OpenStudio: Building Envelope

Terminology

Envelope – Walls, roofs, ground, fenestration (doors, skylights, windows)

Construction – the assembly of different layers of material that make up an envelope

Thermal bridging – Walls require studs (wood or metal), clips or other devices for structural integrity (e.g. stop insulation from drooping); using these devices mean that some layer(s) aren't continuous. For example in Figure 1, looking at the insulation layer (pink) in a wall, up to 23% of the area is taken up for metal studs and only 77% of the area is filled with continuous insulation (these numbers are for illustrative purposes only and do not reflect the actual area distribution shown). This means heat doesn't transfer uniformly across the entire layer. Thus, the effective R-value of the overall wall assembly, is less than the sum of the individual layer's R-value. Morrison Hershfield has an extensive guide to estimating the effective R-value and an accompanying list of envelope assemblies with effective R-value.
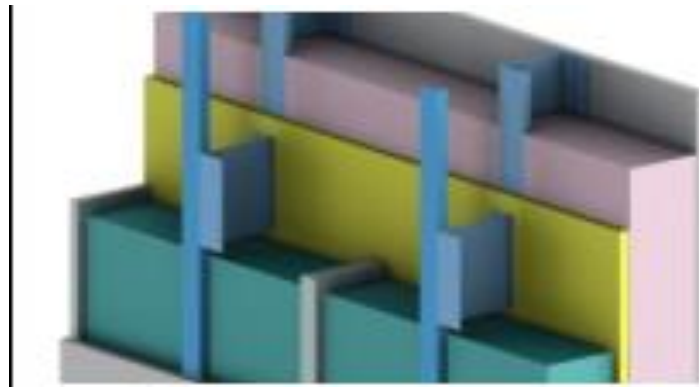

Figure 1 Detail construction of a wall assembly (extensive guide)

OpenStudio Construction tab UI

See this guide to the construction tab in OS that describes the UI

Organizing your envelope data and defining your construction in OS

1. Sources for thermal property data – ASHRAE Fundamentals 2021 Ch. 26 Table 1
2. Organize each construction's material layers with properties
   - See "envelope_data.xlsx"
   - Calculate U-value (compare with OpenStudio's auto-calculated value)
   - Each layer must contain its own thickness and material property in OS

3. Define the material in the material subtab, within the larger **Construction** Tab
   - There are several types of material to be define. In most cases, **Materials** is used to define physical opaque material (e.g. masonry, insulation, gypsum etc.)
   - Air gaps can be define separately as an **Air Gap Material** (enter RSI for the air gap - ASHRAE Fundamentals 2021 Ch. 26 Table 3
   - **No Mass Material** are used when the material has negligible thermal mass (very low density or specific heat capacity) – enter a single RSI
   - Layers for windows are defined as a **Glazing Window Material** (glass) and **Gas Window Material** (e.g. air, argon etc.)
     - **Simple Glazing System Window** is a simpler window model, requiring a only U-value and solar heat gain coefficient (SHGC). There may be significant differences compared to the window construction defined above.
   - Thermal
4. Define a construction by dragging each material layer from **My Model** and not **Library** from the menu on the right.
   - The **Library** contains default material data
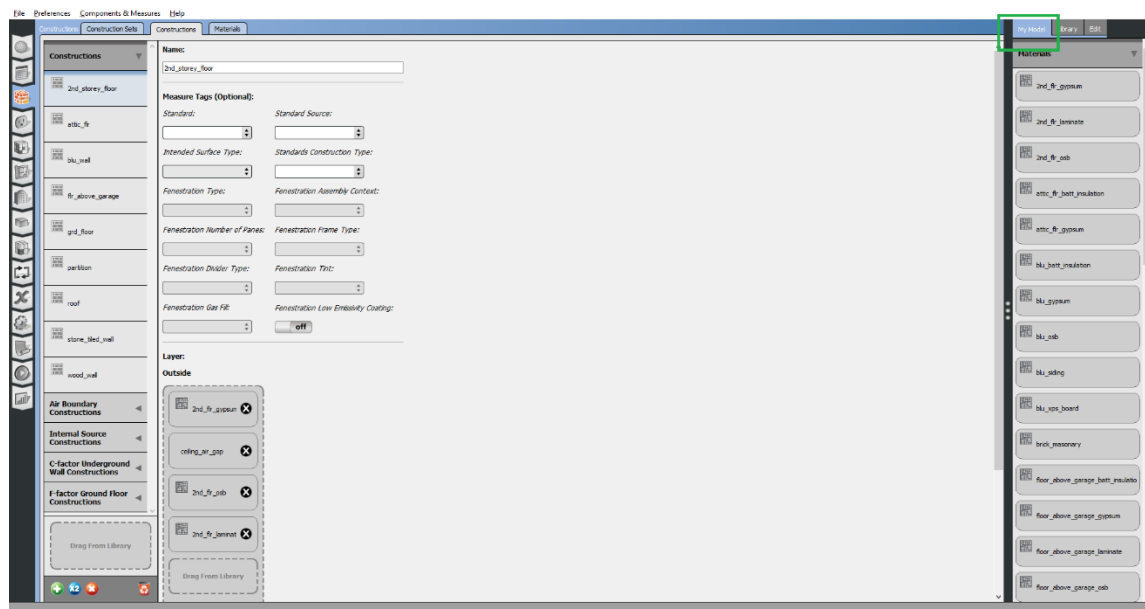   - The order of the material (outside to inside) matters

