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CLASS: BE(C)

SUBJECT: Hydraulic Structure

SECTION: A

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ASSIGHNMENT No 01

Sour:.

Scour is an erosional process that can occur in rivers due to the interaction between any of structure located under water and the river fulow

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. Manmade scour can be caused for instance by legal or illegal sediment extraction dam operation and the influence in general of any structure placed in to the river stream.

Different types of Scour:

Natural Scour:

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

Local scour:

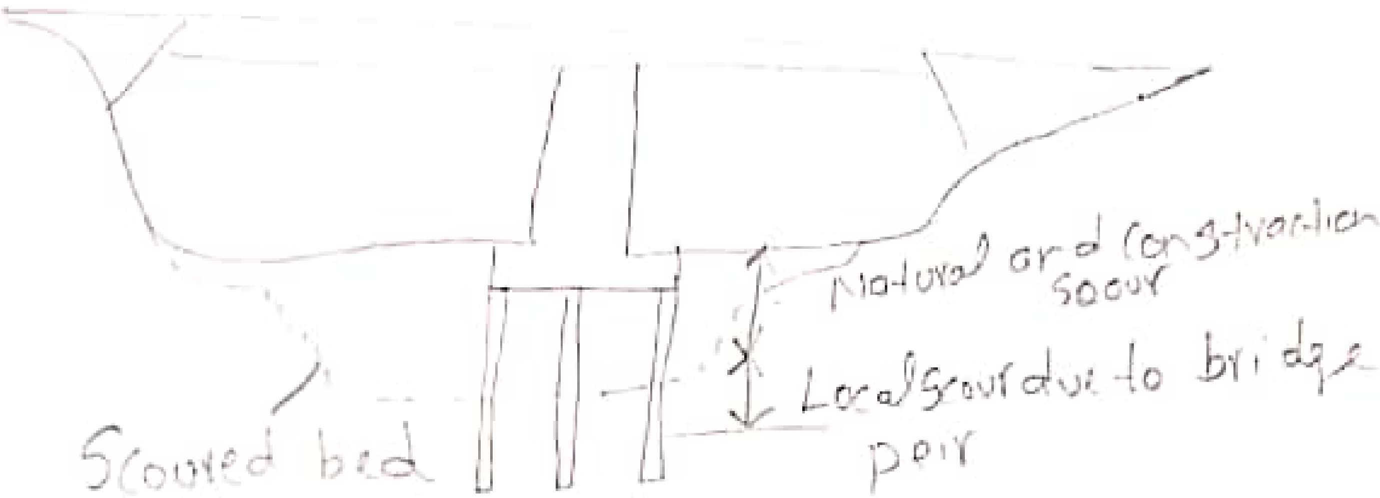
Local scour emerges due to a local concentration of turbulence generated by structures that obstruct and split the flow (e.g bridge piers and abutements Local scour occurs around these structures because of the limited influence range they have on the river flow.

Contraction Scour:

Constraction scour occurs due to flow contraction when flow velocity and thus shear stressess, increase, for instance between bridge abutments. Constraction scour ~~occurs around these~~ normally take place with in the Compulete river stream width

Total Scour::

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



Scanned with CamScanner

Mechanics of Scour on bridge

Initial Phase:

The scour process starts showing erosional patters 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 coincide at the front of the pier, the deepest scour depth is achieved.

Developing phase.

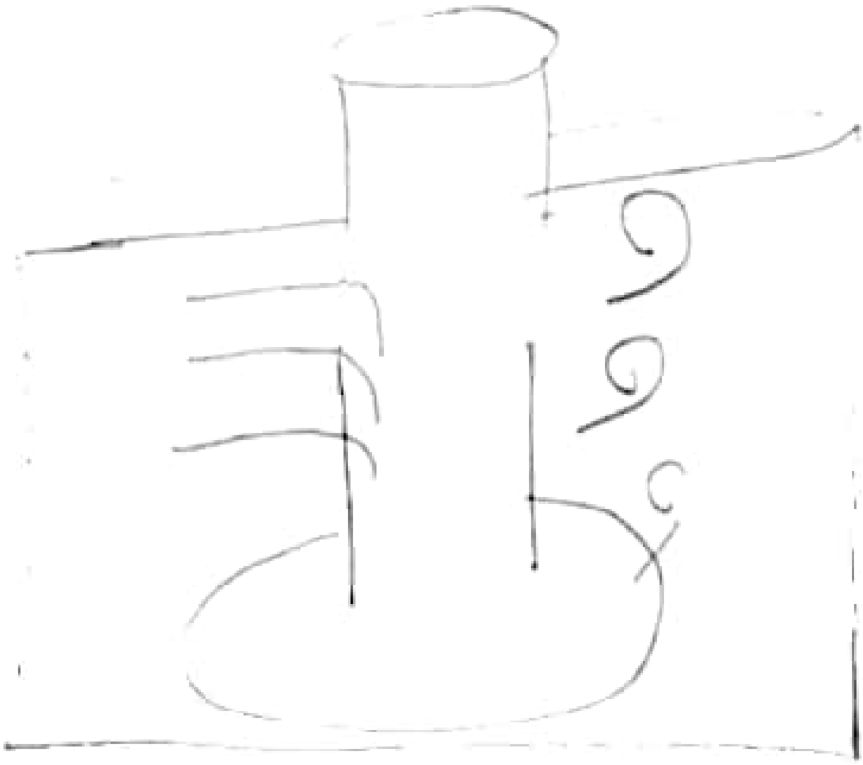
The scour process develops and the scour rate slows down

