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construction innovation

NRC · CNRC

IRC-designed CAF fire-suppression system shows promise for use in aircraft hangars

In collaboration with the Department of National Defence, researchers in IRC's Fire Risk Management program are investigating the use of a newly developed compressed-air foam (CAF) fire-suppression system in aircraft hangars. Because of CAF's good fire-suppression capability, low water requirements and easy cleanup, they believe the system has good potential for providing fire protection in these buildings, as well as in other special applications.

If a fire occurs in an aircraft hangar, protecting the aircraft in the building from possible fuel spill fires is the first priority, while protecting the building itself comes second. National Fire Protection Association (NFPA) standard 409 for aircraft hangars specifies 90 per cent fire control within 30 seconds and 100 per cent within 60 seconds.

Using these criteria, IRC researchers developed a prototype CAF system for a 55 metre by 37 metre hangar using specially designed ceiling-level and floor-level nozzles to cover the hangar floor with foam rapidly. The overhead nozzles provide coverage of approximately 100 square metres in a circular pattern with a diameter of 11.3 metres. The low nozzles provide coverage of approximately 66 square metres in a circular pattern with a diameter of 9.1 metres.

IRC's system uses compressed air to generate foam—in contrast to current foam systems that incorporate aspirating nozzles and blower generators—and produces superior quality foam with substantial injection velocity. These characteristics are particularly important in buildings with high ceilings, such as aircraft hangars, where the injected foam must penetrate fire plumes to reach the seat of the fire.

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Gasoline fire at time of CAF activation

Fire 15 seconds after activation

Fire 30 seconds after activation

Fire 45 seconds after activation

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Technical inquiries for national model code documents

The Canadian Codes Centre (CCC) at the National Research Council Canada's Institute for Research in Construction (IRC) provides administrative and technical support in the development of the national model code documents. Because Codes Centre staff participate in the committee work that leads to technical changes to these documents, they develop a good understanding of the intent of the committees when these decisions are taken.

CCC staff are frequently asked by architects, engineers and contractors to "interpret" the requirements in the national model codes, or provide an opinion as to whether a certain design, system or material is "acceptable." While staff are quite capable of explaining the purpose of a requirement (its intent), or how to use the code, they cannot express an opinion or interpretation on what meets or does not meet a code's requirements.

Why not? The reason is that interpreting a code and determining what meets that code's requirements is the domain of the provincial and territorial regulatory authorities. It is a power and responsibility given to them by the Canadian Constitution Act. In many jurisdictions this responsibility is wholly or partly delegated to municipalities. In the case of federal buildings, federally regulated industries such as airports, and land reserved for the exclusive use of aboriginal peoples, interpretation of the code may be the responsibility of the federal department or agency involved.

The primary clients of the CCC's technical inquiry service are, therefore, the regulatory authorities. When municipal, provincial, territorial or federal officials encounter unusual designs or construction situations, staff at the CCC, and at the Institute for Research in Construction (IRC), can be consulted for information to assist the official in making a decision.

Architects, engineers, contractors and other code users are encouraged to take their technical inquiries to the municipality where the project will be built. If the municipality does not have the expertise to provide a response or does not have access to expertise at the provincial/territorial level, code users should consider engaging a professional consultant who specializes in code matters.

For more information, please contact Mr. John Archer at (613) 993-5569, fax (613) 952-4040, or e-mail codes@nrc.gc.ca.

Newsbrief

Training needs assessment to take place concurrently with public consultation on objective-based codes

The provinces, territories, Canada Mortgage and Housing Corporation (CMHC) and IRC have provided resources to develop training for building, plumbing and fire code regulatory officials, to assist them in making the transition from the current codes to objective-based codes. An assessment of training needs will take place concurrently with the public consultation on objective-based codes. The assessment itself is expected to be complete in March 2003.

If you would like to contribute your views or ideas on training needs, please contact Madeline McBride at (613) 993-0045, fax (613) 952-4040, or e-mail madeline.mcbride@nrc.gc.ca.

Public Consultation on Proposed Technical Changes to the National and Provincial/Territorial Building, Fire and Plumbing Codes

This consultation will be held from January 2–March 31, 2003. For details and links to provincial/territorial Web sites, check www.nationalcodes.ca.

