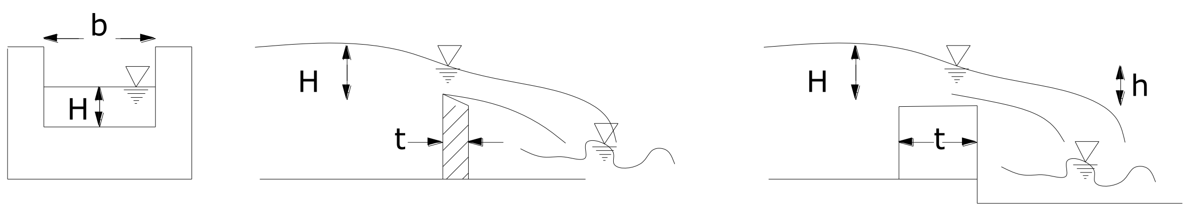
Aliran Melalui Bangunan Ukur

Bangunan ukur ditempatkan melintang pada arah saluran, yang diatur melalui takikan (notch) dan pelimpahan (weir) →"peluap"

Peluap = bukaan pada salah satu sisi kolam/tangki sehingga zat cair dalam kolam tesebut melimpas diatas peluap

Menurut bentuk puncak



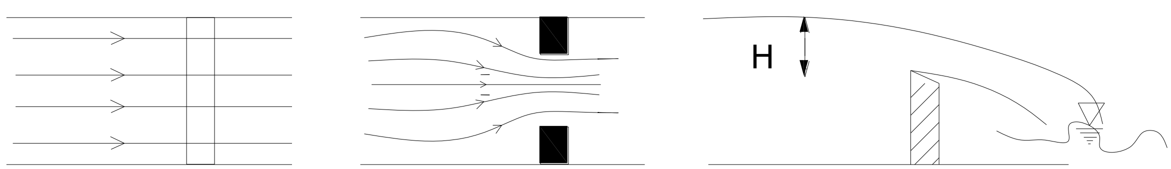
Peluap ambang tipis/tajam　　Peluap ambang lebar

H = tinggi peluapan

Peluap ambang tipis : t < 0,5 H

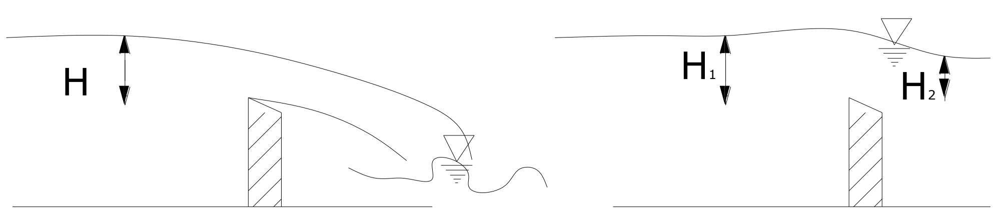
Peluap ambang lebar : t > 0,66 H

0,5 H < t < 0,66 H → aliran tidak stabil



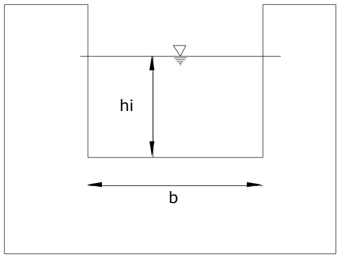
Peluap tertekan　　Peluap konstraksi samping

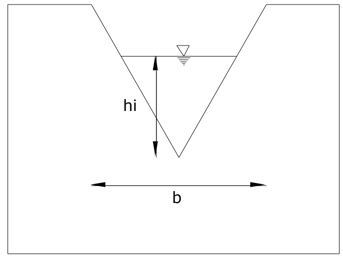
Menurut elevasi muka air

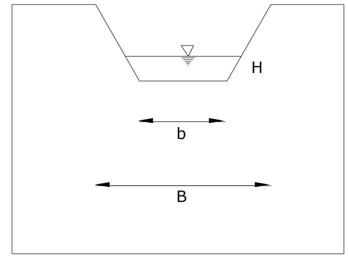


Peluap tertujunan (sempurna)　　Peluap terendam (tidak sempurna)

Muka air hilir < puncak peluap　　Muka air hilir > puncak peluap





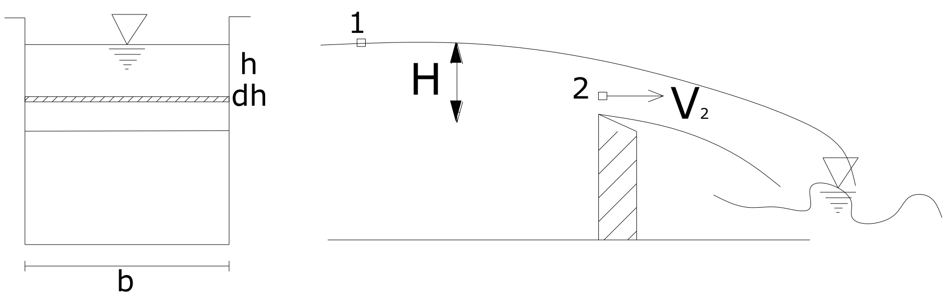


Peluap segi empat

Peluap segi tiga (v-notch/Thomson)

