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Sec C

Subject Hydraulic Structure

Assignment 2nd

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Ans: "Stage Discharge relationship for a concrete rectangular Box Culvert;

Given data:

Width = 1.4m

Height = 0.9m

Length = 26m

Slope = 1:1000

mannigs: $n = 0.013$

Square edged entrance; $Ke = 0.5$

Range = 0-3m

Solution:

$H/D \leq 1.4m$

$H < 0.9m$

Discharge is given by:

$$Q = 2.92 y_0 \left[1.2 y_0 / 1.2 + 2y_0\right]^{2/3} \quad \text{— "A"}$$

y_0 (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 values of "y_0" we will get the corresponding discharge.

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

$= 0.299 \ m^3/s$

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

$= 0.785 \ m^3/s$

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

Critical Depth:

$$Y_c = \left(q^2/g\right)^{1/3} \text{ ——— "A"}$$

$$q = Q/B \text{ ——— "B"}$$

By putting values in eq "B"

$$q_1 = Q_1/B = 0.299/1.4 = 0.213$$

$$q_2 = Q_2/B = 0.785/1.4 = 0.561$$

$$q_3 = Q_3/B = 1.330/1.4 = 0.95$$

Now by putting values in eq "A":

$$Y_{c1} = \left(q_1^2/g\right)^{1/3} = \left(\frac{(0.213)^2}{9.81}\right)^{1/3} = 0.166\ m$$

$$y_{c_2} = \left(\frac{q_2^{\,2}}{g}\right)^{1/3} = \left(\frac{0.561^2}{9.81}\right)^{1/3} = 0.317\,m$$

$$y_{c_3} = \left(\frac{q_3^{\,2}}{g}\right)^{1/3} = \left(\frac{0.95^2}{9.81}\right)^{1/3} = 0.451$$

At the Inlet over a Short reach;

$$\text{"} H = y_0 + \frac{V^2}{2g} + K_e \cdot \frac{V^2}{2g} \text{"}$$

$$V_1 = 1.142\ m/s$$

So,

$$H_1 = y_{0_1} + \frac{V^2}{2g} + K_e \cdot \frac{V^2}{2g}$$

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

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

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

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

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

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

Y_o(m)	H (m)	Q (m^3s^{-1})
0.3	0.399	0.299
0.6	0.699	0.785
0.9	0.999	1.330
oriface>0.9 "1.2D"	1.08 →	1.477 By Intepolation

"2" $H/D \geq 1.4$

"a"; For oriface flow;

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

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

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

The following Results are obtained

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

→ no oriface flow exists.

"b" For pipe flow the energy Equation gives;

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

Where ;

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

Thus

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

During rising stages the barrel flows fall form $H = 1.08$m and during falling stages the flow becomes free- surface flow when

$H = 0.999$m.

"The following table Summarizes the result";

H (m)	Q (m³/s)	Type of flow
Rising Stages;		
0.399	0.299	open channel
0.699	0.785	open channel
0.999	1.330	open channel
1.080	1.477	Pipe flow
2.000	2.487	Pipe flow
3.000	3.242	Pipe flow
Falling Stages		
2.000	2.487	Pipe flow
1.080	1.477	Pipe flow
0.999	1.330	Pipe flow
0.699	0.785	Open channel
0.399	0.299	Open channel

Scour:-

It is an erosional process that can occur in rivers due to the interaction between any of structure located underwater and the river flow.

OR,

Scour is an erosional that can occur in rivers due to natural or made man events.

Natural erosional process take place in rivers because they act as conduits for movement of water sediment. Man made scour can be caused for instance by legal or illegal sediment extraction dam operation and the influence in general of any structure placed onto the river system.

Different Types of Scour:-

Natural Scour:-

Natural Scour occurs due to the natural variability of river stream flow and sediment regima, considering the influence from the catchment to the river scale. Gradation of the river bed, lateral channel migration, bend and confluence scour are part of natural scour.

