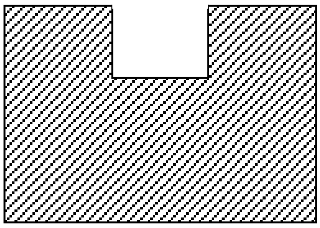
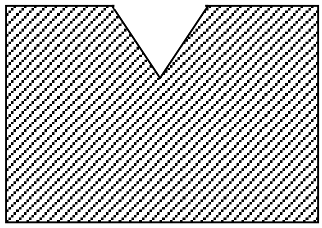
7.2.4 <u>The Notch or Weir</u>

The flow of liquid presenting a free surface (open channels) can be measured by means of a weir. The pressure energy converted into kinetic energy as it flows over the weir, which may or may not cover the full width of the stream, and a calming screen may be fitted before the weir. Then the height of the weir crest gives a measure of the rate of flow. The velocity with which the liquid leaves depends on its initial depth below the surface.

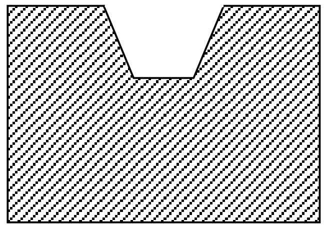
Many shapes of notch are available of which three shapes are given here as shown in Figures,



Rectangular notch

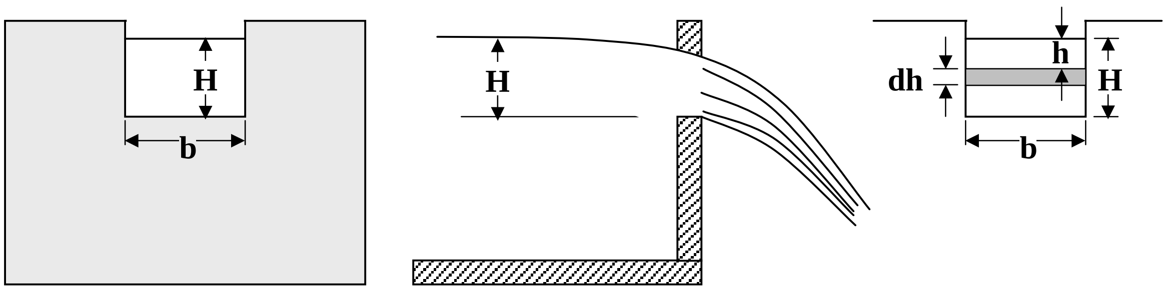


Triangular notch



Trapezoidal notch

7.2.4.1 <u>Rectangular Notch</u>



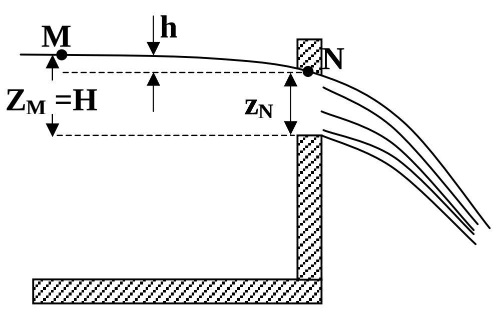
H: height of liquid above base of the notch

h: depth of liquid from its level

b: width or length of notch

Consider a horizontal strip of liquid of thickness (dh) at depth (h).

The theoretical velocity of liquid flow through the strip = $\sqrt{2gh}$



To prove this equation applies Bernoulli's equation between points M and N as shown in Figure;

$$\frac{P_M}{\rho g}+\frac{u_M^2}{2g}+z_M=\frac{P_N}{\rho g}+\frac{u_N^2}{2g}+z_N$$

The cross sectional area of flow at point M is larger than that at notch (point N), then ($u_M \approx 0$)

$P_M = P_N = P_o$ atmospheric pressure

$$\Rightarrow\quad z_M - z_N = \frac{u_N^2}{2g} \qquad \boxed{\therefore u_N = \sqrt{2gh}}$$

