Typical Ideas for Building Science Final Exam Questions

The intent of the exam is to test your knowledge of what we have developed in the course. The most important information can be found in the handouts, presentations, and notes taken during lectures. The text provides a different way of saying many of the same things and should be used as a complementary resource.

Example Study Questions
Define

- Define the function of a building., the function of the building enclosure,
- List, three, maybe four, sub-classifications of enclosure functions
- List, describe, and provide an example for the three different rain control strategies for walls.
- Define relative humidity, vapour pressure, absolute humidity (provide example units too)
- What is thermal bridging and provide three examples and how to solve them.
- What is flashing and give three examples of its use in building.

Calculate

- the R-value of this x mm thick piece of material with a k-value of y.
- the overall U value for an assembly made up of these three materials …
- the heat loss from this boxy building if wall made of z and temp outside is 10 C.

Short Practical Questions

- Give 5 reasons why we would want to control air movement through an enclosure.
- What is stack effect? What problems can it cause in winter time?
- Define and compare and contrast an air barrier vs vapour barrier
- What SHGC value would you recommend for windows of an office facing west? For a passive solar house facing south?

Question: Air and Vapour Barriers

- What are the functions of a vapour barrier?
- What are the technical requirements of a vapour barrier?
- List 2 materials that could be used as a vapour barrier.
- What are the functions of an air barrier system?
- List the technical requirements of an air barrier system.
- List three materials that could be used as part of an air barrier system.
- List the main reason(s) we wish to control air flow?
- List the main reason(s) we wish to control vapour diffusion?
- Can the same material(s) be used for both? Give examples.
- How does the location of a vapour barrier within an enclosure vary between a hot-humid climate (Miami) and a cold climate (Ottawa)? Why?
- List three forces that drive air leaks through building enclosures.
- Draw a psychrometric chart and label the three axis
- Describe the process of cold weather air leakage condensation in words with the aid of a sketch of the psychrometric chart that includes each step.

Question : Rain control

- What are the three rain control strategies available for enclosures? Describe them?
- What kind of rain control strategy is used in
  - brick veneer over an airspace with weep holes
  - three-wythe brick with interior plaster
  - an exposed membrane roof with a tar/bitumen membrane over insulation over a metal deck
- Provide a sketch of three uses of flashing in building enclosures.

Question: Sketch
Draw and label a vertical section from the footings to the roof of a typical platform frame house made with 2x6 wall filled with batt insulation, OSB sheathing and brick veneer. The foundation is 200 mm of plain concrete, insulated on the interior. The drawing should show objects at sizes relatively close to scale, and at least 12 building items not mentioned in the question should be correctly identified.

Sketch of Function
Draw and label a 2-D detail of (e.g. wall-roof, wall to foundation, wall-floor, curtainwall mullion to glazing unit). Indicate how heat, air, rain, vapour, and movements are controlled. Sketch must include all practical important detail.

Question: Critique
Given the 2-D detail of (wall-roof, wall-to-foundation, wall to floor, wall to window) in Figure X, list 3 mistakes and/or potential problems (e.g., it could work, but the risk is higher than other solutions).

Question: Critique Case Study
This is a detailed and involved question – I would not ask you something this difficult, but it may be informative.
A large 4 storey health sciences building is to be constructed at an upstate New York university (climate similar to Waterloo). The architect specified the enclosure drawn at the left in Figure 1. An American building engineer was asked to review the drawings, and she suggested the wall section on the right in Figure 1 be used instead. Because the wall she specified was both different and likely more expensive than the wall the architect specified, an argument resulted.
To settle the argument, the owner has called in a Canadian building science expert. That would be you. Critique and compare each of the walls, pointing out the enclosure design principles at work (or not at work as the case may be), overall wall and building performance issues, and finally make your recommendations for which wall should be used. Compare at least 5 aspects of enclosure performance.
List and describe at least 3 changes you would make to the wall that you choose so as to provide the best service to your client.
Note also that the enclosure wall cost was less than 5% of the total building cost.

