

Interim Report:

**Investigation of Optional Enhanced Construction Techniques for the
Wind, Flood, and Storm Surge Provisions of the Florida Building Code**
Project #: P0091032

Submitted to:

**Florida Department of Business and Professional Regulation
with Building a Safer Florida, Inc.**

Mo Madani, Program Manager
Building Codes and Standards
1940 North Monroe Street
Tallahassee, Florida 32399

Prepared by:

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

Report No. 01-19
30 October 2019

T. Eric Stafford
T.E. Stafford & Associates

Rebecca Quinn
RCQuinn Consulting, Inc.

Peter Vickery, PhD
Applied Research Associates

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.

EXECUTIVE SUMMARY

This research led by the University of Florida in coordination with several other groups will provide the latest knowledge available for evaluating enhance building construction provisions for Storm surge and floods and extreme wind conditions generated by hurricanes in Florida. The recommendations will be based upon site-specific hazard risk maps developed for the coastal counties. This interim report outlines the scope of work, and the approach to be taken by the three respective consultants, ARA, RCQuinn and Stafford.

TABLE OF CONTENTS

| | |
|--|------------|
| Executive Summary | iii |
| 1 Overview and Scope of Work | 7 |
| 2 Background | 7 |
| 3 Goals | 8 |
| 4 Motivation and Purpose | 8 |
| 5 Relevant Sections of the Code (& related documents) | 10 |
| 6 Site Specific Hazards Tasks: | 12 |
| 7 Optional ENHANCED Storm surge and Flood Provisions: | 13 |
| 8 Optional ENHANCED WIND HAZARD Provisions: | 15 |
| Appendix A. (DRAFT) 10-30-2019 Enhanced Building Code Provisions for Flood and Storm Surge (RCQuinn) | 17 |
| Appendix B. Enhanced Building Construction Matrix (Stafford) | 18 |

List of Figures

Figure 1. – Exceedance probability curve for single - family dwellings in Florida, as modeled by the RMS® U.S. Hurricane Model (Young, 2009)..... 9

Figure 2. – Timeline of 30 years Hazard Mitigation 9

1 OVERVIEW AND SCOPE OF WORK

The Division of Business and Professional Regulation on behalf of the Florida Building Commission contracted with the University of Florida, Engineering School of Sustainable Infrastructure and Environment (ESSIE) shall review the literature on the 2007 Florida Legislature bills on wind protections revising specific Building Code provisions. The intent of this research is to compare current building code provisions of the 2017 Florida Building Code, with stipulations and guidelines developed by Applied Research Associates and others.

The project will be led by David O. Prevatt, Associate Professor of Civil Engineering. There are three consultants who have agreed to contribute their knowledge to this research project, listed below:

- Dr. Peter Vickery, Applied Research Associates, Raleigh, NC (Site-specific hazard risks)
- Rebecca Quinn, RCQuinn Consulting, Inc. (Flood and Storm Surge Hazards)
- T. Eric Stafford, T.E. Stafford & Associates (Extreme Wind Hazards)

2 BACKGROUND

In 2007 the Florida State Legislature passed a number of bills revising specific Building Code Provisions to enhance the wind protections of structures (FBC, 2007). The provisions established a voluntary Code-Plus guide to increase the hurricane resistance of buildings. The University of Florida and Applied Research Associates developed insurance qualifying criteria for buildings located within 2,500 ft of the coast (Applied Research Associates, Inc., 2008). The Code-Plus recommendations were simple, understandable and easily communicated and it included three modifications:

- Single wind speed per county based on a 500-year recurrence interval hurricane,
- High Velocity Hurricane Zone protection for wind-borne debris, and
- Building elevations based on FEMA 500-year recurrence interval hurricane flood elevations.

3 GOALS

The goals of this research are the following:

1. Review the prior Code-Plus stipulations and guidelines and compare the effectiveness of previous provisions in the reviewed documents against current Building Code provisions.
2. Extract and analyze data from the data set of building observations made during Hurricanes Irma and Hurricane Michael studies and create a subset of structures built to Code-Plus provisions.
3. Develop and present recommendations to the FBC for a Codes-Plus Provisions for Florida in order to explicitly provide an enhanced construction option to the Florida Building Code.

4 MOTIVATION AND PURPOSE

Providing Florida residents with enhanced design options for their houses can be another provision to guide building owners and address the current and future risks of hurricane related building damage. The public in many cases misunderstand that building code provisions represent only a minimum standard and as consumers and owners of their property, that they are at liberty to build to higher standards. By explicitly providing an enhanced construction option the Building Code, as it has been done in 2013 by Georgia State (Georgia State IRC, 2013), could serve to change that erroneous perception.

In 2018 the US Census Bureau estimates that Florida has just over 9.5 million single-family residential houses and 4.9 million of those houses (as of 2009) are considered vulnerable to extreme winds, because they were built before implementation of the Florida Building Code in 2002.

Building to higher standards has benefits of reducing the vulnerability of a structure and potentially reducing or minimizing wind or storm surge damage. Figure 1 illustrates how rebuilding all of the single-family dwellings in Florida to a more stringent building construction standard, such as the IBHS FORTIFIED Home (IBHS, 2019) and FORTIFIED Commercial (IBHS, 2019) programs, can reduce risk.

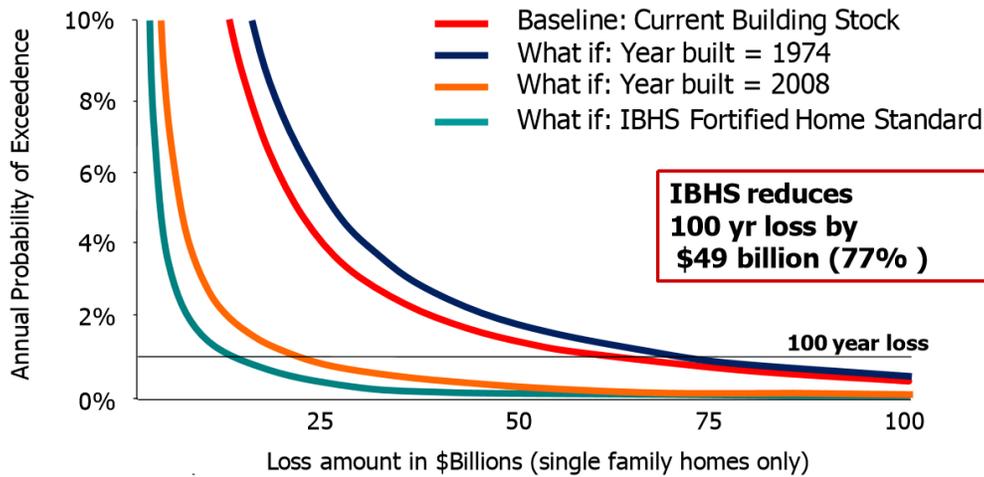


Figure 1. – Exceedance probability curve for single - family dwellings in Florida, as modeled by the RMS® U.S. Hurricane Model (Young, 2009)

Research at state and federal levels has shown substantial benefits of strengthening houses; in one study for one dollar (\$1) spent on structural retrofit a homeowner may benefit by the avoidance of up to \$6 dollars in future storm damage (National Institute of Building Science, 2019).

