

DTENS PAST PAPERS
TECHNICAL

SIR ARTHUR LEWIS COMMUNITY COLLEGE
DIVISION OF TECHNICAL EDUCATION AND MANAGEMENT STUDIES

EXAMINATION SESSION : December 2007 Examination
TUTOR(S) : Mr. Damian Combie
PROGRAMME TITLE : Construction Engineering
PROGRAMME CODE : 3BD-CON-AD
COURSE TITLE : Soil Mechanics
COURSE CODE : BSC106
CLASS : Year 2
DATE : December 7th 2007
TIME : 9:00 a.m.
DURATION : 3 hours
ROOM : SME R1
INVIGILATOR(S) : Ms. R. Isaac, Mr. N. Hyacinth



#S17

INSTRUCTIONS:

- Attempt not more than **five** questions
- Begin each question on a separate sheet
- Write your ID Number on *each* answer sheet
- Students must write legibly
- Students **must** show sufficient working steps to indicate the method of solution
- Any formulae used must first be stated
- Students must sign **IN** and **OUT** of examination class list

Question 1

A sample of soil, $\frac{1}{1000} \text{ m}^3$, weighed in its natural state 1.82 kg, the degree of saturation being 67.5%. After oven drying at 105°C the sample weighed 1.53 kg. Find:

- the specific gravity of the solids. (5 marks)
- the natural water content. (1 mark)
- the void ratio. (1 mark)
- the bulk density, the dry density, the saturated density and the submerged density. (5 marks)
- A borehole on a building site has the soil profile shown in **Figure 1**. Find the effective stress at the bottom of the clay. (8 marks)

Question 2:

The following results were obtained from a compaction test using the 2.5kg rammer.

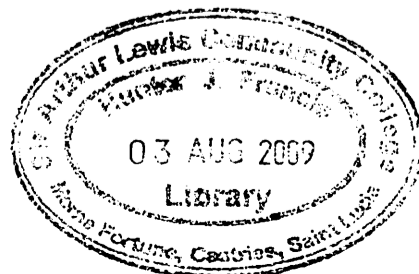
Mass of mould and wet sand (g)	2798	3072	3239	3296	3265	3211
Water content (%)	8.1	9.9	12.0	14.3	16.1	18.2

The weight of the compaction mould less its collar and base was 1130g. The volume of the mould is 1000 cm^3 , and the soil had a specific gravity of 2.7.

- Plot the curve of dry density against moisture content and determine the optimum moisture content and maximum compaction. (10 marks)
- Plot the five per cent air voids line. (4 marks)
- Calculate the moisture content necessary for complete saturation at this maximum dry density. (2 marks)
- What are the values of void ratio, porosity and degree of saturation at its condition of optimum moisture content? (4 marks)

Question 3:

- In a laboratory a constant head permeability test was conducted on a silty sand. For the constant head the following data were obtained.
 - Quantity of water discharged during test = 250 cm^3 .
 - Length of specimen = 11.43cm
 - Time required for a given quantity of water to be discharged = 65 secs.
 - Head (difference between manometer levels) = 5.5cm.
 - Area of cross-section of sample 2000 mm^2 .Determine the coefficient of permeability. (5 marks)
- In a laboratory, a falling-head permeability test was conducted on a silty soil. For the falling-head apparatus the following data were obtained.
 - Length of specimen = 15.8cm
 - Diameter of specimen = 10.16cm
 - Cross-sectional area of burette = 1.83 cm^2 .



- iv) Hydraulic head at beginning of test (h_1) = 120.0cm
- v) Hydraulic head at end of test (h_2) = 110.0cm
- vi) Time required for water in the burette to drop from h_1 to h_2 = 20.0 mins.
Determine the coefficient of permeability. (5 marks)
- c) A well point lowering is carried out on a proposed construction site and after steady conditions have been obtained the readings in the observation wells are as shown in **Figure 2**. Determine the coefficient of permeability of the sandy soil. (5 marks)
- d) A well point lowering is carried out on a proposed construction site and after steady conditions have been obtained the readings in the observation wells are as shown in **Figure 3**. Determine the coefficient of permeability of the sandy soil. (5 marks)

Question 4:

In an un-drained tri-axial test on three specimens of sandy clay taken from a depth of 3 m below ground level the following results were obtained:

