There are many pathways for commercial building envelope compliance per IECC. Only one pathway, Prescriptive Design, requires continuous insulation in mass walls. (see FAQ below). The code does offer the Performance Path option and deals with the U-factor alternative and discontinuous insulation. All of the other methods of design (e.g. Whole Building Energy Analysis, Cost Budget Analysis, using Comcheck etc.) **do not require continuous insulation in mass walls**.

Using Comcheck is the most appropriate and simple way to evaluate an integrally insulated block wall for a commercial building type. The proper way to plug in data for Comcheck, is to select the wall type **Mass Wall**. (see compliance certificate below). The input is a U-factor and Heat Capacity. No separate insulation value or steady state R-value is needed.

The code (see below and FAQ) tells us that you SHALL use the U-factor alternative. The U-factors are published on Omni Block's test report (see below). The Heat Capacity value is dependent on your grouting schedule and can be interpolated from NCMA Tek note 6-16A (see below). The grout cell size for Omni Block is similar to a 6″ hollow unit on this NCMA Tek Note, so use those values from the 6″ hollow table.

U-factor is required for use with Integrally Insulated Concrete whether it's an insulated block or insulated concrete panel. The code is clear. You are not to use the R-value of the insulation when the insulation is integral to the concrete. You are instead, to use the U-factor of the assembly. The is measuring the walls' overall performance and not values for each component. The Comcheck program is holistic in its approach.

SECTION C402 IECC 2012
BUILDING ENEVELOPE REQUIREMENTS

C402.1 General (Prescriptive).
The building thermal envelope shall comply with Section C402.1.1. Section C402.1.2 shall be permitted as an alternative to the R-values specified.

C402.1.2 U-factor alternative. An assembly with a U-factor, C-factor, or F-factor equal or less than that specified in Table C402.1.2 shall be permitted as an alternative to the R-value in Table 402.2.

C402.2. Commercial buildings or portion of commercial building enclosing Group R occupancies **shall use the U-factor**, C-factor, or F-factor from the "Group R" column in Table C402.1.2. Commercial buildings or portions of commercial buildings enclosing occupancies other than Group R **shall use the U-factor**, C-factor, or F-factor from the "All Other" column of Table C402.1.2.

C402.2.3 Thermal resistance of above-grade walls.
The minimum thermal resistance (R-value) of the insulating materials installed in the wall cavity between the framing members and continuously on the walls shall be specified in Table C402.2, based on framing type and construction materials used in the wall assembly. **The R-value of integral insulation installed in concrete masonry units (CMU) shall not be used in determining compliance with Table C402.2**

This last paragraph above is critical for the examiner's understanding. If you have a frame wall or a cavity wall, and depending upon your design basis: "framing type and construction materials used in the wall assembly"; you are then directed to the R-values and continuous insulation.

A CMU with insulation installed within the CMU, e.g. foam filled standard CMU, NRG, Omni Block, etc. then you "SHALL NOT" use the R-value to determine compliance.

An Informational Series from NCMA
Answering Frequently Asked Questions
NATIONAL CONCRETE MASONRY ASSOCIATION
Sustainable Concrete Products for Structures and Hardscapes

Do concrete masonry walls require continuous insulation?

No. This is a common misconception. Although one particular compliance path (IECC Table C402.2) requires insulation to be continuous, there are several other options in the International Energy Conservation Code (IECC) that do not require continuous insulation. The following discussion references specific sections and requirements of the 2012 IECC[1], but applies equally to other editions of the IECC as well. The IECC allows three different methods to be used to show compliance with minimum energy efficiency requirements: prescriptive, trade-off or system performance, and whole building energy analysis. A project need only comply with one of these methods, not all three.

Of the three compliance methods, the prescriptive method is the easiest to apply and perhaps the best recognized. Prescriptive requirements for building envelope elements are listed in table format, with requirements listed separately for each element and climate zone, as shown in Table 1. Table 1 shows that in Chicago (Climate Zone 5), a flat roofed building (other than Group R) must have R25 continuous insulation and masonry walls must have R11.4 continuous insulation to comply with this table. This table is often the sources of the misconception that these elements must have continuous insulation in order to comply with the IECC.

Table 1: Excerpt from 2012 IECC Table C402.2 Showing Prescriptive Wall and Roof R-Value Requirements[1]

CLIMATE ZONE	1		2		3		4 EXCEPT MARINE		5 AND MARINE 4	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Roofs										
Insulation entirely above deck	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-25ci	R-25ci	R-25ci	R-25ci
Attic and other	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-49
Walls, Above Grade										
Mass[2]	R-5.7ci	R-5.7ci	R-5.7ci	R-7.6ci	R-7.6ci	R-9.5ci	R-9.5ci	R-11.4ci	R-11.4ci	R-13.3ci
Metal building	R-13 + R-6.5ci	R-13 + R-6.5ci	R-13 + R-6.5ci	R-13 + R-13ci	R-13 + R-6.5ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci
Metal framed	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci
Wood framed and other	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-7.5ci or R-20 + R-3.8ci

Notes:
1. ci = continuous insulation
2. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90, ungrouted or partially grouted at a spacing no less than 32 in. o.c. vertically and 48 in. o.c horizontally, with ungrouted cores filled with insulation.

