THE OPEN UNIVERSITY OF SRI LANKA
Department of Civil Engineering
Bachelor of Technology (Civil) - Level 6

135

CVX6444/CVX6530 - Geotechnics

FINAL EXAMINATION - 2021/2022

Time Allowed: Three (03) Hours

Date: 17-02-2023 (Friday) Time: 09:30 – 12:30 hrs.

Answer any five (5) questions. All questions carry equal marks.

Q1.

A drained direct shear test was conducted on a clayey soil sample having shear strength parameters $C' = 8.66$ kN/m² and $\Phi' = 30°$. Coordinates of the pole of the failure Mohr circle are $\sigma' = 60.00$ kN/m² and $\tau = 25.98$ kN/m².

Compute/Measure by drawing the Mohr circle,

(a). Normal stress and shear stress at failure. [04 Marks]

(b). Major principal stress and the orientation of the major principal plane with the horizontal. [08 Marks]

(c). Minor principal stress and the orientation of the minor principal plane with the horizontal. [08 Marks]

Q2.

The section through a dam is shown in Figure Q2. Determine the quantity of seepage under the dam in m³/day [04 Marks] and plot the distribution of uplift pressure on the base of the dam [16 Marks]. The coefficient of permeability of the foundation soil is 2.5×10^{-5} m/s.

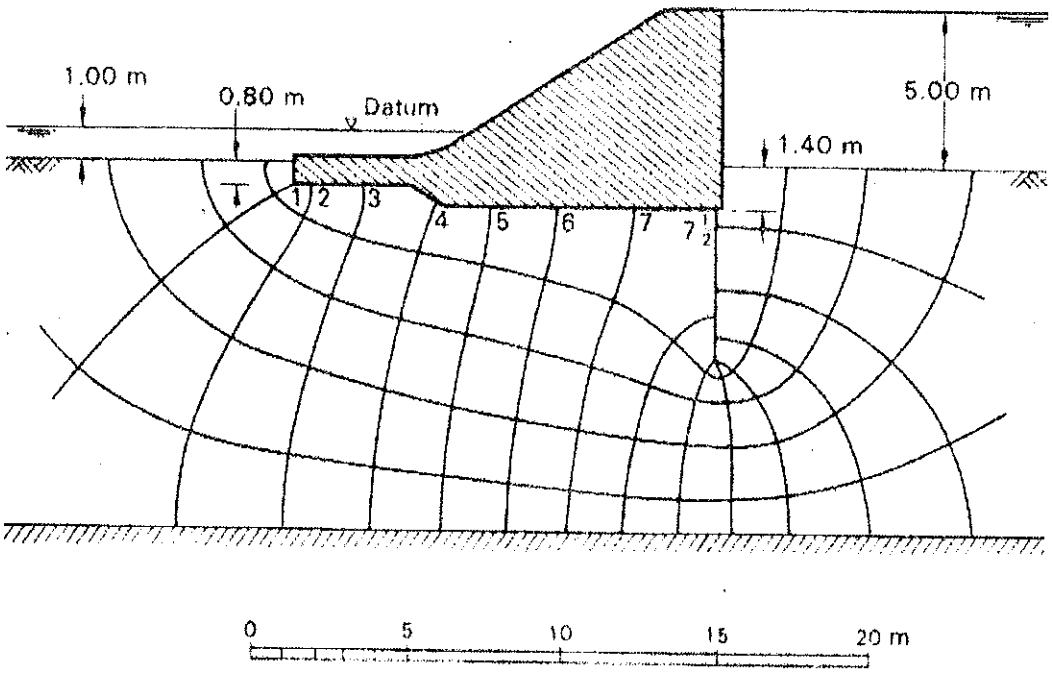


Figure Q2

Q3.

A gravity retaining wall shown in Figure Q3 is required to retain 5.0 m of soil. The backfill is a coarse grained soil with saturated unit weight =18.0 kN/m^3, and friction angle, ϕ = 30°. The existing soil below the base has the following properties; γ_{sat} = 20.0 kN/m^3, ϕ = 36°. The wall is embedded 1.0 m into the existing soil as shown. Ignore any passive resistance from the soil in front of the wall and use Rankine's theory to evaluate lateral earth pressures. Take the coefficient of friction between the base of the wall and the soil = tan ϕ and the density of wall material = 24.0 kN/m^3.

