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Gallagher, J. F.

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An Update on IRC Research Activities

By Jim Gallagher

This article gives highlights of current research being conducted by the Institute for Research in Construction.

The Institute for Research in Construction (IRC), part of the National Research Council of Canada, serves Canada's construction industry with a diverse program of services in research, building code development, materials evaluation and technology transfer. Working with partners nationally and internationally, IRC addresses construction issues that have a significant economic impact. The accent is on promoting and developing innovative technologies that improve the performance and durability of built facilities, enhance occupant satisfaction and safety, increase industrial competitiveness, and protect the environment. There is an increased emphasis on life cycle costing. A hallmark of IRC's research is its multi-disciplinary strategy, enabling a holistic approach to the investigation of problems.

Building Envelope and Structure Research

Technologies for the design, construction and operation of durable, energy-efficient and cost-effective building envelope systems is one key focus of IRC's research services. In a pivotal consortium project, IRC is studying how to best control moisture from four sources: construction moisture, moisture from interior air, moisture from exterior air, and moisture in the form of precipitation. The goal is to produce water-management ratings for specific types of wall systems and lead, ultimately, to moisture-management guidelines that can be used throughout North America. IRC is a world leader in the modelling of thermal and moisture effects on the building envelope.

Through another consortium project, IRC is continuing its ground-breaking work assisting industry to evaluate the response of roof systems to dynamic wind loads. The goal is to reduce wind damage and repair costs. The state-of-the-art facility developed for the project is being used not only for evaluating dynamic wind loads but also other environmental parameters such as temperature and relative humidity.

Work continues on developing ways to enhance the performance of sealed insulating glass units and to develop improved evaluation methods, such as infrared technology. A highly successful study of basement wall systems (including interior and exterior insulation) and masonry wall systems is leading to guidelines to help industry design for more functionality and durability.

Fire Research

IRC operates a comprehensive fire research program in an effort to improve public safety in buildings and to reduce the high cost of fire to Canadian industry. Emphasis is on structural fire protection, fire barriers, fire detection, fire suppression, and smoke management. The development and refinement of computer models for fire risk assessment of buildings is a key component of the research. Close collaboration with other research programs within IRC allows the development of fire-safety solutions that consider related issues, such as sound transmission and indoor air quality.

FiRECAM™ and FIERAsystem are computer-based fire risk assessment tools that can be used to evaluate fire protection options, risks and costs for office, apartment and light-industrial buildings. Both models simulate fire growth and spread, smoke movement, occupant response and evacuation, and fire department response and effectiveness. Work is underway to extend their modelling capabilities to other buildings, such as industrial plants, arenas and shopping malls. Both models have been developed to support Canada's move from a prescriptive-based system of construction codes to one that is objective-based.

The response and evacuation of building occupants are among the key factors considered in the two models. Data is gathered from extensive research conducted by IRC on human factors in fires. Evacuation drills in residential and office buildings also provide input.

Finding environmentally benign, cost-effective options to replace halon for fire suppression is now an international priority and IRC is actively engaged in evaluating the performance of various technologies. Currently, full-scale fire tests are being conducted using water mist, gaseous agents and streaming agents.

In a collaboration with the University of Ottawa, fire researchers have initiated a study of the feasibility of using Brillouin scattering based distributed fiber optic sensors to provide early fire detection in applications where small fires might be encountered.

The Indoor Environment

IRC's Indoor Environment program studies such elements as acoustics, lighting, thermal comfort, ventilation, and air quality to develop a clear understanding of how these elements, singly or in combination, affect occupant satisfaction, performance and health.

