Estruturas Hidráuicas I

Aula 5

Extravasores 4

Soleiras Labirinto & Piano Keys

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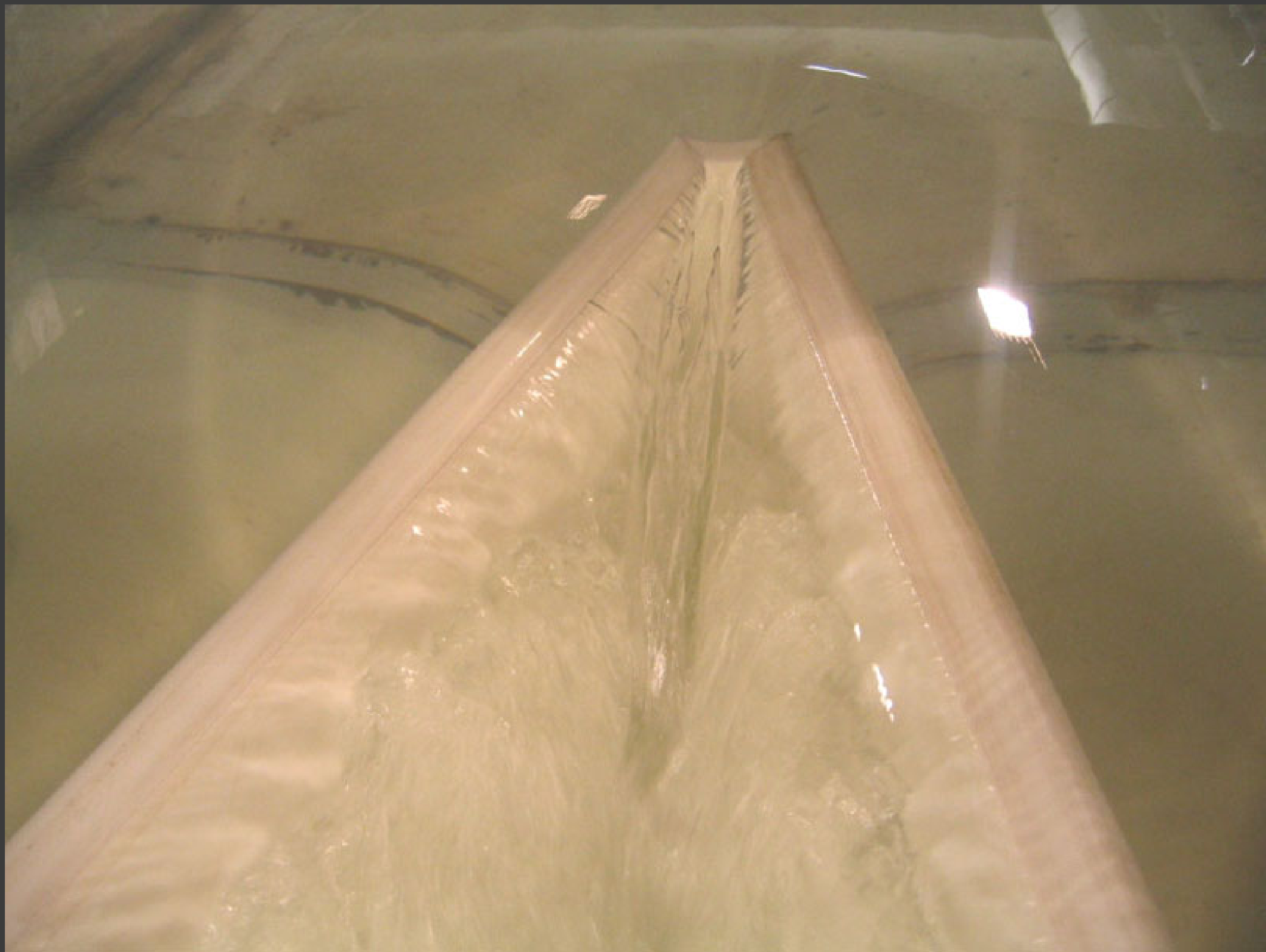
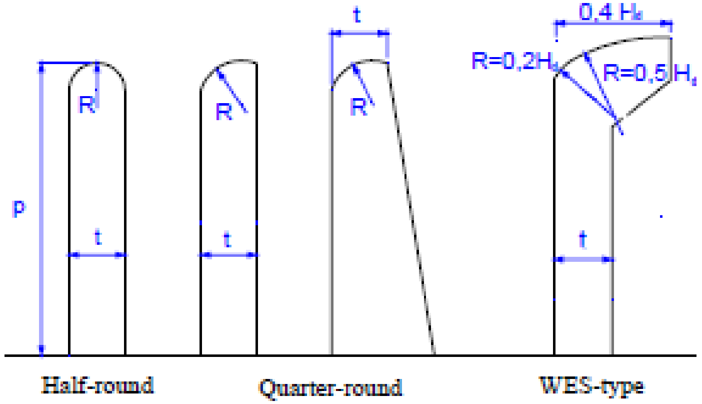
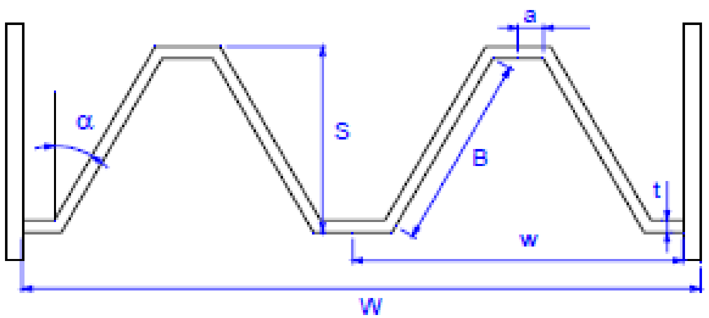
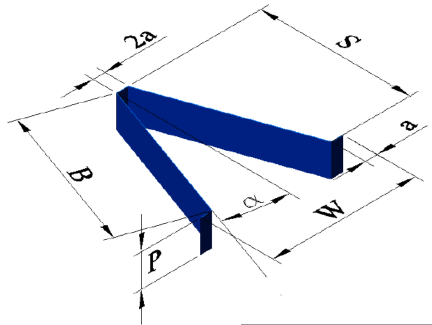


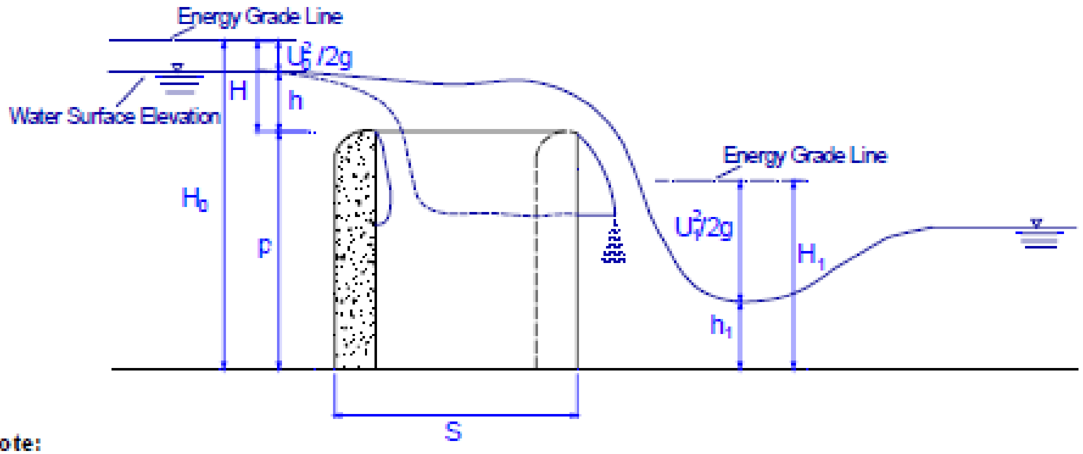
Fig. 1 - S. Domingos labyrinth spillway, Portugal (1991): a) prototype; b) physical model (courtesy of A. Pinto de. Magalhães).

a) b)

