IQRA NATIONAL UNIVERSITY

Sessional AssignmenT

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SECTION: A

SUBJECT: HYDRAULIC STRUCTURE

INSTRUCTOR: ENGGR. ADEED KHAN

Date July-2

Example:

Establish the stage (headwater) discharge relationship for a concrete rectangular box culvert using the following data (width = 1.2m; height = 0.6m. length = 30 m; slope = 1 in 1000; Mannings $n = 0.013$; square-edged enterance condutions free jet outlet flow; range of headwater level for investigation = 0-3 m; neglect the velocity of approach.

SOLUTION :-

1. H/D = 1.2 For HL 0.6 m, free flow open channel conditions prevail. Reffering to Fig: 10.6 and assuming that a steep slope entry gives entrance control i-e the depth at the inlet is critical for H = 0.2 m ignoring entry loss $y_c = (2/3) \times 0.2 = 0.133$ m and $V_1 = 1.142\ ms^{-1}$. This gives the critical

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slope $(Vn)^2/R^{4/3} = 0.00424$. Therefore the slope of the culvert is mild and hence subcritical. flow analysis gives the following results.

$$Q = 1.2y_0[1.2y_0/(1.2+2y_0)]^{2/3}(0.001)^{1/2}/(0.00$$

$$= 2.92y_0[1.2y_0/(1.2+2y_0)]^{2/3}.$$

Cross Drainage & Drop Structures:

y_0 (m)	Q (m^3s^{-1}) (eq. (i))	y_c (m)
0.2	0.165	0.124
0.4	0.451	0.243
0.6 (= D)	0.785	0.352

At the inlet over a short reach,

$$H = y_0 + V^2/2g + K_c V^2/2g$$

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The entrance loss co-efficient, K_e, is as follows;

for a square-edged entry, 0.5;

for a flared entry, 0.25;

for a rounded entry, 0.05;

Y_o(m)	H(m) (Eq ii)	Q $(m^3 s^{-1})$
0.2	0.236	0.165
0.4	0.467	0.451
0.6	0.691	0.785
orifice ← > 0.6 ← (1.2D=)	0.72	→ 0.817 (by interpolation)

2) $H/D \geq 1.2$,

(a) for orifice flow

$$Q = C_d(1.2 \times 0.6)[2g(H - D/2)]^{1/2}$$

With $C_d = 0.62$ the following results are obtained:

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H(m)	$Q(m^3s^{-1})$	Y_0(m) (eq, ii)
0.72	1.29	>0.6 → no orifice flow exists

(b) For pipe flow the energy equation gives

$$H + S_0 L = D + h_L$$

where

$$h_L = k_e V^2/2g + (v_n)^2 L/R^{4/3} + V^2/2g$$

Thus,

$$Q = 2.08(H - 0.57)^{1/2}$$

	H(m)	$Q(m^3s^{-1})$ (eq, iv)
Y_0=0.6 (eq, i) ←	0.691 ←	0.723
	0.72	0.805
	1.00	1.364
	2.00	2.487
	3.00 ↓	3.242 ↑

SMNotes

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H(cm)	Q(m^3s^{-1})	Type of flow
Rising Stages		
0.236	0.165	Open channel
0.467	0.145	//
0.691	0.785	//
0.720	0.805	Pipe flow
1.00	1.364	//
2.00	2.487	//
3.00	3.242	//
Falling Stages		
2.00	2.487	Pipe flow
1.00	1.364	//
0.72	0.804	//
0.691	0.723	//
0.691	0.785	Open channel
0.467	0.451	//
0.236	0.165	//