High Wind Design of New Woodframe Houses has an Average Benefit-Cost Ratio of 6:1 in Canada

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Severe windstorms are growing in frequency and magnitude of loss. Major damaging tornadoes struck Ottawa/Gatineau in September 2018 and in Barrie in July 2021, resulting in $344 million and $107 million in insured loss respectively. The May 2022 Canadian derecho in southern Ontario and Quebec cost an estimated $875 million in insured losses. Out of 139 recorded insurance catastrophe events between 2009 and 2022, 111 (80%) had a wind loss component.

Damage to non-structural components – including roof cover and cladding – is one of the most frequent drivers of loss during wind events. Even relatively moderate wind events can result in damage to, or loss of roof coverings.

Images: Northern Tornadoes Project.

Very severe structural damages may occur during high intensity wind events associated with hurricanes and tornadoes. Severe windstorms can damage buildings by imposing severe lateral loads and uplift forces. Buildings are more likely to experience damage from uplift forces (e.g., removal of roof cover, sheathing, and framing) because modern Canadian building codes do not fully address uplift resistance for smaller, low-rise, woodframe buildings.

Images: Northern Tornadoes Project.

Institute for Catastrophic Loss Reduction

Building resilient communities

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How can we reduce losses?

Loss reduction options outlined in CSA S520:22 include enhancing the vertical and lateral load paths in buildings, and installing building materials that are more resistant to high winds. Because of the life-safety risk created by structural damage to buildings, this study focusses on vertical load path enhancements outlined in CSA S520:22.

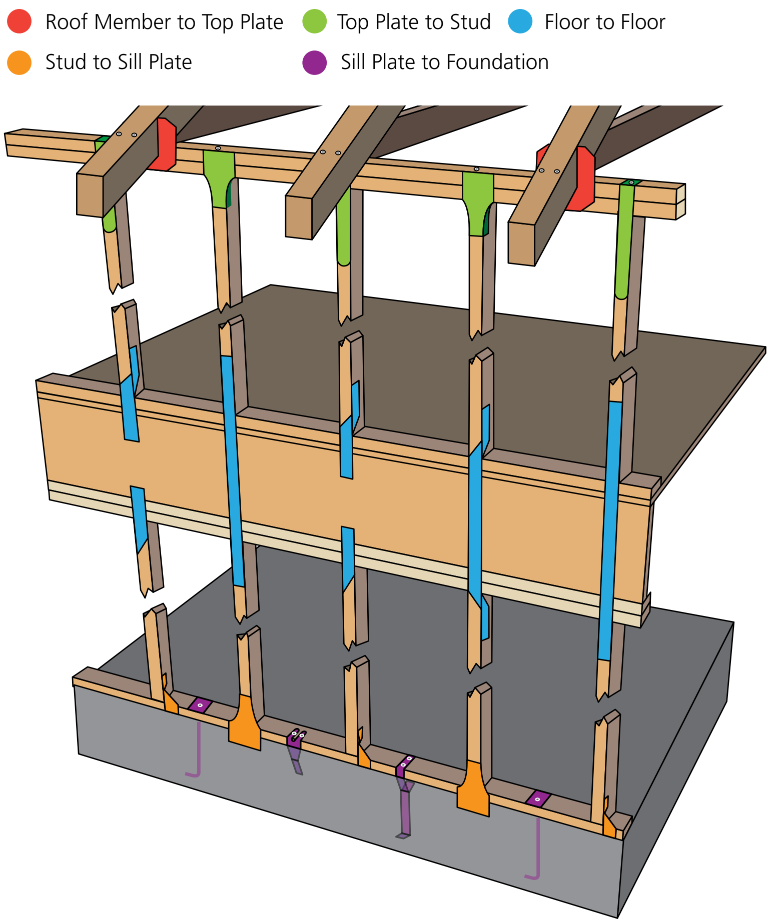
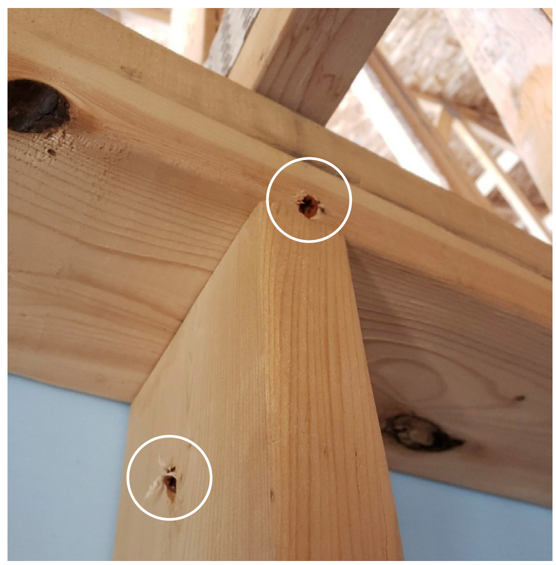


Image modified from U.S. Department of Housing and Urban Development. 2023. Designing for Natural Hazards: A Resilience Guide for Builders and Developers. Volume 1: Wind. U.S. Department of Housing and Urban Development: Washington, D.C.

How was climate change considered in this assessment?

The study applied a future climate scenario associated with SSP3-7.0 – that is, an expectation that CO_2 concentrations will double by 2100, and global warming of ~2°C by the mid 2100s. Future wind pressures were obtained from PCIC's Design Value Explorer.

