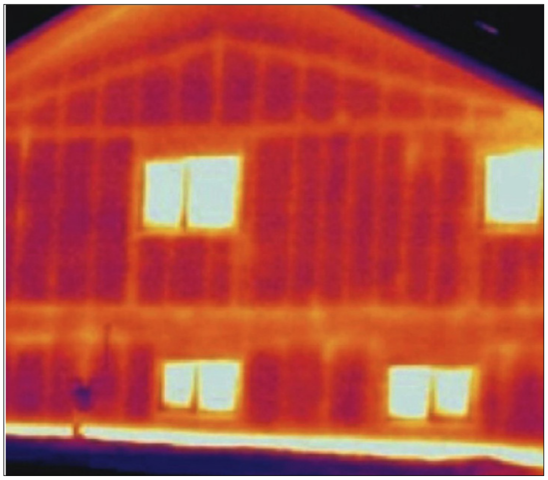
TECHNICAL BULLETIN No. 12



Thermal image of exterior framed wall showing heat escaping through the studs. Studs act as a thermal bridge through which heat can pass through the wall increasing heating and cooling loads.

Thermal image of exterior ICF wall showing no heat escape through the wall. Continuous thick insulation with a solid concrete core wall prevents thermal bridging and heat escape through Element walls.

We all know that insulation is a major factor in contributing to an energy efficient, comfortable building.

However, in terms of energy efficiency the performance of a wall assembly is more critical than the insulation alone. This fact is supported when you consider buildings with exterior walls made with insulated concrete forms (ICFs) require 44% less energy to heat, and 33% less energy to cool, compared to wood framed walls of similar insulation value[1]. Despite the similarity in insulation values, ICF walls contribute to a much more energy efficient building than framed walls. This attribute of ICFs is known as the "ICF Effect."

So what is it about ICFs that create the ICF effect? Three properties:

- Continuous insulation
- Air tightness and
- Thermal mass

Compared to framed, and even masonry construction, ICFs are the only wall types that inherently encompass all three properties. Element and the ICF Effect are discussed in detail below.

CONTINUOUS INSULATION

Discontinuities in the insulation, such as gaps between the insulation or where the thickness of the insulation decreases, can reduce the overall insulation value of the wall assembly.

For example, R-19 batt-insulation in framed walls will not provide an R-19 wall assembly[2]. Framed walls consists of batt-insulation between studs, which means the insulation is only effective between the studs, so about 20 percent of the wall is not insulated. Wood studs provide little insulation value, and act as a thermal bridge where heat can pass through the wall increasing heating and cooling loads.

Building energy codes in the US, such as ASHRAE and IECC, require an additional layer of continuous insulation in framed walls to make up for the insulation loss. Energy codes in Canada will have similar requirements.

Element block panels provide a minimum insulation value of R-22 (R-24 as an assembled wall with gypsum board[2]) - more than batt-insulation. And unlike framed walls, the R-value of Element block panels will always be representative of the actual R-value installed in the wall. Element block panels are constant in thickness and continuous. In addition, the block ties within Element walls do not act as a thermal bridge. As a result, the R-value remains constant throughout the wall assembly.

Insulation products are tested to an industry standard where R-values are required to be determined based on a mean temperature of 75 °F (24°C). For consumers this provides a straight forward comparison of R-values between different insulation materials and products. However, testing for R-value can also be conducted at a lower mean temperature, which results in a higher R-value, and in turn can mislead some consumers to believing they are getting a higher R-value compared to other insulation products.

[1]RP 11P Vanderwerf, *Energy Comparisons of Concrete Homes vs. Wood Framed Homes.*

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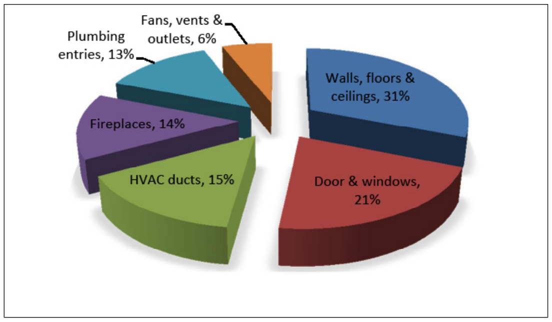

Energy loss contribution of typical residential home.
Source: U.S. Department of Energy

Where R-values measure resistance to heat flow, U-values measure how well a material allows heat to flow through (thermal conductance). The higher the U-value the better the material is at allowing heat to pass. The more heat that passes through a material then the less effective it acts as insulation – the lower the R-value. In other words, as the U-value decreases the R-value increases, and vice versa (U-value is simply the inverse of the R-value). To determine the U-value, simply divide 1 by the R-value.

Window and door manufacturers often use both R- and U-values to grade their products. For windows and doors, the lower the U-value the better it is at keeping out heat and cold.

