NRC·CNRC
Institute for Research in Construction

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construction innovation

Material emissions studies lead to new software

Researcher examines a specimen used in NRC-IRC's extensive material emissions studies, which have provided the basis for its new IA-QUEST software.

One of the many challenges facing building designers is providing assurance that the indoor environment is healthy for the occupants. Although it has been known for some time that building materials and furnishings can emit volatile organic compounds (VOCs), it has been difficult to consistently measure their concentrations—and little has been known about their health effects. This means there has not been much guidance available to help designers select materials to reduce the exposure of occupants to potentially harmful emissions.

In the late 1990s, NRC-IRC launched a research program called the *Consortium of Material Emissions and Indoor Air Quality Modelling* (CMEIAQ) with the overall goal of developing guidelines for indoor material selection and ventilation strategies to meet specific indoor air quality requirements. Initial work resulted in the development of test standards to enable consistent measurement of the emissions from building materials and furnishings. Next, the new testing protocols were used to determine the quantity and composition of emissions for 48 commonly used building materials. Based on this information, an indoor air quality prediction software called IA-QUEST was developed.

Athough this was a good start, the database of material VOC emission characteristics was small relative to the number of materials and furnishings in the marketplace. A second stage of the research was initiated in 2000 to 1) expand the number of materials and chemical compounds in the database 2) advance the development of indoor air quality guidelines and 3) improve the software.

Now complete, the research has resulted in design aids that will make it easier for building designers to achieve lower VOC levels: The database now contains more than 2,300 combinations of materials and chemicals, and the software has been improved to make it more user friendly. This software can be used to determine whether materials and ventilation strategies meet a specific air quality guideline, and is available for downloading from the NRC-IRC Web site at http://irc.nrc-cnrc.gc.ca/ie/iaq/iaquest_e.html.

Even though it is known that VOCs can adversely affect health, much more research is needed to determine safe exposure levels for each type of chemical, taking into account the variations in people's sensitivities. In the meantime, the information from the material emissions research can be used to keep VOC emissions from building materials and furnishings as low as possible by facilitating the selection of low-emission materials.

Continued on page 11

Project partners

For a listing of project partners go to http://irc.nrc-cnrc.gc.ca/ie/iaq/iaquestpartners_e.html

Highlights

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CCBFC confirms new standing committees for next code cycle

At its last meeting in January, the Canadian Commission on Building and Fire Codes (CCBFC) established new standing committees and their chairs for the next code development cycle. A nominating committee was responsible for recommending changes to the Commission regarding the matrices of the standing committees and for nominating members of these committees to the CCBFC chair for appointment. With the approval of the CCBFC, the standing committees can now start their work on the next code cycle's initial code development priorities (see *Construction Innovation*, December 2005).

One of the significant changes regarding the structure of the standing committees was to split the former Standing Committee on Fire Safety and Occupancy into two committees—the Standing Committee on Fire Protection and the Standing Committee on Use and Egress, bringing the total number of standing committees to seven. The Commission acknowledged that the anticipated workload of the former (single) committee would have been very high and agreed with the recommendation of the nominating committee that it be split in two.

The names, terms of reference, chairs and Canadian Codes Centre contacts for each standing committee are as follows:

Standing Committee on Housing and Small Buildings. This committee is responsible for all requirements found in Part 9 Housing and Small Buildings of the National Building Code (NBC). It is also responsible for the related appendix notes and for the technical content of the NBC's ancillary documents, such as the National Housing Code and Illustrated Guide (NHC&IG).

Chair: Tom Cochren
Principal, Thomas Cochren Homes, Hamilton
Canadian Codes Centre contact:
Adaire Chown at (613) 993-0352 and
Nedjma Belrechid at (613) 990-8457

Standing Committee on Structural Design. The committee is responsible for structural design requirements in the national model codes related to structural loads and procedures; excavations and foundation design; structural materials (wood, masonry, concrete, steel, aluminum, glass); and for the design requirements related to special structures (air-supported structures, parking structures). These provisions are currently located in Part 4 of the NBC, in the Structural Commentaries on the NBC and in the National Farm Building Code (NFBC).

Chair: Russ Riffell
Manager, Construction Materials Division, Levelton Engineering Ltd., Richmond, BC
Canadian Codes Centre contact:
Cathy Taraschuck at (613) 993-0049

Standing Committee on Building and Plumbing Services. The committee is responsible for requirements for building services in the national model codes related to heating, ventilating, and air-conditioning and plumbing systems. These provisions are currently located in Parts 6 and 7 of the NBC, in the National Plumbing Code (NPC), in the Model National Energy Code for Buildings (MNECB) and in the NFBC.