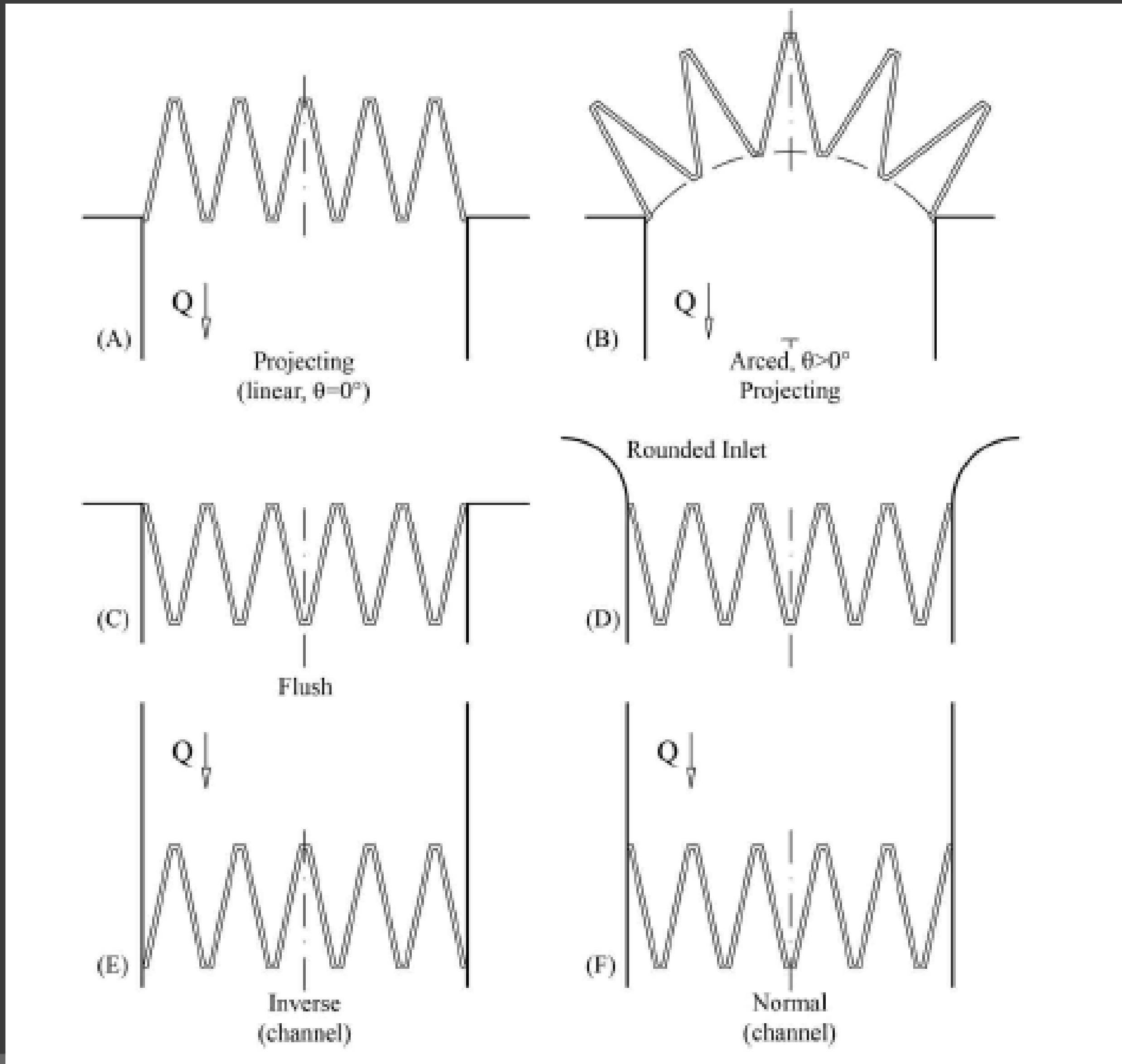


0,4 H
R=0,2H
R=0,5 H
t
R
p
Half-round
Quarter-round
WES-type


a
α
S
B
t
w
W

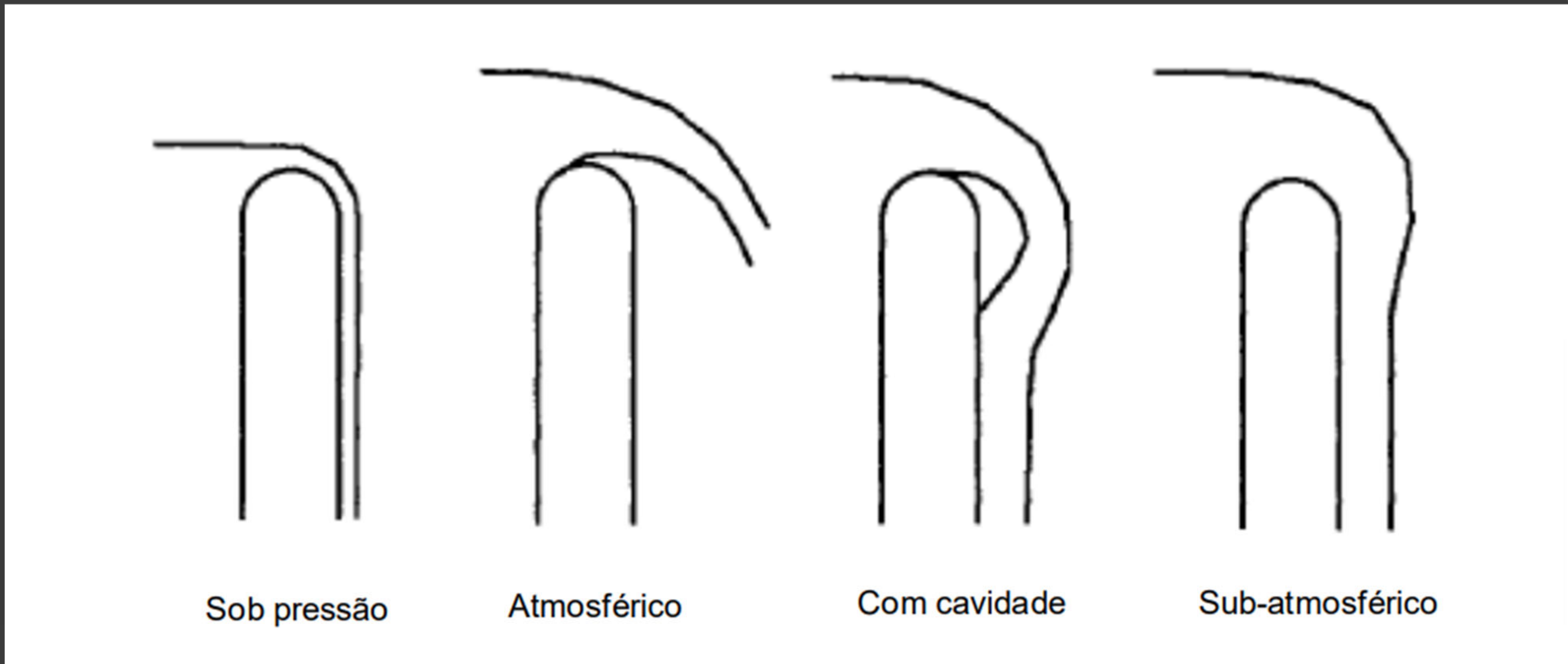

2a
S
a
B
α
W
P


Energy Grade Line
$U_0^2/2g$
H
h
Water Surface Elevation
H_0
p
Energy Grade Line
$U_1^2/2g$
H_1
h_1
S

Note:



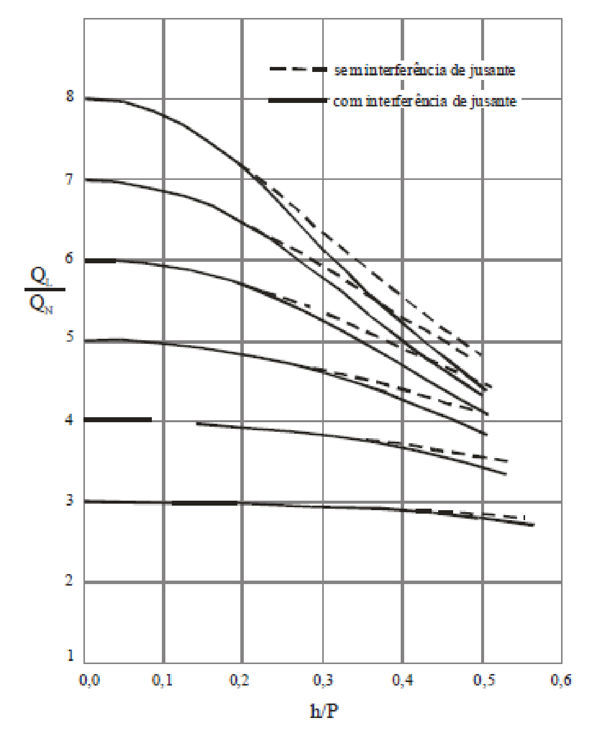
Q
(A)
Projecting
(linear, θ=0°)
Q
(B)
Arced, θ>0°
Projecting
Rounded Inlet
(C)
Flush
(D)
Q
Q
(E)
Inverse
(channel)
(F)
Normal
(channel)

