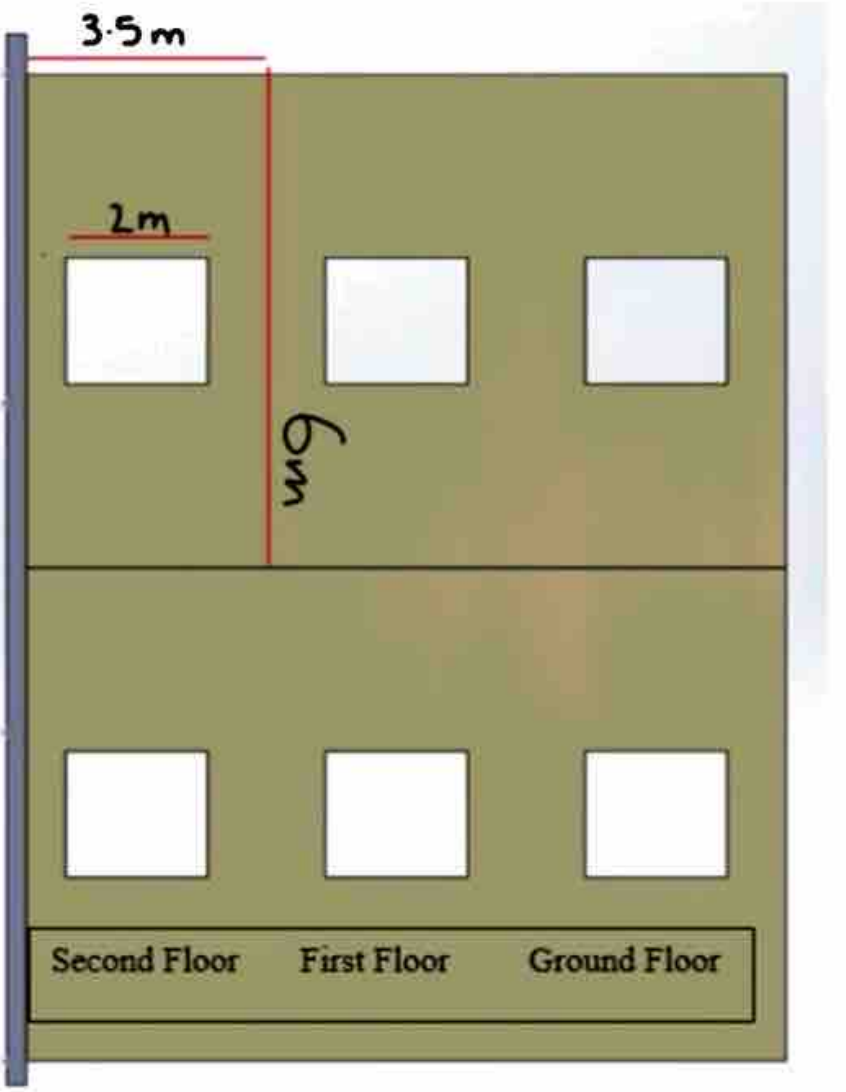
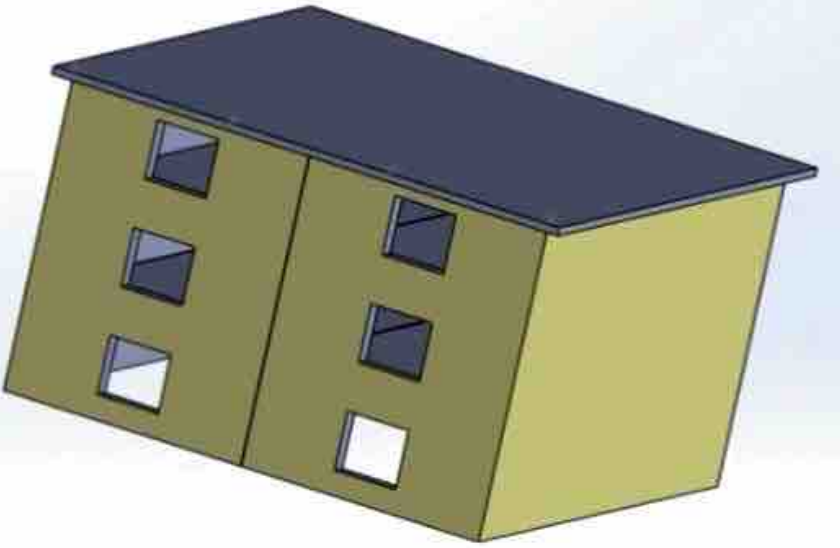


