

construction innovation

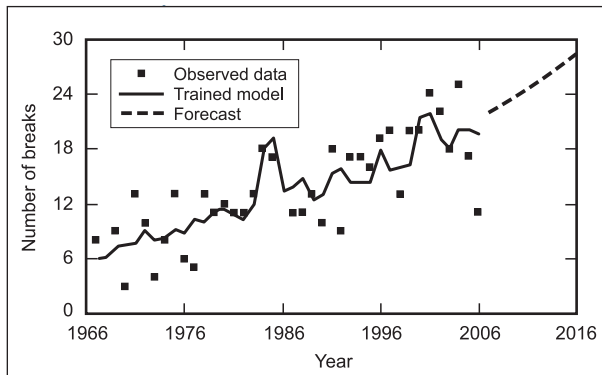
I-WARP: Individual Water Main Renewal Planner

Typical water distribution systems comprise hundreds and even thousands of buried pipes. Effective planning for pipe renewal requires the identification of individual pipes that are most likely to experience elevated breakage frequencies. This is challenging because the deterioration mechanisms of water

mains are complex and involve numerous factors, both static (e.g., pipe material, size, age, soil type) and dynamic (e.g., climate variations, cathodic protection).

Examination and analysis of historical water main breakage patterns using statistical methods provide an effective and inexpensive way to estimate deterioration for individual pipes or groups of pipes. These historical patterns are used to forecast anticipated future breakage rates which are subsequently used to plan and prioritise water main renewals.

NRC-IRC has developed a model that estimates future failure rates by considering both static and dynamic factors that affect deterioration. The model, implemented in the form of a computer application called Individual Water Main Renewal Planner (I-WARP), will be available



Historical pattern and forecast of breaks for a group of pipes.

through the Water Research Foundation (formerly known as the American Water Works Association Research Foundation) www.waterresearchfoundation.org/.

I-WARP differs from other statistical models for the analysis of breakage patterns of individual water mains in that it considers dynamic factors in addition to static factors. Qualitative dynamic factors, such as operational changes (leak detection campaigns, pressure zone changes, etc.) that might influence breakage rates can also be considered, provided appropriate information is available. Currently available statistical models capable of considering dynamic factors (e.g., D-WARP, www.nrc-cnrc.gc.ca/eng/projects/irc/renewal-planner.html) are designed to conduct high-level (group-level) water main renewal

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plans for groups (or cohorts) of pipes.

I-WARP is based on a probabilistic concept called the Non-Homogeneous Poisson Process (NHPP). A Poisson Process describes a stochastic (random) process in which events (in this case, water main breaks) occur randomly, albeit at a given mean rate. This same process is used to model the arrival of cars at a traffic light.

I-WARP application requires inventory and breakage data about individual pipes. Pipes are divided into homogeneous groups – pipes of the same material, same diameter, same vintage – or any other grouping criterion for which data is available. The model is first trained (or calibrated) to discern historical breakage patterns of each pipe group. This calibration exercise provides group-specific parameters, which are then used to forecast future breaks.

Mandatory inventory data for each individual pipe include pipe diameter and year of installation. Optional inventory data include

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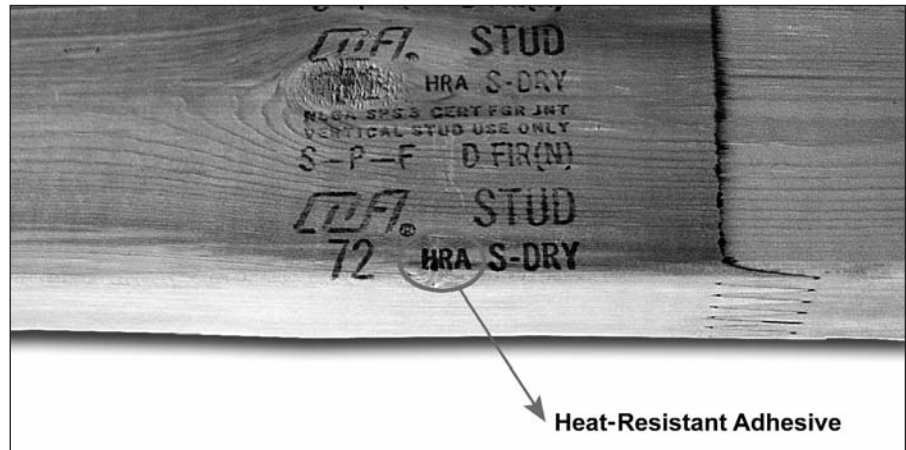
Construction codes

New requirements for adhesives used in fire-rated structural wood assemblies

Subject to final approval by the Canadian Commission on Building and Fire Codes, the National Building Code (NBC) of Canada 2010 will contain new requirements for adhesives employed in the manufacture of fingerjoined studs and prefabricated I-joists to be used in assemblies that require a fire-resistance rating in buildings covered in Part 9 of the NBC (e.g., commercial and multi-unit residential buildings).

