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www.nrc-cnrc.gc.ca/ci

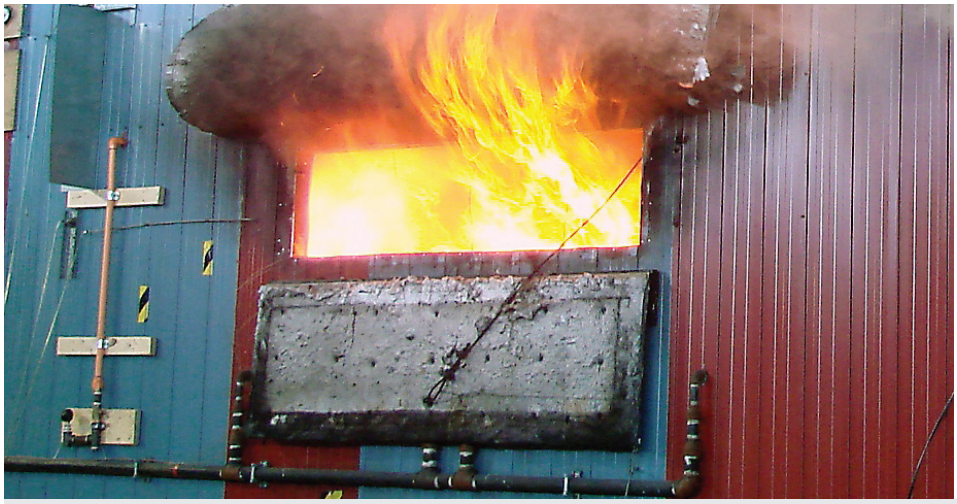
RESEARCHING FIRE PERFORMANCE OF CONSTRUCTION MATERIALS IN HOUSES

Gaining a better understanding of the performance of construction materials and systems used in houses, and determining their impact on the life safety of occupants under fire conditions, are key areas of research at the NRC Institute for Research in Construction (NRC-IRC).

NRC-IRC researchers recently completed a series of tests to investigate the fire performance of protected floor/ceiling assemblies, and the tenability conditions in a full-scale test facility simulating a single-family house with a basement fire. This is a follow-up study to research on unprotected floor/ceiling assemblies under basement fire scenarios (see *Construction Innovation* March 2009).

The basement in the test facility had an open stairwell to the main floor. Test floor assemblies were selected from the previous study, constructed with wood I-joists, steel C-joists, metal web wood trusses or solid wood joists over the basement. The test assemblies were protected on the basement side by a regular gypsum board ceiling, residential sprinklers, or a suspended ceiling.

The experiments utilized a relatively severe, fast-growing fire set in the basement to challenge the structural integrity of the floor system above the basement, which provides the normal egress route on the first storey for occupants. The study focused on life safety from the perspective of tenability for occupants on upper storeys, and on the integrity of the floor structure above the basement as egress routes. The table shows a matrix for the full-scale fire experiments.



Fire testing is performed at an NRC fire research facility

Some of the key findings from this series of fire experiments include:

- In the tests conducted on the floor assemblies protected with gypsum board, all fire events exhibited the same chronological sequence: initiation of the fire, activation of smoke alarms, loss of tenable conditions in open areas on upper storeys, and finally structural failure of the test floor assembly above the basement (loss of first-storey egress route).
- Compared to the experiments conducted previously using the same floor assemblies without gypsum board protection, tenability conditions were similar or improved slightly while the structural performance was improved significantly with gypsum board protection. The time taken to reach structural failure for the protected floor assemblies was much longer than for those with no protection.
- In the previous study, the time to reach structural failure for the engineered floor assemblies

Test assembly	Gypsum board ceiling	Suspended ceiling	Sprinklered
Wood I-joist	√	√	√
Metal web wood truss	√		√
Steel C-joist	√		
Solid wood joist	√		

Matrix of full-scale fire experiments

Continued on page 8

UPDATE ON THE 2011 NATIONAL ENERGY CODE FOR BUILDINGS

Two major decisions related to the 2011 National Energy Code of Canada for Buildings (NECB) were made this spring at the annual meeting of the Canadian Commission on Building and Fire Codes (CCBFC). The most critical was approval of the final version of proposed changes slated for inclusion in the NECB. This includes a new set of objectives and functional statements and assures that the updated model code can be published by the end of 2011. The other decision relates to approval of the work plan of the Standing Committee on Energy Efficiency for Buildings, which will now start working on the next edition of the NECB.

