# Stage Discharge Relationship for a Concrete Rectengular Box Culvert:—

## Given Data:—

Width = 1.4m
Height = 0.9m
Length = 26m
Slope = 1: 1000
mannings; $\eta = 0.013$
Squre edge entrance; Ke = 0.5
Range = 0 - 3m.

## Solution:—

$H/D \leq 1.4m$

As $H = 0.9m$

Discharge is Given by;

$$Q = 2.92\, Y_0 \left[1.2 Y_0 / 1.2 + 2 Y_0\right]^{2/3} \longrightarrow (A)$$

Now

| $Y_0$ (m) | Q ($m^3/s$) | $Y_c$ (m) |
|---|---|---|
| 0.3 | 0.299 | 0.166 |
| 0.6 | 0.785 | 0.317 |
| 0.9 | 1.330 | 0.451 |

By putting values of $Y_0$ we will get the correspondings discharge

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

$$\boxed{Q_1 = 0.299\ m^3/s}$$

2) $$Q_2 = 2.92(0.6)\left[\frac{1.2(0.6)}{1.2+2(0.6)}\right]^{2/3}$$

$$\boxed{Q_2 = 0.785\ m^3/s}$$

3) $$Q_3 = 2.92(0.9)\left[\frac{1.2(0.9)}{1.2+2(0.9)}\right]^{2/3}$$

$$\boxed{Q_3 = 1.330\ m^3/s}$$

**Critical depths:—** As we know that

$$Y_c = \left(\frac{q^2}{g}\right)^{1/3} \longrightarrow (A)$$

$$q = Q/B \longrightarrow (B)$$

Put the values in eq (B)

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

$$q_2 = \frac{Q_2}{B} = \frac{0.785}{1.4} = 0.561$$

$$q_3 = \frac{Q_3}{B} = \frac{1.330}{1.4} = 0.95$$

Now put the values in eq (A)

$$Y_{c1} = \left(\frac{q_1^2}{g}\right)^{1/3} = \left(\frac{(0.213)^2}{9.81}\right)^{1/3}$$

$$\boxed{Y_{c1} = 0.166m}$$

$$Y_{c2} = \left(\frac{q_2^2}{g}\right)^{1/3} = \left(\frac{(0.561)^2}{9.81}\right)^{1/3}$$

$$\boxed{Y_{c2} = 0.317m}$$

$$Y_{c3} = \left(\frac{q_3^2}{g}\right)^{1/3} = \left(\frac{(0.95)^2}{9.81}\right)^{1/3}$$

$$\boxed{Y_{c3} = 0.451m}$$

## At the inlet over a Short Reach:-

$$H = Y_0 + \frac{V^2}{2g} + ke * \frac{V^2}{2g}$$

$$V_1 = 1.142 \ m/s$$

So

$$H_1 = Y_{01} + \frac{V^2}{2g} + ke \cdot \frac{V^2}{2g}$$

$$= 0.3 + \frac{(1.142)^2}{2(9.81)} + 0.5\left(\frac{(1.142)^2}{2(9.81)}\right)$$

$$\boxed{H_1 = 0.399m}$$

Also

$$H_2 = 0.6 + \frac{(1.142)^2}{2(9.81)} + 0.5\left(\frac{(1.142)^2}{2(9.81)}\right)$$

$$\boxed{H_2 = 0.699\,m}$$

&

$$H_3 = 0.9 + \frac{(1.142)^2}{2(9.81)} + 0.5\left(\frac{(1.142)^2}{2(9.81)}\right)$$

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

Also

| $Y_o$ (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 |
| orifice > 0.9 "1.2D" | 1.08 | 1.477 |

By interpolation

(2) $H/D \geq 1.4$

Let à for orifice flow

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

$$Q = 0.62\,(1.4 \times 0.9)\left[2(9.81)\left(1.08 - \frac{0.9}{2}\right)\right]^{1/2}$$

$$\boxed{Q = 2.746\,m^3/s}$$

As we obtained the following Results

| H (m) | Q ($m^3/s$) | Yo(m) |
|---|---|---|
| 1.08 | 2.746 | >0.9 |

AS
no orifice flow exists

(b) For the Pipe flow the energy eq :-

$$H + S_o L = D + h_L$$

$$\therefore h_L = K_e \frac{V^2}{2g} + (Vn)^2 L / R^{4/3} + V^2/2g$$

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

So

During Rising Stages the barrel flows full from H = 1.08 m and during falling stages the flow becomes free surface flow when $\boxed{H = 0.999 m}$

## Answer #02:-

Scour of sediments around bridge foundations by the Stream is the most Significant controlling factor for bridge failure.

### TYPES:

**Natural Scour:-** Naturall Scour occurs due to the naturall variability of river Stream flow and Sediment regima, Considering the influence from the Catchment to the river Scale. Gradation of the riverbed lateral Channel migration, bend and Confluence Scour are part of it.

**Local Scour:-** local Scour emerges due to a local Concentration of turbulence generated by Structures that obstructs and Splits the flow (e.g: bridgepiers & abutments) local Scours occurs around these Structures because of the limited influence range they have on the River flow.