Preventing Building Collapse

There are many reasons a building or structure may collapse. According to the National Institute of Standards and Technology (NIST) data, an average of 10 building collapses occur each year in the United States.[1] Several of the most common reasons include a change in building occupancy or use; natural disasters such as earthquakes, hurricanes, floods, and tornadoes; design and construction errors such as improper foundation design, inadequate structural support, or inadequate construction materials; and poor maintenance, such as ignoring cracks or uneven foundations, and not correcting or addressing structural damage.

Additionally, as a building ages, its ability to resist collapse generally does not improve due to weathering, roofing/building envelope deterioration, subsidence, and many other contributing factors that vary depending on the specific situation. Lastly, construction materials in service for many years approach their end of design lifespan—losing their load-bearing properties—which will warrant closer review.

General Assessment Tips

There are many signs of building distress to help identify and prevent structural failure and collapse. The following are some common examples that are easily identifiable and warrant attention by qualified professionals:

Look for visible signs of damage or structural deformation, such as cracks, leaning walls, roof deflection (bending), or uneven floors. Many cracks occur normally as concrete ages. However, when you see exposed (and rusted) steel or rebar reinforcement that was originally inside the concrete, it's time to bring in an expert, such as a licensed structural engineer, to determine if the structure remains safe or needs repair.

Figure 1: Significant Cracking

Figure 2: Exposed Rebar

Consider changes from the building's original intended use. If the occupancy has changed - such as from a retail space to a storage warehouse, or from a residential space to a manufacturing space – then a structural review is necessary. When occupancies change, structural load requirements may also change, warranting review by licensed structural engineers.

Figure 3: Change in Occupancy

Focus on renovations and additions. Identify areas where distress is expected and the structural building element is visible. Potential scenarios include previous structure features or floors being removed, new floors being added vertically, new interior stairways penetrating existing floor slabs, or new building-mounted solar panels or green roofs being planned or recently installed. In such cases, ensure an engineering analysis is completed and look for signs of distress at the main beams, columns, and walls.

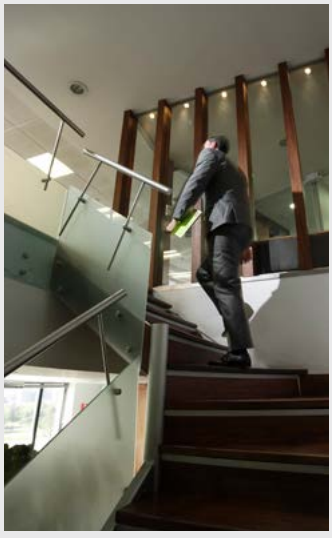

Figure 4: New Interior Stairway

Figure 5: Rust and Corrosion

Figure 6: Highly Deteriorated Bolted Connection (CARTA Advisors, LLC)

Corrosive environments warrant special attention. Operations and areas that create humid, caustic, or acidic environments (e.g., electroplating, pickling, anodizing, chemical blending, etc.) can result in accelerated corrosion of structural steel members, bracing, bolted connections, and structural metal decks.

Parking structures are particularly susceptible to collapse as they are exposed to weather. Look for formal snow removal plans and procedures reviewed by a structural engineer. Ensure weight and height restriction signs/bars are installed at access points. The best practice is to complete a thorough structural audit by licensed engineering professionals every three years to address critical deficiencies.

Figure 7: Severe Cracking

Figure 8: Exposed Rebar

Figure 9: Collapse from Snow (CARTA Advisors, LLC)

Excessive snow loading can cause the collapse of any building. Signs of distress include sagging roof beams, cracked or split wood roof members, sprinklers pushed down below ceiling tiles, and doors or windows that are difficult to open. Listen for creaking, groaning, cracking, popping, or other unusual noises from the building. In such cases, immediately evacuate the building and contact a licensed structural engineer.

Water intrusion is a leading cause of distress and collapse. Observe the building's condition from the outside and look for obvious signs of distress to the building envelope. A qualified design professional should immediately address signs of water intrusion. Waterproofing systems should be routinely inspected and maintained to ensure structural integrity.

