

CATtales

e-newsletter of the Institute for Catastrophic Loss Reduction

Volume 8, Issue 4
July/August 2014



Building a more weather-resilient home

By Michael Lio
President, buildABILITY Corp.

Inside this issue:

Building a more weather-resilient home	2
Two water/flood related workshops set for September	3
First person: The August 4 Burlington storm	4
Full-scale tests of residential walls under extreme wind loads	5/8

Dunnink Homes has demonstrated a number of building practices promoted by the Institute for Catastrophic Loss Reduction (ICLR) to make homes more resilient to extreme weather. The demonstration house, located in Guelph, goes beyond code requirements to include advanced building practices that offer better protection from damage caused by wind, snow, ice and other hazards from extreme weather events. The house includes a backwater valve, improved backfill and overland drainage, engineered trusses to resist high winds, strapping between rafters and wall framing, ½” roof sheathing with nails spaced at 6”, eave protection and roof underlayment.

ICLR, established in 1997, is a world-class centre devoted to disaster prevention research and communication. It is an independent not-for-profit research institute

founded by the insurance industry and affiliated with Western University. ICLR has devoted many years to developing new construction practices to help build more weather-resilient housing. Their work provides a science-based foundation for the construction of disaster-resilient homes as part of an adaptive strategy to deal with the increasing frequency and severity of extreme weather events.

ICLR’s research responds to the increased severe weather events that cost Canadians billions of dollars every year. One of the most recent examples is last summer’s severe flooding event in the GTA. “Insured losses from flooded basements have increased drastically over the past decade in Canada, costing insurers close to \$2 billion per year,” said Dan Sandink, manager of resilient communities and research ►

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at ICLR. “Homeowners also suffer significantly when their homes flood. This is especially true when they are flooded from sewer backup, which frequently includes flooding from raw sewage.

“While there are many critical measures that must be taken on the municipal infrastructure side to reduce risk,” he continued, “many important risk reduction measures can also be economically and effectively applied at the lotside. For example, sanitary backwater valves are widely applied in many Canadian provinces to reduce the risk of sewer backup. It seems likely these types of measures will be increasingly encouraged, if not required, for homeowners to retain affordable and effective insurance coverage for sewer backup in the future.”

The Dunnink house demonstration was designed using a number of ICLR-recommended construction details. buildABILITY Corporation on behalf of ICLR consulted with a working group of the Ontario Home Builders’ Association (OHBA) technical committee to determine the practices builders would favour. A number of these were included in the demonstration home.

Manufacturers were contacted regarding specific products for the demonstration home. Mainline Backwater Valve Company provided the backwater valve and Henry building products also assisted by providing the roof underlay and ice damming protection with the use of their Henry Company’s Blueskin RF200 Self-Adhesive Ice and Water Barrier. “Henry Company shares the views of ICLR. We see the need to build more weather-resilient housing,” said Martin Kuypers, residential business development leader at Henry. “Henry products and systems manage the flow of water, air, vapour and energy through the building envelope

from foundation to roof.”

Henry products used on the demonstration house are:

- Blueskin TWF (Thru-Wall Flashing) brick sill
- Blueskin WB (Weather Barrier) window and door flashing
- Blueskin VP (Vapour Permeable) breathable air barrier for exterior walls
- Blueskin Roof (RF200) Ice and Water Barrier, total roof coverage.

After working with the OHBA technical committee working group, John Dunnink from Dunnink Homes was the first to take up the challenge and build a more resilient home. “Building the first Discovery House using some of the ICLR building practices was a great experience that was very informative,” he said. “For the completed Discovery Home, the additional labour and materials total approximately \$7,000 for the upgrades, which provide additional protection from flooding, wind storms, snow and ice buildup and hail.”

“ICLR learned a great deal working with John Dunnink and the manufacturers,” said Jason Thistlethwaite, director of the Climate Change Adaptation project and research associate at ICLR. “ICLR has committed to working with homebuilders to improve awareness and uptake of resilient-housing practices. Resilient housing will grow in demand as the frequency of extreme weather increases. The implementation of high-wind straps, wind-resistant nails and backwater valves represents an important step in learning the building techniques necessary to meet this objective. John’s efforts have helped provide important lessons on the opportunities and limitations of resilient-building practices in the marketplace. Without support from homebuilders like John Dunnink,

it is difficult to build a bridge between the science and practice.”

Adapting housing to severe weather events caused by climate change will better protect homeowners from the emotional and financial hardships of damage to what is often their largest investment. Continued collaboration between researchers, builders, manufacturers and government is required to further these endeavours. **CT**

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Two water/flood-related workshops set for September

3

Deriving rainfall intensity-duration-frequency (IDF) curves for future climate scenarios set for September 10, The role of groundwater in flooding on for September 24.

