FEMA Proposed Research Topics for Consideration by the

Florida Building Commission's (FBC)

Hurricane Research Advisory Committee (HRAC)

30 Mar 22

The following is a list of six (6) FEMA proposed research topics selected from various FEMA Mitigation Assessment Team (MAT) report Recommendations developed from recent Presidentially declared disasters. They are being submitted for consideration by the Florida Building Commission's Hurricane Research Advisory Committee (HRAC).

Each proposal meets the following criteria for funding consideration provided by the FBC 2022 research work plan.

CRITERIA FOR FUNDING

- Meets Definition of "Research" and/or "Technical Enrichment."
- Within the scope of hurricane resistance research (water and wind resistance).
- Urgency/Immediacy: Needed to support the development of 2023 FBC.

FEMA Proposed research topics:

These research topics are numbered only for reference purposes; they are NOT listed in priority order as to their importance, preference, difficulty or ease in research, cost or potential greater or lesser mitigation impacts to buildings or communities. Priorities can be determined by the FBC HRAC according to their own purposes. All of these research proposals are intended, and expected, to help the State of Florida and the Florida Building Commission with improving building performance, reducing vulnerabilities and enhancing building and community resilience.

A) ***FEMA P-2077 Mitigation Assessment Team Report; Hurricane Michael in Florida; Building Performance Observations, Recommendations, and Technical Guidance***; February 2020; https://www.fema.gov/sites/default/files/2020-07/mat-report_hurricane-michael_florida.pdf

1) Recommendation #FL-14b. Industry groups should assess the causes for the widespread asphalt shingle roof covering loss that was observed by the MAT.

Installation issues of asphalt shingles were observed at many sites. More research should be considered by industry groups (e.g., manufacturers, insurers, builders) and academia to explain why post-FBC asphalt shingle damage was observed to be widespread. In particular, this research should focus on areas where wind speeds were below design level. The research should attempt to determine whether these failures were the result of design, installation, testing, inspection, manufacturing, or other issues.

- Clear definition of the problem to be researched: **Asphalt shingle failure following Hurricane Michael was a common observation; why is this occurring and how can it be mitigated?**

Conclusion FL-14 The roof coverings for many residential buildings appeared to have inadequate resistance to wind loads; the loss of the primary roof covering contributed to significant water infiltration in many buildings.

Similar to historical and Hurricane Irma in Florida observations, widespread damage to asphalt shingles was observed on post-FBC residential buildings. The MAT was not always able to determine the reason(s) for this damage. In addition, observations of roof replacements indicated underlayment was not being installed as required by the FBC. Multiple MAT observations revealed contractors were not repairing roof coverings and installing replacements in conformance to the FBC requirements.

- If available, technical data/research in support of the research topic

  - Chapter 4. Wind-Related Observations: Residential has information on poor roof covering performance for residential structures beginning on page 4-1 with more specific observations in section 4.2.1 of the of FEMA P-2077. Furthermore, FEMA P-2023 which is the MAT Report for Hurricane Irma in Florida, also has this same recommendation (Recommendation FL-9a) just below.
  - Recommend researchers coordinate with the Florida insurance commission to gather much more detailed data on this issue.

***FEMA P-2023; Mitigation Assessment Team Report Hurricane Irma in Florida; Building Performance Observations, Recommendations, and Technical Guidance December 2018*; https://www.fema.gov/sites/default/files/2020-07/mat-report_hurricane-irma_florida.pdf**

Recommendation FL-9a. Industry groups should investigate the causes for the widespread asphalt shingle roof covering loss that was observed by the MAT. More research needs to be done by industry groups (e.g., manufacturers, insurances, builders) to explain why post-FBC asphalt shingle damage was observed to be widespread following a below design-level event and whether these failures were the result of design, installation, testing, inspection, or other issues. Appropriate mitigating actions should then be taken.

- Clear definition of the problem to be researched: **Asphalt shingle failure following Hurricane Irma in Florida was a common observation; why is this occurring and how can it be mitigated?**

Conclusion FL-9 The MAT observed evidence of inadequate resistance to wind loads for roof coverings of residential buildings.

In particular, the MAT observed widespread damage to asphalt roof coverings on post-FBC residential structures; the reason(s) for this damage was not determined by the MAT.

- If available, technical data/research in support of the research topic
  - Observations on roof covering performance for residential structures begins on page 4-6, with more specific observations of asphalt shingle roof coverings in Section 4.2.1.1.

2) Recommendation #FL-16. Industry groups and academia should perform research on commonly used ridge vent products to better determine the causes of ridge vent failure and develop solutions.

