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Separating Fact from Fiction:

Insurance Claims and Building Envelope Failure

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For insurance claims related to hurricanes, tornadoes, and other natural disasters, the task is to determine how much of the damage is attributable to the event, and how much pre-existed. Experienced architects and engineers should be called in as soon as possible after an extreme weather event to assess the damage and confer with insurance adjusters. The sooner the assessment team can observe conditions, the more likely they will be to develop an accurate picture of causality.

In the wake of a natural disaster, architectural investigation helps reconstruct the chain of events to accurately attribute the cause of damage.

Because the exterior envelope is the building's protection from the elements, it is often the site of the most extensive damage from a natural disaster. Roof blow-offs, shattered windows, stripped wall cladding, unhinged doors, and debris impact can quickly escalate into whole-building damage as breaches in the building's weather shield permit wind and water entry and interior damage. As pieces of the building dislodge, they become projectiles in the high-speed winds, posing hazard to property and threatening life safety.

In the wake of disaster, owners are reeling from property and productivity losses, and insurance companies are overwhelmed by claims. How to sort through the wreckage? The first step is to establish a feasible account of building conditions before, during, and after the event. In some cases, buildings meet codes and disaster planning guidelines, with good building practice and routine maintenance. These structures sustain damage in spite of best efforts at protection and planning. In other cases, problems pre-date the event, and the building is ill-prepared for the high wind speeds and driving rains of extreme weather. To the un-

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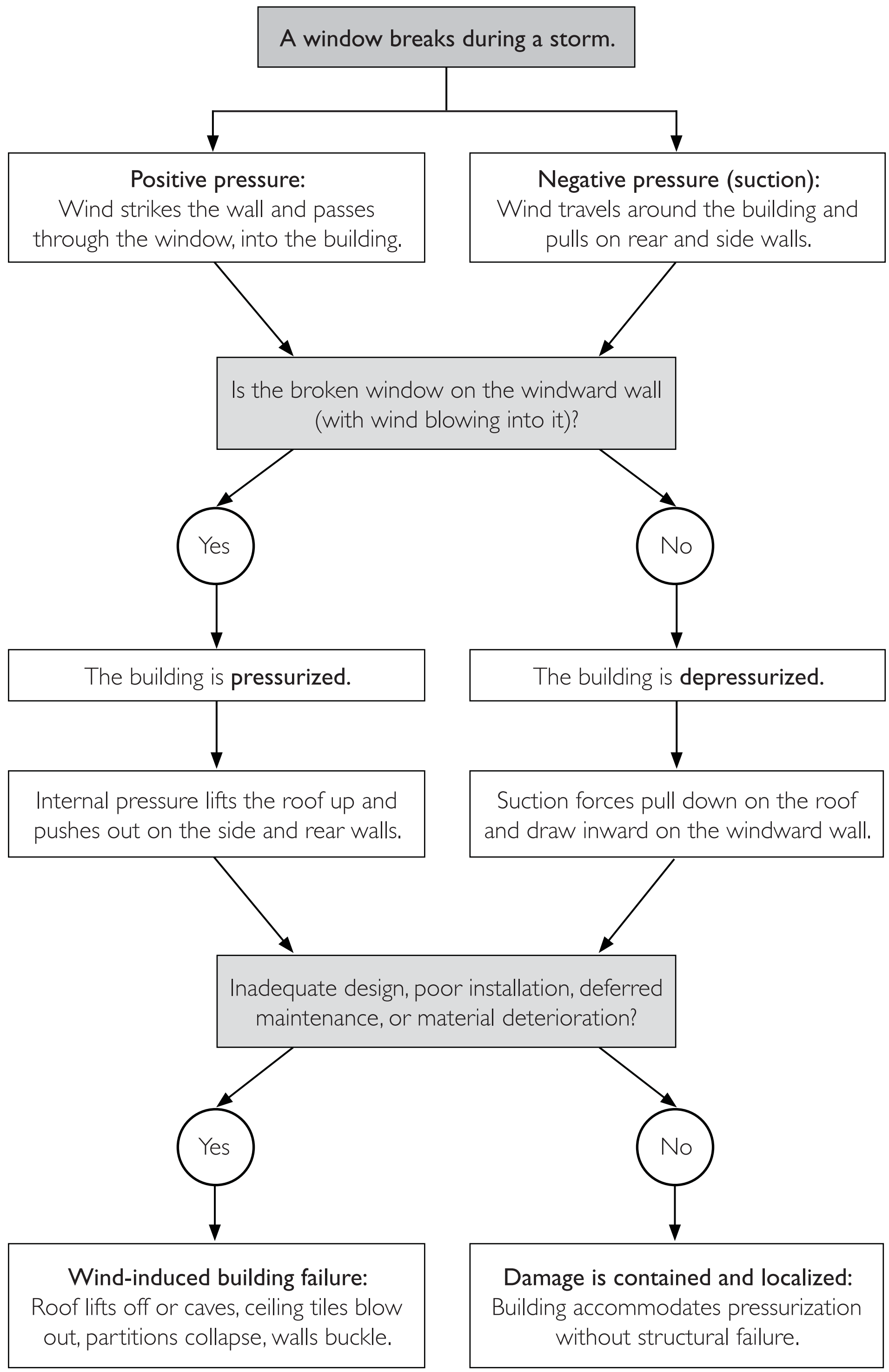
Internal Pressure and Building Envelope Damage



