Insulated Concrete Forms (ICFs) Benefits and Advantages

Nudura

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Construction Products Group

Purpose and Learning Objectives

Purpose: It is an expectation that today's buildings have to be more than just aesthetically pleasing: they have to provide measurable, environmental benefits. This course outlines how insulated concrete forms (ICFs) help meet sustainable design objectives and examines the advantages that ICFs and ICF technology have over conventional construction materials for building envelopes in all building types.

Learning Objectives:
At the end of this program, participants will be able to:

- describe what insulated concrete forms (ICFs) are and recall the different types available
- explain the environmental benefits—thermal, fire, and sound resistance, safety and security, indoor air quality, and sustainability—of building with ICFs
- summarize the steps in the ICF construction process and how they contribute to a safe, durable, energy-efficient project
- list codes and standards applicable to ICF construction, and use case studies to illustrate how ICFs contribute to energy efficiency in various building types.

What Are ICFs?

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ICFs are stay-in-place concrete forms that provide design professionals, architects, homeowners, and contractors the freedom and versatility to design and build a structure the way it was envisioned.

The concrete form is composed of two panels of expanded polystyrene (EPS) foam insulation that are held together with engineered cross ties or “webs,” which are integrally molded into the foam to create a block or form unit. Reinforcement bars are placed horizontally and vertically in the ICF. Concrete is then poured and consolidated into the ICF. The final product is an insulated reinforced concrete wall.

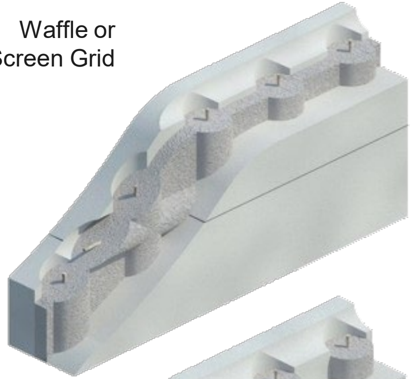
This type of building envelope provides an affordable, eco-friendly building solution that allows for faster, more efficient builds and offers substantial benefits over traditional construction.

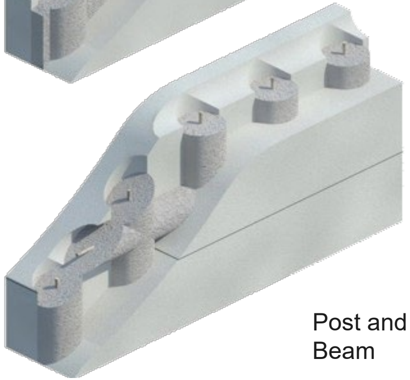
ICF Wall Types

Waffle and screen grid forms have reinforced, thickened columns and beams with a thinner section of concrete between these columns and beams. This style of form was developed to meet the minimum requirements for buildings while reducing the amount of concrete that was required within the wall. Some of the limitations for this type of wall include reduced wall heights between floors and reduced fire resistance ratings due to the concrete thickness variations. Among the benefits is an increased thermal R-value due to the thicker EPS in the waffle areas of the forms.

Although similar to waffle or screen grid forms, the waffle section in post and beam forms is made of EPS foam rather than concrete. Post and beam forms have limitations as well. The diameter of the columns and beams puts design restrictions on both wall height and the number of stories. In addition, the solid EPS foam between the columns and beams prevents the wall from achieving any significant fire-resistance rating.

Waffle or Screen Grid





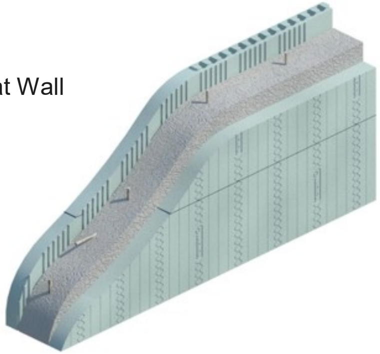
Post and Beam

ICF Wall Types

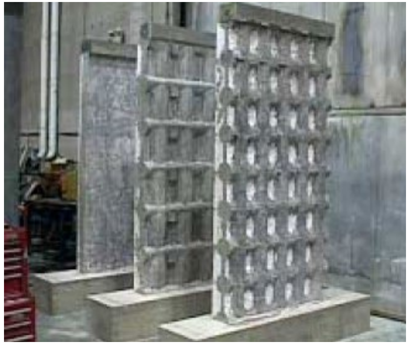
Flat wall forms provide a continuous, monolithic concrete core, and the thickness is consistent throughout the forms. Flat wall forms allow design professionals to create structures without limitations. They can achieve a 4-hour fire-resistance rating and beyond and are suitable for a range of building types. Engineering is only limited to the reinforcing steel and concrete. These forms represent 90% of the ICF market.

Some flat wall forms have a dovetail design on the inside face of the panels to allow the concrete to bond to the form unit, while other designs have a smooth interior face, allowing the concrete to bond to the cross webs only.

Flat Wall



Concrete Configurations



ICF Assembly Methods

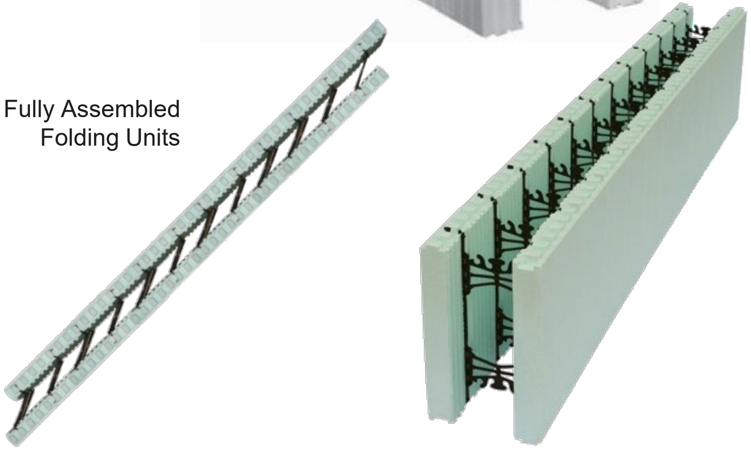
ICFs are modular block units. Flat wall design can be broken down into two different form types: fully assembled units and site-assembled units. Webs are molded into the EPS form panels for fully assembled types.

There are two types of fully assembled units:

- Preformed, fully assembled units
  - These forms are shipped fully assembled for the required concrete core sizing. Fully assembled forms take up extra space within a trailer and require additional storage on site.
- Fully assembled folding units
  - These units come fully assembled to the required concrete core sizing and fold flat, reducing shipping costs and space required for on-site storage.

Preformed, Fully Assembled Unit

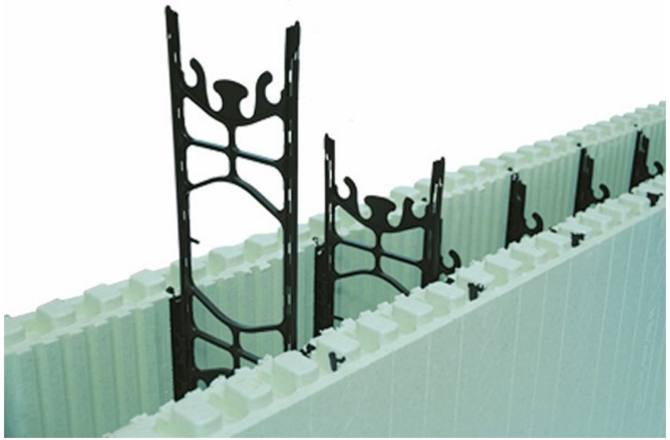
Fully Assembled Folding Units



ICF Assembly Methods

Site-assembled forms are available in knock-down units that have two EPS panels with insertable webs. Similar to fully assembled folding units, they also reduce shipping costs and the space required for on-site storage. Another benefit is their ability to handle areas of congested reinforcement. Their disadvantage is the additional labor required on site for assembly of the units.

Site Assembled Units

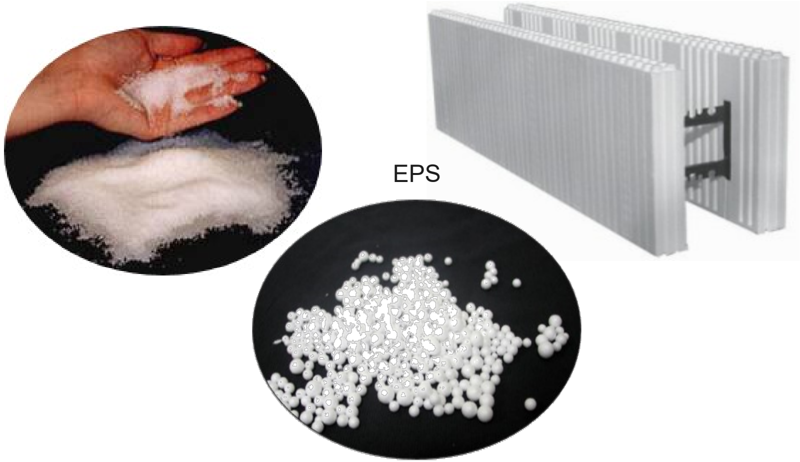


ICF Materials: Expanded Polystyrene (EPS)

Approximately 99% of all ICFs are manufactured with EPS. However, extruded polystyrene (XPS foam) is also available. Both are composed of polystyrene but have different manufacturing processes and performance properties. EPS is manufactured by expanding spherical beads in a mold, using heat and pressure to fuse the beads together. EPS insulation used in the building envelope is typically covered with some type of finish material. With XPS, a continuous extrusion process produces a homogeneous closed-cell cross-section; however, it is more toxic than EPS when burned.