CCBFC Standing Committee meetings to review public comments on Proposed Technical Changes to the National Building, Fire and Plumbing Codes

These meetings will be held in September and October 2003. For dates and locations, go to www.nationalcodes.ca.

You can also contact the Canadian Codes Centre for further information on the Public Consultation and the CCBFC meetings:
E-mail: codes@nrc.gc.ca
Tel.: (613) 993-9960

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Revised: December 2002

CI

Industry update: CCMC involved in efforts to make engineered wood joists easier to use

Over the past 10 years, there has been strong growth in the development and use of engineered wood products such as engineered wood joists and structural composite lumber. These innovative structural products have greatly changed the way wood-frame buildings are constructed because they are able to provide greater strength and longer spans, among other advances.

In an effort to make such products easier for designers and builders to use, CCMC, working in conjunction with the Canadian Wood Council, manufacturers and experts, has assembled test protocols and criteria, and validated manufacturers' span tables for engineered wood joists, thus eliminating the need for further project-specific engineering for small buildings. As part of this work, vibration criteria were also established (see sidebar).

Engineered wood joists and related products

In the late 1960s, the committee responsible for Part 4 of the National Building Code (NBC) and the engineering community initiated the conversion of codes and standards from Working Stress Design (WSD) to Limit States Design (LSD) in order to better address structural safety and serviceability issues such as deflection, vibration and cracking. LSD was introduced into Part 4 of the NBC in 1975 and will likely become mandatory for all materials in the next edition of the NBC. The CSA standard "Engineering Design in Wood" has provided for I-joists to be designed using LSD since 1998.

As part of its evaluation process, CCMC has guided engineered wood joist manufacturers in the conversion to LSD, which has made it easier for engineers to incorporate this type of product into their designs. Products evaluated by CCMC include prefabricated I-joists and open-web joists—both metal-web joists and wood-web glued joists—as well as structural wood adhesives and rimboards. Each type of joist has gone through an initial "qualification" process involving testing to establish suitable design values.

I-joists

CCMC bases its evaluation of prefabricated I-joists on ASTM D5055, which outlines the qualification process required to determine characteristic values for flexural strength and creep, shear, flange end-joints, stiffness, end-bearing and web openings. These values are then converted to Limit States Design format. The next step is to confirm that the engineered floor joist design meets the CSA O86-01 loading and deflection requirements as well as the NBC vibration requirement. Once this has been ascertained, manufacturers can develop span tables for end users.

Open-web joists

Proprietary open-web floor joists are typically designed using known structural analysis models. Manufacturers then develop span charts according to the NBC, taking into account anticipated loads and serviceability criteria. CCMC confirms these span tables by specifying full-scale tests, thus verifying that the manufacturer's span charts are adequate to support the design loads and account for long-term creep. In addition, manufacturers have to conduct specific tests to confirm the variability of the failure modes of these joists. This focused test program for open-web joists is necessary to assist in the conversion process to Limit States Design (from Working Stress Design) until such time as that process for this type of joist has been completed and published.

Structural wood adhesives

Currently, structural wood adhesives must conform to CSA standards O112.6 and O112.7, which

Engineered wood joist vibration criteria

Vibration criteria to achieve acceptable performance (i.e., to avoid floors that are uncomfortably bouncy) were added to the NBC in 1990. However, translating these abstract concepts into criteria for new structural products—in this case, engineered wood joists—required the development of a design procedure funded by a consortium of engineered wood product manufacturers.

The vibration criteria for acceptable performance are represented by an allowable deflection under concentrated load for a given span (not to be confused with the NBC criteria for deflection under uniform load).

Once these criteria were developed, manufacturers were able to design vibration-controlled spans of up to 10 m, taking into account the composite action of the sub-floor, bridging and strapping, ceiling membrane and concrete topping that provide equivalence to NBC lumber span charts.

