NRC·CNRC
Institute for Research in Construction

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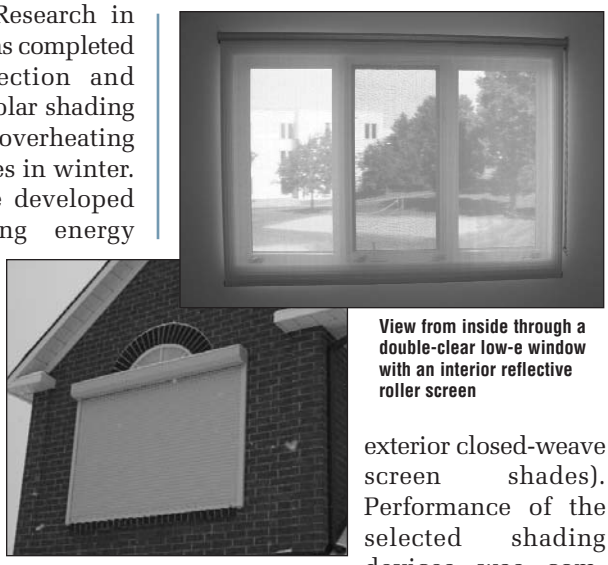
construction innovation

Guidelines for solar shading of residential windows completed

The NRC Institute for Research in Construction (NRC-IRC) has completed guidelines for the selection and operation of residential solar shading devices that can reduce overheating in summer and heat losses in winter.

The guidelines were developed using a whole-building energy computer simulation and field energy performance data for the selected shading devices. The computer simulation model was successfully validated using experimental data from field measurements in the twin houses at the Canadian Centre for Housing Technology (CCHT) in Ottawa. Energy performance of each window and shading combination was calculated for Winnipeg, Ottawa, Montreal and Halifax.



View from inside through a double-clear low-e window with an interior reflective roller screen

Exterior rollshutter

The CCHT test house, with extensive windows on the south and north facades, was used to test various combinations of window types (windows typical of older housing and high-performance windows for current and future housing) and shading devices (typical interior blinds, interior highly reflective metallic blinds, interior highly reflective closed-weave screen shades, between-pane highly reflective metallic blinds, exterior insulating rollshutters, and exterior closed-weave screen shades). Performance of the selected shading devices was compared to the performance of typical interior blinds commonly used in houses.

The guidelines address: thermal peak loads and energy use for old, current and future low or net-zero energy Canadian houses; energy costs and payback periods; thermal and visual comfort conditions near windows; potential risk of moisture condensation on the interior surfaces of windows; and thermal stresses of window glazing.

Key elements of the guidelines are as follows:

- Windows with high solar heat gains and low insulating properties were found to provide higher annual total energy savings for all types of houses in cold climates (see *Construction Innovation*, December 2007).
- Windows with typical interior blinds can reduce the house cooling energy use and the on-peak cooling power demand by up to 12% compared to un-shaded windows.

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Highlights

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Canada

New residential care classification created in building and fire codes

The Canadian Commission on Building and Fire Codes (CCBFC) has approved a series of technical changes related to residential care occupancies for inclusion in the 2010 National Model Construction Codes. It includes a proposal to create a new classification, Group B Division 3 Major Occupancy (B3), for care facilities where persons receive special or supervisory care because of cognitive or physical limitations. The new B3 occupancies will include, but are not limited to: retirement homes, certain group homes, supportive housing, children's custodial homes, convalescent homes and residential care facilities.

Residents of these care facilities may be adults or children and may receive care under a variety of different approaches. These range from a high-support setting in which residents with multiple disabilities receive 24-hour supervisory care, to a low-support setting in which adult residents receive less care.

Though these premises generally require more fire and structural safety features than those found in residential occupancies (i.e., Group C Major Occupancy), they do not generally require the extensive fire and structural safety features found in institutional uses such as hospitals (i.e., Group B, Division 2). Currently, owners of residential care facilities are often burdened with the capital cost of meeting the higher B2 requirements, without a corresponding benefit to their clients or occupants.

This new series of technical changes to the National Building and Fire Codes establishes requirements that are more stringent than those applied to residential uses, but less stringent that those currently applied to care and detention uses.

