



Thermal Catalog of Concrete Masonry Assemblies



National Concrete Masonry Association
FOUNDATION

FOREWORD

NCMA promotes the use of concrete masonry in part through the development and dissemination of technical information. This catalog is intended as a guide for architects, engineers and building code officials.

The material presented does not cover all possible situations, but is intended to represent some of the more widely used concrete masonry constructions. The values provided are steady-state only (i.e., R-values); and do not take into account concrete masonry's thermal mass contributions that often offer additional efficiencies for specific projects and climate zones. Care has been taken to ensure that the information included in this catalog is as accurate as possible. However, NCMA does not assume responsibility for errors or omissions resulting from the use of this catalog or in the preparation of plans or specifications. Additionally, information contained herein may not conform to local building code requirements and should therefore be reviewed carefully to ensure compliance.

All photographs, illustrations and other graphic representations published in this catalog are the property of NCMA unless otherwise noted.

Table of Contents

Introduction to the Catalog	1
Single Wythe Concrete Masonry Assembly R-Values	4
Concrete Masonry Cavity Assembly R-Values	17
Appendix A—Thermal Data Used to Develop Tables	26
Appendix B—Metric Conversions	27
Appendix C—References	27

COPYRIGHT

Copyright 2010 National Concrete Masonry Association
ISBN 1-881384-23-3
NCMA Publication Number TR 233

NCMA ENGINEERING STAFF

Jason J. Thompson, Director of Engineering
Dennis W. Graber, Director of Technical Publications
Nicholas R. Lang, Manager, Research & Development Laboratory
Gabriela Mariscal, Geotechnical Engineer

National Concrete Masonry Association
13750 Sunrise Valley Drive
Herndon, VA 20171
www.ncma.org

Printed in the United States of America

INTRODUCTION

Today's buildings are being designed in a changing environment with regard to energy efficiency. From a recent past of very basic energy requirements, a new generation of energy codes has evolved, as have more comprehensive programs that include building energy efficiency as only part of the larger design goal of sustainability.

Masonry, an ancient material, can provide significant benefits to modern sustainable buildings. In addition to its energy efficiency, concrete masonry is a locally-produced, natural material that is durable and long-lived, minimizing the need for repair or replacement. Concrete masonry can incorporate recycled materials, and can itself be reused or recycled at the end of its life. Various architectural finishes are available that can eliminate the need for paint or other coatings, the addition of which can impair indoor air quality.

Whether your building project is being designed to maximize sustainability or to meet the current energy code requirements as economically as possible, concrete masonry construction can fulfill the project's energy efficiency requirements, while also providing superior structural capacity, durability, and resistance to fire, sound transmission, insects and mold.

1. Concrete Masonry Thermal Performance

Although this catalog presents a compendium of concrete masonry assembly R-values, it is important to note that R-values alone do not fully describe the thermal performance of a concrete masonry assembly. Concrete masonry's thermal performance depends on its steady-state thermal characteristics (described by R-value or U-factor) as well as the thermal mass (heat capacity) characteristics of the assembly. The steady state and mass performance are influenced by the size and type of masonry

unit, type and location of insulation, finish materials, density of masonry, climate, and building orientation and exposure conditions.

Thermal mass describes the ability of materials to store heat. Because of its comparatively high density and specific heat, masonry provides very effective thermal storage. Masonry walls remain warm or cool long after the heat or air-conditioning has shut off. This, in turn, effectively reduces heating and cooling loads, moderates indoor temperature swings, and shifts heating and cooling loads to off-peak hours. Due to the significant benefits of concrete masonry's inherent thermal mass, concrete masonry buildings can provide similar energy performance to more heavily insulated frame buildings.

The benefits of thermal mass have been incorporated into energy code requirements as well as sophisticated computer models. Energy codes and standards such as the *International Energy Conservation Code (IECC)* (ref. 1) and *Energy Efficient Standard for Buildings Except Low-Rise Residential Buildings*, ASHRAE/IESNA Standard 90.1 (ref. 2), permit concrete masonry assemblies to have less insulation than frame systems to meet the energy requirements, due to their thermal mass.

Although the thermal mass and inherent R-value/U-factor of concrete masonry may be enough to meet energy code requirements (particularly in warmer climates), concrete masonry assemblies often require additional insulation, particularly when designed under more contemporary building code requirements. When they do, there are many options available for insulating concrete masonry construction.

Although in general higher R-values reduce heat flow through a building element, R-values have a diminishing impact on the overall building envelope energy use. In other words, it's important not to automatically equate higher

R-value with improved energy efficiency. As an example, consider a two-story elementary school in Bowling Green, Kentucky. If this school is built using single wythe concrete masonry walls with core insulation only and a wall R-value of 7 hrft²°F/Btu, a simplistic estimate of the building envelope energy use for this structure is 27,800 Btu/ft². If we replace that wall with an R14 wall while holding the other envelope variables constant, the building envelope energy use drops by only 2.5%, which is not in proportion to doubling the wall R-value. Figure 1 illustrates this trend: as wall R-value increases, it has less and less impact on the building envelope performance. In this example, a wall R-value larger than about R12 no longer has a significant impact on the envelope energy use. At this point, it makes more sense to invest in energy efficiency measures other than wall insulation.

When required, concrete masonry can provide assemblies with R-values that exceed code minimums. For overall project economy, however, the industry suggests a parametric analysis to determine reasonable insulation levels.

2. Scope of the Catalog

This *Thermal Catalog of Concrete Masonry Assemblies* presents tabulated R-values of some common concrete masonry constructions. Because of concrete masonry's inherent design flexibility, the assemblies presented are not all-inclusive, but are intended to

represent a wide range of common concrete masonry wall designs.

Each page of the *Catalog* addresses a particular assembly and includes brief notes on the features of that construction and a Table of R-values for 6-in., 8-in., 10-in. and 12-in. concrete masonry units of various concrete densities and with various types and amounts of insulation. The basis and assumptions used to determine these R-values are described in the following section.

Tabulated R-values include ungrouted walls, lightly reinforced walls, heavily reinforced walls and fully grouted walls. "Lightly reinforced," as used in this *Catalog*, refers to reinforcement and grout at 8 ft on center both vertically and horizontally, which is approximately the same amount of grouted cores as vertical reinforcement only at 48 in. o.c. "Heavily reinforced" refers to reinforcement and grout at 32 in. on center vertically and 48 in. on center horizontally, which is approximately the same amount of grout as vertical reinforcement only at 24 in. o.c. Other reinforcement schedules can be calculated using the information in [TEK 6-2B, R-Values and U-Factors of Single Wythe Concrete Masonry Walls](#) (ref. 3).

The grouting of hollow cells primarily impacts concrete masonry R-values when core insulation is used (Assemblies 1 and 2 in this *Catalog*), because the grout displaces some of the wall insulation. Some rigid insulation inserts, however, are configured to accommodate reinforcing steel and grout in the same cell to maintain a more continuous insulation layer when core insulation is used.

This *Catalog* is intended as a tool to determine R-values for energy analysis and/or code compliance, although the tables do not indicate whether a particular assembly meets a particular energy code. More detailed information on concrete masonry energy code compliance is included in Section 4 below.

3. Basis of the Thermal Catalog R-Values

The R-values listed in the following tables were determined by calculation using the series-parallel (also called isothermal planes) calculation method (refs. 4, 5). The method accounts for the thermal bridging that occurs through the webs of concrete masonry units. The method is fully described in [TEK 6-1B, R-Values of Multi-Wythe Concrete Masonry Walls](#) (ref. 6).

Thermal values for concrete masonry assemblies are correlated to density because the thermal conductivity of concrete increases with increasing concrete density. For each unit density listed in the following tables, a range of thermal conductivities may exist based on variations in factors such as aggregate type(s), concrete mix design or moisture content. The values in the following tables represent the middle of the range, based on a compendium of historical data on thermal conductivity of concrete (refs. 4, 5). Locally available products and local conditions may result in values that differ from those presented here.

Although the R-values are based on typical 8-in. high concrete masonry units, 4-in. high units ("half-high" units) are also widely available and other heights may be available in some markets. Because the wall R-values vary so little with different unit heights, the following tables can be considered to also apply to units heights other than 8 in.

The calculations include the effects of mortar and grout, when used, as well as surface air film resistances. Thermal data for these and other included materials are listed in Appendix A.

4. Energy Performance Goals for Concrete Masonry Assemblies

Today's buildings have varied energy efficiency goals. Programs such as LEED and Green Globes make it easier for designers to integrate sustainability throughout the design and produce a comprehensively "green" building. For these projects, the energy efficiency goal for the building envelope is often to minimize energy use. Another approach is taken on projects where economy is the top priority. For these buildings, the design goal

is to meet the current energy code requirements as economically as possible. Between the two are a range of building types and design goals that could be met.

For buildings using LEED or other sustainability incentive programs, the R-values listed in this catalog can be used in computer programs such as EnergyPlus, DOE-2 or BLAST to develop an estimate of energy use for the building under consideration.

If the project goal is to meet, rather than exceed, the energy code requirements, most codes allow any one of three methods to be used to show compliance: prescriptive, trade-off or system performance, and whole building energy analysis. The project need only comply under one of these methods, not all three.

Of the three compliance methods, the prescriptive method is the easiest to apply and perhaps the most well-recognized. Requirements for building envelope components are listed in table format, with requirements listed separately for each component and climate zone. In the case of the *International Energy Conservation Code* (IECC), prescriptive requirements are listed as either a maximum U-factor of the overall wall (U-factor is simply the inverse of R-value, i.e., $U = 1/R$) or as a minimum R-value of continuous insulation.

The IECC prescriptive R-value table calls for "continuous insulation" on concrete masonry and other mass walls. This refers to insulation uninterrupted by furring or by the webs of concrete masonry units. Examples include rigid insulation adhered to the interior of the wall with furring and drywall applied over the insulation, continuous insulation in a masonry cavity wall, and exterior insulation and finish systems. Assemblies 3, 4, 5, 8, 9 and 10 in this *Catalog* have continuous insulation.

If the concrete masonry assembly will not include continuous insulation, there are several other options to comply with the IECC requirements—concrete masonry assemblies are not required to have continuous insulation in order to meet the IECC, regardless of climate zone.

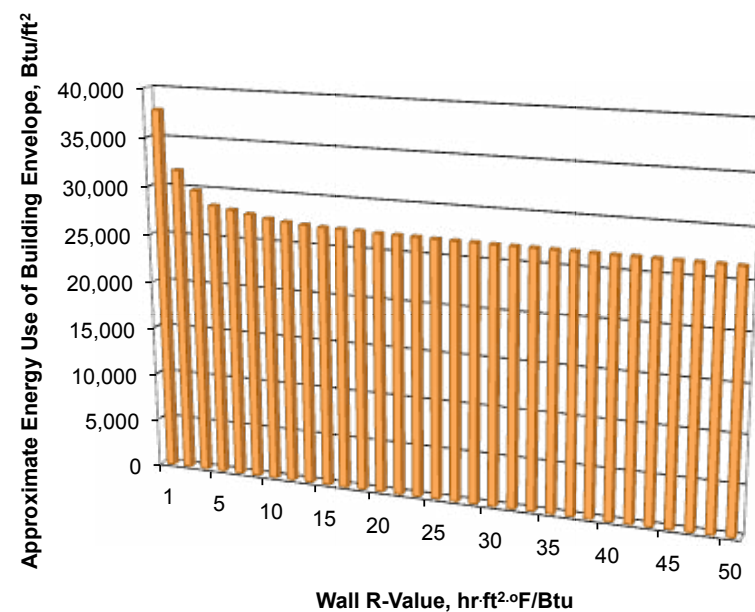


Figure 1:
Diminishing
Returns of
Added Wall
Insulation

**SINGLE WYTHE CONCRETE MASONRY ASSEMBLIES
R-VALUE TABLES**

Single wythe concrete masonry assemblies are often constructed of hollow units with cores filled with insulation and/or grout. Hence, single wythe assemblies allow insulation and reinforcement to be used to increase thermal and structural performance, respectively, without increasing the wall thickness.

Masonry core insulation is typically molded polystyrene inserts, foams, or, less frequently, expanded perlite or vermiculite granular fills. The thermal resistance of the concrete masonry webs and any grouted cores are accounted for when determining the assembly R-values. When using core insulation, the insulation should occupy all ungrouted core spaces (although some rigid inserts are configured to accommodate insulation, reinforcing steel and grout in the same cell).

Single wythe construction also provides the options of installing insulation on either the exterior or interior of the masonry. The insulation may be rigid board (extruded or expanded polystyrene or polyisocyanurate), closed-cell spray polyurethane foam, cellular glass, fibrous batt, or fibrous blown-in insulation (note, however, that fibrous insulation is susceptible to moisture).

When an interior finish is included in the following tables, that finish is assumed to be 1/2 in. gypsum wallboard on steel or wood furring. Other interior finish materials are available, including paneling, plaster and adhered masonry veneer, among others.

Changing the interior finish materials does not typically change the overall assembly R-value significantly, unless the finish material itself is insulative. For finish materials installed on furring, such as wood paneling, the R-value tables for gypsum wallboard on furring can be used as a very close approximation. For finishes applied directly to the concrete masonry, such as an adhered mason-

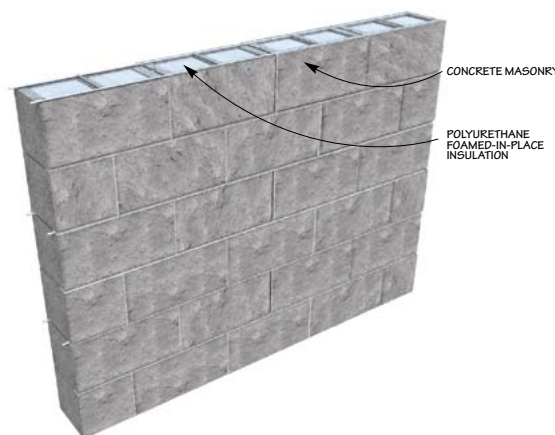
ry veneer or plaster, R-values of assemblies without an interior finish should be used.

When using interior or exterior insulation, concrete masonry can accommodate both vertical and horizontal reinforcement with partial or full grouting without interrupting the insulation layer.

Exterior-insulated masonry assemblies provide a continuous exterior insulation layer that envelops the masonry, minimizing the effect of thermal bridges. This also places the thermal mass inside the insulation layer, keeping the masonry directly in contact with the interior conditioned air and maximizing the thermal mass benefit.

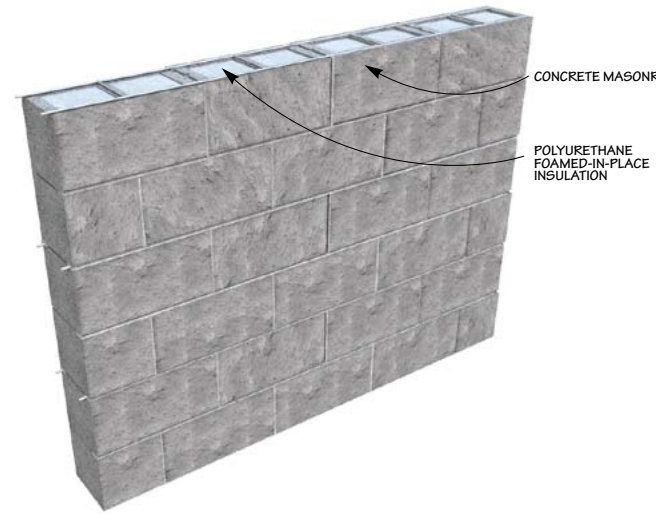
Exterior insulation can also reduce heat loss and moisture movement due to air leakage when joints between the insulation boards are sealed. Exterior insulation negates the aesthetic advantage of exposed masonry, however. In addition, the insulation requires a protective finish to maintain the durability, integrity, and effectiveness of the insulation.

When concrete masonry is used as infill in a structural concrete or steel frame, the R-value of the concrete masonry portion of the wall may be obtained from the following tables. This is then combined with the thermal performance of the framing material to determine the overall wall R-value or U-factor.