According to (FEMA, 2019), the total number of properties mitigated through Hazard Mitigation Assistance grants exceeds 138,000.

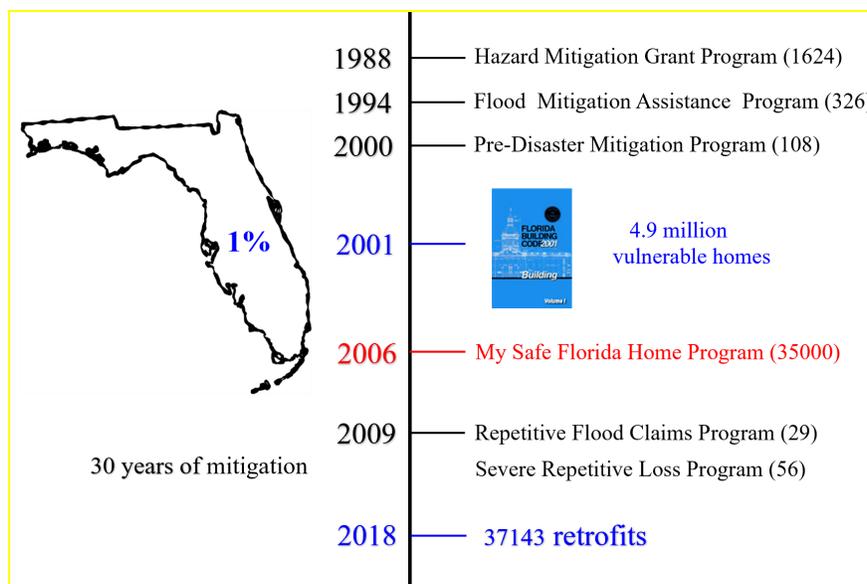


Figure 2. – Timeline of 30 years Hazard Mitigation

This proposal reviews the prior Code-Plus stipulations and guidelines that were developed by Applied Research Associates, and IBHS and implemented by the Florida Building Commission in or around 2007. New data set of building observations made during Hurricanes Irma and Hurricane Michael studies will be used to create a subset of structures built to Code-Plus provisions. Based on the analyzes of the performance of the Code-Plus houses against a group of similar houses that were subject to the same wind speeds the new recommendations to the FBC for a Codes-Plus Provisions for Florida will be developed and presented.

5 RELEVANT SECTIONS OF THE CODE (& RELATED DOCUMENTS)

- 2017 Florida Building Code - Building, Six Edition: Chapters 14-20, 22-26, 31, 35 (FBC, 2017).
- 2017 Florida Building Code - Residential, Six Edition: Chapter 44 (FBC, 2017).
- 2017 Florida Building Code - Test Protocols for High Velocity Hurricane Zone (FBC, 2017).

Related Documents

- Applied Research Associates, Inc. (2008). "2008 Florida Wind Loss Mitigation Study", ARA Final Report 18401, Version 1.11, Florida Office of Insurance Regulation, Contract Number IR018, Florida, October. (Applied Research Associates, Inc., 2008)
- Applied Research Associates, Inc. (2002a). "Development of Loss Relativities for Wind Resistive Features of Residential Structures," Florida Department of Community Affairs, Tallahassee, Florida, March. (Applied Research Associates, Inc., 2002a)
- Applied Research Associates, Inc. (2002b). "Development of Loss Relativities for Wind Resistive Features of Residential Buildings with Five or More Units," Florida Department of Community Affairs, Tallahassee, Florida, March. (Applied Research Associates, Inc., 2002b)
- FORTIFIED Home, FORTIFIED for Safer Living (existing & new construction): Fortified Home Hurricane Standards (IBHS, 2019).
- FORTIFIED Commercial, FORTIFIED for Safer Business: Fortified Commercial Hurricane Standards (IBHS, 2019).
- Federal Alliance for Safe Homes (FLASH) Blueprint for Safety (Federal Alliance for Safe Homes, Inc., 2010).
- Set of code-plus recommendations to increase the tornado resistance of wood-framed dwellings developed by Simpson Strong-Tie Company, Inc. (Simpson Strong-Tie Company, Inc., 2015)
- Federal Emergency Management Agency

- FEMA Successfully Retrofitting Buildings for Wind Resistance – Hurricane Michael in Florida Recovery Advisory 1, 1 June 2019; FL-RA1
- FEMA Best Practices for Minimizing Wind and Water Infiltration Damage – Hurricane Michael in Florida – Recovery Advisory 2, 2 June 2019 FL-RA2
- Other Documents Potentially for consideration?
 - FEMA p-55
 - FEMA P-424
 - FEMA P499
 - FEMA MAT Reports (2017 and 2018)
 - Florida
 - Texas
 - US Virgin Islands
 - Puerto Rico

6 SITE SPECIFIC HAZARDS TASKS:

The scope of ARA's work is delineated in their proposal:



September 18, 2019

David O. Prevatt, Ph.D., PE (MA)
Associate Professor
Eng. School Sustainable Infrastructure and Environment
University of Florida
365 Weil Hall, Gainesville, FL 32611

Dear David:

In this effort, ARA will provide hurricane wind speeds at one location in each of the 63 Counties in the State of Florida. The locations will be provide by the University of Florida. Wind speeds will be given for return periods of 50, 100, 300, 700, 1,700 and 3,000 years. All wind speeds will be produced using ARA's hurricane simulation model updated to include all storms though 2018.

