IKHTISAR RUMUS
OPEN CHANNEL FLOW

1. Rumus Chezy :

$$C = 18 \log \frac{6R}{a + \delta/7} \qquad (1)$$

dimana $\delta = \dfrac{11{,}6\,\nu}{\sqrt{gRI}}$

hubungan K_s, n, C

$$C = K_s R^{1/6} = \frac{1}{n} R^{1/6} \qquad (2)$$

2. Rumus Kecepatan Chezy :

$$\bar{u} = C\sqrt{RI} \longrightarrow \text{umum}.$$

Jika pada h normal H maka : $I = i_{dsr}$.

$$\bar{u} = C\sqrt{R\,i_{dsr}}$$

$$C^2 = \frac{Q^2 P}{i A^3} \longrightarrow \frac{A^3}{P} = \frac{\delta Q^2}{i} \qquad (3)$$

3. Keadaan Kritik (h_{kr}) jika

$$\frac{A^3}{B} = \frac{\alpha Q^2}{g} \qquad (4)$$

$$u_{kr}^2 = \frac{gA}{\alpha B}$$

$$i_{kr} = \frac{g}{\alpha C^2} \cdot \frac{P}{B}$$

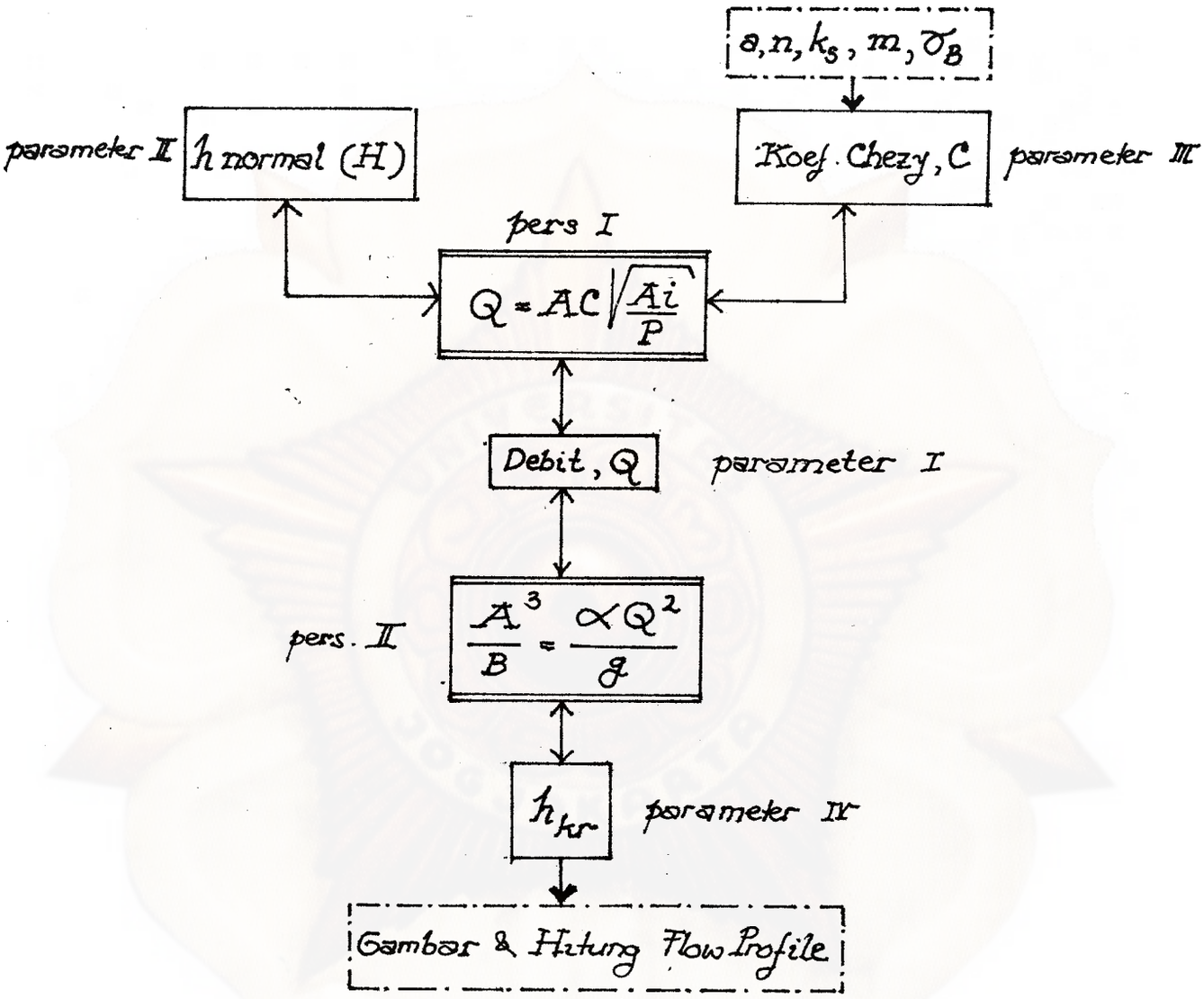
4. Rumus PPTB

$$\frac{dh}{ds} = i\left\{\frac{1 - \dfrac{\delta Q^2}{iA^3} P}{1 - \dfrac{\alpha Q^2}{gA^3} B}\right\} \quad \left(\delta = \frac{1}{C^2}\right) \qquad (5)$$

5. Rumus Flow Profile : Integrasi grafis (sembarang profil)
   Bresse ($B = \infty$)
   Flamant (persegi)
   Deret ($B = \infty$, khusus h_1)

6. Rumus Khusus : a. Loncat Air
b. Bendung / Pelimpah.

Diagram Pokok Hitungan O.C.F



Keterangan.

1. Persamaan I mempunyai 3 parameter yaitu parameter I, II, III. Jika 2 parameter diketahui maka parameter yang lain dapat dicari.
2. Persamaan II mempunyai 2 parameter yaitu parameter I, IV. Jika 1 parameter diketahui maka lainnya bisa dicari.
3. Hubungan antara m, σ_B dan C :

Kutter $C = \dfrac{100}{1 + \dfrac{m}{\sqrt{R}}}$

Bazin $C = \dfrac{87}{1 + \dfrac{\sigma_B}{\sqrt{R}}}$

Rumus ² Open Channel Flow

1. Loncat air :

$$h_2 = \frac{1}{2} h_1 \left(\sqrt{1 + \frac{8\beta q^2}{g h_1^3}} - 1 \right)$$

