CONCORDIA UNIVERSITY
Department of Civil Engineering
Foundation Design - CIVI 435/4

Professor: A. M. Hanna | **Final Examination** | Time: 9:30 - 12:30
Open Book Examination | Winter 1995 | Date: May 3, 1995

Further data required may be reasonably assumed

ALL QUESTIONS ARE OF EQUAL MARK

Question (1)

Explain briefly:

a. Given only the specific gravity test results, determine if the soil is slightly or heavily mixed up with organic material.
b. Repeat question (a) above if you were given only the results of the consolidation test.
c. Reasons for failure of a high rise tower after 5 years.
d. Reasons for failure of a highly statically indeterminate structure, immediately after construction.
e. Reasons for failure of a hospital built on clay after heavy rains.
f. Governing factors for determining the depth of a bridge foundation beyond the factors given for shallow foundation.

Question (2) p. 789

Figure Question No. 2 shows the plan of three columns A, B & C (all of 400x400 mm in dimension) which form part of a reinforced concrete skeleton building. The building is of three stories situated in an area where the soil formation is soft clay to a great depth where the cohesion c = 35 kPa and unit weight is 18 kN/m^3. The water table is at 3.0 meters below the ground level. Design a combined foundation for the three columns. The foundation depth is 1.5 m below the ground level and factor of safety against bearing capacity is 3. Draw (without calculations) a neat sketch showing clearly the main reinforcement in elevation.

Column	Dead Load (tons)	Live Load (tons)
A	35	25
B	70	60
C	60	45

$S_T = q \frac{12}{N} \left(\frac{B}{1+B}\right)^2$ Terzaghi & Peck

Question (3)

a fine silty sand deposit, standard penetration testing provided the following values of N (blows/0.3 m):

Depth in meters	1.5	3.0	4.5	6.0	7.5	9.0	10.5	12.0
N value	14	17	24	28	30	30	28	31

$E_s = 766N$ (kN/m²)

The water table is found at a depth of 2.0 m. Above the water table, the unit weight of the silty sand is 18.6 kN/m^3 and the saturated unit weight is 19.8 kN/m^3. A square footing 3.0 x 3.0 m is founded at a depth of 1.50 m in this deposit. Determine the allowable load on the footing to assure factor of safety of 3 against bearing capacity and maximum allowable settlement of 20 mm.

p. 89 & 91 ϕ & C_u

$Z_2 = 2B = 2(3) = 6$; $D_f + Z_2 = 1.5 + 6 = 7.5$ m

• q_u p. 163 ? • $q_{net(all)}$ from Smart p. 212

Question (4) p. 799

The concrete retaining wall shown in figure Question No. 4 retains a dry sand backfill. The angle of shearing resistance of the sand, as determined by triaxial testing, is 35°. As shown, there is a surcharge loading on the surface of the backfill. The unit weight of the fill is 17.8 kN/m^3.

a. Determine the factor of safety against overturning of the wall about its base. (Neglect passive earth pressure effects at the toe).
b. If the foundation soil has a cohesion of 30 kPa, an angle of shearing resistance of 25°, and a unit weight of 18 kN/m^3, determine the factor of safety against bearing capacity failure.
c. Determine the factor of safety against sliding (Neglect passive earth pressure effects at the toe).

Question (5)

Compare the ultimate skin friction capacity of two piles driven into sand. Both piles are driven to a depth of 8 m. One pile is 0.30 m in diameter, the other is 0.60 m in diameter. The sand is compacted to an angle of shearing resistance of 35°. The unit weight of the saturated sand is 19 kN/m^3 and the dry unit weight is 17.5 kN/m^3. The piles are of concrete with a unit weight of 24 kN/m^3. The water table is at a depth of 4 m.

Note: The tip capacities of the piles are not required.

