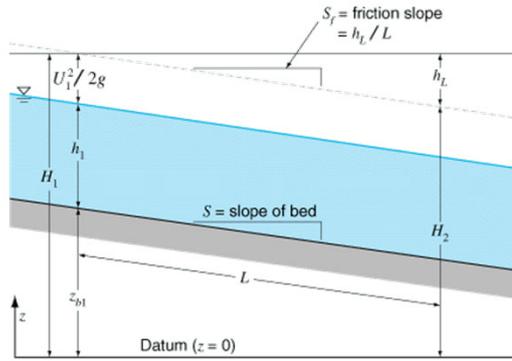
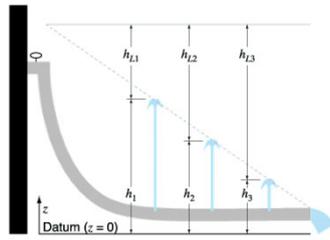


ベルヌイの定理の応用

溪流流速



エネルギー損失

$$h_L \equiv f \frac{L U^2}{D 2g}$$

$$U = \sqrt{\frac{h_L 2gD}{L f}} \quad (1)$$

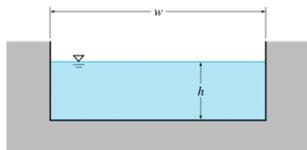
$$\frac{p_1}{\rho g} + z_1 + \frac{u_1^2}{2g} = \frac{p_2}{\rho g} + z_2 + \frac{u_2^2}{2g} + h_L$$

$$\frac{h_L}{L} = \frac{1}{\rho g} \frac{p_1 - p_2}{L} = -\frac{1}{\rho g} \frac{dp}{dx} \quad (2)$$

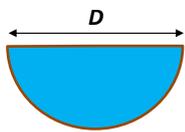
$$(1) \text{と} (2) \text{より} \quad U = \sqrt{-\frac{2D}{\rho f} \frac{dp}{dx}} \quad (3)$$

1

径深RHの定義



$$R_H \equiv \frac{A}{W} = \frac{wh}{2h + w}$$



$$R_H = \frac{D}{4} \quad (4)$$

$$\frac{h_L}{L} \equiv S \quad (5)$$

: 損失エネルギー勾配を河床勾配と等しいと仮定

(3)、(4)、(5)より

$$U = \sqrt{S \frac{8gR_H}{f}} = \sqrt{\frac{8g}{f}} \sqrt{SR_H} = C \sqrt{SR_H} \quad (6)$$

: Chézy式

Flamantの提案 $C = \frac{R_H^{\frac{1}{6}}}{n}$ を(6)に代入

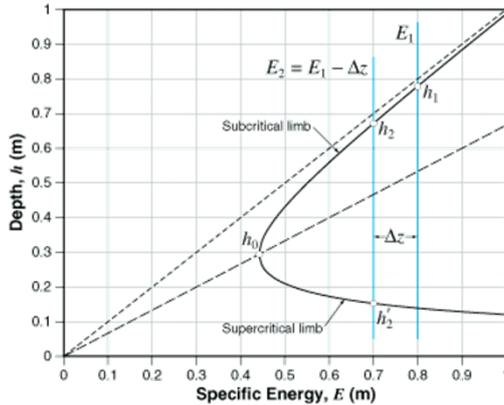
n: 粗度の関数 (自然溪流で0.024~0.075)

$$U = \frac{R_H^{\frac{1}{6}}}{n} S^{\frac{1}{2}} R_H^{\frac{1}{2}} = \frac{1}{n} R_H^{\frac{2}{3}} S^{\frac{1}{2}} \quad (7) \quad \text{: Manning式}$$

2

水位－流量関係

$$E = h + \frac{u^2}{2g} \text{ を考える}$$



$$q = uh \text{ として } E = h + \frac{q^2}{2gh^2}$$

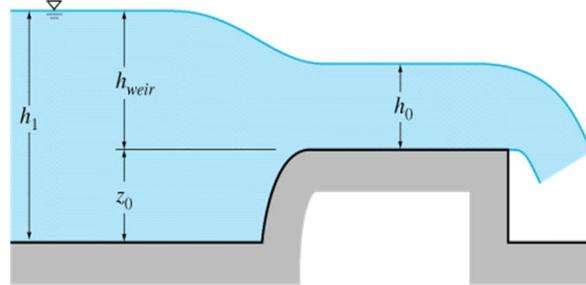
$$\left. \frac{dE}{dh} \right|_{h=h_0} = 1 - \frac{q^2}{gh_0^3} = 1 - \frac{u^2}{gh_0} = 0$$

$$\frac{u}{\sqrt{gh_0}} = F : \text{フルード数 を考える}$$

$$F > 1 \quad \text{射流}$$

$$F < 1 \quad \text{常流}$$

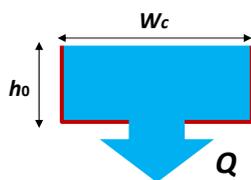
3



$$h_1 + \frac{u_1^2}{2g} = z_0 + h_0 + \frac{u_0^2}{2g}$$

$F = 1$ 射流-常流転換点なら流速が水位の関数になる

$$z_0 + h_w + \frac{u_1^2}{2g} = z_0 + h_0 + \frac{u_0^2}{2g} \text{、 } h_0 = \frac{u_0^2}{g} \text{ より } h_w = \frac{3u_0^2}{2g}$$



$$h_0 = \frac{2}{3} h_w \text{ であるから}$$

$$Q = u_0 h_0 w_c = \left(\frac{8}{27} g \right)^{\frac{1}{2}} h_w^{\frac{3}{2}} w_c$$

4



5