2307/304
SOIL MECHANICS AND HYDRAULICS
Oct./Nov. 2009
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN CIVIL ENGINEERING

SOIL MECHANICS AND HYDRAULICS

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:

Answer booklet
Scientific calculator/mathematical tables
Drawing instruments.

*This paper consists of **EIGHT** questions in **TWO** sections A and B.*
*Answer **FIVE** questions choosing at least **TWO** questions from each section.*
All questions carry equal marks.
Maximum marks for each part of a question are as shown.

This paper consists of 8 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

SECTION A: SOIL MECHANICS

*Answer at least **TWO** questions from this section.*

1. (a) (i) Define the following, giving the relevant expressions:

- Void ratio
- Porosity
- Degree of saturation
- Dry unit weight
- Bulk unit weight.

(ii) Show that the dry unit weight of soil is given by $\gamma d = \frac{\gamma b}{\gamma n + 1}$ where γb is the bulk unit weight and m is the moisture content.

(8 marks)

(b) Table 1 shows the results of a sieve analysis of a soil sample.

TABLE 1

SIEVE SIZE(MM)	10	6	2	1	0.6	0.3	015	0.063	Pass 0.063
MASS RETAINED (g)	0.0	5.5	25.7	231	22	17.3	127	6.9	2.3

(i) Plot the particle size distribution curve and describe the soil.

(ii) Define and determine the following for this soil sample:

- Effective size;
- Uniformity coefficient.

(12 marks)

2. (a) (i) With the aid of a sketch, derive the equation for determining the coefficient of permeability using field method.

(ii) During the test to determine the permeability of a bed of soil 13.5m thick overlying an impermeable stratum, the following data was recorded:

- Discharge from test well = 14.2 litres/sec.
- Drawdowns in observation wells 15m and 31m from test well were 1.805m and 1.532m respectively.
- Original ground water level - 1.985m below ground level.

Determine the coefficient of permeability for the stratum.

(14½ marks)

(b) State **three** properties and **two** uses of flownets. (2½ marks)

(c) Define the following in consolidation theory:

(i) Coefficient of volume compressibility;
(ii) Coefficient of consolidation;
(iii) Degree of consolidation. (3 marks)

3. (a) Figure 1 shows the conditions of a pile driven through two soils strata.

