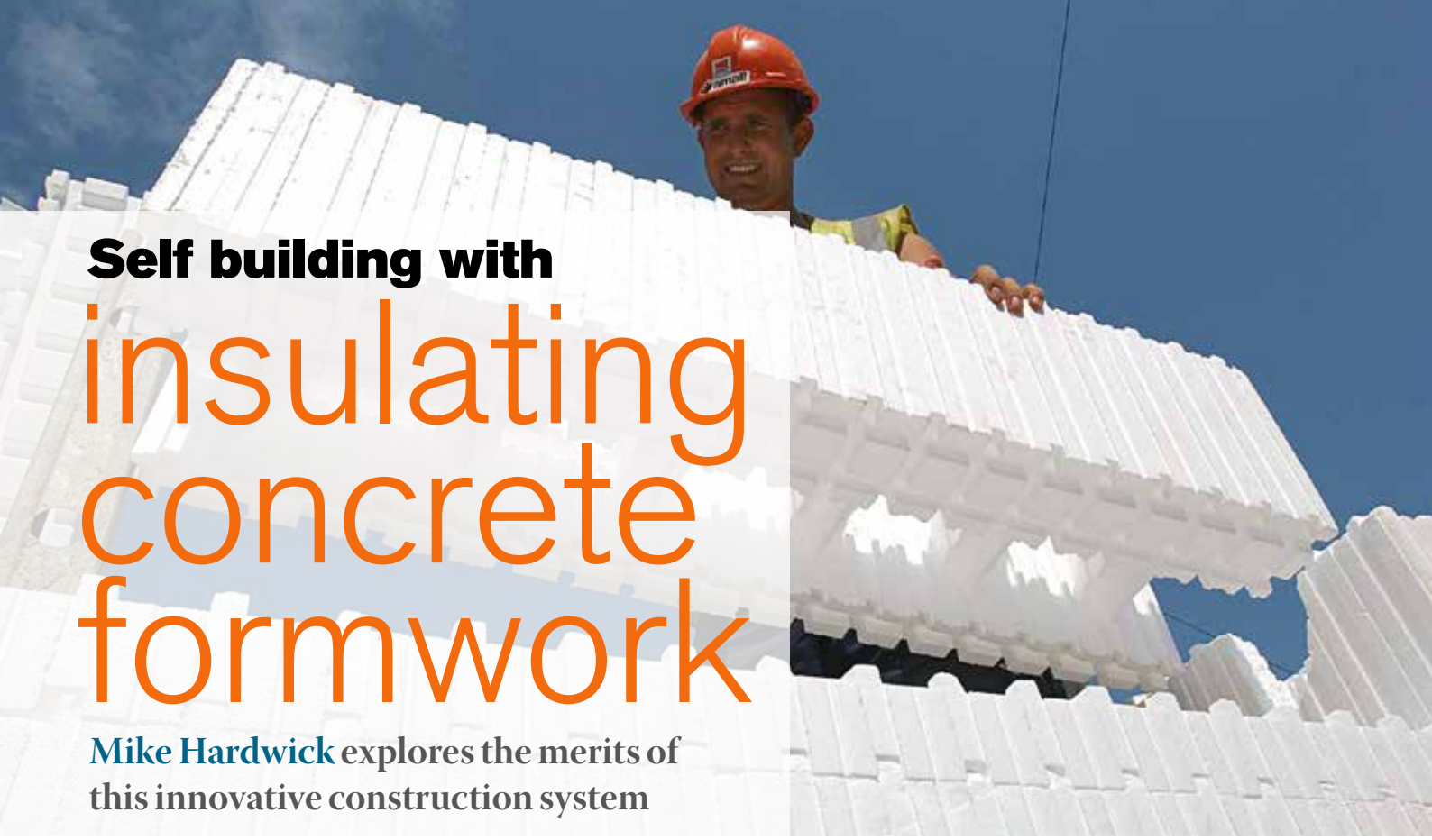

Self building with insulating concrete formwork

Mike Hardwick explores the merits of this innovative construction system

You might think that packing foam would be the last thing you'd want to build a house with. To be fair, at first look, the stuff we throw away after unwrapping the new TV doesn't seem anything like strong enough for the job. Yet when polystyrene is treated, moulded and filled with concrete, we end up with one of the miracles of modern construction: insulating concrete formwork (or as we commonly refer to it, ICF). Since its inception in Germany back in the 1950s, this structural system has gone from strength to strength and it is now a regular choice for mainstream developers, commercial specifiers and self builders.

