Hurricane Michael

Executive summary
On October 10, Hurricane Michael, the eleventh named storm of 2018, made landfall on the Florida Panhandle as a Category 4 hurricane. More than any other, the cities of Mexico Beach, Lynn Haven and Panama City suffered extensive property damage due to Michael's extreme winds and storm surge. Extensive infrastructure interruption ensued across the region, including power outages, obstruction of roads and contamination of potable water.

Willis Re's damage reconnaissance team spent four days assessing Michael's damage. The objective was to research and collect examples of property damage due to wind and storm surge, and to identify elements of properties that exhibited both good and poor resistance. The team traveled nearly 1,000 miles, covering various properties exposed to the storm including in Panama City Beach, Panama City, Lynn Haven, Tyndall AFB, Mexico Beach, Port St. Joe, Apalachicola, South Port, Youngstown, Fountain, Marianna and Tallahassee in Florida; Bainbridge, Georgia; and Dothan, Alabama. In this report, we present their findings.

Hurricane Michael’s estimated wind speeds on the ground for Marianna, Panama City, Lynn Haven and Mexico Beach were in the order of 120 mph to 160 mph, above the 700-year return period wind gust according to ASCE 7-10. The majority of homes in Panama City, Lynn Haven, Mexico Beach and Marianna, as to be expected, were not designed to resist 700-year return period wind gusts.

In general, the direct wind damage to insured properties that we observed ranged from minor impacts to major structural failures. Michael’s storm surge leveled many buildings in Mexico Beach. Key observations of our reconnaissance survey include:

- Catastrophic wind damage to residential properties in Panama City, Lynn Haven and Mexico Beach
- Catastrophic storm surge damage to buildings along the coast of Mexico Beach
- Significant damage to properties due to treefall
- Major damage to residential buildings, commercial buildings, industrial buildings, boats, marinas, long-span light metal warehouses, airport hangers, schools, religious buildings, public buildings and gas stations
- In general, newer buildings and roofs performed better than older construction
- Metal roofs performed much better than shingles in areas exposed to low-to-moderate intensity wind speeds (less than 120 mph gust)
- Wide failure of connections between stilts and floor beams in elevated buildings

This report details the various damage patterns we observed from our field reconnaissance for various lines of business and/or building types. Key points from the damage survey that can benefit catastrophe risk managers specific to each line of business/building type are noted at the beginning of each section to allow you to efficiently focus on the areas of greatest interest to you.
Meteorology of Hurricane Michael

Michael was the third most intense hurricane to ever make landfall in the U.S. The storm’s central pressure plunged to 919 mb at landfall, driving sustained one-minute average winds of 155 mph. These were the strongest U.S. landfalling winds since Hurricane Andrew in 1992.

Fall hurricanes preferentially develop in the Caribbean and Gulf of Mexico. Waters here are still warm and are far from the influence of any fall weather systems dragging cool air off the North American continent. This year was no exception. In fact, the Gulf of Mexico and the Caribbean had yet to feel the influence of any cool fall weather. They remained summer like and favorable for hurricane activity. These conditions generated a sprawling and circulating mass of disturbed weather centered over Central America, known as the Central American gyre. This gyre is notorious for spawning hurricanes. Hurricane Michael gathered strength within this gyre, supported by the rich moisture-laden air and sea surface temperatures that were 0.75°C to 1.5°C above normal.

The intensifying storm became embedded within the southerly flow between two large weather systems. Forecast models can handle these large-scale weather systems very well. As a result, the track guidance for Michael was extremely strong, and led to excellent track forecasts. Michael accelerated north toward the Gulf Coast, and forecast guidance was in higher than normal agreement for a landfall on the Florida Panhandle.

On October 8 and 9, Michael struggled against upper-level winds. Most of the thunderstorm activity was pushed off to the northwest side. However, boosted by the warm waters of the Gulf, Michael’s structure organized into a more typical circular storm. The warm waters extended to a great depth. This limited any upwelling of cooler water that can act to weaken hurricanes. However, even when the storm was at Category 3 intensity, a complete eye-wall structure had yet to form. Eventually, a complete eye-wall formed, overnight on October 9, allowing the robust storm’s winds to jump to high-end Category 4 speeds. Nothing stood between the storm and the Florida coast other than energy-rich waters. The storm continued to intensify right up until landfall, leading to remarkable satellite images of barrier islands within the eye. This continued intensification was driven by the winds still spinning up to balance the rapidly deepening central pressure.

