UNIVERSITY OF JOHANNESBURG

FACULTY OF ENGINEERING AND BUILT ENVIRONMENT
KINGSWAY CAMPUS
DEPARTMENT OF CIVIL ENGINEERING SCIENCE
JUNE EXAMINATION 2016
MODULE: GEOTECHNICAL ENGINEERING 4A 11

ASSESSOR	Mr. Mupembe Tshisekedi
MODERATOR	Prof Williams K. Kupolati
DURATION:	120 MINUTES
MARKS:	100

QUESTION 1

Define the following terms:

(a) Spring constant, (b) coefficient of subgrade reaction, (c) undamped natural circular frequency, (d) undamped natural frequency, (e) period, (f) resonance, (g) critical damping coefficient, (f) damping ratio, (h) damped natural frequency.

[9 Marks]

QUESTION 2

In conventional geotechnical engineering practice, when do you opt to use CPT results in comparison to SPT results, Explain your answer?

(6 marks)

QUESTION 3

In many assumptions, it is the settlement and not the bearing capacity that is the governing parameter in the design of foundations in coarse-grained soils. Elaborate this statement with desirable examples.

(8 marks)

QUESTION 4

In recent years geotextiles and geosynthetics have been increasingly used to improve the performance and also to reduce the costs associated

with the construction of retaining walls on highways. Explain in your words how these objectives are achieved. (7 marks)

QUESTION 5

You own a geotechnical engineering firm in eastern part of Johannesburg and your company has been hired to conduct a slope stability analysis. Consider a 14.0 m-thick mass of regolith (The layer of loose rock resting on bedrock) sitting on top of a bedrock surface with a slope of 16 degrees. A home is located at the top of this slope (and set back from the edge only 21 m). Upon an initial visit, you determine that the regolith is unsaturated. You also estimate the following additional parameters for this site:

Regolith cohesion = 1100 N/m^2
Regolith angle of internal friction = 15^o
Density of regolith = 2200 kg/m^3
Density of water = 1000 kg/m^3

a) Calculate current values for shear strength and shear stress on this slope. Show your work. (7 Marks)
b) What is the value for the Factor of Safety? Would you consider the slope currently stable? Explain your answer. (7 Marks)
c) What your advice to the homeowners regarding the safety of their home? What remediation can you suggest if any is needed? (6 Marks)

[20 Marks]

QUESTION 6

Using the Modified Bishop's Method, perform an effective stress analysis to determine the factor of safety for the trial circle shown in Figure Q6. The soil is homogeneous with soil properties as follows C' = 1400 N/m^2 and $\emptyset'$ = 29^0. The unit weight is 17 kN/m^3 above the groundwater table, and 21 kN/m^3 below. (15 Marks)
Height = 31 m tall,
Slope to be built 1.5:1 as shown in Figure 6
For iteration use (1) F = 1.85 and (2) F = 1.90

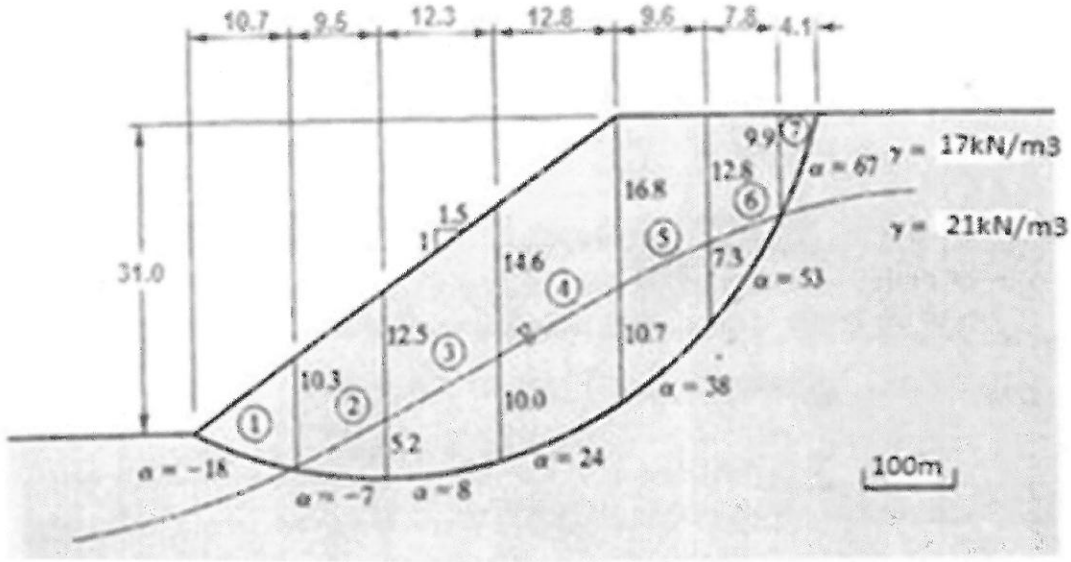

Figure Q6: Cross-section of the Proposed Slope

QUESTION 7

A machine and its foundation weight equals to 189 kN. The spring constant and the damping ratio of the soil supporting the soil are respectively as $16x10^4$ kN/m and 0.2. Forced vibration of the foundation is caused by a force that can be expressed as:

