FIU Webinar

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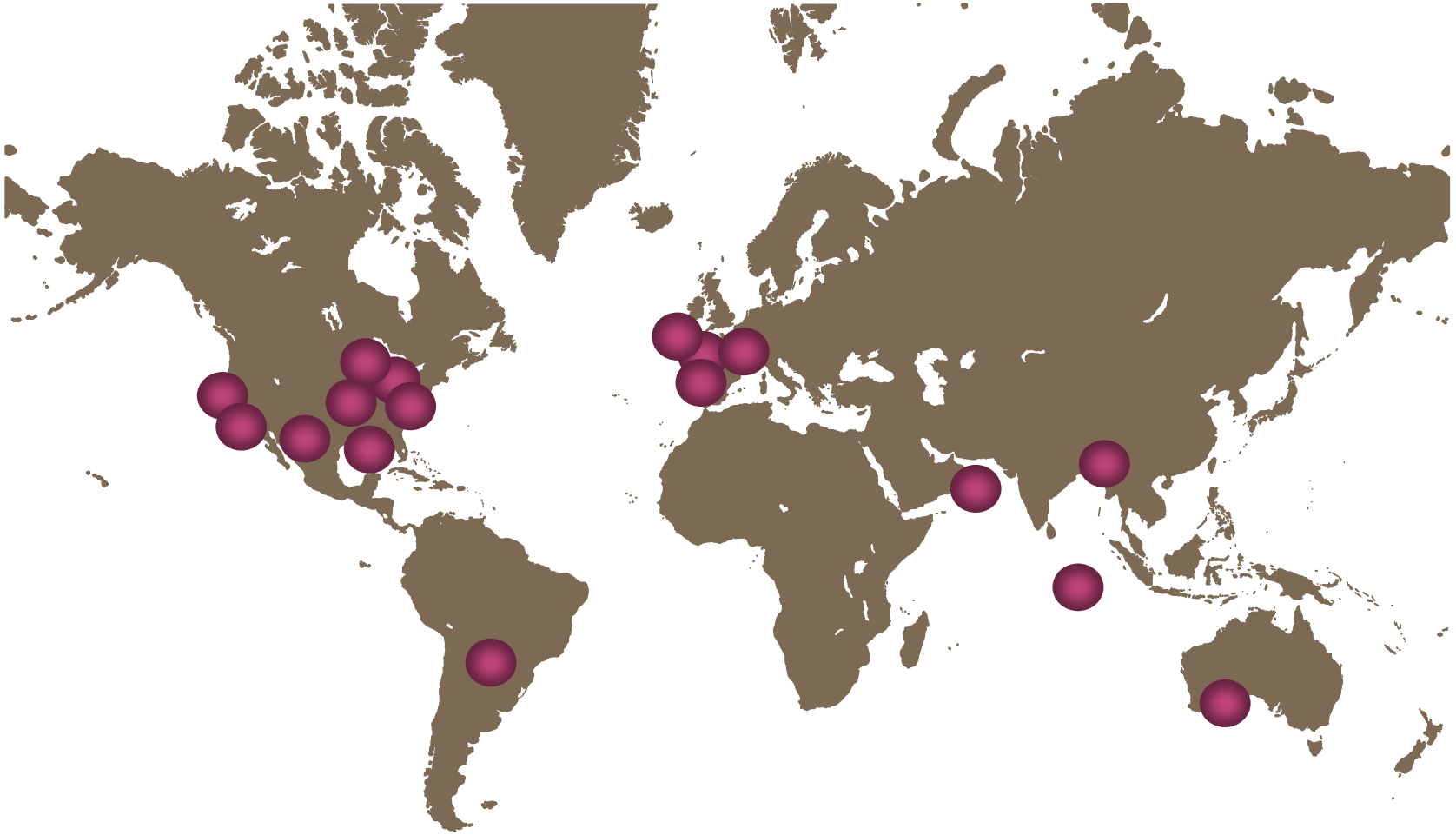
RESILIENCE IS A CHOICE.

Who is FM Global?



Who is FM Global?

- One of the world's largest highly protected risk (HPR) industrial and commercial property insurers in the world.
- Company is 185 years old.
- FM Global is a mutual insurance company, meaning it is owned and directed by its policy holders.
- Produces about 300 Property Loss Prevention Data Sheets
- Building Codes primary focus is life safety – our focus is to keep our clients in business.
- Nearly 2000 engineers and scientists worldwide.

Objectives of this Discussion

- Discuss property insurers' approach to HPR engineering for extreme wind events
- Discuss key construction features focused on during plan review and regular field inspections

Historic Wind Events Losses – Adjusted for Inflation

- Hurricane Andrew, 1992 - US$42. billion
- Hurricane Katrina, 2005 - US$214 billion, one loss alone was US$930 million
- Number of tropical cyclones has increased since the 1980's due to climate warming trend
- Average cost of tropical cyclones in the US since 1980 is about US$21.5 billion per event
- Population in coastal counties almost doubled between 1960 and 2008.

