EGT2
ENGINEERING TRIPOS PART IIA

Wednesday 20 April 2016   9.30 to 11

Module 3D1

GEOTECHNICAL ENGINEERING I

Answer not more than ***three*** *questions.*

All questions carry the same number of marks.

The ***approximate*** *percentage of marks allocated to each part of a question is indicated in the right margin.*

Write your candidate number ***not*** *your name on the cover sheet.*

STATIONERY REQUIREMENTS
Single-sided script paper
Graph paper

SPECIAL REQUIREMENTS TO BE SUPPLIED FOR THIS EXAM
CUED approved calculator allowed
Attachment: 3D1 & 3D2 Geotechnical Engineering Databook (19 pages)
Engineering Data Book

10 minutes reading time is allowed for this paper.

You may not start to read the questions printed on the subsequent pages of this question paper until instructed to do so.

1 A 30 m diameter circular concrete storage tank is to be constructed at a site comprising of 8 m of silty clay, underlain by dense sand. The water table can be taken at the surface. The bearing pressure of the tank is expected to be 400 kPa, when full, and 50 kPa when empty.

A specimen taken from a depth of 4 m is tested in the oedometer with the results shown in Fig. 1. The specific gravity of the clay G_s is 2.70 and the natural water content of the specimen is 49%.

(a) Discuss potential concerns for the integrity and performance of the tank due to settlements. [15%]

(b) Estimate the expected settlement once the tank is quickly filled. List your assumptions and justify them. Is the estimated settlement likely to cause damage to the structure? [25%]

(c) What is your level of confidence on the results from part (b)? What are your concerns with your calculations and how would you improve your prediction? [20%]

(d) It is decided that the site will be preloaded before construction of the tank with a temporary fill with the resulting bearing pressure equal to that which will eventually be exerted by the full tank. The fill will then be removed and the tank constructed. Estimate the expected settlement when the tank is first filled to its capacity. [25%]

(e) The solution outlined in part (d) raises some issues about constructibility. Explain what these may be and suggest solutions or alternatives where appropriate. [15%]

