Memories of IRC: a recounting of some of our major achievements: 1947-1997

National Research Council of Canada. Institute for Research in Construction

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https://doi.org/10.4224/20373881

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NRCC-53603

September 1997

A version of this document is published in / Une version de ce document se trouve dans:
Ottawa : National Research Council Canada, pp. 1-10

National Research Council Canada | Conseil national de recherches Canada

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Memories of IRC: A Recounting of Some of Our Major Achievements, 1947-1997

Institute for Research in Construction

IRC

ROBERT BULLIS

IRC celebrates 50 years: consortia speed pace of innovation

The National Research Council's Institute for Research in Construction has developed a reputation as a centre for innovation over its 50-year history; today, its government-industry consortium initiatives are accelerating the pace of that innovation.

A relatively new mode of research funding and management, consortia bring researchers together with those operating on the vanguard of the industry: manufacturers, contractors, suppliers, consultants and industry associations. The result is productive exchanges of practical experience and scientific research that over the past 10 years have contributed better products, techniques and knowledge to the industry.

IRC consortia involve large-scale research projects underwritten not only by private-sector firms, but by government agencies involved in construction. And they have become a key entry point for industry participants seeking early access to the kind of knowledge that provides a competitive edge in a market where innovation can mean lower costs, larger profit margins — and success.

"IRC was one of the early agencies to make the move into public-private co-operation," says George Seaden, Ph.D., P.Eng., IRC's director general. "Two driving forces made it happen: government deficit reduction, and the challenge inherent in transferring technology from the laboratory to the building site."

Over the past decade, IRC's budget has shrunk by approximately 40 percent. Seaden notes, however, that its research activity has never diminished. "That provides an indication of the change in the funding mix that has taken place, thanks largely to the consortium process."

With the continued cutbacks to public funding, IRC realized it needed to find other ways of funding research. Asking the people who benefited from the research to help fund it seemed logical, but the request came as somewhat of a shock to those used to the long tradition of government underwriting most Canadian construction research. Today, collaborative-type research efforts account for 60 to 80 per cent of IRC's budget, with consortia forming an ever-increasing portion.

One reason for the interest lies in a consortium's capacity to facilitate technology transfer. The old way involved IRC researching new technologies, and delivering them to potential industry users who often needed convincing of the innovation's practical worth. With consortia, the industry is involved in funding, guiding and conducting the research process, so the research results arrive with credibility and proven applications. Because consortium members have immediate access to the research results, they become leaders in the new technology, with other users picking it up from them.

According to IRC analysis, early access to research results is one of the most important reasons for industry's consortia participation. Many participants also seek to learn from each other and from the researchers in a co-operative environment.

Les Richardson agrees with this observation. A senior researcher with Forintek, the wood industry's research arm, Richardson is involved with two IRC consortia studying the noise-control and fire-resistance ratings of wood-frame wall and floor assemblies. "It is a large enough project that the wood industry would never have done it on its own," he says. "But by dealing with IRC, we have brought together all the affected industries — not just the wood industry, but the steel-framing industry, gypsum-board manufacturers, insulation manufacturers and concrete interests — into one huge program in which an unbiased evaluation of all our products can be carried out."

Other consortia concentrate on a common problem, rather than an improved product. In western Canada, for example, longitudinal sidewalk cracking is a persistent problem. Because no-one could explain the mechanism underlying the problem, six western Canadian municipalities joined IRC several years ago to underwrite a study seeking solutions.

Some consortia develop out of the need for shared facilities, since testing may require large, expensive, specialized set-ups, with experts to run them. While such facilities may be far beyond the reach of individual organizations, a consortium can pool resources to provide the necessary funding. IRC's indoor-environment facility is an excellent example: IRC proposed to industry that it help underwrite the cost of a laboratory in which one could investigate and measure the various factors — lighting, air quality and acoustics — affecting the indoor environment. Today, the shared facility works with other research organizations around the world to further our understanding of the optimum indoor conditions.

Of course, consortia exist primarily to increase knowledge, create better construction guidelines or encourage higher standards. One of IRC's early consortia dealt with both a common problem — deteriorating parking garages — and the need for better product knowledge.

Most IRC consortia get their start the same way: IRC approaches industry with a research proposal it believes is of value to all potential partners. In other cases, one consortium breeds several related projects as participants see first-hand the benefits of the collaborative process.

While it was difficult to get the first consortia going, they are now so successful that future consortia are almost overcrowded. The industry as a whole benefits from the knowledge gained and the new products and technology developed. And IRC obtains a wealth of information, including hard engineering data, which it uses to develop predictive models. This helps it fulfill its mandate, namely to help the industry deliver its goods and services at the highest quality possible at the most reasonable cost, while protecting public safety through improvements to fire and building codes. CE

ROBERT BULLIS

IRC celebrates 50 years: *the institute's major achievements*

From the institute's beginnings as the Division of Building Research, it was clear that climate was a crucial factor influencing the design and performance of Canada's buildings and structures. Obviously, one dominant climatic element in Canada is snow. One of the first snow-related projects undertaken was an investigation of the properties of the annual snow cover across the country. Researchers, using a kit of instruments they designed specially for the task, took measurements of snow depth, density, temperature, grain size, grain type, and compressive strength.

