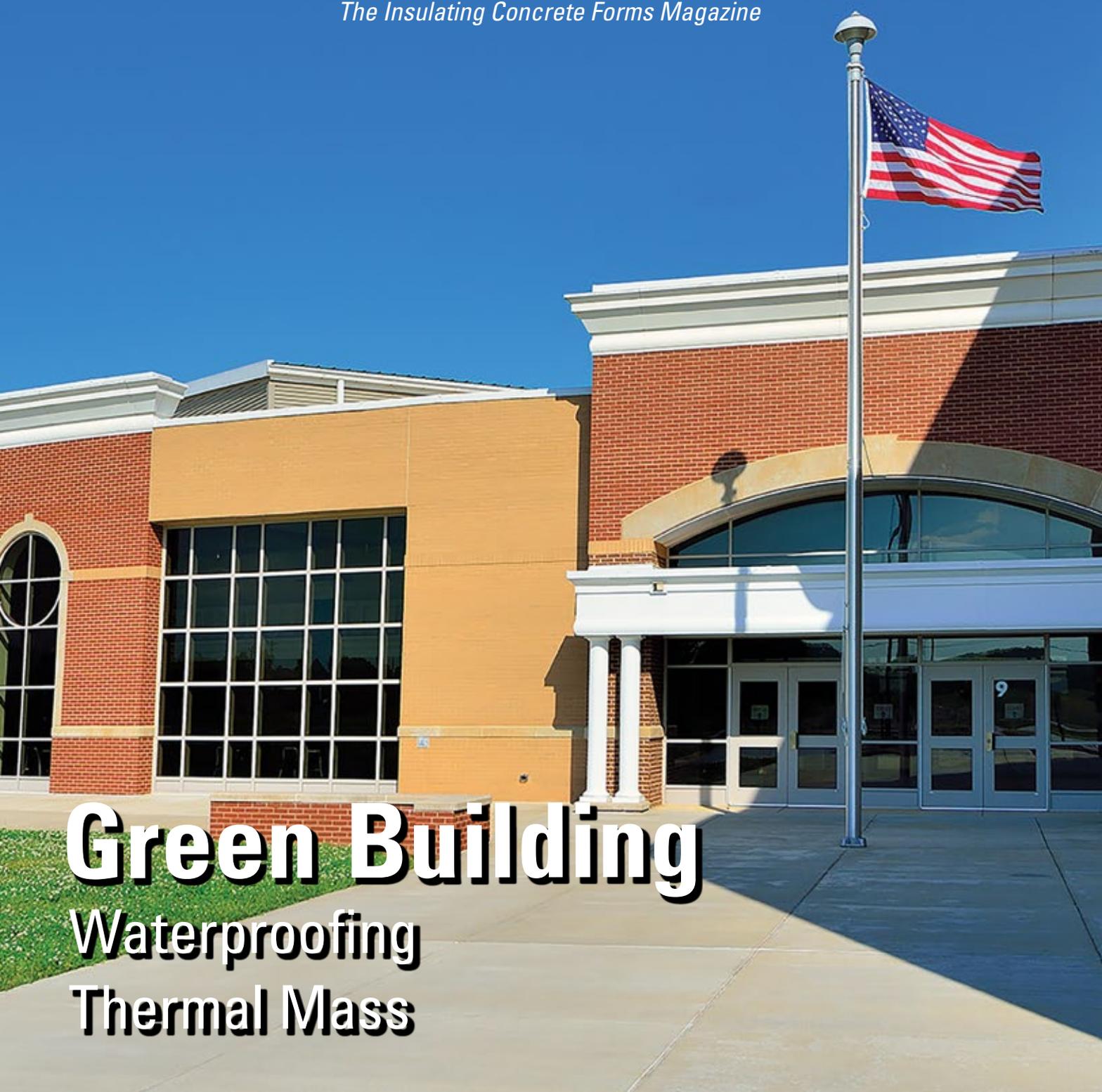


May/June 2017

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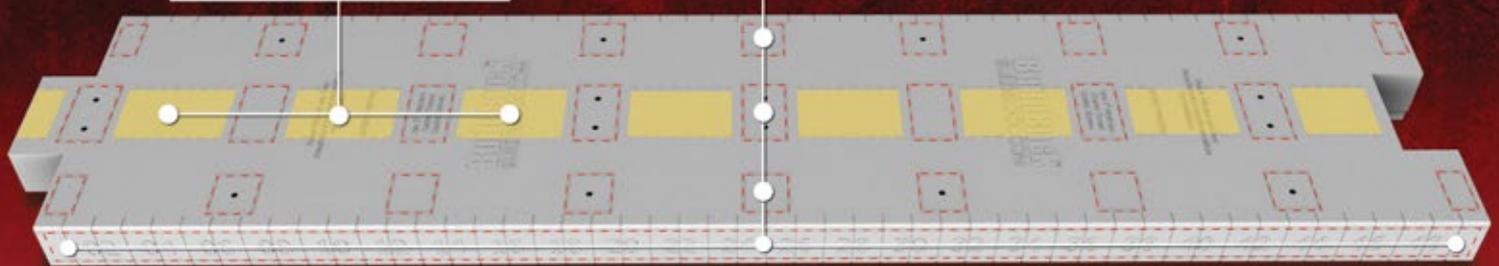
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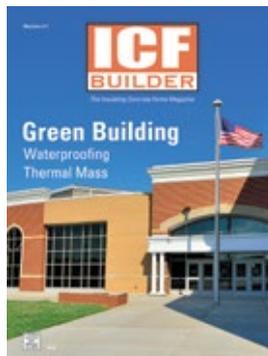
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**On the Cover:** South Warren High School in Bowling Green, Ky., has demonstrated the potential ICFs offer in the commercial sector. For more information see pp. 20-25.

Photo by Chris Phebus; Courtesy Sherman Carter Barnhart



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# As I See It

by Clark Ricks

## Honesty

ICFs are a remarkable technology. The combination of a reinforced concrete core sandwiched between rigid EPS foam creates a structure of remarkable strength, energy efficiency, and value. However, in our zeal to advance the industry, many—including me—may have occasionally been guilty of “over-promoting” ICFs. Sometimes, we’ve damaged our credibility by exaggerating or making claims that cannot be backed up by independent testing.

The truth is, ICFs are remarkable enough on their own merits. Both lab testing and field results demonstrate that no exaggeration is needed, and the evidence of their superiority continues to grow year after year.

For example, the thermal mass study (facing page) is a big deal. Thanks to the efforts of the ICFMA, we now have proof that—in addition to superior R-value and airtightness—the thermal mass of an ICF wall also contributes to energy efficiency. We know exact percentages, and can share those results knowing the test was performed in accordance to widely recognized ASTM standards.

Real-world examples are similarly noteworthy. South Warren High School and Middle School (see story on p. 23) is one of the largest schools in the nation. It’s also one of the most energy

efficient. And yet, the construction cost per square foot was the lowest in the state. Even more noteworthy is that it’s not an isolated example. Many of the best-performing schools in the U.S., including the first net-zero commercial building, are built with ICF (see story on p. 20).

There are scores of similar projects in the residential sector, too. In nearly every state, the homes that meet the highest green building, efficiency, and disaster-resistance standards are built with ICF. Shelving Rock (profiled in this issue on p. 10) for instance, meets net-zero and accessibility standards.

Honesty requires that we admit that ICFs are not the best fit for every project and budget. But when quality, efficiency, sustainability and longevity are factors, no other building method comes close to the benefits ICF bring to the table. ■



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# In The News

## New Study Quantifies Thermal Mass Benefit

For years, this industry has claimed that the massive concrete core inside ICF walls dampens temperature swings and reduces energy use. Now, results from a recent study commissioned by the ICF Manufacturers Association (ICFMA) has qualified those savings. By combining continuous high-R-value EPS insulation with high-mass draft-free walls, insulated concrete form construction can achieve up to 58% annual energy savings for building owners.

Released in late March, the study quantifies the benefits of both thermal mass and the continuous insulation properties of ICF technology over traditional code-compliant wood-frame cavity insulated systems.

While many studies have been conducted in the past by the Portland Cement Association (PCA), the Canada Mortgage and Housing Corporation (CMHC) and the Department of Housing and Urban Development (HUD), these were all based on limited field comparisons or thermographic computer modelling

To address this deficiency, the ICFMA recently commissioned a comprehensive series of impartial studies comparing traditional insulated wood frame construction to a standard six-inch-core insulated concrete form (ICF) wall. This is the first time a fully accredited testing facility has been commissioned to evaluate a realistic side-by-side comparison of the two building methods.

"For decades, the ICF industry has been asked to provide definitive proof that thermal mass, the airtightness and continuous insulation features of ICF walls deliver real, quantifiable benefits," says Andy Lennox, chair of ICFMA. "Now we can reference this study, which confirms dramatically superior ICF energy-efficiency performance."