Difference Between Building Codes and HPR Insurers

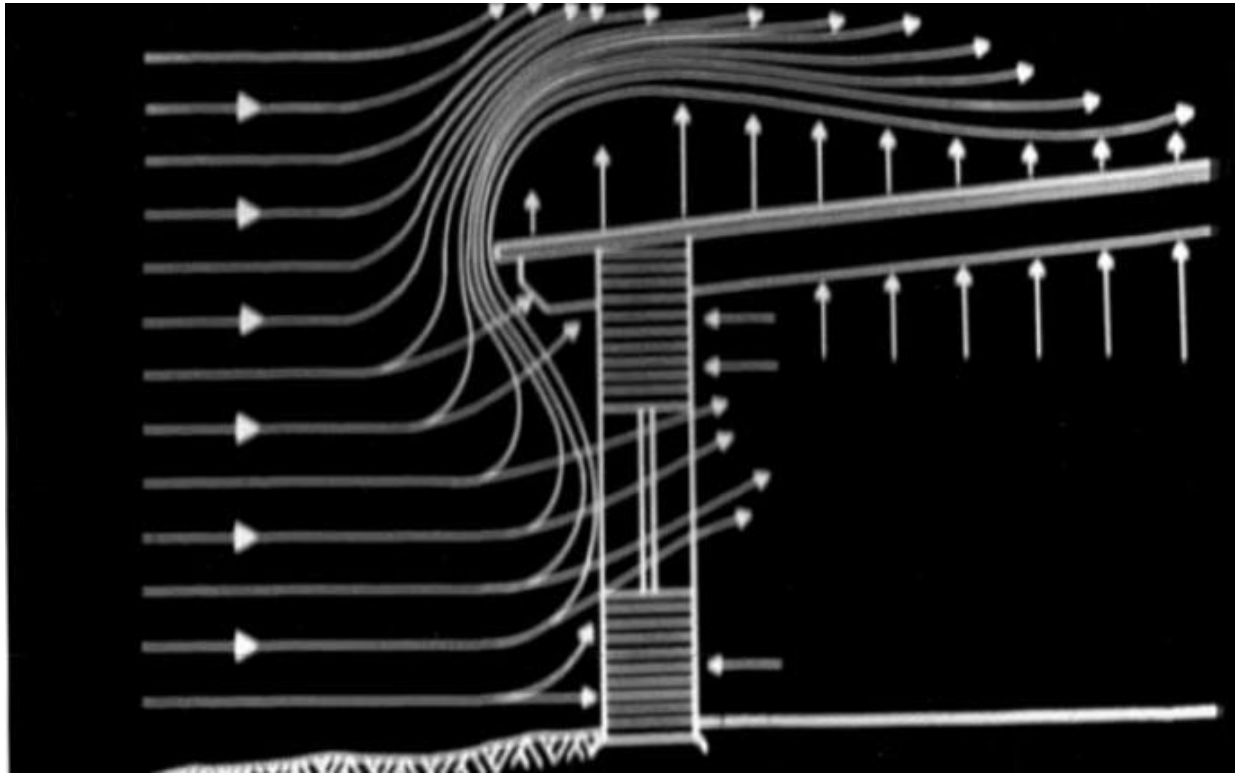
- **Building Codes**
  - Focus first on life safety
  - Property protection is mentioned in the scope, but is a lesser priority
  - Building code changes are not applied retroactive to existing buildings

- **HPR Insurers**
  - Focus on property protection, more attention to details beyond code requirements.
  - Field Engineers pay more attention to certain property protection details than most AHJs.
  - Recommendations applied retroactively in tropical cyclone prone regions, where cost justified.

Why Go Beyond Code/AHJ Requirements?

- Wind losses usually due to design or installation errors
- Damage goes beyond replacing construction materials
- The client is responsible for damage up to their deductible and wants to stay in business

When you understand how things fail …



… you can design them so they don’t.

Why Go Beyond Code/AHJ Requirements?

- Water damage can occur to building contents and equipment
- Business interruption could be months long
- The interruption can result in loss of clients and skilled labor
- Total loss at a given location could be in the $U.S. Millions

