Wind Mitigation in Florida

3

Professional Development Hours (PDH) or

Continuing Education Hours (CE)

Online PDH or CE course

Wind Mitigation in Florida

This course consists of two sections: practical and technical. The first section is the practical section and the second section is the technical section.

By the end of this course the licensee would know:

- What is wind mitigation.
- Why every Floridian home owner faces damage to their home a result of high wind.
- Load path of the hurricane force.
- Installation of Gable-end Bracing, strengthening roof decking attachments and secondary water barriers to roof.

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Table of Contents

First Section

Make Mitigation Happen

Mitigating your home could translate to savings and peace of mind.

What

What is wind mitigation? Wind mitigation includes specific activities to strengthen your home. This booklet will review what can be done to strengthen your home.

Why

Every year Floridians face damage to their homes as a result of high winds.

Load Path

A continuous load path and roofing protections are the key components of protecting the structural integrity of your home during a storm. Learn a variety of activities that can help strengthen your home.

Protect Openings

Protecting openings by shuttering or replacing with high-standard products.

Florida Law and Insurance Discount Notification Form Florida Statute 627.711 Notice of premium discounts for hurricane loss mitigation; uniform mitigation verification inspection form.

Preparedness Checklist 

Protecting your home from high winds is a part of being prepared. Have a plan. Use this checklist to help you prepare for disasters.

Letter from Director Bryan Koon

Prior to joining Florida's Division of Emergency Management Director Koon served as the Director for Walmart's Emergency Management Department and worked at the White House Military Office for seven years. Director Koon also served as a surface warfare officer in the US Navy.

Florida has been fortunate to avoid major catastrophic damage over the last few hurricane seasons. While many become complacent, this training and booklet are meant to engage you in actively preparing your home for future hurricanes. It is a matter of time before the next major hurricane impacts Florida.

Will your home, your family and you be ready to survive and recover from the next major hurricane to impact your community?

Hurricane Mitigation

This guide provides insight into proven, researched activities that directly improve your ability to recover from a hurricane. Please take time to review the activities, properly mitigate your home against damage caused by high winds and join the effort throughout Florida to survive the next hurricane.

Together we can demonstrate that investing in the homes of our citizens can improve Florida's recovery from future disasters.

Take the time to Get A Plan! and prepare your home.

- Bryan Koon

What is Wind Mitigation?

Shutters can be seen, so they are the first things most people think of when protecting their home against high winds. But shuttering windows is only one of the recommended activities. It's what you can't see that can make a big difference.

Mitigation is defined as a noun that is the lessening of the force or intensity of something unpleasant. Wind mitigation specifically targets the structural and nonstructural aspects that prevent or lessen damage caused by high winds that occur with storms.

In Florida, our primary concern is the wind damage caused by hurricanes. Hurricane season begins June 1 and ends November 30. That means for five of twelve months of every year, Floridians are at risk for exposure to high winds. Also, it is not unusual to have a hurricane or tropical storm outside of hurricane season.

The first step is to have an inspection of your home.

Obtaining an inspection generally costs but is well worth the investment to fully mitigate your home. Activities to mitigate your home are research-based recommendations.

Multiple organizations including the Florida Department of Financial Services, Florida Division of Emergency Management, Florida's Foundation, Florida Alliance for Safe Homes, and the Insurance Institute for Business and Home Safety all endorse the same research based recommendations and provide resources to inform and assist homeowners. See more information in the Disaster Preparedness Organizations section.

But what is wind mitigation? What actions or changes constitutes mitigating your home?

The primary damages from hurricanes are wind and water intrusion[1]. Water, as rain directed by varying wind directions, enters homes through gable ends, soffit vents and poorly sealed windows and doors. Once rain enters homes mildew can develop within days. Like water, wind causes damage by entering the home through poorly sealed openings. Wind damages homes by increasing pressure and causing uplift forces on the roof.

[1] Summary Report on Building Performance 2004 Hurricane Season FEMA 490 / March 2005

WHY MITIGATE?

FEMA's Federal Insurance and Mitigation Administration participated in a study that estimated the value of all mitigation activities funded between mid-1993 through mid-2007. This study included mitigation of floods, hurricanes and earthquakes. The study concluded a value of $4 saved in response and recovery for every $1 spent on mitigation.

The Florida Department of Finance states that 15% - 70% of your insurance premium could be attributed to wind-damage risk.

