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Housing Research Summary for 2014

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A report prepared for the Canadian Home Builders' Association

March 2015

A French version of this report is **available upon request**.

Une version française de ce rapport est **disponible sur demande**.

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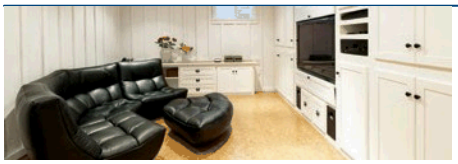

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> “If Canada is to become one of the top urbanization markets in the next five to six years as has been projected, the industry needs to position itself today to exploit the new business opportunities this will offer.”

Message from the General Manager of NRC Construction

It is a pleasure for me to present this report highlighting the research, technical projects and code-related activities undertaken by NRC in support of the Canadian residential construction industry in 2014.

For over 65 years, NRC has provided a competitive advantage to the industry by addressing uniquely Canadian problems and advancing technologies to improve building performance, safety and comfort. If Canada is to become one of the top urbanization markets in the next five to six years as has been projected, the industry needs to position itself today to exploit the new business opportunities this will offer. We are working closely with stakeholders, collaborators and clients in construction and related industries to ensure they continue to be important players as markets evolve.

We are already taking a lead role in key areas with increased market potential. Responding to the wood industry's request for support, we have collaborated with industry and fire safety authorities to complete a comprehensive research project facilitating the use of wood-based structural products in mid-rise buildings. The results can be used by industry to meet building code requirements in fire safety, acoustics and building envelope performance. The work will also support the commercialization of innovative products, while offering builders and homeowners more choices.

We have also helped industry overcome challenges by making notable strides in support of more healthy and comfortable indoor conditions for Canadians. For instance, we have advanced the technology for testing radon infiltration in homes and developed solutions for reducing Canadian families' exposure to radon. We have shown how a high-efficiency fan can reduce the possibility of pollutants from car and small engine exhaust entering homes from attached garages. We've also evaluated the performance of a counter-flow air exchanger – a furnace fan generated air exchanger – and compared it to a conventional motorized heat recovery ventilator.

Together with our stakeholders, we have made significant progress updating the National Model Construction Codes. Publication of the new editions by the end of 2015 remains on schedule. New User's Guides were also published last year, and more will be developed over the coming year.

As we assume our role as a world-class research and technology organization, we are constantly strengthening our links with industry and will continue to work with CHBA to develop timely and effective technologies for our clients. We are proud to be able to provide impartial expertise and technical services to Canadian builders.

On behalf of NRC, I would like to extend my thanks for your continued partnership in innovation.

Keira Torkko,
General Manager (Acting)

Research

NRC Construction has been carrying out housing-related research since 1947. Through the years, countless innovations in building practice and major advances in building codes have made Canadian housing a model for other countries. Research continues to probe issues of concern to builders and to make further strides to improve the efficiency and comfort of homes.

Before research results can be incorporated into practice and building codes, they must be subjected to thorough analysis. This takes time and effort and builders rely on this careful scrutiny to give them the confidence to introduce new technologies that will achieve dependable, long-term performance at an efficient cost.

This requires a team effort involving not only builders and researchers but numerous other stakeholders including code authorities at all levels, manufacturers, standards organizations and specifiers.

Research is also directed toward improving market opportunities for manufacturers, who can use results to pursue in-plant innovations to enhance their products and develop new ones.

The purpose of this housing report is to inform builders of ongoing research, to provide status reports on completed projects, many of them being long term, and to report on code development activities, especially the reviews that take place in the consideration of proposed code changes.

Pollutants in Homes

Along with continuing to pursue advances in envelope performance and energy efficiency, researchers are working on projects aimed at enhancing the comfort and health of occupants regarding indoor pollutants. These pollutants originate from a variety of sources, such as emissions from equipment, products and materials used in and around the home, radioactive soil gases, and mould. In conjunction with business partners, NRC Construction is currently conducting several projects addressing these issues.

Reducing radon levels in homes

In recent years, there has been heightened awareness for the need to better understand the issue of radioactive soil gases seeping into homes. Since 2011, NRC and Health Canada have been working on a multi-year laboratory study to develop practical and cost-effective solutions to minimize the health risks from these gases and to provide guidance for prevention and mitigation of problems. The intent is to generate outcomes to support proposed changes to the National Building Code (NBC) and to provide input for updating guidance documents to be adopted as standards, such as the CGSB National Standards for Radon Mitigation in Residential Buildings.

In response to Canadian builder and homeowner requests, NRC completed several projects in its full-scale facilities to answer the following key questions:

- Does the negative pressure created by a radon depressurization fan increase the risk of backdrafting from combustion appliances operating in the basement?
- Can alternative components such as ventilation panels be used as a gas permeable layer under the concrete slab to accommodate the future installation and functionality of an active sub-slab depressurization system for radon mitigation?
- How airtight are the commercially available radon mitigation fans? This aspect is especially important since mounting of fans within the habitable space is a practice that has been proven to work in Canada; however, most radon fans are manufactured in the United States and are not marketed for indoor installation. (This element of the research has been supporting the development of the CGSB national radon mitigation standard for the establishment of radon fan selection and installation criteria.)
- To what degree can improved membranes and concrete assemblies – promising reduced permeability for radon – reduce radon concentrations in basements or first floors?
- Can passive radon stacks with various configurations (straight vertical, tortuous vertical, and side-wall near ground level) create sufficient stack effect to allow them to be used as passive radon mitigation systems? This aspect is especially important for the industry since the passive radon stack has been adopted by some builders as common practice in order to obtain LEED credits for passive radon-resistant construction.