A brief report outlining the approach used to develop the wind speeds will be presented, along with comparisons to the wind speeds given in the current version of ASCE as given by the ATC Hazards by Location tool (<https://hazards.atcouncil.org/>). The study will be completed within one month of authorization to proceed. The work will be performed for a firm fixed price of \$17,000.00

Sincerely,

Peter J. Vickery, Ph.D., PE
Principal Engineer

Outline

1. Introduction
2. Hurricane Simulation Model Overview
3. Updates to Changes to Hurricane Simulation Model Since ASCE 7-16
4. Predictions of Hurricane Induced Wind Speeds at Key Locations in Coastal Counties

IntraRisk Division
8537 Six Forks Road, Suite 600 • Raleigh, NC 27615-2963
Ph: (919) 582-3400 • Fax: (919) 582-3401

7 OPTIONAL ENHANCED STORM SURGE AND FLOOD PROVISIONS:

The scope of RCQuinn Consulting Inc. (RCQuinn) work is appended their 13 September 2019 proposal, below:

RCQUINN CONSULTING, INC.

NFIP Rebecca C. Quinn, CFM
104 4th St. NE, #2
Charlottesville, VA 22902-5200
434.296.1349 ■ fax 320.514.3513
rcquinn@earthlink.net
CODES
PLANNING www.RCQuinnConsulting.com
MITIGATION

September 13, 2019

David O. Prevatt, Ph.D., PE (MA)
Engineering School Sustainable Infrastructure and Environment
University of Florida
365 Weil Hall
Gainesville, FL 32611

RE: Investigation of Optional Enhanced Construction Techniques for the
Wind, Flood, and Storm Surge Provisions of the Florida Building Code

Dr. Prevatt:

Enclosed please find the proposed scope of work and level of effort and cost estimate for my contributions to the referenced investigation.

Sincerely,



Rebecca C. Quinn
RCQuinn Consulting, Inc.

MITIGATION ■ NFIP ■ CODES ■ PLANNING

September 13, 2019

RE: Investigation of Optional Enhanced Construction Techniques for the Wind,
Flood, and Storm Surge Provisions of the Florida Building Code

SCOPE OF WORK

The following is based on the document titled <Final SOW showing changes_08-28-19.docx>. To support the referenced project, RCQuinn will:

1. Review literature identified by DBPR and FLASH and other publications pertinent to flooding in Florida.
2. Identify, review and summarize recent reports and publications that relate damage caused by flooding to requirements for the design and construction of buildings in flood hazard areas, notably Mitigation Assessment Team reports published by FEMA after Hurricanes Irma and Michael, the 2004 hurricanes in Florida, and Hurricane Sandy in New York and New Jersey.
3. Review previous reports (“datasets”) prepared by the University of Florida with regard to content pertinent to structures damaged by flooding/storm surge.
4. Prepare a brief summary of the flood provisions in the FBC and how those requirements have changed since the 2010 edition. For the most part, the changes originated in the International Codes. This content is readily available in existing publications.
5. Conduct a limited search for ways states and communities have “enhanced” requirements for buildings in locations exposed to flooding, especially coastal locations exposed to storm surge flooding. FEMA and the Association of State Floodplain Managers produce publications describing the benefits of strengthening regulations.
6. Contribute to interviews of building officials and contractors.
7. Develop and present options for enhancing the flood provisions of the FBC, with descriptions and summaries of available information on the benefits and costs of each option. A joint FEMA-International Code Council publication describes recommendations and offers code change language for the most common code amendments to strengthen codes.

LEVEL OF EFFORT AND COST ESTIMATE

Not to exceed 90 hours at \$175/hour for a maximum of \$15,750.

8 OPTIONAL ENHANCED WIND HAZARD PROVISIONS:

The scope of T.E. Stafford and Associates (Stafford) is delineated in their 22 October 2019 proposal, shown below:



October 22, 2019

To: David Prevatt
University of Florida

From: T. Eric Stafford ✓
T. Eric Stafford & Associates, LLC

Re: Investigation of Optional Enhanced Construction Techniques for the Wind, Flood,
and Storm Surge Provisions of the Florida Building Code

This letter serves to acknowledge that T. Eric Stafford agrees to serve as a consultant to the University of Florida on the project to develop optional enhanced construction techniques for the wind, flood, and storm surge provisions of the Florida Building Code. It is my understanding I will be developing criteria for enhanced construction techniques for buildings that would reduce damage to buildings from hurricane wind loads and water intrusion due to wind driven rain. To develop the criteria, I will perform the following tasks:

- Compare the strength of the wind requirements in the literature identified by DBPR, BASF, and its staff with the Florida Building Code, 6th Edition (2017)'s wind requirements.
- Compare the wind requirements in the literature with any changes to the wind requirements for the Florida Building Code, 7th Edition (2020).
- Develop and present voluntary options for enhanced construction techniques related to the wind provisions of the Florida Building Code.

My hourly rate is \$175.00/hr. I anticipate this project to take 115 hours for a total cost of \$20,125.00.

Sincerely,

A handwritten signature in black ink that reads "T. Eric Stafford".

T. Eric Stafford, PE

2038 Club Road • Birmingham, AL 35244
205-987-9034 • 205-985-4375 (fax)

APPENDICES

**Appendix A. (DRAFT) 10-30-2019 Enhanced Building Code
Provisions for Flood and Storm Surge (RCQuinn)**

DRAFT AS OF 10/30/19

TEXT ITALICIZED AND HIGHLIGHTED IS PLACEHOLDER

ENHANCED CODE PROVISIONS FOR FLOOD AND STORM SURGE

Contents

1 Rationale for Enhancing Building Code Requirements for Flood and Storm Surge..... 2

1.1 Increasing Resiliency of Florida’s Communities..... 2

1.2 Anticipated Impacts that Affect the Design of Buildings..... 4

2 Flood/Storm Surge Requirements in the FBC..... 7

2.1 History of the Flood Provisions in the FBC 7

2.2 Characteristics of Compliance 7

2.3 Compare the Flood Provisions: 6th Edition and 7th Edition..... 9

3 Options for Enhanced Code Requirements 10

3.1 *Brief on research (refer to appendix)* 10

3.2 Options for Enhanced Design and Construction Techniques 11

4 References 12

Appendix A..... 13

History of the Flood Provisions in the FBC, From the 2010 FBC Through the 7th Edition (2020)..... 13

