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IRRIGATION ENGINEERING

[BTAI 2201]

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Flumes:

- ❑ Flumes are well-known hydraulic structures for measurement of discharge.
- ❑ They consist of a narrow section with a well-defined shape. Common types of flumes are Parshall flume and Cut-throat flume.
- ❑ For flume inlet section, the maximum **convergence ratio should not exceed 3:1**. For **divergence, 6:1 ratio** is satisfactory.

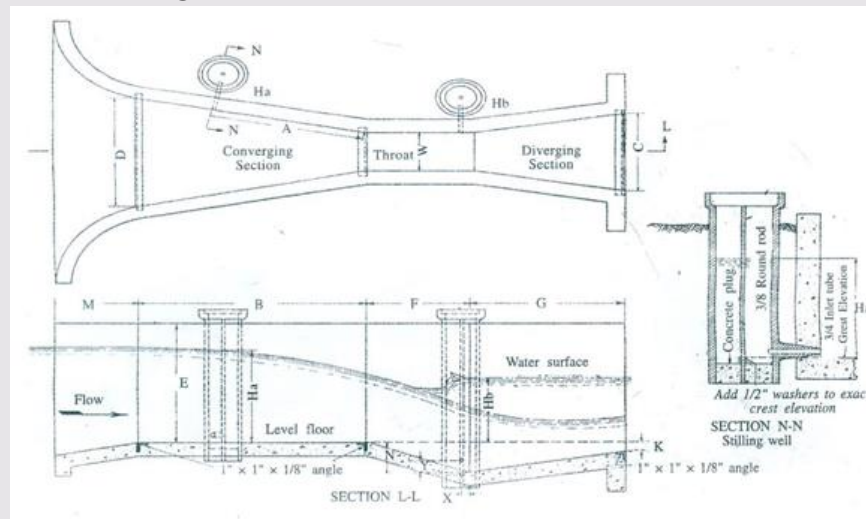


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Parshall Flumes:

- ❑ Parshall flumes are devices for the measurement of flow of water in open channels when depth of flow is less i.e., head drop is very small, the volume of flow is less and channel bed slope is less.
- ❑ The flume consists a **converging section with a level floor** and walls converges towards the throat section, **a throat section with a downward sloping floor** and parallel walls, and a **diverging section with an upward sloping floor** and diverging walls towards the outlet.
- ❑ The size of flume is determined by the width of its throat
- ❑ The size ranges from 7.5 cm to several metres in throat width.





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Parshall Flumes:

On the basis of the throat width, Parshall flumes have been classified into three main groups.

- a) Very small - 25.4 mm to 76.2 mm.
 - b) Small 152.40 mm to 2438.4 mm.
 - c) Large 3048 mm to 15240 mm.
- ✓ Discharge through the flume can occur under either free or submerged flow condition.
 - ✓ Flow is submerged when the down-stream water elevation retards the rate of discharge.
 - ✓ To determine discharge through the flume under free flow condition, head is measured at upstream section (H_a).
 - ✓ However, downstream head (H_b) is also measured for submerged flow condition.

Free flow condition prevails if the **submergence ratio (H_b/H_a)** remains within **0.5**, **0.6** and **0.7** for width of throat varying from **2.5 to 7.5 cm**, **1.5 to 22.5 cm** and **3.0 to 24.0 cm**, respectively.



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Parshall Flumes:

The discharge is measured by the following formula:

$$Q = CH^n$$

Q is the discharge.

C, n are the flume coefficients which vary with the size of the flume

H is the measuring head.



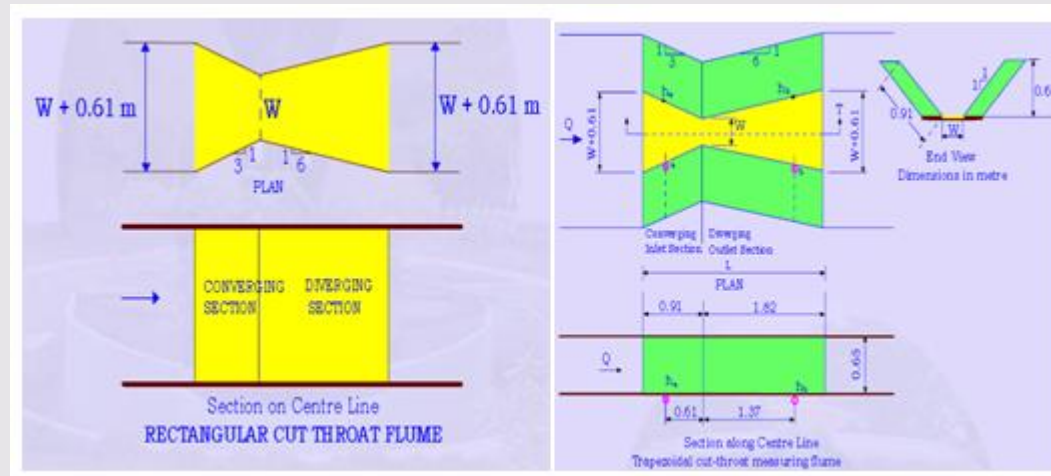
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Cut-throat Flumes:

The geometry of the throat-less flumes with broken plane transition was first developed in Punjab by Harvey in 1912.

In the cut throat flume however, the flume discharge and the modular limit are related to the piezometric heads at two points in the converging section (h_a) and in the downstream expansion (h_b).



The cut-throat flume can operate either as a free flow or a submerged flow structure. Under free flow conditions, critical depth occurs in the vicinity of minimum width, w , which is called the flume throat or the flume neck.



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Cut-throat Flumes:

The attainment of critical depth makes it possible to determine the flow rate, knowing only an upstream depth, h_a .

The relationship between flow rate Q and upstream depth of flow h_a , in a cut-throat flume under free flow conditions is given by the following experimental relationship:

$$Q = C_1 h_a^n L$$

Q = flow rate

C_1 = free flow coefficient, which is the value of Q when h_a is 1.0 foot.

n = exponent, whose value depends only on the flume length L .



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Cut-throat Flumes:

Design Specifications

L = Total length of the flume,

L_1 = Converging section = $L/3$

L_2 = Diverging section = $2L/3$,

L_a = Distance to piezometer tap a = $2L/9$

L_b = Distance to piezometer tap b = $5L/9$

B = width of the converging and diverging section = $W + L/4.5$



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