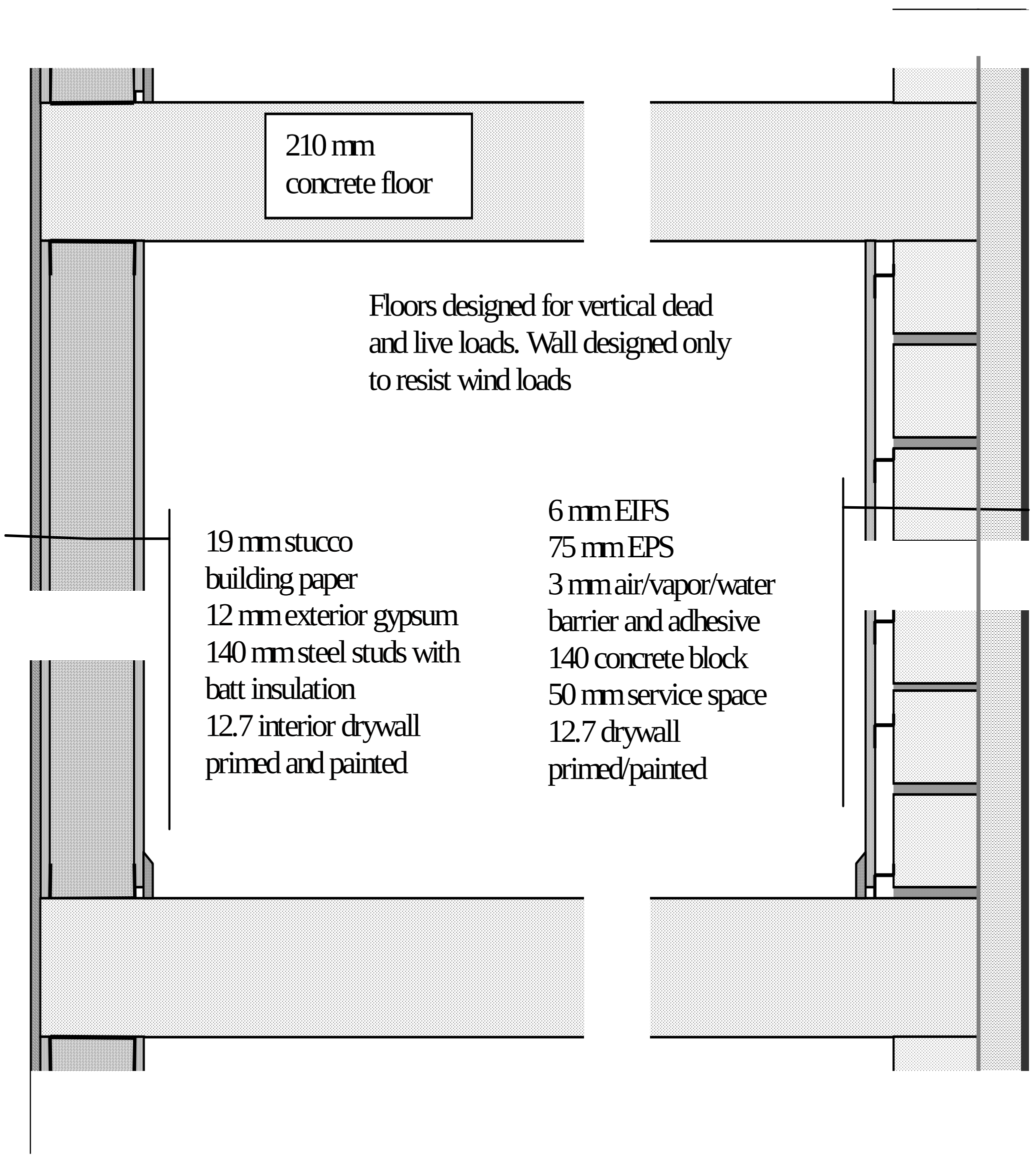

Figure 1: Competing Wall Sections for a Health Sciences Building

A Detailed Answer to the Critique Question

Heat Flow

Wall A has violated the principle that the structure of the enclosure be well insulated. Serious heat loss and dust marking problems be expected through the steel studs of Wall A, and the actual insulation value of the wall is likely to be less than half its rated value. The floor slab supporting the wall is entirely uninsulated, and the area around the baseboard and trim can be expected to be cold enough to cause surface condensation, even frost, and thus support mould growth.

