Thermal Analysis
Effective R-Value Calculations
for
Omni Block
Insulated Concrete Block Walls
March 2013
Revised May 2017

Thermal Analysis
Effective R-Value Calculations
for
Omni Block
8 x 8 x16
Insulated Concrete Block Wall System

March 2013
Revised May 2017

Facts

According to the National Concrete Masonry Association (NCMA) the tested R-Value for a standard 8x8x16 concrete masonry unit (CMU) is 2.2 at 105 lb. density.

The tested solid grouted R-Value for the same unit is 1.7 proving that air is a better insulator than grout (which is a form of concrete).

Expanded Polystyrene (EPS) has a tested R-Value of 4 per inch at a 1.3 lb. density, which is significantly higher than air.

Asssumptions

Improving the CMU design and utilizing an insulating material within the CMU would greatly increase the R-Value of the CMU.

Findings

Omni Block consists of a unique block design that utilizes an additional middle lineal wall, which is parallel to the interior and exterior block face shells.

The additional middle lineal wall allows the block design to include offset and constricted cross webs (see drawings within).

The three face shells and offset and constricted cross webs create unique cells (or cores) that house specifically molded EPS insulation inserts.

Both layers of EPS inserts protrude below the block and the interior layer over laps from block-to-block, thus thermally protecting all horizontal and vertical mortar joints.

Each layer of EPS inserts has a less than a 10% continuous insulation correction factor.

It is this combination of an additional middle lineal wall, offset and constricted cross webs, and insulating cores that provide significantly higher R-values than standard CMU (see Table within).

May 2017 Revision

Graphics only were added; no change to calculations or results.

Block Face Shell Configuration Section

Face Shell - Standard nominally dimensioned 8” x 8” x 16” CMU consists of two (2) face shells.

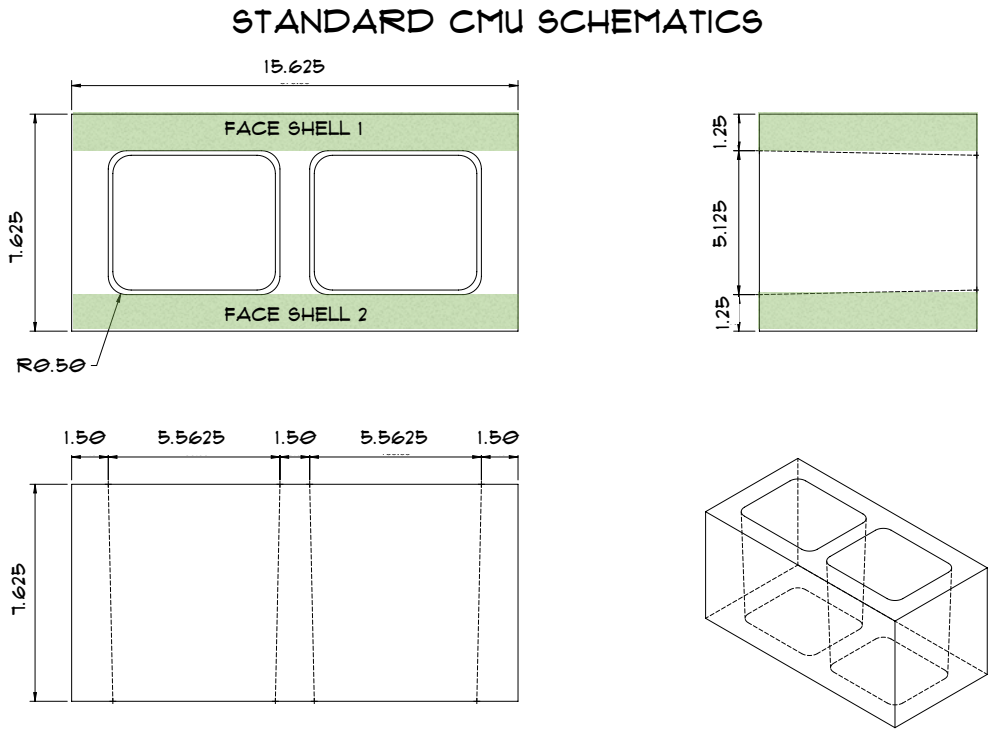
I. Determine cubic inches of two (2) standard nominal 8” CMU face shells (see green shaded areas):

Given:

$15^{5/8}$ = width of CMU face shell, in inches
$7^{5/8}$ = height of CMU face shell, in inches
$1^{1/4}$ = depth of CMU face shell, in inches
2 = quantity of CMU face shells

Then:

15.625 w x 7.625 h x 1.25 d = 148.93 cubic inches per face shell
148.93 x 2 = 297.86 total cubic inches of two standard nominal 8” CMU face shells



Face Shell - The nominally dimensioned Omni Block 8” stretcher unit consists of three (3) face shells.

