Taming the Big Bad Wolf

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An eyewitness account of the damage tornadoes did recently in the Vaughan area of Ontario, just north of Toronto, suggests roof nails are still missing the mark.

Multiple tornadoes ripped across Southern Ontario on Aug. 20, 2009, resulting in the tragic death of a young boy in Durham and significant damage to hundreds of homes in Vaughan, just north of Toronto. Damage was widespread, hitting cars, crops, utility poles and many types of buildings.

The damage in Vaughan was concentrated in two neighbourhoods, one near Hwy 7 and Martin Grove Rd (in an area called Woodbridge), and the other near Jane St and Teston Rd (in an area called Maple).

Many discussions and opinions about construction quality have taken place, as always seems to happen after such events. Much of the information being put forward is incorrect, or at least misleading. In particular, the focus has been on the construction methods used for the walls — i.e. brick versus wood. It's as if the story of the Three Little Pigs has become the focus of our attention. And yet when the Wolf blows, some particular things happen, but the issue is not how the walls are made. In the Woodbridge area, the houses were of masonry construction with block and brick walls. These are strong walls. In the Maple area, the houses were wood-framed and clad with either brick or stone facades and they seemed to be weaker.

In fact, the method of wall construction has little to do with the performance and damage observed in these storms. Rather, the main issue has to do with how the roofs are constructed — most importantly, how the roofs are connected to the walls.

When we joined Environment Canada to examine the storm sites, we observed the vast majority of the damage was due to roof failures such as sheathing (plywood sheets nailed to the trusses) and toe-nailed, roof-to-wall connections coming off. Damage caused by debris also played a role, as discussed below. The more severe Barrie tornado in 1985 showed that deaths often occur when walls collapse; this occurs when roofs

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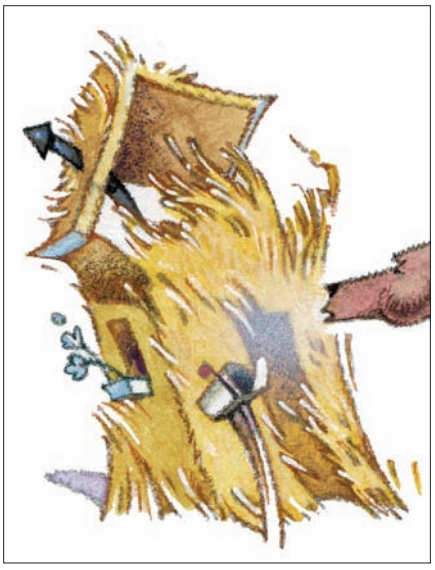
are removed. So, while it is perhaps true that double-brick walls offer more protection when the roof is off, this was not an issue in the instance of the Vaughan-area tornadoes (although there were a handful of locations where walls failed following roof failure). As a matter of fact, double-brick walls collapse, too. We saw a few of these in Woodbridge. Fortunately, no one was hurt there.

When wind blows on a house, or any other structure, it causes uplift on the roof. To understand the effects of this, imagine holding the house upside down and shaking it. One can immediately see the nail connections become the issue (see 'All about the nails,' *Canadian Underwriter*, January 2009). The primary role of the nail connections is to hold the roof in place. If the roof is not connected to the walls, only the weight of the roof holds it down. Since our roofs are made of wood, they tend to be light, offering little resistance to the forces induced by the wind unless they are well-fastened.

The photograph below (See Figure 1) shows one example of a failure because the roof was not connected to the walls; rather, in this pitched roof construction, the structural members of the roof were placed in slots in the blocks. The red arrow points to where one of the connections should be, but, in fact, there is nothing holding the lumber to the interior wall. In Vaughan, we also saw many roofs that had been properly connected,



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and yet failed. This was a severe windstorm.

The other major issue in windstorms, particularly for tornadoes, is wind-borne debris. When upwind structures or parts of structures fail, the wind carries these elements. They can travel a long way and with high speed. In a suburban neighbourhood, a high probability exists that these elements will subsequently hit down-wind houses. If debris happens to collide with a window or a garage door, the window or garage door will likely fail, allowing wind and rain to enter the building. Although the rain itself causes a lot of damage, the wind entering the building pressurizes it like a balloon, adding to the uplift on the roof and increasing the forces the nails must resist. At this point, roofs often fail.

