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Section A

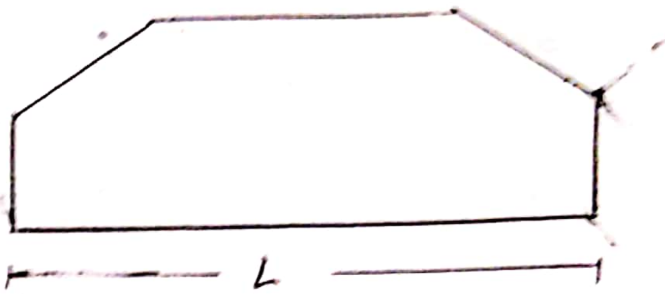
Subject Hydraulic engineering

Submitted to Engr Adeed

Assignment No.

① Establish the stage discharge relationship for a concrete rectangular box culvert: using suitable data of your own choice.

Given data.



Width = 1.2m

Height = 0.6m

Length = 30m

Slope = 1 in 1000

Manning's n = 0.013

squared edge entrance

range of headwater level for investigation = 0-3m

Sol

$\frac{H}{D} \leq 1.2$ for $H < 0.6m$

assuming the steep slop entry gives entrance control ie depth at the inlet is critical

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(2)

For $H = 0.2m$

Ignoring entry loss $y_c = (2/3) \times 0.2 = 0.133\ m$

$V_c = 1.142\ ms^{-1}$

This gives critical slope $\frac{(Vn)^2}{R^{4/3}} = 0.00424$

$Q = 1.2 y_0 [1.2 y_0 / 1.2 + 2y_0]^{2/3} (0.001)^{1/2} / 0.013$

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

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(3)

y_o(m)	Q($m^3 s^{-1}$)	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

$$H = y_o + \frac{V^2}{2g} + \frac{K_e V^2}{2g}$$

The entrance loss coefficent K_e is as follows

for a squar edge entry . 0.5

for a flared entry 0.25

for a rounded entry 0.05

y_o(m	H(m)	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)

(4)

$H/D \geq 1.2$

(a) for orifice flow

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

With $C_d = 0.62$ the following results are obtained

H (m)	Q ($m^3 s^{-1}$)	y_0 (m)
0.72	1.29	70.6 → no orifice flow exists

(b) for pipe flow the energy equation gives

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

where

$$h_L = \frac{K_e V^2}{2g} + \frac{(V n)^2 L}{R} + \frac{V^2}{2g}$$

Thus

$$Q = 208(H - 0.57)^{1/2}$$

	H(m)	Q($m^3 s^{-1}$)
$y_0 = 0.6$ (equation (i)) ←	0.691 ←	0.723 ↑
	0.72 ↓	0.805 ↑
	1.00 ↓	1.384 ↑
	2.00 ↓	2.487 ↑
	3.00 ↓	3.242 ↑

During raising stages of barrel flow full from H = 0.72m and during falling stages the flow becomes free-surface when H = 0.629 m

The following table summarize the results.

H (m)	Q ($m^3 s^{-1}$)	Type of flow
Raising stages		
0.236	0.165	open channel
0.467	0.451	open channel
0.691	0.785	open channel
0.720	0.805	pipe flow
1.00	1.364	pipe flow
2.00	2.487	pipe flow
3.00	3.242	pipe flow
Falling stages		
2.00	2.487	pipe flow
1.00	1.364	pipe flow
0.72	0.805	pipe flow
0.691	0.723	pipe flow
0.691	0.785	open channel
0.467	0.451	open channel
0.236	0.165	open channel

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(2)

Bridge Scour : Bridge scour is removal of sediment such as sand and rocks from around bridge piers. pier scour is one of the greatest causes of bridge failures. it is estimated that about 80% of all bridges failures result from scour and other hydraulic-related causes. Water normally flow with speed around the piers due to speed it produce heavy load on pier which cause to local scour. At bridge opening contraction scour can occur. when water accelerates it flow through opening that is narrow

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Due to which its loads effect the foundation of bridge. scaring can remove the sediment from bridge foundation. it is very dangerous for bridge.

<u>Types of scarr:</u>

① Natural scarr

② Total scarr

③ Local scarr

④ Contraction scarr

⑤ Live bed scarr

- Scarr make lowering the rive bed around pier.
- piles exposed to river due to long scarring

Mechanisms of scour

Development of hole

Vortex system formed in front of the obstruction and has the form of horseshoe obstruction ~~and has the form of~~. River flow and boundary condition rise to the energy of the vortex increased shear stress commence local sediment transport.

Local Scour at piers

- occurs due to the acceleration of flow around the pier and formation of flow vortex.