The testing was undertaken at CLEB Laboratories (formerly Air-Ins Industries Inc.) in Varennes, Quebec, Canada, just east of Montreal.

They subjected two specimen walls to a month-long period of study. One wall

**Lab results verify that a 2x6 wood frame wall system uses up to 60% more energy vs. an ICF wall system.**

was constructed to current code-compliant standards: an R-20 insulated wood frame cavity wall with typical drywall and exterior vinyl siding finishes applied. The other wall used a standard six-inch-core (150mm) ICF wall with two layers of Type II EPS foam each approximately 2 1/2" (64mm) in nominal thickness and the exact same code compliant finishes.

The tests were conducted in strict accordance with ASTM C1363-11 *Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus*. To conduct this test, the wall sample separates two chambers, one of which is heated, and the other cooled. Then, temperature sensors measure how long it takes for the temperature between the two chambers to equalize.

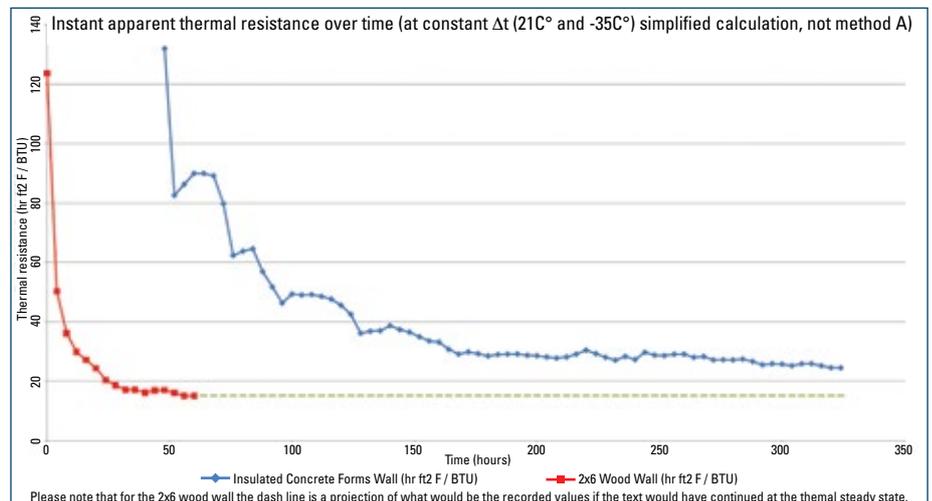
The results indicate that the ICF as-

sembly took nearly 324 hours to reach steady state performance under an exterior air temperature of -31 degrees F (-35 degrees C) whereas the wood frame wall reached steady state within 60 hours of the start of the test.

Although the lag time has been corroborated in previous studies, CLEB's studies have clearly illustrated when comparing the amount of energy required to maintain both walls at steady state over this same 324-hour period, the wood frame wall consumes 149% more energy than the ICF wall. Even after both walls attained steady state under the test conditions, the ICF wall consumed 58% less energy than the wood framed wall specimen to maintain temperature.

What does this mean in the "real world"? Consider two typical homes, each with 2,000 sq. ft. of wall area; one constructed with wood frame to code minimums, the other constructed with the same wall area using ICFs. In terms of average kWh value for all of North America, this study proves that during the most extreme cold conditions an ICF wall could end up saving between \$100 and \$180 per month in equivalent electrical consumption over any traditionally constructed wood frame wall.

A PDF of the complete report can be found in the online version of this magazine, or at <http://www.icf-ma.org/thermalstudy>. ■



# ICF News Roundup



## ICF Expo a Success

In early March, Fab-Form hosted a well-attended ICF Expo near Vancouver, B.C. Canada. Rick Fearn, who organized the one-day event, reports that about 200 building professionals from the region attended to learn about "the role of ICFs in the future of construction."

The expo included an exhibit area where fourteen manufacturers displayed their ICF wall and floor forms including accessory products. The primary focus, though, was the education seminars, where 18 industry experts presented a variety of topics. Speakers included architect Reema Masri, who discussed the many ICF midrise condominium complexes her firm has designed in Waterloo, Ontario; Luke Pinkerton, CEO of Helix Steel, who discussed concrete reinforcing with micro fibers; Kev-en Rector, technical director at ICFMA who discussed engineering challenges; and Chris Mattock, a principal at HDC Consulting, who discussed the greening of construction.

Videos of the presentations are available online and can be accessed via the expo website [www.icf-expo.org/archives](http://www.icf-expo.org/archives).

## Appraisals To Include HERS Scores

An effort is underway to require homebuilders to disclose energy efficiency data to potential buyers.

The cost of home ownership—such as utilities, maintenance, and association dues—is a major factor in purchasing a home, but not always obvious. Energy costs are a major portion of these costs, approximately to 4% (roughly \$2,200 per year) of

the average household's income, but many consumers in the market for a home have little or no information on the energy efficiency of homes they are evaluating.

Now, a new effort by Residential Energy Services Network (Resnet) and the Appraisal Institute, the association of professional real estate appraisers, will make home energy efficiency more transparent to buyers. Going forward, appraisers will be able to add an addendum covering "green" elements of the home, such as additional insulation, and includes them into the valuation of the property. The building's HERS score will be included, as well as any certifications, such as LEED for Homes.

Resnet executive director Steve Baden explains, "One of the largest barriers to the building and selling of high performance homes is that the value is often not reflected in the real estate appraisal. Many of the features that make a home energy efficient



are hidden behind drywall and aren't obvious to home buyers. Our goal is to make information, such as the HERS score of a home, visible in the appraisal so that consumers have more facts available to make their decisions."

Resnet has already compiled a database with HERS scores for more than 200,000 homes across America. The Appraisal Institute will have access to Resnet's database of HERS-rated homes on a state-by-state basis.

"Often the builder has to 'eat' the added cost for high performance or the buyer has to pay for the improvements out of pocket," Baden notes. "Having the energy performance of the homes recognized in the appraisal means they can be financed through the mortgage loan, which reduces out-of-pocket costs to the owners."

He continues, "The technology is there, the economics are good and NAHB research has shown that consumers want energy efficient homes. It's time that we made this information more transparent to consumers so that they can have as much information as possible to make that critical home-purchase decision," Baden says.

## Logix Offers Small Home Designs

In January, Logix ICF unveiled a new series of home plans developed in conjunction with Civic Homes.

Dubbed "Civic Home Plans for Logix," the floor plans focus on efficiency. They include one-, two-, three- and four-bedroom layouts with living areas ranging from 415 to 1,810 sq. ft. and are "Net-Zero Ready". The designs are optimized to Logix' dimensions, and are offered fully estimated,



including the finishes and appliances.

"This is a collection of tasteful home designs crafted to provide families with strong, long-lasting, disaster-resilient homes that are comfortable, energy-efficient and affordable," says Andy Lennox, marketing director for Logix ICF.

### Concrete Midrise Advocacy Continues

The National Ready Mix Concrete Association (NRMCA) continues to advocate for ICFs in midrise construction. The campaign, called "Build With Strength" offers design assistance for specific projects in addition to promotion and lobbying efforts.

Recent activities include calling on the Maryland State Senate to limit dangerous and combustible lightweight wood construction in mid-rise residential buildings, and urging the Florida Building Commission to maintain its prohibition on using wood-frame construction in public school and college buildings.

The Maryland advocacy centered around a discussion of Senate Bill 722. Six young children were killed in a Baltimore house fire in December, and nine other state residents were killed due to fires in the first 30 days of 2017. In response, the fire safety community, structural engineers and proponents of safer construction methods are coming together to urge Maryland's lawmakers to enact stricter building code standards to prevent needless tragedies from striking the community.

"The code changes that have gone into effect in Maryland over the last eight years allowing the use of combustible framing materials in taller and larger buildings contain unparalleled levels of risk," said Steve Lohr, fire chief in Hagerstown, Md. "SB 722 is without a doubt a definite move in the right direction."

The Florida Building Commission was debating whether to amend the Florida Supplement to the 2015 International Building Code, which specifically prohibits wood-frame construction in school board and college buildings. NRMCA partnered with the Masonry Association of Florida and the Florida Concrete & Products As-



A COALITION OF THE NATIONAL READY MIXED CONCRETE ASSOCIATION

sociation, to defeat the proposed modifications to allow wood-framing.

"Requiring the use of noncombustible materials that won't rot, mold, or warp, and can withstand the full force of hurricane-

force winds, is a no brainer for schools," said Kevin Lawlor, a spokesperson for Build With Strength. "In Florida, that means bricks and mortar, concrete and steel rebar, not wood-framing." ■

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## SHELVING ROCK HOME

The Shelving Rock Home—located a few miles northwest of Albany, NY—is a landmark ICF project. The remarkably functional and beautiful design also meets two demanding design criteria. It's registered as a Net-Zero Ready home by the U.S. Dept. of Energy, and also meets Universal Design guidelines.

