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Window shadings reduce residential cooling energy

By Aziz Laouadi and Anca Galasiu

This article presents results of experiments at the Canadian Centre for Housing Technology comparing the performance of two types of window shadings for houses: exterior rollshutters and interior blinds.

NRC-IRC researchers conducted summer studies to determine the effect of exterior rollshutters on residential cooling energy consumption and on physical conditions associated with occupant thermal comfort. The study took place at the Canadian Centre for Housing Technology (CCHT) and compared the performance of the facility's Test House fitted with exterior rollshutters to the performance of the identical Reference House fitted with interior blinds. Both houses were equipped with a standard set of major appliances and a simulated occupancy system that replicated the daily water draws, heat and electrical loads of a family of four.

The similarity between the two CCHT houses had been verified during 18 summer days prior to the installation of the rollshutters. For the verification, the windows in both houses were equipped with interior blinds with slats in an open (horizontal or vertical) position.

Test Arrangement

The Reference House was fitted with interior, beige, horizontal, Venetian blinds on most windows and beige, vertical blinds on the patio glass door, dining room window, and stairwell window. The slats of the Venetian blinds were slightly curved and made of aluminum, while the vertical blinds were made of fabric. All interior blinds were mounted outside the window frames, leaving an open air space between the blinds and the wall incorporating the window frames.

All windows of the Test House, except the east-facing windows (which were kept identical to those in the Reference House), were fitted with movable rollshutters (see photo). The rollshutters were made of fixed and articulated aluminum slats (beige colour) with a sandwiched polyurethane insulation. The slats could be arranged so that they are tightly abutting (for winter use) or arranged with a small gap between the slats to admit some light and provide a view from inside (summer use). They were not designed to allow the slats to be angled, and could only be adjusted up and down in the vertical plane of the window using side railings installed on the brick walls. A rubber gasket installed between the side railings and the walls sealed the air space between the shutters and windows. The bottom of the shutters was not sealed to the window sill; it had a few holes to allow for water drainage.

Environmental conditions for thermal comfort (air temperature and velocity, globe temperature and relative humidity) were also measured at a distance of 1.2 m from the south-facing living room window.

The window shading measurements covered a three-week period (June 27 to July 21, 2008). The shading devices in both houses were kept closed throughout the testing period to explore the maximum effects. The slats of the rollshutters were loosely closed, leaving gaps between the slats to provide a view of the outdoors from inside the house and to admit minimum daylight indoors. The slats of the interior blinds were tightly squeezed. The set point temperature for cooling was fixed at 24ºC. Indoor relative humidity was free-floating.

The testing period comprised days with various sky conditions (seven clear, three overcast, 11 mixed partly cloudy/overcast), with outdoor temperatures ranging from a minimum of +13ºC during the night to a maximum +33ºC during the day. Outdoor relative humidity levels were 32-99%.

Results

The results show that the rollshutters decreased the total daily energy consumption (AC + furnace circulation fan) of the Test House by ~26±10% compared to the Reference House. The daily energy used by the A/C unit of the Test House was on average 45% lower than that used by the A/C unit of the Reference House. The maximum difference in A/C daily energy use recorded was 72%, while the lowest difference was about 23%.

A maximum reduction of 80% in peak electrical demand was recorded around 2 p.m. under clear sky conditions, while for a heavily overcast day the demand reduction was still a substantial 50%. Calculated across the 21 days of the testing period, the daily maximum average reduction in electricity demand was 67%.

The thermal conditions near the south-facing living room window in the house equipped with rollshutters were also better than those measured in the house equipped with interior blinds, especially during night and evening hours.

These measurements have been used to calibrate a simulation model of residential energy performance. This model is being used to estimate shading effects for a greater variety of house constructions and locations, shading types, and more realistic shading positioning.

Conclusions

The fact that the Test House consistently used less electrical energy for cooling than the Reference House indicates that the exterior rollshutters were more effective shading devices than the interior blinds. Rollshutters offer the potential for reducing peak electrical demands, especially during heat waves and mid-to-late-afternoon hours, regardless of the sky condition.

Additional information about the energy performance of rollshutters is available at:

http://irc.nrc-cnrc.gc.ca/pubs/ci/v12no4/v12no4_13_e.html
http://www.ccht-cctr.gc.ca/projects/solar_e.html

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The Canadian Centre for Housing Technology is a facility jointly operated by the National Research Council, Canada Mortgage and Housing Corporation, and Natural Resources Canada.

Photo captions:

Researcher adjusts rollshutter
Close-up of rollshutter
View from inside house with rollshutter