Peluap trapesium (cipolleti weir)

Peluap segi empat



Aplikasi persamaan Bernoulli pada titik 1dan 2 :

$$Z_1 + \frac{\rho_1}{\gamma} + \frac{V_1^2}{2g} = Z_2 + \frac{\rho_2}{\gamma} + \frac{V_2^2}{2g}$$

Asumsi, di hulu $V_1 = 0$; $P = P_{atm} \approx 0$

$$Z_1 = Z_2 + \frac{V_2^2}{2g} \Rightarrow V_2 = \sqrt{2g.(Z_1 - Z_2)} = \sqrt{2.g.h}$$

Luas pias, dA = b.dh

Debit melalui pias, $dQ = V_2.Da = \sqrt{2.g.h}\ b.dh$

$= b.\sqrt{2.g}.\ h^{1/2}.dh$

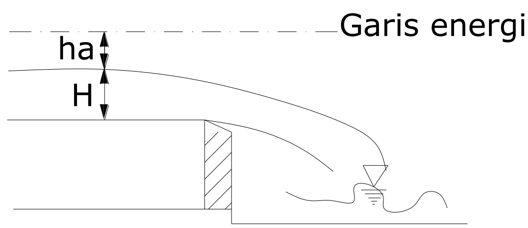
$= Cd.\ b.\sqrt{2.g}.\ h^{1/2}.dh$

Debit total dari h = 0 (muka air) → h = H (puncak ambang)

$$Q = \int_0^H dQ = Cd.b.\sqrt{2.g}\int_0^H h^{1/2}.dh = Cd.b.\sqrt{2.g}\ \frac{2}{3}[h^{3/2}]_0^H$$

$$= \frac{2}{3}Cd.b.\sqrt{2.g}.H^{3/2}$$

Jika di hulu peluap terdapat kecepatan awal (Va), maka harus ditambah dengan tinggi kecepatan ha = $\alpha.V_a^2/2g$



Dengan cara yang sama, tinjau pada pias dh

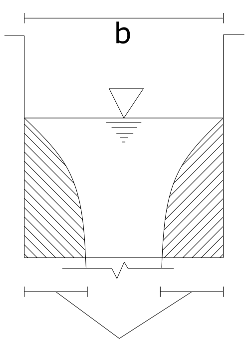
Kecepatan pada pias, V =√2g(h+ha)

Debit pada pias, dq = Cd.b.dh. √2g(h+ha)

Debit total: Q = $\int_0^H dq = Cd.b\sqrt{2.g}.\int_0^H (h+ha)^{1/2}$

$$= \frac{2}{3}.Cd.b\sqrt{2.g}.[(H+ha)^{3/2} - ha^{3/2}]$$

Jika ada konstraksi



1/10 (H+ha)

Formula Francis:

Q = 1,84 [b-0,1n (H+$\{(H_1 + \alpha\frac{Va^2}{2g})^{3/2} - \alpha\frac{Va^2}{2g})^{3/2}$

Cd = 0,623

n = jumlah ujung konstraksi (nappe)

Formula Bazin :

Q = $(0,405+0,003/H_1).\sqrt{2.g}.b.(H_1)^{3/2}$

$H_1 = H + 1,6\ Va^2/2g$

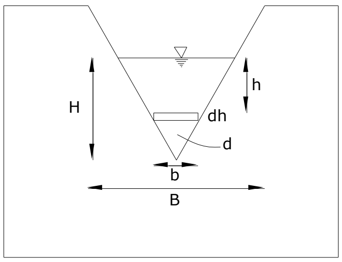
Formula Rehbock

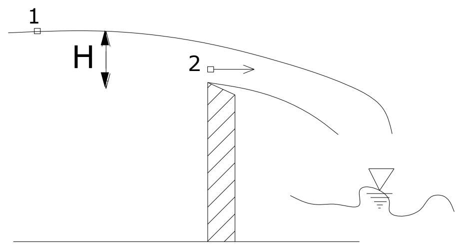
$Q = [1{,}78 + 0{,}245(H_e/P)].b.(H_e)^{3/2}$

He = H + 0,0012 m, P = tinggi Sill

Cd = 0,602 +0,083 He/P

Peluapan Segitiga (V-notch/Thomson)





