00155

The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Civil Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: CVX6530/CEX6230 Geotechnics**
Academic Year	: 2019/20
Date	: 6th October 2020
Time	: 1330-1630hrs
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Seven (7)** questions in **Seven (7)** pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. Relevant charts/ codes are provided.
6. This is a Closed Book Test (CBT).
7. Answers should be in clear hand writing.
8. Do not use Red colour pen.

Question 1.

Sheet pile walls are used to stabilize the sides of banks of canals. Anchors placed in the retained side at regular intervals at shallow depths help to improve the stability of such walls. Figure Q1 shows such a wall. There is a uniformly distributed surcharge of 20 kN/m^2 acting on sand behind the wall. The river water level and the groundwater level are 2m above the river bed level. The cohesionless sand into which the wall is driven has a bulk unit weight of 18 kN/m^3 above the water table, submerged unit weight of 11 kN/m^3 below the water table, and an angle of shearing resistance of 28 degrees. Assuming free earth support condition and a smooth wall,

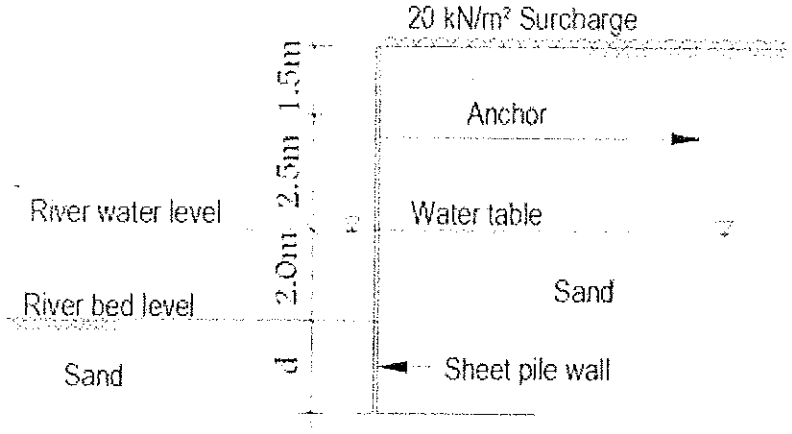


Figure Q1

(a). Compute the active and passive pressure distribution along the sides of the sheet pile wall at key depths. (06 Marks)

(b). Plot on a neat sketch the active and passive pressure distribution with depth showing principal values. (04 Marks)

(c). Compute the required total length of sheet piles after allowing for 25% extra penetration for safety. (04 Marks)

(d). Compute the force in an anchor if the anchors are placed at 1.0m intervals. (04 Marks)

(e). If 20mm diameter tor steel bars with a yield strength of 460 N/mm^2 are used as anchors compute the safety factor provided for anchors. (02 Marks)

Question 2.

A square pad footing 1.20m x 1.20m in size constructed in a sand stratum carrying a column load of 200kN is shown in Figure Q2. The eccentricity, e, of the column load is 0.10m. The size of the column is 225mm x 225mm. Groundwater level is 3m below ground level.

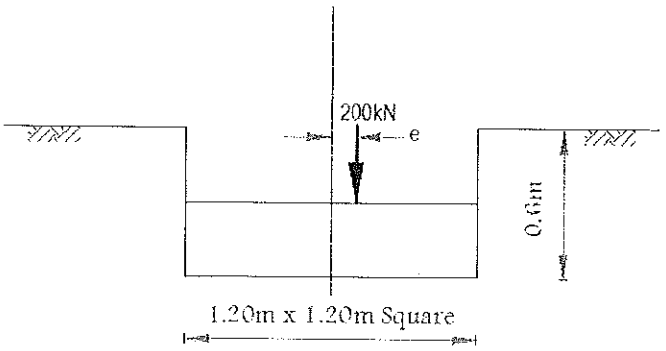


Figure Q2

(a). Derive the expression used to compute the contact pressures at the two extreme ends of the footing following the usual notation. (06 Marks)

(b). Compute the allowable bearing capacity of the footing based on a limiting settlement of 25mm. Average SPT N values: Ground to 0.6m depth – 10; 0.6m to 3.0m depth – 20. (04 Marks)

(c). Determine whether this footing can carry the given load safely without exceeding the allowable bearing capacity using the expression derived in 2(a). (06 Marks)

(d). Determine the maximum allowable eccentricity you can permit without exceeding the allowable bearing pressure. (04 Marks)

Question 3.

