Chapter 1
Heating and Cooling load calculations

Loads categories are:

Transmission load

This load is due to temperature difference across the Building

The comfort indoor conditions are:

Temperature: 20–24

Relative humidity: 40% – 60%

Formula used: $Q = U\ A\ \Delta T$ (A → Area of wall; ΔT → outdoor and indoor conditions)

For U: $U = \frac{1}{\Sigma R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

To calculate R:

$R = \frac{\text{Thickness}}{\text{Thermal conductivity}} = \frac{\text{Lm}}{\text{W/m.K}}$

Internal load

- People load
- light load
- Equipments load

a. People load (occupants)

Formulas:

- Sensible $Q_s = N\ q_s\ CLF$
  - N → Number of occupants
  - CLF → cooling load factor (From Table 4-9)
  - q_s → Gain per person (Rate of heat emission)
- latent $Q_L = N \times q_L$
  - q_L → Gain per

b. light load

Formula: Q_{light} = lamp heat generation × F_{ul} × F_b × N × CLF

- lamp heat generation: 80 usually for normal lights
- From Table 4-6
- F_{ul}: utilization Factor Based on usage (0.85 for office)
- F_b: = 1.2 For fluorescent lamps
- N: Number of lights

Another formula: Q_{light} = lamp heat generation/m^2 × Area

(lamp heat generation/m^2 = Density)

c. Equipments load: Equipements such as: computers, printers Monitors ..... generates heat

Solar load

1. Transparent surfaces (Absorbed): $Q_{glass} = SHGF_{max} \times SC \times A \times CLF$
   - $SHGF_{max}$: Solar heat gain factor Based on orientation + month + latitude in watts
   - SC: Shading coefficient (curtains) Type of glass + curtains
   - A: Area
   - CLF: Depends on: Window orientation + At what time

2. Opaque surfaces:
   1. $Q_{roof} = U \times A \times CLTD$
      - CLTD: Cooling load temperature difference
   2. $Q_{wall} = U \times A \times CLTD$

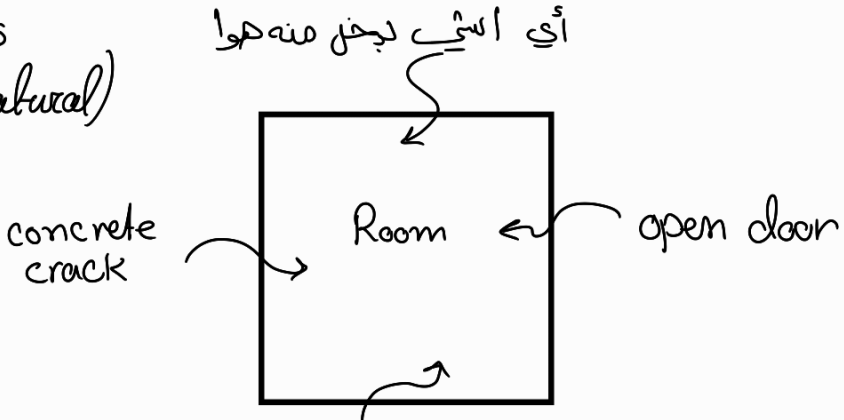
For CLTD it can be adjusted based on the Design

$$CLTD_{adj} = CLTD + (25 - t_i) + (t_{av} - 29)$$

- t_i: inside design dry bulb temperature
- t_{av}: Average out-door dry-bulb temp

Infilteration and ventilation load

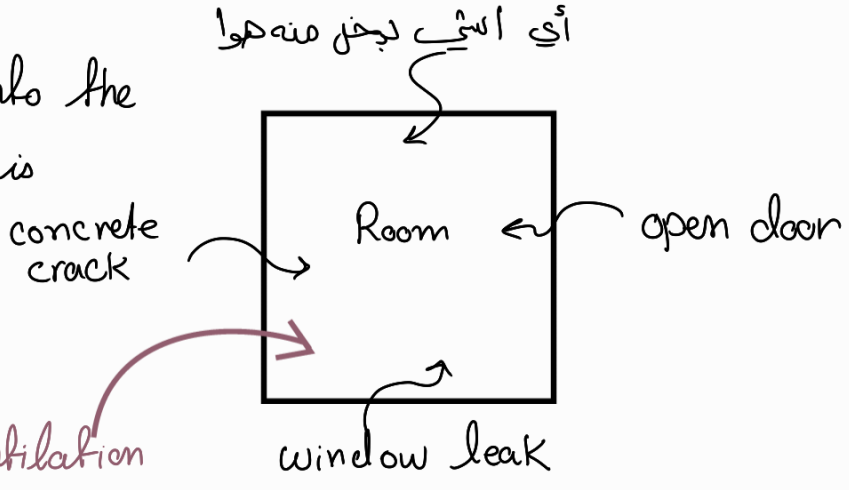
Infiltration load: results from uncontrolled air (natural) entering the Room



ventilation load: Air intentionally brought into the building by mechanical means

Either infiltration is calculated or ventilation is

when air is forced into the room, the pressure inside is higher than outside and so air outside won't enter which cancels infiltration load



Formulas

$$Q_{sensible} = 1.23 \times V_{vent} \times \Delta T$$

$$Q_{latent} = 3000 \times V_{vent} \times \Delta \omega$$

Where V_{vent} (LPS) = Room volume $\times$ ACH $\times \frac{1000}{3600}$

Room volume: m^3

ACH: 1/hour from Tables

= 1.7 for natural ventilation

Ventilation Systems are: (Done with AHU)

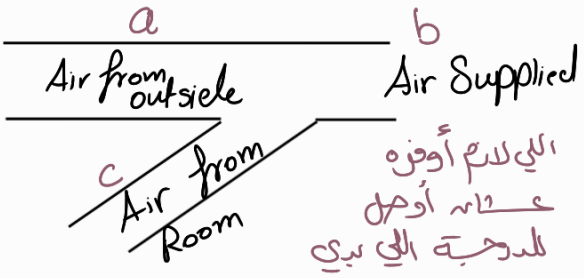
1. Fresh air ventilation : All air entered is exhausted

2. high ventilation load : Some air is returned
Meaning that fresh air is brought from outdoor and some room air is brought back to AHU

$T_{out} = a$

$T_{supply} = b$ → Mixing temperature

$T_{room} = c$



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3. ACPH
- 75% return of $V_{vent} = \dot{m}_1$
- 25% fresh air of vent $= \dot{m}_2$

To find T_{mixing}:

$\dot{m}_1 h_1 + \dot{m}_2 h_2 = \dot{m}_{Tot}\, h$

$\dot{m}_1 \omega_1 + \dot{m}_2 \omega_2 = \dot{m}_{Tot}\, \omega$

→ obtain these then use psychometric chart to obtain T_{mixing}