FLOW THROUGH OPEN CHANNEL SLUICE GATE

OBJECTIVE :

To investigate the operating characteristics of a sluice gate in open channels.

SCOPE :

Sluice gates are used in irrigation systems for controlling flow rate. Study of characteristics of sluice gates provide informations essential for their hydraulic designs.

APPARATUS :

(a) Open channel flume

(b) Stop watch

THEORY :

(a) Flow through a rectangular orifice is

$$Q_{th} = A\sqrt{2g\,H}$$

Where, Q_{th} = Theoretical discharge

A = Area of gate opening

H = Head

g = Accelaration due to gravity.

(b) Coefficient of discharge $C_d = \frac{Q_a}{Q_{th}}$

(c) Actual discharge $(Q_a) = \frac{\text{Volume}}{\text{Time}}$

EXPERIMENTAL PROCEDURE :

(a) Start the pump and allow water to flow through the flume with the valve set at minimum opening.

(b) Set the gate opening at 25mm.

(c) Operate the flow control valve to give a head of about 100mm in the tank and allow the condition to settle.

(d) Determine the flow rate by timing a known volume (m^3) passing through the flow meter at the bottom.

(e) Note the inlet head.

(f) Now increase the gate opening to 50mm and 75mm while keeping the head at 100mm by operating the flow control valve, measure discharge at each step.

(g) Repeat the procedure for heads in the tank of 15mm, 200mm, 250mm, 300mm and 350mm for the sluice gate opening of 25mm, 50mm and 75mm.

OBSERVATIONS :

Width of the flume =

25≈28

Number of observations	Head mm	Gate Opening mm	Volume m^3	Time Sec.
1	100	~~25~~ 28	0.1	1:53.73
		50		~~0:47.12~~ 0: 41.55
		75		~~0:34.95~~ 38.06
2	150	25		0: 47.12
		50	c	0: 24.86
		75		15.66
3	200	25		0:34.95
		50		0: 18.06
		75		13.37
4	250	25		0: 29.32
		50		16.82
		75		11.15
5	300	25		0: 25.38
		50		14.26
		75		
6	350	25		0: 25.16
		50		12.58
		75		

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CALCULATIONS :

(a) Actual discharge Q_a

(b) Theoretical discharge Q_{th}

(c) Coefficient of discharge C_d

(d) Show the figure of the apparatus and simple description

PRESENTATION :

(a) Show a sample calculatión.

(b) Present the results in a tabular form.

Number of observations	Head mm	Gate Opening mm	Actual Discharge Qa m^3/s	Theoretical Discharge Q^{th} m^3/s	Coefficient of Discharge C_d
1	100	25			
		50			
		75			
2	150	25			
		50			
		75			
3	200	25			
		50			
		75			
4	250	25			
		50			
		75			
5	300	25			
		50			
		75			
6	350	25			
		50			
		75			

(c) Plot between head H and actual discharge Q_a

COMMENT :

Comment on the value of Cd. Explain the uses of sluice gate in actual practices in irrigation system.

OPEN CHANNEL FLOW-HYDRAULIC JUMP

OBJECGIVE :

To compare the experimental value of depth before a hydraulic jump to that calculated from theory and calculate energy loss in a hydraulic jump.

SCOPE :

The formation of hydraulic jump is associated with a sudden rise in the water depth, large scale turbulence and dissipation of energy. It is employed at the foot of spillways and other hydraulic structures to dissipate energy for the protection of bed against scour. This experiment help to under the features of hydraulic jump.

APPARATUS :

(a) Open channel flume

(b) Stop watch

THEORY :

$$Y_1 Y_2 / (Y_1 + Y_2) = \frac{2q^2}{g}$$

Where, Y_1 = Depth before jump.

Y_2 = Depth after jump.

q = Discharge per unit width of the flume.

g = Acclaration due to gravity.

Energy loss $E_L = (Y_1 - Y_2)3/4\ Y_1 Y_2$

EXPERIMENTAL PROCEDURE :

(a) Start the pump and set the sluice gate to about 25mm.

(b) Adjust the flow rate to give about 300mm head above the sluice.

(c) Raise the adjustable weir to form a hydraulic jump within the central portion of the flume.

(d) Note the depth before and after the jump.

(e) Measure the flow rate and head.

(f) Repeat for a head of 500mm above the sluice and repeat steps c, d & e.