Characteristics of EPS:

- Type II, closed-cell foam
- High R-value per inch (R-4)
- Stable, long-term performance
- Low embodied energy
- No off-gassing
- Moisture resistant, nonabsorbent
- Inert resistant to mold and rot
- Contains a flame retardant
- Smoke is nontoxic
- Recyclable

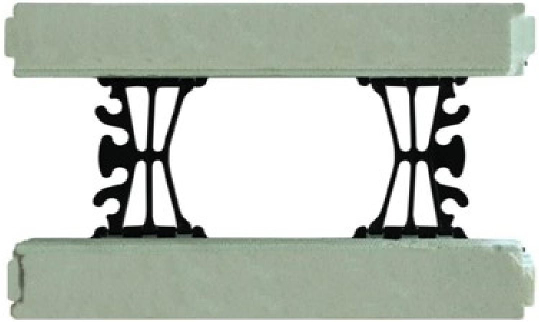


ICF Materials: Webs or Cross Ties

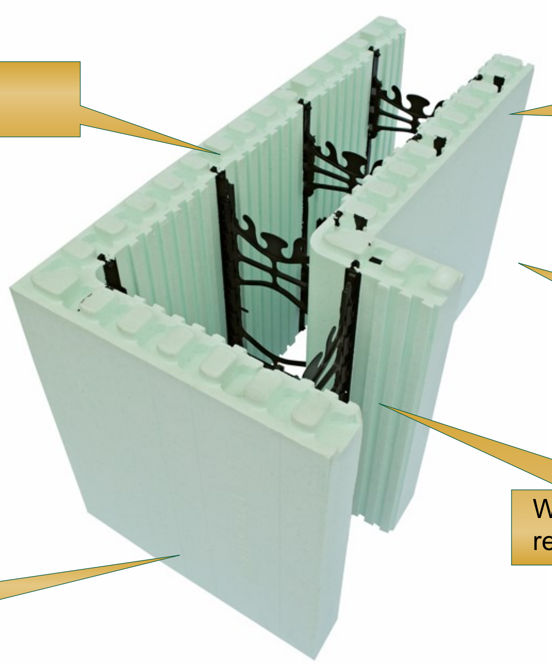
The webs or cross ties are molded into the EPS panels and are typically made of polypropylene plastic (PP), but some may be steel.

Polypropylene plastic webs are:

- specifically designed per ICF manufacturer
- engineered to withstand liquid concrete pressure
- made with 100% recycled industrial plastic
- designed to accommodate reinforcement bars
- spaced in the block typically at 6″ or 8″ intervals
- immune to thermal bridging
- moisture resistant
- durable and won’t rot or degrade, and
- designed with fastening strips for screw-on attachment of finishes.



ICF Components



ICF Variations per Manufacturer

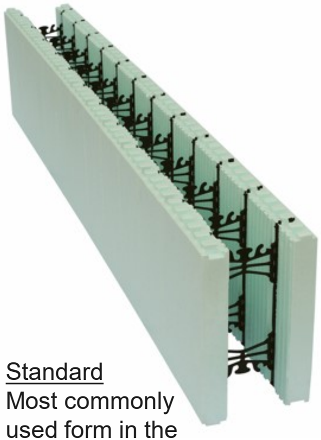
Every ICF manufacturer has customized differences in a standard block, each with a wide variety of attributes. When investigating an ICF, it is important to understand how some of these attributes may influence your design. Because of these variations, DO NOT assume all ICFs are the same.

Variations in ICFs:

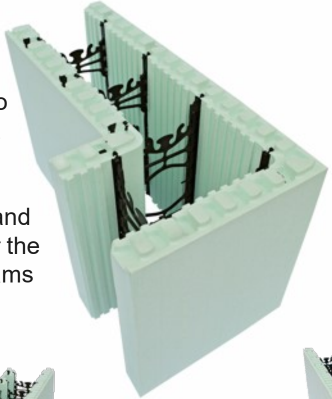
- Form length – either 48″ or 96″
- Form heights vary – 12″, 16″, 18″, or 24″
- EPS thickness – 2 ½″ to 2 ⅝″
- Interlock design
- Web design, web spacing (6″, 8″, or 12″), and web materials
- Style of forms – flat wall, waffle grid, or post and beam
- Forms – fully assembled or knock down
- Availability of concrete core thickness and block types

Manufacturers also have accessory products for their ICFs such as spray foam glue, connectors, fasteners, tape, etc.

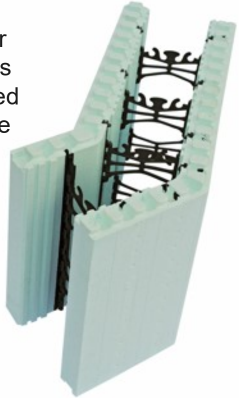
ICF Block Configurations



<u>Standard</u>
Most commonly used form in the ICF industry



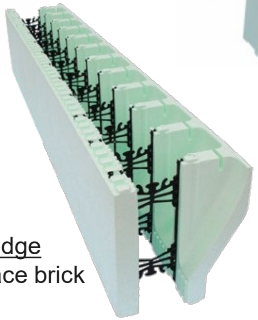
<u>90˚ Corner</u>
Designed to create right angles and many are reversible and will stagger the vertical seams



<u>45˚ Corner</u>
Common for bay windows and designed similar to the 90˚; used when a full 90˚ is not required

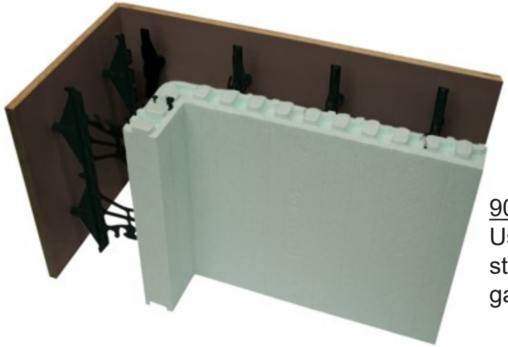
<u>T Block - Short Leg, Long Leg</u>
Used when intersecting two perpendicular walls

<u>Taper Top</u>
Used when additional bearing is required at the top of the wall

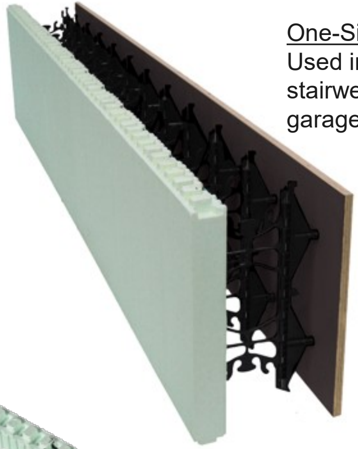


<u>Extended Brick Ledge</u>
Used to support face brick

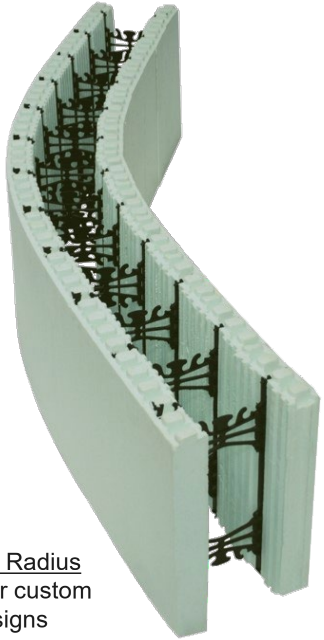
ICF Specialty Blocks



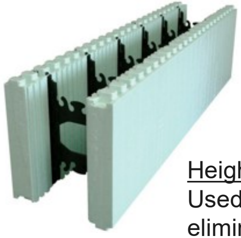
<u>90˚ One-Sided Corner</u>
Used in elevator shafts, stairwells, and parking garages

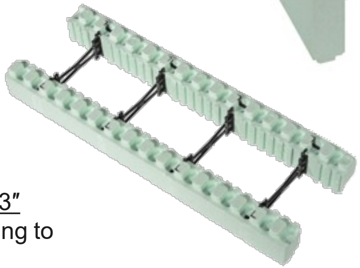


<u>One-Sided Standard</u>
Used in elevator shafts, stairwells, and parking garages



<u>Custom Radius</u>
Used for custom wall designs





<u>Height Adjustment Blocks - 12″ or 3″</u>
Used to assist in wall height coursing to eliminate cutting

Approximately 99% of all ICFs are manufactured with EPS.

List some of the characteristics of EPS.

REVIEW QUESTION

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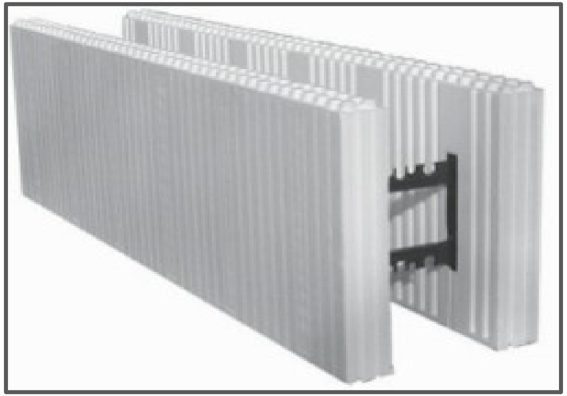
ANSWER

Type II, closed-cell foam
High R-value per inch (R-4)
Stable, long-term performance
Low embodied energy
No off-gassing
Moisture resistant, nonabsorbent
Inert—resistant to mold and rot
Contains a flame retardant
Smoke is nontoxic
Recyclable