Local Scour:

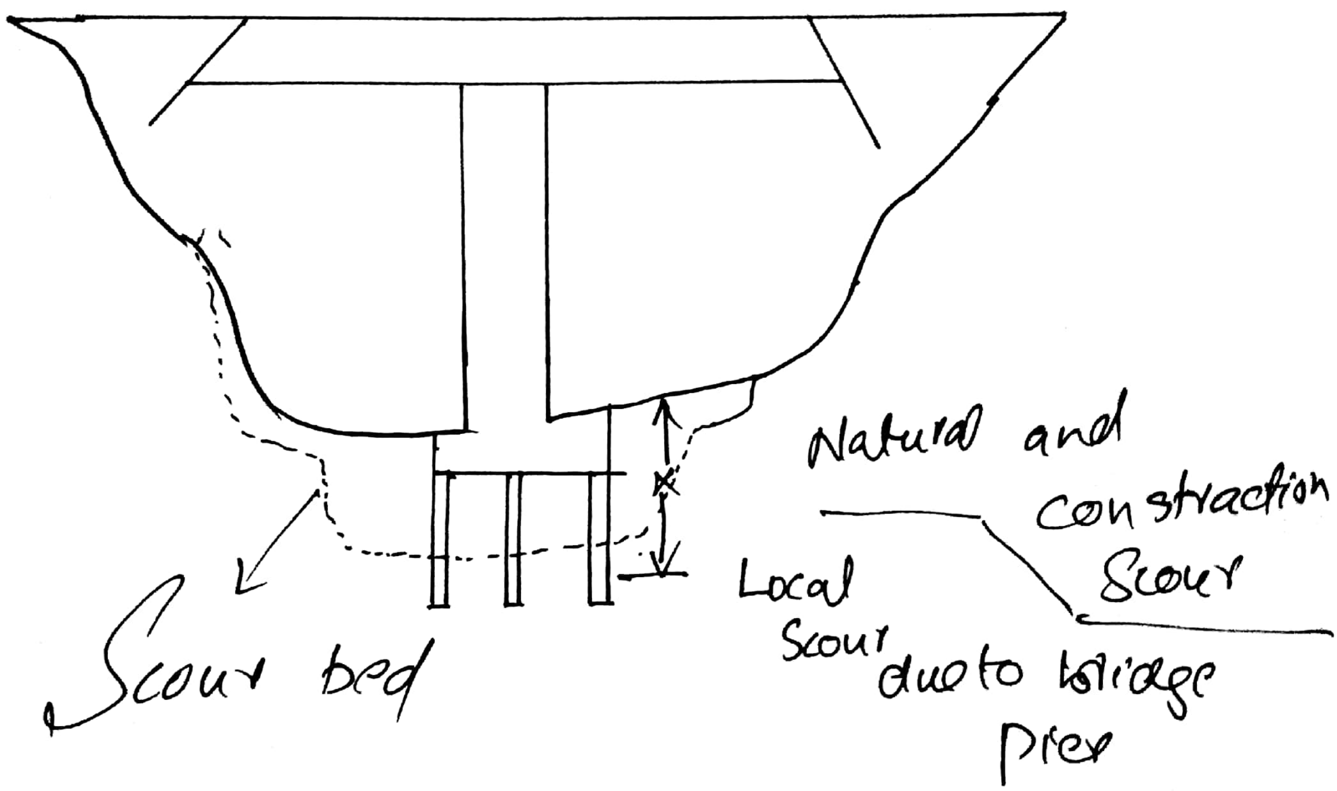
Local Scour emerges due to a local concentration of turbulence generated by structures that obstruct and split the flow. Local scour occurs around these structures because of the limited influence range the have on the river flow.

Contraction Scour:-

Occurs due to flow contraction when flow velocity and thus shear stressess, increase, for instance between bridge abutmats. Constraction · Scour normally take place within the complete river steam width.

Total Scour:

Total scour is defined as "The Sum of effects of all the Scour process that take place at a given location


Natural and constraction Scour
Local Scour due to bridge pier
Scour bed

Mechanics of Scour on bridge

1. Initial Phase:

The Scour process starts showing erosional pattern on the lateral side of the cylinder pier.

Progressing phase:

The erosional pattern progress from the lateral side to the front of pier. From the moment the two scour pattern concide at the front of the pier, the deepest scour depth is achieved.

