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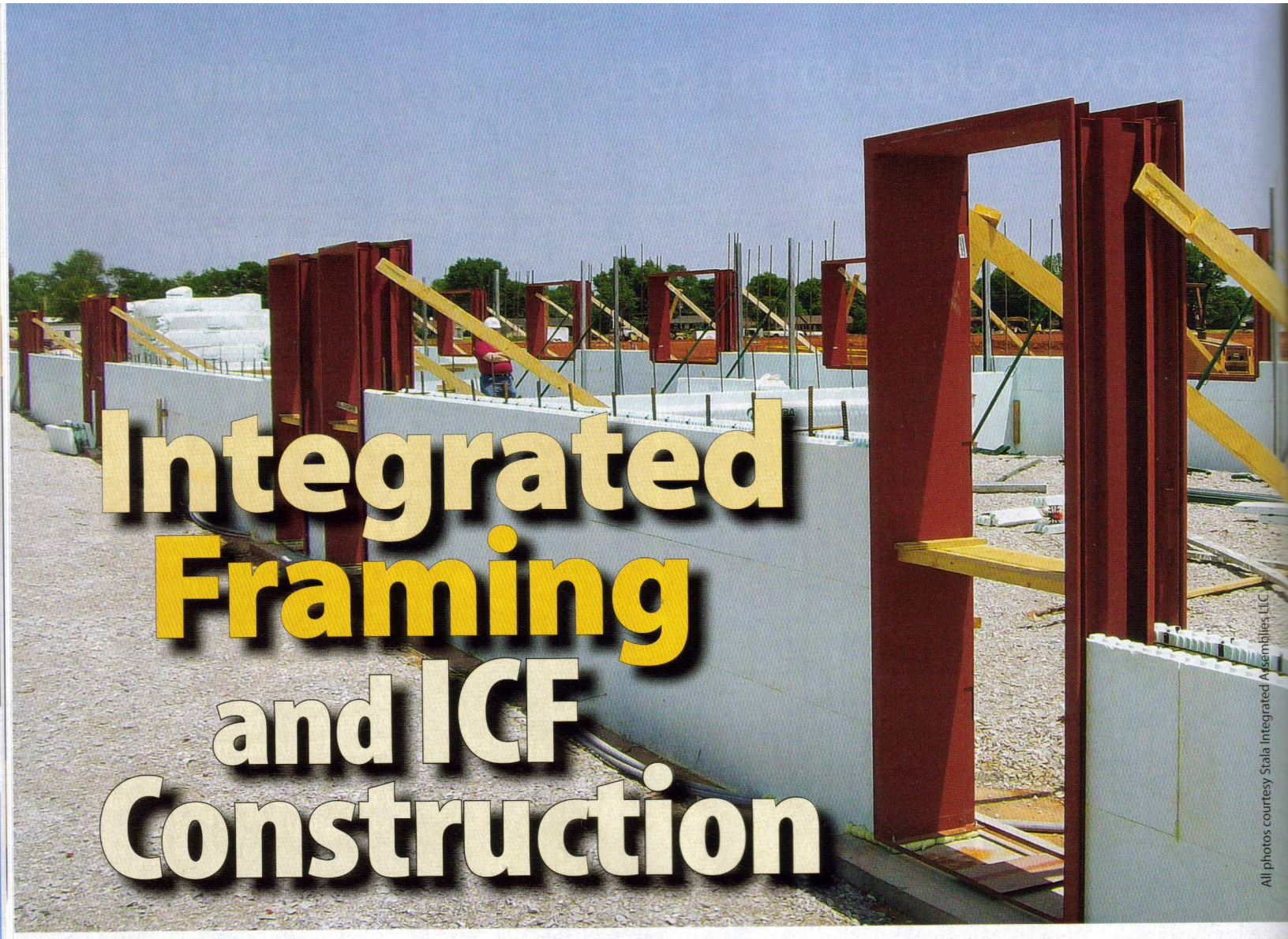

Integrated Framing and ICF Construction

All photos courtesy Stala Integrated Assemblies, LLC

by J. Andrew Keith, CSI, AHC, CDC, and Chris Keith, PhD

Historically tied to residential applications, insulating concrete forms (ICFs) have become increasingly common in commercial projects. Over the course of this year, it is estimated 3.9 million m^2 (42 million sf) of commercial buildings were constructed with the material, compared to just 464,515 m^2 (5 million sf) in 2000.[1]