Universal Design, sometimes called "aging-in-place," incorporates a range of accessibility features to allow owners to stay in their homes even when age makes mobility difficult. In this home, that meant lowered sinks, no-step showers, and other touches such as installing the microwave below the counter. All halls are a minimum

of four feet wide, with 36-inch-wide doors throughout. Proponents claim the concept saves tens of thousands of dollars over the long-term by allowing occupants to live independently rather than in a retirement home or assisted living center.

For now, though, the biggest savings at Shelving Rock are reduced energy costs.

Built through the winter months, ICFs made all the difference. Concrete was poured despite temperatures of 15 to 17 degrees F.





The design included 30 corners, more than half of which are 45-degree-angles.

Walls were built with Logix Pro Series ICF, a foam-and-concrete wall system which offers exceptional insulation, airtight walls, and enough thermal mass to virtually eliminate temperature swings. Heating and cooling is accomplished via an in-floor radiant hydronic system, tied to a ground-source heat pump (GSHP) that takes advantage of the earth's stable temperatures for even greater efficiency. Heat Sheet EPS panels were used under the basement slab to ensure it's thermally isolated. The wood-frame hipped roof was sealed with spray foam insulation, and high-efficiency windows complete the envelope. Blower door tests revealed the home has a HERS rating of 22, meaning the home uses only 22% of the energy compared to a code-minimum structure.

It's rated by the DOE as "net-zero ready," meaning that with the addition of solar panels, the home could generate as much energy as it consumes.

The home has a number of other sustainable design features, including exterior landscaping composed of non-invasive, native plants, trees, and grass, reclaimed or locally made furniture, and low-VOC paint.

The footprint of the home is far more complex than it appears from the front. The house measures about 3,500 sq. ft., plus an 800-sq.-ft. bonus room above the garage. But two bay window bump-outs and an ICF garage meant the layout involved 30 corners, more than half of which are 45 degrees. Additionally, the project broke ground in an unusually wet late fall. Andy Ellis, who served as general contractor

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and ICF installer, says, "The sitework was a nightmare. The soil is all shale and clay, and there were very strong and consistent winds that always had to be dealt with."

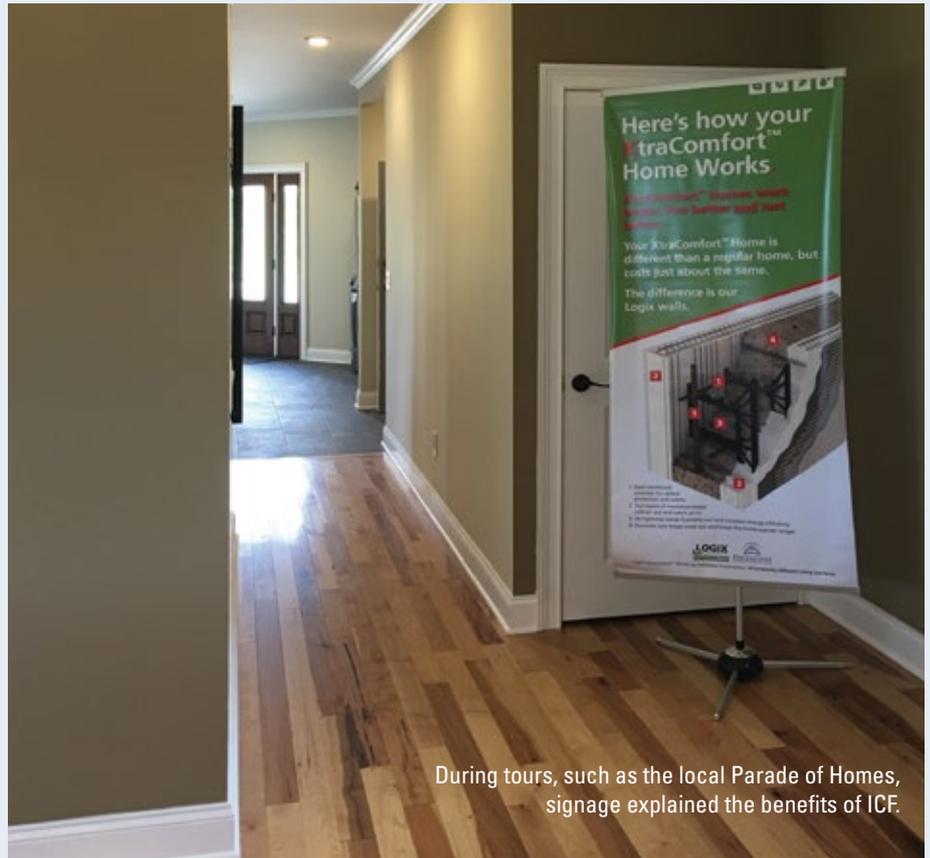
By the time the basement was back-filled, winter had set in. Ellis continues, "This was a winter build with below-freezing pour days. ICFs made all the difference. We poured in temperatures of 15 to 17 degrees F. All we had to do was cap the tops of the ICF walls." He adds, "We checked the day following the pour, and the concrete temperature was still 72 to 73 degrees F."

In total Ellis and the crew from Halfmoon Construction Company stacked 8,700 sq. ft. of forms.

The home was appointed with high-end finishes, including crown molding in all living areas, a cathedral ceiling in living room, and pocket doors for all bedrooms and bathrooms. Hardwood flooring throughout ties together the open and functional floor plan.

Finished in July 2016, Shelving Rock spent much of the summer serving as an

Testing reveals that the home uses only 22% of the energy compared to a code-minimum structure.

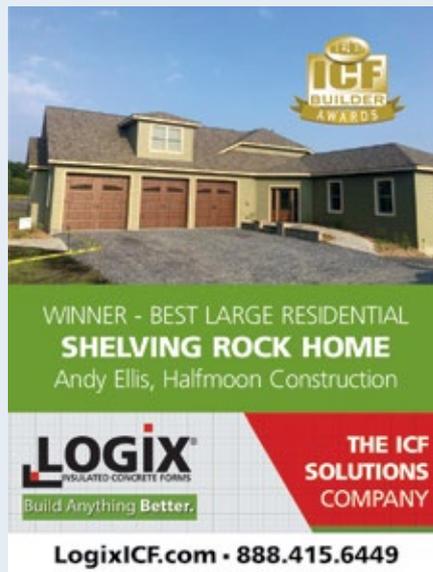


During tours, such as the local Parade of Homes, signage explained the benefits of ICF.

ambassador for the industry. It was the subject of a lengthy article in the *Green Energy Times*, and hundreds toured the house as part of the local Parade of Homes. During the tours, Ellis had signage set up explaining the benefits of ICF, and he reports that at least three projects have already resulted from the show, one already under construction, plus two in the design phase.

At a cost of \$200 per sq. ft., the initial

expense is higher than a traditional stick-built home, but the annual utility savings can compensate for most of that. The cost of heating is estimated at \$559 yearly, plus cooling at \$139; a savings of \$4,302 per year. ■



### Project Statistics

- Location:** Glenville, NY
- Type:** Custom Home
- Size:** 4,280 sq. ft. (floor)
- ICF Use:** 8,170 sq. ft.
- Cost:** \$840,000
- Total Construction:** 30 weeks
- ICF Installation time:** 60 days

### Construction Team

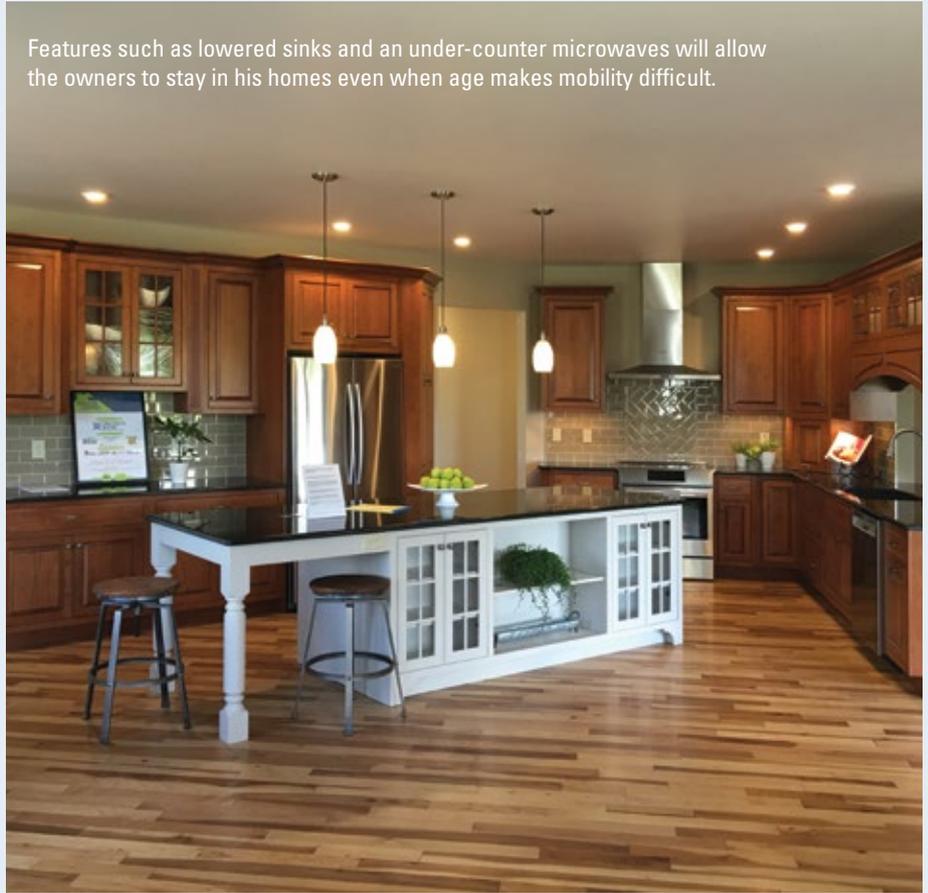
- General Contractor + ICF Installer:** Andy Ellis/Halfmoon Construction Company
- Form Distributor:** Curtis Lumber
- Architect:** Eric Vickerson
- ICF System:** Logix Pro

### Fast Facts

- 30 corners, half are 45 degrees
- Net Zero ready
- Meets Universal Design guidelines
- Winter build with below-freezing pour days



High-end finishes, including crown molding and hardwood floors are installed throughout the home.



