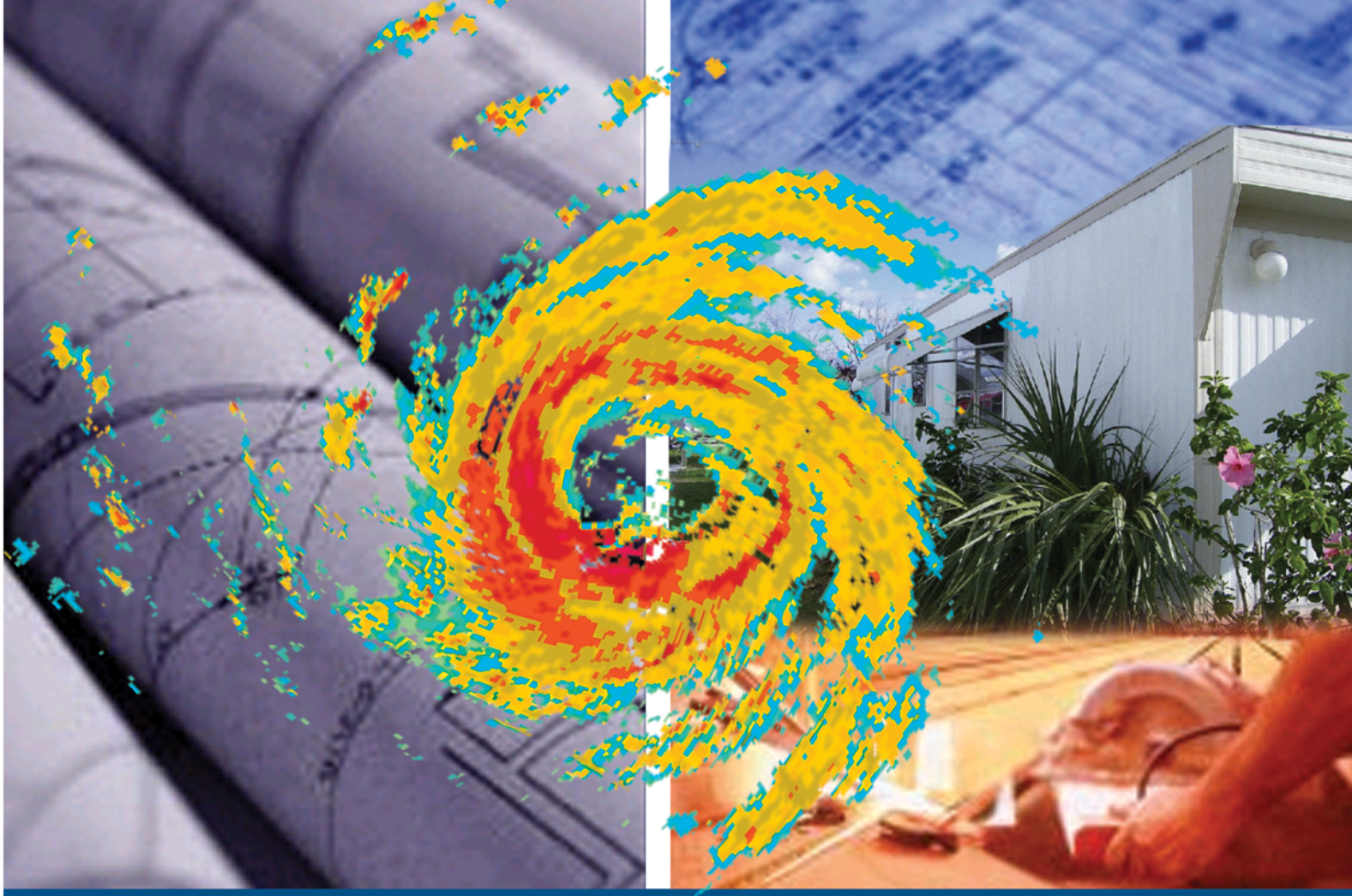

Hurricanes' Impact on Florida's Building Codes & Standards

We Have Been Given A Wake Up Call

Developed by FEMA, Mitigation Section, Technical Services Branch
DR-1539 / 1545 / 1551 / 1565 - Orlando - LTRO

FEMA

June 2005

TABLE OF CONTENTS

Introduction iii

Background 1

Cumulative Damages 1

Hurricane Assistance 2

Critical and Essential Facilities 3
Existing Codes for Critical and Essential Facilities 3

Observations 3
Critical and Essential Facilities 3
Building Performance 3
Structural 4
- Manufactured Housing 6
- Accessory Structures 6
- Building Envelope 6
- Soffit 6
- Doors 7
- Windows and Shutters 7
- Foundations and Structures 7

Recommendations 8
Critical and Essential Facilities 8
- General: Hurricane shelters and EHPA 8
- General: Minimum debris impact protection 8
- General: Alternative for designing shelters 8
- General: Process of development 8

Building Performance 8
Building Envelope Components 9
- Edge flashing and coping 9
- Gutters 9
- Ridge vents 9
- Metal panel roof systems 9
- Asphalt shingles 9
- Mortar, set tile roof system 9
- Build up roof 9
- Roof system 9

Soffits 9
Windows and Shutters 9
Shutters 9
Windborne debris region 9
Exterior Equipment 11
General 11
Flood Hazard 11
General 11
Code 11

Pending Changes to the FBC/Certification 11

Recommendations beyond Codes 11

Guidance 12
Design Guidance 12
Testing 12
Construction 12

Education 12

Conclusion 13

Visual References 14

Abbreviations and Acronyms 16

Glossary 16

References and Resources 18

Introduction

Florida endured four hurricanes and one tropical storm in 2004—resulting in the highest storm impact since 1851. These storms affected all of the State's 67 counties within a two-month period, causing devastation statewide. When state agency staff was deployed to help local county emergency management coordinators, they reported areas that were virtually unrecognizable to their own residents.

As another season soon approaches, it is critical that we learn from the destruction that affected homes, businesses, communities, and local and state governments. These experiences can prompt further consideration for actions and methods to reduce and eliminate the effects from future storms.