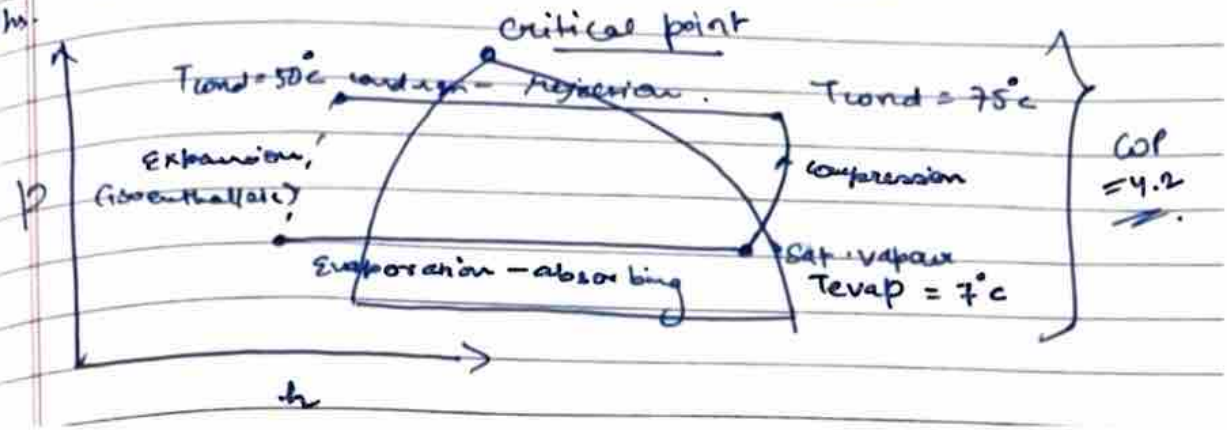

Side View



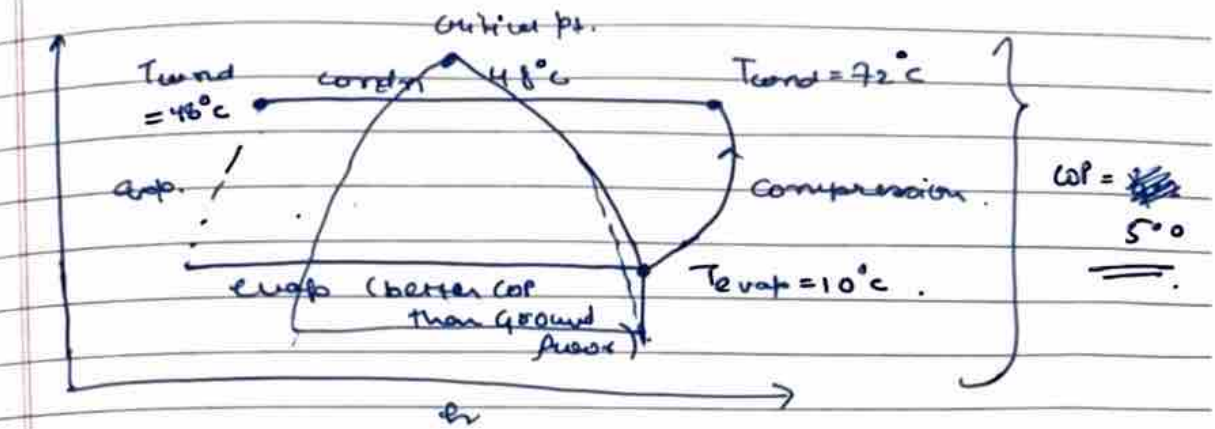
Isometric View

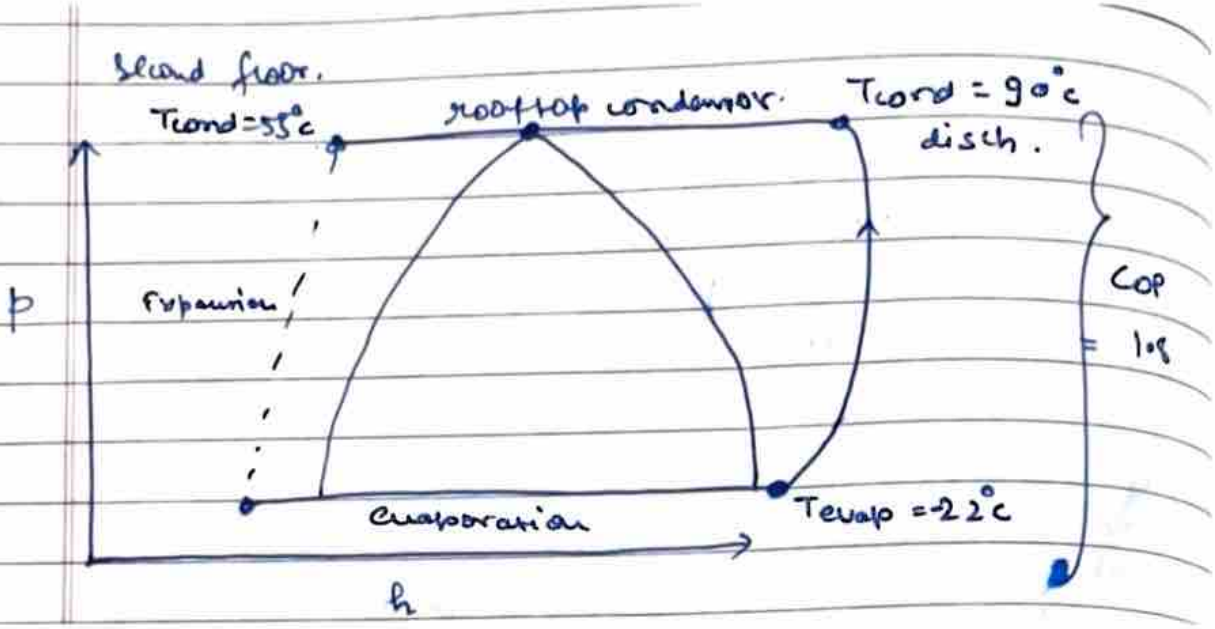