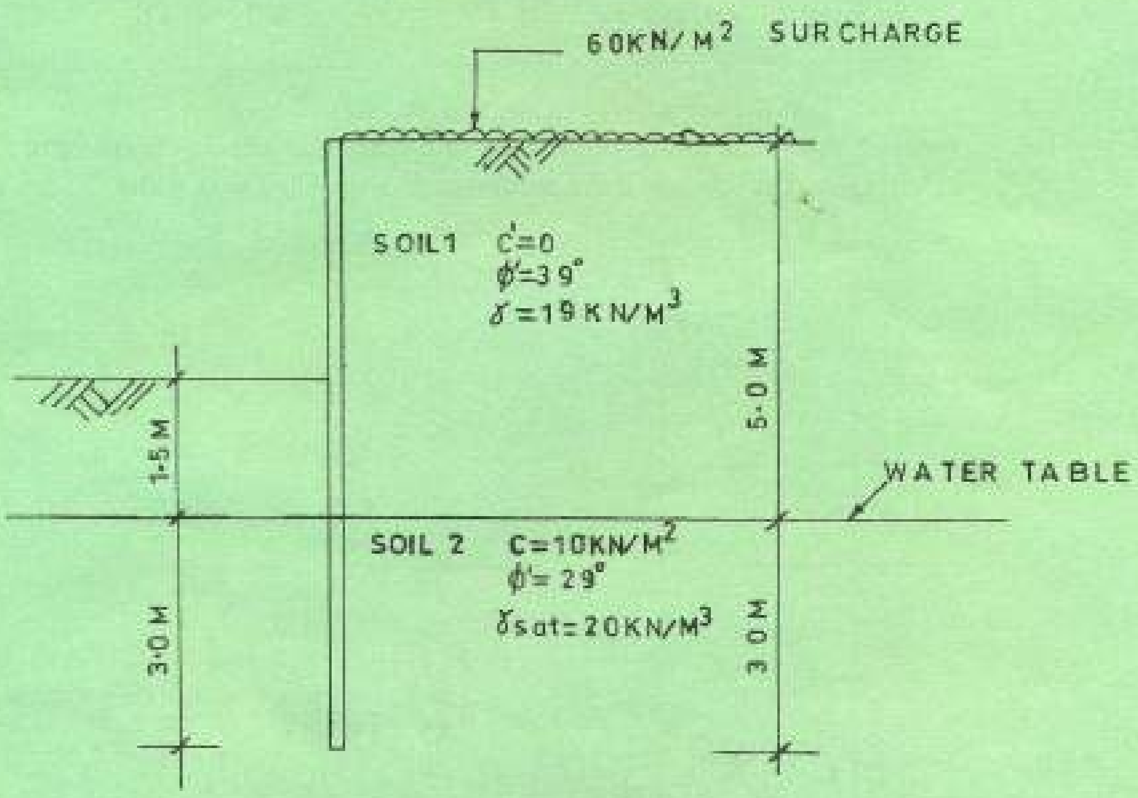


FIGURE 1

Determine:

(i) the active pressures at critical points and hence sketch the pressure distribution diagram;

(ii) total lateral thrust and its point of action from the base. (11 marks)

(b) Describe the consolidated undrained triaxial test. (4 marks)

(c) Table 2 shows the results from a shear box test. Determine graphically the cohesion and the angle of shearing resistance of the soil sample. (5 marks)

TABLE 2

NORMAL STRESS KN/M^2	100	200	300	400
SHEAR STRESS AT FAILURE KN/M^2	98	139	180	222

4. (a) Figure 2 shows the profile of the bank of a canal. Determine the factor of safety against slip failure if the tension cracks are filled with water. (9 marks)

