St-Venant / Shallow-water:

$$\frac{dH}{dx} = J_f - J_e$$

$$\frac{d\left(h + \alpha \frac{u^2}{2g}\right)}{dx} = J_f - J_e$$

Manning Strickler:

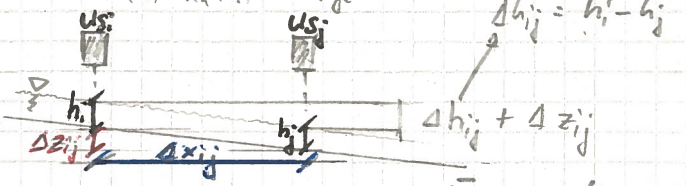
$$Q = A \cdot R_h^{2/3} \cdot k_s \cdot \sqrt{J_e}$$

$$\Rightarrow J_e = \left(\frac{Q}{A(h) \cdot R_h(h)^{2/3} \cdot k_s}\right)^2$$

$$\Leftrightarrow k_s = \frac{Q}{A(h) \cdot R_h(h)^{2/3} \cdot \sqrt{J_e}}$$

$$\Rightarrow -J_e = \frac{dh}{dx} + \frac{u}{g}\frac{du}{dx} - J_f$$

$$J_{e_{ij}} = \frac{h_i - h_j + \frac{\bar{u}_i^2}{2g} - \frac{\bar{u}_j^2}{2g}}{\Delta x_{ij}} + \frac{\Delta z_{ij}}{\Delta x_{ij}}$$



$$\bar{h}_{ij} = 0.5 \cdot (h_i + h_j)$$

$$J_{e_{ij}} = \frac{\Delta h_{ij}}{\Delta x_{ij}} + \frac{1}{2g} \cdot \frac{1}{\Delta x_{ij}} \cdot (\bar{u}_i^2 - \bar{u}_j^2) + \frac{\Delta z_{ij}}{\Delta x_{ij}}$$

$$J_{e_{ij}} = \frac{1}{\Delta x_{ij}} \cdot \left[\Delta h_{ij} + \frac{1}{2g}(\bar{u}_i^2 - \bar{u}_j^2) + \Delta z_{ij}\right]$$

* En: Evaluation by exp. measurements in undisturbed channel

EXAMPLE US 1 - US 2

$$J_{e_{12}} = \frac{1}{\Delta x_{12}} \cdot \left[\Delta h_{12} + \frac{1}{2g}(\bar{u}_1^2 - \bar{u}_2^2) + \Delta z_{12}\right]$$

- for different discharges Q
- in the undisturbed Channel
- without and with bedload
  - exp # 300/310 (100)
  - exp # 201 - 211 (100)

- with lateral constriction
- without and with bedload
  - exp # 00-510 1 513
  - exp # 01 211 0

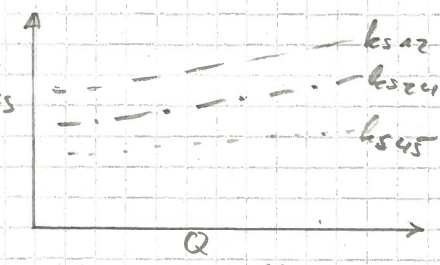
- with surface constriction
- without and with bedload
  - exp # 00-411/412
  - exp # 01-103/104, 105 & 110

$$k_{s12} = \frac{Q}{A(\bar{h}_{12}) \cdot R_h(\bar{h}_{12})^{2/3} \cdot \sqrt{J_{e12}}}$$

idem for US2 - US4

idem for US4 - US5

$\Rightarrow$



VALIDATION!