Chair: Ken Newbert
Partner, Cobalt Engineering, Vancouver
Canadian Codes Centre contact:
Raman Chauhan at (613) 993-9633 and
Diane Green at (613) 993-0046

Standing Committee on Environmental Separation. This committee is responsible for environmental separation requirements in the national model codes related to heat transfer (except heat from fire); ingress of precipitation, surface water, and water in the ground; diffusion of water vapour; transfer of air and other gases, air-borne dust, spores and other particulates (except combustion products); air pressure loads including mechanical, stack effect and wind; and the transmission of sound. These provisions are currently located in Part 5 of the NBC, in Part 3 of the MNECB and in the NFBC.

Chair: Douglas Clancey
Principal, KWC Architects, Ottawa
Canadian Codes Centre contact:
Frank Lohmann at (613) 993-9599

Standing Committee on Fire Protection. This committee is responsible for the code requirements for building components and systems, including those at construction and demolition sites, that are related to structural fire protection; combustibility of building materials; fire spread within buildings, including smoke movement; fire spread to adjacent buildings; suppression of fires; and fire protection of fire alarm and detection systems. These provisions are currently located in Part 3 and Appendices B and D of the NBC, in Parts 2, 5, 6 and 7 of the National Fire Code of Canada (NFC), and in Parts 2 and 3 of the NFBC.

Chair: Tony Crimi
Founder of A.C. Consulting Solutions Inc., Toronto
Canadian Codes Centre contact:
Igor Oleszkiewicz at (613) 991-4807

Standing Committee on Use and Egress. This committee is responsible for code requirements related to the safety of occupants during emergencies; the safety of occupants during normal use; accessibility for persons with physical disabilities; fire safety planning; safety on and around construction and demolition sites (related to the movement of people); fire fighting access; health of occupants; and fire alarm and detection systems (related to the notification of occupants). These provisions are currently located in Parts 3 and 8 of the NBC, in Parts 2, 5 and 6 of the NFC and in Part 3 of the NFBC.

Chair: Greg Sereda
Associate, The Cohos Evamy Partners, Calgary
Canadian Codes Centre contact:
Claire Fréchette at (613) 993-9632

Standing Committee on Hazardous Materials and Activities. This committee is responsible for the requirements in the codes for the prevention, mitigation and control of hazards in buildings and outside areas, including underground areas, where activities posing a fire or explosion hazard are conducted; or where combustible materials, dangerous goods, flammable liquids or combustible liquids are stored, used, handled or processed. These requirements are located in Parts 2, 3, 4 and 5 of the NFC, in Parts 3 and 6 of the NBC and in Subsection 3.1.4 of the NFBC.

Chair: Ralph Bartlett
President, R.J. Bartlett Engineering Ltd., Fredericton
Canadian Codes Centre contact:
Philip Rizcallah at (613) 993-4064

Public review coming soon on proposed changes to hot water delivery requirements, insulating glass standards and plumbing fittings standards

The Canadian Commission on Building and Fire Codes (CCBFC) agreed at its last meeting in January to take proposed changes on three issues—hot water delivery in buildings, insulating glass standards and plumbing fitting standards—to national public review (see sidebar below). These proposed changes are being considered for possible inclusion in the 2005 National Plumbing Code (NPC) and the 2005 National Building Code (NBC) as Interim Changes.

Hot water delivery in buildings

In 2004, a task group with broad stakeholder representation was formed to examine the health and safety risks associated with hot water delivery in buildings. The standing committee responsible for the NPC reviewed the task group report in June 2005 and recommended to the CCBFC that technical changes be made to the code requirements. These recommended changes are as follows:

- The temperature of water supplied to a shower, bathtub or lavatory shall not exceed 49°C in all buildings.
- Service water heaters shall be set to provide a water storage temperature of not less than 60°C in all buildings.

The CCBFC concurred that this is an urgent matter and agreed to submit the proposed Interim Changes to the 2005 NPC and the 2005 NBC Part 9 to public review.

ASME/CSA B125 plumbing fittings

The CCBFC also agreed to take additional proposed Interim Changes to reference new ASME/CSA B125 standards to public review at the same time. The CSA B125 standard dealing with plumbing supply and waste fittings has been harmonized with the ASME standards, which have a similar scope. Referencing the ASME/CSA B125 standards in the 2005 NPC would complete the harmonization process.

ASTM 2190 insulating glass

At a previous meeting, held in April 2004, the Commission reviewed a request to add a reference to a new ASTM E 2190 standard on insulating glass to Part 9 of the 2005 NBC even though the proposed change had not gone through the normal public review process. The Commission did not agree to this request and asked that it go to public review at the earliest opportunity.

Public review to be held in May and June 2006

The public review on the proposed changes related to these three issues will take place over a two month period in May and June 2006. The proposed changes will be made available on May 1, 2006 on the National Construction Codes Web site at www.nationalcodes.ca/publicreview.

The public is invited to review the proposed changes and submit comments to increase the range of expert review on this subject and to allow those most affected by the proposed changes to give their feedback. Public comments will be reviewed by the standing committees in the fall of 2006. The CCBFC will then consider the report and recommendations of the standing committees on these matters at its next meeting, which is planned for late November or early December 2006. If these proposed changes are approved by the CCBFC, they could be considered as Interim Changes for inclusion in the 2005 NPC and 2005 NBC.