More research should be considered by industry groups (e.g., manufacturers, insurance organizations—IBHS, builders, trade associations—NRCA) to determine why ridge vent failure was observed to be widespread and whether these failures were the result of design, installation, testing (including for wind-driven rain infiltration), inspection, manufacturing, or other issues. Information to help improve the performance of ridge vents in high-wind areas can be found in Hurricane Michael in Florida Recovery Advisory 2, Best Practices for Minimizing Wind and Water Infiltration Damage (in FEMA P-2077, 2019a).

- Clear definition of the problem to be researched: **What causes ridge vents to fail and what can be done to mitigate these failures to prevent water-infiltration?**

Conclusion FL-16 The failure of ridge vents contributed to significant water infiltration at many sites.

The loss of ridge vents can expose large openings in the roof deck to water infiltration. Water infiltration can cause extensive interior damage, contribute to the growth of mold and mildew, and result in degraded building function or downtime until repairs are made.

- If available, technical data/research in support of the research topic
  - Chapter 4. Wind-Related Observations: Residential has information on poor roof covering performance for residential structures beginning on page 4-1 with more specific observations in section 4.2.1.1 on ridge vents. Information to help improve the performance of ridge vents in high-wind areas can be found in Hurricane Michael in Florida Recovery Advisory 2, *Best Practices for Minimizing Wind and Water Infiltration Damage* (in FEMA P-2077, 2019) but more research is needed as to their failure and how best to mitigate them.

3) Recommendation #FL-21b. The State of Florida and FDEM should consider re-evaluating EHPA criteria and re-assess safety of existing EHPAs, particularly those designed prior to the 6th Edition FBC (2017).

While new EHPAs are required by the 6th Edition FBC (2017) to be designed and constructed in accordance with the hurricane wind load provisions of ICC 500, structural

criteria for EHPA as designed and constructed prior to 6th Edition FBC (2017) were less stringent and non-mandatory. The State of Florida and FDEM should consider reassessing existing EHPAs that were designed and constructed prior to the 6th Edition FBC (2017) to identify and retrofit their vulnerabilities or explore incentivizing local authorities to replace the more vulnerable aging EHPAs with new EHPAs, or better yet, storm shelters or safe rooms.

- Clear definition of the problem to be researched: **What are some additional criteria or actions which can increase the protection provided by EHPAs, especially already existing structures?**

Conclusion FL-21 The HESs observed by the MAT demonstrated significant vulnerabilities to high-wind hazards.

The Bay County HESs, which the County identified through assessment and mitigation of existing spaces, incurred significant damage during Hurricane Michael and exposed shelter occupants to hurricane hazards. The Calhoun County HESs, which were designed to meet earlier EHPA criteria, incurred significant damage as well. Based on damage observations, roof systems of both types of HES are particularly vulnerable to high winds.

- If available, technical data/research in support of the research topic
  - Chapter 2. Building Codes, Standards, and Regulations: Section 2.4, which begins on page 2-21 provides background information on Florida's State Shelter Emergency Shelter Mandate and the resulting different types of shelters throughout the state. Section 5.2.3 which starts on page 5-44 discusses the observations made by the MAT for HESs visited during their deployment.
  - Another potential source of information may be Florida's Department of Emergency Management, as they charged with updating the Statewide Emergency Shelter Plan (SESP), and may have data on the structural and planning criteria for each shelter, as well as any information on its past performance during an event.

4) Recommendation #FL-30. The FBC should provide more specific criteria with restrictions on how, when, and where roof aggregate can be used.

Aggregate roof surfacing provides a ready source of wind-borne debris that can damage unprotected glazing in high wind. The 2003 through 2018 editions of the IBC prohibit the use of aggregate roof surfacing in hurricane-prone regions. This is a stark contrast to the FBC, which permits roof aggregate. Chapter 15, Roof Assemblies and Rooftop Structures, of the FBC includes some requirements for roof aggregate, including size and percent embedded. However, additional criteria should be incorporated to prevent aggregate blow-off or to specify that roof aggregate is prohibited.

- Clear definition of the problem to be researched: **What is the measured impact of roof aggregate on surrounding buildings as wind-borne debris; how can these impacts be mitigated?**

Conclusion FL-30 Roof aggregate can cause glazing damage to other floors on existing buildings or to nearby buildings.

The MAT observed incidents of blown-off roof aggregate causing glazing damage to other floors of the same building as well as adjacent buildings. This is a frequent observation made by previous MATs.