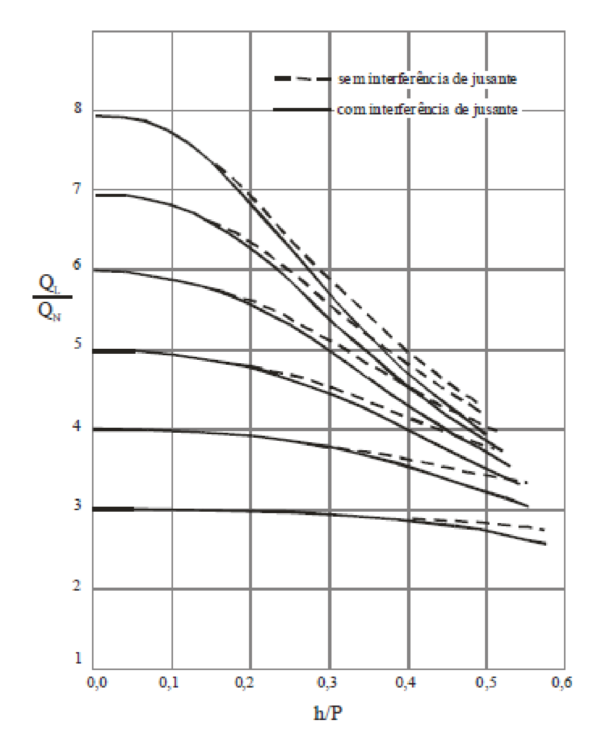

Sob pressão
Atmosférico
Com cavidade
Sub-atmosférico

Capacidade de Descarga

$$Q_N = C_{HT} L . H^{\frac{3}{2}}$$

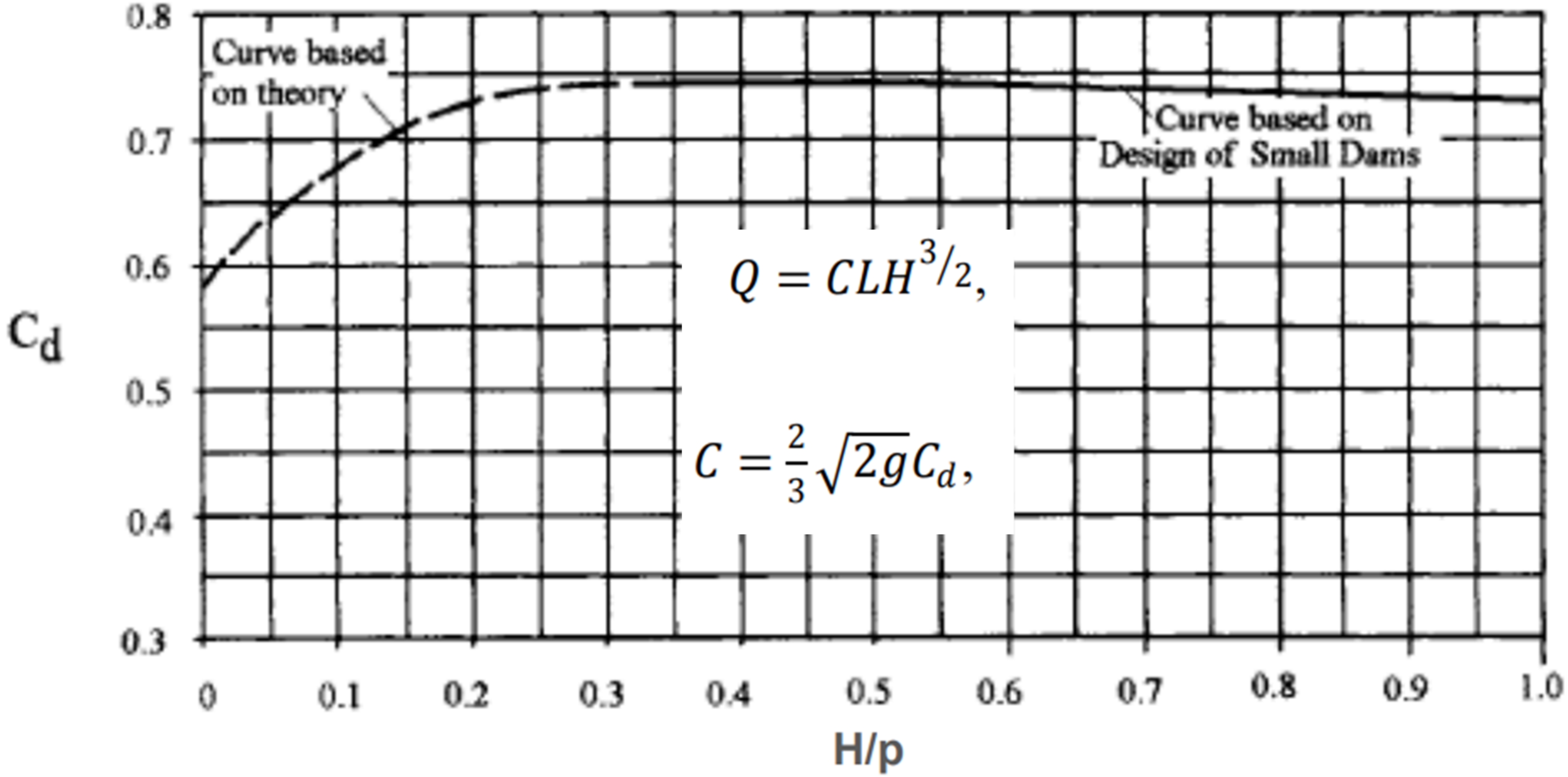
$$C_{HT} = 3{,}22 + \frac{h}{P}$$





Hayland & Taylor

Capacidade de descarga (USBR Small Dams)