In a direct shear test conducted under drained conditions on a soil having C′= 15 kN/m^2, the sample failed at a shear stress of 97.85 kN/m^2, when the constant normal load applied was 510.6 N. Measured dimensions of the sample cutter were 59.65 mm x 59.65 mm x 19.70 mm.

(a). Determine the angle of internal friction of tested soil. (02 Marks)

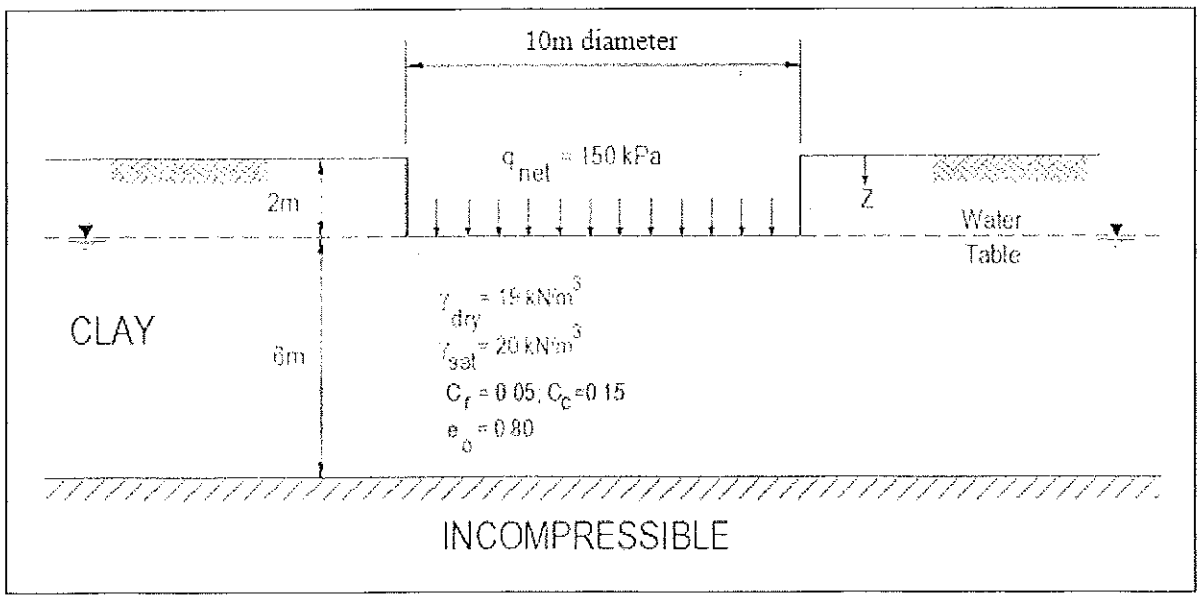
(b). Determine the magnitude, and orientation of the major and minor principal stresses with horizontal, at failure. (08 Marks)

(c). Find out the value, and the orientation of the plane, of maximum shear stress. (04 Marks)

(d). If a specimen of this soil were to be tested in a triaxial cell under CD conditions at a cell pressure of 170 kN/m^2, determine the deviatoric stress at failure. (06 Marks)

Question 4.

Figure Q4 shows a 10.0m diameter raft foundation constructed on a clay layer to support a cylindrical oil tank. There is a net increase in contact stress of 150 kPa due to the construction of the raft at a 2m depth. Sub-divide the clay layer into two layers of 3m thickness each and do the following.



(a). Compute the total stress, water pressure and vertical effective stress at mid-depths of the two layers before construction of the raft foundation. (04 Marks)

(b). Compute the vertical stress increment at the same levels due to the construction of the raft foundation assuming a 1 horizontal to 2 vertical load spread? (04 Marks)

(c). Compute the total consolidation settlement of the clay layer due to the construction of the raft foundation; Pre-consolidation pressures of clay – at 3.5m depth = 65 kPa and at 6.5m depth = 95 kPa. (12 Marks)

Question 5.

Figure Q5 shows a sheet pile wall driven to a river bed in order to achieve a dry construction area. A 2.5m deep trench is excavated within the sheet piles. Water needs to be pumped out continuously from this trench bed to keep the excavation dry.

