UNIVERSITY COLLEGE LONDON

University of London

EXAMINATION FOR INTERNAL STUDENTS

For The Following Qualifications:-

B.Eng. *M.Eng.*

Civil Eng 1003: Soil Mechanics part I

COURSE CODE	:	**CIVL1003**
UNIT VALUE	:	**0.50**
DATE	:	**02-MAY-06**
TIME	:	**10.00**
TIME ALLOWED	:	**3 Hours**

06-C0274-3-120

TURN OVER

CIVL1003 SOIL MECHANICS 1
First year BEng/MEng
Examination 2006

Time allowed: 3 HOURS

Answer FIVE questions

The unit weight of water may be taken as $10\,kN/m^3$.

Q1. (a) Derive the two expressions for the dry & saturated unit weight of soil using the phase diagram.

[7 marks]

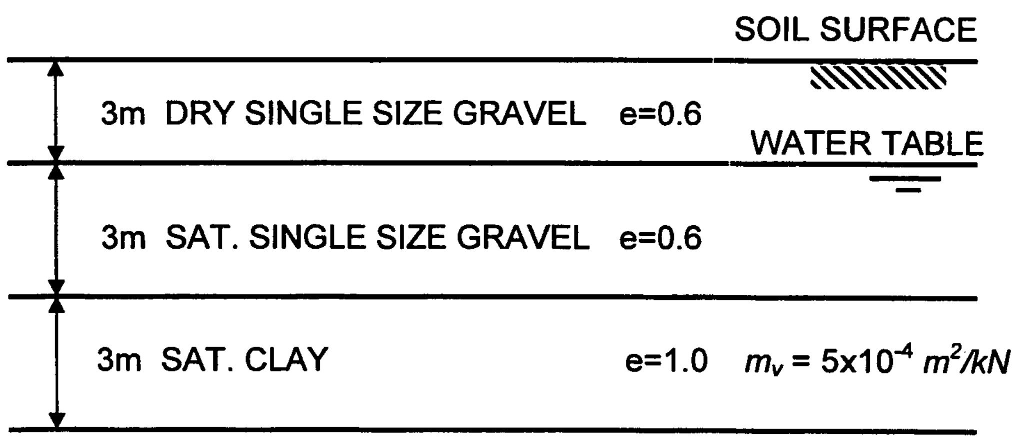


Figure Q1

(b) Figure Q1 is a soil profile showing gravel overlying clay. If the specific gravity, G_S, of both gravel and clay particles is 2.7, determine and draw the variation of total vertical stress, pore water pressure and effective vertical stress with depth for the soil profile.

[7 marks]

(c) If the water level is lowered to the gravel-clay interface and the gravel becomes dry, determine the change in effective stress at the middle of the clay layer, and then calculate the consequent settlement of the clay.

[6 marks]

The coefficient of volume compressibility, m_v, of the clay is $5\times10^{-4}\ m^2/kN$.

TURN OVER

Q2 Figure Q2 illustrates a constant head permeameter in which water flows vertically upwards through the apparatus.