Metals and expanded polystyrene (EPS) are good examples of materials that conduct and resist heat well. Most metals conduct heat, therefore, are bad insulators (high-U value, low R-value); EPS does not conduct heat well, therefore, are good insulators (low U-value, high R-value).

AIR TIGHTNESS

Air leakage in framed buildings contributes to the majority of energy loss. As more air infiltrates through the wall the less effective the insulation becomes. Framed walls are basically hollow structures offering many places where air leakage can occur (i.e., through sheathing joints, floor/wall joints, and insulation gaps to name a few). Overtime, wood framed walls tend to shrink and crack leading to more potential sources for air leakage. Building paper and spray or blown insulation can help seal most gaps but will not guarantee all leaks have been addressed, or that it will block future air leaks.

Compounded with continuous foam insulation panels sandwiching a solid concrete wall, Element provides a virtually air tight structure. Air leakages in an Element wall are easily identifiable and sealed (service penetrations, windows and doors). No air leakage through the walls ensures Element maintains its insulation value.

THERMAL MASS

High mass wall structures such as concrete have the added benefit of increasing the energy performance of a building despite having a low R-value. This property of concrete is known as the "thermal mass effect."

Building energy codes in the US recognize the energy saving benefits of mass walls, and thus require less insulation for buildings that use high mass exterior walls, than framed walls.

The thermal mass effect is influenced by differences between the indoor and outdoor temperatures. Since heat flows naturally from a warmer place to a cooler place, two scenarios can occur that impact the mass effect of concrete:

1. Outdoor temperatures fall above and below indoor temperatures
2. Outdoor temperatures never go above, or never go below, indoor temperatures.

Scenario 1

On a hot summer day the heat will be absorbed by the concrete and naturally move towards the cooler interior side of the wall. At night if the outside temperature falls below the indoor temperature then the heat absorbed in the concrete will reverse direction and move to the cooler air outside.

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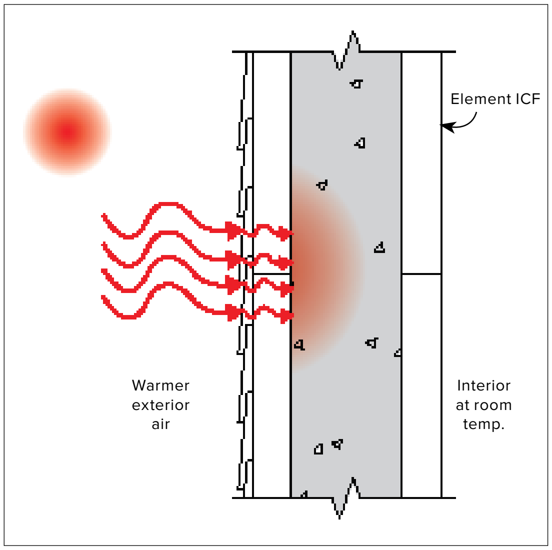
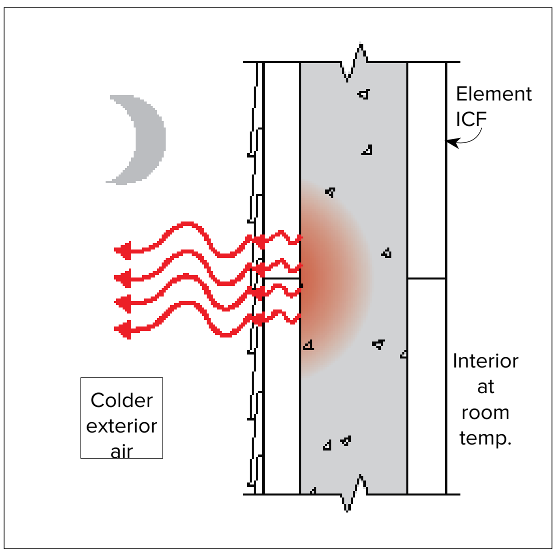


During warm summer days, heat is absorbed into the concrete core wall of Element, but must first travel through a thick layer of insulation impeding the heat absorption. (See Scenario 1)



At night temperatures fall below the interior temperature, which causes the heat absorbed during the day to flow to the colder exterior side of the wall. (See Scenario 1)

As a result, the interior of the building receives less heat from the outside, reducing cooling loads.

Scenario 2
In regions where outdoor winter temperatures are always below the indoor temperature, the indoor heat will be absorbed by the concrete and migrate to the colder air outside. Because warm air will naturally move to cooler air, the direction of heat flow is always from the warm interior to the cold exterior side of the wall. However, since the heat must move through the concrete before being lost to the outside, it causes a delay in using energy to replace the heat lost. As a result, it delays heating loads. This effect is known as "thermal lag."

Similarly, in regions where outdoor summer temperatures are always above indoor temperatures, the outdoor heat will be absorbed by the concrete and migrate to the cooler interior side of the wall. Since the heat must make its way through the wall before reaching the interior it delays cooling loads.

