

RISK INSIGHTS

PREVENTING THE COLLAPSE OF PARTIALLY CONSTRUCTED NEW HOMES

Blow-down of partially constructed houses and other light-frame wood buildings occurs numerous times every year across Canada.

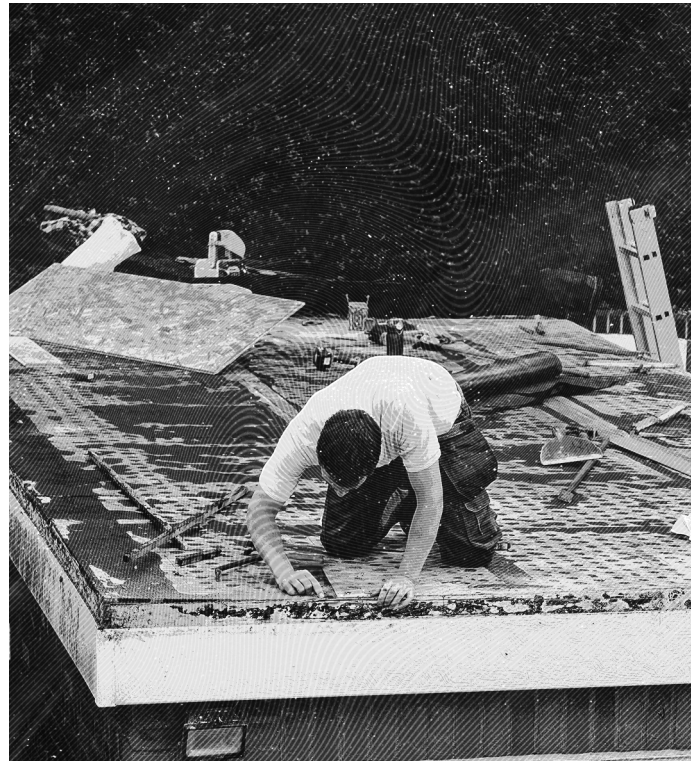
THE NATIONAL BUILDING CODE OF CANADA (NBCC) AND PROVINCIAL BUILDING CODES SPECIFY THE **DESIGN WIND SPEED** FOR RESPECTIVE AREAS.

In many instances, the gusts causing such failures do not exceed the design wind speed that the completed house is required to withstand. The problem is that these requirements are intended for completed buildings at their maximum lateral strength. Structures under construction are not yet strong enough to withstand windstorms.

An event in 2018 in Niagara Falls, ON caused failure of several houses under construction. Nearby instrumentation measured wind gusts of up to 100 km/h; the National Building Code of Canada (NBCC) specifies a design (3-second gust) wind speed for the Niagara Falls region of 141 km/h. Several design features, particularly of modern houses, increase susceptibility to collapse during a particular stage in construction. There are a number of steps that homebuilders can take to help prevent loss of homes during the vulnerable stages.

In most failures observed in partially built houses, the first-storey walls collapse entirely, with the roof and upper storeys landing nearly intact on top of the pile. These houses are at a stage in construction before interior drywall or first-storey windows have been installed. In a completed house, the NBCC allows for required lateral strength to be provided by gypsum drywall. However, since interior finish is installed so late in the construction process, there is often at least a week where the house has minimal lateral strength. Since the NBCC applies to the finished building, there is no clear requirement for lateral bracing during the phases of construction.

