Stronghold ICF

Thermal Resistance Calculations

12/22/2020 Rev 0

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Revision History

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1 INTRODUCTION

This report summarizes calculations of the effective thermal resistance of Stronghold Insulated Concrete Form (ICF) assemblies. The calculations are carried out in accordance with ASHRAE Handbook Fundamentals, and are appropriate for use with ASHRAE Standard 90.1, National Energy Code for Buildings (NECB), International Energy Conservation Code (IECC) and any other North American building codes which are aligned with methodologies outlined in ASHRAE Handbook Fundamentals.

The analysis in this report is of the Stronghold ICF FX and KD Series Block.

1.1 References

This report references the following documents.

1. ASHRAE Handbook Fundamentals 2013 (ASHRAE Fundamentals)
2. ASHRAE 90.1-2016
3. ASTM C 578
4. Building Envelope Thermal Bridging Guide

2 METHODOLOGY

The effective thermal resistances of Stronghold Insulated Concrete Forms (ICFs) are calculated using layer by layer methodology, including air films, as per ASHRAE Handbook Fundamentals.

Table 1. Air Films

Air Films	Resistance *R* (h·ft²·°F/Btu)	Reference
Exterior air film (winter)	0.17	ASHRAE Fundamentals Chapter 26 Table 10
Interior air film, vertical	0.68	ASHRAE Fundamentals Chapter 26 Table 10

Table 2. Materials

Material	Thermal Conductivity k (Btu·in/h·ft²·°F)	Reference
Type II Expanded Polystyrene	0.17	ASTM C 578
Concrete (generic)	16.0	ASHRAE 90.1-2016 Table A9.4.4-1
Fiber Cement board	1.7	ASHRAE Fundamentals Chapter 26 Table 1
Gypsum Board	1.1	ASHRAE Fundamentals Chapter 26 Table 1
Wester Red Cedar	0.86	ASHRAE Fundamentals 2013 Chapter 26 Table 1
Cement and Sand Plaster	5	ASHRAE Fundamentals 2013 Chapter 26 Table 1
EIFS Finish	6	Building Envelope Thermal Bridging Guide

3 RESULTS SUMMARY

A summary of the results is shown below, for detailed calculations and descriptions see section 4.

Table 3. Summary of Total Resistances

Assembly	Total Assembly Resistance *R* (h·ft²·°F/Btu)
4" Concrete Core, 2.75" EPS inside and outside	23.1
6" Concrete Core, 2.75" EPS inside and outside	23.2
8" Concrete Core, 2.75" EPS inside and outside	23.4
10" Concrete Core, 2.75" EPS inside and outside	23.5
12" Concrete Core, 2.75" EPS inside and outside	23.6

Table 4. Summary of Total Resistances – Finished and Clad Assemblies

Assembly	Total Assembly Resistance *R* (h·ft²·°F/Btu)
8" Concrete, 2.75" EPS inside and outside, 1/2" Interior Drywall, 3/8" Exterior Fiber-Cement Board	24.3
8" Concrete, 2.75" EPS inside and outside, 1/2" Interior Drywall, 1/2" Exterior Cedar Board	24.5
8" Concrete, 2.75" EPS inside and outside, 1/2" Interior Drywall, R2.0 Exterior Insulated Lap Siding	26.1
8" Concrete, 2.75" EPS inside and outside, 1/2" Interior Drywall, 1/8" Exterior Stucco	24.1
8" Concrete, 2.75" EPS inside and outside, 1/2" Interior Drywall, 1/8" EIFS	24.1

4 CALCULATIONS

4.1 Base Assemblies

The following assemblies are of the ICF product and concrete alone, without accounting for any cladding or interior finishing.

Table 5. 4 Inch Concrete

Layer	Thermal Conductivity *k* (Btu·in/h·ft²·°F)	Thickness (in)	Resistance *R* (h·ft²·°F/Btu)
Exterior air film (winter)			0.17
Type II Expanded Polystyrene	0.25	2.75	11.00
Concrete	16.0	4.00	0.25
Type II Expanded Polystyrene	0.25	2.75	11.00
Interior Air film, vertical			0.68
		Total	23.1

Table 6. 6 Inch Concrete

Layer	Thermal Conductivity *k* (Btu·in/h·ft²·°F)	Thickness (in)	Resistance *R* (h·ft²·°F/Btu)
Exterior air film (winter)			0.17
Type II Expanded Polystyrene	0.25	2.75	11.00
Concrete	16.0	6.00	0.38
Type II Expanded Polystyrene	0.25	2.75	11.00
Interior Air film, vertical			0.68
		Total	23.2