p-h graphs.

Ground floor - comm. supermarket:



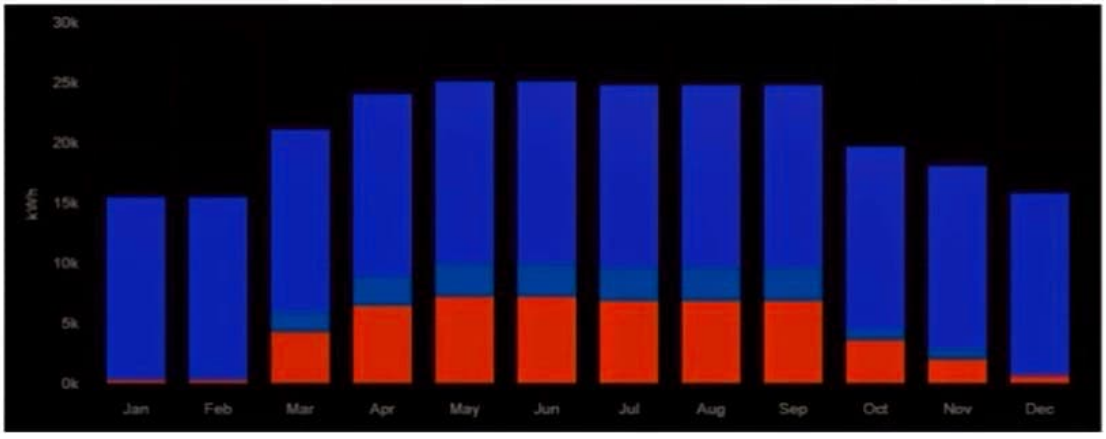

First floor - residential household (Ground)