The proposed changes reviewed by the CCBFC included two that were revised due to comments received during the fall 2010 public review. One resulted in reintroduction of a simple prescriptive trade-off for the building envelope. The other related to heat recovery ventilators in self-contained residential units. The CCBFC agreed with a public review comment that the costing analysis performed on the latter proposal was not adequate and approved a revision that left the requirement as closely aligned as possible with the related provision in the 1997 Model National Energy Code for Buildings. A post-public review consultation held by the provinces and territories did not elicit any further changes.

An important characteristic of the NECB will be its flexibility. As with all other national model codes, provinces and territories will be able to adopt the NECB as is or tailor the document to suit their particular jurisdictional needs. The CCBFC will offer detailed guidance to those jurisdictions who, for policy reasons, may want to amend the Code.

Collaboration

The development of the NECB 2011 by the CCBFC is the result of a collaboration between the National Research Council of Canada and Natural Resources Canada, both of which provided technical support and funding for the project.

NATIONAL BUILDING CODE PART 9 ENERGY EFFICIENCY REQUIREMENTS TAKE SHAPE

The development of energy efficiency provisions for housing and small buildings is progressing well. Technical requirements have been prepared and a cost/benefit analysis is underway. Proposed changes are expected to be submitted for public review in late fall 2011. Final changes, providing they are approved by the Canadian Commission on Building and Fire Codes (CCBFC) in spring 2012, will be published late in 2012 as revisions to Part 9 of the 2010 National Building Code of Canada (NBC).

The revisions will include addition of a new objective originally developed for the 2011 National Energy Code of Canada for Buildings and called "Environment," along with its sub-objective, "Excessive Use of Energy," to Division A of the 2010 NBC. All energy efficiency requirements in Part 9 will be attributed to this subsidiary objective.

The Part 9 energy requirements will offer three compliance paths. The prescriptive path for housing will also apply to small non-residential buildings and will contain proposed changes addressing the building envelope; heating, ventilating and air conditioning equipment; and service water heating. For larger residential and non-residential Part 9 buildings, compliance with prescriptive lighting and electrical power requirements will also be required. Secondly, an alternative, full performance compliance path is being introduced that will allow the energy use modeling of a proposed house against that for a reference house assumed to be built to prescriptive requirements. Finally, a simple trade-off compliance path for the building envelope is being added to allow for additional flexibility within the building envelope requirements. It could be used, for example, to trade off more insulation in walls for lower performing windows.

Continued on page 3

Collaboration

The development of energy efficiency requirements for housing and small buildings by the CCBFC is the result of a collaboration between the National Research Council of Canada and Natural Resources Canada, both of which provided technical support and funding for the project.

Continued from page 2

The prescriptive path will also address various construction details that are known to be problematic for air tightness. Heat recovery ventilators will not be mandated, but there will be a separate set of building envelope requirements for where they are installed. As for renewable energy technologies, the performance compliance path will not contain any barriers to their use, and no explicit credits will be provided in the prescriptive path.

For more information, contact Frank Lohmann at 613-993-0049 or frank.lohmann@nrc-cnrc.gc.ca.

Available soon!
User's Guide – NBC 2010, Structural Commentaries (Part 4 of Division B)

This important Guide is intended to help Code users understand and apply the design requirements provided in Part 4 of Division B of the National Building Code of Canada 2010. The Structural Commentaries contain valuable background information and, in some cases, suggested approaches to certain design questions.

This new Guide will be available on August 31, 2011, in a practical, soft-cover book for $130. To pre-order a copy starting July 4th, please visit the NRC Virtual Store (www.nrc-cnrc.gc.ca/virtualstore) or complete the order form on page 4.

CCBFC APPROVES NEW ACTIVITIES FOR ITS STANDING COMMITTEES

The Canadian Commission on Building and Fire Codes (CCBFC) reviewed the work plans of its nine standing committees at its April 2011 meeting and approved several new activities. Below is a list of these activities, by standing committee.

Standing Committee on Building and Plumbing Services

Review intent and application statements for the National Plumbing Code of Canada and Part 6 of the National Building Code of Canada (NBC); relocate/remove requirements for lightning protection systems; develop requirements for profile polyethylene drainage products, seismic protection of plumbing systems, vacuum breakers (spill resistant type), grease interceptors, combo domestic water heaters, frames and covers for maintenance holes and catch basins.