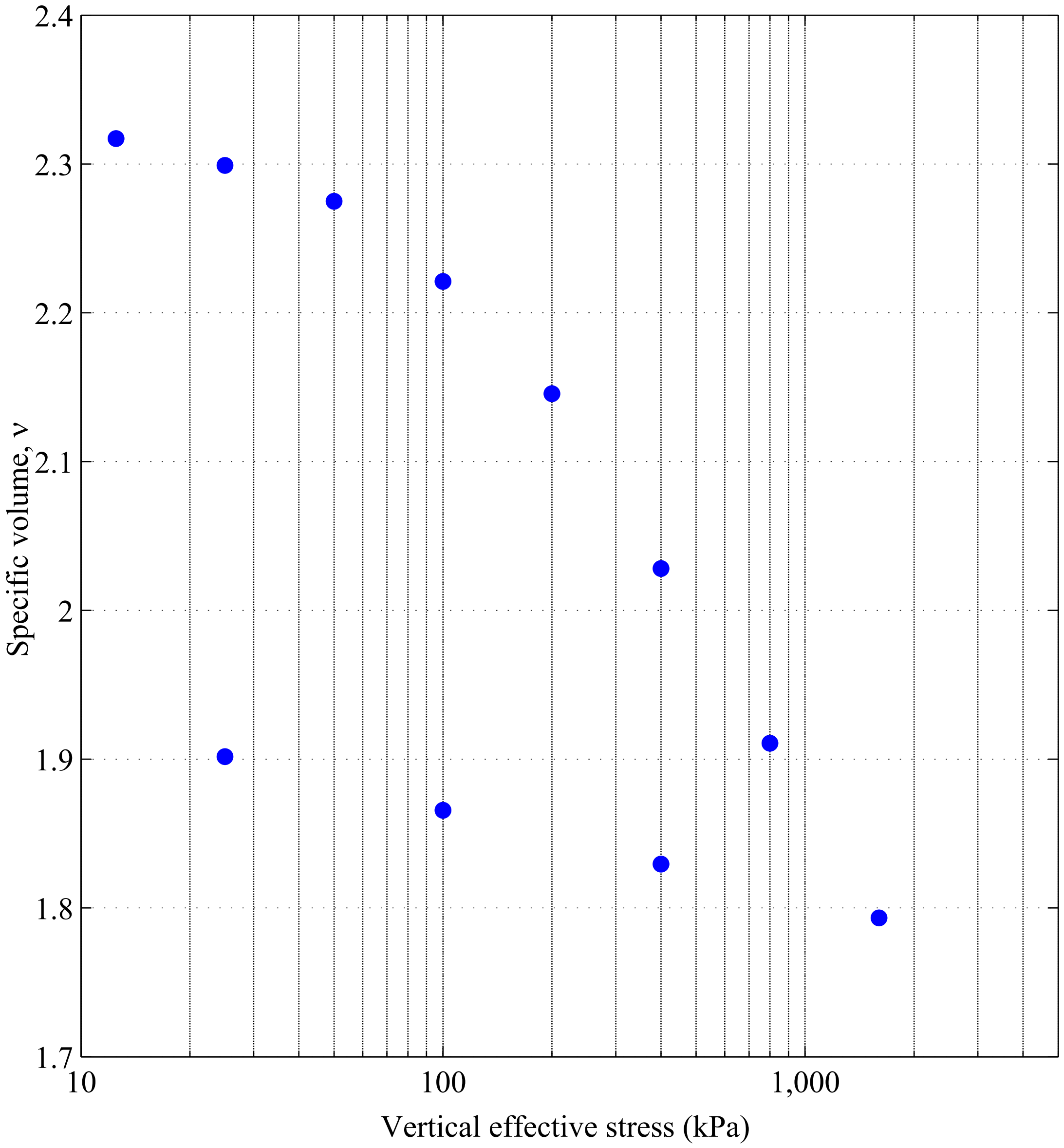

Fig. 1

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2 A new 4 m high embankment is to be constructed across a site consisting of 1 m of medium dense sand, underlain by 12 m of silty clay, and 3 m of dense clean sand. The sand has a dry unit weight of 18 kN m^{-3} and a saturated unit weight of 19.5 kN m^{-3}. The water table is at 1 m depth.

(a) The embankment will be built with compacted silty sand with specific gravity $G_s = 2.67$. Results of the standard compaction test are given below. Plot the results and comment on the quality of the test. [20%]

Water content (%)	4.89	7.45	10.01	12.57	16.12	18.09
Dry Unit Weight (kN m^{-3})	18.2	19.0	19.8	19.3	18.7	17.9

(b) A specimen of silty clay is retrieved from a depth of 6 m. The specimen is tested in the oedometer. Results from the load increment from 50 kPa to 140 kPa are given in Fig. 2. The specimen has a specific gravity $G_s = 2.72$, and initial natural water content of 73%. Estimate the settlement of the embankment. Discuss any assumptions you make and their impact on your estimate. [30%]

(c) Estimate the time required for 90% of the settlement of the embankment to be completed. [20%]

(d) The settlement after 1 year is 38 cm. Estimate the coefficient of consolidation from field data. How does it compare with the laboratory derived value? Explain the reasons for any discrepancies. Estimate the time for 90% of the embankment settlements to be completed using the new estimate for the coefficient of consolidation. [20%]

(e) Further testing shows that the soil pre-consolidation pressure is 65 kPa. Propose a solution to reduce both the potential for differential settlements and the time it takes for the embankment to settle. Discuss advantages and disadvantages of your proposed solution. [10%]

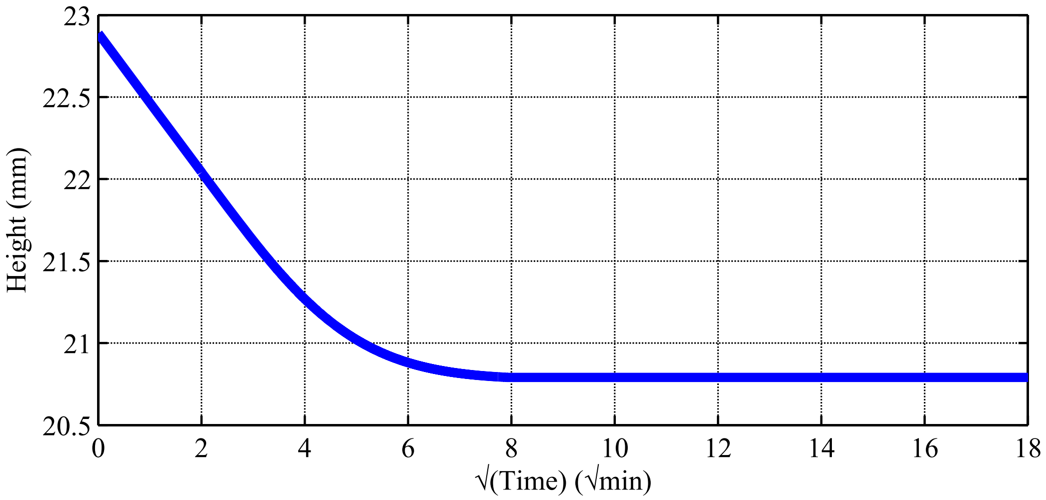

Fig. 2

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3 A retaining wall is to be constructed to support an 8 m deep basement excavation in sand as shown in Fig. 3(a). The sand has a voids ratio of 0.8, specific gravity of 2.65 and angle of friction of 33°.