trained eye, it can be nearly impossible to tell the difference; a well-maintained weather damaged building can look very much like a poorly equipped damaged one. To the building envelope design professional, though, there are clues hiding in the rubble. The key is expert forensic investigation.

Understanding Wind Pressure

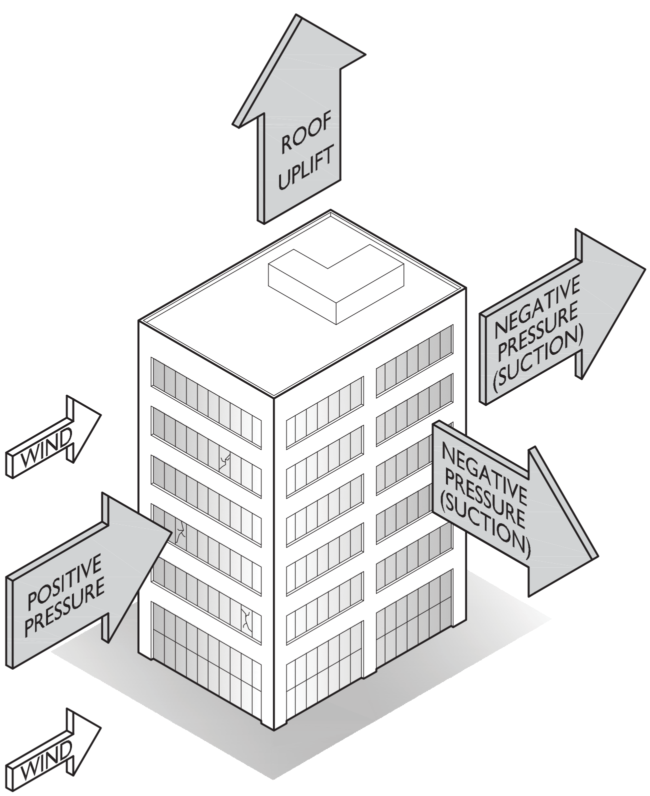
Once a breach occurs in the building envelope, damage can quickly escalate due to the sudden shift in pressure. Because of the rapid build-up of internal pressure, a single wall panel blow-off or broken window can permit a surprising volume of water and debris to enter the building interior.

Because even small building envelope openings, such as weak sealant or doors that are not airtight, can cause a change in pressure within a building, it is impossible to prevent pressurization completely. However, well-maintained seals, joints, and intersections can help to minimize pressure differentials. The critical difference between a building with adequate wind loading design, sound construction, and good upkeep and one that is ill-prepared for severe weather is in the effect pressurization has on building integrity.

The magnitude of pressure exerted on the building envelope during a storm is dependent upon a number of factors, including:

- Exposure, such as proximity to water or rough terrain;
- Building height, with taller buildings subjected to greater wind pressure;
- Building aerodynamics, a function of building shape and configuration; and
- Wind speed.

A structure that has been correctly designed and maintained can withstand design loads without succumbing to structural failure. It is true that even a well-fortified and properly constructed facility may be damaged should wind speeds exceed those it was designed to withstand. However, it is more commonly the case that buildings which sustain serious damage in a hurricane, thunderstorm, tornado, or nor'easter showed symptoms of distress or failure well before the event. The question becomes, then, how to tell the difference?



