Wind Damage to Commercial Properties
A Review of the Last 3 Years of Events

- Loss Statistics
  - Historical loss stats
  - Insurance losses

- 2016 – 18 Hurricane Seasons Losses in review
  - Hurricane Matthew
  - Hurricane Harvey
  - Hurricane Irma
  - Hurricane Maria
  - Hurricane Michael

- Lessons Learned
  - Lessons Learned and observations
### US Weather Catastrophe Losses 1980-2019 (CPI Adjusted)

<table>
<thead>
<tr>
<th>DISASTER TYPE</th>
<th>NUMBER OF EVENTS</th>
<th>PERCENT FREQUENCY</th>
<th>CPI-ADJUSTED LOSSES ($B)</th>
<th>% OF TOTAL LOSSES</th>
<th>AVERAGE EVENT COST ($B)</th>
<th>DEATHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tropical Cyclone</td>
<td>44</td>
<td>17.30%</td>
<td>$938.20</td>
<td>54.70%</td>
<td>$22.30</td>
<td>6,502</td>
</tr>
<tr>
<td>Drought</td>
<td>26</td>
<td>10.20%</td>
<td>$249.10</td>
<td>14.50%</td>
<td>$9.60</td>
<td>2,993</td>
</tr>
<tr>
<td>Severe Storm</td>
<td>110</td>
<td>43.00%</td>
<td>$241.40</td>
<td>14.10%</td>
<td>$2.20</td>
<td>1,640</td>
</tr>
<tr>
<td>Flooding</td>
<td>32</td>
<td>12.60%</td>
<td>$126.20</td>
<td>7.40%</td>
<td>$4.40</td>
<td>555</td>
</tr>
<tr>
<td>Wildfire</td>
<td>16</td>
<td>6.30%</td>
<td>$80.40</td>
<td>4.70%</td>
<td>$5.00</td>
<td>344</td>
</tr>
<tr>
<td>Winter Storm</td>
<td>17</td>
<td>6.70%</td>
<td>$49.20</td>
<td>2.90%</td>
<td>$2.90</td>
<td>1,048</td>
</tr>
<tr>
<td>Freeze</td>
<td>9</td>
<td>3.50%</td>
<td>$30.40</td>
<td>1.80%</td>
<td>$3.40</td>
<td>162</td>
</tr>
</tbody>
</table>

Source: NOAA


<table>
<thead>
<tr>
<th>Name</th>
<th>Disaster Type</th>
<th>Total Cost ($B)</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hurricane Katrina (August 2005)</td>
<td>Tropical Cyclone</td>
<td>168.8</td>
<td>1833</td>
</tr>
<tr>
<td>Hurricane Harvey (August 2017)</td>
<td>Tropical Cyclone</td>
<td>130.0</td>
<td>89</td>
</tr>
<tr>
<td>Hurricane Maria (September 2017)</td>
<td>Tropical Cyclone</td>
<td>93.6</td>
<td>2981</td>
</tr>
<tr>
<td>Hurricane Sandy (October 2012)</td>
<td>Tropical Cyclone</td>
<td>73.5</td>
<td>159</td>
</tr>
<tr>
<td>Hurricane Irma (September 2017)</td>
<td>Tropical Cyclone</td>
<td>52.0</td>
<td>97</td>
</tr>
<tr>
<td>Hurricane Andrew (August 1992)</td>
<td>Tropical Cyclone</td>
<td>50.2</td>
<td>61</td>
</tr>
<tr>
<td>U.S. Drought/Heatwave (Summer 1988)</td>
<td>Drought</td>
<td>44.4</td>
<td>454</td>
</tr>
<tr>
<td>Midwest Flooding (Summer 1993)</td>
<td>Flooding</td>
<td>37.7</td>
<td>48</td>
</tr>
<tr>
<td>Hurricane Ike (September 2008)</td>
<td>Tropical Cyclone</td>
<td>36.6</td>
<td>112</td>
</tr>
</tbody>
</table>

Source: NOAA
Tropical Storms and Hurricanes in the U.S., 1980-2018
(Insured property losses per state)

