NRC·CNRC
Institute for Research in Construction

Volume 12 Number 3 **September 2007**

construction innovation

Strengthening the foundation of the construction industry over 60 years

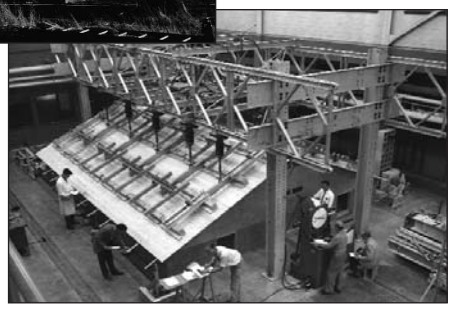
While NRC is celebrating 90 years of achievement, collaboration and contributions to Canada in 2007, NRC-IRC is commemorating its own anniversary.

Welcoming its anniversary with a renewed vision, NRC has a new corporate strategy, *Science at Work for Canada*, which is taking an industry-centred approach to encouraging economic growth and improving the lives of Canadians. Construction has been identified as one of nine key sectors in which NRC will contribute to national priorities such as health and wellness, sustainable energy and the environment.

Construction has in fact been a focus for NRC since 1947, when Robert F. Legget laid the foundation for a research agency dedicated to serving the construction industry. As the first director of the NRC Division of Building Research (DBR)—renamed the NRC Institute for Research in Construction (NRC-IRC) in 1986—Dr. Legget took on two additional roles for his team: providing technical support to the then Central (now Canada) Mortgage and Housing Corporation (CMHC) and perhaps most important, coordinating the development of the National Building Code (NBC), first published in 1941.

The post-war housing boom saw residential building on a grand scale, challenging the construction industry to build a large quantity of high-quality houses within a short time frame. DBR responded by carrying out research on wood-frame materials, construction practices and structural issues. Of particular note was the full-scale testing of roof trusses. This work resulted in major revisions to wind and snow design loads, which in turn resulted in trusses that were safer and made with smaller members. Great strides were also made in dealing with heat, air and moisture problems associated with the Canadian climate, particularly with regard to the increasing use of insulation and vapour and air barriers, and the introduction of the rainscreen principle. Key research results were incorporated into the NBC, which began to bring consistency to building regulation across the country.

Buildings slated for demolition in preparation for the construction of the St. Lawrence Seaway provided a unique opportunity for fire researchers.



Full-scale testing of roof trusses led to trusses that were safer and made with smaller members.

Early in its tenure, the Division established significant expertise in geotechnical research, studying a wide range of problems concerning soils, muskeg, snow and ice, and permafrost. Researchers provided assistance in the construction of the Trans-Canada Highway through the avalanche-prone Rogers Pass, BC, developing avalanche-control methods used to this day. Years of study in the North concluded with new engineering guidelines and the publication of a permafrost distribution map in 1967, enabling the construction of entire communities.

Continued on page 7

Highlights

Read *Construction Innovation* on the Web at **http://irc.nrc-cnrc.gc.ca/ci**

National Research Council Canada
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Have your say in the national construction codes

The Canadian Commission on Building and Fire Codes (CCBFC) invites all Canadians to take part in the public review of proposed changes to the national construction codes this fall. The public review is one of the main steps in the process for developing national code documents. This review will include changes proposed for the 2010 version of the codes and proposals for the updating of the tables of referenced standards from the 2005 codes.

The public review will run from September 24, 2007 until November 23, 2007, using the national codes Web site **www.nationalcodes.ca** as in previous public reviews.

Public review for proposed technical changes

The following are a few of approximately 150 proposed technical changes to the 2005 national model code documents—National Building Code (NBC), National Fire Code (NFC) and the National Plumbing Code (NPC):

- revisions to requirements for fire alarms, smoke alarms, fire detectors, smoke detectors and sprinkler systems
- addition of requirements for fire stopping and fire blocks within Part 3 and Part 9 buildings
- addition of requirements for fire safety at demolition and construction sites
- new referenced standards for preservative treatment of wood and calcium silicate (sand-lime) brick
- decrease in minimum dimensions for attic access hatches
- deletion of requirements related to asbestos-cement cladding and ducting in or beneath slabs on ground
- addition of curbs as an option to sloping of garage floors
- additions and revisions for steel-frame wall assemblies in Table A-9.10.3.1.A, Fire and Sound Resistance of Walls
- addition of requirements to permit the use of PE/AL/PE composite pipe material in hot water delivery systems.

Public review of updated tables of referenced documents

The CCBFC's standing committees have reviewed the documents included in the tables of referenced documents in the 2005 codes and are recommending that the tables be updated to reflect more current versions of the documents. The purpose of this public review is to confirm the public's concurrence with the updating of the tables of referenced documents, and to receive comments from those who might object to such updating.

Periodic updating of referenced documents in the codes has been a normal practice in the past but this work was previously done by the standing committees without giving the public an opportunity to express their views. The public review of the tables of referenced documents is an example of the CCBFC's ongoing efforts to maintain an open and transparent process for the updating of the codes.

You are invited to participate in this public review and to submit your comments by visiting the national codes Web site at **www.nationalcodes.ca**.