While climate change enhances the need to address high wind in residential construction, the BCR remains highly positive even when climate change is not incorporated into the analysis.



Truss screws used to enhance the connection between the roof structure and the wall.

Many options are available to enhance the vertical load path in housing and small buildings. For example, truss screws used in place of hurricane ties and floor-to-floor connection straps offer a simpler, less expensive alternative with similar performance characteristics. **Builders and designers are encouraged to select measures that are practical and cost effective.**

Benefit-cost ratios vary from place to place because of local differences in weather. But on average, the benefit cost ratio for applying vertical load path enhancements outlined in CSA S520 is 6:1.

A performance-based wind engineering method was applied to assess the benefit cost ratio of implementing CSA S520:22 recommendations in a typical single test home of 2 storeys and ~2,200 ft^2.

Wind protection measures added ~1% to construction cost (roughly \$1.70 per ft^2), and avoid, on average, \$22,000 in future losses (or, roughly \$10 per ft^2).

High Wind Resilience Costs and Benefits

For an average new 2-storey, 2,180 ft^2 home:

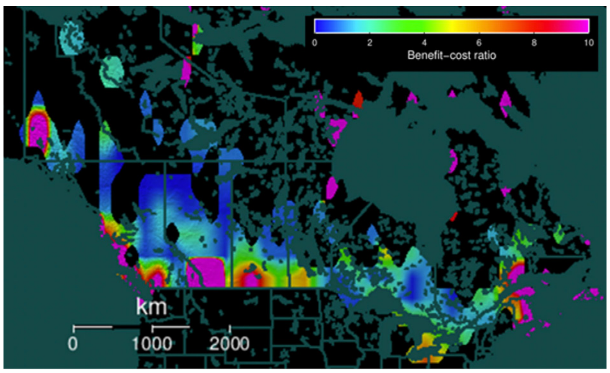
Wind resilience cost = $3,600 = $1.70/ft^2, or about 1% of construction cost.

Benefit = $22,000

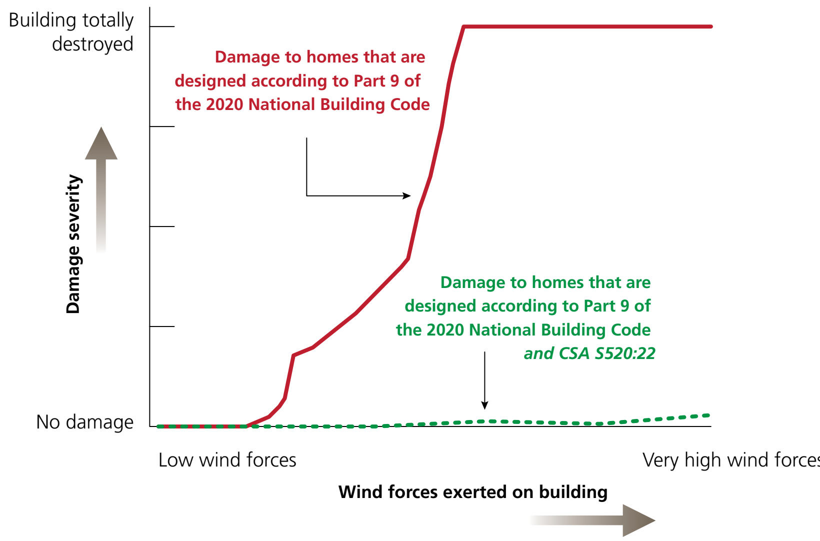
Benefit-cost ratio = 6:1

The benefit-cost ratio reaches as high as 100:1 in Canada's windiest places.

The above costs are incremental costs associated with enhancing the vertical/uplift load path for a new, 2-storey, ~2,200 ft^2 Part 9 building in Canada. The incremental costs are associated with enhanced roofing practices (roof cover, sheathing, sheathing fasteners), improved structural connections (roof-to-wall, wall-to-wall, wall-to-floor, and wall-to-foundation, and enhanced post base/cap connections), as well as expected overhead and profit associated with application of these enhanced construction measures.



Benefit-cost ratios are as high as 100:1 in regions with recurrent high wind exposure.



A Benefit Cost Ratio of 6:1 is a conservative, low estimate of the overall benefits of protecting Canadian homes from high wind impacts. This figure does not fully reflect the benefits to society of protecting homes from damaging wind events. **We should expect a much higher return on investment** for protecting Canadian homes from high wind damage.

Damages/costs that are included in this analysis

- Repair costs for buildings, including labour, equipment, overhead and profit for construction work
- Repair/replacement cost for building contents
- Living expenses for displaced households
- The costs of carbon (average of 202 kg equivalent CO_2 for a Canadian home, social cost of carbon of $261 per tonne of CO_2)

Damages and impacts ***not included*** in this analysis

- Loss of life, injury, PTSD, and other life and health impacts
- Impacts on pets
- Loss of sentimental/irreplaceable items
- The social impact of displacement of residents and families
- Costs and impacts of managing and disposing of solid waste caused by damaged buildings and contents

See the full report for more detail: Porter, K.A. (2023) *High-wind design of new woodframe houses has an average benefit-cost ratio of 6:1 in Canada*. Institute for Catastrophic Loss Reduction, Toronto, ON, 34 p. Available here.