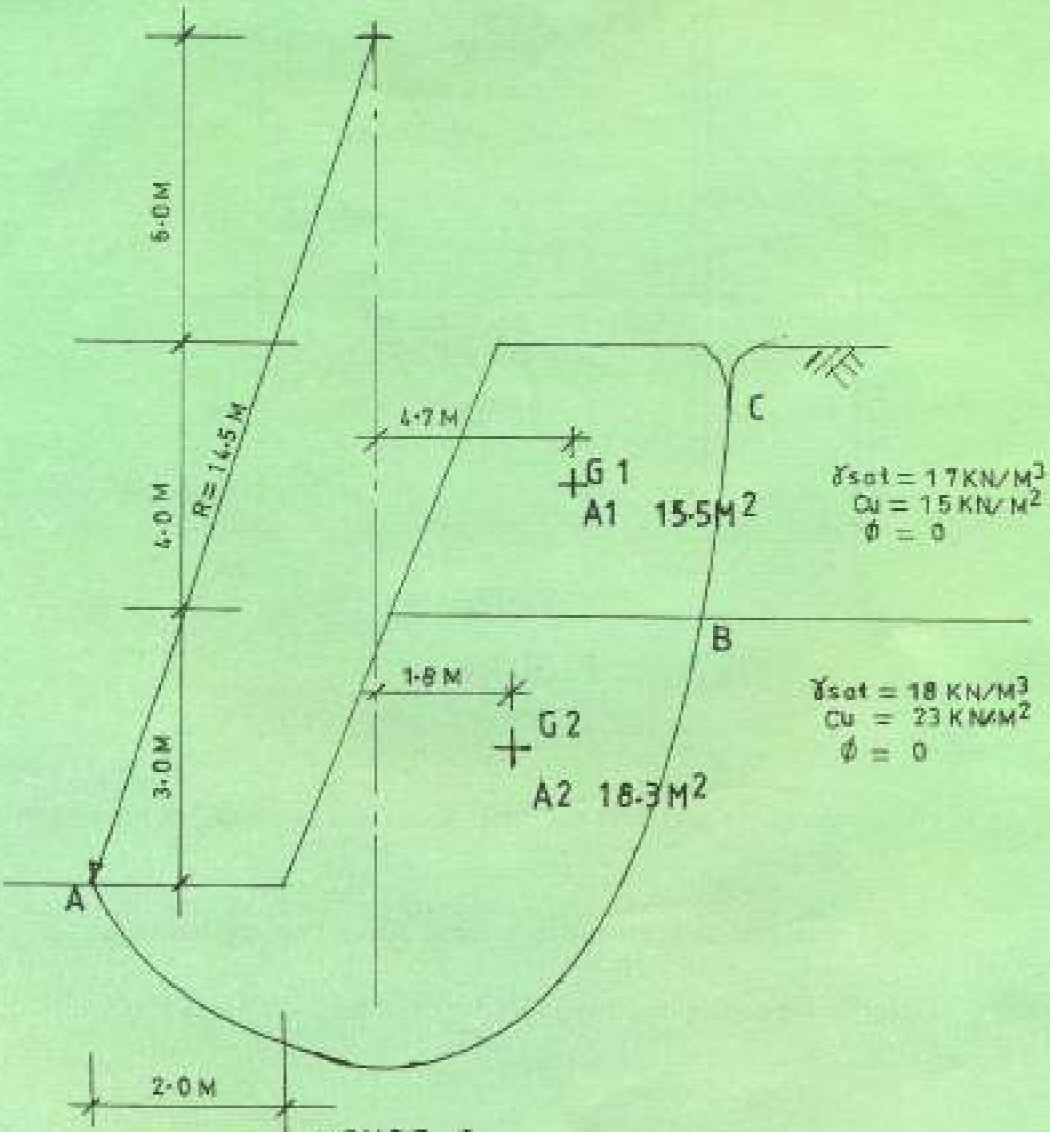


FIGURE 2

(b) Sketch the following:

- **two** types of slip failures;
- **two** methods of increasing the factor of safety against slip failure.

(5 marks)

(c) (i) State Terzaghi's equation for the gross ultimate bearing capacity stating the significance of each of the three terms.

(ii) A strip footing 2.75m wide is to be constructed at a depth of 3m below ground level. Calculate the safe bearing capacity for the footing using a factor of safety of 3 if the cohesion and the density of the soil are $65 kN/m^2$ and $19 kN/m^3$ respectively.
Take $\varphi = 15°$.

(6 marks)

SECTION B: HYDRAULICS

*Answer at least **TWO** questions from this section.*

5. (a) (i) Distinguish between 'gauge pressure' and 'absolute pressure'.

(ii) A U-tube differential manometer connects two pressure pipes A and B. Pipe A contains a liquid having a specific gravity of 1.594 under a pressure of $0.12 N/mm^2$ while pipe B contains oil of specific gravity 0.8 under a pressure of $0.2 N/mm^2$. If pipe A lies 2.5m above pipe B, find the difference of pressure measured by mercury manometer.

(11 marks)

(b) (i) Define the term centre of pressure.

(ii) An isosceles triangular plate of base 4.5m and height 4.5m is immersed vertically in oil of specific gravity 0.8 with the base level with the oil surface. Determine:

- the total pressure;
- the centre of pressure on one side of the plate.

(9 marks)

6. (a) From basic assumptions derive the expression for the discharge over a rectangular weir.

(6 marks)

(b) The difference in levels between the upper catchment reservoir and the lower service reservoir of a town water supply is 200m and the distance between them is 66 km. The reservoirs were originally connected by a single pipe designed to carry 30×10^6 litres per day. It was found later necessary to increase the flow by another 10×10^6 litres per day, and it was decided to lay another pipe of the same diameter alongside the first over part of the length, the two pipes being cross connected.

Calculate:

(i) the diameter of the pipes;
(ii) the length of the second pipe.

Take f = 0.008 for each pipe and neglect minor losses.