For more information on the CCBFC and on the national code development process, please visit http://www.nationalcodes.ca/ccbfc/index_e.shtml, or contact the Secretary to the Canadian Commission on Building and Fire Codes at (613) 993-5569, fax (613) 952-4040, or e-mail codes@nrc-cnrc.gc.ca.

New Evaluation Reports

Company	Product Name	CCMC #	Description
EMCO Building Products Corp.	Gripgard	13273-R	"Gripgard" is a self-adhered, modified bituminous membrane reinforced with a glass-fibre mesh. "Gripgard" may be used as an eave protection material under shingle, shake or tile roofs. It may also be used at hips, ridges, valleys, and at roof system penetrations.
Brite Manufacturing Inc.	Brite Composite Decking (Hollowcore)	13279-R	"Brite Composite Decking (Hollowcore)" comprises hollow core planks made from a cellulosic/polymer composite extrusion derived from fibreboard and polyethylene. "Brite Composite Decking (Hollowcore)" is used as exterior decking installed over traditional structural wood framing.
Cullen Building Products Inc.	Cullen Joist Hangers (FFI, TFI, LI and HI)	13281-R	"Cullen Joist Hangers (FFI, TFI, LI and HI)" are metal joist hangers with fasteners used to transfer loads from lumber, wood trusses, glued-laminated timber, prefabricated wood I-joists or structural composite lumber to supporting members.

For further information on the performance, usage and limitations of these products, as well as for other reports and listings by CCMC, see the Web Registry of Product Evaluations located at **http://irc.nrc-cnrc.gc.ca/ccmc/regprodeval_e.shtml**.

Canada's Model National Energy Code for Buildings to be updated

Natural Resources Canada Minister Gary Lunn announced on June 20 that his department would be contributing resources and expertise to the National Research Council to update the 1997 Model National Energy Code for Buildings (MNECB). NRC and NRCan will work with the provinces and territories to support the updating of the MNECB, under the leadership of the Canadian Commission on Building and Fire Codes (CCBFC).

The next edition of the MNECB is scheduled to be released in 2011, shortly after the publication of the next edition of the National Building Code of Canada in November 2010. For the first time, the MNECB will be published in an objective-based format, which will offer new information to facilitate the evaluation of innovative products and systems.

Interested in contributing to the updating of Canada's Model National Energy Code for Buildings?

A new standing committee is being created by the CCBFC to carry out the work needed to update the technical provisions of the 1997 MNECB. Members of the standing committee will be selected from the applications received this summer and will start their work this fall.

There is always a need for technical expertise to assist the standing committee, particularly when special task groups are formed. If you are interested in participating in this important national code development work, please send an expression of interest, along with a recent curriculum vitae, to the Secretary of the CCBFC Nomination Committee at:

Secretary to the CCBFC Nomination Committee
Canadian Commission on Building and Fire Codes
Canadian Codes Centre,
Building M-23A
National Research Council Canada
1200 Montreal Road,
Ottawa, Ontario K1A 0R6
Fax: 613-952-4040
E-mail :
nomination-irc@nrc-cnrc.gc.ca

If you are not available but know of someone, who in your judgement would make a good contributor, please invite that person to submit an expression of interest. NRC-IRC will reimburse travel and accommodation expenses for the committee and task group members.

For more information on the CCBFC's standing committees, please go to: http://www.nationalcodes.ca/ccbfc/committee_e.shtml.

NEW! CSA Standards Compilation CD-ROM—standards referenced in the National Building Code of Canada 2005

The Canadian Standards Association (CSA) is Canada's leading developer of standards and related publications in the field of construction. CSA has published over 300 construction-related standards, which serve the needs of residential, commercial, institutional, industrial and civil infrastructure sectors.

Over 80 CSA standards related to construction materials and various systems, including electrical, fire and HVAC systems, are referenced in the National Building Code of Canada 2005 (NBC). The new CSA Standards Compilation includes all these standards in a convenient CD-ROM format at significant savings.

Highlights:

- Convenient and easy access to the complete collection of CSA standards referenced in the NBC.
- The Standards Index lists all the CSA standards in numerical order and indicates whether the standard has been withdrawn or updated since the publication of the NBC.
- A listing of all the NBC provisions that reference each individual CSA standard is provided for quick reference.
- The easy-to-use PDF format allows the user to search within each standard for a specific term or phrase in addition to being able to copy, paste and print clauses.
- To purchase each of the CSA standards individually would cost over $7,000. The new CSA Standards Compilation CD-ROM gives you the complete collection of CSA standards referenced in the NBC at a special package cost of only $1,495.

To obtain further information, visit www.csa.ca.

Please note that the CSA Standards Compilation CD-ROM **does not include the provisions** of the NBC. To purchase the printed or CD-ROM versions of the NBC, please visit NRC's Virtual Store at www.nrc.gc.ca/virtualstore.