OBSERVATIONS :

Gate opening = 21 mm

Channel width = 103 mm

Number of observations	Head in mm	Depth Y_1 mm	Depth Y_2 mm	Volume m^3	Time Sec.
1	285	12.4	76.00	0.1	40.83
2	388 453	16.4 19.6	90.3 ~~99.3~~ 104.3	0.1	30.66 28.94

CALCULATIONS :

(a) Discharge per unit width q.

(b) Use q and Y_2 to comute Y_1.

(c) Compute E using theoretically derived Y_1 and experimental value.

(d) Show the figure of the apparatus and simple description

PRESENTATION :

(a) Present a sample calculation.

(b) Present the results in a tabular form.

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Number of Observations	Discharge Q m^3/s	Discharge /Unit Width q	Y_1 m	Experiment EL m	Theoretical EL m
1					
2					

COMMENTS :

Comment on the variation of Y1 and on the accuracy of depth measurement.

Discuss application of hydraulic jump in irrigation structures.

HEAD LOSSES IN PIPE LINE

OBJECGIVE :

To study the head loss due to friction in pipes and to compare the value with existing data.

SCOPE :

Transmission of fluid through pipe is a practical problem faced by engineers. Distributions of water for domestic purposes, flow of liquid in processing industries, pumping of water and oil, passing of steam in thermal plants and flow of gas through pipes to consumers are some examples of flow of fluid through conduit. Flow of fluid through pipes is associated with loss of energy. The basis of designing pipes for above uses in the accurate determination of the loss of energy incurred during flow. In water distribution system, estimation of frictional loss is essential to decide on the height of overhead tank and the size of supply mains so that a specified residual head remains at the end of the distribution system. The estimation of frictional loss also enables us to determine the type and capacity pump required and the power consumption. This experiment enables us to determine frictional loss is closed conduit.

APPARATUS :

(a) Pipe Network

(b) Thermometer

THEORY :

The head loss due to friction in a pipe flow according to Darcy Weisbach's equation is

$$h_L = \frac{f\,LV^2}{2g\,D}$$

Where, hL = Head loss

L = Length of pipe

V = Velocity of flow (Q_a/A)

D = Diameter of pipe

F = Friction factor

g = Accelaration due to gravity.

Q_a = Actual discharge shows by detameter = 9.81

A = Cross-section area of pipe

EXPERIMENTAL, PROCEDURE :

(a) Set the apparatus and start the pump.

(b) Select the pipe and by operating appropriate valves allow flow to pass through the system.

(c) Connect the pressure tappings at the pipe to the mainfold by operating small cooks so that the manometer comes in contact with water in the pipe.

(d) Allow water to flow through the manometer until the entire tube is filled with water.

(e) Now using the cocks in the manifold, disconnect the pressure tappings.

(f) Operating the drain cocks in the manometer and the air vent bring water level in the manometer to some appropriate level. Close the air vent.

(g) Regulate the flow control valve and allow a small discharge to pass through the pipe.

(h) Now open the manifold cocks (the manometer liquid will stand at two difference heights).

(i) At this condition note the pressure difference and the discharge as indicated by the rotameter.

(j) Repeat for seven more flows.

(k) Repeat (b) to (j) for larger diameter two pipes.

(l) Observe water temperature.

OBSERVATIONS : length of pipe = 2m

Temperature of water = 30°C = 303 K

Number of observations	PIPE DIAMETER					
	1/2"		3/4"		1"	
	Q_1/hr	$h_2 - h_1$ mm	Q_1/hr	$h_2 - h_1$ mm	Q_1/hr	$h_2 - h_1$ mm
1			200	263-252		
2			400	274-249		
3			600	289-245		
4			800	314-238		
5			1000	344-229		
6			1200	378-216		
7			1400	412-214		
8						

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LOSSES DUE TO FITTINGS IN A PIPE LINE

OBJECGIVE :

To find the losses incurred when various fittings are installed in a pipe line carrying water.

SCOPE :

Water distribution system consists of pipes of different diameters and pipe specials like bends, elbows and values to control the flow. Presence of these specials incur loss of energy in the flow. In the design of distribution system these losses have to be taken into account. Allowance must be made for minor losses in designs even if their magnitude is small compared to frictional losses. This experiment enables determination of coefficients that are essential for computing magnitude of minor loss.

APPARATUS :

(a) Pipe Network

THEORY :

(a) The loss of energy through a pipe special can be represented by a function of velocity head as

$$h_L = K - \frac{V^2}{2g}$$

Where, h_L = Head loss

V = Velocity of flow (Q_a/A)

g = Accelaration due to gravity.