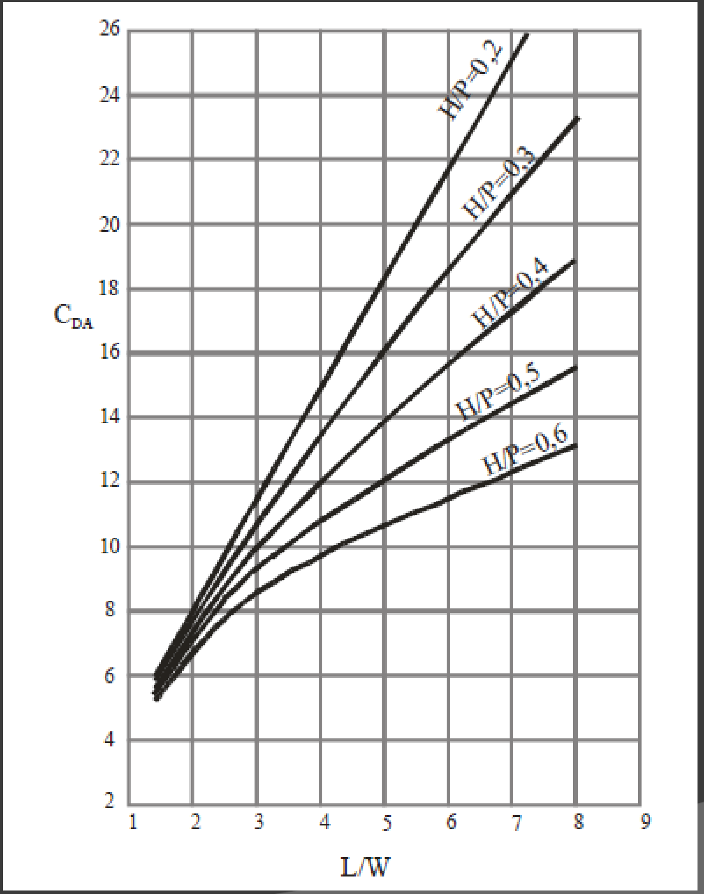
$$Q = CLH^{3/2},$$

$$C = \frac{2}{3}\sqrt{2g}C_d,$$

Capacidade de Descarga

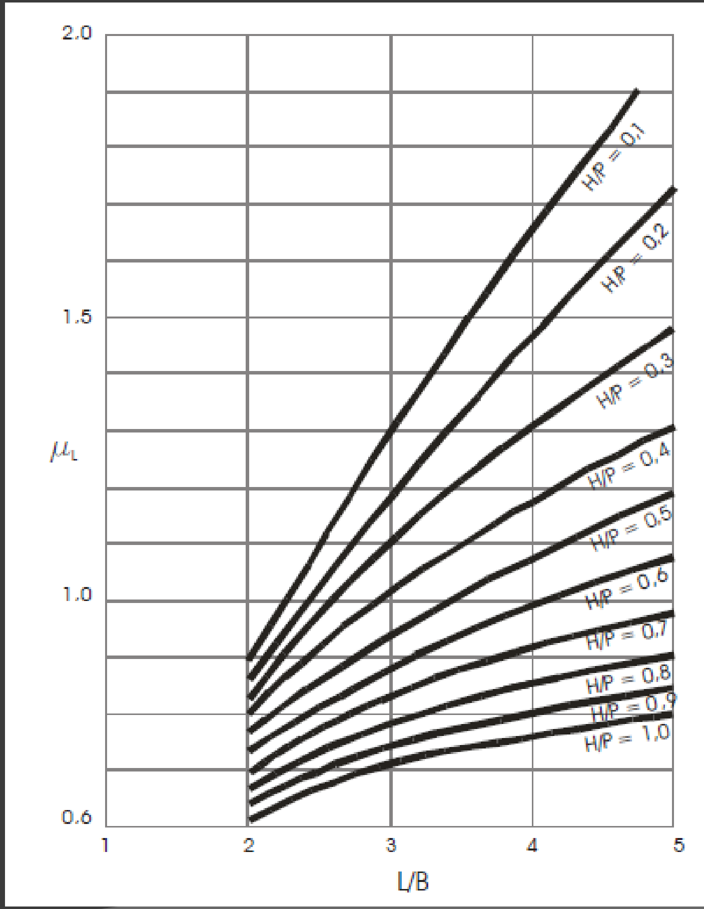
$$C_{DA} = \frac{Q_L}{W.H_0^{\ 1,5}}$$

Darvas



Capacidade de Descarga

$$\mu_L = \frac{Q}{L.\sqrt{2.g}.H^{1,5}}$$

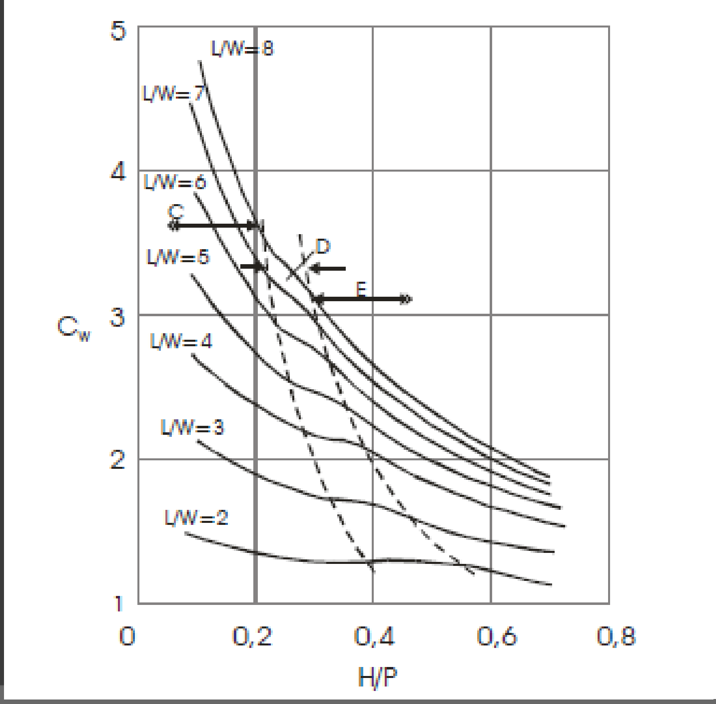


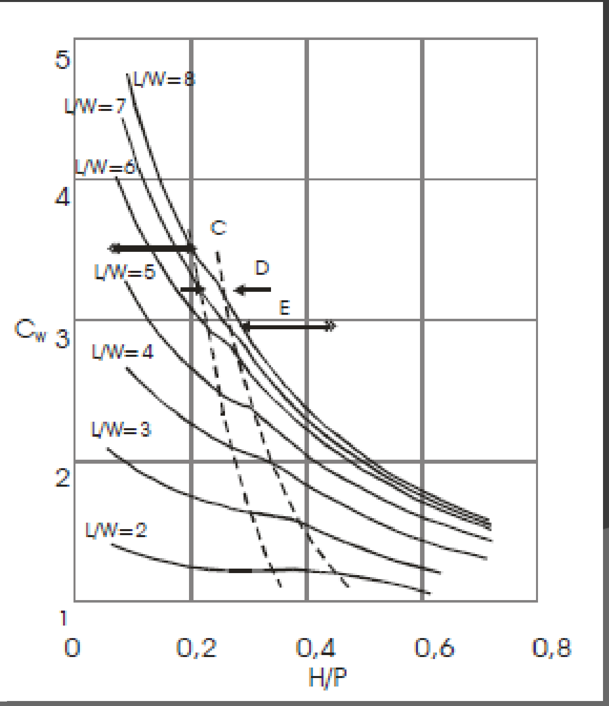
Magalhães & Lorena

Capacidade de Descarga

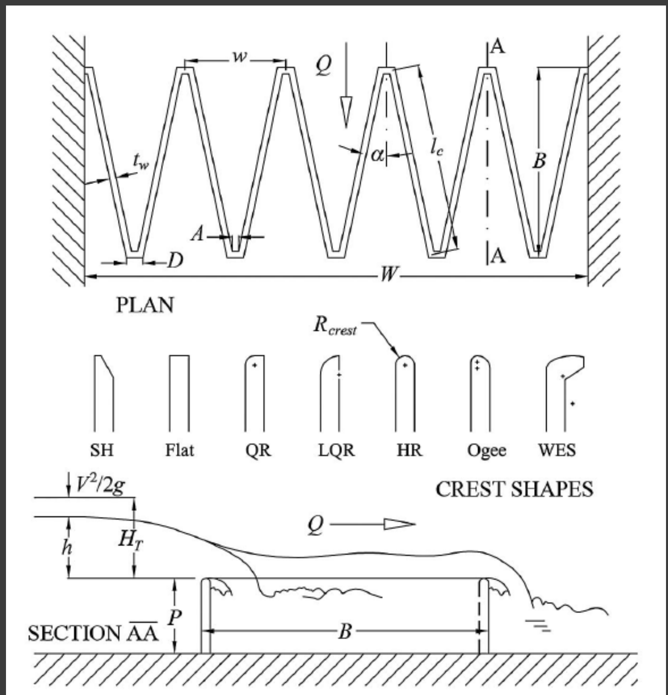
$$Q = C_w \cdot \left(\frac{\frac{W}{P}}{\frac{W}{P} + k} \right) W.H.\sqrt{g.H}\text{ , válida para W/P} \geq 2$$

