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Insulated Concrete Forms--A Concrete Revolution

by John Straube

Insulated Concrete Forms (ICFs) are an increasingly popular type of lost-form system used to build concrete walls. According to the Portland Cement Association, nearly 20,000 homes--from affordable 1,000 square foot starter homes to 30,000 square foot mansions--were constructed using ICFs last year. Although no separate statistics are kept, the use of ICFs in the ICI sector is also growing quickly.

The forms, made of some insulating material, are either provided as complete interlocking blocks or as separate panels connected with ties. The two insulation layers used as formwork not only provide continuous insulation, but a space for services to be placed, and a backing for finishes on the inside and outside.

The North American use of ICFs can be traced back to Buckminster Fuller's Stockade Building System, an ICF made of magnesium-oxy-chloride bonded wood fibre. Although Fuller's company failed, ICFs made of bonded wood fibre were successfully used in Europe as early as the 1930s. These became important in housing and multi-family buildings after World War II, when energy, materials, and skilled labour became scarce. The leading European ICF product was introduced to North America in 1953. Unlike the foam plastic used by most of the more recently launched products, this type of ICF was--and still is--made of cement-bonded recycled wood chips. The material has been used in over 15 million square feet of mostly commercial and institutional buildings since then. Foam-based ICF blocks have since been introduced, but significant market penetration only seriously began in the 1990s, and now numerous companies produce ICFs with varying details.

The shape of the concrete in the voids is one of the features that distinguishes one ICF from another. Flat slab systems produce a continuous wall thickness just like other formwork and hence can be engineered using standard approaches. The concrete wall produced by grid systems has a waffle-like pattern which results in varying concrete thickness and reduced concrete use. Post and beam systems, comprised of individual closely-spaced horizontal and vertical columns of concrete, use the least volume of concrete.

Most ICFs provide 50-63 mm (two to 2.5 inches) of insulation on both faces of the concrete core, which is between 100 to 200 mm (four and eight inches) thick. The result is a solid wall assembly from 200 to 300 mm thick with good thermal resistance.

The insulation material is usually expanded polystyrene (EPS), but can be cement-bonded polystyrene, or cement-bonded wood fibre. In many systems, ties connect the two layers of insulation together. These ties are often made of plastic, but can be made of light-gauge steel. These ties are also used as locations on the face of the ICF to which one can fasten finishes, or to keep rebar within the core in place during pouring.

In the last five years new ICF manufacturers have proliferated. There are now more than 50 companies in North America, many offering slightly different wall shapes, means of attaching finishes, or wall thicknesses. While each system has its advantages, most are very similar in performance and methods of construction.

ICFs have many advantages as a wall system. They typically provide sufficient strength to meet most needs (the 25-storey Windsor Hilton was built with the traditional cement-bonded recycled wood chip form of ICF), and the strength of reinforced concrete is often seen as reassuring for owners in hurricane and earthquake regions. The materials are typically moisture tolerant, and so mould, rot and corrosion are rarely a problem.

Almost all ICFs blanket a building with insulation--from R8 to over R20--with few thermal bridges such as wood or steel studs. This means that the interior surface temperature is comfortably high and uniform. The thermal mass of the concrete helps to moderate temperature swings, which is especially useful for reducing air conditioning energy consumption. Systems that place the concrete mass closer to the interior will have a greater potential for energy savings. Air leakage through and air movement within ICFs is far lower than frame construction because ICFs use dense insulation and concrete.

The lack of thermal bridging, thermal mass, and air tightness are real, measurable and significant benefits of ICFs. The space-conditioning energy consumption of a building built of ICFs will be significantly less than for standard construction. However, some salespeople have promoted their ICF product's R-value as being 40 or 50--these claims are misleading at best and fraudulent at worst. While "effective R-values" of close to this level are possible in unique situations, such claims should be ignored without an engineer's detailed dynamic analysis of the specific project.

The performance--structural, thermal, moisture, acoustic--of an ICF wall is in most cases superior to that of walls framed with light-gauge wood or steel. However, the installed cost is also significantly higher, especially in house construction. The popularity of ICFs is evidence that the industry considers the cost increase for a relatively small part of the house cost (the walls) to be worth the significant benefits.

Many of ICF's benefits are shared by masonry cavity walls with at least 100 mm (four inches) of cavity insulation. The installed cost of masonry is, however, often higher, and the skilled trades required to build masonry are increasingly difficult to find. Unlike normal reinforced concrete and masonry walls, ICFs can be constructed in cold weather. Their insulating nature retains the heat of the concrete even in very cold weather, allowing curing without tenting or heating.

Fire performance is one attribute that can become an obstacle in commercial construction. Although most ICFs can provide a high level of fire
separation by virtue of the continuous concrete core, the flame spread and smoke produced values for foam plastics require the use of a thermal barrier. In many cases gypsum wallboard can be used to protect the foam (cement-bonded (delete wood - cement-bonded foam too) products require no fire protection). The increasing
number of commercial projects being built with ICFs is a testament to their growing acceptance by building officials.

Almost any finish can be applied to the inside and outside of an ICF wall. Some products may require slightly different methods of application however. Masonry, stucco, EIFS, and siding can all be applied directly over ICFs. Most systems have fastening surfaces to attach siding such as wood, vinyl, and aluminum. Interior finishes are typically drywall or direct applied plaster.

ICFs are likely here to stay both in all types of construction. Their virtues of energy-efficiency, durability, and lower labour input are becoming increasingly sought after while the size of the cost premium is steadily dropping.

John Straube teaches in the Department of Civil Engineering and the School of Architecture at the University of Waterloo.