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Coast2Coast Comfort Report

Westside Report

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Healthy HEATING

Comforting Your Mind, Body & *Soles*

The Importance of the Building Envelope for a Healthy Home

By Geoff McDonell P.Eng.

The dominant construction method for residential dwellings, from single family detached houses to four storey condominium apartments, is based on wood framed structural building systems. While wood is a renewable resource and readily available in most of North America for buildings, the way we've been designing and building wood framed buildings isn't much better than "wooden tents". Yes, there have been many improvements in terms of how we design and construct wood frame buildings over the last couple of decades, but fundamental design and construction issues are still affecting the overall efficiency level of a good quality house.

Wood framed buildings and houses can be flexible, durable, healthy and comfortable provided they are appropriate for the local climate, and the detailing of the structure and envelope is properly designed. For a typical, conventionally constructed House (and almost every other building type), up to 50% of the thermal transmission energy losses are through the windows, another 30% can be attributed to thermal bridging and poor insulation application, and another 20% is lost to air leaks and infiltration through walls and joints.
I hear a lot about "high performance" double glazed wood and

The single-story, 1,600-square-foot house will cost less than $200 a year to heat at current natural gas prices because of a radiant heating system in the foam-insulated concrete floor and materials that keep warm air inside while deflecting heat and cold from the outside.

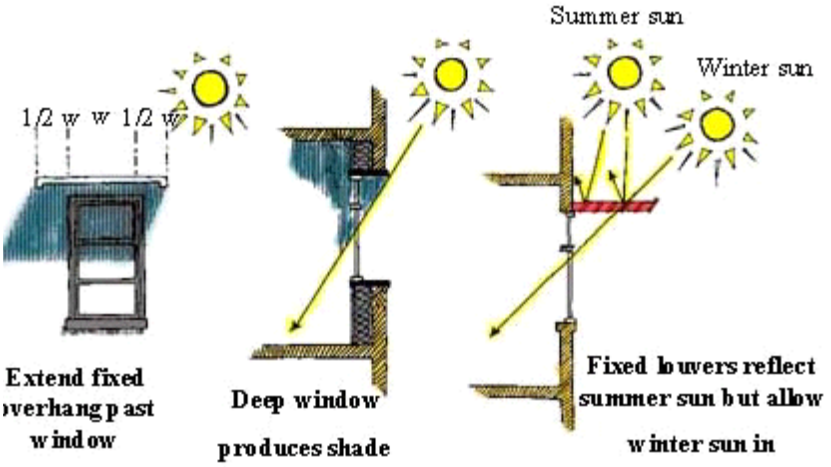
Sandusky builder 'foams' home to save money on high energy costs, By STEVE MURPHY, BLADE STAFF WRITER, Copyright 2005 The Blade

vinyl windows. The reality is that there is a lot of sales hype, and very little increase in overall thermal and solar performance when the rubber hits the road. There are two fundamental aspects to assessing window performance: thermal resistance and solar gain control.

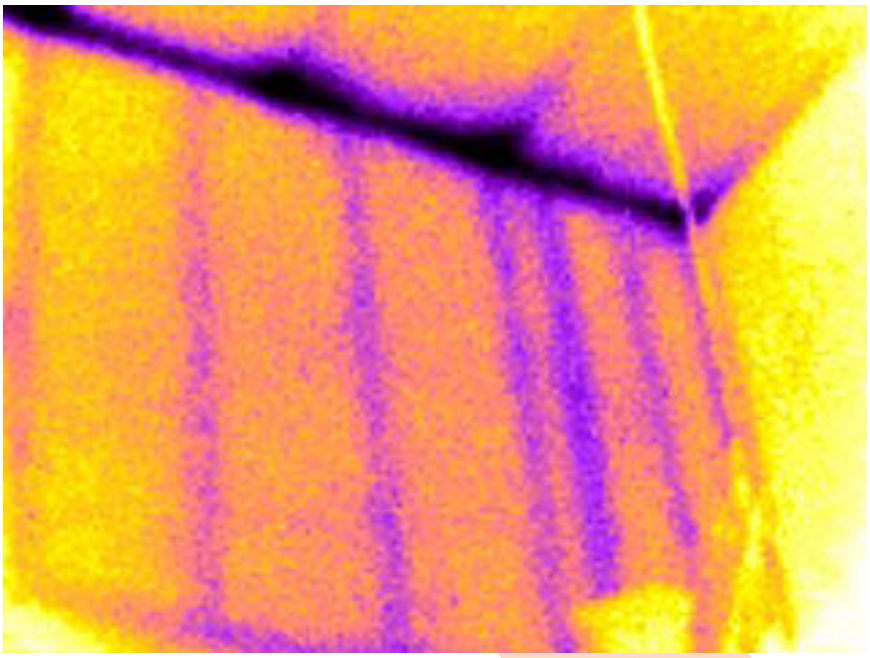
Thermal resistance is the "R-value" of the window. Almost all of the window manufacturers rate their windows based on the "centre of glass" performance, which shows the "best" performance. The problem is that the type of window frame can degrade this performance by up to 25%. The REAL number you want to ask about is the "overall" thermal performance, which is a measure of how well the window and frame works together. Adding low-e coating to the right surface of the window can help add thermal resistance performance by reflecting heat energy back into the room for cold climates. The higher the "Overall R-value" the better the windows' thermal resistance.