We saw a lot of evidence of debris impact in both neighbourhoods. Many windows and garage doors were broken by debris. We saw many 2x6 and 2x8 pieces of wood penetrate roofs and windows like spears. (See Figure 2 on Page 70.) This is why you are always advised to stay away from windows in tornadoes and head for the basement.

Wind-borne debris is very dangerous, as shown by the tragic events in Durham, and should be mitigated as much as possible. A primary way to do so is to ensure that the roof structure remains intact. Reducing the possibility of shingle and vinyl siding failures also helps. In this latter regard, it was good that the houses in Vaughan were brick-clad, so that vinyl-siding was not an issue. Also, the brick material meant relatively little debris penetrated the walls. We saw many black marks on walls where shingles had hit the bricks.

Figure 3 on Page 70 shows an example of the type of roof failure induced by wind-borne debris. Here, the second

Figure 1

floor windows were broken, leading to severe internal pressurization, causing the subsequent failure of the roof. Thus, when failures occur in one house, it can lead to failures in neighbouring houses because of the wind-borne debris. In Maple, debris caused a lot of damage. It broke many second floor windows and garage doors. The garage door failures led to garage roofs coming off in several instances, while window failures led to roof failures.

The solution for the problem of roof failures for winds as severe as occurred in these F2 tornadoes, is actually rather inexpensive — hurricane straps. These are readily available, easy to install in new construction, less prone to errors in installation and, best of all, inexpensive. At most, they would add a few hundred dollars to the cost of a new house. As part of the '3 Little Pigs' project at our Insurance Research Lab for Better Homes (IRLBH) at the University of Western Ontario, we are currently testing such technology in order to find optimal solutions that minimize costs and maximize safety for both new homes and existing ones. If the houses in Vaughan had been built with this technology, we believe the overall losses would have been significantly reduced. Examples of such construction exist in Ontario. Two houses have been recently constructed following the Institute for Catastrophic Loss Reduction's "Designed for Safer Living" program. These are in Fort Erie and Sudbury (with a third in P.E.I.). All were built in partnership with The Cooperators.

We hope more houses get built this way, thereby taming the Big, Bad Wolf.

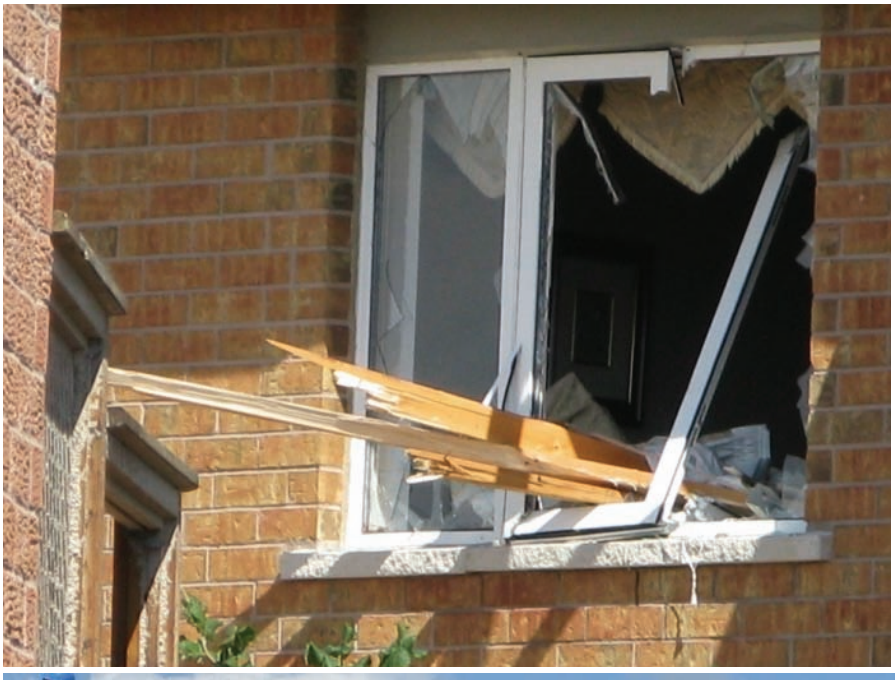

Figure 2

Figure 3