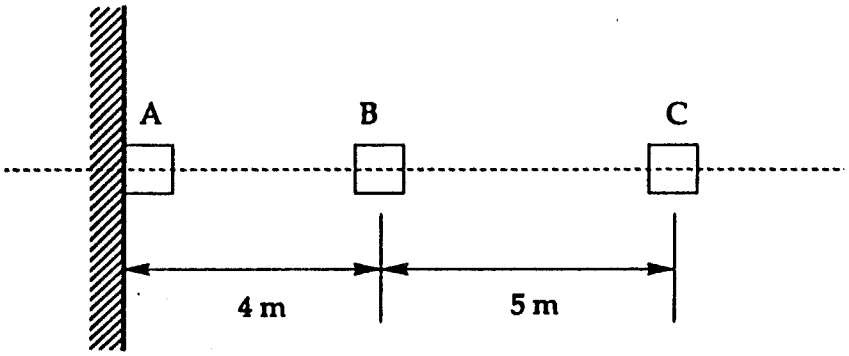

Figure: Question No. (2)

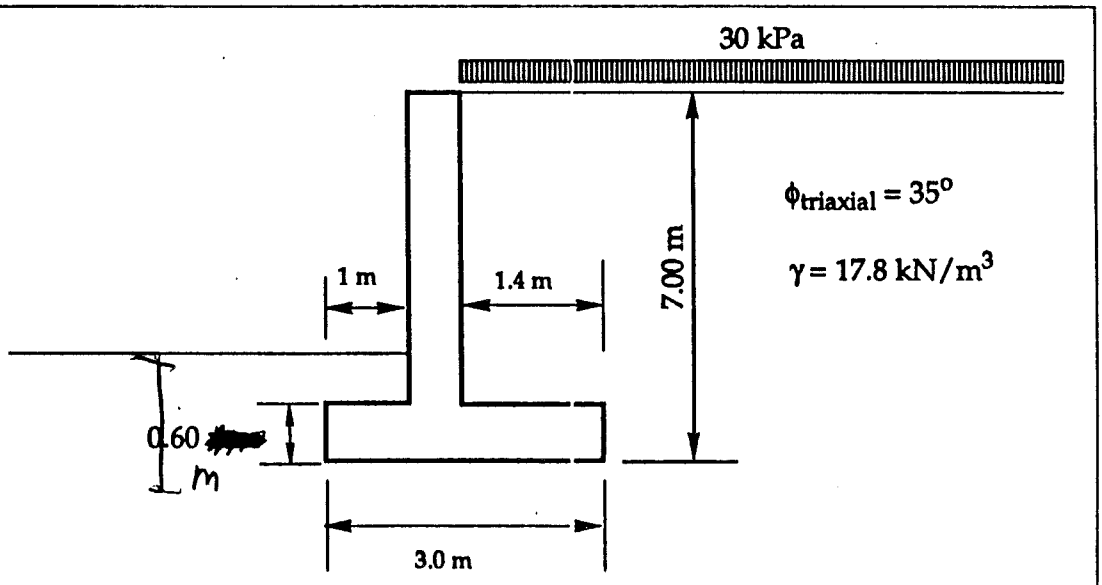

Figure: Question No. (4)

CONCORDIA UNIVERSITY
FINAL EXAMINATION
CIVI 435/4 - FOUNDATION DESIGN

INSTRUCTOR:	**DR. A.M. HANNA**	**STUDENT NAME:**	[redacted]
DATE:	**April 28, 1993**	**STUDENT I.D. #:**	[redacted]
TIME:	**9:30 to 12:30**		

OPEN BOOK EXAMINATION
Further data required may be reasonably assumed.

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1. (a) Describe briefly the factors that govern the magnitude and distribution of earth pressure on retaining walls.
   (b) Discuss the various methods that can be used to determine whether the clay is normally loaded or over consolidated.
   (c) Describe briefly the effect of the clay stress history on the magnitude of settlement.

2. A load of 8 MN is to be supported by a square footing founded at a depth of 1.3 m in a deposit of silty sand as shown in Figure 1. The water table is located at a depth of 3 m. Above the water table the unit weight is 17.6 kN/m^3 and the saturated unit weight is 18.4 kN/m^3. The friction angle of the soil is 33°.