After landfall, Michael zipped across the Southeastern U.S. bringing tropical storm strength winds and localized flash flooding. As the storm emerged off the East Coast it tapped into a new source of energy available from temperature gradients and transformed into a powerful extra-tropical storm.

Michael was the strongest storm ever to make landfall in the Florida Panhandle. This was the region’s first Category 4 hurricane since records began in 1851 and building codes were not designed to protect against such an intense storm, particularly one that brought Category 3 winds all the way into Southwest Georgia. As a high-end Category 4 event with sustained 155 mph winds, Michael was only 10 mph below the Florida record of 165 mph brought by Hurricane Andrew in 1992 (Category 5). In terms of its area of damaging winds, Michael was a midsize hurricane, smaller than Hurricane Ivan (2004) but larger than Hurricane Dennis (2005). We know size can play a major role in the resulting damage. Large Hurricane Ivan, for example, generated seven times the insured losses of the smaller Hurricane Dennis, despite both storms making landfall in a similar location near the Florida-Alabama border.
Hurricane Michael wind speed versus Florida building code design wind speed

Building design requirements for hurricane winds in Florida are among the strongest and stringent standards worldwide, and Hurricane Michael certainly tested both these design requirements and the resistance of existing buildings to strong winds. Within Florida, wind design requirements for buildings vary by location, and code requires buildings in the Panhandle to resist relatively less intense wind speeds compared to similar buildings located in Miami or the Florida Keys. This is primarily due to historical experience and the likelihood of hurricane landfalls and winds estimated using probabilistic models in different regions.

Still, Hurricane Michael battered the communities of Panama City, Lynn Haven, Mexico Beach and Marianna with significantly stronger winds compared to code-required design speeds. Estimated wind gusts for much of Mexico Beach, Panama City and Lynn Haven were from 130 mph to 160 mph, above the 700-year return period wind gust, which the majority of homes in these cities were definitely not designed to resist. It should not be a surprise that many buildings failed to resist Michael’s brutal hurricane force wind.

To dig deeper into how Michael’s hurricane force winds impacted buildings on the ground specifically, we need to reflect on what wind level the existing building stock was designed to withstand. Current Florida building code refers to the American Society of Civil Engineers’ standards (ASCE 7-10) for wind design. More than 90% of homes in our surveyed area were built before 2011 (pre-ASCE 7-10 era). In fact, about 70% to 80% of homes in the surveyed area were built before 2002 (pre-2001 Florida state-wide building code era).

Wind design takes into consideration velocity pressure/force on building components, which is directly proportional to the square of the wind speed (p ∝ v^2). This means that a small difference between design and actual impacted wind speed will have an exponential impact on the wind pressure experienced by a building. This, of course, can lead to significant building damage.

Design wind speed for Panama City, Florida, as per the pre-2001 building code was in the order of 120 mph. Michael’s estimated 140 mph wind speed in Panama City impacted buildings with 400 times more wind pressure than they were designed to resist. Homes built before 1995 (pre-Andrew era building code) were impacted by significantly more than 400 times wind pressure compared to what they were designed to withstand. Knowing this, we were not surprised by the widespread damage to older buildings in the surveyed area (pre-2002).

<table>
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<th>Location</th>
<th>ASCE 7-10 mean recurrence interval wind speed</th>
<th>Estimated Michael wind speed</th>
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<tr>
<td>Miami Beach, FL</td>
<td>129 mph</td>
<td>140 mph</td>
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Wind damage to buildings

Overall, we observed minor to catastrophic damage to buildings from Hurricane Michaels’s direct winds. In general, the damage path of Hurricane Michael was very narrow and damage extended 60 to 80 miles across the coast and 100 miles inland from the coast. The damage path was much narrower than 60 miles further inland. If Michael's wind-field extent was as wide as last year’s Hurricane Irma, major loss to the insurance industry would have been seen, as areas around Tallahassee and Destin-Fort Walton would have been impacted by damaging winds.