Features such as lowered sinks and an under-counter microwaves will allow the owners to stay in his homes even when age makes mobility difficult.



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# Effective Waterproofing for ICF Structures

by Brian Corder

Protecting a structure from moisture is a critical part of any construction, especially below grade. There are two levels defined by building codes to protect a structure from water. Dampproofing protects a basement or other enclosed space from moisture found in the soil around a home. Impermeable in most instances, it may not protect against a column of liquid water. Waterproofing systems will protect a basement or other enclosed space from liquid water as well as the moisture commonly found in soils. Building codes require any walls below grade with an interior enclosed space that is habitable to have appropriate

moisture control. There are many waterproofing systems to choose from and several of these are widely used and perform exceptionally well.

In many installations, a combination of materials offers the best waterproofing performance. The primary methods of waterproofing are: peel and stick membranes; liquid systems that are sprayed, rolled, or applied with a trowel; and dimpled drainage mats which are mechanically fastened to ICF walls. Spray-on membranes for ICF

are beginning to grow in popularity, but are dependent on the regional availability of applicators.

When installing waterproofing or dampproofing, the applicator should ensure that no untreated penetrations are present in the barrier. Failures of the barrier could occur due to fastener placement, rips or tears that are not properly sealed, or an incomplete seal at seams.

## Waterproofing ICFs

Waterproofing is a multi-step project,

## General ICF Waterproofing Options

- Self-adhesive membrane. This is typically 60 mils in thickness and is often used in conjunction with an air gap or dimpled membrane that protects the membrane from backfill and provides additional hydrostatic pressure relief.
- An ICF compatible spray-on membrane. (Caution: Do not use a petroleum based paint or primer. These products will dissolve the EPS foam.)
- A one-step dimpled plastic mat type protection that provides an air gap between the ICF wall and the surrounding earth.

A peel-and-stick membrane ensures a consistent thickness, bridges any gaps or seams, and facilitates easy clean-up.



Photo by Dan McCullough/Utah ICF

## Causes of Hydrostatic Pressure in Soil

- Proximity to a body of water. Lakes, rivers, oceans, artesian wells, and underground streams all affect the water table.
- Precipitation, including the amount of rain or snow melt both locally and upstream of the site can increase the hydrostatic pressure against a basement.
- Different types of soil have different properties when relating to retention of groundwater.
- Locally heavy rains can saturate the soil and overwhelm its ability to soak up the water increasing fluid pressure on the walls.

involving many areas of the ICF wall and other building components. Moisture control begins with flashing at the roof line, parging at grade level, membranes below grade, air gap barriers and foundation and site drainage to route water away from the structure. This includes water shed from the structure and runoff from other sources on the property.

A typical basement will have much of the wall square footage backfilled. This backfill will contain moisture and will apply hydrostatic pressure against the wall. Any moisture or liquid water will seek out cracks or voids, and use them to migrate into your basement. Careful attention to waterproofing will ensure that your structure is dry, comfortable, and energy-efficient.

Waterproofing an ICF structure is substantially different from standard concrete construction. While it is important to place a barrier between the elements and the interior of the home, the nature of that barrier is much more important when working with ICFs.

Due to the nature of EPS foam and its susceptibility to solvents, only water-based materials should be used. A peel-and-stick membrane may also be used with ICFs to maintain a consistent membrane thickness, bridge any gaps or seams, and facilitate easy installation and cleanup.

A combination of waterproofing materials and systems to adequately manage the different factors influencing moisture and hydrostatic pressure in the soil is recommended. Each of these systems provides a different function and complements the other.

### Peel-And-Stick Waterproofing Membranes

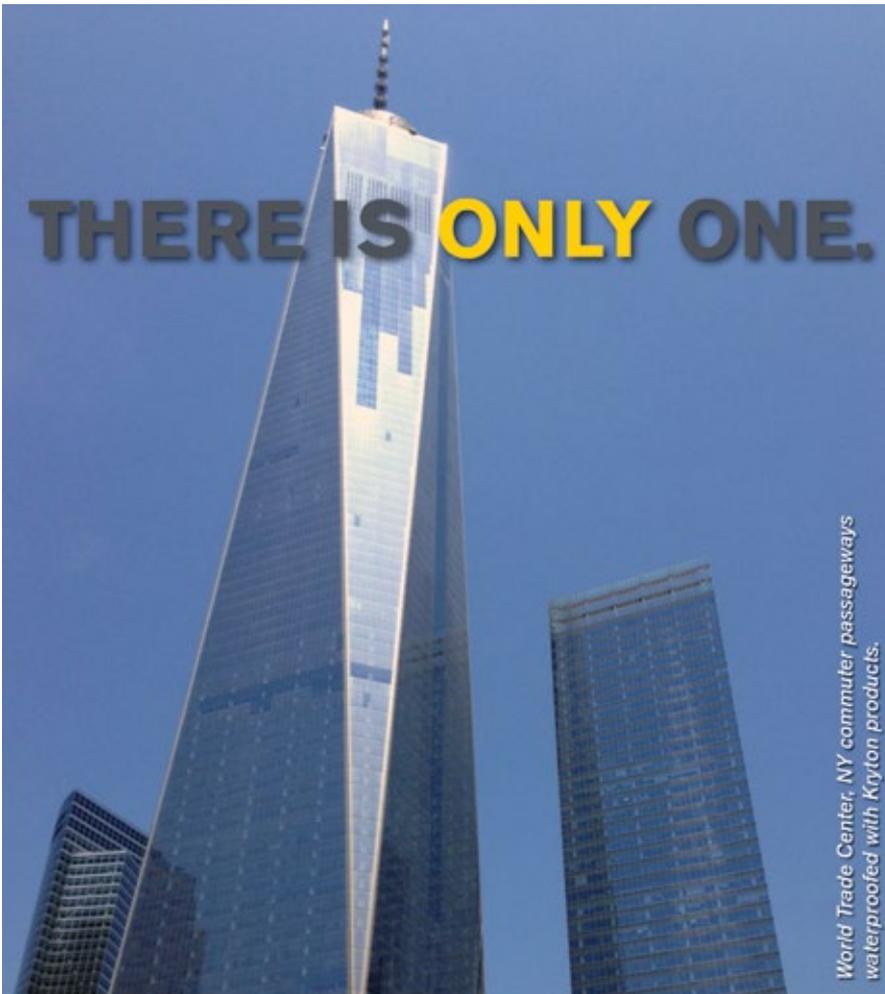
A peel-and-stick waterproofing membrane provides a positive seal against the wall and acts as a barrier to prevent liquid water or water vapor from finding a way into the basement. A flexible self-adhering rubberized asphalt sheet waterproofing membrane is well suited for below-grade waterproofing ICF forms. It is typically 1.5mm (60 mils) thick and is supplied in 100-cm-wide (39-3/8") rolls. A water-based primer should be used to enhance the bond with the EPS foam.

### Air Gap Membranes

An air gap membrane or dimpled membrane is a plastic membrane with raised flat tabs on one side. The membrane is installed vertically with the raised tabs placed against the wall creating a uniform space between the wall and the membrane. As hydrostatic pressure increases, air is displaced relieving pressure against a basement or foundation. This membrane also provides a clear drainage plane against the wall.

### Other Waterproofing Options

Other systems available include rolled, troweled, and sprayed coatings. It is important to note that solvent-based coatings will dissolve the foam. Some coatings may do so slowly, and it may go unnoticed until after back-filling. Without the foam to support the coating, the waterproofing loses its effectiveness. Test these products on EPS prior to application.



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Dimple sheets provide an excellent drainage plane, and also serve as protection during backfill operations.

