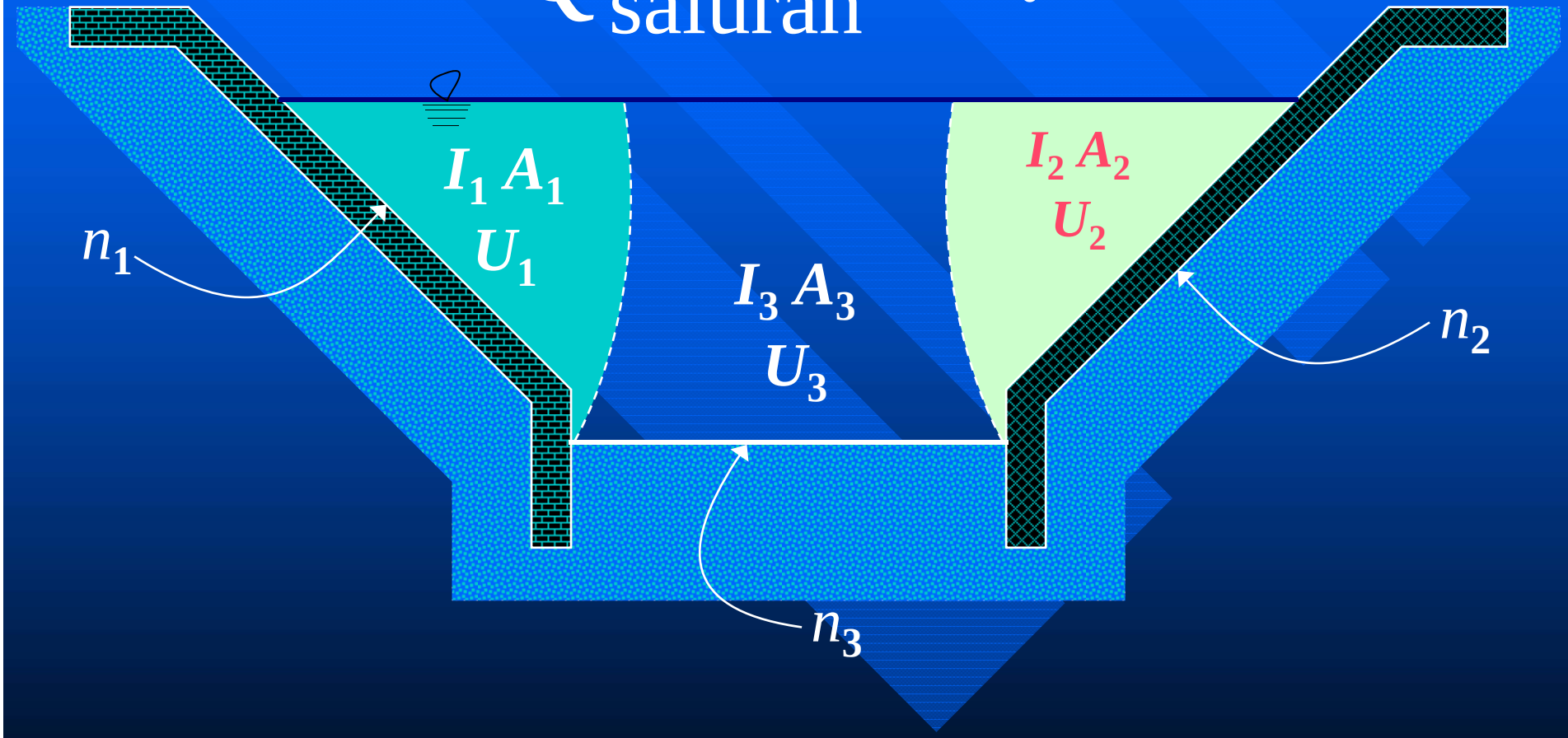
Hidraulika Terapan

Roughness Composite Formula
(Einstein Formula, 1942)

Jurusan Teknik Sipil & Lingkungan FT UGM

Tampang saluran komposit

$$Q_{\text{saluran}} = ?$$



Kekasaran Komposit

- Tiap pias (*i*) saluran terdapat
  - *I*, kemiringan garis energi
  - *A*, luas tampang basah
  - *U*, kecepatan rerata
  - *n*, koefisien Manning
  - *P*, keliling basah

Rumus Kekasaran Komposit Manning

- Anggapan Dasar
  1. Kecepatan rerata sama besar di setiap pias.
     $U_1 = U_2 = \ldots = U_{co}$
  2. Kemiringan Garis Energi sama besar di setiap pias.
     $I_1 = I_2 = \ldots = I_{co}$