Single Wythe Concrete Masonry Assemblies: Core Insulation

Assembly 1: Polyurethane foamed-in-place insulation in ungrouted cores, exposed masonry (interior and exterior)



- Masonry exposed on both the interior and exterior provides maximum durability.
- Values in table assume no insulation in grouted cores. Note that some rigid inserts are configured to accommodate insulation, reinforcing steel and grout in the same cell, significantly improving R-values.
- Other masonry core insulations include molded polystyrene inserts, and expanded perlite or vermiculite granular fills.
- Core insulation allows some of the thermal mass (masonry) to be in direct contact with the indoor air, providing excellent thermal mass benefits.
- Insulation should occupy all ungrouted cores.
- “Lightly reinforced” = grout 8 ft o.c. both vertically and horizontally (vertical reinforcement only at approximately 48 in. o.c.). “Heavily reinforced” = grout 32 in. o.c. vertically and 48 in. o.c. horizontally (vertical reinforcement only at approximately 24 in. o.c.).

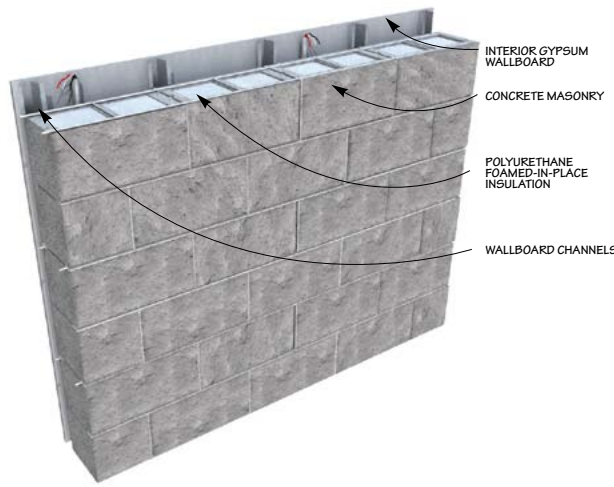
Concrete Masonry Assembly R-Values, hrft²·F/Btu

Density of CMU, pcf	6-in. Concrete Masonry				8-in. Concrete Masonry			
	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted
85	5.9	4.2	3.0	1.7	7.9	5.3	3.7	1.9
95	5.0	3.7	2.8	1.6	6.7	4.6	3.3	1.8
105	4.2	3.3	2.5	1.5	5.6	4.1	3.0	1.7
115	3.6	2.9	2.3	1.4	4.7	3.6	2.7	1.6
125	3.1	2.6	2.1	1.4	4.0	3.2	2.5	1.5
135	2.6	2.3	1.9	1.3	3.4	2.8	2.3	1.5

Density of CMU, pcf	10-in. Concrete Masonry				12-in. Concrete Masonry			
	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted
85	9.6	6.1	4.1	2.1	11.9	7.1	4.6	2.3
95	8.1	5.4	3.8	2.0	9.9	6.3	4.2	2.1
105	6.7	4.7	3.4	1.9	8.2	5.5	3.9	2.0
115	5.6	4.2	3.1	1.8	6.8	4.9	3.5	1.9
125	4.7	3.6	2.8	1.7	5.7	4.3	3.2	1.9
135	4.4	3.5	2.7	1.6	4.7	3.7	2.9	1.8

Single Wythe Concrete Masonry Assemblies: Core Insulation

Assembly 2: Polyurethane foamed-in-place insulation in ungrouted cores, exposed exterior masonry, 1/2 in. gypsum wallboard on furring on interior



- Interior furring allows for electrical rough-in.
- Values in table assume no insulation in grouted cores. Note that some rigid inserts are configured to accommodate insulation, reinforcing steel and grout in the same cell, significantly improving R-values.
- Other masonry core insulations include molded polystyrene inserts, and expanded perlite or vermiculite granular fills.
- Core insulation allows some of the thermal mass (masonry) to be in direct contact with the indoor air, providing excellent thermal mass benefits.
- Insulation should occupy all ungrouted cores.
- “Lightly reinforced” = grout 8 ft o.c. both vertically and horizontally (vertical reinforcement only at approximately 48 in. o.c.). “Heavily reinforced” = grout 32 in. o.c. vertically and 48 in. o.c. horizontally (vertical reinforcement only at approximately 24 in. o.c.).

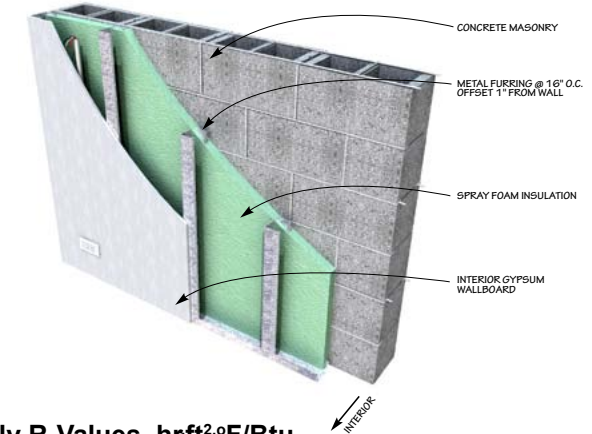
Concrete Masonry Assembly R-Values, hrft²·F/Btu

Density of CMU, pcf	6-in. Concrete Masonry				8-in. Concrete Masonry			
	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted
85	7.3	5.6	4.4	3.1	9.3	6.7	5.1	3.3
95	6.4	5.1	4.2	3.0	8.1	6.0	4.7	3.2
105	5.6	4.7	3.9	2.9	7.0	5.5	4.4	3.1
115	5.0	4.3	3.7	2.8	6.1	5.0	4.1	3.0
125	4.5	4.0	3.5	2.8	5.4	4.6	3.9	2.9
135	4.0	3.7	3.3	2.7	4.8	4.2	3.7	2.9

Density of CMU, pcf	10-in. Concrete Masonry				12-in. Concrete Masonry			
	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted
85	11.0	7.5	5.5	3.5	13.3	8.5	6.0	3.7
95	9.5	6.8	5.2	3.4	11.3	7.7	5.6	3.5
105	8.1	6.1	4.8	3.3	9.6	6.9	5.3	3.4
115	7.0	5.6	4.5	3.2	8.2	6.3	4.9	3.3
125	6.1	5.0	4.2	3.1	7.1	5.7	4.6	3.3
135	5.8	4.9	4.1	3.0	6.1	5.1	4.3	3.2

Single Wythe Concrete Masonry Assemblies: Interior Insulation

Assembly 3: 1-in. continuous closed-cell spray polyurethane foam (SPF) interior insulation, metal furring with additional SPF insulation between the furring, and 1/2 in. gypsum wallboard on interior, exposed exterior masonry



- Interior furring allows for electrical rough-in.
- Reinforcement and grouting schedule has little effect on assembly R-values.
- Interior insulation reduces the benefits of thermal mass.
- “Lightly reinforced” = grout 8 ft o.c. both vertically and horizontally (vertical reinforcement only at approximately 48 in. o.c.). “Heavily reinforced” = grout 32 in. o.c. vertically and 48 in. o.c. horizontally (vertical reinforcement only at approximately 24 in. o.c.).

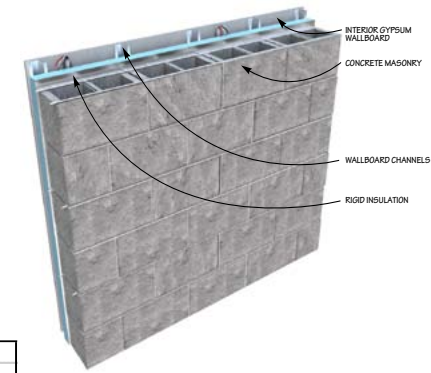
Concrete Masonry Assembly R-Values, hrft²·F/Btu

Thickness of SPF insulation between furring:	Density of CMU, pcf	6-in. Concrete Masonry				8-in. Concrete Masonry			
		UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted
1 in.	85	12.9	12.8	12.6	12.3	13.1	13.0	12.8	12.5
	95	12.8	12.6	12.5	12.2	12.9	12.8	12.7	12.4
	105	12.7	12.5	12.4	12.1	12.8	12.7	12.6	12.3
	115	12.5	12.4	12.3	12.0	12.7	12.6	12.5	12.2
	125	12.4	12.3	12.2	12.0	12.6	12.5	12.4	12.1
2 in.	85	13.8	13.7	13.5	13.2	14.0	13.9	13.7	13.4
	95	13.7	13.5	13.4	13.1	13.8	13.7	13.6	13.3
	105	13.6	13.4	13.3	13.0	13.7	13.6	13.5	13.2
	115	13.4	13.3	13.2	12.9	13.6	13.5	13.4	13.1
	125	13.3	13.2	13.1	12.9	13.5	13.4	13.3	13.0
3 in.	85	14.3	14.2	14.0	13.7	14.5	14.4	14.2	13.9
	95	14.2	14.0	13.9	13.6	14.3	14.2	14.1	13.8
	105	14.1	13.9	13.8	13.5	14.2	14.1	14.0	13.7
	115	13.9	13.8	13.7	13.4	14.1	14.0	13.9	13.6
	125	13.8	13.7	13.6	13.4	14.0	13.9	13.8	13.5
3 1/2 in.	85	14.5	14.4	14.2	13.9	14.7	14.6	14.4	14.1
	95	14.4	14.2	14.1	13.8	14.5	14.4	14.3	14.0
	105	14.3	14.1	14.0	13.7	14.4	14.3	14.2	13.9
	115	14.1	14.0	13.9	13.6	14.3	14.2	14.1	13.8
	125	14.0	13.9	13.8	13.6	14.2	14.1	14.0	13.7

Thickness of SPF insulation between furring:	Density of CMU, pcf	10-in. Concrete Masonry				12-in. Concrete Masonry			
		UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted
1 in.	85	13.1	13.1	13.0	12.7	13.2	13.1	13.0	12.9
	95	13.0	12.9	12.8	12.6	13.0	13.0	12.9	12.7
	105	12.9	12.8	12.7	12.5	12.9	12.9	12.8	12.6
	115	12.8	12.7	12.6	12.4	12.8	12.8	12.7	12.5
	125	12.6	12.6	12.5	12.3	12.7	12.7	12.6	12.5
2 in.	85	14.0	14.0	13.9	13.6	14.1	14.0	13.9	13.8
	95	13.9	13.8	13.7	13.5	13.9	13.9	13.8	13.6
	105	13.8	13.7	13.6	13.4	13.8	13.8	13.7	13.5
	115	13.7	13.6	13.5	13.3	13.7	13.7	13.6	13.4
	125	13.5	13.5	13.4	13.2	13.6	13.6	13.5	13.4
3 in.	85	14.5	14.5	14.4	14.1	14.6	14.5	14.4	14.3
	95	14.4	14.3	14.2	14.0	14.4	14.4	14.3	14.1
	105	14.3	14.2	14.1	13.9	14.3	14.3	14.2	14.0
	115	14.2	14.1	14.0	13.8	14.2	14.2	14.1	13.9
	125	14.0	14.0	13.9	13.7	14.1	14.1	14.0	13.9
3 1/2 in.	85	14.7	14.7	14.6	14.3	14.8	14.7	14.6	14.5
	95	14.6	14.5	14.4	14.2	14.6	14.6	14.5	14.3
	105	14.5	14.4	14.3	14.1	14.5	14.5	14.4	14.2
	115	14.4	14.3	14.2	14.0	14.4	14.4	14.3	14.1
	125	14.2	14.2	14.1	13.9	14.3	14.3	14.2	14.1

Single Wythe Concrete Masonry Assemblies: Interior Insulation

Assembly 4: Continuous rigid interior insulation, 1-1/2 in. metal furring and 1/2 in. gypsum wallboard on interior, exposed exterior masonry



Concrete Masonry Assembly R-Values, hrft²·°F/Btu

Rigid insulation type and thickness:	Density of CMU, pcf	6-in. Concrete Masonry				8-in. Concrete Masonry			
		UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted
extruded polystyrene, 3/4 in.	85	7.5	7.4	7.2	6.9	7.7	7.6	7.4	7.1
	95	7.4	7.2	7.1	6.8	7.5	7.4	7.3	7.0
	105	7.3	7.1	7.0	6.7	7.4	7.3	7.2	6.9
	115	7.1	7.0	6.9	6.6	7.3	7.2	7.1	6.8
	125	7.0	6.9	6.8	6.6	7.2	7.1	7.0	6.7
polyisocyanurate, 3/4 in.	85	10.6	10.4	10.3	9.9	10.8	10.6	10.5	10.2
	95	10.5	10.3	10.2	9.8	10.6	10.5	10.4	10.1
	105	10.3	10.2	10.1	9.8	10.5	10.4	10.3	10.0
	115	10.2	10.1	10.0	9.7	10.4	10.3	10.2	9.9
	125	10.1	10.0	9.9	9.6	10.2	10.2	10.1	9.8
extruded polystyrene, 1 in.	85	8.7	8.6	8.4	8.1	8.9	8.8	8.6	8.3
	95	8.6	8.4	8.3	8.0	8.7	8.6	8.5	8.2
	105	8.5	8.3	8.2	7.9	8.6	8.5	8.4	8.1
	115	8.3	8.2	8.1	7.8	8.5	8.4	8.3	8.0
	125	8.2	8.1	8.0	7.8	8.4	8.3	8.2	7.9
polyisocyanurate, 1 in.	85	12.3	12.1	12.0	11.6	12.4	12.3	12.2	11.9
	95	12.1	12.0	11.9	11.5	12.3	12.2	12.1	11.7
	105	12.0	11.9	11.7	11.4	12.2	12.1	11.9	11.6
	115	11.9	11.8	11.7	11.4	12.0	11.9	11.8	11.6
	125	11.8	11.7	11.6	11.3	11.9	11.8	11.7	11.5
extruded polystyrene, 1 1/2 in.	85	11.2	11.1	10.9	10.6	11.4	11.3	11.1	10.8
	95	11.1	10.9	10.8	10.5	11.2	11.1	11.0	10.7
	105	11.0	10.8	10.7	10.4	11.1	11.0	10.9	10.6
	115	10.8	10.7	10.6	10.3	11.0	10.9	10.8	10.5
	125	10.7	10.6	10.5	10.3	10.9	10.8	10.7	10.4
polyisocyanurate, 1 1/2 in.	85	16.1	15.9	15.8	15.4	16.2	16.1	16.0	15.7
	95	15.9	15.8	15.7	15.3	16.1	16.0	15.9	15.5
	105	15.8	15.7	15.5	15.2	16.0	15.9	15.7	15.4
	115	15.7	15.6	15.5	15.2	15.8	15.7	15.6	15.4
	125	15.6	15.5	15.4	15.1	15.7	15.6	15.5	15.3
extruded polystyrene, 2 in.	85	13.7	13.6	13.4	13.1	13.9	13.8	13.6	13.3
	95	13.6	13.4	13.3	13.0	13.7	13.6	13.5	13.2
	105	13.5	13.3	13.2	12.9	13.6	13.5	13.4	13.1
	115	13.3	13.2	13.1	12.8	13.5	13.4	13.3	13.0
	125	13.2	13.1	13.0	12.8	13.4	13.3	13.2	12.9
polyisocyanurate, 2 in.	85	20.0	19.8	19.7	19.3	20.1	20.0	19.9	19.6
	95	19.8	19.7	19.6	19.2	20.0	19.9	19.8	19.4
	105	19.7	19.6	19.4	19.1	19.9	19.8	19.6	19.3
	115	19.6	19.5	19.4	19.1	19.7	19.6	19.5	19.3
	125	19.5	19.4	19.3	19.0	19.6	19.5	19.4	19.2
extruded polystyrene, 2 1/2 in.	85	16.2	16.1	15.9	15.6	16.4	16.3	16.1	15.8
	95	16.1	15.9	15.8	15.5	16.2	16.1	16.0	15.7
	105	16.0	15.8	15.7	15.4	16.1	16.0	15.9	15.6
	115	15.8	15.7	15.6	15.3	16.0	15.9	15.8	15.5
	125	15.7	15.6	15.5	15.3	15.9	15.8	15.7	15.4
polyisocyanurate, 2 1/2 in.	85	23.4	23.2	23.1	22.7	23.5	23.4	23.3	23.0
	95	23.2	23.1	23.0	22.6	23.4	23.3	23.2	22.8
	105	23.1	23.0	22.8	22.5	23.3	23.2	23.0	22.7
	115	23.0	22.9	22.8	22.5	23.1	23.0	22.9	22.7
	125	22.9	22.8	22.7	22.4	23.0	22.9	22.8	22.6
extruded polystyrene, 3 in.	85	18.7	18.6	18.4	18.1	18.9	18.8	18.6	18.3
	95	18.6	18.4	18.3	18.0	18.7	18.6	18.5	18.2
	105	18.5	18.3	18.2	17.9	18.6	18.5	18.4	18.1
	115	18.3	18.2	18.1	17.8	18.5	18.4	18.3	18.0
	125	18.2	18.1	18.0	17.8	18.4	18.3	18.2	17.9
polyisocyanurate, 3 in.	85	26.8	26.6	26.5	26.1	26.9	26.8	26.7	26.4
	95	26.6	26.5	26.4	26.0	26.8	26.7	26.6	26.2
	105	26.5	26.4	26.2	25.9	26.7	26.6	26.4	26.1
	115	26.4	26.3	26.2	25.9	26.5	26.4	26.3	26.1
	125	26.3	26.2	26.1	25.8	26.4	26.3	26.2	26.0
135	26.2	26.1	26.0	25.8	26.3	26.2	26.1	25.9	