How does this system work?

ICF blocks are preformed, hollow expanded polystyrene (EPS) bricks manufactured to fit together without any bonding agent (like glue or mortar). When joined, they form an insulated inner and outer wall with a cavity in between that's filled with concrete. Once the concrete has cured, the end result is a single masonry leaf that's highly insulated, immensely strong, airtight and waterproof. It's often described as grown up Lego, and that's a pretty good summary of how it works and how easy it is to use.

Why use it?

ICF offers a straightforward way to achieve the high efficiency standards demanded by even the most zealous designer, while still producing an aesthetically pleasing result that doesn't blow your budget. As a result, it has grown in popularity to become the system of choice for many eco projects. PassivHaus Institute standards demand a wall U-value (a measure of heat loss) of 0.11 W/m^{2}K or lower. While achieving that with traditional masonry or timber frame is possible, it involves layer upon layer of materials and high grade insulation that will drive up costs when added together. ICF starts with a very good U-value built-in, but comprises nothing more than a single screen of concrete and expanded polystyrene (EPS). There's no cavity required, so walls can be remarkably thin, maximising useable internal floor space.

What does ICF do that timber frame and traditional masonry don't?

Because the system uses the lightest of materials, the need for heavy lifting gear on site is minimal. What's more, the concrete is poured directly into the insulated forms, so it retains the heat necessary to cure properly. Consequently, the method can be used regardless of very wet or frosty conditions, which would halt a typical masonry build. ICF started life as a basement solution and is still widely used for that role because it is easy to waterproof. This also makes it the natural choice if you're building in a flood risk zone. Any waterlogged areas are relatively easy to clean up and dry out with no damage to the structural fabric. The nature of ICF means airtightness is automatically going to be impressive, too, so some form of mechanical ventilation and heat recovery is usually required.

Does using ICF need specialist skills?

One of the beauties of this method is that it's easy to use, and as more builders become aware of it, the pool of trades trained to use it has grown. At a time when skilled bricklayers are hard to come by and charging handsomely for their time, this is a technique that can be mastered by semi-skilled labourers with minimal on-site training. It's also not uncommon for self builders with reasonable DIY skills to construct their ICF superstructure themselves.

Once the first course has been laid accurately, the rest of the blocks slot neatly into each other and, just like Lego, the partitions stay naturally square and true as they are built. The walls usually go up no more than three metres at a time with concrete allowed to cure before the next lift,

Above: The Wallform blocks used by Beco are lightweight, easy to handle and interlock tightly without the need for bedding or adhesives

thus avoiding the wet mix seeping through the lower joints under hydraulic pressure. It's also good practice to use a vibrating rod or air poker to force any bubbles to the top, thus eliminating voids which could become weak spots.

What are the downsides?

Actually, there are remarkably few negatives. You could argue that it's not easy to change the design once the concrete is poured; and making alterations later can be more difficult as cutting new doors and windows in a solid concrete wall is challenging. There's also the embodied carbon footprint argument; no one would suggest that EPS is a particularly green material as it is a by-product of the petrochemical industry. However, it does such a good job as an insulator that it saves far more carbon in its lifetime than was ever used in its production. If embodied energy really is a problem for you, then non-EPS alternatives like Durisol's wood-based concrete formwork might fit the bill.

Can you tell what the house is made of when it's completed?

The internal and external coverings are fixed directly to the EPS blocks and you can have any finish, subject to planning approval. Rendered effects are popular, but you can glue on brick or stone slips for a traditional look, or apply battens and hang tiles or affix timber cladding. Inside, the plasterboard is dot and dabbed to the internal facings and plaster skimmed ready for final finishing. Once this is done, the structure looks just like any other house.

Surely EPS is flammable?

Basic polystyrene can easily set on fire, but the dense material used in ICF builds is treated with flame retardants, so while it might smoulder it won't burn.

How do I hang stuff on the wall?