Costs vs. Savings

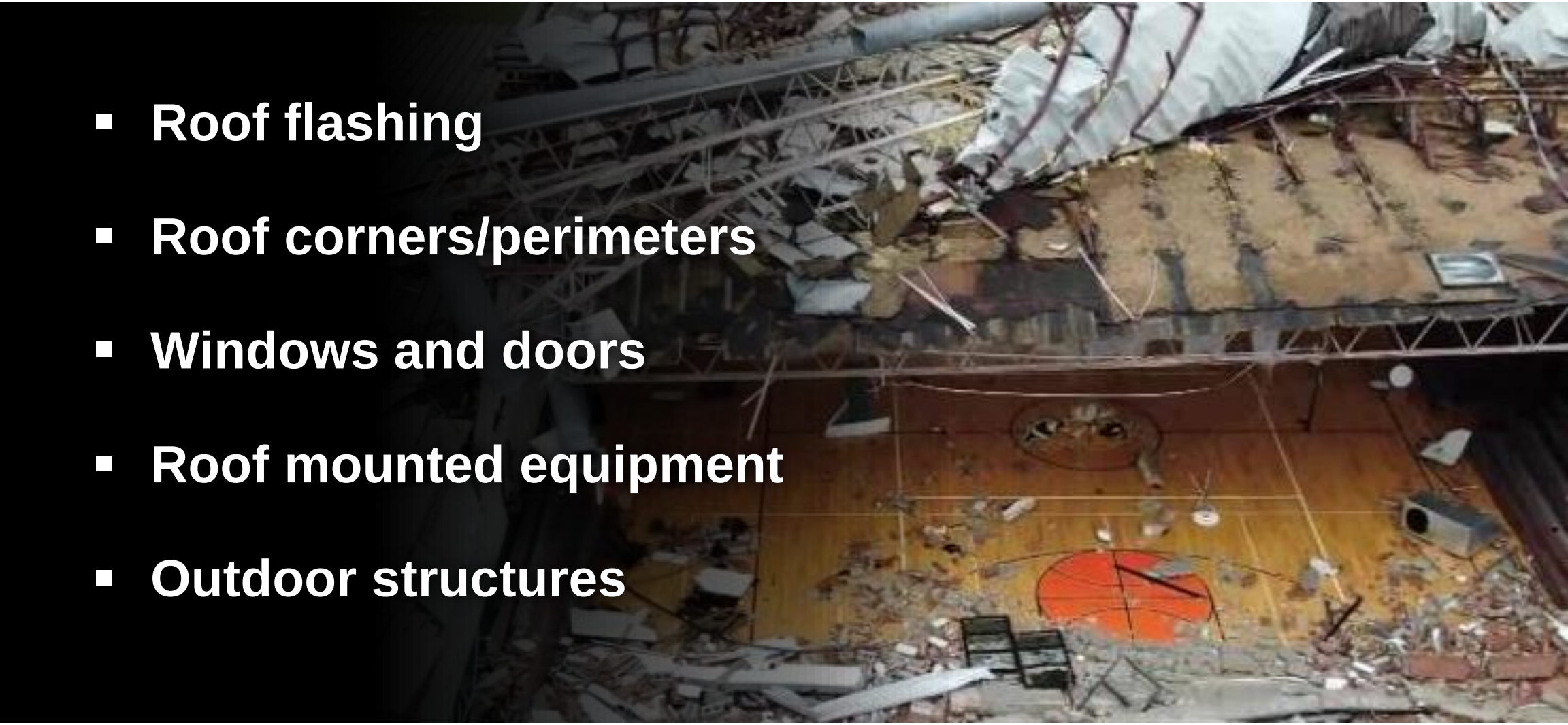
- Extra costs for design and installation are justified by a reduction in loss costs
- If **NOT** designed and installed correctly from a property insurance protection standpoint, loss costs are about **4-6 times higher** in an extreme wind event

- Average Loss Costs to FM Global clients over a 10-year period - **$380. mil. per year**
- Over **70%** of wind losses were due to **hurricanes** and **tropical cyclones**
- **Losses at proper installations less than half what hurricane computer models predict**

Some Problems are Design and Some Installation

- Plan Review services for insured clients – best to receive acceptance letter and/or recommendations prior to ordering materials
- Construction follow-ups on larger projects to view key steps
- Final acceptances
- Periodic inspections to manage change

