Interim Report:

Hurricane Michael Data Enhancement (Phase II), Performance of Modular Houses and FEMA Recovery Advisory Reviews

Project #: P0157245

Submitted to:

Building A Safer Florida Inc. on behalf of
Florida Department of Business and Professional Regulation
Mo Madani, Program Manager
Building Codes and Standards
2601 N Blair Stone Rd
Tallahassee, Florida 32399

Prepared by:

David O. Prevatt, Ph.D., PE (MA)
Principal Investigator
Associate Professor (Structures)

David B. Roueche, Ph.D.
Co-Principal Investigator
Assistant Professor (Structures)
Auburn University

Report No. 04-20

20 April 2020

Engineering School of Sustainable Infrastructure and Environment
Department of Civil and Coastal Engineering
University of Florida
365 Weil Hall
P.O. Box 116580
Gainesville, FL 32611-6580

DISCLAIMER

The material presented in this research report has been prepared in accordance with recognized engineering principles. This report should not be used without first securing competent advice with respect to its suitability for any given application. The publication of the material contained herein does not represent or warrant on the part of the University of Florida or any other person named herein, that this information is suitable for any general or particular use or promises freedom from infringement of any patent or patents. Anyone making use of this information assumes all liability for such use.

Table of Contents

1 RELEVANT SECTIONS OF THE FLORIDA BUILDING CODE

- 2017 Florida Building Code- Residential, Sixth Edition Chapter 6- Wall Construction (FBC, 2017)
- 2017 Florida Building Code- Residential, Sixth Edition Chapter 7- Wall Covering
- 2017 Florida Building Code- Residential, Sixth Edition Chapter 8- Roof Ceiling Construction all Covering (FBC, 2017)
- 2017 Florida Building Code- Residential, Sixth Edition Chapter 9- Roof Assemblies (FBC, 2017)
- 2017 Florida Building Code- Building, Sixth Edition, Chapter 14 “Exterior wall” (FBC, 2017)
- 2017 Florida Building Code- Building, Sixth Edition, Chapter 17 “Special installations and test”

1.1 Relevant Statutes, Standards, Definitions or Other Regulations:

- Florida Statute 553.36(13) defines a Modular Building as follows:

“Manufactured building”, “modular building,” or “factory-built building” means a closed structure, building assembly, or system of subassemblies, which may include structural, electrical, plumbing, heating, ventilating, or other service systems manufactured in manufacturing facilities for installation or erection as a finished building or as part of a finished building, which shall include, but not be limited to, residential, commercial, institutional, storage, and industrial structures. The term includes buildings not intended for human habitation such as lawn storage buildings and storage sheds manufactured and assembled offsite by a manufacturer certified in conformance with this part. This part does not apply to mobile homes.

- Florida Statute 553.80(d) states the following:

Building plans approved under s. 553.77(3) and state-approved manufactured buildings, including buildings manufactured and assembled offsite and not intended for habitation, such as lawn storage buildings and storage sheds, are exempt from local code enforcing agency plan reviews except for provisions of the code relating to erection, assembly, or construction at the site. Erection, assembly, and construction at the site are subject to local permitting and inspections.

- Florida Statute 553.37(3)-(5) states the following:
  (3) After the effective date of the Florida Building Code, no manufactured building, except as provided in subsection (12), may be installed in this state unless it is approved and bears the insignia of approval of the department and a manufacturer’s data plate. Approvals issued by the department under the provisions of the prior part shall be deemed to comply with the requirements of this part.

(4) All manufactured buildings issued and bearing insignia of approval pursuant to subsection (3) shall be deemed to comply with the Florida Building Code and are exempt from local amendments enacted by any local government.

(5) No manufactured building bearing department insignia of approval pursuant to subsection (3) shall be in any way modified prior to installation, except in conformance with the Florida Building Code.

2 BACKGROUND

Hurricane Michael (October 10, 2018) caused landfall in the south of Panama City, FL with the National Hurricane Centre reported that a minimum pressure 919 MB and maximum sustained winds of 150 mph. The measured peak wind gust observed near the eyewall of at least 130 mph and 10 m height, but gusts may have been higher as several observation stations damaged and stopped reporting. It was estimated that the design wind speeds for many structures were exceeded for a sizable region near Mexico Beach and further inland. The hurricane particularly affected the Mexico Beach and Panama City and nearby coastal towns as well as interior areas, such as Blountstown and Marianna FL located north of the I-10 Interstate highway.

