

Test Case 01 – Multiple exterior wall elements

Test Description: Often time, BIM modelers put multiple wall elements together to form an exterior wall. There are many reasons to use such technique such as creating a wall with uneven surface, or separate one layer, for instance, the exterior insulation finishes system, from the primary structure, for manufacturer quantity take-off. In these cases, the exported gbXML model should capture the multiple layers of walls and combine them into one assembly for performance analysis.

Spaces / Rooms/Surface:

There is one space in this test model named as “level_1_space_1”.

Special Considerations:

1. The model is 10’ x 10’ x 10’ (middle line), and the total wall thickness is 8”
2. There are two walls in this model, one is the primary wall that consist of interior finish, structure, and sheetrock, and the other one is the external layer. In this test case, there are two external layers, one is exterior insulation finish system (EIFS), and the other is a rain screen system.
3. All the walls face to an orientation shall be named as: “[orientation]_wall_[custom index]”
4. All the other surfaces shall be named as their function, such as “interior_wall_[custom index]”
5. The custom index is an index to differentiate the same type surfaces. The tester can decide how to label the custom index.

Table 1. Primary wall assembly details

Function	Material Name	Thickness (inches)	R (ft ² -F-hr/Btu)	Conductivity (BTU/h.ft.F)	Density (lb/ft ³)	Specific Heat (Btu/lb-F)
Exterior Side						
Air Gap	Steel Batten	1”	0.85	-	-	-
WRB	Building paper	-	-	-	-	-
Substrate	Plywood	1/2"	-	0.07	33.7	0.29
Structure	Fiber glass	4”	13	-	-	-
Finish	Gypsum board	1/2"	-	0.09	49.9	0.26
Interior Side						

Table 2. External layer - EIFS

Function	Material Name	Thickness (inches)	R (ft ² -F-hr/Btu)	Conductivity (BTU/h.ft.F)	Density (lb/ft ³)	Specific Heat (Btu/lb-F)
Exterior Side						
External Insulation	EIFS	2"	10	-	-	-
Primary wall side						

Table 3. External layer - rainscreen

Function	Material Name	Thickness (inches)	R (ft ² -F-hr/Btu)	Conductivity (BTU/h.ft.F)	Density (lb/ft ³)	Specific Heat (Btu/lb-F)
Exterior Side						
External Insulation	Fiber cement	2"	0.0	-	-	-
Primary wall side						

It should be noted that that the EIFS has 2" of extruded polystyrene (XPS), of which, its R-value is around R-10. On the other hand, the rainscreen system uses fiber cement board as the exterior façade. A typical rainscreen system has an air cavity that is open on the top and bottom parts of the façade to allow constant circulation of air. Thus, it is assumed to have 0 thermal resistance in this test case.

Guideline for creating the BIM model:

Figure 1 shows a 3-dimensional isometric view of this test model.

Figure 2 shows a typical floor plan to indicate dimensions and directions of the space, with wall thickness. The dashed line represents the profile of the shading of the roof.

Figure 3 shows a typical section view to indicate positions and dimensions of the slab floor, the height of the roof and the ceiling element.

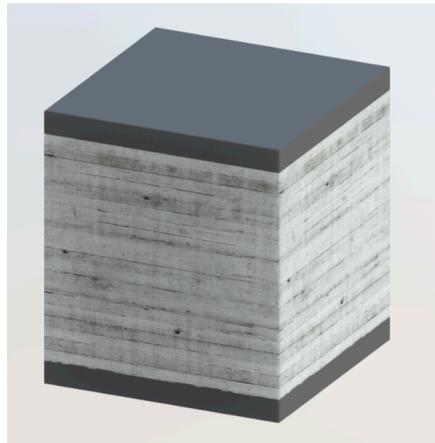


Figure 1. Isometric View

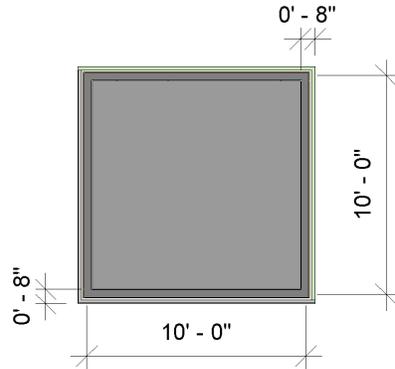


Figure 2. Floor and Ceiling Plan View

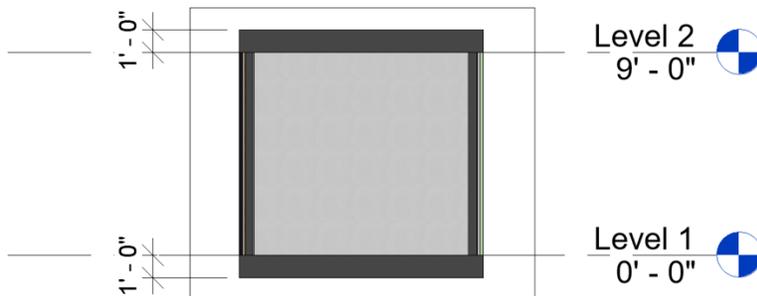


Figure 3. Section View

Expected Outcomes:

In the exported gbXML, using middle lines as the room boundary, the model should be 10'x10'x10' (Figure 4).