Common Failures in Windstorms

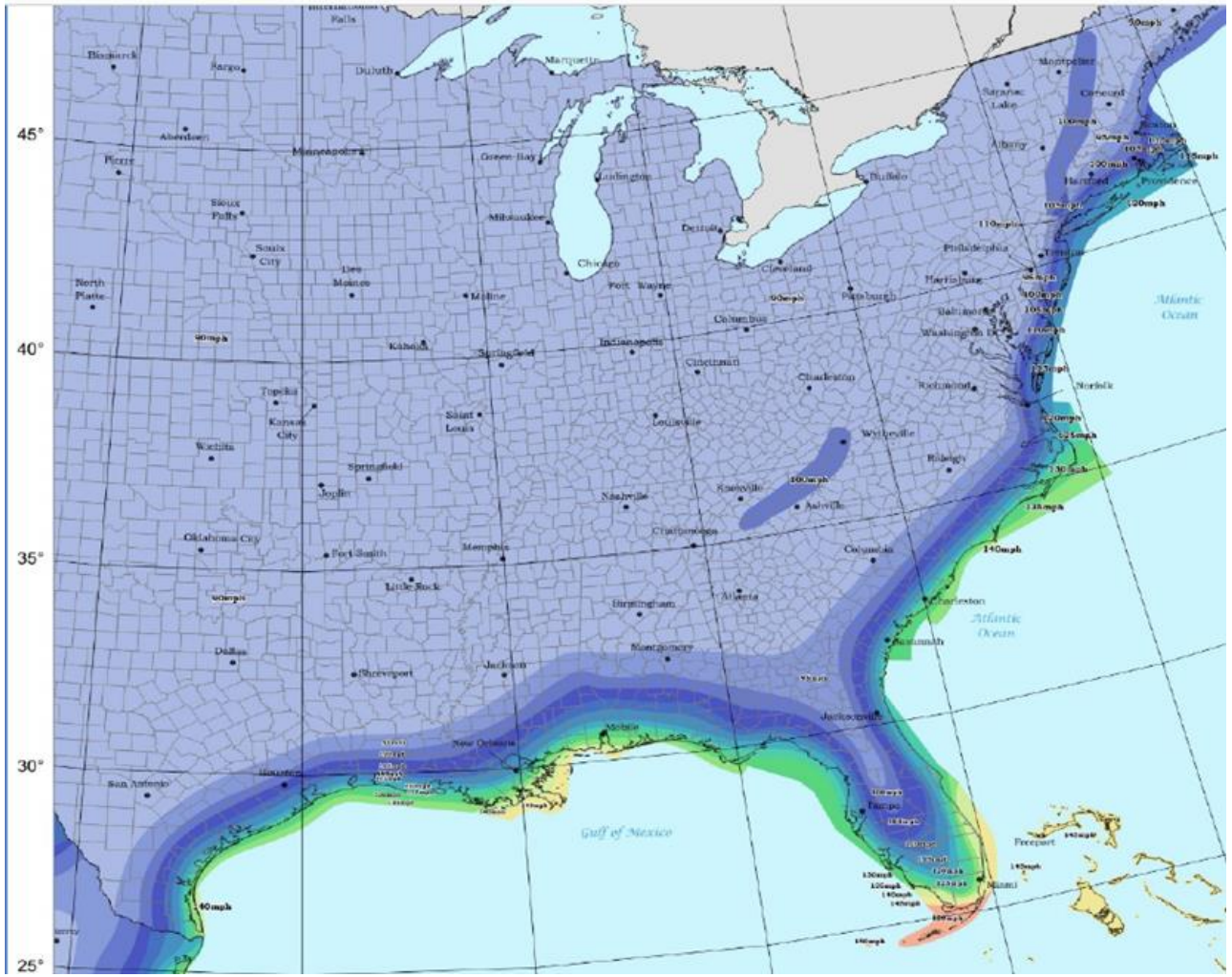


- Roof flashing
- Roof corners/perimeters
- Windows and doors
- Roof mounted equipment
- Outdoor structures

FM Global Design Wind Speeds

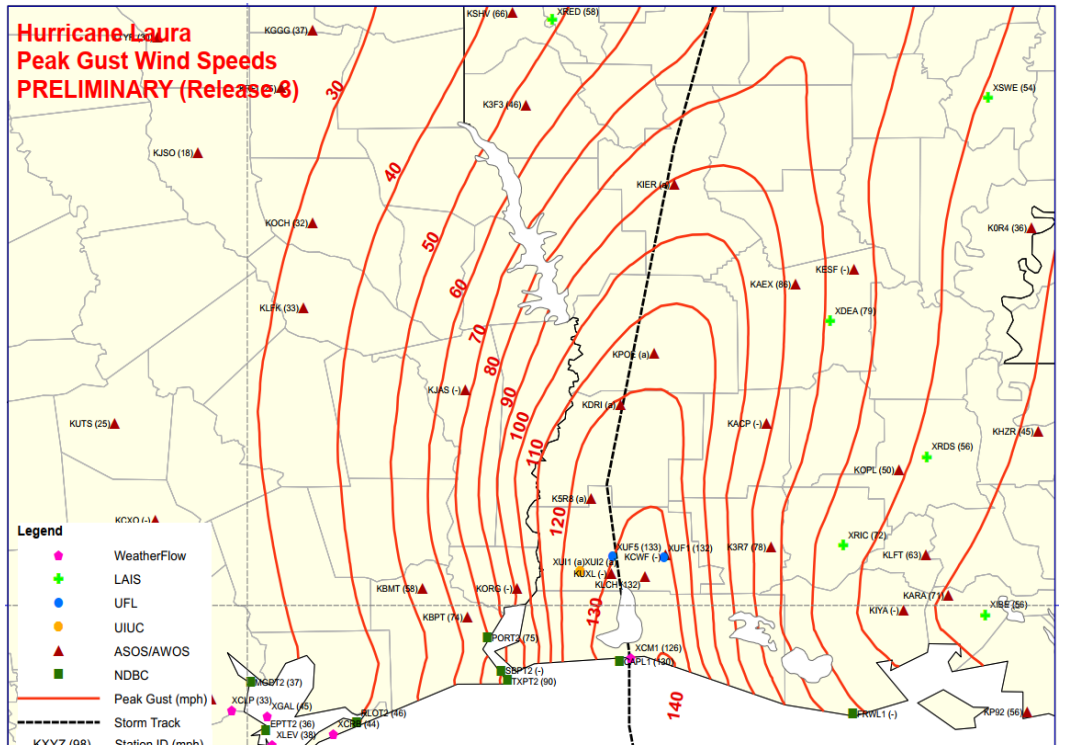
- FM Global uses Allowable wind speeds not Ultimate wind speeds – business in 140+ Countries, nearly all others use Allowable wind speeds
- For comparison, similar to ASCE 7-05, Load Factors, and Importance Factors are applied after wind speed selection
- ASCE 7-16 uses Ultimate wind speeds, Load Factors, and Importance Factors are effectively embedded in the wind speed map

FM Global Design Wind Speeds



Design vs. Actual Wind Speeds

- Most of the areas impacted by tropical cyclones (hurricanes) experience wind speeds that are <= design wind speeds
- Actual wind field data from event is reviewed after storm
- This is from Hurricane Laura



Types of Window Damage

- Small windborne debris (roof aggregate)
- Large windborne debris (wood framing, tree branches, broken roof tiles)
- Wind pressure
- Wind driven rain/leakage

Window Protection

- Windows exposed to windborne debris should pass required tests (ASTM E1886 and E1996, or TAS 201 and 203).
- Usually, they are laminated glass.
- Alternatively, use shutters.

