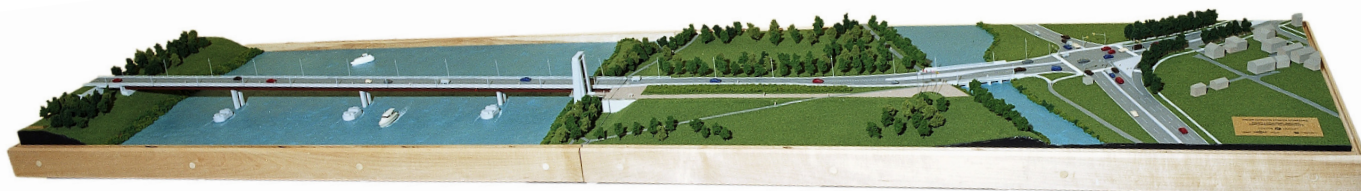


## NRC'S SELF-CURING CONCRETE TO BE USED ON THE NEW NORTH CHANNEL BRIDGE IN CORNWALL



Model of the future North Channel and Canal Bridges in Cornwall. (Courtesy of Federal Bridge Corporation)

A more durable concrete that will increase the average lifespan of bridge decks by more than 20 years compared to typical high-strength concrete, and by more than 40 years compared to normal-strength concrete, has been developed by Dr. Daniel Cusson, a senior researcher at the NRC Institute for Research in Construction (NRC-IRC).

This high-performance concrete has been specially formulated to minimize shrinkage, which is typical of high-strength concrete, while maintaining its excellent mechanical properties. It

also greatly reduces cracking, which diminishes the penetration of aggressive agents into the concrete, such as chlorides from the de-icing salts used on roads. As a result, it takes considerably more time for the chlorides to reach the steel reinforcement, initiate corrosion, and induce further damage to the structure.

The key difference is in the sand—lightweight porous shale fine aggregate, which replaces about a quarter of the normal sand used to make concrete. This porous sand can hold

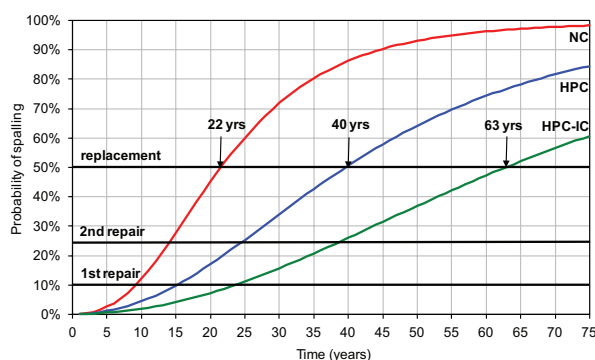
up to 20% of its own weight of water, which serves to cure the concrete uniformly from the inside, thus preventing self-desiccation. With a unit cost only 5% higher than that of a standard high-strength concrete, Dr. Cusson expects concrete bridge decks made with this new concrete to last longer, saving taxpayers money in

annual bridge maintenance, recurring repairs and associated traffic disruption, and replacement.

Currently, this new self-curing high performance concrete is being put to the test at the NRC outdoor slab testing facility, where its mechanical performance and corrosion resistance are being monitored with embedded instrumentation and periodic non-destructive testing. This field testing is being conducted under the severe weather conditions that most Canadian bridges face: cyclic loading, exposure to de-icing salts, freeze-thaw cycles, wet-dry cycles and solar radiation.

This concrete formulation is being considered for the deck construction of the Canal Bridge, which is part of the North Channel Bridge replacement project in Cornwall. The \$75 million infrastructure project from Federal Bridge Corporation is slated to start later this year. Research partners include: City of Ottawa, Federal Bridge Corporation, National Capital Commission, Transports Québec and W.R. Grace.

For more information, contact Daniel Cusson at [daniel.cusson@nrc-cnrc.gc.ca](mailto:daniel.cusson@nrc-cnrc.gc.ca) or 613-998-7361.



