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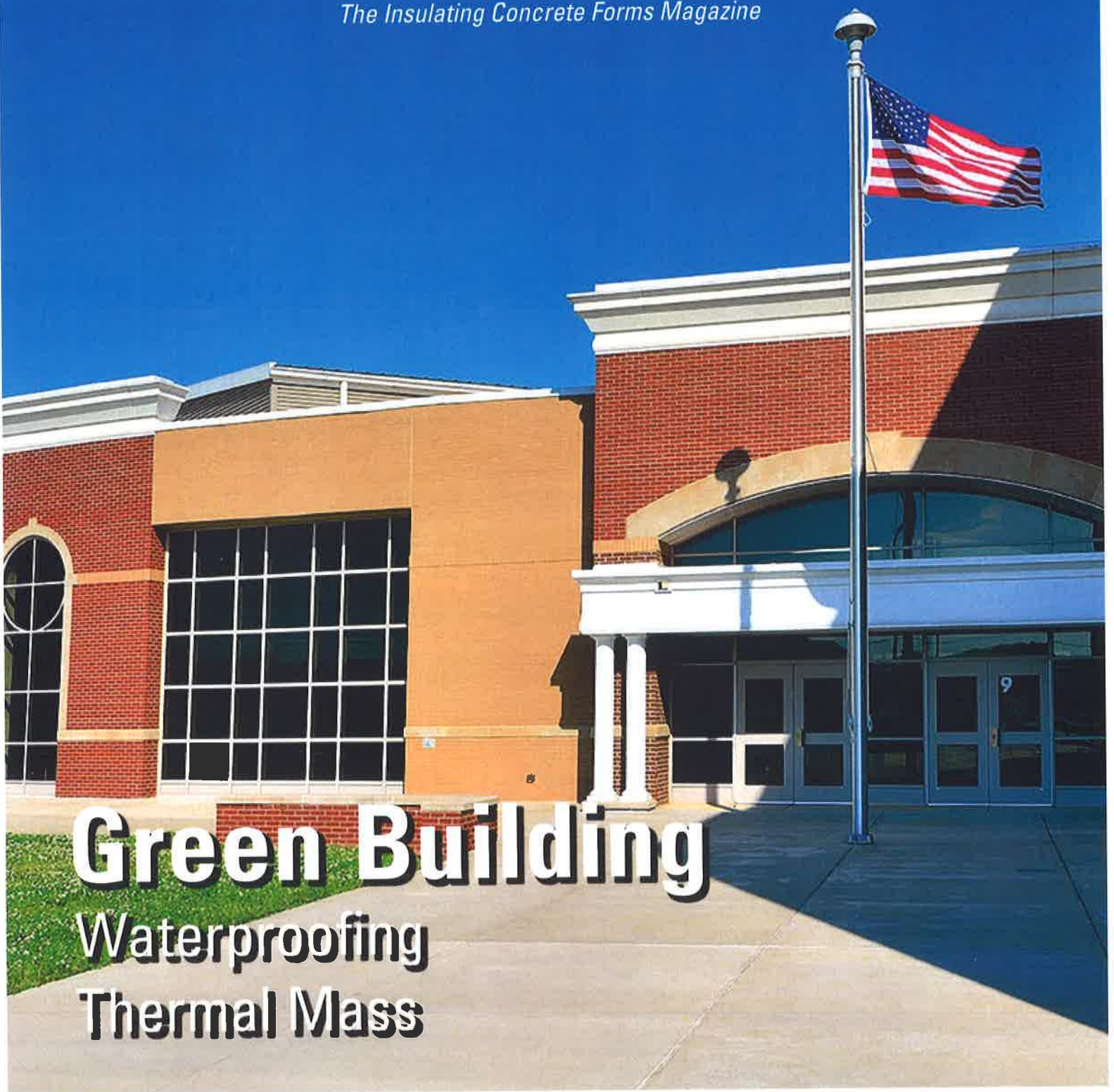
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How ICF Contributes To The Green/Energy Efficient School Movement

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. ■

Annual Energy Savings To KY Taxpayers

\$1,373,184*

Richardsville Elementary	18.9 EUI
Jody Richards Elementary	20.0 EUI
Finkerty Elementary	22.1 EUI
Bristow Elementary	23.6 EUI
South Warren Middle & High School	24.3 EUI

* Savings compared to 73 EUI (average energy use in climate zone 4)



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.

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. ■

All interior photos by Chris Preibus Photography

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