Loss Events in the U.S., 1980-2018
(Number of relevant events by peril)
2016 Matthew | 11 year drought to FL impact ends

- Life: 9/28 – 10/10/2016
- First Cat 5 Atlantic hurricane since 2007
- 2nd Hurricane to impact FL in 2016 (Hermine), after 11 yr. drought.
- Est. $10B+ in losses in the US

Losses:

Loss summaries were categorized by the following cause types:

- Design (Preventable)
- Workmanship (Preventable)
- Materials (Preventable)
- Maintenance (Preventable)
- Normal Wind Loss (WNLE) (Not Preventable)

2016 Matthew FL Losses | Location 1

Description

- Circa 1970s 36,000 sq. ft. store located in a typical strip shopping center located 1,800 ft. from the Atlantic Ocean.
- The eye of Matthew passed NNW about 40 miles to the east as a Category 3 hurricane.
- Wind gust speeds (3 sec) at the site were up to 80-90 mph.
- Roof is a modified bitumen and gravel on built-up roof over ISO insulation layer mechanically attached to steel deck, at a rate of about one or 2.5 ft.² in the field and the perimeters. SFs: C=1.56
- No parapet on the west side; there is a gutter on the west side supported by gutter clips about every 44 inches.
- The north, east and south sides have 1 to 2 ft. high parapets.
2016 Matthew FL Losses | Location 1

Damage
- Damage originated from the West.
- The gutter and/or flashing may have been loose and led to the roof covering peeling back.
- The result was about 7,000 sq. ft. loss of roof covering.
- No window/door damage.
- Proper gutter/flashing securement would have resulted in no loss.
- Loss estimates at this time are roughly $0.5M PD, $1.2M S&S, total $1.7 M PD and $1.75 M TE

<table>
<thead>
<tr>
<th>LOC.</th>
<th>Loss Type</th>
<th>TOTAL</th>
<th>Design (Preventable)</th>
<th>Workmanship (Preventable)</th>
<th>Maintenance (Preventable)</th>
<th>WNLE (Not Preventable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Roof</td>
<td>$70,000</td>
<td>100%</td>
<td>$70,000</td>
<td>0%</td>
<td>$0</td>
</tr>
<tr>
<td></td>
<td>Contents</td>
<td>$1,700,000</td>
<td>100%</td>
<td>$1,700,000</td>
<td>0%</td>
<td>$0</td>
</tr>
<tr>
<td></td>
<td>Bus. Interruption</td>
<td>$1,750,000</td>
<td>100%</td>
<td>$1,750,000</td>
<td>0%</td>
<td>$0</td>
</tr>
</tbody>
</table>

2016 Matthew FL Losses | Location 2

Description
- Circa 2000 building located in a typical strip shopping center located 5.8 miles from the Atlantic Ocean.
- The eye of Matthew passed NNW about 48 miles to the east as a Category 2-3 hurricane. Wind gust speeds (3 sec) at the site were up to 70-80 mph.
- The roof is a fully adhered EPDM membrane to iso. insulation that is mechanically attached to steel deck on steel joists roof.

Damages
- Some metal coping was displaced on the east wall.
- Some holes were created in the roofing from windborne debris.
- The EPDM membrane reportedly detached from the insulation throughout the roof for a total of approximately 30% of the roof area.
- No roofing actually blew off and leaking reportedly did not occur.
- The roof covering delaminated in 30% of the area; 100% roof cover will need to be replaced. $1.375 M PD & $0 BI.
- $2.5K Uplift Tests would likely have found the adhesion problem.

<table>
<thead>
<tr>
<th>LOC.</th>
<th>Loss Type</th>
<th>TOTAL</th>
<th>Design (Preventable)</th>
<th>Workmanship (Preventable)</th>
<th>Maintenance (Preventable)</th>
<th>WNLE (Not Preventable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Roof</td>
<td>$1,375,000</td>
<td>0%</td>
<td>$0</td>
<td>100%</td>
<td>$1,375,000</td>
</tr>
</tbody>
</table>
2016 Matthew FL Losses | Summary

The majority of the physical losses were preventable.

