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Real Energy Savings from Windows Upgrades

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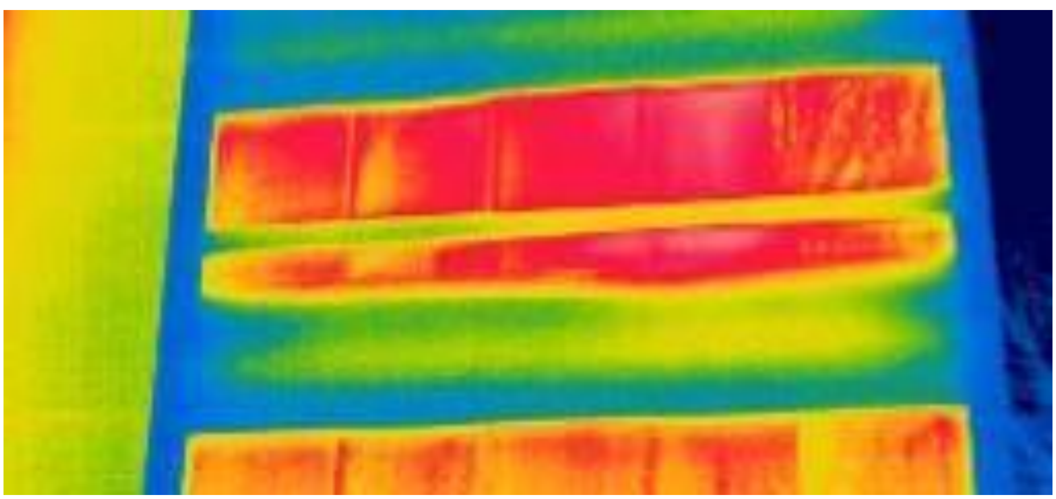


Introduction

This bulletin presents the thermal improvements, improved airtightness, and measured energy savings resulting from the upgrading of windows in two 1970's vintage residential concrete towers.

Need for an Upgrade

BC Housing owns, manages, and pays the utilities for hundreds of buildings across the Province. No doubt they are feeling the impact of increased energy costs, particularly in their aging housing stock. In order to reduce energy costs in some of these high consumption buildings, energy upgrades have been implemented. RDH was involved with one such project known as Sunset Towers, where the original single glazed air-leaky aluminum windows and sliding doors in the two adjoining towers were upgraded. Further improvements are needed to address the poorly insulated exposed concrete areas of the two towers.

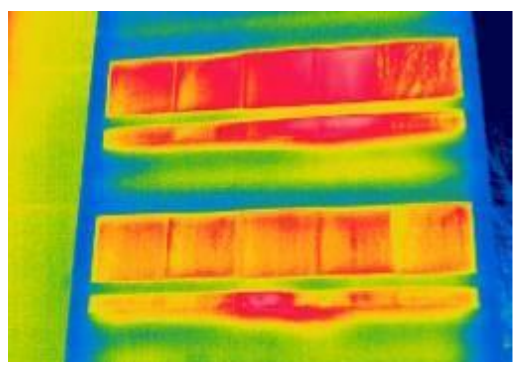
Thermal Improvements

The glazed windows and doors in the two towers account 59,000 square feet or 37% of the overall wall area. The overall R-value of the original building wall enclosure with single glazed aluminum frame windows and sliding doors was approximately R-1.4.

Thermally broken aluminum Kawneer series 5500 fixed frames, AA900 casement vents and AA3900 sliding doors were selected for the replacement program. Insulating glazing units within the frames utilized a high quality low-e coating on surface #2 (interior side of exterior pane), argon gas fill, and thermally improved stainless steel edge spacers. The overall R-value of the building wall enclosure was improved by approximately 90% to R-2.7.

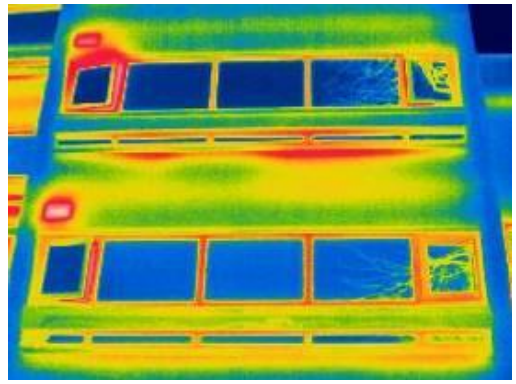
To visualize the performance of the window assemblies, infrared photographs were taken before and after the window upgrade to compare the thermal improvement of the new windows and locate heat loss through the building enclosure. Warm surface temperatures on the exterior are indicators of poor thermal resistance or air-leakage (red to white in images below).

BEFORE: The original windows.