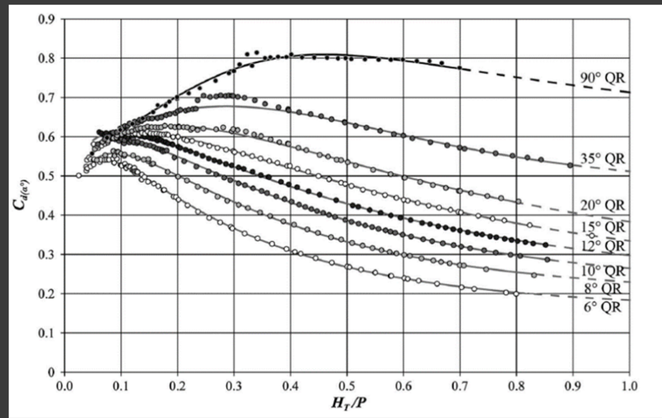
Lux & Hinchliff

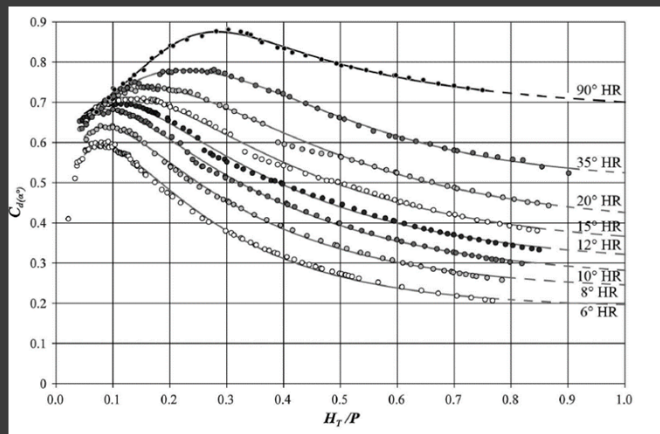




Capacidade de Descarga – Crookston & Tullis







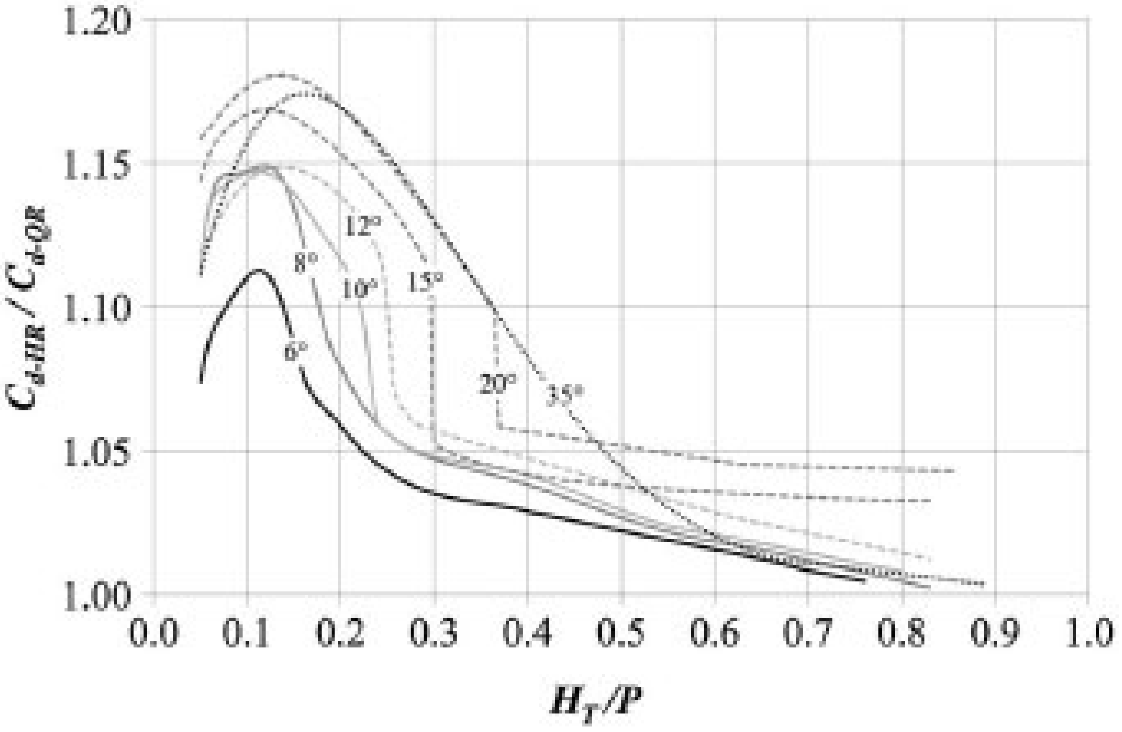


Fig. 4. Comparison of half-round and quarter-round crest shape on hydraulic performance of labyrinth weirs

Paredes Convergentes

$$\mu_W = \frac{Q}{W\sqrt{2g}H^{1,5}}$$

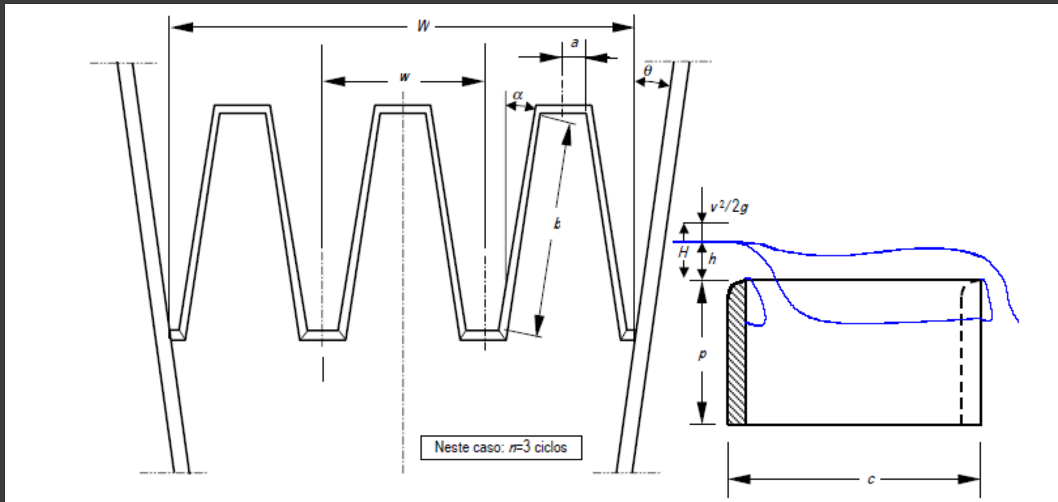
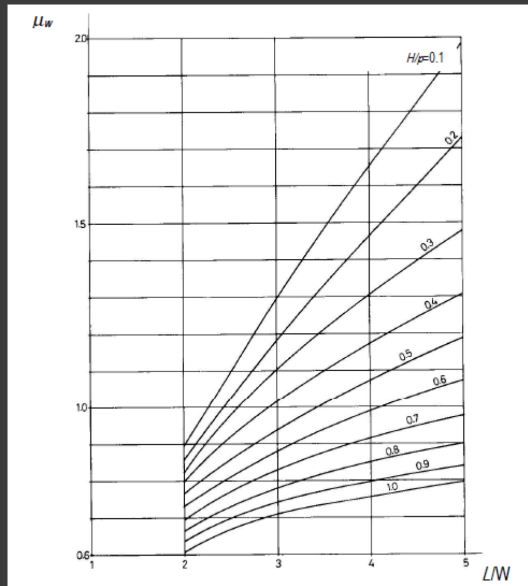
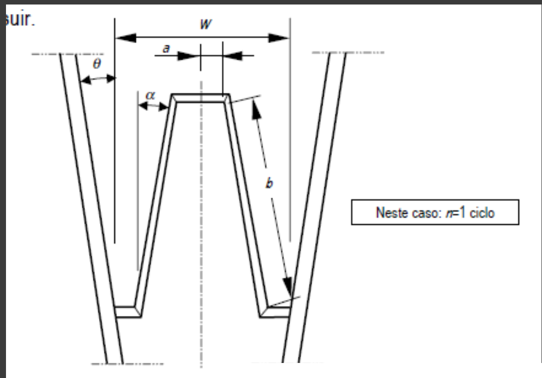


Figura 1 - Definição esquemática de uma soleira em labirinto e identificação das principais variáveis envolvidas na determinação da sua capacidade de vazão.