Time-dependent probability of concrete cover spalling in a typical reinforced concrete bridge deck. (NC=normal-strength concrete; HPC=typical high performance concrete; HPC-IC=high performance concrete with internal curing)

## WATER USE EFFICIENCY OBJECTIVE UNDER CONSIDERATION FOR NATIONAL CODES

The Canadian Commission on Building and Fire Codes (CCBFC) is considering the possibility of developing a water use efficiency objective for Canada's National Building Code and National Plumbing Code. As with the recently developed energy efficiency objective, the matter will be decided using the CCBFC's approved protocol for adding new objectives.

The first two steps of the protocol, receipt and initial consideration of a request to add a water use efficiency objective, were completed by the CCBFC's Executive Committee in fall 2010. A steering committee was then set up to oversee completion of step three, a consultant's analysis of the issues surrounding the matter. The consultant will review various policy directives (municipal, provincial/territorial, federal) related to water use efficiency as well as existing mechanisms (e.g., regulations, incentives and disincentives) to address it and then recommend a course of action.

The consultant's report will inform the CCBFC Executive Committee in their recommendation on whether or not to add water use efficiency to the codes as an objective. The recommendation will be considered by both the CCBFC and the Provincial/Territorial Policy Advisory Committee on Codes (PTPACC) and submitted to public review.

A decision on whether or not to proceed with an objective is expected to be made by summer 2011. If the decision is positive, the CCBFC will set up a joint task group with PTPACC to scope out the task. This will include development



of a water use efficiency objective and functional statements, as well as technical requirements, all of which would be submitted for public review prior to implementation in the 2015 Codes.

For more information, contact Cathy Taraschuk at 613-993-0049 or [cathleen.taraschuk@nrc-cnrc.gc.ca](mailto:cathleen.taraschuk@nrc-cnrc.gc.ca).

### Now Available: 2010 Codes Online Presentations

Free online presentations providing detailed overviews of major technical changes in the 2010 National Model Construction Codes are now available on the national codes website at [www.nationalcodes.ca](http://www.nationalcodes.ca). They include changes to the National Building Code of Canada (NBC), the National Fire Code of Canada (NFC) and the National Plumbing Code of Canada (NPC). These presentations replace the cross-country seminars traditionally offered during past model code launches.

The following subjects are covered:

- Combustible Penetrations and Plenum Cables (NBC 2010, Parts 3 and 9)
- Dangerous Goods, Flammable and Combustible Liquids and Hazardous Activities (NFC 2010)
- Fire Alarms and Exit Signs (NBC 2010, Parts 3 and 9, and NFC 2010)
- HVAC and Plumbing (NBC 2010, Part 6 and NPC 2010)
- Lateral Load Resistance (NBC 2010, Part 9)
- Part 9 Changes (NBC 2010, Part 9)
- Radon (NBC 2010, Parts 5, 6 and 9)
- Residential Care (NBC 2010, Part 3)
- Secondary Suites (NBC 2010, Part 9)
- Spatial Separations (NBC 2010, Parts 3 and 9)
- Stairs (NBC 2010, Parts 3 and 9)
- Structural Loads (NBC 2010, Parts 4 and 5)
- Windows, Doors, Skylights and Sealants (NBC 2010, Parts 5 and 9).

## NEW LEADERS APPOINTED TO CODE DEVELOPMENT PROVINCIAL/TERRITORIAL ADVISORY BODY

A new Chair, Ted Ross and Vice-Chair, Georges Tessier, have been appointed to lead the Provincial/Territorial Policy Advisory Committee on Codes (PTPACC) during the 2010-2015 code development cycle. The appointments took effect on November 8, 2010.

Mr. Ross has been actively engaged in the code development system, as Nova Scotia's building code coordinator, since 1995. Previously, he worked for more than 20 years in residential planning, development, construction, project supervision and property management. He is a member of both the Canadian Commission on Building and Fire Codes and the Canadian Commission on Construction Materials Evaluation.

Mr. Tessier, a member of the PTPACC since 2005, is a professional engineer as well as director of standardization and qualification at the Régie du bâtiment du Québec.

