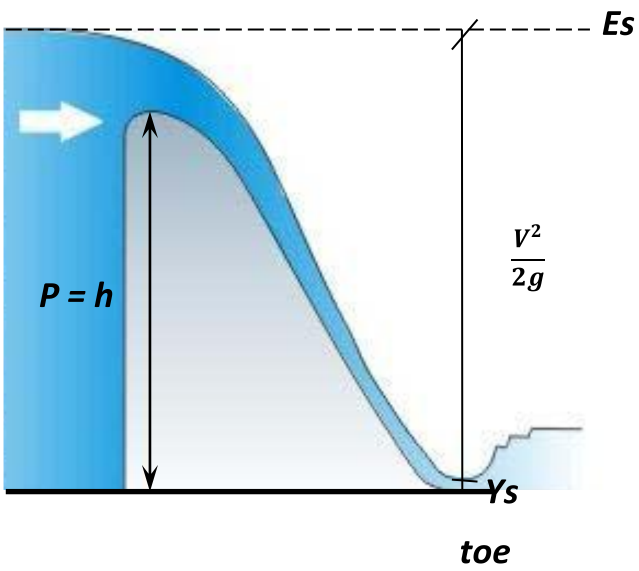
Example: ***For the following spillway find:***

1- The flow rate (rating curve), at the following stages ***(H = 2 , 4 , 6 , 8 , 10).*** Considering that the design head is ***9 m*** and the height of the spillway ***p = 20 m*** with ***100m*** long. Sketch the curve

2- Theoretical and actual velocity at the toe point for the design head.



Given

Hd = 9 m , P = 20 m , L = 100 m

So, g = 9.81 m/s²

Solution

$$\frac{P}{Hd} = \frac{h}{Hd} = \frac{20}{9} = 2.222 > 1.33$$

$$\therefore \quad ha = \frac{V^2}{2g} = 0 \quad \text{and} \quad H=He \text{ any where}$$

$$Q = C\sqrt{2g}\,L\,He^{1.5} = C\sqrt{2g}\,L\,H^{1.5} \qquad \text{with } L = 100 \ \& \ g = 9.81$$

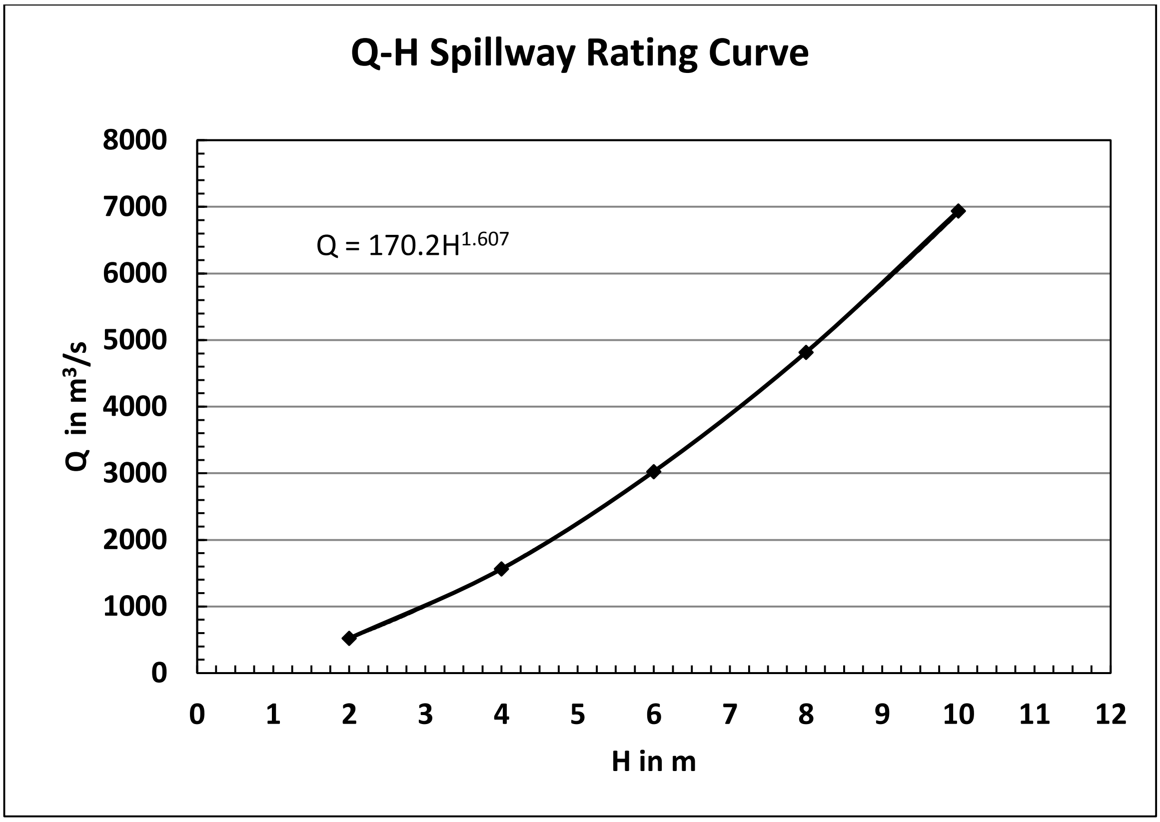
$$\therefore \ Q = C\sqrt{2 * 9.81}\,100\,H^{1.5} = 442.945\,C\,H^{1.5} \qquad \text{Where H in m \& Q in } m^3/s$$