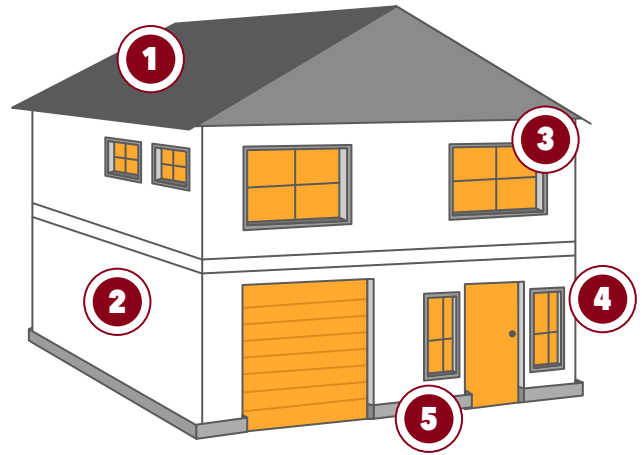
It is the builders' responsibility to take the necessary measures in **strengthening partially built structures** during vulnerable stages of construction. This is crucial in keeping personnel safe, avoiding construction delays and preventing business interruption. This Risk Insight summarizes the causes of blow-down of partially built homes and provides recommendations for measures that can improve their lateral strength. It also discusses how to improve lateral strength to your unfinished structure and primarily focuses on commercial roofs, wood frame structures and low-rise buildings.



Causes of collapse during construction

In many modern subdivisions, house floor plans are relatively narrow, with the front and back end walls much shorter than the sidewalls that extend into the lot. The end walls also contain large windows, garage door openings, and front and back door openings, while side walls have minimal openings due to proximity to neighbouring houses.

1. Steeper roof slopes in larger proportion of wind load acting horizontally.
2. Long sidewalls with minimal openings—larger surface area for wind pressure to act on.
3. Upper-storey windows may be installed early, providing stiffness to the upper walls.
4. End walls with large openings have limited structural length available to resist lateral (shear) forces.
5. First-storey windows and doors installed late in construction.

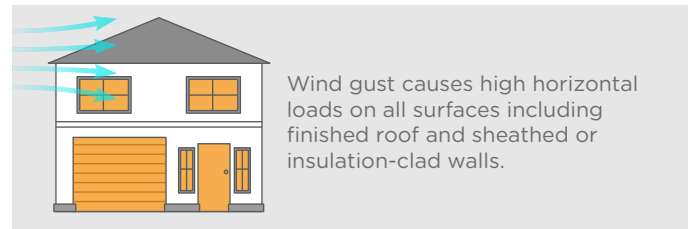


During construction, if wood sheathing is not applied, the racking strength of the end walls is provided only by the wall studs, top and bottom plates, framing around openings, and the end-nailed connections between them. A house at this stage in construction stands up to gravity loads due to the strength of the wall studs under compression. However, if a wind gust occurs that is strong enough to make the walls start to lean, it takes relatively little force to cause rotation at the nailed connections. If the studs lean out of plumb (top of stud is no longer in alignment with bottom), the weight of the structure above contributes further to the collapse. When such failures occur, the house at the end of a row will typically collapse first due to wind hitting its exposed side wall, and then it may fall onto neighbouring houses causing a domino effect.

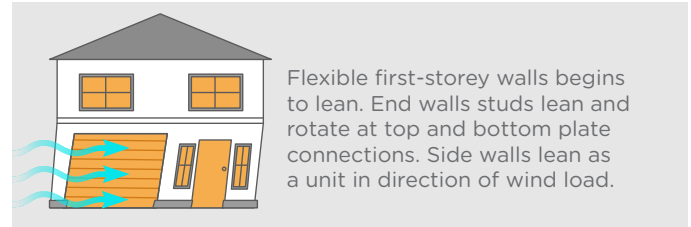
When it comes to protecting houses from blow-down during construction, the critical form of mitigation is to brace the walls, particularly on the first storey where there are large openings. The first recommended option is to sheathe the walls with structural wood sheathing in place of continuous rigid insulation. This is a permanent method for providing better lateral strength for the lifespan of the building. However, this method requires alterations to the design of the house and may interfere with the insulation performance. Where use of permanent structural wood sheathing is not desired, a number of temporary measures can be taken to provide early shear strength to the walls.

