UNIVERSITY OF SWAZILAND

SUPPLEMENTARY EXAMINATION PAPER

PROGRAMMES: BSc. LWM 3

COURSE CODE: LUM 303

TITLE OF PAPER: FLUID AND SOIL MECHANICS

TIME ALLOWED: TWO (2) HOURS

SPECIAL MATERIAL REQUIRED: NONE

INSTRUCTIONS: ANSWER QUESTION ONE AND ANY TWO OTHER QUESTIONS

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QUESTION 1

a. Starting with the Bernoulli and Continuity equations derive the following expression that can be used to measure flow rate with a Venturi meter.   **[15 marks]**

$$Q_{actual} = c_d A_1 A_2 \sqrt{\frac{2g\left[\frac{p_1 - p_2}{\rho g} + z_1 - z_2\right]}{A_1^2 - A_2^2}}$$

b. Also show that when the pressure difference is measured using a manometer the following expression can be used;   **[15 marks]**

$$Q_{actual} = c_d A_1 A_2 \sqrt{\frac{2gh\left(\frac{\rho_{man}}{\rho} - 1\right)}{A_1^2 - A_2^2}}$$

c. A vane of length 250mm and diameter 100mm is used to measure the shear strength of a saturated soil. If the torque required to fail the vane is 518 Nm, calculate the apparent shear strength of the soil.   **[10 marks]**

QUESTION 2

a. What are the two forms of expressing failure envelope?   **[5 marks]**

b. Outline and discuss the steps of conducting an unconfined compression test. What is the relationship between unconfined compressive strength and undrained shear strength?

[15 marks]

c. What size pipe of new cast iron pipe, 244m long, will deliver 1.06 m^3/s of water with a drop in the in the hydraulic grade line of 65.60m ? (Assume V = 3.96m/s and f = 0.02)

[10 marks]

QUESTION 3

a. A rectangular channel 30.5m wide carries 11.3m^3/s.

    (i)   Tabulate (as preliminary to preparing a diagram) depth of flow against specific energy for depths from 0.3m to 2.5m.   **[5 marks]**

    (ii)   Determine the minimum specific energy.   **[5 marks]**

    (iii)   What type of flow exists when the depth is 0.6m and when it is 2.5m?

[10 marks]

    (iv)   For C = 100, what slopes are necessary to maintain the depths in (iii).

[10 marks]

QUESTION 4

a. In a compaction test the weight of wet soil in the mould (0.001m^3) was 1.88kg. By drying out a small quantity of the soil its moisture content was found to be 20.7%. The specific gravity of the particles was 2.72. Determine;

    (i)   The dry density   **[5 marks]**

    (ii)   The void ratio   **[5marks]**

    (iii)   The percentage air voids   **[5 marks]**

b. Outline the Stoke's law of sedimentation   **[10 marks]**

c. What is the atmospheric pressure in kPa when a mercury barometer reads 742mm?

[5 marks]

APPENDIX

$$E = y + \frac{V^2}{2g}$$

$$y_c = \sqrt[3]{q^2/g} = \frac{3}{2}E_c = V_c^2/g$$

$$Q = CA\sqrt{RS}$$

$$E_{min} = \frac{3}{2}\sqrt[3]{q^2/g}$$

$$V_c/\sqrt{gy_c} = Fr = 1$$

$$T = c(\pi d h)\frac{d}{2} + c\left(\pi\frac{d^2}{4}\right)\frac{1}{3}d \times 2$$

$$T = c_V(\pi d h)\frac{d}{2} + c_H\left(\pi\frac{d^2}{4}\right)\frac{1}{3}d \times 2$$