Existing Window Protection

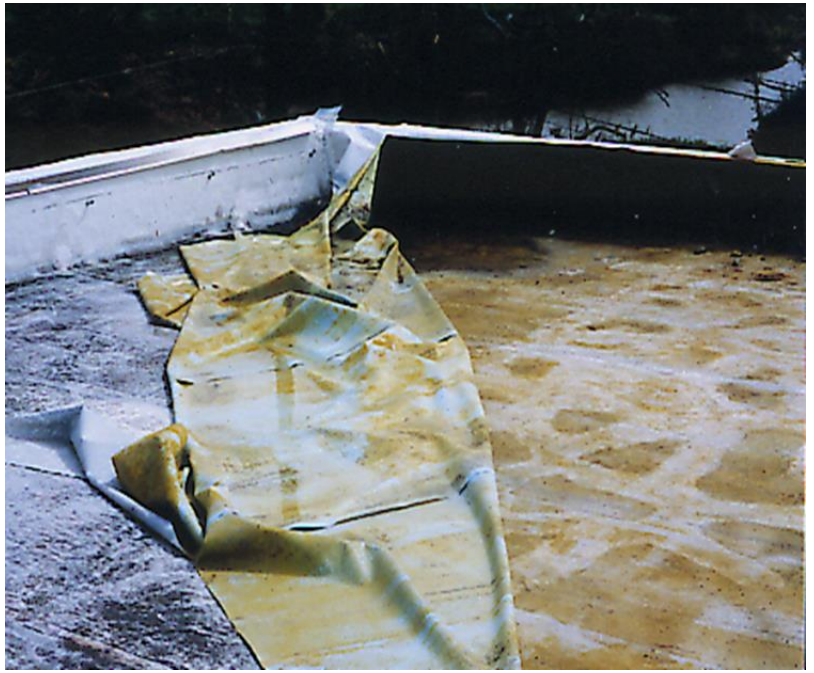
- Alternatively, install plywood over existing windows.
- Plywood - before the start of each hurricane season, it should be pre-cut, hardware attachments installed, and inventory taken prior to hurricane season.

Dock Doors

- Often large doors are not tested or designed for the proper wind pressure
- Blowing in or out causes direct damage to building contents
- Also increases wind pressure on other construction components
- Doors should be tested similarly to windows.
- Brace existing doors

Perimeter Roof Flashing

- **Most likely failure in extreme wind event**
- **If not well secured, metal flashing will peel roof cover off insulation or deck**



Perimeter Roof Flashing

- Lower edge of flashing should be secured
- Example of proper securement
- Usually, a metal hook strip is secured to wood nailer or metal wall panel
- The lower edge of the fascia slips over the hook strip

Perimeter Roof Flashing

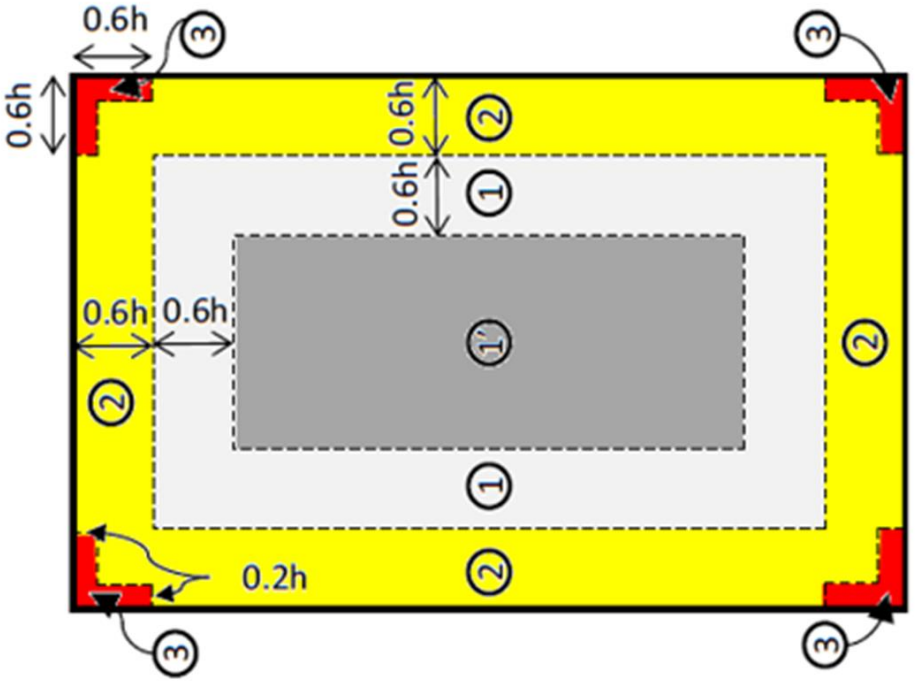
- If there is this much movement, it is not properly secured at its lower edge
- Can be retrofitted by securing the lower edge to the nailer or wall structure with self-drilling fasteners and rubber washers

Above Deck Roof Assemblies and Roof Decks

- This example is a metal standing seam roof, which acts as both the roof deck and roof cover
- Most failures occur at the roof corners or edges where wind uplift pressures are higher

Above Deck Roof Assemblies and Roof Decks

- Many designers or installers do not understand that pressures are higher and do not enhance the roof assembly in those areas.
- Plan drawing on right shows the areas (red and yellow) in ASCE 7-16 where wind pressures are higher than in interior roof sections for low slope roofs.