$$Q(kN) = Q_0 sinwt,\ Q_0 = 56\ kN,\ \omega = 167\ rad/s$$

Determine

(a) The undamped natural frequency of the foundation, (5 Marks)
(b) Amplitude of motion, and (5 Marks)
(c) Maximum dynamic force transmitted to the subgrade. (5 Marks)
[15 marks]

QUESTION 8

Determine the maximum allowable bearing capacity that a square foundation (B x B = 1 m x 1 m) constructed in a coarse-grained soil can carry. The factor of safety should be greater than 3 and the permissible settlement is 25 mm. The variation of E_s (i.e. elastic modulus) with depth obtained from CPT test is shown in Figure Q8. Use Terzaghi's equation and strain influence factor method to calculate bearing capacity and settlement, respectively. The average unit weight of the sand and the internal friction angle are 18 kN/m^3 and 35°, respectively.
(20 Marks)

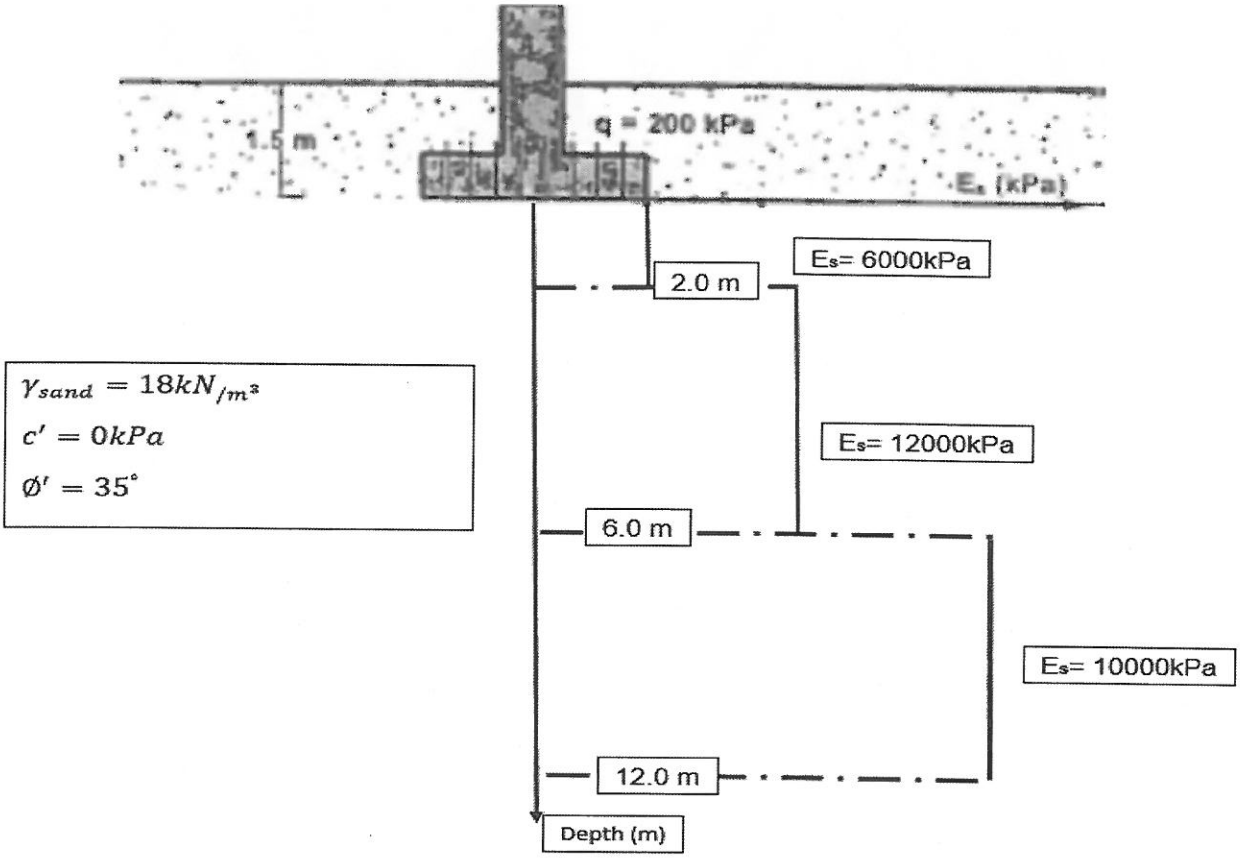
1.5 m
q = 200 kPa
Es (kPa)
2.0 m
Es= 6000kPa
Es= 12000kPa
6.0 m
Es= 10000kPa
12.0 m
Depth (m)
$\gamma_{sand} = 18kN_{/m^3}$
$c' = 0kPa$
$\emptyset' = 35^{\circ}$