The approved technical changes can be summarized as follows:

- Establishment of a new Major Occupancy classification, Group B Division 3 (B3), for situations where residents require services because of cognitive, physical or behavioural limitations. This new classification will not apply in cases where care services are provided by residents of dwelling units or suites, or where services are arranged directly by residents of dwelling units or suites with outside agencies.
- Permission to construct B3 occupancies up to three stories in building height having a limited occupancy using either combustible or non-combustible construction under Part 3 of the National Building Code.
- Elimination of the current fire resistance rating requirements for mezzanine floors in smaller one-storey (< 600 m^2) B3 occupancies.
- Relaxation of sprinkler requirements that allows the use of systems designed according to the National Fire Protection Association's NFPA 13R "Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height." This would be in lieu of NFPA 13 "Installation of Sprinklers," provided that the building is three stories or less.
- Permission to use smoke alarms in lieu of smoke detectors within sleeping rooms and suites of residential care.
- Reduction in the width of corridors serving residential care occupancies from the current 1650 mm to 1100 mm where the occupant load does not exceed ten persons.
- Establishment of a clear doorway width of 850 mm for all residential care occupancies.

These changes have received general support by regulators, designers and facility management groups, and should improve the cost-effectiveness of construction. For more information, contact Philip Rizcallah at 613-993-4064 or philip.rizcallah@nrc-cnrc.gc.ca.

2009 Housing Report available

NRC-IRC is pleased to announce the availability of the following report at:
www.nrc-cnrc.gc.ca/obj/irc/doc/pubs/nrcc53227.pdf

A Summary of NRC-IRC Housing Activities for 2009: A Report Prepared for the Canadian Home Builders' Association, February 2010

The report, produced annually for builders, presents highlights of NRC-IRC research projects, summarizes key technical issues related to the National Construction Codes, and addresses the evaluation of innovative construction products. Research conducted at the Canadian Centre for Housing Technology is also featured.

Updating the National Energy Code for Buildings

This spring, the Canadian Commission on Building and Fire Codes (CCBFC) decided on the direction to be taken in updating the 1997 National Energy Code for Buildings (NECB). Presented with several policy papers related to this task at its February 2010 meeting, the Commission requested that the information be made available to interested stakeholders for comment prior to it being voted on and ratified.

One of the papers reviewed by the CCBFC outlined the principles being used to update technical requirements in the NECB. The principles touched on various aspects, including energy performance, cost impact methodologies, energy source differentiation, different assembly constructions and different occupancies. According to these principles:

- The CCBFC would agree to recognize the energy performance goal set by the July 2008 statement of the Council of the Federation (an intergovernmental body made up of Canada's premiers) that the 2011 NECB be 25% better than the 1997 NECB.
- The CCBFC would agree that the costing methodology used in the background cost-benefit analysis supporting the technical changes be a simple payback approach. The technical requirements are being developed with the expectation that the payback for the proposed building component enhancements (to the building envelope, lighting systems, HVAC, etc.) will vary in accordance with their anticipated service life.
- The CCBFC would also agree that the NECB not differentiate requirements based on energy source, which varies between the provinces and territories (along with production characteristics), but rather address the overall energy used by the building irrespective of energy source.
- For assembly constructions, the CCBFC would agree that it would be beneficial to let the market drive design, taking into account the energy efficiency provisions set by the Code, because certain industry areas would have more difficulty meeting prescribed performance levels.
- Lastly, the Commission would agree that the NECB would not set different levels of thermal performance for a building envelope based on occupancy, since advances in construction materials and techniques have made it possible to achieve similar energy performance levels.

An interim report on proposed objectives and functional statements for the NECB, produced in collaboration with the provinces and territories, was also presented at the February meeting. The functional statements were then approved by the CCBFC, but more work remained to be done on the objectives, including important steps of the official protocol for adding a new objective to the core codes. The proposed objectives and functional statements for the NECB (scheduled to be published in 2011) as well as its technical content are expected to be finalized in June 2010. They will be submitted for broad public review in fall 2010.

For more information, contact Cathy Taraschuk at 613-993-0049 or cathleen.taraschuk@nrc-cnrc.gc.ca.

2010 National Model Construction Codes coming soon

New editions of the National Building Code, National Fire Code, and National Plumbing Code are scheduled for publication in November 2010. These latest editions will contain more than 800 technical changes that make the codes clearer and easier to apply. To learn more about important technical changes in these new editions, visit the National Model Construction Codes Web site at **www.nationalcodes.ca**.

Further information on the 2010 Codes, and how to purchase them, will be published in the September issue of *Construction Innovation*. Stay tuned!