- Rumus kecepatan $U = \frac{1}{n} R^{2/3} I^{1/2} \Rightarrow R = \left(\frac{nU}{I^{1/2}} \right)^{3/2}$

  maka tiap pias i $\quad R_i = \frac{n_i^{3/2} U_i^{3/2}}{I_i^{3/4}}$

Kekasaran Manning Komposit

- Untuk setiap pias *i* berlaku

$$R_i = \frac{n_i^{3/2} U_i^{3/2}}{I_i^{3/4}} \quad \text{dan} \quad \sum_{i=1}^{N} A_i = \sum_{i=1}^{N} R_i P_i$$

sehingga untuk keseluruhan tampang saluran berlaku

$$\sum_{i=1}^{N} A_i = \sum_{i=1}^{N} \frac{n_i^{3/2} U_i^{3/2}}{I_i^{3/4}} P_i \Rightarrow A_{co} = \sum_{i=1}^{N} \frac{n_i^{3/2} U_i^{3/2}}{I_i^{3/4}} P_i$$

$$R_{co} P_{co} = \sum_{i=1}^{N} \frac{n_i^{3/2} U_i^{3/2}}{I_i^{3/4}} P_i \Rightarrow R_{co} P_{co} = \sum_{i=1}^{N} \frac{n_i^{3/2} U_{co}^{3/2}}{I_{co}^{3/4}} P_i$$

… Manning Komposit

$$R_{co}P_{co} = \sum_{i=1}^{N} \frac{n_i^{3/2} U_{co}^{3/2}}{I_{co}^{3/4}} P_i \Rightarrow R_{co}P_{co} = \frac{U_{co}^{3/2}}{I_{co}^{3/4}} \sum_{i=1}^{N} n_i^{3/2} P_i$$

$$\frac{n_{co}^{3/2} U_{co}^{3/2}}{I_{co}^{3/4}} P_{co} = \frac{U_{co}^{3/2}}{I_{co}^{3/4}} \sum_{i=1}^{N} n_i^{3/2} P_i$$

$$n_{co} = \left(\frac{\sum_{i=1}^{N} n_i^{3/2} P_i}{P_{co}} \right)^{\frac{2}{3}}$$

Rumus Manning Komposit

$$n_{co} = \left(\frac{\sum_{i=1}^{N} n_i^{3/2} P_i}{P_{co}} \right)^{\frac{2}{3}}$$

Menghitung Q Saluran

- Gunakan n_{co} saluran untuk menghitung kecepatan rerata saluran:

$$U_{co} = \frac{1}{n_{co}} R_{co}^{2/3} I_{co}^{1/2}$$

- Menghitung debit, Q, saluran:

$$Q = A_{co} \times U_{co}$$

Rumus Kekasaran Komposit Chezy

- Anggapan Dasar
  1. Kecepatan rerata sama besar di setiap pias.
     $U_1 = U_2 = \ldots = U_{co}$
  2. Kemiringan Garis Energi sama besar di setiap pias.
     $I_1 = I_2 = \ldots = I_{co}$

- Rumus kecepatan $U = C\sqrt{RI} \Rightarrow R = \dfrac{U^2}{C^2 I}$

  maka tiap pias i $\quad R_i = \dfrac{U_i^{\,2}}{C_i^{\,2} I_i}$

Kekasaran Chezy Komposit

- Untuk setiap pias *i* berlaku

$$R_i = \frac{U_i^{\,2}}{C_i^{\,2} I_i} \qquad \text{dan} \qquad \sum_{i=1}^{N} A_i = \sum_{i=1}^{N} R_i P_i$$

sehingga untuk keseluruhan tampang saluran berlaku

$$\sum_{i=1}^{N} A_i = \sum_{i=1}^{N} \frac{U_i^{\,2}}{C_i^{\,2} I_i} P_i \Rightarrow A_{co} = \sum_{i=1}^{N} \frac{U_i^{\,2}}{C_i^{\,2} I_i} P_i$$

$$R_{co} P_{co} = \sum_{i=1}^{N} \frac{U_i^{\,2}}{C_i^{\,2} I_i} P_i \Rightarrow R_{co} P_{co} = \sum_{i=1}^{N} \frac{U_{co}^{\,2}}{C_i^{\,2} I_{co}} P_i$$

… Chezy Komposit

$$R_{co}P_{co} = \sum_{i=1}^{N} \frac{U_{co}^{\,2}}{C_i^{\,2} I_{co}} P_i \Rightarrow R_{co}P_{co} = \frac{U_{co}^{\,2}}{I_{co}} \sum_{i=1}^{N} \frac{P_i}{C_i^{\,2}}$$

$$\frac{U_{co}^{\,2}}{C_{co}^{\,2} I_{co}} P_{co} = \frac{U_{co}^{\,2}}{I_{co}} \sum_{i=1}^{N} \frac{P_i}{C_i^{\,2}}$$

$$C_{co} = \left(\frac{P_{co}}{\sum_{i=1}^{N} \frac{P_i}{C_i^{\,2}}} \right)^{\frac{1}{2}} = \sqrt{\frac{P_{co}}{\sum_{i=1}^{N} \frac{P_i}{C_i^{\,2}}}}$$

Rumus Chezy Komposit

$$C_{co} = \left(\frac{P_{co}}{\sum_{i=1}^{N} \frac{P_i}{C_i^2}} \right)^{\frac{1}{2}} = \sqrt{\frac{P_{co}}{\sum_{i=1}^{N} \frac{P_i}{C_i^2}}}$$

Menghitung Q Saluran

- Gunakan C_{co} saluran untuk menghitung kecepatan rerata saluran:

$$U_{co} = C_{co}\sqrt{R_{co} I_{co}}$$

- Menghitung debit, Q, saluran:

$$Q = A_{co} \times U_{co}$$