The lumber industry quickly responded by developing a fire-testing protocol, as well as an HRA (heat-resistant adhesive) stamp, for fingerjoined lumber intended for use in fire-rated wall assemblies.

The fingerjoined stud lumber issue arose when the lumber industry asked that its special products standard SPS-3 “Fingerjoined Stud Lumber-Vertical Use Only” be included within the CSA standard O86



“Engineering Design in Wood.” The specific question was whether adhesives currently used in fingerjoined wood studs met fire resistance requirements. The lumber industry quickly responded by developing a fire-testing protocol, as well as an HRA (heat-resistant adhesive) stamp, for fingerjoined lumber intended for use in fire-rated wall assemblies.

To reflect these developments, a footnote would be added to Table A-9.10.3.1.A. of the 2010 NBC stating

that fingerjoined studs for fire-rated assemblies must meet the SPS-3 standard, which specifies that studs shall have the HRA stamp (*see photo*). These HRA adhesives are mostly phenolic-based (usually dark brown in colour), as well as some specifically formulated urethanes and melamines (pale coloured) that pass the test.

In the case of pre-fabricated I-joists, the fire resistance ratings in the 2005 NBC (Table A-9.10.3.1.B.) were derived from the results of tests conducted by the NRC Institute for Research in Construction (NRC-IRC) on I-joists that contained strictly phenolic-based adhesives.

Questions arose when some manufacturers began using adhesives different from those in the NRC tests. The new requirements in the 2010 NBC would clarify the issue by adding two footnotes to Table A-9.10.3.1.B.: one stating that the I-joist adhesive must be a phenolic that complies with CSA standard O112.7.; the other stating that the adhesive used in laminated veneer lumber (LVL) flanges must be a phenolic that complies with CSA standard O112.6.

Questions regarding these new requirements can be directed to Frank Lohmann at (613) 993-9599 or email frank.lohmann@nrc-cnrc.gc.ca.

Final Public Review for 2010 Codes now taking place

A public review of proposed changes to the National Construction Codes is now taking place and will continue until October 30, 2009 on the National Codes website (www.nationalcodes.ca). The Canadian Commission on Building and Fire Codes (CCBFC) invites all Canadians to take part in this last opportunity for public review of technical changes proposed for the 2010 Codes.

The technical changes being proposed cover four main topics – care occupancies, climbable guards, protection against falls from residential occupancy windows, and radon. Also included will be proposals for updating the tables of documents currently referenced in the Codes, as well as those for seismic data and localities in National Building Code Appendix C.

If you are interested in receiving more information, please contact Anne Gribbon, Secretary to the CCBFC, at 613-993-5569 or email codes@nrc-cnrc.gc.ca.

NRC-CCMC business review moves forward

A business review of the NRC Canadian Construction Materials Centre (NRC-CCMC) conducted by the Montreal-based consulting firm, Brio Conseils, is well underway (see *Construction Innovation*, June 2009).

The now-completed Phase 1 included an internal study of NRC-CCMC operations as well as one-on-one telephone interviews with senior officials in the provinces and territories responsible for construction policy. This was followed by development of a web-based questionnaire that building officials, manufacturers and others (laboratories, universities, engineering consultants) were invited to complete. Brio Conseils subsequently prepared a

report on its findings and submitted it in September to the business review project team, which is composed of a cross-section of stakeholders tasked with overseeing the project.

In Phase 2, the findings from Phase 1 will be discussed and verified by focus groups meeting in five major cities across the country. Comprising invited stakeholders (manufacturers, building officials, ministry officials), each focus group will meet for a half-day workshop (afternoon or evening). The first sessions are scheduled for Calgary on September 29. Sessions in Halifax, Montreal, Toronto and Vancouver will take place over a five-week period ending in early November.