Within each EPS block, at around 200mm spacings (known in the trade as centres), a hard plastic or metallic strip is incorporated and highlighted with a tell-tale pattern on the inside face to show exactly where it is. This allows fixtures such as cupboards, towel rails and radiators to be secured using self-tapping screws. For large areas, plywood or fibreboard panels can be used as well.

Above: This mountaintop dwelling was built by Thermohouse. An attractive mix of grey stone cladding and crisp white render were attached to the ICF structure

What about services?

Electric cabling or water pipes are fitted into conduits or recesses in the EPS blocks, which can be chased to suit using a hot wire cutting tool. Larger ducts such as wastes and soil vent pipes can be embedded into the wall before the concrete is poured so they're completely hidden away. This allows for a clean, contemporary internal finish.

Is it expensive?

In cost per m^2 terms, the blocks and concrete pour are a bigger investment than the cavity walling equivalent, but the speed of construction and the use of semi-skilled labour means significant savings can be made on site. Like all systems, the final cost is down to the quality of the build, but according to the ICF Association, savings of 25%-30% can be achieved on overall construction costs.

Nudura's hollow polystyrene blocks are shipped flat to site and opened up before being stacked and filled with steel-reinforced concrete

The owners of this house in Somerset and the builders they contracted attended an ICF training course before starting work on site. They selected Nudura's eight-inch-core form with a thermal insert thanks to the product's excellent insulation properties and its cost effectiveness

Above: Warm red brick slips lend this house traditional appeal. The ICF structure was erected by Logix. Bottom right: At the upcoming *Build It Live* show in Bicester visitors can explore The Naked House, where a section of a real dwelling will be constructed so it's possible to see how building materials – such as Nudura's ICF products – look at the first fix stage. See page 133 to find out more about our new exhibition

How durable is it?

EPS doesn't degrade, so the house will last as long, if not longer, than most other building systems. The monolithic wall system means no maintenance is required except to external claddings, and these can be repaired or completely replaced as required.

What flexibility is there when it comes to the size and shape of the project?

Even though the EPS units are square, some ICF companies will manufacture blocks to any radius to meet a curved design. However, most simply cut wedges out of one face of a cube-shaped brick with a hot wire before bending it into the desired profile. In terms of size, Jean-Marc Bouvier of Nudura is currently constructing a 27-storey hotel in Toronto, Canada that is made entirely with ICF. How high were you thinking of building?

Can I get a mortgage if I use ICF?

The Council of Mortgage Lenders (CML) confirmed that this system was suitable as a standard form of construction for mortgage lending in February 2010. If your provider is certified by the ICF Association, you won't have a problem.

CONTACTS

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MIKE HARDWICK

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THE BUILDER'S VIEWPOINT

For self builders who want to get hands-on with their schemes, Andy Peers from AKP Construction shares his top tips on how to plan an ICF project:

- At the design stage, try to align the dimensions of the structure to suit chosen ICF system and also the position and size of openings (this saves time and waste once construction has begun).
- Seek impartial advice on build detailing. You should ask for two days of on-site instruction on how to erect houses using ICF and a third day assisting with the concrete pour. If you use someone independent you will learn more from their experience than you will from reading the suppliers' training manuals.
- It's important to spend time getting the foundation concrete absolutely level.
- When setting out the first course of ICF blocks, make sure you get them level, straight and plumb. This makes the next courses easy to lay.
- Whatever the block supplier says, make sure that all openings are well strapped and braced. A little extra time at this stage can prevent disaster later on.
- Position service ducts and any other conduits in the wall before the concrete is poured. Common items that are often missed include exterior wall lights, external power sockets and outside taps.
- Only order and pump in the concrete when you're comfortable you're ready. Don't tempt fate by rushing.
- Remember the story of the boy and the dyke? The moral of this tale can be applied to an ICF build. If you suspect there might be small voids or any damage to the blocks, plug it with polyurethane foam and reinforce with a timber strap if required (in other words, always adopt the belt and braces approach).
- Make sure the slumpage of the concrete (how wet it is) is correct. If it's too high, you're asking for trouble. Don't rush the pour and allow a suitable period of time between loads.
- Don't believe all the tales of woe about bursts. If you get one there's no need to panic; they can be easily fixed if you are prepared for quick action.