(14 marks)

7. (a) (i) State **four** advantages and **two** disadvantages of centrifugal pumps.

(ii) Briefly describe the principle of operation of a centrifugal pump.

(6 marks)

(b) With the aid of sketches, describe how a river discharge is determined using Simpson's rule for area of flow and pitot tube for average velocity.

(10 marks)

(c) State **four** precautions taken when rating current meters.

(4 marks)

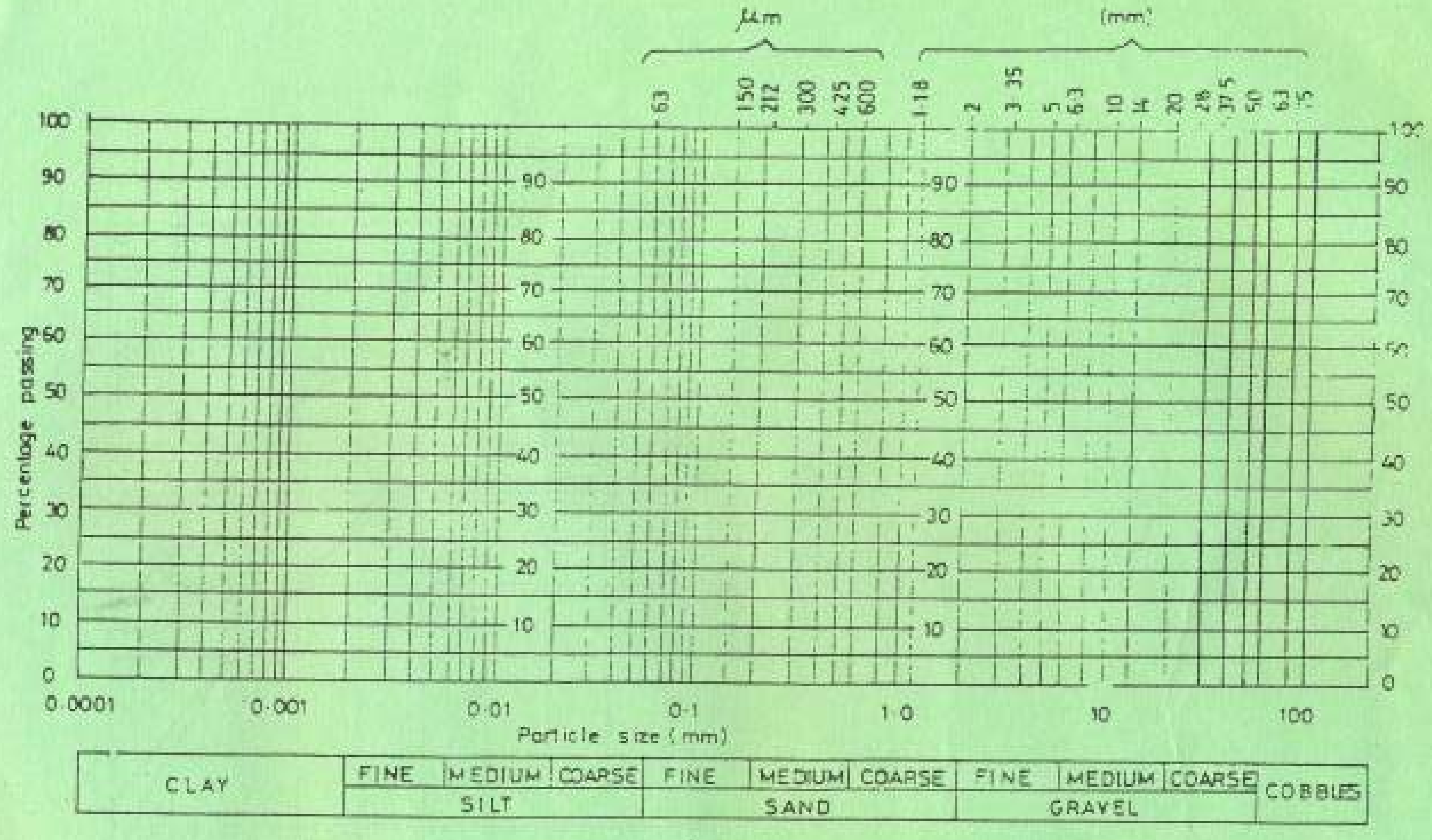
8. (a) With the aid of a sketch, describe the hydrological cycle.