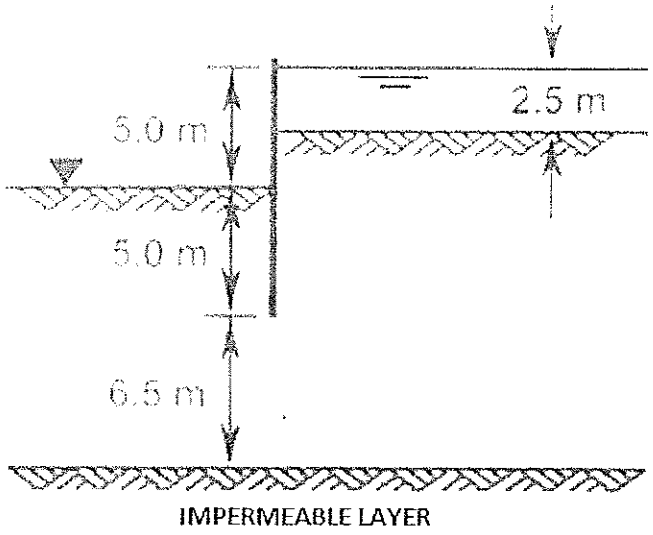


Figure Q5

(a). List four rules to be followed in drawing flow nets. (04 Marks)

(b). Draw the flow net following the rules listed in 5(a). Use the figure drawn to scale in Page 7; detach it from the question paper and attach the drawn flow net to the answer script. (08 Marks)

(c). Compute the rate of pumping required to keep the trench bed dry (permeability of river bed material is 5.0×10^{-5} m/s). (04 Marks)

(d). Indicate on the drawn flow net the location where the hydraulic gradient is maximum and compute the value. (04 Marks)

Question 6.

Bored and cast in-situ concrete pile foundations are becoming very common in Sri Lanka with lot of high rise buildings and elevated highways coming up all over the island.

(a). State four reasons to select bored piles for foundations of structures. (02 Marks)

(b). Draw a neat sketch to indicate how structure loads are transferred to the ground through a bored and cast in-situ pile. (04 Marks)

(c). Explain why the total capacity of a pile group is not equal to the summation of individual capacities of piles when piles are cast close to each other. (04 Marks)

(d). A 500mm diameter cast-in-situ concrete bored pile is to be formed in the soil profile shown in Figure Q6. Properties of different soil types shown in the figure are;
Loose granular fill: $\gamma = 20.0$ kN/m^3, $\phi' = 30°$, $K_s = 1.0$
Dense gravel: $\gamma = 21.0$ kN/m^3, $\phi' = 35°$, $K_s = 2.0$

Glacial clay: γ = 20.0 kN/m^3, C_u varies linearly from 120 kPa at 7 m depth to 220 kPa at 11m, Adhesion factor, α = 0.60

Determine the safe bearing capacity of the pile [take soil-pile friction angle, $\delta = (3/4)\phi$] with an overall factor of safety of 2.5. (10 Marks)