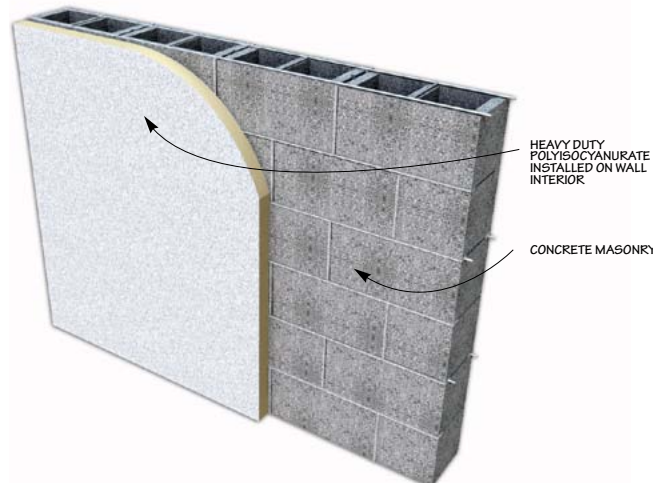
Concrete Masonry Assembly R-Values, hrft²·°F/Btu

10-in. Concrete Masonry				12-in. Concrete Masonry			
UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted
7.7	7.7	7.6	7.3	7.8	7.7	7.6	7.5
7.6	7.5	7.4	7.2	7.6	7.6	7.5	7.3
7.5	7.4	7.3	7.1	7.5	7.5	7.4	7.2
7.4	7.3	7.2	7.0	7.4	7.4	7.3	7.1
7.2	7.2	7.1	6.9	7.3	7.3	7.2	7.1
7.1	7.1	7.0	6.8	7.2	7.2	7.1	7.0
10.8	10.7	10.6	10.4	10.8	10.8	10.7	10.5
10.7	10.6	10.5	10.2	10.7	10.7	10.6	10.4
10.5	10.5	10.4	10.1	10.6	10.5	10.5	10.3
10.4	10.4	10.3	10.1	10.5	10.4	10.4	10.2
10.3	10.2	10.2	10.0	10.4	10.3	10.3	10.1
10.2	10.1	10.1	9.9	10.3	10.2	10.2	10.0
8.9	8.9	8.8	8.5	9.0	8.9	8.8	8.7
8.8	8.7	8.6	8.4	8.8	8.8	8.7	8.5
8.7	8.6	8.5	8.3	8.7	8.7	8.6	8.4
8.6	8.5	8.4	8.2	8.6	8.6	8.5	8.3
8.4	8.4	8.3	8.1	8.5	8.5	8.4	8.3
8.3	8.3	8.2	8.0	8.4	8.4	8.3	8.2
12.5	12.4	12.3	12.0	12.5	12.5	12.4	12.2
12.3	12.3	12.2	11.9	12.4	12.3	12.3	12.1
12.2	12.1	12.1	11.8	12.3	12.2	12.2	12.0
12.1	12.0	11.9	11.7	12.1	12.1	12.0	11.9
12.0	11.9	11.8	11.6	12.0	12.0	11.9	11.8
11.9	11.8	11.8	11.6	11.9	11.9	11.9	11.7
11.4	11.4	11.3	11.0	11.5	11.4	11.3	11.2
11.3	11.2	11.1	10.9	11.3	11.3	11.2	11.0
11.2	11.1	11.0	10.8	11.2	11.2	11.1	10.9
11.1	11.0	10.9	10.7	11.1	11.1	11.0	10.8
10.9	10.9	10.8	10.6	11.0	11.0	10.9	10.8
10.8	10.8	10.7	10.5	10.9	10.9	10.8	10.7
16.3	16.2	16.1	15.8	16.3	16.3	16.2	16.0
16.1	16.1	16.0	15.7	16.2	16.1	16.1	15.9
16.0	15.9	15.9	15.6	16.1	16.0	16.0	15.8
15.9	15.8	15.7	15.5	15.9	15.9	15.8	15.7
15.8	15.7	15.6	15.4	15.8	15.8	15.7	15.6
15.7	15.6	15.6	15.4	15.7	15.7	15.7	15.5
13.9	13.9	13.8	13.5	14.0	13.9	13.8	13.7
13.8	13.7	13.6	13.4	13.8	13.8	13.7	13.5
13.7	13.6	13.5	13.3	13.7	13.7	13.6	13.4
13.6	13.5	13.4	13.2	13.6	13.6	13.5	13.3
13.4	13.4	13.3	13.1	13.5	13.5	13.4	13.3
13.3	13.3	13.2	13.0	13.4	13.4	13.3	13.2
20.2	20.1	20.0	19.7	20.2	20.2	20.1	19.9
20.0	20.0	19.9	19.6	20.1	20.0	20.0	19.8
19.9	19.8	19.8	19.5	20.0	19.9	19.9	19.7
19.8	19.7	19.6	19.4	19.8	19.8	19.7	19.6
19.7	19.6	19.5	19.3	19.7	19.7	19.6	19.5
19.6	19.5	19.5	19.3	19.6	19.6	19.6	19.4
16.4	16.4	16.3	16.0	16.5	16.4	16.3	16.2
16.3	16.2	16.1	15.9	16.3	16.3	16.2	16.0
16.2	16.1	16.0	15.8	16.2	16.2	16.1	15.9
16.1	16.0	15.9	15.7	16.1	16.1	16.0	15.8
15.9	15.9	15.8	15.6	16.0	16.0	15.9	15.8
15.8	15.8	15.7	15.5	15.9	15.9	15.8	15.7
23.6	23.5	23.4	23.1	23.6	23.6	23.5	23.3
23.4	23.4	23.3	23.0	23.5	23.4	23.4	23.2
23.3	23.2	23.2	22.9	23.4	23.3	23.3	23.1
23.2	23.1	23.0	22.8	23.2	23.2	23.1	23.0
23.1	23.0	22.9	22.7	23.1	23.1	23.0	22.9
23.0	22.9	22.9	22.7	23.0	23.0	23.0	22.8
18.9	18.9	18.8	18.5	19.0	18.9	18.8	18.7
18.8	18.7	18.6	18.4	18.8	18.8	18.7	18.5
18.7	18.6	18.5	18.3	18.7	18.7	18.6	18.4
18.6	18.5	18.4	18.2	18.6	18.6	18.5	18.3
18.4	18.4	18.3	18.1	18.5	18.5	18.4	18.3
18.3	18.3	18.2	18.0	18.4	18.4	18.3	18.2
27.0	26.9	26.8	26.5	27.0	27.0	26.9	26.7
26.8	26.8	26.7	26.4	26.9	26.8	26.8	26.6
26.7	26.6	26.6	26.3	26.8	26.7	26.7	26.5
26.6	26.5	26.4	26.2	26.6	26.6	26.5	26.4
26.5	26.4	26.3	26.1	26.5	26.5	26.4	26.3
26.4	26.3	26.3	26.1	26.4	26.4	26.4	26.2

- Note that R-values for walls with polyisocyanurate insulation include a reflective air space (i.e., polyisocyanurate is foil-faced and foil-faced side faces the air space).
- Interior furring allows for electrical rough-in.
- Reinforcement and grouting schedule has little effect on assembly R-values.
- Interior insulation reduces the benefits of thermal mass.
- “Lightly reinforced” = grout 8 ft o.c. both vertically and horizontally (vertical reinforcement only at approximately 48 in. o.c.). “Heavily reinforced” = grout 32 in. o.c. vertically and 48 in. o.c. horizontally (vertical reinforcement only at approximately 24 in. o.c.).

Single Wythe Concrete Masonry Assemblies: Interior Insulation

Assembly 5: Continuous polyisocyanurate heavy duty (HD) attached directly to masonry, exposed exterior masonry



- Joints of the HD polyisocyanurate must be butt-caulked or taped.
- Several types of HD polyisocyanurate are available with various amounts of impact resistance.
- Reinforcement and grouting schedule has little effect on assembly R-values.
- Interior insulation reduces the benefits of thermal mass.
- “Lightly reinforced” = grout 8 ft o.c. both vertically and horizontally (vertical reinforcement only at approximately 48 in. o.c.). “Heavily reinforced” = grout 32 in. o.c. vertically and 48 in. o.c. horizontally (vertical reinforcement only at approximately 24 in. o.c.).

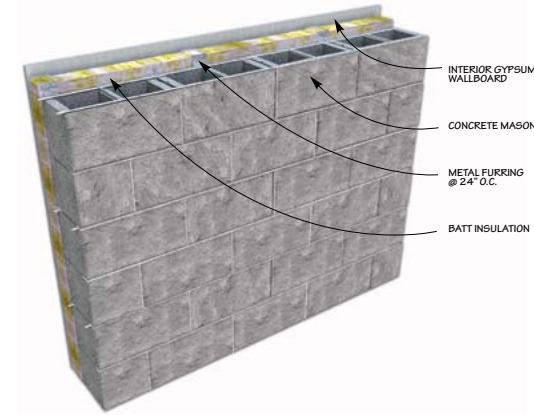
Concrete Masonry Assembly R-Values, hrft²·F/Btu

Thickness of HD polyisocyanurate:	Density of CMU, pcf	6-in. Concrete Masonry				8-in. Concrete Masonry			
		UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted
2 in.	85	16.7	16.6	16.4	16.1	16.9	16.8	16.6	16.3
	95	16.6	16.4	16.3	16.0	16.7	16.6	16.5	16.2
	105	16.5	16.3	16.2	15.9	16.6	16.5	16.4	16.1
	115	16.3	16.2	16.1	15.8	16.5	16.4	16.3	16.0
	125	16.2	16.1	16.0	15.8	16.4	16.3	16.2	15.9
2 1/2 in.	85	20.1	20.0	19.8	19.5	20.3	20.2	20.0	19.7
	95	20.0	19.8	19.7	19.4	20.1	20.0	19.9	19.6
	105	19.9	19.7	19.6	19.3	20.0	19.9	19.8	19.5
	115	19.7	19.6	19.5	19.2	19.9	19.8	19.7	19.4
	125	19.6	19.5	19.4	19.2	19.8	19.7	19.6	19.3
3 in.	85	23.5	23.4	23.2	22.9	23.7	23.6	23.4	23.1
	95	23.4	23.2	23.1	22.8	23.5	23.4	23.3	23.0
	105	23.3	23.1	23.0	22.7	23.4	23.3	23.2	22.9
	115	23.1	23.0	22.9	22.6	23.3	23.2	23.1	22.8
	125	23.0	22.9	22.8	22.6	23.2	23.1	23.0	22.7
3 1/2 in.	85	26.9	26.8	26.6	26.3	27.1	27.0	26.8	26.5
	95	26.8	26.6	26.5	26.2	26.9	26.8	26.7	26.4
	105	26.7	26.5	26.4	26.1	26.8	26.7	26.6	26.3
	115	26.5	26.4	26.3	26.0	26.7	26.6	26.5	26.2
	125	26.4	26.3	26.2	26.0	26.6	26.5	26.4	26.1
135	26.3	26.2	26.1	25.9	26.5	26.4	26.3	26.1	

Thickness of HD polyisocyanurate:	Density of CMU, pcf	10-in. Concrete Masonry				12-in. Concrete Masonry			
		UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted
2 in.	85	16.9	16.9	16.8	16.5	17.0	16.9	16.8	16.7
	95	16.8	16.7	16.6	16.4	16.8	16.8	16.7	16.5
	105	16.7	16.6	16.5	16.3	16.7	16.7	16.6	16.4
	115	16.6	16.5	16.4	16.2	16.6	16.6	16.5	16.3
	125	16.4	16.4	16.3	16.1	16.5	16.5	16.4	16.3
2 1/2 in.	85	20.3	20.3	20.2	19.9	20.4	20.3	20.2	20.1
	95	20.2	20.1	20.0	19.8	20.2	20.2	20.1	19.9
	105	20.1	20.0	19.9	19.7	20.1	20.1	20.0	19.8
	115	20.0	19.9	19.8	19.6	20.0	20.0	19.9	19.7
	125	19.8	19.8	19.7	19.5	19.9	19.9	19.8	19.7
3 in.	85	23.7	23.7	23.6	23.3	23.8	23.7	23.6	23.5
	95	23.6	23.5	23.4	23.2	23.6	23.6	23.5	23.3
	105	23.5	23.4	23.3	23.1	23.5	23.5	23.4	23.2
	115	23.4	23.3	23.2	23.0	23.4	23.4	23.3	23.1
	125	23.2	23.2	23.1	22.9	23.3	23.3	23.2	23.1
3 1/2 in.	85	27.1	27.1	27.0	26.7	27.2	27.1	27.0	26.9
	95	27.0	26.9	26.8	26.6	27.0	27.0	26.9	26.7
	105	26.9	26.8	26.7	26.5	26.9	26.9	26.8	26.6
	115	26.8	26.7	26.6	26.4	26.8	26.8	26.7	26.5
	125	26.6	26.6	26.5	26.3	26.7	26.7	26.6	26.5
135	26.5	26.5	26.4	26.2	26.6	26.6	26.5	26.4	

Single Wythe Concrete Masonry Assemblies: Interior Insulation

Assembly 6: Metal furring at 24 in. o.c. with batt insulation between furring and 1/2 in. gypsum wallboard on interior, exposed exterior masonry



- Note: batt insulation is susceptible to moisture.
- Steel penetrations through insulation significantly affect the thermal resistance by conducting heat from one side of the insulation to the other.
- Reinforcement and grouting schedule has little effect on assembly R-values.
- Interior insulation reduces the benefits of thermal mass.
- “Lightly reinforced” = grout 8 ft o.c. both vertically and horizontally (vertical reinforcement only at approximately 48 in. o.c.). “Heavily reinforced” = grout 32 in. o.c. vertically and 48 in. o.c. horizontally (vertical reinforcement only at approximately 24 in. o.c.).

