Energy Efficiency of Older pre-war Windows

This project makes case that restored wooden windows are as energy efficient as new ones, supporting changes to provincial programs.

Abstract

Headed by Shannon Kyles, Instructor at Mohawk College in Hamilton, Ontario, the research project aimed at measuring and comparing the air infiltration of restored old windows and new windows in the same environment. In order to provide for accurate measurements, a twelve-foot by eight-foot building was built using modern construction methods and complying with Ontario Building Code requirements for insulation and vapour barriers. Two restored windows and two new windows were installed in this new build. The area of the two sets of windows was the same. The windows, installed by the same person, were treated with respect to insulation and sealing. The Ontario government-approved energy efficiency test then carried out by an independent company. Three sets of tests were done. The air infiltration was measured with all four windows covered. Then the restored windows were uncovered and the test was repeated. Finally, the restored windows were recovered and the new windows were uncovered. The test results demonstrate that there is no difference in air infiltration between new windows and restored pre-war windows. The project supports arguments for changes to provincial energy policy and funding to encourage window restoration.

Introduction - Window replacement versus restoration

Current Canadian Building Code specifications do not allow for the installation of restored pre-war windows on new buildings. Current energy retrofit funding is limited to replacement of windows, and is not available for window restoration.

For many reasons, it is often better to restore existing good quality windows, rather than replace them.

Energy comes in many forms. When considering a restored window, primarily the focus is on embodied energy. An existing 200 year-old window essentially consists of wood and glass with paint or varnish. The energy needed to restore it is minimal. Comparing this to a new window, one must consider first the embodied energy required to extract raw materials to produce the new product, then the direct energy used to remove the existing window and dispose of it in a land fill. More direct energy is needed to then take the new window to the building. The indirect energy of the manufacturing process also needs to be considered. Finally there is a recurring energy cost to replace this new window as it wears out. Once replaced, the new window will last between 10 and 30 years while the old window, properly maintained will last indefinitely, making a new plastic or vinyl window has a much heavier environmental footprint.

Among many studies in this area is the report by Ted Kesik which examines various forms of energy use in construction. Kesik observe “Preserving historic windows not only conserves their embodied energy, it also eliminates the need to spend energy on replacement windows.

Aluminum and vinyl - the materials used in many replacement windows - and new glass itself possess levels of embodied energy that are among the highest of most building materials."[1]

On a more practical level, the payback period for restoring windows has been examined by many different sources. Keith Haberman has provided evidence that the payback period for replacing windows is between 34 and 240 years while the payback period for restoring is only 4.5 years.[2]

As far as the actual energy savings enjoyed by people who replaced their old windows, the news is not impressive. Michael Blasnik studied a series of smaller homes in New York State. As Rob Yagid reports in Fine Home Building "The findings were less than impressive. On average, the homeowners saved about $40 on their annual heating bills. Consider the expense of replacing all the windows in a house, which could cost as much as $10,000, and replacement hardly seems sensible or economical. By dividing the total investment by the annual energy savings, you get a shocking payback period: The owners of these Northern homes won't see net cost savings for another 250 years."[3]

The cost of repairing new windows versus old windows in the short run is also rarely considered. Wooden windows are easily repaired. Modern windows are usually not repairable: the whole unit must be replaced. Modern units rely heavily on insulated glass (IG). The IG of a new window is dependant upon the quality of the manufacturing process and the amount of seals and desiccants involved, the amount of damage done in shipping, and the quality of the installation. Once the seal is gone, the window must be replaced at a cost much higher than that of a single pane of glass. Older windows are usually sealed with wood which, if properly maintained, will never fail.

While there may be other considerations in large part, the consumer's interest is limited to budget. But the consumer may not have all the facts. A recent study surveying home owners in Stratford, Ontario found that those who had replaced their pre-war windows with new windows had done so because they were convinced that new windows were more energy efficient. The study also found that most home owners would have kept their original windows had they had proof that a restored window would be as energy efficient as a new window. [4]

A final consideration, after energy use to replace versus restore windows and the respective

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[1]Water Sedovic and Jill H. Gotthelf, What replacement windows Can't Replace: The Real Cost of Removing Historic Windows, http://www.dahp.wa.gov/sites/default/files/WhatReplacementWindowsCantReplace.pdf

[2] Keith Haberern quoted in Noelle Lord, "Embracing Energy Efficiency" The Old House Journal pp 40-45, Oct, 2007.