Appendix B..... 14

Model Language for Enhanced Code Provisions - Flood and Storm Surge..... 14

1 RATIONALE FOR ENHANCING BUILDING CODE REQUIREMENTS FOR FLOOD AND STORM SURGE

PLACEHOLDER NOTES

FEMA maps are 'snapshots' in time, at best reflecting past flood events and conditions as of a few years before the date of the published effective map. Don't get revised to incorporate more recent events, so the lacking

Codes affect design (how to build), not where and what to build (zoning has a role in planning for increased flooding)

Existing requirements only apply in mapped flood hazard areas: limitations of FEMA FIRMs)

FBC: FLOOD or FLOODING. A general and temporary condition of partial or complete inundation of normally dry land from: (1) The overflow of inland or tidal waters. (2) The unusual and rapid accumulation or runoff of surface waters from any source.

somewhere: SFHA not equivalent to storm surge predictive

1.1 Increasing Resiliency of Florida's Communities

Many organizations publish about climate change and sea level rise in Florida, including contributing factors, impacts and options.

The University of Florida Sea Grant Florida web site summarizes the situation and identifies pertinent reports as follows:

The incidence of flooding in our coastal areas has increased dramatically over the past decades, as cataloged in [the report titled "Sea Level Rise and Nuisance Flood Frequency Changes around the United States,"](#) from the National Oceanic and Atmospheric Administration and the report titled "[When Rising Seas Hit Home,](#)" from the Union of Concerned Scientists. And the trend of increasing sea-level rise will continue, as indicated by the [Unified Sea Level Rise Projection](#) of the Southeast Florida Climate Compact, the [Recommended Projection of the Sea Level Rise in the Tampa Bay Region](#) by the Tampa Bay Climate Science Advisory Panel, [Global and Regional Sea Level Rise Scenarios for the United States](#) by the National Oceanic and Atmospheric Administration, a short paper by geologist Dr. Hal Wanless called [The Coming Reality of Sea Level Rise: Too Fast Too Soon,](#) and many other sources. [<http://www.flseagrant.org/climate-change/sea-level-rise/>; accessed October 22, 2019]

The Sea Level Solutions Center at the Florida International University, in a 2019 report prepared for the Florida Building Commission states:

Sea Level Rise (SLR), and any changes to rainfall (both averages and extremes) have the potential to increase the flood elevations in several ways. Increased

ocean levels due to sea level rise and storm surge will impact the efficiency of water control structures along the coast, primarily due to low topography in places such as Miami-Dade County. Potential increase in extreme rainfall will not only increase flood levels but also rain loads on buildings. Finally, rising water tables due to sea level rise and porous geology will increase the runoff volumes due to the decrease in storage typically available above the shallow water table.

The Office of Resilience and Coastal Protection Programs in the Florida Department of Environmental Protection is an umbrella for several initiatives, notably the Florida Resilient Coastlines Program to “prepare Florida’s coastal communities and habitats for the effects of climate change, especially rising sea levels.” The Florida Adaptation Planning Guidebook (2018) illustrates a road map taking communities through vulnerability assessment, adaptation planning, and implementation. This approach supports local jurisdictions’ efforts to respond to the requirements of the 2015 “Peril of Flood” Statute (sec. 163.3178(2)(f) 1-6, F.S.). The redevelopment component of the coastal management planning element are must, among other requirements:

- Identify site development techniques and best practices that may reduce losses due to flooding and claims made under flood insurance policies issued in this state.
- Be consistent with, or more stringent than, the flood-resistant construction requirements in the Florida Building Code and applicable flood plain management regulations set forth in 44 C.F.R. part 60.
- Require that any construction activities seaward of the coastal construction control lines established pursuant to s. 161.053 be consistent with chapter 161.

A growing body of work identifies adaptation approaches to sea level rise, including calls for changes in long-term planning and zoning, transportation and infrastructure adjustments, public awareness and involvement, and measures that would influence where to build (e.g., setbacks, habitat conservation). For example, Sea Grant Florida provides access to several studies online at <https://www.flseagrant.org/climate-change/coastalplanning/resources/policy-tools/>.

And, in recent years, some states, communities and nonprofit organizations engaged in adapting to changing conditions, specifically as those conditions affect changes in flooding, are identifying options that influence how to build to increase resiliency. FEMA

and others have long promoted a variety of options to increase resiliency of the built environment to flood conditions. Section 3 of this paper briefly describes reasonable and feasible options that could be incorporated in the Florida Building Code, or that could be adopted as local amendments to the FBC.

1.2 Anticipated Impacts that Affect the Design of Buildings

Changes in the coastal floodplain may be the most obvious result of rising sea levels, but climate changes are predicted to change in rainfall patterns, resulting in some areas experiencing more frequent and more intense storms, while other areas may have overall reduction in rainfall. These changes will change inland riverine floodplains and exacerbate poor drainage from low-lying areas.

Anticipated impacts that affect how buildings are designed include:

- **Increasing frequency and severity of coastal storms.** Tropical storms are expected to be, on average, more intense and storms with damaging winds and storm surge are expected to occur more frequently.
- **Increasing frequency and intensity of rainfall events.** Freshwater flooding from rainfall affects not only streams and rivers, but low-lying, poorly drained areas. Large parts of Florida have very flat topography, which means accumulation of rainfall on the ground surface.
- **Deeper flooding.** Because of increasing frequency and intensity of storms, future flooding with the same recurrence interval (1% annual chance) is expected to rise higher than shown on FEMA Flood Insurance Rate Maps (FIRMs).
- **Larger areas will be affected by flooding.** Using the FIRM parameters, the base flood (1 % annual chance flood) will inundate larger areas. Whether along streams or shorelines, the inland boundary of Zone A will move inland (see Figure XXXX).