At an industry meeting in May 2000, representatives of the engineered wood joist industry agreed to move toward a more comprehensive frequency-based approach to predicting floor vibration in light-frame floors. They concluded that the current vibration criteria may overestimate the maximum acceptable span for concrete-topped floors and floors with bridging and/or blocking at the limit of the permitted span. Manufacturers are now aware of this shortcoming and should be consulted when these classes of floors are installed at this limit (i.e., the maximum span).

apply to phenol formaldehyde (PF) and phenol-resorcinol formaldehyde (PRF) adhesives.

Dark-coloured PRFs have a long-standing record with respect to strength and durability. But as the popularity of engineered wood products has increased, there has been increased consumer interest in newly developed, pale adhesives that provide a cleaner look. While there is a CCMC protocol for evaluating and assessing the durability of these new adhesives (see CCMC 12846-R and 12905-R for examples of such evaluations), at present, there is no CSA standard that addresses these issues. A new performance-based CSA adhesive standard is currently being developed, and once it has been published, it will be adopted by CCMC.

Rimboards

Rimboards, which take the place of the headers used in traditional wood flooring, complete the floor design and ensure that the floor transfers loads successfully from the shearwalls above the floor to the shearwalls or foundation below, which is particularly important in high wind or seismic zones.

CCMC evaluated proprietary engineered wood rimboards for capacity under compressive loads, for lateral loads and bending when the rimboards act as lintels for basement windows, and for durability. CCMC's lateral load test includes a specific configuration that verifies lateral capacity according to the NBC nailing schedule. For an example of a rimboard evaluation, see CCMC 12974-R.

Specific questions can be directed to Mr. Bruno Di Lenardo at (613) 993-7769, fax (613) 952-0268, or e-mail bruno.di_lenardo@nrc.gc.ca.

NRC reappoints chair and welcomes new members to the CCCME

The National Research Council (NRC) has reappointed Wayne McLean as chair of the Canadian Commission on Construction Materials Evaluation (CCCME). At the beginning of McLean's second term, the CCCME is undergoing its second membership expansion in two years to reflect its growing responsibility for assessing infrastructure products and processes.

The CCCME is an advisory body of industry experts who provide policy advice on all matters pertaining to the operation of the Canadian Construction Materials Centre (CCMC) and its offshoot, the Canadian Infrastructure Technology Assessment Centre (CITAC). The Commission ensures the reliability and quality of CCMC's technical decisions, supports innovation, technology transfer, productivity and competitiveness in the Canadian construction industry, and works to enhance public safety in the built environment.

NRC selects CCCME members from a mix of backgrounds to ensure that the Commission can represent different regions of Canada and different sectors of the construction industry, as well as meet the needs of those who use the evaluation services that CCMC offers.

In 2000, four additional members were appointed to place a greater emphasis on infrastructure technologies. Recently, two more members were added. The latest round of appointments brings 10 newcomers to the CCCME for a total of 24. The members represent regulatory authorities, major user groups and the building sector, as well as provincial and municipal infrastructure jurisdictions.

The Standing Committee on Technical Evaluations (SCTE) is also welcoming new members. The five appointments to this Committee represent product design, product development, industry testing and evaluation, certification, and product acceptance at the provincial level.

All members of the two-year-old Standing Committee for Infrastructure Technology Assessment (SCITA) have been reappointed for another three years.

For complete lists of the members of the CCCME and its standing committees, see CCMC's Web site at www.nrc.ca/ccmc/home_e.shtml. Specific questions can also be directed to Mr. Ron Waters at (613) 993-6602, fax (613) 952-0268, or e-mail ron.waters@nrc.gc.ca.

IRC award recognizes contribution of industry partners

Since 1999 IRC has recognized industry partners who have provided meritorious and longstanding service on the Canadian Commission on Construction Materials Evaluation (CCCME). This acknowledgement takes the form of the Gordon L. Walt Award, named after the founding manager of the Canadian Construction Materials Centre (CCMC) and the driving force behind the creation of the Commission.

Now is one of those times for recognition. The latest recipient of the Gordon L. Walt Award is Ali Arlani, Director of the Building and Development Branch of the Ontario Ministry of Municipal Affairs and Housing. Dr. Arlani has been a member of the Commission and its executive since it was formed in 1991. In addition, he has been involved with the development and implementation of building codes in Ontario throughout his career and has promoted CCMC within the province since CCMC was formed in 1988.