Single-family and low-rise residential buildings

Key points for catastrophe risk managers

- Performance of newer homes to wind forces is better than older homes. Age of roof/roof-covering is a key to the performance of roofing at less intense wind levels.
- Gable roofs performed worse than other roof geometries, gable wall failures were observed when exposed to high intensity winds.
- Professionally installed metal roofs performed better than shingles, at less intense wind levels.
- Structurally connected roof overhangs such as canopies and porches can exacerbate damage to the main structure.
- Strong connections (anchorage) of floor beams and stilts, floor beams and walls, and stilts bracing can improve wind resistance of homes on stilts.

Our team observed minor to total damage to single-family dwellings, low-rise multi-family residential buildings and manufactured homes (mobile homes) in the surveyed areas. Damage to residential buildings included loss of roof cover, major loss of roof deck and truss, complete loss of roof structure, gable wall failure, wall siding loss, brick veneer failure, wall failure and foundation connection failure. We also observed moderate to minor damage to wall siding in areas exposed to less intense wind, such as inland locations and locations away from the center of the storm track. Damage to residential buildings exposed to high intensity gusts (greater than 120 mph gust) included complete loss of roof cover, roof deck, roof truss, wall cladding, gable end wall and foundation connections failure. Property damage due to treefall was widespread and caused total loss in many cases.
The degree of damage to homes varied with the age of construction — newer buildings showed less damage than older buildings when exposed to the same wind intensities. We saw significant loss of roof and siding damage with buildings older than 15 years. In addition, roof age seemed to play a role in limiting roof cover damage at low wind intensities. As one might expect, older homes with newer roofs performed better than older homes with older roofs.
About 30% to 35% of homes in the surveyed areas have metal roofs. Similar to what had been observed during Willis Re's Hurricane Irma damage survey last year (Link), metal roofs performed better than shingle roofs, in general. Major damage to metal roofs was observed in Mexico Beach and Panama City, both of which were battered by Michael’s strong gusts (greater than 120 mph). However, the quality of metal roofs in the surveyed areas varied. In some cases, metal roofing was installed on top of an existing shingle roof. This could be a choice made by homeowners to minimize the costs of a complete roof cover replacement; it is an easy quick fix for roof leaks and avoids the costs in hiring a certified/professional roofer and roofing material.

![Damaged metal roof on residential buildings in Mexico Beach (left) and Panama City (right)](image)

Among all metal roof homes observed, moderate to extensive roof damage was observed where metal roofs were installed on top of shingles. Poor construction quality and installation of these metal roofs are key factors in such cases. Examples of fasteners connecting metal panels and roof, and not reaching deeply into battens and decking was observed. In addition, poor quality edge flashing may have increased the potential for winds to reach between metal sheets and shingles, thereby increasing the uplift pressure on metal sheets and causing damage.

![Metal over shingles roof under construction in Marianna (left), damaged metal roof over shingles in Mexico Beach (right)](image)
In Mexico Beach our team saw major wind damage to homes elevated on stilt columns. In particular, homes with a built-in front porch/canopy suffered extensive damage and showed signs of failure at foundation connections. Additional uplift pressure due to front porches assisted direct wind to tilt and/or lift the main structure off of the foundation causing foundation connection failure. Besides the brutal wind force of Michael, high storm surge along the coast knocked many beach-side elevated buildings from their foundations. We also observed many cases with no straps connecting the wall frame and floor beams/support system. Interestingly, roof connections seem to perform much better than foundation connections on many of these homes.

Residential single-family buildings knocked off their stilts in Mexico Beach

Many low-rise (less than or equal to three story) multi-family residential buildings experienced major damage in the surveyed region. In general, damage to these buildings included loss of roof cover, complete roof damage and wall siding damage.