(6 marks)

(b) A trapezoidal canal section has side slopes 1.5 horizontal to 1.0 vertical. It is required to convey $20m^3$/sec of water. If the average velocity of flow is not to exceed 1.2 m/sec, find the wetted perimeter and bed slope for the most economical section.
Take Mannings N = 0.015

(14 marks)

CHART 1



CANDIDATE'S NAME ____________________

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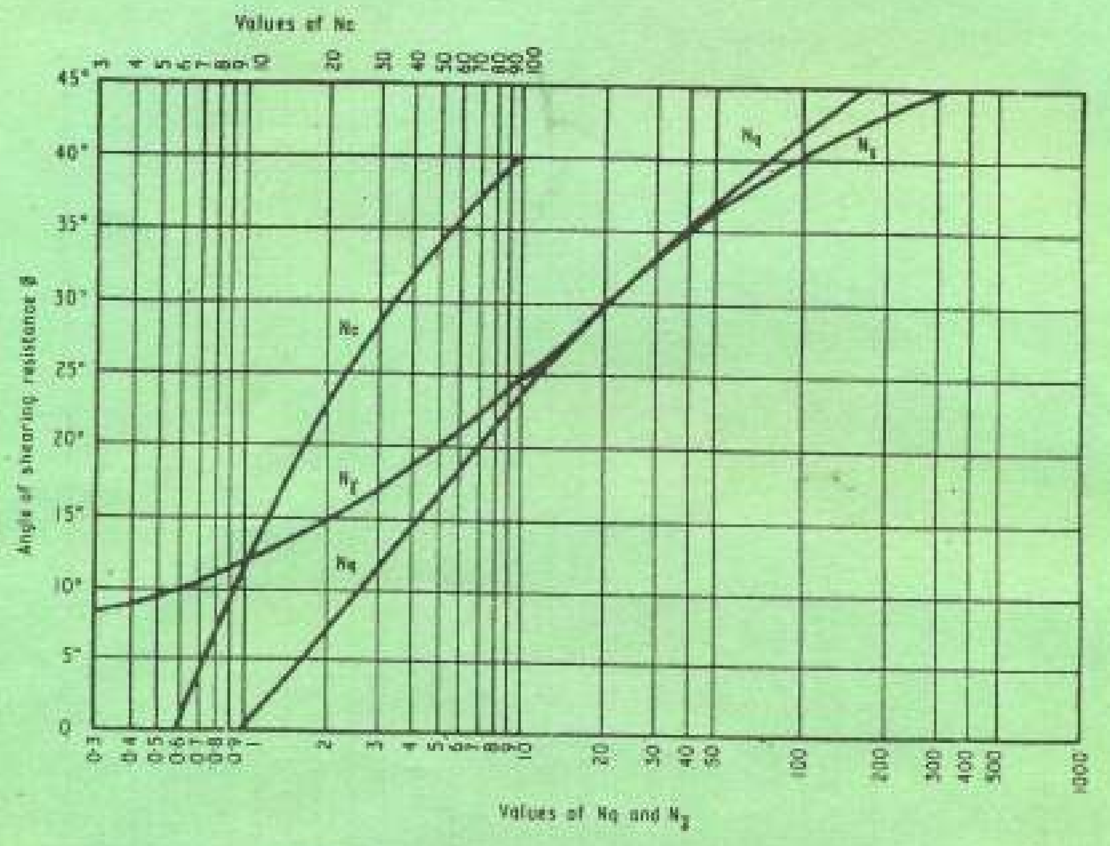
CHART 2



Terzaghi's bearing capacity factors for shallow foundations.