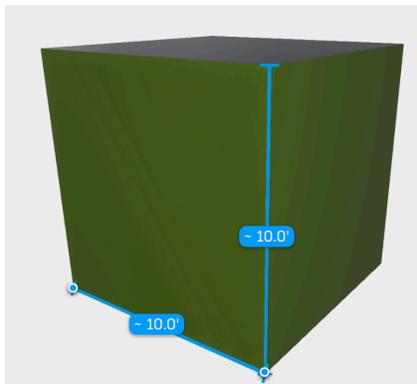


Figure 4. Exported gbXML model

For north and west walls, the wall assembly is demonstrated below. It should note that besides element ID, description and name, the properties and the order of materials have to match the script.

```
<Construction id="wall-eifs">
  <U-value unit="BtuPerHourSquareFtF">0.041667</U-value>
```

```

<Absorptance unit="Percent" type="ExtIR">0.7</Absorptance>
<LayerId layerIdRef="layer-01"></LayerId>
<Name>R-23 wall with EIFS system</Name>
<Description>2x4 studs with fiber glass and 2" EIFS with XPS</Description>
</Construction>
<Layer id="layer-01">
  <MaterialId materialIdRef="eifs"/>
  <MaterialId materialIdRef="airgap"/>
  <MaterialId materialIdRef="substrate"/>
  <MaterialId materialIdRef="structure"/>
  <MaterialId materialIdRef="finish"/>
</Layer>
<Material id="eifs">
  <Name>2" EIFS system</Name>
  <Description>exterior surface</Description>
  <R-value unit="HrSquareFtFPerBTU">10</R-value>
</Material>
<Material id="airgap">
  <Name>1" Air gap</Name>
  <Description>exterior surface</Description>
  <R-value unit="HrSquareFtFPerBTU">0.85</R-value>
</Material>
<Material id="substrate">
  <Name>1/2" Plywood</Name>
  <Description>substrate</Description>
  <Thickness unit="Inches">0.5</Thickness>
  <Conductivity unit="BtuPerHourFtF">0.07</Conductivity>
  <Density unit="LbsPerCubicFt">33.7</Density>
  <SpecificHeat unit="BTUPerLbF">0.29</SpecificHeat>
</Material>
<Material id="structure">
  <Name>3-5/8" fiber glass</Name>
  <Description>structure</Description>
  <R-value unit="HrSquareFtFPerBTU">13</R-value>
</Material>
<Material id="finish">
  <Name>3-5/8" fiber glass</Name>
  <Description>finish</Description>
  <Thickness unit="Inches">0.5</Thickness>
  <Conductivity unit="BtuPerHourFtF">0.09</Conductivity>
  <Density unit="LbsPerCubicFt">49.9</Density>
  <SpecificHeat unit="BTUPerLbF">0.26</SpecificHeat>
</Material>

```

For south and east wall, the assembly is demonstrated below. Similarly, the order of materials as well as material properties should match the script.

```

<Construction id="wall-rainscreen">
  <U-value unit="BtuPerHourSquareFtF">0.0714</U-value>
  <Absorptance unit="Percent" type="ExtIR">0.7</Absorptance>
  <LayerId layerIdRef="layer-02"></LayerId>
  <Name>R-13 wall with rainscreen system</Name>
  <Description>2x4 studs with fiber glass</Description>
</Construction>
<Layer id="layer-02">
  <MaterialId materialIdRef="airgap"/>
  <MaterialId materialIdRef="substrate"/>
  <MaterialId materialIdRef="structure"/>
  <MaterialId materialIdRef="finish"/>
</Layer>

```

Common Outcomes and Test Results:

One common issue is finding the boundary of the space. BIM software could find the external layer as the boundary, thus creates a space that is not enclosed by walls (Figure 5) or uses the internal wall as the room boundary, but translate the external layer into shades (Figure 6).

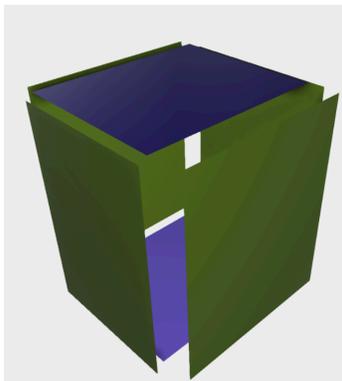


Figure 5. Common error – using external layer of exterior wall as room boundary

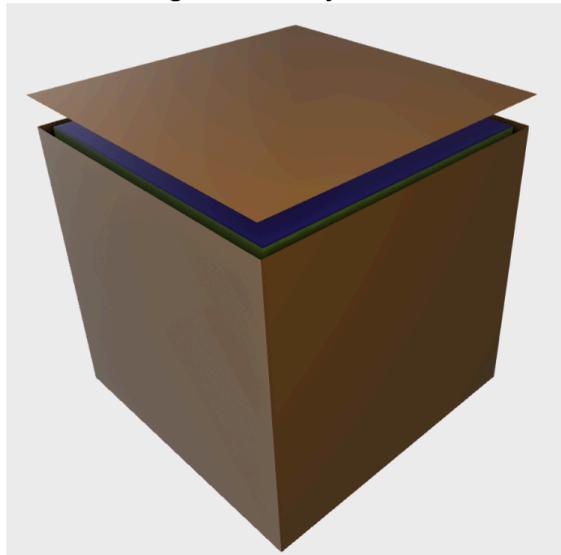


Figure 6. Common error – using internal layer of exterior wall as room boundary

Software should have capability of combine wall assemblies if both internal and external wall contains insulations. For instance, in the test case, north and west walls are combined the EIFS system with the primary structures in the exported gbXML model.