The results of this radon research will be released in the form of practical cost-effective solutions and guidance for builders and homeowners, and in reports to NBC committees.

Information

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Reducing pollutant transfer from attached garages into homes

Concentrations of some health-related pollutants can be higher in homes with attached garages, compared to homes where the garage is a separate structure. Pollutant transfer from an attached garage into living spaces may be due to several factors. It may be lack of attention to detail and quality control during construction and retrofitting, or it may be due to occupant activities. Practices such as disabling self-closing doors between the house and garage, operating gas-powered equipment or idling a vehicle inside the garage can lead to contamination of the air in the home.

In partnership with Health Canada, NRC Construction conducted a study in the National Capital Region to assess various methods to reduce the transfer of pollutants from attached garages into adjoining living spaces. The study investigated, separately, the effectiveness of installing an exhaust fan in the garage and increasing the airtightness of the common wall between the garage and the dwelling through improved sealing.

The results of the study are being analyzed and once verified will be disseminated to assist builders, contractors and homeowners to reduce the likelihood of pollutants entering living spaces. Committees responsible for the National Building Code will consider the information in their deliberations about possible code changes.

Information

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Chemical emissions from building materials and consumer products

A key element of NRC Construction's work in indoor air quality is to help the construction industry and authorities in health and other scientific fields to evaluate, characterize and mitigate chemical emissions from building materials and consumer products.

In 2014, NRC evaluated emission source strengths of 20 consumer products and items of equipment used and stored in and around the home and the attached garage. These included paint, lawnmowers and snow blowers.

This followed extensive work in 2013 when researchers evaluated 30 building materials with a focus on wood, paint and insulation products and the chemical emissions released from them. This was in support of Health Canada's work developing a Canadian health-based emissions standard.

The data for both 2013 and 2014 are being incorporated into a refined version of IA-QUEST (indoor air quality emission simulation tool). This data will improve the understanding of the major sources of indoor pollutants such as formaldehyde and benzene in homes while also assessing the effectiveness of mitigation strategies to improve indoor air.

Using results from recent testing and those from many years past, along with the regular updating of IA-QUEST, is part of a long-term effort to help manufacturers to develop low-emission products while enabling health and code authorities to establish criteria for material emission standards. This work is equipping builders with key information they need in order to understand pollutant issues and to support their efforts to provide better air quality and comfort in homes.

Information

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Resistance of building materials to mould

Mould is one of the air quality/health issues receiving greater attention in research and practice these days. There is heightened interest in learning about the effect of certain kinds of mould, in assuring quality construction to avoid mould growth, and in developing mould-resistant products and materials.

Industry clients have contracted NRC to continue with a multi-year project that provides comprehensive assessments of product performance, including resistance of building materials to mould growth.

Two research groups and the Canadian Construction Materials Centre (CCMC) are working together to develop complete test protocols for evaluating structural performance (including hygrothermal properties), volatile organic compound emissions affecting indoor air quality and mould resistance under dynamic temperature and humidity conditions.

Additional industry participation in the development of these new test methods is welcome.

Information

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Evaluation of indoor air quality technologies and solutions

While the selection of low-emission products and the prevention of emissions are key approaches to ensuring acceptable indoor air quality, technologies are needed to remove or deal with contaminants that do materialize. NRC is conducting a multi-year study to evaluate the performance of several technologies and solutions intended to improve indoor air quality in an energy-efficient manner. This project is part of the Government of Canada's Clean Air Regulatory Agenda. The first phase entails developing test protocols necessary to evaluate and compare three technologies: indoor passive panels, portable air cleaners, and in-duct filtration.

Researchers have now developed a protocol to assess the performance of indoor passive panels in regard to their ability to remove formaldehyde and toluene. These two chemical pollutants are emitted into indoor air mainly from household products and building materials. Exposure to these pollutants at high concentrations can have an impact on people's health. The performance assessment, based on commercial samples, is being carried out by NRC using a chamber designed to test indoor passive panel technologies that are based on sorption or light activation. This project benefits from the assistance of a technical advisory committee with broad industry representation.

Reports and related papers are available at **www.nrc-cnrc.gc.ca/eng/reports/2013_2014/clean_air_regulatory_agenda.html#4**

Information

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High-efficiency furnace fan generated air exchanger system studied

The building industry has seen continual advances in HVAC equipment over the years, with major savings in energy use and improvements in air quality in the home. NRC Construction has played a role in assessing many of these technologies, in the laboratory and using the twin houses of the Canadian Centre for Housing Technology.