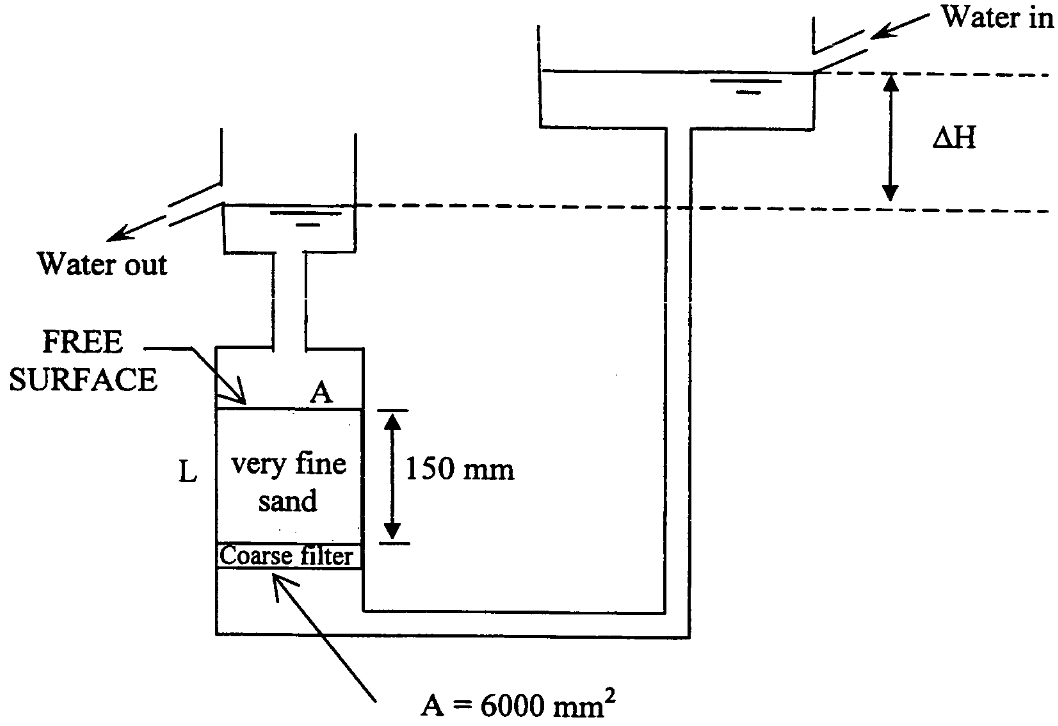


Figure Q2

(a) Explain and show the relevant formulae necessary for the permeability of a soil to be determined.

[7 mark]

(b) Table Q2 gives data from this constant-head permeameter on a sample of initially dense fine sand. Plot the graph of flowrate, Q, against hydraulic gradient, i, and estimate the permeability of the sample when the flow rate is low.

i	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
Q (cm^3/s)	0	0.50	1.00	1.50	2.00	2.73	3.75	4.77	5.80

Table Q2

[8 marks]

(c) Explain why there is a change in slope at high flow rates.

[5 marks]

CONTINUE

Q3 Figure Q3, drawn to scale, (**separate sheet which must be returned with your answer book**) shows a section of a model sheet pile wall inside a large tank with a concrete apron set 0.6 m from it.

(a) Draw all the boundary flow lines and equi-potential lines, and then draw one additional flow line between the two boundary flow lines and an appropriate number of equi-potential lines to ensure a 'square' flow net results. Assuming that the elevation head is zero at the base of the tank, calculate and mark on the diagram the total head of each equi-potential line assuming that the water level at the upstream face is at a height *x* m.

[10 marks]

(b) By choosing an appropriate equi-potential line below the downstream soil surface, determine the height of water, *x*, which will initiate piping.

[6 marks]

(c) Explain whether this apron encourages or discourages piping.

[4 marks]

Q4 Figure Q4 shows the cross-section of an infinite slope of soil with thickness h_1 overlying impermeable rock. The slope inclines at an angle α to the horizontal. Water flows parallel to the surface at a depth h_2 below the soil surface. Assuming the angle of friction between the soil and rock and the unit weight of soil are ϕ and γ respectively:

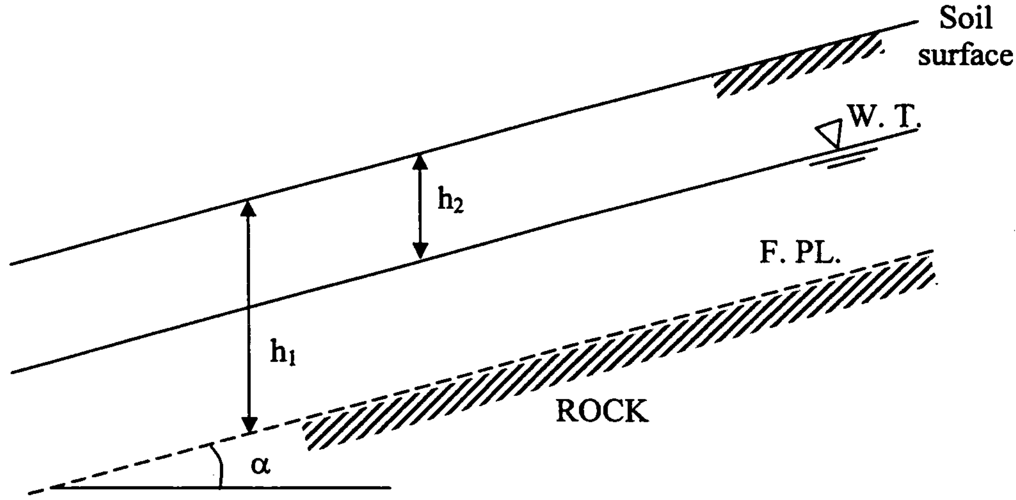


Figure Q4

(a) Calculate the pore water pressure acting on the potential failure plane illustrated in Figure Q4.

