EAH 225 HYDRAULICS: OPEN CHANNEL FLOW TUTORIAL

SPECIFIC ENERGY

A rectangular channel with a width of 4 m has a depth of 2.5 m at a flow rate of 12 m^3/s. Draw a specific energy diagram for the given flow condition and determine whether the flow is subcritical or supercritical?

SOLUTION

Given: B = 4 m

y = 2.5 m

Q = 12 m^3/s

$$E_s = y + \frac{Q^2}{2gA^2}$$ (Velocity Head)

Rewrite as:

$$E_s = y + \frac{q^2}{2gy^2}$$

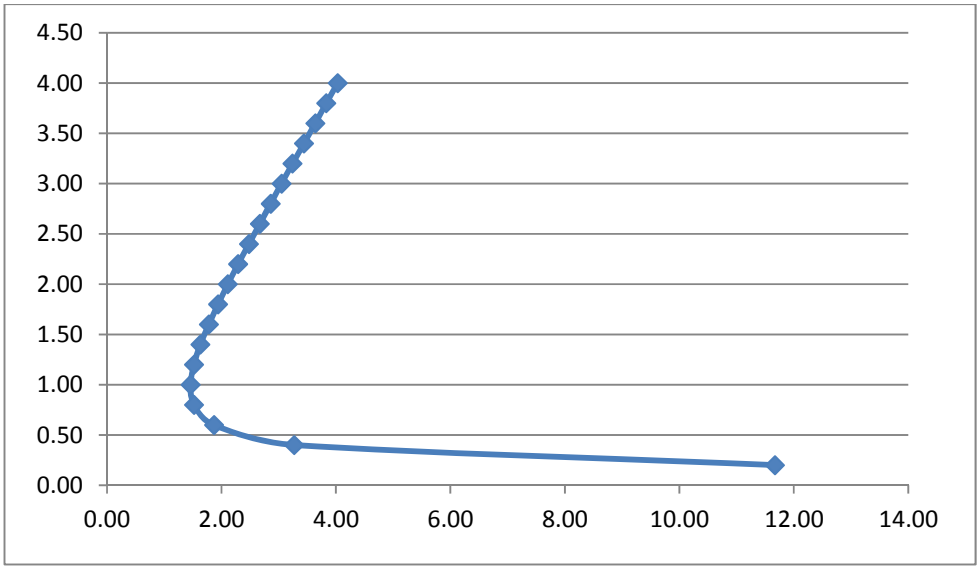
where unit discharge = q = Q/B

q = 12/4 = 3 m^2/s

Set up a table and compute the velocity head and specific energy for every 0.2m depth increment:

y (m)	Velocity Head (m)	E_s (m)
0.20	11.47	11.67
0.40	2.87	3.27
0.60	1.27	1.87
0.80	0.72	1.52
1.00	0.46	1.46
1.20	0.32	1.52
1.40	0.23	1.63
1.60	0.18	1.78
1.80	0.14	1.94
2.00	0.11	2.11
2.20	0.09	2.29
2.40	0.08	2.48
2.60	0.07	2.67
2.80	0.06	2.86
3.00	0.05	3.05
3.20	0.04	3.24
3.40	0.04	3.44
3.60	0.04	3.64
3.80	0.03	3.83
4.00	0.03	4.03

y (m)



E_s

From the above figure y_c = 1.0 m;

Since the flow depth is 2.5 m > 1.0 m, the flow is **subcritical.**

Explicit computation

For critical flow ($y = y_c$),

$$\frac{q^2}{g y_c^3} = 1 \text{ Or}$$

$$y_c = \sqrt[3]{\frac{q^2}{g}}$$

$$y_c = \sqrt[3]{\frac{3^2}{9.81}} = 0.971 \text{ m}$$