Figure 8

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SUPPLEMENTARY EXAMINATION 2016
MODULE: GEOTECHNICAL ENGINEERING 4A 11

ASSESSOR — Mr. Mupembe Tshisekedi

MODERATOR — Prof Williams K. Kupolati

DURATION: 120 MINUTES
MARKS: 100

QUESTION 1

Recently, in the field of geotechnical engineering, geosynthetics and geotextiles, techniques have been increased to improve the performance and also to reduce the cost associated with the construction of retaining walls on highways. Explain in your words how these objectives are accomplished. (6 Marks)

QUESTION 2

Explain the approach that you will adopt to design a raft foundation, which is proposed to be constructed on soft clay which has a shallow ground water table? (7 Marks)

QUESTION 3

What are the appropriate shear strength parameters and the other properties that are required in determining the long-term stability of a slope for an earthen dam constructed with a clayey type of soil? Which method do you advice for determining the factor of safety of such a slope? Give a reasons why these shear strength parameters are recommended. Also, what tests do you recommend to conduct to determine these parameters? (7 Marks)

QUESTION 4

In many assumptions, it is the settlement and not the bearing capacity that is the governing parameter in the design of foundations in coarse-grained soils. Elaborate this statement with suitable practical examples. (10 Marks)

QUESTION 5

A CU triaxial compression test was conducted on a saturated clay sample with a confining stress of 270 kPa. The sample failed when the axial stress (deviator stress) applied was 210 kPa. The pore water pressure at failure was measured to be 145 kPa. Assume the cohesion intercepts c = c' = 0 kPa.

(1) Find the major and minor effective principal stresses at failure (σ'_{1f} and σ'_{3f}).

(2) Determine the effective angle of internal friction ($\emptyset'$).

(3) Determine the normal effective stress (σ'_{ff}) and shear stress (τ'_{ff}) on the plane of failure.

(4) The expected shear strength at failure if a direct shear test is conducted on the same sand with an effective normal stress of 170 kPa is conducted.

N.B: Sketch your Mohr Coulomb circle approximately. (20 Marks)

QUESTION 6

You own a geotechnical engineering firm in eastern part of Johannesburg and your company has been hired to conduct a slope stability analysis. Consider a 14.0 m thick mass of regolith (The layer of loose rock resting on bedrock) sitting on top of a bedrock surface with a slope of 16 degrees. A home is located at the top of this slope (and set back from the edge only 21 m).

For the initial visit, you determine that the regolith is unsaturated. Then, you also estimate the following additional parameters for this site:

Regolith cohesion = 1100 N/m^2

Regolith angle of internal friction = 15^0

Density of regolith = 2200 kg/m^3

Density of water = 1000 kg/m^3

a) Calculate current values for shear strength and shear stress on this slope. Show your work. (7 Marks)

b) What is the value for the Factor of Safety? Would you consider the slope currently stable? Explain your answer. (7 Marks)

c) What your advice to the homeowners regarding the safety of their home? What remediation can you suggest if any is needed?
(6 Marks)
[20 Marks]

QUESTION 7

The ordinary method of slice (OMS) is used on a homogeneous soil with parameters, C' = 950 N/m^3 and $\emptyset'$ = 31^0, and the unit weight is 19 kN/m^3 above the groundwater, and 23 kN/m^3 below, perform an effective stress analysis to compute the factor of safety for the trial circle shown in figure Q7. (15 Marks)