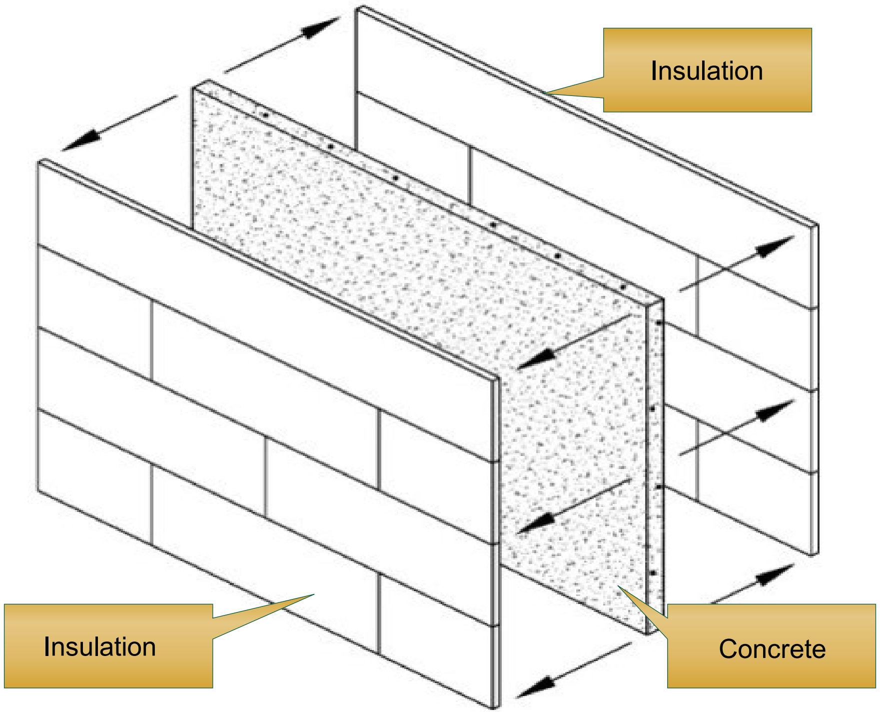


Codes and Design Capabilities

Building Codes and ICFs

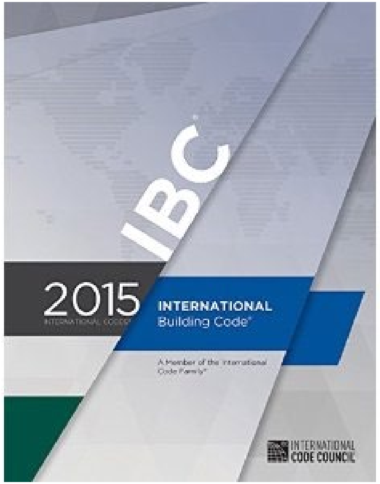
Building codes recognize ICFs as flat, monolithic, reinforced concrete walls with EPS foam plastic insulation on both sides of the concrete core.

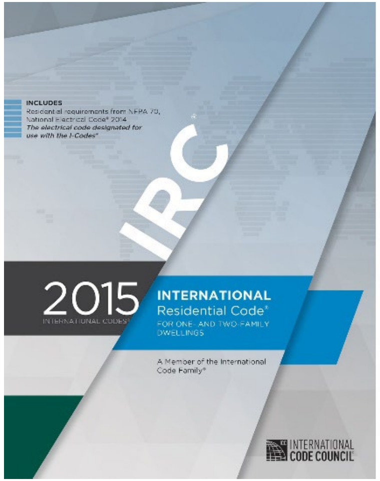
The building construction type will determine the section of the International Building Code (IBC) or the International Residential Code (IRC), and/or engineering that is applicable to ICF design for below-grade and above-grade walls of any height.



ICF Codes and Standards

All ICF manufacturers have a code compliance report, such as an ES Report, and meet the ICC acceptance criteria. There is also an ASTM material standard for flat wall ICFs. Some states require additional evaluation, such as Miami-Dade for high winds and hurricanes.





ICC Acceptance Criteria:

- ✓ **AC12,** "Foam Plastic Insulation"
- ✓ **AC15,** "Concrete Floor, Roof and Wall Systems and Concrete Masonry Systems"
- ✓ **AC353,** "Stay-in-place Foam Plastic Insulating Concrete Form (ICF) Systems for Solid Concrete Walls"

ASTM Standards:

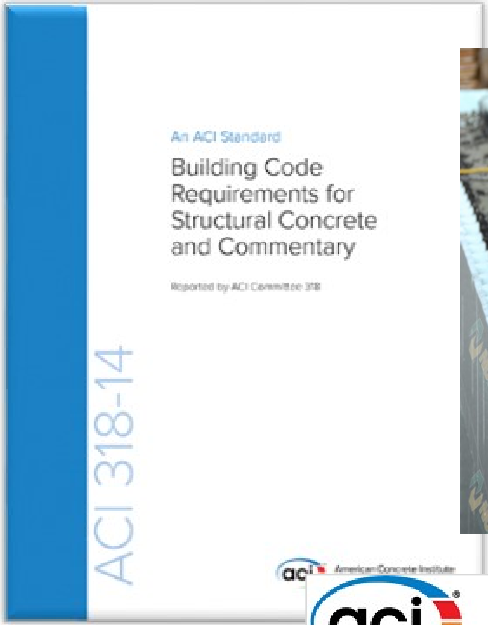
- ✓ **ASTM E2634,** "Standard Specifications for Flat Wall Insulating Concrete Form (ICF) Systems"

ICF Codes and Standards

Concrete design for a flat wall ICF is the same as for any reinforced concrete wall; it is a regular mix, typically 3000 psi with a higher slump of 5″ to 6″ to allow it to flow in the forms.

Concrete design follows the slender wall design criteria within ACI 318, “Building Code Requirements for Structural Concrete.”

Concrete achieves very high strength within an ICF due to the extended presence of moisture allowing proper hydration to occur.



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Always advancing

ICF Associations / Affiliations

The ICF industry has been around for over 50 years; has its own council of industry manufacturers, Council of ICF Industries (CICFI); and is affiliated with and follows the guidelines of these major associations and institutes for testing and development.

CICFI
COUNCIL OF ICF INDUSTRIES

PCA Portland Cement Association

ASTM INTERNATIONAL

EPS Industry Alliance

ICC ES

Intertek

U.S. GREEN BUILDING COUNCIL USGBC

CHANGE FOR THE BETTER WITH ENERGY STAR

aci American Concrete Institute
Always advancing

GreenSpec®

12-Story ICF University Dormitory

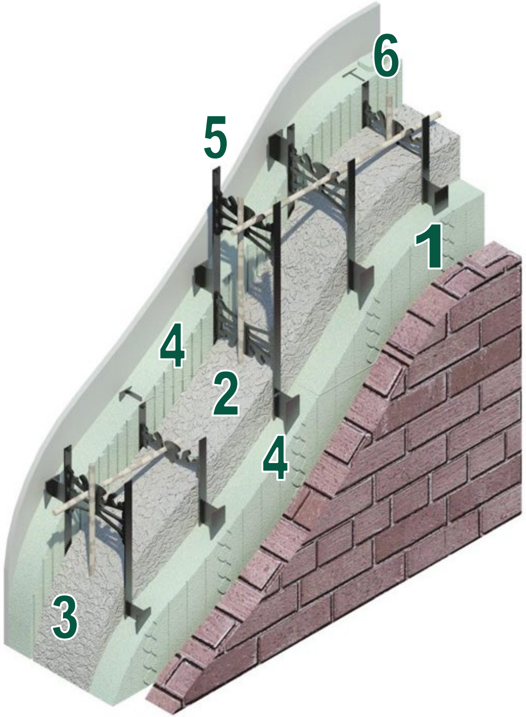
Environmental Benefits of ICFs

Technical Benefits of ICFs

An ICF system completes six building steps with one product, which eliminates costly building steps and allows the building project to be constructed faster and more efficiently.

ICF simplicity of design combines six building envelope elements:

1) Exterior Fastening Strips
2) Structurally Reinforced Concrete
3) Continuous Air Barrier (Concrete)
4) Continuous Exterior/Interior Insulation
5) Interior Fastening Strips
6) Continuous Vapor Barrier (EPS)

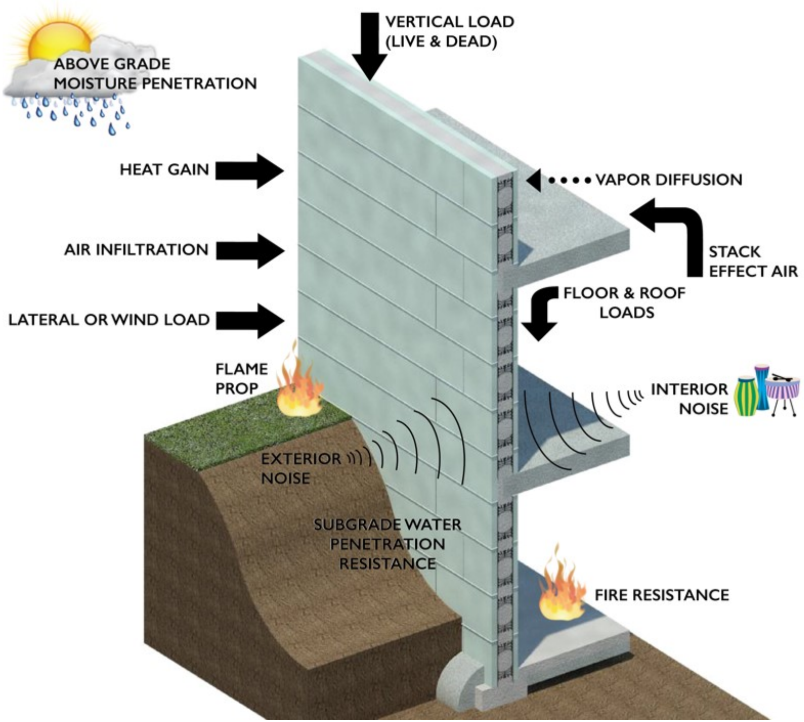


Environmental Benefits of ICFs

Buildings have to be more than just aesthetically pleasing; they have to provide benefits. ICF buildings enjoy greater comfort, safety, and energy efficiency, and are healthier and more eco-friendly than those built with conventional construction materials.