ICLR is involved in offering two water/flood related workshops for September with the first being conducted by Western University and the Canadian Water Network with assistance by ICLR and the second taking place as part of ICLR's monthly Friday Forum workshop series.

Deriving Rainfall Intensity-Duration-Frequency (IDF) Curves for Future Climate Scenarios: A Publically Accessible, Online Tool

**Wednesday, September 10, 2014
11:30 am to 1:00 pm (EDT)**

Municipal water management in Canada is heavily dependent on the use of IDF curves in planning, design, and operation of municipal water infrastructure. Many watershed management activities related to water supply, water quality management, flood control etc. also rely on the use of IDF curves.

While there is a need in almost every Canadian municipality to adapt to changing climatic conditions, there is a lack of necessary expertise within municipalities for implementing current research related to the impact of climate change on IDF curves. Thus, one of the primary aims of this project is to standardize the IDF update process and make the results of current research on climate change impacts on IDF curves accessible to everyone.

This computerized, web-based IDF tool integrates a user interface with a Geographic Information System (GIS). By creating or selecting a rain station, the user will be able to carry out statistical analysis on historical data, as well as generate and verify possible future change based on a methodology using a combination of global climate modeling outputs and locally observed weather data.

This webinar will provide an introduction and demonstration of this free, web-accessible tool, currently in draft form. Webinar participants will be provided an opportunity to ask questions about and provide comments on the draft version of the tool.

For more information see <http://www.slideshare.net/glenmccgillivray/idf-climate-change-tool-september-10-2014-webinar>

The role of groundwater in flooding

**Wednesday, September 24, 2014
1:00 pm to 2:30 pm (EDT)**

Part of ICLR's ongoing Friday Forum series, this event will feature Cathy Ryan, a professor in geoscience at the University of Calgary.

Ryan is trained as a geotechnical engineer and hydrogeologist. She has been researching groundwater, river interaction and river-connected alluvial aquifers in the Calgary region for more than a decade.

Her interest in the role of groundwater in flooding was sparked after the 2005 Calgary floods when anecdotal information collected from a door-to-door survey of residents in neighbourhoods around Calgary's Elbow River suggested groundwater inundation (as opposed to overland flooding) caused a significant amount of the economic damage to homes.

It's Ryan's view that groundwater flooding is under-recognized but can be easily monitored and understood.

This event will be held at ICLR's Toronto office and via Webex.

For more information see <http://www.canadianunderwriter.ca/news/iclr-event-to-focus-on-groundwater-role-in-flooding/1003221707/>

First person: The August 4 Burlington storm

By Glenn McGillivray, Managing Director
Institute for Catastrophic Loss Reduction

It was raining in Oakville, but it was nothing worth writing home about, just a normal run-of-the-mill summer storm. But as soon as I crossed the boundary into Burlington, that changed.

I was quite amazed at the experience: after a torrential, typhoon-like downpour, the rain would stop just long enough to allow me to open the car windows and get some fresh air, then another wave would come, then another, and another. It's called a 'training' storm, because the cells came on like a train, one after another after another.

While Environment Canada didn't have any rain gauges right in the hardest hit area of the city, it is understood that a volunteer/unofficial gauge recorded 191 mm of rain. Official EC radar estimates were between 100 and 150 mm, but radar often underestimates actual amounts.

The radar indicates the rain came in two main shots, with the first coming at between about 2:00 and 3:30 pm and the second between roughly 5:00 and 8:00 pm, which likely dumped the majority of the rain amounts eventually recorded. At the end of it, parts of Burlington received about two months of rain in just one day, while Hamilton and Oakville were virtually untouched.

Travelling west on Lakeshore Road, I first hit a large puddle. Then, just a few blocks later, the roadway was completely flooded. I instantly told myself 'Do what you tell others to do and turn around', so I did. A car can float in just 30 cm of water, and the risk is not worth it. In the time it took to pull into a parking lot and position myself to take a quick cellphone picture (see right), a first car became stranded in the rapidly rising water.

In all my years of working on and writing about natural

hazards, this was really the first that I experienced first-hand.

The next day I drove through the city, but there was little evidence of basement flooding, save for a smattering of disaster restoration and furnace repair vehicles. A few bins had been dropped and some homes had piles of sodden carpet and the like on the curb. But, overall, evidence of widespread damage was not immediately evident—it was probably too soon.

