Major Exam

Advanced Hydraulics **Max^{m} Marks: 55**

Q(1) The deposition and dredging requirements of a navigational channel in a wide river are to be studied using a movable bed model. The bed material in river is sand (Sp. Gr. of 2.65) with median size 0.4 mm. The model bed has specific gravity of 1.25.

a) Determine the median diameter for model bed and the required length scale. Assume $R_r = Y_r$

b) Assuming that the dimensionless sediment transport $q_s / U_* d_s$ is a function of Ψ from Shield's diagram, where q_s is the volumetric sediment discharge per unit width and U_* is the shear velocity, determine the sediment transport ratio q_{sr} and from the result.

c) Determine also the time ratio t_r for sediment modeling.

d) Determine the sediment transport ratio based on weight g_{sr}

e) If the model study indicates that dredging of the model channel is required every 100 hours. calculate the frequency with which the prototype channel will require dredging.

$$R_r Y_r / \sigma_r d_r X_r = 1. \qquad R_r Y_r d_r^2 / X_r = 1, \qquad d_r^{1/6} = R_r^{2/3} / X_r^{1/2}$$

(10 marks)

Q(2) The velocity distribution in a river is found to vary in accordance with the seventh power law $(u/U_0) = (y/D)^{1/7}$, where u is the velocity at height y and U_0 is the velocity at the free surface. D is the flow depth. The river is 1.5 m deep and 100 m wide and the suspended sediment sample collected at 75 mm depth above the bed has a concentration of 10 N/ m^3. If the surface velocity is 2 m/s, what is the sediment transport rate in N/s above the height of 75 mm.

$c/C_a = (((D-y)\,a) / (y\,(D-a)))^{Z_*}$, take $Z^* = 1$

(7 marks)

Q(3) Assuming Manning's n is the same in both a wide and a narrow reach of a river, and $\tau_0 >> \tau_c$, which is probably true for moderate to high flows in such a river, at steady state, show that

$$(y_2 / y_1) = (B_1/B_2)^a \quad \text{and} \quad (S_1/S_2) = (B_1/B_2)^b, \qquad \text{determine a and b.}$$

Use Duboy's Eqn. for sediment transport $g_b = C_s \tau_0 (\tau_0 - \tau_c)$, where g_b is the weight discharge of sediment per unit width.

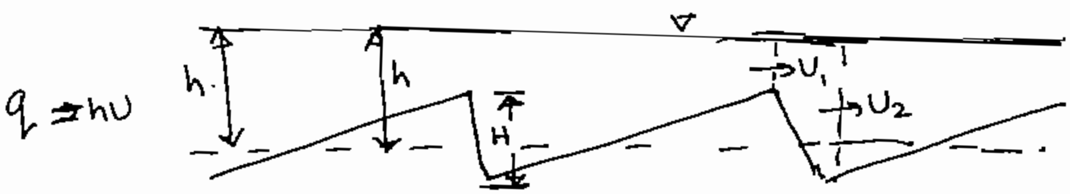
(8 marks)

P. T. O.

Q(4) (a) Derive the differential equation that describes the most efficient shape of an ideal stable channel. Why is such a channel better than a trapezoidal channel?

(b) Derive the Duboy's bed load formula $q_b = C_s \tau_0 (\tau_0 - \tau_c)$, and list all drawbacks of this analysis.

(c) Show that the head loss due to one bed form in Engelund's model of the divided slope approach is expressed as $h_L = \alpha\, U^2/2g\, (H/h)^2$ when h>>H , where h= mean depth of flow, α = loss coefficient and H= average height of a bed form



(d) Einstein in 1950 presented the most extensive analysis on bed load transport based on fluid mechanics and probability theory, what were their important conclusions?

(12 marks)

Q(5) A 38 m high dam fails suddenly. The initial reservoir height was 35 m above the downstream channel invert and the downstream channel was filled with 0.5 m of water initially at rest.

(a) Estimate the free surface profile 7 mins after the failure.

(b) Calculate the time at which the wave will reach a point 10 km downstream of the dam and the surge front height.

Assume an infinitely long reservoir and a horizontal smooth channel.

$(d_0/d_1)^{0.5} =(0.5U/ (gd_1)^{0.5}) (1-(1/X)) + (X)^{0.5}$ and $X = d_2/d_1 = 0.5((1+(8U^2/gd_1))^{0.5} - 1)$

$x/t = 2((g\, d_0)^{0.5} - 3((gd)^{0.5}$

(10 marks)

Q(6) Water flows in an irrigation canal at steady state, V =0.9 m/s and d = 1.65 m. The canal is assumed smooth and horizontal with flow controlled by a downstream gate. At t=0, the gate is very slowly raised and the water depth upstream of the gate decreases at a rate of 5cm/min until the water depth becomes 0.85m.

Determine V, c, d at the gate at t=10 mins.

What is the maximum extent of disturbance at 10 mins?

(8 marks)