II. Determine cubic inches of three (3) Omni Block 8” stretcher face shells (see orange shaded areas):

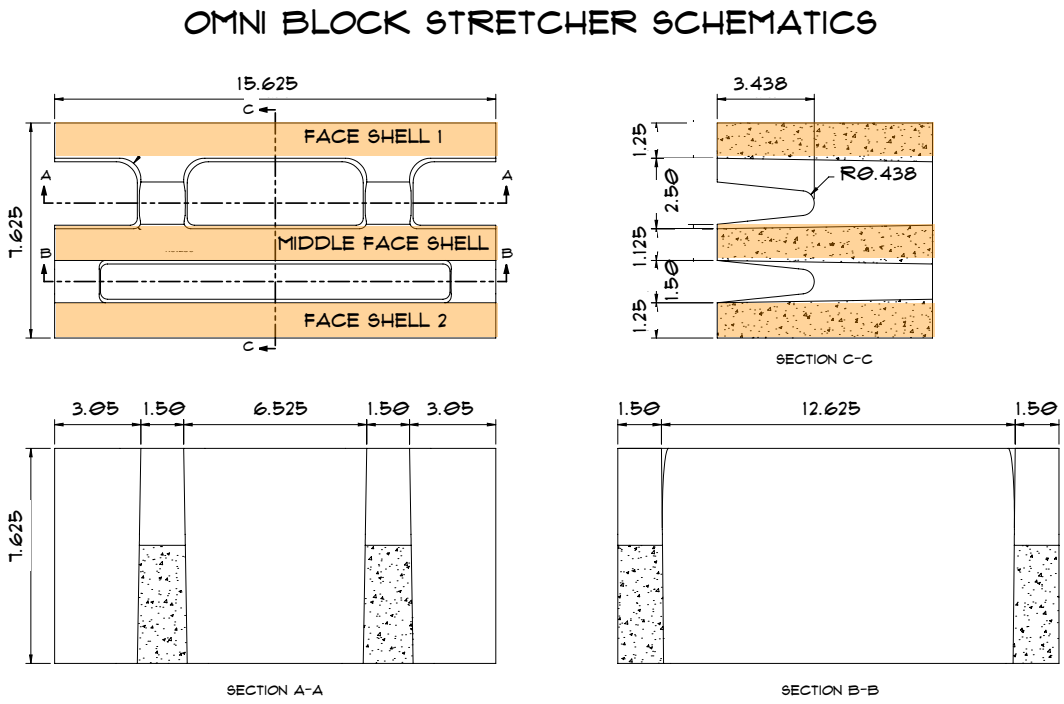
Given:

$15^{5/8}$ = width of Omni Block face shell, in inches
$7^{5/8}$ = height of Omni Block face shell, in inches
$1^{1/4}$ = depth of Omni Block face shell, in inches
3 = quantity of Omni Block face shells

Then:

15.625 w x 7.625 h x 1.25 d = 148.93 cubic inches per face shell
148.93 x 3 = 446.79 total cubic inches of three Omni Block nominal 8” stretcher face shells

Block Face Shell Configuration Section - continued



The objective of this section is to calculate the additional thermal resistance (or delayed thermal conductance) provided by an additional face shell.

Given:

297.86 = total cubic inches of two standard 8" CMU face shells

446.79 = total cubic inches of three Omni Block 8" stretcher face shells

Then:

(446.79 / 297.86) = 1.50

Omni Block 8" stretcher has 150% more or 1.50 times the resistance (or delayed thermal conductance) of a standard 8" CMU due to an additional face shell.