Information on the business review, details on the focus group sessions and a summary of the Phase 1 report are available on the NRC-CCMC website at: www.nrc-cnrc.gc.ca/eng/services/irc/ccmc.html.

Individuals who have not received an invitation but would like to contribute to the review are asked to contact Dr. John Flack at 613-990-8518 or e-mail john.flack@nrc-cnrc.gc.ca.

I-WARP: Individual Water Main Renewal Planner

Continued from cover

such parameters as pipe material, length, geographic location, cathodic protection and soil type. Mandatory breakage data (for a minimum of five years) includes break date and its association with a specific pipe in the inventory data. Since I-WARP allows for the consideration of dynamic factors, the inclusion of climate data (temperature and precipitation) is beneficial.

I-WARP will enable one to prioritise the renewal of individual water mains within a homogenous group. It will help users plan water main renewal activities at pipe level, thus complementing the D-WARP software developed earlier at NRC-IRC.

For more information, contact Dr. Yehuda Kleiner at (613) 993-3805 or email yehuda.kleiner@nrc-cnrc.gc.ca.

Quebec Construction and Plumbing Codes now available on CD-ROM and the Web!

The 2008 Quebec Construction Code and the 2009 Quebec Plumbing Code can now be consulted on CD-ROM and through an online Web-based subscription service.

Main Features of CD-ROM and Online Versions

- Links allowing easy navigation between various parts of the Codes
- Code provisions viewable by section
- Instant links to cross-references, defined terms, appendix notes, etc.
- Powerful, easy-to-use search engine
- Quebec-specific changes are indicated
- Automatic updating with revisions to the Codes



The Quebec Construction and Plumbing Codes on CD-ROM are available for \$240 and \$144 respectively. Annual or 10-day subscriptions can also be purchased to access these new Codes on the Web. Go to www.nrc-cnrc.gc.ca/eng/services/irc/codes-centre/cdrom-codes-guides.html or www.nrc-cnrc.gc.ca/eng/services/irc/codes-centre/online-codes-library.html for more information on these new products.

To purchase a CD-ROM, subscription or printed version of the Quebec Construction and Plumbing Codes, please visit the NRC Virtual Store at www.nrc.gc.ca/virtualstore or contact NRC-IRC publication sales at 1-613-993-2463 (Ottawa-Gatineau and U.S.) or 1-800-672-7990 (across Canada).

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Fire research

Thermal expansion of reinforced concrete structures in fire

Providing a better understanding of thermal expansion in reinforced concrete structures under fire exposure is the focus of a new four-year study by NRC-IRC's Fire Research program. Thermal expansion is defined as the tendency of structural elements to change in volume (size) as the result of change in temperature. In fire, high temperatures cause building elements such as floors, beams and columns to expand significantly which, in turn, may cause stress and potential failure of supporting columns.

Thermal expansion has been reported as an initial cause of structural failure in several mid- to high-rise buildings. It is believed that thermal expansion has an important effect on concrete structures, depending on the size of the elements and their restraint conditions.

This research project will develop assessment and design tools for improving fire protection and safety in reinforced concrete buildings including residential, hotel, hospital and care facilities as well as offices. The project aims to answer questions such as:

- How significant are the effects of thermal expansion on building performance and safety?

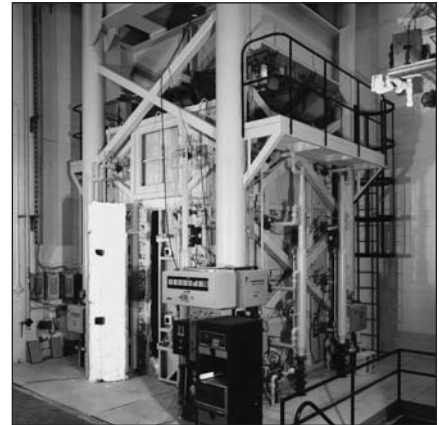
- How does one simulate performance of structures in fire, considering thermal expansion?
- What types of building damage or failure are caused by thermal expansion?
- How does one improve safety and design in reinforced concrete buildings with regard to the effects of thermal expansion?

A new testing technique will be used to focus on the effects of floor thermal expansion and how it relates to the performance of reinforced concrete columns – elements that play a major role in the stability of an entire structural system. The results will be applied to concrete columns using the NRC-IRC full-scale column furnace test facility. Analysis will be conducted in collaboration with the University of Toronto.

