CONCRETE MASONRY & HARDSCAPES ASSOCIATION

Provided By:

CONCRETE MASONRY IN THE 2012 EDITION OF THE IECC

INTRODUCTION

Although masonry is an ancient material, today's concrete masonry can be a significant benefit 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 which can impair indoor air quality or impede moisture control.

The *International Energy Conservation Code* (IECC) (ref. 1) serves as a written model for states, counties, cities or other jurisdictions to develop local codes for energy efficient building design. Concrete masonry construction can help meet these energy requirements, while also providing superior structural capacity, durability, and resistance to fire, sound transmission, insects and mold.

This TEK describes concrete masonry wall compliance for commercial buildings in accordance with the 2012 edition of the IECC.

CONCRETE MASONRY ENERGY PERFORMANCE

The thermal performance of a masonry wall depends on its steady-state thermal characteristics (described by R-value and U-factor) as well as its thermal mass (described by heat capacity). The steady-state and thermal mass performance are influenced by the size and type of masonry unit, cross-web configuration, type and location of insulation, finish materials, and density of masonry. Concrete masonry units (CMU) made with lower density concrete have higher R-values (i.e., lower U-factors) than units made with higher density concrete.

Thermal mass is the ability of materials such as concrete masonry to store heat—they heat up and cool down slowly, which can help mitigate heating and cooling loads. Due to the significant benefits of concrete masonry's inherent thermal mass, concrete masonry buildings can often provide similar thermal performance to more heavily insulated frame buildings.

The benefits of thermal mass have been incorporated into energy code requirements and computer models. The IECC and ANSI/ASHRAE/IESNA Standard 90.1, *Energy Standard for*

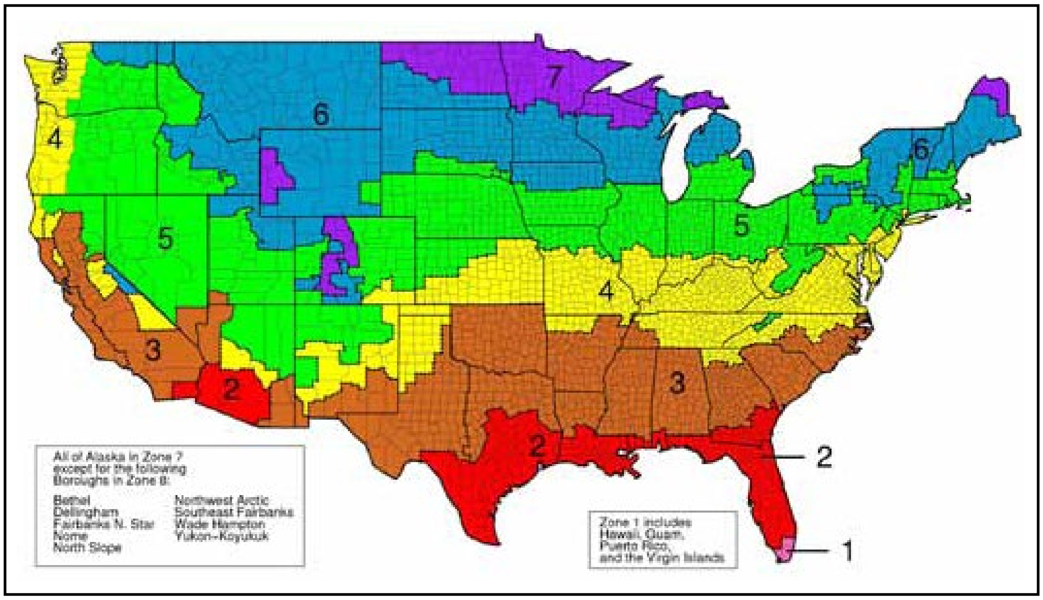

Figure 1—IECC Climate Zones

Buildings Except Low-Rise Residential Buildings (ref. 2), permit concrete masonry walls to have less insulation than frame wall systems and metal buildings to meet the energy requirements.