Snow loads on roofs was an issue of critical importance to designers and builders. A Canada-wide survey led to rationalized design snow loads in the 1965 National Building Code. The work also led to the calibration of wind-tunnel and water-flume tests for obtaining snow loads on unusual roofs, and to the calibration of an analytical model for snow drifting, developed by a private firm.

The impact of snow is also felt in a large way in avalanches, another area of study in which IRC researchers gained global acclaim. Their research, which began in the late 1950s, found practical application when roads and railways were being constructed and maintained in avalanche-prone areas, such as Rogers Pass in the Canadian Rockies. Disruptions to the rail line through the pass were so frequent and serious that a tunnel was later constructed to avoid the danger. When the Trans-Canada Highway was built, IRC research was instrumental in developing appropriate defence systems such as snow sheds.

Also in the geotechnique arena, there was considerable research conducted on permafrost, muskeg, soil and ice. In every one of these areas, this research had a profound effect on Canadian construction practices, and indeed, on the location of facilities and even towns. For example, virtually all current design guidelines for using ice surfaces for load-bearing purposes, such as roads and airfields, is based on work by IRC researchers, who spent many years studying the microstructure and properties of ice.

The results of IRC's extensive field work — begun in the 1950s in the permafrost zones in Canada's North — were drawn together in books such as "Permafrost in Canada: Its Influence on Northern Development," and "Permafrost: Engineering Design and Construction."

Photo: courtesy of IRC

Wind pressure on low- and high-rise buildings was measured to confirm and calibrate wind-tunnel tests used to obtain wind loads for design. This work also led to research on the structural strength of windows under wind loads and to the first standard in North America for structural design of glass for buildings.

Early work on building materials and design focused on testing insulation materials for their insulation value. Studies of the building envelope as a system greatly advanced the understanding of heat, air and moisture transport through walls, leading to the development of improved wall construction techniques. One revolutionary system pioneered and promoted by IRC was the rainscreen wall for controlling the effects of rain (and other exterior moisture) on walls. This work also demonstrated the importance of air barriers, which are vital to controlling air leakage, the main carrier of moisture entering walls from the inside.

Significant advances have occurred in window technology, especially sealed glazing units. Today part of the work in this area entails the use of warm-edge technology to control condensation and the development of techniques to assure the integrity and long-term performance of units filled with inert gases such as argon.

The 1970s saw a rapid expansion in research aimed at improving the energy efficiency of buildings. IRC made major advances in this area, particularly in the air-tightening of building enclosures. When air-tightness led to concerns about indoor-air quality and condensation, IRC was there with ventilation research.

Acoustics, an important aspect of the indoor environment, has been a hallmark of IRC work since the earliest days, when researchers developed guidelines for house construction near airports, railways and roads, specifying how to minimize noise intrusion. A more recent product has been publication of sound-insulation data for gypsum-board and concrete-block walls. For those who design and build the world's concert halls, the work of IRC acoustics researchers made the evaluation of concert-hall acoustics a quantitative science.

Since building research extends from top to bottom, IRC sought to advance the technology of foundation design and construction. This work, of particular significance for residential and small-building construction, and for buildings and structures in the North, was incorporated into the National Building Code and the Canadian Foundation Engineering Manual.

Developments in limit-states design brought together research on structural loads, materials and their variabilities and failure probabilities, to give a new approach to structural design in the National Building Code and Canadian standards.

Thanks to the efforts of IRC researchers, guidelines for the seismic evaluation and upgrading of building structures are now available for engineers to use in Canada's pockets of seismic activity, especially in British Columbia, Ontario and Quebec. Recent research on building vibration caused by buses, freight trains and subway trains has led to a clear understanding of the problem and to development of remedial measures. Floor vibration in buildings caused by the activities of people has also been studied: design criteria have been incorporated into the National Building Code.

A research paper published in 1970, "A New Model For Hydrated Portland Cement," is another IRC research effort that had a profound impact on the construction industry, vastly increasing our knowledge of cement — its chemical, physical and mechanical properties — and making possible the whole range of concrete research and development that has followed. Some of that research deals with the repair and protection of reinforced-concrete structures, and the use of fibre-reinforced plastic to prevent corrosion damage.

Obviously, a vast range of IRC research advances the National Building Code, which stands as one of the most significant contributions of this institute to Canadians and our construction industry. Founding director Robert Legget saw the benefit in linking code-development with research: IRC researchers continue to support the work of the industry committees that develop the National Building Code and other national codes.

The many books and publications that have come out of IRC have served not only as guides for practising engineers, architects and builders, but also as reference texts in post-secondary educational institutions. The Canadian Building Digest series, which ran from 1960 until 1988, and "Building Science for a Cold Climate," are still used in schools of engineering, architecture and building studies. "Roofs" is another major IRC book that has enjoyed great popularity, and numerous other works penned by IRC staff have been published privately throughout North America. CE

In our May/June issue Robert Bullis will trace the evolution of some of IRC's recent consortium projects. A review of IRC fire research will appear in the July/August issue of CCE.