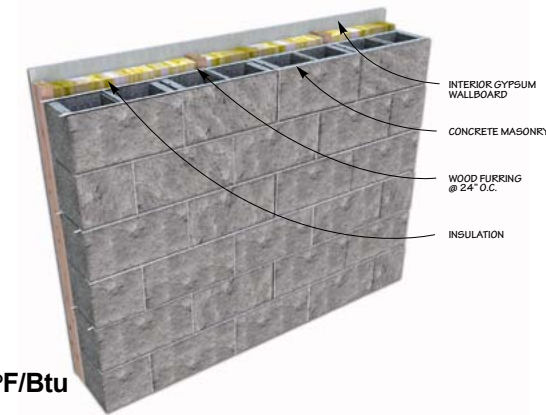
Concrete Masonry Assembly R-Values, hrft²·F/Btu

Insulation type	Density of CMU, pcf	6-in. Concrete Masonry				8-in. Concrete Masonry			
		UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted
R11 batt	85	9.4	9.3	9.1	8.8	9.6	9.5	9.3	9.0
	95	9.3	9.1	9.0	8.7	9.4	9.3	9.2	8.9
	105	9.2	9.0	8.9	8.6	9.3	9.2	9.1	8.8
	115	9.0	8.9	8.8	8.5	9.2	9.1	9.0	8.7
	125	8.9	8.8	8.7	8.5	9.1	9.0	8.9	8.6
R13 batt	85	10.0	9.9	9.7	9.4	10.2	10.1	9.9	9.6
	95	9.9	9.7	9.6	9.3	10.0	9.9	9.8	9.5
	105	9.8	9.6	9.5	9.2	9.9	9.8	9.7	9.4
	115	9.6	9.5	9.4	9.1	9.8	9.7	9.6	9.3
	125	9.5	9.4	9.3	9.1	9.7	9.6	9.5	9.2
R15 batt	85	10.6	10.5	10.3	10.0	10.8	10.7	10.5	10.2
	95	10.5	10.3	10.2	9.9	10.6	10.5	10.4	10.1
	105	10.4	10.2	10.1	9.8	10.5	10.4	10.3	10.0
	115	10.2	10.1	10.0	9.7	10.4	10.3	10.2	9.9
	125	10.1	10.0	9.9	9.7	10.3	10.2	10.1	9.8
R19 batt	85	11.4	11.3	11.1	10.8	11.6	11.5	11.3	11.0
	95	11.3	11.1	11.0	10.7	11.4	11.3	11.2	10.9
	105	11.2	11.0	10.9	10.6	11.3	11.2	11.1	10.8
	115	11.0	10.9	10.8	10.5	11.2	11.1	11.0	10.7
	125	10.9	10.8	10.7	10.5	11.1	11.0	10.9	10.6
R21 batt	85	11.8	11.7	11.5	11.2	12.0	11.9	11.7	11.4
	95	11.7	11.5	11.4	11.1	11.8	11.7	11.6	11.3
	105	11.6	11.4	11.3	11.0	11.7	11.6	11.5	11.2
	115	11.4	11.3	11.2	10.9	11.6	11.5	11.4	11.1
	125	11.3	11.2	11.1	10.9	11.5	11.4	11.3	11.0
135	11.2	11.1	11.0	10.8	11.4	11.3	11.2	11.0	

Insulation type	Density of CMU, pcf	10-in. Concrete Masonry				12-in. Concrete Masonry			
		UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted
R11 batt	85	9.6	9.6	9.5	9.2	9.7	9.6	9.5	9.4
	95	9.5	9.4	9.3	9.1	9.5	9.5	9.4	9.2
	105	9.4	9.3	9.2	9.0	9.4	9.4	9.3	9.1
	115	9.3	9.2	9.1	8.9	9.3	9.3	9.2	9.0
	125	9.1	9.1	9.0	8.8	9.2	9.2	9.1	9.0
R13 batt	85	10.2	10.2	10.1	9.8	10.3	10.2	10.1	10.0
	95	10.1	10.0	9.9	9.7	10.1	10.1	10.0	9.8
	105	10.0	9.9	9.8	9.6	10.0	10.0	9.9	9.7
	115	9.9	9.8	9.7	9.5	9.9	9.9	9.8	9.6
	125	9.7	9.7	9.6	9.4	9.8	9.8	9.7	9.6
R15 batt	85	10.8	10.8	10.7	10.4	10.9	10.8	10.7	10.6
	95	10.7	10.6	10.5	10.3	10.7	10.7	10.6	10.4
	105	10.6	10.5	10.4	10.2	10.6	10.6	10.5	10.3
	115	10.5	10.4	10.3	10.1	10.5	10.5	10.4	10.2
	125	10.3	10.3	10.2	10.0	10.4	10.4	10.3	10.2
R19 batt	85	11.6	11.6	11.5	11.2	11.7	11.6	11.5	11.4
	95	11.5	11.4	11.3	11.1	11.5	11.5	11.4	11.2
	105	11.4	11.3	11.2	11.0	11.4	11.4	11.3	11.1
	115	11.3	11.2	11.1	10.9	11.3	11.3	11.2	11.0
	125	11.1	11.1	11.0	10.8	11.2	11.2	11.1	11.0
R21 batt	85	12.0	12.0	11.9	11.6	12.1	12.0	11.9	11.8
	95	11.9	11.8	11.7	11.5	11.9	11.9	11.8	11.6
	105	11.8	11.7	11.6	11.4	11.8	11.8	11.7	11.5
	115	11.7	11.6	11.5	11.3	11.7	11.7	11.6	11.4
	125	11.5	11.5	11.4	11.2	11.6	11.6	11.5	11.4
135	11.4	11.4	11.3	11.1	11.5	11.5	11.4	11.3	

Single Wythe Concrete Masonry Assemblies: Interior Insulation

Assembly 7: Wood furring at 24 in. o.c. with insulation between furring and 1/2 in. gypsum wallboard on interior, exposed exterior masonry



Concrete Masonry Assembly R-Values, hrft²·°F/Btu

Insulation type and thickness:	Density of CMU, pcf	6-in. Concrete Masonry				8-in. Concrete Masonry			
		UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted
extruded polystyrene, 3/4 in.	85	7.4	7.3	7.1	6.8	7.6	7.5	7.3	7.0
	95	7.3	7.1	7.0	6.7	7.4	7.3	7.2	6.9
	105	7.2	7.0	6.9	6.6	7.3	7.2	7.1	6.8
	115	7.0	6.9	6.8	6.5	7.2	7.1	7.0	6.7
	125	6.9	6.8	6.7	6.5	7.1	7.0	6.9	6.6
polyisocyanurate, 3/4 in.	85	10.0	9.9	9.7	9.4	10.2	10.1	9.9	9.6
	95	9.9	9.7	9.6	9.3	10.0	9.9	9.8	9.5
	105	9.8	9.6	9.5	9.2	9.9	9.8	9.7	9.4
	115	9.6	9.5	9.4	9.1	9.8	9.7	9.6	9.3
	125	9.5	9.4	9.3	9.1	9.7	9.6	9.5	9.2
extruded polystyrene, 1 1/2 in.	85	10.5	10.4	10.2	9.9	10.7	10.6	10.4	10.1
	95	10.4	10.2	10.1	9.8	10.5	10.4	10.3	10.0
	105	10.3	10.1	10.0	9.7	10.4	10.3	10.2	9.9
	115	10.1	10.0	9.9	9.6	10.3	10.2	10.1	9.8
	125	10.0	9.9	9.8	9.6	10.2	10.1	10.0	9.7
polyisocyanurate, 1 1/2 in.	85	14.1	14.0	13.8	13.5	14.3	14.2	14.0	13.7
	95	14.0	13.8	13.7	13.4	14.1	14.0	13.9	13.6
	105	13.9	13.7	13.6	13.3	14.0	13.9	13.8	13.5
	115	13.7	13.6	13.5	13.2	13.9	13.8	13.7	13.4
	125	13.6	13.5	13.4	13.2	13.8	13.7	13.6	13.3
R11 batt	85	12.5	12.4	12.2	11.9	12.7	12.6	12.4	12.1
	95	12.4	12.2	12.1	11.8	12.5	12.4	12.3	12.0
	105	12.3	12.1	12.0	11.7	12.4	12.3	12.2	11.9
	115	12.1	12.0	11.9	11.6	12.3	12.2	12.1	11.8
	125	12.0	11.9	11.8	11.6	12.2	12.1	12.0	11.7
R13 batt	85	13.9	13.8	13.6	13.3	14.1	14.0	13.8	13.5
	95	13.8	13.6	13.5	13.2	13.9	13.8	13.7	13.4
	105	13.7	13.5	13.4	13.1	13.8	13.7	13.6	13.3
	115	13.5	13.4	13.3	13.0	13.7	13.6	13.5	13.2
	125	13.4	13.3	13.2	13.0	13.6	13.5	13.4	13.1
R15 batt	85	15.2	15.1	14.9	14.6	15.4	15.3	15.1	14.8
	95	15.1	14.9	14.8	14.5	15.2	15.1	15.0	14.7
	105	15.0	14.8	14.7	14.4	15.1	15.0	14.9	14.6
	115	14.8	14.7	14.6	14.3	15.0	14.9	14.8	14.5
	125	14.7	14.6	14.5	14.3	14.9	14.8	14.7	14.4
R19 batt	85	19.2	19.1	18.9	18.6	19.4	19.3	19.1	18.8
	95	19.1	18.9	18.8	18.5	19.2	19.1	19.0	18.7
	105	19.0	18.8	18.7	18.4	19.1	19.0	18.9	18.6
	115	18.8	18.7	18.6	18.3	19.0	18.9	18.8	18.5
	125	18.7	18.6	18.5	18.3	18.9	18.8	18.7	18.4
R21 batt	85	20.6	20.5	20.3	20.0	20.8	20.7	20.5	20.2
	95	20.5	20.3	20.2	19.9	20.6	20.5	20.4	20.1
	105	20.4	20.2	20.1	19.8	20.5	20.4	20.3	20.0
	115	20.2	20.1	20.0	19.7	20.4	20.3	20.2	19.9
	125	20.1	20.0	19.9	19.7	20.3	20.2	20.1	19.8
135	20.0	19.9	19.8	19.6	20.2	20.1	20.0	19.8	

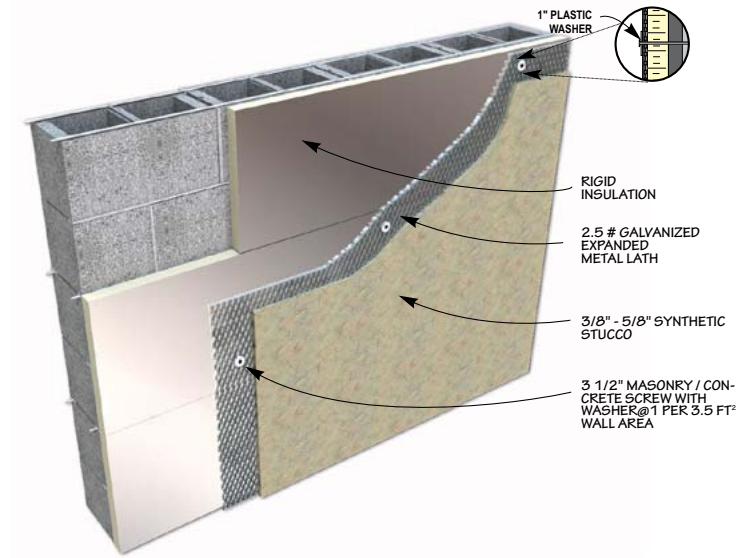
Concrete Masonry Assembly R-Values, hrft²·°F/Btu

10-in. Concrete Masonry				12-in. Concrete Masonry			
UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted
7.6	7.6	7.5	7.2	7.7	7.6	7.5	7.4
7.5	7.4	7.3	7.1	7.5	7.5	7.4	7.2
7.4	7.3	7.2	7.0	7.4	7.4	7.3	7.1
7.3	7.2	7.1	6.9	7.3	7.3	7.2	7.0
7.1	7.1	7.0	6.8	7.2	7.2	7.1	7.0
7.0	7.0	6.9	6.7	7.1	7.1	7.0	6.9
10.2	10.2	10.1	9.8	10.3	10.2	10.1	10.0
10.1	10.0	9.9	9.7	10.1	10.1	10.0	9.8
10.0	9.9	9.8	9.6	10.0	10.0	9.9	9.7
9.9	9.8	9.7	9.5	9.9	9.9	9.8	9.6
9.7	9.7	9.6	9.4	9.8	9.8	9.7	9.6
9.6	9.6	9.5	9.3	9.7	9.7	9.6	9.5
10.7	10.7	10.6	10.3	10.8	10.7	10.6	10.5
10.6	10.5	10.4	10.2	10.6	10.6	10.5	10.3
10.5	10.4	10.3	10.1	10.5	10.5	10.4	10.2
10.4	10.3	10.2	10.0	10.4	10.4	10.3	10.1
10.2	10.2	10.1	9.9	10.3	10.3	10.2	10.1
10.1	10.1	10.0	9.8	10.2	10.2	10.1	10.0
14.3	14.3	14.2	13.9	14.4	14.3	14.2	14.1
14.2	14.1	14.0	13.8	14.2	14.2	14.1	13.9
14.1	14.0	13.9	13.7	14.1	14.1	14.0	13.8
14.0	13.9	13.8	13.6	14.0	14.0	13.9	13.7
13.8	13.8	13.7	13.5	13.9	13.9	13.8	13.7
13.7	13.7	13.6	13.4	13.8	13.8	13.7	13.6
12.7	12.7	12.6	12.3	12.8	12.7	12.6	12.5
12.6	12.5	12.4	12.2	12.6	12.6	12.5	12.3
12.5	12.4	12.3	12.1	12.5	12.5	12.4	12.2
12.4	12.3	12.2	12.0	12.4	12.4	12.3	12.1
12.2	12.2	12.1	11.9	12.3	12.3	12.2	12.1
12.1	12.1	12.0	11.8	12.2	12.2	12.1	12.0
14.1	14.1	14.0	13.7	14.2	14.1	14.0	13.9
14.0	13.9	13.8	13.6	14.0	14.0	13.9	13.7
13.9	13.8	13.7	13.5	13.9	13.9	13.8	13.6
13.8	13.7	13.6	13.4	13.8	13.8	13.7	13.5
13.6	13.6	13.5	13.3	13.7	13.7	13.6	13.5
13.5	13.5	13.4	13.2	13.6	13.6	13.5	13.4
15.4	15.4	15.3	15.0	15.5	15.4	15.3	15.2
15.3	15.2	15.1	14.9	15.3	15.3	15.2	15.0
15.2	15.1	15.0	14.8	15.2	15.2	15.1	14.9
15.1	15.0	14.9	14.7	15.1	15.1	15.0	14.8
14.9	14.9	14.8	14.6	15.0	15.0	14.9	14.8
14.8	14.8	14.7	14.5	14.9	14.9	14.8	14.7
19.4	19.4	19.3	19.0	19.5	19.4	19.3	19.2
19.3	19.2	19.1	18.9	19.3	19.3	19.2	19.0
19.2	19.1	19.0	18.8	19.2	19.2	19.1	18.9
19.1	19.0	18.9	18.7	19.1	19.1	19.0	18.8
18.9	18.9	18.8	18.6	19.0	19.0	18.9	18.8
18.8	18.8	18.7	18.5	18.9	18.9	18.8	18.7
20.8	20.8	20.7	20.4	20.9	20.8	20.7	20.6
20.7	20.6	20.5	20.3	20.7	20.7	20.6	20.4
20.6	20.5	20.4	20.2	20.6	20.6	20.5	20.3
20.5	20.4	20.3	20.1	20.5	20.5	20.4	20.2
20.3	20.3	20.2	20.0	20.4	20.4	20.3	20.2
20.2	20.2	20.1	19.9	20.3	20.3	20.2	20.1

- Note that R-values for assemblies with polyisocyanurate insulation include a reflective air space (i.e., polyisocyanurate is foil-faced and the foil-faced side faces the air space).
- R-values for assemblies with extruded polystyrene insulation include a nonreflective air space.
- Note that batt insulation is susceptible to moisture.
- Reinforcement and grouting schedule has little effect on assembly R-values.
- Interior insulation reduces the benefits of thermal mass.
- “Lightly reinforced” = grout 8 ft o.c. both vertically and horizontally (vertical reinforcement only at approximately 48 in. o.c.). “Heavily reinforced” = grout 32 in. o.c. vertically and 48 in. o.c. horizontally (vertical reinforcement only at approximately 24 in. o.c.).