The PTPACC, established in 2001 by provincial and territorial governments, is a forum for the identification and discussion of issues affecting building, fire and plumbing codes, as well as standards, conformity assessment and regulations addressing health and safety and other areas relating to the public interest. On behalf of the provinces and territories, the PTPACC provides policy advice to the Canadian Commission on Building and Fire Codes on matters related to the National Model Construction Codes.





## ***Build with the times!***

### **Purchase the 2010 National Model Construction Codes Today**

The 2010 National Building, Fire and Plumbing Codes of Canada are now available! Incorporating close to 800 technical changes that address technological advances, as well as health and safety concerns raised since 2005, these Codes are used as models for virtually all building and fire regulations in Canada. They provide minimum requirements for a safe and healthy built environment and are an indispensable source of information for building, fire and plumbing officials, as well as construction professionals and educators.

Published by the National Research Council of Canada, the 2010 National Model Construction Codes were prepared under the direction of the Canadian Commission on Building and Fire Codes, in partnership with the provinces and territories.

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For more information: [www.nationalcodes.ca](http://www.nationalcodes.ca)  
1-800-672-7990 or 1-613-993-2463 (Ottawa-Gatineau and U.S.)

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[www.cnrc.gc.ca/magasinvirtuel](http://www.cnrc.gc.ca/magasinvirtuel)

#### **Formats available**

- **Print:** binder or soft cover
- **Electronic:**
  - downloadable PDF
  - online subscription (10 day, 1 year, or 5 years)

#### **Online presentations**

- Free presentations on major technical changes available in February 2011 at:  
**[www.nationalcodes.ca](http://www.nationalcodes.ca)**

#### **Coming soon**

- National Energy Code for Buildings 2011
- User's Guide – NBC 2010, Structural Commentaries (Part 4 of Division B)
- Illustrated User's Guide to Part 9 of the 2010 NBC



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of Canada

Gouvernement  
du Canada

Canada

## DEVELOPING TECHNOLOGIES FOR AIRCRAFT CABIN ENVIRONMENTS

The first Aircraft Cabin Environment Technologies (ACET) industry workshop was held on October 28, 2010. Facilitated by the NRC Institute for Research in Construction (NRC-IRC) in partnership with NRC Aerospace, this Ottawa event was attended by aerospace stakeholders, NRC staff and others.

The workshop revealed a strong need in the Canadian aerospace industry to develop technologies for new aircraft cabin environments. More specifically, it identified the necessity for several innovations if the Canadian industry is to develop more comfortable and safe aircraft cabins. Such innovations address a variety of issues including clean water

supply, novel lighting concepts, insect control strategies, durable yet lightweight materials, improved acoustical treatments, protection against infectious disease, and enhanced air quality.

*Innovations are needed to develop more comfortable and safe aircrafts.*

Aerospace stakeholders recognized that there are technologies and techniques being employed in the construction sector that can be applied to the aircraft cabin environment. Likewise, technologies developed for the aircraft cabin may

have spinoff applications for the construction sector.

NRC would like to identify Canadian stakeholders who may not have a stake in the aerospace sector but otherwise may be positioned to develop new technologies or spin off their existing technologies to the aircraft cabin environment. Working with the aerospace sector, NRC is well positioned to increase business opportunities for companies normally positioned to serve the construction sector.

For more information on this business development opportunity, contact Paul Lebbin at paul.lebbin@nrc-cnrc.gc.ca or 613-991-4644.

## NEW CCMC EVALUATION REPORTS AND LISTINGS

Company	Product Name	CCMC #	Description
Les Systèmes Adex Inc.	AkrilonPRO-RS	13262-R	Exterior Insulation and Finish Systems (EIFS) Class PB
Ply Gem Siding Group	Variform and Mastic Siding	13351-L	Vinyl Siding, Soffits and Fascia
Rmax Operating, LLC	Thermasheath-3	13381-L	Thermal Insulation, Polyurethane and Polyisocyanurate, Boards, Faced
SWD Urethane Company	SWD Quik-Shield®106	13390-R	Spray-in-Place, Open-Cell Polyurethane Foam (OPF) Thermal Insulation
Tarco	MS300 Ice and Water Armor	13451-R	Eave Protection, Self-Sealing Modified Bituminous Membranes
Airlite Plastics Co.	Fox Block Insulating ConcreteForm Wall System	13472-R	Modular, Expanded-Polystyrene Concrete Forms
Murphy Engineered Wood Division	Murphy LVL	13507-R	Structural Composite Lumber
Uponor Ltd.	AquaPEX	13529-R	Domestic Water Piping
BASF Canada Inc.	WALLTITE ECO™ v.2	13530-L	Spray-Applied Rigid Polyurethane Foam Insulation - Medium Density
Arclin	Arclin 5440	13533-L	Wood Adhesives
Pinkwood Ltd.	NJ(PKI15)10-12, NJH(PKI25)10-16 and NJU(PKI35)10-18 Series I-Joists	13535-R	Prefabricated Wood I-Joists



