Investigation Of Miniature Venturiflume In Floating Condition

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Abstract- *One of the important problem in irrigation is measuring irrigation water that flows in open channel. Several devices has been used for measuring irrigation water including weirs and Parshall flumes. Unfortunately, at many locations where flow measurement is desired there may be insufficient space available for operation of a critical-flow measurement structure under all flow conditions that may occur. Using the traditional technique for measuring discharge in open channel flow a new technique of discharge measurement is being developed by calibration of miniature venturiflume in floating condition to facilitate discharge measurement, which will lead the work in efficient way and achieving economy and accuracy.*

Keywords- Discharge measurement, Traditional venturiflume Miniature Venturiflume, Open channel.

I. INTRODUCTION

One of the important problems in irrigation is measuring irrigation water that flows in open channel. Several devices have been used for measuring irrigation water including weirs and Parshall flumes. In areas of flat topography, low canal gradients and lack of freeboard may not provide sufficient head to allow use of such devices. One of the main disadvantages of weirs and Parshall flumes in canals of flat gradients is the reduction of the capacity of the canal owing to the further reduction of the gradient.

A Venturiflume is a critical-flow flume, where in the critical depth is created by a local reduction of the channel width. For open channel conveyance systems, the Venturiflume offers the simplicity of a direct correlation between the upstream head and a corresponding discharge. Compared to a weir, this flume possesses the advantages of operating successfully without significant deposition of sediments and conveying water with smaller energy losses. If the Venturiflume is designed to be operated under free flow conditions, the flow passes from the subcritical to the supercritical state through the flume channel.

Following are the desirable characteristics of a suitable water measuring devices for use in canals of low gradients.

1. A low resistance to flow i.e. low head loss.
2. Easily measurable head.
3. Small effect on silt and debris deposition.
4. Simple construction and low cost.
5. Freedom from clogging by floating debris.

The evolving circumstances under which irrigation operate include growing demands for more accurate knowledge and accountability of flow throughout the conveyance network, along with increased needs for timely awareness when unexpected flow conditions are present. For Open channel conveyance systems, critical-flow structures offer the simplicity of a direct correlation between upstream water level and a corresponding discharge. Unfortunately, at many locations where flow measurement is desired there may be insufficient space available for operation of a critical-flow measurement structure under all flow conditions that may occur.

II. TRADITIONAL VENTURIFLUME IN FLOATING CONDITION

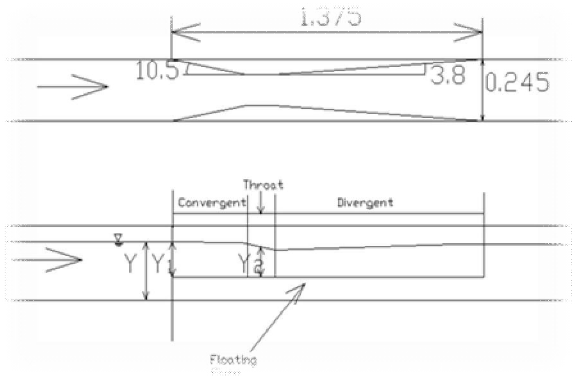


Fig 1: traditional venturiflume in floating condition

For experiment purpose the venturiflume is designed for full width of channel in floating condition then flume is considered as a traditional flume in floating condition.

Equation of venturiflume,

$$Q = C_d \frac{a_1 a_2 \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$$ ……………………..(1)

Where,

$a_1 = b_1 y_1$ $a_2 = b_2 y_2$……………… (2)

Q = Discharge in m^3/sec.
Cd = Coefficient of discharge.
a_1= Area of inlet in m^2.
a_2 = Area of throat in m^2.
b_1= Width of inlet in m.
b_2= Width of throat in m.
h= y_1 - y_2

III. MINIATURE VENTURIFULME IN FLOATING CONDITION

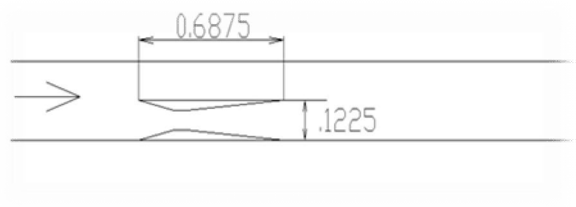


FIG 2: MINIATURE VENTURIFULME WITH HALF WIDTH

For experiment purpose the miniature venturiflume is designed for half width of channel and kept flume in floating condition at 50% of total depth of water.