Single Wythe Concrete Masonry Assemblies: Exterior Insulation

Assembly 8: Continuous exterior insulation and finish system, exposed interior masonry



Concrete Masonry Assembly R-Values, hrft²·F/Btu

Rigid insulation type and thickness:	Density of CMU, pcf	6-in. Concrete Masonry				8-in. Concrete Masonry			
		UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted
polyisocyanurate, 1 in.	85	9.3	9.2	9.0	8.7	9.5	9.4	9.2	8.9
	95	9.2	9.0	8.9	8.6	9.3	9.2	9.1	8.8
	105	9.1	8.9	8.8	8.5	9.2	9.1	9.0	8.7
	115	8.9	8.8	8.7	8.4	9.1	9.0	8.9	8.6
	125	8.8	8.7	8.6	8.4	9.0	8.9	8.8	8.5
expanded polystyrene, 1 1/2 in.	85	8.6	8.5	8.3	8.0	8.8	8.7	8.5	8.2
	95	8.5	8.3	8.2	7.9	8.6	8.5	8.4	8.1
	105	8.4	8.2	8.1	7.8	8.5	8.4	8.3	8.0
	115	8.2	8.1	8.0	7.7	8.4	8.3	8.2	7.9
	125	8.1	8.0	7.9	7.7	8.3	8.2	8.1	7.8
expanded polystyrene, 2 in.	85	10.6	10.5	10.3	10.0	10.8	10.7	10.5	10.2
	95	10.5	10.3	10.2	9.9	10.6	10.5	10.4	10.1
	105	10.4	10.2	10.1	9.8	10.5	10.4	10.3	10.0
	115	10.2	10.1	10.0	9.7	10.4	10.3	10.2	9.9
	125	10.1	10.0	9.9	9.7	10.3	10.2	10.1	9.8
extruded polystyrene, 2 in.	85	12.6	12.5	12.3	12.0	12.8	12.7	12.5	12.2
	95	12.5	12.3	12.2	11.9	12.6	12.5	12.4	12.1
	105	12.4	12.2	12.1	11.8	12.5	12.4	12.3	12.0
	115	12.2	12.1	12.0	11.7	12.4	12.3	12.2	11.9
	125	12.1	12.0	11.9	11.7	12.3	12.2	12.1	11.8
polyisocyanurate, 2 in.	85	17.0	16.9	16.7	16.4	17.2	17.1	16.9	16.6
	95	16.9	16.7	16.6	16.3	17.0	16.9	16.8	16.5
	105	16.8	16.6	16.5	16.2	16.9	16.8	16.7	16.4
	115	16.6	16.5	16.4	16.1	16.8	16.7	16.6	16.3
	125	16.5	16.4	16.3	16.1	16.7	16.6	16.5	16.2
extruded polystyrene, 2 1/2 in.	85	15.1	15.0	14.8	14.5	15.3	15.2	15.0	14.7
	95	15.0	14.8	14.7	14.4	15.1	15.0	14.9	14.6
	105	14.9	14.7	14.6	14.3	15.0	14.9	14.8	14.5
	115	14.7	14.6	14.5	14.2	14.9	14.8	14.7	14.4
	125	14.6	14.5	14.4	14.2	14.8	14.7	14.6	14.3
expanded polystyrene, 3 in.	85	14.6	14.5	14.3	14.0	14.8	14.7	14.5	14.2
	95	14.5	14.3	14.2	13.9	14.6	14.5	14.4	14.1
	105	14.4	14.2	14.1	13.8	14.5	14.4	14.3	14.0
	115	14.2	14.1	14.0	13.7	14.4	14.3	14.2	13.9
	125	14.1	14.0	13.9	13.7	14.3	14.2	14.1	13.8
polyisocyanurate, 3 in.	85	23.8	23.7	23.5	23.2	24.0	23.9	23.7	23.4
	95	23.7	23.5	23.4	23.1	23.8	23.7	23.6	23.3
	105	23.6	23.4	23.3	23.0	23.7	23.6	23.5	23.2
	115	23.4	23.3	23.2	22.9	23.6	23.5	23.4	23.1
	125	23.3	23.2	23.1	22.9	23.5	23.4	23.3	23.0
135	23.2	23.1	23.0	22.8	23.4	23.3	23.2	23.0	

Concrete Masonry Assembly R-Values, hrft²·F/Btu

10-in. Concrete Masonry				12-in. Concrete Masonry			
UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted
9.5	9.5	9.4	9.1	9.6	9.5	9.4	9.3
9.4	9.3	9.2	9.0	9.4	9.4	9.3	9.1
9.3	9.2	9.1	8.9	9.3	9.3	9.2	9.0
9.2	9.1	9.0	8.8	9.2	9.2	9.1	8.9
9.0	9.0	8.9	8.7	9.1	9.1	9.0	8.9
8.9	8.9	8.8	8.6	9.0	9.0	8.9	8.8
8.8	8.8	8.7	8.4	8.9	8.8	8.7	8.6
8.7	8.6	8.5	8.3	8.7	8.7	8.6	8.4
8.6	8.5	8.4	8.2	8.6	8.6	8.5	8.3
8.5	8.4	8.3	8.1	8.5	8.5	8.4	8.2
8.3	8.3	8.2	8.0	8.4	8.4	8.3	8.2
8.2	8.2	8.1	7.9	8.3	8.3	8.2	8.1
10.8	10.8	10.7	10.4	10.9	10.8	10.7	10.6
10.7	10.6	10.5	10.3	10.7	10.7	10.6	10.4
10.6	10.5	10.4	10.2	10.6	10.6	10.5	10.3
10.5	10.4	10.3	10.1	10.5	10.5	10.4	10.2
10.3	10.3	10.2	10.0	10.4	10.4	10.3	10.2
10.2	10.2	10.1	9.9	10.3	10.3	10.2	10.1
12.8	12.8	12.7	12.4	12.9	12.8	12.7	12.6
12.7	12.6	12.5	12.3	12.7	12.7	12.6	12.4
12.6	12.5	12.4	12.2	12.6	12.6	12.5	12.3
12.5	12.4	12.3	12.1	12.5	12.5	12.4	12.2
12.3	12.3	12.2	12.0	12.4	12.4	12.3	12.2
12.2	12.2	12.1	11.9	12.3	12.3	12.2	12.1
17.2	17.2	17.1	16.8	17.3	17.2	17.1	17.0
17.1	17.0	16.9	16.7	17.1	17.1	17.0	16.8
17.0	16.9	16.8	16.6	17.0	17.0	16.9	16.7
16.9	16.8	16.7	16.5	16.9	16.9	16.8	16.6
16.7	16.7	16.6	16.4	16.8	16.8	16.7	16.6
16.6	16.6	16.5	16.3	16.7	16.7	16.6	16.5
15.3	15.3	15.2	14.9	15.4	15.3	15.2	15.1
15.2	15.1	15.0	14.8	15.2	15.2	15.1	14.9
15.1	15.0	14.9	14.7	15.1	15.1	15.0	14.8
15.0	14.9	14.8	14.6	15.0	15.0	14.9	14.7
14.8	14.8	14.7	14.5	14.9	14.9	14.8	14.7
14.7	14.7	14.6	14.4	14.8	14.8	14.7	14.6
14.8	14.8	14.7	14.4	14.9	14.8	14.7	14.6
14.7	14.6	14.5	14.3	14.7	14.7	14.6	14.4
14.6	14.5	14.4	14.2	14.6	14.6	14.5	14.3
14.5	14.4	14.3	14.1	14.5	14.5	14.4	14.2
14.3	14.3	14.2	14.0	14.4	14.4	14.3	14.2
14.2	14.2	14.1	13.9	14.3	14.3	14.2	14.1
24.0	24.0	23.9	23.6	24.1	24.0	23.9	23.8
23.9	23.8	23.7	23.5	23.9	23.9	23.8	23.6
23.8	23.7	23.6	23.4	23.8	23.8	23.7	23.5
23.7	23.6	23.5	23.3	23.7	23.7	23.6	23.4
23.5	23.5	23.4	23.2	23.6	23.6	23.5	23.4
23.4	23.4	23.3	23.1	23.5	23.5	23.4	23.3

- Thermal mass exposed to the conditioned space maximizes the benefits of thermal mass.
- Reinforcement and grouting schedule has little effect on assembly R-values.
- Exterior insulation negates the aesthetic and durability advantages of exposed masonry.
- “Lightly reinforced” = grout 8 ft o.c. both vertically and horizontally (vertical reinforcement only at approximately 48 in. o.c.). “Heavily reinforced” = grout 32 in. o.c. vertically and 48 in. o.c. horizontally (vertical reinforcement only at approximately 24 in. o.c.).

Multi-wythe concrete masonry construction lends itself to placing insulation between two wythes of masonry when the wythes are separated to form a cavity.

Placing insulation between two wythes of masonry offers maximum protection for the insulation while allowing a vast amount of the of the thermal mass to be exposed to the conditioned interior to help moderate temperatures. The means to meet or exceed energy code requirements are easily obtainable, because the cavity installation allows a continuous layer of insulation to envelop the masonry. When properly sealed, this continuous insulation layer can also increase energy efficiency by mitigating air infiltration/exfiltration.

Cavity construction, as well as single wythe masonry with core insulation, provides hard, durable surfaces on both sides of the assembly, efficiently utilizing the inherent impact resistance and low maintenance needs of concrete masonry. While these needs are most commonly associated with multi-family dwellings, hospitals, schools and detention centers, the benefits of resistance to damage from hail, shopping and loading carts, gurneys, motorized chairs, and even sports make cavity construction ideal for any application.

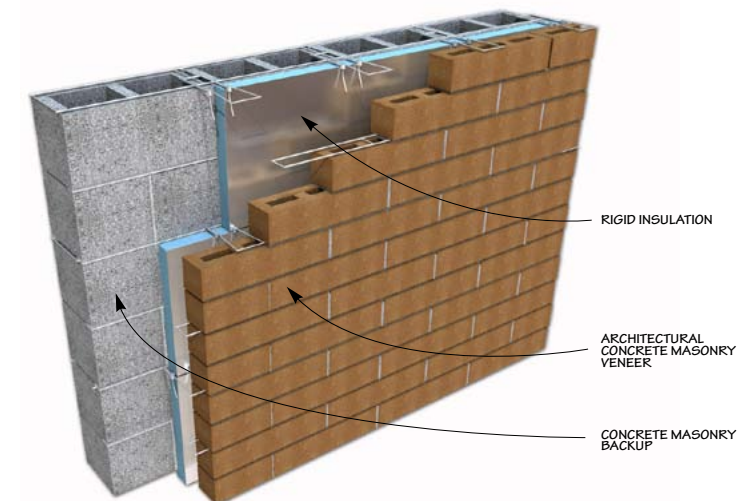
The term cavity insulation, which in some codes refers to the insulation between studs in light-weight framing systems, should not be confused with the long established term: "masonry cavity wall." Masonry cavity assemblies are comprised of two wythes of masonry separated by a continuous airspace (cavity).

With closed-cell rigid board cavity insulation, a 1 in. clear airspace between the insulation and the outer wythe is required (2 in.

is preferred) to help ensure free water drainage (ref. 7). Cavity assemblies are typically designed and detailed using actual out-to-out dimensions. Thus, a 14-in. cavity wall with a nominal 4-in. exterior wythe and 8-in. backup wythe has a nominal cavity width of $2\frac{3}{4}$ in., allowing for $1\frac{3}{4}$ in. of rigid board insulation.

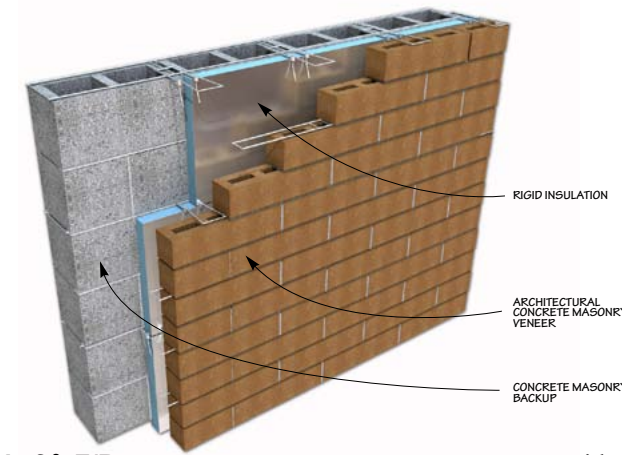
Typical cavity assemblies are constructed with a 4, 6, 8, 10 or 12 in. concrete masonry backup wythe, a 2 to $4\frac{1}{2}$ in. wide cavity, and a 4-in. masonry veneer. By reference to *Specification for Masonry Structures* (ref. 8), the *International Building Code* (ref. 9) prescriptively allows cavity widths up to $4\frac{1}{2}$ in., beyond which a detailed wall tie analysis must be performed.

Changing the interior finish materials does not typically change the overall assembly R-value significantly, unless the finish material itself is insulative. For cavity assemblies with interior-side finish materials installed on furring, such as wood paneling, the R-values for Assembly 10 can be used as a very close approximation. For finishes applied directly to the interior concrete masonry, such as an adhered masonry veneer or plaster, Assembly 9 R-values should be used.



Concrete Masonry Cavity Assemblies: No Interior Finishes

Assembly 9: Continuous insulation in cavity, 4-in. concrete masonry veneer
(Continued on next page)



Concrete Masonry Assembly R-Values, hrft²°F/Btu

Insulation type and thickness:	Density of CMU, pcf	6-in. Concrete Masonry				8-in. Concrete Masonry			
		UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted
extruded polystyrene, 1 in.	85	9.1	9.0	8.8	8.5	9.3	9.2	9.0	8.7
	95	9.0	8.9	8.7	8.4	9.2	9.0	8.9	8.6
	105	8.9	8.7	8.6	8.3	9.0	8.9	8.8	8.5
	115	8.8	8.6	8.5	8.2	8.9	8.8	8.7	8.4
	125	8.6	8.5	8.4	8.2	8.8	8.7	8.6	8.3
closed cell spray polyurethane foam, 1 in.	85	10.9	10.8	10.6	10.3	11.1	11.0	10.8	10.5
	95	10.8	10.7	10.5	10.2	11.0	10.8	10.7	10.4
	105	10.7	10.5	10.4	10.1	10.8	10.7	10.6	10.3
	115	10.6	10.4	10.3	10.0	10.7	10.6	10.5	10.2
	125	10.4	10.3	10.2	10.0	10.6	10.5	10.4	10.1
polyisocyanurate, 1 in.	85	12.6	12.5	12.3	12.0	12.8	12.7	12.5	12.2
	95	12.5	12.4	12.2	11.9	12.7	12.5	12.4	12.1
	105	12.4	12.2	12.1	11.8	12.5	12.4	12.3	12.0
	115	12.3	12.1	12.0	11.7	12.4	12.3	12.2	11.9
	125	12.1	12.0	11.9	11.7	12.3	12.2	12.1	11.8
extruded polystyrene, 1 1/2 in.	85	11.6	11.5	11.3	11.0	11.8	11.7	11.5	11.2
	95	11.5	11.4	11.2	10.9	11.7	11.5	11.4	11.1
	105	11.4	11.2	11.1	10.8	11.5	11.4	11.3	11.0
	115	11.3	11.1	11.0	10.7	11.4	11.3	11.2	10.9
	125	11.1	11.0	10.9	10.7	11.3	11.2	11.1	10.8
closed cell spray polyurethane foam, 1 1/2 in.	85	14.0	13.9	13.7	13.4	14.2	14.1	13.9	13.6
	95	13.9	13.8	13.6	13.3	14.1	13.9	13.8	13.5
	105	13.8	13.6	13.5	13.2	13.9	13.8	13.7	13.4
	115	13.7	13.5	13.4	13.1	13.8	13.7	13.6	13.3
	125	13.5	13.4	13.3	13.1	13.7	13.6	13.5	13.2
polyisocyanurate, 1 1/2 in.	85	16.4	16.3	16.1	15.8	16.6	16.5	16.3	16.0
	95	16.3	16.2	16.0	15.7	16.5	16.3	16.2	15.9
	105	16.2	16.0	15.9	15.6	16.3	16.2	16.1	15.8
	115	16.1	15.9	15.8	15.5	16.2	16.1	16.0	15.7
	125	15.9	15.8	15.7	15.5	16.1	16.0	15.9	15.6
extruded polystyrene, 2 in.	85	14.1	14.0	13.8	13.5	14.3	14.2	14.0	13.7
	95	14.0	13.9	13.7	13.4	14.2	14.0	13.9	13.6
	105	13.9	13.7	13.6	13.3	14.0	13.9	13.8	13.5
	115	13.8	13.6	13.5	13.2	13.9	13.8	13.7	13.4
	125	13.6	13.5	13.4	13.2	13.8	13.7	13.6	13.3
closed cell spray polyurethane foam, 2 in.	85	17.1	17.0	16.8	16.5	17.3	17.2	17.0	16.7
	95	17.0	16.9	16.7	16.4	17.2	17.0	16.9	16.6
	105	16.9	16.7	16.6	16.3	17.0	16.9	16.8	16.5
	115	16.8	16.6	16.5	16.2	16.9	16.8	16.7	16.4
	125	16.6	16.5	16.4	16.2	16.8	16.7	16.6	16.3
polyisocyanurate, 2 in.	85	20.3	20.2	20.0	19.7	20.5	20.4	20.2	19.9
	95	20.2	20.1	19.9	19.6	20.4	20.2	20.1	19.8
	105	20.1	19.9	19.8	19.5	20.2	20.1	20.0	19.7
	115	20.0	19.8	19.7	19.4	20.1	20.0	19.9	19.6
	125	19.8	19.7	19.6	19.4	20.0	19.9	19.8	19.5
135	19.7	19.6	19.6	19.3	19.9	19.8	19.7	19.5	