An ICF building envelope provides the following benefits:

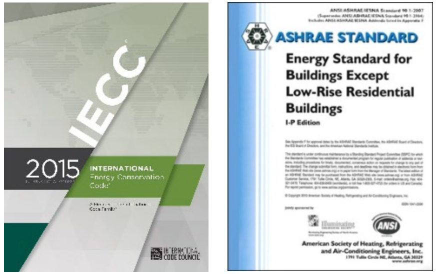
- Thermal resistance
- Fire resistance
- Sound resistance
- Safety and security
- Health and indoor air quality
- Sustainability
- Construction efficiency
- Innovative design

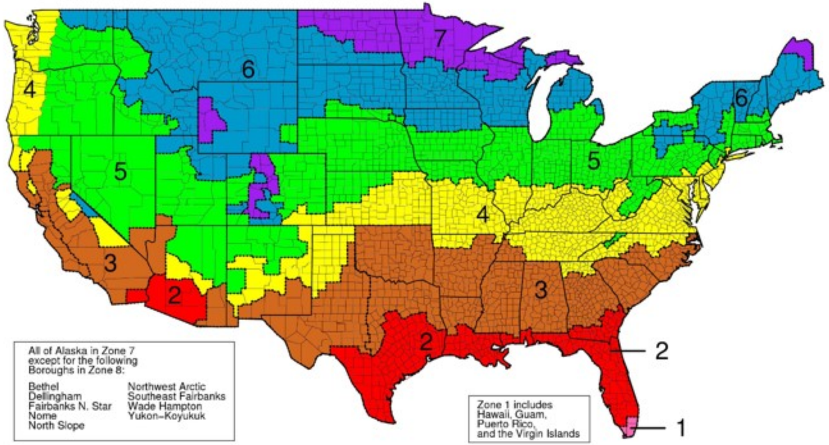


Thermal Resistance

ICFs are considered by the IECC and ASHRAE 90.1 as mass walls with continuous insulation. Typically, a whole wall ICF assembly has an R-value of R-24 or U = 0.041. ICFs exceed the requirements for all climate zones for commercial thermal envelopes above and below grade.

As energy codes increase the requirements for higher R-values on traditional construction, ICFs are ahead of the curve in relation to energy efficiency for the building envelope. Some ICFs have flexible R-values or the ability to increase the R-value to more than R-35 for wall assemblies to meet specifications in northern areas.

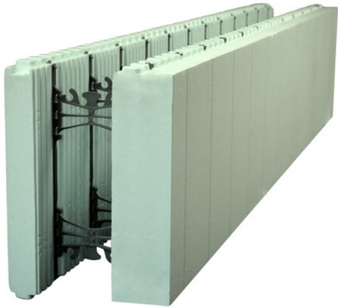




Thermal Resistance

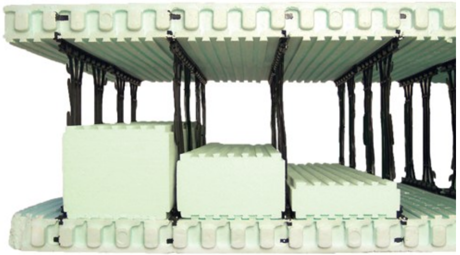
Where required, extra insulation may be added to customize the R-value to enhance the overall wall thermal resistance. This can be achieved with either a thicker exterior insulation panel or with EPS inserts. Using insert panels means the overall wall thickness increases to maintain the desired concrete core thickness.

Inserts are available in 2″, 4″, or 6″ EPS panels. The whole wall R-value may be increased to R-33, R-40, or R-47+.



Custom Exterior Panel

Varying Sizes of Insert Panels



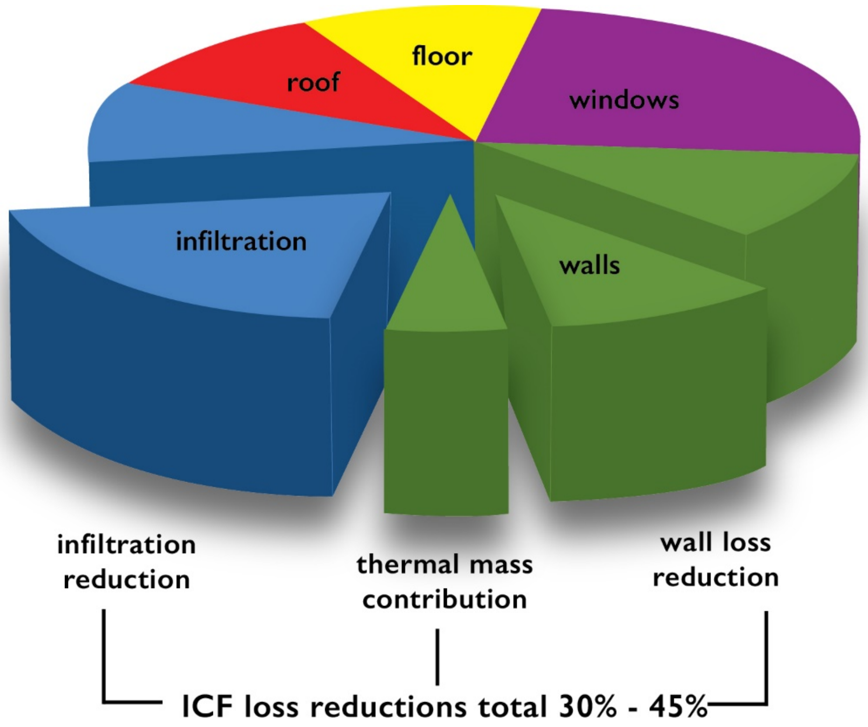
Plan View of Insert Panels in a Block

Energy Efficiency

The following three elements combined together determine the contribution of ICFs to the energy efficiency of the building envelope:

- High insulation value due to continuous insulation layers
- High thermal mass of the concrete core
- Low air infiltration

These elements reduce energy loss and allow for increased cost savings for heating and air conditioning for the life span of the building. An ICF building envelope allows for better control of the indoor environment, meaning a reduction in the overall size of HVAC equipment, which is another initial cost savings.

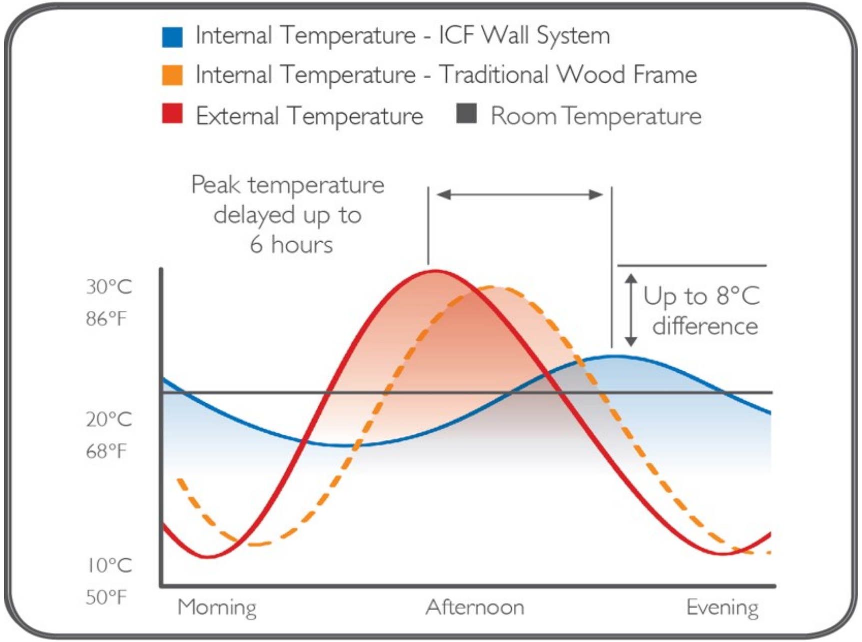


Thermal Mass

Thermal mass is the ability of a material to absorb and store heat energy. A lot of heat energy is required to change the temperature of high-density materials like concrete. The concrete mass between two layers of insulation moderates the temperature fluctuations between indoor and outdoor conditions. This lag in the temperature change on the interior side of the ICF wall reduces the need for the HVAC system to operate by reducing and delaying peak loads, providing a more constant control and comfort level for the indoor environment.

Although evident with conventional wood or metal stud walls, an ICF wall exhibits no thermal bridging through the monolithic insulated concrete wall.

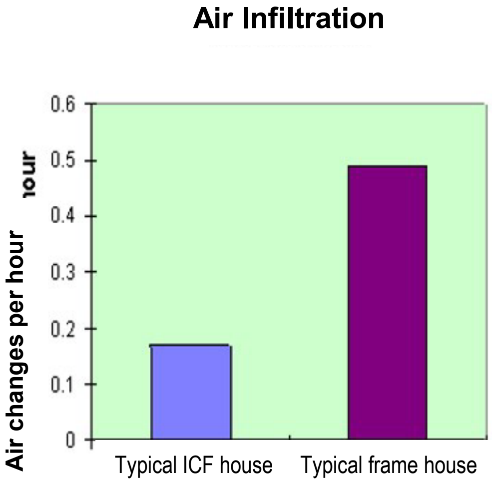
Stabilizing effect of thermal mass on internal temperature.



Based on no additional mechanical heating or cooling.