Recently, NRC evaluated the performance of a counter-flow air exchanger (a furnace fan generated air exchanger) and compared it to a conventional motorized heat recovery ventilator. Unlike the conventional system, the Motorless Heat Recovery System (MHRS) uses the furnace fan to circulate air through the heat exchanger.

For purposes of the comparison, the innovative air exchanger was installed in one house (the test house) and the conventional heat recovery ventilator was installed in the other (the reference house). In this side-by-side study, the whole house thermal and energy performance was measured for both houses during winter and summer 2014.

It was found that the MHRS system installed with exhaust from the supply plenum (and bathrooms/kitchen) showed a higher apparent sensible effectiveness (ASE – a measure of the performance of an HRV) than the conventional HRV (over 10 percentage points higher). Additionally, the MHRS operated continuously in cold weather – no "defrost cycles" were required.

During the firing cycle only, the warmer air exhausted through the MHRS system from downstream of the furnace eliminated ice accumulation and flow restrictions, thereby allowing a continual flow of exhausting air to the outside.

The airflow performance of the MHRS system was very dependent on the static pressures generated by the furnace fan that drives the intake and exhaust airstreams. The available static pressure generated by the furnace fan depends on where the MHRS system ducts are connected to the forced air system, and the mode of operation of the furnace. Intake airflows were higher than the exhaust airflows leading to an unbalanced air exchanger system. This did not appear to manifest itself significantly in house pressurization or depressurization.

Overall, though there was a limited impact on cooling/heating energy consumption with the Motorless Heat Recovery System, there was a higher sensible effectiveness than the conventional HRV. The new system is suitable for cold climates since no defrost cycles are required as the system relies on the firing cycle of the furnace to melt accumulated ice within the unit.

Information

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Building Envelope

Effect of enhanced interior insulation on wall performance in houses

In partnership with Canada Mortgage and Housing Corporation, Natural Resources Canada and industry, NRC Construction continues work on a project established in 2013 to determine the effect of various building envelope retrofit strategies on heat, air and moisture performance of conventional wood-frame walls. The second round began in September 2014 after the installation of a set of three retrofit strategies in NRC's full-scale facility for testing exterior walls. Each strategy consists of a wall specimen, each having a different type of insulation.

One specimen (W1) featured 38 mm by 140 mm (2"x 6") construction with fibreglass insulation in the stud cavity (R24). XPS (R10), 50 mm (2") was installed on the interior surface of the stud wall giving it a total insulation value of R34.

The second specimen (W2) consisted of built-up studs; this was made up of 38 mm by 140 mm studs each with a 38 mm by 89 mm stud attached to it (2"x 6" + 2"x 4"). Closed-cell foam insulation was applied to the interior surface of the sheathing board – (R13.3), 50 mm (2"). The stud cavity was filled with fibreglass insulation – (R32), 178 mm (8") giving the specimen a total insulation value of R45.3.

The third wall assembly (W3) consisted of double-stud construction with two 38 mm by 89 mm studs separated by a 100 mm space (2"x 4" stud + 4" space + 2"x 4" stud). The resulting large cavity space was filled with cellulose insulation of a density between 3.5 pcf and 4.0 pcf. The total insulation value was R42 for this assembly.

The vinyl-siding clad exteriors of the specimens were exposed to climate conditions in Ottawa, whereas on the interior, conditions were maintained at 20°C and 50% relative humidity.

Although the testing is being conducted in Ottawa, NRC researchers will be able to broaden the application of the results by using their hygrothermal model, hygIRC-C, to simulate the response of these retrofit walls to the outdoor and indoor conditions found in the different climatic regions of Canada. The model will assess the moisture and thermal performance of the assemblies, and determine the relative reductions in energy use achieved with each strategy.

The performance of the three strategies being studied will also be compared to the performance achieved with two other systems:

1. the insulation levels of a baseline wall assembly – the minimum 2011 National Energy Code for Buildings (RSI 3.27 – 4.13) and

2. those of walls designed according to the new R-2000 thermal performance levels (RSI 7.04 – 7.92).

The results of this work will be shared with partners to facilitate the adoption of high-performance residential wood-frame wall systems (EnerGuide for Houses rating system EGH 83 and 86), and to support building authorities and industry with regulations, policies and best practices on energy performance and durability of highly insulated wood-frame walls in houses.

Information

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W3 with empty cavity

W3 filled with 12" of cellulose

W1, W2 and W3 before the finish drywall

Research

Mid-Rise wood buildings

Collaborating with the Canadian Wood Council and FPInnovations, and partnering with Natural Resources Canada and the governments of Ontario, Quebec and British Columbia, NRC has completed a comprehensive research project on the use of wood-based structural products in mid-rise (up to six stories) buildings. This research focused on developing solutions to meet building code objectives in key areas, including fire safety, acoustical quality, and building envelope performance.

One of the important objectives of this research was to determine whether specific technical solutions (construction designs and details) developed for any one aspect of building performance might have a negative effect on the performance of another. For example, mid-rise exterior wall specifications that worked successfully from the fire and moisture standpoints were investigated by the acoustics team for flanking effects in the exterior wall to adjacent units. Their findings indicated that the exterior wall system configurations developed to control fire spread, precipitation and moisture accumulation, did not adversely affect the acoustic performance of the mid-rise exterior wall assemblies.