Resulting block face shell configuration calculation of an Omni Block 8" stretcher:

Given:

(hrft^2°F/Btu) = R-value of standard 8" CMU per associated density of concrete, all other variables remain constant (NCMA TEK 6 2-B)

1.50 additional face shell resistance (or delayed thermal conductance)

Then:

(hrft^2°F/Btu)(1.50) = additional resistance (or delayed thermal conductance) provided by additional face shell of an Omni Block 8" stretcher

Block Cross Web Configuration Section

Cross Web - Standard nominally dimensioned 8” x 8” x 16” CMU typically has three (3) full-height direct cross webs from one face shell to the other face shell.

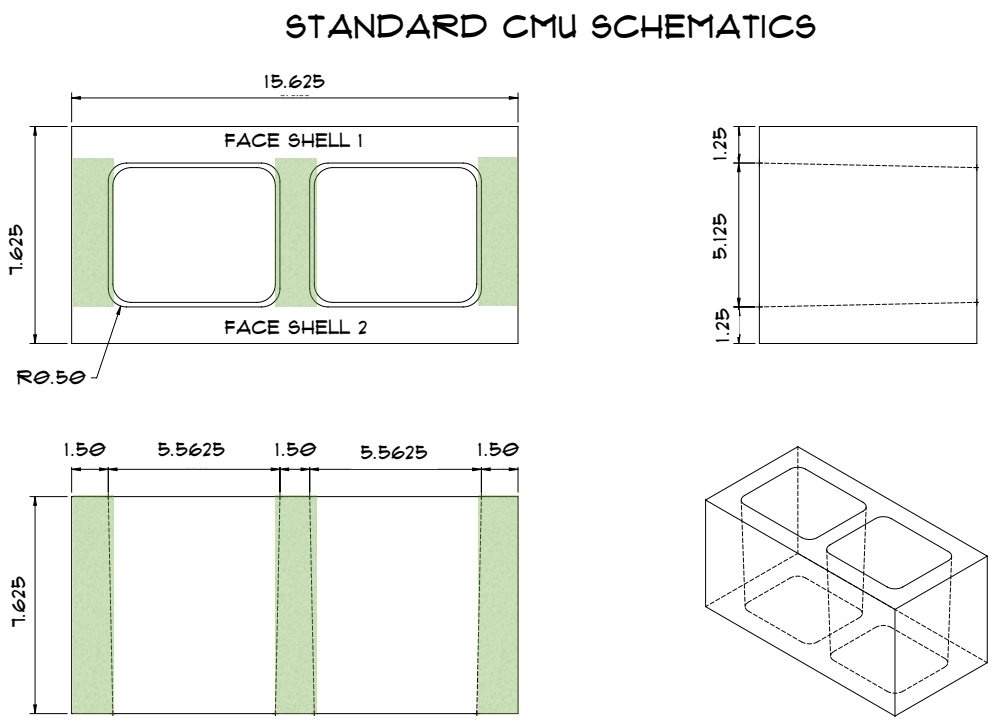
III. Determine cubic inches of three (3) standard 8” CMU cross webs (see green shaded areas):

Given:

$1^{1/2}$ = width of CMU cross web, in inches
$7^{5/8}$ = height of CMU cross web, in inches
$5^{1/8}$ = depth of CMU cross web (excluding interior and exterior face shell sections), in inches
3 = quantity of CMU cross webs

Then:

1.50 w x 7.625 h x 5.125 d = 58.62 cubic inches of cross web
58.62 x 3 = 175.86 total cubic inches of three standard 8” CMU cross webs



Cross Web - The nominally dimensioned Omni Block 8” stretcher has four (4) indirect, reduced-height, cross webs; two are from the interior face shell to the middle face shell and two from the middle face shell to the exterior face shell.