Further information about the Commission and these proposed Interim Changes can be obtained by contacting John Archer, Secretary to the CCBFC, at (613) 993-9960, fax (613) 952-4040, or e-mail codes@nrc-cnrc.gc.ca.

Newsbrief

CCBFC holds discussions on proposed three-year code development cycle

At its last meeting in January, the Canadian Commission on Building and Fire Codes (CCBFC) discussed the possibility of moving to a three-year coordinated codes development cycle.

The joint task group responsible for evaluating the coordinated codes development system proposed a shorter code development cycle to the CCBFC, which would work as follows:

With the publication of the 2010 national codes documents, a three-year code publication cycle would be initiated. It would be characterized by an annual public review of the proposed changes, with established dates for key activities. The new code development cycle would essentially comprise the publication of a new code edition on November 1, 2010 and every three years afterwards, a public review over a two month period every year in September and October, and the annual approval of technical changes that have been through the complete process. Requests for changes could be submitted at any time, and the provinces and territories would continue to be involved at every stage.

The Commission decided at its meeting that consultation with the provinces and territories, and other key code development participants, was needed before going ahead with this new cycle. This consultation activity is expected to begin in 2006.

If you have any questions or comments on the proposed three-year cycle, please contact John Archer, Secretary, Canadian Commission on Building and Fire Codes, at (613) 993-5569, fax (613) 952-4040, or e-mail john.archer@nrc-cnrc.gc.ca.

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CCMC

2005 EDITION OF REGISTRY OF PRODUCT EVALUATIONS NOW AVAILABLE IN BOTH CD-ROM AND BOOK FORMATS!

CCMC is pleased to announce the release of the 2005 edition of the Registry of Product Evaluations. The Registry of Product Evaluations contains evaluation reports and listings for over 500 products evaluated by CCMC. The documents can easily be found according to MasterFormat number, manufacturer's name, product name, or report or listing number.

For the first time, the Registry of Product Evaluations is available free of charge on CD-ROM. It is also offered in a soft cover book format for $5.00 (plus shipping and handling fees). The official version of CCMC's Registry of Product Evaluations, which is updated quarterly, can also be viewed free of charge on the Web at http://irc.nrc-cnrc.gc.ca/ccmc.

To order the 2005 edition of the Registry of Product Evaluations, please visit the NRC's Virtual Store at www.nrc.gc.ca/virtualstore or contact IRC's Publication Sales Department at 1-800-672-7990.

New CCMC Evaluation Reports

Company	Product Name	CCMC #	Description
Leak-Bye Incorporated	Leak-Bye	13201-R	A sub-floor perimeter drainage form creating an air space for interior water from basement walls to travel and drain to the aggregate bed under the concrete floor.
Carlisle SynTec Canada	Sure-Weld™ TPO	13206-R	A membrane comprised of a base layer of a thermoplastic polyolefin (TPO), a polyester-reinforced (scrim) layer and a TPO top layer, available in either white or grey, used as a mechanically fastened roofing membrane for low-slope roofing applications.
Stevens EP	Stevens EP	13207-R	A membrane comprised of a base layer of a thermoplastic polyolefin (TPO), a polyester-reinforced (scrim) layer and a TPO top layer, available in either white or grey, used as a mechanically fastened roofing membrane for low-slope roofing applications.
Northern Elastomeric Inc.	Northern G Ice and Stormseal	13210-R	A self-adhesive composite composed of modified asphalt reinforced with a glass fibre mat used as underlayment and eave protection under shingle, shake, concrete and tile roofs.

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

2005 Editions of National Construction Codes

NOW AVAILABLE!

The 2005 National Construction Codes are now available for purchase. They include the National Building Code of Canada 2005 (NBC), the National Fire Code of Canada 2005 (NFC) and the National Plumbing Code of Canada 2005 (NPC). These new documents offer many improvements over the 1995 editions, including close to 1,300 technical updates and new information for understanding what must be done to satisfy the Codes' provisions. The new National Construction Codes are clearer, easier to apply to existing buildings and more accommodating to innovation.

Printed versions are now available for purchase in two practical formats (binder and soft cover version) through the National Research Council's Virtual Store at www.nrc.gc.ca/virtualstore.

The CD-ROM versions of the 2005 NBC, NFC and NPC will be released in **June 2006**. Also available for purchase in **June 2006**:

- User's Guide – NBC 2005, Application and Intent Statements (CD-ROM only)
- User's Guide – NFC 2005, Application and Intent Statements (CD-ROM only)
- User's Guide – NPC 2005, Application and Intent Statements (CD-ROM only)
- User's Guide – NBC 2005, Structural Commentaries (Part 4 of Division B) (printed version and CD-ROM)

For more information on the 2005 National Construction Codes, please visit the National Construction Codes Web site at www.nationalcodes.ca

NRC-IRC researcher joins NIST team to survey Hurricane Katrina damage

Hurricane Katrina is now known to have caused the costliest natural disaster in U.S. history. To reduce the impact of such powerful hurricanes in future, it is important to carefully assess the destruction and absorb the lessons to be learned from this event so that mistakes and weaknesses in the built environment can be rectified.