Cell pressure (kN/m ²)	Deviator stress (kN/m ²)
200	221
400	365
600	505

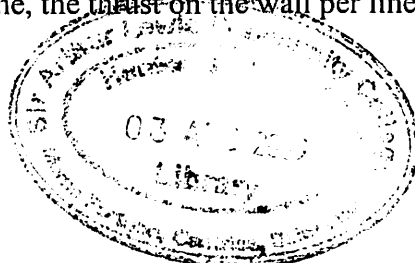
- a) Draw the Mohr diagram and determine the apparent cohesion and angle of shearing resistance of the soil. (12 marks)
- b) Derive Coulomb's equation for this soil. (2 marks)
- c) If a superimposed load of 60kN/m² is applied to the top of the sandy clay layer, at ground level, find the permissible shear stress at a depth of 3m, assuming the Coulomb equation remains unchanged and $\gamma = 2000\text{kg/m}^3$. The water table is below the 3 m level. (6 marks)

Question 5:

Un-drained shear-box tests on samples of sandy clay gave the following results;

Normal pressure (kN/m ²)	50	125	250
Shearing resistance (kN/m ²)	61	83	119.5

- a) Find the apparent cohesion and angle of shearing resistance. (10 marks)
- b) Derive Coulomb's equation for this soil. (2 marks)
- c) Find the value of apparent cohesion which would be expected from an unconfined compression test on a sample of the same soil. (4 marks)
- d) If another specimen of this soil is subjected to an un-drained tri-axial test with lateral pressure 280 kN/m², find the total axial pressure at which failure would be expected. (4 marks)
- 7) **Figure 4** shows a retaining wall with a cohesive backfill.
 - i) Find the depth of tension cracks. (4 marks)
 - ii) Find for this slip plane, the thrust on the wall per lineal metre. (16 marks)



Question 6:

Figure 5 shows a retaining wall and silt backfill. If the unit weight of the silt is 17.66 kN/m^3 , the cohesion 15 kN/m^2 , the wall adhesion 12 kN/m^2 , the angle of shearing resistance of the retained earth is 18° , and the angle of friction between the wall and the retained earth is 12° ;

- a) Find the depth of tension cracks z_0 . (3 marks)
- b) Find the maximum active thrust on the wall by the method of wedges using the trial slip plane shown. (17 marks)

Question 7:

Figure shows the backfill behind a smooth vertical retaining wall.

- a) Determine the shear force in kN which must be mobilised beneath the base of the wall to prevent movement away from the backfill. (16 marks)
- b) At what height above the base does the horizontal thrust act? (4 marks)

Question 8:

A vertical sheet pile wall is shown in **Figure 6**. The properties of the soil both behind and in front of the wall are $\gamma = 21 \text{ kN/m}^3$, $\phi = 30^\circ$, and $c = 0$. Determine the minimum penetration depth of the pile to achieve free earth support conditions, using Rankine Theory. (Give answer to 2.d.p). (20 marks)

FORMULAS

SOIL DEFINITIONS:

i) $\gamma = \frac{W}{V}$ ii) $\gamma_d = \frac{W_s}{V}$ iii) $m = \frac{W_w}{W_s}$ iv) $V_s = \frac{W_s}{G_s \gamma_w}$
v) $\gamma_{sat} = \frac{W_s + W_w}{V}$ vi) $e = \frac{V_v}{V_s}$ viii) $n = \frac{V_v}{V}$ ix) $S_r = \frac{V_w}{V_v}$

COMPACTION:

i) $\gamma_d = \frac{\gamma}{1 + m}$ ii) $\gamma_d = \frac{G_s \gamma_w (1 - V_a)}{1 + m G_s}$

PERMEABILITY:

i) $k = \frac{Q}{A} \times \frac{l}{t} \times \ln \frac{H_1}{H_2}$ ii) $k = \frac{Q}{A} \times \frac{l}{AH}$
iii) $k = \frac{\frac{Q}{l} \ln \frac{r_1}{r_2}}{\pi(z_2^2 - z_1^2)}$ iv) $k = \frac{\frac{Q}{l} \ln \frac{r_1}{r_2}}{2\pi d(z_2 - z_1)}$



$1000 \text{ litres} = 1 \text{ m}^3$
 $1 \text{ m}^3 = 10^9 \text{ mm}^3$

END OF EXAMINATION