ANSWER NO:-1

Establish the stage (headwater level) discharge relationship for a concrete retangular box culvert, using the following data: width = 1.2m, height = 0.6, length = 30m, Slope = 1 in 1000, Mannings n = 0.013, square-edged entrance conditions; free jet outlet flow, range of headwater level for investigation = 0.3m, neglect the velocity of apporach.

Solution:-

1. $H/D < 1.2$. For $H < 0.6m$, free flow open channel conditions prevail. Referring to fig. 10.6 & assuming that a steep slope entry gives entrance control, i.e the depth at the inlet is critical, for $H = 0.2m$, ignoring entry loss $y_c = (2/3) \times 0.2 = 0.133m$ & $V_c = 1.142 ms^{-1}$.

This is gives the critical slope $(Vn)^2/R^{4/3} = 0.00424$. Therefore the slope of the culvert is mild & hence subcritical flow analysis gives the following results:-

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

$$= 2.92y_0 [1.2y_0/(1.2 + 2y_0)]^{2/3}; \quad (i)$$

y_0 (m)	Q ($m^3 s^{-1}$)(equi)	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,

$$H = y_0 + V^2/2g + K_e V^2/2g. \quad (ii)$$

Cross-Drainage & Drop Structures:-

The entrance loss coeffecient k is as follows:-

~~The~~ ~~on~~

For a square-edged entry, 0.5;
For a flared entry, ~~Vz~~ 0.25;
For a rounded entry, 0.05;

y_1 (m)	H(m) (eq ii)	Q(m^3s^{-1})
0.2	0.236	0.165
0.4	0.467	0.451
0.6	0.691	0.785
conifice → 0.6 ← (1.2D)	0.72 →	0.817 (by interpolation)

2. H/D ≥ 1.2

(a) For orifice flow

$Q = C_d(1.2 \times 0.6)[2g(H - D/2)]$ (iii).

With $C_d = 0.62$ the following results are obtained;

H(m)	Q(m^3s^{-1})	y_1(m) eq iii
0.72	1.29	> 0.6 → no orifice flow exists.

(b) For pipe flow the energy equation gives:

$H + S_o L = D + h_1$

where

$h_1 = k_e V^2/2g + (Vn)^2 L/R + V^2/2g$.

Thus

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

	H (m)	Q ($m^3 s^{-1}$) (eq. (iv))
$y_o = 0.6$ (equation (i)) ←	0.691 ←	0.723
	0.72 ↓	↑ 0.805
	1.00	1.364
	2.00	2.487
	3.00	3.242

During rising stages the barrel flows full from $H = 0.72$ m & during falling stages becomes free-surface flow when $H = 0.691$ m.

The following table summarizes the results:

Date: ____________

H (m)	Q ($m^3 s^{-1}$)	Type of Flow
Rising 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

Date:

