What is Building Envelope Design?

Worksheet

Building envelope design shapes the walls, roof, and windows that separate inside from outside; its thermal performance is measured by U-value, where U = 1 / R_total and R_total is the sum of each layer's thermal resistance.

Questions

1. A wall has layer R-values of 1.5, 0.4, and 0.3 mK/W. What is its U-value?

A) 0.45 W/mK
B) 2.2 W/mK
C) 4.5 W/mK
D) 0.22 W/mK

2. What does the building envelope separate?

A) Floors from ceilings
B) The conditioned interior from the outdoor environment
C) The structure from the foundation
D) Electrical from plumbing systems

3. A lower U-value means

A) Worse insulation
B) Better insulation
C) Always higher cost
D) No relation to insulation

4. How do the R-values of layers in series combine?

A) They are multiplied
B) They are averaged
C) They are summed
D) They are subtracted

5. A wall assembly has insulation R = 2.5, sheathing R = 0.3, and finishes R = 0.2 (mK/W). Find its U-value.

6. An upgraded wall uses insulation R = 4.0 instead, with sheathing 0.3 and finishes 0.2 unchanged. Find the new U-value and the improvement.

7. A roof must meet U 0.20 W/mK with fixed sheathing R = 0.3 and finishes R = 0.2. Find the minimum insulation R required.

8. Define: What is the building envelope?

9. Define: What is U-value?

10. Define: What is R-value?

Answer Key

1. A) 0.45 W/mK - R_total = 1.5+0.4+0.3 = 2.2; U = 1/2.2 0.45 W/mK.

2. B) The conditioned interior from the outdoor environment - The envelope is the boundary between conditioned indoor space and the outdoors.

3. B) Better insulation - U-value is inversely related to resistance, so lower U means better insulating performance.

4. C) They are summed - R_total = R1 + R2 + R3 + for layers in series.

5. R_total = 2.5 + 0.3 + 0.2 = 3.0 mK/W U = 1 / R_total = 1 / 3.0 = 0.333 W/mK

6. R_total = 4.0 + 0.3 + 0.2 = 4.5 mK/W U = 1 / 4.5 = 0.222 W/mK Improvement (0.333 0.222)/0.333 33%

7. R_total,min = 1/0.20 = 5.0 mK/W R_insulation = 5.0 0.3 0.2 = 4.5 mK/W

8. The physical separator - walls, roof, floor, windows - between a building's conditioned interior and the outdoor environment.

9. The rate of heat transfer through an assembly, per unit area per degree of temperature difference (W/mK); lower is better insulated.

10. The thermal resistance of a material or layer (mK/W); higher is a better insulator. R-values in series simply add up.