IV. Determine cubic inches of two (2) Omni Block 8” stretcher exterior cross webs (see orange shaded areas):

Given:

$1^{1/4}$ = width of Omni Block interior cross web, in inches
$4^{1/4}$ = height of Omni Block interior cross web, in inches
$2^{1/2}$ = depth of Omni Block interior cross web, in inches (from interior face shell to middle face shell)
2 = quantity of Omni Block interior cross webs

Then:

1.25 w x 4.25 h x 2.50 d = 13.28 cubic inches of interior cross web
13.28 x 2 = 26.56 total cubic inches of two Omni Block 8” stretcher interior cross webs

Block Cross Web Configuration Section - continued

v. Determine cubic inches of two (2) Omni Block 8” stretcher exterior cross webs (see orange shaded areas):

Given:

$1^{1/4}$ = width of Omni Block exterior cross web, in inches

$4^{1/4}$ = height of Omni Block exterior cross web, in inches

$1^{3/8}$ = depth of Omni Block exterior cross web, in inches (from middle face shell to exterior face shell)

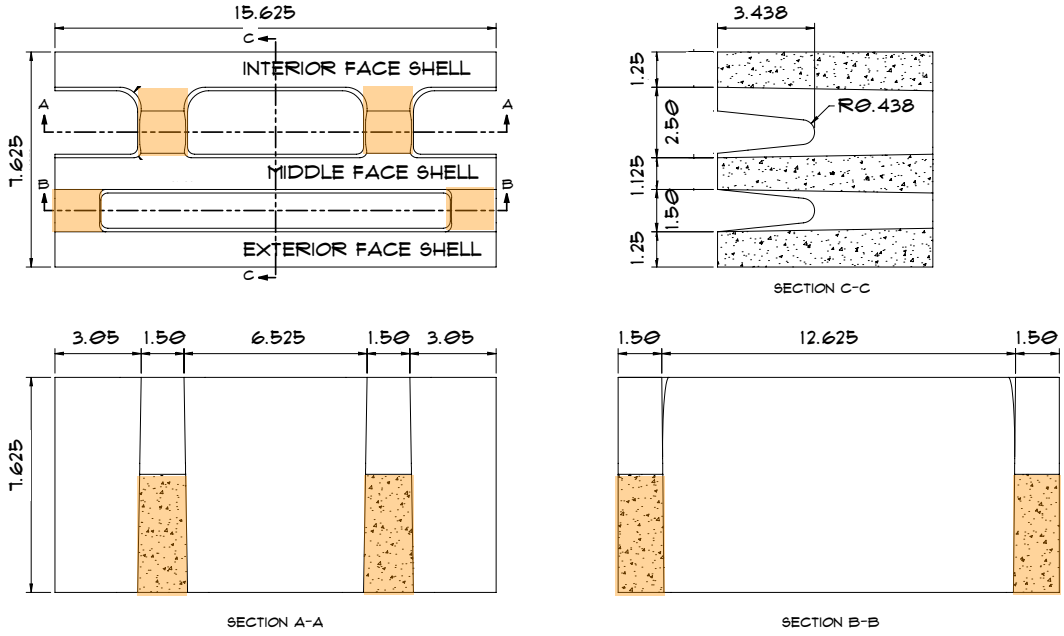
2 = quantity of Omni Block exterior cross webs

Then:

1.25 w x 4.25 h x 1.375 d = 7.30 cubic inches of exterior cross web

7.30 x 2 = 14.60 total cubic inches of two Omni Block 8” stretcher exterior cross webs

OMNI BLOCK STRETCHER SCHEMATICS



Given:

26.56 = total cubic inches of two Omni Block 8” stretcher interior cross webs

14.60 = total cubic inches of two Omni Block 8” stretcher exterior cross webs

Then:

26.56 + 14.60 = 41.16 total cubic inches of the Omni Block 8” stretcher cross webs

Block Cross Web Configuration Section - continued

The objective of this section is to calculate the additional thermal resistance (or delayed thermal conductance) provided by the indirect, reduced-height, cross webs of an Omni Block 8" stretcher.

Given:
175.86 = total cubic inches of standard 8" CMU cross webs
41.16 = total cubic inches of Omni Block 8" stretcher cross webs
Then:
41.16 / 175.86 = 0.234
Omni Block 8" stretcher cross web volume is equal to 23.4% of standard 8" CMU cross web volume.

Given:
0.234 = percent of Omni Block 8" stretcher cross web volume to standard 8" CMU cross web volume
5.125 = total standard 8" CMU cross web, in inches
7.625 = total standard 8" CMU block width, in inches
Then:
5.125 / 7.625 = 0.672 standard 8" CMU cross web volume (less face shells) within total standard 8" CMU block volume
0.672 x 0.234 = 0.157 Omni Block 8" stretcher cross web volume to total standard 8" CMU block volume
1 - (0.157 / 0.672) = 0.766
Omni Block 8" stretcher has a total of 76.6% additional effective resistance (or delayed thermal conductance) due to indirect, reduced-height, cross webs.