B =2H.tgα/2, tinjau pias dh pada jarak h dari muka air

Panjang pias, b = 2(H-h). tgα/2

Luas pias, da = 2(H-h). tgα/2.dh

Kecepatan melalui pias, V =√2,g.h

Debit aliran melalui pias, dQ = Cd.da. √2,g.h

dQ = Cd.2(H-h) tgα/2.dh.√2,g.h

$$Q = \int dQ = 2.Cd.\ tg\alpha/2\sqrt{2.g}.\int_0^H (H h^{1/2} - h^{3/2}).dh$$

$$= 2.Cd.\ tg\alpha/2\sqrt{2.g}.[\frac{2}{3}H^{3/2} - \frac{2}{5}H^{5/2}]_O^H$$

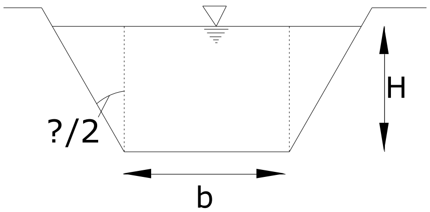
$$= 2.Cd.\ tg\alpha/2\sqrt{2.g}.[\frac{2}{3}H^{5/2} - \frac{2}{5}H^{5/2}]_O^H = 2.Cd.\ tg\alpha/2\sqrt{2.g}.\ \frac{4}{15}H^{5/2}$$

$$Q = \frac{8}{15}.Cd.\frac{tg\alpha}{2}.\sqrt{2.g}.H^{5/2}$$

Jika α = 90^o, Cd = 0,6 dam g = 9,81 m/det^2

$Q = 1{,}417\ H^{5/2}$

Peluap Trapesium (Cipolleti Weir)



α = sudut antara sisi peluap dengan garis vertical

$$Q = \frac{2}{3} Cd_1 . b . \sqrt{2,g} . H^{3/2} + \frac{8}{15} . Cd_2 . \sqrt{2,g} . tg \frac{\alpha}{2} H^{5/2}$$

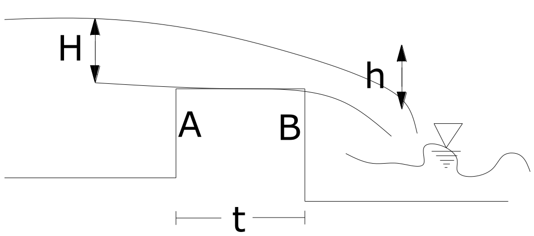
OGIEE SPILLWAY

- Peluap banjir pada dam → saluran pelimpah
- Profil ogiee → bentuk peluap ambang tajam

Gambar

Peluap ambang lebar

Ambang lebar, t > 0,66H



Aplikasi persamaan Bernoulli pada titik A dan B

$$Z_1 + \frac{P_1}{\gamma} + \frac{V_1^2}{2.g} = Z_2 + \frac{P_2}{\gamma} + \frac{V_2^2}{2.g}$$

0 + H + 0 = 0 + h + $\frac{V_2^2}{2.g}$ → V = kecepatan aliran pada sisi hilir peluap

$\frac{V_2^2}{2.g}$ = H – h → V = √2.g (H-h)

Debit aliran : Q = Cd.b.h.V = Cd.b.h. √2.g (H-h)

Q = Cd.b.√2.g (Hh^2-h^3)……………………………………………………………..a

Debit maksimum jika, dQ/dh = 0

dQ/dh = Cd.b.√2g.d/dh √(Hh^2-h^3) = 0

$$\frac{2Hh - 3h^2}{2.(Hh^2 - h^3)^{1/2}} = 0$$

$$2Hh - 3h^2 = 0$$

$$2H - 3h = 0$$

$h = \frac{2}{3}H$ …………………………………………………..substitusikan ke a

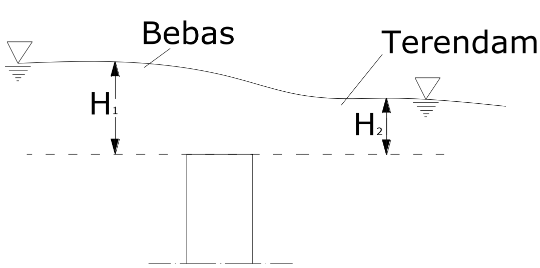
Qmaks = Cd.b.√2g.√H(2/3H)^2 –(2/3H)^3 = Cd.b.√2g.√H(4/9H)^3 –(8/27H)^3

= Cd.b.√2g.√4/27H)^3 = Cd.b.√2g.2/3H.√H/3

$$= \frac{2}{3\sqrt{3}}.Cd.b.\sqrt{2.g}.H^{3/2} = 0{,}384.Cd.b.\sqrt{2.g}.H^{3/2}$$

Peluang Terendam (Sill)

Muka air di hilir peluap berada di atas puncak peluap → peluapan tidak sempurna (peluap terendam).



Debit aliran = Jumlah aliran melalui tinggi peluapan bebas sebesar (H_1-H_2) dan bagian aliran yang terendam dengan tinggi peluapan H_2 .

$Q = Q_1+Q_2 \rightarrow Q_1= \frac{2}{3}.Cd.b.\sqrt{2.g}.(H_1 - H_2)^{3/2}$

$Q_2= \frac{2}{3}.Cd.b.H_2\sqrt{2.g.(H_1 - H_2)}.$

$$Q = \frac{2}{3}.Cd.b.\sqrt{2.g}.(H_1 - H_2)^{3/2} + Cd.bH_2.\sqrt{2.g.(H_1 - H_2)}.$$

$$Q = \frac{2}{3}.Cd.b.\sqrt{2.g}.[\frac{2}{3}(H_1 - H_2)^{3/2} + H_2.\sqrt{2.g.(H_1 - H_2)}.].$$