Jika $\alpha = \beta$ maka $h_2 = \frac{1}{2} h_1 \left(\sqrt{1 + \left(\frac{2h_{kr}}{h_1}\right)^3} - 1 \right)$

$$\Delta E_s = \frac{(h_2 - h_1)^3}{4 h_1 h_2}$$

$$\Delta P = Q \cdot \sigma \cdot \Delta E_s \longrightarrow 1\ PK = 75\ kgm/det.$$

$$l_w = 6 (h_2 - h_1)$$

2. Bendung ($B = \infty$) :

$$q = \mu \sqrt{\frac{g}{\alpha}} \cdot d^{3/2}$$

$$H_0 = \frac{3}{2} d$$

$$P + H_0 = h_{max} + \frac{\alpha q^2}{2 g h_{max}^2}$$

3. Flow Profile :

a. Integrasi Grafis : $ds = \dfrac{1 - \frac{\alpha Q^2}{g A^3} B}{i - \frac{\beta Q^2}{A^3} P} dh$

Steep : $J = \dfrac{n^2}{R^{1/3}}$; Flat : $J = \dfrac{1}{C^2}$

b. Bresse ($B = \infty$)(Flat profile)

$$i (S_{ka} - S_{ki}) = (h_{ka} - h_{ki}) + \left(1 - \frac{\alpha_i}{\beta g}\right) H \left\{ \Phi\left(\frac{h_{ki}}{H}\right) - \Phi\left(\frac{h_{ka}}{H}\right) \right\}$$

c. Deret ($B = \infty$, PI_1)

$$i (S_{ka} - S_{ki}) = (h_{ka} - h_{ki}) + \left(1 - \frac{\alpha_i}{\beta g}\right) H \left\{ \frac{1}{2} \left(\frac{H^2}{h_{ki}^2} - \frac{H^2}{h_{ka}^2} \right) + \frac{1}{5} \left(\frac{H^5}{h_{ki}^5} - \frac{H^5}{h_{ka}^5} \right) \right\}$$

d. Flamant (Persegi)

$$i (S_{ka} - S_{ki}) = (h_{ka} - h_{ki}) \left(1 - \frac{m}{gn}\right) + \frac{mH}{n} \ln \left\{ \frac{h_{ka}}{h_{ki}} \cdot \frac{H + \frac{2}{3} h_{ki}}{H + \frac{2}{3} h_{ka}} \right\}$$

dimana :

$$m = 1 - \frac{\alpha_i}{\beta g} \cdot \frac{B}{B + 2H}$$

$$n = \frac{3B + 4H}{B + 2H}.$$

4. Rumus h_{kr}, i_{kr}, u_{kr}, H

a. $B = \infty$

$H^3 = \frac{\alpha q^2}{i}$	$u_{kr}^3 = \frac{gh}{\alpha}$
$h_{kr}^3 = \frac{\alpha q^2}{g}$	$i_{kr} = \frac{\alpha g}{\alpha}$

b. Trapesium.