$7.6M of the losses were easily preventable
- Flashing securement
- Flood protection
- EIFS damage
- Rooftop equipment securement
- Roof Drainage overflow

$5.9M of the losses were preventable with thorough inspections
- Workmanship and Maintenance issues for windows & doors
- Confirm fully adhered SPMs are well bonded; Uplift Testing

$0.8M of the losses are deemed normal with no practical recommendations

2017 Hurricane Season | One for the Record Books

- Most active season since 2005, 7th most active season on record, 5th most since 1851
- Ended 12 year drought of major landfall to continental US
- Four Cat 4, with two reaching Cat 5, Irma and Maria
- Three Cat 4 landfalls in the same year – 1st time in US history
- Four US landfalls
- Jose, along with Irma, marked the first time two Atlantic hurricanes had maximum sustained winds of at least 150 mph
- Economic losses could be as high as USD $250-300B and total insurance industry insured damages could range from $80-130B

Courtesy of US National Weather Service
2017 HARVEY | More of a Flood Event

- Harvey made landfall as Cat 4 near Rockport, TX.
- 1st Cat 4 to make landfall in US since Charley in 2004.
- Produced 51 in. of rain and **27 trillion gallons of rain in 6 days**, much more than the expected 100-yr floods in TX.
- Many river streams experienced more than 500-yr floods.
- FEMA maps are outdated.
  - 50% of maps are over 10 years old.
  - 49% are less than 5 yrs old.
  - Several cases where updated maps failed quality control checks.
  - These maps were updated with old rainfall data.
  - Recent work by NOAA found that rainfall rates used in the Texas maps are underestimated.
  - NOAA is currently updating rainfall data in TX which will significantly increase rainfall rates in Houston which can lead to significant changes in the FEMA maps.
- A study showed that half of the insurance claims in Houston were for properties outside the mapped flood plain.
- In some parts of Texas, the rate was as high as 80%.
- Overall losses of about $126B.

2017 IRMA | It Could have Been Worse

- Life: 8/30 – 9/12/2017
- Strongest Cat 5 hurricane ever recorded in the Atlantic Basin.
- Irma spent **3 days as a Cat 5 – the longest known**.
- Longest period of winds more than **185 mph ever (37 hours)**.
- 6.3 M people ordered to evacuate in FL, likely the largest in history.
- After an 11 yr. drought, the 3rd hurricane to impact FL in 2 years since 2016 (Hermine, Matthew).
- For the 1st time in 100 years, its landfall was the **2nd Cat 4** hurricane landfall in the same year.
- Landfall in Cudjoe Key, FL as a Cat 4 (barely) storm and again a day later in Marco Island, FL as a Cat 3.
- The size of the tropical storm force wind area was larger than FL.
- 1.3 M people without power.
- Est. $50.5B in losses in the US. The **5th costliest** Atlantic hurricane in history – but could have been worse.
Maria is the 2nd strongest hurricane ever to hit Puerto Rico, behind only the 1928 San Felipe Segundo hurricane. In that sense it was a ~50 year event.

Puerto Rico was battered by heavy rain from Irma and Maria within a span of 2 weeks, causing extensive flooding and damage to infrastructure, power and transmission lines.

Irma & Maria resulted in a cascade of consequences resulting in significant increased proportions of loss.

Significantly increased rebuilding costs & Business Interruption (BI) was a big surprise due to factors such as:

- Poor infrastructure
- Limited accessibility to the damaged areas
- Socio-economic condition
- Non-availability of material and labor
- Economic demand surge – increased cost of labor and materials as demand for repair exceeds supply
- Claims inflation – increased cost due to insurer’s ability to fully adjust claims
- Cat models didn’t completely capture loss amplification for hurricanes like Maria as the impact of large scale infrastructure damage is not included.