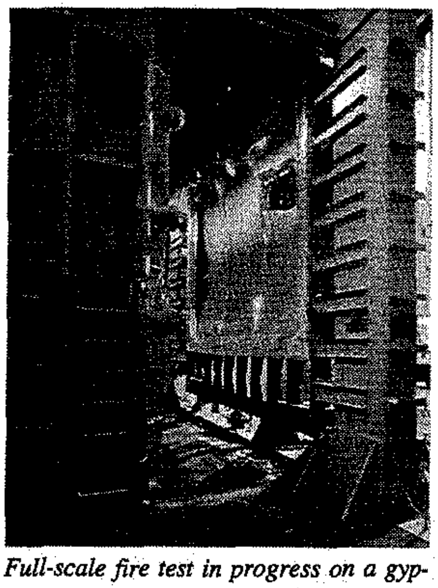
ROBERT BULLIS

IRC celebrates 50 years: NFL plays role in reducing fire cost

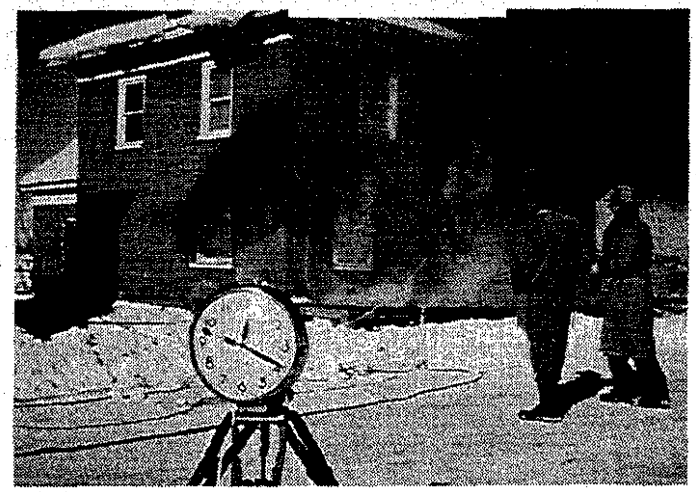
On the evening of Sept. 16, 1949, the Great Lakes cruise ship S.S. Noronic caught fire at her berth in Toronto harbor. Fire spread quickly through the Noronic, turning her into an inferno that ultimately claimed the lives of 118 passengers. It was a tragedy on a massive scale, and it stunned the nation.

Canadian and foreign newspapers featured the story on their front pages, and when the shock gave way to a demand for answers, authorities recognized the need for a better understanding of fire and the ways we can protect ourselves from it.

One of the most tangible and productive outcomes of the event was the 1951 founding of a fire-research section at the National Research Council's Division of Building Research, which had been established only four years earlier. The fire section later became the National Fire Laboratory, an entity that has yielded invaluable insight into fire, resulting in building practices, materials and fire-safety systems that save lives and reduce the total cost of fire. Canada's premier centre for fire research, the NFL has unique full-scale fire-test facilities, an array of specialized equipment and a contingent of dedicated researchers.



Full-scale fire test in progress on a gypsum-board wall (1994).



Researchers observing the "St. Lawrence burns."

The lab occupies a specially designed building in Ottawa as well as a huge facility near Carleton Place, just west of Ottawa, where large-scale studies are conducted. The latter's 2,000-square-meter burn hall can accommodate almost any kind of test scenario and it has a 10-storey tower for studying smoke control and fire in tall buildings.

"The total cost of fire — which means the cost of fire protection, fire equipment, fire services and actual fire losses, as well as the value assigned to lives lost and injuries suffered — amounts to about $12 billion annually in Canada," says Ken Richardson, head of the NFL. "This is a staggering cost to the country, but at the NFL, all of our efforts have been directed toward reducing this cost.

"Over the years we have made great strides, exploiting our research findings by applying them to practical-application technologies that solve problems in a cost-effective manner."

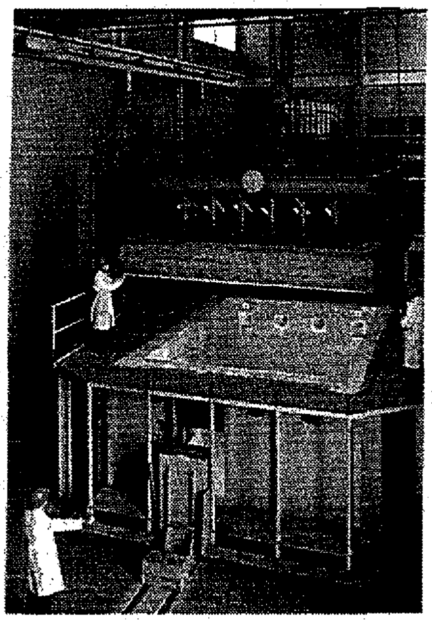
One major activity of the NFL was its research into smoke movement and control in high-rise buildings. Researcher George Tamura and his colleagues addressed the problems in the early 1970s, placing Canada at the forefront of this field. NFL research found practical application in design and construction considerations and codes (at home and in foreign countries) for these structures. Canada remains a leader, with current research efforts aimed at smoke control in large atrium buildings.

Earlier in the lab's history, research was conducted to calculate acceptable spacing between buildings in order to reduce the risk of fire spreading from one structure to another. Valuable insight was gained through a significant project called the "St. Lawrence Burns." Researchers set fire to six dwellings and two larger buildings that were abandoned in areas to be flooded as part of the St. Lawrence Seaway development. In planning the burns, particular attention was given to those measurements that would yield information on fire spread between buildings. In the end, research by the NFL's Gordon Shorter (the first head of the fire section), John McGuire and George Williams-Leir led to important changes to the National Building Code of Canada and other international codes.