In November, Dr. Arlani received a plaque and a framed certificate outlining his contribution to the Commission. His name was also added to the list of recipients maintained within CCMC.

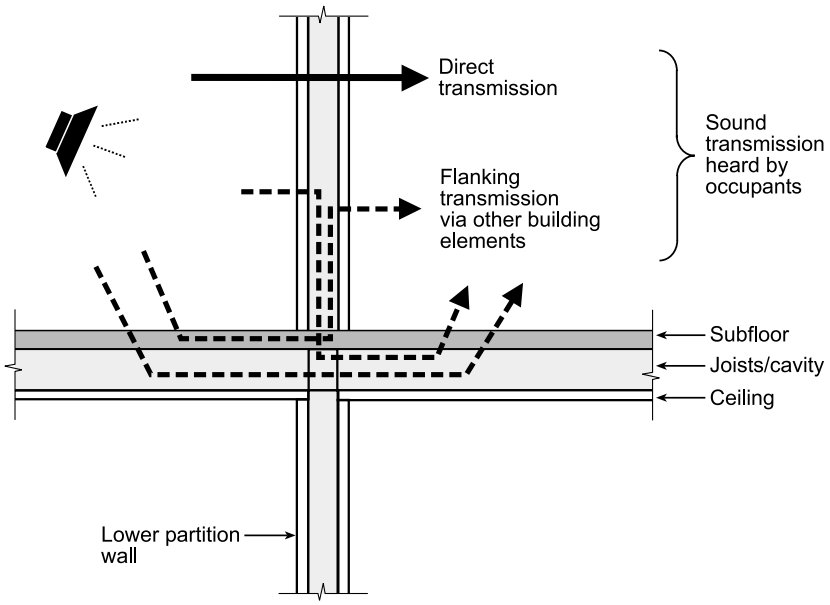
For more information on the Gordon L. Walt Award or its recipients, contact Mr. Ron Waters at (613) 993-6602, fax (613) 952-0268, or e-mail ron.waters@nrc.gc.ca.

How wall/floor details affect sound insulation in multi-family dwellings

Every day builders are faced with the problem of building cost-effective housing that meets sound insulation targets. Recent IRC acoustics research makes it abundantly clear that without an understanding of how the various building elements interact, the system may not provide adequate sound insulation.

Wood-framed multi-family dwellings built in regions where there are high wind loads or potentially severe seismic conditions pose a particular problem, as they often require continuous building elements to ensure that structural integrity among units is maintained. While continuous floor elements help the building withstand wind or seismic loads, they can also transmit sound energy between adjacent dwellings in the form of structure-borne vibration. This type of vibration passing ***via*** the floor and ***around*** the separating wall is known as flanking transmission; this can lead to reduced sound insulation between dwellings or rooms. It is the combined acoustic performance of the wall/floor system —not that of the separating assembly itself— that determines the sound insulation between the two rooms. (See figure).

Flanking transmission is sound transmission between two rooms by paths other than the direct path through the separating wall or floor assembly.



Flanking occurs in all buildings and its importance in determining the sound insulation perceived by occupants is a function of the construction details of the wall/floor system, not just those of the wall.

The research project

To address the problem of flanking, IRC researchers undertook a three-year consortium project to examine the effect of using continuous structural elements that pass under a partition wall between two horizontally separated multi-family dwellings—for example, subfloor sheathing and joists. (See figure.) In addition to varying structural continuity, researchers also systematically investigated the effect of changing joist type, blocking details at the wall/floor junction and type of partition wall.

Project results

The research clearly demonstrated that except in cases where required to provide adequate structural performance, building elements (such as OSB, gypsum board and joists) should not be continuous across or under a partition because they introduce significant flanking paths.

When the OSB subfloor was continuous, the sound insulation was limited to an apparent STC (i.e., the STC as experienced by the occupant) as low as 44, despite the fact the rooms were separated by an STC 52 wall. When both the joists and subfloor were continuous, the degree of structural coupling increased and flanking was even more severe, achieving an apparent STC as low as 38. Because the dominant transmission path is from the floor in one room to the floor in the adjacent room, increasing the sound insulation of the separating wall assembly would be largely ineffective.

