Life Cycle Thinking Favors ICFs

Green building has become very sophisticated. Products can no longer get by on "organic" looks alone. They are now subject to a rigorous review of their total cradle-to-grave environmental impacts. That's good news for Insulating Concrete Forms (ICFs).

ICFs have a good environmental track record not only in the manufacturing of the product, but they also generally deliver a higher performance thermal envelope. Since the operating energy consumption is the biggest source of a building's environmental footprint, the energy savings contributions of ICFs represents a good life cycle investment.

Life Cycle Thinking ...

supports the choice of ICFs as a durable wall assembly that can reduce the operating energy for the service life of a building.

Life Cycle Tools

While products are typically measured in terms of first cost, a *life cycle cost (LCC)* approach accounts for all expenditures incurred over the lifetime of a particular structure, discounted to present value. The life cycle cost is a powerful tool to compare the total economics of different building alternatives. Durable and energy efficient materials such as ICFs often have a favorable LCC, due to lower future costs of utility, maintenance, and replacement over the life of the building.

A product can also be evaluated on the basis of its environmental impact. A *life cycle inventory (LCI))* captures the embodied energy of a product, i.e. the energy consumed in the acquisition of raw materials, their processing, manufacturing, transportation, and construction. An LCI also includes the energy consumed during the use of the building and during the demolition and disposal/recycling.

To assess an entire building system, the cumulative LCI product data is used to determine the *life cycle assessment (LCA),* which includes the environmental impacts associated with that product. These include resource depletion, land use, greenhouse gases, environmental degradation, human health effects, and reduction of biodiversity. An efficient building envelope, such as an ICF wall system, can play a significant role in reducing these environmental impacts.

Service Life

Clearly, a long service life is desirable for most buildings and materials, especially for the building structure / envelope, which accounts for around 50% of the embodied energy attributed to the total building materials. Determining an appropriate service life is the challenge. How long can one reasonably expect the building to perform its intended purpose; is there an opportunity for adaptive re-use; is the building material sufficiently durable?

The published data for expected life of a commercial building range from 50 to 99 yrs.[1] An ICF wall can contribute to this longevity, both by virtue of its own durability, and the ability to build in long-term flexibility. The concrete walls can be engineered to allow for extra loads, extra floors, or added roof-top gardens. The shell can be designed to offer clear spans, which allows for easier changes in interior wall partitions.

Durability

A design service life is only as good as the ability of the building assembly to provide the intended function for the stated length of time. The two materials used in ICF, concrete and expanded polystyrene (EPS) foam plastic, have a proven track record of durability with no compromise to performance.

The Canadian Standard on Durability awards concrete walls with their highest length of design service life (100 years) and the lowest maintenance requirements.[2] In the case of ICFs, the concrete is further protected on both sides by EPS foam, which will not lose any of its properties over time when properly protected from UV light. The ICF wall components are not likely to ever need replacement, so the initial embodied energy for the wall structure will not likely be incurred again in the life of the building.

Operating Energy

The greatest environmental impacts in a life cycle assessment (LCA) are from the production and use of energy needed for heating and cooling. Operating energy outweighs initial embodied energy within the first 10 yrs of a building's life.[3] Stated another way, over a 75 yr life of a building, about 85% of the impact of a building comes from its use phase and only 15% of the impact is traced to the material production, transport and demolition.

In traditional framed single family residential construction, operating energy can account for even more of the overall energy use, often up to 95%. Of this operating energy, ICFs houses can typically save 44% of the heating and 32% of the cooling costs.[4] That represents a significant improvement to the life cycle cost and the life cycle assessment.

"The most significant environmental impacts are not from the construction materials but from the production and use of electricity and natural gas in the houses by the occupants."

Martha G. VanGeem, PE, LEED AP
CTLGroup

ICFs and LCA

What does all this mean for ICF construction? An LCA was conducted comparing an ICF wall with a code compliant wood frame wall. Though these materials perform the same basic function (i.e., structural), they were not equivalent in terms of performance. In most cases for a given climate, the long term environmental impacts of the ICF wall were significantly less, due to the calculations of sizable energy savings.

Though a framed wall assembly could achieve the same level of insulation and air tightness, it would require far more materials and connections. Each of these is subject to the test of durability over time. And, an increased complexity of installation means more opportunities for errors.

ICFs have few components and the installation is straightforward. ICFs provide the most energy efficient use of insulation, since the EPS foam is continuous and not short circuited by structural members. In summary, ICFs are a simpler, more durable solution to reducing operating energy.

Using Life Cycle Tools

The methodology for conducting an LCI is well established and documented.[5] This is not a ranking system which would allow for easy "green" labeling of a material. Life cycle tools are best suited for use as an internal company audit, for product or production process improvement.

In the case of building materials that contribute to energy performance, the scope of the LCA should always include an energy modeling comparison of two identical building designs, built to code. A reasonable design service life should be selected. For an accurate analysis, environmental impacts relevant to buildings should be included. These are land use, resource use, climate change, ozone layer depletion, health effects, acidification, toxicity, reduction of biodiversity and solid waste.

How does this fit into the bigger, global issue of environmental issues? Energy consumed for building operations represents more than 40% of the total energy used in the US. Energy efficient construction is not only good fiscal management, but also sound environmental stewardship.

Life cycle thinking supports the choice of ICFs - a durable building envelope which reduces operating costs. A great combination in one straightforward system.

[1] 70 to 75 years U.S. DOE 2006 Buildings Energy Data Book (PNNL in Table 2.2.7). 50-99 years, Canadian Green Building Council CSA Standard S413.
[2] CSA Standard *S478-95* (Reaffirmed 2001) G*uideline on Durability in Buildings Structures (Design)* Table A3, Comprehensive Design Life and Maintenance Summary
[3] *Components of Energy Use During 50-Year Life Cycle of Typical Office Building with Underground Parking, Averaged Over Wood, Steel and Concrete Structures in Vancouver and Toronto*, Cole and Kernan, 1996.
[4] VanderWerf, *Energy Consumption Comparisons of Concrete Homes versus Wood Frame Homes*. Portland Cement Association. 1997.
[5] Methodology in accordance with the U.S. EPA, the Society of Environmental Toxicology and Chemistry (SETAC), and the International Organization for Standardization (ISO).

REV. 1/31/08

Insulating Concrete Form Association

1730 Dewes Street • Glenview, IL 60025
(888) 864-4232 • www.forms.org

The Insulating Concrete Form Association (ICFA) is a business association, representing over 500 international firms through ICF promotion, codes and standards, research, partnering and education. Founded in 1994, the ICFA is located in Chicago, IL.