[5 marks]

(b) Develop an expression for the slope angle, α, when the soil is just about to fail on the rock surface.

[10 marks]

(c) If however the rock was permeable, the water surface remained unchanged and vertical flow occurred, show that the pore water pressure on the failure plane is zero and consequently the soil will fail when $\alpha = \phi$.

[5 marks]

TURN OVER

Q5 Figure Q5 is a section of a 20m high rock fill dam with a thin clay core. Water tables on either side of the clay core are shown.

It is envisaged that the clay underlying the dam may be at its residual angle of friction and the dam may fail by the combined effect of the two blocks A and B on the failure planes shown. Assuming no shear develops between A and B on the clay core, determine the slope angle, α, of the downstream slope, so that the dam is just in equilibrium.

[20 marks]

Rockfill

$\phi = 30°$

$\gamma_{dry} = 17\,kN/m^3$

$\gamma_{sat} = 20kN/m^3$

Clay

$\phi_r = 10°$

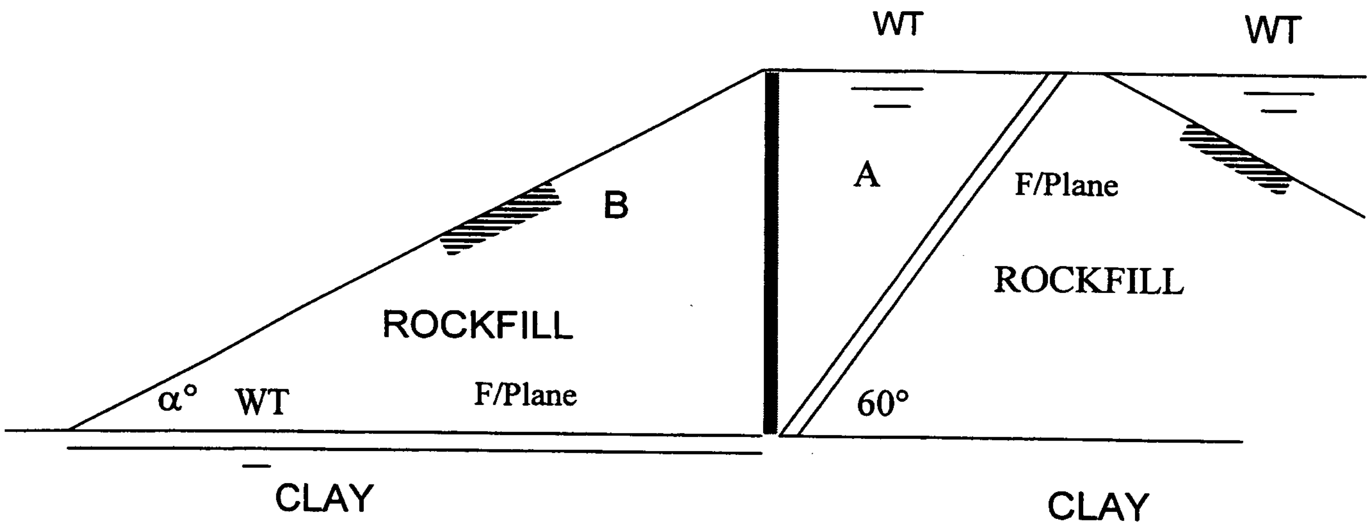


Figure Q5

CONTINUE

Q6 A frictionless vertical steel sheet pile wall is driven into saturated sand having a water table 4m below its surface. The wall is first propped at the surface and then sand excavated to the water table on one side of the wall.

Determine the total depth the wall has to be driven so that it is just in moment equilibrium about the prop after excavation is complete. The sand has a unit weight of 20 kN/m^3 and an angle of friction of 30°.

[16 marks]

How might you include a factor of safety in your calculation?

[4 marks]

Q7 A sample of soft silty clay is first consolidated in the triaxial apparatus to reach a cell pressure of 200 kN/m^2 and a pore water pressure of 50 kN/m^2 after consolidation is complete. The test is continued under undrained loading with the cell pressure held constant at 200 kN/m^2 until failure occurs.

Measurements of deviator stress and pore water pressure during this stage of loading are shown in Table Q7:

Deviator Stress $(\sigma_1-\sigma_3)$ kN/m^2	0	20	40	60	74	76
Pore Water Pressure (u) kN/m^2	50	65	86	110	126	148

Table Q7

Using stress axes of $(\sigma_1+\sigma_3)/2$, $(\sigma_1'+\sigma_3')/2$ and $(\sigma_1-\sigma_3)/2$ plot the total and effective stress paths on graph paper.