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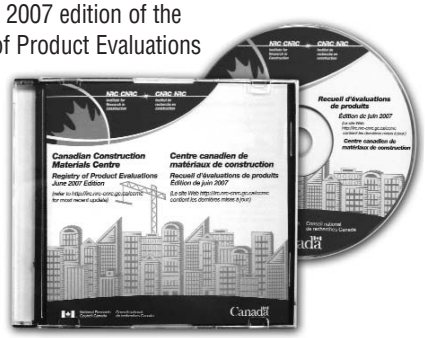
2007 edition of Registry of Product Evaluations now available!

CCMC is pleased to announce the release of the 2007 edition of the Registry of Product Evaluations. The Registry of Product Evaluations contains evaluation reports and listings for over 500 products evaluated by CCMC. The documents can easily be found according to MasterFormat number, manufacturer's name, product name, or report or listing number.

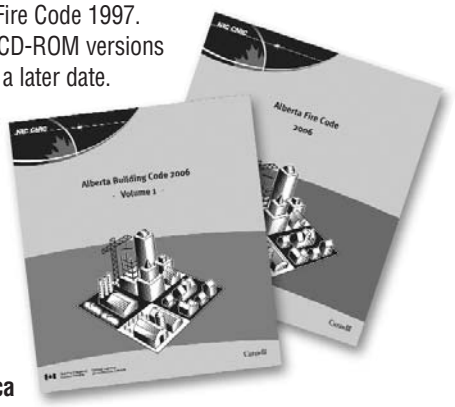


The Registry of Product Evaluations is available free of charge on CD-ROM. The official version of CCMC's Registry of Product Evaluations, which is updated quarterly, can also be viewed free of charge on the Web at **http://irc.nrc-cnrc.gc.ca/ccmc**.

To order the 2007 edition of the Registry of Product Evaluations, please visit the NRC's Virtual Store at **www.nrc.gc.ca/virtualstore** or contact NRC-IRC's Publication Sales Department at 1-800-672-7990.

New Alberta Building, Fire and Plumbing Codes adopted!

Alberta Municipal Affairs and Housing has announced that the *Alberta Building Code 2006* and the *Alberta Fire Code 2006* have taken effect, as of September 2, 2007. The new codes, which are based on the 2005 editions of the National Building and Fire Codes, replace the Alberta Building Code 1997 and the Alberta Fire Code 1997. Both codes are available in printed formats. CD-ROM versions of the codes are scheduled to be released at a later date.



Where to get copies

Printed copies of the 2006 Alberta Building and Fire Codes can be ordered from:

Learning Resources Centre
12360-142 Street North West
Edmonton, Alberta T5L 4X9
Tel: (780) 427-2767
Fax: (780) 422-9750
Online: **http://www.lrc.education.gov.ab.ca**

Alberta Building Code 2006 – Order No. 683161
Alberta Fire Code 2006 – Order No. 683179

Alberta Municipal Affairs and Housing has also announced that the *National Plumbing Code of Canada 2005* has taken effect, as of September 2, 2007. The *2005 National Plumbing Code* can be ordered from:

National Research Council Canada
Tel.: 613-993-2463 or 1-800-672-7990
Fax: 613-952-7673
Online: **www.nrc.gc.ca/virtualstore**

OR

Learning Resources Centre (noted above)

Newsbrief

New code provisions to avoid scalding in bathtubs and showers

The Canadian Commission on Building and Fire Codes (CCBFC) has approved new code provisions that require hot water delivery to bathtubs and shower fixtures at a temperature of not more than 49°C. A new provision now requires that the thermostat controls for electric hot water heaters be set to 60°C. This provision does not apply to oil or gas fired hot water heaters, as these heating systems are not subject to stratification of the water in the hot water tank. It has been demonstrated that such water stratification in hot water tanks could lead to the growth of legionella bacteria.

The CCBFC decision follows the recommendations of its Standing Committee on Building and Plumbing Services (SCBPS), which determined, following public review, that this change will:

- reduce the risk of scalding injuries at the location of the most frequent incidences
- reduce the risks of legionella bacteria growth in electric hot water heaters.

The Standing Committee on Housing and Small Buildings supports the change. These technical revisions will be published as Interim Changes to the 2005 National Building and Plumbing Codes (NBC and NPC) in the First Series of Revisions and Errata this fall.

In Canada, most of the severe tap water scald injuries occur in the bathtub and these tend to be extensive body scalds due to full immersion. Groups particularly at risk for scald burns include children, seniors, people with disabilities, and people with health conditions that cause reduced skin sensitivity. The 2005 NPC already requires that valves supplying showerheads be designed such that the outlet temperature does not exceed 49°C. With these new provisions, the 49°C water temperature limit will now apply to bathtubs as well.

The standing committee felt that with the information at hand it could justify the cost benefits of adding these requirements to the NPC to manage the risk of scalding and legionella effectively without adding undue costs to new construction.

In keeping with the spirit of performance requirements, the method of complying with this new provision is not explicitly prescribed in the new requirement; rather it is left up to the designer to determine which of the various methods of design and installation will be used to comply with this temperature limit.

Other proposed changes related to water temperature, namely the maximum temperature of water supplied to lavatories and the maintenance of temperature in re-circulating systems, have been withdrawn from the SCBPS's recommendation based on comments received from public review of the proposed changes.