Building Science Insight

NRC Institute for Research in Construction will not be offering its Building Science Insight (BSI) seminar series in 2010-11. Planning is underway, however, for a renewal of the series for 2011-12. The seminar team is taking this opportunity to consider a range of possible topics, to recommend and develop suitable publications and electronic media, and to identify speakers and collaborators. At the same time, the team will take stock of technical concerns in construction to ensure that seminar content dovetails with industry needs.

As always, the goal of BSI will be to deliver high-quality presentations that offer practical guidance to industry practitioners and encourage audience participation. For information on past BSI seminars, please visit **www.bsi.gc.ca**.

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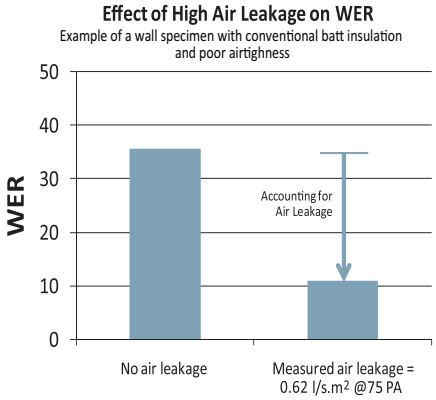
Building envelope and structure

Energy rating of insulated wall assemblies

Air leakage rates and thermal resistance values are important factors in the development of an energy code for buildings. Air leakage has a negative impact on the overall performance and durability of the building envelope. So how does the thermal performance of a wall system vary with the permitted air leakage?

It is difficult to incorporate the effect of air leakage through the envelope on the overall thermal performance of the wall systems into building codes and related standards. There is a standard available for a window energy rating (CSA Standard A-440.2) but there is no similar standard for wall systems.

Researchers at the NRC Institute for Research in Construction (NRC-IRC) have developed a simple tool for determining the Wall Energy Rating (WER) of walls constructed according to field practices. In order to arrive at the WER number, two standard tests were performed on ten full-scale wall specimens: thermal resistance tests in the Guarded Hot Box (GHB) at zero air leakage and air leakage tests according to the NRC Canadian Construction Materials Centre Air Barrier Technical Guide 07272.



Effect of air leakage on the WER number for an air leaky wall and an airtight wall with different thermal insulations and airtightness strategies. The better the airtightness strategy and R-value of the wall system, the higher the resulting WER number.

Walls with cavities filled with glass fibre insulation and a polyethylene-based air barrier were tested and used as reference walls. Then open cell and closed cell spray polyurethane foam insulations applied with old and new blowing agents were used. The polyurethane was sprayed in the cavity while other leakage paths in the wood-frame assembly were identified and sealed. The resulting WER tool accounts for simultaneous thermal conduction and air leakage heat losses through a full-scale wall system.

A 3D numerical representation of the wall specimens was then developed to combine the results of these tests to obtain an accurate prediction of thermal resistance (apparent R-value) under the influence of air leakage. The numerical simulations were conducted using the NRC-IRC hygrothermal model.

A new project utilizing 3D simulations for additional walls is being considered. Research will be conducted to refine the WER procedure through collaboration and partnerships with stakeholders. The WER procedure will eventually be proposed as an alternative compliance tool for future energy codes. The next step is to propose the development of national and international standards for that purpose.

For more information on the current studies and to discuss collaboration and partnering opportunities, contact Mike Swinton at 613-993-9708 or mike.swinton@nrc-cnrc.gc.ca.

Managing rainwater – an update on flanged window installation

Watertightness of the window opening is a crucial element in ensuring the life of a building assembly. Inadequate detailing practices and improper installation of windows have led to numerous premature building envelope failures. There are a number of different approaches to window installation with various types and related components. But which methods are best to ensure watertightness? Which installation features are most likely to ensure optimal long-term performance?

The NRC Institute for Research in Construction (NRC-IRC) assessed the robustness of specified window installations by considering what occurs when jointing products fail, windows leak, or the assembly has reduced airtightness (see *Construction Innovation*, June 2006).

To represent residential window installation practice, laboratory testing was conducted on wall-window interface details incorporating "vinyl" windows with mounting flanges and variations in approaches to their installation. The wall-window assemblies were subjected to watertightness performance tests that mimic significant wind-driven rain loads. These test loads match those of significant rainfall events of 5, 15 or 30 minutes duration that might occur every 10 to 30 years. Results from these tests indicate that window installation details of the type described in this study are adequate to manage even the most significant rainfall events occurring in North America (see paper at **www.nrc-cnrc.gc.ca/obj/irc/doc/pubs/nrcc50033.pdf**). Window installation

Continued on page 5

NRC-IRC studies temperature sensors for fire-resistance tests

Passive fire protection is a growing industry in the built environment. Fire-rated building systems (walls, floors, beams and columns formed with new materials and designs) have been increasingly used in residential and non-residential buildings alike. To ensure adequate performance, building codes rely on standard tests carried out using full-scale furnaces to determine the fire-resistance ratings of these systems.