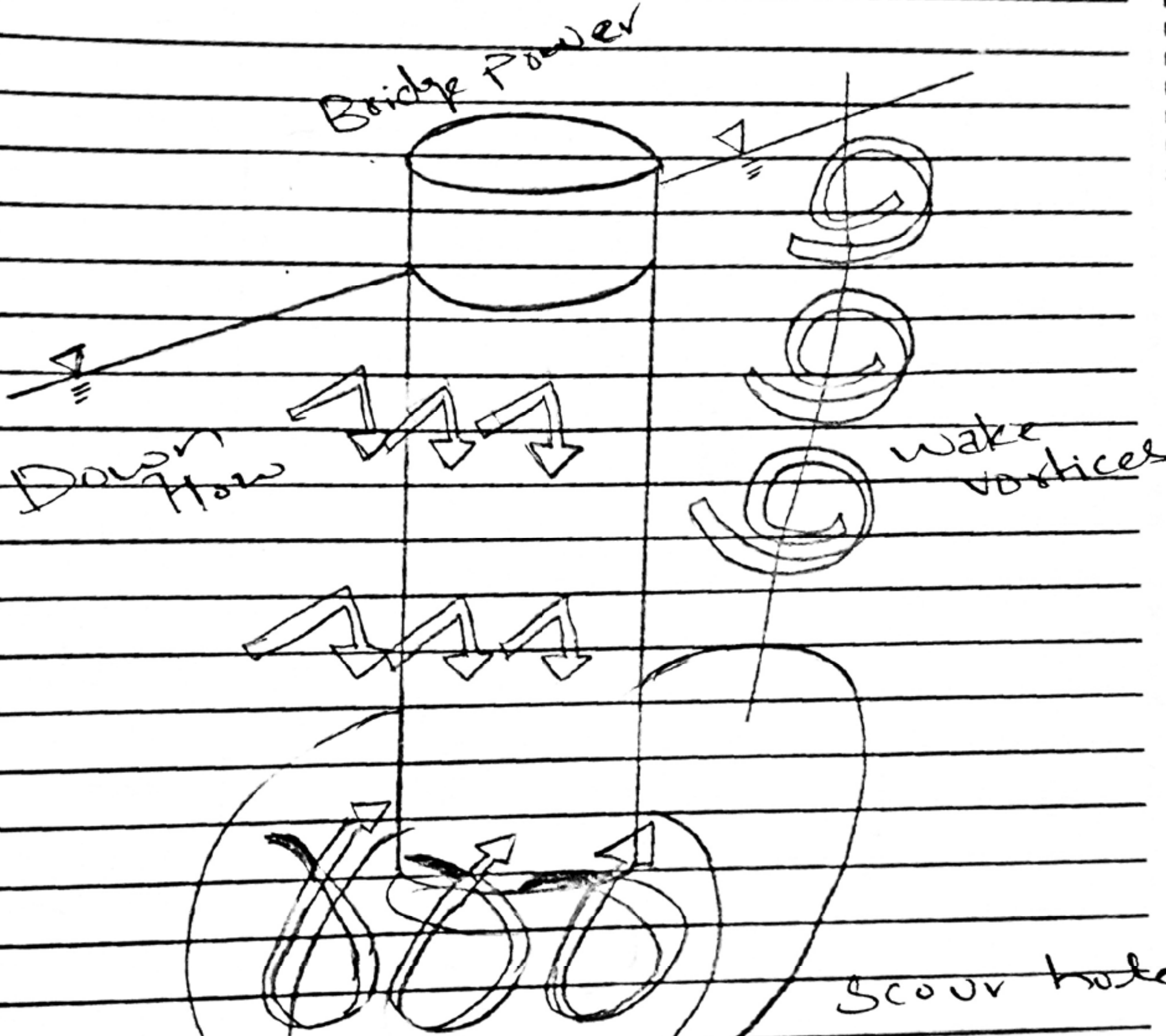
H (m)	Q ($m^3 s^{-1}$)	Type of Flow
Rising stages.		
0.236	0.165	Open channel
0.467	0.451	Open channel
0.691	0.785	Open channel
0.720	0.805	pipe flow
1.00	1.364	pipe flow
2.00	2.487	pipe flow
3.00	3.242	pipe flow
Falling stages.		
2.00	2.487	pipe flow
1.00	1.364	pipe flow
0.72	0.805	pipe flow
0.691	0.723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

ANSWER NO:2

Scour of sedimentation arround bridge foundations by the stream is the most significant contribution factor for bridge failures. The scour failures tend to occur without prior warning & have economic loss every year. A significant of work has been conducted on bridge scour. Such efforts can be classified into two major categories, namely science driven & engineering driven. The science-driven focuses on understanding the scour & aims to explain of scour due to different factors. Meanwhile engineering-driven reseach focuses & of bridge scour. This paper presents a comprehensive review of bridge scour research & practice.

Date: (7)

Firstly a brief introduction is given while include recent cases of failures caused by bridge scour. Then, both scientific research on bridge scour is reviewed, which are caterorized into four aspects:- macroscopic, & microscopic mechanism, scour depth experimental & field data, direct & remote methods & active & passive countermeasres. Finally, a summary covering both experimental & computational methods for scour reseach. Disscussion is also provided on emerging ideas to investigate bridge scour from both science & engeneering perspectives.



Horseshoe vortices

Scour can be defiend as the excavation & removal of material from the bed & bank of streams as a results of the erosive action of flowing water. General scour occurs naturally in river channels & includes the aggradation & deaggradation of the river bed that may occur as the flow rate or changes in the channel. It relates to the evolution of the waterway and is associated with the progression of scour & filling, in the absence of obstacles. Contraction scour of the reduction in the channel's cross-sectional areas that arises due to the construction of structures, such bridg piers & abutments. It increase in flow velocity & resulting bed shear stresses, in the channels cross-sectional area at the location of a bridge. The increasing shear stresses the channel bed's threshold shear stress & mobilize the sediments. Local Scour arround individual bridge piers & abutments. Downward flow is induced upstream end of bridge piers:- Horseshoe vortices develope due to the separation of the flow a the edge of the scour hole upstream of the pier & result in pushing the down-flow inside the scour hole closer to the pier. Furthermore, separation of the flow at the sides of the Pier results in wake vortices, local scour depends on the balance b/w streamed erosion & sediment deposition. Clear-water Scour is the term given to describe the situation where an

Date:

(11)

interaction exists between sediment transport & the scour process. The presence of live-bed conditions leads to smaller ultimate scour ~~help~~ depths than in clear-water conditions.

X ═══════════════ X