   (a) Using a factor of safety of 3.0 against a bearing capacity failure, determine the dimensions of the footing. Beneath the sand there is a layer of clay. A sample of the clay was taken from the mid-point of the layer. A consolidation test provided the results shown in Figure 2. The water content of the sample was 45% and the specific gravity of the solid particles was 2.72.
   (b) Estimate the settlement of the footing due to the consolidation of the clay layer.
   (c) What will be the pore pressure at the mid-point of the clay layer, 8 months after the placement of the load?

3. (a) A rectangular footing of dimensions 3 m x 2 m is founded at a depth of 1.5 m in a saturated clay. The unconfined compression strength (q_u) is 120 kPa and the unit weight is 18.4 kN/m^3. The footing carries an oblique and excentric load as is shown in Figure 3. Using a factor of safety of 3.0, determine the bearing capacity of the footing.

4. The reinforced concrete retaining wall shown in Figure 4 retains a dry sand backfill. On the surface of the fill, there is a 20 kPa surcharge. The friction angle of the sand, as determined by triaxial test, is 34°. The unit weight of the dry sand is 16.0 kN/m^3. Check the stability of the wall.

5. A square concrete pile, 0.3 m x 0.3 m, is driven to a depth of 12 m in a deposit as shown in Figure 5. The effective friction angle of the soil is 33° and the friction angle between the pile and the soil is 25°. Above the water table, which is found at a depth of 6 m, the unit weight of the soil is 18.7 kN/m^3 and the saturated unit weight is 19.5 kN/m^3. Use a value of 2.3 for the lateral earth pressure coefficient.

   (a) Using a factor of safety of 2.0, determine the bearing capacity of a single pile.
   (b) If the same pile is driven to a depth of 12 m in a clay deposit as shown in Figure 6, determine the bearing capacity of a single pile having a safety factor of 2.0.

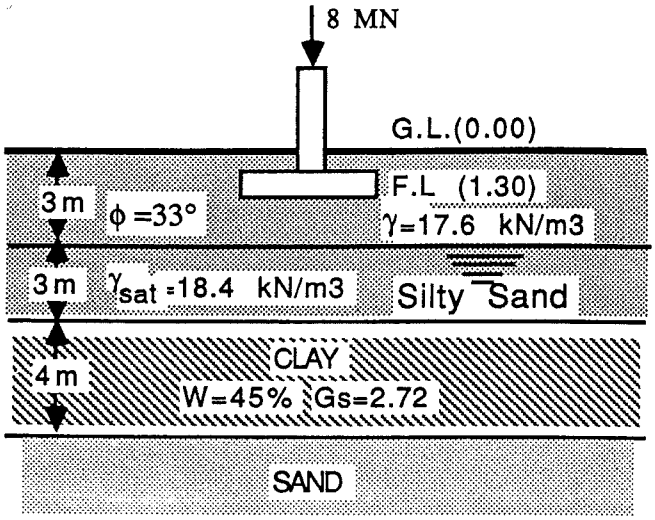

Figure (1)

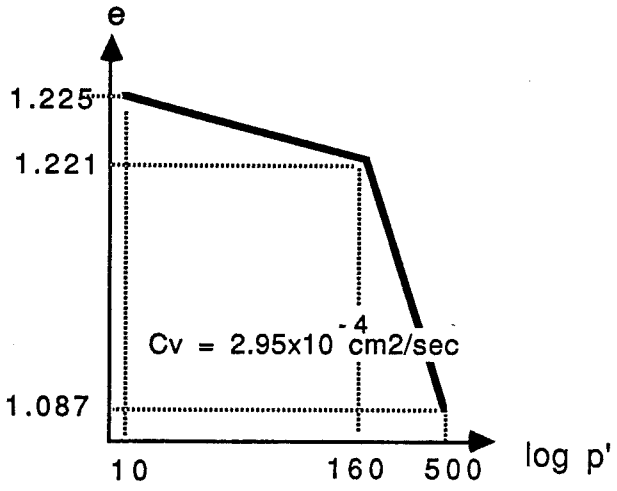

Figure (2)