With this general objective in mind, the U.S. National Institute of Standards and Technology (NIST) deployed three teams of engineers and scientists in October 2005 to survey the damage in the Katrina-stricken area. NRC-IRC's Dr. Habib Rahman participated in one of the teams that surveyed Mississippi and Alabama over a five-day period, making observations that could have an impact on the National Building Code and related Canadian construction standards.

It was apparent to the NIST survey team that storm surge was the most destructive agent along the Mississippi coastline. The depth of surge varied from 6 m in Biloxi to more than 10 m in Waveland. The worst hit structures were the casino barges, which are not permitted on land in Mississippi. Of the more than a dozen casinos built on barges and moored alongside hotels, almost all were torn loose and deposited inland by the storm surge. The casino decks on these barges, which are built like three- and four-storey steel-frame buildings, were badly battered by both wind and storm surge. In addition, four unmoored barges collided with and caused heavy damage to land-based buildings.

The team also observed that precast concrete parking garages performed very poorly in the hurricane. All six of these garages on the Biloxi-Gulfport coast suffered partial to complete collapse of the first deck and ramp. From visual surveys of these cordoned-off structures, the primary causes of failure appeared to be the narrow seating of the double-T deck beams and the weak connections of the supporting spandrels and beams to the columns. As well, upward pressure from the rushing and sloshing water may have caused bending failure of the deck beams, whose capacity to withstand upward pressure is reduced by the prestressing. Partial first-floor collapse was also observed in one six-storey residential building of precast shear-wall and hollow-core slab construction.

Post-tensioned parking garage severely damaged by a casino barge moored alongside

Collapsed precast parking garage deck, apparently caused by the lateral and uplift forces of the storm surge

Post-tensioned slab and beam systems found in two parking garages and one under-construction residential building observed near the coastline did not fare much better than the precast concrete garages. Storm-surge forces appear to have caused bending failure of the post-tensioned beams and slabs, which—like the double-T decks—are prestressed structures.

Steel and cast-in-place concrete-frame structures, on the other hand, withstood the storm surge well. However, the exterior walls of most such buildings were destroyed on the lower two floors. Even 200-mm-thick reinforced block masonry walls did not survive; only heavy masonry walls in some older buildings managed to do so, but there was still damage to the contents in the lower floors as a result of the flooding through broken windows and doors.

Continued on page 6

NRC-IRC provides technical support to Health Canada to reduce cigarette ignition propensity

As of October 1, 2005, Canada became the first country in the world to require a reduction in the propensity of cigarettes to ignite other materials, in order to reduce the number of related fires, with their associated fatalities and property damage. (In 2001, the last year for which full statistics are available, smokers' materials were associated with approximately 20% of all fires, 32% of all fire deaths and 16% of property damage costs.) Under the *Tobacco Act*, Health Canada has promulgated *Cigarette Ignition Propensity Regulations*, which use the ASTM E2187-04 method to regulate the ignition propensity of cigarettes.

To support Health Canada in developing these regulations, NRC-IRC's Fire Research program undertook a series of background studies to examine the ignition propensity of cigarettes sold in the Canadian market. The studies also established baseline data for evaluating the impact of these regulations in the future. In addition, NRC-IRC has provided technical information to industry (via Health Canada) that facilitates the establishment of private facilities for routine testing. NRC-IRC will continue to provide technical support to Health Canada in its efforts to reduce the number of cigarette-ignited fires and to provide quality control services.

NRC-IRC's facility is used to test the propensity of different types of cigarettes to ignite materials.

For more information about this project, go to http://irc.nrc-cnrc.gc.ca/fr/mfc/ignition_e.html. Specific questions can be directed to Dr. Joseph Su at (613) 993-9616, fax (613) 954-0483, or e-mail joseph.su@nrc-cnrc.gc.ca.

Climate Change Conference

The Engineering Institute of Canada invites you to attend the
EIC Climate Change Technology Conference
May 9–12, 2006
Ottawa

For more information and to register, go to www.ccc2006.ca

NRC-IRC researcher joins NIST team to survey Hurricane Katrina damage

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Other observations made by the team include the following:

- Wood-frame structures of some multi-family residential buildings failed.
- Small single-family dwellings over a large area along the coast were literally washed away by the storm surge, leaving heaps of rubble.
- Four highway and railway bridges in the bays lost their decks as they were knocked off by the storm surge. The deck structures of these bridges were apparently not anchored down.