For the majority of homeowners, their home is their largest asset, the primary source of shelter and holds unlimited sentimental value. Truly the value of the mitigation will only be seen if impacted by a hurricane. Strengthening your home against high winds will hopefully prevent any catastrophic damage to your home in the event of a hurricane.

By protecting your greatest asset you will minimize the expense of recovery and speed the time it takes to recover from a natural disaster.

"No amount of strengthening of your home should ever cause you to disregard evacuation orders."

Safety

Too often people wonder why damage occurred after a disaster. Wind mitigation is meant to avoid a hazard by reducing the amount of damage to your home and reducing the amount of debris that may result in damage to other homes and speed cleanup efforts. The steps to mitigating your home that follow in this manual are research-based activities that will help minimize the damage to your home. Ideally in the event of a disaster, your home will be waiting when you return.

The arm bands of hurricanes often spawn tornados or generate gusts of wind so strong that objects, trees and other debris can cause extensive damage regardless of your mitigation efforts.

Recovery

Community recovery from a disaster doesn't take one or two years. It can take five years before a community recovers jobs, housing and revenue lost from a disaster.

You evacuate to a shelter and then come home - from here let's imagine two different scenarios.

Scenario A - A large piece of the roof to your home is missing, there is significant water damage to three rooms of your house and four windows are shattered. Clearly this is not a safe environment and mold will grow within days.

Scenario B - There is minimal damage to your roof due to a tree leaning on your home. There is minor water damage in your living room and is manageable by placing a tarp on your roof. You are back in your home after one night in a shelter.

Which scenario would you prefer?

Economic

627.711 F.S. requires insurance companies to notify homeowners of premium discounts for hurricane loss mitigation and establishes a uniform mitigation verification inspection form.

If your home has undergone a wind inspection you are potentially eligible for insurance discounts or credits.

Beyond insurance savings - the value of your home increases and there are cost savings when a disaster occurs. These savings are dependent on many different variables and cannot be predicted.

Types of Mitigation

Shutters can be seen, so they are the first things most people think of when protecting their home against high winds. But shuttering windows is only one of the recommended activities. It's what you can't see that can make a big difference.

Water Barriers

Providing a sealed roof deck will prevent significant water intrusion if pieces of your roof coverings (shingles) are blown away. This also provides additional insulation to make your home more energy efficient.

Don't forget your soffit vents!

Anchoring, Roof-to-Wall

Reinforce your foundation-to-wall, floor-floor (multistory homes) and wall-to-roof connections to establish a continuous load path. A continuous load path allows your home to resist high-wind forces as a unit. Weak links in a load path are generally where damage occurs.

Gable Ends

Gables that are taller than 4 feet will benefit from reinforcing the framing and bracing the top and bottom of the gable. Generally, a licensed professional engineer is best to design a gable end bracing system appropriate for your specific location and home construction.

Window Openings

There are many options for window openings. Shatterproof glass windows are expensive, but eliminate the need to shutter before a storm.

Clear, lightweight, cloth, electric and roll-down shutters exist to assist persons with varying disabilities.

Doorways

Doors, including garage doors, are best replaced with a hurricane-rated door.

For existing garage doors additional bracing can be applied. Hurricane-rated garage doors are heavier and often in a storm power is lost, so electric openers won't work.

The following specifications apply to the 2007 Florida Building Code. Once the 2010 Florida Building Code becomes effective specifications will vary.

Water Barriers

Water can devastate a home by direct damage and by fostering the growth of mold and mildew. The best mitigation is to prevent water from entering your home.

Establishing a water barrier is cost-effective when replacing your roof. At that time it is easiest to replace damaged boards and place a water barrier on the roof deck. Allowable methods and products vary based on local building codes, so please check with your local building department.

First, inspect the roof deck. If any boards are warped, damaged or deteriorating, replace them. Secure all boards with an 8d ring shank nail. Re-nail sections if needed. A ringed shank (grooves in the nail) provides more secure grip and prevent forces pulling the nails out of the wood. Recommended spacing is a maximum of 6 inches on-center. Follow manufacturers guide for spacing in high-wind areas. Once the integrity of the roof deck is confirmed you can seal the deck.

On the roof deck you can tape the horizontal and vertical seams with a 4” or wider self-adhering membrane tape followed by a synthetic underlayment. Self- adhering tape may have difficulty adhering to the surface due to the texture, any wax added and general job-site conditions. A primer may be needed to secure attachment of the tape.

For the underlayment, the Institute for Business and Home Safety recommends a code compliant 30-pound ASTM D226, Type II underlayment and attached using annular ring or deformed shank roof fasteners with minimum 1-inch diameter caps. Metal caps are recommended where wind speeds may exceed 140 mpg.