How to Address Higher Wind Loads in Roof Zones 2 and 3 Option 1

- ***Performance based approach***. Use variations of same system that meets needed ultimate wind pressure ratings for various roof zones. These can be found in a) RoofNav, on-line software by FM Approvals, or b) ASTM E1592 test data from manufacturer.
- For the ***example***, a 60, 90, 120 and 165 psf ultimate wind rating in Zones 1',1, 2 and 3, respectively. Can use higher rating in lower zone if acceptable.

Performance based approach – Using RoofNav

Found: 31 records

Assembly #	Cover Type	Application Type	Securement Type	Deck Type	Wind Uplift ▼	I/Fire	E/Fire	Slope	Hail
156287-0-0	Standing/Lap Seam System	New Roof	Attached	No Deck	180	1	A	5	SH
177-0-0	Standing/Lap Seam System	New Roof	Attached	No Deck	165	1	A	5	SH
180-0-0	Standing/Lap Seam System	New Roof	Attached	No Deck	135	1	A	5	SH
76684-0-0	Standing/Lap Seam System	New Roof	Attached	No Deck	135	1	A	5	SH
76685-0-0	Standing/Lap Seam System	New Roof	Attached	No Deck	135	1	A	5	SH
376080-0-0	Standing/Lap Seam System	New Roof	Attached	No Deck	135	1	A	5	SH
396713-0-0	Standing/Lap Seam System	New Roof	Attached	No Deck	135	1	A	5	SH
396715-0-0	Standing/Lap Seam System	New Roof	Attached	No Deck	135	1	A	5	SH
396714-0-0	Standing/Lap Seam System	New Roof	Attached	No Deck	120	1	A	5	SH
17563-0-0	Standing/Lap Seam System	New Roof	Attached	No Deck	120	1	A	5	SH
45-0-0	Standing/Lap Seam System	New Roof	Attached	No Deck	120	1	A	5	SH
9-0-0	Standing/Lap Seam System	New Roof	Attached	No Deck	120	1	A	5	SH
154921-0-0	Standing/Lap Seam System	New Roof	Attached	No Deck	105	1	A	5	SH
156289-0-0	Standing/Lap Seam System	New Roof	Attached	No Deck	105	1	A	5	SH
156292-0-0	Standing/Lap Seam System	New Roof	Attached	No Deck	105	1	A	5	SH
376079-0-0	Standing/Lap Seam System	New Roof	Attached	No Deck	105	1	A	5	SH
396716-0-0	Standing/Lap Seam System	New Roof	Attached	No Deck	105	1	A	5	SH
396717-0-0	Standing/Lap Seam System	New Roof	Attached	No Deck	105	1	A	5	SH
76678-0-0	Standing/Lap Seam System	New Roof	Attached	No Deck	105	1	A	5	SH
396712-0-0	Standing/Lap Seam System	New Roof	Attached	No Deck	90	1	A	5	SH

How to Address Higher Wind Loads in Roof Zones 2 and 3 Option 2

- Prescriptive Enhancements acceptable for certain conditions.
- Use a system with an ultimate wind rating acceptable for Zone 1.
- Reduce fastener spacing, etc. in accordance with FM Global Data Sheets 1-29 and 1-31 in Zones 2 and 3.
- There are limitations to the type of assemblies and wind pressures that these prescriptive enhancements are acceptable for.

SSR (standing seam roof) - Wind Performance

- After a hurricane, often the internal clips and screws are still attached to the purlins – but the standing seam roof panels are gone.

Standing Seam Roofs (SSR) - Wind Uplift Resistance

- The flat part of the panel between the deck ribs has limited stiffness.
- This results in the panel bending more between the deck ribs than between the supporting purlins.
- As the deck deflects upward, it exerts a vertical and horizontal force at the deck seams.
- Often wind failure occurs by the SSR deck coming apart at the seams.