### Waterproofing Concrete Additives

Concrete additives that provide integral crystalline waterproofing are available from a variety of companies. The active ingredient, crystalline silica and the hydrated compounds in the concrete react in the presence of water. An insoluble crystal grows into the void, toward the water source, effectively sealing cracks and fissures in the concrete.

These additives are best used to prevent water wicking into the concrete core or should water enter the wall cavity. Concrete may form small capillaries that would allow water to travel through the wall. This type of water infiltration is difficult to detect as the entry and exit of the moisture may be far apart. These materials also increase the compressive strength of the concrete and provide a water resistant buffer protecting rebar from moisture and corrosion.

### Footings or Base Drainage Systems

Adequate drainage around the footings or base is necessary to maintain a dry basement. Several methods are used for perimeter drains including drain tiles, corrugated pipe and specialty drain products. Stay-in-place footing forming systems interconnect a drain on the inside and outside of the footing. This drain connects to a sump or daylight drain and can also be designed to evacuate radon gas from foundations through passive or active venting. Many codes are shifting toward active venting. If used with passive venting and a sump, the sump must be sealed and tested to prevent radon gas from entering through the drainage system.

### Below Grade Moisture Control

Proper backfilling around below-grade walls requires more than replacing and compacting soil around the walls. Backfill materials should be free from large inclusions, such as stones, sticks, or other large debris. These can damage the waterproofing. If the

## Basement and Crawlspace Waterproofing Requirements

The International Residential Code Section R406 specifies that, "Foundation walls that retain earth and enclose interior spaces and floors below grade shall be dampproofed from the top of the footing to the finished grade." Additionally, "In areas where a high water table or other severe soil-water conditions are known to exist, exterior foundation walls that retain earth and enclose interior spaces and floors below grade shall be waterproofed from the top of the footing to the finished grade."

Crawlspace requirements vary by the type and use of the crawlspace and local codes. Stem or frost walls that have fill against both sides do not typically need to be waterproofed.

waterproofing is damaged it may require the backfill to be removed and sections of waterproofing replaced at great cost.

Once the entire wall has been waterproofed layer, it should be backfilled correctly. The correct type of material should be placed in the proper location and compacted as specified. Fine gravel should be placed to the height of at least 12-inches at the base around the drain pipe or stay in place forming system. A layer of silt cloth should then be placed on top of the gravel before additional backfill is placed. Backfilling can only occur after the walls are poured and floor trusses are in place to help support the walls from pressure of the backfill.

Backfill and compaction must be done

carefully to prevent waterproofing from being pulled loose from the walls. Backfill material should then be built up around the basement or stem/frost walls until it is higher than the surrounding grade, and sloping smoothly away from the home or building, ensuring standing water drains away from foundation walls.

### Above Grade Moisture Control

EPS foam is considered a Class 2 Vapor Retarder. It reduces the transmission of moisture and water vapor through the material. The concrete core likewise offers protection against water vapor, when installed properly, with a well-drained footing, and appropriate waterproofing and dampproofing.

Air Barriers may be any number of materials or coatings used to slow or eliminate air infiltration. ICFs typically do not need a whole wall air barrier, as the concrete core serves as a very effective air barrier. To meet some standards (LEED, Passivhaus, Net-Zero, and others), it may be necessary to add an air barrier at windows and doors, sealing the bucking to the wall and the window or door frame to the bucking.

Independent testing in accordance with ASTM E283 concluded an ICF wall assembly with a six-inch concrete core has negligible air infiltration and therefore the wall assembly acts as an air barrier itself. No additional materials are required to be installed over ICF forms for the wall system to act as an air barrier.

### Moisture Control Around Windows and Doors

Bucking is the process of using a wood, steel, vinyl, or EPS forming material to create openings in an ICF wall. They also serve as anchors or attachment points for windows and doors.

Waterproofing openings typically consists of applying external flashing, such as peel-and-stick materials or HVAC tape covering the bucking material and framing.

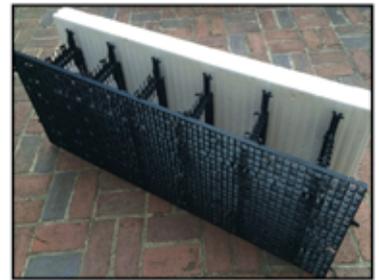
Flashing is used in many areas of an ICF installation and is intended to direct the flow of liquid water away from moisture sensitive materials and away from the interior of the home. It should always



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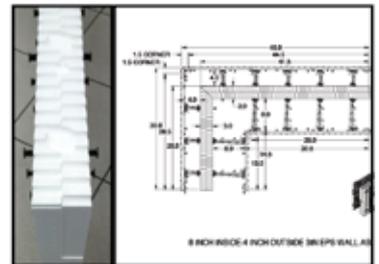
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Flashing should be installed around doors, windows and at the tops of walls.

extend past the layer below it, much like shingles in a roof continuously overlap. Window and door flashing performs the double duty of flashing against moisture and air infiltration.

Flashing should be installed at the top of a wall, around doors and windows, and at the base of walls where water may be present at a cold joint. Flashing may also be used below brick or exterior fin-

**Here, a combination of materials combine to create a complete moisture solution, including peel-and-stick waterproofing, dimple sheets for drainage, and metal flashing details at the top of the foundation.**

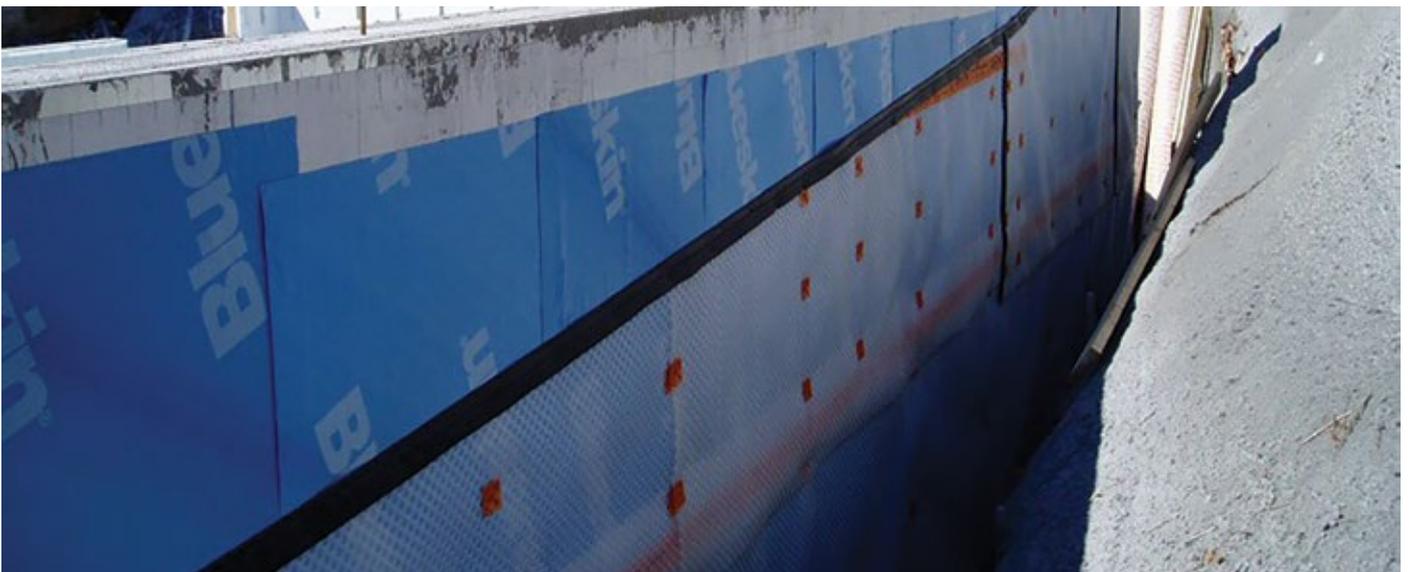
ishes to direct water outside of the walls structural layers.

### Conclusion

There are many proven options to prevent moisture or liquid water through an ICF wall below or above grade. Placing the appropriate barrier to moisture is critical to ensuring the ICF walls perform to their highest level. The specific combination of materials for use in your project will vary based on local conditions and manufacturer recommendations. Design and build your structure right from the start and prevent lingering problems caused by cutting corners, skimping on mate-

rials, or improper installation. Many manufacturers recommended that all below grade crawlspaces or basements be waterproofed even if not used as a living space. Consult local codes and choose the solution that will provide the best below grade protection for the life of the structure.

*Brian Corder is the president of sales and marketing for BuildBlock Building Systems. This article is based on the BuildBlock Comprehensive Guide to ICF Waterproofing and was prepared in collaboration with Insulating Concrete Forms Manufacturers Association (ICFMA) members. ■*



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# Green Building in the Commercial Sector

## How ICF Contributes To The Green/Energy Efficient School Movement

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By *Kenneth W. Stanfield, AIA, LEED AP*

South Warren Middle and High School is the largest K-12 School Building in Kentucky. It combines a 1,250-student high school and a 750-student middle school under one roof—essentially two schools “joined at the hip,” with a shared auditorium complex and centralized kitchen. The facility contains over 332,000 sq. ft. on two floors constructed on an 85-acre site. The building is considered “net zero ready” due to its extraordinary low energy use, operating at only 24.3 EUI (energy use intensity), and for its size, is one of the most energy efficient schools in the nation.