Using a continuous subfloor, researchers altered various construction details to assess their effectiveness in controlling flanking. Although structure-borne vibration must flow through the wall/floor junction connecting the upper two rooms (as shown in the figure),

blocking details proved not to be an important factor, nor did joist type—solid wood and wood-I joists performed similarly. Changing the partition wall from single- to double-stud construction produced a minor improvement, primarily because the attenuation of structure-borne vibration at the wall/floor junction increased. However, the better sound insulation of the double-stud wall was short-circuited by the flanking transmission.

They (researchers) learned that a correctly designed and applied floor topping can effectively control the severe flanking paths created when continuous elements are introduced, and can also improve the sound insulation of the floor/ceiling assembly.

Flanking between rooms separated vertically by a floor/ceiling assembly was also investigated. The dominant path is typically from the subfloor above to the wall in the room below. However, this vertical flanking is typically less severe than the flanking that occurs between horizontally separated rooms because vertically separated rooms are not usually coupled by continuous building elements. Flanking that involves wall and ceiling surfaces can be significantly suppressed by mounting the gypsum board on resilient channels, and adding additional layers.

How to control flanking

Because the dominant flanking paths between both horizontally and vertically separated rooms are typically via the subfloor, researchers also investigated the effectiveness of various floor toppings.

They demonstrated that a correctly designed and applied floor topping can effectively control the severe flanking paths created when continuous elements are introduced, and can also improve the sound insulation of the floor/ceiling assembly. It should be noted, however, that the optimal physical properties of the topping system for airborne sound are different than those for impact sound. Although attenuation for both types of sound is improved by adding a topping that increases the mass of the subfloor, the hardness of the surface exposed to impacts should not be increased. Toppings such as gypsum concrete should be used in conjunction with pliable materials placed either on the surface (such as carpet or vinyl) or between the topping and the subfloor (resilient interlayer).

More information

Specific questions can be directed to Dr. Trevor Nightingale at (613) 993-0102, fax (613) 954-1495, or e-mail trevor.nightingale@nrc.gc.ca. You can also visit our Web site at http://www.nrc.ca/irc/publications.html for the detailed project report, IRC Research Report RR-103.

Industry partners

Canada Mortgage and Housing Corporation
Forintek Canada Corporation
Marriott International
National Research Council Canada
Owens Corning
Trus Joist
USG Corporation

IRC-designed CAF fire-suppression system shows promise for use in aircraft hangars

Continued from cover page

To determine how well the prototype CAF system could perform in extinguishing a fire, IRC researchers conducted a series of full-scale tests. The first test involved a ceiling-level nozzle alone, the second involved a floor-level nozzle alone, and the third involved both nozzles together. For each combination of nozzles, the researchers tested two kinds of foam: Class A foam, used for solid fuel fires, and aqueous film-forming foam (AFFF), used for liquid fuel fires. Researchers set the test fire in a pan, 2.44 metres in diameter, containing 40 litres of gasoline floating on 100 millimetres of water. The gasoline was allowed to burn for 20 to 30 seconds before the CAF system was activated.

Test results showed that the ceiling-level (overhead) nozzle working alone did not meet the fire-protection criteria listed above; however, in all cases, the floor-level nozzle working alone met these criteria. The overhead and low-level nozzles working together also met the criteria. And while the test results showed that the AFFF performed better than the Class A foam in both the control and extinguishing of the test fires, the system should be able to accommodate other foam concentrates.

IRC's patented CAF technology has recently been licensed to a Canadian company (FireFlex Systems Inc.) for commercialization. The company plans to develop systems that utilize fixed piping and special nozzle technology to deliver the CAF to the area of the fire, providing a high level of fire protection with low water requirements at a competitive cost.

For more information about IRC's CAF fire-protection system, contact Dr. Andrew Kim at (613) 993-9555, fax (613) 954-0483, or e-mail andrew.kim@nrc.gc.ca.