Using this prescriptive table, the requirements for individual elements are independent of each other. In Climate Zone 5, if the mass wall has R14 insulation and the roof has R20, the building cannot comply prescriptively based on R-values. Hence, although using the prescriptive tables is very straightforward, it is also very limiting in terms of design flexibility.

IECC Table C402.2 is also misinterpreted as not permitting insulation within the hollow cells of a single wythe concrete masonry assembly for energy compliance. Although concrete masonry with integral insulation cannot comply under the Table C402.2 requirement for continuous insulation because the webs of the masonry units interrupt the insulation, the IECC provides an additional prescriptive option in Table C402.1.2 based on the overall U-Factor of the wall assembly. (The U-Factor is the inverse of R-Value, i.e. U = 1/R and R = 1/U).

For compliance with IECC Table C402.1.2, the U-Factor of the wall assembly must meet the prescriptive U-Factor requirement *instead* of the insulation meeting the prescriptive R-Value of IECC Table C402.2. For example, the mass wall U-Factor requirement for Chicago (Climate Zone 5) is U0.078, which corresponds to an R-Value of 12.8. As long as the wall as a whole (not the insulation alone) meets the U0.078/R12.8 requirement, the wall complies with the IECC in Climate Zone 5. Although not as flexible as the trade-off or whole building analysis compliance options, the prescriptive U-Factor option of the IECC often provides additional flexibility over the prescriptive R-Value approach.

Table 2: Excerpt from 2012 IECC Table C402.1.2 Showing Prescriptive Mass Wall U-Factor Requirements by Climate Zone for Buildings Other than Group R

Climate Zone:	1	2	3	4	5	6	7	8
U-Factor requirement	0.142	0.142	0.110	0.104	0.078	0.078	0.061	0.061
Corresponding overall wall R-Value	7.0	7.0	9.1	9.6	12.8	12.8	16.4	16.4

Additional discussion on thermal efficiency and code compliance options for concrete masonry construction is provided in References 2-5.

References

[1] 2012 International Energy Conservation Code (IECC), International Code Council, www.iccsafe.org.
[2] NCMA TEK 6-1C, 2013, "R-Values of Multi-Wythe Concrete Masonry Walls", National Concrete Masonry Association, www.ncma.org.
[3] NCMA TEK 6-2C, 2013, "R-Values and U-Factors of Single Wythe Concrete Masonry Walls", National Concrete Masonry Association, www.ncma.org.
[4] "Thermal Catalog of Concrete Masonry Assemblies, 2nd Edition", 2012, National Concrete Masonry Association, www.ncma.org.
[5] NCMA FAQ 13-14, 2014, "What options are available for complying with the International Energy Conservation Code?", National Concrete Masonry Association, www.ncma.org.

COMcheck Software Version 4.3.5.2
Envelope Compliance Certificate

Project Information

Energy Code:	2015 IECC
Project Title:	Scalaplus
Location:	Baltimore, Maryland
Climate Zone:	4a
Project Type:	New Construction

Construction Site: Owner/Agent: Designer/Contractor:

Building Area	Floor Area
1-Retail : Nonresidential	25000

Additional Efficiency Package

High efficiency HVAC. Systems that do not meet the performance requirement will be identified in the mechanical requirements checklist report.

Envelope Assemblies

Assembly	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Proposed U-Factor	Budget U-Factor(a)
Ext. Wall: Other Mass Wall, Heat capacity 8.0, [Bldg. Use 1 - Retail] (b)	8000	---	---	0.064	0.104

(a) Budget U-factors are used for software baseline calculations ONLY, and are not code requirements.
(b) 'Other' components require supporting documentation for proposed U-factors.

Project Notes

8" Split Face, Omni Block

Envelope PASSES: Design 38% better than code

Envelope Compliance Statement

Compliance Statement: The proposed envelope design represented in this document is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed envelope systems have been designed to meet the 2015 IECC requirements in COM*check* Version 4.3.5.2 and to comply with any applicable mandatory requirements listed in the Inspection Checklist.

Name - Title　　　　Signature　　　　Date

Omni Block
AN INSULATED CONCRETE BLOCK

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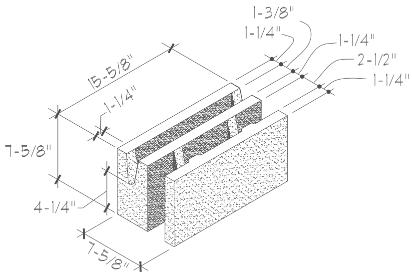
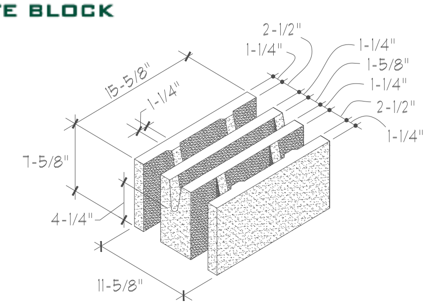
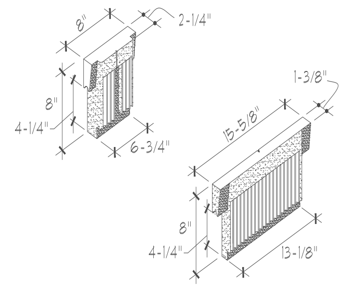
WWW.OMNIBLOCK.COM



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 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

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.