Resulting reduced cross web calculation of an Omni Block 8" stretcher:
Given:
(hrft^2°F/Btu) = R-value of standard 8" CMU per associated density of concrete, all other variables remain constant (NCMA TEK 6 2-B)
76.6% additional effective resistance (or delayed thermal conductance) due to indirect, reduced-height, cross webs
Then:
(hrft^2°F/Btu)(1.766) = additional resistance (or reduced thermal conductance) provided by indirect, reduced-height, cross webs of an Omni Block 8" stretcher

Block Face Shell Configuration and Cross Web Configuration Effect on Omni Block Stretcher R-Value

Summation of the additional resistance (or reduced thermal conductance) that must be factored for the Omni Block 8" stretcher when all cores are empty:
Given:
(hrft^2°F/Btu)(1.50) = additional resistance (or delayed thermal conductance) provided by additional face shell of an Omni Block 8" stretcher
(hrft^2°F/Btu)(1.766) = additional resistance (or reduced thermal conductance) provided by indirect, reduced-height, cross webs of an Omni Block 8" stretcher
Then:
(hrft^2°F/Btu)(1.50)+(hrft^2°F/Btu)(1.766) = (hrft^2°F/Btu)(1.50 + 1.766) = (hrft^2°F/Btu)(3.266)
Omni Block 8" stretcher has 3.266 times the R-value of standard 8" CMU.

Continuous Interior Insert Insulation Correction Section

Interior Continuous Insulation Correction - Omni Block 8" stretcher interior continuous insulation has two (2) partial "breaks" (due to constricted block cross webs).

VI. Determine cubic inches of Omni Block 8" stretcher interior EPS foam inserts:

Given:

16 = total width of foam, in inches
8 = total height of foam, in inches
$2^{1/4}$ = interior insert depth, in inches

Then:

16 w x 8 h x 2.25 d = 288 total cubic inches of Omni Block 8" stretcher interior foam

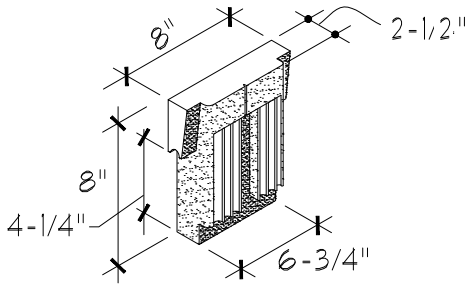
VII. Determine cubic inches of two (2) Omni Block 8" stretcher interior cross webs :

Given:

$1^{1/4}$ = width of Omni Block interior cross web, in inches
$4^{1/4}$ = height of Omni Block interior cross web, in inches
$2^{1/2}$ = depth of Omni Block interior cross web (interior face shell to middle face shell), in inches
2 = quantity of Omni Block interior cross webs

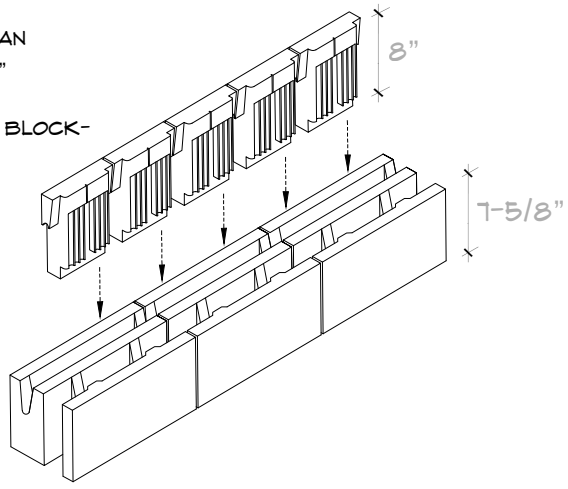
Then:

1.25 w x 4.25 h x 2.50 d = 13.28 cubic inches of Omni Block 8" stretcher interior cross web
13.28 x 2 = 26.56 total cubic inches of two Omni Block 8" stretcher interior cross webs



INTERIOR INSULATION INSERT

NOTE:
1) INSULATION IS 3/8" TALLER THAN BLOCK TO PROTECT THE 3/8" HORIZONTAL MORTAR JOINT.
2) INSULATION OVERLAPS FROM BLOCK-TO-BLOCK TO PROTECT THE VERTICAL MORTAR JOINT.