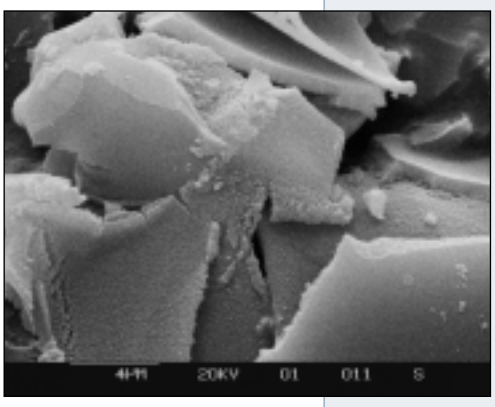
New IRC research project applies nanotechnology to construction materials

IRC has initiated a multi-researcher project to develop new technologies and products for the construction industry based on nanotechnology (see sidebar), with an emphasis on cements, cement-based products, admixtures and concretes. Cement is the most widely used construction material, making concrete and cement nanotechnology particularly important to the industry. Initial research will focus on the synthesis and use of reactive and non-reactive nanoparticulates and their role in cement binders, novel strategies for the controlled release of chemical admixtures and new approaches to concrete reinforcement.

IRC researchers expect that the addition of nanoscale particles to concrete will improve the control of concrete microstructure beyond what is possible with existing technologies, resulting in stronger, tougher and more durable concretes. They also expect that programming the time-release of chemical admixtures in concrete will provide maximum effectiveness at the construction site, while reinforcing cement binders with nanodiameter fibres and rods will produce tougher cement-based products by impeding crack formation and growth.

The project will develop new products that are suitable for rapid transfer to industry as well as undertake longer-term, more strategic investigations. Negotiations are already in progress for the licensing of the first product resulting from this new research direction.

IRC is planning the creation of a special interest group on nanotechnology in the construction industry as part of its nanotechnology activities. Companies or individuals interested in joining this group should contact Dr. Jim Beaudoin at (613) 993-6749, fax (613) 954-5984, or e-mail jim.beaudoin@nrc.ca.



Highly reactive, nanoporous calcium aluminate particles manufactured at IRC

Nanotechnology and construction

Nanotechnology is the engineering of materials and structures with sizes ranging from 1 to 100 nanometres (10^{-9} to 10^{-7} metres) in length. Bigger than atoms and smaller than the silica fume particles that are currently added to concrete, nanoscale structures and systems have novel properties and functions because of their size. The latest computer hard drives, oil industry catalysts, and fire-resistant polymers are all based on nanotechnology.

In the construction industry, nanotechnology could potentially improve many construction materials, including structural steel, polymers and concretes. Concrete, which contains the complicated, nanoscale structures of cement and its hydrates, is an excellent candidate for nanotechnology manipulation and control.

Mark your calendars!

The 9th Canadian Conference on Building Science and Technology is going West

Preparations are well underway for the National Building Envelope Council's (NBEC) *9th Canadian Conference on Building Science and Technology* to be held February 27 and 28, 2003 at the Vancouver Trade and Convention Center in Vancouver. Focusing on the design and construction of durable building envelope systems, the conference promises to be a worthwhile event for professionals involved in building design, construction and operations. More than 400 Canadian and international delegates are expected to attend.

The conference, which is being organized by the British Columbia Building Envelope Council on behalf of NBEC and its constituent regional councils, will provide a forum for the presentation and discussion of the latest in building science and building envelope performance.

Early planning should ensure that the upcoming conference balances the latest in laboratory and theoretical research with a wide variety of practical applications. Already more than 40 papers have been accepted for publication from authors in New Zealand, Germany, Sweden, Hong Kong, Cyprus and the United States. Topics will range from solar effects, moisture modelling, mold remediation and computer analysis to failure surveys, construction quality control and environmentally responsible design.

This conference is a must for those interested in building science and the building envelope. Visit the conference Web site at www.nbec.net/conference.htm for more information on how to register, or contact the organizers at info@nbec.net.

NRC is a sponsor of the *9th Canadian Conference on Building Science and Technology*. This conference has a similar format to that of the International Conference on Building Envelope Systems and Technology (ICBEST), which is held every three years in different parts of the world—North America, Europe and South East Asia.