The University of Florida conducted two damage surveys immediately following the landfall of the hurricane and revealed that structural performance of the buildings. As a result of the survey, it was suggested that the age of structure has a greater influence on whether it was just damaged or destroyed.

The University of Florida in coordination with Auburn University were able to compare the performance of the Houses in Cedar's Crossing, Magnolia Hills, Brentwood's, Gulf Aire and Beacon Hill during the Hurricane Michael based on the built year before and after Florida Building Code and also presented the building performance based on the wind and storm hazard was updated in Survey and Investigation of Buildings Damaged by Hurricane Michael Project Phase I (2019). The Second Phase of this project will continue the data enhancement of the remaining areas (400-450 buildings) and compared the performance of the Pre- and Post FBC buildings.

3 RESEARCH AIMS AND MOTIVATION

A result of the insurance crisis following the 2004 and 2005 hurricanes was that the legislature saw the impact Florida Building Codes can have on building damage and insurance losses. Subsequently, state building code law was revised further from the 2002 changes to enhance the impact of the code. The state law of Florida now prioritizes property protection from hurricane winds and water intrusion and mitigation of existing buildings. In order to do this, the Florida Building Commission continues to focus on developing the fundamental science essential to good engineering standards and buildings codes.

The motivation of this research is to analyze the data collected from the Hurricane Michael and estimate the exterior and interior damage of the buildings. There are different factors affecting the damage to the components of the buildings. In order to compare the performance of the Pre- and Post FBC buildings, it is better to analyze the data in large areas. In Phase I of this project (Prevatt & Roueche, 2019), we were able to do data enhancement of approximately 200 buildings in Cedar's Crossing area. In the Phase II of this project we will do data enhancement of other (400-450) buildings.

A tangential motivation of this research is to assess the performance of modular homes, which are subject to the requirements of the Florida Building Code but are manufactured off-site. The null hypothesis is that the performance of these buildings is equivalent to a site-built home, all else being equal. This hypothesis will be tested using post-hurricane data collected by the PIs following Hurricanes Irma and Michael.

4 PROJECT TASK ITEMS

There are three primary tasks within the scope of this project. The progress on each task, and our proposed schedule to conclude it is described below.

4.1 Data Processing and Information Extraction of the Complete post-Hurricane Michael Reconnaissance Dataset

The complete Hurricane Michael dataset 737 assessments, as previously described in Prevatt and Roueche (2019). Approximately 220 of the 737 building assessments were enriched in the Phase I study to quantify precise building attributes and component-level building damage extent. The objective of this task is to extend the study to enrich the remaining 517 buildings affected by Hurricane Michael and perform an exploratory evaluation of the pre- and post-Florida Building Code building performance.

4.1.1 Task Status

This task is 75% completed and on schedule.

4.1.2 Summary of Progress

- Data enrichment for the remaining 517 assessments was completed. The dataset now consists of 737 assessments, which includes 705 individual buildings and 32 general area assessments. Figures xx through xx summarize the spatial distribution of the data and characterize the data for specific attributes, including building type, wind and surge damage rating, wall cladding type, roof cover type, and estimated wind speed.
- Enrichment of the assessments incorporated data from multiple sources, including the raw reconnaissance data, processed reconnaissance data (UAV point clouds and post-event streetview), county property assessor data, Pictometry EagleView, and pre-event Google Streetview.
- Completed dataset underwent multiple QA/QC checks to ensure data is accurate and precise within the limitations of reconnaissance data and the other supplemental data sources used. A four-fold, 20 sample cross-validation check resulted in a 2% error rate.
- Analysis of the dataset is ongoing to explore the relative performances of various roof cover and wall cladding types.
- A more user-friendly web platform for interacting with the completed dataset has been initialized that utilizes Bootstrap and Google Maps frameworks.

4.1.3 Key Remaining Sub-Tasks

- Assemble a more user-friendly public web platform for parsing and viewing the completed dataset.
- Complete a preliminary analysis of the dataset to evaluate the relative performance of pre- and post-Florida Building Code homes and explore the performance of various types of cladding elements.

4.2 Evaluate the Relative Hurricane Performance of Modular/ Manufactured Single-Family Houses

Modular (or manufactured homes) are defined in Section 1 of this report. This definition specifies that modular homes are manufactured off-site but conform to the provisions of the Florida Building Code, unlike mobile homes (oftentimes also called manufactured homes if built after 1976) which conform to the federal Housing and Urban Development (HUD) standards. The relative hurricane performance of modular homes vs traditional site built homes is to be examined in this study using our data from Hurricanes Irma (2017) and Michael (2018).