Wind Loads on the Building Envelope

The Burden of Proof

Unfortunately for building owners, in the event of a loss, the burden of proof rests on their shoulders. To avoid unfounded claims, insurance carriers need evidence to attribute catastrophic building envelope failure to a particular event. Even when there is no question that, say, a hurricane tore panels from the building facade, there may still be disagreement as to how much of the other distress, such as cracks and displacement, pre-existed the storm. A compelling case must be made on behalf of the building owner as to why these conditions should be ascribed to the event and not to lack of maintenance, aging, or long-term weather exposure.

For large properties with frequent claims, retaining a design professional immediately after an event, such as a fire, flood, or storm, can expedite the process of damage recovery and repair. Often, owners will first contact the insurance company, which will in turn call in a consultant to assess the damage. By proactively bringing in a building envelope expert, owners can quickly determine the best way to stabilize the property, while developing an appropriate scope of work. At the same time, forensic analysis can be completed to verify and document damage that occurred due to the event, expediting insurance claim reporting. A condition evaluation and photographic evidence submitted by an architect or engineer assists owners in identifying required repairs and provides insurance carriers with necessary evidence pertaining to a loss.

Where secondary insurance carriers are involved in a claim, retaining a design professional can also be important to review the assessments of the primary insurer. Independent verification of a claimant's, insurance company's, or contractor's remedial recommendations can be important to eliminating unnecessary expenditures. For example, Hoffmann Architects' review of a storm-damaged facade assembly determined that significantly fewer anchors would be required to stabilize the wall panels than was recommended by the rehabilitation contractor. Based on this information, the insurer was spared the undue expense of the extra anchors, and the owner avoided the additional time and disruption of a larger repair project.

Protection and Planning

Basic exterior envelope maintenance is important for any building, but it's especially critical for those structures in hurricane or tornado zones or in coastal areas with high wind loads. Some basic "To-Do List" items:

Roofs

- Remove debris from roof and clean roof drains and gutters to permit drainage.
- Anchor rooftop equipment, such as HVAC units, pipes, conduits, fans, and access hatches.
- When reroofing, choose uplift-resistant systems designed for Wind-Borne Debris Regions and High-Velocity Hurricane Zones, as per local building codes.
- Secure edge flashings and copings with closely spaced exposed fasteners, rather than concealed cleats, for greater wind resistance.

Exterior Doors

- Impact-resistant rolling service doors should be used to cover garage and service entries.
- Door assemblies, including hardware, frame, and frame attachment to the wall, should comply with wind load testing standards, such as American Society of Testing and Materials (ASTM) guidelines.
- Doors should be equipped with appropriate weatherstripping to resist water infiltration. Out-swinging doors have weatherstripping on the interior side of the door, making it less susceptible to degradation than that on in-swinging doors.

Windows

- As with doors, windows and skylights must have sufficient strength to resist wind pressures at all points in the assembly (glazing, frame, frame attachment to wall or roof).
- Maintain sealant joints, paying particular attention to product selection, cleanliness of the substrate, and tooling of the sealant.
- To protect against leaks during high winds, windows should have multiple lines of defense against water entry, such as sealant covered with a removable stop.
- Use hurricane shutters to protect openings in a storm.
- In wind-borne debris regions, replace large windows or glazed curtain walls with impact-resistant glazing.

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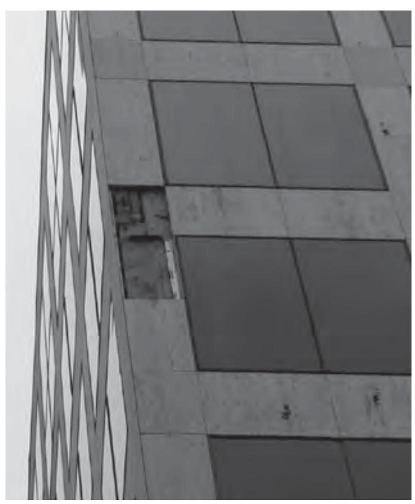
Sandbags temporarily secure this roof membrane, which detached during a storm.



Insufficient anchorage allowed this stone panel to blow off in a hurricane.

In high winds, these steel beams became dangerous projectiles.

Build Your Building's Resistance

The Federal Emergency Management Agency (FEMA) recommends that "building owners have a vulnerability assessment performed by a qualified architectural and engineering team."* As building envelope materials deteriorate over time, they become increasingly susceptible to failure. Many existing facilities lack adequate strength to resist current design level winds, whether due to age, design flaws, material failure, or improper construction. By retaining a design professional to perform a vulnerability assessment, owners can prioritize areas that need to be strengthened or replaced. Proactively addressing building envelope weaknesses before a natural disaster strikes can prevent the expense and disruption of emergency stabilization and rehabilitation.