(a) Calculate the active and passive earth pressure coefficients K_a and K_p and the dry and saturated unit weights of the soil. [10%]

(b) If no propping is to be used and the sand is dry, what are the earth pressure distributions acting on the wall and hence what is the minimum depth D below the excavation level that the retaining wall must penetrate? [40%]

(c) If the water table is at the ground surface and pumping is used to draw the water table down to the base of the excavation, calculate the earth and fluid pressures acting on the retaining wall if it penetrates 5 m below the excavation level. Is the wall stable? [40%]

(d) If a prop is installed at the ground surface as shown in Fig. 3(b), with all other conditions remaining as in part (c), is the wall stable? [10%]

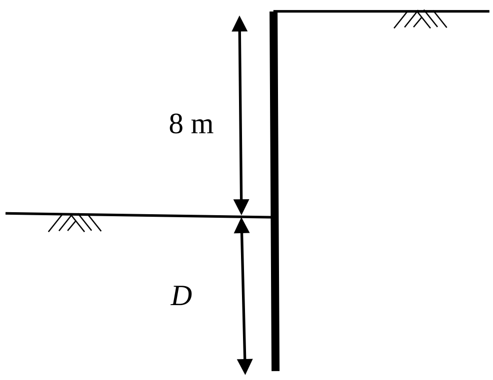

Fig. 3(a)

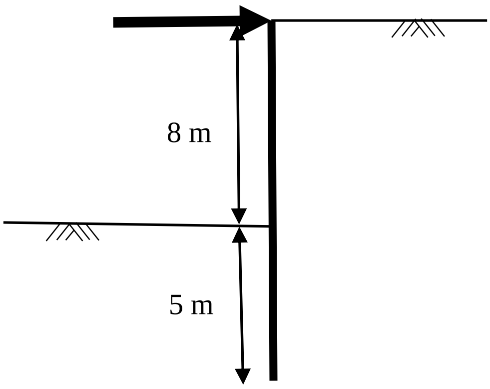

Fig 3(b)

4 A rigid strip footing of width B is placed at the top of a clay slope as shown in Fig. 4. The slope angle is ϑ. The undrained shear strength of the soil is s_u.

(a) Assuming that the soil is weightless, calculate the relationship between the maximum vertical load V that can be applied to the foundation and the slope angle ϑ. [25%]

(b) If the applied load is inclined such that the foundation carries both a vertical load V and a horizontal load H, derive an expression for combinations of V and H that can cause failure of the foundation, considering both sliding and bearing failure. [45%]

(c) At what vertical load will the transition between sliding and bearing capacity failure be observed? [10%]

(d) Discuss qualitatively how the answers in parts (a) through (c) will change if the soil is not weightless for: [20%]

(i) $\vartheta = 0°$

(ii) $\vartheta = 30°$

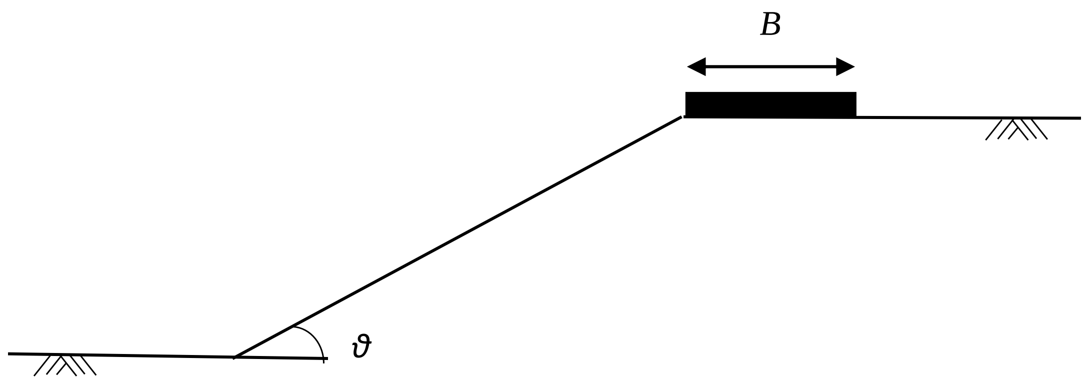

Fig. 4

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