The team's observations in the areas affected by Hurricane Katrina suggest that if structures are to be built in areas prone to high storm surge, storm-surge loads should be taken into account in codes and standards, and engineering solutions to these loads developed. Changing zoning laws so that building in the path of high storm surge is not permitted would be another solution. A review of the design principles of precast and prestressed structures to improve their robustness should also be considered. Requiring these structures to be designed for some minimum specified lateral and upward loads would not likely add significantly to their cost but could substantially improve their robustness against abnormal and accidental loads such as explosions and vehicle impacts.

A full report with recommendations will be issued by NIST in the near future.

Specific questions can be directed to Dr. Habib Rahman at (613) 993-6290, fax (613) 954-5984, or e-mail habib.rahman@nrc-cnrc.gc.ca.

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9. Would you like to see occasional articles on new technologies from other countries?
   ❑ Yes ❑ No
10. Do you share *Construction Innovation* with colleagues?
    ❑ Yes ❑ No
    If "Yes," approximately how many? _____
11. Do you know that *Construction Innovation* is also available on the IRC Web site?
    ❑ Yes ❑ No
    If "Yes," do you refer to back issues on the Web site?
    ❑ Yes ❑ No
12. Do you find the contact name or Web address provided at the end of each article useful?
    ❑ Yes ❑ No
13. If you access these Web addresses, do you then explore other parts of the IRC Web site?
    ❑ Yes ❑ No
14. What is your main occupation or business activity?
    ❑ Architect/Specification Writer
    ❑ Engineer/Consultant
    ❑ Technologist
    ❑ Home Builder/Renovator
    ❑ Contractor
    ❑ Owner/Manager
    ❑ Educator/Student
    ❑ Building Official/Inspector
    ❑ Fire Service
    ❑ Manufacturer/Supplier
    ❑ Bookstore
    ❑ Federal/Provincial Government
    ❑ Municipal Government
    ❑ Other: Specify

    _____
15. Judging from the content you are used to seeing in *Construction Innovation*, which audience groups, including your own, would benefit most from reading it?
    ❑ Architects/Specification Writers
    ❑ Engineers/Consultants
    ❑ Technologists
    ❑ Home Builders/Renovators
    ❑ Contractors
    ❑ Owners/Managers
    ❑ Educators/Students
    ❑ Building Officials/Inspectors
    ❑ Fire Services
    ❑ Manufacturers/Suppliers
    ❑ Federal/Provincial Governments
    ❑ Municipal Governments
    ❑ Other: Specify

    _____
16. Do you have suggestions for improving *Construction Innovation*?

    _____
    _____
    _____
    _____
    _____

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NRC-IRC WEB SITE can be found at: http://irc.nrc-cnrc.gc.ca/ *GO THERE!*

The NRC-IRC Web site is playing an increasingly important role in the dissemination of practical information and research results to users in the construction industry. On our site, you will find extensive information describing our current research activities dealing with the building envelope, urban infrastructure, fire safety, and the indoor environment.

Complementing our research and technology transfer activities is our leadership in support of the development and publication of the National Construction Codes (such as the National Building Code), and our national service for the evaluation of innovative construction products. These activities also figure prominently on our Web site. Links to other relevant construction-related sites, many of them belonging to our partners and collaborators, give you access to additional sources of useful information.

Once you have accessed our Web site, you can then enter the most popular part of our electronic world, the "**Publications**" section. You can do this by clicking on "Publications" in the blue banner at the top of the site, or by typing this URL:

http://irc.nrc-cnrc.gc.ca/pubs/index_e.html

The IRC Publications section opens up many doors for you. If you are looking for information on a certain subject, you can type in key words and search a database of all documents we have published since our inception in 1947. This convenient search capability will retrieve numerous titles linked to your area of interest. In the same area of the Publications section, you can ***subscribe to our weekly alert***, which allows you to be informed each Friday of new titles recently published, including the full-text publications that have been added to our database.

The Publications section also contains links to several series of full-text publications that are available free of charge, including some of our most popular series such as:

- Construction Technology Updates: These practical 4-6 page publications, part of a current series presenting applications of research results and reviews of building science issues, are intended for architects, engineers, specification writers, property managers, builders and building officials. All 65 of these titles can also be purchased in print form.
- Canadian Building Digests: This is a discontinued but still valuable series of 250 4-page treatises containing scientific and technical principles, background information and practical guidelines on virtually every aspect of building design, materials and construction in Canada, published between 1960 and 1990. These publications are no longer available in print form.
- Seminar Publications: This is a collection of publications and other documentation arising from building science and construction technology seminars presented by NRC-IRC over the years. Many of these are available for purchase in print form.
- Registry of Product Evaluations: The Registry contains all Evaluation Reports and Listings for products evaluated by our Canadian Construction Materials Centre, providing you with easy access to technical and standards-related data on hundreds of evaluated materials, products and construction systems.