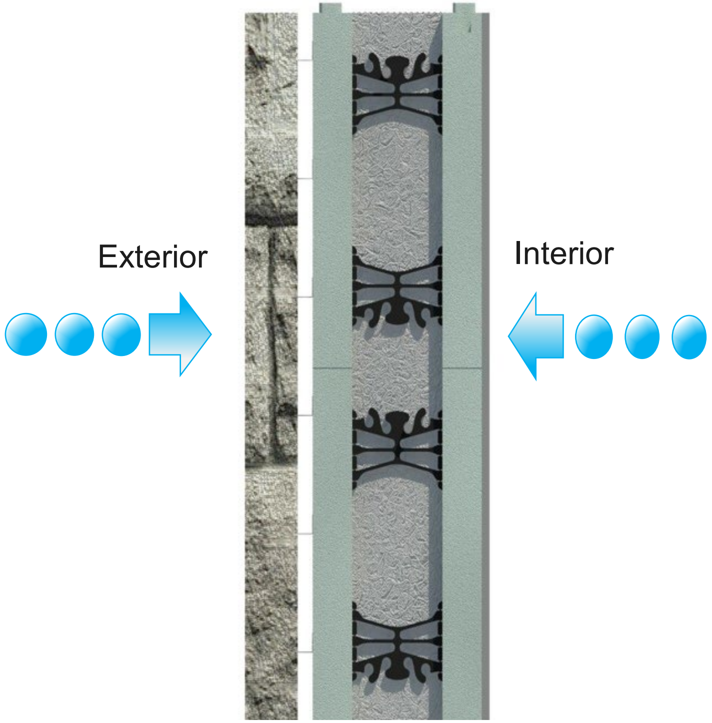
Air Infiltration

Monolithic concrete walls provide a continuous air barrier for the building envelope. With both the solid concrete core and the EPS insulation acting as air barriers, ICF wall assemblies substantially reduce the air changes per hour rate. Lowering the building's peak heating and cooling loads by 57% and 16% respectively results in major energy savings for the life span of the building.



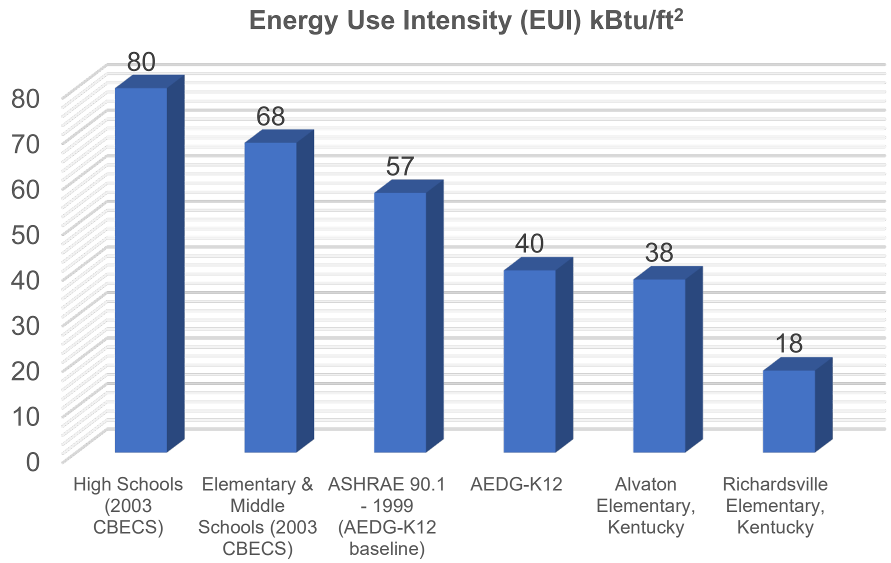
Vapor Permeance

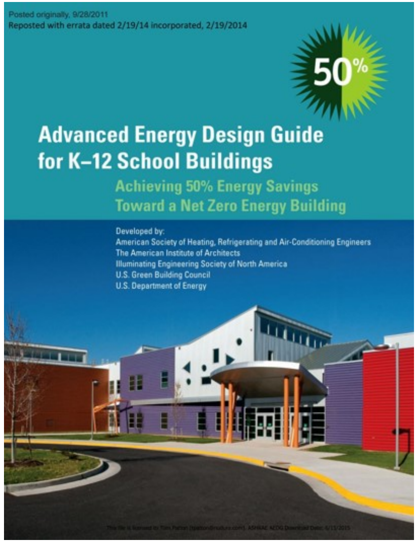
The use of a vapor barrier or vapor retarder is not required with ICFs. The EPS used for the insulation is a Class II vapor retarder with a permeance rating less than 1.0 perm. This is another cost savings as it is another building material that is not required as part of the building envelope.



Case Study: School Energy Savings

Two ICF designed elementary schools in Kentucky show a reduced energy consumption over schools designed with traditional construction methods. One school won the National ENERGY STAR® Award, and the other project is LEED Gold®. Both are 55% below the “Advanced Energy Design Guide (AEDG) for K–12 School Buildings” guidelines. These energy efficiencies contribute to dollars saved per year that can be used for other educational requirements.





Superior Fire Resistance

A flat wall form, 6-inch core, load-bearing ICF wall can be designed to meet a 4-hour fire resistance rating when tested to ASTM E119, “Standard Test Methods for Fire Tests of Building Construction and Materials.” The interior face of all ICF walls requires a thermal barrier protection, which may be ½″ gypsum board or drywall.

CLASSIFIED UL ®

ICF Fire Testing

IFCs are typically tested to meet the following standards:

It is important to note that EPS smoke is nontoxic, EPS for ICFs has a flame retardant, and the EPS ignition temperature is higher than wood.

- ASTM E119, “Standard Test Methods for Fire Tests of Building Construction and Materials”
  - Up to 4-hour rating with regular ½″ gypsum board
- ASTM E84, “Standard Test Method for Surface Burning Characteristics of Building Materials”
  - Smoke Development Index – less than 75
  - Flame Spread Index – less than 450
- UL1715, “Standard for Fire Test of Interior Finish Material,” UBC 26-3, “Room Fire Test Standard for Interior of Foam Plastic Systems,” or NFPA 286, “Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth”
  - Corner Room Fire Test – 15-minute thermal barrier

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UL - ASTM E119
Testing of ICF Assembly

ICF Fire-Rated Wall Assemblies

ICF fire-rated wall assemblies are used in all building types for load-bearing exterior walls and are especially applicable for interior load-bearing corridor walls or demising walls.


Educational, Institutional


Hospitality, Residential

Efficient Sound Attenuation

Sound attenuation is another key feature of ICF walls. Depending on the building type ICF walls can be constructed to meet the STC ratings needed for elevator shafts and garbage chutes; demising walls in theatres, schools, and hotels; and for buildings constructed near freeways, rail lines, airports, and other facilities requiring high sound attenuation. A 6-inch ICF provides a sound transmission classification of STC 50. Walls can be easily adapted to achieve increased ratings of STC 71 or higher.

Movie Theatre

Superior Disaster Resilience

Natural disasters are becoming increasingly more severe, and ICF reinforced concrete walls can be designed to withstand wind speeds of up to 250 mph for tornado and hurricane prone regions. ICFs can be incorporated into FEMA safe room designs and have been used by the State of Florida and other states to build mitigation complexes and safe rooms. Insurance companies recognize the financial benefits of making claims for minor wind damage as opposed to full destruction claims. ICFs have passed a windblown debris cannon test where 2x4s shot from a cannon at various wall assemblies bounced off the ICF walls.

Click on the image to view the video on YouTube (includes audio).

Earthquake Resilience

Flat wall reinforced concrete has over six times the racking load resistance of a conventionally framed wall. Steel anchorage in the ICF concrete walls at the footings, floors, and roof provides stiffness, strength, and ductility.

Some ICF product lines provide EPS concrete forms for floor and roof systems for a complete concrete building.

Earthquake prone regions such as Alaska and California are large markets for ICF construction.

Image courtesy of Naypong at FreeDigitalPhotos.net

Security: Blast Resistance

The surprising results of these destructive tests by the military are that the concrete walls stayed intact and were judged to be structurally sound. The EPS cushioned the force of the explosion and was blown off the wall, but the concrete only received minor cracking. The test used 50 lb of TNT and 6″ ICF #4@16″ o.c., with the blast 6′ away from the assembly.

U.S. Military Blast Testing on ICF Walls

Click on the image to view the video on YouTube (includes audio).

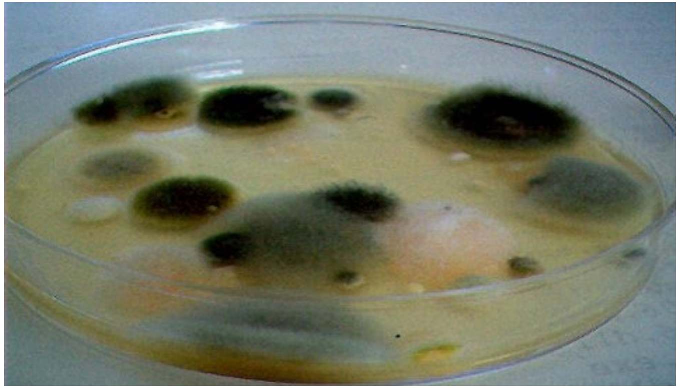
Structural Integrity Sustained

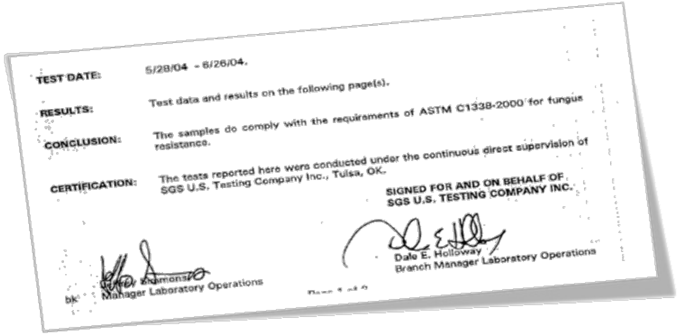
Superior Mold Resistance

One of the key benefits of EPS foam and concrete is that they will not propagate mold or mildew growth. ICFs are biologically friendly products.

EPS is not a food source for insects. EPS passes all fungi resistance testing; the EPS molders Association has conducted extensive testing and found that mold spores will not attach to the EPS and grow.

The high reduction in air infiltration achieved with ICFs provides better control of indoor air quality for a healthier environment.





TEST DATE: 5/28/04 - 6/26/04.

RESULTS: Test data and results on the following page(s).

CONCLUSION: The samples do comply with the requirements of ASTM C1338-2000 for fungus resistance.

CERTIFICATION: The tests reported here were conducted under the continuous direct supervision of SGS U.S. Testing Company Inc., Tulsa, OK.