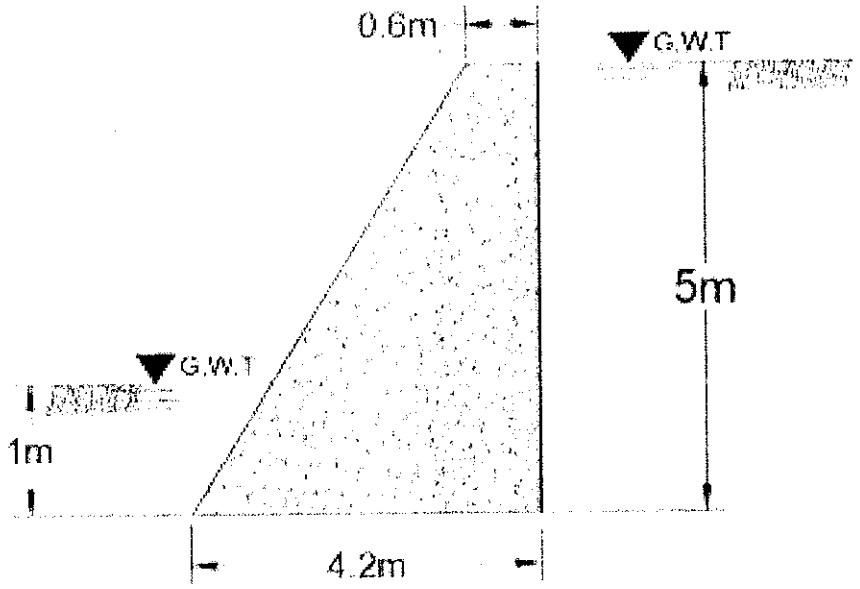


Figure Q3

(a). Suggest one action which could have been taken during the construction of the wall to improve the safety. [02 Marks]

(b). Determine the factor of safety against sliding. [06 Marks]

(c). Determine the factor of safety against overturning. [06 Marks]

(d). Determine the maximum and minimum bearing stresses exerted by the retaining wall. [06 Marks]

Q4.

The tri-axial shear test is the most versatile of all the shear strength testing methods for getting shear strength of soils.

(a). Draw total stress (in continuous line) and effective stress (in dotted line) failure Mohr circles and the failure envelopes in σ,σ'- τ space for three conventional triaxial loading tests each conducted with increasing cell pressures for (separate sketches for UU, CU and CD tests),

i) UU Test. [03 Marks]

ii) CU Test. [03 Marks]

iii) CD Test. [03 Marks]

(b). Following observations were made in a conventional consolidated undrained (CU) triaxial loading test conducted on a clay sample: cell pressure = 50.00 kN/m^2; deviatoric stress at failure = 74.64 kN/m^2; pore pressure at failure = 30.00 kN/m^2. Determine Φ' of soil if c' = 10.00 kN/m^2. [11 Marks]

Q5.

National Building Research Organization (NBRO) issues landslide warnings to residents in the central hill country prone to landslides during rainy seasons.

(a). Explain what makes the soil mass to lose its shear strength when the potential slip surface has saturated conditions. [04 Marks]

(b). Explain how subsurface drainage could improve slope stability. [04 Marks]

(c). A canal 8.0 m deep with side slopes of 60° has been excavated in a soil having the following geotechnical properties: $c = 25.00\ kN/m^2$, $\phi = 20°$, $\gamma_b = 19.80\ kN/m^3$.
Assuming that the same factor of safety is allowed on both cohesion and friction, calculate the factor of safety of the side slopes using Taylor's stability chart,

i) When the slope is completely submerged. [06 Marks]

ii) When the slope is subjected to a sudden complete drawdown. [06 Marks]

Q6.

A cross section of a piled raft foundation constructed in a clay layer is shown in Figure Q6. 50 piles (5 x 10) of 1.00 m diameter are located in a rectangular grid having a 5.00 m centre to centre distance in two perpendicular directions. The safe carrying capacity of an individual pile is 1000 kN and the group efficiency is 0.80. 18.0 m (D) deep piles are constructed in a 30.0 m thick clay layer having a rigid boundary at the bottom as shown.

(a). Determine the safe carrying capacity of the pile group considering the individual pile failure. [04 Marks]

(b). Evaluate the consolidation settlement of the pile group assuming that the pile group is loaded to its full safe capacity. [16 Marks]

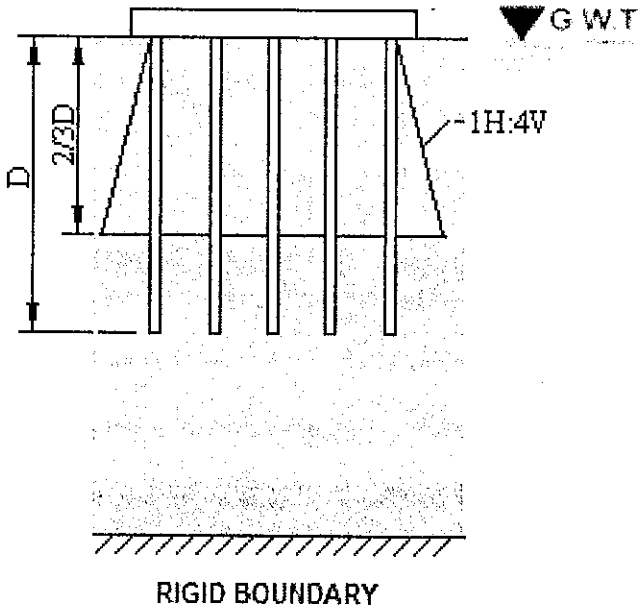


Figure Q6

Properties of clay,
$\gamma_{dry} = 18.2\ kN/m^3$
$\gamma_{sat} = 19.2\ kN/m^3$
$C_r = 0.05$; $C_c = 0.15$
$e_0 = 0.80$
Pre consolidation pressure = 205 kN/m^2

The ground water table is at ground level.

