

Arch 264: Assignment 2

Groups of 4 (not 3 or 5)

Due: Wed Nov 9, in box by 4:30 pm

A warehouse formerly used as a spinning mill for fabric, has been converted to a school for a dynamic school of architecture in Cambridge. Each floor of the three-story school is 3.5 m high and has the complex plan form shown in the figure below.

You are told the enclosure is made up of, from the inside, of:

Roof

1. 600 mm deep open web steel joist (original)
2. 50 of solid wood planking (original)
3. 60 mm of polyisocyanurate rigid roof insulation (new)
4. Built up roof membrane (new)

Wall

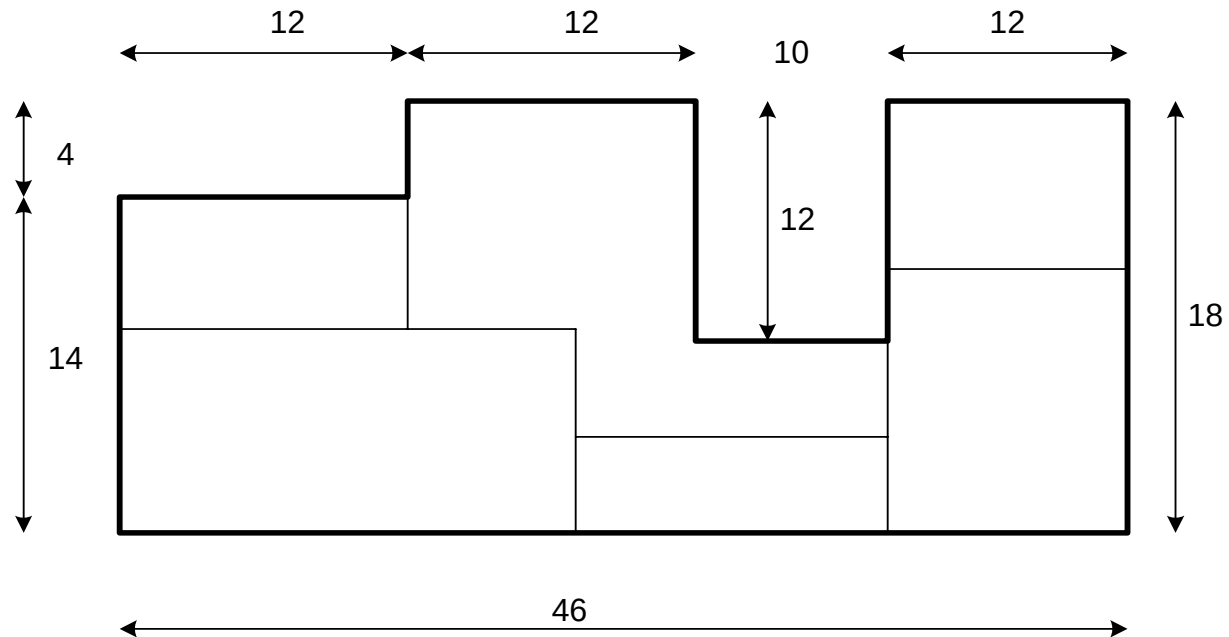
1. 300 mm of face brick (original)
2. 50 mm of extruded polystyrene (new)
3. 90 mm airspace (new)
4. 15 mm drywall (new)

Part of the front face of the school (which faces solar west) has a 12 m wide full height glass curtainwall with a U-value of $2.2 \text{ W/m}^2/\text{C}$. The remainder of the west side has 100 m^2 of windows like the other sides. The other three sides have punched windows (U-value= $2.0 \text{ W/m}^2/\text{C}$), $1.5 \times 2.0 \text{ m}$, covering a total of 300 m^2 . Assume that the building leaks air at about 0.4 ACH (air changes per hour). Use an interior surface film $C=8 \text{ W/m}^2 \text{ C}$ and an outside film of $C=17 \text{ W/m}^2 \text{ C}$. Ignore the effect of the floors and doors.

1. Draw a sketch of the building, calculate or list the areas of each of the enclosure components.
2. Calculate the R-value of the roof and walls including surface films.
3. Find the total heat loss coefficient (U in W/C) for the walls, roof, windows+curtainwall, and air leakage. Also find the percentage of the total lost through each component.
4. Calculate the overall heat loss (Q) of the building when the temperature outside is -5 C .
5. If the interior energy usage is 10 W/m^2 floor area (eg lights, computers etc), how much energy must be purchased to heat the space at the -5 C average January Cambridge temperature.
6. How large of a furnace would be required if the school is designed for a -20 C temperature (and no interior heat sources like lights and people were present).
7. How big would the air-conditioner have to be assuming an outdoor temperature of 30 C , and no solar gains through the windows or walls but including the interior gains of 10 W/m^2 floor area and normal air leakage.
8. If clear double-glazing with a SGHC of 0.70 were used in the curtainwall (which is 95% glass and 5% opaque aluminum), what would be the solar gains through the west facing glass at 16:00 on July 21 in Cambridge (close to 45 N). Compare the gains through this

limited area of glass to the heat gains from walls, roof and air leakage. Use the table in the online notes to calculate solar intensity.

9. Go to the Trane or Carrier website and choose a roof-top unit (these are called packaged or unitary products) that would be adequate to meet the heating and cooling needs described above – assume that four identical units will be chosen for the building.
10. What could you do to improve the thermal performance of the building as little cost?



Dimensions in meters

Plan view of conversion to school. 46 m long face is oriented to the east.

Reminder: All assignments must be bound (with staples or better – no paper clips) have a separate cover page with the students' full name and ID# clearly written or typed. One warning will be issued, after which the assignment will be marked out of half.