What can we do specifically to better protect the next communities that are impacted by future storms? We can examine current building codes and analyze their performance. Additionally, we can examine how we communicate; advance professional relationships; utilize professional wisdom, skills, knowledge, and integrity; and analyze building design, materials, fasteners, applications, and maintenance.

The following report offers select statistical data about the 2004 Hurricane Season. In general, the conclusions are based upon the Mitigation Assessment Team (MAT) and the writer's observations and evaluations of the relevant codes, standards, and regulations. In addition, interviews with state and local officials, engineers, architects, building associations, contractors, homeowners, and other relevant parties were considered. These conclusions are intended to assist the State of Florida, local communities, businesses, and individuals in their recovery process in an effort to reduce and resist the impacts of future storms.

Background

Affecting areas from Maine to Texas, hurricanes are Atlantic storm systems that can foster dangerous weather elements such as: strong winds, storm surge, energy waves, wind-driven rain, flooding, inland fresh water flooding, and tornadoes. In turn, families, communities, and state environments may be disrupted as homes, businesses, enterprise zones, public sector facilities, and personal keepsakes are damaged or destroyed.

Accordingly, hurricanes cost the United States Government over five billion dollars yearly, says Dr. Stephen Letherman, Director of the Florida International University's Hurricane Research Center. These storms are the most costly natural disasters in the nation's history.

Notably, all four hurricanes to impact Florida in 2004 are in the top-ten most costly hurricanes to strike the United States. Collectively, the year's storms have exceeded the greatest dollar and resource expense ever on Florida: an estimation of over the 34.9 billion dollars record set by Hurricane Andrew.

Cumulative Damages

Consecutive occurrences further intensified the impacts of the four hurricanes, where three of the four hurricanes followed similar paths and had overlapping swatches, as shown in **Figure 1.**

As depicted, Francis and Jeanne followed identical paths as they entered the State near Vero Beach and exited north of Tampa. These two wide-path storms crossed the course of Charley (which traveled west to east through Central Florida and exited around Daytona). Although Hurricane Ivan tracked through the Gulf of Mexico and struck Alabama, the storm brought severe wind and water elements to both Florida and Alabama.

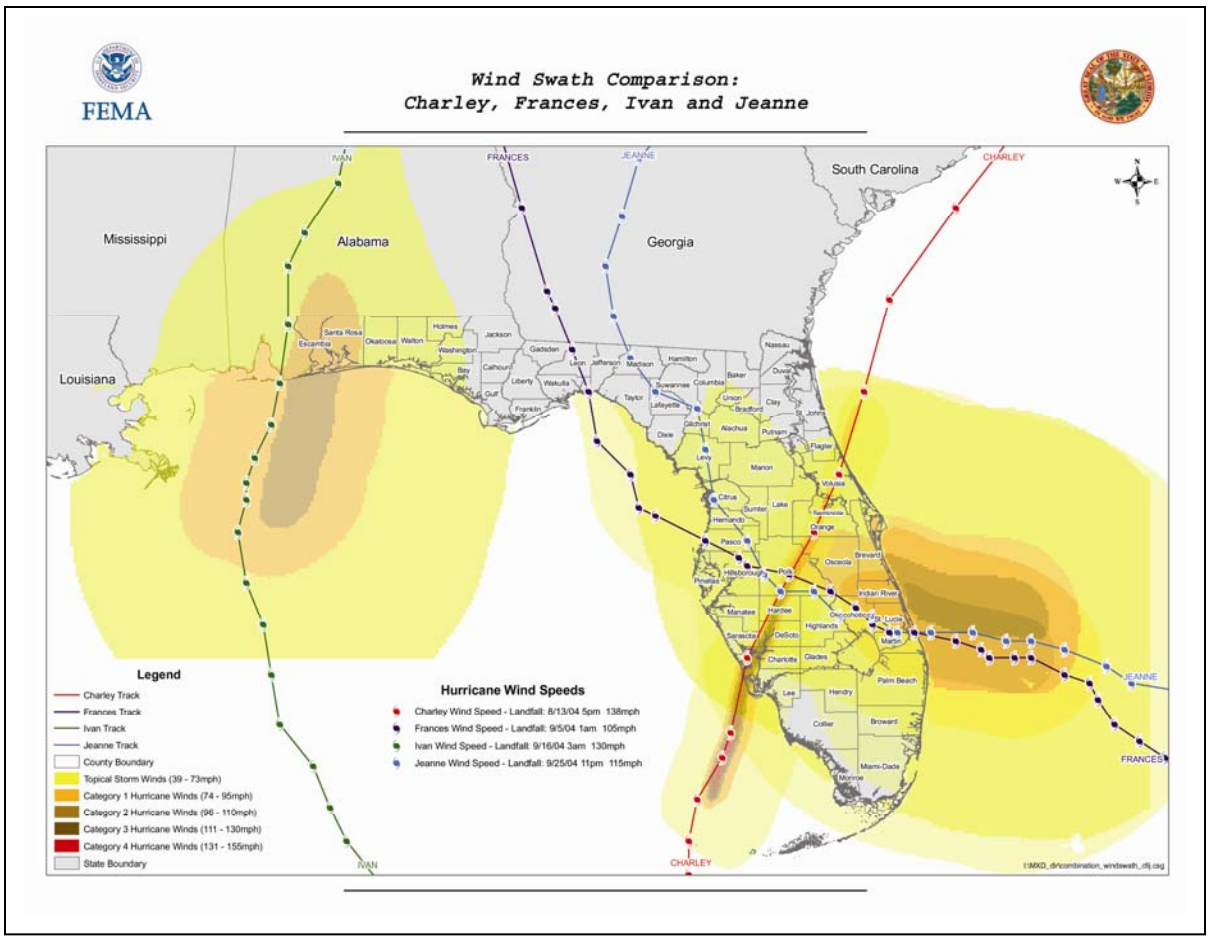

Figure 1: *Florida Hurricane Paths of 2004*

Despite their varying degrees, all four hurricanes caused wind and water damage to commercial, residential, and public facilities, as well as vegetation, agricultural crops, and infrastructures (such as utilities and roadways).