| # | Variable | Why It Matters | Suggested Value / Range |
|---|---|---|---|
| 1 | Outdoor Dry Bulb Temperature | Primary basis for cooling/heating load calculations | 40–45 °C (Delhi summer design) |
| 2 | Outdoor Relative Humidity | Determines latent heat load and dehumidification requirement | 40–60% RH |
| 3 | Geographic Location / Climate Zone | Defines design conditions, solar intensity, seasonal variation | Composite Climate |
| 4 | Solar Radiation Intensity | Major contributor to heat gain through roof/walls/windows | 700–950 W/m² |
| 5 | Building Orientation (Sun Facing Direction) | East/west facades experience higher solar loads | Long axis: North–South preferred |
| 6 | Wind Speed & Direction | Affects infiltration, ventilation effectiveness, heat transfer | 2–5 m/s prevailing winds |
| 7 | Adjacent Building Height & Spacing | Causes shading or heat trapping; impacts airflow | 1–1.5× building height clearance |
| 8 | Wall Material & Thickness | Governs conductive heat transfer (U-value) | 230 mm brick wall + plaster |
| 9 | Roof Construction & Insulation | Roof receives maximum solar load in India | RCC slab + 50 mm insulation |
| 10 | Window-to-Wall Ratio (WWR) | Larger glazing increases solar heat gain | 25–40% |
| 11 | Glass Type / SHGC / U-Value | Impacts radiation and conductive heat entry | Double glazed, SHGC ≈ 0.3–0.4 |
| 12 | Occupancy Density (People per Floor) | Humans contribute sensible + latent heat | GF: 15–25 people FF: 4–6 people SF: 2–5 staff |
| 13 | Equipment & Appliance Heat Load | Lighting, refrigerators, electronics, commercial machinery | GF: 20–40 W/m² FF: 10–15 W/m² SF: 50–120 W/m² |
| 14 | Ventilation Requirement / ACH | Fresh air requirement directly impacts HVAC tonnage | GF: 6–10 ACH FF: 3–5 ACH SF: 10–20 ACH |
| 15 | Infiltration Rate | Leakage through doors/windows increases cooling load | 0.3–0.7 ACH |
| 16 | Floor Usage Type | Commercial, residential, and cryogenic spaces have radically different HVAC demands | GF: Retail FF: Residential SF: Cryogenic/Industrial |
| 17 | Required Indoor Design Conditions | Desired temperature/humidity for each floor defines final system sizing | GF: 22–24 °C, 50% RH FF: 23–26 °C, 45–60% RH SF: −20 °C to −80 °C |

*Table 1.1: Suggested Values for Parameters*




Ground floor (GF) First floor (FF) Second floor (SF)