SIGNED FOR AND ON BEHALF OF
SGS U.S. TESTING COMPANY INC.

Dale E. Holloway
Branch Manager Laboratory Operations

Manager Laboratory Operations

bk

Sustainability: LEED Credit Advantages

ICF wall assemblies enable the application of the design and operational credits for sustainability programs. Many buildings with ICFs have achieved LEED Gold® and LEED Platinum®. Consult ICF manufacturers for their reports on possible point contributions under LEED evaluations.

Ways in which ICFs may contribute to sustainable building:

- ICFs may improve building energy efficiency by 25 to 50%.
- ICF wall systems use greater than 50% recycled materials by weight.
- ICFs are composed of durable, long-life materials.
- ICFs reduce construction waste.

Enermodal Engineering Building: LEED Platinum®

LEED

LEED® is the preeminent program for the design, construction, maintenance and operations of high-performance green buildings.

CHANGE FOR THE BETTER WITH ENERGY STAR

GreenSpec®

Sustainability: Recyclability

All components of an ICF may be recycled or recovered for reprocessing.

- Expanded polystyrene properties enable it to be recycled.
- Polypropylene plastic webs are recyclable.
- Concrete and steel are recyclable.

Efficiency: Speed of Construction

Overall construction time is reduced through the speed of assembling the ICF wall. ICFs are a modular system; one block is more than 5 sq ft of wall area. Speed of construction is a major factor when constructing hotels or other income generating buildings. Another benefit is the faster return on investment once the building is operational.

There are fewer materials required for the building envelope, which reduces the number of subtrades necessary on the site, resulting in a lower number of man hours per square foot for a project.

There are also fewer weather constraints; there is no time delay for cold weather winter builds. In the picture to the right, concrete is being poured in the winter.

This speed of construction results in faster close-ins to be weather tight for interior trades.

Efficiency: Speed of Construction

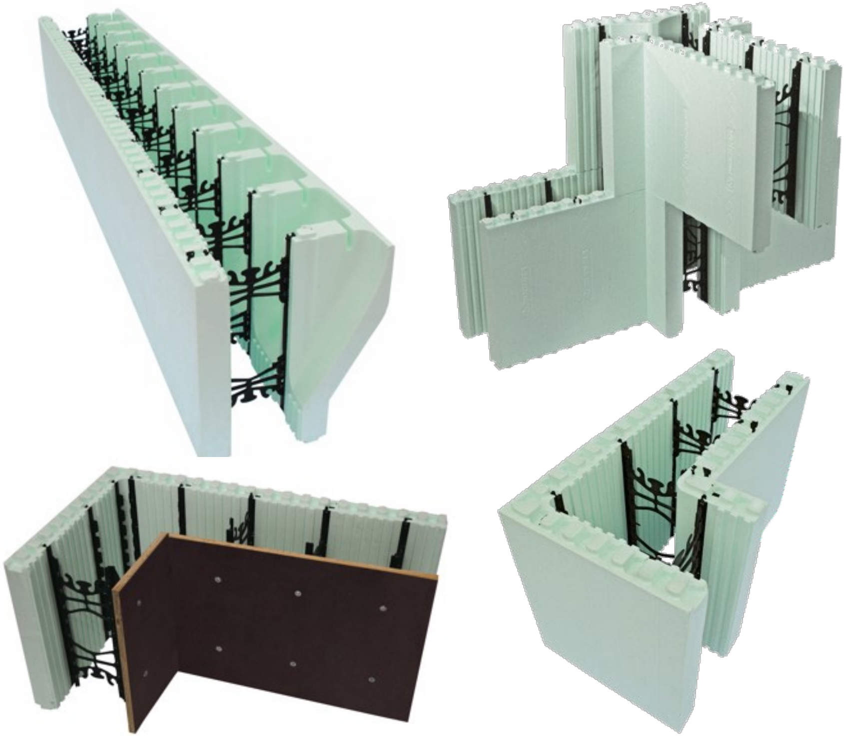
This is an example of the speed of ICF construction with a five-man crew.

Anderson County Elementary School – Lawrenceburg, KY

- 78,000 sq ft – five-man crew
- 18-month construction schedule – completed in 12 months
- Typical man/hr rate per gross sq ft of wall area – ± 0.08

Innovative Design

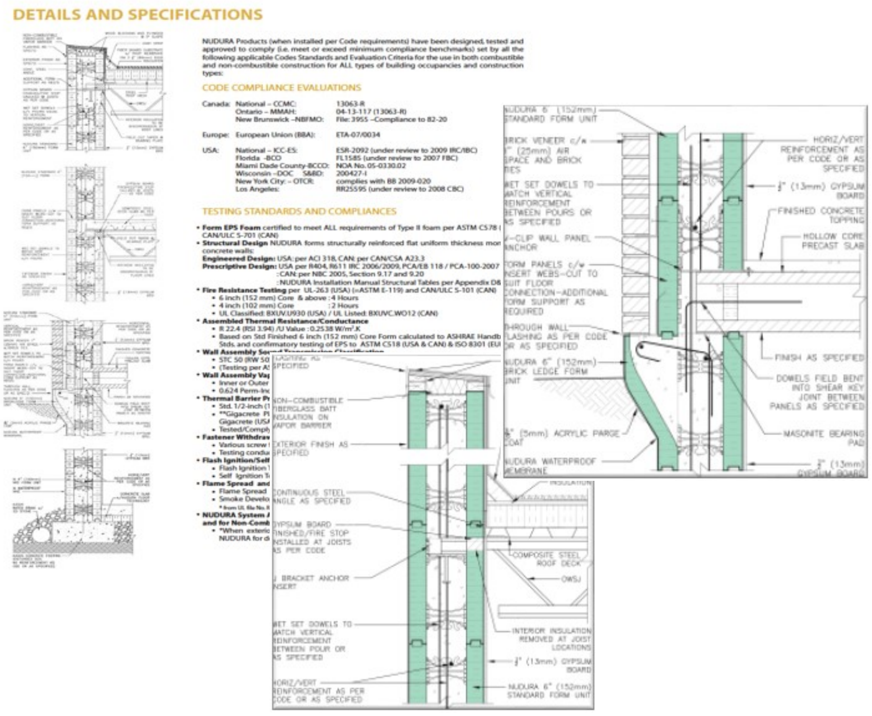
- Versatility in concrete core thicknesses 4″ to 12″+
- Transition of form size from foundation to top floor—e.g., 10″ form for foundation, reduce to 8″ form for 1^{st} and 2^{nd} floors, reduce to 6″ form for next three floors
- Variety of exterior finish applications
- T-forms for demising walls
- Radius forms
- Specialty blocks to suit coursing heights and increased R-values
- Easy to cut to suit dimensions and opening shapes
- ICF block configurations suit any wall design



Innovative Design

Details and specs should be available from the manufacturer’s website. Most manufacturers provide technical support for applications and detailing.

- ICF manufacturer’s product specific .dwg AutoCad® details
- BIM – Revit wall templates
- CSI specification – Section 03 11 19 Insulated Concrete Forming
- Material Safety Data Sheet (MSDS)
- Standard engineering for flat wall ICFs per ACI 318



Building Applications

All of the aforementioned environmental benefits coupled with innovative design technology may be applied to all building types in any of these applications.

- Below grade walls
- Single story
- Multistory high-rise
- Tall walls
- Load-bearing and curtain walls
- Retaining walls

List some of the ways in which ICFs may contribute to sustainable building.

REVIEW QUESTION

Nudura

TREMCO
Construction Products Group

ANSWER

ICFs may improve building energy efficiency by 25 to 50%.

ICF wall systems use greater than 50% recycled materials by weight.

ICFs are composed of durable, long-life materials.

ICFs reduce construction waste.

Construction Process

Nudura

TREMCO
Construction Products Group

ICF Construction Process Overview

- Footings
- Stacking forms
- Reinforcement
- Alignment/bracing
- Openings
- Placing concrete
- Connections
- Utilities
- Finishes

1 Prepare Footings For Block

2 Stack Forms & Create Openings

3 Place Rebar In The Walls

4 Align Wall For Concrete Pour

5 Pour Concrete Into Walls

6 Install Electrical, Plumbing, & Roof

Footings

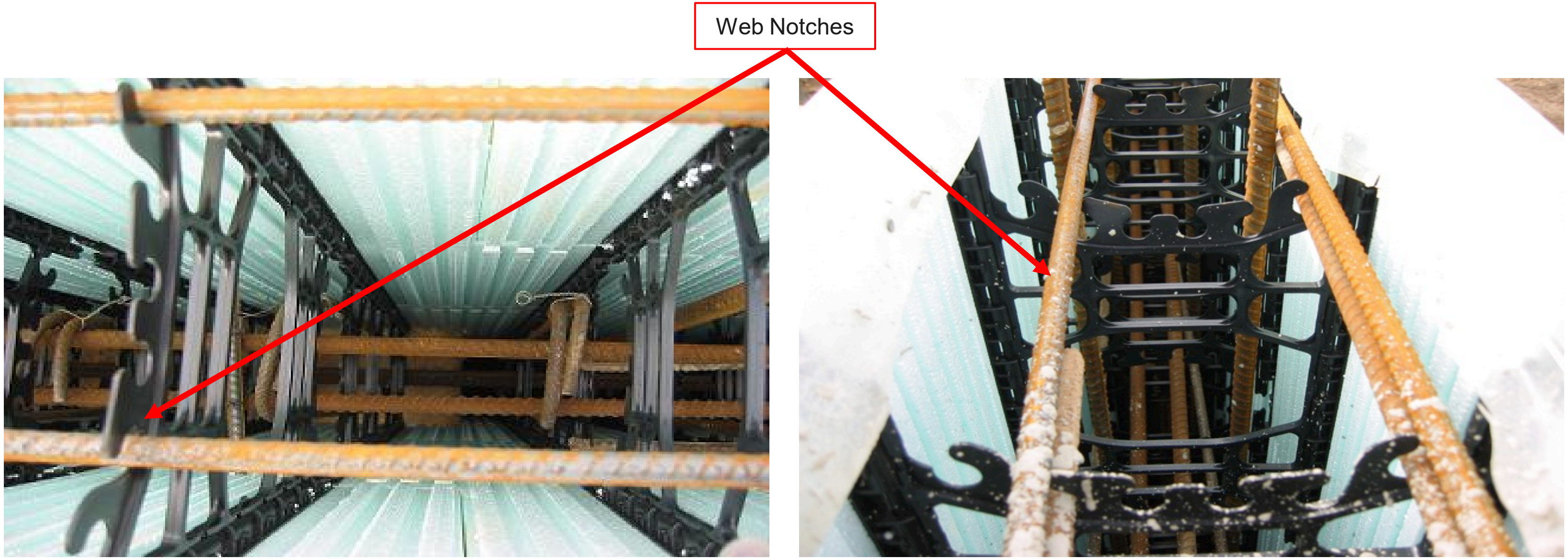
As with any building construction, the first step is to install the footing for the wall. Standard footings are installed according to applicable building codes and engineering requirements. Stepped footings are easily accommodated with the flexibility of ICF construction. Most ICFs require the footings be within ¼″ of level.