During the design phase, the Warren County Board of Education specified several goals for the design of this new school: energy efficiency, speed of construction, student safety, and “green” design principles. To accomplish these goals, Sherman Carter Barnhart chose to utilize Insulated Concrete Form (ICF) for the building structure, knowing ICF’s could achieve all the owner’s goals in one building system.

The Warren County Board of Education and Sherman Carter Barnhart Architects had significant experience together with ICF construction, beginning with the design of Alvaton Elementary School, the first ICF school facility in Kentucky. In 2005, the average energy consumption for a similar school was 76 EUI. The year it opened, Alvaton’s energy consumption was cut in half, operating at only 36 EUI, with ICF construction being the only significant design change.



Alvaton Elementary was first ICF school in Kentucky. Completed in 2005, it uses half the energy of similar schools, with ICF walls being the only significant design change.

In 2008, Warren County hired Sherman Carter Barnhart to design Plano Elementary, and with changes to the geothermal system and kitchen equipment, the resulting energy performance was reduced to 28 EUI.

In 2010, Sherman Carter Barnhart designed the nation’s first net zero energy public school, [Richardsville Elementary] in Warren County and a once-thought-unattainable EUI of 18.9 was realized. Today, the five most energy efficient schools operating in Kentucky are designed by Sherman Carter Barnhart Architects and are all ICF buildings.

This experience gave Sherman Carter Barnhart insight into the benefits of ICF construction, especially in reducing energy demands.

### The Design Process

First and foremost, “net zero ready” design is a subtraction or “diet” problem to solve. During the design of South Warren Middle and High School, the design team had to re-think every decision, and asked “How does this strategy affect energy consumption?” It’s important to note that the average school today will consume more than 73 EUI per sq. ft. per year in climate zone four. South Warren Middle and High School operates at only 24.3 EUI, which equates to a 70% reduction in energy use.

With a building “diet” strategy, the design team identified targets for potential energy reduction, such as a high performance geothermal system, improved building envelope, and daylight harvesting to name a few. But in terms of a critical path for these decisions, the building envelope

kept rising to the top of the list.

Past experience with ICF buildings had proven that ICF construction significantly affected energy performance. The strategy would, however, need to be two-fold: First, design the building to be more compact in plan and volume. Second, choose products/systems that would substantially increase the insulating value/air tightness/thermal mass of the envelope.

Ultimately, Sherman Carter Barnhart chose ICF for the wall system, and increased the R-value of the roof to an R-32 with 6" of polyisocyanurate rigid insulation. The ICF manufacturer provided 8" and 12" ICF forms for the entire wall system (interior and exterior), and Sherman Carter Barnhart then optimized the system with a simple design that significantly reduced the building's perimeter wall area. The resulting plan, oriented for proper solar exposure, reduced both construction costs and operating costs with an HVAC system requiring significantly less load.

The design decisions go well beyond



South Warren Middle and High School is the largest school in Kentucky and also one of the most efficient.

choosing a material with a high R-value, though, thermal mass plays an incredibly important role in reducing energy consumption. While the high R-value of ICF's resist internal temperature change, the high mass of the concrete wall system absorbs energy and stores it. This is critical in any climate where daytime temperatures

fluctuate from nighttime temperatures.

In the case of South Warren Middle and High, as well as Sherman Carter Barnhart's other ICF designs, night temperatures in Kentucky are less than daytime, and the stored energy gathered during the day is slowly released at night when the building is unoccupied, helping to re-



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In 2010, Sherman Carter Barnhart designed the nation's first net zero energy public school. Richardsville Elementary in Warren County has a once-thought-unattainable EUI of 18.2. This amount of energy is generated by on-site solar panels.



sist a temperature “fall off” that must be corrected during operating hours. Bringing the temperature back up in the morning takes far less energy than traditionally built schools, thanks to the thermal mass of the ICF system. This, in turn, allowed the design team to design a smaller capacity geothermal HVAC system, which also reduced energy consumption.

There really are only a couple of ideas to reduce energy that offer large reductions. When you get beyond ICF and geothermal systems—the building envelope and HVAC, the design decisions to reduce energy further become smaller and more numerous. You go from making a couple of big decisions to making hundreds of smaller ones. This was one of the big challenges—taking a hard look at every aspect of the building that potentially uses energy, even to the point of deciding whether or not the teachers are allowed to plug in personal microwaves in their classrooms.

The project timeline presented a critical path of 18 months for construction, which would include two Kentucky “winters.” At the time South Warren was bid, ICF construction cost less per square foot than traditional masonry, so the design team utilized ICF for both interior and exterior load bearing walls.

Because the concrete is protected and insulated as it is placed and cured, the winter weather played less of an issue in the ICF construction. This, in turn, allowed the construction to speed up, and all walls

were built to “bearing” at the same time, ready for the hollow core concrete planks to be installed throughout the building at multiple locations.

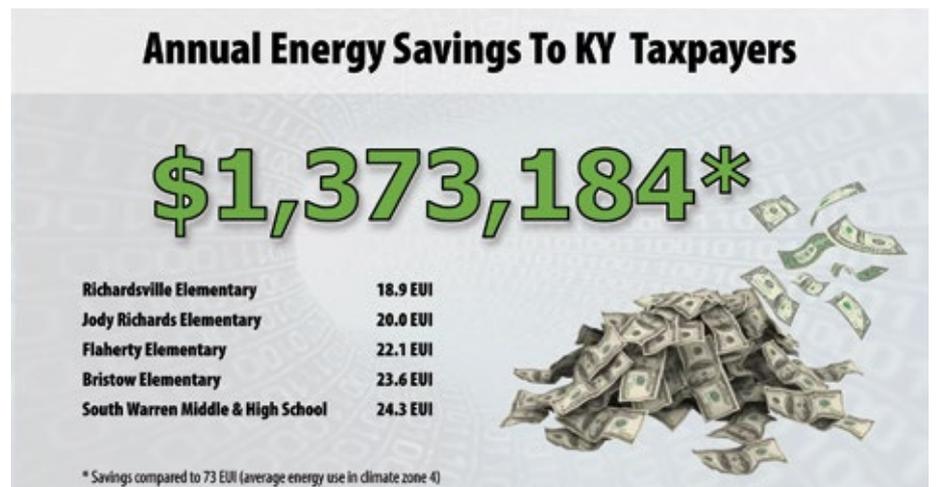
South Warren Middle and High School also provides students a safer building during severe weather, with storms and tornadic activity common during Kentucky’s spring and summer seasons. The inherent strength of the ICF wall system, coupled with the hollow core concrete plank floor system, creates a building structure capable of resisting 250 mph winds.

By using ICF’s and taking advantage of design decisions to maximize the performance of the wall system, the design team delivered a facility capable of achieving net zero with the addition of future solar

panels. But the real-time savings come from reducing energy and saving dollars that can now be used for student achievement in the classroom rather than utility bills.

With ICF construction, there is not just one advantage, there are multiple advantages. Based on Sherman Carter Barnhart’s experience, it would be hard to see a better alternative. In the true spirit of green design, the South Warren Middle and High School project saves resources and operating costs, all while providing an optimum learning environment for its students.

*Kenneth W. Stanfield, AIA, LEED AP is a principal at Sherman Carter Barnhart Architects, one of North America’s leading architectural design firms. ■*



Today, the five most energy efficient schools in Kentucky are all ICF buildings. The 1.3 million dollars saved annually can be directed toward student achievement rather than utility bills.



The largest and most cost-effective K-12 school in Kentucky is also one of the most energy efficient.

Here we see how a “dark sky” approach to the school’s night illumination reduces potential light pollution and reduces energy demands.



## SOUTH WARREN HIGH SCHOOL & MIDDLE SCHOOL

Photo by Chris Phebus Photography

Warren County, Ky., is growing rapidly; the school district averages 200 to 300 new students every year. To address that issue, Warren County Public Schools has built at least seven new schools over the last decade or so, most of which have been built with ICF.

Among the most notable is South Warren High School and Middle School, an immense facility with more than 320,000 sq. ft. under one roof. That makes it the largest school in Kentucky and the largest insulated concrete form (ICF) building in the nation to date. This project pioneered the all-ICF concept that has since appeared elsewhere, and set a benchmark for construction and efficiency that few others have matched.

Kenny Stanfield at architectural firm Sherman Carter Barnhart (SCB) was the lead designer on the project. He says the school was originally envisioned as two separate buildings, but combining them saved money, space and energy. The final design consists of two wings, each housing a separate school with its own gyms, cafeteria, and library. The high school portion has 65 classrooms; the middle school has 48. The two wings join at a shared auditorium and kitchen. The gyms and cafeterias (which double as additional gym space) are adjacent to the auditorium, which allows administrators to unlock them for after-hours events without having to open either school.