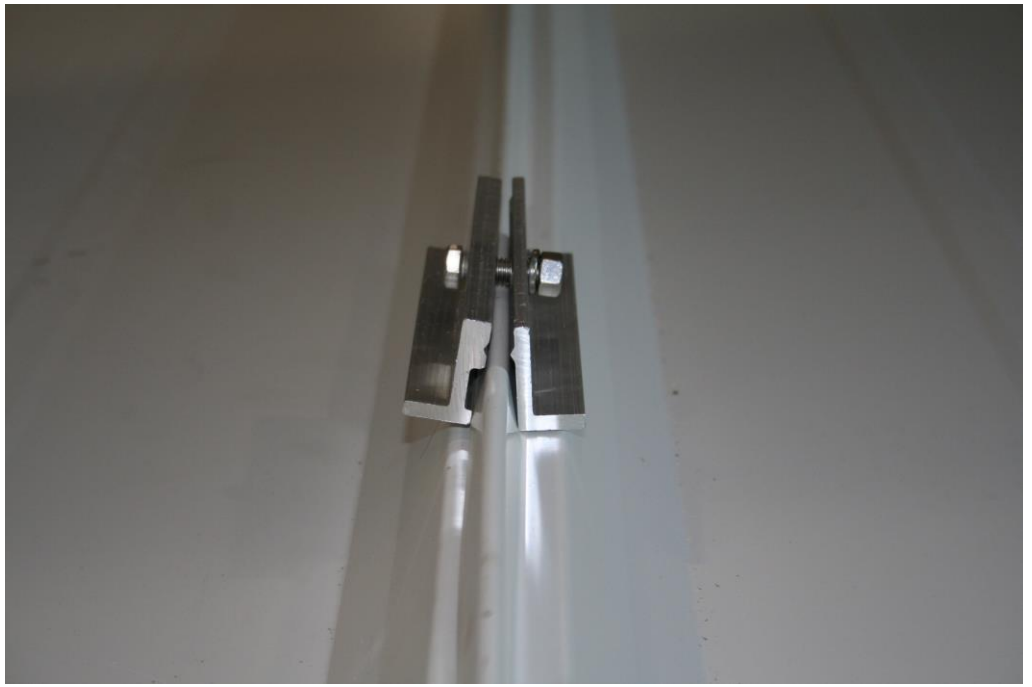
How To Increase Wind Resistance of SSRs

- Reduce purlin and clip spacing – this usually does NOT result in a linear increase in uplift resistance.
- Increase SSR thickness – 26, 24, 22-gauge steel
- Reduce the panel width/seam spacing
- Add external seam clamps (ESC) – this can change the failure mode from the seam coming apart to the internal clip breaking or pulling out of the purlins

Panels Bend Between Seams – Without External Seam Clamps (ESC), this SSR failed at only 50 psf

Same Assembly Tested with ESC That Did NOT Fit Properly

- 12 x 24 ft Test without ESC failed at 50 psf. Tested same assembly 2 more times – 24 ga. SSR, ribs 24 in. OC, purlins at 42 in. OC.
- With fully tightened, but NOT properly fitting ESC, SSR failed at only 60 psf.
- Insufficient increase in wind resistance.

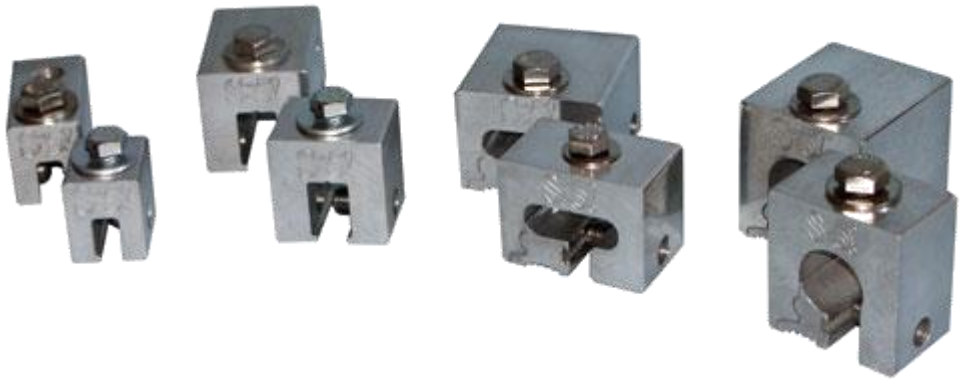


Same Assembly Tested with ESC That Did Fit Properly

- Failure occurred at 150 psf.
- For existing SSR where they did not reduce purlin and clip spacing in the perimeter and corners, only practical way to improve is ESC

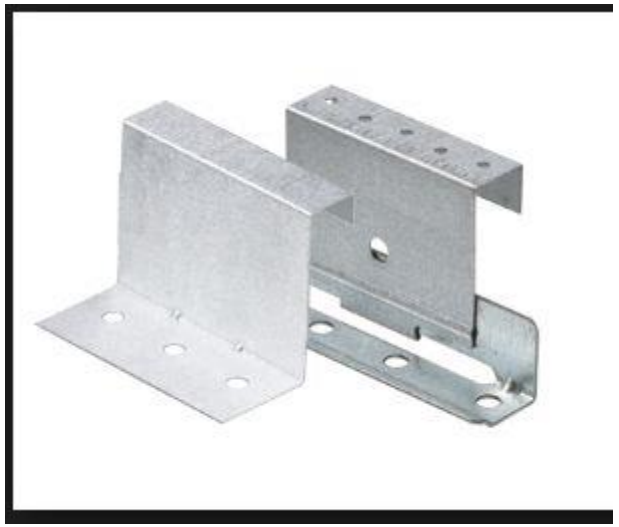
Standing Seam Roofs - External Seam Clamps (ESC)

- ESC must fit the specific SSR seam it is going on – otherwise strength increase may be minimal
- Need to know how strong existing clip and its securement is