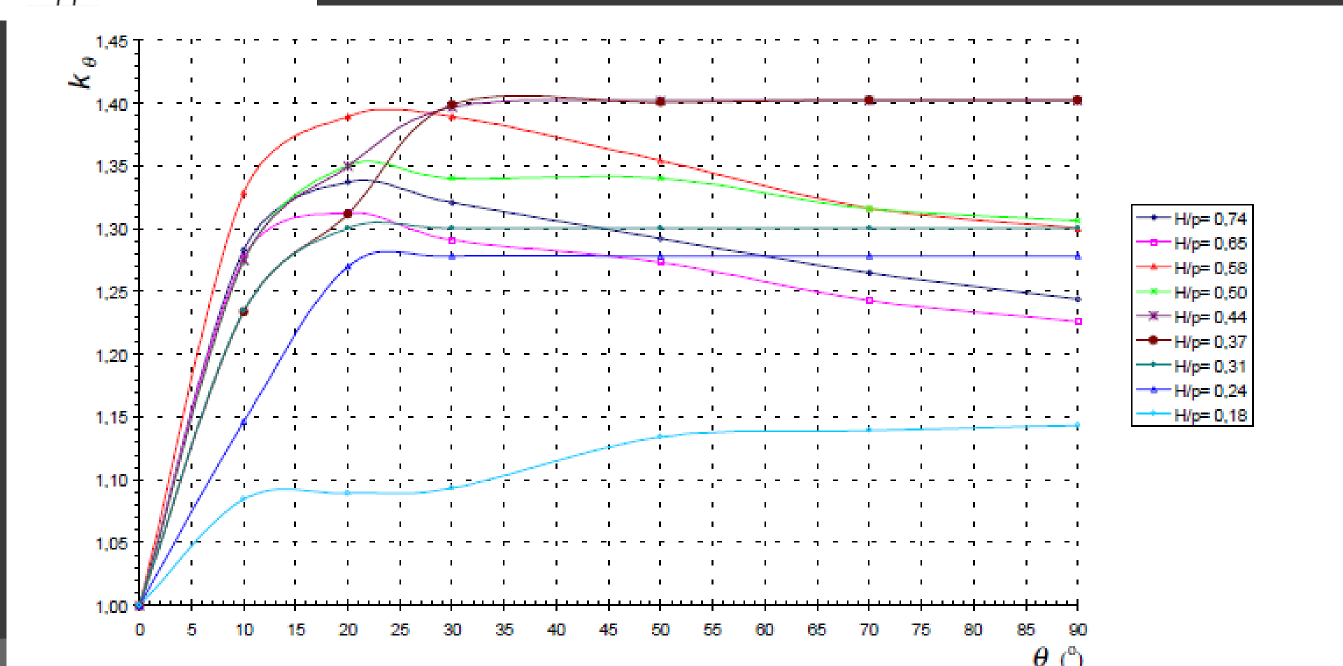


Falcão & Ramos

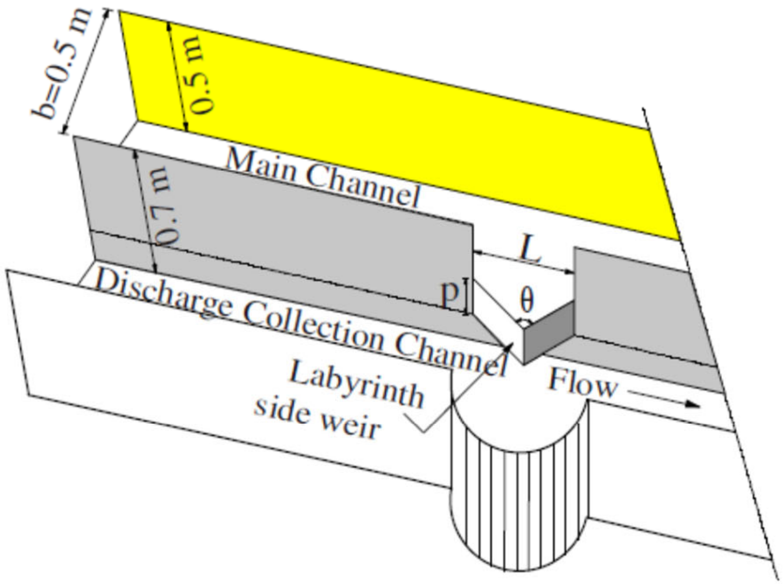
Paredes Convergentes



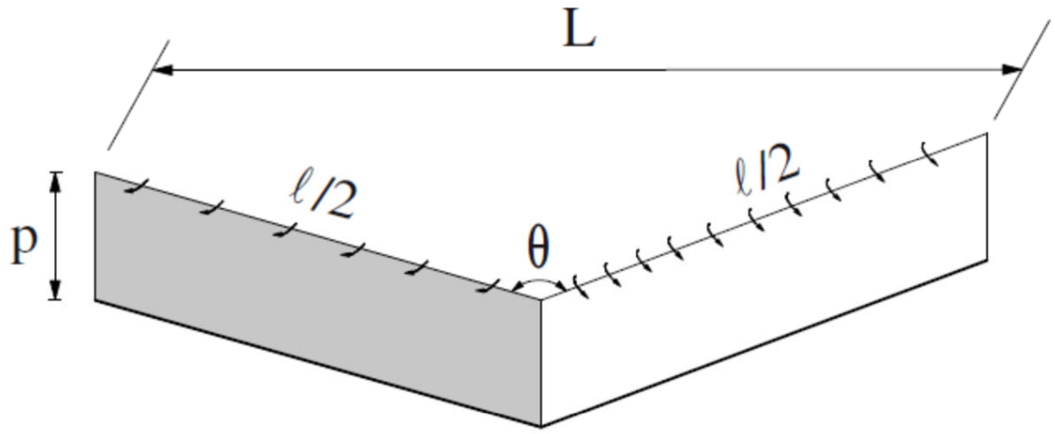
$$Q = k_\theta \mu_W W \sqrt{2g} H^{1,5}$$



Soleira lateral labirinto



(a)



(b)

J. Irrig. Drain Eng., 2010, 136(1): 37-46

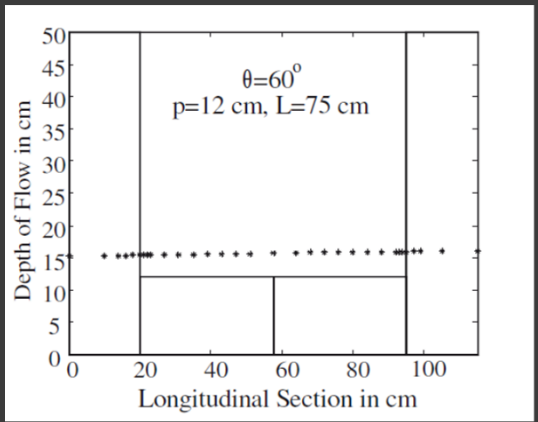
M. Emin Emiroglu[1]; Nihat Kaya[2]; and Hayrullah Agaccioglu[3]

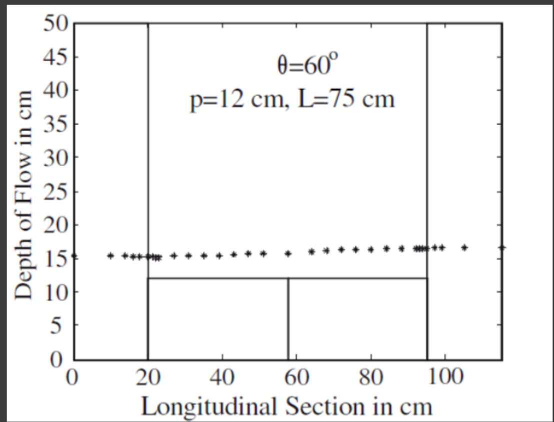
Capacidade de descarga – soleira lateral regular

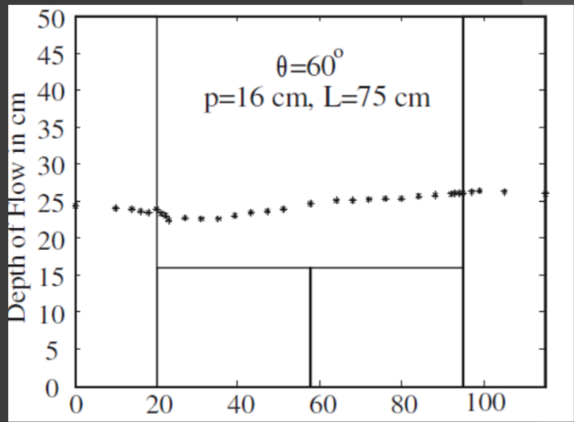
Table 1. Side-Weir Discharge Coefficient Equations Presented in the Literature for Straight Channels

Reference	Discharge coefficient	Froude number	L/b	p/h_1
Subramanya and Awasthy (1972)	$C_d\!=\!0.864\{1-F_1^2/2+F_1^2\}^{0.5}$	0.02–0.85	0.2–1.0	0.2–0.96
Yu-Tech (1972)	$C_d\!=\!0.415-0.148F_1$	—	—	0.2–0.5
Nandesamoorthy and Thomson (1972)	$C_d\!=\!0.288\{2-F_1^2/1+2F_1^2\}^{0.5}$	—	—	($p\!=\!0.0-0.6$ m)
Ranga Raju et al. (1979)	$C_d\!=\!0.54-0.40F_1$	0.10–0.50	0.10–0.70	($p\!=\!0.2-0.5$ m)
Hager (1987)	$C_d\!=\!0.485\{2+F_1^2/2+3F_1^2\}^{0.5}$	0.0–0.87	3.33	($p\!=\!0.0-0.2$ m)
Cheong (1991), for trapezoidal channel	$C_d\!=\!0.30-0.14F_1^2$	0.28–0.78	0.50–1.64	0.42–0.85
Singh et al. (1994)	$C_d\!=\!0.33-0.18.F_1+0.49p/h_1$	0.23–0.43	0.25–0.50	0.42–0.85
Borghei et al. (1999)	$C_d\!=\!0.7-0.48F_1-0.3p/h_1+0.06L/b$	0.1–0.9	0.67–2.33	($p\!=\!0.01-0.19$ m)