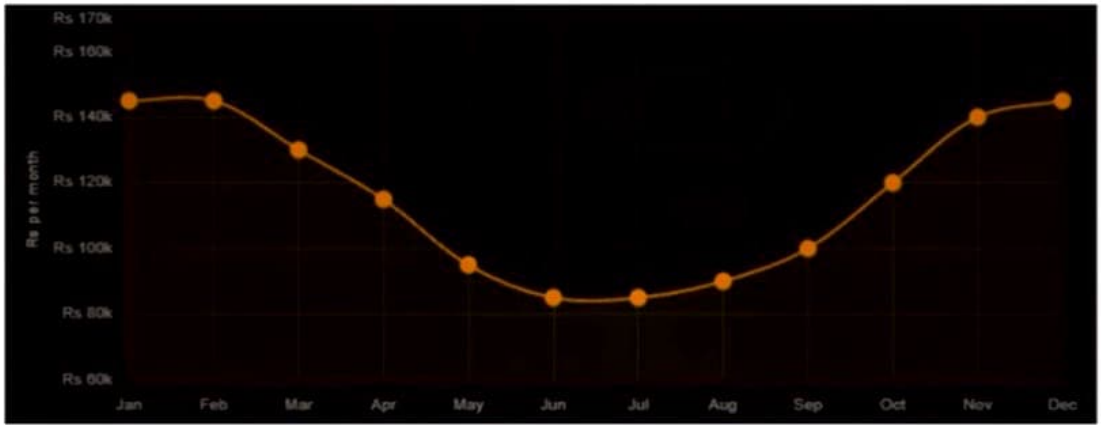
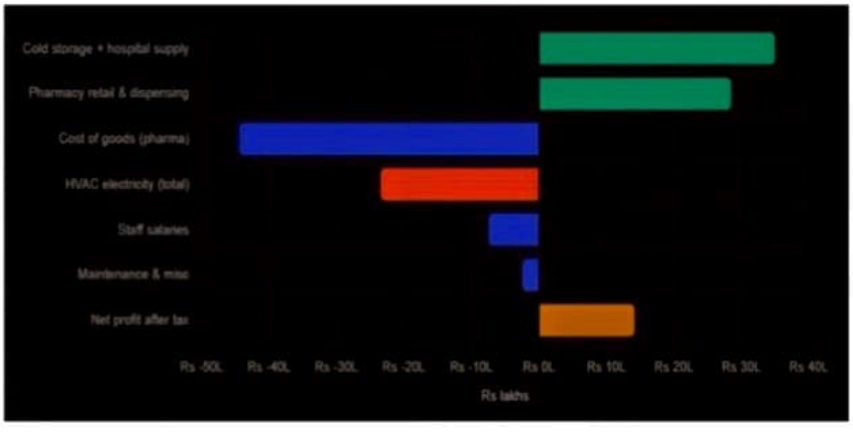



Chart 1 reveals the seasonal structure of the building load. The SF base load of 15,257 kWh per month is the flat constant floor under all twelve bars. The GF and FF contributions sit on top of it, peaking in June and July and nearly disappearing in December and January.

Chart 2 shows the monthly cash flow dip in May, June, and July when the GF and SF electricity bills peak simultaneously with Delhi summer. This is the stress period for the business - net monthly surplus drops from Rs 1.45 lakhs in winter to Rs 85,000 in peak summer.