One street, however, shocked me. In the middle of a seemingly untouched neighbourhood just south of New Street in the south-central part of the city, I came across Regal Road. On a small street leading to Regal, there were hints of muck on the roadway. However, when I turned the corner onto Regal, the road was covered from curb to curb in an inch of bright red clay. It was up driveways and into garages. Residents of the street also clearly had to deal with basement flooding. The mess was dramatic.

At writing, 2,313 homes were reported to have flood damage,



Residents of the lower section of Regal Road in Burlington not only had to contend with water, but also had to deal with a tsunamis of red clay.

according to the city. The total may be closer to double that as our research shows that more people call their insurer to report basement flooding than call their city.

Preliminary insured losses for the August 4 Ontario storm, as compiled by PCS Canada and reported by Insurance Bureau of Canada September 2 came in at "more than \$90 million" with the lion's share from Burlington. **CT**



Glenn McGillivray
@ICLRCanada

Serious flooding beginning on Lakeshore Road in Burlington, ON, between Burloak and Appleby. Avoid the area!

5:49 PM - 4 Aug 2014

25 RETWEETS 4 FAVORITES

Follow

Full-scale tests of residential walls under extreme wind loads

By Gregory A. Kopp & Derek Steadman
Boundary Layer Wind Tunnel Laboratory, University of Western Ontario

Roofs are the most vulnerable part of houses during extreme wind storms. Analysis of roof capacities based on full-scale structural testing, wind tunnel studies, as well as observations from tornado damage surveys, suggests that the weak link in wood-frame houses is the connection of the roof to the walls. Thus, in terms of structural performance, it is often the complete roof that comes off first (notwithstanding that cladding systems tend to fail at lower speeds, like asphalt shingles and wall siding). With the loss of the roof, walls tend to become vulnerable, which, when they collapse, is a significant life safety issue. In addition, when structural roof components fail, they tend to fly through the air and can impact downwind structures, causing otherwise safe houses to fail. Windborne debris is also a serious life safety issue for people caught in storms, where 2-by-4s can easily penetrate brick walls, windows, and doors.

At the University of Western Ontario's Insurance Research Lab for Better Homes, we have been studying the performance of wood-frame houses for more than a decade now. We have examined the performance of two full roofs under extreme winds, as well as roof and wall sheathing, roof-to-wall connections, vinyl siding, windows and other components. In addition to this, we have conducted wind

tunnel studies on more than 40 houses in a variety of neighbourhood patterns. While the focus of much of this research has been to find optimum solutions for building codes and low-cost mitigation strategies to reduce damage, we have also been motivated to better understand the effects of tornadoes on houses and other structures.

Wind speeds in tornadoes are rarely measured. Rather, when tornadoes occur, we observe the damage and then estimate the wind speeds that may have caused the damage. This approach was first developed by Fujita in the early 1970s, and his observations became known as the Fujita Scale. Since the most common structures are houses, houses played a critical role in his original damage scale. In 2006, the



Damage from the Goderich tornado, August 2011.

National Weather Service in the USA implemented a new scale, called the Enhanced Fujita (EF) Scale, which was developed by Texas Tech University and was based on expert opinion. In 2013, Canada adopted a slightly revised version of the EF-Scale. The main enhancements of the EF-Scale were to bring in many (i) more types of building types (called Damage Indicators, DIs), (ii) more levels of damage (called Degrees of Damage, DOD) for ►

Degree-of-Damage	Damage Description	Expected value (km/hr)	Lower bound (km/hr)	Upper bound (km/hr)
1	Threshold of visible damage	105	85	129
2	Loss of roof covering material (less than 20%), gutters and/or awning; loss of vinyl or metal siding	127	101	156
3	Broken glass in doors and windows	154	127	183
4	Uplift of roof deck and loss of significant roof covering material (20% or more); collapse of chimney; garage doors collapse inward; failure of porch or carport	156	130	187
5	Entire house shifts off foundation	195	166	227
6	Large sections of roof structure removed; most walls remain standing	196	167	229
7	Exterior walls collapsed	212	182	246
8	Most walls collapsed, except small interior rooms	245	204	286
9	All walls collapsed	274	229	319
10	Destruction of engineered and/or well-constructed residence; slab swept clean	322	266	354

remain standing”, DOD-7 has “exterior walls collapsed”, and DOD-8 has “most walls collapsed, except small interior rooms”, as shown in the table . The wind speed ranges for