Solar gain performance of glass is usually expressed as a number labeled "shading coefficient" or "solar heat gain coefficient". This number is a measure of how well the window keeps out solar heat gain in the summertime. Ideally the best way to control solar gain though the windows is to provide exterior sun-shades or overhangs. This allows a lot of natural lighting while keeping the solar heat gains minimized. Otherwise tinted windows, with special coatings to reduce ultra-violet light penetration, will provide solar heat gain control. Low-e coatings applied to certain surfaces of the window can help reflect heat back outside the window for warm climates. The lower the shading coefficient number, the better the performance.

Solar control is ideally performed by exterior shading devices that are designed to keep out the hot summer sunlight while still allowing an amount of low winter sun in for some passive heating.



Thermal bridging is a very easy heat loss to prevent, if the right exterior wall detailing is applied. The common exterior wall construction method is to use 2x4 or 2x6 wood studs, apply exterior sheathing, and then stuff insulation in between the studs on the inside of the sheathing before the interior wall board is nailed up. Trouble is, there is a direct thermal bridge from the outside to the inside because of the wood stud being directly connected from the outside wall surface to the inside wall surface. The standard wall stud spacing of 16" (400mm) on centre can degrade the insulation performance by up to 30%, including the base plate and header bridging as well. You might think you are getting R-28 insulation in that 6" exterior wall cavity, but the reality is the effective overall thermal resistance you will get is somewhere around R-18 to R-20. So, hopefully, whoever is designing the heating system has taken this into account, or the homeowner will be getting a cool surprise during the winter.



Thermal bridging through the wall studs, seen through an infra-red camera looking at an exterior wall from inside the room.

Infiltration and air leakage is another easy issue to deal with if the proper envelope detailing has been incorporated. In a cold climate, a vapour barrier is normally applied to the "warm side" of the wall, so that warm humid air from the house doesn't migrate into the cold wall cavity, condense and become a breeding ground for rot and moulds. In a warm, humid climate, the vapour barrier is normally applied to the exterior part of the wall so that the warm humid outdoor air doesn't migrate into the cooler interior zone to condense

"The building features a geo-exchange system using ground-source heat pumps, radiant slabs for heating and cooling, a combination hybrid ventilation system and dedicated outdoor air unit, a high performance envelope and natural lighting. The building also includes thermal energy storage with night pre-cooling and heating, heat recovery from exhausted air, and rain water harvesting."

excerpt from
AHR EXPO HIGHLIGHTS:
New Pinnacle Show hosts a record number of exhibitors.
By Richard Babyak

and create conditions for rot and mould. Areas where infiltration commonly occurs are around window openings, doors, and perimeter edges of the exterior walls. There are a number of ways to eliminate air leakage through the building envelope:

the house ventilation system must maintain the interior air pressure in a "neutral condition" at all times, not too negative and not too positive relative to outdoors.
the vapour barrier must be very tight- taped at all joints and edges, use types of wall insulation that don't allow air movement (icynene, styrofoam, etc.)

The bottom line is: when you are designing a new home, ask the right questions – what are the overall window thermal and solar performance factors?, what details have been incorporated to reduce or prevent thermal bridging?, and what are the air barrier/ vapour barrier details that are being used to prevent air leakage?

For any home project, whether a new house or a renovation - the attention MUST be paid to the exterior envelope to reduce the heat losses and heat gains to a minimum, and THEN a very low energy/ high comfort heating/cooling system can be designed and installed. For every dollar spent on the building envelope, a corresponding dollar in the heating and ventilating systems installed costs can be saved, with on-going operating costs savings. A good envelope design will provide the cheapest, lowest maintenance, and greatest energy reductions in a house, period.

REFERENCES:

Website: www.bcbuildingscience.com/INFORMATION.htm
Website: www.cmhc-schl.gc.ca/en/imquaf/himu/wofren_001.cfm
Website: http://www.durable-wood.com/links/index.php
Website: http://www.wbdg.org/design/psheating.php
Website: http://www.wbdg.org/design/windows.php

Geoff McDonell, P.Eng., Is a graduate of the University of Alberta and is responsible for developing institutional and sustainable projects. He specializes in very low semi - passive building systems including radiant cooling, displacement ventilation and high performance building envelopes design. He has been practicing as a consulting building service design engineer for over 23 years, and is a LEED (Leadership in Energy and Environmental Design) accredited professional.