4.2.1 Task Status

25% Complete.

4.2.2 Summary of Progress

- We discovered that modular homes can only be conclusively identified on-site by an insignia denoting design acceptance by the Florida Department of Community Affairs or Department of Business & Professional Regulation. The insignia and accompanying manufacturer data plate are typically located on the inside cover of the electrical panel, or an interior cabinet door, and would not be accessible in exterior assessments. Therefore, identification must rely upon obtaining permit records or other information for manufactured buildings provided by the counties or local jurisdictions and matching the information with buildings in our hurricane datasets.
- We have extracted a list of permits issued for modular homes in Monroe County, FL (N = 303) and Bay County, FL (N = 38). Contacts have been made in the building departments of Monroe County, Bay County and Gulf County regarding expansion of these datasets to ensure all modular homes are captured. These permits are being matched using the provided address to homes in our Irma and Michael datasets.

- Wind speed and direction time histories have been prepared for all homes in the Hurricane Irma and Michael datasets to facilitate rapid wind load evaluations once modular homes in our datasets are identified.

4.2.3 Key Remaining Sub-Tasks

- Remaining permits need to be matched with homes in our Irma and Michael datasets.
- Develop additional metadata such as structural plans, manufacturer and date of installation of the modular houses using publicly available County Property Appraisal data and the Florida Department of Business and Professional Regulation website for manufactured (modular) buildings (https://floridabuilding.org/mb/mb_default.aspx).
- Evaluate and compare the performance of the modular residential structures as against the total database of houses conditioned on wind speed, wind exposure, and mean roof height.

4.3 Research Outcomes from FEMA's MAT Reports

FEMA recently released a Recovery Advisory 2 for Hurricane Michael that outlines best practices for minimizing wind and water infiltration into residential buildings. Many of the recommendations may already be included into the FBC and others that have not been. The scope of work is:

- We will review the recently published documents and identify the differences between the current Building Code and the additional recommendations presented.
- Report the findings to the FBC, prioritizing the modifications for code changes for consideration in future codes.

The Hurricane Michael Recovery Advisory 1 discusses Successfully Retrofitting Buildings for wind resistance and it is focused on the effective retrofit strategies for critical facilities. The details here are also pertinent to both residential and on-residential structures. We will review this publication and extract relevant practices that ought to be considered by the Florida Building Commission.

4.3.1 Task Status

10% Complete.

4.3.2 Summary of Progress

The FEMA documents have been reviewed, and documentation of the relationships between recommendations and the building code will be addressed in the period of May 2020 through end of project.