For years, the NRC Institute for Research in Construction (NRC-IRC) has been helping industry develop accurate, reliable testing procedures so that systems can be used with confidence by the construction industry and approved by regulatory authorities.

A key element in ensuring the reliability of fire-resistance tests is the availability of accurate temperature sensors. Why are these sensors important? Standards specify a time-temperature curve that furnaces need to follow. To do this, temperature is measured at nine locations in the furnace and the average temperature is used to control the amount of fuel supplied. If furnace temperature is higher than required, fuel is decreased. Conversely, if furnace temperature is lower, fuel is increased.

A key element in ensuring the reliability of fire-resistance tests is the availability of accurate temperature sensors.

Two types of sensors are commonly used in fire test standards: shielded thermocouples are stipulated in the Canadian and North American standards (CAN/ULC S101 and ASTM E119) while ISO 834 calls for plate thermometers. With a slow temperature response time (5 to 7 minutes), shielded thermocouples are less effective in tests of short duration. Plate thermometers, by contrast, respond faster to thermal changes within the furnace, especially in the first 10 minutes of the testing process when the temperature rises rapidly; however, they have a shorter life span than shielded thermocouples and must be replaced regularly.

Researchers at NRC-IRC recently completed a study evaluating the performance of six different temperature sensors, including shielded thermocouples and plate thermometers. Researchers carried out experiments in NRC-IRC's full-scale wall and floor furnaces, which enabled accurate, tightly controlled conditions. Results showed that during the initial period of fire exposure (first 10 minutes) the difference in temperature measured by the six sensors was significant. However, after 10 minutes, the difference was insignificant.

This research will assist standards organizations in harmonizing the standards, which would help manufacturers minimize the number of tests they need to conduct to market their systems internationally. For further information, contact Dr. Mohamed Sultan at 613-993-9771 or mohamed.sultan@nrc-cnrc.gc.ca.

Managing rainwater – an update on flanged window installation

Continued from page 4

designs that do not permit drainage from the sill are vulnerable to excessive water retention when exposed to the higher simulated loads.

Critical elements for achieving functional window installation details included:

- Sill pan flashing (with watertight corners);
- Integral back dam;
- Openings along the interface between the sill and the bottom window flange to permit water drainage; and
- Continuity of the air barrier system at the interface with the window frame and window opening. This means locating the interface joint towards the interior of the window frame, thus ensuring it is well away from wetted surfaces.

A follow-up project (**www.nrc-cnrc.gc.ca/eng/projects/irc/condensation.html**) is underway to address other window installation issues including hygrothermal effects (the movement of water vapour that occurs as a result of temperature and humidity difference across the assembly).

For more information, contact Dr. Michael Lacasse at 613-993-9715 or michael.lacasse@nrc-cnrc.gc.ca.

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Canada

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Sustainable municipal infrastructure – the search for innovative solutions

Finding innovative solutions to municipal infrastructure challenges is the goal of Communities of Tomorrow (CT), a Saskatchewan-based, public-private partnership that includes the NRC Centre for Sustainable Infrastructure Research (NRC-CSIR), NRC Industrial Research Assistance Program (NRC-IRAP), the City of Regina, the University of Regina, Enterprise Saskatchewan, and Western Economic and Diversification Canada. The community-based organization is focused on growing a sustainable infrastructure cluster by facilitating collaboration between firms and researchers to develop innovative solutions for the global market.

As part of its business strategy, CT is moving municipal engagement in cluster activities to a new level through creation of the Municipal Innovation Network (MIN). MIN provides a platform for municipalities and industries to contribute to the development of innovative infrastructure technology and practices.

The broad objectives and perceived benefits of the MIN are to:

- Identify and act on municipal needs and problems with a view to improving services and/or saving money;
- Engage municipal employees in innovative infrastructure practices;
- Harness the knowledge and creativity of the municipal infrastructure work force;
- Develop a network of infrastructure practitioners to facilitate communication, collaboration and transfer of knowledge among municipalities; and
- Encourage municipalities to collaborate with researchers and industry on R&D projects and to serve as *living labs*.