While the wind swatches, flood levels, and tracks of the hurricanes are easily mapped, the boundary of damages associated with each event is not as easily determined.

Because of their back-to-back occurrences within a short period of time, it was difficult to accomplish field observations. Therefore, the overlapping hurricane events and track similarities led to a succession. In turn, this multiplied the damages, and ultimately the four events were considered collectively rather than separately.

Specifically, the elements of all the hurricanes that impacted Florida were: hurricane winds, coastal storm surge, sustained torrential rain, large battering waves, inland fresh water flooding, tornadoes, and sinkholes. **Table 1** presents some of this information. The dynamic impacts of those elements were structural, topographical, and socioeconomic.

Table 1: *Summary of Hurricane Data for 2004*

Description of Hurricane Events

Hurricane	Landfall	Sustained MPH	Category	Storm Surge	Hurricane Elements
Frances	Sep 5	105-112	II	5'	W, R+, T, SH, SS-, F
Charley	Aug 13	125-130 gusts 155	IV	1.5' - 8'	W, R, T+, SS
Ivan	Sep 16	100 gusts 120	III	16' - 19'	W, SS+, T+, BW
Jeanne	Sep 25	120	III.8	6'	W, R, T, SS+, F

ELEMENT LEGEND

W	- Winds	BW	- Battering Waves	+	- Severe Degree!
R	- Rain	F	- Fresh Water Flooding	-	- Less Severe
SS	- Storm Surge	T	- Tornadoes		

Hurricane Assistance

Along with the wide-spread damages, FEMA has reported the following figures as of April 22, 2005:

- Almost **1.174 million** individuals received IHP approved assistance.
- Nearly **1.24 million** victims applied for Federal and State assistance.
- Almost **885,032** housing inspections were completed.
- FEMA provided more than **16,029** temporary housing units to hurricane victims.
- Amount of debris removed was **48.296 million** cyds.
- Lost earnings (wages and benefits) from the 4 hurricanes are estimated at **748.6 million** dollars for Florida's workplace. This occurred in the 16 most impacted counties (FEMA-Technical Services Branch).

These figures raise a concern for the people that could potentially be impacted by a destructive storm. In turn, the figures magnify the humanitarian aspect of a disaster. Therefore, educating people about how actions of today impact the future is crucial.

Critical and Essential Facilities

Critical and essential facilities are defined by each local jurisdiction. For planning purposes, a jurisdiction should determine criticality based on upon the following: the relative importance of various assets in delivering vital services, the protection of special populations, and the relevance of other important functions. Each community must calculate the initial cost of the facility protection versus the potential cost of lost functionality. Typical examples of critical and essential facilities include emergency services such as:

- police and fire stations
- 911 call centers
- EOCs (Emergency Operating Center)
- control centers
- communication networks
- necessary utilities
- transportation networks
- public works garages and facilities
- public schools
- community centers

When a building performs poorly as a result of a natural disaster, the impact on the community and the state transcends the cost of repair. Community safety can be jeopardized if critical and essential infrastructures and facilities cannot function due to disaster damage. Loss of the residential and commercial portion of the community causes human suffering, economic loss, relocation, reconstruction, reconstruction, and loss of life functions (such as style and livelihood). As the loss and impact on the entire community cannot be totally measured, it becomes dysfunctional to some degree.

Existing Codes for Critical and Essential Facilities

The National Flood Insurance Program (NFIP) provides zoning regulations for communities to address protection of all structures located in a designated flood plain. To prevent loss of function, 44CFR part 9 offers definitions for critical actions. As defined, critical actions are those for which even a slight chance of flooding is too great. Accordingly, the minimum floodplain for critical action is the *500-year flood plain*. In other words, critical facilities must be protected to flooding equal to or exceeding a 0.2% annual chance of flood occurrence.

For essential facilities in Florida, the Florida Building Code (FBC) requires that the wind loading be increased a minimum of 15% from the anticipated speed as indicated on the wind-borne debris map (created by the American Society of Civil Engineers, ASCE 7-98).

Observations

Critical and Essential Facilities

Poor performance of numerous critical and essential facilities and shelters occurred during the four hurricanes. The building damages these facilities sustained caused significant, yet avoidable, loss of functions.

Many of the essential and critical facilities (excluding shelters) were housed in older buildings, and most were evidently not mitigated to resist known hurricane storm risks. If these essential and critical operations were housed in buildings built to current codes, which provide a higher level of protection from the elements of storm damage, some of these buildings would have remained operational. Alternatively, many of these facilities could have remained operational if they would have been mitigated or retrofitted for wind and windborne debris design requirements for their location as specified in the current codes.

Building Performance

Key building structural capacities appeared to have improved since Hurricane Andrew (1992) because of stronger building codes and better enforcement, resulting in less structural damage from hurricanes such as Hurricane Charley.

Accordingly, damage patterns show that new code-driven construction techniques led to good

structural performance in many of the buildings throughout Florida. When materials are used to withstand high winds and other hurricane forces, the latest building code provisions are implemented, and adequate enforcement is applied, the codes are most effective. However, there is still opportunity for improvement in building performance (such as code, materials, techniques, applications, and maintenance).

Structural

Building envelope failure (especially structural, roof covering, roof mounted equipment, soffits, wall covering, and unprotected glazing) led to widespread damage to building interiors throughout the path of the hurricanes. Sustained rain, winds, and high tides caused severe flooding and flood-borne debris, while wave surges caused fatigue, subsequent damage, and failure to building envelope systems.

The statistical graphs depicted in **Figures 2**, **3**, **4**, and **5** represent a systematic and structural investigation. **Figures 2**, **3**, and **4** graphs the percentages of homes with roof-cover and window damage within various wind zones. **Figure 5** depicts the percentage of homes with damage to soffits.

The study, by Kurt Gurley, Associate Professor of the University of Florida, Department of Civil and Coastal Engineering, includes homes that had range of ages, construction, types, and in peak wind zones. These survey figures were compiled from Charlotte County (Charley), St. Lucie County (Francis), Escambia and Santa Rosa Counties (Ivan), but only the wind survey figures from Charlotte County were available for use in this document. Specifically, the graphs evaluate relative performance on homes built in 1994 thru 2004 that experienced the highest wind speeds of the 2004 Hurricane Season.