Standing Committee on Earthquake Design

Review and possibly reference a standard for seismic risk reduction of a building's operational and functional components.

Standing Committee on Energy Efficiency in Buildings

Develop a technical user's guide; establish quantitative energy targets; consider requirements for air barrier assembly testing; update piping and duct insulation values for heating, ventilating and air-conditioning systems and service water heating systems; update equipment efficiencies and trade-off coefficients affected by the Energy Efficiency Act; update sections on lighting and electrical power items; develop prescriptive requirements for semi-heated buildings.

Standing Committee on Environmental Separation

Consider requirements for air barrier assembly testing in the NBC.

Standing Committee on Fire Protection

Review area and height limitations using combustible construction.

Standing Committee on Housing and Small Buildings

Address nailing with automatic/pneumatic nail guns on an urgent basis.

Standing Committee on Use and Egress

Conduct an environmental scan on accessibility design requirements.

Executive Committee (acting as a Standing Committee for Divisions A and C of the National Model Construction Codes)

Review hierarchy of code objectives as well as functional statements.

Others

There are no new tasks for the Standing Committee on Hazardous Materials and Activities and the Standing Committee on Structural Design.

A complete list of approved standing committee tasks is available at **www.nationalcodes.ca**.

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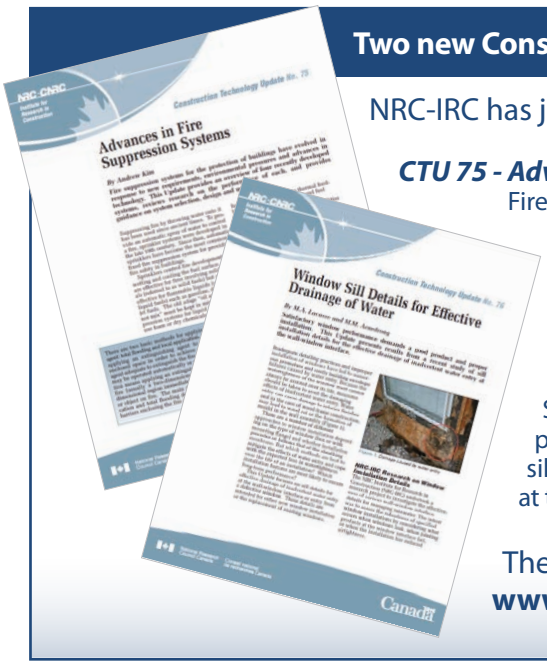
NEW CCMC EVALUATION REPORTS AND LISTINGS

Company	Product Name	CCMC #	Description
GR Green Building Products Inc.	*GR Synthetic Slate™ GR Synthetic Cedar™*	*13341-R*	*Recycled Thermoplastic Composite Simulated Roofing, Slate Tiles*
Bayer MaterialScience LLC	*EcoBay™ CC CAN/EcoBay™ CC Polar CAN*	*13359-L*	*Spray-Applied Rigid Polyurethane Foam Insulation – Medium Density*
Edco Products Inc.	*ArrowLine Shingle Shake, and ArrowLine Slate*	*13380-R*	*Metal Roof Panels*
Le Groupe Legerlite Inc.	*Legerclad (Composite EPS Board and Sheathing Membrane)*	*13510-R*	*Faced Insulating Sheathing Panel*
Premium Spray Products Canada	*Foamsulate-ECO*	*13527-L*	*Spray-Applied Rigid Polyurethane Foam Insulation – Medium Density*
Mason City Recycling Center Ltd.	*Comfortzone Cellulose Insulation*	*13532-L*	*Cellulose Fibre Insulation (CFI) for Buildings*
Deksmart Products Ltd.	*DekSmart™ Ultra*	*13534-R*	*PVC Sheet-Applied Waterproof Decking Membrane (Exposed to Light Pedestrian Traffic)*
Cullen Building Products Ltd.	*Cullen Joist-Hangers (HFFI, UI, LUI & VS) and Cullen Shear Connector (I-clip)*	*13539-R*	*Joist Hangers and Shear Connectors*
Elastochem Specialty Chemicals Inc.	*Insulthane 200 & Home Foam Super 180*	*13545-L*	*Spray-Applied Rigid Polyurethane Foam Insulation - Medium Density*

For further information on the performance, usage and limitations of these products, as well as for other reports and listings by NRC-CCMC, see the Web Registry of Product Evaluations located at **www.nrc-cnrc.gc.ca/eng/services/irc/ccmc/registry-product-evaluations.html**.