Working with researchers and/or industries, a *living lab* municipality acts as a test bed for emerging technologies and solutions by permitting its infrastructure to be used for real-life monitoring and trials. Its staff contributes their experience and understanding of infrastructure practices and issues and shares its knowledge, expertise, data and operating experience to guide others in the testing and evaluation of new technology.

A key element of the CT business strategy is a series of facilitated workshops for municipal employees that foster innovative thinking and practices in their workplace. The first series, held in eight Saskatchewan cities, provided a forum to identify infrastructure problems and to explore opportunities to participate in the search for innovative solutions.

Identified during these workshops were the needs and opportunities for development of new technologies and practices. One example was the need for better ways to repair or replace potable water service connections. Conventional practice is costly and disruptive to both public infrastructure and private property. CT has established an innovation team composed of municipal practitioners and technical

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Guidelines for solar shading of residential windows completed

Continued from cover

- Exterior insulating rollshutters and exterior close-weave screens were found to be the most effective shading devices for reducing house heating and cooling energy use, on-peak cooling power demand, risk of moisture condensation on the interior surfaces of windows, and thermal discomfort conditions near windows. On the other hand, they have long payback periods.
- Exterior rollshutters can reduce the annual heating energy use by 7%, the cooling energy use by more than 40%, and the on-peak cooling power demand by 30% for older houses with conventional double clear windows.
- Interior reflective, close-weave screens can reduce annual cooling energy use and cost by up to 25% and on-peak cooling power demand by 13%, without negatively affecting heating energy use. Thermal glass breakage due to high temperature is not a risk if the air space between the shades and the window is well ventilated, but there is a risk of moisture condensation on the interior surfaces of windows.
- Interior reflective metallic blinds can reduce house cooling energy use by up to 15%, and the on-peak cooling power demand by 7% on average, but they are not cost-effective in energy terms.

These guidelines will help homeowners and builders select energy-efficient and cost-effective shading and window systems for renovations of older houses, or for building new, low-energy houses. For more information, contact Aziz Laouadi at 613-990-6868 or aziz.laouadi@nrc-cnrc.gc.ca or view the full guideline report at **www.nrc-cnrc.gc.ca/obj/irc/doc/pubs/rr/rr300.pdf**.

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Upcoming events

JULY

5-7
Interflam 2010, 12th International Conference on Fire Science & Engineering, Nottingham, England. http://www.intercomm.dial.pipex.com/html/events/interflam10cfp.htm

15-17
MS 2010, 21st IASTED International Conference on Modeling and Simulation, Banff. http://www.iasted.org/conferences/home-696.html

AUGUST

3-6
8th International Conference on Short and Medium Span Bridges 2010, Niagara Falls. http://www.csce.ca/2010/smsb/

28-31
ASCE Pipeline Conference 2010, Keystone, Colorado. http://content.asce.org/conferences/pipelines2010/call.html

SEPTEMBER

13-15
1st Central European Symposium on Building Physics, Cracow, Poland. http://www.cesbp2010.p.lodz.pl/

22-24
2nd Historic Mortars Conference, Prague, Czech Republic. http://www.itam.cas.cz/HMC2010

OCTOBER

10-13
2010 IEEE International Conference on Systems, Man, and Cybernetics, Istanbul, Turkey. http://www.smc2010.org/

JUNE 2011

21-26
International Structural Engineering and Construction Conference (ISEC-6), Zurich, Switzerland. http://www.isec-society.org/ISEC_06/index.htm

JULY 2011

3-8
2011 ICCC – XIII International Conference on the Chemistry of Cement, Madrid, Spain. http://www.icccmadrid2011.org/

Sustainable municipal infrastructure

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experts to explore, design, and test new methods, materials and equipment that will reduce cost and inconvenience.

Several municipalities will participate in the project as living labs. This venture will serve as a model for building collaborations among municipalities, industry and researchers based on proactive problem solving through innovation and design. CT will use the outcomes from these sessions to select and prioritize innovation projects.

As its contribution, NRC-CSIR provides access to specialized laboratory equipment and expertise for researchers, students and professionals from firms, universities, government agencies and international institutions. The NRC Regina research team has established expertise in technologies and solutions with a focus on water infrastructure around three themes: evaluation and condition assessment, decision support systems, and water quality and security. Its presence in Regina is helping to improve the expertise of western businesses active in the fields of public and municipal infrastructure.

For more information, visit the website **www.communitiesoftomorrow.ca** or contact Bland Brown at bland.brown@nrc-cnrc.gc.ca.

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