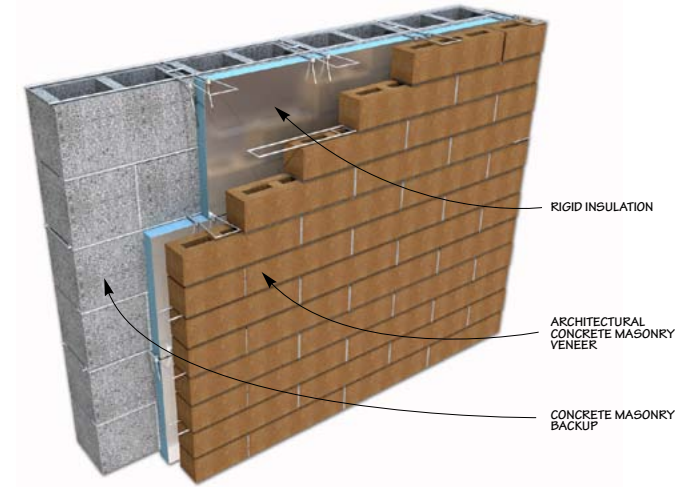
Concrete Masonry Assembly R-Values, hrft²°F/Btu

10-in. Concrete Masonry				12-in. Concrete Masonry			
UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted
9.3	9.3	9.2	8.9	9.4	9.3	9.3	9.1
9.2	9.1	9.0	8.8	9.2	9.2	9.1	9.0
9.1	9.0	8.9	8.7	9.1	9.1	9.0	8.9
9.0	8.9	8.8	8.6	9.0	9.0	8.9	8.8
8.8	8.8	8.7	8.5	8.9	8.9	8.8	8.7
8.7	8.7	8.6	8.4	8.8	8.8	8.7	8.6
11.1	11.1	11.0	10.7	11.2	11.1	11.1	10.9
11.0	10.9	10.8	10.6	11.0	11.0	10.9	10.8
10.9	10.8	10.7	10.5	10.9	10.9	10.8	10.7
10.8	10.7	10.6	10.4	10.8	10.8	10.7	10.6
10.6	10.6	10.5	10.3	10.7	10.7	10.6	10.5
10.5	10.5	10.4	10.2	10.6	10.6	10.5	10.4
12.8	12.8	12.7	12.4	12.9	12.8	12.8	12.6
12.7	12.6	12.5	12.3	12.7	12.7	12.6	12.5
12.6	12.5	12.4	12.2	12.6	12.6	12.5	12.4
12.5	12.4	12.3	12.1	12.5	12.5	12.4	12.3
12.3	12.3	12.2	12.0	12.4	12.4	12.3	12.2
12.2	12.2	12.1	11.9	12.3	12.3	12.2	12.1
11.8	11.8	11.7	11.4	11.9	11.8	11.8	11.6
11.7	11.6	11.5	11.3	11.7	11.7	11.6	11.5
11.6	11.5	11.4	11.2	11.6	11.6	11.5	11.4
11.5	11.4	11.3	11.1	11.5	11.5	11.4	11.3
11.3	11.3	11.2	11.0	11.4	11.4	11.3	11.2
11.2	11.2	11.1	10.9	11.3	11.3	11.2	11.1
14.2	14.2	14.1	13.8	14.3	14.2	14.2	14.0
14.1	14.0	13.9	13.7	14.1	14.1	14.0	13.9
14.0	13.9	13.8	13.6	14.0	14.0	13.9	13.8
13.9	13.8	13.7	13.5	13.9	13.9	13.8	13.7
13.7	13.7	13.6	13.4	13.8	13.8	13.7	13.6
13.6	13.6	13.5	13.3	13.7	13.7	13.6	13.5
16.6	16.6	16.5	16.2	16.7	16.6	16.6	16.4
16.5	16.4	16.3	16.1	16.5	16.5	16.4	16.3
16.4	16.3	16.2	16.0	16.4	16.4	16.3	16.2
16.3	16.2	16.1	15.9	16.3	16.3	16.2	16.1
16.1	16.1	16.0	15.8	16.2	16.2	16.1	16.0
16.0	16.0	15.9	15.7	16.1	16.1	16.0	15.9
14.3	14.3	14.2	13.9	14.4	14.3	14.3	14.1
14.2	14.1	14.0	13.8	14.2	14.2	14.1	14.0
14.1	14.0	13.9	13.7	14.1	14.1	14.0	13.9
14.0	13.9	13.8	13.6	14.0	14.0	13.9	13.8
13.8	13.8	13.7	13.5	13.9	13.9	13.8	13.7
13.7	13.7	13.6	13.4	13.8	13.8	13.7	13.6
17.3	17.3	17.2	16.9	17.4	17.3	17.3	17.1
17.2	17.1	17.0	16.8	17.2	17.2	17.1	17.0
17.1	17.0	16.9	16.7	17.1	17.1	17.0	16.9
17.0	16.9	16.8	16.6	17.0	17.0	16.9	16.8
16.8	16.8	16.7	16.5	16.9	16.9	16.8	16.7
16.7	16.7	16.6	16.4	16.8	16.8	16.7	16.6
20.5	20.5	20.4	20.1	20.6	20.5	20.5	20.3
20.4	20.3	20.2	20.0	20.4	20.4	20.3	20.2
20.3	20.2	20.1	19.9	20.3	20.3	20.2	20.1
20.2	20.1	20.0	19.8	20.2	20.2	20.1	20.0
20.0	20.0	19.9	19.7	20.1	20.1	20.0	19.9
19.9	19.9	19.8	19.6	20.0	20.0	19.9	19.8

- For assemblies with clay brick veneer, subtract 0.4 from the R-values listed. For 4-in. solid concrete masonry veneer, subtract 0.45.
- Note that R-values for assemblies with polyisocyanurate include a reflective air space (i.e., polyisocyanurate is foil-faced and the foil-faced side faces the air space).
- Thermal mass exposed to the conditioned space maximizes the benefits of thermal mass.
- Masonry exposed on both the interior and exterior provides maximum durability.
- The cavity width can be varied to accommodate various insulation thicknesses, achieving a wide range of R-values.
- Reinforcement and grouting schedule has little effect on assembly R-values.
- Cavity insulation can reduce heat loss and moisture movement due to air leakage when joints between the insulation boards are sealed.
- “Lightly reinforced” = grout 8 ft o.c. both vertically and horizontally (vertical reinforcement only at approximately 48 in. o.c.). “Heavily reinforced” = grout 32 in. o.c. vertically and 48 in. o.c. horizontally (vertical reinforcement only at approximately 24 in. o.c.).

Concrete Masonry Cavity Assemblies: No Interior Finishes

Assembly 9: Continuous insulation in cavity, 4-in. concrete masonry veneer
(continued)



Concrete Masonry Assembly R-Values, hrft²·°F/Btu

Insulation type and thickness:	Density of CMU, pcf	6-in. Concrete Masonry				8-in. Concrete Masonry			
		UngROUTED	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTED	Lightly reinforced	Heavily reinforced	Fully grouted
extruded polystyrene, 2 1/2 in.	85	16.6	16.5	16.3	16.0	16.8	16.7	16.5	16.2
	95	16.5	16.4	16.2	15.9	16.7	16.5	16.4	16.1
	105	16.4	16.2	16.1	15.8	16.5	16.4	16.3	16.0
	115	16.3	16.1	16.0	15.7	16.4	16.3	16.2	15.9
	125	16.1	16.0	15.9	15.7	16.3	16.2	16.1	15.8
closed cell spray polyurethane foam, 2 1/2 in.	85	20.1	20.0	19.8	19.5	20.3	20.2	20.0	19.7
	95	20.0	19.9	19.7	19.4	20.2	20.0	19.9	19.6
	105	19.9	19.7	19.6	19.3	20.0	19.9	19.8	19.5
	115	19.8	19.6	19.5	19.2	19.9	19.8	19.7	19.4
	125	19.6	19.5	19.4	19.2	19.8	19.7	19.6	19.3
polyisocyanurate, 2 1/2 in.	85	23.7	23.6	23.4	23.1	23.9	23.8	23.6	23.3
	95	23.6	23.5	23.3	23.0	23.8	23.6	23.5	23.2
	105	23.5	23.3	23.2	22.9	23.6	23.5	23.4	23.1
	115	23.4	23.2	23.1	22.8	23.5	23.4	23.3	23.0
	125	23.2	23.1	23.0	22.8	23.4	23.3	23.2	22.9
extruded polystyrene, 3 in.	85	19.1	19.0	18.8	18.5	19.3	19.2	19.0	18.7
	95	19.0	18.9	18.7	18.4	19.2	19.0	18.9	18.6
	105	18.9	18.7	18.6	18.3	19.0	18.9	18.8	18.5
	115	18.8	18.6	18.5	18.2	18.9	18.8	18.7	18.4
	125	18.6	18.5	18.4	18.2	18.8	18.7	18.6	18.3
closed cell spray polyurethane foam, 3 in.	85	23.1	23.0	22.8	22.5	23.3	23.2	23.0	22.7
	95	23.0	22.9	22.7	22.4	23.2	23.0	22.9	22.6
	105	22.9	22.7	22.6	22.3	23.0	22.9	22.8	22.5
	115	22.8	22.6	22.5	22.2	22.9	22.8	22.7	22.4
	125	22.6	22.5	22.4	22.2	22.8	22.7	22.6	22.3
polyisocyanurate, 3 in.	85	27.1	27.0	26.8	26.5	27.3	27.2	27.0	26.7
	95	27.0	26.9	26.7	26.4	27.2	27.0	26.9	26.6
	105	26.9	26.7	26.6	26.3	27.0	26.9	26.8	26.5
	115	26.8	26.6	26.5	26.2	26.9	26.8	26.7	26.4
	125	26.6	26.5	26.4	26.2	26.8	26.7	26.6	26.3
extruded polystyrene, 3 1/2 in.	85	21.6	21.5	21.3	21.0	21.8	21.7	21.5	21.2
	95	21.5	21.4	21.2	20.9	21.7	21.5	21.4	21.1
	105	21.4	21.2	21.1	20.8	21.5	21.4	21.3	21.0
	115	21.3	21.1	21.0	20.7	21.4	21.3	21.2	20.9
	125	21.1	21.0	20.9	20.7	21.3	21.2	21.1	20.8
closed cell spray polyurethane foam, 3 1/2 in.	85	26.1	26.0	25.8	25.5	26.3	26.2	26.0	25.7
	95	26.0	25.9	25.7	25.4	26.2	26.0	25.9	25.6
	105	25.9	25.7	25.6	25.3	26.0	25.9	25.8	25.5
	115	25.8	25.6	25.5	25.2	25.9	25.8	25.7	25.4
	125	25.6	25.5	25.4	25.2	25.8	25.7	25.6	25.3
polyisocyanurate, 3 1/2 in.	85	30.5	30.4	30.2	29.9	30.7	30.6	30.4	30.1
	95	30.4	30.3	30.1	29.8	30.6	30.4	30.3	30.0
	105	30.3	30.1	30.0	29.7	30.4	30.3	30.2	29.9
	115	30.2	30.0	29.9	29.6	30.3	30.2	30.1	29.8
	125	30.0	29.9	29.8	29.6	30.2	30.1	30.0	29.7
135	29.9	29.8	29.8	29.5	30.1	30.0	29.9	29.7	

Concrete Masonry Assembly R-Values, hrft²·°F/Btu

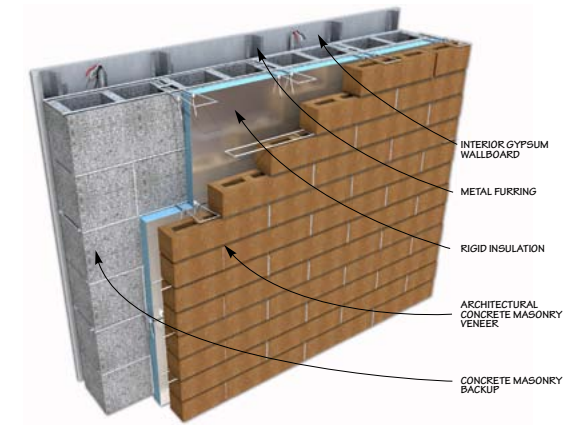
10-in. Concrete Masonry				12-in. Concrete Masonry			
UngROUTED	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTED	Lightly reinforced	Heavily reinforced	Fully grouted
16.8	16.8	16.7	16.4	16.9	16.8	16.8	16.6
16.7	16.6	16.5	16.3	16.7	16.7	16.6	16.5
16.6	16.5	16.4	16.2	16.6	16.6	16.5	16.4
16.5	16.4	16.3	16.1	16.5	16.5	16.4	16.3
16.3	16.3	16.2	16.0	16.4	16.4	16.3	16.2
16.2	16.2	16.1	15.9	16.3	16.3	16.2	16.1
20.3	20.3	20.2	19.9	20.4	20.3	20.3	20.1
20.2	20.1	20.0	19.8	20.2	20.2	20.1	20.0
20.1	20.0	19.9	19.7	20.1	20.1	20.0	19.9
20.0	19.9	19.8	19.6	20.0	20.0	19.9	19.8
19.8	19.8	19.7	19.5	19.9	19.9	19.8	19.7
19.7	19.7	19.6	19.4	19.8	19.8	19.7	19.6
23.9	23.9	23.8	23.5	24.0	23.9	23.9	23.7
23.8	23.7	23.6	23.4	23.8	23.8	23.7	23.6
23.7	23.6	23.5	23.3	23.7	23.7	23.6	23.5
23.6	23.5	23.4	23.2	23.6	23.6	23.5	23.4
23.4	23.4	23.3	23.1	23.5	23.5	23.4	23.3
23.3	23.3	23.2	23.0	23.4	23.4	23.3	23.2
19.3	19.3	19.2	18.9	19.4	19.3	19.3	19.1
19.2	19.1	19.0	18.8	19.2	19.2	19.1	19.0
19.1	19.0	18.9	18.7	19.1	19.1	19.0	18.9
19.0	18.9	18.8	18.6	19.0	19.0	18.9	18.8
18.8	18.8	18.7	18.5	18.9	18.9	18.8	18.7
18.7	18.7	18.6	18.4	18.8	18.8	18.7	18.6
23.3	23.3	23.2	22.9	23.4	23.3	23.3	23.1
23.2	23.1	23.0	22.8	23.2	23.2	23.1	23.0
23.1	23.0	22.9	22.7	23.1	23.1	23.0	22.9
23.0	22.9	22.8	22.6	23.0	23.0	22.9	22.8
22.8	22.8	22.7	22.5	22.9	22.9	22.8	22.7
22.7	22.7	22.6	22.4	22.8	22.8	22.7	22.6
27.3	27.3	27.2	26.9	27.4	27.3	27.3	27.1
27.2	27.1	27.0	26.8	27.2	27.2	27.1	27.0
27.1	27.0	26.9	26.7	27.1	27.1	27.0	26.9
27.0	26.9	26.8	26.6	27.0	27.0	26.9	26.8
26.8	26.8	26.7	26.5	26.9	26.9	26.8	26.7
26.7	26.7	26.6	26.4	26.8	26.8	26.7	26.6
21.8	21.8	21.7	21.4	21.9	21.8	21.8	21.6
21.7	21.6	21.5	21.3	21.7	21.7	21.6	21.5
21.6	21.5	21.4	21.2	21.6	21.6	21.5	21.4
21.5	21.4	21.3	21.1	21.5	21.5	21.4	21.3
21.3	21.3	21.2	21.0	21.4	21.4	21.3	21.2
21.2	21.2	21.1	20.9	21.3	21.3	21.2	21.1
26.3	26.3	26.2	25.9	26.4	26.3	26.3	26.1
26.2	26.1	26.0	25.8	26.2	26.2	26.1	26.0
26.1	26.0	25.9	25.7	26.1	26.1	26.0	25.9
26.0	25.9	25.8	25.6	26.0	26.0	25.9	25.8
25.8	25.8	25.7	25.5	25.9	25.9	25.8	25.7
25.7	25.7	25.6	25.4	25.8	25.8	25.7	25.6
30.7	30.7	30.6	30.3	30.8	30.7	30.7	30.5
30.6	30.5	30.4	30.2	30.6	30.6	30.5	30.4
30.5	30.4	30.3	30.1	30.5	30.5	30.4	30.3
30.4	30.3	30.2	30.0	30.4	30.4	30.3	30.2
30.2	30.2	30.1	29.9	30.3	30.3	30.2	30.1
30.1	30.1	30.0	29.8	30.2	30.2	30.1	30.0