Stacking Forms (Wall Assembly)

As modular units with standard length forms and corners, the walls are assembled very fast. Building dimensions are determined, building corner pins are located, and the form units are then easily stacked similar to building blocks in a running bond pattern. Most ICF manufacturers recommend developing a pattern when placing forms to ensure the placement is as efficient as possible.

Reinforcing Steel

Depending on wall requirements, reinforcing is designed per ACI 318, IBC, and IRC specifications or manufacturer's prescriptive tables. Reinforcing steel is placed into the notches provided by the ICF webbing. Reinforcement is typically rebar #4 or #5 and is generally installed in a single mat horizontally and vertically.



Efficient Steel Placement

ICF design (notches in web) allows for accurate positioning of the steel in the wall—vertical at 8″ or 16″ o.c. and horizontally at 16″ or 18″ or 24″ o.c.

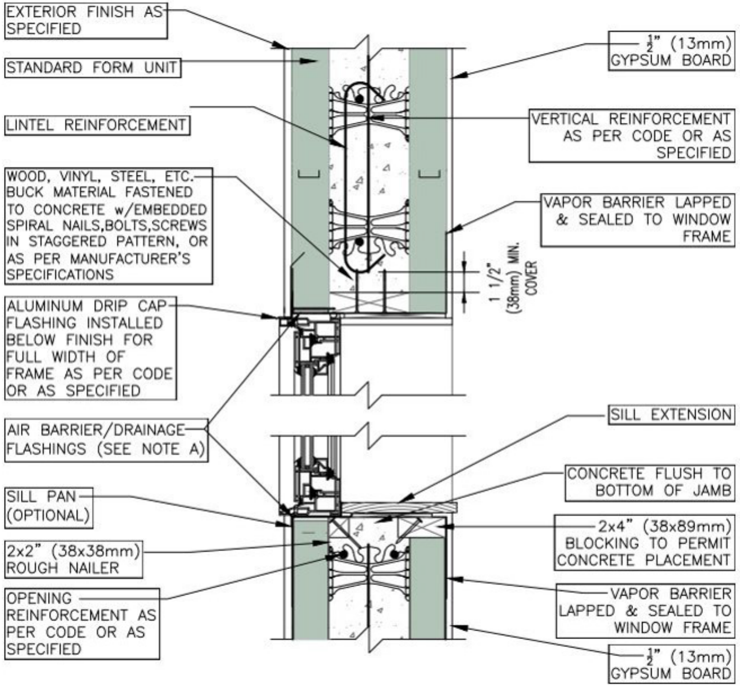
- Noncontact lap splicing
- No wire ties required
- Single or double mat
- ICF design allows rebar to a min. ¾″ from face of concrete per ACI 318 – 7.7.1(c)

Below-Grade Moisture Resistance

An EPS compatible "peel and stick" membrane is available to provide a below-grade waterproof barrier against moisture infiltration. ICF manufacturers usually supply a proprietary product for this purpose.

Wall Openings

Openings are constructed as the wall is being erected. As with any opening that is created in a concrete wall, a temporary or permanent buck is required to hold back the concrete until it has cured, and to support the attachment of the window or door. Window and door openings can be any size and shape, and the bucks or frames may be made to suit any opening. There are several types of buck materials that can be used, including wood, metal, and EPS.

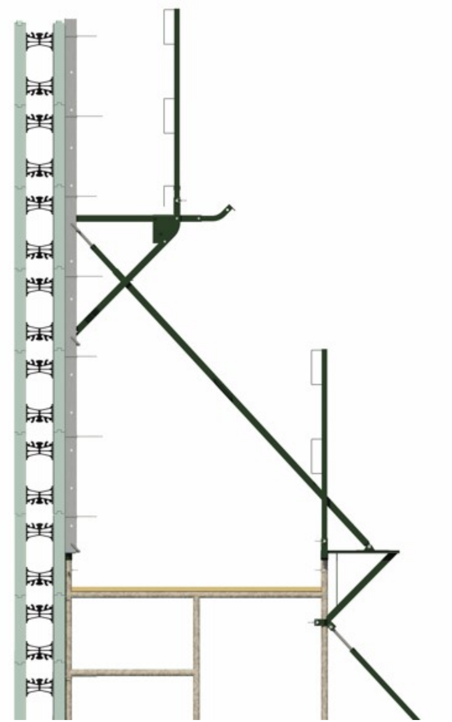


Aluminum Window Detail

Wall Alignment and Bracing

The key to a successful ICF project is the use of an ICF alignment and bracing system. The system not only braces the walls but also adjusts and aligns them to be straight and plumb, and serves to safely support workmen. The wall alignment bracing is placed as the wall is stacked. There are systems available for tall walls, and all wall alignment systems are engineered to be OSHA (Occupational Safety & Health Administration) compliant.

System for walls up to 16′



System for tall walls

Concrete Placement

The concrete mix has a higher slump of 5″ to 6″ for ICF walls, and for 4″ and 6″ forms a small aggregate at ⅜″ is specified. This allows for better flow within the forms. Most ready-mix suppliers offer an ICF mix design. Concrete core widths are available in 4″, 6″, 8″, 10″, and 12″ thicknesses. The concrete placed within the walls will require consolidation, which is usually done internally. Concrete is placed continuously in lifts of 4″, which is standard.

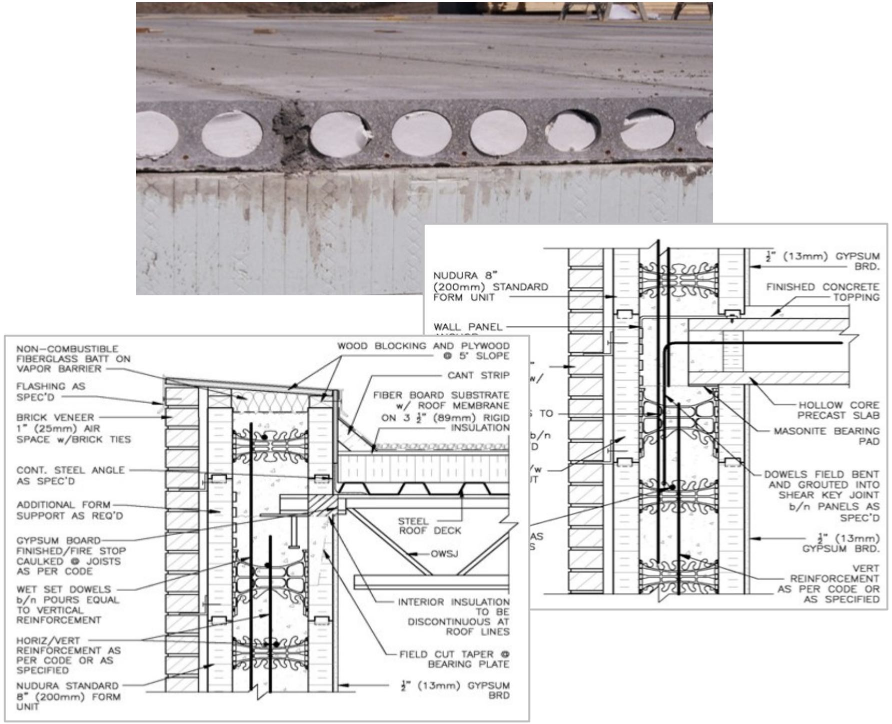
Floor / Roof Systems: Options

As a reinforced concrete wall, the thickness and design strength allows ICFs to solve vertical and axial loading for floors and roofs.

- ICFs are compatible with any system
- Connections may be either on top of the wall or to the side of the ICF wall

Options include the following:

- Open web steel joists, steel joists
- Composite steel deck
- Hollow core precast
- Precast “Ts”
- Flat slab
- Insulated concrete deck



Wall-to-Floor Connections

ICFs are compatible for the connection of any floor system, be it on top of the wall or into the side of the wall. Intermediate floor connections can be integrated to hang off the ICF wall or can be imbedded into the core of the concrete wall. Any floor type can be used with ICF construction, including: hollow core slabs, steel joists with concrete slabs, steel joists with steel pan decks and a concrete slab, wood joists, or any other floor system on the market.

Wood

Hollow Core

Steel/Concrete

Roof Connections

Different roof types can be integrated on to ICF walls, including flat roof or sloped roof tops constructed from wood, steel, or concrete, depending on the requirements for the building.

Wood or Steel Truss Systems

Flat Steel Roof Systems

Connection of these elements occurs via:

- anchor bolts
- weld plates set into the concrete, and
- hurricane straps.