Wind Zones	MPH
8-9	110-120
10	130-140
11	140-150

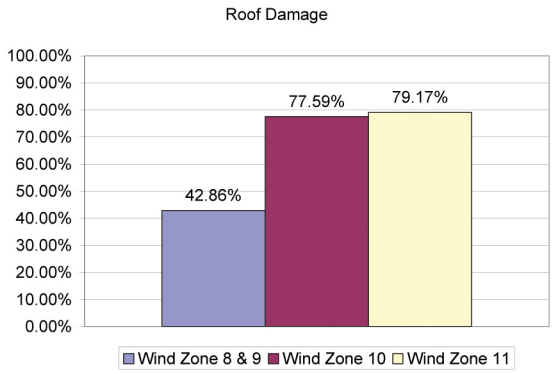

Figure 11: Percentage of homes with any roof cover damage by wind zone. Stratifications of Shingle, tile, old code, new code are all combined.

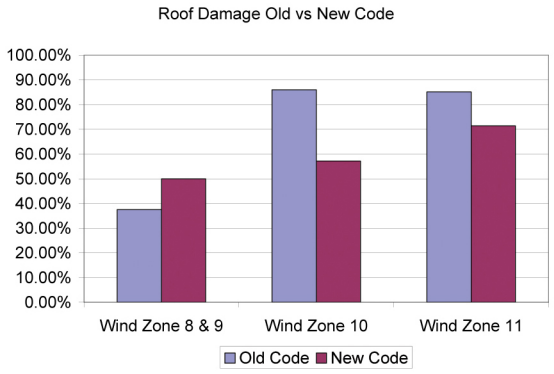

Figure 12: Percentage of homes with any roof cover damage by wind zone and code. Stratifications of Shingle, tile combined.

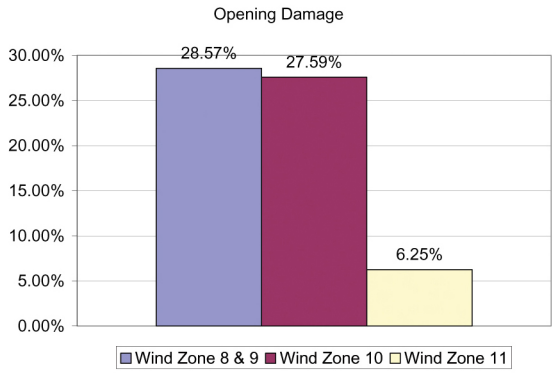

Figure 15: Percentage of homes with window damage by wind zone. Shutter use not factored in.

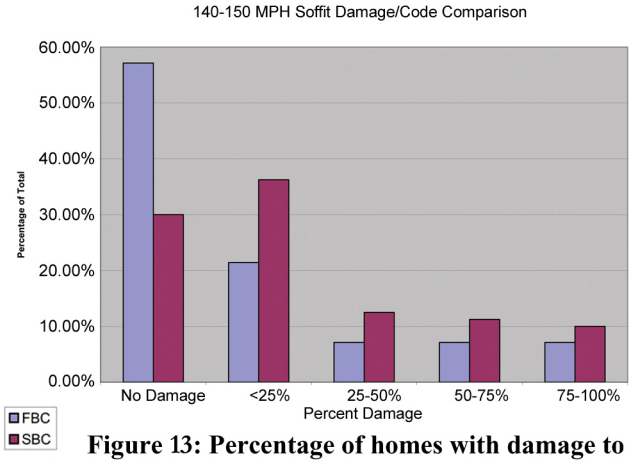

Figure 13: Percentage of homes with damage to soffits, stratified by amount of damage and code, wind zone 11 only (140-150 m.p.h.)

Zones

8-9	**110-120**
10	**130-140**
11	**140-150**

Manufactured Housing

Manufactured housing performance was based on the unit's age and the codes and standards implemented when they were constructed and installed. In high wind areas, pre-HUD standard homes were mostly destroyed beyond repair. Prior to 1994, HUD home performance varied, and a vast majority of these homes in the path of the hurricanes were significantly damaged. However, HUD standard homes performed well structurally after 1994. The damage sustained 56related to the building envelope and accessory structure failures.

The Mobilization Assistance Team (MAT) also found widespread damage caused by failures of improper design and construction of attached accessory structures (such as carports and screen rooms). When these attached structures failed, they often tore away siding roof covering. Wood deck and exterior walls became windblown debris, causing further damage to surrounding homes in the local communities.

Accessory Structures

Significant damage to accessory structures occurred throughout the hurricane-impacted areas. Most of the accessory structures observed was associated with residential dwellings, and many were attached to primary residences.

Not only did the accessory structure fail, but it caused damage to the primary structure at the point of attachment. In several incidences, neighboring homes were impacted by pieces of the failed accessory structures that became windborne debris, damaging both the primary residence it was associated with and the neighboring community residences.

Aluminum structures are another topic of concern. In the past, they were considered expendable accessory structures, which have little rigorous engineering applied to them. When structural components are not properly reinforced and bracing is inadequate, ultimate failure may occur (connection detail failure).

Building Envelope

Primarily, wind damaged the building envelope components and accessory structures. The building envelope includes exterior doors, windows, non-load bearing walls, wall coverings, soffits, roof covering, shutters, skylights, and exterior mounted electrical and mechanical equipment.

Based on the 2004 hurricane season, the six building envelope components that performed poorly are the following: roof systems (such as mortar set tile roofs), exterior set mechanical and electrical equipment, windows and doors (especially unprotected glazing), and wall cladding. The failure to one or more of these systems allows rainfall to enter the building, which results in significant damage to the interior contents of the building. A portion of the failures were a result of installing materials and systems that cannot perform under high-wind loads.

Another key element of the building envelope is ancillary equipment. Rooftop and ground level equipment (such as mechanical, electrical, storage tanks, curbing and special fasteners and brackets) have not received the design, installation, or code compliance needed.