COMPLIANCE OPTIONS

For commercial buildings, there are three alternatives for demonstrating building energy compliance:

1. Prescriptive compliance, which requires each building envelope element to independently meet the R-value or U-factor requirements listed in IECC Table C402.1.2 or Table C402.2(1). The approach is simple to implement, but offers no design flexibility.
2. A building envelope trade-off procedure, which demonstrates that the envelope as a whole meets the energy requirements. This approach allows more design flexibility, since elements that do not meet prescriptive IECC requirements can be offset by other elements with higher performance. Although not specifically referenced in the code, COM*check* software (ref. 3) developed by the U. S. Department of Energy is a commonly accepted compliance tool for demonstrating total envelope performance.
3. A total building performance analysis, which simulates a full year of building operation. The analysis treats the entire building as a system, and accounts for virtually all aspects of building energy use, including the building envelope, mechanical systems, service water heating, and electric power and lighting. Detailed energy simulation software, such as EnergyPlus or eQuest (refs. 4, 5), is typically used when employing this option. This compliance path offers the maximum design flexibility, but requires a fairly rigorous and detailed analysis. For a project which will be LEED certified, a total building analysis is required, and the prescriptive criteria need not be met. See TEK 06-09C, *Concrete Masonry and Hardscape Products in LEED 2009*, (ref. 6) for more detailed information.

Note that a project need only comply under one of these compliance options, not all three. The following sections briefly describe prescriptive and trade-off compliance. See the design example at the end of the TEK for how these options may be implemented.

IECC PRESCRIPTIVE COMPLIANCE

Of the three compliance methods, the prescriptive method is easiest to apply. Requirements for building envelope components are listed in table format, by climate zone. Figure 1 illustrates the IECC climate zones.

Under the prescriptive option, requirements for individual elements are independent of each other. Hence, although using the prescriptive tables is very straightforward, it can also be very limiting in terms of design flexibility.

The IECC prescriptive building envelope requirements for commercial buildings (IECC section 402) list minimum energy performance criteria for roofs, above and below grade walls, slab-on-grade floors, and fenestration. The wall, roof and floor requirements are stated in terms of maximum assembly U-factor or minimum insulation R-value. The user may choose to use whichever table is more applicable to the project's assemblies.

In the IECC prescriptive tables, concrete masonry walls fall under the *Mass Wall* category, which is defined as walls weighing at least 35 psf (171 kg/m^2), or 25 psf (122 kg/m^2) if the material weight is not more than 120 lb/ft^3 (1,900 kg/m^3).

Prescriptive Compliance via Overall Wall U-Factor

The 2012 IECC prescriptive U-factor requirements for above and below grade walls are shown in Table 1. U-factor is numerically the inverse of R-value. So, a wall with an overall R-value of 10 h·ft^{2}·°F/Btu (1.76 m^{2}·K/W) has a U-factor of 0.10 Btu/h·ft^{2}·°F (0.568 W/m^{2}·K) and vice-versa.

Using the U-factor criteria, rather than the insulation R-values discussed below, allows walls without continuous insulation

Table 1—Prescriptive Maximum Overall Wall U-Factor Requirements (ref. 1)[A]

Climate Zone:	1	2	3	4 except marine	5 and marine 4	6	7	8
Above grade wall type:								
Mass walls	0.142	0.142	0.110	0.104	0.078	0.078	0.061	0.061
Metal building	0.079	0.079	0.079	0.052	0.052	0.052	0.052	0.052
Metal framed	0.077	0.077	0.064	0.064	0.064	0.064	0.064	0.045
Wood framed & other	0.064	0.064	0.064	0.064	0.064	0.051	0.051	0.036
Below grade walls[B]:								
All wall types	1.140	1.140	1.140	0.119	0.119	0.119	0.092	0.092

[A] From IECC Table C402.1.2. U-factors apply to the entire wall assembly. Only the requirements for non-residential buildings are shown.

[B] Values shown are C-factors, surface-to-surface conductance values, vs. U-factors, which are air-to-air conductance values.