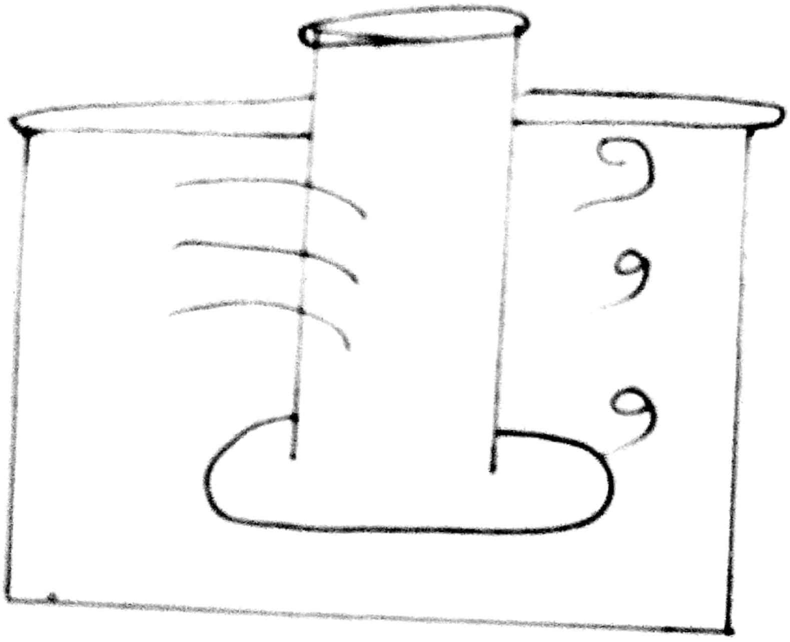
Developing phase:

The scour process develops and the scour rate slows down.

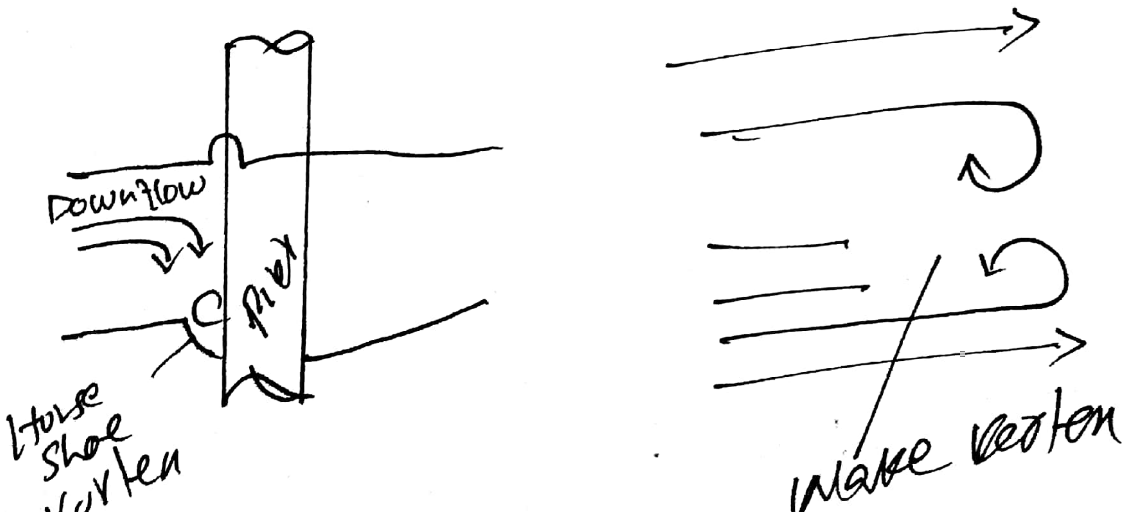
Equilibrium phase:

Erosion inside the scour hole is negligible

At the obstruction in form of pier or abutement the unidirectional flow changes into three dimensional as the water pile-up in front face of the obstruction and the flow accelerates around the nose. This phenomenon results. The pilup of water due to obstruction because of decelerating of flow due to stagnation pressure of water ~~causes~~ a downword flow results in horse vortex. The vertical component of the downward flow causes erosion around the base of the pier.



Information of vorten at the base of the pier known as horse shoe vorten and the vorten from in the vertical direction downstream of the pier known as wake vorten as shown in figure.



Presentation of vorten around a circular path

Due to rolling of unstable layer at the surface of the pier wake vortex are generated at the separation & moves forward with flow down stream of the pier. It can be shown

In the practical case the river bed is generally composed of mixture ~~of different~~ size of material due to washing ~~out~~ scour finer material and armor layer is formed or coarser materials which protects the under-lying ~~finger~~ finer particles from further scour.