Many Canadian engineers and architects are aware of the concept of using window sprinkler systems to contain fire in large buildings: this is another NFL accomplishment. The work of researchers Andrew Kim and Gary Lougheed during the 1980s has meant that most large buildings today are able to offer open-concept interior design while providing good fire protection at a reasonable cost.

There have, and continue to be, major research programs at the NFL dealing with the fire resistance of building materials and components. Earlier work by Tibor Harmathy (a former lab head), Tiam Lie and Murdoch Galbreath focused on typical concrete and steel structural members: simple techniques to calculate fire resistance were included in the National Building Code.

Current research on advanced composite materials such as FRP-reinforced concrete, concrete-filled hollow-section steel columns and high-performance concrete is providing designers with the calculation tools and test results they need. As well, significant effort is being expended on light-weight wood and steel floor and wall assemblies as these cost-effective systems become more widely used in larger buildings. Eighteen partners are now collaborating with the NFL on a project dealing with light-weight floors headed by Mohamed Sultan.



The fire-research facility built in the 1960s to determine fire endurance of floors (shown here), ceilings, beams and columns.

A key tool in the battle to reduce the total cost of fire — FiRECAM, a powerful fire-risk and cost model — was developed by IRC researchers David Yung and George Hadjisophocleous in collaboration with fire-research experts at the Victoria University of Technology in Australia. FiRECAM permits the objective evaluation of different building designs on the basis of both fire risk and cost. Estimates indicate that use of the model can yield savings of up to 5 per cent of the cost of a construction project by reducing the cost of fire-safety technology (by removing unnecessary safeguards that provide little fire deterrent, for instance, or showing how cost-effective fire-safety options can provide equivalent safety).

The foregoing research and development projects exemplify the work underway at the NFL, an organization considered to be one of the top three fire-research centres in the world.

NRC-CNRC Construction Technology Series

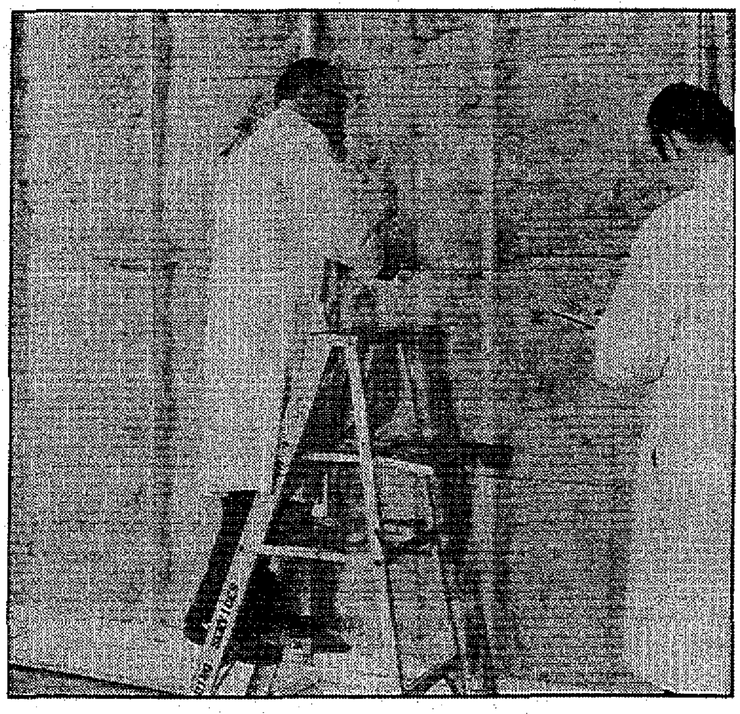
A series of technical articles on construction technology and related subjects attributed to research and development activities at NRC's Institute for Research in Construction

Institute for Research in Construction: 50 Years of Building Envelope Research

by Robert Bullis

The principal function of a building is to shelter its occupants and its contents from the weather — a fact that's widely appreciated in a country like Canada, with its geographical variations and climatic extremes. Of course, in serving this function, the building envelope — walls, windows and roof — plays a central role in separating the inside from the outside. This article focuses principally on walls.

Since its earliest days, NRC's Institute for Research in Construction (IRC) has worked to make this enclosure system work effectively by studying and developing solutions to problems related to air flow, moisture penetration, heat loss and condensation — multi-faceted issues influenced by climate, available building materials, technology, economic factors and building practices.



Early IRC research on insulation revealed that the fit of insulation in stud spaces of wood-frame walls and the stability of the insulation in place can affect the performance of the wall.

A Pioneering Effort in Insulation

Formed in the immediate post-War years, when there was a building boom, particularly in single-family dwellings of wood-frame construction, and in multi-family dwellings of three or four stories, the new research organization (originally called the Division of Building Research) had to quickly tackle problems related to wall performance, occupant comfort and energy conservation.

One important early contribution was the testing of various types of insulation to determine thermal resistance values (R Values) and to see how the performance of insulation was affected by building and installation practices. This activity had serious implications for the insulation industry, and for Central (now Canada) Mortgage and Housing Corporation (CMHC), Canada's federal housing agency responsible for all government housing stocks and new home construction.