The results of the project are being analyzed by researchers and reviewed by code committees.

Information

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Shading impact on the energy yield of PV

The photovoltaic (PV) industry is emerging with new technologies for the power conditioning of solar photovoltaic modules. NRC Construction is supporting these efforts with research on the energy yield of new generation micro-inverters in steep slope roofing applications. The focus of this research is to evaluate the energy production of these micro-inverters relative to the conventional string inverter with an emphasis on shading and weather exposure impacts.

Two side-by-side PV arrays were constructed on the experimental test rig, simulating an 18° steep sloped roof. The two 1.5 kW solar arrays were identical, except for the PV power electronics: one (the reference array) was equipped with the standard string inverter, while the other (the test array) was equipped with the micro-inverters to be tested.

Shading conditions that are experienced by a typical residential rooftop were applied systematically to both arrays, and the alternating current (AC) kWh production of the two systems was compared. The micro-inverter was found to increase production by 10 to 50% relative to the string inverter.

The project also investigated the interaction of the PV system with the roofing system in terms of heat and moisture performance. The outcomes of this preliminary assessment could either pave the way to opening up markets for this new generation of PV products, or identify the technical barriers for the adoption of such technologies for Canadian climates.

Information

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Impact of a one-hour residential fire on an interior wall assembly during recent testing conducted at NRC

Fire-related Research

Improved wall systems for fire performance of houses

In support of industry clients, NRC is investing in a new phase of research on the fire performance of single-family houses constructed with innovative materials, products and systems. The work is part of an exhaustive long-term study to assist code authorities and builders to understand how these innovative technologies behave in a fire and how they affect the safety of occupants.

In this new phase, researchers will study the use of innovative loadbearing foundation walls and above-grade wall systems that support the floor systems. These include preserved wood foundations, insulated concrete forms, and structural insulated panels. The projects will include a study on the impact of innovative combustible insulations, which may adversely affect the performance of a wall during a fire.

The results, along with those from the previous work on floor systems, will be used to establish parameters for determining acceptable levels of fire performance for houses and to reduce the risk of using innovative technologies.

Information

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Ignition in living room set-up

One minute after ignition

Five minutes after ignition

Characteristics of fires in multi-suite residential dwellings

Analysis of the results from a collaborative project to determine the characteristics of residential fires and typical combustible furnishings was recently completed. Started in 2006, the project focused on fires that can occur in apartments, semi-detached houses, duplexes, row houses, secondary suites and residential care facilities, as these can have a great impact on adjacent suites.

Outcomes from these extensive fire tests show that fire development and severity vary according to the type of residential building, and differences in combustible content characteristics, ventilation, and geometric dimensions of the living spaces. Primary bedrooms resulted in the most severe fire conditions since they contained the greatest amount of combustible materials, such as mattresses, clothing and carpeting.

The detailed results of the project were documented in three reports published in January 2015.

Designers, builders and code authorities can draw on this volume of data to better understand the behaviour and impact of fires on multi-suite residential dwellings.

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National Model Construction Codes

Progress on updating the 2010 National Model Construction Codes continued in 2014, with publication of new editions scheduled for December 2015.

At its February 2014 annual meeting, the Canadian Commission on Building and Fire Codes (CCBFC) added several tasks to Standing Committee work plans. These tasks included addressing firewalls, prescriptive insulation requirements (energy) and step dimensions in dwelling units. The Commission also directed the Standing Committees to examine farm building requirements during the next (2015-2020) code cycle.

In January 2015, the CCBFC's Standing Committees reviewed comments on proposed code changes that were submitted for public review in fall 2014. The proposed changes were reviewed by the Provincial/Territorial Policy Advisory Committee on Codes (PTPACC) a month later. Final changes will be submitted for CCBFC approval at its annual meeting in March 2015. If approved, these changes will be included in the 2015 Codes.

Renewal of the CCBFC's membership for the next code cycle is well underway. New Standing Committee members have been appointed and a call is now underway for volunteers to serve on the CCBFC itself. These appointments will take effect September 1, 2015.

National Model Construction Codes

The following highlights describe progress on some of the Standing Committee work related to Part 9 (Housing and Small Buildings) of the National Building Code (NBC).

Basements

Basements have changed. Today, they are typically fully finished, conditioned spaces that are used daily by the occupants. Code requirements for residential basements and crawl spaces, however, have not kept pace in some instances, and one of the CCBFC's current priorities is to review and update these requirements.

The CCBFC's Standing Committee on Housing and Small Buildings has established a task group to investigate basement issues identified by previous task groups. The task group will also act on several code change requests including window well construction; exterior and interior dampproofing; use of low-permeance materials to insulate the top portion of basement walls; foundation wall height and thickness requirements; concrete strength and reinforcement requirements; special solutions for walk-out basements; and use of dimpled boards.

