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Section :- B

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Subject :- hydraulic

Stage discharge relationship for a concrete rectangular box culvert:

given Data.

Wiedth = 1.4

H = 0.9m

L = 26m

Slope = 1:1000

mannings : $\eta = 0.013$

Square edged entrance = 0.5

Range = 0-3m

Solution:-

$H/D \leq 1.4m$

$H < 0.9m$

Dis charge is given by

$$Q = 2.92\, y_0 \left[1.2 y_0 / 1.2 + 2y_0\right)^{2/3}$$

m

$\boxed{H_3 = 0.999\,m}$

y_0 m	H (m)	Q (m^3/s)
0.3	0.399	0.299
0.6	0.699	0.785
0.9	0.999	1.330

$H/D \geq 1.4$

$$Q = C_d\,(1.4 \times 0.9)\,(2g(H - D/2))^{1/2}$$

$$= 0.82(1.4 \times 0.9)\,(2(9.8)(1.08 - \tfrac{0.9}{2}))^{1/2}$$

$$= 2.746\ m^3/s$$

The following result are obtained

H (m)	Q ($m^3 s^{-1}$)	y_0 m
1.08	2.746	0.9

no orifice flow

(b) For pipe flow the energy equation gives.

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

$$h_L = K\frac{v^2}{2g} + (vn)^2 \frac{L}{R^{4/3}} + \frac{v^2}{2g}$$

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

Mechanism of Scour:-
All the obstruction in the form of pier abutment or abutment the unidirectional flow changes into three dimensional As the water pile up inform face of the obstruction the flow accelerated around the noise.

figure-1 presentation of vortox around a circuler pier.

The pile up of water due to obstruction because of decleration of flow water due pressure of water cause downward

⇒ Due to rolling of unstable shear ~~by~~ layer at the surface of pier wake ~~wes~~ vortex are generated at the seperation line and move forward with flow downward of the pier

Due to pressure of Armor layer the clear water regime can be attended as the value of critical velocity

0.399	1.330	//
0.699	1.477	
0.999	2.487	//
1.080	3.242	
2.000		
3.000		pipeflow
falling stage.	3.242	//
2.000	1.477	
1.080	1.330	//
0.999	0.785	chanalflow
0.699		
0.399	0.299	//

$q_2 = \frac{q_2}{B} = \frac{0.785}{1.4} = \boxed{0.561}$

$q_3 = \frac{1.330}{1.4} = \boxed{0.95}$

Now putting value in equation (A)

$y_{c_1} = \left(\frac{q_1^2}{g}\right)^{1/3} = \left(\frac{(0.213)^2}{9.81}\right)^{1/3} = \boxed{0.166m}$

$y_{c_2} = \boxed{0.317\ m}$

$y_{c_3} = \boxed{0.451\ m}$

At the inlet over a short reach

$H = y_0 + \frac{v^2}{2g} + Ke \cdot \frac{v^2}{2g}$.

$v_1 = 1.142\ m/s$.

$H_1 = y_0 + \frac{v^2}{2g} + Ke \cdot \frac{v^2}{2g}$.

$= 0.3 + \frac{(1.142)^2}{2 \times 9.81} + 0.5 \cdot \frac{(1.142)^2}{2(9.81)}$

$\boxed{= 0.399m.}$

$H_2 = \boxed{0.699m.}$

y_o m	Q ($m^3 s^{-1}$)	y_c (m)
0.3	0.299	0.166
0.6	0.785	0.317
0.9	1.330	0.451

by putting value of y_o will get the corresponding discharge.

$$Q_1 = 2.92(0.3)\left[1.2(0.3)/_{1.2} + 2(0.3)\right]^{2/3}$$

$$= 0.299\ m^3/s$$

$$Q_2 = 0.785\ m^3/s$$

$$Q_3 = 1.330\ m^3/s$$

critical depth

$$y_c = \left(\frac{q^2}{g}\right)^{1/3} \quad — \quad (A)$$

$$q = Q/B \quad — \quad (B)$$

By putting value in equation B

$$q_1 = \frac{Q_1}{B} = \frac{0.299}{1.4} = 0.213$$

increase

The armor layer is shown in figure 3 taken from Raikar and Day (2009)