Although this research is being conducted for building columns, the findings could be applied to other structures such as bridge columns.

Seeking Collaborators

NRC-IRC is seeking industry and regulatory collaborators for the study. Participants will have the opportunity to comment on the project's scope, designs and documents as well as to assist with technology transfer to



An NRC-IRC full-scale column furnace test facility will be used to research the effect of thermal expansion on reinforced concrete building columns.

regulatory bodies and the construction industry. They will receive both preliminary results and a final report containing the technical basis of the study, experimental methods, and an evaluation of results. A results database including the characteristic and performance profiles and temperature will be accessible, forming the basis of a modelling tool that may be used to generate both appropriate designs and guidelines.

If you are interested in joining this project or have any questions, contact Dr. Hossein Mostafaei at 613-993-9729 or email Hossein.Mostafaei@nrc-cnrc.gc.ca.

Renovation complete on NRC-IRC website

It's time to update your NRC-IRC Web bookmark. As part of an effort to unite all NRC websites under a single "look and feel," and to comply with new standards for federal government websites, the NRC Institute for Research in Construction can now be found at www.nrc-cnrc.gc.ca/irc. From our new home page you will discover information about our research programs, projects, facilities, software, business opportunities and more.

With over 7200 publications, and more added each week, the NRC-IRC site remains an excellent source for technical information and product evaluations. Visit our main publications page at www.nrc-cnrc.gc.ca/eng/ibp/irc/publications/index.html to find links to these popular items:

- **Codes and Guides:** Descriptions of the national model codes and their various companion guides, all of which can be purchased online.

- **Construction Innovation newsletter:** Find both current and past issues, free of charge. To subscribe to the online version and stop receiving the paper copy in the mail, just drop us an email (IRC.Client-Services@nrc-cnrc.gc.ca).
- **Construction Technology Updates:** Free, practical 4-6 page publications presenting applications of research results and reviews of building science issues.
- **Registry of Product Evaluations:** This free registry provides users with easy access to technical and standards-related data on hundreds of NRC-CCMC evaluated materials, products and construction systems.

We welcome your feedback. If you have any comments or questions about the site, please don't hesitate to contact us at webadmin.irc@nrc-cnrc.gc.ca.

Indoor environment

SPMSOft – New Speech Privacy Measurement Software

Distraction from unwanted sounds and lack of privacy for many common office tasks are frequent complaints made by open-plan office occupants. A solution is at hand with the development of new speech privacy measurement software (SPMSOft) by NRC-IRC.

Traditional measurements of speech privacy in open-plan offices have proven cumbersome and usually have not identified causes of the problems. During traditional testing, sound attenuation (reduction in sound level) between workstations was measured using loud test sounds after hours in unoccupied offices. Results of these tests were combined with daytime measurements of ambient noise levels (a composite of sounds from sources both near and distant) and various privacy measures were calculated. This approach was costly, time consuming and not frequently used, often leaving acoustical problems unresolved.

SPMSOft makes it possible to measure ambient noise and speech privacy during occupied conditions with minimal disturbance to occupants. The degree of speech privacy is quantified in terms of repeatable objective measurements including values of speech privacy measures. At the same time, it can provide diagnostic information to determine

the most important causes of lack of speech privacy.

SPMSOft uses impulse response techniques to measure sound attenuation between workstations in an open-plan office. It avoids the use of loud, disturbing test sounds. The results can be displayed with the key sound paths identified so that users know if the more serious cause of the lack of speech privacy is sound reflecting from the ceiling or sound passing over workstation panels.

The ambient noise spectrum is measured during normal working hours so that it is representative of normal daytime sounds. Speech privacy measures are calculated to quantify speech privacy between various pairs of measurement positions.

Such improved measurements and diagnostics provide a new tool for consultants and make the systematic improvement of open-plan office acoustics a practical option.

SPMSOft was developed with the support of Public Works and Government Services Canada (PWGSC). Further software information and case study results are available at www.nrc-cnrc.gc.ca/eng/projects/irc/spmsoft/overview.html. Specific questions can be directed to Dr. John Bradley at (613) 993-9747 or email john.bradley@nrc-cnrc.gc.ca.