One result of this early work was the development for CMHC of provisional thermal performance requirements for insulated wood-frame walls. The research also formed the basis for the evaluation of a number of non- traditional wall designs in subsequent years.

The Revolutionary Rainscreen Wall

In the 1960's the performance of the building envelope against rain penetration was improved dramatically with IRC's promotion of the revolutionary "rainscreen" concept for wall construction. This concept was to construct a wall with an air space, or air barrier, between the outer shell and the main wall structure. This equalized outside and inside air pressure on the cladding so that water penetrating the cladding or entering through holes, would run down the inside shell and out through appropriate drains.

Through their work on the rainscreen wall and numerous other efforts, IRC researchers demonstrated the importance of treating the building envelope as a system, with a number of key components, including insulation, playing a role to ensure effective performance. The need for air barriers and vapour barriers became obvious, with research playing an major role in defining their use and differentiating between them. Air barriers evolved from the realization that air leakage was a key carrier of moisture through the envelope and a major cause of condensation problems. Important work has been done in defining the key elements that ensure the proper construction and performance of air barriers.

Part of IRC's work on airtightness was the creation of computer programs for calculating the air infiltration component of building heating loads. This enabled designers to predict air infiltration more precisely, to appreciate its importance in heat loss, and to match the heating system to the load.

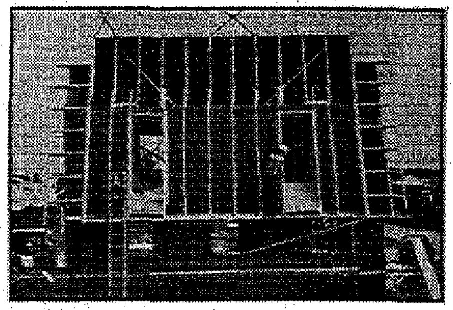
The Energy Crisis of the 1970's

Other computer programs were developed to simulate the thermal performance of a house — an area of keen concern sparked by the energy crisis of the early 1970's. One program was widely used by CMHC and the Canadian Standards Association to calculate the amount of energy needed to heat different types of houses, and as a teaching tool at several colleges and universities.

In the late 1970's, IRC embarked on an energy-related research project with the Housing and Urban Development Association of Canada (now the Canadian Home Builders Association); four test houses in a city subdivision were instrumented and monitored for several years. During the same period, researchers at IRC's Prairie Regional Station in Saskatoon were developing and perfecting new practices for the construction of low-energy housing; their work has seen wide application across Canada and around the world.

In the course of its energy work, IRC determined that 25 percent of the heat loss from a house is through basement walls and floors. This led to the development of a method to predict these losses, as well as recommendations to remedy the problem.

IRC has always been uniquely positioned for building envelope studies (and remains so) thanks to its accumulated knowledge and specially designed full-scale facilities. More and more, IRC services are helping companies evaluate and advance their products for use in an extremely competitive marketplace. Recent work includes helping companies to evaluate increasingly popular exterior insulation and finish systems (EIFS) and to identify design flaws that lead to failure.



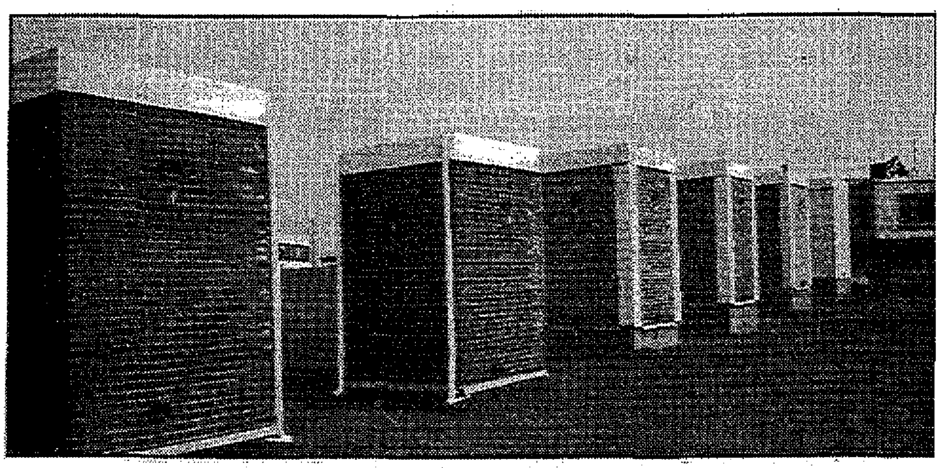
This house under construction was one of four used in an energy research project carried out by IRC in the late 1970's for the Canadian Home Builders Association.

IRC's reputation drew the attention of the plastics industry when it learned, from the Montreal protocol of 1987, that ozone-depleting CFC blowing agents could no longer be used in plastic insulations. IRC quickly and successfully developed an accelerated method for evaluating the performance of insulations made with new blowing agents.

The Work Continues

Today, IRC researchers continue their research efforts, benefiting designers, builders and manufacturers. One dynamic field is the development of computer models to predict the performance of building envelope systems — IRC's models are the most accurate in the world, according to the International Energy Agency.