Equilibrium phase

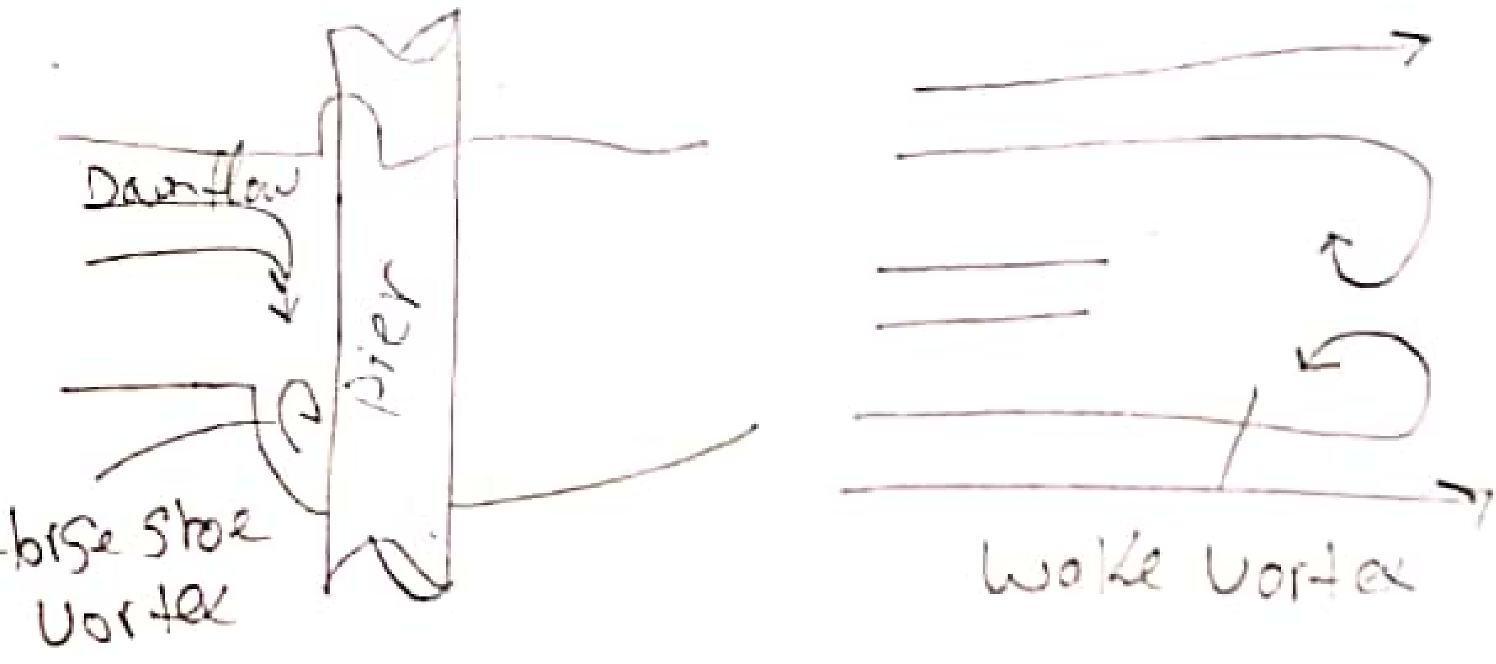
Erosion inside the scour hole is negligible

At the obstruction in form of pier or abotement the unidirectional flow changes in to three dimensional as the water pileup in front face of the obstruction and the flow accelerates around the nose. This phenomenon results

The pileup of water due to obstruction because of decelerations 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.