For further information about these Interim Changes, please contact Raman Chauhan at 613-993-9633, fax 613-952-4040, or e-mail codes@nrc-cnrc.gc.ca.

CONSTRUCTION CODES ORDER FORM

NRC·CNRC Construction

To Order Construction Codes

By Internet: www.nrc.gc.ca/virtualstore ***By fax***: 1-613-952-7673

By mail: Publication Sales, M-20, National Research Council of Canada, Institute for Research in Construction, Ottawa, Ontario, Canada K1A 0R6

For more information, please call 1-800-672-7990 or 1-613-993-2463 (Ottawa-Gatineau and U.S.)

Discounts: Package Deals (2)

- $60 discount on minimum order of 3 different 2005 National Codes (same printed format)
- Bulk orders: 10% discount on minimum order of 10 copies of same printed document
- Bookstores: 25% discount on minimum order of 10 printed documents

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new **National Fire Code 2005**	$140		$130		$250*		$1,000		$1,500	
new **National Plumbing Code 2005**	$120		$110		$180*		$720		$1,080	
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Alberta Building Code 1997 on CD	n/a**		n/a**		$149		$596		$894	
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CI REVISED SEPTEMBER 2007

Fire Safety Research for Better Building Design: *Building Science Insight 2007*

www.bsi.gc.ca

Every year, NRC-IRC presents a national seminar to provide construction professionals with practical information. Each seminar focuses on a single topic and reports the results of recent NRC-IRC research. In 2007 the seminar will focus on fire safety in buildings.

Over the last decade, there have been significant advances in fire engineering and the understanding of human behaviour, which can contribute to better and safer buildings. BSI 2007 will summarize some of these advances for the benefit of those engaged in the design and construction of new and existing buildings, the management and operation of facilities, and the application of building and fire codes. Please note that this seminar will not deal with code compliance issues.

The seminar will address several topics:

Design Fires

Designing buildings to minimize the impact of fires requires the use of computational design tools, which are based on design fires, a quantitative description of the characteristics of a fire. This session will present some results from research aimed at developing design fires that can be used to evaluate the likely impact of fires on life safety, fire-safety systems and building elements. The presentations will also provide information on the types, quantities and burning characteristics of combustibles typically found in commercial buildings, which is required in order to develop suitable design fires.

Smoke Management and Control

Combustion products, including smoke and carbon monoxide, can have major effects on the life safety of occupants. This presentation will examine our understanding of the dynamics of smoke movement in the built environment. It will also report on recent research on issues arising from various technologies and approaches to smoke management, and on the interaction between smoke-control and sprinkler systems.

Fire Alarms, Occupant Response and Evacuation

Improving our understanding of the likely behaviour of occupants during an emergency is a key component of reducing fire risk. NRC-IRC researchers will discuss occupant behaviour in fire and how this information can be integrated into a building's design and operation. They will also discuss some typical occupant responses in fires and how these could be incorporated into strategies for ensuring the safety of occupants during fire emergencies as well as into the development of building emergency action plans.

Fire-Suppression Systems

The use of halon as a fire-suppression agent is being discontinued because it has been found to contribute to the depletion of ozone in the atmosphere. However, newly developed replacement fire-suppression systems are available, including halocarbon and inert gaseous agents, water-mist systems, compressed-air-foam systems, and gas generators (solid propellants that convert to inert gases for fire-suppression purposes). All of these systems perform well in terms of extinguishing fires, but no one system is best for all applications. This presentation will provide brief descriptions of these fire-suppression systems, provide technical information on the performance of each, and describe limitations or concerns related to their use.

Case Studies

Two case studies will be presented: one on the use of photoluminescent material for emergency evacuation, and another on the use of sprinkler-protected window systems.

Speakers

The roster of speakers includes NRC-IRC fire researchers Noureddine Bénichou, Alex Bwalya, Andrew Kim, Gary Lougheed, Guylène Proulx and Russ Thomas, and building science generalist Luc Saint-Martin.

This one-day seminar will be held in the follow locations:

English Seminars

- ***Whitehorse, Oct. 2, 2007***
- ***Vancouver, Oct. 4, 2007***
- ***Yellowknife, Oct. 30, 2007***
- ***Edmonton, Nov. 1, 2007***
- ***Iqaluit, Nov. 14, 2007***
- ***Winnipeg, Nov. 28, 2007***
- ***Regina, Nov. 30, 2007***
- ***St. John's, Dec. 11, 2007***
- ***Halifax, Dec. 13, 2007***
- ***Fredericton, Jan. 15, 2008****
- ***Ottawa, Jan. 24, 2008****
- ***Calgary, Feb. 5, 2008***
- ***Toronto, Feb. 7, 2008***

French Seminars

- ***Quebec City, Feb. 19, 2008***
- ***Montreal, Feb. 21, 2008****

***** With simultaneous translation

The cost of the seminar is $349 plus tax. Please visit the Web site at **http://bsi.gc.ca** for more details and registration information.

