Air flow

- Ventilation
  - supply of fresh air
  - removal of internal heat
  - heat dissipation from skin

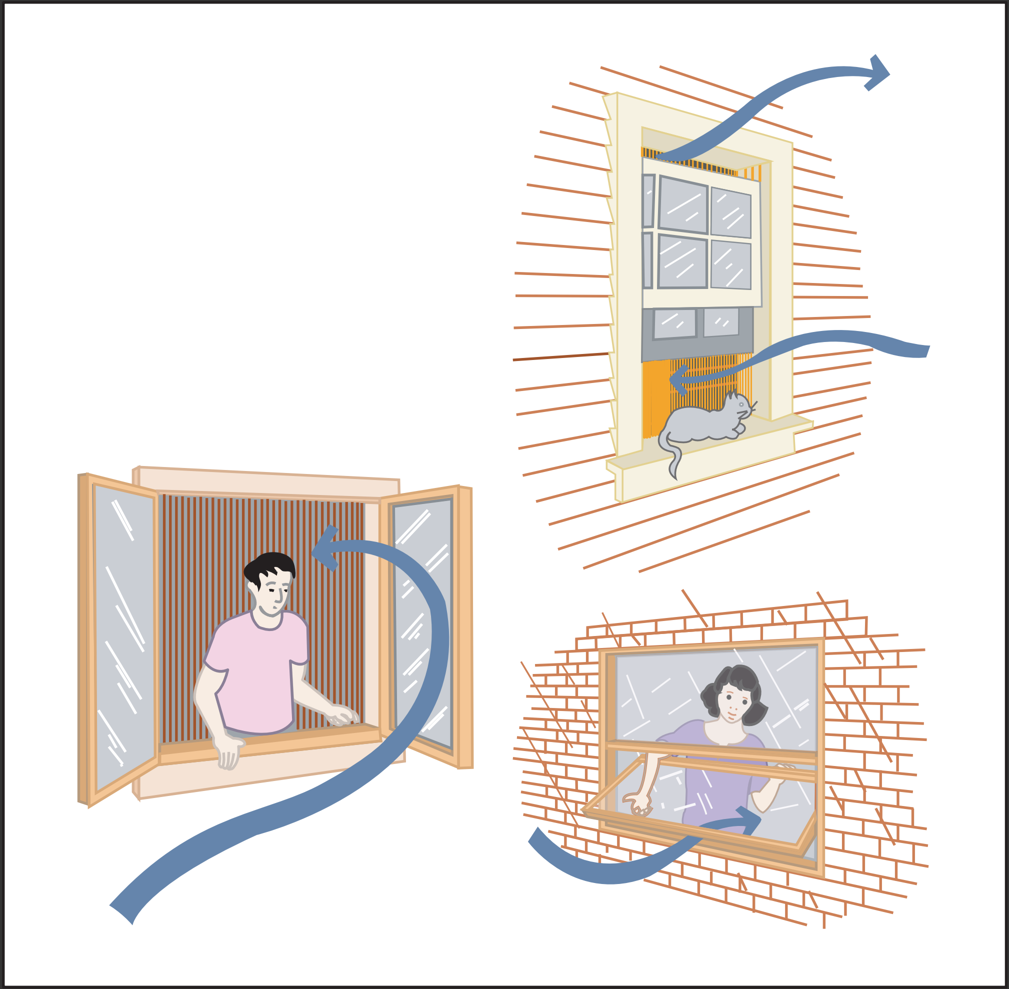


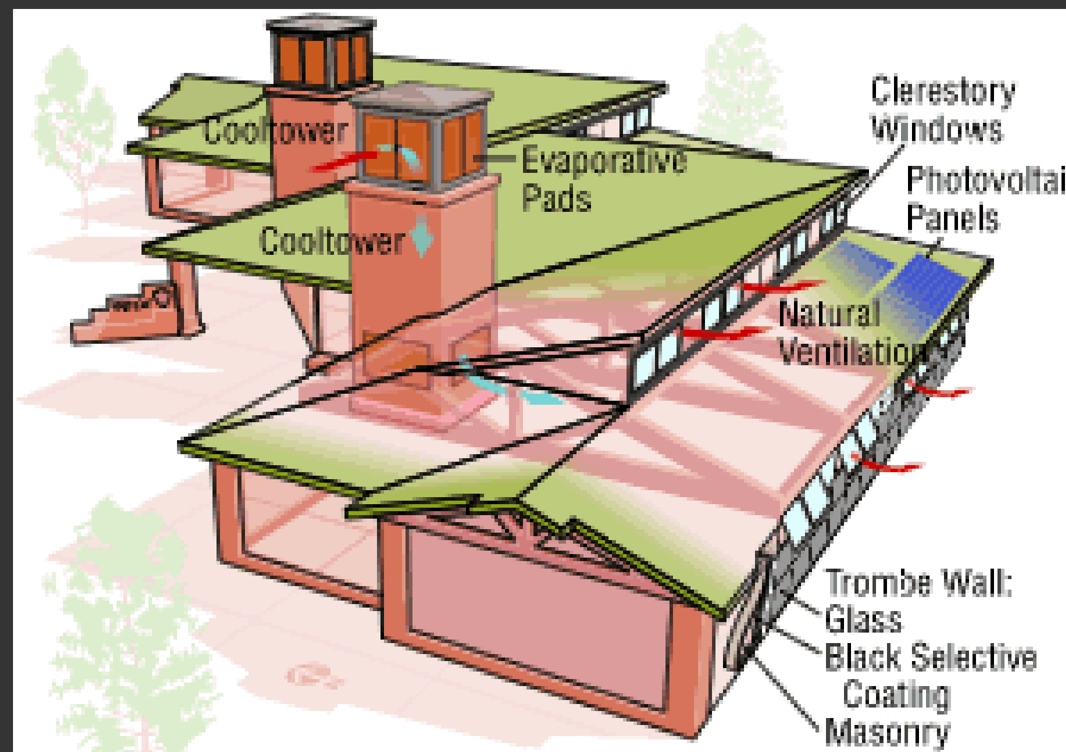
Image by MIT OCW.

Air flow

- Ventilation
  - supply of fresh air
  - removal of internal heat
  - heat dissipation from skin

Air flow

- Ventilation
  - Zion National Park Visitor Center (National Park Service & NREL)



Images courtesy of the U.S. Department of Energy.