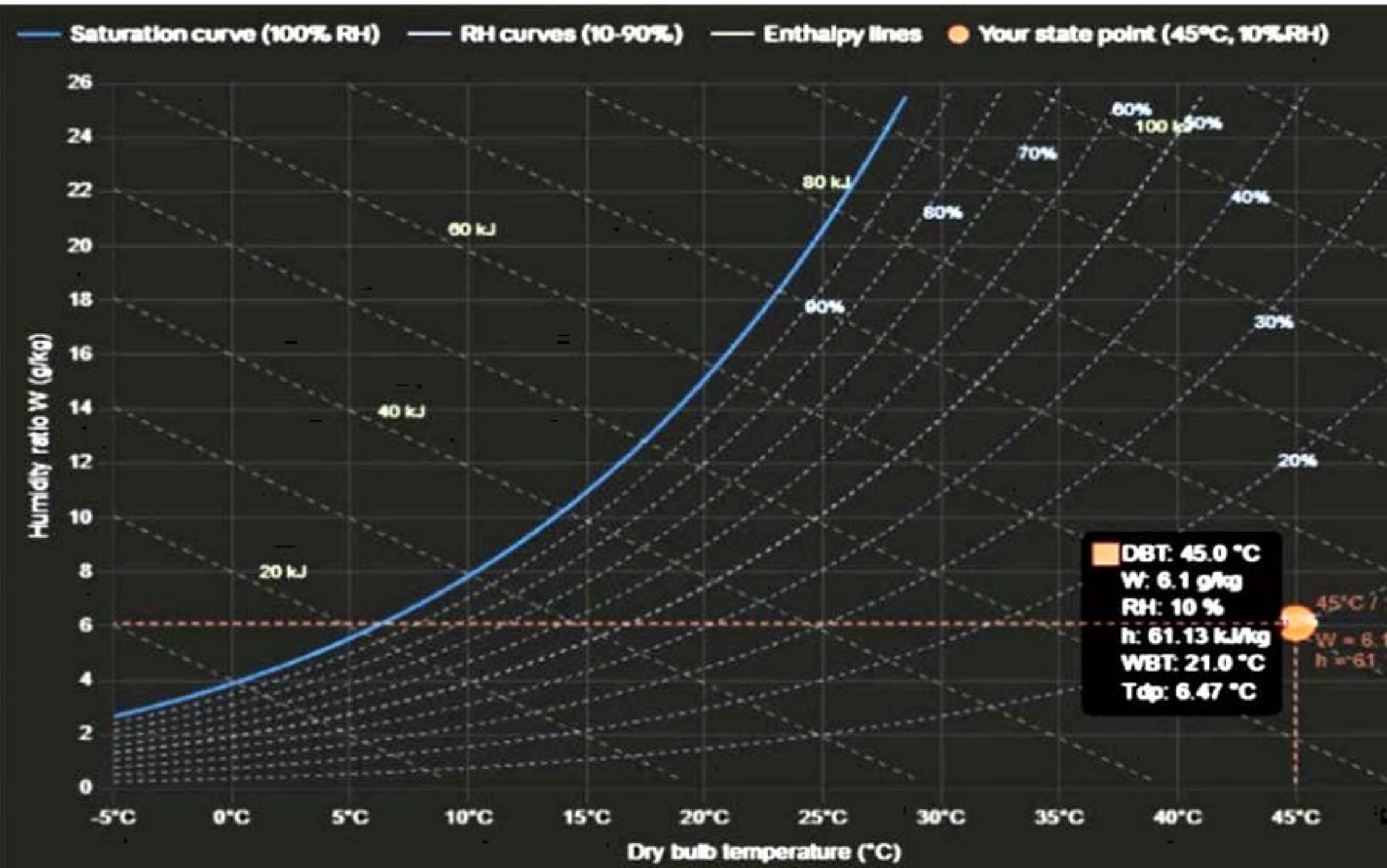
The charts are a cause and consequence to one another, the bill shows rise during the middle of the year, and thus the net cash flow decreases during those parts of the year.