Strengthening the foundation of the construction industry over 60 years

Continued from cover page

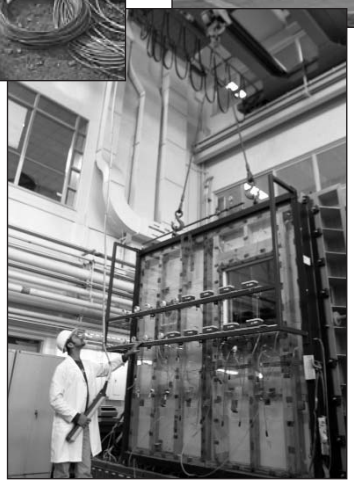
Fire research became a focal point owing to the huge toll in lives and property damage from building fires. When buildings slated for demolition during the St. Lawrence Seaway construction were made available for experimental fires, extensive full-scale burns produced valuable information related to spatial separation of buildings. Tables were developed for inclusion in the NBC and subsequently other countries drew on these results for their fire protection regulations and practices. The following decade saw the first National Fire Code published (in 1963).

Energy conservation was front-page news during the oil crisis of 1973, and DBR garnered attention with advances in technology that reduced energy use in buildings and improved airtightness, helping form the basis of NRCan's R-2000 program. Researchers also tackled smoke movement and fire control in tall buildings. Fire research took a leap forward in 1981 with the opening of a large laboratory complete with a smoke control tower.

The 80's also saw DBR create its first research consortium, working with the public and private sectors to study the costly problem of reinforcement corrosion in concrete parking garages. This successful effort was the forerunner to many subsequent consortium projects, involving extensive contributions by countless partners in industry and government in Canada, the United States, and indeed other countries.

In 1988, with many new construction products and services vying for market acceptance, NRC-IRC created the Canadian Construction Materials Centre (CCMC). In time, CCMC had a national presence and was working hand in hand with industry and the provinces and territories to evaluate innovative products in relation to building code requirements.

Measuring the magnitude of forces acting on water mains



Wall and window assemblies being prepared for water entry experiments on the NRC-IRC Dynamic Wall Test Facility

As the effects of aging infrastructure systems began to appear, NRC-IRC responded by establishing an Urban Infrastructure Rehabilitation research program in the early 90's. Over the past 15 years researchers have addressed numerous issues concerning pavement, buried utilities, and concrete bridges.

The 90's also saw the Institute expand its research on the indoor environment, especially its effects on the comfort, satisfaction and productivity of building occupants. The outcomes include a number of software packages addressing acoustics, lighting and materials emissions. Excellent new facilities for the study of flanking noise and heating and ventilation systems, along with a new initiative on mould, have further advanced NRC-IRC's capability in indoor environment research.

Then in 1997, the Canadian Centre for Housing Technology (CCHT) was created in partnership with CMHC and Natural Resources Canada. CCHT is spearheading the assessment of high-performance technologies in a whole-house setting.

Another new initiative, the Centre for Sustainable Infrastructure Research (CSIR) in Regina, was launched in 2004. CSIR teams with local partners

Twin research houses at the Canadian Centre for Housing Technology

to act as a catalyst for emerging technologies to maintain and develop civil infrastructure.

Working closely with provincial and territorial governments, municipalities and construction practitioners, the Canadian Codes Centre of NRC-IRC is keeping pace with the industry's ever-changing technologies and techniques. This teamwork saw the publication of the objective-based 2005 national construction codes, which give industry a better understanding of the underlying intent of the requirements, which in turn helps it develop alternatives to traditional products and designs.

NRC-IRC recently began exploring the use of nanotechnology in various construction applications, including new materials for buildings, roads and bridges, and fire prevention.

With numerous notable achievements in its first 60 years and with new initiatives in place, NRC-IRC, under the guidance of Director General Bob Bowen, is committed to a new era in service to the construction industry and Canada's economy. NRC-IRC will continue to work with other NRC institutes to improve the lives of Canadians through a vibrant construction sector that provides a high-quality and cost-effective built environment.

Researchers study role of lighting control systems in saving energy

As part of the drive toward sustainability, there is a need for buildings to be more energy efficient. Several research studies have suggested that electrical energy consumption can be substantially reduced by using automatic lighting control systems. The studies also indicate that personal dimming controls may contribute to reduced energy use while increasing occupant satisfaction.

Typical open-plan office used in this study

Project partners

Program on Energy Research and Development; Public Works and Government Services Canada; BC Hydro Power Smart; Ledalite Architectural Products.

However, the uptake of such technologies remains slow, partly due to the lack of information about the ability of controls to perform as claimed by manufacturers. In this context, NRC-IRC researchers monitored a commercial lighting system equipped with three different types of controls, with the goal of examining its long-term performance. They monitored this system for a year, determined the energy-saving contributions of each control, and examined the occupants' satisfaction with the lighting system and their work environment.

Overall, the results of the study showed that lighting systems incorporating both automatic and personal controls have the potential to realize considerable energy savings and peak power reductions in open-plan environments, while at the same time being positively perceived by the occupants.

The lighting system with its three control systems was installed on four floors of a typical open-plan office building. The luminaires used 1) integral occupancy sensors that gradually switched off the lights when they detected vacancy in the work space; 2) light sensors that gradually dimmed the lights when sufficient daylight was present; and 3) individual dimming controls accessed through sliding panels on occupants' computer screens.