Roof damaged low-rise (less than or equal to three story) residential multi-family buildings in Panama City
Roof damaged low-rise (less than or equal to three story) residential multi-family buildings in Mexico Beach (left) and Lynn Haven (right)

Similar to historical experience, damage to manufactured homes was extensive and, in general, older homes suffered major damage compared to newer homes. Similar to what was observed during our Hurricane Matthew damage survey in 2016 (Link), no failure to tie-downs/foundation connections was observed in areas exposed to less intense winds (less than 100 mph gust).

Completely damaged manufactured home in Lynn Haven (left), roof damaged manufactured home in Fountain (right)
Commercial buildings

Key points for catastrophe risk managers

- Performance of newer construction to wind forces is better than older construction.
- High-rise buildings with roof-mounted equipment, architectural roof elements and tiled/metal roofs are prone to damage.
- Long-span warehouses and retail buildings with glass openings are more likely to experience major damage at high wind intensities.
- Professionally installed metal roofs performed better than shingles at less intense wind levels.

Our team observed minor to major damage to commercial buildings such as retail stores, restaurants, warehouses, strip malls, hotels and condominiums. Engineered structures, such as mid-rise and high-rise reinforced concrete and steel frame structures, experienced minor to moderate nonstructural damage in the surveyed areas. Similar to what was observed with residential homes, newer buildings performed better than older buildings and metal roofs performed better than shingles.

Damage patterns of low-rise commercial buildings are somewhat similar to what was observed with residential buildings. In addition, collapse of built-up roofs, truss-supported roof membranes, unreinforced masonry walls and brick veneer walls was observed in areas exposed to high intensity winds. Retail stores and restaurants are known to have more openings and wall glazing. In some cases, the failure of these openings might have resulted in internal pressurization, thereby blowing off the roof and walls. Contents and business interruption loss, if covered, can be significant due to major structural damage for these small retail stores.

![Damaged shingles on a two-story motel in Bainbridge, GA (left), metal roof on a three-story motel in Marianna, FL (right)](image1)

![Collapsed roof and walls of retail store in Panama City (left), two-story masonry building in Marianna, FL (right)](image2)
In general, damage to mid- to high-rise commercial and residential buildings was minor to moderate. Damage to these buildings included damaged window panes, architectural awnings and overhangs, loss of roof tiles, loss of wall stucco/plaster and exterior insulation finishing system (EIFS). Though the physical damage to most structures was not extensive, the cost of repairing some buildings will likely be very expensive due to required workmanship and associated challenges. Buildings with damaged roofing and windows allowed rain water to penetrate the structure causing additional damage to contents.

Buildings with metal and/or tile roofs experienced damage to roof components. Loss of stucco and EIFS was observed on high-rise buildings in Panama City and eastern Panama City Beach. As per the publically available records, the majority of these buildings were built between 1980 and 1990.

Roof damaged seven-story condominium in Panama City (left), 10-story condominium in Panama City Beach (right)

Wall stucco and EFIS damaged 12-plus story hotel in Panama City Beach (left), condominium in Panama City (right)
Industrial buildings

Key points for catastrophe risk managers

- Long-span industrial warehouses and metal cladding on open frame structures and plant buildings are more likely to experience major damage at high wind intensities.
- Administrative buildings and other service buildings similar to small commercial buildings showed similar damage patterns.

Our team visited a range of industrial facilities including a wooden crate and box manufacturing facility, solid waste to energy plant (waste treatment plant), air conditioning and HVAC manufacturing plant, automotive parts manufacturing facility, large chemical plant, petroleum storage plant and many small scale industrial buildings. According to publicly available records, the waste to energy plant was built in 1987 and the chemical plant was originally built in 1930. A significant number of structures were added to the chemical plant facility after 1930.

Significant damage to industrial facilities in Panama City, Lynn Haven and Marianna was observed. Hurricane Michael’s estimated wind gusts at the surveyed industrial facilities in these cities was greater than 110 mph. Our team saw numerous instances of major damage to plant buildings, administration buildings and warehouses of industrial facilities. Damage to these building types included loss of roof cover (shingles, metal and built-up flat roof), gable wall failure, loss of roof deck, failure of free-standing unreinforced masonry walls and metal siding/panel wall failure.