Two new Construction Technology Updates now available

NRC-IRC has just released two new Construction Technology Updates (CTUs).

CTU 75 - Advances in Fire Suppression Systems

Fire suppression systems for the protection of buildings have evolved in response to new requirements, environmental pressures and advances in technology. This Update provides an overview of four recently developed systems, reviews research on the performance of each, and provides guidance on system selection, design and use.

CTU 76 – Window Sill Details for Effective Drainage of Water

Satisfactory window performance demands a good product and proper installation. This Update presents results from a recent study of sill installation details for the effective drainage of inadvertent water entry at the wall-window interface.

The complete list of CTUs can be found on the NRC-IRC website at **www.nrc-cnrc.gc.ca/ctu**.

NRC-IRC RESEARCH ON CANADIAN WOOD-FRAME CONSTRUCTION IN CHINA

Researchers at the NRC Institute for Research in Construction (NRC-IRC) recently completed a five-year project investigating the moisture management performance and durability of Canadian wood-frame exterior building envelope construction practices in China. The broad objectives of this initiative, conducted in association with Canada Wood (representing the Canadian forest industry), are to provide competitive and quality housing to meet China's housing needs and to develop growing and sustained markets for Canadian wood and wood products in China.

While numerous criteria must be considered in striving to meet these objectives, building envelope design and construction is deemed most important. Effective moisture management strategies for the design of exterior walls and roofs in the hot, humid and mixed climates of China, and measures to counter the associated risks of biological decay and termite infestations within the wood-frame assemblies are the key challenges. Canadian experience with long-term performance of wood-frame construction and the research expertise of NRC-IRC were crucial to the success of the project, ensuring the development of satisfactory technology for the successful performance of wood-frame construction in China.

NRC-IRC's contribution to the project was to use its numerical simulation tool, hygIRC-2D, to examine the performance of selected wall and roof designs deemed suitable for the climates of Beijing and Shanghai. The results from these numerical simulation exercises have been supplemented with limited field performance data obtained from experimental wood-frame houses built in Shanghai.

Guide to Good Practice – Construction of Wood Platform Frame Buildings, China, *has contributed to the growth of Canadian wood exports to China in recent years.*

The findings have been incorporated into the *Guide to Good Practice – Construction of Wood Platform Frame Buildings, China,* both 2007 and 2010 editions, regional training programs, the Shanghai local code on wood-frame construction, and standard design drawings.

The guide and associated research and technical outputs have contributed to exceptional growth in the exports of Canadian wood to China in recent years. For 2010, exports of SPF (spruce/pine/fir) dimension lumber used for construction of Chinese wood buildings are estimated at 1.6 billion board feet. This represents a doubling of exports every year since 2007. (data source: *Statistics Canada*)

For more information, contact Phalguni Mukhopadhyaya at 613-993-9600 or phalguni.mukhopadhyaya@nrc-cnrc.gc.ca.

10TH INTERNATIONAL VACUUM INSULATION SYMPOSIUM

Stay up-to-date on the latest developments in vacuum insulation panel (VIP) technology and its applications in the construction industry by attending the 10th International Vacuum Insulation Symposium (IVIS-X), Advances in Applications.

Scheduled for Ottawa on September 15-16, 2011, the symposium will feature experts from around the world presenting their latest research findings.

IVIS-X 2011 will provide a platform for international researchers, manufacturers, builders, architects, design engineers, energy managers and other stakeholders to exchange information about advances in VIP technology that promise to accelerate the use of VIPs in North American construction. NRC-IRC's Building Envelope group is a leader in VIP research and is hosting the symposium on behalf of the construction industry in Canada.

The last IVIS, held in London, UK (2009), highlighted the importance of vacuum insulation technology in the context of climate change and energy efficiency.

As the countdown to IVIS-X 2011 continues, regular updates will be posted to the website **www.ivis2011.org**. For more information contact Phalguni Mukhopadhyaya at 613-993-9600 or phalguni.mukhopadhyaya@nrc-cnrc.gc.ca.