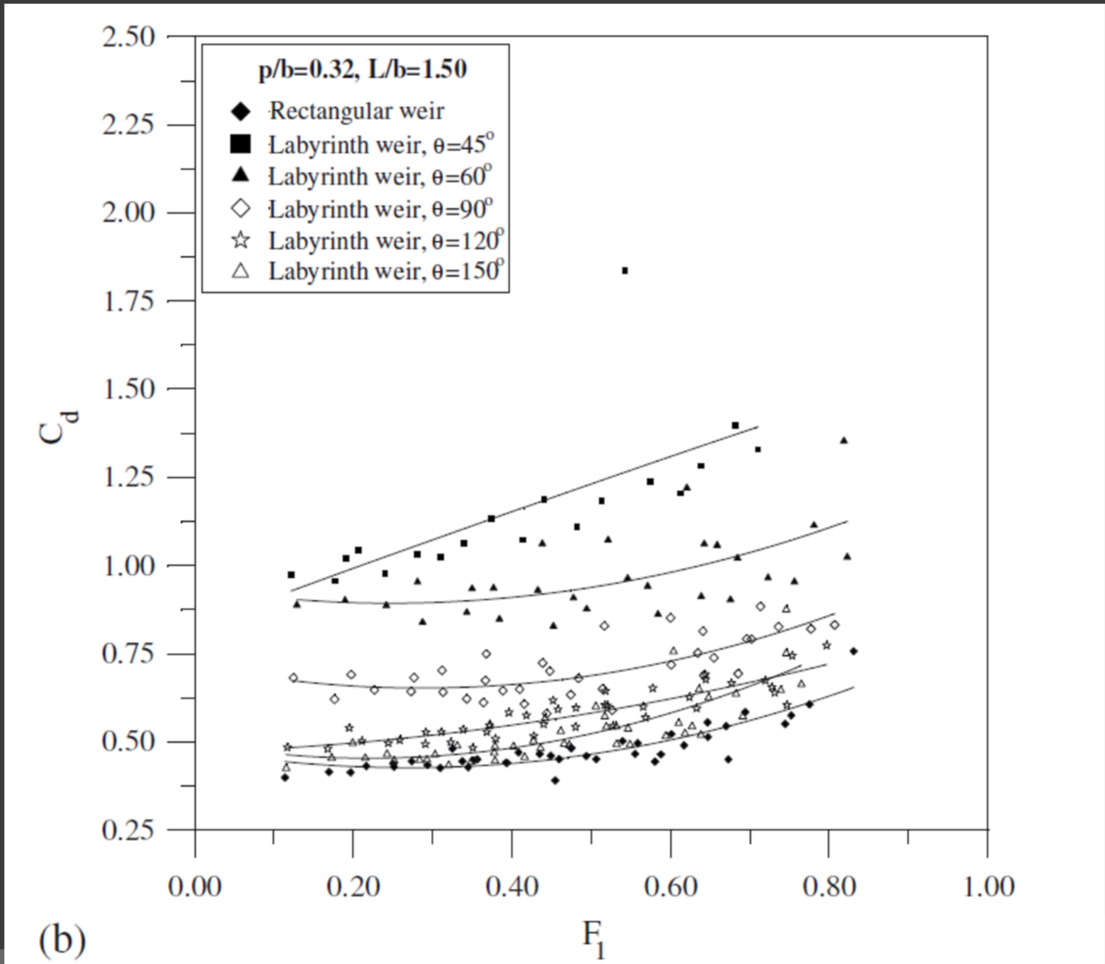
Linhas d´’agua e perfis de velocidade

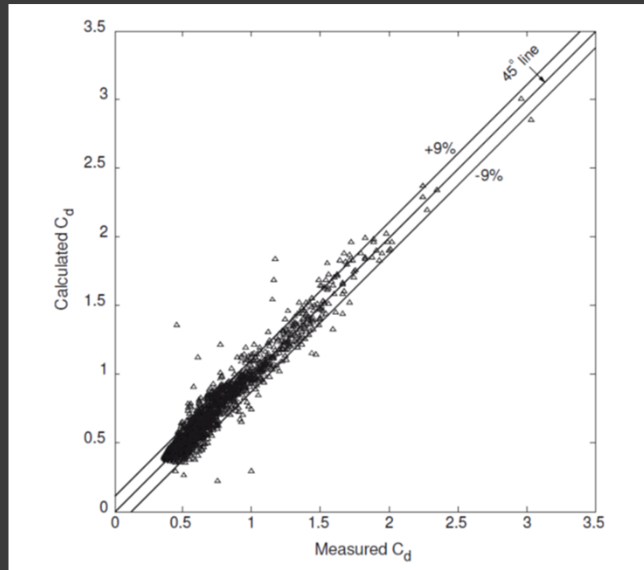






Efeito do Número de Froude





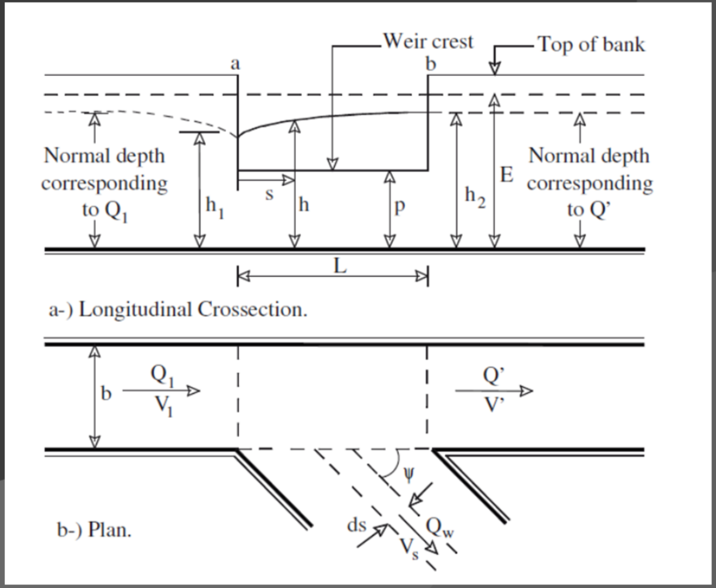
Capacidade de descarga combinada

$$-\frac{dQ}{ds}=\frac{2}{3}C_d\sqrt{2g}[h-p]^{3/2}$$

$$C_d=f\left(F_1=\frac{V_1}{\sqrt{gh_1}},\frac{L}{b},\frac{L}{h_1},p/h_1,\psi\right)$$

$$\sin\psi=\sqrt{1-\left(\frac{V_1}{V_s}\right)^2}$$

$$C_d=\left[18.6-23.535\left(\frac{L}{b}\right)^{0.012}+6.769\left(\frac{L}{l}\right)^{0.112}-0.502\left(\frac{p}{h_1}\right)^{4.024}\right.$$
$$\left.+0.094\sin\theta-0.393F_1^{2.155}\right]^{-1.431} \quad (6)$$



Roteiro de Cálculo

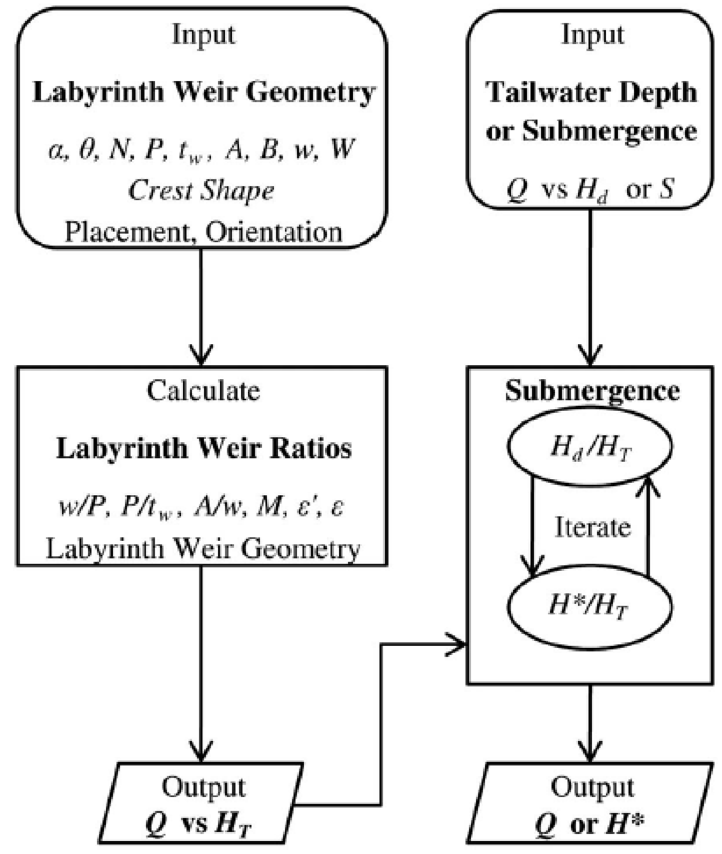
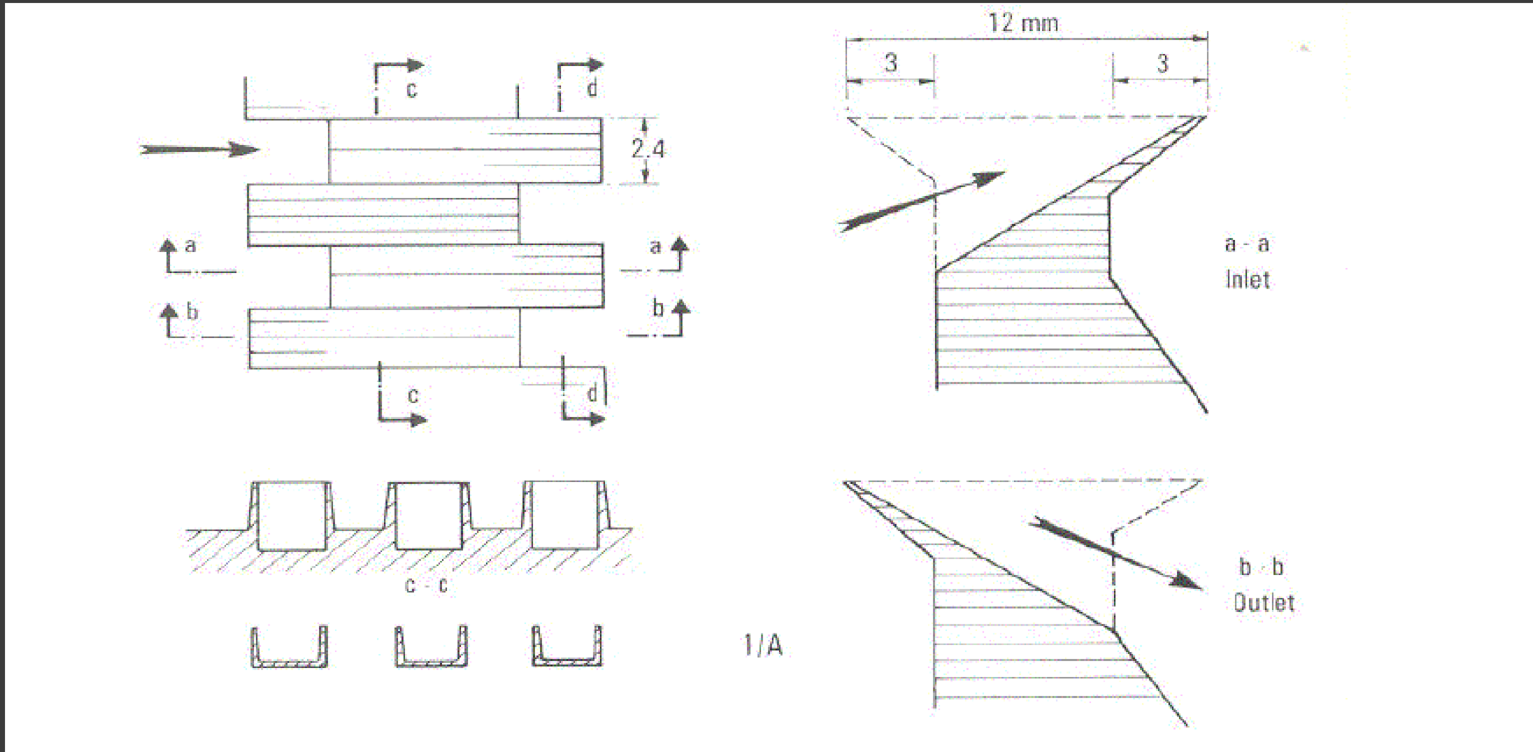