ICBEST 2001 was organized by the National Research Council of Canada's Institute for Research in Construction and held in Ottawa, and ICBEST 2004 will take place in Sydney, Australia, March 31–April 2, 2004. In the years between the ICBEST, conferences are held around the globe at the national level.

For more information about ICBEST 2004, please contact bas.baskaran@nrc.gc.ca.

IRC will host world building congress in Toronto

If your work depends on staying up to date on the latest trends and technology in the building and construction industry, reserve May 2 to 7, 2004 in your agenda. On those dates, the leading experts on building and construction from industry, education and the research community will meet in Toronto for the CIB World Building Congress 2004.

With its theme "Building for the Future," this action-oriented event will bring together both practitioners and researchers from among CIB's member organizations and beyond to discuss the latest research and advances in the building and construction industry, and to focus on creating solutions to the key issues affecting the sector.

In addition to the main conference, concurrent international conferences on indoor air quality, ventilation and energy conservation, and multi-purpose high-rise towers and tall buildings will be held, adding significantly to the substance of the event. (Future articles in *Construction Innovation* will provide more information about these conferences.)

"CIB 2004 is a unique event, offering three conferences in one to provide a forum for communications among construction practitioners, building managers and researchers on a host of critical building-related issues," said Dr. Sherif Barakat, president of CIB and director general of IRC.

CIB is the International Council for Research and Innovation in Building and Construction, a worldwide network of 5000 members and 500 member organizations active in all fields of building and construction-related research.

"As an organization, CIB is a relevant source of global information on construction-related research and innovation. It also provides an effective access point to the building and construction industry for the research community, and a reliable forum for practitioners and researchers," says Dr. Sherif Barakat, the current president of CIB.

The congress will provide an excellent forum for the presentation and assessment of new research results on a wide range of timely issues in building construction. Topics will include:

- the construction process
- trends in codes and regulatory systems
- construction in developing countries
- ventilation requirements
- strategies and control systems
- safety considerations in HVAC systems design
- indoor air quality and energy conservation
- occupant environment in high-rise buildings
- fire and structural safety
- security in tall buildings

The variety and insight of presentations can define the quality of a meeting; thus communications packages were sent in September to industry partners, universities, and government organizations calling for submission of abstracts. The deadline for abstracts is February 15, 2003. All abstracts and papers will be peer-reviewed.

Leading professionals from around the world make up the various committees responsible for organizing the congress, which is expected to draw around 700 participants from 40 countries.

As the countdown to the congress continues, regular updates will be posted on the Web site at www.cib2004.ca.

Newsbrief

Evaluating the effectiveness of window/wall interface details in managing rainwater

IRC and Canada Mortgage and Housing Corporation (CMHC) have just launched a collaborative research project to evaluate the effectiveness of various window/wall construction details in managing rainwater over the life of the wall assembly.

The study will:

- develop a procedure to assess the ability of such details to mitigate rainwater penetration into the wall assembly
- assess the water management capabilities of specific construction details for different types of windows for a given wall cladding system (e.g. stucco, vinyl, cement fibre, metal, brick) when subjected to simulated wind-driven rain conditions representative of the geographical regions of interest to those who join the project.

Results of the collaborative study will be used by CMHC to develop and publish a best practice guide for window installation that will be applicable to both low-rise wood-frame construction and high-rise residential buildings.

Both public and private organizations interested in improving the water-management performance of wall assemblies are invited to join this three-year project.

For more information, please contact Dr. Michael Lacasse at (613) 993-9715, fax (613) 954-5984, e-mail michael.lacasse@nrc.gc.ca, or visit the project Web site at www.nrc.ca/irc/bes/fenestra.

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CTU 55: Dynamic Wind Testing of Commercial Roofing Systems

You can find CTU's 1 - 48 in full text at: www.nrc.ca/irc/catalogue/ctu.html

Comprehensive Publications

Guidelines for the Condition Assessment and Rehabilitation of Large Sewers

78 p., 2001 - $25. Order NRCC 45130.