Table 7. 8 Inch Concrete

Layer	Thermal Conductivity *k* (Btu·in/h·ft²·°F)	Thickness (in)	Resistance *R* (h·ft²·°F/Btu)
Exterior air film (winter)			0.17
Type II Expanded Polystyrene	0.25	2.75	11.00
Concrete	16.0	8.00	0.50
Type II Expanded Polystyrene	0.25	2.75	11.00
Interior Air film, vertical			0.68
		Total	23.4

Table 8. 10 Inch Concrete

Layer	Thermal Conductivity *k* (Btu·in/h·ft²·°F)	Thickness (in)	Resistance *R* (h·ft²·°F/Btu)
Exterior air film (winter)			0.17
Type II Expanded Polystyrene	0.25	2.75	11.00
Concrete	16.0	10.00	0.63
Type II Expanded Polystyrene	0.25	2.75	11.00
Interior Air film, vertical			0.68
		Total	23.5

Table 9. 12 Inch Concrete

Layer	Thermal Conductivity *k* (Btu·in/h·ft²·°F)	Thickness (in)	Resistance *R* (h·ft²·°F/Btu)
Exterior air film (winter)			0.17
Type II Expanded Polystyrene	0.25	2.75	11.00
Concrete	16.0	12.00	0.75
Type II Expanded Polystyrene	0.25	2.75	11.00
Interior Air film, vertical			0.68
		Total	23.6

4.2 Clad and Finished Assemblies

The following assemblies are examples of total effective R value as calculated to include common examples of interior finishing and exterior cladding, all applied to the 8" concrete version of the product.

Table 10. 8" Concrete with Gypsum and Fiber Cement Board

Layer	Thermal Conductivity *k* (Btu·in/h·ft²·°F)	Thickness (in)	Resistance *R* (h·ft²·°F/Btu)
Exterior air film (winter)			0.17
3/8" Fiber cement Board	1.7	0.375	0.22
Type II Expanded Polystyrene	0.25	2.75	11.00
Concrete	16.0	12.00	0.75
Type II Expanded Polystyrene	0.25	2.75	11.00
1/2" Gypsum Board	1.1	0.5	0.45
Interior Air film, vertical			0.68
		Total	24.3

Table 11. 8" Concrete with Gypsum and Cedar Board

Layer	Thermal Conductivity *k* (Btu·in/h·ft²·°F)	Thickness (in)	Resistance *R* (h·ft²·°F/Btu)
Exterior air film (winter)			0.17
1/2" Cedar Board	0.86	0.375	0.44
Type II Expanded Polystyrene	0.25	2.75	11.00
Concrete	16.0	12.00	0.75
Type II Expanded Polystyrene	0.25	2.75	11.00
1/2" Gypsum Board	1.1	0.5	0.45
Interior Air film, vertical			0.68
		Total	24.5

Table 12. 8" Concrete with Gypsum and Insulated Cladding

Layer	Thermal Conductivity *k* (Btu·in/h·ft²·°F)	Thickness (in)	Resistance *R* (h·ft²·°F/Btu)
Exterior air film (winter)			0.17
Insulated Lap Siding (R2.0)			2.00
Type II Expanded Polystyrene	0.25	2.75	11.00
Concrete	16.0	12.00	0.75
Type II Expanded Polystyrene	0.25	2.75	11.00
1/2" Gypsum Board	1.1	0.5	0.45
Interior Air film, vertical			0.68
		Total	**26.1**

Table 13. 8" Concrete with Gypsum and Stucco

Layer	Thermal Conductivity *k* (Btu·in/h·ft²·°F)	Thickness (in)	Resistance *R* (h·ft²·°F/Btu)
Exterior air film (winter)			0.17
Cement and Sand Plaster (Stucco)	5	0.125	0.03
Type II Expanded Polystyrene	0.25	2.75	11.00
Concrete	16.0	12.00	0.75
Type II Expanded Polystyrene	0.25	2.75	11.00
1/2" Gypsum Board	1.1	0.5	0.45
Interior Air film, vertical			0.68
		Total	**24.1**

Table 14. 8" Concrete with Gypsum and EIFS

Layer	Thermal Conductivity *k* (Btu·in/h·ft²·°F)	Thickness (in)	Resistance *R* (h·ft²·°F/Btu)
Exterior air film (winter)			0.17
EIFS	6	0.125	0.02
Type II Expanded Polystyrene	0.25	2.75	11.00
Concrete	16.0	12.00	0.75
Type II Expanded Polystyrene	0.25	2.75	11.00
1/2" Gypsum Board	1.1	0.5	0.45
Interior Air film, vertical			0.68
		Total	**24.1**

5 CLOSING

The Stronghold Insulated Concrete forms have effective thermal resistances as summarized in section 4. Performance values are theoretical based on best practices and ASHRAE Handbook Fundamentals. Actual performance may vary with concrete mix and installation.

Sincerely,

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