ICF 101

An Introduction to the Advantages of EPS and Concrete Construction

Photo courtesy Michael Duerinckx

Due to the unique combination of foam and concrete, ICFs homes can create significant energy savings, remarkable durability, and quieter interiors while still providing a cost-effective, beautiful building.

Insulated Concrete Forms (ICFs) are gaining popularity as an alternative building material. They offer a host of benefits, such as faster construction times, lower insurance rates, and quieter interiors, but the two primary reasons behind their growth is their remarkable durability and energy efficiency.

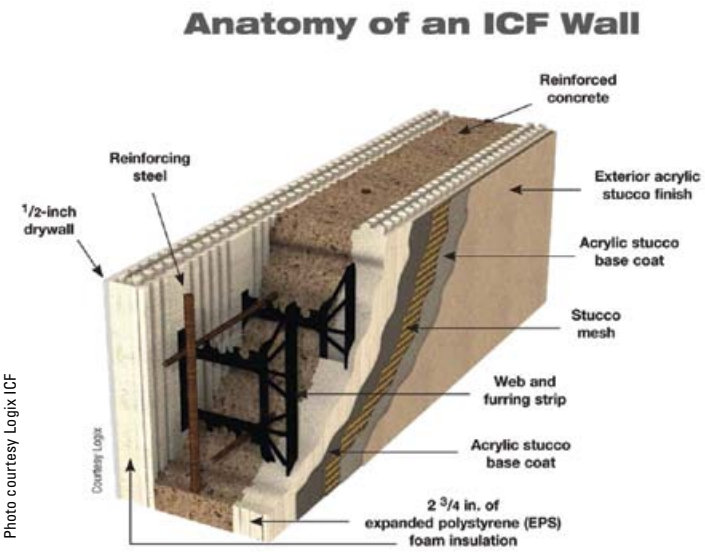


Photo courtesy Logix ICF

ICFs are hollow foam blocks or panels which are filled with steel-reinforced concrete. They can be finished with conventional interior and exterior finishes.

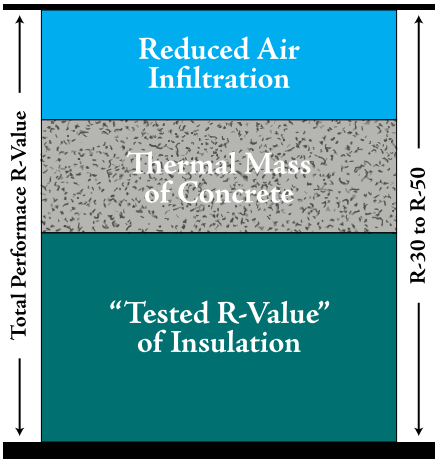
In short, ICFs allow owners to create a building that is more comfortable to be in while only using half the energy to heat and cool as regular construction. ICF walls protect occupants and their belongings from tornadoes, hurricanes, wildfires, car wrecks and disasters. From a design standpoint, ICF technology is extremely flexible; the architecture can match virtually any style, and ICFs are compatible with all popular interior and exterior finishes. And yet, in most areas of the country, the cost of ICF construction is typically less than 10% more than wood. With careful planning and considering the utility savings, the monthly expense of living in an ICF house can actually be less expensive. The same holds true for commercial buildings. Many churches, schools, stores, and hotels have found that ICFs allowed them to build a better structure for far less than expected.

The key to all these remarkable attributes is the combination of foam and concrete. Regardless of the brand of ICF chosen, all consist of two rigid EPS foam panels which sandwich a core of reinforced concrete. The concrete provides exceptional strength and thermal mass; the foam provides a continuous layer of the world's best insulation, and is an ideal substrate for many finishes.

Energy Efficiency

Let's talk about energy efficiency first.