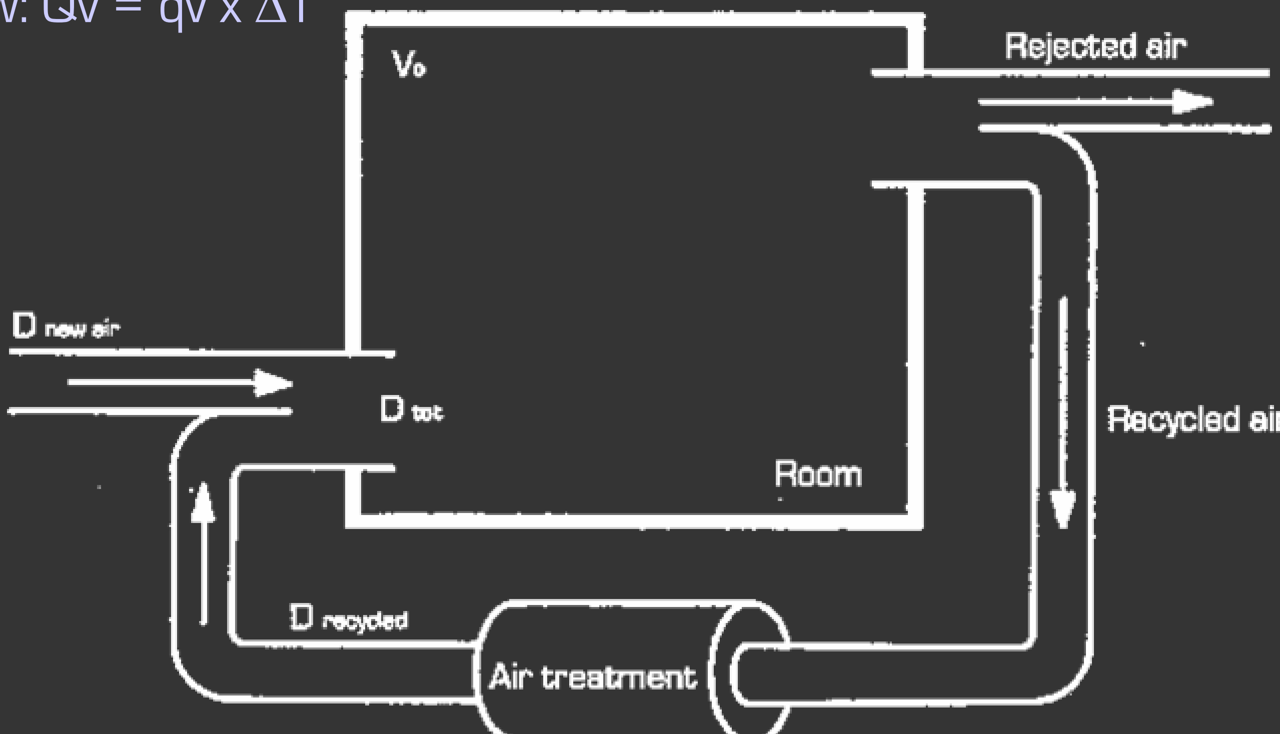
Air flow

- Active air flow
  - Supply of fresh air based on renewal and change rates

    Ventilation flow rate vr (m^3/s) = V x N (nb of air changes per hour) / 3600

    Ventilation conductance qv (W/K) = 1200 (J/m^3K) x vr = 0.33 x N x V

    Ventilation heat flow: Qv = qv x ΔT



Air flow

Active air flow

- Supply of fresh air based on renewal and change rates

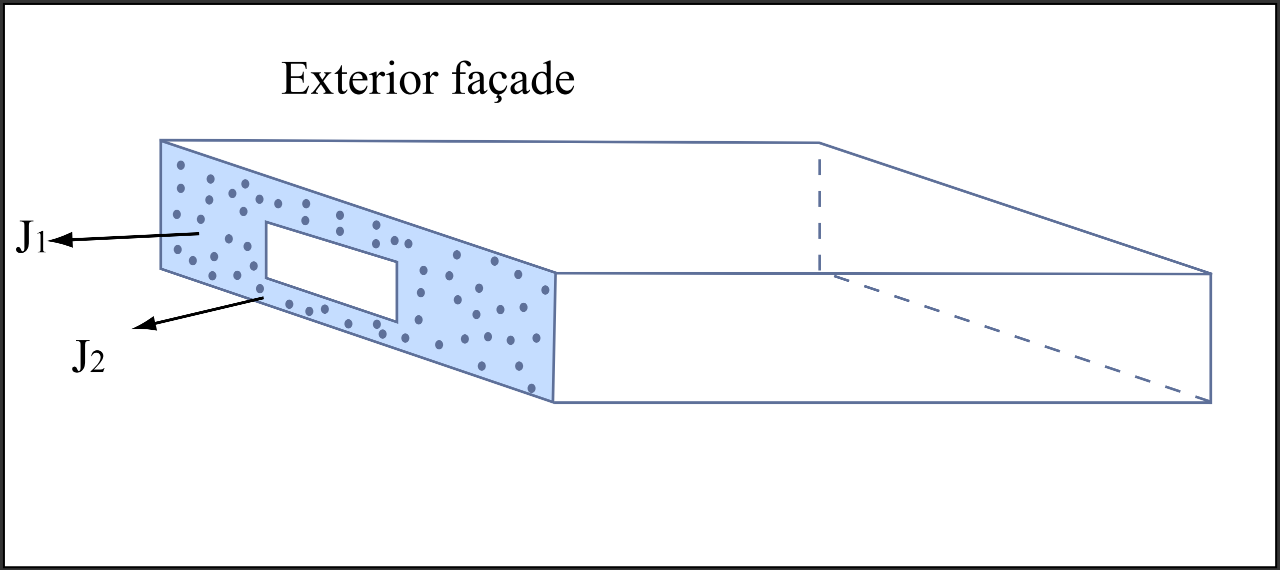


Image by MIT OCW.