RFID-BASED LIFE CYCLE TRACKING OF PRECAST CONCRETE UNITS

Finding accurate information on the status of materials is cited as one of the most common causes of non-productive time in construction projects. Materials are often misplaced or even go missing, resulting in countless hours spent searching for them. Sometimes they are never found. Since contractors are working on tight deadlines, missing components have to be re-ordered or re-fabricated, leading to additional costs and possibly penalties for late delivery. This can have a negative impact on productivity and project performance, and lead to problems with schedules, budgets, and quality.

The application of information technology for tracking construction materials can provide an accurate and efficient means for reducing time and resources being spent collecting and managing data. In a recent example, the NRC Centre for Computer-assisted Construction Technologies (NRC-CCCT), in collaboration with Armtec, a leading infrastructure and construction company, has developed a system for tracking precast tunnel liner segments manufactured in Armtec's Woodstock, Ontario plant. The system relies on commercially available encapsulated Radio Frequency Identification (RFID) tags which, during the fabrication process, are embedded in the liner segments. As the segments move through the plant, their status (i.e., fabrication, quality, storage and shipping) and associated data are updated by the field crew using mobile computers.

Armtec is using the system in its Woodstock plant to track the fabrication and inventory data for 58,000 tunnel liner segments being supplied for the York-Spadina subway extension project in Toronto, which involves construction of two 6.5 km tunnels.

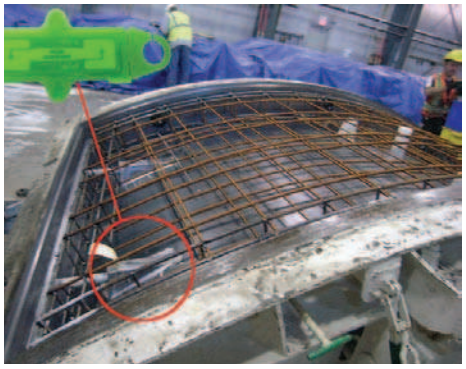
The system helps reduce time and resources spent locating concrete units in the storage yard and managing production and quality control data. Another key benefit of the system is that it generates the product handover documentation in electronic format that many asset owners are now requesting.

Apart from helping reduce inefficiencies in the fabrication process, RFIDs and linked data in the tracking system also provide many benefits in the construction and maintenance phase. For example, the product handover documentation is currently used by Toronto Transit Commission (TTC) construction contractors working at the subway site to validate the materials received.

In the long term, the embedded RFIDs and associated fabrication data will help TTC, as well as other infrastructure owners, to improve the maintenance and rehabilitation of a tunnel over its lifespan. The embedded RFID chips in infrastructure systems like bridges and tunnels have the potential to help owners to locate damaged pieces during operation and maintenance.

The RFID-based system offers significant advantages over the paper-based system, which is still the most prevalent method in the construction industry. While it provides all of the functionality of paper-based tracking systems, the RFID system has the added benefits of reduced user input time, faster data communication and fast record searching.

For more information, contact Ajit Pardasani at 519-430-7085 or ajit.pardasani@nrc-cnrc.gc.ca.



Top: RFID chips are tied to the rebar at a predetermined location before concrete is poured. The encapsulated RFID tag is placed in the area shown by the red circle.

Centre: RFID chips are read with a handheld scanner.

Bottom: Tunnel segments stored in the Woodstock plant all contain RFID chips that can be scanned through the concrete.

TESTING FUSELAGE PANELS FOR POST-CRASH FIRE PERFORMANCE

Researchers in the NRC Institute for Research in Construction (NRC-IRC) Fire Research program recently conducted a series of fire tests on aircraft fuselage materials for Bombardier Aerospace. The Canadian company had first approached the NRC Institute for Aerospace Research, which has conducted numerous research projects on its behalf in the past.

The fuselage of a typical jet aircraft is composed of many different types of panels utilizing various composite materials and designs. Panels vary in thickness. Some may be of solid construction while others may be a honeycomb design used to reduce weight while maintaining strength. Bombardier sought research help to determine how these types of panels would perform in a post-crash fire.

NRC-IRC met Bombardier's needs by carrying out specialized tests to evaluate the decomposition products generated inside an intact fuselage during a simulated post-crash fuel fire. The researchers built a test apparatus based on one developed by the U.S. Department of Transportation's Federal Aviation Administration in 2008.