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A favourite landing spot for our customers is our new Virtual Store. This is a safe, secure and convenient means for you to purchase the new 2005 construction codes and our practical publications in the language of your choice. You can enter the store at:

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Then click on "NRC Construction Publications," which will display a list of clickable buttons on the left-hand side.

We invite you to visit our Web site often, because we are constantly adding new information to keep you up to date on our current activities and the latest results from our research.

Crack sealant research: developing effective construction and material specifications

Spring may come and go like a lion or a lamb, but it always sees one sure thing: pavement crack repairs. Temperature swings, freeze-thaw cycles and an abundance of road salt through the winter take a toll on Canadian roads, causing pavement to crack on many streets and bridges. These cracks need to be repaired, but such repairs can cause long traffic delays and disruptions.

Researchers in NRC-IRC's Urban Infrastructure program, however, hope to minimize disruptions by extending the present three- to five-year service life of crack sealants to 12 to 15 years. This requires effective construction and sealant (material) specifications for crack sealants. Performance-based sealant specifications are developed in the laboratory (see sidebar on consortium) whereas construction specifications are reviewed and updated through continued field work.

Recent NRC-IRC field work on sealant installation has led to the development of a best practice guide, Guidelines for Sealing and Filing Cracks in Asphalt Concrete Pavements. This document, published by InfraGuide, provides the basis for state-of-the-art construction specifications and is available through their Web site at www.infraguide.ca in the Roads and Sidewalks section.

Road repair crews use bituminous sealants to repair cracks and joints in pavements, bridges and other structures in order to prevent water, brine and incompressible materials from damaging the pavement and shortening its service life. These sealants are "hot-poured" at temperatures typically between 180°C and 200°C, temperatures the material reaches after approximately three hours of heating under ideal conditions.

Reduced traffic disruption another possible result of crack sealant research

NRC-IRC Urban Infrastructure researchers have even more good news for motorists stranded in traffic jams waiting for road repair crews to complete crack fix-ups. They have found that currently recommended cooling times for crack sealants may be excessive and could possibly be halved, saving time and money for road crews and motorists alike.

In the past, road repair crews have protected sealants from traffic for about 30 minutes after installation to reduce or eliminate the risk of vehicles deforming them. There is no data available, however, on the suitability of the 30-minute protection period. To help fill this information gap, the researchers measured the cooling rates of three sealants in the field and in the laboratory.

They found that sealant temperatures were more than 50°C lower than application temperatures almost immediately after pouring, depending on the sealant and pavement temperatures and the amount of sealant poured. After 15 minutes on the ground, they found that the sealant temperature was 40°C, or less, a temperature at which early sealant deformation would not be a concern.

This finding indicates that the usual 30-minute time for sealant protection may be excessive and that roadways with treated cracks may reopen to traffic after 15 minutes thus reducing traffic disruption.

Specific questions on this work can be directed to Dr. J.-F. Masson at (613) 993-2144, fax (613) 952-8102, or e-mail jean-francois.masson@nrc-cnrc.gc.ca.

Crack sealant consortium

NRC-IRC, with the University of Illinois, Urbana-Champaign, leads a North American consortium of sealant users and producers whose goal is to develop guidelines to ensure the selection of bituminous sealants with superior performance and greater durability for crack and joint sealing. In the guidelines, sealant aging and weathering, sealant rheology and field temperatures, and the effect of the aggregate type used in the pavement are all taken into consideration.

Consortium partners

Canadian members	U.S. members
Canadian cities	Departments of Transportation
Calgary	Connecticut
Edmonton	Georgia
Hamilton	Michigan
Regional Municipality of Peel	Minnesota
Regional Municipality of Niagara	New Jersey
Toronto	New York
Winnipeg	Rhode Island
Department of National Defence	Virginia
Greater Toronto Airport Authority	Texas
Ministry of Transportation of Ontario	Washington, DC
McAsphalt Industries	New Hampshire
Ashwarren-Lafarge	University of Illinois,
National Research Council of Canada	Urbana-Champaign

Unfortunately, as the researchers observed, the heating conditions for the sealants are not always ideal, and sealants are often exposed to extended pre-installation heating times of more than three hours at temperatures around 150°C.

Continued on page 11

Typical crack sealing train

What we're hearing

Norway e-system streamlines zoning and building application processes

Applying for zoning or building approval can sometimes be a complicated and time-consuming process. To expedite matters, the government of Norway has developed an innovative secure online information-sharing system called ByggSøk that streamlines zoning and building application processes; and it seems to be well received by the Norwegian construction industry. Accessible to developers, designers, contractors and local government officials since 2003, the system is reportedly already handling 20 per cent of all zoning and building applications in Norway.

Based on a standard way of categorizing the different elements of a building (ISO 16739), ByggSøk allows for the online sharing of building model information between various software tools (such as those for location mapping, building design, and project bidding and tendering). Interestingly, it also includes a code compliance module that provides instant feedback to users about the conformity of the proposed project to existing codes and regulations.