Maria’s losses are $90B with $20 – 30B in insured losses.
2017 Hurricane Season Lessons Learned

Dangodara Consulting, PA

2017 Hurricane Season Lessons Learned
2017 Hurricane Season Lessons Learned | Summary

**Expected:**
- The majority of the physical losses were preventable, often with simple fixes.
  - Flashing/nailer securement
  - Building to accurate Flood levels or protection
  - EIFS damage
  - Rooftop equipment securement
  - Windows & Doors water infiltration continues to be a problem
  - Dock doors need to be secured
  - Confirm roofs are well bonded; Uplift Testing
  - Standing seam roofs poor performance
  - Adhered Single-ply membranes
  - Window breakage
  - Window leakage
- Installed flood defenses after 2001 Tropical Storm Allison performed well during Harvey

**Not Expected:**
- Flood risks outside of known flood zones need to be evaluate more closely as many FEMA maps are outdated. Urban flooding and smaller drainage ways not mapped by FEMA can and did flood
- Flood Emergency Response Plans (FERP’s) need to be consistently established at flood exposed locations
- Better evaluation of infrastructure and electrical grid is needed to determine contributing factors to extended power outages and what guidance should be given going forward
2018 Hurricane Michael

- 3rd most intense Atlantic hurricane to make landfall behind 1935 Labor Day and 1969 Camille.
- Strongest storm by wind speed since Andrew.
- Rapid intensification from a Cat 1 to 4 in 2 days.
- Landfall nearly Cat 5 (155 mph) near Mexico Beach, FL
- 14 ft. storm surge.
- Michael losses are ~$25B with ~$6.2B in insured losses.

2018 Hurricane Michael – Bay Medical

- The eye of Michael passed NNE about 7 miles to the east as a Category 3 hurricane.
- Wind gust speeds (3 sec) at the site were up to 125-135 mph.
- Design wind speeds (3 sec) at the site is 130 mph.
Patient Tower

- Roof is 2010 TPO adhered to coverboard over tapered iso insulation.
- Uplift testing done in 2017 – PASSED. (F: 77, C: 195 psf)
- 4 to 5 ft. high parapets.
West Tower

- Roof is 2002 Gravel BUR adhered to a concrete roof deck.
- Uplift testing done in 2017 – PASSED. (F: 74, C: 187 psf)
- No parapets.
2018 Hurricane Michael – Bay Medical

Materials Management Building
- Roof is 1987 Standing Seam Roof.
- Walls are Metal lath and plaster on steel framing.
- 1 to 5 ft. high parapets.
2018 Hurricane Michael – Bay Medical

AIG
Building 97

- Roof is 1997 Gravel BUR with a base sheet mechanically attached to LWIC.
- Uplift testing done in 2017 – FAILED. (F: 60, C: 45 psf)
- No parapets.
2018 Hurricane Michael – Bay Medical

Medical Office Building
- Building is 1986
- Roof is ~<10 yr. old TPO fully adhered.
- Walls are EIFS on steel framing.
- 4 to 5 ft. high EIFS parapets.
2018 Hurricane Michael – Bay Medical

[Images of damaged buildings and structures]

Dangodara Consulting, PA

2018 Hurricane Michael – Bay Medical

[Images of damaged buildings and structures]
2018 Hurricane Matthew

[Image of damaged building]

2018 Hurricane Matthew

[Image of damaged pool]

Dangodara Consulting, PA
2016-18 Hurricane Seasons | Key Takeaways

Lessons (Re-)Learned: The majority of the physical losses were preventable, often with simple fixes!

- Flashing/nailer securement
- EIFS damage
- Rooftop equipment securement
- Windows & Doors water infiltration continues to be a problem
- Dock doors need to be reinforced/secured
- Confirm roofs are well bonded; Uplift Testing
- Adhered Single-ply membranes
- Standing seam roofs poor performance continues
- Window protection

Wind Damage to Commercial Properties | Challenges for Industry

- Not enough consideration for partially enclosed wind pressure
- Better material choice & quality control for structural connections/fasteners needed
- Nailer design and construction needs improvement
- Parapet wall and soffit wind design/construction often inadequate
- EIFS systems (still) prone to failures
- Water infiltration in buildings with many windows
- Pre-engineered metal buildings envelope and MWFRS continue to perform poorly
- Holistic design for wind forces on the building envelope needs more consideration. Any weak link in the design will likely fail and propagate to cause other failures.
Thank You for Your Attendance and Participation!

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