[10 marks]

Draw the failure effective and total stress circles and determine the constant volume angle of friction of the clay and its undrained strength.

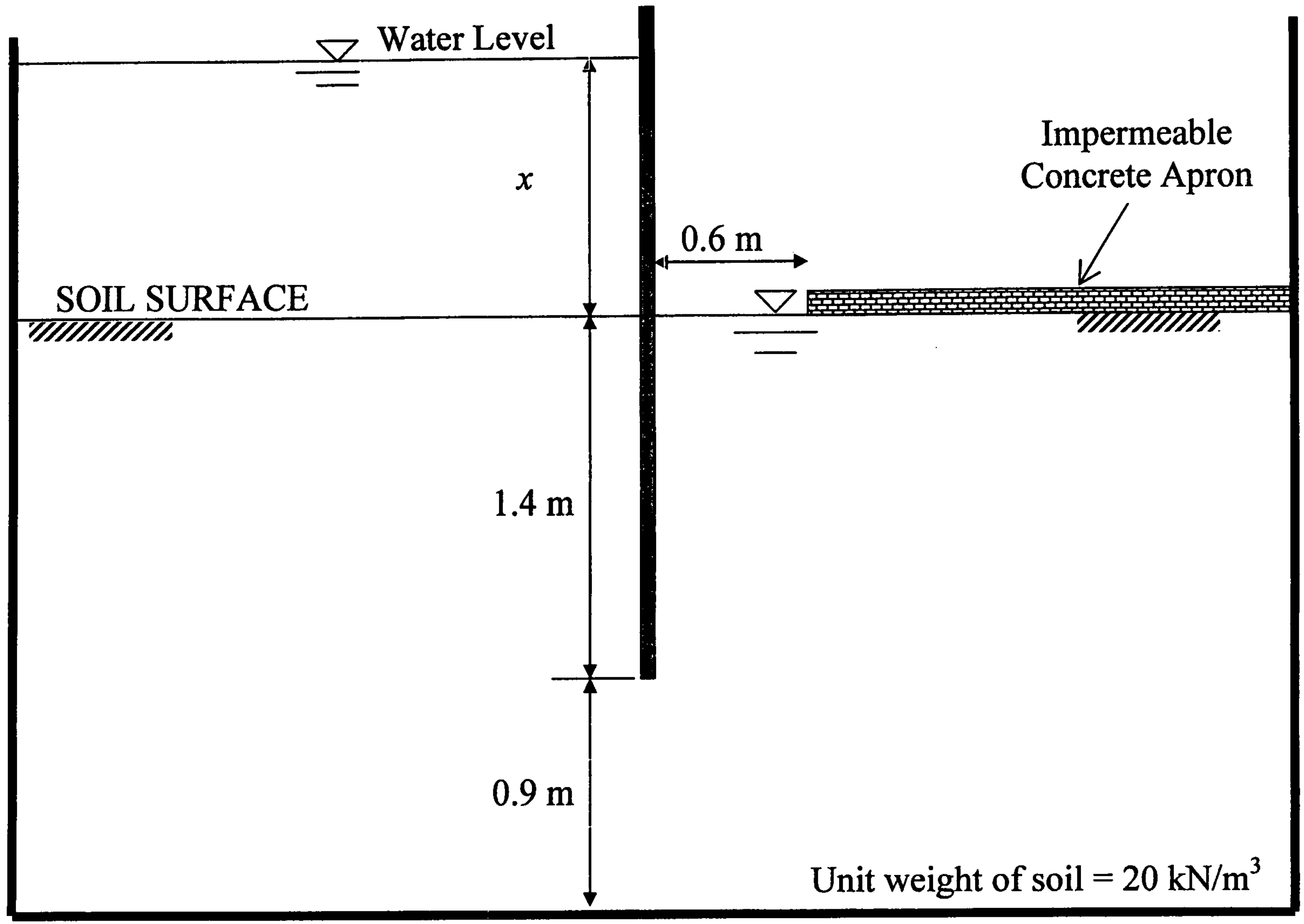
[6 marks]

Explain how the undrained strength would be used in determining horizontal stresses behind a retaining wall when the soil is in the active state.

[4 marks]

END OF PAPER

FIGURE Q3



Candidate Identifier ______________

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