We also saw loss of roof cover and siding on plant buildings, process towers, conveyor belt towers and open frame structures. At large industrial facilities, we observed damage to storage tanks, distillation units, boilers and cooling towers. In many cases, exterior insulation and/or skin was peeled off by the strong winds of Hurricane Michael.

At one of the large industrial facilities visited, the team observed the complete collapse of a cooling tower and the associated distillation unit. Based on a note on the distillation unit, though, it looks like this unit was either decommissioned or not in use when Michael hit.

Collapsed industrial warehouse buildings
Collapsed cooling tower and distillation units (left), damaged distillation units (right)

Damaged process tower and main plant towers of chemical plant (left), waste to energy plant (right)
Schools, Public, Government and Religious buildings

Key points for catastrophe risk managers

- Free-standing roof mounted equipment and architectural elements are highly damageable to hurricane force winds and can inflict additional damage to the main structure.
- Performance of gable roofs at strong wind intensities is worse than other roof types, and gable wall failure can breach structural integrity.
- Newer buildings and roofs performed better than older buildings.

The Willis Re reconnaissance team saw major damage to schools, public, government and religious buildings located in Mexico Beach, Panama City, Lynn Haven and Marianna, Florida, but minor to moderate damage to these building types in other surveyed areas.

Damage to schools included collapse of unreinforced masonry (URM) walls, damaged gymnasium buildings that are typically light metal construction, loss of roof and gable wall failure. Of all surveyed schools, Jinks Junior High School in Panama City experienced the most severe damage. Every building in this school complex experienced some damage and some buildings were brought to the ground by Michael’s winds. Available public records indicate the oldest and largest building of the complex was originally built in 1950. Additional buildings were built subsequently in 1978, 1980, 2000 and 2009. Almost all buildings are masonry construction with built-up roofs except for the 2000 and 2009 additions. A nearby charter school, Palm Bay Prep Academy, also experienced extensive damage due to unreinforced masonry wall and roof failures.

Collapsed URM wall and roof of gymnasium (left), class room (right) of two different schools in Panama City

Collapsed URM wall (left), gable wall (right) of two different schools in Panama City
The major to moderate damage we saw included post offices, police stations, libraries, county and state administrative buildings, and hospitals in the surveyed areas. Their construction types included wood, unreinforced and block masonry, concrete and light metal construction; and the observed damage included loss of roof cover, gable wall failure, URM wall failure, and stucco and wall panel failure. The majority of the surveyed public buildings were in Panama City and Lynn Haven – two cities that experienced some of Hurricane Michael’s strongest winds.

Bay Medical Hospital in Panama City suffered major damage. Publically available records indicate the majority of buildings in this complex were built between 1960 and 1980. Two additional six-story buildings were added to the hospital complex in 2002 and 2009. Significant damage to rooftop equipment and damage related to flying debris was also observed.

Collapsed wall panels of a Bay Medical Hospital building (left), roof damage to a Bay County government building (right) in Panama City

Given the close proximity to the point of landfall, Tyndall Air Force Base experienced Michael’s strongest winds. Post hurricane aerial images by NOAA indicate significant damage to hangers, warehouses, living quarters, administrative buildings and security posts on the Air Force base. Direct access to buildings within the base was not available to our survey team.

Post hurricane aerial image from NOAA (left) and roof damaged hanger (right) of Tyndall Air Force Base
Damage to a large number of religious buildings was observed in surveyed areas, and the damage to these buildings ranged from minor to major. Major damage to religious buildings was observed in Panama City, Lynn Haven, Mexico Beach and Marianna, Florida. Their construction types included wood frame, unreinforced masonry, concrete block masonry and light metal frame with masonry infill walls. About 70% to 80% of observed buildings contained gable roofs with either shingles or metal roofing. Similar failure patterns were observed among all buildings including the collapse of roof mounted steeples, gable wall failure and roof cover damage.

