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Index No. _____

2307/304

Candidate's Signature _____

SOIL MECHANICS AND HYDRAULICS

Oct/Nov 2013

Date _____

Time: 3 hours



THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN CIVIL ENGINEERING

SOIL MECHANICS AND HYDRAULICS

3 hours

INSTRUCTIONS TO CANDIDATES

- Write your name and index number in the spaces provided above.
- Sign and write the date of the examination in the spaces provided above.
- Your should have a scientific calculator for this examination.
- This paper consists of **EIGHT** question in **TWO** Sections: **A** and **B**.
- Answer **FIVE** questions: choosing at least **TWO** questions from each Section in the spaces provided in this question paper.
- All questions carry equal marks.
- Maximum marks to each part of a question are as shown.
- Do **NOT** remove any pages from this booklet.
- Candidates should answer the questions in English.

For Examiner's Use Only

Question	1	2	3	4	5	6	7	8	TOTAL SCORE
Candidate's Score									

This paper consists of 20 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) Define the following soil properties:
- (i) void ratio;
 - (ii) porosity;
 - (iii) degree of saturation. (3 marks)
- (b) From basic principles, show that:
- (i) void ratio = $\frac{n}{1-n}$;
 - (ii) porosity = $\frac{e}{1+e}$. (4 marks)
- (c) A sample of soil weighing 30.8 kg had a volume of 0.0193 m³. When oven dried, its mass was reduced to 27.4 kg. If the specific gravity of the solids was found to be 2.65, determine the following:
- (i) bulk density;
 - (ii) dry density;
 - (iii) percentage moisture content;
 - (iv) saturated density;
 - (v) percentage air voids. (13 marks)
2. (a) With the aid of sketches, describe the standard proctor compaction test. (10 marks)
- (b) From a compactor test, the density of a soil was found to be 1,875 kg/m³ when the water content was 16%. A cylindrical test specimen 100 mm diameter by 200 mm long was prepared by static compaction. Determine the mass of oven dried soil and water required for the specimen. (5 marks)
- (c) Define each of the following in the theory of consolidation:
- (i) coefficient of volume compressibility;
 - (ii) degree of consolidation;
 - (iii) coefficient of consolidation. (5 marks)



3. (a) With the aid of a sketch, describe the constant head permeameter test. (10 marks)
- (b) (i) Using Darcy's law, derive an expression for the coefficient of permeability;
- (ii) Determine the coefficient of permeability of a sample of sand given the following data:
- diameter of permeameter = 75 mm
 - loss of head on a 200 mm length = 86.2 mm
 - water collected in 1 minute = 67.8 ml.
- (7 marks)
- (c) Define the following soil bearing capacity terms:
- (i) ultimate bearing capacity;
- (ii) safe bearing capacity;
- (iii) allowable bearing pressure. (3 marks)
4. (a) With the aid of sketches, describe the laboratory procedure for determining the plasticity index of a soil. (10 marks)
- (b) State three properties and two uses of flow nets. (5 marks)
- (c) The bank of a canal has the profile shown in figure 1. The material is homogenous. Clay density is $2,010 \text{ kg/m}^3$, cohesion is 31 kN/m^2 and angle of shearing resistance is zero. For the trial slip circle shown, the area ABCDE is 151 m^2 and the centroid is at G. Allowing for tension crack 3 m deep which may be filled with water, determine the safety for this slip circle if the:
- (i) water in the canal is level with the top of the bank;
- (ii) canal is empty. (5 marks)

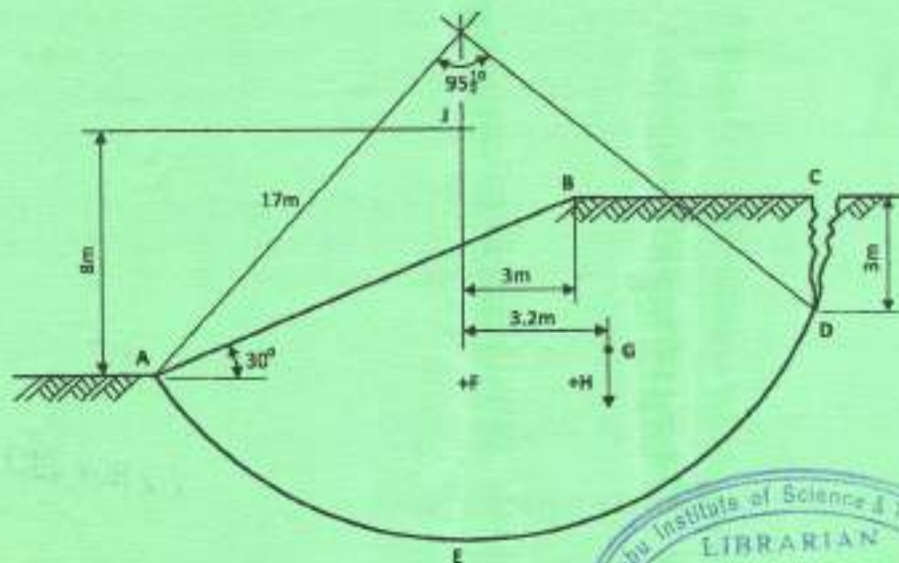


Fig. 1

SECTION B: HYDRAULICS

Answer at least TWO questions from this Section.