For many years, ICF experts talked about "performance R-Value." These figures were impossible to verify, and the term has

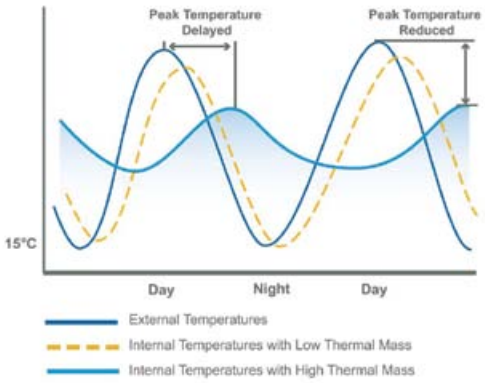


thankfully disappeared. But the concept remains true: The actual, real-world performance of an ICF wall far exceeds its nominal insulation value. This is due to a combination of three factors: more insulation, less air infiltration, and high-mass walls.

Higher Rated, Continuous R-Values: EPS foam, from which ICFs are made, is one of the best insulating materials yet invented. The R in "R-Value" stands for thermal resistance, and the higher the R-Value, the better the wall is at stopping the flow of heat.

Homes built using wood frame construction typically have exterior walls rated between R-13 and R-19. ICF walls, on the other hand, have foam with tested insulation values of R-22 or R-26. (A frame wall would need to be a full 12 inches thick to achieve a similar rating!) Some ICF manufacturers offer foam inserts for even thicker sidewalls, with tested values of R-32 or even R-40.

Additionally, ICFs offer continuous insulation. With frame construction, the average frame wall is 25% wood, so even though the fiberglass or cellulose may be rated at R-13 (for 2x4) or R-19 (for 2x6), the "whole wall" insulation value is significantly less.



With ICFs, the owner is assured of continuous insulation without gaps or installation mistakes.

Airtight Construction: Anyone who has lived in a drafty house when a winter storm howls outside knows how significantly air infiltration can affect insulation value. For the past decade or so, homebuilders have tried to address this by covering exterior walls in a layer of paper-like "homewrap." However, frame walls are made from dozens of individual components which guarantee that outside air will be able to infiltrate the living space.

ICF walls, though, are virtually airtight. Even hurricane-force winds can't force their way through four to six inches of solid concrete.

Thermal Mass: Many historic buildings in the American Southwest have pleasantly cool interiors even when the hot summer sun has been beating down on them for hours. The secret is in their adobe walls—usually several feet thick—that take hours to heat up. And when the sun sets and temperatures drop, the stored-up heat keeps the interior pleasant through much of the night. This phenomena, called *thermal lag or temperature damping*, is due to the mass of the walls.

Like adobe, ICF walls take advantage of thermal mass. Even a modest ICF home uses dozens of yards of concrete, and that weight creates thermal lag in ICF structures, moderating temperature swings.

A few years ago, the Portland Cement Association (PCA), conducted a study of 58 single-family houses across the U.S. and Canada. All were less than six years old. Half had exterior walls constructed with ICFs; the other half were traditional frame homes of a similar size built nearby. The study found that the ICF homes used 44% less energy to heat and 32% less energy to cool than comparable frame houses.

That means a typical 2,000-sq.-ft. ICF home in the central U.S. would save $200 in heating costs and $65 in cooling costs each year.

There are other factors in play as well. Maximizing energy-efficiency in an ICF structure requires some other important steps, such as the use of adequate attic insulation, quality windows and doors, and a properly-sized high-efficiency HVAC system.

Disaster Resistance

With a solid, monolithic core of steel-reinforced concrete, it should be obvious that ICF homes, schools, and other buildings perform well when disaster strikes. What is more remarkable is the number of real-world examples. ICF homes have survived arson attempts and wildfires, hurricanes and tornadoes, storm surge, drunken drivers, even explosions at close range from TNT.

A few years ago, tired of absorbing massive losses from natural disasters, the insurance industry set up a program to encourage homeowners to build more durably. *The Fortified…For Safer Living* program specifically encourages ICF use.

