

1) $b = 2 \text{ m}$

$I_0 = 9 \text{‰} = 0,009$

$Q = 1,8 \text{ m}^3/\text{s}$

$\eta = 0,014 \text{ m}^{-1/3} \text{ s} = 0,014 \cdot \frac{1}{\sqrt{m}}$

a) $L = ?$



$I_0 = I_0 \quad Q = \frac{1}{n} \cdot A \cdot R^{2/3} \cdot \sqrt{I_0}$

$R = \frac{A}{O} = \frac{b \cdot L}{b + 2L} = \frac{2L}{2 + 2L} = \frac{2L}{2(1+L)} = \frac{L}{1+L}$

$Q = \frac{1}{n} \cdot 2L \cdot \sqrt[3]{\left(\frac{L}{1+L}\right)^2} \cdot \sqrt{I_0}$

$1,8 \frac{\text{m}^3}{\text{s}} = \frac{1}{0,014 \frac{\text{s}}{\sqrt{\text{m}}}} \cdot 2L \cdot \sqrt[3]{\left(\frac{L}{1+L}\right)^2} \cdot \sqrt{0,009}$

$1,8 = 13,55 \cdot L \cdot \sqrt[3]{\left(\frac{L}{1+L}\right)^2}$

$0,35 = L \cdot \sqrt[3]{\left(\frac{L}{1+L}\right)^2}$

$0,01 = \frac{L^5}{(1+L)^2}$

$L = 0,65 \text{ m}$ ✓

b) $Fr = 1 \Rightarrow R_{cr} \quad Fr = \frac{Q^2 \cdot b}{g \cdot A^3} = \frac{1,8^2 \cdot 2}{9,81 \cdot (2 \cdot h_{cr})^3} = 1$

$1,8^2 \cdot 2 = 9,81 \cdot 8 \cdot h_{cr}^3$

$16,08 = 78,48 \cdot h_{cr}^3$

$h_{cr}^3 = 0,59$

$h_{cr} = 0,84 \text{ m}$ ✓

$R_{cr} > L \Rightarrow$ Supercritical



$$6) \quad h = R_{\text{ext}}$$

$$I_0 + I_{\text{ext}} = 0$$

$$Q = \frac{1}{n} \cdot A \cdot R^{\frac{2}{3}} \cdot \sqrt{I_E}$$

$$4,8 = \frac{1}{0,014} \cdot 2 \cdot 0,84 \cdot \sqrt[3]{\left(\frac{0,84}{1+0,84}\right)^2} \cdot \sqrt{I_E}$$

$$4,8 = 74,43 \cdot 1,68 \cdot 0,593 \cdot \sqrt{I_E}$$

$$\sqrt{I_E} = \frac{4,8}{74,45} = 0,0675$$

$$I_E = 4,56 \cdot 10^{-3} = 0,00456 = 4,56\%$$

2.

$$z = 2 + 1,2a = 3,56 \text{ m} \quad \checkmark$$