- If available, technical data/research in support of the research topic
  - Chapter 5. Wind-Related Observations: Non-Residential: Section 5.2, which begins on page 5-24 provides background information on the performance of non-residential buildings (commercial and critical facilities) and also discusses the building-specific observations made by the MAT which includes the effect of roofing aggregate as wind-borne debris.
    - Section 5.2.5.1 Bay Medical Sacred Heart Health System
  - Another potential source of information may be the ASCE 7-22 Wind Load Subcommittee; Mr. Tom Smith gave a presentation regarding ASCE 7 and the observed impacts of aggregate roofing materials and ways to improve requirements surrounding use of these materials.

B) ***FEMA P-2023; Mitigation Assessment Team Report Hurricane Irma in Florida; Building Performance Observations, Recommendations, and Technical Guidance December 2018***; **https://www.fema.gov/sites/default/files/2020-07/mat-report_hurricane-irma_florida.pdf**

(NOTE: Recommendation FL-9a above is from the H. Irma MAT in Florida report. It was added to and in support of the H. Michael MAT asphalt shingle recommendation above, since they are both related to the same research topic and to avoid duplication.)

5) Recommendation FL-12a. Industry groups and/or academia should study debris generation and strikes to protective systems during hurricanes to determine whether the wind speed triggers for the ASCE 7 wind-borne debris region are appropriate.

Industry groups and/or academia should study debris generation and associated debris strikes to protective systems from the 2017 hurricane, as well as for future storms, to determine whether the current wind speed triggers for the wind-borne debris region as defined in ASCE 7 are appropriate. Data collected and analyzed during the study can be used to make recommendations on ASCE 7-required protection of windows and glazed doors.

- Clear definition of the problem to be researched: **What wind speed trigger is appropriate for the ASCE 7 wind-borne debris region for Florida?**

Conclusion FL-12 The MAT observed evidence of wind-borne debris, but very few instances of glazed openings being breached.

ASCE 7-required protection of windows and glazed doors in the wind-borne debris region appears to have been widely applied. However, the few instances of

observed damage to protected glazed openings occurred in areas where estimated wind speeds during Hurricane Irma were well below the 130 mph wind-borne debris trigger for which ASCE 7 requires glazed opening protection. This suggests that wind-borne debris was generated at wind speeds well below the 130-mph trigger.

- If available, technical data/research in support of the research topic
  - Section 2.3.1 Wind Loads and Wind Design in the FBC for background information.
  - Chapter 4. Wind-Related Observations: Residential: Section 4.2, which begins on page 4-6, provides background information on the performance of residential buildings envelopes and also discusses wind-borne debris observations made by the MAT in Section 4.2.4 Glazed Openings and Opening Protection Systems, starting on page 4-24.
  - Could check if data is available through any insurance consortiums, especially those which are FL-specific and able to share their data
  - IBHS
  - NSF/StEER

C) ***FEMA P-2022 Mitigation Assessment Team Report; Hurricane Harvey in Texas; Building Performance Observations, Recommendations, and Technical Guidance; February 2019***
https://www.fema.gov/sites/default/files/2020-07/mat-report_hurricane-harvey-texas.pdf

6) **Recommendation TX-22a. FEMA should work with industry partners to evaluate whether ASTM testing requirements for debris impacts and wind pressures should be adjusted.**

Using damage observations made after Hurricane Harvey, the FEMA Building Science Branch should collaborate with industry partners and identify trends in damages (e.g., interior finishes subject to water intrusion/wind driven rain) that are potentially a result of inadequate testing requirements. For example, ASTM E1886, the standard for glazing protection systems impacted by missiles and exposed to cyclic pressure differentials, does not consider water leakage after debris impact, nor does it consider debris impact to the framing around the opening. The current testing standard evaluates missile impacts to the window, but the framing around the glazing is not impacted during testing.

- Clear definition of the problem to be researched: **What adjustments are needed to the ASTM E1886 testing requirements standard to cost effectively improve resilience from windborne debris impacts, wind pressures and water leakage / intrusion?**

Conclusion TX-22 Current testing standards may need to further consider debris impact.

In multiple locations, the MAT observed broken laminated glass that remained in the frame, but allowed water infiltration; the leakage may have been related to flashing deficiencies, glass breakage, or both. The MAT also observed one instance where a

window subframe blew out of the main window frame because windborne debris impacted a jack stud; the stud was pushed inward, which caused the main window frame to twist. While the products observed were tested for the region in which they were installed, the damage indicates the performance measures in current testing requirements may need to be reevaluated and adjusted, especially with respect to limiting infiltration of wind-driven rain.

- If available, technical data/research in support of the research topic
  - See section 4.1.6 Windows and Shutters
  - See section 4.1.8 Debris Impacts