- For assemblies with clay brick veneer, subtract 0.4 from the R-values listed. For assemblies with 4-in. solid concrete masonry veneer, subtract 0.45 from listed the R-values.
- Note that R-values for assemblies with polyisocyanurate insulation include a reflective air space (i.e., polyisocyanurate is foil-faced and the foil-faced side faces the air space).
- Thermal mass exposed to the conditioned space maximizes the benefits of thermal mass.
- Masonry exposed on both the interior and exterior provides maximum durability.
- The cavity width can be varied to accommodate various insulation thicknesses, achieving a wide range of R-values.
- Reinforcement and grouting schedule has little effect on assembly R-values.
- Cavity insulation can reduce heat loss and moisture movement due to air leakage when joints between the insulation boards are sealed.
- “Lightly reinforced” = grout 8 ft o.c. both vertically and horizontally (vertical reinforcement only at approximately 48 in. o.c.). “Heavily reinforced” = grout 32 in. o.c. vertically and 48 in. o.c. horizontally (vertical reinforcement only at approximately 24 in. o.c.).

Concrete Masonry Cavity Assemblies: Interior Wallboard

Assembly 10: Continuous insulation in cavity, 4-in. concrete masonry veneer, 1/2 in. gypsum wallboard on furring

(Continued on next page)



Concrete Masonry Assembly R-Values, hrft²·°F/Btu

Insulation type and thickness:	Density of CMU, pcf	6-in. Concrete Masonry				8-in. Concrete Masonry			
		UngROUTED	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTED	Lightly reinforced	Heavily reinforced	Fully grouted
extruded polystyrene, 1 in.	85	10.5	10.4	10.2	9.9	10.7	10.6	10.5	10.1
	95	10.4	10.3	10.1	9.8	10.6	10.5	10.3	10.0
	105	10.3	10.2	10.0	9.7	10.4	10.3	10.2	9.9
	115	10.2	10.1	9.9	9.6	10.3	10.2	10.1	9.8
	125	10.1	10.0	9.9	9.6	10.2	10.1	10.0	9.8
closed cell spray polyurethane foam, 1 in.	85	12.3	12.2	12.0	11.7	12.5	12.4	12.3	11.9
	95	12.2	12.1	11.9	11.6	12.4	12.3	12.1	11.8
	105	12.1	12.0	11.8	11.5	12.2	12.1	12.0	11.7
	115	12.0	11.9	11.7	11.4	12.1	12.0	11.9	11.6
	125	11.9	11.8	11.7	11.4	12.0	11.9	11.8	11.6
polyisocyanurate, 1 in.	85	14.0	13.9	13.7	13.4	14.2	14.1	14.0	13.6
	95	13.9	13.8	13.6	13.3	14.1	14.0	13.8	13.5
	105	13.8	13.7	13.5	13.2	13.9	13.8	13.7	13.4
	115	13.7	13.6	13.4	13.1	13.8	13.7	13.6	13.3
	125	13.6	13.5	13.4	13.1	13.7	13.6	13.5	13.3
extruded polystyrene, 1 1/2 in.	85	13.0	12.9	12.7	12.4	13.2	13.1	13.0	12.6
	95	12.9	12.8	12.6	12.3	13.1	13.0	12.8	12.5
	105	12.8	12.7	12.5	12.2	12.9	12.8	12.7	12.4
	115	12.7	12.6	12.4	12.1	12.8	12.7	12.6	12.3
	125	12.6	12.5	12.4	12.1	12.7	12.6	12.5	12.3
closed cell spray polyurethane foam, 1 1/2 in.	85	15.4	15.3	15.1	14.8	15.6	15.5	15.4	15.0
	95	15.3	15.2	15.0	14.7	15.5	15.4	15.2	14.9
	105	15.2	15.1	14.9	14.6	15.3	15.2	15.1	14.8
	115	15.1	15.0	14.8	14.5	15.2	15.1	15.0	14.7
	125	15.0	14.9	14.8	14.5	15.1	15.0	14.9	14.7
polyisocyanurate, 1 1/2 in.	85	17.8	17.7	17.5	17.2	18.0	17.9	17.8	17.4
	95	17.7	17.6	17.4	17.1	17.9	17.8	17.6	17.3
	105	17.6	17.5	17.3	17.0	17.7	17.6	17.5	17.2
	115	17.5	17.4	17.2	16.9	17.6	17.5	17.4	17.1
	125	17.4	17.3	17.2	16.9	17.5	17.4	17.3	17.1
extruded polystyrene, 2 in.	85	15.5	15.4	15.2	14.9	15.7	15.6	15.5	15.1
	95	15.4	15.3	15.1	14.8	15.6	15.5	15.3	15.0
	105	15.3	15.2	15.0	14.7	15.4	15.3	15.2	14.9
	115	15.2	15.1	14.9	14.6	15.3	15.2	15.1	14.8
	125	15.1	15.0	14.9	14.6	15.2	15.1	15.0	14.8
closed cell spray polyurethane foam, 2 in.	85	18.5	18.4	18.2	17.9	18.7	18.6	18.5	18.1
	95	18.4	18.3	18.1	17.8	18.6	18.5	18.3	18.0
	105	18.3	18.2	18.0	17.7	18.4	18.3	18.2	17.9
	115	18.2	18.1	17.9	17.6	18.3	18.2	18.1	17.8
	125	18.1	18.0	17.9	17.6	18.2	18.1	18.0	17.8
polyisocyanurate, 2 in.	85	21.7	21.6	21.4	21.1	21.9	21.8	21.7	21.3
	95	21.6	21.5	21.3	21.0	21.8	21.7	21.5	21.2
	105	21.5	21.4	21.2	20.9	21.6	21.5	21.4	21.1
	115	21.4	21.3	21.1	20.8	21.5	21.4	21.3	21.0
	125	21.3	21.2	21.1	20.8	21.4	21.3	21.2	21.0
135	21.2	21.1	21.0	20.7	21.3	21.2	21.1	20.9	

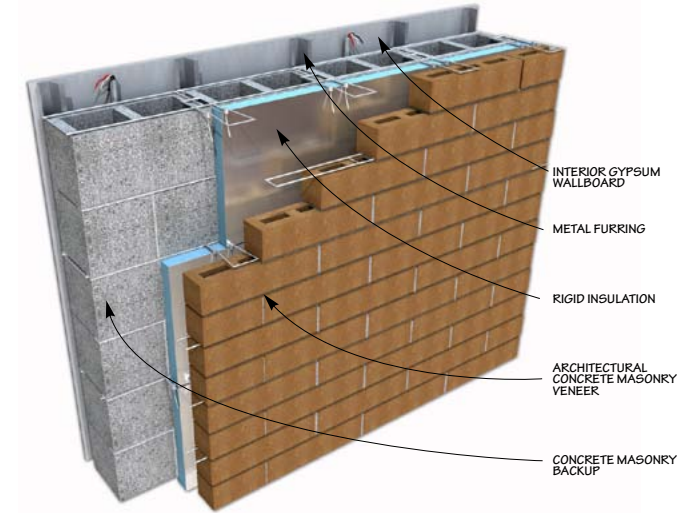
Concrete Masonry Assembly R-Values, hrft²·°F/Btu

10-in. Concrete Masonry				12-in. Concrete Masonry			
UngROUTED	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTED	Lightly reinforced	Heavily reinforced	Fully grouted
10.8	10.7	10.6	10.3	10.8	10.7	10.7	10.5
10.6	10.5	10.5	10.2	10.7	10.6	10.5	10.4
10.5	10.4	10.3	10.1	10.5	10.5	10.4	10.3
10.4	10.3	10.2	10.0	10.4	10.4	10.3	10.2
10.3	10.2	10.1	9.9	10.3	10.3	10.2	10.1
10.2	10.1	10.0	9.8	10.2	10.2	10.1	10.0
12.6	12.5	12.4	12.1	12.6	12.5	12.5	12.3
12.4	12.3	12.3	12.0	12.5	12.4	12.3	12.2
12.3	12.2	12.1	11.9	12.3	12.3	12.2	12.1
12.2	12.1	12.0	11.8	12.2	12.2	12.1	12.0
12.1	12.0	11.9	11.7	12.1	12.1	12.0	11.9
12.0	11.9	11.8	11.6	12.0	12.0	11.9	11.8
14.3	14.2	14.1	13.8	14.3	14.2	14.2	14.0
14.1	14.0	14.0	13.7	14.2	14.1	14.0	13.9
14.0	13.9	13.8	13.6	14.0	14.0	13.9	13.8
13.9	13.8	13.7	13.5	13.9	13.9	13.8	13.7
13.8	13.7	13.6	13.4	13.8	13.8	13.7	13.6
13.7	13.6	13.5	13.3	13.7	13.7	13.6	13.5
13.3	13.2	13.1	12.8	13.3	13.2	13.2	13.0
13.1	13.0	13.0	12.7	13.2	13.1	13.0	12.9
13.0	12.9	12.8	12.6	13.0	13.0	12.9	12.8
12.9	12.8	12.7	12.5	12.9	12.9	12.8	12.7
12.8	12.7	12.6	12.4	12.8	12.8	12.7	12.6
12.7	12.6	12.5	12.3	12.7	12.7	12.6	12.5
15.7	15.6	15.5	15.2	15.7	15.6	15.6	15.4
15.5	15.4	15.4	15.1	15.6	15.5	15.4	15.3
15.4	15.3	15.2	15.0	15.4	15.4	15.3	15.2
15.3	15.2	15.1	14.9	15.3	15.3	15.2	15.1
15.2	15.1	15.0	14.8	15.2	15.2	15.1	15.0
15.1	15.0	14.9	14.7	15.1	15.1	15.0	14.9
18.1	18.0	17.9	17.6	18.1	18.0	18.0	17.8
17.9	17.8	17.8	17.5	18.0	17.9	17.8	17.7
17.8	17.7	17.6	17.4	17.8	17.8	17.7	17.6
17.7	17.6	17.5	17.3	17.7	17.7	17.6	17.5
17.6	17.5	17.4	17.2	17.6	17.6	17.5	17.4
17.5	17.4	17.3	17.1	17.5	17.5	17.4	17.3
15.8	15.7	15.6	15.3	15.8	15.7	15.7	15.5
15.6	15.5	15.5	15.2	15.7	15.6	15.5	15.4
15.5	15.4	15.3	15.1	15.5	15.5	15.4	15.3
15.4	15.3	15.2	15.0	15.4	15.4	15.3	15.2
15.3	15.2	15.1	14.9	15.3	15.3	15.2	15.1
15.2	15.1	15.0	14.8	15.2	15.2	15.1	15.0
18.8	18.7	18.6	18.3	18.8	18.7	18.7	18.5
18.6	18.5	18.5	18.2	18.7	18.6	18.5	18.4
18.5	18.4	18.3	18.1	18.5	18.5	18.4	18.3
18.4	18.3	18.2	18.0	18.4	18.4	18.3	18.2
18.3	18.2	18.1	17.9	18.3	18.3	18.2	18.1
18.2	18.1	18.0	17.8	18.2	18.2	18.1	18.0
22.0	21.9	21.8	21.5	22.0	21.9	21.9	21.7
21.8	21.7	21.7	21.4	21.9	21.8	21.7	21.6
21.7	21.6	21.5	21.3	21.7	21.7	21.6	21.5
21.6	21.5	21.4	21.2	21.6	21.6	21.5	21.4
21.5	21.4	21.3	21.1	21.5	21.5	21.4	21.3
21.4	21.3	21.2	21.0	21.4	21.4	21.3	21.2

- For assemblies with clay brick veneer, subtract 0.4 from the R-values listed. For assemblies with 4-in. solid concrete masonry veneer, subtract 0.45 from the listed R-values.
- Note that R-values for assemblies with polyisocyanurate insulation include a reflective air space (i.e., polyisocyanurate is foil-faced and the foil-faced side faces the air space).
- When using closed cell spray polyurethane foam insulation, use one approved for contact with water.
- Thermal mass exposed to the conditioned space maximizes the benefits of thermal mass.
- Interior furring allows for electrical rough-in.
- The cavity width can be varied to accommodate various insulation thicknesses, achieving a wide range of R-values.
- Reinforcement schedule has little effect on assembly R-values.
- Cavity insulation can reduce heat loss and moisture movement due to air leakage when joints between the insulation boards are sealed.
- “Lightly reinforced” = grout 8 ft o.c. both vertically and horizontally (vertical reinforcement only at approximately 48 in. o.c.). “Heavily reinforced” = grout 32 in. o.c. vertically and 48 in. o.c. horizontally (vertical reinforcement only at approximately 24 in. o.c.).