(such as concrete masonry with insulated cores) to comply prescriptively. The U-factor compliance table may also be a good option for concrete masonry walls with proprietary inserts, or other walls that have better thermal performance than that assumed in the code.

CMHA TEK 06-02B, *R-Values and U-Factors of Single Wythe Concrete Masonry Walls*, and TEK 06-01C, *R-Values of Multi-Wythe Concrete Masonry Walls,* as well as the *Thermal Catalog of Concrete Masonry Assemblies* (refs. 7, 8, 9) list R-values, and in some cases U-factors, for a wide variety of concrete masonry walls.

Prescriptive Compliance via Insulation R-Value

Table 2 shows minimum insulation R-value requirements for above grade walls. These R-values apply to the insulation only, regardless of the underlying wall's R-value.

In the table "ci" means continuous insulation. There is a widespread misconception that all walls must have continuous insulation in order to meet the IECC. In fact, continuous insulation is required only to comply with this particular table – other compliance options are available, including compliance via the prescriptive U-factor table discussed above, and COM*check*, discussed below.

Note that in Climate Zones 1 and 2, the IECC includes an exception for single wythe concrete masonry walls with insulated cores. Where the table requires R5.7 continuous insulation, the IECC allows concrete masonry walls with ungrouted cells filled with insulation such as vermiculite, perlite or foamed-in-place (with a thermal conductivity less than or equal to 0.44 Btu-in./h·ft^{2}·°F, or R-value per inch $\geq$ 2.27 (63.4 W·mm/m^{2}·°K)) to comply, as long as the amount of grouting does not exceed 32 in. (813 mm) o.c. vertically and 48 in. (1,219 mm) o.c. horizontally. The exception allows the majority of single wythe ungrouted and partially grouted concrete masonry walls containing insulation in the ungrouted cells to comply with the IECC, regardless of that wall's R-value.

TRADE-OFF COMPLIANCE USING COMCHECK

The trade-off option allows the user to demonstrate compliance based on the building envelope as a whole, rather than on the prescriptive component-by-component basis. These trade-offs are most often implemented using easy-to-use software, such as COM*check* (ref. 3).

There are two main benefits to using trade-off software for compliance rather than prescriptive tables. First, the user gains design flexibility because parameters such as increased glazing area can be offset by increasing roof or wall insulation. Second, once the basic building data is entered into the program and saved, design changes or building location can be quickly modified, and compliance immediately redetermined.

More detailed information on using COM*check* for concrete masonry buildings can be found in TEK 06-04B, *Energy Code Compliance Using COMcheck* (ref. 10).

DESIGN EXAMPLE

Consider a "big-box" retail building in St. Louis, MO (Climate Zone 4). For aesthetics and durability, the designer opts for single wythe core-insulated 12-in. (305-mm) concrete masonry walls with an overall wall R-value of 6.3 Btu/h·ft^{2}·°F (1.11 m^{2}·°K/W).

Table 2—Prescriptive Wall Insulation R-Value Requirements (ref. 1)[A]

Climate Zone:	1	2	3	4 except marine	5 and marine 4	6	7	8
Above grade wall type:								
Mass walls	R5.7ci[C]	R5.7ci[C]	R7.6 ci	R9.5ci	R11.4ci	R13.3ci	R15.2ci	R25ci
Metal building	R13 + 6.5ci	R13 + 6.5ci	R13 + 6.5ci	R13 + 13ci	R13 + 13ci	R13 + 13ci	R13 + 13ci	R13 + 13ci
Metal framed	R13 + 5ci	R13 + 5ci	R13 + 7.5ci	R13 + 7.5ci	R13 + 7.5ci	R13 + 7.5ci	R13 + 7.5ci	R13 + 7.5ci
Wood framed & other	R13 + 3.8ci or R20	R13 + 3.8ci or R20	R13 + 3.8ci or R20	R13 + 3.8ci or R20	R13 + 3.8ci or R20	R13 + 7.5ci or R20 + 3.8ci	R13 + 7.5ci or R20 + 3.8ci	R13 + 15.6ci or R20 + 10ci
Below grade walls:								
All wall types	NR[B]	NR[B]	NR[B]	R7.5ci	R7.5ci	R7.5ci	R10ci	R10ci

[A] From IECC Table C402.2. R-values apply only to the insulating materials used. Only the requirements for non-residential buildings are shown. NR = no requirement. ci = continuous insulation (note that walls without continuous insulation can comply via U-factor requirements (Table 1) or COM*check*).