## REDUCING GREENHOUSE GASES IN CONCRETE PRODUCTION



Researchers at the NRC Institute for Research in Construction (NRC-IRC) have initiated a new project aimed at developing an environmentally friendly concrete by replacing part of the cement with alternative cementing materials. The work addresses the issue of reducing

the levels of greenhouse gases emitted during the production of concrete. NRC-IRC researchers are investigating new ways to add different cementitious materials, including recycled waste products such as fly ash and slag from steel production, to reduce the environmental impact of the concrete production.

As an example, ultra high performance concrete (UHPC) is made not only of various cementitious materials, such as fly ash, slag, and silica fume in replacement of part of the cement, but also contains large amounts of chemical admixtures that improve its fresh and/or hardening properties. More complex than the original three-component system of water-cement-aggregates, UHPC is a product to which interdisciplinary specialties (physics, chemistry and engineering) contribute to improve quality, performance and sustainability.

Advances in chemical admixtures, in combination with new cementitious

materials with or without other powdered additives, have opened several interesting technological avenues. The synergy achieved by these carefully controlled combinations increases the durability and service life of concrete structures while reducing greenhouse gases.

Research and industry experience have shown, however, that using new powdered materials in concrete needs to be well controlled, because not all combinations are compatible with, and beneficial to, the final product properties. Some of these materials interact directly with cement components, their hydration products and with each other. The NRC-IRC research will pay special attention to these issues.

NRC-IRC is seeking partners for the project. For more information, contact Pierre-Claver Nkinamubanzi at pierre-claver.nkinamubanzi@nrc-cnrc.gc.ca or 613-993-6560.

## DRAINAGE AND DRYING PERFORMANCE OF WALL ASSEMBLIES

An industry-sponsored collaborative research project assessing the drainage and drying performance of wall assemblies is now underway with the NRC Institute for Research in Construction (NRC-IRC) and the Air Barrier Association of America (ABAA). The three-year project was outlined at an initial meeting in December. Eight industry partners (see box), representing sheathing membrane, drainage component and cladding interests, took part.

Currently, there is not an agreed-upon method to determine how wall assemblies incorporating a drainage cavity behind the cladding respond to heightened rain loads. This research project aims to assess these wall assemblies with respect to the consequences of water entry

behind the cladding and the resulting effects on the moisture sensitive components in the wall.

Unique testing and simulation facilities at NRC-IRC are a key to the success of the project. Results from the research will assist in determining locations across North America where wall systems with drainage components may adequately manage inadvertent water entry behind the cladding.

NRC-IRC is seeking other industry partners. For more information, contact Dr. Michael Lacasse at 613-993-9715 or michael.lacasse@nrc-cnrc.gc.ca. The project website can be found at <http://www.nrc-cnrc.gc.ca/eng/projects/irc/sheathing.html>.

### Industry Partners

- Benjamin Obdyke / Fiberweb
- Canadian Concrete Masonry Producers Association
- Cosella-Dörken Products
- DuPont
- Keene Building Products
- Pactiv Corporation
- Roxul
- Sto Corp

## QUALITY LIGHTING CONTRIBUTES TO ORGANIZATIONAL EFFECTIVENESS

A field study on the links between lighting appraisals, room appearance judgments, mood, and well-being in the workplace was recently completed by the NRC Institute for Research in Construction (NRC-IRC). The project was supported by the Light Right Consortium.