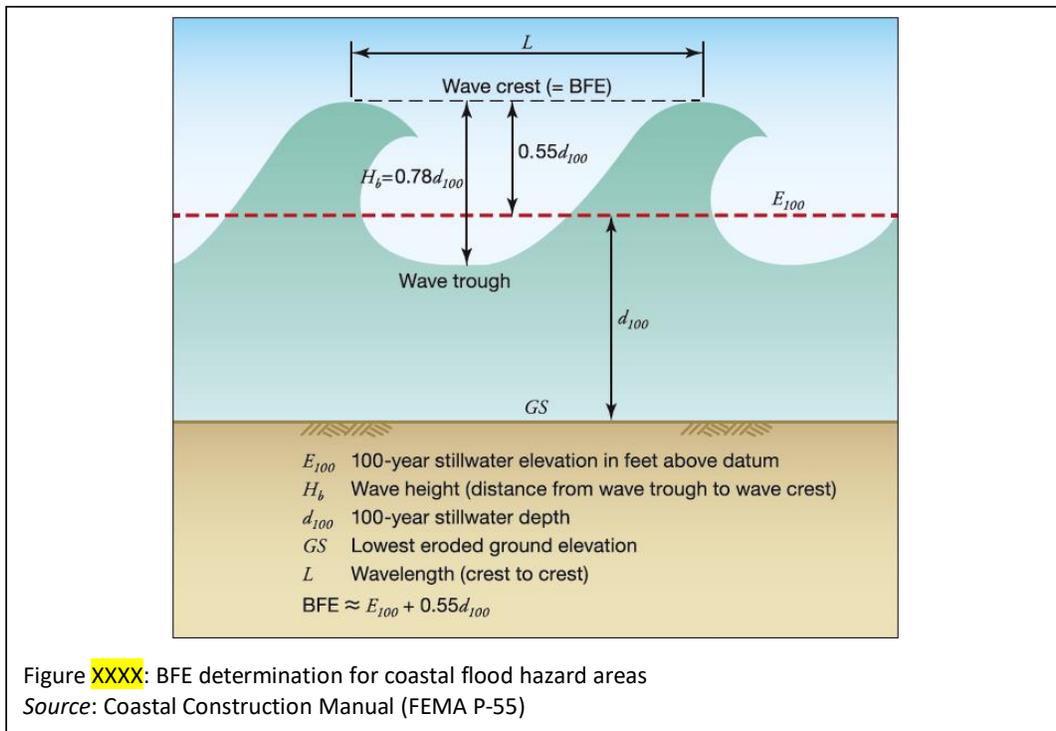
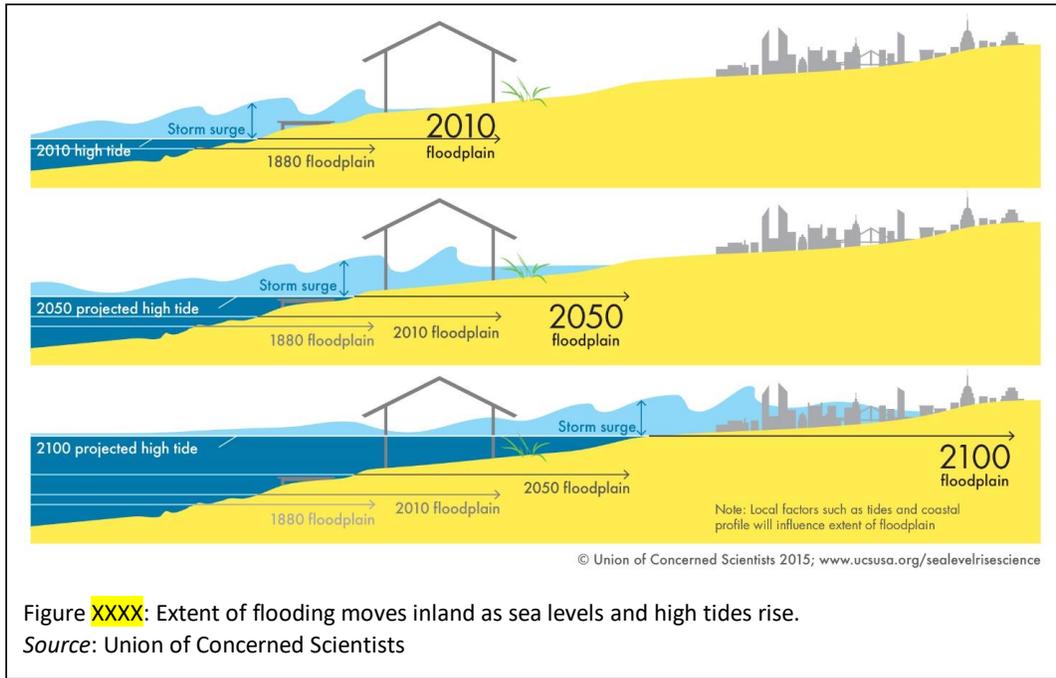
1% Annual Chance Flood, the Base Flood. The “base flood” is used by FEMA to produce FIRMs used by communities to regulate flood hazard areas. FIRMs are “snapshots” in time, reflecting conditions as of the time the studies were done. FIRMs do not show future conditions associated with increasing frequency and severity of coastal and inland storms.

Today’s base flood, and the base flood elevations used to delineate special flood hazard areas, underestimate future flood risk.

FEMA works with communities that elect to study and depict future conditions on FIRMs, <https://www.fema.gov/final-guidelines-using-future-conditions-hydrology>

- **Higher waves.** Wave height is a function of stillwater depth, with wave heights approximately have as high as stillwater depths (see Figure XXXX). Thus, the deeper the flooding, the higher the waves. Just one additional foot of stillwater depth adds nearly 7 inches of waves.
- **Boundary between Zone V and Zone A will move inland.** Deeper flooding and higher waves changes the physical location where wave heights drop below 3 feet, the point at which FEMA delineates the inland extend of Zone V. For the same reason, the location of the Limit of Moderate Wave Action, where wave heights drop below 1.5 feet, will move inland.
- **Increased scour and erosion.** Although many factors influence scour and erosion, increased frequency and intensity of storms is expected to increase the rate of shoreline changes, lowering beach profiles, and scour at building foundations.
- *Freshwater runoff (rivers, local drainage) blocked during high-high tides – graphic*
- *FIU's groundwater effects in some areas.*

Commented [RQ1]: maybe too technical



2 FLOOD/STORM SURGE REQUIREMENTS IN THE FBC

2.1 History of the Flood Provisions in the FBC

Editions of the FBC that predate the 2010 FBC did not include the flood provisions from the I-Codes because those provisions were explicitly removed. With funding and technical support from FEMA Headquarters and FEMA Region IV, the Florida Division of Emergency Management asked the Florida Building Commission to appoint a flood standards workgroup to develop recommendations for integrating the I-Code flood provisions into the FBC. As a result, the 2010 FBC included requirements for buildings in flood hazard areas. Also see a brief history of the flood provisions in the Florida Building Code in *Mitigation Assessment Team Report: Hurricane Irma in Florida* (FEMA P-2023).