In the tests, a specially designed oil-fired burner was used to create a flame simulating burning jet fuel. A cube-shaped steel box, approximately 1.2 m per side, served to simulate the intact fuselage. An actual fuselage panel was mounted to one side of the box. During each fire test, the gases emitted by the burning fuselage material were collected in the box and continually measured using a gas analysis system. This analysis system identified the gases given off by the fuselage material as well as their level of toxicity. In addition, the temperatures inside the box were monitored.

The tests demonstrated the ability of NRC-IRC researchers to adapt a test procedure developed elsewhere and to carry out controlled experiments that provide vital technical support to a key industry. It is an example of applying NRC-IRC facilities and expertise to a need that is outside the realm of traditional construction. The research results will be used by Bombardier to enhance its aircraft safety program and advance its product development in a competitive market.

For more information, contact Bruce Taber at 613-256-4464 ext. 225 or bruce.taber@nrc-cnrc.gc.ca.

Fire testing fuselage panels

Continued from page 1

without gypsum board protection was 35-60% shorter than for the solid wood-joist assemblies. With gypsum board protection, all engineered test assemblies had similar structural failure times, matching that of the solid wood joist assembly.

- The experiment using the test assembly with the suspended ceiling followed the same sequence of fire events. The benefit of the suspended ceiling as a protection measure for the test assembly was marginal compared to the same test assembly without a suspended ceiling.
- The residential sprinkler systems effectively protected the structural integrity of the test floor assemblies and there was no structural failure or damage. The residential sprinkler systems also kept the conditions tenable in the test house during the experiments. Note that, outside the scope of this study, additional experiments were conducted for sprinkler-protected assemblies under more severe fire conditions.

  For more information, see **www.nrc-cnrc.gc.ca/obj/irc/doc/pubs/rr/rr308.pdf.**
- Research on the fire performance of houses includes several phases of studies, with each investigating a specific structural system of single-family houses based on specified fire scenarios. The next phase of research, expected to begin in 2012, will explore the fire performance of wall assemblies for single-family houses.

A full report on this study can be downloaded at **www.nrc-cnrc.gc.ca/obj/irc/doc/pubs/rr/rr307.pdf**. Questions can be directed to Dr. Joseph Su at 613-993-9616 or e-mail joseph.su@nrc-cnrc.gc.ca.

JULY

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

www.icccmadrid2011.org

JULY

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

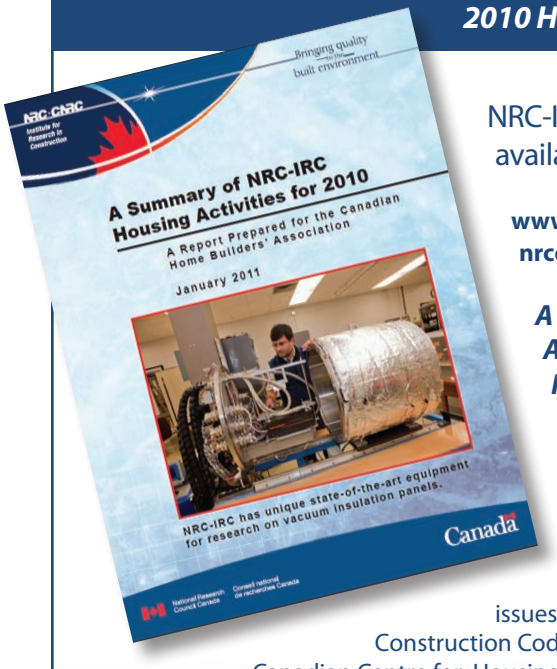
www.icwe13.org

AUGUST

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

www.ibk.ethz.ch/fa/icasp11

2010 Housing Report Available



NRC-IRC is pleased to announce the availability of the following report at:

www.nrc-cnrc.gc.ca/obj/irc/doc/pubs/nrcc53968.pdf

A Summary of NRC-IRC Housing Activities for 2010: A Report Prepared for the Canadian Home Builders' Association, January 2011

The report, produced annually for builders, presents highlights of NRC-IRC research projects and summarizes key technical issues related to the 2010 National Model Construction Codes. Research conducted at the Canadian Centre for Housing Technology is also featured.

SEPTEMBER

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

www.ivis2011.org

Construction innovation

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