This new publication, developed with municipal engineers from across Canada, is an excellent resource for practitioners, and sewer system managers and personnel in the municipal infrastructure field. The user-friendly guidelines will help you: manage sewer inspection and rehabilitation based on rational, credible information; identify problem areas for large (person-entry) sewer systems; set priorities for corrective action and for future inspection; select appropriate inspection, repair, and rehabilitation methods; compare sewer costs and performance with those of other municipalities in Canada.

Deterioration of Concrete: Symptoms, Causes, and Investigation

90 p., 2000 - $40. Order NRCC 44494.

This comprehensive publication, intended for the engineer, specifier, chemist, materials scientist, and architect, describes the causes and nature of the most common durability problems in concrete. It explains the types of structures affected and the mechanisms of deterioration; presents the methods of investigating defects in materials and construction; and describes methods of evaluating structures using destructive and non-destructive testing and microscopic and instrumental analysis.

Durability and Performance of Gravity Pipes: State of Current Practice

48 p., 1998 - $20. Order NRCC 42559.

This publication summarizes the results of returns from questionnaires sent out to 80 municipalities across Canada and to all provincial departments of transportation about the inventory and condition of sewer pipes and storm drains and culverts. The information gathered ranges from the type and size of new culverts installed across Canada, to the rehabilitation techniques that cities used to correct problems with existing pipes.

Durability and Performance of Gravity Pipes: A State-of- the-Art Literature Review

60 p., 1998 - $30. Order NRCC 42868.

Currently, municipal engineers often choose the type of sewer pipe based on initial cost alone, but this publication can help you consider the life-cycle cost, by giving you valuable information on the performance and durability of four types of gravity sewer pipes. Pipe products and their materials and design are reviewed, and bedding and backfill types and installation procedures are examined. Resistance of the various pipes to fire, abrasion, and chemical and biological attack are discussed. A summary shows the best type of pipe to use for each situation.

Upcoming events

2003 FEBRUARY

8-13
85th Annual Conference Canadian Construction Association. Quebec City. http://www.cca-acc.com/conf2k3/home.html

9-12
AWWA/WEF Joint Management Conference. Dallas. http://www.awwa.org/conferences/jmc/

23-26
ROMA (Rural Ontario Municipal Association) and OGRA (Ontario Good Roads Association) Combined Conference. Toronto. http://www.ogra.org/home.asp

MARCH

20-22
"Work, Stress, and Health: New Challenges in a Changing Workplace." Toronto. Co-convened by the American Psychological Association, the (US) National Institute for Occupational Safety and Health, and Queen's University School of Business. Contact: Wesley Baker (202) 336-6030; wbaker@apa.org; http://www.apa.org/pi/work/wsh5/

23-26
AWWA Water Security Congress. Los Angeles. http://www.awwa.org/education/congress/

MAY

7-9
Eighth International Conference on Structural Studies, Repairs and Maintenance of Heritage Architecture 2003. Halkidiki, Greece. http://www.wessex.ac.uk/conferences/2003/stremah03/index.html

18-22
NFPA World Safety Conference and Exposition. Dallas. http://www.nfpa.org

29-June 1
2003 Structures Congress & Exposition. Seattle. http://www.asce.org/conferences/structures2003/

30-June 2
Competitive Communities, FCM's 66th Annual Conference and Municipal Expo. Winnipeg. http://www.fcm.ca/conference/main.htm

JUNE

1-4
9th North American Masonry Conference. Clemson, SC. http://www.masonrysociety.org/conferences/9NAMCmain.html

4-7
31st CSCE Annual Conference: Building Our Civilization. Moncton. www.csce2003.ca

11-13
56th Annual National CWRA Conference. Vancouver. http://www.cwra.org/cwra_main.html

15-19
AWWA Annual Conference & Exposition 2003. Anaheim, CA. http://www.awwa.org/ace2003/call/index.cfm

16-18
International Workshop High Performance Fiber Reinforced Cement Composites (HPFRCC4). Ann Arbor, MI. http://www.rilem.org

22-25
8th International Conference on Low-Volume Roads. Reno, NV. http://www.nationalacademies.org/trb/publications/conferences/2003LVR.pdf

23-26
World Water and Environmental Resources 2003. Philadelphia. http://www.asce.org/conferences/ewri2003/

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://www.nrc.ca/irc/whatsnew/events.html

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