Among the many industry and practice documents available on this topic, the task group will refer to, and base its review of the issues on, the *Performance Guidelines for Basements* published by NRC Construction in 2006. The task group's work started in January 2015 and is expected to be completed by mid-2016.

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Concrete strength requirements

Revisions to the 2014 edition of the CSA A23.1 standard, which is referenced in NBC Part 9 requirements, call for higher strength and lower water-cement ratios for concrete used in foundations, footings and interior floor slabs of houses and small buildings. Before recommending an update to the Part 9 requirements, the Standing Committee on Housing and Small Buildings conducted a survey to assess failures of foundation walls and concrete floors on ground. The responses, however, were not convincing, as many areas were already using higher strength concrete, and failures were occurring at any strength owing to poor handling and installation practices. The Standing Committee also determined that while increasing the concrete strength would reduce permeability, there are already requirements in Part 9 for waterproofing and dampproofing. The committee decided that the need to increase the requirements, which would result in higher construction costs, was not clearly established.

A proposed change was prepared for the fall 2014 public review that creates a qualified reference to the 2014 edition

of CSA A23.1 by explicitly writing the existing strength and water-cement ratio requirements into the body of the code. Comments from the public review were subsequently evaluated by the committee and a final change will be submitted to the CCBFC for approval at its 2015 annual meeting.

Information

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Fire performance of houses

The increasing use of innovative materials, products and systems in house construction has created a need for better understanding of the impact of these materials and products on occupant life safety under fire conditions and development of a technical basis to evaluate their fire performance. This may result in code revisions to address their increasing use, and impact, on house fire performance.

In recent years, difficulties have arisen in evaluating the fire performance of innovative structural products for houses because the NBC has not provided explicit information on their expected performance. To rectify this situation, NRC is conducting a long-term, three-phase research project for the CCBFC to determine the impact of these products and systems on occupant life safety under fire conditions in single-family houses. In question was whether their assumed fire resistance level allows enough time for occupants to escape.

Phase 1 of the research, now completed, focused on basement fire scenarios for a variety of protected and unprotected

floor assemblies commonly used above a basement. Phase 2, now in the planning stages, will investigate load-bearing foundations and above-grade wall systems. Phase 3 will address ceiling and roof products.

On completion of Phase 1, the CCBFC's Executive Committee asked the Standing Committees to determine whether houses built with innovative framing components have an acceptable fire performance.

The committees struck a joint task group to investigate the question. Its mandate is to:

- analyze the research findings with respect to reported times available for egress and protection of occupants;
- analyze the prescriptive requirements and implicit assumptions for egress and occupant protection in the NBC;
- review and analyze studies on evacuation times; and
- assess whether the Part 9 requirements and objectives need to be revised.

Information

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Fire ratings for glass fibre batts

Fire resistance ratings for a number of generic assemblies covered by Parts 5 and 9 of the NBC are referenced in Tables A-9.10.3.1.A and B. These ratings result from tests on similar assemblies, or were assigned by extrapolating test results. In either case, the impact of any requested change to the material or assembly specifications, as well as the Table notes, must be carefully considered, as does the fact that generic ratings have been applied to a wide variety of common assemblies. NRC provides support to the CCBFC's Standing Committees who deal with these issues by conducting research to obtain needed data and by bringing together experts in common construction materials and fire protection to analyze the results and make recommendations.

For instance, building officials frequently do not permit the use of glass fibre insulation in EW1 exterior wall assemblies, as it is currently excluded in the fire ratings in Table A-9.10.3.1.A of the NBC. While it is recognized that assemblies using rockwool or slag insulation have an overall better fire performance, assemblies with glass fibre insulation have also demonstrated acceptable fire performance.

After investigating the issue, a joint task group of the Standing Committees on Housing and Small Buildings, and Fire Protection, prepared a proposed change and submitted it for public review in fall 2014. The proposed change introduces a new exterior wall assembly, EW2, for glass fibre insulation fill. This new assembly would be deemed to comply with fire resistance ratings of 45 minutes and 1 hour and would be consistent with the existing fire-rated assembly EW1 that is still limited to mineral fibre insulation. Comments from the public review have been reviewed and the final change will be submitted for approval to the CCBFC at its annual meeting in March 2015.

Information

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Firewalls

Firewall performance levels are also up for review to maintain a newly introduced exemption allowing firewalls to be built in part with combustible material. Previously, firewall ratings in the NBC 2010 required that firewalls be constructed as a non-combustible fire separation having a fire resistance rating of either two or four hours. These ratings required that they be constructed with masonry or concrete.

An exemption was introduced in the NBC 2005 for firewalls that are permitted to have a fire resistance rating of not more than two hours. In these cases, the fire separation providing the fire resistance rating could use non-combustible materials other than masonry or concrete. However, the assembly must be protected against damage that would compromise its integrity. This exemption applies to all buildings, as firewall construction requirements for both Parts 3 and 9 buildings are located in Part 3.

Following publication of the NBC 2005, several code change requests were received asking that firewall construction requirements be reviewed and that NFPA 221, "Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls," be referenced, either wholly or partly, in the NBC.