Same 60 m^3 room as studied for heat flow. Heat losses through façade due to conduction = 190 W

Losses due to air renewal (N = 0.7 h^{-1}) ? What should N be for ventilation and conduction losses to be equal ?

Air flow

Passive air flow

- Fluid mechanics: $p + \rho g h + \frac{1}{2} \rho v^2 = \text{constant}$ (Bernouilli)

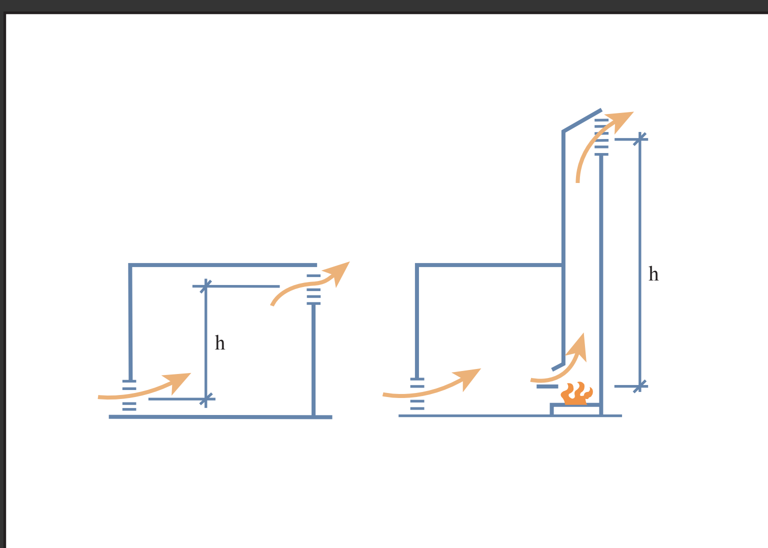
hydrostatics :

$$\Delta p = -\Delta h \rho g$$

stack effect :

$$\Delta p_{i-e}(h) = (h-h_n) g (\rho_e - \rho_i)$$

$$\rho(T) = \rho_0 \cdot p / p_0 \cdot T_0 / T$$



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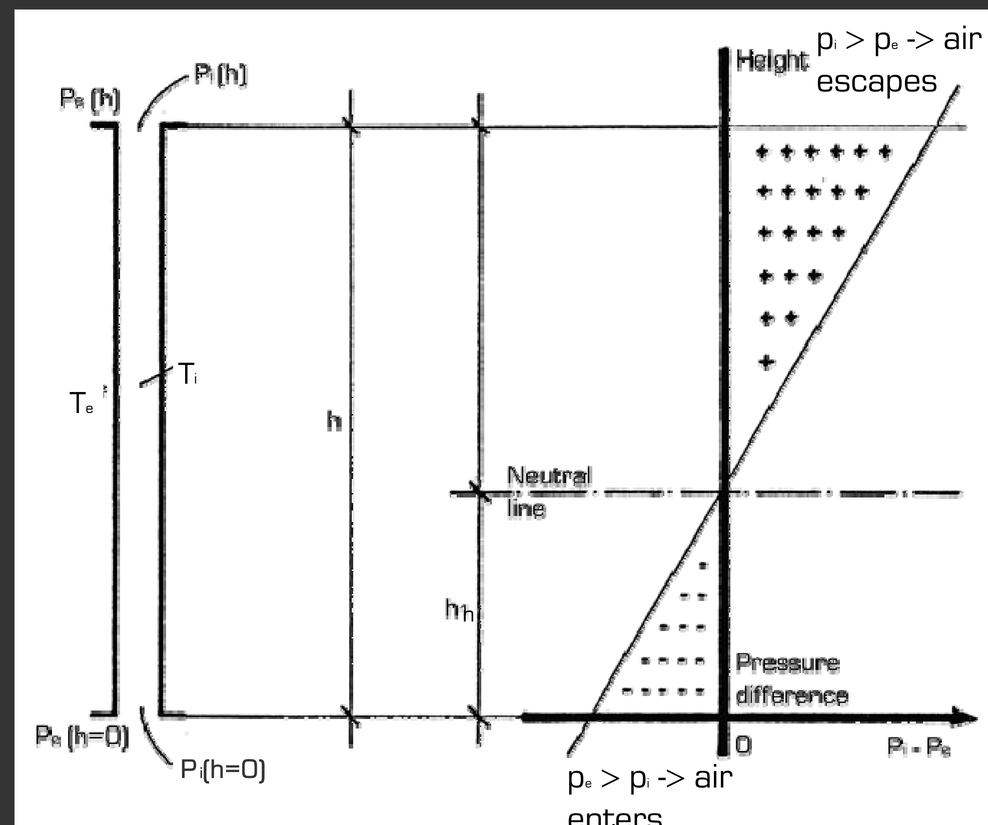