$H^3 = \frac{\alpha Q^2}{i} \cdot \frac{D + 2H\sqrt{1+m^2}}{(D+mH)^3}$	$u_{kr}^2 = \frac{g}{\alpha} \cdot \frac{(D+mh_{kr})h_{kr}}{D+2mh_{kr}}$
$h_{kr}^3 = \frac{\alpha Q^2}{g} \frac{D+2mh_{kr}}{(D+mh_{kr})^3}$	$i_{kr} = \frac{\alpha g}{\alpha} \frac{D+2h_{kr}\sqrt{1+m^2}}{D+2mh_{kr}}$

c. Lingkaran.

φ dalam radian.

$P = 2\varphi r$

$B = 2r \sin\varphi$

$h = r(1 - \cos\varphi)$

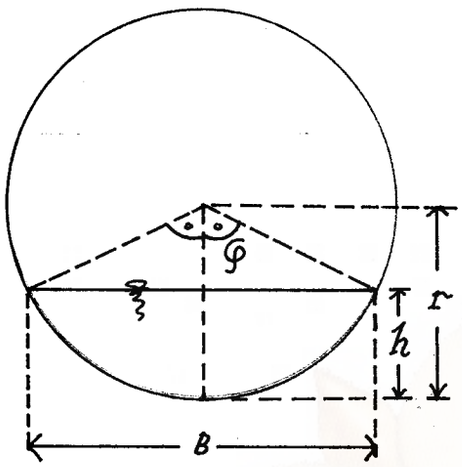
$A = r^2(\varphi - \frac{1}{2}\sin 2\varphi)$

H jika $\frac{(\varphi - \frac{1}{2}\sin 2\varphi)^3}{2\varphi} = \frac{\alpha Q^2}{ir^5}$	$u_{kr}^2 = \frac{g}{\alpha} \cdot \frac{A_{kr}}{B_{kr}}$
h_{kr} jika $\frac{(\varphi_{kr} - \frac{1}{2}\sin 2\varphi_{kr})^3}{2\sin\varphi_{kr}} = \frac{\alpha Q^2}{gr^5}$	$i_{kr} = \frac{\alpha g}{\alpha} \cdot \frac{\varphi_{kr}}{\sin\varphi_{kr}}$

5. Koefisien Manning.

$$n_{co} = \left\{ \frac{\Sigma (n_i^{3/2} P_i)}{P_{co}} \right\}^{2/3}.$$

Penggunaan ELEMEN GEOMETRIK



Rumus Lingkaran :

Luas basah $A = r^2(\varphi - \frac{1}{2}\sin 2\varphi)$

Lebar m.a $B = 2r\sin\varphi$

Kell. basah $P = 2\varphi r$

Hubungan antara φ dan h :

$\cos\varphi = \frac{r-h}{r}$

$= 1 - \frac{h}{r} \longrightarrow$ a. $h = r(1-\cos\varphi)$

b. $\varphi = \text{arc}\cos\left(1-\frac{h}{r}\right)$

I. Mencari h_{kr} & h normal dari φ_{kr} & φ normal :

φ_{kr} dicari dari : $\dfrac{(\varphi_{kr} - \frac{1}{2}\sin 2\varphi_{kr})^3}{2\sin\varphi_{kr}} = \dfrac{\alpha Q^2}{g r^5}$

φ_n dicari dari : $\dfrac{(\varphi_n - \frac{1}{2}\sin 2\varphi_n)^3}{2\varphi_n} = \dfrac{\alpha Q^2}{i r^5}$

Langkah hitungan : trial $\varphi \longrightarrow$ dihitung $h = r(1-\cos\varphi)$

II. Mencari h_{kr} & h normal langsung :

h_{kr} dicari dari : $\dfrac{A^3}{B} = \dfrac{\alpha Q^2}{g}$ dan h_n dicari dari : $\dfrac{A^3}{P} = \dfrac{\alpha Q^2}{i}$

Langkah hitungan :

A. trial $h \longrightarrow$ hitung $\varphi = \text{arc}\cos\left(1-\frac{h}{r}\right)$

$A = r^2(\varphi - \frac{1}{2}\sin 2\varphi)$

$B = 2r\sin\varphi$

$P = 2\varphi r$

} harus memenuhi rumus diatas.