When buying asphalt shingles verify the technical standards for the product. The highest standard is currently over 130+mph winds and should be installed using the number of fasteners recommended by the manufacturer for high-wind areas. In some areas, local building code requires more fasteners than the manufacturer’s recommendation.

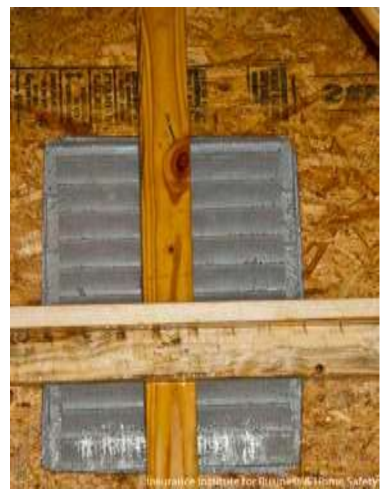
Other roof coverings, such as metal panels and tiles (clay and concrete), require strict adherence to manufacturer’s and local building department’s recommended installation to ensure required uplift resistance.

Chimneys over 5 feet above the roof and/or on the side of the home should be anchored. It is best to have a licensed engineer to ensure adequate stability.

There also now options for roof vents that have passed wind- driven water tests and prevent water intrusion. Consider replacing existing roof vents.

If you are not considering a roof replacement or any major roofing repairs, you may still strengthen your existing roof by re-nailing the sheathing using 8d ringed shank nails and by providing a water barrier on the underside of the roof deck.

Spray-on polyurethane foam adhesives provide additional anchoring of the roof deck and is an acceptable water barrier. This is messy! Documentation of application from a properly trained and qualified applicator is generally required for insurance discounts.



Gable Vents

Winds from hurricanes and thunderstorms can vary directions and push water into vents causing extensive mold and mildew damage. Vents should be covered with a nonporous material.

Covering gable vents can be difficult due to the height of most gables ends, but you should be able to access the vents from the attic. Vent covers can be installed inside the attic.

Soffits and Vents

Like a roof deck, soffits should be inspected for damage, cracks, weaknesses and deteriorated material. Building standards for soffits have changed for high-wind prone areas and you should check with your local building department to verify current standards. When strengthening the roof-to-wall anchors, you will have to remove the soffits, and it will be the perfect time to replace the soffits and ensure proper installation.

Follow manufacturers instructions for installation in high-wind zones. Ensure soffits are properly anchored to the overhang and to the wood along the building length. Spacing of anchors should be 12 inches of center.

A polyurethane sealant can be used to secure aluminum or vinyl soffits and seal the gap between the track and wall.

Wood soffits have not had a high failure rate during storms and are generally properly anchored, but the same techniques of anchoring and applying sealant can be used to further secure wood soffits.

Insurance savings vary by company, location and your specific home. If you have multiple mitigation features, the percentages below cannot be combined. In general, water barrier improvements include the following savings:

Roof Covering:

Approved shingles - 11%

Concrete roof - 82%

Secondary Water Barriers:

Self-adhesive tape and foam - 6%

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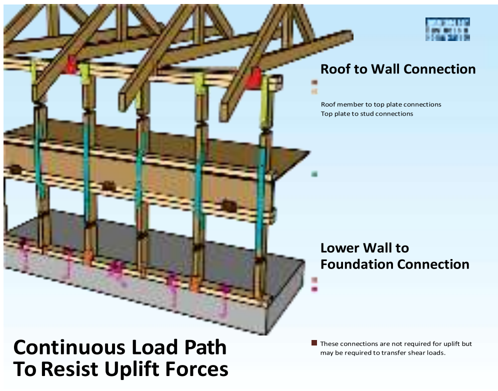
Anchoring, Roof-to-Foundation

Anchoring your home is time consuming and labor intensive, but worth the investment to establish a continuous load path.

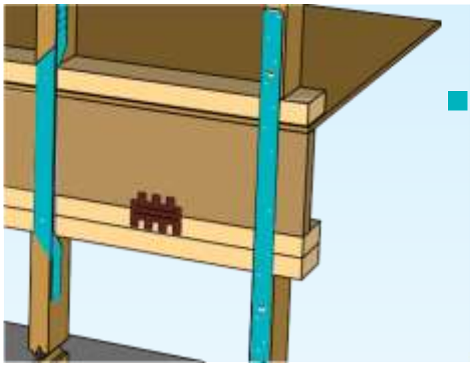


A continuous load path, in laymen's terms, is the function of your house as whole, not components of a foundation, walls and a roof. By anchoring the walls to the foundation, the first floor to the second floor and the walls to the roof, you establish a connection of roof to foundation and your home can resist the various forces that exist when winds push on your roof and walls, and penetrate your home.

