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SEISMIC/WIND

The Benefits of Assessing and Mitigating Weather Vulnerabilities BEFORE Mother Nature Strikes

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Extreme weather events from massive catastrophes like the floods in Texas and fires in Los Angeles to lesser, but no less destructive waves of tornados, hurricanes, and record snowfall events have created a crisis of wide proportions throughout the building industry. How do you protect employees, assets and supply chains from weather-based destruction that seems to be touching every location in the country? Is there anything cost effective that can be done to mitigate the damage that can be caused? The short answer is yes there is, but the time to do it is now.

It Came at Night

Overnight on April 2-3, 2025, the Louisville, Kentucky, region received warnings from the National Weather Service that numerous supercells were developing ahead of a cold front over southern Illinois and western Kentucky. This front led to four days of showers and storms with flash and area flooding. It also unleashed a series of eight registered tornadoes that touched down that evening. One EF-3, two EF-2s and five EF-1s. Luckily, this only produced two injuries and no deaths. It did produce a 10-mile-wide swath of destruction in Louisville including a heavy industrial area where the EF-3 touched down. Catastrophic roof and building loss was recorded at 13 industrial structures. However, one building in the same area remained unscathed. Was it just the luck of the draw? After all, tornadoes have a way of hitting one building but not another right next to it. Or was it something else?

Ten years ago, Bala was engaged by that building's owner to study and design structural modifications to strengthen existing buildings and introduce additional anchorage of outdoor MEP equipment to withstand extreme wind speeds associated with tornadoes.

Careful study and analysis of the building load path, down to the screw, was performed. Two levels of upgrades were studied for EF-2 and EF-1 level tornados. The upgrades included strengthening the weakest links in the building load path such as reinforcing the building's braced frame gusset plates, and adding hold down straps to enhance the roof deck's resistance to uplift forces.

We found that the most susceptible elements of the building were

at the roof and corners of the building, which are known to be the starting points for losing portions of or entire roofs. Roof top equipment is vulnerable to overcome the light manufacturers' attachments to their support curbs.

The solution involved reinforcing the existing corrugated metal roof deck with additional straps below and wrapped around the existing framing. Additionally, the roof joists were reinforced and braced to resist buckling of the members from the reverse bending forces.

The overall building was analyzed for lateral force resistance. The existing perimeter concrete tilt-up walls had residual strength to resist a tornado as-is, however, the building contained a joint from a prior building addition which required supplemental reinforcing to the braced frames. Additionally, the collectors and chords of the roof diaphragms required reinforcing by adding additional screw attachments of the roof deck to the steel collectors, and additional concrete anchors of the collector angles to the concrete tilt walls.

The ROI for funding the study and modifications drastically outweighed the potentially devastating costs to staff safety, loss of valuable products, supply chain disruption and rebuilding costs that would have been incurred if the company had foregone resiliency measures as their industrial neighbors had. Instead of months of recovery from the storm, the facility remained fully functional with no operational interruptions.

When to Move Past Code Minimum

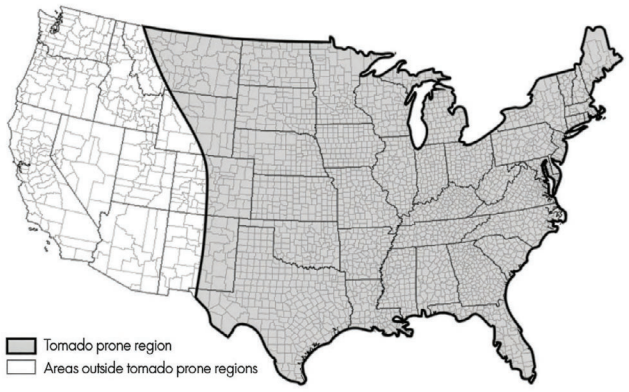
As the need to take mitigating action has become widespread there has been an uptick in the market for targeted studies of existing and new buildings. Particularly in growth industries like data centers and mission critical facilities that require uninterrupted, 24/7, 365-day use, as well as buildings that store high value material and products.

While building codes provide a minimum societally acceptable level of safety for all buildings, it is still important to break down facilities further with their owners and determine the specific needs with respect to reliability, longevity, and future needs. Consideration should be given to the importance of the building as well as local site-specific hazards.

Recently, tornado provisions have been implemented into the ASCE 7-22 *Minimum Design Loads and Associated Criteria for Other Structures*. These provisions could be triggered for Risk Category III and IV buildings—facilities that present substantial hazard to human life such as schools, public assembly buildings, utility buildings, and hazardous storage buildings. In tornado prone regions known for significant tornado speeds, these buildings will be required to be designed for tornado wind speeds. However, the code also leaves it to the discretion of the stakeholder (owner) to design against tornados.

Legacy Codes in Existing Buildings

Existing buildings have added complications since they were built to earlier codes with very generic lateral loads, if they were incorporated at all. Yes, they are still standing and in use, but their ability to withstand one of these events is uncertain. These inquiries show that building owners are interested to know what their risk is, along with recommended remedies, but upgrading to the latest codes could be a high-cost decision. They need to weigh the true cost of both—do you roll the dice and hope to not be in the path of storm, or do you bite the bullet, upgrade and possibly see better insurance rates to offset the construction costs.



Locations of tornado-prone regions, from the 2022-ASCE-7 Code for Minimum Design Loads and Associated Criteria for Buildings and Other Structures.

Modern Codes in New Buildings

For new buildings, the choice is somewhat easier: is minimum code adherence going to protect your investment well enough to risk not upgrading?

When deciding on the level of resilience for a building, cost premiums are always the driving factor. It is important as designers to have basic guidelines for the durability of the different construction materials (such as concrete tilt-up walls versus Insulated Metal Panels (IMP), and conceptual designs for options at each resilience level. Working with a construction manager at these early decision levels helps provide a spectrum for cost impacts that the building stakeholders can evaluate. Institutions that tend to own their facilities for the foreseeable future, and industrial facilities that either store or manufacture high value products are where we see the early adopters stretching their buildings beyond code minimum and performing resiliency studies beyond the basic standard of care.

The Best Defense Is a Strong Offense—Doing Something Before It's a Problem

The last ten years have shown that the chances of a weather catastrophe have increased, and, at the same time, the locations for those events have dramatically expanded. Tornadoes are not just in Tornado Alley. Hurricanes are not just on the Gulf Coast. Huge snowfall will not only land in the Rockies or Sierra Nevada, or along the Great Lakes. Massive fires are not only in California. Building owners across the country ought to take a serious look at their inventory and get a true assessment of the risks they might encounter throughout the lifetime of the building. Understanding the potential risks is the first step. Taking measures to mitigate those risks could be the key to being the only building still standing, and operational, after a weather disaster. ▪

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