INTERIOR INSULATION INSTALLATION

Continuous Interior Insert Insulation Correction Section - continued

The objective of this calculation is to determine the percent that should be deducted from the R-value of the interior insulation inserts due to the cross web areas of each block.

Given:

288 = total cubic inches of Omni Block interior foam

26.56 = total cubic inches of two Omni Block 8" stretcher interior cross webs

Then:

26.56 / 288 = 0.092 percent of total Omni Block 8" stretcher interior cross web volume to total interior EPS foam insert volume

1 - .092 = 0.908

Omni Block 8" stretcher has 90.8% of continuous insulation value of interior foam insert R-value.

Resulting calculation provides the continuous insulation correction of the interior foam insert:

Given:

2.25 = EPS foam depth, in inches

4.00 = R-value per inch of 1.35 lb. EPS foam (ICC ESR-1498 and ASTM C 578)

0.908 = percent of continuous insulation value of interior foam insert

Then:

[(2.25)(4.00)](0.908) = 8.17 additional interior continuous insulation R-value of an Omni Block 8" stretcher in relation to non-insulated standard 8" CMU.

Continuous Exterior Insert Insulation Correction Section

Exterior Continuous Insulation Correction - Omni Block 8" stretcher exterior continuous insulation has two (2) partial "breaks" (due to constricted block cross webs).

VIII. Determine Omni Block 8" stretcher exterior EPS foam inserts cubic inches:

Given:

$15^{5/8}$ = total width of foam area, in inches

8 = total height of foam area, in inches

$1^{3/8}$ = exterior insert thickness, in inches

Then:

15.675 w x 8 h x 1.375 d = 172 total cubic inches of Omni Block exterior foam

IX. Determine cubic inches of two (2) Omni Block 8" stretcher exterior cross webs:

Given:

$1^{1/4}$ = width of Omni Block exterior cross web, in inches

$4^{1/4}$ = height of Omni Block exterior cross web, in inches

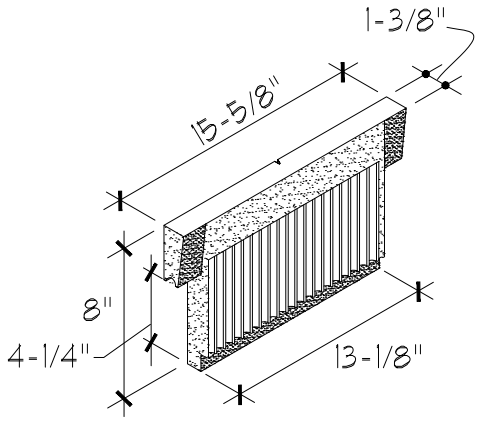
$1^{3/8}$ = depth of Omni Block exterior cross web, in inches

2 = quantity of Omni Block exterior cross webs

Then:

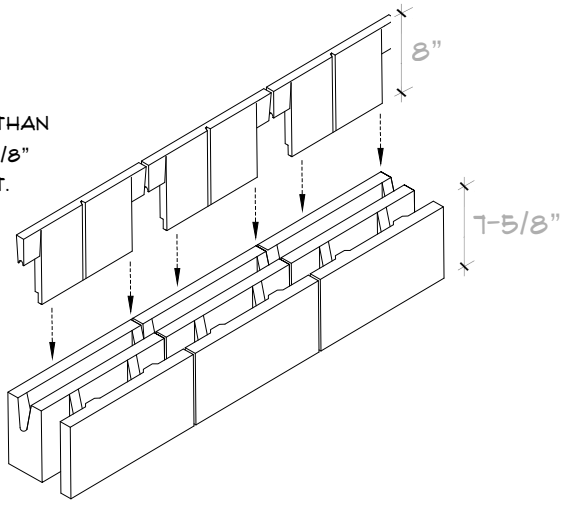
1.25 w x 4.25 h x 1.375 d = 7.30 cubic inches of Omni Block exterior cross web

7.30 x 2 = 14.60 total cubic inches of two Omni Block exterior cross webs



EXTERIOR INSULATION INSERT

NOTE:
1) INSULATION IS 3/8" TALLER THAN BLOCK TO PROTECT THE 3/8" HORIZONTAL MORTAR JOINT.