One vs. Two-Piece Internal Clips

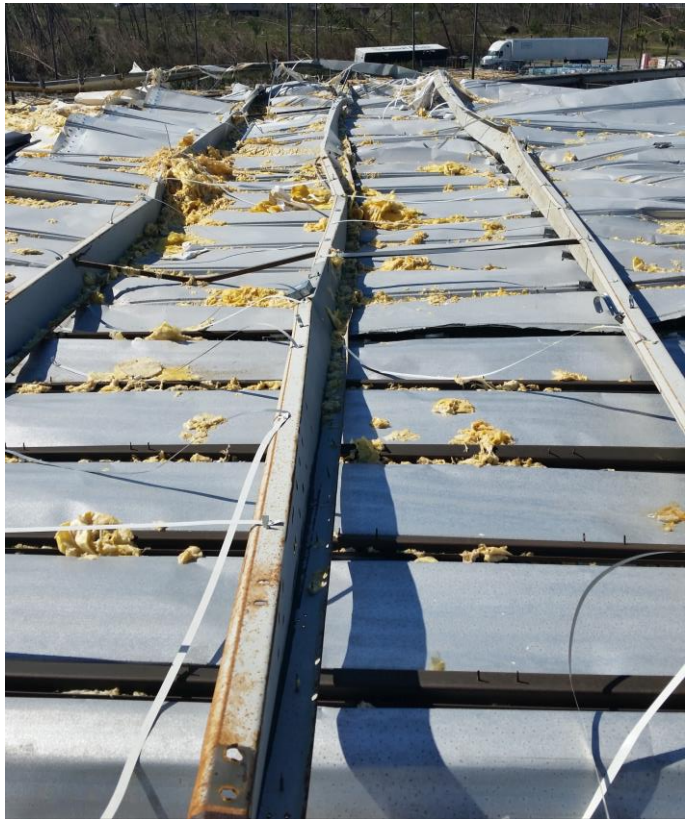
- With two-piece internal clips, secure ESC directly over internal clips, one clamp per clip.
- With one-piece internal clips, install one ESC on each side of clip



Importance of Torque on External Seam Clamps

- The amount of torque may vary from 130 to 180 in.-lb. depending on:
- The manufacturer of the ESC
- The thickness of the material
- Whether the SSR is steel SSR or aluminum

ESC Added, Purlin Installation Error, Roof Pulled Up Purlins

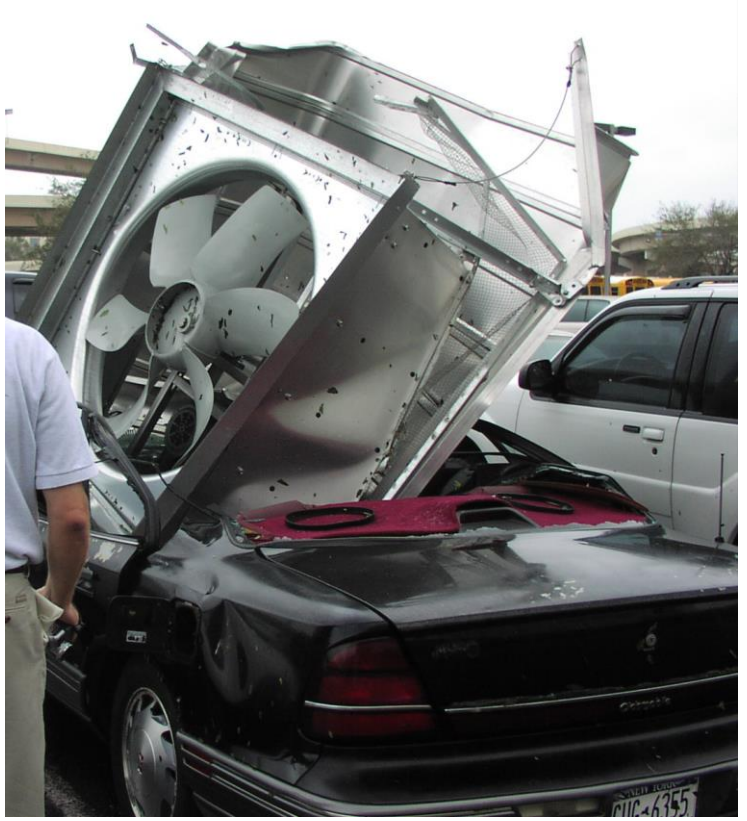


Roof Mounted Equipment

- In many cases the designer assumes that the dead weight alone will resist the design wind event

Roof Mounted Equipment

- Usually that assumption is wrong.
- In most cases, the dead weight may resist 60 – 70 mph, 3 second gusts.
- That is well below the design wind speed, especially in a hurricane prone region.



Roof Mounted Equipment

- Some anchorage systems for RME are not fancy looking, but they are effective

Roof Mounted Equipment

- Maintenance Issues
  - Often fan covers are removed for maintenance
  - After the work is done, they forget to replace all the bolts

Top Actions for Wind

1. Know your (specific) risk.
2. Know your insurance coverage limitations.
3. Locate outside of harm's way or design to minimize risk. Relocate critical equipment and valuables
4. Inspect roof and rooftop mounted equipment prior to hurricane season.
5. Keep utilities and emergency power operable.
6. Secure the building envelope - Protect windows and doors.
7. Plan for community impact.
8. Have a comprehensive plan & implement it.

Acknowledgment – Mike Mutua, Staff Engineering Specialist

Thank you.

https://www.fmglobal.com/research-and-resources/fm-global-data-sheets

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References – Available Free on FM Global Site

- FM Global Data Sheet 1-15, Roof Mounted Solar PV
- FM Global Data Sheet 1-28, Wind Design
- FM Global Data Sheet 1-29, Roof Deck Securement and Above-Deck Roof Components
- FM Global Data Sheet 1-31, Panel Roof Systems
- FM Global Data Sheet 1-49, Perimeter Flashing

References – Available Free on FM Global Site

- RoofNav – FM Approvals On-line Software
- FM Approval Guide – lists tested products for building construction and fire protection
- FM Approval - FM 4470 Test Standard, Single-Ply and Multi-Ply Roofs
- FM Approval – FM 4471 Test Standard, Metal Panel Roofs
- FM Approvals – FM 4435, Edge Systems Used with Low-Slope Roof Systems