(Hint: The settlement of a pile group in clay is calculated on the assumption that the group acts as a fictitious buried raft foundation located at a depth of 2/3 of the length of piles as shown in Figure Q6. The dimensions of the fictitious raft are based on a stress distribution of 1H: 4V. Further, this contact stress of the fictitious raft is dispersed 1H: 2V. Use only a single clay layer to simplify your settlement calculation.)

Q7.

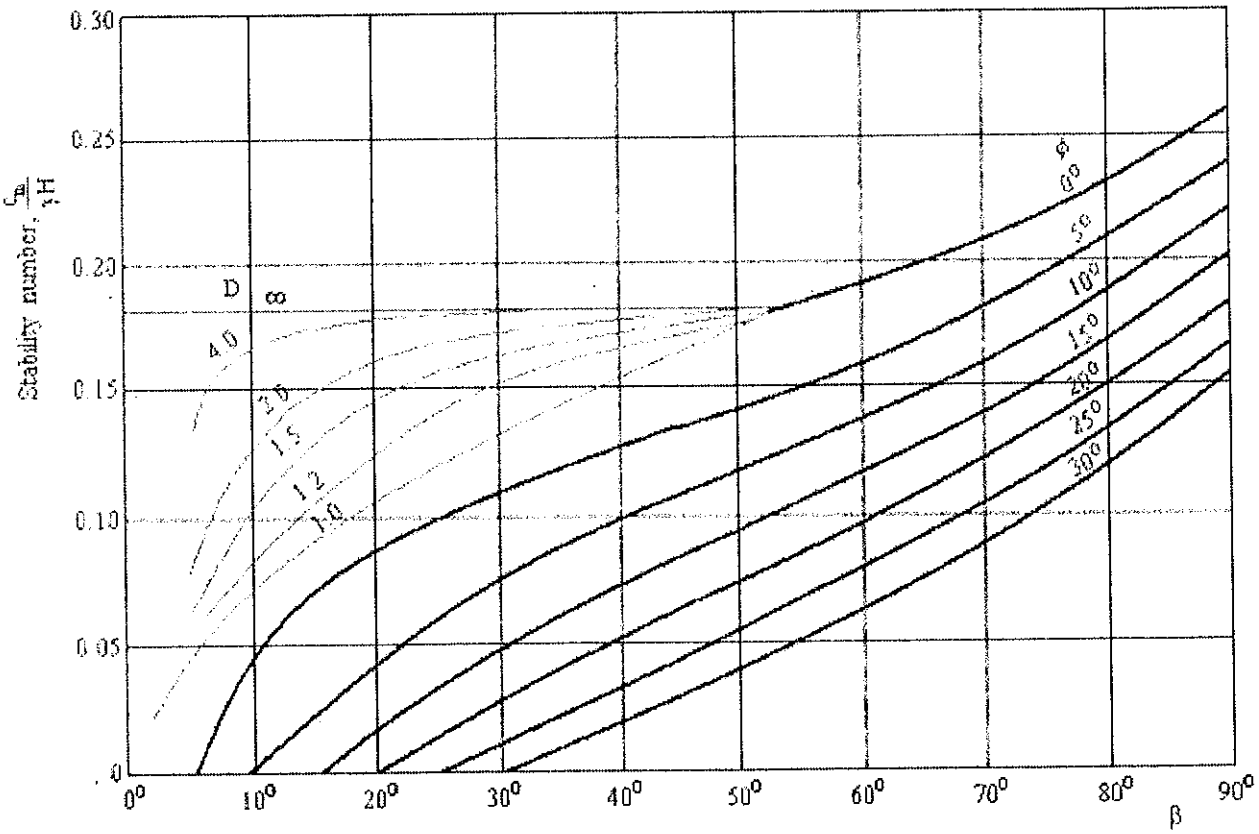
(a). Sketch a typical load and deflection Vs time graph observed during a maintained load test conducted on a bored pile and discuss the usefulness of the outcome. [06 Marks]

(b). Differentiate between individual failure and block failure in a pile group. [05 Marks]

(c). Discuss how Standard Penetration Test N value (SPT N) can be used in designing shallow foundations. [05 Marks]

(d). Write a short note on quicksand condition. [04 Marks]

Annex



Taylor's Stability Chart