Why it's important to prevent partially constructed homes from collapsing:

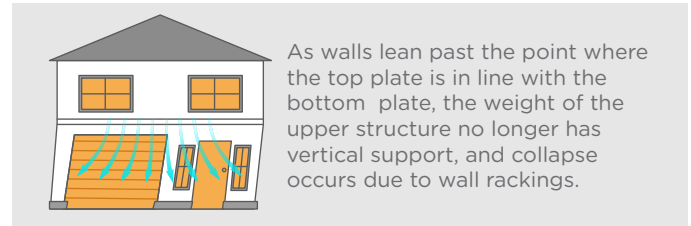
- Worker safety
- Prevention of insurance claims
- Preventing delays in home closures



Wind gust causes high horizontal loads on all surfaces including finished roof and sheathed or insulation-clad walls.



Flexible first-storey walls begins to lean. End walls studs lean and rotate at top and bottom plate connections. Side walls lean as a unit in direction of wind load.



As walls lean past the point where the top plate is in line with the bottom plate, the weight of the upper structure no longer has vertical support, and collapse occurs due to wall racking.

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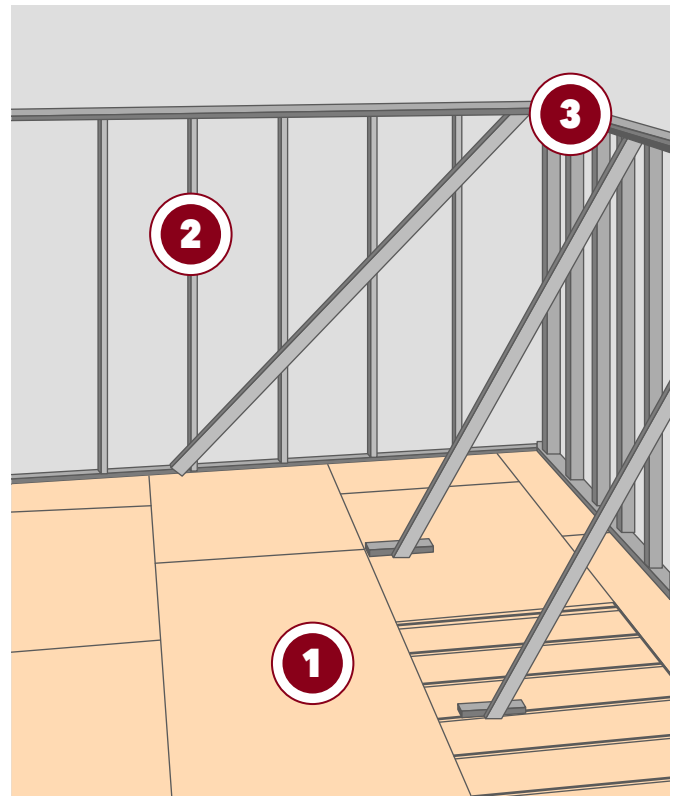
Temporary wood bracing

End walls, interior walls, and side walls can be braced using temporary wood members running in the direction of likely collapse (along the narrow dimension of the house).

Side walls can be propped up in the out-of-plane direction using diagonal braces (30° to 50° angle) nailed to a cleat that is fastened to the floor inside the house. The top of the brace should be fastened to the face of a stud near the top plate using at least two 8d (63 mm) nails each, and the bottom should be similarly nailed to the cleat. These out-of-plane braces should be installed every 2-3 m. Avoid simply toe-nailing the brace at either end, especially at the subfloor.

End walls and interior walls in the narrow direction can be braced using diagonal braces (45° angle) fastened to the studs and the top and bottom plates, using at least one nail per intersecting member. Such braces might cover part of window or door openings.

1. Nail to cleat at bottom of brace with at least two 8d (63 mm) nails, and fasten cleat through subfloor into floor joists with 2-3 nails along length of cleat.
2. End wall wood and interior wall braces should be nailed at every intersecting stud and plate with minimum of one 8d (63 mm) nail each.
3. Side wall braces installed at 30° to 50° angle, every 2-3 m along the side wall. Nail to face of stud near top with at least two 8d (63 mm) nail.