Study findings

The lighting system with multiple controls used considerably less energy than a conventional, ceiling-recessed, parabolic louvered lighting system, achieving overall savings of 69% compared to the conventional system. Two-thirds of these savings were due to the lower power density (the electric power used for a given area) of the installed system, and one-third was attributable to the controls. Furthermore, the energy savings were directly related to concomitant reductions in the daily peak power demand for lighting. The daily average effective lighting power density was only 3 W/m^2, which represents an important benefit for electric utilities seeking to balance supply and demand on days of high demand.

The researchers also determined what the energy savings would have been if only one type of control had been installed. The data indicated, that if used on their own, the occupancy sensors would have saved about 35% compared to the lights used at full power, while the light sensors would have saved about 20%. Savings from the individual dimming controls alone were only about 10%, and their frequency of use averaged only 0.02 user actions per workstation per day. Nevertheless, the study confirmed that the ability of occupants to choose their preferred lighting level is an important benefit not offered by the other two types of control. Occupant surveys, conducted as part of the study, indicated that the lighting system with multiple controls was associated with an indoor environment of superior quality when compared to the conventional lighting system.

Additional information about this project can be found at http://irc.nrc-cnrc.gc.ca/ie/lighting/office/envirocontrolspubs_e.html.

Specific questions can be directed to Anca Galasiu at 613-993-9670, fax 613-954-3733, or e-mail anca.galasiu@nrc-cnrc.gc.ca.

Four architectural firms win RAIC awards for their innovative projects

Innovation is a word charged with promise, new ideas and steps forward. These connotations certainly play out in the Awards of Excellence for Innovation in Architecture from the Royal Architecture Institute of Canada (RAIC). As an active promoter of innovative ideas within the construction sector, NRC-IRC was pleased to host a meeting of the award selection committee and serve as a jury member for the 2007 awards. Four projects were selected by the jury in three categories: one in business, one in art, and two in science.

In the business category, a unique door, hardware and access control database designed for the Alberta Children's Hospital won distinction. Calgary-based Kasian Architecture Interior Design and Planning created a user-friendly database to bring together all door, hardware and related electrical information for the construction project in one convenient location. Credited with contributing to the completion of the hospital months ahead of schedule and millions under budget, the database transformed what was once considered a coordination nightmare into a simple and effective process.

The award for innovation in the art category went to Vancouver firm Hotson Bakker Boniface Haden Architects + Urbanistes for their work on the Nk'Mip Desert Cultural Centre in Osoyoos, British Columbia. Featuring the largest rammed earth wall in North America, the Centre explores the expressive potential of architecture to convey the rich past and transforming future of aboriginal culture. The Centre's reduced water use, all-natural ventilation and green roofs are also a sustainable response to the building's unique location—the unusual Canadian desert found south of the Okanagan Valley.

In the science category, Edmonton-based Manasc Isaac Architects Ltd. won an award for their work on the Greenstone Government of Canada Building in Yellowknife. The building features a unique photovoltaic system integrated within a pre-glazed exterior curtain wall. This system, imported from Europe and carefully tested in Canada, generates electricity in the glazing of the building's south-facing atrium, while providing the building with external shading. The resulting "city room" is reportedly warm, sunny and pleasant year-round, even in the extreme climate of the Canadian North.

The second award in the science category went to Levitt Goodman Architects of Toronto for their work on Leonard Avenue Modular Housing. The Leonard Avenue project added two storeys of pre-fabricated modular units to the roof of an existing residential building to provide housing for people living in shelters in record time. Existing tenants remained in the building throughout construction and now benefit from the additional outdoor space added in green roof installations.

For more information on RAIC's 2007 Awards of Excellence, go to http://www.raic.org/raic/honours_and_awards/awards/raic-2007recipients/index_e.htm or contact NRC-IRC's Guy Gosselin at (613) 990-0458, fax (613) 952-7673, or e-mail guy.gosselin@nrc-cnrc.gc.ca.

Newsbrief

Looking at alternative supplementary cementitious materials as an innovative way to achieve concrete sustainability

NRC-IRC researchers have initiated a new project involving alternative supplementary cementitious materials (ASCMs). They are conducting background studies and laboratory and field investigations aimed at developing new performance criteria to facilitate the use of ASCMs in concrete structures. The next step will be to develop a test program with screening tools and criteria for the safe inclusion of ASCMs in concrete and cement-based products for different applications.

Cement manufacturing is an energy-intense process that accounts for approximately 7–8% of global CO_2 emissions. Partial substitution of cement with hydraulically active waste materials, such as industrial waste by-products, would not only save energy and decrease the emission of greenhouse gases but could also improve the durabilty of concrete and conserve declining natural resources.

Millions of tonnes of different industrial waste by-products are added to landfill sites every year in Canada and around the world. A significant portion of these materials possess chemical and/or physical characteristics that are not taken into account in current prescriptive-based specifications for traditional cementitious materials such as fly ash, silica fume and slag.