Urban infrastructure

Newsbrief

B.C. construction firm wins CCA Excellence in Innovation Award

Greyback Construction Limited of Penticton, British Columbia, was awarded the 2009 Canadian Construction Association (CCA) Excellence in Innovation Award for its inspired decision to use snow-making machines in building concrete pontoons and the sub-structure of the floating William R. Bennett Bridge, found in Kelowna, BC. The award, supported by the NRC Institute for Research in Construction, is given for innovation and “outside the box” thinking in Canadian construction practices, and is presented with the Hugh R. Montgomery Memorial Trophy.

In lieu of the traditional approaches to pouring concrete, Greyback needed to find a safe, predictable and cost-effective method to pour cool concrete on hot summer days to meet its project deadline. Greyback’s “outside the box” solution? – using snow-making machines to cool the ambient air instead of the concrete on days where temperatures in the mid-30s are not uncommon in the Okanagan Valley.

The results were impressive. The use of snow-making machines greatly enhanced worker safety and working conditions, was very predictable, improved the quality of the concrete cure at minimal additional cost, and was environmentally friendly, using water that was already being pumped.

NRC-IRC is proud to be on the jury for the CCA Excellence in Innovation Award. The development and promotion of innovative solutions in the construction sector is one of the Institute’s top priorities.

ICBEST 2010

27-30 June 2010, Vancouver

NRC-IRC to host Building Envelope Conference

Stay up-to-date on the latest trends and technology in building envelope engineering by joining leading experts from the construction industry, education and the research community at the International Conference on Building Envelope Systems and Technology (ICBEST) 2010 in Vancouver.

ICBEST 2010 is a unique event, offering an exclusive worldwide forum for the exchange of information and discussion of recent developments in building envelope engineering. It aims to bridge the gap between researchers, engineers, designers and manufacturers and to enhance the exchange of ideas between them.

An equally important objective is the application of new findings to the development of design, manufacturing and construction methods and the codification of information for practicing engineers and architects.

As the countdown to ICBEST 2010 continues, regular updates will be posted to the website at www.icbest.ca/.

Organized by: Institute for Research in Construction
National Research Council of Canada

Energy Efficiency in Buildings – New Tools and Technologies

Building Science Insight is a national seminar series presented annually by the National Research Council of Canada Institute for Research in Construction (NRC-IRC) to provide construction professionals with practical information. Each seminar focuses on technical advances in building science on a specific topic and includes the results of NRC-IRC research. This year's seminar will address the efficient use of energy in buildings through five presentations on recent research and one on issues related to energy codes.

The following topics will be addressed:

Overview of the National and Provincial Energy Codes for Buildings

This presentation will provide an overview of the development of the Model National Energy Code for Buildings 1997 and its evolution to the updated provisions planned for the National Energy Code for Buildings 2011. It will also discuss the current and future status of energy regulations for buildings in the provinces and territories and their association with the National Energy Code for Buildings 2011.

Dimmable Lighting: Energy Savings and Occupant Satisfaction

Dimming ballasts with appropriate controls can reduce lighting energy consumption as much as 50%. Personal dimming controls can produce additional energy savings of about 10%, while also improving occupant satisfaction and productivity. NRC-IRC researchers will review their research findings in this field and predict future trends.

Energy Rating of Insulated Wall Assemblies

The Wall Energy Rating (WER) is a tool for energy rating of wall assemblies, comparable to the window Energy Rating found in CSA Standard A-440.2, which may eventually be referenced in similar national and international standards. This presentation will provide background on the development of the Wall Energy Rating, and present the results of a recent NRC-IRC research project that determined the WER of walls constructed with various thermal insulation materials according to common construction practices.

Making Buildings Responsive to Peak Energy Demand

Meeting peak electrical demand is costly, but failure to do so leads to blackouts. Building operators can help by dimming lights and changing thermostat set points and ventilation rates during peak periods. This presentation looks at the extent to which energy demand can be reduced without significantly affecting the indoor environment.

High-Performance Thermal Insulation in Building Envelopes

Although still virtually unknown in Canada, vacuum insulation panels (VIPs) have thermal resistance values up to 10 times those of conventional insulation materials. This presentation will outline NRC-IRC studies on the performance and construction of VIPs, explain how they work, and demonstrate the challenges and advantages of using them in building construction.

Energy-Efficient Roofs

Properly designed roofs can play a significant role in efforts to achieve energy efficiency and sustainability in construction. This presentation will review and clarify misunderstandings surrounding sustainable, green, reflective and high-performance roofs; present some recent research on the performance of these roofs; address environmental, durability and life-cycle issues; discuss design and construction; and encourage the use of new technologies.