5. (a) Define each of the following in open channel flow:
- wetted perimeter;
 - hydraulic mean depth. (3 marks)
- (b) (i) From basic principles, derive the proportions of a trapezoidal channel which will make the discharge a maximum for a given cross-sectional area;
- (ii) Show that the sides and base of the section in (b) (i) are tangential to a semi-circle whose centre is at the water surface. (11 marks)
- (c) Determine the discharge through the channel section shown in figure 2. Take $C = 70$ and bed slope = $\frac{1}{1000}$. (6 marks)

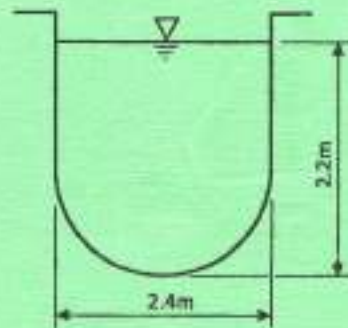


Fig. 2

6. (a) A pipeline connecting two reservoirs having a difference of level of 6.5 m is 752 m long, and rises to a height of 3.5 m above the upper reservoir at a distance of 250 m from the entrance before falling to the lower reservoir. If the pipe is 1.1 m in diameter and the frictional coefficient $f = 0.01$, determine the discharge and the pressure at the highest point of the pipeline. (8 marks)
- (b) A single-acting reciprocating pump, running at 55 rpm delivers $0.00738 \text{ m}^3/\text{s}$ of water. The diameter of the piston is 200 mm and the stroke length is 300 mm. If the suction and delivery heads are 3.5 m and 12.5 m respectively, determine the:
- theoretical discharge;
 - coefficient of discharge;
 - percentage slip of the pump;
 - power required to run the pump. (6 marks)
- (c) Outline **three** advantages and **three** disadvantages of a centrifugal pump. (6 marks)



7. (a) With the aid of a sketch, describe the hydrologic cycle. (6 marks)
- (b) An opening 1.0 m diameter on the side of a vertical wall of water storage tank is sealed by a circular plate 1.1 m in diameter. The plate is hinged at the top and bolted at the bottom as shown in figure 3. Determine the force on bolt. (7 marks)

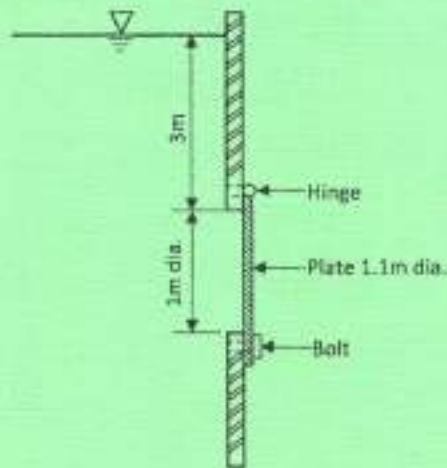


Fig. 3

- (c) (i) A horizontal jet of liquid issues from an orifice in the vertical side of a tank. The jet moves a horizontal distance x and fall a vertical distance y . If the head of liquid above the centre of the orifice is h , derive an expression for the actual velocity and the coefficient of velocity for the jet;
- (ii) A circular orifice, 655 mm^2 provided on the vertical side of a tank discharges $0.11 \text{ m}^3/\text{min}$. If the jet moves 1.5 m horizontally and falls 0.5 m vertically, determine the horizontal reaction of the jet on the tank. (7 marks)
8. (a) Derive an expression for the actual discharge through a horizontal venturi meter. (7 marks)
- (b) A broad crested weir 65 m wide has a depth of 0.6 m above the crest. The approach channel has a cross-sectional area of 48 m^2 . If the coefficient of discharge for the weir is 0.615, determine the discharge:
- (i) without considering the velocity of approach;
- (ii) considering the velocity of approach. (5 marks)
- (c) Outline **four** advantages of a Francis Turbine. (4 marks)
- (d) State **four** factors considered in the selection of a size for river stage measurements. (4 marks)