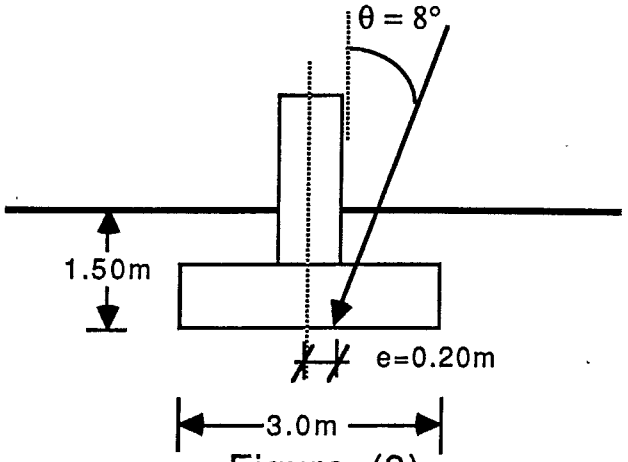

Figure (3)

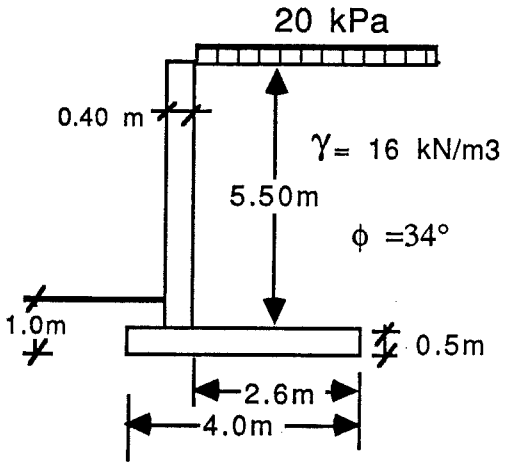

Figure (4)

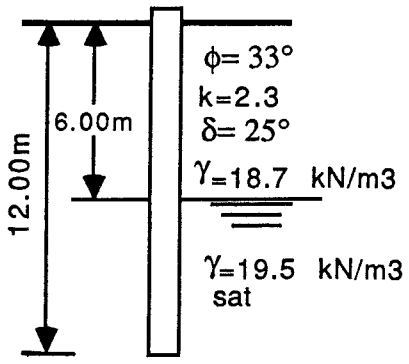

Figure (5)

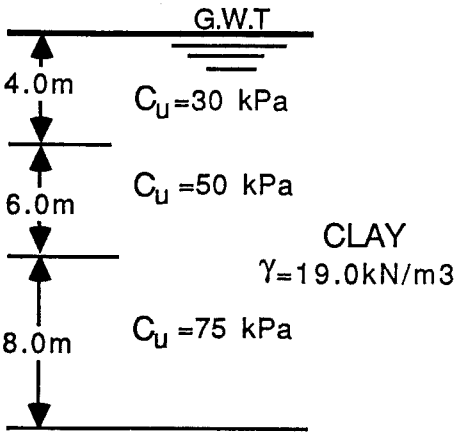

Figure (6)

CONCORDIA UNIVERSITY
CIVI 437/2
Final Examination, Monday December 1992, 9:30-12:30
CLOSED BOOK EXAMINATATION
ANSWER ALL QUESTIONS

Question (1)- The dynamic equation of equilibrium in a saturated soil medium is;

$$\partial\sigma'_{ij}/\partial x_j + \partial u/\partial x_i = \partial v_i/\partial t$$

where σ'_{ij} is the conventional effective stress, u is the pore water pressure and v_i is the velocity of movement assumed to be the same for both the solid and the fluid phase. Prove that each term in the above equation is a first order tensor.