Steeple and gable wall collapsed church in Fountain, FL (left), Lynn Haven, FL (right)

Gable wall and roof damaged large churches in Panama City, FL
Marinas, boats, gas stations and electrical, transmission and distribution systems

Key takeaways for catastrophe risk managers:

- Light metal warehouses exhibited poor performance to strong winds; bracings on the end walls, side walls and purlins can improve the performance of these buildings to wind loads.
- Performance of metal wall and roof panel in marina warehouses is poor in heavy wind loads.
- Performance of gas station canopies supported by two rows of columns to hurricane force winds is superior to canopies supported by a single row of columns.

Marinas and boats in Panama City and Mexico Beach were severely damaged. In Panama City, many marina warehouses constructed of light metal collapsed causing damage to the boats stored inside. End bay failure due to strut purlins buckling was commonly observed as well, damaging light metal marina warehouses and leading to the collapse of entire end bays. Strut purlins failed to resist the combined effect of wind loads on the end walls and suction on the roof surfaces. Longitudinal bracing of end walls, side walls and purlins could have limited end bay collapse on these buildings. In one of the collapsed warehouses, a rusted end wall column failed at the foundation, which led to the buckling of other columns and beams due to the combined force of bending and wind loads.

Collapsed marina warehouses in Panama City (rusted and failed column-foundation connection inserted in the right picture)

A wide range of types and sizes of boats were sunk and/or crushed by hurricane-force winds and storm surge. Our team observed boats knocked off from their moorings by Michael’s strong winds along the ocean inlets.

Crushed and damaged boats at the Panama City Marina (left), sunken ship near Panama City (right)
Gas station buildings and canopies were severely damaged by Michael’s winds. The observed damage to these structures included damage to soffit, fascia, framing, and foundation of canopies, building roof damage and failed unreinforced walls. In general, canopies supported by two rows of columns exhibited higher resistance compared to canopies supported by a single row. We also saw that rusted foundation to column connections led to an increased likelihood of canopy collapse.

![Partially collapsed single-row column supported canopy](image1) ![Damaged soffit, fascia of two row column supported canopy](image2)

Partially collapsed single-row column supported canopy (left), damaged soffit, fascia of two row column supported canopy (right)

The electrical distribution system in the surveyed areas had been installed on wooden or concrete poles that were severely damaged by hurricane force winds and treefall. Subsequent loss of electrical service resulted in widespread power disruptions, which, in turn, affected personal lives as well as rescue efforts. Widespread treefall in the study region caused significant loss to transmission and distribution lines. In some cases, we saw how treefall snapped power lines from the poles, creating uneven loads and twisting poles. Damage to transmission and distribution lines included broken wooden poles, leaning wooden and concrete poles, damaged conductors and snapped lines, causing progressive failure to other poles.

![Twisted and tangled transmission tower](image3) ![Fallen and leaned electricity poles](image4)

Twisted and tangled transmission tower (left), fallen and leaned electricity poles (right)
Treefall damage to buildings

Damage to properties due to treefall was widely observed. Intense winds of Michael uprooted or broke entire trees and snapped large branches in many of the surveyed areas. Widespread property damage due to treefall was present in Panama City, Lynn Haven and Marianna, Florida, and inland as far as Bainbridge, Georgia. Treefall was most significant in Panama City and Lynn Haven due to Hurricane Michael's intense winds in these cities (120 mph – 150 mph). The damage profile of homes from treefall ranged from partial damage to roofs to complete collapse of buildings.

In addition to wind intensity, factors such as tree species, age, structure, soil moisture content and soil type determined the extent of tree failure. The most widely observed tree species in the surveyed area include live oaks and pines. Live oaks are generally regarded as highly resistant to hurricane winds, but in some areas, these trees were uprooted because of their shallow root structures in landscaped soils. In some cases, fallen trees split homes down to the ground, causing complete structural failure.

What percentage of property loss is caused by treefall? We don’t know yet. During Hurricane Andrew in 1992, 18% of fallen trees damaged property. Hurricane Erin (August 1995) and Opal (October 1995), which both made landfall in the Florida Panhandle, saw 21% and 8% of fallen trees damage property, respectively. Given the high intensity winds of Michael, and observed treefall damage to property in populated neighborhoods, the percentage of fallen trees causing property damage in developed areas may be higher than observed in the past.

