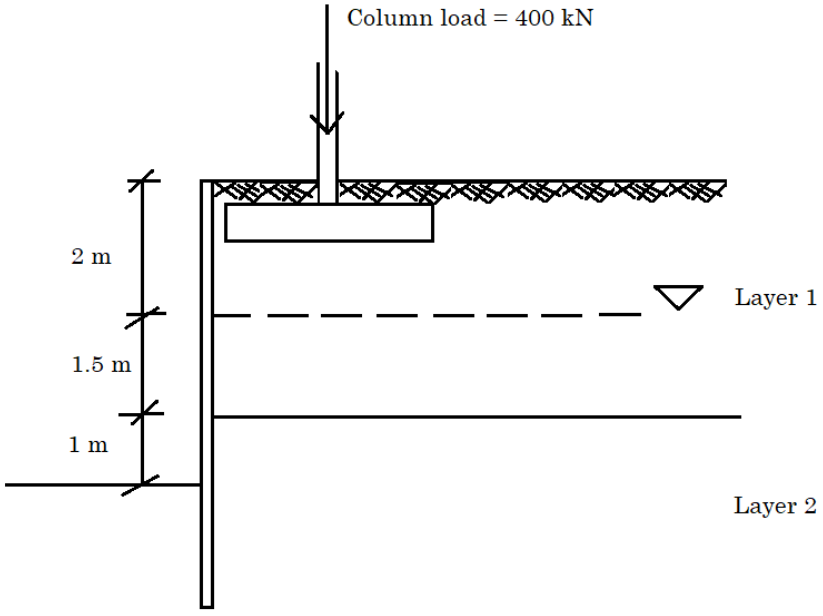
Soil parameters are given as follows.

Layer 1 (Silty-Clay) – $\gamma_{bulk}$ = 17 kN/m$^3$ $\gamma_{sat}$ = 20 kN/m$^3$, c = 20 kPa, $\emptyset$ = 18$^0$

Layer 2 (Dense Sand) – $\gamma_{bulk}$ = 19 kN/m$^3$ $\gamma_{sat}$ = 21 kN/m$^3$, c = 0 kPa, $\emptyset$ = 30$^0$

Assume the following during your calculations

- a wall friction, $\delta$, to be 2/3$^{rd}$ of the angle internal friction of the respective soil layer
- the weight of the reinforcements in the pad to be 15% of the weight of the foundation.
- the ground water is kept up to the level of the dredge line (the ground surface) on the face of the retaining wall.



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