The story of South Warren has its beginnings back in 2004,

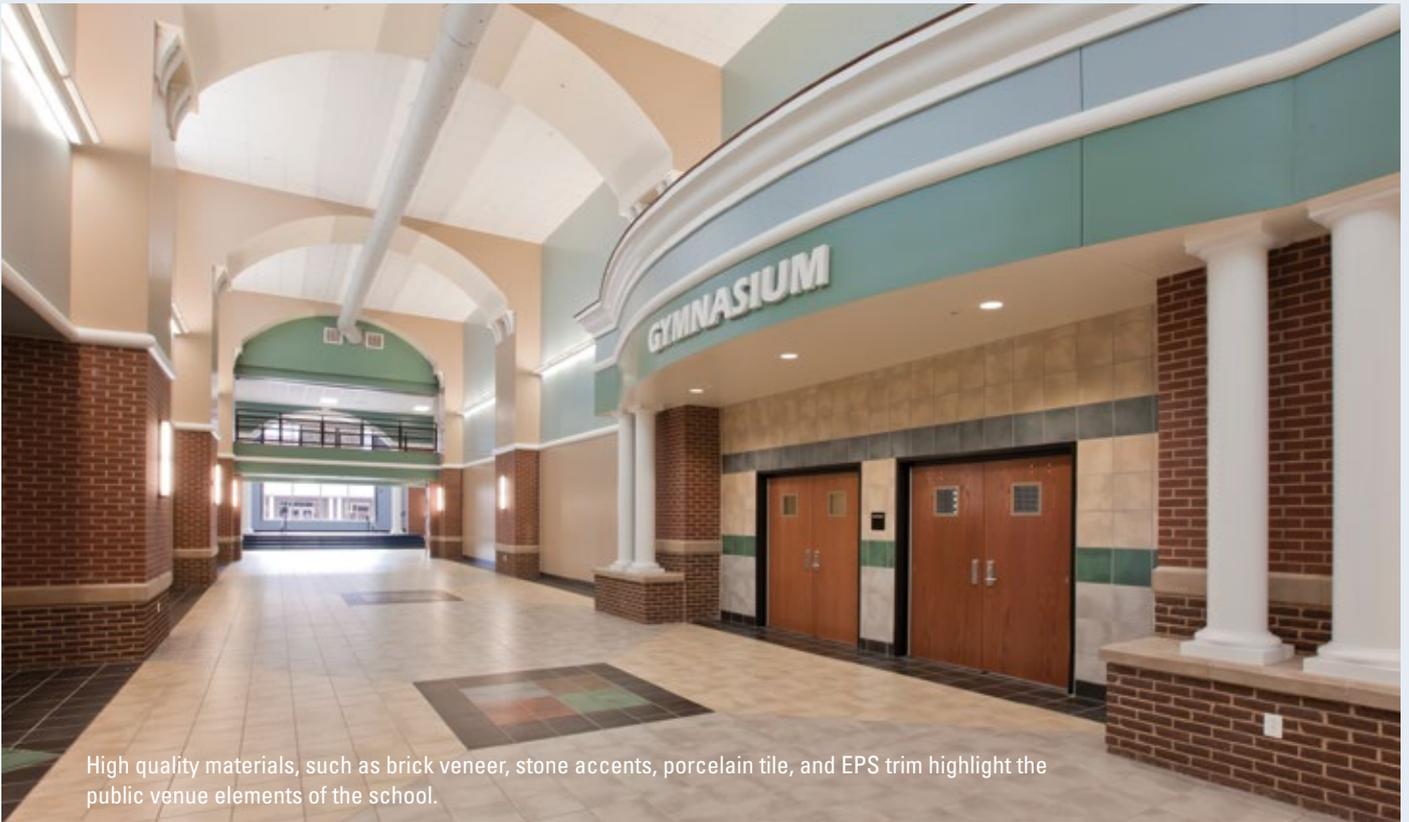
when the local ICF distributor, Martin Clark, met with the district and convinced them to take a look at using ICFs for an new elementary school then under consideration. School officials and the architectural firm they'd selected (SCB) toured an ICF school in Arkansas, and were convinced.

At that time, neither SCB or the general contractor, D.W. Wilburn, had used ICF, but with ample support from the manufacturer, the project was a complete success. The school, Alvaton Elementary, was completed in 2006 (see story in the Oct. '08 issue) and was soon named “best elementary in the country”.

In the years since, Warren County Schools, SCB, D.W. Wilburn, and NUDURA collaborated to build a number of other schools in quick succession, each pushing the envelope a little farther.

For South Warren High School and Middle School, the entire structural wall system—all interior and exterior bearing walls—were built with ICF. This was the first educational project in North America to do so. D.W. Wilburn subbed out the ICF install to Beacon Construction, which stacked an incredible 333,000 sq. ft. of forms in 180 days. About 200,000 sq. ft. was used in exterior walls, with the remainder as interior load-bearing walls.

This was not a simple proposition. In addition to the scale of the work, there were lots of tall wall and radius sections. Both gymnasiums have walls topping 40 feet high without intermediate



High quality materials, such as brick veneer, stone accents, porcelain tile, and EPS trim highlight the public venue elements of the school.

floors. The cafeterias and auditorium reach 35 feet.

The front entrance and performing arts center have long radius sections which were poured to perfection. Newby Walters, at SCB, says, "The curved ICF walls were extremely accurate allowing the brick exterior to be of exceptional quality. The floor system was

hollow core concrete planks, which required a high degree of field precision in layout and overall dimensional consistency."

To heat and cool such a massive building—the building footprint tops 7.5 acres —the facility has a super-insulated roof system to complement the energy efficiency of the ICF structure, and uses geothermal heat pumps with dual stage compressors for even greater efficiency. The site features bio-swales for controlling pollutants from run-off.

Walters says, "To date, South Warren High School and Middle School has achieved the status of being the most energy efficient high school in Kentucky, and is considered to be 'net zero achievable' due to its extremely low energy use." The school uses 22.1 EUI per sq. ft. per year, compared to a national average of 141.4 EUI.

Building off the success here, the district, architect, and ICF brand went one step further to build the first large net-zero commercial building in the nation, Richardsville Elementary. The district's five ICF schools, including Alvaton, Richardsville, and South Warren, saved the district \$597,250 in energy costs for the 2014-2015 school year alone.

Despite these sustainable features and cutting-edge components, South Warren was still remarkably affordable to build. The construction cost was \$56 million or so, which works out to be \$169 per sq. ft., the lowest in the state at the time of the bid.

D.W. Wilburn finished up on schedule (late May 2010) which gave crews time to set up the thousands of desks, stock the library, and other essential tasks prior to the August opening. South Warren opened the first year at about two-thirds of its design capacity of 2,000 students: about 750 in the high school and 500 in the middle school.

In the years since completion, South Warren continues to be

### Project Statistics

- Location:** Bowling Green, Ky.
- Type:** High School/Middle School
- Size:** 332,979 sq. ft. (floor)
- ICF Use:** 332,979 sq. ft.
- Cost:** \$56.3 million
- Total Construction:** 128 weeks
- ICF Installation time:** 180 days

### Construction Team

- Owner:** Warren County Board of Education
- General Contractor:** D.W. Wilburn
- ICF Installer:** Beacon Construction
- Form Distributor:** Holdfast Technologies
- Architect + Structural Engineer:**  
Sherman Carter Barnhart Architects
- Engineer:** Marcum Engineering LLC
- ICF System:** NUDURA

### Fast Facts

- Largest school in Kentucky
- All load-bearing ICF walls
- Construction cost lowest in the state
- Net-zero ready



The walls of the gymnasium are 12" ICF, which provided excellent acoustic separation from the adjacent instructional spaces.



The 'student commons', flanked by the grand stair, allows students to congregate in safe, easy to supervise areas between classes.



Science, chemistry, and physics labs provide multiple career pathways for the students.

All interior photos by Chris Phebus Photography

remarkable in all aspects. Because of the success of this project, ICF schools have spread across Kentucky and Ohio and beyond. School districts from across the country have toured this school, and the energy savings pile up year after year. ■

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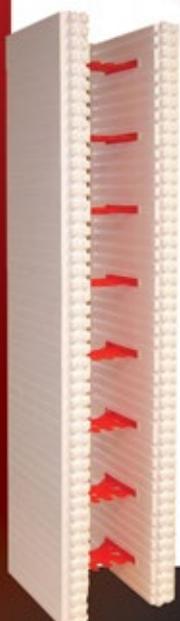
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# MultiFamily — Winner

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Climbing up a steep and substantial hill, this five-story dormitory terminates in a new chapel and contemplation space adjacent to the century-old St. Francis Chapel visible in the background.