Figure 10: Roof Inspection

Figure 11: Poorly Drained Roof

Well-maintained roofing systems are key to keeping out water and helping to prevent collapse. Routine roof inspection by a qualified roofing contractor is fundamental to the early identification of deficiencies – from blocked gutters/downspouts to open penetrations, tears, seams, and standing water, to name a few. Exposed rooftop structural steel is especially important to review, including large signage, billboards , and the like. Formal roof preventative maintenance programs and routine inspections are critical.

Aging exterior masonry walls warrant special attention. Water intrusion into structural masonry walls can quickly result in collapse. Look for cracked and open mortar joints, loose/displaced fallen bricks/tiles/terra cotta, rust stains (where steel reinforcement may be behind), etc. Aging and failed sealant joints will need to be addressed.

Figure 12: Masonry Wall at Risk of Collapse (CARTA Advisors, LLC)

Figure 13: Collapsed Masonry Wall

Foundation wall leaks below grade are common causes of structural failure. If you see signs of below-grade water on foundation walls, have a qualified professional conduct a leak survey and review areas of stress cracking, spalling concrete, deteriorating steel, and displacement of any structural elements.

Figure 14: Highly Corroded Steel Beam

Balconies can present extraordinary collapse risk. Cantilevered concrete balconies, exposed to the weather, can rapidly deteriorate as the result of water intrusion into the slab and structural components. Look for cracking, loose railings, and signs of poor drainage, and perform annual visual inspections.

Figure 15: Cracking on Cantilevered Balcony Railing

Figure 16: Close-up of RAAC (Loughborough University[3])

Life-expired construction materials, such as older (before 1990) reinforced autoclaved aerated concrete (RAAC), are highly porous and prone to crumbling and collapse – especially when used as roofing planks.[2]

Figure 17: Rooftop Pool

Elevated and rooftop swimming pools, when improperly waterproofed or designed, can result in collapse exposure—especially when designed with water treatment areas directly underneath.

Importance of Preventing Building Collapse

Routine visual inspections can be very effective in helping to identify structural concerns and should be part of any property's preventative maintenance program. General visual inspections of roofing systems, building envelopes, below-grade areas such as foundation walls and basements, and areas of renovation and addition can usually be easily accomplished internally. If visual or audible cues are evident, contact a licensed, qualified professional structural engineering firm to conduct a formal structural audit.

Additional Resources

The following resources are located on the Chubb Risk Consulting Library and can provide more information on specific aspects of structural protection:

- Winter Storms – Don't Wait for Snowfall
- To The Point: Cold Weather Preparedness
- To the Point: Roof Inspection
- To The Point: Water Damage Assessment and Mitigation

Learn More & Connect

For more information on protecting your business, contact your local risk engineer, visit the Chubb Risk Consulting Library, or check out www.chubb.com/riskconsulting.

[1]National Institute of Standards and Technology (NIST), https://www.nist.gov/buildings-construction

[2]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1185593/GUIDE-DFE-XX-XX-T-X-9002-Reinforced_Autoclaved_Aerated_Concrete_Identification_Guidance-A-C03.pdf

[3]Loughborough University, https://www.lboro.ac.uk/news-events/news/2023/march/reinforced-autoclaved-aerated--concrete-raac/

Chubb is the marketing name used to refer to subsidiaries of Chubb Limited providing insurance and related services. For a list of these subsidiaries, please visit our website at www.chubb.com. Insurance provided by ACE American Insurance Company and its U.S. based Chubb underwriting company affiliates. All products may not be available in all states. Surplus lines insurance sold only through licensed surplus lines producers. The material presented herein is advisory in nature and is offered as a resource to be used together with your professional insurance advisors in maintaining a loss prevention program. It is not intended as a substitute for legal, insurance, or other professional advice, but rather is presented for general information only. You should consult knowledgeable legal counsel or other knowledgeable experts as to any legal or technical questions you may have. Chubb, 202 Hall's Mill Road, Whitehouse Station, NJ 08889-1600.