Problem		Solution
Weak curtain walls, masonry, or veneers	⇨	Remediate components incapable of withstanding wind design loads.
Aging or deteriorated windows and seals	⇨	Replace gaskets and sealants, or replace window assembly.
Hurricane zone building with standard glazing	⇨	Replace with impact-resistant glazing, or install hurricane shutters.
Aggregate roof surfacing, lightweight pavers, or cementitious-coated insulation boards	⇨	If building is in a hurricane zone, remove down to the deck and replace.
Unanchored rooftop equipment	⇨	Screw or bolt equipment to curbs. Add latches to access panels.
Weak roof structure	⇨	When reroofing, strengthen deck attachment and support structure.
Poor edge flashing or coping attachment	⇨	Attach vertical flanges with face-mounted fasteners.
Single roof membrane system	⇨	For hurricane-prone areas, incorporate a secondary membrane when reroofing.
Failed precast concrete connections	⇨	Augment or replace connections to resist wind loads.
Low parapet wall on low-slope roof	⇨	Raise parapet to at least 3 feet and secure base flashing.
Old sectional or rolling doors	⇨	Strengthen weak doors and tracks or replace.

*"Making Critical Facilities Safe from High Winds," *Design Guide for Improving Critical Facility Safety from Flooding and High Winds: Providing Protection to People and Buildings,* Federal Emergency Management Agency, 2007.

Case Studies in Forensic Architecture

Hoffmann Architects has provided litigation and insurance claim support for building owners, design professionals, insurance companies, contractors, attorneys, and manufacturers. In a number of insurance cases, our architects and engineers have provided expert evaluation of building envelope conditions to assess the likely causes of observed distress and failure. The following examples provide insight into the process of identifying and interpreting the evidence for causality.

Case 1: Structural Failure

For insurance claims related to fire, the task of sorting fact from fiction can be especially challenging, as much of the evidence has been damaged beyond recognition. At an industrial food processing facility, the task was to evaluate whether observed structural damage was caused by the fire, or whether it pre-existed.

Sharp edges and color differences were clues that these cracks hadn't been there before the fire.

Cracks in the precast concrete structure were sufficient to compromise structural integrity. But were they new or old? Sharp edges, rather than rounded or weathered ones, were evidence that these cracks happened recently. Additionally, the color of the concrete inside the cracks differed from the color of the concrete surface, a sign that the cracks had not been open for long. Therefore, the project engineer concluded that the cracks were caused by the fire and could be legitimately included in the insurance claim.

Case 2: Facade Damage

During Hurricane Katrina, a New Orleans high-rise suffered damage to the anchoring system that secures marble panel cladding to the concrete structure. Some panels were blown off entirely, while others sustained cracks, breaks, or dislodgement.

Originally built in the 1960s, the building was designed in conformance with the building code of the time, which required significantly lower wind loading resistance than do current codes.

Insufficient load capacity compromised the wind resistance of these panels, which otherwise might have remained intact.

Renovations to the building facade had been performed before the hurricane, which included field tests to determine the load capacity of the panel anchors. Despite the repair effort, the post-hurricane evaluation revealed that the majority of anchors did not meet current requirements for wind loading with an acceptable factor of safety. Although more stringent codes were adopted in the wake of Katrina, the investigation found that the designed anchorage of the panels not only failed to meet new requirements, it did not comply with the building code in effect at the time of the event.

To make this determination, the project engineer calculated wind loads to be resisted by the marble panels for various heights, building positions, and panel sizes. A sampling of 372 individual marble panels was also evaluated in place. Although the storm was violent enough to have caused pervasive damage, it turns out it wasn't entirely to blame for the extent of the destruction at the high-rise office tower. Had the renovation effort upgraded panel anchors to conform to wind load requirements, the panels would have stood a chance of weathering the storm.

Case 3: Roof Blow-Off

Even outside hurricane zones and tornado belts, weather forces can be strong enough to cause considerable damage to building envelope components. A case in point: at a university campus in the Northeast, sustained winds contributed to catastrophic failure of a building's roof system. During a major rainstorm, the corner of the single-ply ethylene propylene diene monomer / terpolymer (EPDM) membrane sustained a 20-foot tear. As the storm continued, separation proliferated to encompass nearly 100% of the roof area.