Equation of Miniature Venturiflume,

$$Q' = C_d' \frac{a_1' a_2' \sqrt{2gh'}}{\sqrt{a_1'^2 - a_2'^2}}$$ ………………(3)

Where,

$a_1' = b_1' y_1$ $a_2' = b_2' y_2'$………………(4)

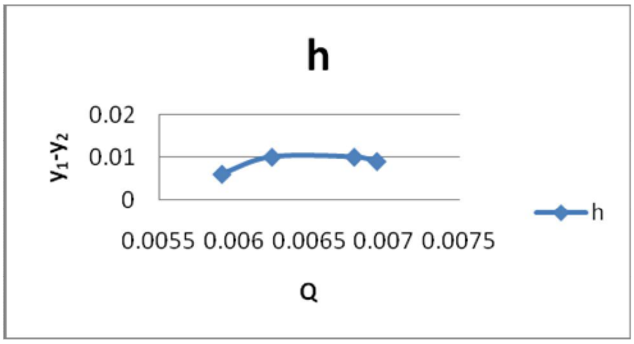
Q' = Discharge in m^3/sec.
C_d' = Coefficient of discharge.
a_1'= Area of inlet in m^2.
a_2' = Area of throat in m^2.
b_1'= Width of inlet in m.
b_2'= Width of throat in m.

IV. EXPERIMENTATION ON TRADITIONAL VENTURIFLUME IN FLOATING CONDITION

PIC 1: TRADITIONAL VENTURIFULME IN FLOATING CONDITION

Set 1

t	Q	y	y_1	y_2	a_1	a_2	h	Cd
2.23	0.0069	0.093	0.041	0.032	0.009963	0.003872	0.009	3.93
2.28	0.0067	0.095	0.045	0.035	0.010935	0.004235	0.01	3.34
2.48	0.0062	0.089	0.044	0.034	0.010692	0.004114	0.01	3.16
2.62	0.0059	0.074	0.037	0.031	0.008991	0.003751	0.006	4.17



Graph 1: Q vs y_1 - y_2

Graph 1 shows the curve obtained for Q VS y_1 - y_2. It clearly shows that difference between depth at inlet and at throat in floating condition is increases as discharge increases.

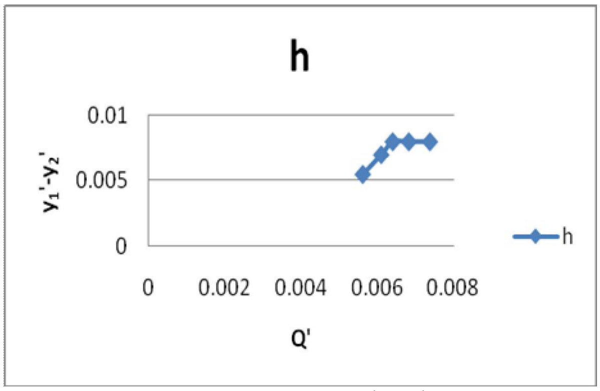
From Set 1 it is clear that the value of Cd is around 3.5. For traditional flume it is 0.92-0.98. Since value of Cd is changed due to floating condition.

V. EXPERIMENTATION ON MINIATURE VENTURIFLUME IN FLOATING CONDITION

PIC 2: MINIATURE VENTURIFULME IN FLOATING CONDITION

Set 1

t	Q'	y'	y_1'	y_2'	a_1'	a_2'	H'	Cd'
2.1	0.0074	0.097	0.05	0.042	0.0059	0.00252	0.008	6.68
2.27	0.0068	0.089	0.046	0.037	0.0054	0.00225	0.008	6.76
2.42	0.0064	0.093	0.045	0.037	0.0053	0.00222	0.008	6.61
2.54	0.0061	0.093	0.046	0.039	0.0054	0.00234	0.007	6.34
2.76	0.0056	0.089	0.046	0.0405	0.0054	0.00243	0.007	6.29



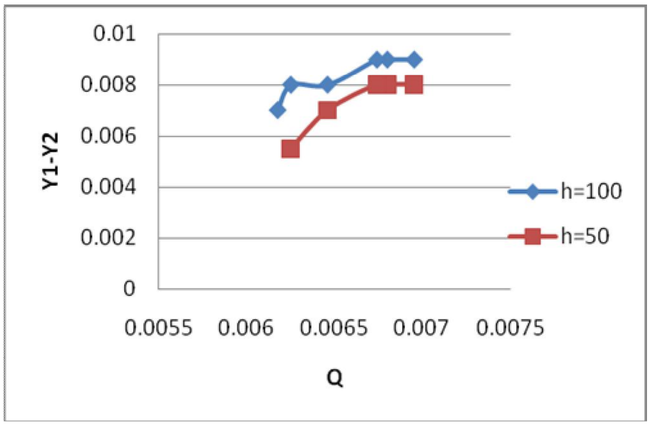
Graph 2: Q' VS $y_1' - y_2'$

Graph 2 shows the curve obtained for Q' VS $y_1' - y_2'$. It clearly shows that difference between depth at inlet and at throat in floating condition is increases as discharge increases. The same shows the Graph 1.

