Fire Engineering®

Construction Concerns: Wood-frame Lean-over Collapse

Article and photos by Gregory Havel

March 26, 2009

In a “lean-over” collapse of a wood-frame structure, the building’s walls are no longer vertical and the structure tilts to one side, although the floors may remain approximately level. This tilt changes the studs’ or posts’ original axial loading to eccentric loading, which transfers more of the load to the fasteners and makes the structure unstable.

A lean-over collapse can occur because the wood mortise-and-tenon joints have dried out and shrunk (in post-and-frame construction); the wood studs have dried out and shrunk and the nails have rusted (in balloon-framed or platform-framed buildings); the foundation is weak or the mud sills are rotten on one side of the building; the building has suffered a fire.

Photo 1 shows a barn during a lean-over collapse. It can no longer stand by itself and is partly supported by the trees to its right, and partly by its contents. Without these secondary supports, the century-old nails would fail and gravity would complete the collapse.

In a rural area, a building’s collapse in this way may seem less significant than if it occurred in an urban area with neighbors (exposures). However, we must keep in mind that this barn is already unhealthy; and that if there is a fire, we do not want to be on top of or under the structure while it finishes its collapse.

In an urban area, with closely-spaced, hundred-year-old buildings of two and three stories, a lean-over collapse of one building can place an undesigned load on its neighbor, causing its collapse, and the collapse of other nearby buildings.

When post-and-frame buildings are restored, the posts and walls are often made plumb and vertical, and the loads made axial by adding wood bracing, and steel turnbuckles.

Photo 2 shows part of the attic and second floor of a post-and-beam structure built in the 1860s. During this most current restoration, the architect designed several steel-rod turnbuckles to stabilize the building frame, which was beginning to lean toward the street.

Although this building now has vertical walls and horizontal floors and is an attractive part of the historical preservation district, we must remember that these rods will elongate and loosen when heated in a structure fire, returning the building to its previous instability, the result of aged and loosened mortise-and-tenon joints.

Photo 2 also shows new white plywood gusset plates nailed to the rafters at the underside of the ridge. This building was unusual for the era, since the top ends of the rafters were nailed directly to each other, without a ridge-board.

The presence of steel rod or cable turnbuckles and the absence of a ridge board in the roof framing should be significant enough to note on our prefire plan for this building. If a fire were to go beyond the contents of a single room, we should be prepared for a lean-over building collapse. We should also expect the roof to be as unsuitable for roof-ladder work as if it were built on wood trusses.

Gregory Havel *is a member of the Burlington (WI) Fire Department; a retired deputy chief and training officer; and a 30-year veteran of the fire service. He is a Wisconsin-certified fire instructor II and fire officer II, an adjunct instructor in fire service programs at Gateway Technical College, and safety director for Scherrer Construction Co., Inc. Havel has a bachelor's degree from St. Norbert College and has more than 30 years of experience in facilities management and building construction.*

- **CLICK HERE** for more 'Construction Concerns' articles!

Fire Engineering, March 26, 2009