The claimed benefits of the new system include reduced costs and errors associated with the processing and data entry of zoning and building applications, a more transparent, accessible government service, and significant time savings for all involved. The model generates all drawings and allows important design changes to be made in real time. When linked to 3-D visioning software, communication with clients and potential users can be greatly enhanced by 'virtual' walk-throughs.

Although the system is leading-edge technology at this stage of its development, there are some aspects that require attention when attempting to apply it in a different country. For example, the system has not yet been proven effective on completed, larger buildings. In addition, it is not clear how much investment would be required for national and local governments to program in and update their zoning and code requirements regularly, or who would be responsible for certifying code-checking modules developed by third-party software vendors. Design software presents yet another difficulty, as currently there are only limited available software options that comply with the system's method for categorizing buildings. However, ByggSøk is opening up a vast new market, and software product developers are quickly responding.

For more information on this project, visit http://www.byggsok.no/english/english.php or contact Guy Gosselin at (613) 990-0458, fax (613) 952-7673, or e-mail guy.gosselin@nrc-cnrc.gc.ca.

Using precast Portland cement concrete to build roads

At the recent 8th International Conference on Concrete Pavements, held in August 2005 in Colorado, there was extensive discussion on the use of precast concrete panels in the construction of roads.

The perception that it is not feasible or cost effective to repair Portland cement concrete (PCC) roads has led to limited application of this technology for road construction. The lengthy curing period required when PCC is poured in-situ may contribute to this perception.

Because there is a need for rapid construction to reduce the time for road closure, the use of precast concrete panels can provide a viable approach. The PCC slabs are manufactured at a plant and then transported to the site once the material has gained the necessary strength. Thus, repair and restoration can be scheduled, and executed during low-traffic periods within a short period of time (6 to 8 hours), depending on the size of the job.

Recently, the Ministry of Transportation of Ontario (MTO) carried out trials on Highway 427 to evaluate different precast slab repair techniques. These trials identified:

- processes for the effective removal of damaged road sections
- means for adequately preparing the base that supports the precast panel
- techniques for effective load transfer across new joints.

Recommendations emerging from the MTO trials focused on the need for precision when locating the dowel bar slots to ensure proper alignment of the precast slabs so that the dowel bars provide efficient load transfer from one slab to another. Precision is also required in determining the thickness of the precast slab to establish a smooth surface profile. In the MTO trials, the repairs were carried out within the required time frame and produced an acceptable ride quality.

In addition, the U.S. Federal Highway Administration (FHWA) and state departments of transportation (Texas, California and New York) have reported the results of successful trials involving different precasting options, including prestressed panels. Specifically, the trials showed that the prestressed approach enhances the longevity of roads by reducing the stresses in concrete associated with traffic travelling over PCC slabs resting on top of uneven base layers. This approach also allows for reduction in required slab thickness. The trials also indicated that the construction process can be further expedited by replacing dowel bars with post-tensioning across joints between newly installed slabs to improve load transfer efficiency.

For more information on this technology, readers can contact Dr. Elhussein H. Mohamed at (613) 993-3817, fax (613) 954-5984, or e-mail elhussein.h.mohamed@nrc-cnrc.gc.ca.

For more information on the Conference on Concrete Pavements go to http://www.concretepavements.org. Proceedings of this conference can be purchased at http://www.pavement.com/ecommerce/main.html (search by keyword: "proceedings").

International trends in performance-based building and fire codes

Over the last 20 years, several countries have embarked on various forms of regulatory reform aimed at making their building and fire codes more accommodating to innovation. The response of most of these countries has been to develop "performance-based codes."

NRC-IRC's participation in international committees and initiatives has helped the Canadian Commission on Building and Fire Codes (CCBFC) in its development of Canada's unique "objective-based codes" concept (see *Construction Innovation* March 2005), which has resulted in the September 2005 publication of new editions of the national construction codes (National Building, Fire and Plumbing Codes) in the new objective-based format.

The codes have retained the technical requirements that code users are familiar with, while at the same time providing important technical updates to them. These technical requirements constitute the "acceptable solutions" to which new information has been added. This new information consists of objectives, functional statements, and intent and application statements that will help code users understand the thinking behind every code requirement and facilitate the application of the codes to innovative designs and the renovation of existing buildings (see *Construction Innovation* September 2005).

The Canadian objective-based codes share many features with the performance-based codes that have been developed in other countries, but there is one major difference: the performance-based codes in these countries have not retained the "acceptable solutions" as a mandatory component. In these countries, a building can therefore be designed and built in compliance with only the objectives and functional statements, which are mainly expressed in qualitative terms with no measurable criteria or verification method. Some countries have developed quantitative fire-safety and structural performance criteria, but many areas of their codes have only qualitative statements.