[3]Rob Yagid, 'Should your old wood windows be saved?" Fine Home Building, 2010 http://www.finehomebuilding.com/membership/pdf/5161/021210040.pdf

[4]. Ron Bean, Barriers to the Conservation of Pre-World War II Residential Wood Windows

payback periods is the authenticity of the window. The aesthetic and historic value of an older window cannot be replicated.

Given the many arguments to support the restoration versus replacement of older windows (see Appendix B), and that the mandate of most levels of government is concerned with sustainability, why is there no financial or legislative support for restoration?

The research project aimed to provide further evidence on the energy efficiency question in line with accepted government processes for regulation.

The current standard for measuring energy efficiency in windows is the A440 test set up by NRC 20 years ago. Clause 10-2 of this protocol is a test to measure air infiltration. This is the test that most people refer to when discussing energy efficiency in windows. It was determined that an air infiltration test comparing restored nineteenth century windows and new twenty-first century windows might provide the necessary evidence

The Building

In testing air infiltration in older buildings, each building will be different and thus the results may vary. To provide a test that compared strictly the window performance and not the building, a test building, eight feet by twelve feet, was constructed.

The test building was constructed according to Ontario Building Code requirements. The floor was constructed with 2 x 4 spruce insulated with Roxul 4" batting. The walls were insulated with 6" Roxul insulation. There was a six millimeter vapour barrier installed on the interior side of the insulation. On the outside , a Tyvek barrier was installed. The finish for the building was in 8 inch tongue and groove. The ceiling was insulated with R 40 Roxul.

Two 1830s Georgian windows were purchased. One was restored by Furlan Conservation in Hamilton Ontario. The other was restored by Paradigm Shift Customs in Brantford. Two new windows were purchased from Pollard Windows. One was a wooden sash window. The other was a vinyl casement. All four windows were installed by John Deelstra, Professor of Carpentry at Mohawk College. All windows were installed with foam insulation.

To make a complete comparison, other considerations including ease of opening and access to air circulation were also considered. The restored windows had opening windows and storms that were hinged so that no lifting or access from the exterior was needed for air circulation.

The Test

On May 10, 2017, Green Venture of Hamilton sent Certified Energy Advisor Michael Masney with an Air Infiltration kit. Local MPPs, building officals, and college officials were invited to attend. In addition, students, faculty and staff of Mohawk College were invited. Those attending the test included prominent members of the restoration community:

Robin Pixner - President - Stellchem - Waterloo
Sasha Knight - ARA Archeology
Alan Stacey - Principle - Heritage Mill - Dundas ON
John Wilcox - Vitreous Glassworks - Toronto - also Willowbank
Craig Cooper - Mohawk College - Green Tech
Gary Strong - Mohawk College

The test was conducted first with all four windows covered with painted plywood and sealed with strippable sealer. The second test was conducted with the two older windows sealed. The third test was conducted with the two new windows sealed.

Conclusion

The air infiltration test is accurate to plus or minus three percent. The results as shown in the report (see Appendix A) show that there was virtually no difference between the performance of the restored old windows and the new windows.

Conclusion

The air infiltration test conducted on May 10, 2017 provides solid proof that restored windows are as efficient as new windows using a completely level testing field and a government approved testing protocol.

Recent publications have focused on the many other areas of energy consumption and do not address the generally held belief that restored windows are less energy efficient than new ones.[5] Ontario government policies and funding, whether in the form of bursaries or tax credits, do not currently recognize the significant value of restoration of doors and windows. This project should inspire a reconsideration of the energy efficiency of historic windows and doors and serve as a catalyst for change in provincial approaches including energy efficiency support programs.

Ron Bean, Barriers to the Conservation of Pre-World War II Residential Wood Windows

Noelle Lord, "Embracing Energy Efficiency" The Old House Journal pp 40-45, Oct, 2007.

National Trust for Historic Preservation 2012 Report on Window Restoration

Water Sedovic and Jill H. Gotthelf, What replacement windows Can't Replace: The Real Cost of Removing Historic Windows

Rob Yagid, 'Should your old wood windows be saved?" Fine Home Building, 2010

[5]National Trust for Historic Preservation 2012 report on Window Restoration http://forum.savingplaces.org/connect/community-home/librarydocuments/viewdocument?DocumentKey=59eab0e4-f0f4-45c5-97c8-147a8def82ae&CommunityKey=00000000-0000-0000-0000-000000000000&tab=librarydocuments