The study was carried out in three office buildings with recent major renovations. The renovations included replacing recessed parabolic-louvered luminaires with workstation-specific, individually controllable, suspended direct/indirect luminaires (see photos). The occupants were asked to complete an online questionnaire on three occasions during the study, to provide their assessments of the work environment and lighting, their mood, physical and visual discomfort at work, self-reported absenteeism, job satisfaction, organizational commitment, and intent to turnover (voluntarily seek other employment). These measurements are widely accepted proxies for organizational productivity.

*Good quality office lighting should provide: a mix of direct and indirect lighting; room surfaces that contribute to light distribution and individual lighting controls...*

Three main observations were made from the research:

- **Workstation-specific direct-indirect lighting with individual control is preferred.** People with this lighting reported higher pleasure, room attractiveness and illumination ratings, lighting satisfaction, overall environmental satisfaction, job satisfaction and organizational commitment, and lower frequency and intensity of physical symptoms and intent to turnover.

- **Room surface reflectance influences lighting quality.** Workstation-specific direct-indirect luminaires with individual controls in offices with darker surfaces were rated higher than similar offices with light-coloured workstation surfaces.
- **Luminous conditions matter to organizational productivity.** Better lighting conditions generally produced better lighting appraisals, and these in turn indirectly related to reduced health problems (both physical discomfort and self-reported absenteeism) and to reduced intent to turnover.

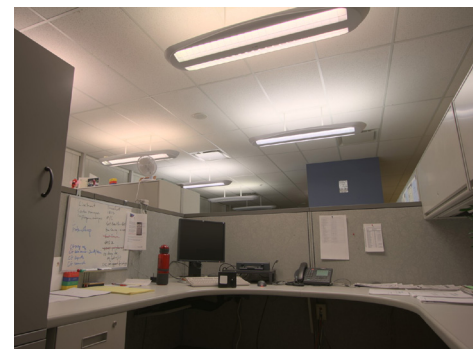
### What the research tells us

This study, combined with previous research over the last 15 years (see Construction Innovation, June 2004 and September 2007) showed that good-quality office lighting should provide:

- a mix of direct and indirect lighting;
- room surfaces that contribute to light distribution;
- individual lighting controls to accommodate the different needs and desires of occupants.

Moreover, providing good-quality lighting is indirectly related to having fewer health problems, higher job satisfaction, higher organizational commitment, and lower intent to turnover. If good-quality lighting only resulted in more attractive spaces, the chain of relationships would stop at room appearance. The research showed that it did not. Rather it showed that lighting conditions affect organizational productivity through effects on employees.

For more information, contact Jennifer Veitch at 613-993-9671 or [jennifer.veitch@nrc-cnrc.gc.ca](mailto:jennifer.veitch@nrc-cnrc.gc.ca). Information is also available at [www.lightright.org](http://www.lightright.org) and <http://www.nrc-cnrc.gc.ca/obj/irc/doc/pubs/rr/rr306.pdf>.



*Top: Pre-renovation offices included teal panels and parabolic-louvered lighting recessed in the ceiling.*

*Middle: Post-renovation, white and beige panels, and workstation-specific individually controllable suspended direct-indirect lighting.*

*Bottom: Post-renovation, some offices have dark grey panels and a layout more like the old offices, but have the workstation-specific individually controllable suspended direct-indirect lighting.*



## TUBULAR DAYLIGHTING DEVICES AN ALTERNATIVE TO SKYLIGHTS

Tubular daylighting devices (TDDs) deliver daylight without the unwanted solar heat gain sometimes associated with roof windows and skylights.

With the rapid technology development of TDDs, manufacturers currently lack reliable and accurate calculation methods and design tools. As a result, they are not able to predict the energy performance of installed TDDs, show compliance with building energy codes, or rate existing or innovative products.