EXTERIOR INSULATION INSTALLATION

Continuous Exterior Insulation Insert Correction Section - continued

The objective of this calculation is to determine the percent that should be deducted from the R-value of the exterior insulation inserts due to the cross web areas of the block.

X. Determine cubic inches where Omni Block 8" stretcher exterior foam does not protect the vertical mortar joint:

Given:

$^{3/8}$ = width of vertical mortar joint, in inches

8 = height of vertical mortar joint, in inches

$1^{3/8}$ = depth of unprotected vertical mortar joint, in inches

Then:

0.375 w x 8 h x 1.375 d = 4.13 cubic inches of the unprotected vertical mortar joint

Given:

14.60 = total cubic inches of two Omni Block exterior cross webs

4.13 = cubic inches of the unprotected vertical mortar joint

Then:

14.60 + 4.13 = 18.73 total cubic inches without EPS insulation

Given:

18.73 = total cubic inches without EPS insulation

172 = total cubic inches of Omni Block exterior insulation

Then:

18.73 / 172 = 0.109 percent of total Omni Block 8" stretcher exterior cross web volume to total exterior EPS foam insert volume

1 - 0.109 = 0.891

Omni Block 8" stretcher has 89.1% percent of continuous insulation value of exterior foam insert R-value.

Resulting calculation provides the exterior Omni Block 8" stretcher continuous insulation correction:

Given:

1.375 = EPS foam depth, in inches

4.00 = R-value per inch of 1.35 lb. EPS foam (ICC ESR-1498 and ASTM C 578)

0.891 = percent of continuous insulation value of exterior foam insert

Then:

[(1.375)(4.00)](0.891) = 4.90 additional exterior continuous insulation R-value of an Omni Block 8' stretcher in relation to non-insulated standard 8" CMU

Continuous Interior Insulation Insert Correction and Continuous Exterior Insulation Insert Correction Effect on Omni Block Stretcher R-Value

Summation of the Omni Block 8" stretcher continuous insulation correction:

Given:

[(2.25)(4.00)](0.908) = 8.17 additional interior continuous insulation R-value of an Omni Block 8" stretcher

[(1.375)(4.00)](0.891) = 4.90 additional exterior continuous insulation R-value of an Omni Block 8' stretcher

Then:

8.17 + 4.90 = 13.07

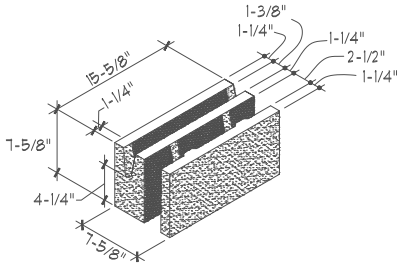
Omni Block 8" stretcher has 13.07 total additional continuous insulation R-value in relation to non-insulated standard 8" CMU

Totals

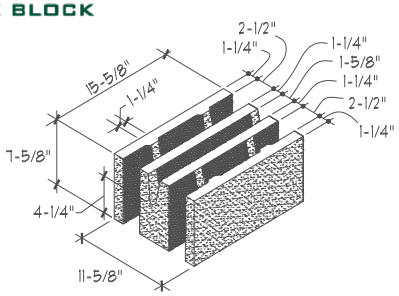
The table below illustrates the R-Value effects of the preceeding calculations of the Omni Block 8” stretcher Face Shell and Cross Web Correction Factors as well as the Continuous Insulation Correction.