DISCLAIMER

The information presented in this report/analysis is to assist architects, designers, professional builders, and professional engineers when utilizing the Omni Block Insulated Concrete Block System. While the material is presented in good faith and beleived to be reliable, it does not constitute a part of, or terms and conditions of sale. No engineering data, design information or other material contained herein shall be deemed to constitute a warranty, expressed or implied, that said information is correct or that the products described are fit for a particular purpose of design application.

PREVAILING CODE

The information presented in this report/analysis is not intended to supercede any building code.

Omni Block US Patent 6,513,293

NCMA TEK

National Concrete Masonry Association
an information series from the national authority on concrete masonry technology

HEAT CAPACITY (HC) VALUES FOR CONCRETE MASONRY WALLS

TEK 6-16A
Energy & IAQ (2008)

Keywords: energy, energy codes, energy efficiency, heat capacity, thermal mass, thermal storage

INTRODUCTION

Heat capacity is a material property used to assess a wall's thermal mass, and it is often used as a criteria in energy codes and standards. Thermal mass is defined as: the absorption and storage of significant amounts of heat in a building or in walls of a building (ref. 1). Wall thermal mass, such as that present in concrete masonry construction, tends to decrease both heating and cooling loads in a given building, thus saving energy. The amount of savings realized by incorporating thermal mass into a building's design is a function of several variables. These include local climate, wall heat capacity, fenestration (window) area, fenestration orientation, fenestration solar gain, building occupancy load and other internal gains such as lights and office equipment. The most manageable approach to account for energy savings due to thermal mass is to relate the savings to the wall heat capacity and local climate.

Heat capacity (*HC*) is defined as the amount of heat necessary to raise the temperature of a given mass one degree (refs. 2, 3), and is calculated as the product of a wall's mass per unit area by its specific heat.

A building with massive walls, such as concrete masonry, often uses less energy for heating and cooling than does one with lightweight frame walls, wood or steel studs for example. Because of this, the *International Energy Conservation Code* and ASHRAE Standard 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings* (refs. 4, 3), prescribe lower R-value requirements for concrete masonry walls than those for frame walls and metal buildings, in many cases. (This lower required R-value corresponds to a higher required U-factor.) In order to qualify for this lower minimum R-value, ASHRAE Standard 90.1 requires the wall to achieve a minimum *HC* value. The *International Energy Conservation Code* defines "mass walls" in terms of wall weight, rather than heat capacity (see reference 5 for detailed information).

This TEK is intended for use by engineers and designers as a guide to determining the heat capacity (*HC*) of concrete masonry walls.

HEAT CAPACITY VALUES IN CODES AND STANDARDS

ASHRAE Standard 90.1 defines a mass wall as one with a heat capacity exceeding:

- 7 Btu/ft^2·°F (45.2 kJ/m^2·K), or
- 5 Btu/ft^2·°F (32.2 kJ/m^2·K) provided that the wall has a material unit weight not greater than 120 lb/ft^3 (1,922 kg/m^3). This criteria clarifies that most lightweight concrete masonry walls are defined as mass walls for the purposes of the Standard.

Walls meeting either of these criteria are considered mass walls, and are eligible to comply to the Standard using the lower mass wall requirements in the prescriptive compliance tables.

In addition to these prescriptive compliance tables, heat capacity is also used in the ENVSTD compliance software, that forms a part of ASHRAE Standard 90.1, when defining a mass wall assembly. See TEKs 6-12, *International Energy Conservation Code and Concrete Masonry*, and 6-4A, *Energy Code Compliance Using COMcheck* (refs. 5, 6) for further information on energy code compliance options.

Concrete masonry heat capacity values are also required for more rigorous energy analyses, such as those necessary to demonstrate compliance with the Total Building Performance option in the *International Energy Conservation Code,* demonstrate compliance with the Energy Cost Budget Method in ASHRAE Standard 90.1, or demonstrate energy savings to qualify for LEED® program points.

CALCULATING HEAT CAPACITY

Wall heat capacity is defined as: the sum of the products of the mass of each individual material in the wall per unit area times its individual specific heat (ref. 3). As indicated previously, *HC* is equal to the mass, or wall weight, multiplied by the specific heat. Therefore, for example, a single wythe concrete masonry wall weighing 34 lb/ft^2 (166 kg/m^2) has a