Question (2)- Break the by-harmonic equation;

$$\nabla^4\phi=0$$

into its finite difference form (show the results graphically and assume $\Delta x=\Delta y$.)

Question (3)- Describe **very briefly** the principles involved in a geotechnical investigation of rock stratification at great depths by means of bore holes. Write as many equations as you know to illustrate the technique.

Question (4)- Using the Airy stress function

$$\phi=Ar\theta\sin\theta$$

or otherwise calculate the normal component of the traction across the diameter marked AA in Fig.(1) which shows a cylindrical sample undergoing a compression test. Given that the diameter and the length of the sample is 10 and 20 cm respectively and that the compressive load P at failure was measured to be 300 kN calculate the tensile strength of the rock.

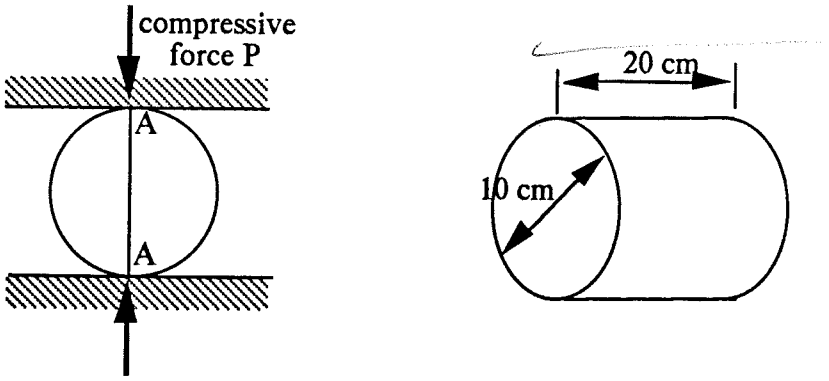

Fig.(1)

Question (5)- Write a short account of your understanding of the liquefaction phenomenon.

Question (6)- The tunnel shown in Fig.(2) is in layered rock. The Young modulus and unit weight of all the three layers are the same. Derive an equation to express the maximum tensile stress induced in the roof of the tunnel.

(2)

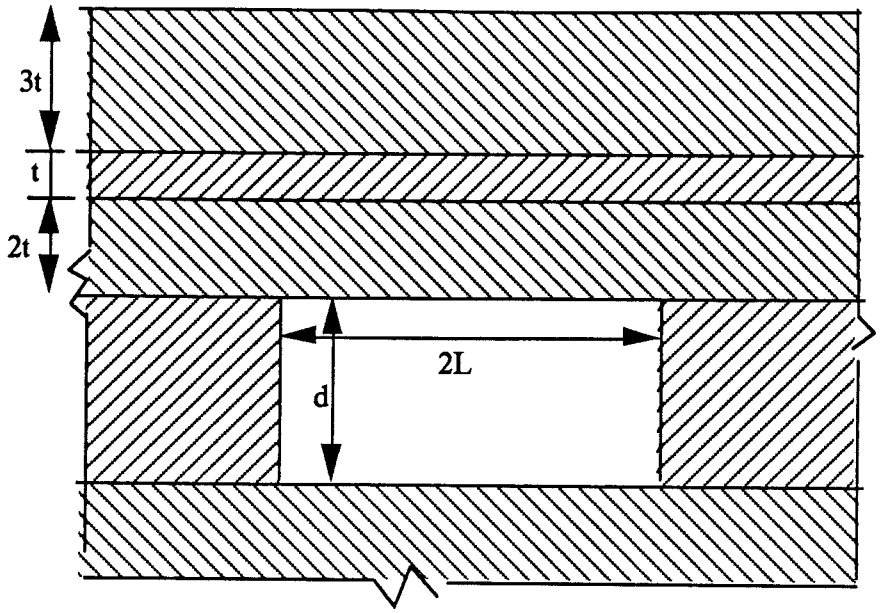

Fig.(2)