Nominal Thickness	Concrete Density pcf	Standard CMU Cores Empty R-Value		Face Shell and Cross Web Correction Factor		Omni Block Stretcher Cores Empty R-Value		Continuous Insulation Correction Add		Omni Block Stretcher Cores with EPS Inserts R-Value
8”	85	2.5	X	3.266	=	8.2	+	21.24	=	21.2
8”	95	2.3	X	3.266	=	7.5	+	21.24	=	20.6
8”	105	2.2	X	3.266	=	7.2	+	21.24	=	20.2
8”	115	2.1	X	3.266	=	6.8	+	21.24	=	19.9
8”	125	2.0	X	3.266	=	6.5	+	21.24	=	19.6
8”	135	1.9	X	3.266	=	6.2	+	21.24	=	19.3

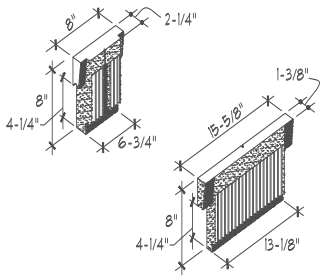
The resulting data is used to complete the Tables on the following page.



STRETCHER - 8 x 8 x 16



STRETCHER - 12 x 8 x 16



INSULATION INSERTS

Table 1 - U-Factors (Btu/hrft²°F) and R-Values (hrft²°F/Btu) of Concrete Masonry Walls [A]

Nominal Wythe Thickness in. (mm)	Concrete Density pcf	Standard CMU Cores Empty		100% Solid Grouted [B]	
		U	R	U	R
8 in. (203mm)	85	0.402	2.5	0.525	1.9
	95	0.427	2.3	0.559	1.8
	105	0.452	2.2	0.592	1.7
	115	0.479	2.1	0.623	1.6
	125	0.507	2.0	0.654	1.5
	135	0.537	1.9	0.684	1.5
12 in. (305mm)	85	0.390	2.6	0.441	2.3
	95	0.411	2.4	0.466	2.1
	105	0.433	2.3	0.490	2.0
	115	0.455	2.2	0.515	1.9
	125	0.478	2.1	0.539	1.9
	135	0.503	2.0	0.564	1.8

Table 1 Source: Abbreviated NCMA TEK 6-2B

[A] (hrft²°F/Btu) (0.176) = m²K/W. Mortar joints are 3/8" (9.5 mm) thick, with face shell mortar bedding. Unit dimensions based on *Standard Specification for Loadbearing Concrete Masonry Units,* ASTM C 90. Surface air films are included.

[B] Grout density is 140 pcf (2,243 kg/m³). Lightweight grouts will provide higher R-values and may be used.

Table 2 - U-Factors (Btu/hrft²°F) and R-Values (hrft²°F/Btu) of Omni Block Walls [A]

Nominal Wythe Thickness in. (mm)	Concrete Density pcf	Stretcher Unit Cores Empty [C]		Cores With EPS Inserts [D,E]	
		U	R	U	R
8 in. (203mm)	85	0.123	8.2	0.047	21.2
	95	0.133	7.5	0.048	20.6
	105	0.139	7.2	0.049	20.2
	115	0.146	6.8	0.050	19.9
	125	0.153	6.5	0.051	19.6
	135	0.161	6.2	0.052	19.3
12 in. (305mm)	85	0.102	9.8	0.032	31.0
	95	0.110	9.1	0.033	30.3
	105	0.115	8.7	0.033	29.9
	115	0.121	8.3	0.034	29.5
	125	0.126	7.9	0.034	29.2
	135	0.133	7.5	0.035	28.8

Table 2 Source: Tom Norris, Architect (ICC Certified)

[C] 8 inch unit has an additional face shell and reduced cross-web conductance. Resulting formula: (hrft²°F/Btu)(1.50)+(hrft²°F/Btu)(1.76).
12 inch unit has two additional face shells and reduced cross-web conductance. Resulting formula: (hrft²°F/Btu)(2.00)+(hrft²°F/Btu)(1.772).

[D] Values apply when all cores are filled completely.

[E] Average continuous insulation correction factor is 10% less than total insert R-value.

Some table values are the same due to rounding.

Table 3 - Thermal Resistance of EPS Foam Insulation

EPS Type	Minimum Density (pcf) [F]	R-Value Per Inch of Thickness (F°•ft²•h/Btu)
II	135	4.00

Table 3 Source: ICC ESR - 1498 per ASTM C 578

[F] pcf = 16.02 kg/m³, 1°F ft²hr/Btu=0.176m²K/W, 1°F=1.8°C+32

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Omni Block US Patent 6,513,293