Although the possibility of using these wastes as ASCMs in concrete is attractive, their potential impact on the long-term performance of concrete structures is unknown. Hence the launch of the two-year project, which is partially funded by NRCan's program on Climate Change Technology and Innovative Initiative (CCTII), Advanced End-use Efficiency—Industry.

Those interested in the development of new materials or finding solutions to industrial waste disposal are also welcome to join the project. For more information, please contact Dr. Laila Raki at 613-991-2612, fax 613-954-5984, or e-mail laila.raki@nrc-cnrc.gc.ca.

Researchers conclude ten-year evaluation of corrosion-inhibiting systems on concrete bridge barrier walls

The rehabilitation and replacement of deteriorated concrete bridges is a multi-billion problem in North America, where the main cause of deterioration is chloride-induced reinforcement corrosion from the use of deicing salts on the roads (see *Construction Innovation* September 2002). Design solutions, in part, involve specifying the appropriate concrete mix, an adequate concrete cover, the coating of the reinforcement, and/or the sealing of the concrete to slow down chloride penetration and reduce the rate of rebar corrosion.

Cores are taken from a bridge barrier wall for laboratory analysis.

Of the different protection techniques available, corrosion-inhibiting systems are considered among the most cost effective. The mechanisms by which they protect the reinforcing steel are often complex. Some inhibitors delay corrosion by reducing the rate of the corrosion reactions, others by reducing the permeability of the concrete to chloride ions. Yet little information exists on the long-term performance of concrete structures built with corrosion-inhibiting systems.

A ten-year assessment of the field performance of bridge barrier walls built with reinforced concrete containing commercial corrosion-inhibiting systems was recently completed by NRC-IRC researchers. These barrier walls, which retain and redirect vehicles on the bridge in the event of a collision, were all made of low-permeability concrete and normal steel reinforcement.

The corrosion-inhibiting systems investigated—there were nine such systems plus a control section—included different combinations of concrete admixtures, reinforcing steel coatings, and/or concrete surface coatings/sealers (see sidebar). The field evaluation consisted mainly of annual corrosion surveys of (1) the main barrier wall reinforcement, protected by a 75-mm concrete cover and (2) special rebar ladders embedded at specific locations in each barrier wall at depths ranging from 13 mm up to 50 mm, for purposes of accelerating the corrosion evaluation.

The survey of the 75-mm deep main reinforcement indicated that the risk of chloride-induced corrosion in all test sections, including the control section that had no corrosion inhibitors, was still low after a decade of service. Indeed, the total chloride content measured after 10 years at depths of 50 to 75 mm remained below the critical chloride value in all test spans.

These results clearly show the importance of using low-permeability concrete and a thick concrete cover to provide the first line of defence in reinforced concrete structures exposed to severe environments. The corrosion-inhibiting systems provide a second line of defence in the event the concrete cover is breached because of cracking, or when critical chloride contamination reaches the steel.

The survey of the shallow rebar ladders in the barrier walls indicated that the system using an inorganic concrete admixture consistently provided the best performance, showing the least amount of concrete damage (only minor cracks). The systems using organic concrete admixtures also provided good performance. The epoxy-coating system performed well in the first year, but showed signs of decreasing performance over time due to corrosion of damaged areas of the brittle epoxy coating. The system that included a concrete sealer performed very well, especially in the first few years,

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Project partners

Ministère des transports du Québec, The Regional Municipality of Peel, Axim-Italcementi Group, Caruba Holdings, Euclid Admixture Canada, Cortec Corporation, Israel Richler Trading, Master Builders Technologies, Sika Canada, W.R. Grace & Co., and NRC-IRAP.

Brief description of the investigated corrosion-inhibiting systems

System	Generic description
Control	Carbon-steel reinforcement
Epoxy	Epoxy-coated reinforcement
A	Rebar coating Concrete coating
B	Organic concrete admixture
C	Organic/inorganic concrete admixture
D	Rebar coating
E	Organic concrete admixture
F	Organic concrete admixture
G	Organic concrete admixture Concrete sealer
H	Inorganic concrete admixture

NRC-IRC researchers monitor and evaluate parking structure rehabilitated using hydrophobic concrete

The deterioration of concrete parking structures due to shrinkage cracking and reinforcement corrosion is a wide-spread problem in North America that presents an ongoing challenge for their owners.

The floors of parking structures are subject to chloride-laden moisture in the form of water or snow brought in on the undersides of vehicles. Unlike bridge decks, the interior floors of a parking structure do not get rinsed off by rain. The exposure to chloride ions may be even greater if the slab surface is poorly drained. This can lead to severe corrosion of the steel reinforcement and subsequent cracking and spalling of the concrete.

Deterioration on underside of parking garage floor prior to rehabilitation

In this context, the use of a hydrophobic (i.e., water repellent), pore-blocking admixture in the concrete may provide some advantages relative to normal concrete, such as less ingress of de-icing salt and moisture through the concrete pores and cracks.