Air flow

Passive air flow

- Fluid mechanics: $p + \rho g h + \frac{1}{2}\rho v^2 = \text{constant}$ (Bernouilli)

hydrostatics : $\Delta p = -\Delta h \rho g$

stack effect : $\Delta p_{i\text{-}e}(h) = (h - h_n) g (\rho_e - \rho_i)$

$$\rho(T) = \rho_0 \cdot p/p_0 \cdot T_0/T \approx 1.29\ (\text{kg/m}^3) \cdot 273/T$$

hydrodynamics (wind) : $\Delta p = -\frac{1}{2}\rho\, \Delta v^2$, Venturi effect : $S_1 v_1 = S_2 v_2$

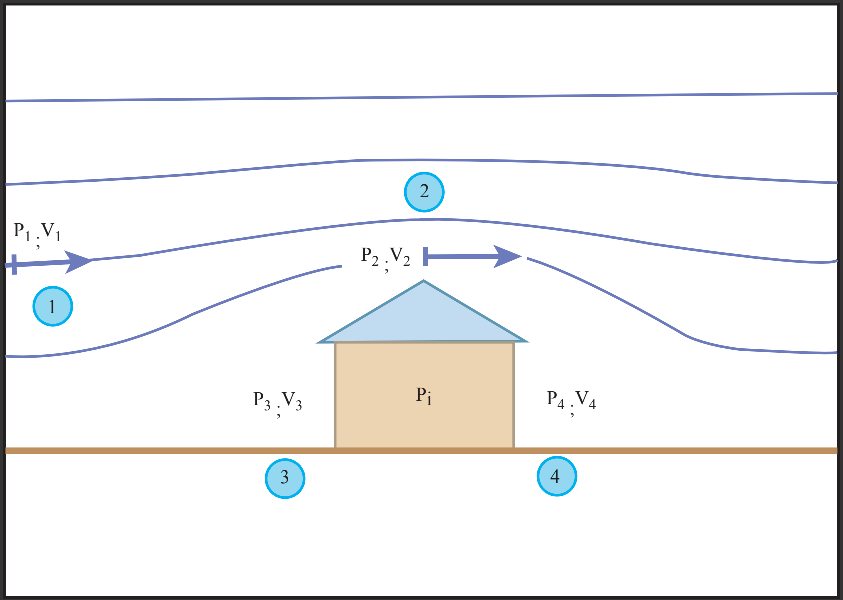
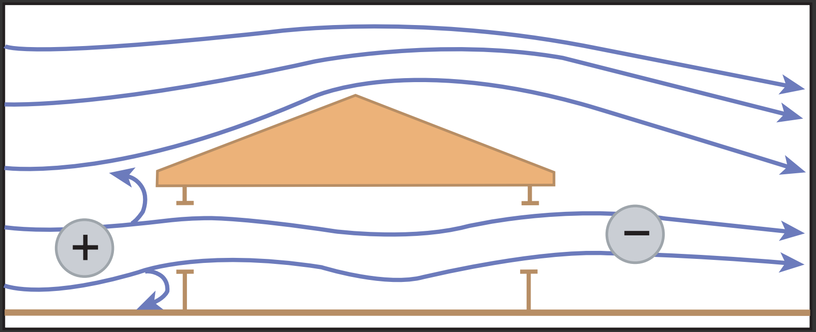


Image by MIT OCW.