K = Coefficient for the fitting

q = Discharge per unit width of the future.

(b) The across a fitting in the network is

$$\frac{p_1}{r}+\frac{V_1^2}{2g}=\frac{p_2}{r}+\frac{V_2^2}{2g}+h_L$$

or $$h_L=\frac{p_1-p_2}{r}+\frac{V_1^2-V_2^2}{2g}$$

(c) For same diameter pipe $V_1 = V_2$ hence

$$h_L=\frac{p_1-p_2}{r}$$

(d) Show the figure of the apparatus and simple description.

Note : At change of section equation (b) holds good. $\frac{p_1-p_2}{r}$ is measured, $\frac{V_1^2}{2g}$ and $\frac{V_2^2}{2g}$ are calculated hence loss can be determined.

EXPERIMENTAL, PROCEDURE :

It is essential to bleed the apparatus before the experiments are conducted,

(a) Set the apparatus and start the pump.

(b) Close all the valves in the manifold and allow flow in the pipe containing the fittings.

(c) For each fitting to be tested repeat steps (c) to (i) as given in experiment No. 9

(d) Repeat for two more flow rates.

OBSERVATIONS :

Basic pipe diamater = 28.0mm

Enlarged pipe diameter = 42.6mm

Number of observations		TAPPING NUMBERS									Flow 1/hr
		1–2	3–4	5–6	7–8	9–10	11–12	27–28	29–30	31–32	
		90° Bend	Gradual Enragement	Gradual Reducer	Globe Valve	Gate Valve	Cock	Bend	sudden Enlargement	Sudden Reducer	
1 2 3	Head Loss Hm										

CALCULATIONS :

(a) Velocity of flow V in m/s.

(b) Velocity head $V^2/2g$.

(c) Coefficient K for each fitting.

PRESENTATION :

(a) Show a sample calculation.

(b) Present the results in a tabular form.

Type of Fittings	Discharge Q m^3/s	Velocity m/s	Velocity head $V^2/2g$ m	Loss in m	Coefficient K
90° Bend					
Gradual Enragement					
Gradual Reducer					
Globe Valve					
Gate Valve					
Cock					
Bend					
sudden Enlargement					
Sudden Reducer					

COMMENTS :

Comment on the valves obtained. Discuss the significance of minor losses in line designs.

Topic : To determine the Manning's coefficient in different types of beds.

Observation Table $S_o = (1/400)$

$(\frac{1}{400})$ So

Obs. No.	Depth of the flume	With of flume (mm)	in the head $H_1 - H_2$
1	29.0	300	630 - 614
2	36.4		677 - 639
3	43.7		732 - 671
4	53.8		870 - 740
5	62.7		965 - 780
6	~~62~~ 1		~~995~~ - ~~975~~ - ~~782~~
7	62.1		971 - 785
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			

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Calculation Table : (Sample) show sample

Obs. No.	$-\nu$	$-R$	$-S$	$-A$	$-b$	$-d$	$-Q_{th}$	$-N$	$-$Rem

Manning's Coefficient

$$v = \left(\frac{1}{h}\right) R^{2/3} \quad S^{1/2}$$

v = Velocity of flow

R = Hydratics radius

S = bed slope

n = Manning's value or coefficient or number

$$R = \frac{A}{P}$$

A = Wetted area of Flame

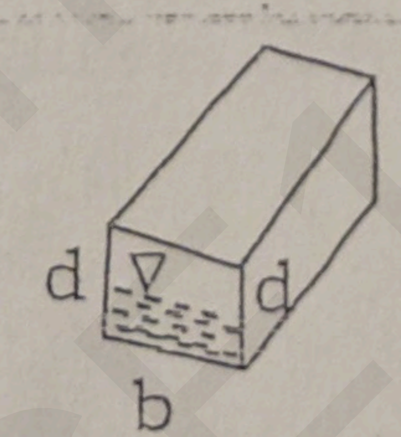
$A = b \times d$

b = width of flume

d = wetted depth of flume

p = wetted perimeter

$p = b + 2d$



$p = b + d + d$

s = bed slope

Here,

$Q = A \times V$

Q = Discharge flow through orifice

A = Area

v = velocity

We have

$\therefore Q = A \times V$

$Q = A\sqrt{2gh}$

Q = Discharge

A = Area of orife

h = Head different $(H_1 - H_2)$