Considering Element consists of a solid concrete wall that's well insulated on both sides with a minimum of 2.75 inches of foam insulation, any heat travel into and out of the concrete layer wall would need to get through a total of 5.5 inches of insulation before having any effects on the interior of the building. Cooling and heating loads are then further reduced.

The combination of the thermal mass of concrete, and high insulation value of the block panels, has an effect of creating an R-value of the wall assembly that can be greater than the tested R-value of the insulation. This is known as the "effective R-value" of ICFs.

Climate Zones
The thermal mass effect of concrete walls will have a greater impact in areas where the outdoor temperature cycles above and below the desired indoor temperature within a 24 hour period, as described in Scenario 1. This is because little or no heat reaches the interior of the building resulting in very little cooling loads.

Areas such as New Mexico and Arizona, where high cooling loads dominate, would benefit most from the mass effect of concrete. In colder climates, such as northern parts of Canada, where the temperature typically remains below the desired indoor temperature in a 24 hour period, mass effect would have less of an impact. (Although, thermal lag, as described in Scenario 2, would still delay heating loads)

Consequently, the thermal mass attribute in the ICF Effect has a greater impact in the southern parts of the US, and a lesser effect as the climate changes northerly towards the colder climates of Canada.

The influence of mass effect in different climates is consistent with the Climate Zone Map found in ASHRAE 90.1 and other building energy codes. Mass walls require less insulation than steel and wood framed walls.

In the US the insulation requirements increase from Zone 1 (hotter climates) to Zone 8 (colder climates). In Canada, climate zones are labelled differently and increase from Zone 4 (hotter climates) to Zone 8 (colder climates).

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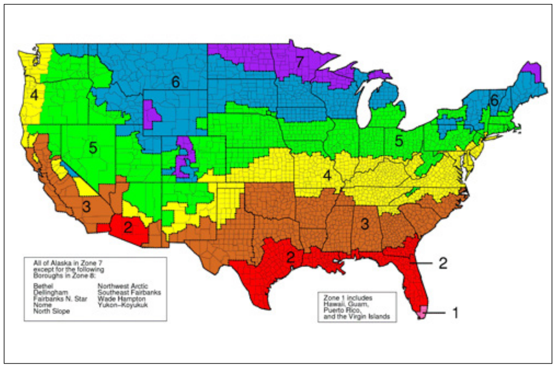
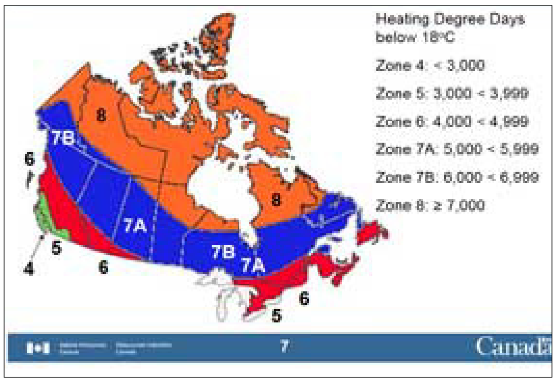


Climate zones in the United States.



Climate zones in the Canada.

Eight specific climate zones are located in the climate zone map for North America. Zones 1 and 2 are located in the hotter climate regions of the southern United States, and progresses northerly where Zones 6 to 8 are found in the milder and colder northern parts of Canada.

The R-value of Element foam insulation panels, which are available from R-22 and incrementally increasing by R8 with every 2" thick XRV panel installed, easily comply with the insulation values required in every climate zone. A comparison of Element forms to the required insulation values in different climate zones are shown in the attached tables (See Building Energy Codes - Minimum Recommended R-values).

Perhaps the most exaggerated claims often heard in the ICF industry is the R-value of an ICF product being R50 or more.

These claims are based on an independent study conducted in 1996 by CTL, Inc. The study looked at the thermal mass performance of ICF homes in different climate zones throughout the US and Canada, and compared the results to wood framed homes of similar size. It concluded that in the southern parts of the US wood framed homes would need to be insulated to at least an R50 to be as energy efficient as an ICF home of similar size. As you move further north the equivalency decreases.

So can an ICF perform to an R50? Consumers should first be aware that R50 is not the tested R-value of the insulation, but an equivalency to framed walls, as noted above. It's also important to note that this claim only applies in hotter southern climates of the US where cooling loads dominate. There is no doubting that ICFs perform beyond their stated R-value due to the ICF Effect, but to substantiate claims of R50 or greater, which is far more than a typical stated R-value of R24, further independent research would be needed.

Growing environmental concerns and Increasing oil prices has shifted the focus in building construction to produce the most energy efficient buildings, and has prompted building energy codes to create more stringent requirements.

The ICF Effect is what enables Element to exceed current and future energy demands. It's not just about R-values that create energy efficient buildings - it's the ICF Effect.

For more information contact info@logixbrands.com.