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Industrialized Housing and Buildings
Technical Bulletin

IHB TB 18-01 – Determination of the U-Factor of Wall Assemblies with Formed Steel Panels by Calculation – Commercial Buildings

Applicable Code: 2015 International Energy Conservation Code (IECC) and ASHRAE 90.1-2013, Energy Standard for Buildings Except Low-Rise Residential Buildings

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Wall assemblies constructed of interlocking formed metal panels, such as shown in the figures below, with insulation in the cavities and metal sheathing attached to the "open" side are not recognized in the common wall types of the IECC, ASHRAE 90.1, or the COMcheck energy compliance software most often used to determine the energy compliance of buildings in the modular industry. Buildings that use this type of wall assembly require the use of energy compliance software such as COMcheck to determine compliance with the energy code, and COMcheck requires the use of "*Other*" as the applicable wall type.

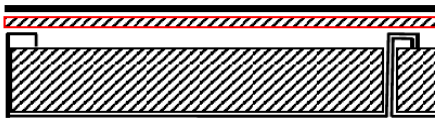

Figure 1

Figure 2

When you select "*Other*" as the wall type in COMcheck, you must enter the overall U-factor of the above-grade wall assembly. The U-factor of the assembly can be determined by testing or calculations in accordance with the 2015 IECC, the ASHRAE *Fundamentals Handbook*, or the appendices of the 2013 ASHRAE 90.1. The method of justification of the U-factor, whether by testing or calculations, must be included in the approved documents. This bulletin will discuss one method to determine the U-factor of the assembly through calculations.

Both the IECC and ASHRAE 90.1 have methods of calculating the U-factor of wall assemblies with steel studs that require the use of the "Effective" R-value of the insulation in the cavities. You cannot use the actual R-Value of the insulation in the cavity because of its proximity to the steel studs; therefore, you must apply a correction factor to the actual insulation R-value.

The U-factor of the assembly is calculated using the following basic equation from Section C402.1.4.1 of the 2015 IECC:

$U = 1/[R_s + (ER)]$

R_s is the cumulative R-value of the wall components along the path of heat transfer, excluding the cavity insulation and steel studs (formed steel panels).

ER is the effective R-value of the cavity insulation with steel studs (formed steel panels).

In addition to the method described in Section C402.1.4.1 of the IECC and Appendix A of ASHRAE 90.1, the U-Factor of the wall assembly may also be calculated using methods described in the "*Thermal Design and Code Compliance for Cold-Formed Steel Walls*" design guide (*Thermal Design Guide*), 2015 Edition. *ASHRAE Fundamentals Handbook* or Appendix A of ASHRAE 90.1 should be used to determine the R-value of other elements of the wall assembly such as the sheathing materials. Manufacturer's specifications should be used for the R-Value of all insulation used in the assembly.

The examples below are based on a wall assembly that consists of the following:

- Exterior interlocking wall panel of formed metal (see Figure 2 above for example), 3.75" stud depth, 16" width – R-Value = 0 (Value obtained from *ASHRAE Fundamentals Handbook*)
- 3.5" thick batt insulation in the wall cavity – R-Value = 15 (Value obtained from manufacturer's specifications)
- 2" thick continuous foam plastic insulation board attached to the formed rib/leg of the panel – R-Value = 13 (Value obtained from manufacturer's specifications)
- Interior metal panel attached through the continuous insulation to the formed rib/leg of the interlocking panel – R-Value = 0 (Value obtained from *ASHRAE Fundamentals Handbook*)

Example 1 – Based on Section C402.1.4.1 of the 2015 IECC

R_s = 13, R-value of continuous insulation

R = 15, R-value of cavity insulation

ER = 6.45, R-value from Table C402.1.4.1 of the IECC

$U = 1/[R_s + (ER)] = 1/[13 + 6.45] = .051$

Example 2 – Based on the "Thermal Design Guide"

This calculation uses the *Path Correction Calculation Method* described in the "*Thermal Design Guide*." Equation 1 in the Design Guide is as follows:

$U_w = 1/[R_s + (R_{ins} \text{ X } F_c)]$

U_w is the U-Factor of the wall assembly

R_s is the R-Value of all elements in the path through the wall cavity excluding the framing and the cavity insulation

R_{ins} is the R-Value of the cavity insulation

F_c is the correction factor from Table 3 of the "*Thermal Design Guide*"

R_s = 13, R-value of continuous insulation

R_{ins} = 15 + 0.68 = 15.68, where 0.68 is the R-Value of the interior air film for the air space that is created when there is an air gap between the wall cavity insulation and the continuous insulation, value obtained from ASHRAE 90.1 - 2013 (the cavity is not completely filled by the insulation)

F_c = 0.43 from Table 3 in the "Thermal Design Guide"

$U = 1/[R_s + (R_{ins} \text{ X } F_c)] = 1/[13 + (15.68*0.43)] = 0.051$

DON'T FORGET THE FOLLOWING:

Foam plastic insulation must be separated from the interior of the building by a 15-minute thermal barrier (equivalent to ½" gypsum board) unless there is a listing on the foam board that specifically shows the thermal barrier is not required.