Wind-Driven Cross Ventilation Flow and Air Changes

Air flow and air change rate of wind-driven cross ventilation through two openings in series from the wind speed, pressure coefficients and opening areas.

Method: Wind-driven flow through openings in series (orifice equation)

Input parameters

Unit system: SI

Parameter	Value	Unit
Windward opening area	1.2000	m²
Leeward opening area	1.0000	m²
Discharge coefficient (sharp opening 0.61)	0.61000	
Wind speed at building height	3.5000	m/s
Pressure coefficient, windward face	0.60000	
Pressure coefficient, leeward face	-0.30000	
Room or building volume	600.00	m³
Air density	1.2000	kg/m³

Calculated results

Parameter	Value	Unit
Effective opening area (openings in series)	0.76822	m²
Wind pressure difference ½ρU²ΔC_p	6.6150	Pa
Air flow	5,601.5	m³/h
Air changes per hour	9.3359	1/h
Mean velocity in the windward opening	2.1257	m/s

Notes for this case

- Orifice flow through openings in series driven by the wind pressure difference; stack effect, internal partitions and wind turbulence are ignored. Pressure coefficients come from wind tunnel data or tables for the building shape.

Formula and method

$$Q = C_d A_{eff} U \sqrt{\Delta C_p}, \quad \frac{1}{A_{eff}^2} = \frac{1}{A_1^2} + \frac{1}{A_2^2}, \quad n = \frac{Q}{V}$$

Variables

A_1	Windward opening area	m²
A_2	Leeward opening area	m²
C_d	Discharge coefficient (sharp opening 0.61)	-
U	Wind speed at building height	m/s
C_{p1}	Pressure coefficient, windward face	-
C_{p2}	Pressure coefficient, leeward face	-
V	Room or building volume	m³
ρ	Air density	kg/m³
A_{eff}	Effective opening area (openings in series)	m²
Δp	Wind pressure difference ½ρU²ΔC_p	Pa

Q	Air flow	m^3/s
n	Air changes per hour	$1/s$
v_1	Mean velocity in the windward opening	m/s

Method and standards

Wind-driven natural ventilation.

Assumptions and limits

- Steady wind, sharp-edged openings, no stack effect.

References

Wind-driven flow through openings in series (orifice equation)

Report details

Report reference	FCC-R7XE-KVTT (the same inputs always give the same reference)
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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/hvac/loads/wind-driven-natural-ventilation

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.