While improved performances of roof systems were observed, damage to the roof system continues to be a leading determinant of building performance. Variation in roof performance was primarily related to installation to building code, manufacturers and attachment methods. Failure of roofing components (such as edge flashing, copings, and gutters/ downspouts) frequently contributed to roof covering failures.

Soffit

Widespread soffit damage resulted in unnecessary rainwater intrusion into the buildings interiors. (Soffits are architectural non-structural covering and cladding that enclose overhangs at the edge of the roof.) These soffits failed from both downward and upward pressure—where they were lost, water drove

over exterior walls sections, into wall cavities and attic spaces, and ultimately into the main portion of the building.

Doors

Normal width swinging doors performed well with few failures. Failure of large door openings, patio and double doors, rollup or sectional garage doors, and apparatus bay doors at fire stations and large commercial warehouses were more common.

Failure of an exterior door has two key effects: First, failure can cause an increase in internal pressure, which may lead to exterior wall, roof, interior partition, and ceiling to structural damage; second, wind can drive rain water through the opening, damage interior contents, and lead to mold development. This can be prevented if doors and tracts that connect roll-up doors to walls are strengthened.

Windows and Shutters

Glazing failure occurred in buildings that were in the windborne debris areas as indicated in ASCE 7 and FBC 2001—where glazing was not impact-resistant or protected by shutters.

Glazing failures resulted in damage to building interiors and, in some cases, resulted in structural failure in older buildings.

Significant window failure damage was observed in manufactured housing parks. This is likely due to lack of window protection, regulations in windborne regions, and poorly constructed accessory structures that became windborne debris, even in non-windborne regions.

Foundations and Structures

Residential structures (single and multifamily) and commercial structures suffered significant damage from a combination of considerable storm surge. The most extreme cases were building failure due to erosion of supporting soil under buildings with shallow foundations. Other foundation types that had major impact were: slab-on-grade, stem wall, pier, and pile foundations.

Slab-on-grade foundations in coastal zones experienced substantial damage or complete destruction when flood elevation levels exceeded the top of the slab, as illustrated in **Figure 6**.

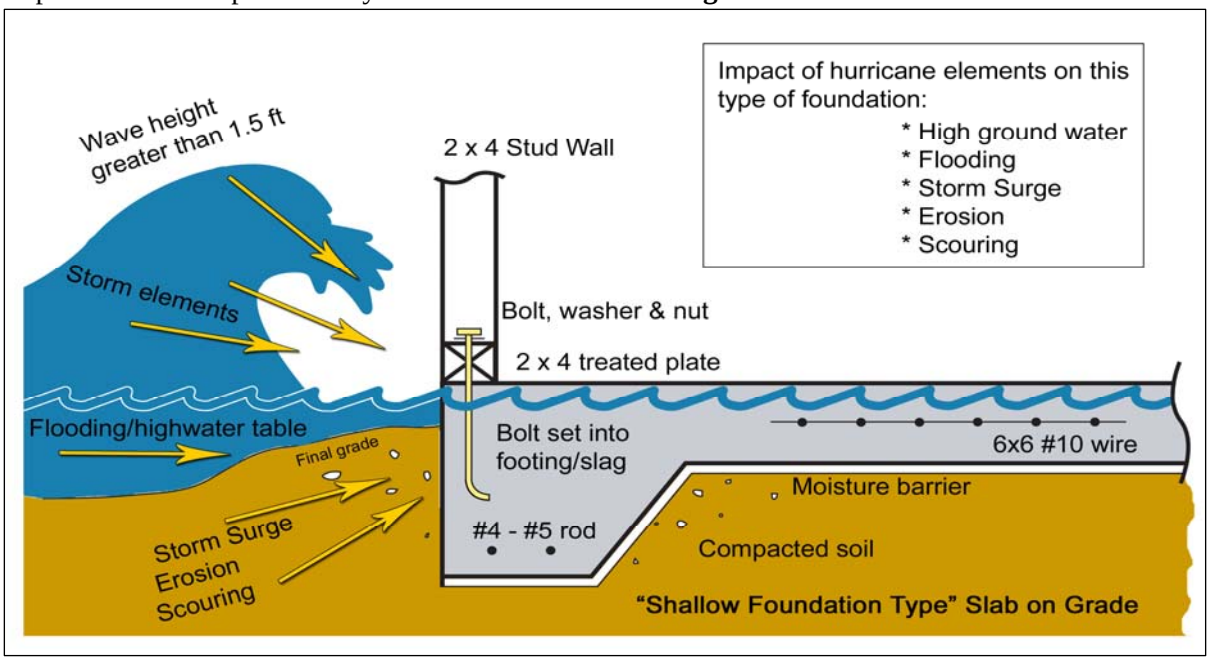

Figure 6: *Slab-On-Grade/ Storm Element Effects*

Many of the homes with slab-on-grade foundation were older homes with pre-FIRM publication. This flood zone delineation noted homes outside the designated floodplain.

Recommendations

Critical and Essential Facilities

General: Hurricane shelters and EHPA

- Adopt wind speed that is recommended by Florida Department of Community Affairs (FLDCA) in the SESP and the ASCE 7-02/2001 FBC wind speed map design wind speed plus 40 mph using Performance Criteria 3.

Currently, this is the recommended best practice in the FL DCA shelter design guidance and in FBC Section 423, Part 24—Change this to a requirement. This criterion should be required by the SESP and should be used until the International Code Council's high wind shelter standard is completed in 2006/2007 and available for adoption.

- Expand the use of the critical and essential facility designation of category classification and critical prioritized use.

These facilities should be designed, constructed, and maintained more conservatively than normal non prioritized and essential facilities.

- Design critical and essential facilities beyond existing code minimums due to their vital purposes.

- Consider critical and essential facilities higher priorities for mitigation (retrofit).

General: Minimum debris impact protection

- Require ASTM E 1996 category E for a 9 pound 2X4 (nominal) missile traveling at 50 mph.

This criterion should be required by the SESP and should be used until the International code Council High wind shelter Standard is completed in 2006/2007 and available for adoption.