Air flow

- Passive air flow
  - Fluid mechanics
  - Pressure ↓ if speed ↑
  - Turbulent vs. steady flow



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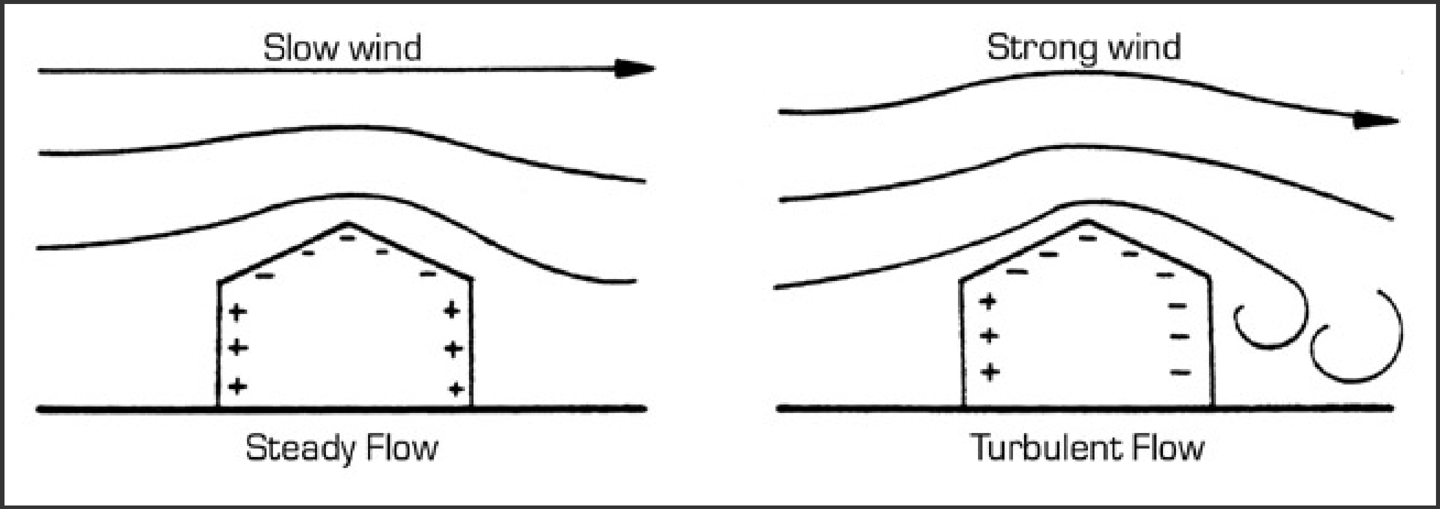
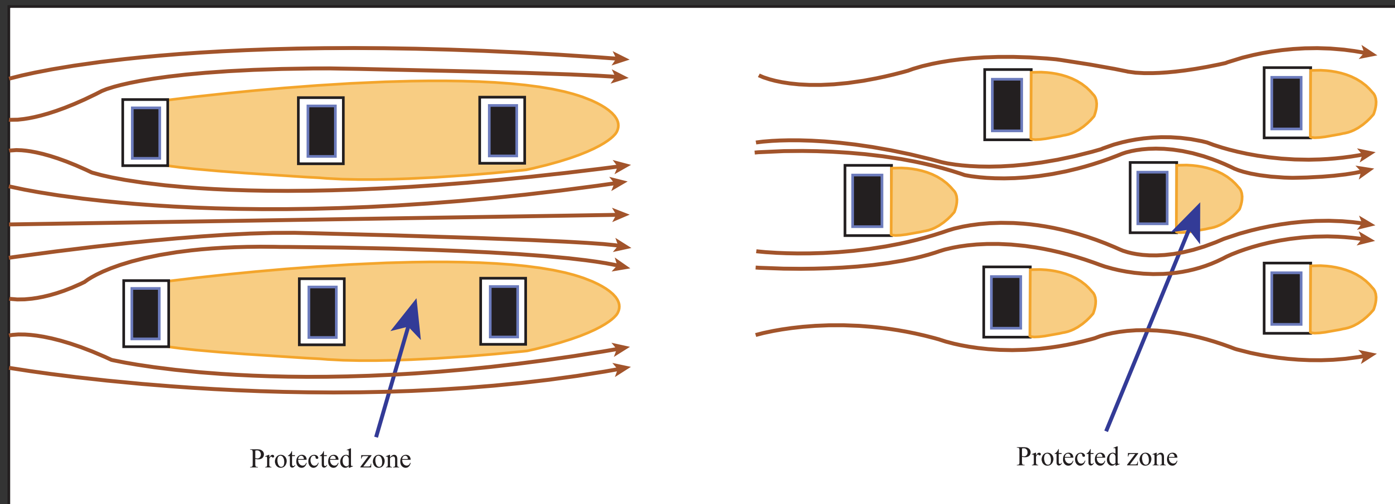