Figure 2 List of material defined by the user is located under the My Model tab on the right

Setting the construction for each surface and subsurface (fenestration)

- Construction needs to be set to each surface

- Go to the **Space** tab ⬚ and then select the **Surfaces** tab.
- Drag and drop the construction to each surface under the **My Model** tab on the menu right
  - Surfaces that have another **Surface** as the **Outside Boundary Condition** means an assembly (e.g. one zone's ceiling is the upper zone's floor) is shared and heat transfers between the zones through it.
  - The adjacent surface, as seen from the other zone, is named under the **Outside Boundary Condition Object**.
  - Setting the construction on either surface will automatically populate the same construction (with the material layers reversed) for the other. The reversed construction will show up as green (you may need to navigate away and back for it to show up in the GUI).
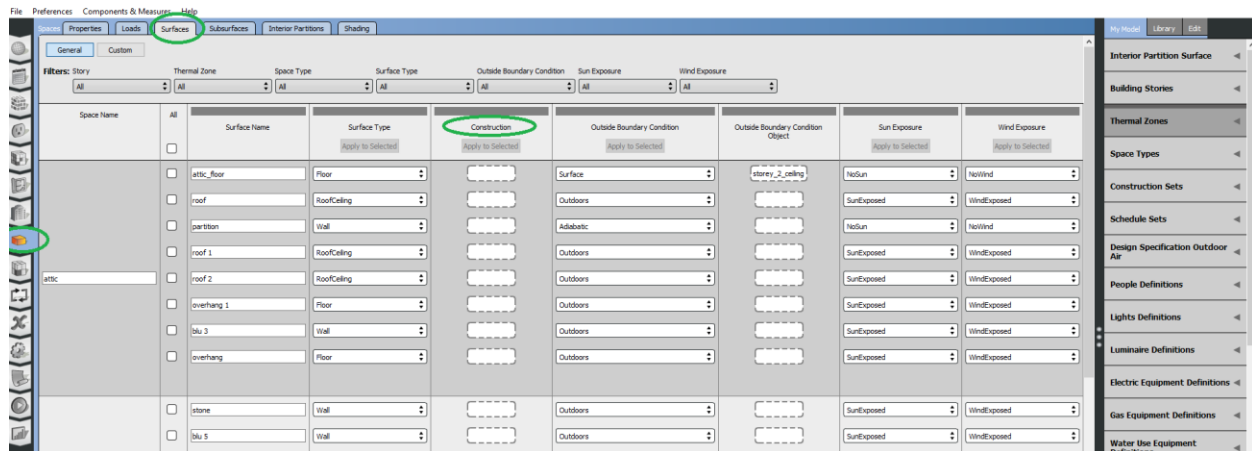
Figure 3 Where to set each surfaces' construction

- The construction of the windows and doors are set in the same manner, in the **Subsurfaces** tab, next to the **Surfaces**.
  - Apply the same construction to all windows by selecting "**All**" and unselecting the doors

References

Morrison Hershfield. (2018). Morrison-Hershfield. Retrieved from https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/power-smart/builders-developers/building-envelope-thermal-bridging-guide-v1-6.pdf