General: *Alternative for designing shelters to the SESP or ASCE criteria*

- Design or retrofit buildings to be used as shelters to the design guidance provided in FEMA 361/424: *Design and Construction Guidance for Community Shelter*s.

General: Process of development

- Analyze weaknesses and implement collective suggestions for improvement.

The building community has a responsibility to reveal the weaknesses in the current development process of critical and essential facilities. This entails a rational analysis of the weaknesses in areas such as: design/standards, building, building code/standards, materials selection based on use, performance testing, mitigation, education, maintenance and annual facility inspection. The information can then be applied to create new facilities or to mitigate old buildings.

Building Performance

Consideration for details associated with the construction of structures is essential due to the potential these elements being impacted by hurricane elements. Such details include: design, elevation, soil condition, materials, methods construction, skilled labor required, and code built structure.

When hurricane winds, sustained rain, storm surge, and other hurricane elements interact with a structure at the same time, the forces can combine and substantially increase the total loads on the structure and its components (such as foundation, anchoring connectors, fasteners, framing, roofing, sheathing, doors, and windows). The proper design, construction, and designed connections of all building components

are essential to prevent damage to the overall structure.

Equally important, adequate communication is essential to facilitate improvements in building performance. When representatives of the building community are able to effectively communicate, knowledge and skills can then be successfully translated.

Building Envelope Components

Improvements to the building envelope can prevent water intrusion. Protecting this key component is critical in order to minimize losses and damages to building contents. Additionally, the building envelope is essential in relation to internal pressurization of a building or structure. Building envelope failure allows increase in the air pressure of the building and allows the wind-driven rain to enter the building. Increased internal pressure can also lead to structural damage.

In order to help identify some of the building components that were evaluated for performance, **Figure 7** displays their locations. Corresponding numbers accompany the recommendations in this section for easy referencing.

1 *Edge flashing and coping: FBC section 1503 (weather protection)*

- Require compliance with ANSI/SPRI ES-1 for edge flashing and coverings.

2 *Gutters: FBC section 1503 (whether protection) and IBC/IRC*

- Develop and add criteria regarding uplift resistance of gutters.

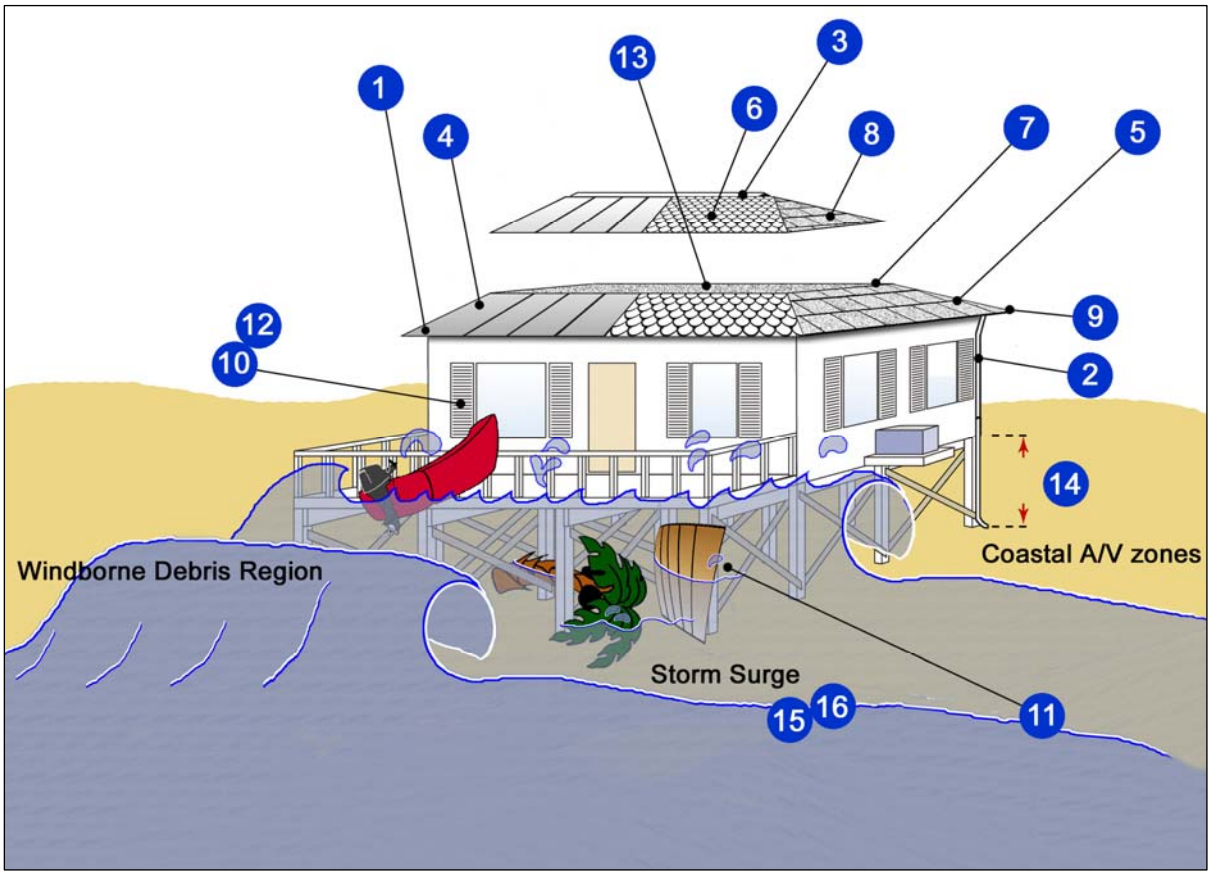

Figure 7: *Building Elements Evaluated*

3 *Ridge vents: FBC section 1503 (weather protection) and IBC/IRC*

- Add criteria regarding wind and wind driven rain vents. (Attachment criteria require development, but TAS 110 could be referenced for rain resistance.)

4 *Metal panel roof systems*: *FBC section 1504 (performance requirements)*

- Require compliance with ASTM E 1592 for testing the uplift resistance of metal pan roof systems.