Editor's Note: This article is the second of a series celebrating the achievements of the Institute for Research in Construction over its 50-year history that began in 1947. ❖



These masonry test huts in Ottawa were used by IRC in the 1950's to conduct tests relative to control of condensation in buildings. The huts were insulated with mineral wool batts between wood furring and they incorporated selected vapour barriers. Similar tests were conducted on wood-frame test huts at the Prairie Regional Station in Saskatoon.

Robert Bullis *is an Ottawa freelance writer.*

Institute for Research in Construction Marks 50th Anniversary

by Robert Bullis

Canada's construction industry will mark a significant milestone this year: the 50th anniversary of NRC's Institute for Research in Construction (IRC), known until 1986 as the Division of Building Research (DBR).

Established in 1947, this organization has made a profound impact on the nation — conducting important research that addresses the full range of construction-related problems; providing knowledge and solutions from around the world; conducting essential evaluation of building materials; and of course, developing Canada's National Building Code.

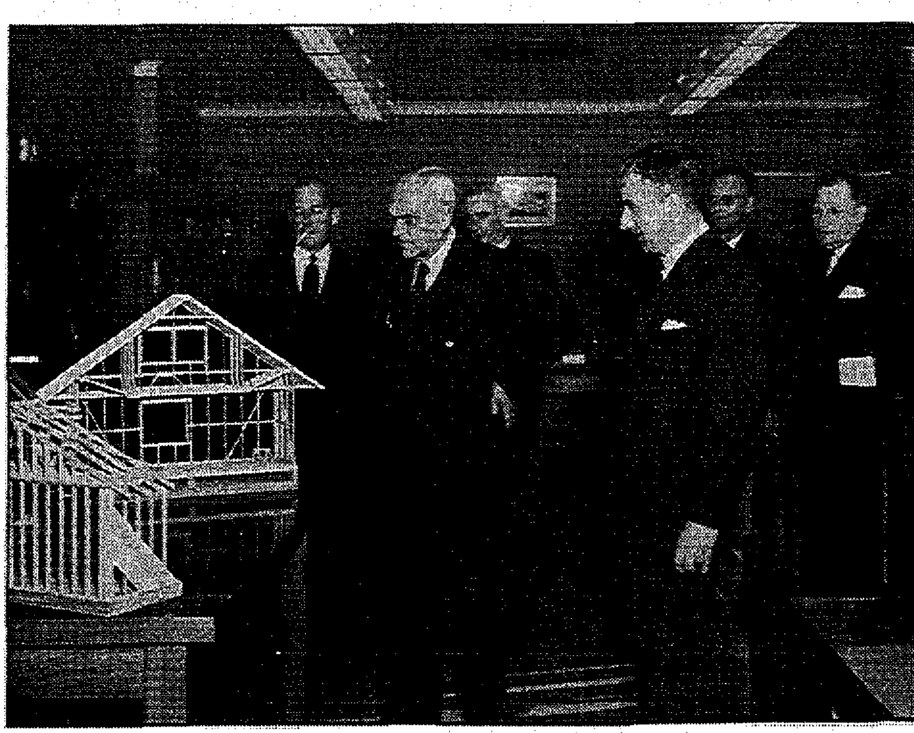
Responding To Canada's Needs

During the Second World War there was very little housing construction, and by 1947, Canada was faced with tremendous pent-up demand for low-cost, quality housing. Those who served overseas had returned home to marry and raise families (the start of the baby boom), and there was an influx of immigrants and refugees, all adding to the pressure for housing.

In 1946, the federal government passed the National Housing Act to provide low-cost mortgages for housing construction. It also created the Central (now Canada) Mortgage and Housing Corporation (CMHC) to administer the Act, manage the government-owned stock of wartime housing, and engage in direct construction of new housing. Besides that, there was a recognized need to advance the National Building Code, first published in 1941.

Also recognized was the need for focused research on building ~~materials~~, practices and the obstacles posed by climate, geology and other factors.

Taking up the challenge, the National Research Council's president, Dr. C.J. Mackenzie, called upon Dr. Robert F.



E.W.R. Steacie, C.D. Howe, F.M. Lea, R.F. Legget, N.B. Hutcheon and D.E. Parsons visiting the Building Design Section of NRC's Division of Building Research (now the Institute for Research in Construction) in October, 1953.

Legget, a respected engineer and professor at the University of Toronto, to create and head up a new division whose primary mandate was to carry out building research, provide research support to CMHC and develop the National Building Code.

The new division was patterned after the British Building Research Station, established in the 1930s.