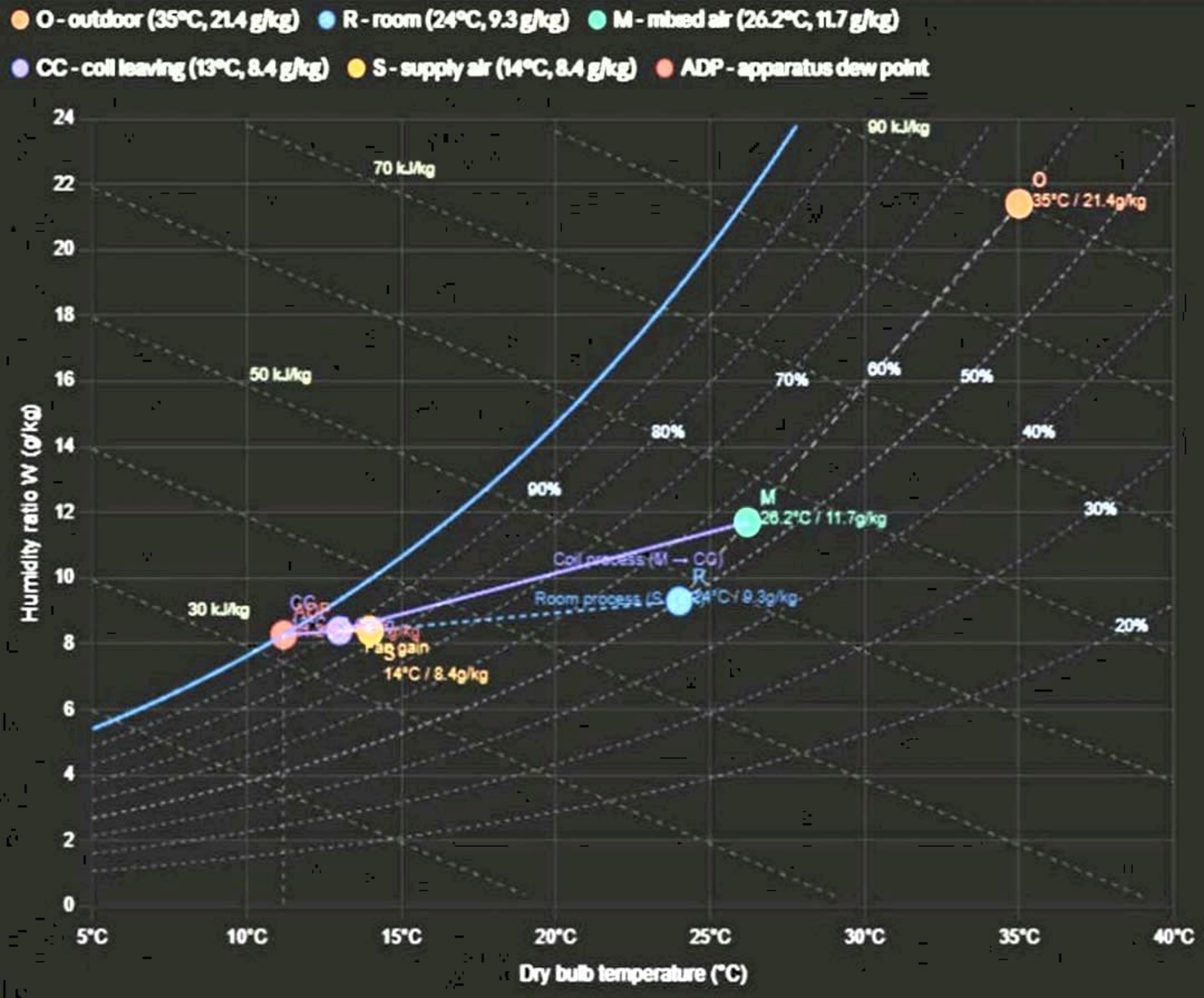


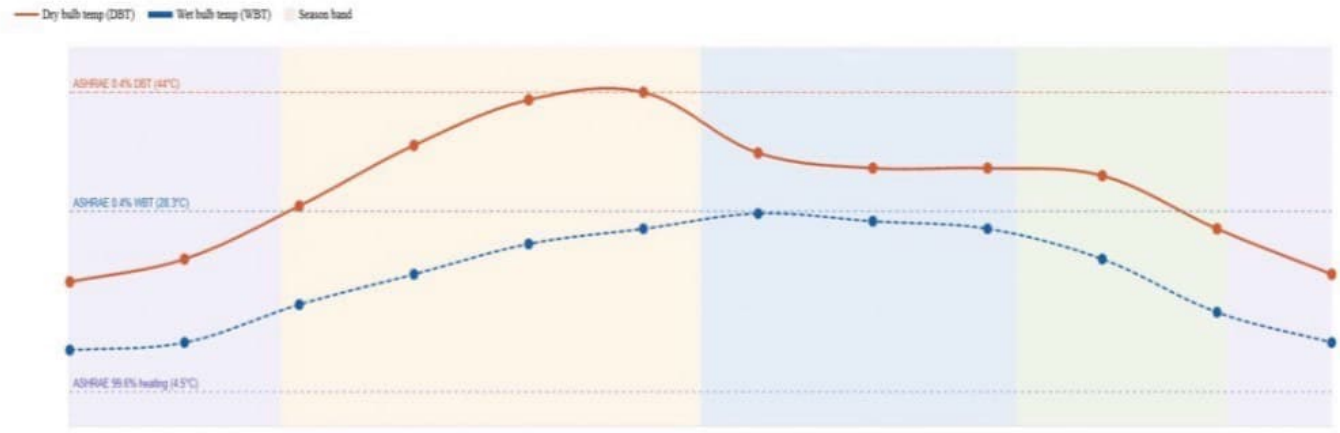

Revenue / income HVAC electricity cost Other operating cost Net profit

Chart 3 shows the P&L structure. The HVAC electricity cost of Rs 23.5 lakhs sits alongside a cost of goods figure of Rs 44.5 lakhs.

In the context of a Rs 63.5 lakh revenue business, HVAC is a significant but not dominant cost - comparable to what any capital-intensive food or pharmaceutical business spends on cold chain infrastructure.


Saturation curve (100% RH)
RH curves (10-90%)
Enthalpy lines
Your state point (45°C, 10%RH)
Humidity ratio W (g/kg)
Dry bulb temperature (°C)
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-5°C
0°C
5°C
10°C
15°C
20°C
25°C
30°C
35°C
40°C
45°C
80 kJ
60 kJ
40 kJ
20 kJ
100 kJ
90%
80%
70%
60%
50%
40%
30%
20%
DBT: 45.0 °C
W: 6.1 g/kg
RH: 10 %
h: 61.13 kJ/kg
WBT: 21.0 °C
Tdp: 6.47 °C
45°C /


O - outdoor (35°C, 21.4 g/kg)
R - room (24°C, 9.3 g/kg)
M - mixed air (26.2°C, 11.7 g/kg)
CC - coil leaving (13°C, 8.4 g/kg)
S - supply air (14°C, 8.4 g/kg)
ADP - apparatus dew point
90 kJ/kg
70 kJ/kg
50 kJ/kg
30 kJ/kg
O
35°C / 21.4g/kg
M
26.2°C / 11.7g/kg
R
24°C / 9.3g/kg
Coil process (M → CC)
Room process (S → R)
CC
ADP
Fan gain
14°C / 8.4g/kg
90%
80%
70%
60%
50%
40%
30%
20%
Humidity ratio W (g/kg)
24
22
20
18
16
14
12
10
8
6
4
2
0
5°C