[B] Insulation is not required, i.e., an uninsulated concrete masonry wall complies.

[C] Concrete masonry single wythe exception applies: ASTM C90 concrete masonry, grouted up to 32 in. o.c. vertically and 48 in. o.c. horizontally, with ungrouted cores filled with insulation, is deemed to comply.

The first step is to check if the walls comply using one of the prescriptive compliance options, since they are the easiest to implement. Table 1 shows an above grade mass wall requirement of U0.104 $h \cdot ft^{2} \cdot {}^{o}F/Btu$ (0.59 $W/m^{2} \cdot {}^{o}K$), which corresponds to a wall R-value of 9.6 $Btu/h \cdot ft^{2} \cdot {}^{o}F$ (1.69 $m^{2} \cdot {}^{o}K/W$). The R6.3 wall does not meet this requirement, nor can Table 2 be used because core insulation does not qualify as continuous insulation.

Using COM*check*, however the building can easily comply, by using the prescriptive minimum level of roof insulation (R25). Note that at the time of publication, because COM*check* did not yet include compliance via the 2012 IECC, compliance was demonstrated using ASHRAE 90.1-2010, which the IECC accepts as an alternate. See TEK 06-04B for more information on compliance using COM*check.*

BUILDING ENVELOPE AIR LEAKAGE REQUIREMENTS

The 2012 IECC includes substantially new air leakage criteria, requiring a continuous air barrier throughout the building envelope. The code also includes several "deemed-to-comply" materials and assemblies which are considered to comply with the code, including fully grouted concrete masonry, various surface coatings, and certain board insulations when installed with taped or sealed joints. The criteria, as well as a full discussion of how the criteria apply to concrete masonry assemblies can be found in TEK 06-14A, *Control of Air Leakage in Concrete Masonry Walls*, (ref. 11) Figures 2 and 3 in particular.

REFERENCES

1. *International Energy Conservation Code*. International Code Council, 2012.
2. *Energy Standard for Buildings Except Low-Rise Residential Buildings*, ANSI/ASHRAE/IESNA Standard 90.1-10. ASHRAE, Inc. and Illuminating Engineering Society of North America, American National Standards Institute, 2010.
3. COM*check*, version 3.9.0. United States Department of Energy, http://www.energycodes.gov/comcheck/download.stm.
4. EnergyPlus, United States Department of Energy, http://apps1.eere.energy.gov/buildings/energyplus/register.cfm?goto=eplus.
5. eQuest, Energy Design Resources, http://www.energydesignresources.com/resources/software-tools/equest.aspx.
6. *Concrete Masonry and Hardscape Products in LEED 2009,* TEK 06-09C, Concrete Masonry & Hardscapes Association, 2009.
7. *R-Values and U-Factors of Single Wythe Concrete Masonry Walls,* TEK 06-02C, Concrete Masonry & Hardscapes Association, 2013.
8. *R-Values of Multi-Wythe Concrete Masonry Walls,* TEK 06-01C, Concrete Masonry & Hardscapes Association, 2013.
9. *Thermal Catalog of Concrete Masonry Assemblies*, CMU-MAN-004-12, Concrete Masonry & Hardscapes Association, 2012.
10. *Energy Code Compliance Using* COM*check,* TEK 06-04B, Concrete Masonry & Hardscapes Association, 2012.
11. *Control of Air Leakage in Concrete Masonry Walls,* TEK 06-14A, Concrete Masonry & Hardscapes Association, 2011.