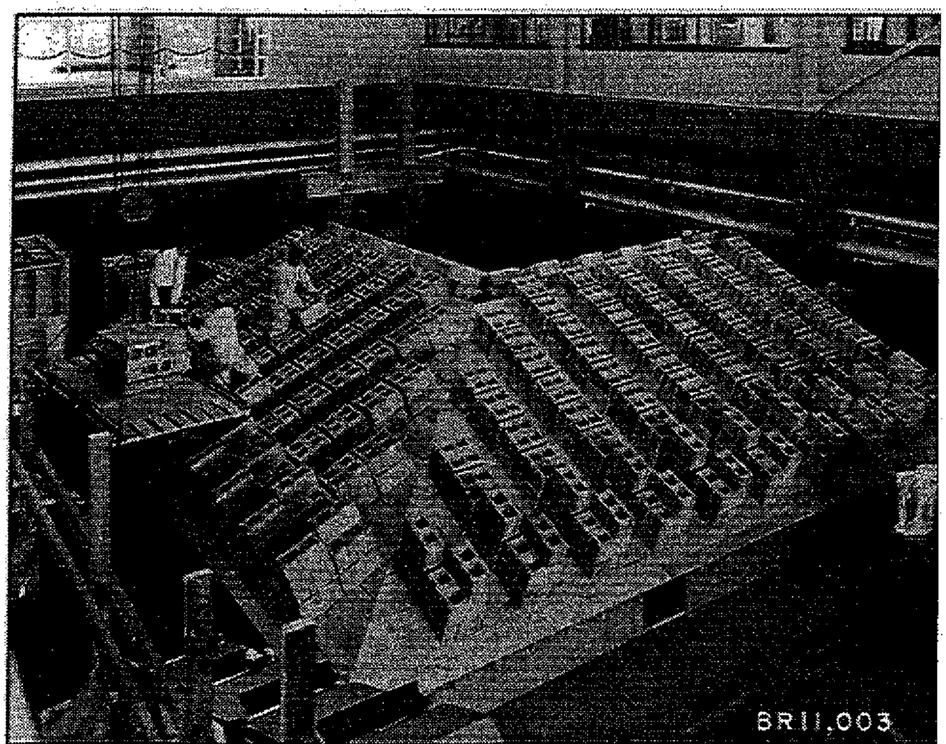
Dr. Legget's Legacy

"IRC is Canada's national technology source for construction, and in many ways its predecessor, DBR, was the founder of building science in Canada," says Jim Gallagher, IRC head of publications and media contact. "Dr. Legget insisted from the outset that DBR concentrate on problems unique to Canada, that researchers serve with dedication and distinction, and that information be transferred to industry in a planned, coherent fashion."

The organization attracted top-ranked young researchers from its earliest days and many gained acclaim for their work in such diverse areas as soil mechanics, fire protection, structural safety, materials and building performance. In doing so, they made Dr. Legget's vision a reality.

Specific examples abound: Dr. Neil Hutcheon, the successor to Dr.Legget as director, pioneered building envelope research and wrote the landmark book, Building Science for a Cold Climate. Another DBR researcher, Dr. Roger Brown, worked with colleagues to map the permafrost zones of Northern Canada; their work was instrumental in helping to open the North for development.

Over time, the original mandate was expanded and today's IRC, under Director General George Seaden, continues to provide research services in most key aspects of construction, while serving as a nationwide resource - one that works in close cooperation with the industry, its various associations and all levels of government. IRC's success in building consortiums, an increasingly popular means of funding and managing research today, reflects the institute's - and DBR's - long tradition of leadership and the willingness of industry groups to pool their resources in pursuit of a common goal.



Full-scale loading test on L-shaped roof using concrete blocks to simulate long-term snow load on houses in 1961.

Contributions Worth Celebrating

Ivan MacFarlane, who was secretary general of the Canadian Construction Research Board when he retired from IRC in 1987, is quick to point out IRC's contribution to Canada: "In the early days there was little construction research going on in Canada. DBR, and later IRC, have made tremendous contributions that benefit the industry and our quality of life. The National Building Code, for example, is a major achievement - most nations don't even have such a thing."

Those outside the organization agree on IRC's importance to the construction industry. Allan Bennett, chairman of the IRC Advisory Board, which replaced the Canadian Construction Research Board, wrote: "Canada's construction industry ... has an urgent and ongoing requirement to innovate. For it is only through the adoption of innovative technologies that the industry will continue to be competitive. IRC is in a position to assist industry in its greater use of appropriate technological innovation.

With those sentiments in mind, the construction industry can be justifiably proud of this distinctly Canadian research resource. ❖

Editor's note: *This article is the first of a series celebrating the achievements of the Institute for Research in Construction over its 50-year history.*

Robert Bullis *is an Ottawa freelance writer.*

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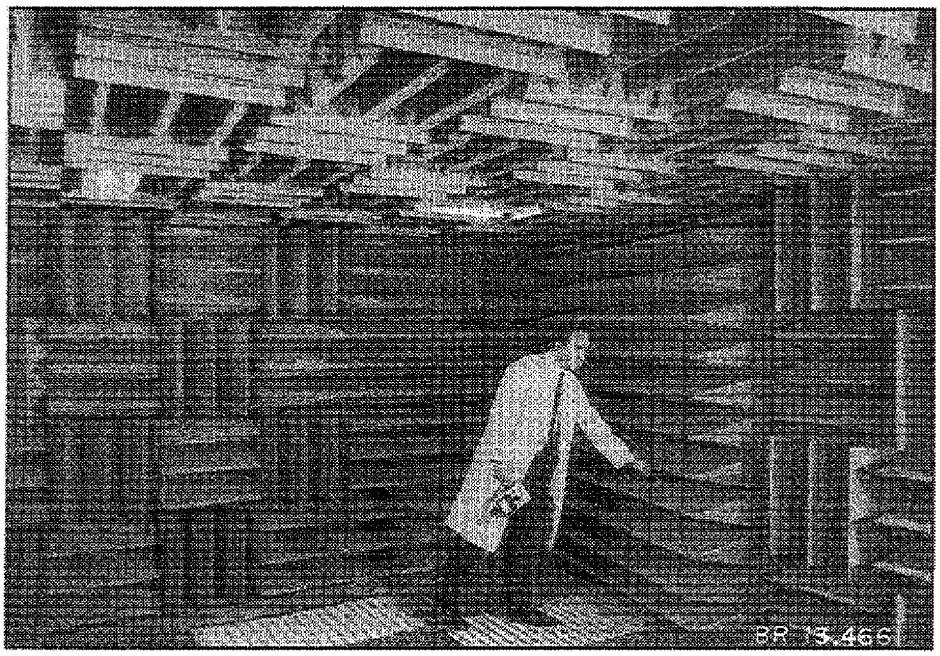
Acoustics Research has Influenced Building Design and Construction