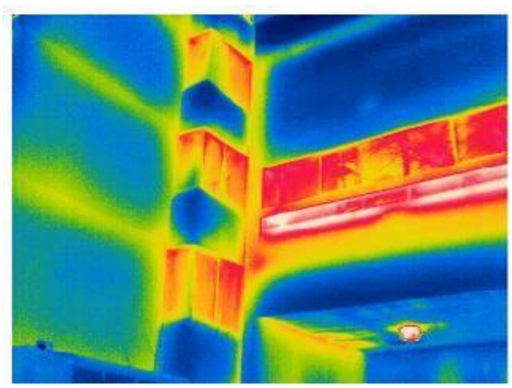


Infrared image of original windows. Red areas indicate poor insulating value and greatest heat loss through single glazing and aluminum frames.

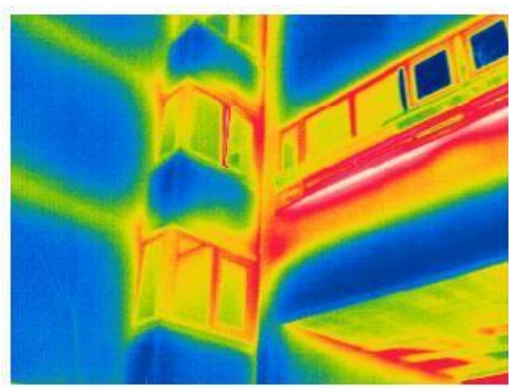
AFTER: New windows installed.



Infrared image of new windows. Reduced heat loss through new window glazing and frames. Heat loss shown at slightly open windows and below the small lower window where the hydronic baseboard heater is in contact with the concrete wall/slab edge. Note air flow/leakage through exhaust louver above windows.



BEFORE: Infrared image of original windows at corner detail. Significant heat loss through window frames and glazing. Also note heat loss at uninsulated slab edge.



AFTER: Infrared Image of new windows at corner detail. Reduced heat loss through windows. Note the heat loss at the poorly insulated walls and slab edge adjacent to the hydronic baseboard heaters.

Reduced Air-Leakage

Air leakage testing was performed at several individual suites before and after the new window assemblies were installed to estimate the relative improvement to the overall suite air-tightness. Testing was performed with a door-fan mounted in the hallway door opening, and measuring the flow-rate and equivalent air-leakage area of the suite. The measured air-leakage is through the exterior and interior walls, floor, and ceiling of the suite, therefore only the relative difference in exterior leakage could be determined between windows.

Air leakage testing found significant improvements to the wall enclosure air-tightness. On average the air-leakage through the exterior walls of a typical suite was reduced by an equivalent hole size of 66 cm2, consisting of air-leakage through the poorly sealed fixed frames and un-gasketed sliding frames of the original windows. In terms of an air-leakage rate for these suites, this is equal to 1.8 air-exchanges per hour (ACH) at 50 Pa or 0.4 ACH at more typical operating pressure of 5 Pa. In terms of overall air-tightness of the suite this has the effect of a 52% reduction in the unintentional suite air-leakage.

Real Energy Savings

The two towers are heated using gas-fired boilers, supplying hot-water to hydronic baseboard heaters within suites. Ventilation air provided to the pressurized corridors is heated using gas at the roof-top make-up air units.

Prior to the commencement of this project, energy savings for the window upgrade were modeled by a mechanical consultant and estimated to be in the order of 2,800 GJ/yr or 24% of the gas required for space-heating. Estimates were based on gross building estimates and approximate window R-values with no consideration for improved enclosure air-tightness.

The window replacement project was completed in the summer of 2008. Gas utility bills were reviewed for building operation prior to the window replacement, during the construction, and after completion of the work over the past heating season. A significant reduction in the overall gas consumption was observed over the past winter for the two buildings.

Weather normalizing the pre- and post-upgrade utility data and subtracting base-line domestic hot water usage shows that the space-heat savings from the window upgrade are in the order of 30% per year or 4,000 GJ/year for the two towers. This is a 17% reduction in the total gas used at the building. At 2008 gas prices this is equal to an annual savings of approximately $45,000 (and rising).

Space-Heat energy savings from the new windows are in the order of 30% or 4,000 GJ per year

The actual energy savings of 30% exceeded the initial modeling estimate of 24% likely due to the additional savings from the improved air-tightness. This comparison helps to build confidence in energy modeling tools to predict energy savings from window upgrades, and also highlight the importance of air-tightness. This case study demonstrates that real space-heat energy savings can be realized by replacing aged single glazed aluminum windows with modern high performance windows in high-rise residential buildings.

For additional information on this and other topics, please visit our website, rdh.com, or contact us at contact@rdh.com.

Additional Resources

→ Technical Bulletin #8 – The Deep Energy Retrofit of the Belmont: http://rdh.com/wp-content/uploads/2015/09/TB-8-Deep-Energy-Retrofit3.pdf