Air flow

- Wind



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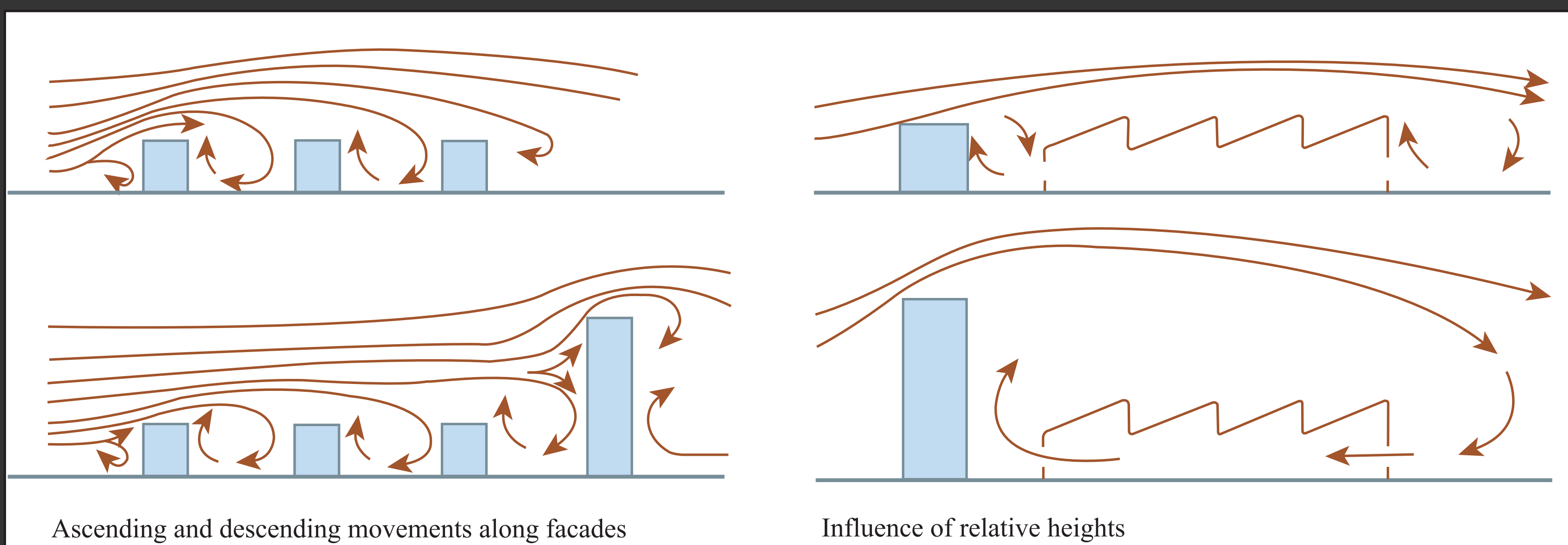

Image by MIT OCW.

Air Flow

- Reading assignment from Textbook:
  - “Introduction to Architectural Science” by Szokolay: § 1.1.4 + § 1.4.2
- Additional readings relevant to lecture topics:
  - "How Buildings Work" by Allen: Chap 11
  - “Sun Wind Light“ by Brown & DeKay: § 6 in Chap 1A