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NRC·CNRC Construction Technology Series

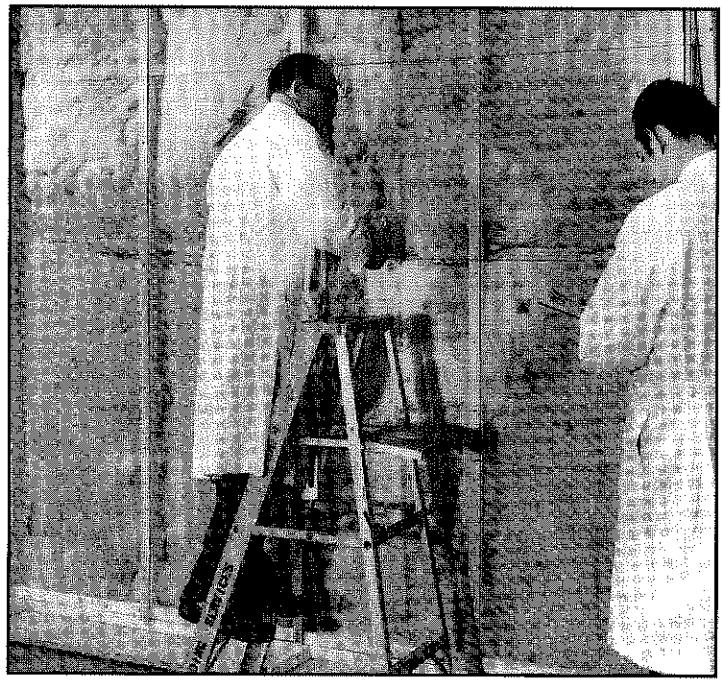
A series of technical articles on construction technology and related subjects attributed to research and development activities at NRC's Institute for Research in Construction

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.

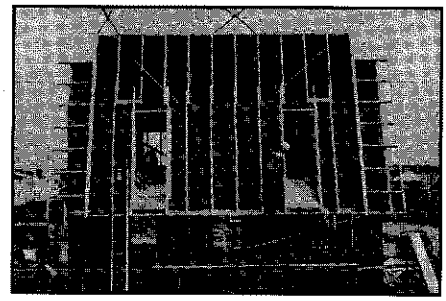
The Energy Crisis of the 1970's

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.



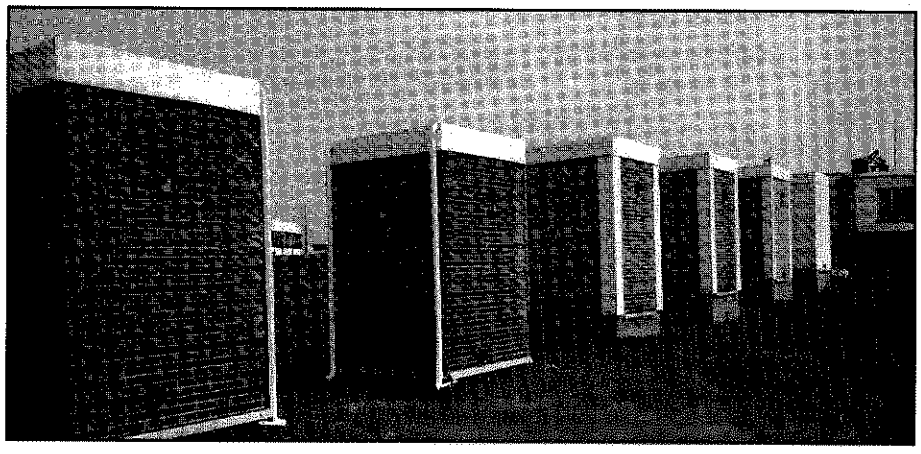
This house under construction was one of four used in an energy research project carried out by IRC in the late 1970's for the Canadian Home Builders Association.

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.*