Each edition of the FBC subsequent to 2010 includes flood provisions from the underlying model I-Codes, with some Florida-specific amendments carried forwarded. FEMA deems the flood provisions in the 2018 and 2015 I-Codes to meet or exceed the National Flood Insurance Program (NFIP) minimum requirements for buildings in flood hazard areas. Thus, the flood provisions of the 6th Edition FBC (2017) and the 7th Edition FBC (2020) also meet or exceed the NFIP minimums. Florida communities rely on the FBC and locally adopted floodplain management regulations to meet the requirements for participation in the NFIP. Many Florida communities adopt local amendments to the flood provisions of the FBC to incorporate more restrictive requirements, pursuant to sec. 553.73(5), F.S.

Appendix A traces the history of the flood provisions in the FBC, from the 2010 FBC through the 7th Edition (2020).

Commented [RQ2]: prepared but not included in 10/30/19 draft. It is in chart form and shows FL-specific amendments and model code amendments

2.2 Characteristics of Compliance

This summary of the defining characteristics of compliance for new buildings and existing buildings in SFHAs does not capture every element in the FBC. The DEM State Floodplain Management Office posts excerpts of the flood provisions of the FBC at <https://www.floridadisaster.org/dem/mitigation/floodplain/> (Community Resources).

New Buildings. Defining characteristics of compliant new buildings:

- Lowest floors (a defined term) are be elevated at or above BFE plus 1 foot in Zone A/AE, and the bottom of lowest horizontal structural members of lowest floors are at or above BFE plus 1 foot in Zone V/VE and Coastal A Zones, if Limit of Moderate Wave Action delineated. Higher elevations are required for more important occupancies (Flood Design Class 4, assigned in accordance with ASCE 24).
- Foundations resist flood forces; in Zone V/VE, CAZ, and floodways, foundations are designed by registered design professionals and designs must be certified.
- Enclosures below elevated buildings are not occupied, are used only for parking, storage and building access, and have flood openings (all zones); walls of enclosures below elevated buildings are breakaway walls in Zone V/VE and Coastal A Zones.
- Flood damage-resistant materials are used below the required elevation.
- Equipment and machinery are elevated to or above the required elevation.
- In Zone A/AE, nonresidential buildings may be designed to be watertight (dry floodproofed) if properly designed for specific locations; Florida permits dry floodproofing in Coastal A Zones if wave loads, scour and erosion are accounted for in the design.

Existing Buildings. Compliance requirements are triggered by improvements or repairs:

- Nonconforming buildings in flood hazard areas are allowed to remain until proposed improvements or repairs trigger the requirement to bring the buildings into compliance with all of the requirements for new buildings. Local official determine whether proposed improvements are substantial improvement and whether damaged buildings have incurred substantial damage.
- The triggers, sometimes called the “50 percent rule,” are:
 - Substantial improvement, which is when the cost of improvements (alterations, renovations, additions) equals or exceeds 50 percent of the market value of the building before the improvements are made.
 - Substantial damage, which is when the cost to repair a building damaged by any cause (flood, wind, fire, earthquake, neglect, etc.) to its before-damaged condition equals or exceeds 50 percent of the market value of the building before the damage occurred.

- Historic structures may be repaired or improved without strict adherence to new building requirements if the work will allow the structures to retain the historic designation.

2.3 Compare the Flood Provisions: 6th Edition and 7th Edition

Some of the flood provision changes between the 6th Edition and 7th Edition FBC flow from changes to the underlying International Codes, while others add new Florida-specific amendments. Previous Florida-specific amendments for flood resistant construction are retained (see Appendix A).

- New Florida-specific amendments:
 - FBC, Building – modify ASCE 24 to permit equipment serving pools be below the required elevation provided the equipment is elevated to the extent practical, is anchored to prevent floatation and resist flood loads, and is supplied by branch circuits that have ground-fault circuit interrupter protection.
 - FBC, Building – add a new Section 3115 to specify limits to allow public use restrooms in flood hazard areas below the base flood elevation (same provisions will be in the 2021 IBC).
 - FBC, Residential – modify requirements for equipment to permit equipment serving pools be below the required elevation provided the equipment is elevated to the extent practical, is anchored to prevent floatation and resist flood loads, and is supplied by branch circuits that have ground-fault circuit interrupter protection.
- New I-Code amendments [reason statements justifying the residential code changes are included in the noted ICC code change proposals]:
 - Update to the 2014 edition of ASCE 24, Flood Resistant Design and Construction.
 - FBC, Residential – add requirements for concrete slabs in Zone V and Coastal A Zone (CAZ). [ICC code change RB160-16.]
 - FBC, Residential – add requirements for stairways and ramps in Zone V and Coastal A Zone (CAZ). [ICC code change RB161-16.]
 - FBC, Residential – add requirements for decks and porches in Zone V and Coastal A Zone (CAZ). [ICC code change RB162-16.]

3 OPTIONS FOR ENHANCED CODE REQUIREMENTS

3.1 Brief on research (refer to appendix)

Finish reviewing pubs and ID options; some may change; maybe put more detail in an appendix (also looked at NC & MA)

The chart will then show which ones recommend which options.

Commented [RQ3]: about halfway through

| | Supplement Flood Maps | Regulate Land Below Freeboard | Regulate CAZ to Full Zone V Requirements | Design Dwellings for Site-Specific Conditions | Build Higher (Freeboard) | Limit Enclosures Below Elevated Buildings | Limit Use of Fill to Elevate Buildings | Design Buildings in Erosion-Prone Locations to be Moveable | Sewer Backflow Prevention | Foundation Protection Where Groundwater Salinity Increasing | Accelerate Compliance of Nonconforming Buildings (CSI, RFL) |
|---|-----------------------|-------------------------------|--|---|--------------------------|---|--|--|---------------------------|---|---|
| FDEP | | | | | | | | | | | |
| FIU | | | | | | | | | | | |
| MATs | | | | | | | | | | | |
| FTF | | | | | | | | | | | |
| ASFPM1 | | | | | | | | | | | |
| ASFPM2 | | | | | | | | | | | |
| CCC | | | | | | | | | | | |
| BOS | | | | | | | | | | | |
| <p>FDEP = Florida Department of Environmental Protection, Resilient Coastlines, Florida Adaptation Guidebook FIU = Obeysekera, et al., Florida International University, Sea Level Solutions Center MATs = FEMA Mitigation Assessment Team reports (Hurricanes Irma Sandy, Irma, Michael) FTF = Hurricane Sandy Federal Task Force ASFPM = NAI How-to Guide for Regulations and Development Standards; Coastal NAI Handbook; Elected Officials Guide to Floodplain Management CCC = California Coastal Commission, Sea Level Rise Policy Guidance BOS = Boston Climate Ready Report: Resilience Initiatives</p> | | | | | | | | | | | |