In ICF construction, wall sections are built by stacking 'blocks' atop each other prior to pouring concrete. Each block consists of two foam panels spanned by webbing of some design. (The foam is typically expanded polystyrene [EPS], but occasionally extruded polystyrene [XPS].) Thus, when stacked, the paneling forms two sides of a wall, with a cavity in between. The concrete is poured into the cavity and, on curing, the foam exterior is left in place, providing insulation (and the material's namesake).[2]

ICF buildings can have several advantages over traditional assemblies of concrete masonry units (CMUs) and stick-frame walls. These attributes range from greater structural strength (demonstrated by ICF homes surviving hurricanes)[3] to better resistance to storm damage (demonstrated by wind projectile tests conducted at Texas Tech University's Wind Engineering Research Center)[4] to improved energy efficiency.[5]

A practical field advantage is ICFs' enabling of shorter project completion times. Crews can easily move the lightweight foam blocks across a site and stack them according to the project's design. For example, the 7153-m^2 (77,000-sf) Alvaton Elementary School (Bowling Green, Kentucky) was bid in December 2005 and begun early in 2006. Despite delays due to site preparation, ICF walls were still completed by August, four months ahead of schedule.[6] However, when it comes to this speed of construction, inclusion of window and door openings within ICFs can be problematic. New proprietary integrated framing assemblies (IFAs) can provide the solution.

The problem of door and window openings in ICFs

Door and window openings have been notorious challenges for ICF builders. The essential difficulty is maintaining opening integrity from the concrete pour through to the installation of windows and/or doors and hardware. This transition from fresh concrete to finished opening is at least a three-stage process:

1. In the pre-pour phase, builders must block out (or 'buck') the opening in the ICF block. (The builder also provides opening bracing in the form of 2x4 lumber or similar.)
2. Once the opening is blocked out and braced, installers pour the concrete.
3. After the concrete has cured, builders must return to the opening to remove the 'blocking-out' assembly, install the door/window frame, and prepare the opening for doors and hardware if necessary.

The combination of materials and methods for bucking ICF door and window openings is labor-intensive. Not only does every opening require the normal amount of attention demanded by each of these three general stages, but often the builder must also give special attention to openings that have not

Insulating concrete forms (ICFs) offer myriad benefits, but the inclusion of door and window openings can slow building schedules. The use of proprietary integrated framing assemblies (IFAs) can prove invaluable.

Specifying IFAs can have significant positive impact. The use of traditional field-fabricated bucks (specifically labor for preparation, installation, and maintaining opening integrity) can mean excess time and money.

remained true during the construction process. Thus, blocking out the ICF openings to be ready to receive door and window frames, and doing so in a manner that preserves the opening's integrity, can constitute a principal problem with ICFs.

Bucking systems of wood (both handmade in the field and specially designed by manufacturers),[7] vinyl,[8] and lightweight steel have experienced a certain degree of success and are helpful (perhaps even ideal) in some residential and light commercial builds. However, these products are not always designed for the heavy commercial market.

For buildings with multiple openings and differing jamb depths at each, the use of traditional bucks—the labor demanded by preparation, installation, and maintaining opening integrity—can be a timely and costly process that threatens to diminish the overall time saved by building with ICFs. Bucking systems that require fieldwork by the contractor exacerbate the problem.

Additionally, some previous solutions for door and window openings cannot meet fire ratings, gage requirements, or architectural designs. In some wood bucks, the wood is left in the opening for the installation of the frame (to the dismay of architects—wood is organic and prone to warping). Alternatively, the wood is removed and the gap between concrete form and frame later filled to ensure the opening is tightly sealed.

Another primary concern with previous ICF door/window solutions is the manner in which the bucking attaches to the concrete form, thus creating a structurally sound opening. In some cases, it attaches via screws or wire coupling ties connected to the rebar. In other cases, it attaches via a nail shot through a compressed-air gun into the concrete form. Again, this is another instance where the method may work well for smaller residential projects, but not for larger ones where greater structural unity is desired.

Integrated framing assemblies

Designed specifically to address the problems at ICF openings, integrated framing assemblies simultaneously serve as both buck and hollow metal frame (which, under other bucking methods, is installed later). Installed prior to pour, they remain in place and coordinate up to at least six separate trades, reducing costs in time and labor while enabling a much earlier site lockup.[9]

Made of 14-gage galvanized steel, IFAs can be customized for various opening sizes or jamb depths. Concrete is poured into and around an angled alignment flange. On curing, then, the integrated framing assembly becomes part of the form, providing the resistance of steel to any force attempting to separate the two. In this manner, IFAs enable the frame and wall to reach a level of structural solidity unattainable for bucking systems using only wire ties, nails, or screws.