In the case of the Laurier-Taché indoor parking structure in Gatineau, QC, which had suffered from severe reinforcement corrosion and concrete deterioration, a $35-million rehabilitation project was initiated by Public Works and Government Services Canada (PWGSC) in 2004. As part of PWGSC's efforts to identify and assess new technologies that have the potential to improve the durability of structures in harsh environments, it was decided that a concrete containing a hydrophobic admixture would be used for the construction of designated areas (totalling 2000 m^2) of an elevated floor of the structure. This work involved the demolition and reconstruction of the concrete slabs with the new concrete.

NRC-IRC researchers instrumented, monitored and evaluated the performance of these designated areas of the newly rebuilt floor, including four slab sections and two interior ramps, over a period of two years. Of the four slab sections, two were made of normal concrete for purposes of comparison. The monitored parameters included deformation, temperature and relative humidity in the concrete; corrosion potential of the reinforcement; and CO_2 level, temperature and relative humidity of the ambient air inside the parking structure.

Initial results from the two-year monitoring and evaluation process are as follows:

- Visual inspections indicated the presence of deep cracks at an early age in all monitored concrete slabs and ramps, including those made with the hydrophobic concrete.
- The measurements and calculations confirmed that this early-age cracking was due to the shrinkage of the slabs during the drying stage, when movement was restrained by the supporting prestressed concrete girders.
- Flood tests also confirmed that the hydrophobic concrete was not effective in preventing moisture migration through the floor cracks, even after repair with epoxy injection.
- The half-cell potential measurements taken on the embedded reinforcement indicated low risks of corrosion so far (after two years).

Given the extensive floor cracking and the presence of moisture and de-icing salts, long-term monitoring is recommended to track the corrosion resistance of the reinforcement, especially in the hydrophobic floor areas where the polymeric membrane was not applied, as would typically be done on normal concrete slabs.

Specific questions about this project can be directed to Dr. Daniel Cusson at 613-998-7361, fax 613-952-8102, or e-mail daniel.cusson@nrc-cnrc.gc.ca.

Researchers conclude ten-year evaluation of corrosion-inhibiting systems on concrete bridge barrier walls

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during which time a much smaller amount of chlorides penetrated the concrete than was the case with the other systems.

In conclusion, a concrete system combining low-permeability concrete, a 75-mm-thick concrete cover, a corrosion-inhibiting admixture and a concrete sealer would provide an excellent defence against corrosion.

Specific questions about this project can be directed to Dr. Daniel Cusson at 613-998-7361, fax 613-952-8102, or e-mail daniel.cusson@nrc-cnrc.gc.ca.

Upcoming events

OCTOBER

9-10
Revaluing Construction 2007—Crossing Boundaries. Copenhagen, Denmark. http://www.rc2007.org/

9-12
Canadian Acoustics Association Annual Conference. Montreal. http://users.encs.concordia.ca/~caa-2007/

14-17
2007 Annual Transportation Association Conference, "Transportation—an Economic Enabler." Saskatoon. http://www.tac-atc.ca/English/annualconference/generalinfo.cfm

21-24
PCI National Bridge Conference. Phoenix, AZ. http://netforum.pci.org/eweb/

28-30
Sustainable Northern Shelter in a World of Diminishing Resources. Fairbanks, AK. http://www.cchrc.org/forum.html

NOVEMBER

1
*Contech. Quebec City. http://www.contech.qc.ca/eng/index_batiment.php. (NRC-IRC booth #507)

6-7
*Construct Calgary. Calgary. http://www.constructcalgary.com/. (NRC-IRC booth #620)

28
*Contech. Montreal. http://www.contech.qc.ca/eng/index_batiment.php. (NRC-IRC booth # 617).

28-30
*Construct Canada. 19th Annual Construct Canada and PM Expo 2007. Toronto. http://www.constructcanada.com/index.htm.

Visit NRC-IRC's booth #1125. We will also be giving seminar presentations on:
- Advances in building envelope products/systems and changes to CCMC's evaluation process
- Photoluminescent wayguiding, water mist, compressed-air foam and other advances in fire-protection systems
- Sustainable roofing—what are the options?

DECEMBER

2-7
Thermal Performance of the Exterior Envelopes of Whole Buildings X International Conference. Clearwater Beach, FL. http://www.ornl.gov/sci/buildings/

2008 JANUARY

17
21st Meeting of the NRC-IRC Working Group on Repointing Mortars (open to all). Ottawa. http://irc.nrc-cnrc.gc.ca/bes/hmpe/masonry/mortar/mortar_e.html

22-24
International Air-Conditioning, Heating, Refrigerating Exposition (AHR Expo). New York, NY. http://www.ahrexpo.com/

FEBRUARY

13-14
*British Columbia Construction Show. Vancouver. http://www.bcconstruct.com/. (NRC-IRC booth #1607).

24-25
20th Meeting of Canadian Commission on Building and Fire Codes. Montreal. Contact: Anne Gribbon at 613-993-5569, or e-mail anne.gribbon@nrc-cnrc.gc.ca

* *NRC-IRC is a participant in this event. You are invited to visit our booth for more information about our research expertise.*

This calendar does not include all events scheduled to take place during this time frame. For a more complete listing, see the Web version of "Upcoming events" at http://irc.nrc-cnrc.gc.ca/events_e.html

construction innovation

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