Researchers at the NRC Institute for Research in Construction (NRC-IRC) are currently developing metrics for the lighting and thermal performance of TDDs. This project will develop validated computer algorithms to compute the optical, lighting and thermal performance indicators (see box) for various types of residential and commercial TDDs. A simple design guide will also be developed to help in the selection and specification of TDDs at the pre-design

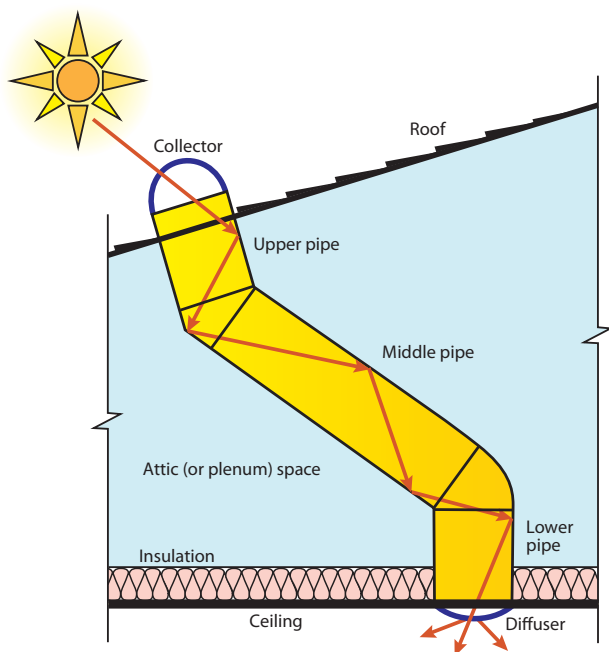
### Three types of performance indicators for TDDs:

- optical (light transmission and solar radiation absorption),
- lighting (lumen output, light diffusion, and intensity/luminance distribution, spacing arrangement) and
- thermal (U-factor and Solar Heat Gain Coefficient).

stage. The project is supported by the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).

NRC-IRC is seeking in-kind support from TDD manufacturers to build a lighting performance measurement facility to test various TDD products.

For more information, contact Dr. Aziz Laouadi at 613-990-6868 or [aziz.laouadi@nrc-cnrc.gc.ca](mailto:aziz.laouadi@nrc-cnrc.gc.ca).



*A typical tubular daylighting device for residential buildings.*

## Canadian Centre for Housing Technology Project Highlights

### Undertaken during 2010

**SUNRISE.** The purpose of this project is to develop ultrahigh efficiency solar cells for photovoltaic concentrator systems. The demonstration phase will continue until the spring of 2011. The Canadian Centre for Housing Technology's (CCHT) role is to measure the performance of the integrated assembly in real-world conditions at one of the twin houses. Project partners include the NRC-Institute for Research in Construction, the NRC Institute for Microstructural Sciences, University of Ottawa, Université de Sherbrooke, Cyrium Technologies Inc. and OPEL Solar, Inc.

### Impact of Awnings on Cooling Loads.

In August 2010, a project was undertaken to examine the impact of awnings on cooling loads. The awnings were installed on the south-facing windows of one of the twin houses.

### Projects for 2011

#### Roof-Integrated Photovoltaics (PV).

Researchers are planning to install a roof-integrated photovoltaic system on the roof of the CCHT InfoCentre. They will monitor energy production, heat and moisture performance and other integration issues. They will also do a laboratory assessment of the durability of the roofing system, model the heat and moisture performance, and perform energy simulations.

#### Multi-Residence Smart Power System.

In 2011, the CCHT FlexHouse will be retrofitted with a system capable of simulating a variety of realistic occupant-driven electrical loads, with the ultimate goal of installing an energy management system. This is part of a project to explore integration issues of energy power systems – including power generation, storage and management.

The Canadian Centre for Housing Technology is a partnership between the National Research Council Canada, Natural Resources Canada and Canada Mortgage and Housing Corporation. For more information on the centre, consult the CCHT Web site at: [www.ccht-cctr.gc.ca](http://www.ccht-cctr.gc.ca).

## NEW STAINLESS STEEL REINFORCEMENT IN CONCRETE STRUCTURES

Conventional carbon steel reinforced concrete structures—bridges, parking garages, marinas and highways—are everywhere. Slowing their deterioration and increasing their durability and life span present continual challenges.