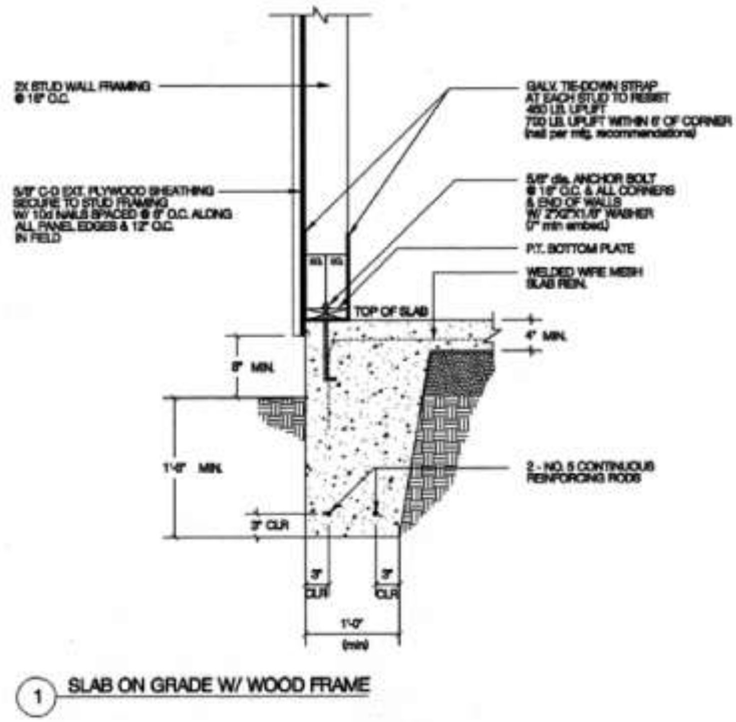
A roof tie-down, like roofing, is easiest done with new construction, re-roofing or major remodeling. On existing homes this generally encompasses the removal of the soffit to expose where the rafters meet the wall framing. Most homes have a standard connection on one side of the beams. For high-wind resistance, metal connectors are bolted to both sides where the rafter and the wall frame meet. A double wrap connector is a continuous connector in the shape of a modified U to fit the framing.

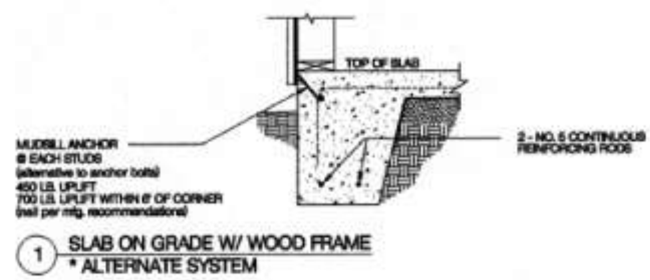
Many varieties of connectors are manufactured to meet the wide variety of connections that could exist between the rafters and the walls. Every connection, every joint must be secured.

Local building departments generally require permits which will leave the soffits uncovered until a post-inspection of work is completed. Work closely with your local building department to minimize this exposure time.



Upper wall to lower wall connections exist with a multistory home. This connection is not required for single story homes. The connector/hurricane strapping for the upper wall to lower wall connection is a solid steel connector that requires the removal of siding on existing homes.





Wall to foundation connectors and reinforcements generally require the removal of siding on existing homes. Block and brick walls require steel rod supports to be added. Like roof to wall connections, every joint should be secured. Seek the guidance from a licensed contractor or engineer with experience in mitigating for high-winds.

Porches that are connected to the house or that share a common roof should be mitigated and attachments strengthened. Enclosed porches should be shuttered as well to minimize uplift forces.

Reinforce wood porch frames much as you would the roof-to- wall and wall-to-foundation for the home. A variety of connectors and strappings are made to support frames at the base and roof joints.

Aluminum porches and screen frames (often found around pool decks) are not designed to withstand hurricane force winds. As most aluminum porches are attached to the boards at the eaves of homes, the best mitigation is to ensure the board is well- reinforced to the roof structure to ensure the board continues connection to the home if the aluminum frame is damaged.

