Do you own a KILLER BUILDING?

Fatal design flaws can be found in many nonengineered buildings. Check with your structural engineer before proceeding with your next project.

by David Bohnhoff

EVERY year, various pockets of the country experience a rash of agricultural building failures. More often than not, these failures occur as all nonagricultural buildings in the same area suffer no such problems. Agricultural buildings fail in large numbers simply because they are either not engineered or are only partially engineered. In other words, agricultural buildings fail because they are not engineered correctly.

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A fully engineered building is developed by following three structural design steps:

Step 1: Calculate all loads and load combinations to which the building will be subjected.

Step 2: Determine how loads from Step 1 are distributed to building elements (this step is known as structural analysis).

Step 3: Select components and connections capable of handling the forces to which they will be subjected. In practice, selections made in Step 3 will influence structural analysis (Step 2), and this makes structural design a continual process.

A fully engineered building also accounts for the interaction of all structural components during analyses and sizes components based on those interactions. In contrast, a nonengineered building accounts for neither component loads nor actual component strengths. A partially engineered building lies somewhere between these two extremes.

Near-death experience

In mid-December 2010, a snow event caused a swath of agricultural building failures in southwest Wisconsin. I investigated six of these buildings. In each case, failure was triggered by drifting and sliding snow loads (unbalanced) that the structure should have easily withstood. In each case, it was obvious the building was not fully engineered.

One of the buildings I toured was owned by dairy farmer Cyril Myren. I met with Cyril four days after the collapse of a portion of his 2-year-old free stall barn. Cyril could barely move as we spoke. He suffered two cracked ribs and lots of bruising. Cyril's son, Todd, received a gash in the back of the head and other injuries in the same collapse.

Both were working to get cattle out of a portion of the building that had already collapsed when additional building bays came down. Todd was trapped until freed by police and fire department personnel. In Cyril's words, they were both lucky to be alive. Some of their cattle were not as fortunate.

I explained to Cyril that his building had several major weaknesses due to a lack of engineering. Cyril's response was one of frustration and anger. He truly believed he had purchased a properly engineered building. A properly engineered building in Cyril's mind is what I refer to as a fully engineered building.

While I applaud the entrepreneurial spirit of anyone starting their own building company, it is scary when individuals erect nonengineered buildings. Realize that participating previously in the erection of engineered buildings does not provide a person with the skills necessary to engineer a structure.

Companies that erect nonengineered buildings typically emulate designs they have seen elsewhere. This causes myriad problems.

Simply copying, altering, and/or scaling up an existing design completely ignores the fact that loads like wind and snow are highly dependent on the size, shape, orientation, and location of a building as well as characteristics of the local topography and the size, shape, and orientation of attached and surrounding structures.

BUILDINGS LACKING ENGINEERING may appear to be an upfront cost savings. But a roof collapse will cost much more.

Snow, wind, and other structural loads act in a variety of combinations. A building must be designed to handle all load combinations to which it could be subjected. Total ignorance of applicable loads and load combinations is a hallmark of nonengineered building design.

Extremely weak connections between components is another common theme of nonengineered structures. The stresses that surround mechanical fasteners (bolts, screws, and nails) are complex. The stresses determine fastener size, spacing, and placement relative to the ends and edges of the components they connect. These conditions are seldom realized by builders attempting to mirror the design of another building. Improperly assembled connections trigger and/or contribute to many building failures.

During my years of investigation into agricultural building failures, it has become quite apparent that a vast majority of farmers are under the impression they purchased a properly engineered building when, in fact, they did not. In some cases, farmers are intentionally misled which is highly unethical, if not criminal.

Frequently, builders quote a "balanced design snow load" (generally in pounds of force per square foot) that was used as an input to a truss design program by an employee of the local lumberyard. Given this number, the farmer assumes they are getting a fully engineered building. This could not be further from the truth.

Trusses designed separate of other components seldom account for all loads to which they are subjected, nor the exact manner in which they will be connected to other components, receive loads from other components, and/or be braced by other components. Furthermore, a truss is only one element in an extensive building system, and each element must be properly engineered with special attention given to unique interactions between elements.

Codes exempt agricultural buildings

The International Building Code (IBC) is the primary nonresidential model building code in the United States. Although the IBC covers agricultural buildings and has been adopted to varying degrees in all 50 states, most agricultural buildings are not designed in accordance with its provisions. This is because most state and local governments that adopt the IBC exempt "buildings used exclusively for farming purposes" from all building code provisions.

Because of this special agricultural exemption, many builders are quick to tell farmers they do not need their agricultural buildings engineered. While this is absolutely true, it is something you would be foolish to do, especially when building a free stall barn, a storage building for expensive equipment, or a facility in which you or your employees will be spending measurable time.

Telling a consumer they do not need to have their building engineered if it is exempt from the building code is no different than telling a person they do not need to wear a seat belt or a bike helmet if the law doesn't require it.

Many agricultural builders will tell you it costs more to construct a fully engineered building. While this may be true for smaller buildings, it generally is not true for larger buildings. Builders who sell you a large nonengineered building for less than the price of a fully engineered building are selling you a relatively dangerous building.

Nonengineered structures generally contain components that are either not needed or larger than needed. This unnecessarily drives up building cost. Nonengineered structures also are frequently missing critical components and/or have numerous underdesigned components. This places building occupants in grave danger. For more, see page 364.