Degrees of Damage for Wood-Frame Houses (DI-2), from Environment Canada

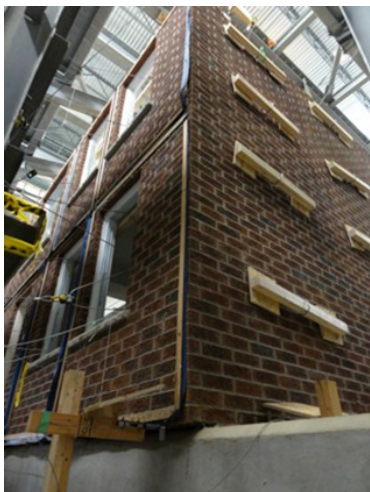
each building type, and (iii) revised wind speeds, particularly at the upper end of the scale. The table above provides the DOD for wood-frame houses (from Environment Canada (2013, <http://ec.gc.ca/meteo-weather/default.asp?lang=En&n=41E875DA-1>). At the Insurance Research Lab for Better Homes, we have also been working on validating the wind speeds in this scale, based on a combination of wind tunnel studies, failure observations in the lab, and correlations of

different types of damage observed in field studies.

With the completion of our research into the performance of roofs, we had a house in the lab that had no roof, as shown in the photographs below. This provided a unique opportunity to evaluate one particular aspect of the EF-Scale, namely the wind loads required to collapse the walls on a brick-clad house without a roof. For DI-2 (wood-frame houses), DOD-6 provides wind speeds which cause roof failure while “most walls

DOD-6 were estimated in the EF-Scale to be 167-229 km/h while for DOD-8 they are 204-286 km/h. The objective of the study was to identify the failure mechanisms for walls when the roof had already failed, and to estimate the wind speeds associated with these failures. Details pertaining to the experimental details can be found in Stedman (2014, MEd Thesis, Department of Civil and Environmental Engineering, University of Western Ontario).

The test results surprised us. We were



expecting failures at relatively low loads since the removal of the roof makes the walls significantly more vulnerable. The first failure in the brick-clad house was ►

Test house at the Insurance Research Lab for Better Homes (IRLBH) without its roof.

at about 1.5 kPa, which is about 50% higher than the factored design load using Part 4 of the National Building Code of Canada (NBCC) for a house in London, ON.

The failure was at the connection between an interior wall and the exterior wall, as shown in the photographs (right). This failure mechanism is remarkably

consistent with failures observed in the field, particularly those in Goderich, (see photos on page 5), as well as others available to the authors.

Analysis of the results suggest that the brick cladding played a significant role in this performance, particularly by strengthening the corners of the walls, which had the effect of reducing outward



Photographs of the first failure in the brick-clad house, looking down on the wall from above: (upper) at the onset of failure, (lower) and just after failure when the exterior wall was disconnected from the interior walls.

displacements along the span of the wall. Subsequent tests on undamaged portions of the walls, but with all of the bricks removed, showed this effect clearly, as do the photographs below. Thus, presuming that the bricks stay intact during the storm – and with the failure of the roof – brick-clad

houses will be more resilient to further damage than, say, vinyl-clad houses. However, when the bricks fail, this will not be the case.

Some additional observations from the study include: ►



Photographs of corner displacements with brick cladding (left) and without bricks (right), at about the same load levels.

- While the walls on the upper floor (of the brick-clad house) were experiencing significant deflections and catastrophic failures, the lower floor walls did not deflect noticeably and were not significantly damaged. Thus, if basement spaces are not available, sheltering in lower floors should be significantly safer than on upper floors.
- Relatively inexpensive changes to the construction of residential structures would cause a significant increase to the ultimate strength of individual walls and the structure, as a whole, should the roof fail. Such changes include: controlling double top plate member overlap, increasing interior-to-exterior wall connection strength and extending brick veneer around corners (or significantly increasing the rigidity of corners). However, it would be better to put additional resources into securing the roof to the walls using hurricane straps.

Using the NBCC, as well as wind loads in ASCE 7-10, it was estimated this failure



Damage from the Angus Tornado due to improper wall connections

mechanism occurs at wind speeds in the range from 170 – 260 km/hr, which is reasonably consistent with the current values in the EF-Scale. However, future work will consider wind tunnel data, tests, which will be conducted in the near future on the same “roofless” house. Further work is also still required to assess the similar wind speeds for houses that are vinyl-clad (or where the brick has failed).

As a final observation, wall failures that occur while the roof remains in place indicate serious construction deficiencies. An example is shown above from the Angus, Ontario Tornado, which

occurred in June 2014. Such failures are due to walls not being fastened into the structure in an adequate manner. **CT**

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Mission
To reduce the loss of life and property caused by severe weather and earthquakes through the identification and support of sustained actions that improve society's capacity to adapt to, anticipate, mitigate, withstand and recover from natural disasters.

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