The design also minimizes air infiltration at openings, creating a more tightly sealed building envelope that enables higher energy efficiency. IFAs include drywall returns for the interior walls, along with a vibrator pocket in the windowsill to allow concrete consolidation. An additional advantage is these frames arrive onsite having already been hardware-prepped for the openings. (Workers must only note the opening tag and use a forklift to deliver the assembly to that opening. In contrast, most traditional bucking methods must be field-constructed from typical lengths.) This saves the contractor time and labor of having to return to each door opening to ready it for receiving hardware.

The most obvious initial drawback to the assemblies is they can be a more expensive solution to ICF openings in terms of initial cost. However, the price difference between IFAs and traditional bucking systems are impossible to state precisely because no two jobsites are the same, with price differential fluctuating depending on the:

- subcontractors involved on a job;
- nature of the bidding and award of the project; and
- dimensions, architectural design, and number of openings.

Generally, IFAs can have an up-front cost of two to three times as much as traditional bucking solutions. Nevertheless, in some circumstances (particularly large projects with hundreds of openings) they can also actually be cheaper than alternative solutions. It is on these larger commercial projects where IFAs' benefits are maximized. Since the systems coordinate multiple subcontractor trades and each frame is customized to the architect's door or window design, the assemblies streamline the aforementioned three-stage construction process at ICF openings.

While these framing assemblies have up-front costs of two to three times as much as traditional bucking methods, their promise of energy efficiency and ease of installation can still mean savings for schools and other buildings with multiple openings and differing jamb depths.

In designing the new Overdale Elementary School as an ICF project, K. Norman Berry and Associates also specified IFAs for mechanical chases. These IFAs have sidelites and mullions.

Beyond the contribution to lower overall energy consumption (via more tightly sealed door and window openings), an IFA's 14-gage galvanized steel frame requires less maintenance than most wood or vinyl alternatives. Thus, while IFAs might not be the perfect opening solution for a two-unit strip mall, they would be suitable for projects with many door and window openings, such as schools, jails, or hospitals.

Another drawback is current IFA products do not have a full thermal break. In more extreme weather environments, a thermal break will be necessary—however, such products are presently in the design process.

Since their recent arrival on the market, IFAs have met success in the field and already received industry recognition. The first sites on which they were used were all Kentucky K–12 projects—Georgetown Middle School, Anderson Elementary School, and Franklin County Elementary School. (The first two featured isolely ntegrated doorframes, while the last one also had window IFAs.) In designing the new Overdale Elementary School as an ICF project, architects from K. Norman Berry and Associates specified IFAs for mechanical chases as well.

Educational case in point

The fact IFAs are erected earlier than their traditional counterparts yields a domino effect on the construction process. Since the building envelope closes faster, subcontractor trades can get onsite earlier. For Division 08 manufacturers, distributors, suppliers, and installers, this means doors, windows, and hardware are needed sooner. The entire initial construction phase is compressed considerably, with manufacturers and distributors having to adjust to shortened lead times.

This impact is illustrated by the construction of Joseph Warren Middle and High School in Bowling Green, Kentucky. Set to open in September 2009, the two-story, 30,658-m^2 (330,000-sf) project will be the largest ICF building in North America. It is also one of the first commercial buildings to use insulating concrete forms for load-bearing interior walls as well as the exterior.

Joseph Warren has several unique openings, such as a 7 x 7.5-m (22.7 x 24.7-ft) view window, but its real significance lies in the fact it contains 497 IFAs, 224 of which are door assemblies. As previously discussed, these integrated assemblies streamline the process because they are simultaneously the bucking method and the doorframe or window sub-frame (*i.e.* for window openings, the aluminum windows sits in the IFA). Thus, IFAs eliminate several steps, as shown in Figure 1.