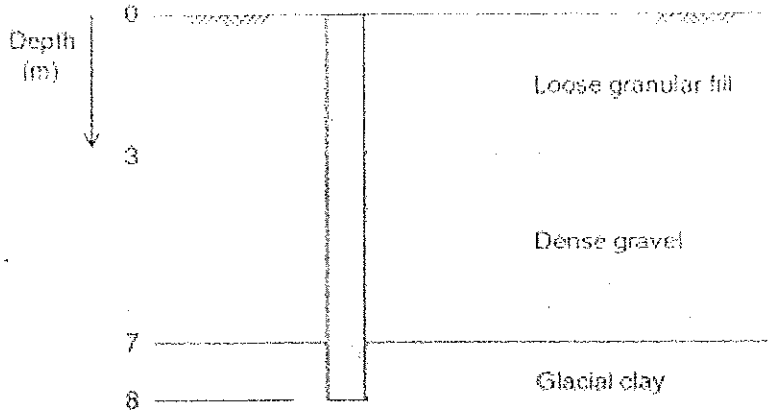


Figure Q6

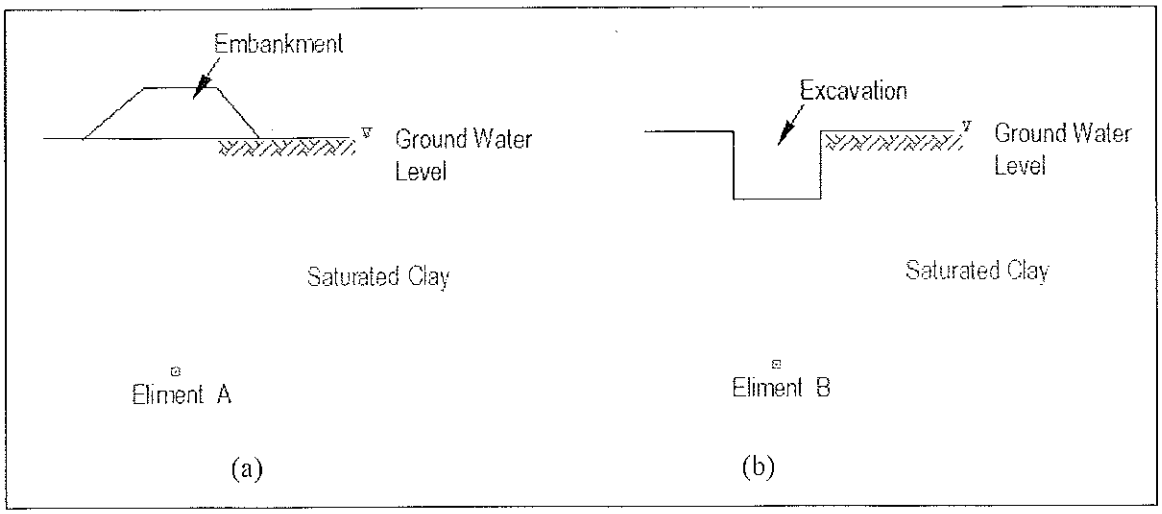
Question 7.

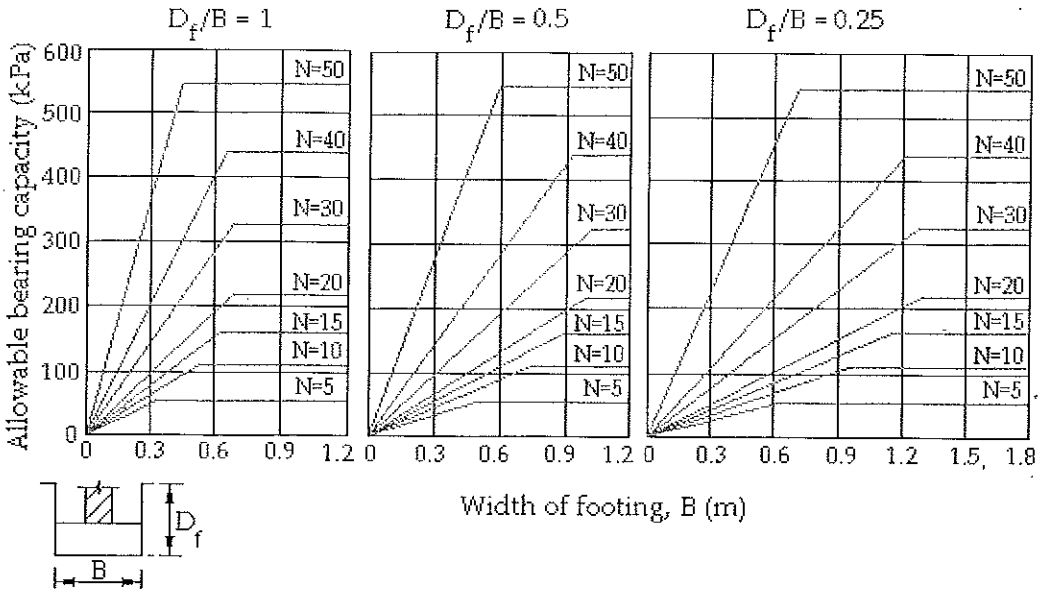
(a). Describe what do you understand when it is said that a particular soil layer is under "artesian condition" and explain how it happens. (04 Marks)