Chuck Vance, IBHS "Fortified" program administrator, says, "We're impressed with the superior wind-load capacity of an ICF wall. It also has other benefits as well, including resistance to fire and fewer problems with water damage."

Vance notes that the program is designed to prevent damage from all types of natural disasters in all areas of the country. Because of this, the criteria for a "Fortified" home varies regionally, based on the natural disasters most likely for that area, such as hurricanes in the southeast or tornadoes in the Midwest. Regardless, ICFs will stand up to whatever threat is greatest in that region better than any other technology.

In some areas of the country, insurance companies will give discounts for "Fortified" homes, or for ICF homes in general.

While hard figures are hard to come by, anecdotal evidence indicates that the savings are real. "I have an ICF builder in Myrtle Beach, South Carolina that builds to our guidelines" says Vance. "Every home he builds gets a discount from the local Farm Bureau affiliate and South Carolina's

Photo courtesy Nudura

Richardsville Elementary in Bowling Green, Ky. is America's first net-zero school. Built with ICF walls, it generates more electricity than it uses, and it was built at a cost comparable to any other new school project.

Wind and Hail Pool. Those two discounts add up to significant savings."

The owners of a 4,800-sq.-ft. ICF home in Florida report an *$18,000 annual savings* as a result of credits attributed to the ICF construction. His annual wind and general liability insurance is "$2,200/year plus some change," less than he pays for the wood frame guest home across the street that's less than half the size.

"The insurance industry understands value of a reinforced concrete ICF structure in a hurricane prone area," says Sandy Esterle, owner of the design/build firm that constructed the home.

As one might suspect, building a hurricane-proof home requires more than just ICF walls. Windows and doors are the most vulnerable, and tests at Texas Tech University show that 2x4 wood studs easily penetrate wood frame and even brick-veneer walls. (See the video on our website.) The boards were shot at speeds up to 80 miles per hour—barely hurricane force. Tornadoes frequently have windspeeds in excess of 200 miles per hour, and currently, concrete is the only material that can stand up to such severe winds.

Many experts believe ICFs are the most cost-effective—and aesthetically pleasing—way to protect occupants and their belongings from wind-related natural disasters, building all exterior walls from ICFs, using impact-resistant windows or metal storm shutters on all openings, and a disaster-proof roof.

As noted above, ICFs stand up to other disasters equally well. When a raging wildfire swept through the suburbs of San Diego in the fall of 2007, it forced more than half a million people from their homes and destroyed more than 2,000 residences. On one suburban street in San Bernardino, every home on the block was burned to the ground, with the exception of three ICF homes, which a newspaper photographer captured standing virtually unscathed amid the charred wreckage surrounding it.

Insulating concrete forms resist fires in several ways. The most obvious is their structural concrete core that will not weaken, warp, twist, or burn regardless of the fire's heat. In so-called "fire-wall" tests, ICF walls withstood temperatures of up to 2000°F for as long as 4 hours without any sign of weakening. In contrast, wood frame walls typically collapse in an hour or less. The concrete core also prevents fire by slowing the conduction of heat from one side of the wall to the other. Contrary to popular belief, the foam used in ICFs will not burn. It will melt if exposed to high heat, but it will not contribute any

The three ICF homes on this street in San Bernardino, Ca. are easily identified, after a 2007 wildfire reduced the neighboring wood-frame homes to ashes.

Photo courtesy San Diego Union Tribune

When a drunken driver lost control and slammed into this home at an estimated 90 mph, the ICF wall kept the owner safe, and damage to a minimum.

fuel to the fire. In fact, it is virtually "self-extinguishing," thanks to a flame retardant all of the leading ICF manufacturers add to the EPS foam.

Other notable examples of ICF homes that have withstood disaster include a beachfront home in New Jersey that withstood Superstorm Sandy, despite having it's siding scrubbed off by the pounding waves, and a Gulf Coast ICF house that withstood a 20-foot storm surge generated by Hurricane Katrina that swept the rest of the neighborhood down to bare foundations.