Height: 30 m tall,
Slope to be built: 1.5:1

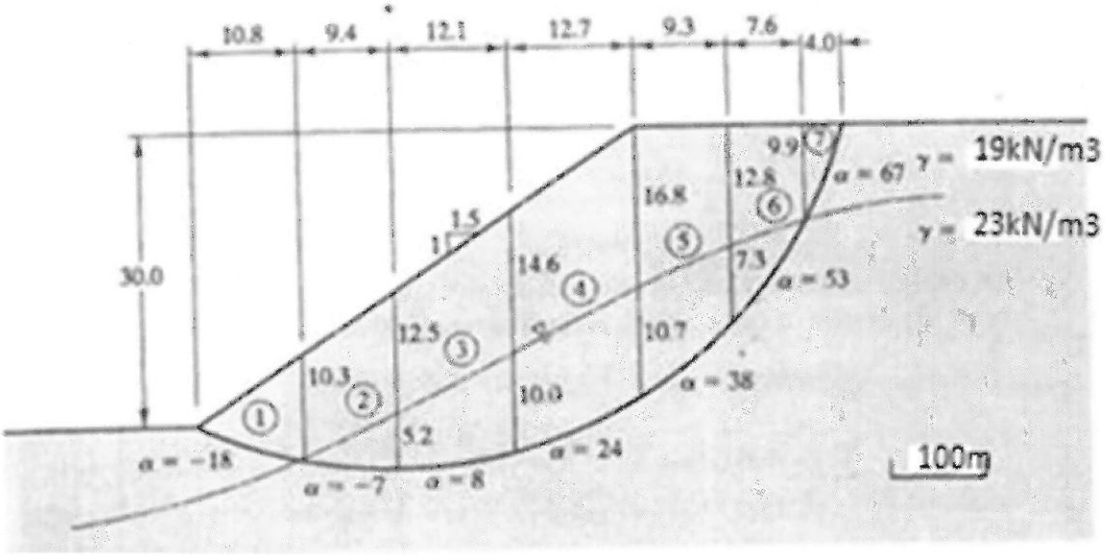

Figure Q7: Cross Section of the Proposed Slope

QUESTION 8

For a rectangular foundation (Length, L = 3 m) shown in Figure Q8 below, determine the width of foundation, B to carry a gross allowable load, Q_a = 950kN (Factor of Safety, FS = 3). It is strongly expected that the ground water table will rise up to the natural ground surface during the rainy season. (15 Marks)

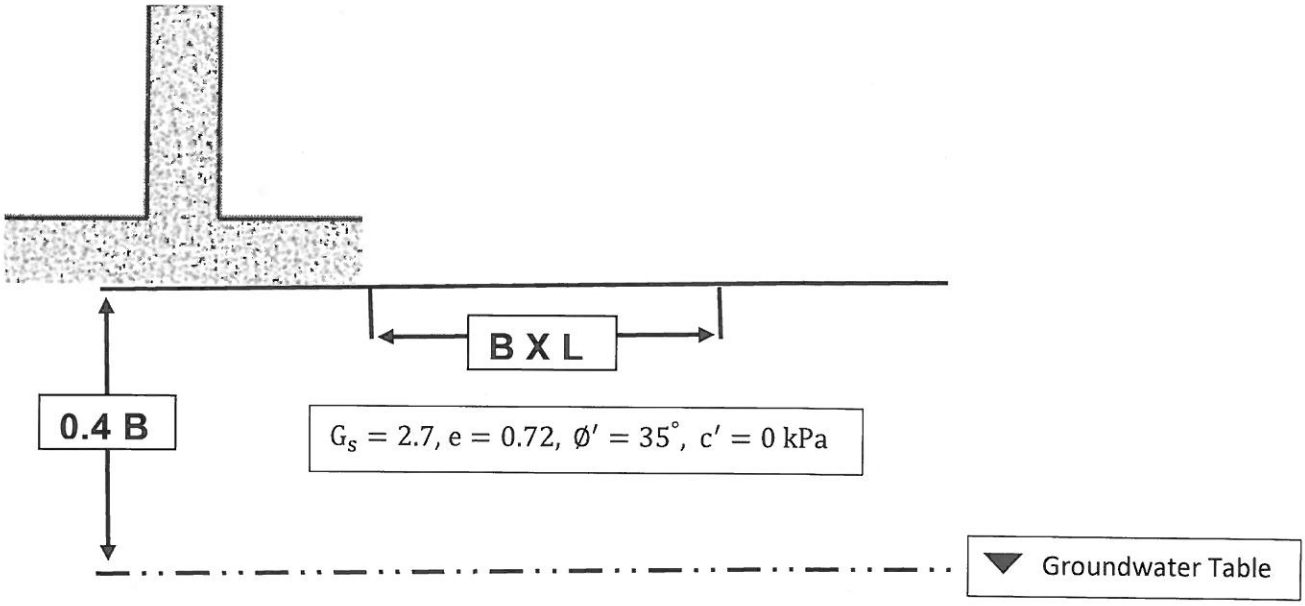

Figure Q8