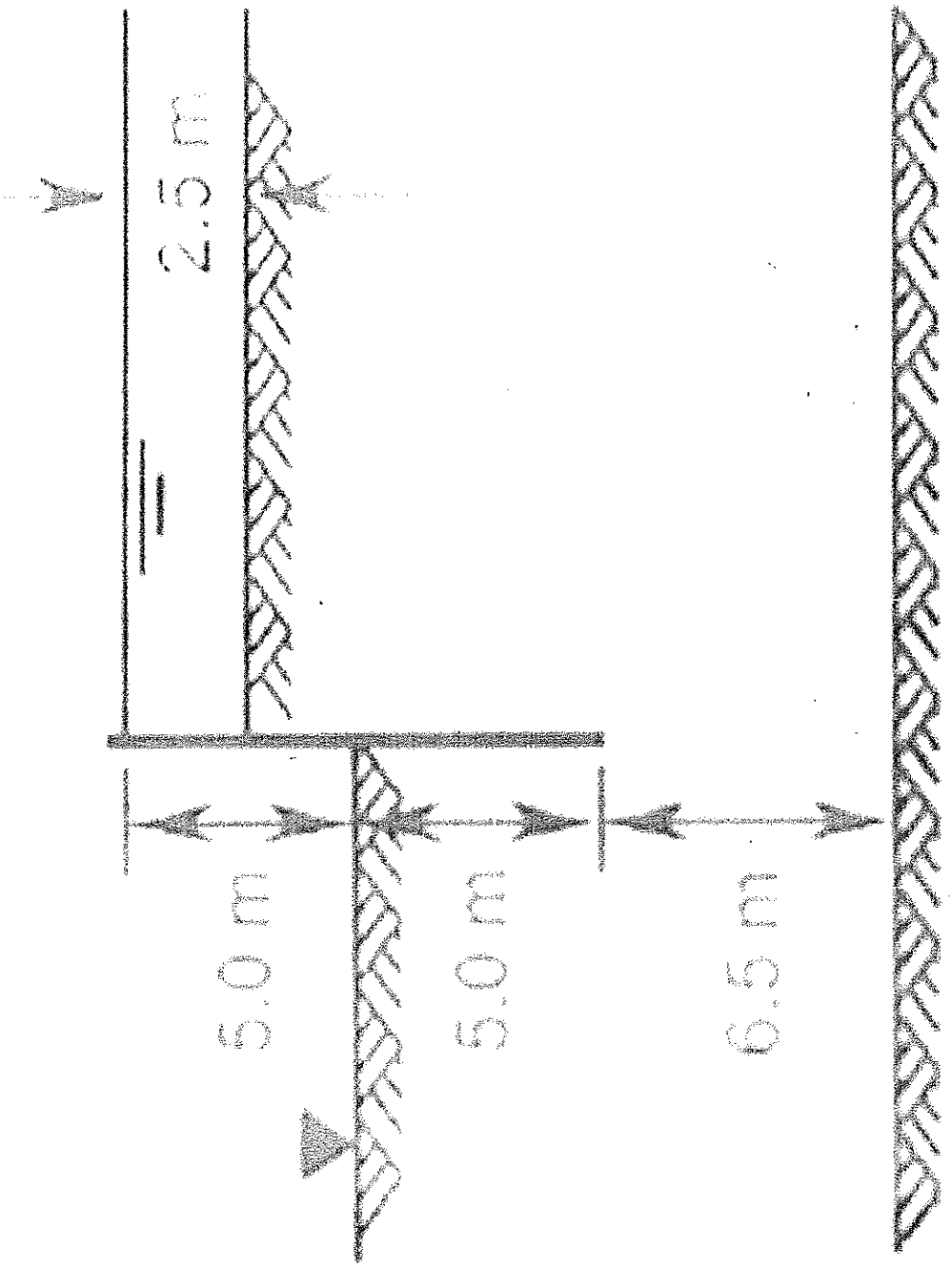
(b). Explain three reasons contributing to instability of slopes. (04 Marks)

(c). Explain the stress-strain behavior of loose and dense sands when sheared under drained conditions. (04 Marks)

(d). Figure Q7 (a) and (b) show two soil elements A and B respectively, subjected to two different stress conditions. Soil element A is subjected to an additional stress caused by an embankment construction. Soil element B is subjected to a reduction in stress caused by a trench excavation. Both soil types are saturated and normally consolidated. Plot the total and effective stress paths for the soil elements A & B separately on p, p′ - q plots, and comment on the short term and long term stability of each soil element. (08 Marks)




$D_f/B = 1$
$D_f/B = 0.5$
$D_f/B = 0.25$
Allowable bearing capacity (kPa)
600
500
400
300
200
100
0
N=50
N=40
N=30
N=20
N=15
N=10
N=5
0 0.3 0.6 0.9 1.2
0 0.3 0.6 0.9 1.2
0 0.3 0.6 0.9 1.2 1.5 1.8
Width of footing, B (m)
D_f
B


2.5 m
5.0 m
5.0 m
6.5 m