(119)

CEL351: Design of Hydraulic Structures
Major Test

Time: Two Hours **Marks: 40**

Solve the following:

Assume any suitable data, if not given.

PART A

Q.1 (a) Discuss briefly the energy dissipators to be used below an overflow spillway, when T.W.C. is below J.H.C. for all discharges. [2]

(b) A canal is to be designed to carry a discharge of 500 cumecs. The slope of canal is 1 in 1600. The soil is coarse alluvium having a grain size of 5 cm. Assume the canal to be unlined with unprotected banks and of a trapezoidal section, determine a suitable section for the canal. angle of repose ϕ and Manning's constant **n** may be taken as 37^0 & 0.026, respectively. [5]

Q.2 (a) Draw the uplift pressures obtained by Khosla's solution and Bligh's theory for a horizontal impervious floor. [2]

(b) A wide irrigation channel is designed to have a depth of 3 m and bed slope of 1.6 x 10^{-4}. The bed sediment has an average median size of 0.3 mm. If the specific gravity of bed soil is taken as 2.65, fall velocity of bed particles as 0.04 m/s and the observed Manning's 'n' to be 0.02, compute the bed load transported by the channel in N/s/m width of channel. Also compute the suspended load concentrations at 2 different depths (y = 1 and 2 m). Make use of Einstein's formulas. Consider $\beta = 1$, $k = 0.4$ and $\nu = 1.01 \times 10^{-6}$ m^2/s. [5]

Q. 3 Determine the location of hydraulic jump and draw pre jump profile taking at least 3 points for a hydraulic structure with following details:

q = 8 cumecs/m; H_L = 1.0 m; RL of u/s floor: 103.0;
RL of d/s floor: 101.5; RL of crest: 104.5; RL of u/s TEL: 107.5
RL of u/s HFL: 107.0. Make use of Crump's analytical method. [6]

$$\tau_c = 0.155 + \frac{0.409 d_{50}^2}{\sqrt{1+0.177 d_{50}^2}} N/m^2; d_{50}(mm). \qquad n' = \frac{1}{24} d_{50}^{1/6}; \text{ } d_{50} \text{ is in m}$$

$$\frac{q_b}{w_0 d_{50}} = 40\left[\frac{R'S}{(G-1)d_{50}}\right]^3 \; ; \qquad C_{2d} = \frac{q_b}{23.2 V'_* d_{50}} \; ; \qquad \frac{C}{C_a} = \left[\frac{a(H-y)}{y(H-a)}\right]^{\frac{w_0}{\beta k V'_*}}$$

$Y = 1+0.93556(Z)^{0.368}$ for $Z \le 1$; $Y = 1+0.93556(Z)^{0.240}$ for $Z > 1$; $XY(X+Y) = 2$;

$$Z = \frac{(Y-X)^3}{4XY}; X = \frac{y_1}{y_c}; Y = \frac{y_2}{y_c}; Z = \frac{H_L}{y_c}$$

$$E_{f1} = m y_c; m = X + \frac{1}{2X^2} \; ; \; E_{f2} = n y_c; n = Y + \frac{1}{2Y^2} \; ; \quad y_c = \left(\frac{q^2}{g}\right)^{\frac{1}{3}}$$

Major Test – CEL351: Part B

Max. Marks 20

1. M15 concrete (σ_{cc} = 4.0 N/mm^2, S_c = 2.4) was used in a 100 m high gravity dam. Assuming intermediate uplift (C = 0.5), compute the limiting height and then identify the type of the dam. (2 Marks)

2. Show that $b = \mu H$ and $\sigma_d = \gamma_w H\left(1 + 1/\mu^2\right)$ to satisfy no sliding and no tension criteria simultaneously in the elementary profile of a gravity dam. (4 Marks)

3. Find the length and depth of the cistern in a Sarda type fall of 1.5 m drop for the following data both for u/s and d/s canals – Discharge = 40 m^3/s, Depth of flow = 1.8 m, Bed width = 24.0 m, and Side slope = 1.5:1. (4 Marks)

4. Design canal transitions and bed levels at key points, and sketch barrel with dimensions (including floor thickness) in a syphon aqueduct for the following data:
   A Canal: Discharge = 40 m^3/s; Depth of flow = 1.8 m; Bed width = 24 m; Side slope = 1.5:1: Bed level = 197 m.
   B River: Flood Discharge = 350 m^3/s; Bed level = 195 m; HFL = 195 m.
   (10 Marks)

Use appropriate data/formula, if required. You may use the following hints:

$n = 0.015;$ $\quad ? = 5\sqrt{EH_L}$ $\quad ? = 0.25(EH_L)^{2/3}$ $\quad ? = 1.835LH^{3/2}(H/B)^{1/6}$

$? = 0.55\sqrt{H+d}$ $\quad ? = 0.55\sqrt{d}$ $\quad ? = C\sqrt{Q}$ $\quad ? = 1.99LH^{3/2}(H/B)^{1/6}$

$? = \left(0.0152 + V^2/17.85\right)\left((A/a)^2 - 1\right)$ $\quad ? = C_0\sqrt{2g}\,LD_d\left(h + (1+e)V^2/2g\right)^{1/2}$

$? = \dfrac{B_c B_f L_f}{B_c L_f - x\left(B_c - B_f\right)}$ $\quad ? = \dfrac{L_f B_c^{1.5}}{B_c^{1.5} - B_f^{1.5}}\left(1 - \left(B_f/B_x\right)^{1.5}\right)$