As information on minimum performance levels for firewalls was lacking, the Standing Committee on Fire Protection recommended that a joint task group be struck with the Standing Committees on Housing and Small Buildings, Structural Design, and Environmental Separation, to address the situation. The joint task group, after reviewing studies and data on firewalls, as well as requirements already in place in other jurisdictions, will recommend changes, where appropriate, and identify where more information is needed. The joint task group's terms of reference and membership were recently finalized. Work will begin shortly.

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View of a house constructed with insulated concrete form during and after construction

Impact assessment and code development system review

From time to time, the CCBFC and the PTPACC strike joint task groups to work on policy-related items. One such group is currently developing guidance for Standing Committees on how to conduct impact assessments of code changes. A final report on this issue, with recommendations and best practice examples, will be available after the CCBFC meeting in 2015.

Another joint task group is reviewing the performance of the entire code development system. Its report will be available later in 2015 and will address the level of provincial/territorial participation. Other topics to be reviewed include timely adoption of codes, stakeholder engagement in the system, the financial viability of the national code development system, and whether a simplification of the process is possible.

The task group will consult stakeholders on its findings. The meetings are open to observers, as are meetings of all joint CCBFC/PTPACC task groups.

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Insulated concrete form construction

Requirements for flat insulated concrete form (ICF) construction were first introduced in the NBC 2005. During the subsequent code development cycle (2005-2010), the Standing Committee on Housing and Small Buildings processed a number of individual changes regarding minor issues related to ICF construction.

Over the last two code cycles, however, the committee has noted that a number of major issues need attention, such as the lack of prescriptive requirements for attaching interior finishes or exterior cladding to ICF walls. In addition, the issues that are addressed in the code do not go beyond structural sufficiency, and recent correspondence has questioned the rationale for reinforcement requirements related to building foundations constructed with ICF.

To deal with these concerns, a joint task group of the Standing Committees on Housing and Small Buildings, and Environmental Separation, was established in January 2014. The task group will review the current ICF requirements in Part 9 and develop a comprehensive approach that considers all aspects of ICF wall construction as well as its interdependency with other construction details. Issues include the previously mentioned ones as well as foundation wall height, dampproofing and waterproofing, restrictions for openings in ICF walls, fire and structural performance implications, and air barrier system continuity. NBC Part 5 requirements governing the use of ICF will also be reviewed. A final report recommending changes is expected to be ready by spring 2016.

Information

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Low permeance materials

In the NBC 2010, a material's water vapour permeance may trigger the requirement to insulate assemblies on the exterior. However, this requirement, which is based on materials having a water vapour permeance of less than 60 ng/Pa s m², creates an uneven playing field because some exterior insulating sheathing products fall below the threshold of 60 ng/Pa s m², while for others the requirements don't apply.

The Standing Committee on Housing and Small Buildings prepared a proposed change to introduce a relaxation of the Part 9 requirement for applications of materials with a permeance value to 30 ng/Pa s m² that also have a minimum thermal resistance of 0.71 m²K/W (R4) and are installed in locations with 6000 heating degree days (HDD) or less.This proposed change would recognize the performance of exterior insulating sheathing products.

The committee's recommendation was based on an NRC modelling research project that examined the risk potential for condensation in assemblies. The project investigated four Canadian locations (Vancouver, Edmonton, Ottawa, and St. John's) and varied the thermal resistance of the insulation within the framing as well as the water vapour permeance of the outermost sheathing material in the standardized assemblies. Results showed that walls with wood-based structural sheathing had a slightly lower condensation risk than those without sheathing and that, as insulating sheathing is added to the wall's exterior, the condensation risk drops further. There was also no significant difference in risk potential between assemblies with low (30 ng) and high (300 ng) permeance values, where the assembly was insulated with at least an RSI 0.71 (R4) insulating sheathing.

Walls clad with low permeance exterior insulating sheathing

The proposed change was submitted for public review in fall 2014. Comments received during the public review were examined by the Standing Committee on Housing and Small Buildings in January 2015, and a final recommendation on the proposed change will be submitted to the CCBFC at its annual meeting in March 2015. If approved by the CCBFC, it will be published in the 2015 NBC.

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Seismic information for building design in Canada

The fall 2014 public review included a proposed change to update seismicity (earthquake) values listed in Appendix C-2 of the NBC 2010. This was due to a recent major overhaul of Canada's seismic model that resulted in revised seismic hazard estimates across the country. This update, the first in 20 years, stemmed from improved analysis methods, as well as a better understanding of the relationship between an earthquake occurrence and the geological structure of the earth's crust.

As a result, for short period buildings such as housing and small buildings, the spectral hazard decreased in many Canadian locations and increased for a few locations in British Columbia, Alberta, Ontario and Quebec. The trigger for NBC Part 9 prescriptive requirements is the spectral acceleration at the 0.2 second time period, $S_a(0.2)$. As in the NBC 2010, locations where $S_a(0.2)$ exceeded 1.2 have to be designed to NBC Part 4 requirements. Given that some locations will now be above this threshold, the Standing Committee on Housing and Small Buildings is recommending changes to Part 9.

