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Improving a Green Wall System

In New Hampshire building walls with solid wood (log) offers one of the "greenest" methods available. This is a reference to the wood's environmental benefit, not its moisture content. Logs are a sustainable material with high carbon sequestration, low travel distances from resource to building site, and a method of construction that reduces labor to construct (only one trade completes the entire wall assembly). Solid wood walls have arguably the best lifecycle benefit of any wall assembly. In addition, a pre-cut or handcrafted package maximizes on-site material usage efficiency. Incorporating methods described in ICC400 *Standard on the Design and Construction of Log Structures*, builders can construct a home that meets the air infiltration rates required in the new energy codes.

As a method of construction, log wall systems are limited as to the points they contribute in ICC700 *National Green Building Standard*. They satisfy points for resource management (ICC700 Ch. 6), while relying on the building contractor to plan, specify and execute other sustainable options to achieve certification. However, solid wood walls need to response to energy conservation measures to satisfy ICC700 Chapter 7. With the 2015 ICC model codes on the horizon, it is important to again consider log wall construction as a viable option.

Thermal Properties in the 2015 I-Codes

The 2015 ICC family of codes (a.k.a., the I-Codes) are available (http://shop.iccsafe.org/codes/2015-international-codes-and-references.html). Relating to energy performance, two of the codes work together for residential construction – the International Energy Conservation Code (IECC) and the International Residential Code for One & Two Family Dwellings (IRC). While the IECC directs insulation levels, glazing requirements, allowable air exchange rates and a new building performance level, one must refer to the IRC to resolve issues of ventilation and vapor retarders. These 2015 codes are an improvement over previous editions because they correct several details caught up in earlier code development debate.

What changed in the 2015 codes relating to log walls? In the fall 2010 issue of *Granite State Builder*, the recognition of log walls in the NH energy code was explained and ICC400-2007 was introduced. The prescriptive tables of the 2009 IECC have changed a little, but the mass wall criteria remain unchanged. Important changes since 2009 are the reference to ICC400-2012 for log walls, the requirement for testing of new construction to an air exchange rate of 3 air changes per hour (3 ACH50), and the allowance for an approach that evaluates performance using HERS-type ratings.

Over the years the log building industry has offset the U-Factor of the log wall by using top quality windows and doors, and upgraded foundation and roof systems, as reflected in Table 305.3.1.2 of ICC400-2012. This table is important because it offers a prescriptive trade-off that reflects industry experience. Other sections of ICC400 offer alternative ways to establish a U-Factor for log walls for thermal modeling, and the standard was used to expand log wall options written into REScheck. It remains important to understand that the U-Factor of the assembly is not the same as the rated R-values of insulation products applied to a conventionally framed wall. Insulating a frame wall with R-20 insulation per code generates a wall assembly with an overall R-value of about 17.5. Therefore, comparing wall systems for resistance to heat transfer is best done using U-Factors. For the 2015 NH Code update, the log wall question in the NH energy code should be handled in a similar manner as it was for the 2009 edition.

A New Focus on Air Infiltration

Later editions of the IECC have focused attention on controlling air infiltration by quantifying it. While a frame wall may be properly insulated, various gaps can allow outside unconditioned air to move into and through it. The energy required to condition that outside air has been attributed to be as much as 30% of a home's heating bill. In recent years the log home industry has learned and evolved with ENERGY STAR® and HERS rating opportunities to learn how air infiltration can be controlled. Using the methods outlined in ICC400, many companies have advanced their building systems. They have been training their builders to construct log homes defined as air tight (5 ACH50 or less). In NH (Climate Zone 6) a log home can perform at or above the 2015 IECC by following the ICC400 insulation levels, achieving blower door test results of 3 ACH50, and improving on the efficiency of heating and cooling equipment.

Achieving success in blower door testing of a log home requires attention to detail. Log homes are commonly completed as weather-tight shells before the interior work is done. That point when the shell is completed is a perfect time to run a blower door test and seal any leaks. If needed for certification, a final blower door test will most likely be successful. With only the wall as a real difference, the sealing of a log home is not much different than preparing any type of home for air tight performance.

Existing Log Structures

Log home designers, producers and builders are well aware of the code requirements for new construction, but the concern remains for the vast inventory of log homes in the region. In a 2011 issue of *Granite State Builder* an article presented a three-step approach for energy upgrades to log homes without modifying the log walls.

With a long heritage of log building in NH, the article intended to direct homeowners and home buyers as to appropriate steps to evaluate a log home.

1. Invest in an energy audit from a certified HERS rater and address air leakage issues.
2. Investigate improvements in roof, window and foundation thermal value.
3. Examine the heating/air conditioning systems to improve efficiency and the distribution systems to minimize losses between the source and the intended space. Duct sizing and leaks can be a major impact on heating efficiency. Ducts in unconditioned crawlspaces and attics must be properly insulated.