Wall B employs a continuous blanket of insulation, thereby ensuring that the rated R-value (3"@R3.6/inch = R11.8). The structure is not only well-insulated, it is thermally massive. The thermal mass will act to improve the effective R-value of the wall (mass effect) improve the stability and uniformity of the interior temperature, and shift and reduce peak heating and air-conditioning loads. For a building housing a health sciences, it is likely that internal gains are significant -- thermal mass is even more important in such situations.

Air Flow

A critical element of any enclosure design is the control of air flow. Wall A has no defined air barrier system, whereas Wall B has a continuous membrane. Provided an appropriate material is specified, Wall B's membrane air/vapor/water barrier is likely to be very durable, stiff, and strong (e.g., an acrylic-based or modified, fiber reinforced cement is commonly used). The stucco/building paper/gypsum sandwich likely provides a fair degree of air flow control, but not one that can be relied upon. Sealing the joints between the gypsum board with a feel-and-stick bituminous membrane would be one means of ensuring a continuous, strong, durable, and impermeable air barrier system. Wall B has the advantage that if a hole were to be left in the membrane, air would not easily leak through the block (relative to flow through batt insulation). While the block will not act as an air barrier, it is certainly much more resistant to air flow than the batt insulation of Wall A.

Rain

The control of rain penetration is critically important to enclosure performance. Both Wall A and B are face-sealed perfect barrier systems and thus susceptible to failure of the finish. Wall A has some moisture storage mass in its cladding, but is prone to small cracks from shrinkage and movement. Wall B is unlikely to absorb any water at all (and thus is likely to have flowing water on its surface during more rain events) and is less likely to have cracks (the EIFS finish should be stretchy=elastomeric).

Rain is most likely to penetrate through joints, windows, balconies and other penetrations in both walls. Wall B, however, has a secondary water barrier in the form of the adhesive air barrier on the block. Since drainage is not provided, any rain that penetrates the finish can only leave by vapour diffusion, as in a mass wall. Although the EPS of Wall B may store some water, and the wall performance will suffer somewhat due to a rain leak, the moisture tolerance of all layers is much higher than that of wall A. If water leaks through the face of the wall or at penetrations, it can be expected to collect at the bottom of the wall and along all vertical surfaces (the studs and the gypsum). Wall A has little safe storage capacity, and corrosion of the steel studs and dissolution of the gypsum would likely occur. Thus, Wall A is more susceptible to damage from rain penetration than Wall B.

Vapor Flow

Vapor flow control should be considered during enclosure design. Diffusion condensation wetting must be minimized or eliminated while water penetration and built-in moisture in the block must have a means of drying. Wall B controls outward vapor diffusion by using a membrane. Wall A may control outward-flowing vapor with paint or poly (if so, this is not specified). The location of the membrane in Wall B is on the warm side of the wall, and so condensation during winter condensation is impossible.

Wall A is very susceptible to inward vapor drives, since the stucco can store water and neither the gypsum, the building paper or the batt are vapor resistant. Wall B is unlikely to experience inward drives unless rain penetration wets the EPS. In this scenario, the inward drives will cause condensation on the exterior of the membrane, from where the water can drive to the exterior.

Movement Control

Almost all enclosures can be expected to move, and if made of stiff materials, significant stresses can develop. The walls being considered act structurally as panel walls, that is, they are intended to transfer lateral loads to the primary structural system. The drawings do not show how the unavoidable vertical movement of the frame (elastic and creep deflections of the floor and columns) or of the block and stucco (drying shrinkage) will be accommodated.

A space must be provided between the top of the concrete block and the bottom of the floor slab to allow for movement. This joint must carry through to the finish and should ideally be designed as a drained-screened joint. The joint would best be achieved by using a flexible membrane to span the joint at the exterior of the block and interface with the adhesive air/vapor/water barrier. A sealant on backer rod on the exterior would usually be specified as the exterior stage of a two-stage joint.