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Snow loads

Climatic data in the NBC are continuously reviewed and updated in collaboration with Environment Canada. In 2014, the snow load values listed in Appendix C-2 of the NBC 2010 were updated using the same methodology as in previous Codes and submitted for comment in the annual fall public review. The result of these updates is that 84% of the locations remain unchanged, 11% have increased and 4% have decreased. Most of the increases are for locations in the Yukon, Northwest Territories, and Nunavut.

On another front, application of the simplified snow load calculation for Part 9 buildings has expanded over time, resulting in increasing concern over the growing discrepancy between Part 4 and Part 9 snow loading requirements. The Standing Committees on Housing and Small Buildings, and Structural Design, established a joint task group to review snow load calculations for Part 9 buildings as well as the appropriateness of applying the Part 9 simplified calculation method to roofs with complex shapes.

The joint task group conducted a survey in January 2014 to collect data on snow-related failures. Analysis of the responses received to date suggests that the most significant factors in Part 9 roof failures are improper workmanship and inadequate bracing.

Although some failures were reported in buildings designed to NBC Part 4, or the National Farm Building Code 1995, the joint task group did not receive any reports of failures in properly constructed buildings. It will continue to review survey results as they are submitted.

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Spatial separation of houses

In the NBC 2010, a 10-minute fire department response time was introduced into Part 9 as a trigger for more stringent spatial separation requirements for detached houses. Since then, some jurisdictions have reported difficulties with the measurement of response times and its application in practice due to inconsistent interpretations.

The main issues revolved around:

- differences in firefighting capabilities among municipalities
- differences in the method used by municipalities to calculate response time ranging from complicated computerized modelling to simple methods using timers and clocks
- fluctuations in fire department response times due to weather, road conditions, construction, traffic, and time of day.

An additional, unintended consequence was that the use of the fire department response time as a basis for NBC requirements became a new performance measure for the fire department itself rather than just a trigger to determine construction specifications.

A joint task group of the Standing Committees on Housing and Small Buildings, and Fire Protection, agreed to replace the 10-minute response time with a more qualitative trigger that allowed flexibility for municipalities, and to restore the wording used in the NBC 2005, with some additional clarifications. The two requirement levels in the NBC 2010 will be kept – a less stringent one where a fire department is organized, and a more stringent one where a fire department does not exist or is not organized, trained and equipped. An alternative introduced in 2010 that allows sprinklered houses to be exempt from the more stringent requirements will also be kept.

A proposed change to this effect was submitted for public review in fall 2014. Comments received during the public review were examined by the Standing Committee on Housing and Small Buildings in January 2015, and a final recommendation on the proposed change will be submitted to the CCBFC at its annual meeting in March 2015. If approved by the CCBFC, it will be published in the 2015 NBC.

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Step dimensions

The tread dimension (i.e., run) of residential stairs will increase in the NBC 2015, if a proposed change submitted for public review in fall 2014 is approved by the CCBFC. The proposed change increases the run dimension in stairs serving single dwelling units to a minimum of 254 mm (10 inches) from the current minimum of 210 mm (8 ¼ inches). This recommendation was based on a review of technical literature and statistics indicating that a larger run dimension provided better foot placement and greater margins of stability, resulting in reduced fall incidents for all fall scenarios and all age groups. While run and rise both play an important role in stair safety, the review indicated that a reduction in rise to 178 mm (7 inches) would have been less significant in improving stair safety.

In January 2015, the CCBFC's Standing Committees on Use and Egress, and Housing and Small Buildings, analyzed the comments resulting from the fall public review. A final recommendation on the proposed change will be submitted to the CCBFC at its annual meeting in March 2015. If approved by the CCBFC, it will be published in the 2015 NBC.

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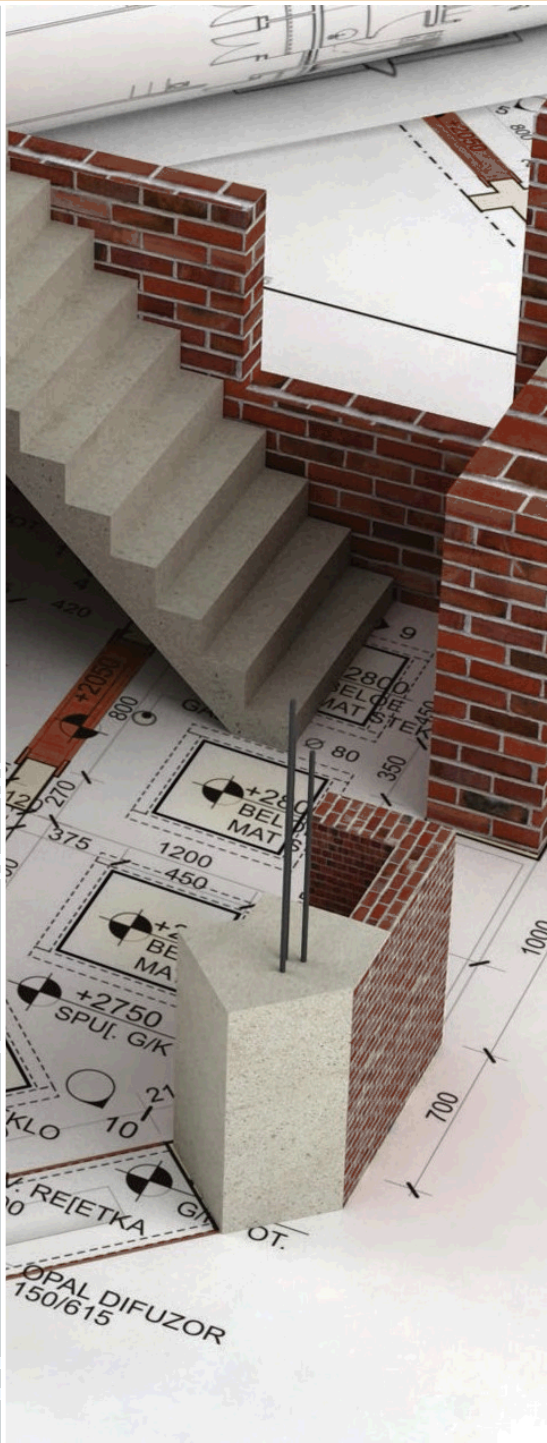
Canadian Centre for Housing Technology