The concern expressed in that article is that well-intended folks will insulate a log wall thinking they are doing the right thing. It is important to consider this option carefully before proceeding. Here's why:

- A properly built and sealed log wall with an average thickness of 5" or larger (likely a nominal 6x milled log width or 7" average diameter) performs adequately in NH (Climate Zone 6) according to many satisfied owners. It acts as the air barrier, insulation system and vapor retarder all in one.

- The 2015 IECC recognizes solid wood walls as a "mass wall" and provides a mass wall benefit in the U-Factor table. A mass wall is only applicable if it is permitted to absorb and release heat to the conditioned space. This is not limited to exterior walls – interior log walls can also provide a mass benefit. One note to consider: when building with mass or radiant technology, maintaining a lower constant indoor temperature is more efficient than savings from using set-back thermostats.

- Computer modeling demonstrates what log home owners have asked: "If log walls don't work, why is the inside surface warm when the outside is cold?" Perhaps Equation 13, 2012 ASHRAE Handbook—HVAC Systems and Equipment, Section 6.5 has the answer. This calculation determines the inside surface temperature (tu) of outdoor exposed walls and outdoor exposed floors or ceilings: simplfied method (ignores short and long wave energy and other heat sources). For an exterior log wall (with temperatures of 65oF in and 0oF out), the equation shows the temperature on the inside face of a log wall (5" average width Eastern white pine, U-Factor of 0.13) will be 59oF. Although this equation is intended to be used to calculate inside surface temperatures of an exterior surface, perhaps this dynamic is more important to log wall performance than thought. It might explain why it doesn't take a tremendous amount of heat to warm up the inside of the log wall.

The important point is there are other areas of the home that can be improved without doing more than regular maintenance on a log wall – and the beauty of a log wall is that there are no hidden joints! If a joint between logs opens up, it can be easily filled with backer rod and a sealant (caulk). This treatment is usually done on the outside, since that's the point of contact with the unconditioned environment. The sealing of the log wall is not the only aspect of a log home that must be evaluated.

Covering a Log Wall

Research has uncovered a vast history of the American log building, many of which were thought to be frame construction until the exterior siding or interior plaster was removed. To the surprise of many, the log wall is safe and sound underneath. Log walls were covered over for a variety of reasons over their history, varying from social perception to reduced maintenance. It would not be a stretch to add reducing drafts as another reason. It could be argued adding a sheathing as an air barrier or added insulation to a log wall is not such a new concept. However these homes were built by pioneers who brought log building tradition from previous homelands.

In today's world of expanding use of building science to evaluate home construction, how would we add insulation to a log wall? How would one do it? Where the log wall has a flat interior face, it would seem easy to insulate the inside of the log wall – but that has the three strike rule going against it. Strike 1 is that the log wall works best when it is interacting with the indoor climate, storing heat and exchanging moisture. This is the benefit of a mass wall combined with the hygroscopic nature of solid wood. Strike 2 is that the bad stuff that can happen to a log wall starts on the outside, not the inside. If the outside is failing, occupants will not have an opportunity to see symptoms of air or water leakage on the inside surface – a more commonly inspected surface. Strike 3 comes from the difficulty in addressing full coverage of an insulation product while accommodating movement of the solid wood wall.

If adding insulation on the interior is not a good idea, how about the exterior? While it's still a difficult process and may lose the look and feel of a log home, it provides an opportunity to seal the exterior from top of foundation to soffit/underside of roof, and around the corners. A continuous air barrier applied to the exterior of a building has been proven effective in reducing infiltration. On a log wall, the first step is to apply appropriate maintenance to the exterior of the log wall. The wall should have a quality preservative applied, and all seams, checks and knots properly sealed. Essentially, this creates the moisture drainage plane. To allow the log wall to move while the new exterior remains rigid, use preservatively treated (or naturally resistant) vertical furring strips attached with fasteners through slotted holes. Apply rigid insulation to the furring.

Whether the log home is designed and constructed to new codes and standards or an existing structure being updated, the home can perform to high standards. Anyone can purchase a copy of ICC400 at *shop.iccsafe.org/icc-400-2012-standard-on-the-design-and-construction-of-log-structures-1.html*. Further discussion of the technical aspects of log construction is available in *The Peril of Log Building*. To purchase as hard copy or electronic version, go to *bookstore.authorhouse.com/Products/SKU-000593265/The-Peril-of-Log-Building.aspx*. Another resource is the National Association of Home Builders' Log & Timber Homes Council (*loghomes.org*), one of the Building Systems Councils.

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