Now for Cd (C at H = Hd=9 m)

$$With \ \frac{P}{Hd} = \frac{h}{Hd} = \frac{20}{9} = 2.222$$ ***Yields that Cd = 0.4905 from the chart***

To find the discharge over the spillway at the required heads we must find the values of C at that heads and as follows:

H	$\frac{H}{Hd}$	$\frac{C}{Cd}$	C	$Q = 442.945\,CH^{1.5}$ (m^3/s)
2	0.22	0.85	0.4169	522.308
4	0.44	0.9	0.4415	1564.482
6	0.67	0.948	0.465	3027.120
8	0.89	0.98	0.4807	4817.912
10	1.11	1.01	0.4954	6939.142



2- Theoretical and actual velocities

A- For theoretical velocity (V_{th}):-

From the Fig.1 Es = P + Hd = 20 + 9 = 29 m

Also, $$Es = y + \frac{V^2}{2g} = y + \frac{Q^2}{2gA^2} = y + \frac{Q^2}{2g(y*L)^2}$$

For H = Hd =9 m the discharge Q is:

$$Q = C\sqrt{2g}\,L\,He^{1.5} = Cd\sqrt{2g}\,L\,Hd^{1.5}$$

$$Q = 0.4905 * \sqrt{2 * 9.81} * 100 * (9)^{1.5} = 5866.138\ m^3/s$$

$$\therefore\ the\ specific\ energe\ Es = y + \frac{Q^2}{2g(y*L)^2}\ \ will\ be$$

$$29 = y + \frac{(5866.138)^2}{2 * 9.81(y * 100)^2}$$

$$\therefore \quad 29 = y + \frac{175.39}{y^2}$$

Solve for super critical depth (y_s)

$$\therefore\ y = \sqrt{\frac{175.39}{29-y}}$$

Y in	Y out
0	2.459
2.459	2.571
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⟶	2.576

So; y_s = 2.576 m

$V_{th} = \frac{Q}{A} = \frac{5866.138}{100*2.576}$ = 22.772 m/s

B- <u>For actual velocity (Va):-</u>

The actual velocity should be calculated from the chart (Fig.13) as follows:

Z = H + p = 9 + 20 = 29 m

Note that (Z & H) should be in ft

$\therefore\quad \boldsymbol{Z = 29\,m = 95.14\,ft} \qquad \& \qquad H = 9\,m = 29.528\,ft$

So; From the Fig.13, with ***Z = 95.14 ft and H = 29.528 ft***

The actual velocity is $\boldsymbol{Va} \approx 72\frac{ft}{s} \approx 21.95\frac{m}{s}$

*Note that the actual velocity (**Va** =21.95) is always less than the theoretical velocity (**V_{th}**=22.772).*