The Canadian Centre for Housing Technology (CCHT) is a partnership between the NRC, Natural Resources Canada (NRCan), and Canada Mortgage and Housing Corporation (CMHC). CCHT features a twin R-2000 house facility. A third building, the InfoCentre, includes a display area and an office space. It also contains the FlexHouse – a townhouse designed to enable studies of how space can be adapted to an occupant's changing needs. Since 1999, CCHT researchers have assessed over 60 housing-related technologies.



Canadian Centre for Housing Technology

Highlights of CCHT projects during 2013 include:

Smart power system with advanced energy storage

This project, which began in 2011 with support from the Clean Energy Fund, has continued to be funded in the experimental and demonstration phase by the Program of Energy Research & Development (PERD). It explores the integration issues of energy power systems – including power generation, storage, and energy management – to minimize the energy consumption and peak power requirements of the FlexHousing™ demonstration unit at CCHT.

As part of this effort, modifications to the CCHT FlexHouse were sufficiently completed in 2013 to initiate a program of experiments and demonstrations. The experimental team made use of a new z-wave wireless system and an adaptive load management circuit panel. This enabled communication between a central energy management system and the technologies that were recently installed, including light switches, controllable power outlets and appliances.

The energy management system was used to first simulate a variety of realistic occupant-driven scenarios of lighting and appliance usage to develop base case electrical load profiles. The same energy management system was then programmed to explore how those electrical loads could be shifted off-peak and reduced to optimize the electrical power requirements associated with operating the FlexHouse.

Plans are now in place to modify the energy management system to integrate next-generation advanced lithium batteries that were assessed at NRCan CANMET laboratories. The resulting energy management and storage system will be the focus of a further experimental program at the FlexHouse. Project partners include NRC, NRCan, Defence Research and Development Canada, and Electrovaya Inc.

High-velocity, two-zone combination space and water heating system

A packaged combination system consisting of a tankless water heater and matched two-zone integrated high-velocity air handler was installed to supply both water heating and space heating/cooling through a two-zone high-velocity ductwork. The two-zone ductwork divided the supply ductwork of the upper floor of the house from the main and basement floors. The system was installed in two configurations: one made use of a buffer storage tank for domestic hot water supply and a second configuration made use of an indirect storage tank for domestic hot water supply and space heat supply.

A number of experiments were planned and executed for this technology at the CCHT twin houses to investigate the system's performance under winter and summer conditions. The project examined the energy performance and temperature control in various zones of the house using the two different configurations and zone control strategies, comparing these against each other as well as against the standard condensing gas furnace and gas storage water heater. The results were used to inform the manufacturer of the integrated performance of each combination under realistic operating conditions.

The potential for the system to reduce summer peak loads was also specifically examined. A final report has been completed for all climate conditions tested and will be available shortly, on request. Project partners include NRCan, NRC and Airmax/Flowmax Technologies.

Air balancing and zoning study

A similar approach to that used above was followed using air dampers. An air balancing and zoning study has been initiated at CCHT, involving the assessment of air flow rates in each duct of CCHT's forced air distribution system in the twin houses. Zone dampers and airflow measuring stations were installed in the Test House – one per branch. This preliminary work was executed by NRCan in summer 2014. Dampers were adjusted, resulting in improvements in temperature control of warm rooms on hot sunny days. This work was in preparation for a larger project to investigate more effective zone distribution strategies for forced air systems, in both winter and summer conditions.

Motorless counter-flow heat recovery air exchanger

An innovative furnace fan generated (motorless) counter-flow air exchanger with heat recovery capabilities was installed at CCHT and was evaluated over the winter and summer of 2014. For details, refer to the write-up under the research section of this report, titled **"High efficiency furnace fan generated air exchanger system in side-by-side testing."**

For more information on CCHT, consult the website at **www.ccht-cctr.gc.ca**

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