Why did the storm lead to such extensive roof failure? Weather history data indicated that wind speeds, while significant, were insufficient to cause a complete blow-off. Examination of the roof system revealed inadequate adhesion of roof assembly components, likely due to poor substrate preparation and inappropriate bonding compound selection. As the weather turned colder, weak adhesion permitted the membrane to pull away from the roof edge, leaving an air pocket. This partial delamination then facilitated further separation when wind gusts struck, with the membrane eventually catching the sharp edge of a fastening plate or termination bar. Bent plates and torn securement strips provided further evidence for this chain of events.

Once the membrane ripped, the path to complete roof failure was as swift as it was inevitable. Under optimum conditions, membrane separation might have been localized to the area around the tear. Here's where good building practice makes the difference: failure to adequately anchor drains during installation allowed them to lift the membrane in several locations. Other poorly secured components opened additional voids, admitting still more air. As wind forced its way under the membrane, more of the membrane lifted. The result: what could have been an isolated problem became a near-total roof failure. ■

Poor anchorage and weak membrane adhesion were signs that this roof failure could have been avoided.

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Walls

- Anchorage of veneers, wall panels, and siding must accommodate high winds. Examples of actions include:
  - Space ties (anchors) in accordance with wind load criteria.
  - Locate ties appropriately with respect to door and window openings and veneer sections.
  - For brick veneer: Contractors should install ties as brick is laid, so they align with mortar joints and are fully embedded in the mortar.
  - For metal panels: Use sealant tape at sidelaps to resist water infiltration, but leave endlaps unsealed to allow for moisture egress.
  - For exterior insulation and finish systems (EIFS) and stucco: Inspect and maintain walls to protect against debondment and compromised wind resistance.
- Don't cover weep holes with sealant. Adequate weep holes and properly designed through-wall flashing permit wind-driven water to exit the wall cavity.
- Rain screens between moisture barriers and siding materials facilitate drainage.
- In a hurricane or tornado, rain can be driven vertically upward by wind. Install additional flashing provisions to accommodate both rising and falling water.

As part of an annual building maintenance program, inspect the building exterior for cracks, loose materials, missing mortar, or damaged sealant. The high winds of a storm, as well as extreme pressure differentials, can dislodge insecure building components. When picked up by the wind, these then become airborne missiles, which can smash windows, break roof tiles, crack facades, or endanger life safety.

In addition to securing the building exterior, redundancy in design can help protect interior spaces should the first line of defense fail. For example, a bitumen-based waterproofing membrane underlying a metal roof can provide leak protection in the event of a blow-off. In some cases, such secondary waterproofing measures can make the difference between an insurance claim for a lost roof and one for a devastated building.

Just the Facts

Even when a weather event or natural disaster doesn't claim lives, it can devastate properties and businesses, sometimes beyond recovery. Repair or replacement of building elements, furniture, equipment, and inventory, as well as clean-up from water damage and mold, can pose serious financial hardship. Wind-borne debris can damage walkways, plazas, garages, and vehicles in the area, compounding losses. When destruction is extensive, it can take months to rehabilitate the building, interrupting usage and possibly incurring additional expenses, such as rent for temporary facilities or storage units. To deal with losses of this magnitude, owners hope to maximize insurance payoffs so as to recoup as much of the expense and lost productivity as possible.

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Even a small breach in the building envelope can lead to serious devastation as tremendous wind pressures build inside the structure.

At the same time, insurers are inundated in the aftermath of a catastrophic event with a barrage of claims, and they must make every effort to minimize payouts in order to stay afloat themselves. Hurricane Katrina, for example, saw insurance companies stagger and, in some cases, fail under the sudden onslaught of claims.

The role of the building envelope design professional, then, is to strike the balance between these parties by distinguishing between damage caused by an event and damage precipitated by bad building practice, age, or long-term wear. An experienced architect or engineer can identify and evaluate the hallmarks of an ill-prepared building and differentiate these from the evidence of catastrophic failure due to a single event.

What's more, a design professional familiar with building envelope detailing can go beyond forensic analysis to recommend a course of rehabilitative action. In the wake of a disaster, it's important not only to establish what happened, but to plan for what's next. The right repair strategy is not only cost-effective and appropriate; it also prepares the structure to better withstand the storm that's yet to come. ■

JOURNAL is a publication of Hoffmann Architects, Inc., specialists in the rehabilitation building exteriors. The firm's work focuses on existing structures, diagnosing and resolving problems within roofs, facades, windows, waterproofing materials, structural systems, plazas/terraces, parking garages, and historic and landmark structures. We also provide consulting services for new building construction, as well as litigation and claim support.

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