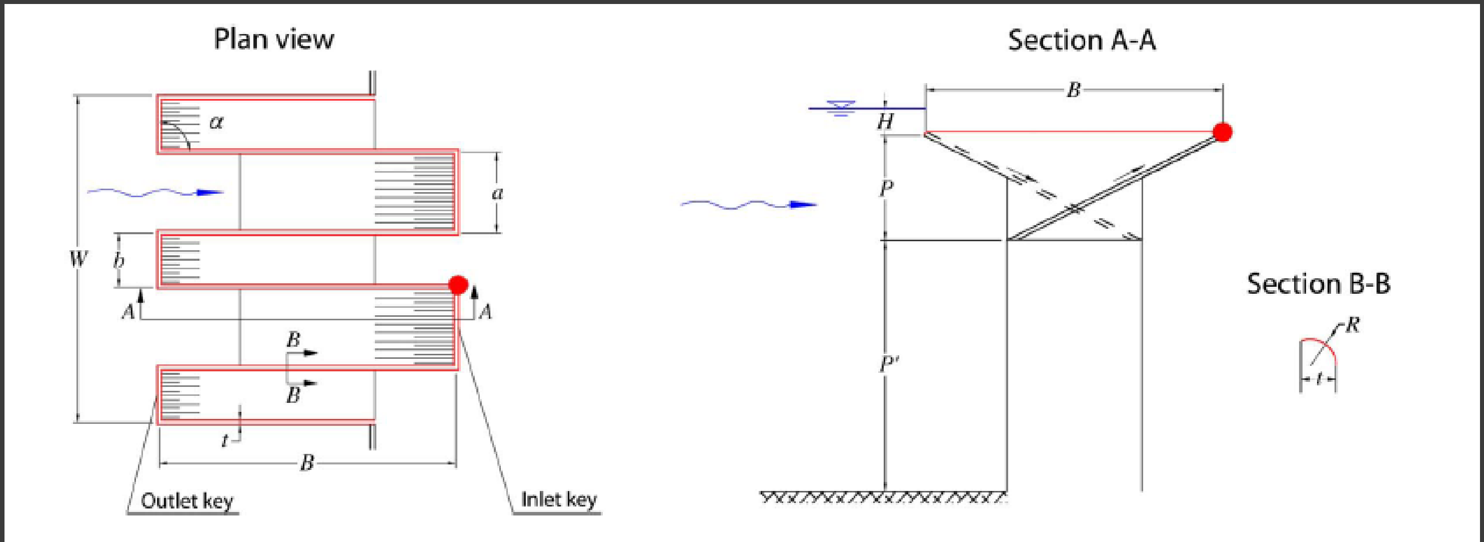
Fig. 7. Recommended procedure for analyses of labyrinth weirs

Soleiras Piano Keys

Piano Keys



Coeficiente de Descarga



$$Q_{\mathrm{PKW}} = f(\rho, g, \nu, \sigma, H, L, P, P', W, a, b, B, s_{\mathrm{in}}, s_{\mathrm{out}}, \alpha, t, R)$$

$$C_{\mathrm{PKW}} = \frac{Q_{\mathrm{PKW}}}{LH^{\frac{3}{2}}\sqrt{2\,g}}$$

$$C_{\mathrm{PKW}} = f\left(\frac{L}{W}, \frac{a}{b}, \frac{P}{a}, \frac{P}{P'}\frac{t}{P}, \frac{t}{R}, \frac{H}{a}, s_{\mathrm{in}}, s_{\mathrm{out}}, \mathrm{F}, \mathrm{R}, \mathrm{W}\right)$$

Coeficiente de Descarga

$$\frac{L}{W} = \frac{a + b + 2B}{a + b}$$

$$r = \frac{Q_{\mathrm{PKW}}}{Q_W} = \frac{C_{\mathrm{PKW}} L H^{\frac{3}{2}} \sqrt{2\,g}}{C_d W H^{\frac{3}{2}} \sqrt{2\,g}}$$

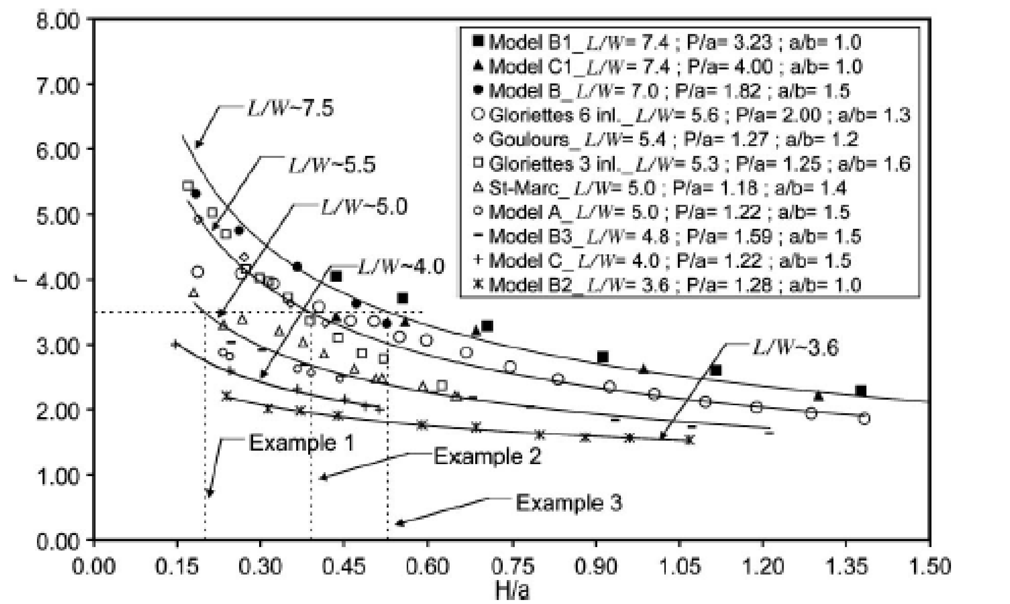


Fig. 3. Discharge enhancement ratio r as a function of H/a for different PK-Weirs and three solutions (L/W) for a given value of r