3.2 Options for Enhanced Design and Construction Techniques

INCLUDE BRIEF DESCRIPTIONS HERE (maybe first briefly what FBC currently requires, so the differences stand out), CODE CHANGE LANGUAGE IN APPENDIX B

Where I can readily pull data out of DEM database of higher standards, I can indicate how many FL communities have already adopted these or similar provisions.

1. Supplemental Flood Maps (adopt of local maps to supplement FIRMs (Somerset Co, MD); proxy inland shift of SFHA boundary and A/V boundary)
2. Regulate land below freeboard elevation (ASFPM graphic)
3. Regulate CAZ to Full Zone V Requirements (eliminate dry floodproofing and stemwall)
4. Design dwellings for Site-Specific Conditions (per ASCE 24, for increased depths, greater scour, higher velocities)
5. Build Higher (Freeboard)
 - a. use 500 year, where provided
 - b. Critical facilities (FDC 3 & 4) even higher
6. Limit Enclosures Below Elevated Buildings (limit size; prohibit solid walls; less debris)
7. Limit Use of Fill to Elevate Buildings (other than stemwall, to protect site drainage)
8. Design Buildings in Erosion-Prone Locations to be Moveable (check DEP erodible shore data; Michigan?)
9. Sewer Backflow Prevention
10. Foundation Protection Where Groundwater Salinity is Increasing
11. Accelerate Increased Resistance of Nonconforming Buildings
 - a. Cumulative substantial improvement (at least 10-year)
 - b. Repetitive flood loss (substantial damage)

Commented [RQ4]: hmmm, FBC points to local ords for map adoption, so this isn't a "code enhancement". But it actually has the greatest potential, along with the next one.

Commented [RQ5]: this might also be an ordinance thing, since it is "otherwise designated"
May need to pull descriptions of these two out from this section which is about how buildings are designed

4 REFERENCES

- American Society of Civil Engineers. ASCE 24, Flood Resistant Design and Construction.
- Association of State Floodplain Managers (2017). No Adverse Impact: How-to Guide for Regulations and Development Standards. <>.
- ASFPM (20xx). Elected Officials Guide to Floodplain Management (tentative title). <publication expected by the end of the year>.
- ASFPM (2007). Coastal No Adverse Impact Handbook. <>.
- California Coastal Commission (2018). Sea Level Rise Policy Guidance. <>.
- City of Boston (). Climate Ready Report: Resilience Initiatives. <https://www.boston.gov/departments/environment/climate-ready-boston>.
- Federal Emergency Management Agency (2018). Mitigation Assessment Team Report: Hurricane Irma in Florida (FEMA P-2023). < <https://www.fema.gov/media-library/assets/documents/176315>>.
- FEMA (2011). Coastal Construction Manual (FEMA P-55). <<http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=1671>>.
- FEMA (2018). Mitigation Assessment Team Report: Hurricane Irma in Florida (FEMA P-2023). < <https://www.fema.gov/media-library/assets/documents/176315>>.
- FEMA (2019). Mitigation Assessment Team Report: Hurricane Michael in Florida (FEMA P-XXXX). <publication expected before the end of the year>.
- Florida Department of Environmental Protection (2018). “Florida Adaptation Planning Guidebook.” Florida Coastal Management Program. <https://floridadep.gov/ResilientCoastlines>.
- International Code Council and FEMA (2019). Reducing Flood Losses Through the International Codes: Coordinating Building Codes and Floodplain Management Regulations. <<http://www.fema.gov/media-library/assets/documents/96634>>.
- Obeysekera, J., Sukop, M., Troxler, T. Irizarry, M., and Rogrs, M. (2019). “Potential Implications of Sea-Level Rise and Changing Rainfall for Communities in Florida using Miami-Dade County as a Case Study.” Sea Level Solutions Center, Florida International University. <<https://slsc.fiu.edu/solutions/research-projects/florida-building-commission-project/index.html>>.
- Sea Grant Florida, University of Florida. Sea-Level Rise in Florida. <<http://www.flseagrant.org/climate-change/sea-level-rise/>>. (accessed October 24, 2019).

APPENDIX A

History of the Flood Provisions in the FBC, From the 2010 FBC Through the 7th Edition (2020).

INSERT TABLE, LANDSCAPE, 4-5 pages

APPENDIX B

Every three yearssomething about adoption by Commission, and barring that, code amendments can be locally adopted

Florida Statute governs adoption of local administrative and technical amendments to the Florida Building Code: Section 553.73 paragraph (5) pertains specifically to administrative or technical amendments to the FBC related to flood resistance; and paragraph (4) pertains more generally to local amendments.

Unlike local amendments adopted pursuant to sec. 553.73(4), sec. 553.73(5) provides that local amendments for higher standards related to flood resistance are not “rendered void” when the code is updated, provided they meet one of three criteria set forth in Sec. 553.73(5):

- if the higher standard had already been adopted by local ordinance prior to July 1, 2010;
- if the higher standard is adopted for the purpose of participating in the Community Rating System (CRS); or
- if the higher standard requires freeboard.

Florida’s CRS Communities. As of April 2019, 242 of Florida’s 467 NFIP participating communities are in the CRS. Many of those communities adopt local amendments to the FBC to increase building resistance to flooding. NFIP policy holders in those communities receive discounts on the cost of premiums ranging from 5 to 35 percent.

The Florida Division of Emergency Management, State Floodplain Management Office, provides instructions for adoption of some FBC amendments related to flood resistance, online at <https://www.floridadisaster.org/dem/mitigation/floodplain/> (Community Resources). For technical support, contact DEM at Flood.Ordinance@em.myflorida.com.

Model Language for Enhanced Code Provisions - Flood and Storm Surge

This will show using underline and strike-thru (with the 7th ed as the base) how the options would look if written into the code.