ICFs are so disaster resistant that the U.S. military conducted blast-resistance tests using 50-lb. charges of TNT. The results were impressive enough that they now frequently specify ICF construction for "force protection" requirements.

Sound Absorption

About 10 years ago, 75 ICF homeowners were surveyed about the features they appreciated most in their ICF homes. It's no surprise that energy efficiency and disaster resistance topped the list. But benefits numbers three and four were comfort and quiet.

In fact, more than 60% of ICF homeowners mentioned the quietness of their homes, versus only 2% of their wood frame counterparts. This is due, once again, to the sound absorbing qualities of EPS foam.

Pieter Vanderwerf, who conducted the study, says, "Many homeowners said their biggest surprise in moving into an ICF house was the noise difference… The ICF owners told two common stories over and over again: 'I looked out the window and saw the traffic on the road, but I couldn't hear it.' And 'While talking with my neighbor one morning, he asked if the thunderstorm the night before woke me up, too. But until that moment I never even realized we'd had one.'"

Most ICFs with a six-inch concrete core have STC ratings of 50 to 55. Insulated 2x4 wood stud walls with 3 ½ inches of fiberglass batt are rated near 38. The difference between an STC rating of 38 and 50 may not seem like much, but the decibel scale is logarithmic, so 50 decibels is ten times as loud as 40 decibels. In real-world terms, only about one-quarter to one-eighth as much sound penetrates an ICF wall when compared to wood frame.

This has become a major selling point in the commercial sector. Theaters and apartment buildings use ICFs to eliminate sound transmission between units, and developments near noisy industrial sites are selling quickly, thanks to ICFs sound sound-absorbing qualities.

The owners of this ICF home in Lighthouse Point, Fla. Report that the disaster-resistant forms have reduced their insurance premium by $18,000 annually.

Photo courtesy Safe Harbor Design/Build

Design Options

Photo courtesy Blue Home Design

Radius walls, such as those on the Massachusetts home above, are much simpler to build with ICFs than any other construction method.

As already noted, insulated concrete form construction can be adapted to virtually any residential or commercial project.

Adapting a plan for ICFs typically starts with stretching the exterior walls outward a few inches to accommodate the thicker walls. Other architectural flourishes are actually easier with ICF. For instance radius walls, which are difficult to build with frame or block construction, are simple. Long clear spans can be easily accommodated, because the walls can carry the loads and steel beams these designs require. Windows can be made larger in seismic zones, and winter construction becomes possible in northern regions.

While ICF walls look dramatically different from plywood-sheathed frame construction, they're actually easier to work with for most exterior finishes. The foam substrate is perfect for cement-based stucco or textured acrylic finishes. Brick, stone, and manufactured stone are also applied more easily to ICFs than frame, as no additional vapor barrier is needed (in most regions). Siding—vinyl, wood or cement board—are also popular. It's as easy as fastening the material to the ICF furring strips, clearly marked on the outside of the forms.

Costs

Incredibly, the cost of living in an ICF home is no higher—and may be cheaper—than living in a regular house. Nationally, an ICF home is estimated to cost 3% to 5% more than frame building. That's about $10,000 for a $250,000 house. Financed with a conventional 30-year loan at 5%, that amounts to an additional $55 on the monthly mortgage. However, because the homeowner will be saving at least that much on energy bills, the actual monthly cash outlay is less. In other words, when energy costs are considered, it's actually less expensive to live in an ICF house. All of the other benefits—like disaster-proof walls, quiet interiors, and less maintenance—are added bonuses at no extra cost. ■

Only about one-quarter to one-eighth as much sound penetrates an ICF wall compared to wood frame, making them popular for movie theaters, such as this one in California's Central Valley.

Photo courtesy Logix ICF