Figure 1 Contractor Tasks at Commercial ICF Openings

Traditional Bucking Method at ICF Opening	IFA Method at ICF Opening
Field-fabricate buck	
Install buck	Install IFA
Install door frame (where necessary)	
Install door (where necessary)	Install door (where necessary)
Install aluminum window (where necessary)	Install aluminum window (where necessary)

Figure 2 Contractor Tasks at ICF Openings at Joseph Warren Middle/High School

Traditional Bucking Method at ICF Opening:	No. of Contractor Tasks at Opening	IFA Method at ICF Opening:	No. of Contractor Tasks at Opening
Field-fabricate buck	497		
Install buck	497	Install IFA	497
Install door frame	224		
Total Tasks at Opening	*1218*	*Total Tasks at Opening*	*497*

Since contractors go about dividing labor differently on a jobsite and different workers work at varied paces (earning a range of wages), it is impossible to assign a time or cost value on each opening for a project like Joseph Warren. Consequently, the authors will refer generically to each 'step' at an ICF opening as a 'contractor task.' In other words, regardless of the number of workers sent to accomplish the jobs or the speed with which they are finished, this is the number of separate tasks a contractor faces at a particular opening to continue the building process.

Using the number of openings at Joseph Warren, Figure 2 shows the impact IFAs' presence can have on a job's total tasks associated with door and window openings. (Since door and aluminum window installations require the same number of contractor tasks whether IFAs or an alternative method of blocking the opening is used, they will not be included here.)

As is clear from Figure 2, using traditional methods of bucking ICF openings would result in 1218 contractor tasks associated with openings prior to being able to install the doors and windows for this project. Since IFAs are being used, however, the realized tasks are only 497—less than half.

This example clearly demonstrates why IFAs are especially suited for the heavy commercial ICF market. A small light-commercial project with only 15 openings may not realize enough savings in contractor tasks to justify the higher price tag of integrated framing assemblies. Conversely, on a school with almost 500 openings, savings in contractor tasks are quite considerable.

Further, IFAs are coordinated with numerous subcontractor trades, making construction at the opening much smoother than otherwise possible. For example, IFAs include standard closure returns that facilitate the interface between brick and the air space cavity, thus coordinating with masonry subcontractors. IFAs also include standard drywall returns, coordinating with the interior/drywall subcontractors.

For these reasons, Division 08 industry professionals should be ready for the changes to their territory. Similarly, as IFAs continue to appear on heavy commercial projects, Division 08 suppliers should be prepared to send their products to the site earlier, and installers must be ready to install sooner. General contractors will be

turning to those suppliers and installers who can aid and continue the quickened early stages of construction enabled by ICFs in general, and IFAs in particular.

Notes

[1] See Clark Ricks' data in "ICF Industry Forecast," in the December 2007/January 2008 issue of *ICF Builder*. Following Ricks' projections, commercial construction will represent 40 percent of the ICF market by the end of this year. (In 2000, non-residential work only accounted for 19 percent of the total.) For other projections on the ICF market, see Becky Brun's "Coming in from the Cold," which appeared in the March 2008 issue of *Sustainable Industries*. For more visit www.sustainableindustries.com/greenbuilding/16126742.html.

[2] For more on ICFs, see "Specifying ICFs: Insulating Concrete Forms and Light Commercial Projects," by Pieter VanderWerf and Doug Drodge in the July 2006 issue of *The Construction Specifier*.

[3] "Concrete House Stands up to Katrina," from the December 12, 2005 edition of *Nation's Building News* is available at www.nbnnews.com/NBN/issues/2005-12-12/Building+Systems/index.html.

[4] See E. W. Kiesling and R. Carter's "Investigation of Wind Projectile Resistance of Insulating Concrete Form Homes" (Portland Cement Association, 1998).

[5] See VanderWerf's "Energy Comparisons of Concrete Homes Versus Wood Frame Houses" (Portland Cement Association, 1997).

In Franklin County, Kentucky, this new elementary school relied on integrated framing assemblies for both doors and windows.

[6] See Todd Blyth's "Learning to Work with Insulated Concrete Forms" in the March 2008 issue of *Environmental Design and Construction*.

[7] See Kelvin Doerr's "Installing Wooden Window Bucks," in the April 2005 issue of ICF Builder. Visit www.icfmag.com/how-to/ht_wooden_window_bucks.html.

[8] See "Vinyl Window Bucks: A Perfect Fit," in the August/September 2005 issue of ICF Builder (August/September 2005). Visit www.icfmag.com/how-to/ht_vinyl_window_bucks.html.

[9] The possible coordinated trades are foundations, ICF installation, masonry (and other exteriors), windows, doors, hardware, solid surface sills, and drywall (and other interiors).

Additional Information

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Abstract

Insulating concrete forms (ICFs) have several benefits, ranging from greater structural strength and resistance to storm damage to improved energy efficiency. However, inclusion of window and door openings can be problematic. New integrated framing assemblies (IFAs) offer a solution.