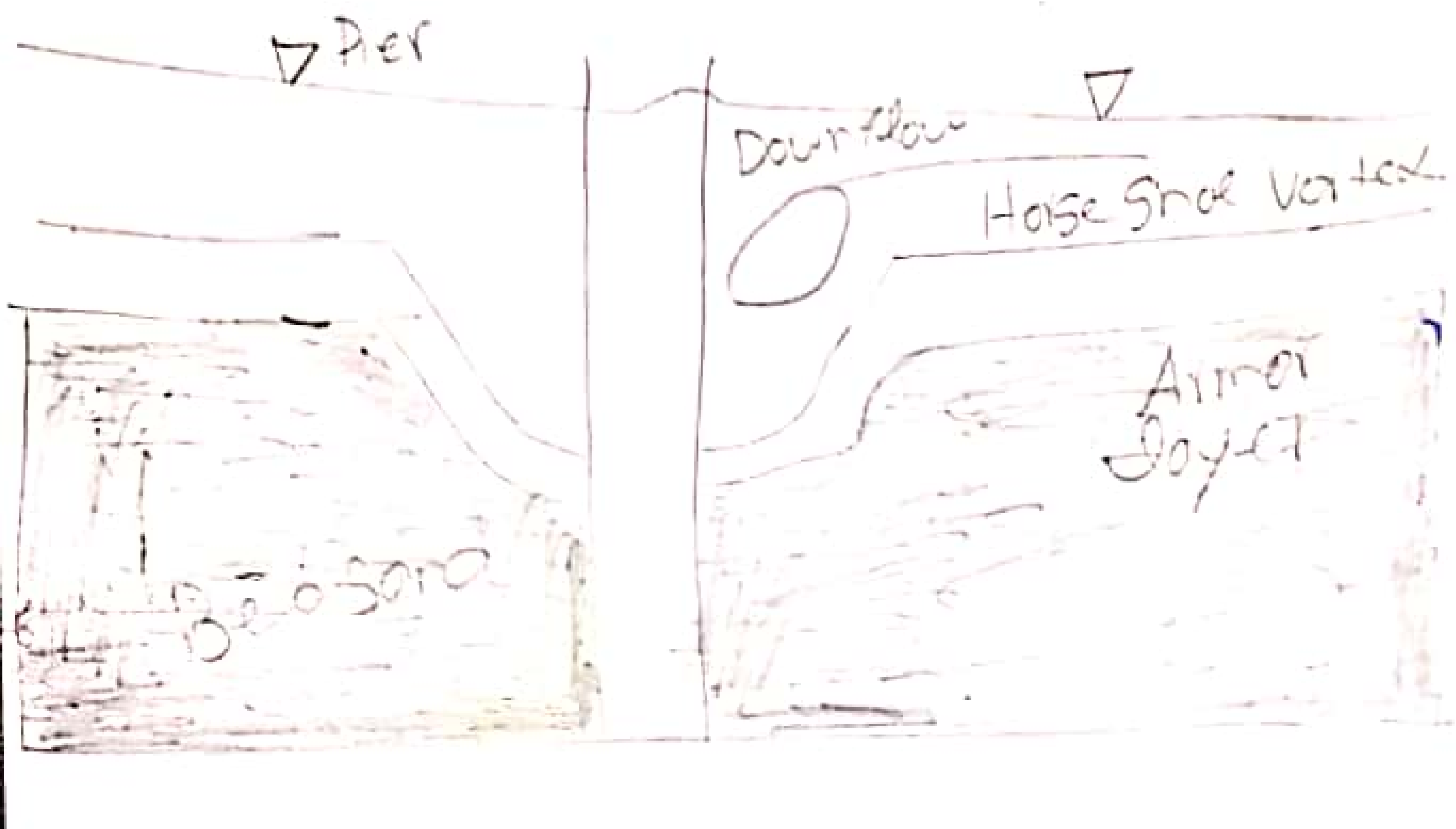
information of vortex at the base of the pier known as horse shoe vortex and the vortex from in the vertical direaction downstream of the pier known as wake vortex as hown in figure



presentation of vortex around a circular path

Due to rolling of unstable layer at the sulface of the pier wake vortex are generated at the separation and moves forward with flow downstream 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 our of finer material and armor layer is formed of coarser materials. Which ~~proje~~ protect the underlying finer particles from further scour.



Pier
Down flow
Horse Shoe Vortex
Armor layer
Bed Sand

"Stage discharge relationship for a concrete rectangular Box culvert;

"Given Data;"

Width = 1.4m
Height = 0.9m
Length = 26m
Slope = 1:1000
mannings ; η = 0.013
Square edged entrance ; K_e = 0.5
Range = 0-3m

"Solution;"

$H/D \leq 1.4m$

$H < 0.9m$

Discharge is given by;

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

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.

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

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

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

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

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

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

"Critical depth";

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

$$q = Q/B \quad \text{— "B"}$$

By putting values in eq "B".

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

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

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

Now by putting values in eq "A".

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

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

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

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;

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

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

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

|

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

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

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

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

y_0 (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
orifice > 0.9 "1.2D"	1.08 →	1.477 By interpolation.

"2" $H/D \geq 1.4$

"a"; For orifice flow;

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

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

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

The following results are obtained.

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

→ no orifice 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 full from H = 1.08m and during falling stages the flow becomes free-surface flow when H = 0.999m.

"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