5 *Asphalt shingles*: *FBC section 1507.2 9 (roof covering application) and IBC/IRC*

- Require compliance with UL 2390.
- Require 6 nails per shingle.
- Require the use of asphalt roof cement at eaves, rakes, hips, and ridges, where basic wind speeds are 110 mph or greater (refer to recovery Advisory No. 2).

6 *Mortar, set tile roof system: FBC section 1507.4 (clay and concrete tile) and IBC/IRC*

- Provide an alternative for mortar usage to attach field tiles and hip/ridge tiles. (See Tech bulletin #3 from 2004 hurricane season.)

7 *Build up roof: FBC section 1508 (roof coverings with slopes Less than 2:12)*

- Add technical based criteria regarding blow-off resistance of aggregate on build-up and sprayed polyurethane foam roofs.

8 *Roof system: FBC 1510.3 (recovering versus replacement) and IBC/IRC*

- Require existing roof covering down to the deck and replacement of deteriorated sheeting in areas where basic wind speeds are 110 mph or greater.

If existing sheathing attachment does not comply with loads derived from Chapter 16, then require installation of additional fasteners to meet loads.

9 *Soffits*: *FBC/IBC/IRC criteria regarding wind resistance*

- Add soffits and wind-load criteria for soffits that require development.
- Add wind-driven rain resistance of ventilated soffits panels.

TAS 110 may be a suitable team method and modified as necessary.

Windows and Shutters

10 12 *Shutters*: *FBC Section 1606.1.4 (protection of openings)*

- Add requirements to label shutters (other than wood).
- Revise 15C of the Rules and Regulations of Florida to provide window protection systems (and a strengthened structure around openings) on Zone ll and Zone lll units being installed in the windborne region defined by Chapter 16 of the FBC.

Without labels, building owners do not know if shutters are suitable.

11 *Windborne debris region*: FBC

- Revise the Florida Panhandle criteria to match ASCE7.

Exterior Equipment

13 *General: FBC Section 1522.2 (rooftop mounted equipment)*

- Make applicable throughout the State of Florida for all wind speeds.
- Develop and add criteria that pertain to attaching lightning protection systems.

Provisions also include mechanical and electrical codes.

Flood hazard

14 15 16 *General*

- Re-evaluate the hazard identification/mapping approaches in Coastal A/V Zones.
- Re-evaluate the storm surge modeling methodology.
- Adopt ASCE 24-05 for elevation requirements and flood resistant materials, equipment.

Code

- Focus on improvements that prevent rainwater intrusion and protect the building envelope.

Protecting the building envelope is important to minimize losses to building contents.

- Initiate mitigation actions, which create a continuous load path from the roof deck to the foundation in order to prevent or minimize damage of older buildings (both residential and commercial).
- Develop dynamic testing.

Testing guidance is needed in the areas where methods are used to test envelope assemblies (called static tests), which are inadequate for some assemblies.

- Improve current practices for designing, constructing, retrofitting, mitigating, and maintaining buildings (especially critical and essential facilities).

Pending Changes to the FBC/Certification

On March 16, 2005, the Florida House Committee supported stronger building codes. The House panels its stamp-of-approval to a bill that would bring the hurricane provisions of the Florida Building Code (FBC) to meet latest engineering standards. The bill still continues to exempt the 12 counties in the Panhandle counties, the territory hardest hit last year.

The International Code Council (ICC) Consensus Committee on Hurricane Resistance Construction was recently formed to develop new standards. When completed, the document will specify prescriptive mythologies of wind-resistance design and construction details for wood-frame, steel-frame, and concrete of masonry structures sited in hurricane prone areas. Perspective details will be provided for roof, walls, windows, doors, floors, foundation, and other applicable components. ICC is also in the process of developing a *Disaster Response Inspector Certification Program*.

Recommendations beyond Codes

Responsibility to seek qualified professionals should be placed on individuals who design and build structures. These individuals ensure that the new or used structures are always well maintained. Ideally, building codes and standards can then be used to mitigate damages from elements such as: sustained wind, rain, storm surge, corrosion, and debris. However, nature and location, not codes or standards, dictate special considerations and the added costs required to build a safe structure in hurricane prone communities. When properly applied and enforced, building codes and standards are the solution, not the hindrance.

Finally, the entire building community throughout Florida and the nation should work together by applying the latest communication, technical knowledge, and educational skills in order to improve future conditions.

Guidance

Some building components failed because established basic construction practices were not implemented. On the contrary, homes built according to FBC 2001 or the IBC 2000/1003 avoided most wind related structural issues. Accordingly, designers and contractors may need additional guidance and training to understand wind-resistance issues. In addition, methodologies and best practices should be provided when code guidance is vague, unclear, or nonexistent. Based on MAT'S observations, specific design, testing, and construction guidance is needed in the following key areas:

Design Guidance

- roof coverings
- gutters
- downspouts
- rolling sectional doors
- soffits
- roof top equipment
- other exterior devices and equipment
- swing sets
- storage sheds
- electrical and communication equipment

Testing

Test methods: Most of the testing methods used to test envelope assemblies are static tests, which are inadequate for some assemblies. The development and application of dynamic testing are recommended.

Construction

There is evidence of significant deviation from national, state, building code and standards, and manufacturer's requirements, which ensures adequate installation instruction training. Manufacturers must ensure adequate instruction to be able to withstand future storms.

Education

The educational challenge is to impact the building community by offering timely resources that question and change how professionals conduct business, without sacrificing character or integrity and excellence. Residential and commercial building owners, architects, engineers, insurance industry, mortgage institutions, contractors, building officials, contractors, manufacturers, maintenance professionals, and state and local governments and associations are among those who can be informed and help improve current methods.

Conclusion

Concerning the upcoming 2005 season, forecasters such as Dr. William Gray of the University of Colorado predict a more severe hurricane season than experienced in 2004. Specifically, Dr. Gray's team forecasts the following for 2005:

- **13** named storms
- **65** storm days
- **7** hurricanes
- **35** hurricane days
- **3** intense hurricanes
- **7** intense hurricane days

Also noteworthy, the State of Florida's Office of Economic & Demographic Research, reports the following figures:

- From 1990 thru 2004, the net migration growth within Florida added **3,387,262** to the Florida's base population total; daily net growth was **1046**.