In the area of air quality, IRC is working to develop information on the emission characteristics of building materials and furnishings, and to create the models and input data needed to predict indoor air quality levels. In a three-year project completed in 2000, researchers developed a computer program, consisting of a material emission database and a single-zone indoor air quality prediction model. The database currently contains emission data for 48 commonly used building materials. Building designers can use the program to make choices regarding building materials and ventilation strategies, in order to strike an acceptable balance between indoor air quality and energy efficiency. Manufacturers can use it to assess how their products will affect indoor air quality. A second three-year project started in April 2001 is addressing the environmental factors that influence emissions of volatile organic compounds, as well as issues regarding impacts on health. Health Canada is participating in the second project and a new Health Advisory Committee will provide guidance on the health issues.

Another project is investigating how the design of an open-plan office space can affect the indoor environment, especially the satisfaction of employees with that environment. Working with major landlords and industry-leading manufacturers, this project is seeking to quantify these effects in order to provide designers and facility managers with guidelines for making the best choices for the workplace. Findings from studies in office space mock-ups, computer simulations, measurements in real office buildings, and literature surveys will be integrated into software tools enabling users to explore the effects of workstation size, partition height, ceiling tile properties and many other office

design parameters. Complementary projects are addressing specific aspects of acoustics, lighting and air quality in the office environment.

There is increasing recognition that high-quality lighting is about more that just good visibility for carrying out tasks. Patterns of light and dark can affect occupant environmental satisfaction and mood, and there is good reason to believe that improved satisfaction and mood are beneficial to occupants and the organizations they work for. In both daylit and non-daylit spaces, IRC is conducting research to discover what aspects of the luminous environment are important in determining satisfaction. Also of interest is how occupants respond when they are not satisfied, through the use of lighting controls or window blinds, for example. The goal is to define high-quality lighting that can be provided with as little energy as possible; this can be achieved by using targeted low-energy electric lighting technologies, intelligent controls, and daylight instead of electric lighting.

To help users take full advantage of the energy benefits of skylights, IRC launched a project to develop software to analyze the optical and thermal characteristics and indoor daylighting performance of conventional skylights and tubular skylights (light pipes). The software will enable users to vary such parameters as the shape of the skylight, the optical characteristics of the glazing, and the characteristics of the indoor space below the skylight. The software will consider not only the optical and thermal characteristics of the skylight system, but also indoor daylight availability.

On the ventilation side, collaboration between IRC and Japanese researchers examined the performance characteristics of mechanical ventilation systems and found that a minimal ducted supply/exhaust system was the most suitable for houses without forced-air heating. Follow-up work is exploring hybrid ventilation systems and their performance under climatic conditions typical of Canada and Japan. Thermal comfort, noise levels, energy consumption, and installation costs are being investigated.

The Canadian Centre for Housing Technology

The twin research houses at the Canadian Centre for Housing Technology (CCHT) are currently being benchmarked in preparation for this winter's testing of innovative space and water heating systems. The new products, being developed under the eKoComfort program led by Natural Resources Canada (NRCan), will combine space heating, domestic hot water heating and heat recovery ventilation in a single integrated unit. The project presents opportunities to combine efficiencies and to evaluate improved motors and system controls.

During the summer of 2001, changes were made to both houses so that they can accommodate residential co-generation systems including fuel cells. The new configuration will be tested this winter in anticipation of receiving the first prototype fuel cell units at CCHT in the fall of 2002.

CCHT, which is a partnership between NRC, Canada Mortgage and Housing Corporation, and Natural Resources Canada, also offers excellent business opportunities to Canadian manufacturers of innovative solutions. The InfoCentre, a three-unit row house located near the two research houses, is inviting manufacturers of new

technologies to demonstrate their products with a permanent working display at CCHT. The Centre, which greets foreign visitors year-round, is an ideal showcase for technologies designed for the residential market. For more information, manufacturers should contact the CCHT Business Manager, Luc Saint-Martin at (613) 991-0960 or Email at luc.saint-martin@nrc.ca

For more information on IRC, please access www.nrc.ca/irc

You can read IRC's newsletter, Construction Innovation, online at: www.nrc.ca/irc/newsletter/toc.html

Jim Gallagher is Manager of Publication Services at NRC's Institute for Research in Construction. He can be reached at jim.gallagher@nrc.ca