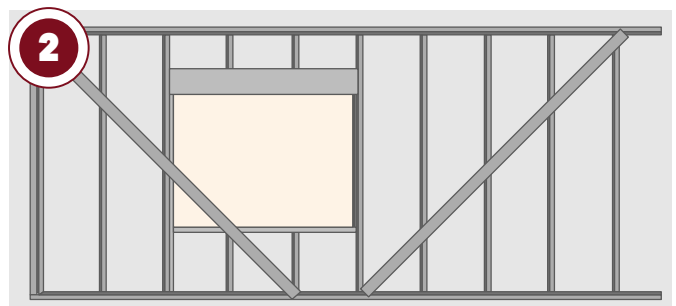
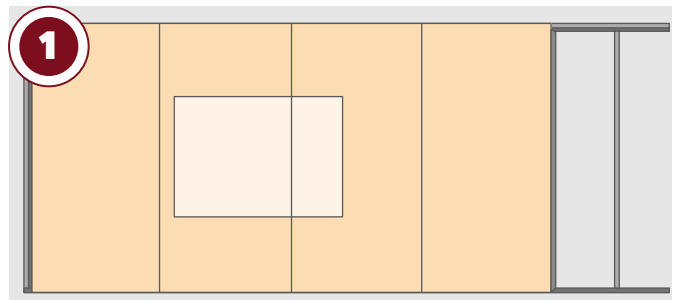


Other bracing method

The goal of this bulletin is to provide methods for adding extra lateral strength to a house, particularly to the first-storey walls before the windows, doors, and interior drywall is installed. In addition to temporary wood braces, other methods may include temporary metal braces such as flat tension straps.

While using either wood or metal diagonal braces, it is important to ensure the diagonal braces are installed in both directions along each face to prevent the house from leaning or rocking in either direction.

1. Permanent structural wood sheathing. Use nail spacing requirements in NBCC Par 9.
2. Diagonal wood bracing on end walls. Use at least one 8d (63 mm) nail per intersecting stud or plate, provide braces in both directions on each end wall.



Another method to improve early wall stiffness—and prevent worsening of wind loads due to internal pressurization—is early installation of first-storey windows. Many builders leave large openings in the end walls on the ground level to facilitate movement of materials in and out of the house. If it is not convenient to install windows early, temporarily sheathing over window and door openings when the site is to be left unattended for an extended period (overnight or over the weekend) may be practical. Sheathe over as many window and door openings as possible, especially on end walls, using structural wood sheathing, minimum 6d (51 mm) nails, and a nail spacing of at least 150 mm around the perimeter of the opening.

1. Diagonal wood bracing on interior walls running in the same direction as end walls. Use at least one 8d (63 mm) nail per intersecting stud or plate, provide braces in both directions where possible.
2. Diagonal metal bracing. Nail according to manufacturer's specifications, provide braces in both directions on each end wall.
3. Temporary structural wood sheathing over openings. Use minimum 6d (51 mm) nails with a 150 mm nail spacing around perimeter.

By anticipating high wind conditions and adequately preparing your staff and construction site, you are better positioned to prevent property loss, damages and injuries. The design, construction and securement methods play crucial roles in ensuring roofs and walls aren't blown away by high winds. Building components, materials and equipment are to be stored properly to prevent damage and destruction. Keep personnel safe by enforcing safety rules and delaying tasks during anticipated hazardous weather conditions.

While natural hazards such as high winds are difficult to predict, you can prepare your construction site to withstand severe weather conditions. Address your job site's wind exposures to keep employees safe, minimize property damage and allow your business to proceed uninterrupted.

For more information on making your business safer, contact our Risk Services team at **1.833.692.4111** or visit us at **www.northbridgeinsurance.ca**.