- In 2004, **381,704** people moved to Florida.

- By 2015, the projected total migration figure will add **3,749,964** to Florida's base population total.

- The 2000 census shows **7,302,947** housing units in Florida– out of which **849,304** are mobile homes (or **11.6%** of the total of all housing units).

- Only **21%** of all homes have flood insurance (from the 2005 NFIP figures and estimates for 2005 for 1 to 4 family housing units in Florida).

- **12.4%** of Florida's population is below the poverty status.

Based on this information, improvements in the current codes, practices, design techniques, and the construction process may be a more critical issue than in the past. Fueling this concern are such reports, which point to the potential for an active hurricane season, coupled with notable Florida growth figures. Unfortunately, the combination of these two possibilities may lead to more devastating damages from future hurricanes. However, analyzing current building codes, learning from previous actions or inactions, exploring new ways to implement current codes, offering guidance to assist members in the building community, and establishing a more effective way of communicating this information are some of the ways we can prevent or eliminate damages from future hurricanes.

Visual References

Figure 1 Florida Hurricane Paths of 2004

Figure 2 Percentages of Homes with Roof-Cover Damage (Stratification of shingle, tile, old code and new code are combined.)

Figure 3 Percentages of Homes with Window Damage (Shutter use not factored in.)

Figure 4 Percentages of Homes with Roof-Cover Damage (Stratification of shingle an tile are combined.)

Figure 5 Percentages of Homes with Damage to Soffits for Wind Zone 11. (Damage and code are stratified.)

Figure 6 Slab-On-Grade Storm Element Effects

Figure 7 Building Elements Evaluated

Table 1 Summary of Hurricane Data for 2004

Abbreviations and Acronyms

ASCE	American Society of Civil Engineers
EOC	Emergency Operations Center
FBC	Florida Building Code
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FL DCA	Florida Department of Community Affairs
HUD	(United States) Department of Housing and Urban Development
IBC	International Building Code
ICC	International Code Council
IRC	International Residential Code
MAT	Mitigation Assessment Team
NFIP	National Flood Insurance Program
NHC	National Hurricane Center
NOAA	National Oceanic and Atmospheric Administration
SESP	Statewide Emergency Shelter Plan
SFHA	Special Flood Hazard Area
TAS	Testing Application Standard

Glossary

100-year flood	The flood elevation that has a 1% chance of being equaled or exceeded each year.
Zone X 500-year flood	Zone X identifies areas subject to inundation by the flood that has a .2% per probability of being equaled or exceeded during a given year.
ASCE-7-98	National design standard issued by the American Society of Engineers (ASCE), Minimum design loads for buildings and other structures, which give current requirements for dead, live, soil, flood, wind, snow, rain, ice, and earthquake loads, and their combinations. Suitable for inclusions in building codes and other documents.
Building Envelope	The entire exterior surface of a building, including walls, doors, windows, which encloses or envelopes the space within.
Building Community	Homeowners, architects, engineers, building departments contractors, manufactures, insurance industry, lending institutions, and maintenance professionals.
Coastal A Zone	The portion of the Special Flood Hazard Area (SFHA) landward of a V Zone in which the principal source of flooding is storm surge and riverine sources. Coastal A Zones may therefore be subject to wave effect, velocity, erosion, scour or a combination of these sources. A Zones areas are subject to breaking waves with heights less than 3 feet and wave run-up with depth less than 3 feet. It is important to note that FEMA uses Zones AE, A1-30, AO and A to designate both coastal and non-coastal SFHAs.
Community	Individual people grouped together by family, profession, geography, or electronic communication; valued partner networks helping one another.
Critical and Essential Facilities	Facilities that, if flooded, would present an immediate threat to life, public health and safety. Includes, but are not limited to, hospitals, emergency operation centers, fire stations, police stations, and water systems and utilities.
Dynamic Testing	Dynamic testing, which measures the response of the physical system to the impute that are not constant to static testing. This type of testing can assess structural performance.
Recovery Advisory No. 2	Issued by FEMA. This advisory recommends practices for installing asphalt roof shingles that will enhance wind resistance in high-wind, hurricane prone areas.
Scour	Process by which flood waters remove soil around objects that obstruct flow, water from rainfall, or snowmelt.
Static Testing	Study or testing for stress, strain, displacement, and shear and axial forces that result from static loading. This type of analysis are assumed to be constant for an infinite period of time.

FEMA 361	A FEMA manual for design and construction guidance for community shelters. These standards provide protection during tornadoes and hurricane events.
FEMA 424	Design guidelines for school safety against earthquakes, floods, and high winds.

References and Resources

Building Safety Journal. February, 2005.

Building Safety Journal. April, 2005.

Baker, Dr. Earl J. "Experts Ponder Storm Categories." Current News/Disaster News Network. Mar. 11, 2005.

Burleson, Jack D AIAA, CSI, CBO, Regional Manager, Governmental Relations, ICC. Texas Field Office. "Hurricane Elements and Building Interaction."

Deschu, Nancy. Mitigation Assessment Report for Hurricanes. "TSB Documents."

FEMA. "Design Guides for Improving School Safety in Earthquake, Floods, and High Winds." FEMA 424. Washington D.C.: Jan. 2004

FEMA. "2004 Hurricane Performance." FEMA 490. Mar. 2005.

FEMA. "Mitigation Assessment Team Report: Hurricane Ivan Florida and Alabama." FEMA 489. Washington D.C.: 2005.

FEMA. Reconnaissance photographs. Charley, Frances, Ivan, Jeanne. 2004-2005.

Florida Building Commission. Florida Department of Community Affairs. "Setting New Standards for Safety: The Florida Building Code.".2003-2004.

Florida Department of Community Affairs. "Action Plan for the Use of Disaster Recovery Funds." Disaster Recovery Initiative.

Florida House of Representatives HB 835. 2005.

Florida Office of Economic and Demographic Research Bureau Net. Nov. 2004.

ICC e/Partners. Apr. 2005.

"Looking Back on the 2004 Hurricane Season." Building Safety Journal. Feb. 2005.