Insurance savings vary by company, location and your specific home. If you have multiple mitigation features, the percentages below cannot be combined to estimate an overall discount.

In general, anchoring your home includes the following savings:

Roof-to-wall connectors: Clip anchors - 35%

Single wrap anchors - 35%

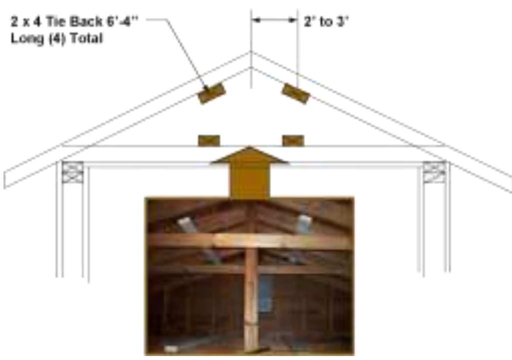
Double wrap anchors - 35%

The following specifications apply to the 2007 Florida Building Code. Once the 2010 Florida Building Code becomes effective specifications will vary.

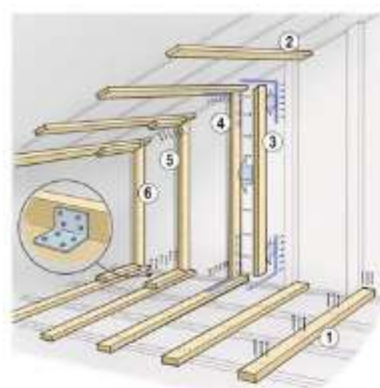
Gable Ends

Gable ends over 4 feet tall should be reinforced. Gables are typically the highest point of a home and are exposed to the highest-force winds.

Gable ends respond to pressure within the house by bowing in and out. This action looses the connections to the wall and roof. When reinforcing the roof-to-wall connections at the gable ends, also make sure you reinforce the connections at the base of the gable end to the wall below.



Mitigating gable ends includes two primary activities. First, by reinforcing the connections to the roof and the wall below. The second activity is to place four horizontal beams two to three feet from the point of the gable end. Horizontal beams should be at least six feet and long enough to connect to at least three attic floor framing boards and extend 2 1/2 feet past the third board. If there is a gap in connecting the horizontal beam to the gable wall, which is more common in block homes, use a wood shim to close the gap. The reinforcement of horizontal beams against the gable minimizes the bowing that occurs as pressure within the house varies during a storm.



In the picture above, the added horizontal frames are painted white so the mitigation is clear. When installing the horizontal beams, it may be best to install the lower beams first to extend the walking surface in the attic. Make sure you do not pinch wires between the boards as this may result in a fire hazard.

In some cases, an engineer may recommend multiple vertical beams attached to an existing stud and connecting to the horizontal beam. This creates a U-shape against the gable end wall. Connect the beam with an L-shape strap and reinforce with a block of wood at the joint to further compress the connection. The top of the retrofit stud should be cut square and does not have to match the pitch of the roof. Further secure the retrofit stud by applying construction adhesive along the sheathing (wall of the gable end).

The following specifications apply to the 2007 Florida Building Code. Once the 2010 Florida Building Code becomes effective specifications will vary.

Glazed Openings

Shutters have to be installed or closed before the arrival of a storm. As this requires action on the part of the resident, a variety of products exists to address varying abilities and preferences of residents.



Glazed openings refers to any opening that has a glazed surface. This includes windows, glass doors and glass block. Panel shutters are the most common type of covering for glazed openings and are available in a wide variety of materials and mounting options.

Panel shutters are mounted either by tracks or by small metal posts. Either option is a permanent feature to your home. For many, the appearance of tracks or posts on the side of their home is not aesthetically pleasing. Most recognize it is a valuable safety feature for high wind prone areas.

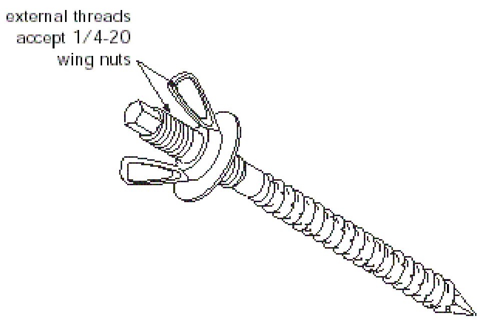
For those bothered by the appearance of tracks or posts, another option for windows and glazed surfaces within doors is to buy windows and doors with impact-resistant glass. These are more expensive and are not shatter proof. Replacement of impact resistant glass can be expensive. Replacement of cracked surfaces is a necessity in securing your home for high-wind storms.