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Property damage due to treefall is largely non-modeled in the catastrophe risk models. From observations of property damage in areas impacted by Michael, approximately one in five fallen trees could be of great concern to homeowners and insurance companies for future hurricanes.

In areas exposed to less intense winds (less than 90 - 100 mph gust), we observed that trees shielded properties from hurricane winds, thereby limiting direct wind damage. Particularly in rural areas, the canopy of tall trees (greater than 60ft high) acted as a natural windbreak for nearby properties.

Graphical illustration of trees shielding home behind it (left, source: Miller and MacGowan, “Tree windbreaks for farms and homes”, Purdue University, 2009), homes shielded by trees in Bainbridge, GA (right)

**Storm surge damage to buildings**

**Key points for catastrophe risk managers**

- Strong connections (anchorage) of floor beams and stilts, floor beams and walls, and stilts bracing can improve storm surge and wind resistance of homes on stilts.
- Newer construction performed better than older construction (especially pre-FIRM and post-FIRM).

Many properties in Mexico Beach collapsed or were severely damaged due to the brutal force of storm surge and related flooding. Storm surge flood water was observed more than 1,500 feet from the coast. Damage to property along the coast indicates storm surge greater than 10 feet in Mexico Beach. The majority of buildings located south of U.S. Highway 98 were on elevated stilts. A small number of homes (likely pre-FIRM) were not elevated and were completely swept away by the storm surge. Overall, Michael’s storm surge damage to buildings in the area can be categorized into two types: 1) buildings inundated by floodwaters causing damage to building and contents (mostly nonstructural); and 2) buildings with structural damage, where large surge waves swept buildings off of their foundations. A majority of buildings immediately close to the beach in Mexico Beach fell into the second category.

Foundation connection failures were widely observed with elevated buildings that were swept away by the storm surge. It may be that the wooden floor beam was connected to foundation rebar with an improper nailed/bolted connection. Observing a large number of stilts standing along the coast, we think a minimal connection between the floor system and the foundation, along with storm surge waves higher than foundation level, knocked these buildings from their foundations.

If the storm surge waves were above the foundation level, it would cause major stress on foundation connections. However, bracing of piles (knee and diagonal) and engineered connections of floor beam/support system to foundation (metal connectors, straps) can limit the storm surge loss to these homes.
Though some elevated buildings in Mexico Beach survived the storm surge, Michael’s strong hurricane force winds inflicted extensive and near complete damage to these buildings. Foundation connections in these homes appeared to have performed better, most likely due to failure of the roof and walls before the failure of connections between the floor system and the foundation.

Storm damaged homes in Mexico Beach

Aerial pictures of Mexico Beach before (top) and after (bottom) Hurricane Michael. Source NOAA
Conclusions

Hurricane Michael’s wind speed in the surveyed cities was above the 1-in-700-year return period wind speeds for which almost all of buildings in the area were not designed to withstand. These high wind speeds created havoc in Panama City, Mexico Beach, Lynn Haven and Marianna. Storm surge damage along the coast, including in Mexico Beach, destroyed many buildings.

Michael caused major damage to various building types including residential, commercial, industrial, schools, hospitals, religious and other public buildings, as well as widespread damage to power and communication lines. In general, older buildings experienced more significant damage compared to newer construction. Combined forces of strong winds and storm surge caused failed foundation connections of homes in Mexico Beach, leading to total loss of many properties.

Hurricane Michael’s damage path was very narrow. Damage extended 60 to 80 miles across the coast and 100 miles inland from the coast - though the damage path was much narrower than 60 miles further inland. If Michael’s wind field extent had been as wide as last year’s Hurricane Irma, the insurance industry would have seen a major loss as areas around Tallahassee and Destin-Fort Walton would have been impacted by damaging winds.

Willis Re continues to evaluate all the scientific data, observations from our field surveys and other information available. Armed with this knowledge, we can help you make business decisions that both utilize the results of our detailed study, as well as your own claims data, and work together before the next big one hits.

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