The area of the strip dA = b.dh

The discharge through the strip dQ = u.dA = C_d ($\sqrt{2gh}$)(b.dh)

$$\Rightarrow \int_0^Q dQ = C_d b\sqrt{2g}\int_0^H h^{1/2}dh \qquad \Rightarrow Q = C_d b\sqrt{2g}\,\frac{H^{3/2}}{3/2}$$

$$\therefore \quad Q = \frac{2}{3}C_d b\sqrt{2g}H^{3/2}$$

<u>Example -7.14-</u>

A rectangular notch 2.5 m wide has a constant head of 40 cm, find the discharge over the notch where $C_d = 0.62$

<u>Solution:</u>

$Q = \frac{2}{3}C_d b\sqrt{2g}H^{3/2}$ = 2/3 (0.62) (2.5) $(2 \times 9.81)^{0.5}$ $(0.4)^{3/2}$

Q = 1.16 m^3/s

<u>Example -7.15-</u>

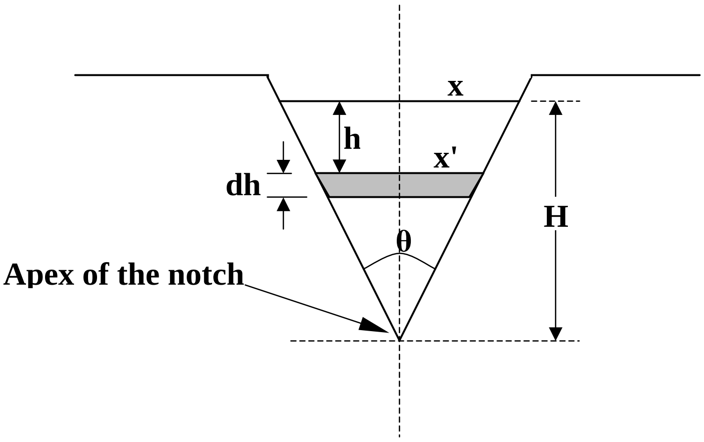
A rectangular notch has a discharge of 21.5 m^3/min, when the head of water is half the length of the notch. Find the length of the notch where $C_d = 0.6$.

<u>Solution:</u>

$Q = \frac{2}{3}C_d b\sqrt{2g}H^{3/2}$ ⇒ 21.5/60 = 2/3 (0.6) (b) $(2 \times 9.81)^{0.5}$ $(0.5\ b)^{3/2}$

⇒ $b^{5/2} = 0.572$ ⇒ $b = (0.572)^{2/5} = 0.8$ m

7.2.4.2 <u>Triangular Notch</u>



A triangular notch is also called a *<u>V-notch</u>*.

H: height of liquid above base of the apex of the notch.

θ: Angle of the notch.

tan (θ/2) = x / H = x' / (H-h)

The width of the notch at liquid surface = 2x = 2H tan(θ/2)

The width of the strip = 2x' = 2(H-h) tan(θ/2)

The area of the strip = 2x' dh = 2(H-h) tan(θ/2)dh

The theoretical velocity of water through the strip = $\sqrt{2gh}$

The discharge over the notch dQ = u. dA = C_d ($\sqrt{2gh}$) [2(H-h) tan(θ/2)dh]

$$\int_0^Q dQ = 2C_d \tan(\theta/2)\sqrt{2g}\int_0^H (Hh^{1/2} - h^{3/2})dh$$

$$Q = 2C_d \tan(\theta/2)\sqrt{2g}\left[\frac{Hh^{3/2}}{3/2} - \frac{h^{5/2}}{5/2}\right]_0^H = 2C_d \tan(\theta/2)\sqrt{2g}\left[\frac{2}{3}H^{5/2} - \frac{2}{5}H^{5/2}\right]$$

$$\therefore \quad Q = \frac{8}{15}C_d \tan(\theta/2)\sqrt{2g}H^{5/2}$$