Improving Energy Efficiency of Older Buildings

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If we are to have any hope of reducing the carbon emissions created by the construction and operation of buildings, we must focus on making our existing building stock as energy efficient as possible.   This makes good sense given the high percentage of existing buildings to new construction and the large amount of energy consumed to operate these buildings. We must devote at least as much of our attention to making existing buildings better as we do making new buildings as efficient as they can be.

However, the task of upgrading the energy performance of an existing building - especially an older building – is not something to be embarked upon lightly. The obvious areas of improvement such as window upgrades or replacement and adding opaque wall insulation can sometimes prove to be either uneconomical or downright destructive.

For example, historic and other older buildings are often built of unreinforced, load-bearing masonry. This provides a unique challenge when it comes to improving energy efficiency. Likely 80% or more of the exterior wall area of an older building is opaque – leaving 20% or less area for windows – and all that wall space seems to cry out for insulation. It stands to reason that if we improve the R-value of the opaque wall we can improve the energy performance and lower energy costs. The problems lie in how we change the *hygrothermic* performance of the wall by adding insulation.

Hygrothermic simply means heat and moisture transfer through building materials. In a load-bearing masonry building for instance, the moisture that starts out as rain on the exterior surface and makes its way to the interior as absorbed moisture in the masonry, dries to the inside with the help of the heating system. The wall gets wet, the wall dries out – and has done so for 100 years in many older buildings and thus maintains equilibrium. From a hygrothermic perspective, this is what has contributed to the longevity of the historic building stock. Unfortunately, the wetting and drying cycle, in the absence of thermal insulation, does little for energy conservation.

When we add interior insulation (and often also a vapor barrier) to a wall assembly, the hygrothermic performance changes. The wall stays colder, and thus wetter, as it loses its ability to dry to the inside. That extra moisture can cause serious problems such as mold, decomposition of the brick and mortar, corrosion of metal fasteners in the wall, rot of wooden beams bearing in masonry beam pockets, efflorescence, and in colder climates, spalling due to freeze/thaw cycling.

Another common problem when improving an older, unreinforced load-bearing masonry building is that a seismic upgrade is sometimes required by Code. When this is the case, we add another level of complexity to the exterior wall. The most common methods of seismic upgrade involve either adding concrete to most of the interior surface of the exterior masonry or constructing a shear wall that can add lateral support and a medium for tying back the masonry. Both of these solutions create difficulties – again by changing the hygrothermic performance of the wall.

The basic principles of building enclosure design are pretty simple. For any enclosure and condition you must control the movement of moisture, air, vapor and heat. Keeping moisture under control is first and foremost and is the main focus of any enclosure. To that end, when we look at improving the energy performance of a particular structure we must be conscious of all the variables and analyze the performance of the system as a whole. One helpful tool is the hygrothermic modeling software WUFI, created by the Fraunhofer Institute for Building Physics in Germany and supported in the United States by the US Department of Energy and Oak Ridge National Laboratory. The software can give projected temperature, humidity and water content levels for a given assembly using real, local weather data. Using this analysis we can analyze variables and predict problems before committing to what could be costly mistakes on a building.

Case Studies have shown that it pays to look at the entire building when considering an energy upgrade. By analyzing the life cycle costs of various options for improving energy performance and then focusing on the best value items we can prioritize our approach. Often upgrading lighting and mechanical system controls, refurbishing windows and adding attic insulation (which is often relatively easy and does not present all of the same potential problems as insulating opaque walls) can dramatically improve the energy efficiency of the building without breaking the budget or putting the structure at risk.

Sometimes it is possible to upgrade the exterior wall by adding insulation. Sometimes replacing worn out windows makes a great deal of sense. Often the best, most cost effective path to better energy performance is not the most obvious. Through careful analysis of the unique circumstances found in our existing buildings, we can start to economically reduce tremendous wasted energy and, at the same time, preserve the enormous investment we have our existing building stock.