# GRAYMOOR FRIARY

Graymoor Friary is one of the most unique ICF projects completed recently. Built into the side of a substantial hill, the building provides housing and worship space for 20 Franciscan friars.

Sam Dillehay, at Alfandre Architecture, explains that the firm was commissioned to design a structure that would be cost effective to construct, while minimizing long-term energy and maintenance costs. It also needed to fit into the landscape, be architecturally pleasing and have a service life of at least 200 years, as it would be the home of the friars for generations to come.

Alfandre was already familiar with ICFs, having used the technology for his own LEED-Platinum office. For the friars, who were looking for a building with low operational costs, energy efficiency and high durability, the use of ICFs fit perfectly with their goals.

The most difficult design criteria, though, was that the new building needed to sit adjacent to a century-old chapel atop the 700-foot summit of Mount Atonement.

The final design consisted of a five story building that linked the chapel with the administration building 60 feet below the summit. The slope is steep enough to accommodate a "ground-level" entry at every floor.

The friary is located in the Hudson River Valley, across the river from the military academy at West Point. The four GCs that expressed interest in bidding the job were not familiar with ICFs. Fox Blocks was the basis of design, and regional manager Brian Medford scrambled to provide the GCs a number of subcontractors for the ICF work. In the end, Sisca Construction Services won the bid to serve as general contractor, with The PCS Group doing the ICF installation.

The job would not be easy. For starters, the project was to be built into a steep hillside with no flat areas for staging materials. Medford says it was almost impossible to even walk up the hill, much less carry any material. The contractor solved this challenge by starting the project at the top, which had a small level area, and worked his way down.

Despite having a top floor reaching 60 feet above the footings, the facility has a ground level entry at each of the five floors.



All Photos Courtesy Brian Medford/Fox Blocks



The installer approached this complex project with a creativity that Territory Rep Brian Medford had not seen before, which increased productivity substantially. For instance, to form this radius wall, instead of the industry standard of cutting and/or notching the forms and bending them around the radius, the installer just stood the forms on end, separated the interlock on the outside and secured them into place by filling the gap with spray foam.

Medford says, "This is the first time I have heard of a five-story structure being built from the top down."

Crews excavated and blasted rock down the mount to accept

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Designed to last at least two centuries, the building offers energy efficiency, natural daylight and contemplative views.



To keep ongoing costs down, Graymoor is "built green." Triple pane windows, underslab insulation, and closed-cell spray foam in roof assemblies minimize energy loss. The south-facing windows provide natural daylight—and fantastic views—to all private rooms and parlors, and the roofs are situated to provide maximum area for a future photovoltaic system.

Other sustainable features include geothermal HVAC, LED lighting, low-flow fixtures to minimize water usage, and energy recovery ventilators to provide continuous tempered fresh air.

Completed in the fall of 2015, the 25,000-sq.-ft. building winds its way up to the summit, terminating in a new chapel that sits adjacent to the old St. Francis Chapel and the tomb of Father Paul, founder of the order.

Construction took just less than 12 months. Dillehay reports that the project has already gained the attention of religious organizations not only in the Central Hudson Valley but across the nation. ■

the step footings and retaining wall. In the process, they created flattened staging areas to work from.

Medford continues, "This project had many complexities. The experienced installer approached these with a creativity that I have not seen before, and substantially increased productivity." For example, when building a radius wall, rather than taking the "industry standard" approach of notching the forms and bending them around the radius, the installer stood the forms on end, separated the interlock on the outside and filled the gaps with spray foam.

There were also a number of irregular corners, variations in concrete core sizes, a wall 21 feet high that had to be poured monolithically and several steel beams that carried ICF walls above with pilasters incorporated in the walls.

Finally, at the tail end of the project, the New York winter set in and portions of the work were performed in wind chill temperatures reaching 20 below zero on the mount.

### Project Statistics

**Location:** Garrison, NY  
**Type:** Housing and Worship  
**Size:** 25,000 sq. ft. (floor)  
**ICF Use:** 34,100 sq. ft.  
**Cost:** \$13 million  
**Total Construction:** 50 weeks  
**ICF Installation time:** 80 days

### Construction Team

**Owner:** Franciscan Friars  
**General Contractor:** Sisca Construction Services  
**ICF Installer:** The PCS Group  
**Form Distributor:** Fox Blocks  
**Architect:** Alfandre Architecture  
**Structural Engineer:** Innovative Engineering Services, LLC  
**Mechanical Engineer:** Novus Engineering  
**ICF System:** Fox Blocks

### Fast Facts

Five-story building built top-down  
 Steep jobsite  
 Radius walls and complex corners  
 Geothermal HVAC, LED lighting, low-flow fixtures

# ✓ New Products

## EnergyFlash for Slab Edges

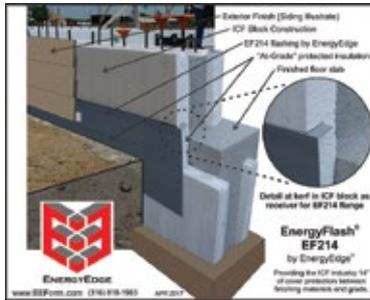
EnergyEdge, LLC, offers a product called EnergyFlash to protect and insulate the edges of concrete slab and stem-wall construction.

Introduced last year and updated this spring, the all new EnergyFlash line of products is designed to protect outboard insulation in the same manner as a traditional metal flashing except without the corrosive deterioration and physical appearance shortcomings of metal.

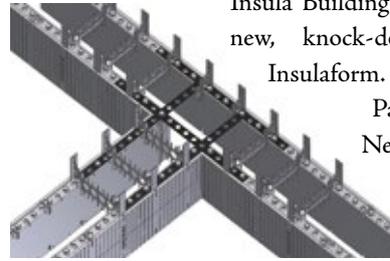
Joshua Sucher, national sales manager for the company, says, "You asked and we listened. You no longer need to create some ad-hoc method to protect insulation."

Like other EnergyFlash products, EnergyFlash ICF is molded from a specially blended PVC formula that protects and insulates the exposed slab edges on projects with a durable, UV-stable, aesthetically consistent product specifically made for this vulnerable and complex transition. EnergyFlash can also be used to correct those projects where the ad-hoc solution has failed. It is the answer for the remainder of the development and beyond.

For more information, visit [www.eeform.com](http://www.eeform.com) or call 316-618-1983.



## New Panel System ICF



Insula Building Systems now sells a brand-new, knock-down ICF system called Insulaform.

Patrick Robak, president of the New York-based company, says, "We set out to develop a solution for the typical issues ICF installers face

daily. The system uses just three components, so it is simple yet effective regardless of the project complexity."

Ties are available in widths of two-inch increments for concrete core thicknesses of 6" to 14". The EPS panels measure 12" x 48" x 2.5". Insulaform panels have no embedded plastic, and they're reversible, lightweight, easy to cut, store and transport. The standard panels can be doubled up for higher R-values. The plastic tie inserts span nearly the full height of each panel for maximum strength and superior fastening.

Proprietary corner straps reinforce corners, T-walls, pilasters and more. These three products work in tandem to make assembly stronger and safer, eliminating the need for temporary wood strapping entirely.

For additional information, visit [www.insulabuildingsys.com](http://www.insulabuildingsys.com) or call 631-902-2992.

## Mobile Manufacturing for Composite Blocks

Eco Building Systems, LLC (EBS) offers a mobile manufacturing plant that produces insulated composite concrete forms for residential and commercial applications.



Tony Nunes, owner of the company, says the mobile plant system is the first of its kind. The 53-foot mobile plant is ideal for developers who want to produce The Perfect Block products for themselves and/or other developers.

The Perfect Block forms provide a 12" on center, horizontal and vertical engineered core of steel and concrete grid structure, making it one of the strongest and most dense structures available today. EBS mobile systems can also be placed as semi permanent and stationary systems depending on market and client requirements.

The Perfect Block System offers various block sizes ranging from 6", 8", 10", 12" & 14" with custom corner and custom end cap. EBS offers a free Build Manual download. For more details visit [www.ThePerfectBlock.com](http://www.ThePerfectBlock.com). ■

## Logix Offers One-Sided Forming

Logix ICF now offers a "one-sided" ICF dubbed XP-1. Andy Lennox, marketing manager at Logix ICF, says the form is designed for maximum simplicity, efficiency, speed and versatility. "XP-1 is self-aligning and forgiving and the 10 available wall thickness configurations permit the seamless integration of XP-1 walls with a wide variety of regular ICF and conventional concrete wall thicknesses." The system uses the company's knockdown (KD Series) panel and ties, combined with regular 4'x8' plywood sheets purchased locally. A proprietary cone-shaped connector is used with conventional drywall screws to fasten the plywood to the ties.



The product is perfect for any application that requires an exposed concrete face on one side of the wall and EPS on the other, such as elevator shafts, parking garages, and industrial buildings.

For more information, visit [www.logixicf.com](http://www.logixicf.com) or call 888-415-6449.

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