After several years of using performance-based codes, lessons have been learned, and remedial measures are being considered in many countries. Although most of these countries agree that the development of measurable performance criteria for all aspects of their codes would be the ideal solution, they also recognize that this would require a very high level of effort, requiring the coordinated contribution of the international research community over a number of years. In the meantime, most countries are trying to provide more guidance to the decision-making process, but there is no consensus on the best approach.

Rather than undertaking major reforms of their codes, most countries are working towards better integrating them into the construction industry through education and training, qualification of the various actors, and through improved control systems, insurance and liability, and tools to evaluate compliance.

Some examples of recent initiatives include:

- guidelines on how to conduct fire-engineering analyses (England and Wales, Australia, New Zealand, Canada and the United States),
- risk-based methodology applied to the use of the codes (Australia, Japan),
- code compliance certification by the building and product evaluation industry in coordination with building regulatory authorities (England and Wales, Australia, New Zealand).

Some of the most noticeable impacts of the adoption of performance-based codes in these countries are the higher qualification requirements for those involved in the decision-making process and an increasing reliance on third-party assessment—in some cases mandated—to determine compliance to codes.

To know more about Canada's code system, visit www.nationalcodes.ca.

Specific questions can be directed to Denis Bergeron at (613) 993-5659, fax (613) 952-4040, or e-mail denis.bergeron@nrc-cnrc.gc.ca.

Material emissions studies lead to new software

Continued from cover

The recent completion of the material emissions project significantly increases the store of knowledge in this domain and provides new tools to help the construction industry manage indoor air quality. NRC-IRC will continue to add to the material emissions database according to the needs and priorities of its stakeholders, and as new products and building techniques evolve.

For more information, please contact Dr. Doyun Won at (613) 993-9538, fax (613) 954-3733, or e-mail doyun.won@nrc-cnrc.ca.

Crack sealant research

Continued from page 9

To determine what happens to the sealant under these conditions, the researchers collected heated sealant every hour after a contractor started the sealing of pavement cracks.

Using a variety of methods, the researchers found that the sealant was in its most degraded state early in the morning after long pre-installation heating at moderate temperatures, approximately 40°C below the recommended installation temperature. This extended heating caused the material to degrade, which led to sealant stiffening caused by a change in polymer structure, as well as a loss in bitumen and polymer content. The researchers also found that the applied sealant always contained a significant amount of degraded material, even when fresh sealant was added to the reservoir throughout the day.

To remedy the problem, the NRC-IRC researchers recommend that construction specifications, as found in the InfraGuide on crack sealing, account for the time and temperature to which hot-poured sealants are heated both prior to and during installation when crack and joint sealing work is being done.

Specific questions on this project can be directed to Dr. J.-F. Masson at (613) 993-2144, fax (613) 952-8102, or e-mail jean-francois.masson@nrc-cnrc.gc.ca.

Upcoming events

APRIL

Technical seminars on the 2005 National Construction Codes

Seminaires techniques sur les Codes nationaux de construction 2005

For more details go to www.nationalcodes.ca/seminars

Note: Remaining seminars in French only

Quebec
April 4 and 5, 2006
Hotel Plaza Quebec
3031 Laurier Blvd.

Montreal
(French)
April 6 and 7, 2006
Holiday Inn Montréal-Midtown
420 Sherbrooke St. West

Montreal
(French)
April 10 and 11, 2006
Holiday Inn Montréal-Midtown
420 Sherbrooke St. West

23
Symposium on Heat-Air-Moisture Transport: Measurements on Building Materials. Toronto. http://www.astm.org/MEETINGS/COMMIT/C16symp.html

30
2006 Pavements Conference. Atlanta GA. http://www.asce.org/conferences/pavements2006/

MAY

9-10
16th Canadian Thermal Analysis Society (CTAS) Annual Workshop and Exhibition. Mississauga, ON. www.ctas.org

9-12
EIC Climate Change Technology Conference. Ottawa. www.ccc2006.ca

9-13
NATO Advanced Research Workshop on Computational Models of Risks to Infrastructure. Primosten, Croatia. http://www.enconet.hr/arw2006/

23-26
2006 Canadian Society for Civil Engineering Annual General Meeting & Conference. Calgary. http://www.csce2006.ca/

JUNE

11-15
AWWA Annual Conference & Exposition (ACE). San Antonio, TX. http://www.awwa.org/ace06/

14-16
International Conference on Computing and Decision Making in Civil and Building Engineering. Montreal. http://www.icccbexi.ca/

AUGUST

27-30
8th Annual Water Distribution Systems Analysis Symposium. Cincinnati, OH. http://www.eng.uc.edu/wdsa2006/

SEPTEMBER

7-8
2nd CIE Symposium on Lighting and Health. Ottawa. http://irc.nrc-cnrc.gc.ca/ie/lighting/health/cie_e.html

24-27
Western Canada Section American Water Works Association Annual Conference. Winnipeg. http://www.wcsawwa.net/

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

construction innovation

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