10°C
15°C
20°C
25°C
30°C
35°C
40°C
Dry bulb temperature (°C)




This is the line graph for different DBTs and WBTs (orange and blue lines) for different seasons (shown as background colour). The legend is as follows.

Summer (Mar-Jun)
Peak sensible load
DBT governs
Size condensers

Monsoon (Jul-Sep)
Peak latent load
WBT governs
Size dehumidification

Transition (Oct-Nov)
Part-load operation
Economiser mode
Free cooling potential

Winter (Dec-Feb)
Heating load (FF)
Heat pump mode
Humidification needed

## 2.2.5 Tabularised Parameters

| Parameter | Value | Used for |
|---|---|---|
| Summer DB (0.4%) | 43.9°C | Equipment sizing - critical spaces |
| Summer DB (1%) | 42.2°C | Equipment sizing - comfort spaces |
| Coincident WB at summer DB | 24°C | Psychrometric analysis, coil selection |
| Summer WB (0.4%) | 28.3°C | Evaporative cooler feasibility, latent load |
| Monsoon coincident DB/WB | 35°C / 28°C | Latent load, dehumidification coil sizing |
| Winter DB (99.6%) | 4.5°C | Heating load, heat pump sizing |
| Winter DB (99%) | 6.8°C | General heating load |
| Latitude | 28.6°N | Solar angle calculations, SHGF table selection |
| Longitude | 77.2°E | Solar time correction |
| Elevation | 216 m | Atmospheric pressure correction (minor) |
| Prevailing wind speed (summer) | 3-5 m/s from SW | Infiltration calculations |