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

English Seminars

- Vancouver Oct. 6, 2009
- Whitehorse, Oct. 8, 2009
- Winnipeg, Oct. 20, 2009
- Edmonton, Oct. 22, 2009
- Iqaluit, Nov. 3, 2009
- Regina, Nov. 16, 2009
- Calgary, Nov. 18, 2009
- Yellowknife, Nov. 20, 2009
- St. John's, Dec. 1, 2009
- Halifax, Dec. 3, 2009
- Toronto, Dec. 9, 2009
- Fredericton, Jan. 12, 2010*
- Ottawa, Jan. 15, 2010*

French Seminars

- Quebec, Feb. 9, 2010
- Montreal, Feb. 11, 2010*

* With simultaneous translation

The registration for the seminar is \$349 plus tax, \$75 for students. Discounts are available for 10 or more people from the same organization. Please visit the website at www.bsi.gc.ca for more details and registration information.

Speakers: The roster of speakers includes NRC-IRC building science specialists Hakim Elmahdy, Guy Newsham, Phalguni Mukhopadhyaya, Benjamin Birt, Aziz Laouadi, Mike Swinton, Ralph Paroli and Morad Atif as well as technical advisors from the Canadian Codes Centre including Cathleen Taraschuk, Mihailo Mihailovic and Heather Knudsen. Provincial representatives responsible for energy regulations will also be invited to address energy code issues.

Past Seminars now on the Web

NRC-IRC is pleased to announce that Webcasts of our three most recent BSI seminars, BSI 2008/09 on **Single and Multi-Family Houses**, BSI 2007/08 on **Fire Safety Research for Better Building Design**, and BSI 2006/07 on **Sustainable Infrastructure** are now available. These consist of complete audio and visual records of each presentation, allowing anyone anywhere, at any time, to stay current with developments in construction research in these areas.

Versions of these seminars are now available at www.nrc-cnrc.gc.ca/eng/ibp/irc/bsi/seminar-publications.html.

The price of each online seminar is \$125.

Upcoming events

OCTOBER

18-23

Society of Fire Protection Engineers Annual Meeting, Scottsdale, Arizona. www.sfpe.org/Education/2009TheAnnualMeetingProfessionalDevelopmentConferenceandExpo.aspx

20

* Contech Building Events Trade Show, Quebec, QC. www.contech.qc.ca/eng/index_batiment.php

26-27

Experiencing Light 2009: International Conference on the Effects of Light on Wellbeing, Eindhoven, The Netherlands. www.experiencinglight.nl/

26-28

EuroNoise 2009, Edinburgh, Scotland. www.euronoise2009.org.uk/

NOVEMBER

3-4

* Buildex Calgary, Calgary AB. www.buildexcalgary.com/

11-13

Greenbuild International Conference and Expo, Phoenix, AZ. www.greenbuildexpo.org

16-19

CAM 2009 (Congrès Algérien de Mécanique), Biskra, Algeria. www.cam2009.com/home.html

17-18

International Workshop on Ultra High Performance Fiber Reinforced Concrete (UHPFRC), Marseille, France. www.lcpc.fr/en/vous/obtenir/index3.dml

25

* Contech Building Events Trade Show, Montreal, QC. www.contech.qc.ca/eng/index_batiment.php

DECEMBER

2-4

* Construct Canada, Toronto, ON. www.constructcanada.com/index.asp

2010 APRIL

21-22

* Buildex Vancouver, the BC Construction Show / HomeBuilder & Renovator Expo, Vancouver, B.C. www.buildexvancouver.com/

MAY

5-7

First International Conference on Nanotechnology in Cement and Concrete, Irvine, California, USA. www.trb.org/news/blurb_detail.asp?id=9750

10-13

CIB World Building Congress, Salford, U.K. www.cib2010.org/

JUNE

16-18

International Conference on Performance-Based Codes and Fire Safety Design Methods, Lund University, Sweden. www.sfpe.org/Education/8thInternationalConferenceonPerformanceBasedCodesandFireSafetyDesignMethods.aspx

27-30

ICBEST 2010 – International Conference on Building Envelope Systems and Technology, Vancouver, B.C. www.icbest.ca/

28-30

Second International Conference on Sustainable Construction Materials and Technologies, Ancona, Italy. www.uwm.edu/Dept/CBU/ancona.html

* At these events, you are invited to visit the NRC-IRC booth to learn more about our research expertise.

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