From Set 1 of miniature venturiflume it is clear that the value of Cd is around 6.5. For traditional flume it is 0.92-0.98. Since value of Cd is changed due to width contraction as well as floating condition.

VI. GRAPHICAL ANALYSIS OF TRADITIONAL VENTURIFLUME & MINIATURE VENTURIFLUME

Q (Cumec)	h=100%	h=50%
0.006951	0.009	0.008
0.006798	0.009	0.008
0.006739	0.009	0.008
0.006458	0.008	0.007
0.00625	0.008	0.0055
0.006175	0.007	



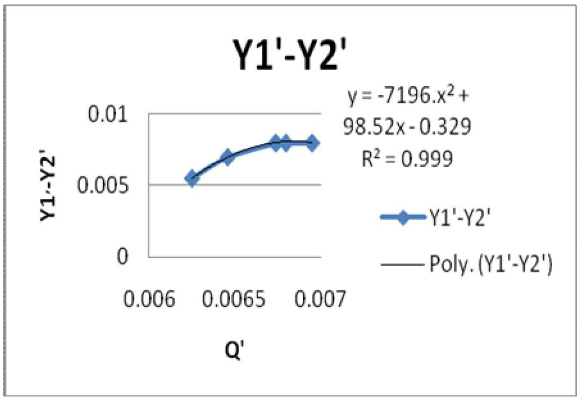
Graph 3: Comparison between Traditional and Miniature venturiflume

Graph 3 shows the curve obtained Q VS $y_1 - y_2$ for traditional and miniature venturiflume. The two different curves shows same trend of line.

VII. RESULT & DISCUSSION

The table shows depths at inlet and throat section for miniature venturiflume. After experimentation the actual discharge is found out. The value of Cd' is obtained and the average Cd' is calculated. Since the value of Cd' is 6.5. With this obtained value theoretical discharge is calculated and % error is obtained. The % error is between ± 5% and it is acceptable.

y_1'	y_2'	$Q_{Observed}$	$y_1' - y_2'$	Cd'	$Q_{theoretical}$	% Error
0.05	0.042	0.0074	0.097	6.68	0.0071	-3.957
0.046	0.037	0.0068	0.089	6.76	0.00654	-4.403
0.045	0.037	0.0064	0.093	6.61	0.00622	-2.97
0.046	0.039	0.0061	0.093	6.34	0.00612	+0.327
0.046	0.0405	0.0056	0.089	6.29	0.006	+5



Graph 4: Q' VS $y_1' - y_2'$ for miniature venturiflume

Graph 4 shows a equation $y = -7196.x^2 + 98.52x - 0.329$ which is obtained from graph.

$$y = -7196.x^2 + 98.52x - 0.329$$

Where,

$y = y_1' - y_2'$
$x = Q$

Hence, range of Cd (coefficient of discharge) for traditional flume is 0.92 to 0.98 but in case of miniature venturiflume in floating condition it is 6.5.Since discharge of full channel is measured with the help of miniature venturiflume i.e. ½ width of channel with taking 6.5 as a value of Cd.

BENEFITS OF MINIATURE VENTURIFLUME:

1. The construction cost of miniature flume will be less than the traditional venturiflume.
2. The problem of sedimentation will be solved as the flume is floating.
3. Generally for taking reading a structure has to be constructed across the venturiflume in actual practice, this is a big advantage in this flume which will be miniature and the dimensions of it will be less so that the taking readings will be an easy task.

FUTURE SCOPE:

1. In this project ratio of dimensions of traditional and miniature venturiflume kept (1/2). In future different ratios can be taken for study.
2. By providing different positions of miniature venturiflume in floating condition in channel, further study can be done.
3. Automation for depth and discharge measurement with the help of advanced electronic instruments can be done to minimize the error.
4. Wide range of discharge can be studied using different venturiflumes.

LIMITATION:

This study is completed in rectangular tilting flume, so result may change for trapezoidal flume.

VIII. CONCLUSION

For traditional venturiflume and miniature venturiflume a relation is obtained , which will lead the work in efficient and economic way.

1. The proposed model is feasible for design discharge of 0.007 m3/sec .
2. Coefficient of discharge= 6.5.
3. Economy is achieved due to reduced dimensions of new venturiflume.
4. The equations obtained is
   $y = -7196.x2 + 98.52x - 0.329$
   $R^2 = 0.999$

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