Appendix B. Enhanced Building Construction Matrix (Stafford)

FBC Enhanced Construction Matrix

T. Eric Stafford, PE

| Structural | | | | |
|-----------------------|--|---|------------------------------|-------------------------------------|
| Component | Material | Recommendation | Resource | In the 2020 FBC? |
| Wind Design | All | Comply with ASCE 7-16 | 2020 FBC | Yes |
| | Roof sheathing attachment (Commercial-FBCB) | Use ring shank roof sheathing (RSRS) nails complying with ASTM F1667 | HVHZ | No |
| | Roof sheathing attachment (Residential-FBCR) | Comply with Section R803.2 of the 7 th Edition (2020) FBCR | 2020 FBC | Yes |
| Envelope | | | | |
| Component | Material | Recommendation | Resource | In the 2020 FBC? |
| Roof Coverings | Underlayment/Sealed roof deck | Require sealed roof deck in accordance with 2020 FBC | Fortified FEMA Docs 2020 FBC | Yes |
| | Drip edge detail | Install drip edge over underlayment at eaves and rakes and attach to roof deck with ring shank nails at 4 inches on center. | Fortified | No |
| | Ridge and off-ridge vents | Require ridge and off ridge vents to be tested in accordance with TAS 100(A) | Fortified FEMA Docs HVHZ | No* |
| | Asphalt shingles | ASTM D7158 Class H | FEMA Docs | No (unless triggered by wind speed) |
| | | Use roofing cement at eaves, | Fortified FEMA Docs HVHZ | No |

| | | | | |
|-------------------------|-----------------------------|--|---|---------------------------------|
| | | rakes, hips and ridges | | |
| | Concrete and Clay Roof Tile | Mortar attachment not permitted | | |
| | | Ridge board required at hips and ridges | Fortified FEMA Docs | No |
| | | Use clips at the perimeter | FEMA Docs | No |
| | | Use stainless steel where within 3000 ft of the ocean | FEMA Docs | No |
| | Metal panel roof | Require metal panel roofs to be tested in accordance with ASTM E1592 | FEMA Docs | No (permitted but not required) |
| | Gutters | Require gutters to be tested in accordance with Test Methods G-1 and G-2 of ANSI/SPRI GT-1 | ICC proposal S17-19 | No |
| Component | | | | |
| Material | | | | |
| Recommendation | | | | |
| Resource | | | | |
| In the 2020 FBC? | | | | |
| Wall Coverings | General | Delete the criteria of Chapter 14 of the FBCB and Chapter 7 of the FBCR that deems walls constructed according to the masonry chapter and concrete chapter requirements to be weather resistant. | HRAC Recommendation | No |
| | Vinyl Siding | Revise vinyl siding required design pressures such that the PEF is 0.8. (Note: | IBHS – Wind Loads on Components of Multi-Layer Wall Systems with Air- | No |

| | | | | |
|--|---------------------|---|---|----|
| | | <p>factors will differ from 2017 and 2020 FBC as the PEF factor has changed in the 2020 FBC.</p> <p>2017 FBC Vinyl siding design wind pressure ratings = required design wind pressure x 2.22</p> <p>2020 FBC Vinyl siding design wind pressure ratings = required design wind pressure x 1.6</p> | Permeable Exterior Cladding – Full Scale Wind Tunnel Test | |
| | Fiber cement siding | Require fiber cement siding to be face nailed | FEMA Docs | No |
| | Stucco | Mass wall provisions from 2007 FBCR | 2007 FBCR | No |
| | | Improve drainage of stucco over wood-frame assemblies by requiring 2 layers of WRB and a dedicated drainage space | 2007 FBC (partial) | No |
| | | Also review RB242-19 | | |
| | Brick veneer | Require 8d ring shank nails for attaching ties to wood framing for anchored masonry veneer. | FEMA Docs | No |
| | | Modify tie spacing based on FEMA P499. | FEMA Docs | No |

| Component | Material | Recommendation | Resource | In the 2020 FBC? |
|----------------|-------------------------------|---|---------------------|------------------|
| Soffits | Wood structural panel soffits | Prescriptive attachment method for wood structural panel soffits | FEMA Docs | Yes |
| | Vinyl | New figures clarifying that vinyl soffits have to be fastened at both ends. | FEMA Docs Fortified | Yes |
| | | Require vinyl soffits to be tested to TAS 100(A) | FEMA Docs | No (yes in HVHZ) |
| | All other soffits material | Require all soffits to be tested to TAS 100(A) | FEMA Docs | No (yes in HVHZ) |

| Component | Material | Recommendation | Resource | In the 2020 FBC? |
|-----------|----------|----------------|----------|------------------|
|-----------|----------|----------------|----------|------------------|

| Windows and Doors | | | | |
|--------------------------|-----|---|-----------|----|
| Windows | All | Install compression-type windows – awnings and casements | UF | No |
| | | Specify windows with a Performance Grade (PG) of AW (tested at 20% of DP) | FEMA Docs | No |
| Doors | All | Require all hinged doors to be tested for water penetration at 20% of DP. | FEMA Docs | No |

| Component | Material | Recommendation | Resource | In the 2020 FBC? |
|-----------|----------|----------------|----------|------------------|
|-----------|----------|----------------|----------|------------------|

| Wind-borne Debris | | | | |
|--------------------------|------------------|--|--------------------------|----|
| Walls | Wood-frame walls | Require all wood-frame walls to be sheathed with | IBHS-Fortified FEMA Docs | No |

| | | | | |
|------------------|------------------|---|---|--|
| | | minimum 7/16" wood structural panel | | |
| Glazed openings | All | Require all glazed openings to be impact-resistant or protected with an impact protective device | IBHS-Fortified FEMA Docs HRAC recommendations | Yes (but only for buildings located in the WBDR or HVHZ) |
| Exterior doors | All | Require all exterior doors to be impact resistant | FEMA Docs | No (only those with glazing) |
| Garage doors | All | Require all garage doors to be impact resistant | FEMA Docs | No (only those with glazing) |
| | Component | Recommendation | Resource | In the 2020 FBC? |
| Other | | | | |
| Porches/Canopies | All | Require all porches and canopies that are not part of a roof overhang to be designed in accordance with the attached canopies provisions of ASCE 7-17 | ASCE 7-16 | Yes |

*Required in the HVHZ