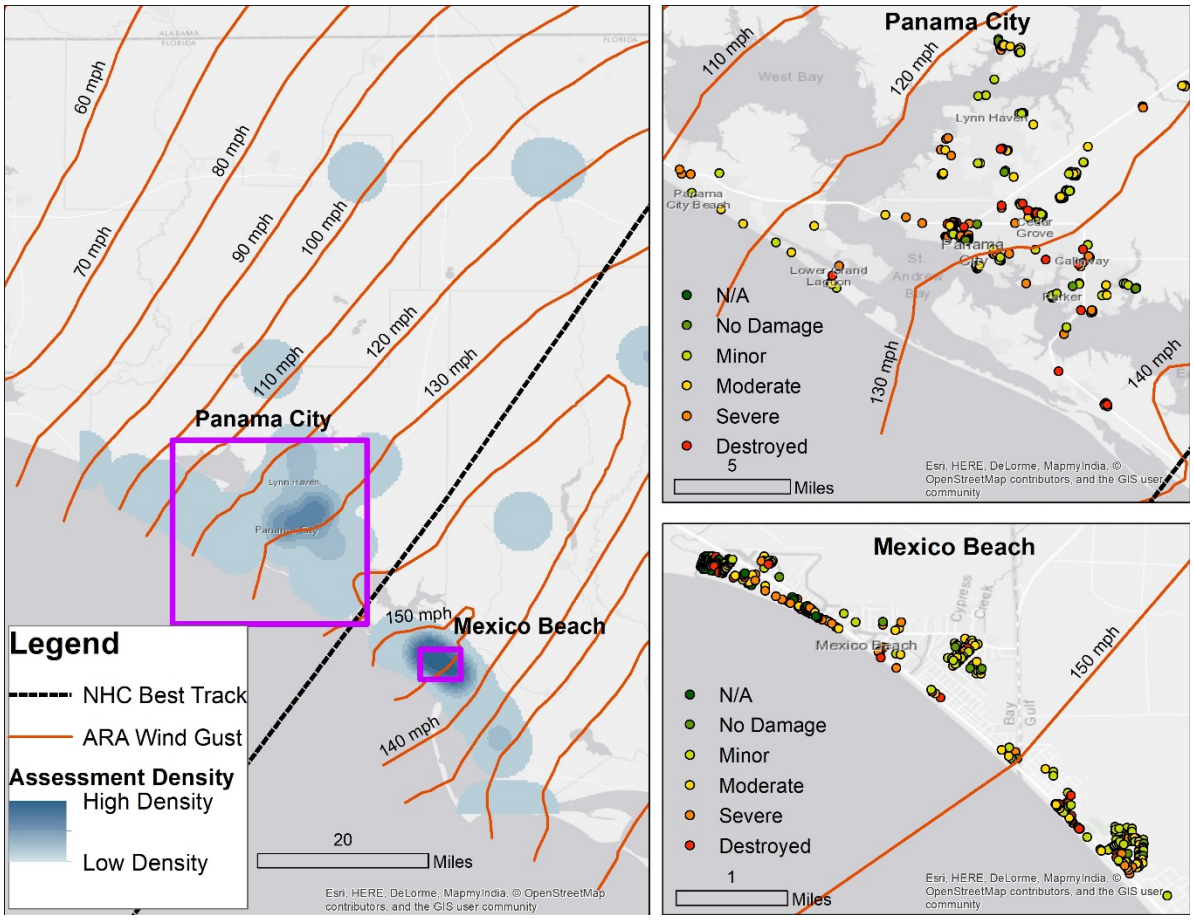

Figure 1. Spatial distribution of the 737 assessments.

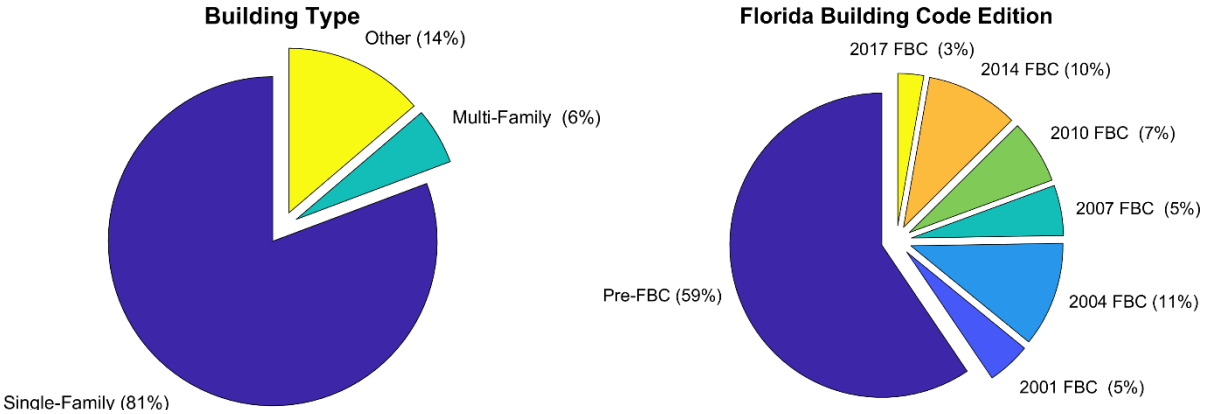

Figure 2. Distribution of (left) building type and (right) edition of the Florida Building Code to which each was constructed. Total number of assessments represented is 705.