For decades, stainless steel (SS) reinforcement has been used in concrete structures to minimize the problem of corrosion, but the practice is limited, partially due to its high initial cost. Recently, the cost has increased significantly with the rising price of nickel, slowing the adoption of SS reinforcement.

New types of SS reinforcement with lower nickel content are thus being evaluated for their corrosion performance under chloride attack and concrete carbonation. A research project investigating the use of new SS types (2304, 2101 and UNS S24100) to improve the durability of reinforced concrete structures has been initiated by the NRC Institute for Research in Construction (NRC-IRC) and its partners. An additional study on the corrosion performance of galvanized reinforcing steel was added at the suggestion of infrastructure asset owners.

Some performance criteria are critical to determining the service life of concrete structures. One is their resistance to chloride attack, usually defined as a threshold chloride concentration for active corrosion to start in the steel.

Another is the corrosion rate after corrosion occurs. Other aspects of corrosion performance continue to be investigated as well, including pitting corrosion resistance, effect of concrete cracking, corrosion initiation and propagation rates of reinforcing steels embedded in concrete. The NRC-IRC study will lead to a better understanding of the corrosion performance of these new types of SS

steels and an assessment of their potential to extend service life and reduce the life cycle cost of reinforced concrete structures.

For further information or to join this project, contact Dr. Shiyuan Qian at (613) 993-3814 or shiyuan.qian@nrc-cnrc.gc.ca or Dr. Jieying Zhang at (613) 993-6752 or jieying.zhang@nrc-cnrc.gc.ca.



*Concrete prisms for testing corrosion performance and coupling corrosion.*



*Different types of steel bars tested during corrosion study.*

### Project partners

- British Columbia Ministry of Transportation and Highways
- City of Calgary
- City of Winnipeg
- Ministère des transports du Québec
- Nickel Institute





## APRIL

7-12 - 2010 IEEE International  
26<sup>th</sup> RCI International Convention  
Trade Show, Reno, Nevada.

[http://www.rci-online.org/  
international-convention.html](http://www.rci-online.org/international-convention.html)

## APRIL

11-13 - ASCE International Confer-  
ence on Vulnerability and Risk Anal-  
ysis and Management (ICVRAM)  
& the Fifth International Sympo-  
sium on Uncertainty Modeling and  
Analysis (ISUMA 2011), Hyattsville,  
Maryland.

[http://content.asce.org/  
conferences/icvram2011/index.html](http://content.asce.org/conferences/icvram2011/index.html)

## APRIL

12-16 - 12<sup>th</sup> International Conference  
on Building Materials and Compo-  
nents, Porto, Portugal.

<http://www.fe.up.pt/12dbmc/>

## MAY

10-13 - 13<sup>th</sup> Canadian Conference on  
Building Science and Technology  
The Future of the Building Enve-  
lope ...

Building Upon Our Past, Winnipeg,  
Manitoba

<http://www.becwinnipeg2011.com/>

## JUNE

21-26 - International Structural  
Engineering and Construction  
Conference (ISEC-6), Zurich,  
Switzerland.

[http://www.isec-society.org/  
ISEC\\_06/index.htm](http://www.isec-society.org/ISEC_06/index.htm)

## JULY

3-8 - 2011 ICCC – XIII International  
Conference on the Chemistry of  
Cement, Madrid, Spain.

<http://www.icccmadrid2011.org/>

## JULY

10-15 - 13<sup>th</sup> International Conference  
on Wind Engineering (ICWE13),  
Amsterdam, Netherlands.

<http://www.icwe13.org/>

## AUGUST

1-4 - 11<sup>th</sup> International Conference  
on Applications of Statistics and  
Probability in Civil Engineering,  
Zurich, Switzerland.

<http://www.ibk.ethz.ch/fa/icasp11/>

## SEPTEMBER

15-16 - 10<sup>th</sup> Annual International  
Vacuum Insulation Symposium  
(IVIS-X), Ottawa.

<http://www.ivis2011.org>

## Construction innovation

[www.nrc-cnrc.gc.ca/ci](http://www.nrc-cnrc.gc.ca/ci)

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**Client Services:**

**Tel.:** 613-993-2607

**Fax:** 613-952-7673

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