B. trial $h \longrightarrow$ hitung $\dfrac{h}{D}$, D = diameter = $2r$

dengan tabel elemen geometrik dicari nilai :

$\dfrac{A}{D^2}, \dfrac{B}{D}, \dfrac{P}{D}$

kemudian dihitung :

$A = \left(\dfrac{A}{D^2}\right).D^2$

$B = \left(\dfrac{B}{D}\right).D$

$P = \left(\dfrac{P}{D}\right).D$

} harus memenuhi rumus diatas.

$\longrightarrow$ dari tabel.

$h_{kr} \longrightarrow \dfrac{A^3}{B} = \dfrac{\alpha Q^2}{g}$

$H \longrightarrow \dfrac{A^{10/3}}{P^{4/3}} = \dfrac{n^2 Q^2}{i}$ atau $\dfrac{A^3}{P} = \dfrac{\mathfrak{I} Q^2}{i}$, $\mathfrak{I} = \dfrac{1}{C^2}$

Loncat Air :

$$F = \frac{\beta Q^2}{gA} + zA$$

Persegi panjang : $h_2 = \frac{1}{2} h_1 \left(\sqrt{1 + \frac{8\beta Q^2}{gB^2 h_1^3}} - 1 \right)$

Jika $\alpha = \beta$: $h_2 = \frac{1}{2} h_1 \left(\sqrt{1 + \left(\frac{2h_{kr}}{h_1} \right)^3} - 1 \right)$

$$E = h + \frac{\alpha u^2}{2g}$$

Persegi panj. & $\alpha = \beta$:

$$\Delta_E = \frac{(h_2 - h_1)^3}{4 h_1 h_2}$$

Panjang LA : $l_w = 6 (h_2 - h_1)$

Bendung : $Q = \mu B d \sqrt{\dfrac{gd}{\alpha}}$

$$H_0 = \frac{3}{2} d$$

$$p + H_0 = h_{max} + \frac{\alpha u^2}{2g}$$

Integrasi Grafis : $ds = \int F(h) . dh$

$$F(h) = \frac{1 - \dfrac{\alpha Q^2}{gA^3} B}{i - \dfrac{\mathfrak{I} Q^2}{A^3} P}$$

atau

$$F(h) = \frac{1 - \dfrac{\alpha Q^2}{gA^3} B}{i - \dfrac{n^2 Q^2}{A^{10/3}} P^{4/3}}$$

$$n = \frac{1}{K_s}$$

Rumus Flamant

$$i(S_{max} - S_x) = (h_{max} - h_x)\left(1 - \frac{m}{gn}\right) + \frac{mH}{n} \ln\left(\frac{h_{max}}{h_x} \cdot \frac{H + \frac{2}{3}h_x}{H + \frac{2}{3}h_{max}}\right)$$

keterangan :

$$m = 1 - \frac{\alpha i}{3g} \cdot \frac{B}{B + 2H} \quad \text{?}$$

$$n = \frac{3B + 4H}{B + 2H} \quad \text{?}$$

Yang asli :

$$i(S_x - S_{max}) = (h_x - h_{max})\left(1 - \frac{m}{gn}\right) + \frac{mH}{n}\left[\ln \frac{h_x}{h_{max}} \cdot \frac{H + \frac{2}{3}h_{max}}{H + \frac{2}{3}h_x}\right]$$

Kemungkinan I :

$$i(S_{max} - S_x) = (h_{max} - h_x)\left(1 - \frac{m}{gn}\right) + \frac{mH}{n}\left[\ln \frac{h_{max}}{h_x} \cdot \frac{H + \frac{2}{3}h_{max}}{H + \frac{2}{3}h_x}\right]$$

Kemungkinan II :

$$i(S_{max} - S_x) = (h_{max} - h_x)\left(1 - \frac{m}{gn}\right) + \frac{mH}{n}\left[\ln \frac{h_{max}}{h_x} \cdot \frac{H + \frac{2}{3}h_x}{H + \frac{2}{3}h_{max}}\right]$$