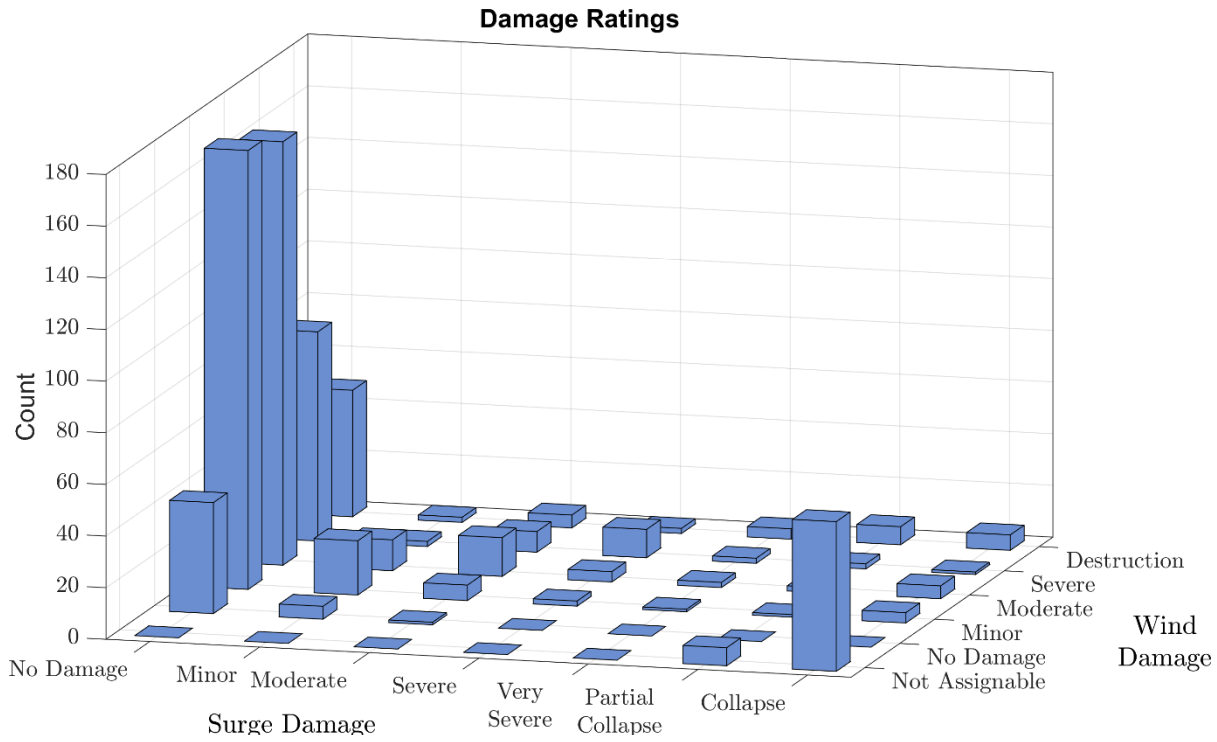

Figure 3. Assigned wind and surge damage ratings for all assessments. A “Not Applicable” wind damage rating indicates a wind damage rating could not be assigned due to complete destruction of the building induced by surge.

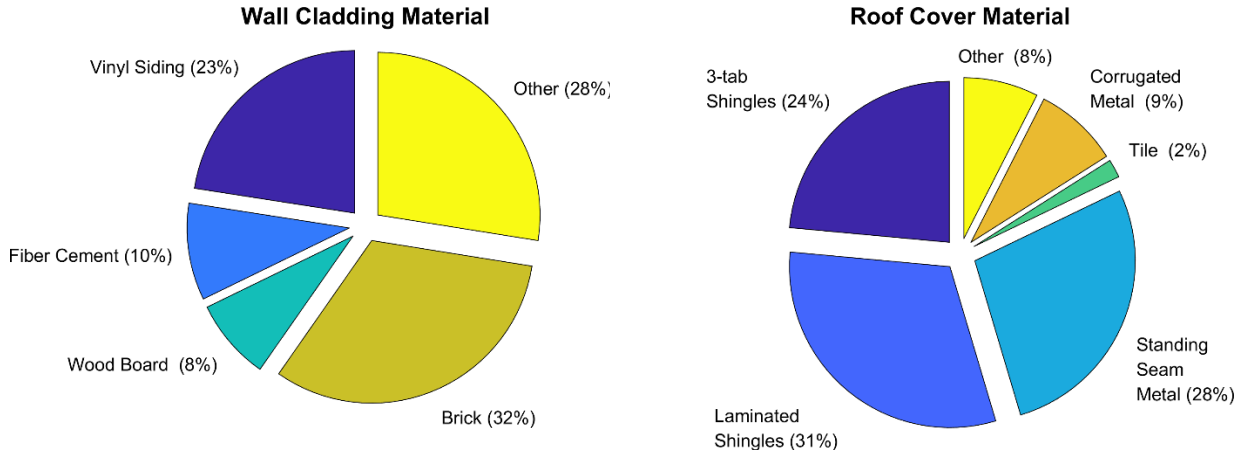

Figure 4. Distribution of (left) wall cladding material usage and (right) roof cover material usage. Multiple wall cladding materials were sometimes used in the same building.

5 REFERENCES

Prevatt, D. O., and Roueche, D. B. (2019). "Survey and Investigation of Buildings Damaged by Category-III, IV & V Hurricanes in FY 2018-2019 - Hurricane Michael." Florida Department of Business and Professional Regulation, Tallahassee, Florida.