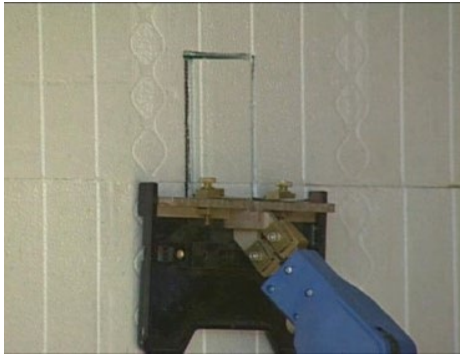
Embedments

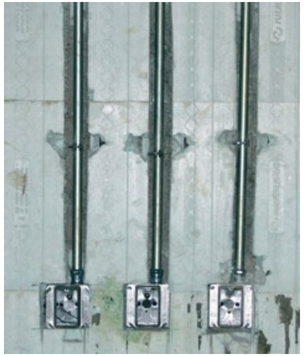
Embedments or steel plates designed with steel studs or determined reinforcement can be added to the face of the form prior to the concrete placement or added to the top during placement. Embedments are crucial for carrying floors, roofs, beams, stairs, signage, and other heavy, all-hung features.

Electrical Installations

As with CMU construction, the electrical contractor is not required on site for conduit installation until the ICF walls are complete, saving time and money on the electrical installation.

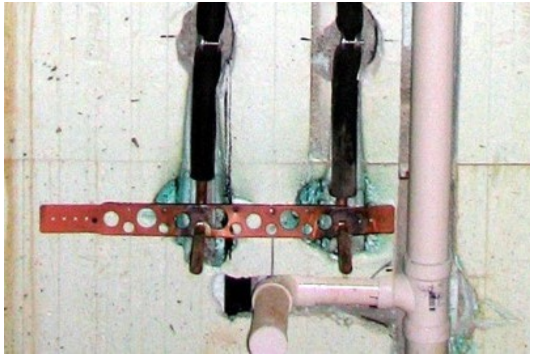
Rough-in for electrical work is accomplished in various ways in the ICF wall face. Electrical chases can be created using a number of different tools, including an electric chain saw, hot knife, or a reciprocating saw. Chases are usually cut into the EPS foam after the concrete has been placed in the wall. Electrical boxes are mechanically fastened to the fastening strip of the form or directly to the concrete.

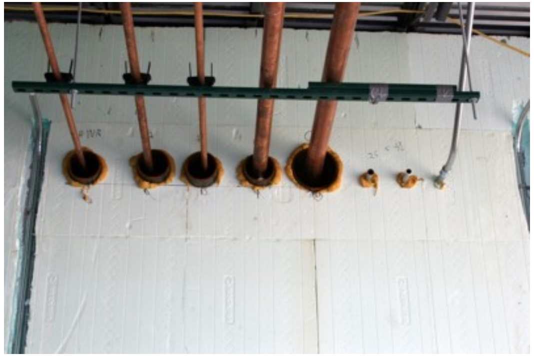




Plumbing Installations

By cutting and removing the foam, PVC pipe up to 1 ½″ with a coupler can be recessed into the wall with no added framing. PVC piping or chases can be cut into the form (prior to placement) for those mechanicals passing through the concrete core.





Interior Finishes

Typically, ½″ gypsum board (drywall) is the most common interior finish. The gypsum board acts as a thermal barrier (fire protection) over the EPS. Gypsum board can be installed directly to ICF walls, on to the fastening strips, spaced at 8″ o.c., using 1 ⅝″ drywall screws. No vapor barrier is required.

Exterior Finishes: Flexibility

A variety of different finishing materials can be directly applied to the exterior of an ICF building. Installation instructions are based upon the finish-manufacturer's recommendations. No air barrier or building wrap is required on ICF walls.

Common exterior finishes include:

- Various sidings (cement, vinyl, steel, wood)
- Stucco (acrylic, hard coat)
- Brick, stone veneers
- Simulated brick or stone
- Curtainwall

The Finished Product

The result is a solid, insulated, reinforced concrete wall assembly with excellent thermal resistance and sound transmission properties.

What floor type can be used with ICF construction?

REVIEW QUESTION

Nudura

TREMCO
Construction Products Group

ANSWER

Any floor type can be used with ICF construction, including:

- hollow core slabs
- steel joists with concrete slabs
- steel joists with steel pan decks, and many other floor system available on the market

Building Types

Residential

A variety of residential buildings have been constructed using ICF technology, and they are not limited to standard style homes. Interesting designs and features can be incorporated into the building plan, offering the ability to build homes that meet a client’s unique design requests.

Multiresidential

Multifamily style buildings, such as seniors' residences, apartments, and condominiums, can be built using ICF technology. A variety of different exterior finishes can be utilized along with architectural design features to give designs a pleasing aesthetic.

Hospitality: Hotel / Motel

Hotel and motel complexes are suitable applications for ICF technology. Both energy efficiency and reduced sound transmission between suites and from outside noise pollution are key factors in the decision to use ICFs.

Hilton Garden Inn

Hampton Inn & Suites

Institutional

Buildings that require a safe, strong, and secure environment are ideal candidates for ICF technology. These include schools, colleges, universities, libraries, gymnasiums, pools, dormitories, community centers, and fire halls.

Medical

Medical and healthcare facilities, such as hospitals, clinics, homes for the elderly, veterinary clinics, and research laboratories can benefit from the reduced sound transmission from outdoor noise pollution as well as the reduced energy consumption that ICFs offer. Buildings, or areas within them, that require strict indoor air quality control can also benefit from ICF construction.

Buildings of Worship

Buildings of worship also find ICF technology to be a great alternative to conventional building materials. These buildings usually remain unoccupied for a good portion of the week but still have to maintain a constant temperature. The energy use reduction helps keep the operating costs lower when the building is not in use.

Commercial

ICF technology is suitable for a variety of commercial style buildings including retail (standalone, strip malls), big box stores, offices, banks, theaters, warehouses, and restaurants.

Industrial / Agricultural

Whether it is service shops for heavy equipment, produce and food storage facilities, animal barns, concrete plants, or manufacturing plants, ICFs can meet the performance requirements for these building types.

Case Studies

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Case Study: Richardsville Elementary

Richardsville Elementary, Bowling Green, KY

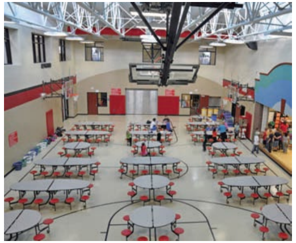
Project Type: Educational Facility

Architects: Sherman Carter Barnhart

Size: 72,285 sq ft

Completion: 2010

Built with a high-performance building envelope with ICFs for the interior and exterior walls, the school is the first net-zero ICF school in the United States and is LEED Gold®. It is designed to use only 18 kBtu/sq ft—annually 68% less than the ASHRAE 90.1 design standard for elementary schools. ICFs were used for sound resistance in the gymnasium, cafeteria, and music media center, and between classrooms. ICFs allowed the building to be constructed quickly during winter and other inclement weather.



Case Study: Turkey Foot Middle School

Turkey Foot Middle School, Edgewood, KY

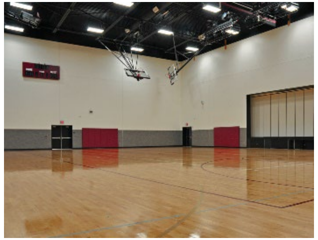
Project Type: Educational Facility

Architects: Piaskowy and Cooper

Size: 133,000 sq ft

Completion: 2010

Built with a high-performance building envelope with ICFs for the interior and exterior walls, the school is the second net-zero school in Kentucky and earned a Merit Award in the 2011 AIA Kentucky Awards for Excellence in Architectural Design.



The building reduced grid energy usage from 21.7 to 10.2 kBtu/sf/yr leading to an energy cost savings of $306,701 from 2010 to 2012. The building also has an ENERGY STAR® rating of 100. Along with ICFs, other thermal envelope strategies included no mezzanines, low infiltration (avoided pitched and vented roof systems), minimized nondaylight glass percentage, and good roof insulation.

Case Study: Kosair Children’s Medical Center

Kosair Children’s Medical Center, Louisville, KY

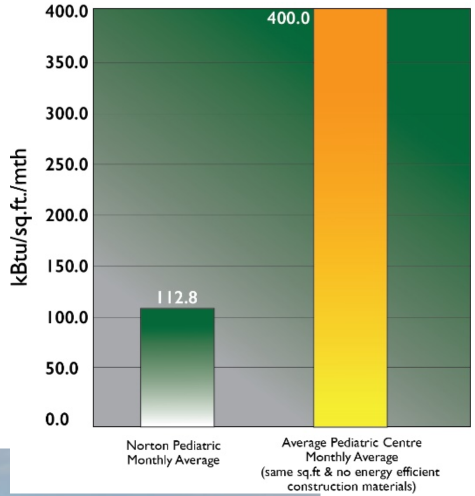
Project Type: Medical/Healthcare

Engineers: CMTA Engineers

Size: 70,040 sq ft

Completion: 2010

Kosair Children’s Medical Center is a pediatric outpatient center built to hospital standards. The facility, built with ICFs, includes a 24-hour emergency department, and diagnostic imaging including MRI, CT, and ultrasound. The surgery and central sterile departments support four operating rooms and two future planned operating room additions. This facility is LEED Gold® and is designed to meet ENERGY STAR® requirements. Energy usage is approximately 112.8 kBtu/sq ft/mth compared to the average center (without ICFs and other energy-efficient construction materials) at 400.0 kBtu/sq ft/mth.



Case Study: First Citizens National Bank

First Citizens National Bank, Wellsville, NY

Project Type: Commercial - Bank

Architect: R.W. Larson

Size: 4,000 sq ft

Completed

The First Citizens National Bank in Wellsville, NY is a single-story banking facility with drive-through capability. It has 4,000 square feet of floor area with 2880 square feet of gross wall area, and 12' high walls on top of frost walls. The exterior load-bearing walls were built with 6″ ICFs. The heating and cooling costs reflected enough savings that both the builder and bank owner are now building future banks and residential developments with ICFs.

Thank You

Resources

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