Concrete Masonry Cavity Assemblies: Interior Wallboard

Assembly 10: Continuous insulation in cavity, 4-in. concrete masonry veneer, 1/2 in. gypsum wallboard on furring
(continued)



Concrete Masonry Assembly R-Values, hrft²·°F/Btu

Insulation type and thickness:	Density of CMU, pcf	6-in. Concrete Masonry				8-in. Concrete Masonry			
		UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted
extruded polystyrene, 2 1/2 in.	85	18.0	17.9	17.7	17.4	18.2	18.1	18.0	17.6
	95	17.9	17.8	17.6	17.3	18.1	18.0	17.8	17.5
	105	17.8	17.7	17.5	17.2	17.9	17.8	17.7	17.4
	115	17.7	17.6	17.4	17.1	17.8	17.7	17.6	17.3
	125	17.6	17.5	17.4	17.1	17.7	17.6	17.5	17.3
135	17.5	17.4	17.3	17.0	17.6	17.5	17.4	17.2	
closed cell spray polyurethane foam, 2 1/2 in.	85	21.5	21.4	21.2	20.9	21.7	21.6	21.5	21.1
	95	21.4	21.3	21.1	20.8	21.6	21.5	21.3	21.0
	105	21.3	21.2	21.0	20.7	21.4	21.3	21.2	20.9
	115	21.2	21.1	20.9	20.6	21.3	21.2	21.1	20.8
	125	21.1	21.0	20.9	20.6	21.2	21.1	21.0	20.8
135	21.0	20.9	20.8	20.5	21.1	21.0	20.9	20.7	
polyisocyanurate, 2 1/2 in.	85	25.1	25.0	24.8	24.5	25.3	25.2	25.1	24.7
	95	25.0	24.9	24.7	24.4	25.2	25.1	24.9	24.6
	105	24.9	24.8	24.6	24.3	25.0	24.9	24.8	24.5
	115	24.8	24.7	24.5	24.2	24.9	24.8	24.7	24.4
	125	24.7	24.6	24.5	24.2	24.8	24.7	24.6	24.4
135	24.6	24.5	24.4	24.1	24.7	24.6	24.5	24.3	
extruded polystyrene, 3 in.	85	20.5	20.4	20.2	19.9	20.7	20.6	20.5	20.1
	95	20.4	20.3	20.1	19.8	20.6	20.5	20.3	20.0
	105	20.3	20.2	20.0	19.7	20.4	20.3	20.2	19.9
	115	20.2	20.1	19.9	19.6	20.3	20.2	20.1	19.8
	125	20.1	20.0	19.9	19.6	20.2	20.1	20.0	19.8
135	20.0	19.9	19.8	19.5	20.1	20.0	19.9	19.7	
closed cell spray polyurethane foam, 3 in.	85	24.5	24.4	24.2	23.9	24.7	24.6	24.5	24.1
	95	24.4	24.3	24.1	23.8	24.6	24.5	24.3	24.0
	105	24.3	24.2	24.0	23.7	24.4	24.3	24.2	23.9
	115	24.2	24.1	23.9	23.6	24.3	24.2	24.1	23.8
	125	24.1	24.0	23.9	23.6	24.2	24.1	24.0	23.8
135	24.0	23.9	23.8	23.5	24.1	24.0	23.9	23.7	
polyisocyanurate, 3 in.	85	28.5	28.4	28.2	27.9	28.7	28.6	28.5	28.1
	95	28.4	28.3	28.1	27.8	28.6	28.5	28.3	28.0
	105	28.3	28.2	28.0	27.7	28.4	28.3	28.2	27.9
	115	28.2	28.1	27.9	27.6	28.3	28.2	28.1	27.8
	125	28.1	28.0	27.9	27.6	28.2	28.1	28.0	27.8
135	28.0	27.9	27.8	27.5	28.1	28.0	27.9	27.7	
extruded polystyrene, 3 1/2 in.	85	23.0	22.9	22.7	22.4	23.2	23.1	23.0	22.6
	95	22.9	22.8	22.6	22.3	23.1	23.0	22.8	22.5
	105	22.8	22.7	22.5	22.2	22.9	22.8	22.7	22.4
	115	22.7	22.6	22.4	22.1	22.8	22.7	22.6	22.3
	125	22.6	22.5	22.4	22.1	22.7	22.6	22.5	22.3
135	22.5	22.4	22.3	22.0	22.6	22.5	22.4	22.2	
closed cell spray polyurethane foam, 3 1/2 in.	85	27.5	27.4	27.2	26.9	27.7	27.6	27.5	27.1
	95	27.4	27.3	27.1	26.8	27.6	27.5	27.3	27.0
	105	27.3	27.2	27.0	26.7	27.4	27.3	27.2	26.9
	115	27.2	27.1	26.9	26.6	27.3	27.2	27.1	26.8
	125	27.1	27.0	26.9	26.6	27.2	27.1	27.0	26.8
135	27.0	26.9	26.8	26.5	27.1	27.0	26.9	26.7	
polyisocyanurate, 3 1/2 in.	85	31.9	31.8	31.6	31.3	32.1	32.0	31.9	31.5
	95	31.8	31.7	31.5	31.2	32.0	31.9	31.7	31.4
	105	31.7	31.6	31.4	31.1	31.8	31.7	31.6	31.3
	115	31.6	31.5	31.3	31.0	31.7	31.6	31.5	31.2
	125	31.5	31.4	31.3	31.0	31.6	31.5	31.4	31.2
135	31.4	31.3	31.2	30.9	31.5	31.4	31.3	31.1	

Concrete Masonry Assembly R-Values, hrft²·°F/Btu

Insulation type and thickness:	Density of CMU, pcf	10-in. Concrete Masonry				12-in. Concrete Masonry			
		UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted	UngROUTed	Lightly reinforced	Heavily reinforced	Fully grouted
extruded polystyrene, 2 1/2 in.	85	18.3	18.2	18.1	17.8	18.3	18.2	18.2	18.0
	95	18.1	18.0	18.0	17.7	18.2	18.1	18.0	17.9
	105	18.0	17.9	17.8	17.6	18.0	18.0	17.9	17.8
	115	17.9	17.8	17.7	17.5	17.9	17.9	17.8	17.7
	125	17.8	17.7	17.6	17.4	17.8	17.8	17.7	17.6
	135	17.7	17.6	17.5	17.3	17.7	17.7	17.6	17.5
	85	21.8	21.7	21.6	21.3	21.8	21.7	21.7	21.5
	95	21.6	21.5	21.5	21.2	21.7	21.6	21.5	21.4
	105	21.5	21.4	21.3	21.1	21.5	21.5	21.4	21.3
	115	21.4	21.3	21.2	21.0	21.4	21.4	21.3	21.2
125	21.3	21.2	21.1	20.9	21.3	21.3	21.2	21.1	
135	21.2	21.1	21.0	20.8	21.2	21.2	21.1	21.0	
85	25.4	25.3	25.2	24.9	25.4	25.3	25.3	25.1	
95	25.2	25.1	25.1	24.8	25.3	25.2	25.1	25.0	
105	25.1	25.0	24.9	24.7	25.1	25.1	25.0	24.9	
115	25.0	24.9	24.8	24.6	25.0	25.0	24.9	24.8	
125	24.9	24.8	24.7	24.5	24.9	24.9	24.8	24.7	
135	24.8	24.7	24.6	24.4	24.8	24.8	24.7	24.6	
85	20.8	20.7	20.6	20.3	20.8	20.7	20.7	20.5	
95	20.6	20.5	20.5	20.2	20.7	20.6	20.5	20.4	
105	20.5	20.4	20.3	20.1	20.5	20.5	20.4	20.3	
115	20.4	20.3	20.2	20.0	20.4	20.4	20.3	20.2	
125	20.3	20.2	20.1	19.9	20.3	20.3	20.2	20.1	
135	20.2	20.1	20.0	19.8	20.2	20.2	20.1	20.0	
85	24.8	24.7	24.6	24.3	24.8	24.7	24.7	24.5	
95	24.6	24.5	24.5	24.2	24.7	24.6	24.5	24.4	
105	24.5	24.4	24.3	24.1	24.5	24.5	24.4	24.3	
115	24.4	24.3	24.2	24.0	24.4	24.4	24.3	24.2	
125	24.3	24.2	24.1	23.9	24.3	24.3	24.2	24.1	
135	24.2	24.1	24.0	23.8	24.2	24.2	24.1	24.0	
85	28.8	28.7	28.6	28.3	28.8	28.7	28.7	28.5	
95	28.6	28.5	28.5	28.2	28.7	28.6	28.5	28.4	
105	28.5	28.4	28.3	28.1	28.5	28.5	28.4	28.3	
115	28.4	28.3	28.2	28.0	28.4	28.4	28.3	28.2	
125	28.3	28.2	28.1	27.9	28.3	28.3	28.2	28.1	
135	28.2	28.1	28.0	27.8	28.2	28.2	28.1	28.0	
85	23.3	23.2	23.1	22.8	23.3	23.2	23.2	23.0	
95	23.1	23.0	23.0	22.7	23.2	23.1	23.0	22.9	
105	23.0	22.9	22.8	22.6	23.0	23.0	22.9	22.8	
115	22.9	22.8	22.7	22.5	22.9	22.9	22.8	22.7	
125	22.8	22.7	22.6	22.4	22.8	22.8	22.7	22.6	
135	22.7	22.6	22.5	22.3	22.7	22.7	22.6	22.5	
85	27.8	27.7	27.6	27.3	27.8	27.7	27.7	27.5	
95	27.6	27.5	27.5	27.2	27.7	27.6	27.5	27.4	
105	27.5	27.4	27.3	27.1	27.5	27.5	27.4	27.3	
115	27.4	27.3	27.2	27.0	27.4	27.4	27.3	27.2	
125	27.3	27.2	27.1	26.9	27.3	27.3	27.2	27.1	
135	27.2	27.1	27.0	26.8	27.2	27.2	27.1	27.0	
85	32.2	32.1	32.0	31.7	32.2	32.1	32.1	31.9	
95	32.0	31.9	31.9	31.6	32.1	32.0	31.9	31.8	
105	31.9	31.8	31.7	31.5	31.9	31.9	31.8	31.7	
115	31.8	31.7	31.6	31.4	31.8	31.8	31.7	31.6	
125	31.7	31.6	31.5	31.3	31.7	31.7	31.6	31.5	
135	31.6	31.5	31.4	31.2	31.6	31.6	31.5	31.4	

- For assemblies with clay brick veneer, subtract 0.4 from the R-values listed. For assemblies with 4-in. solid concrete masonry veneer, subtract 0.45 from the listed R-values.
- Note that R-values for assemblies with polyisocyanurate insulation include a reflective air space (i.e., polyisocyanurate is foil-faced and the foil-faced side is towards the air space).
- When using closed cell spray polyurethane foam insulation, use one approved for contact with water.
- Thermal mass exposed to the conditioned space maximizes thermal mass benefits.
- Interior furring allows for electrical rough-in.
- Cavity width can be varied to accommodate various insulation thicknesses, achieving a wide range of R-values.
- Reinforcement schedule has little effect on assembly R-values.
- Cavity insulation can reduce heat loss and moisture movement due to air leakage when joints between the insulation boards are sealed.
- “Lightly reinforced” = grout 8 ft o.c. both vertically and horizontally (vertical reinforcement only at approximately 48 in. o.c.). “Heavily reinforced” = grout 32 in. o.c. vertically and 48 in. o.c. horizontally (vertical reinforcement only at approximately 24 in. o.c.).

APPENDIX A—THERMAL DATA USED TO DEVELOP TABLES^A

Material:	Thermal resistivity (hrft ² ·°F/Btu·in)
Cellular polyisocyanurate, gas-impermeable facer	6.7 - 7.2 ^B
Closed-cell spray polyurethane foamed insulation (SPF)	6.3 - 6.8 ^C
Expanded polystyrene	4.0
Extruded polystyrene (XPS)	5.0
Polyurethane foamed-in-place ^E	5.91
Wood	1.00
Concrete:	
85 pcf	0.27
95 pcf	0.22
105 pcf	0.17
115 pcf	0.14
125 pcf	0.11
135 pcf	0.09
Grout	0.08
Mortar	0.10
Material:	R-Value (hrft ² ·°F/Btu)
1/2 in. gypsum wallboard	0.45
Surface air films:	
inside	0.68
outside	0.17
Air spaces:	
3/4 - 1 in. nonreflective	0.97
3/4 - 1 in. reflective	2.80
5/8 in. cement stucco	0.13
5/16 in. synthetic stucco	0.20
4 in. hollow concrete masonry exterior wythe	0.84 ^D
4 in. solid concrete masonry exterior wythe	0.39 ^D
4 in. clay brick exterior wythe	0.44

^A Thermal data may vary with manufacturer—verify information with manufacturer’s data.

^B The R-value of polyisocyanurate insulation does not vary linearly with thickness; R-values by thickness are: 1 in. = R6.7; 1.5 in. = R10.5; 2 in. = R14.4; 2.5 in. = R17.8; 3 in. = R21.2; 3.5 in. = R24.6

^C The R-value of SPF insulation does not vary linearly with thickness; R-values by thickness are: 1 in. = R6.8; 2 in. = R13; 3 in. = R19; 3.5 in. = R22

^D Applies to both full- and half-height units.

^E Note that this is not the same as latex or ureaformaldehyde foam.

APPENDIX B—METRIC CONVERSIONS

Inch-Pound To Metric Conversions

Quantity	to convert from these inch-pound units. . .	to these metric units. . .	multiply the inch-pound units by:
Length	mile (mi)	kilometer (km)	1.609344
	foot (ft)	meter (m)	0.3048
	foot (ft)	millimeter (mm)	304.8
	inch (in.)	millimeter (mm)	25.4
Area	square yard (yd ²)	square meter (m ²)	0.83612736
	square foot (ft ²)	square meter (m ²)	0.09290304
	square inch (in. ²)	square millimeter (mm ²)	645.16
Volume	cubic yard (yd ³)	cubic meter (m ³)	0.764555
	cubic foot (ft ³)	cubic meter (m ³)	0.0283168
	cubic inch (in. ³)	cubic millimeter (mm ³)	16,367.064
Mass	pound (lb)	kilogram (kg)	0.453592
	kip (k)	metric ton (t)	0.453592
Mass density	pounds/cubic foot (lb/ft ³ or pcf)	kilogram/cubic meter (kg/m ³)	16.0185
Force	pound (lb)	newton (N)	4.44822
	kip (k)	kilonewton (kN)	4.44822
Force per unit length	pound/foot (lb/ft or plf)	newton/meter (N/m)	14.5939
	kip/foot (k/ft)	kilonewton/meter (kN/m)	14.5939
Force per unit area	pound/square inch (lb/in. ² or psi)	megapascal (MPa)	0.00689476
	kip/square inch (k/in. ² or ksi)	megapascal (MPa)	6.89476
	pound/square foot (lb/ft ² or psf)	pascal (Pa)	47.8803
Bending moment	foot-pound (ft-lb)	newton · meter (N · m)	1.35582
	foot-kip (ft-k)	kilonewton · meter (kN · m)	1.35582
	inch-pound per foot (in.-lb/ft)	newton · meter per meter (N·m/m)	0.370686
Thermal resistance (R-Value)	square foot-hour-degree Fahrenheit/British thermal unit (ft ² -h-°F/Btu)	square meter · degree Kelvin/Watt (m ² · K/W)	0.176
	Thermal conductance (U-Factor)	British thermal unit/square foot-hour-degree Fahrenheit (Btu/h-ft ² -°F)	Watt/square meter · degree Kelvin (W/m ² · K)
Temperature	degrees Fahrenheit (°F)	degrees Celsius (°C)	°C = (°F - 32)/1.8
	degrees Fahrenheit (°F)	degrees Kelvin (K)	K = (°F + 459.67)/1.8

APPENDIX C—REFERENCES

1. *International Energy Conservation Code*. International Code Council, 2006 and 2009.
2. *Energy Standard for Buildings Except Low-Rise Residential Buildings*, ANSI/ASHRAE/IESNA 90.1. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 2004 and 2007.
3. *R-Values and U-Factors of Single Wythe Concrete Masonry Walls*, **TEK 6-2B**. National Concrete Masonry Association, 2009.
4. *ASHRAE Handbook, Fundamentals*. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 2005.
5. *Guide to Thermal Properties of Concrete and Masonry Systems*. ACI 122R-02. American Concrete Institute, 2002.
6. *R-Values of Multi-Wythe Concrete Masonry Walls*, **TEK 6-1B**. National Concrete Masonry Association, 2009.
7. *Building Code Requirements for Masonry Structures*, TMS 402/ACI 530/ASCE 5. Reported by the Masonry Standards Joint Committee, 2008.
8. *Specification for Masonry Structures*, TMS 602/ACI 530.1/ASCE 6. Reported by the Masonry Standards Joint Committee, 2008.
9. *International Building Code*. International Code Council, 2006 and 2009.



National Concrete Masonry Association
FOUNDATION

13750 Sunrise Valley Drive
Herndon, VA 20171
703-713-1900
www.ncma.org