Sluice Gate Discharge (Free Flow)

Discharge under a vertical sluice gate in free flow from the upstream depth and gate opening, by Swamee's discharge coefficient and the energy equation.

Method: Swamee's free-flow discharge coefficient; energy equation with contraction coefficient; momentum for the sequent depth; Swamee; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Upstream depth	2.0000	m
Gate opening	0.40000	m
Gate width	3.0000	m
Tailwater depth downstream (0 if unknown)	0.90000	m
Contraction coefficient	0.61000	

Calculated results

Parameter	Value	Unit
Discharge coefficient (Swamee)	0.54415	
Discharge (Swamee)	4.0897	m³/s
Discharge from energy with C_c	4.3282	m³/s
Depth at the vena contracta C_c a	0.24400	m
Froude number at the vena contracta	3.8224	
Sequent depth of the jump (free flow needs tailwater below this)	1.2026	m

Notes for this case

- Free flow: the jet leaves the gate supercritical and the jump forms downstream. Swamee's C_d fits the experimental data for free flow; the energy equation with C_c ≈ 0.61 is the classical check.

Formula and method

$$Q = C_d B a \sqrt{2 g y_1}, \quad C_d = 0.611 \left(\frac{y_1 - a}{y_1 + 15a} \right)^{0.072}$$

$$Q_E = C_c a B \sqrt{\frac{2 g y_1}{1 + C_c a / y_1}}, \quad y_2{}' = \frac{y_2}{2} \left(\sqrt{1 + 8 Fr_2^2} - 1 \right)$$

Variables

y_1	Upstream depth	m
a	Gate opening	m
B	Gate width	m
y_3	Tailwater depth downstream (0 if unknown)	m
C_c	Contraction coefficient	-
C_d	Discharge coefficient (Swamee)	-
Q	Discharge (Swamee)	m³/s
Q_E	Discharge from energy with C_c	m³/s
y_2	Depth at the vena contracta C_c a	m

Fr_2	Froude number at the vena contracta	-
$y_2{}'$	Sequent depth of the jump (free flow needs tailwater below this)	m

Method and standards

Free-flow sluice gate discharge.

Assumptions and limits

- Vertical sharp-edged gate, free flow, rectangular channel.

References

Swamee's free-flow discharge coefficient; energy equation with contraction coefficient; momentum for the sequent depth, Swamee, Sluice-gate discharge equations, J. Irrigation and Drainage Engineering 118(1), 1992

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