by Robert Bullis

Acoustics research conducted by the Institute for Research in Construction (IRC) has been ongoing for much of the Institute's 50 years and the results have influenced building design and construction practices in Canada and internationally.



An acoustics technician stands in the anechoic (echo-free) chamber located at NRC's Institute for Research in Construction (ca 1965). The unique construction of this chamber enables researchers to make accurate sound measurements in an environment in which there are virtually no reflections from wall surfaces.

Dealing with acoustical environment issues in buildings is essentially a three-step process: identifying occupant needs, translating the needs into quantitative performance criteria, and developing physical structures and materials that will meet the criteria. IRC has been active in all these areas.

Sound transmission is a complex problem, compounded by the fact that acoustics is a two-sided coin: in some circumstances, as in the design of a concert hall, the goal is to improve sound transmission; in a residential high-rise building the opposite is required — reduce sound transmission from one unit to another.

Codes and Standards

A lot of IRC's early work was done in response to National Building Code needs. Researchers were concerned with the development of standard test methods and with relating test results to subjective requirements. The essence of the standards-writing process was the reconciling of these two objectives: a test method must be repeatable and reproducible to an adequate degree of precision, but most of all it must lead to a valid rating of performance.

"This type of research was vital and remains so," says Dr. Alf Warnock of IRC's Acoustics Lab. "Laboratory and on-site studies of acoustical performance, as well as occupant surveys and other research activities, help designers and builders achieve highly effective and economical design."

Practical Application of Research

One early problem presented to IRC researchers illustrates Dr. Warnock's point. Houses built in close proximity to airport runways were greatly affected by external noise penetration into the houses' interiors. Researchers studied the matter and recommended design changes that were widely adopted and resulted in acceptable interior noise levels.

Another example of acoustics research yielding tangible results concerns the design of concert halls and similar public areas. For many years, acoustical excellence was sought by aiming for an optimum reverberation time. However, considerable research, mainly in Europe, showed that other, newer measures of room properties were a much better gauge of an audience's ability to hear speech and their satisfaction with the quality of the musical sounds. Many school boards, theatre companies and others, requested IRC to investigate how those measures could be estimated during the design phase and how well they would work in predicting audience reaction.

Using computer model simulations as well as on-site measurements of acoustical features in such well-known facilities as the Opera of the National Arts Centre in Ottawa, researchers contributed important data that has made concert hall design a quantitative science. This is important in new building design and helps to avoid costly refitting of existing structures to solve acoustical problems.

IRC researchers have studied the sound transmission properties of a host of building materials, too, and examined their efficiency in different environments. One such project resulted from a request by the Ontario Concrete Block Association to measure sound transmission through walls made of concrete blocks and gypsum-board — the gypsum-board applied in various ways.

Researchers found that excellent noise reduction is possible with proper application of gypsum-board; however, incorrect mounting can produce a result worse than that of a bare block wall. The results encouraged the use of good wall design and led to IRC development of a simple model for predicting performance before construction.

In the early 1990's IRC added some excellent new full-scale facilities that have given it unique capabilities in the acoustics research field. It has also developed some innovative approaches to research and business for its clients. Among these are consortia, in which a number of interested parties are brought together on projects that permit vital research to be conducted -- research that would be beyond the means of any single company or organization.

One such consortium was created to study the noise-control (and fire-resistance) capacities of gypsum-board walls after changes to the 1990 National Building Code required an increased sound transmission rating. This nine-member consortium was hugely successful and the project's findings were transformed into tables that were included in the 1995 National Building Code. This gave builders and designers a choice of 180 wall constructions, which is likely to have a long-term, positive impact on the cost of lightweight construction in Canada and on the quality of multi-unit residences.

An even larger consortium was created to study the noise-control and fire-resistance of wood, steel and concrete floor systems. As was the case for the wall consortium, the findings will provide input for the National Building Code. Floors present particularly thorny noise-control problems because of the impact sounds generated by footsteps. New test or rating methods are being investigated that will give more reliable information to Canadian designers.

New complications arise for acousticians when walls and floors are combined into complete homes. The construction details used to combine the basic elements together can drastically reduce the sound insulation in the building below that expected from laboratory testing. A special facility to investigate these problems and related fire issues is also supported by a consortium and is producing interesting and useful results.

Now, as IRC celebrates its 50th anniversary, it continues its acoustics research as part of a larger effort to understand and improve the indoor environment. Key to this work is a $1-million research facility, unique in North America, in which all important indoor conditions — ventilation, air quality, thermal comfort, lighting and acoustics — are considered in order to better define and understand their influence and to ultimately maximize the comfort and productivity of people. ❖

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