While having impact-resistant glass windows prevent the need to shutter before a storm, impact-resistant glass windows are heavier, may be difficult to open for daily use and enjoyment, and do not prevent debris from entering a home if fractured. So the recommended mitigation is to shutter your home. Panels come in steel, lightweight aluminum, plexi-glass and cloth. In addition, shutters can be permanent fixtures and have a traditional appearance (good for registered historical homes and structures), be accordion, or be automated and roll down and lock with the click of a button.

Water can intrude around shutters and cause damage to frames both inside and outside the home. Make sure you inspect all openings before and after a storm to ensure water has not penetrated the walls of the home. If water penetrates the home and is left untreated, mold and mildew will grow quickly.

The picture on the left shows tracks installed above and below the opening. Before a storm arrives, the resident will slide and secure the panels into the tracks. The tracks are permanent installations.

The pictures below shows the post installed around a window that will be used to anchor the panel shutter. These posts are permanent installations and shutters are fastened with a wing- nut.



A quick, effective and easy shutter is a plywood board. There are various clips and braces that can be added to hold plywood in place. Plywood is cheap and easy to customize the size to fit any window. While thick plywood is an effective shutter, insurance companies are not required to provide discounts for plywood shutters.

If you want to install shutters yourself, first consider what type of shutter you want to install, any obstacles or outcrops around windows (including window sills and window AC units) and local building code permits. In some Florida communities shutters require local building permits. This is required to ensure effective and proper installation.

The anchor used for securing shutters is largely dependent on the type of wall (wood or block) and the type of shutter to be installed. If installing shutters yourself, make sure you follow all installation recommendations issued by the manufacturer.

Before installing shutters, inspect the framing around the windows and doors to ensure the framing is in good condition. If necessary, replace or reinforce framing and apply weathering strips or caulk to create a good seal around the windows and doors.

In many cases even shuttering a window will not prevent water intrusion. Sealing the window and framing is as important as shuttering.

Areas around doorways that have decorative glass and/or glazed surfaces should be shuttered. The picture above demonstrates a decorative feature that required shuttering of the entire area. Even though the glazed area is small, the decorative features weaken the wall and its ability to withstand high winds.

To qualify for insurance savings, all windows and doors must be shuttered or replaced with wind rated equivalent. Insurance savings vary by company, location and your specific home. If you have multiple mitigation features, the percentages below cannot be combined to estimate an overall discount.

In general, anchoring your home includes the following savings:

Basic shutters - 35%

Hurricane rated shutters - 44%

Homes that are built after 2001: Basic shutters & Hurricane rated shutters - 6%

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Doorways

For ease of accessibility, main doors should be replaced with hurricane rated doors. Garage doors should also be replaced. In some cases, existing garage doors can be braced.

Wind Resistant Doors

Wind resistant doors are generally heavy, solid doors. The most obvious feature of wind resistant doors is that it opens out. Wind resistant doors also have at least three and generally four mounting brackets with screws that are 2 1/2 to 3 inches long. This will ensure the door is connected to the door frame as well as the wall framing behind the door frame.

When replacing your door, ensure the framing is solid and if necessary replace and reinforce the framing. It is important to ensure the door is installed to manufacturer's specifications.

The hinges strengthen only one side of the door. On the other side is a bolt lock that should also be secure. The bolt lock should be 1" long to extend far enough into the frame to hold the door in a closed position.

Shuttering

French doors or double doors should be shuttered. French doors often fail at their connection point because the center beam is not designed to sustain the force of high winds.

When shuttering your home make sure you have multiple access points.

Garage doors should be shuttered, replaced with a wind rated door or in some cases can be reinforced by adding a bracing bar behind each panel. Using your car to brace your garage door will only result in your car being damaged with impact from the garage door. In addition, any glazed surface panels should be replaced with solid panels before the storm.

Wind rated garage doors are generally solid doors with extra bracing. The added weight of a solid door requires reinforced tracks and a stronger garage door opener.

Often during a hurricane, power is lost for a period of time. If there is a major storm, power may be out for days. Make sure the garage door opener has a manual release. Also, given the added weight of a wind rated garage door, the garage door should not be your primary exit. It may be difficult to open the door after a storm.

The insurance savings for doorways are part of savings for shuttering and glazed surfaces.

Florida Statute: 627.711 Notice of premium discounts for hurricane loss mitigation; uniform mitigation verification inspection form.—

(1)Using a form prescribed by the Office of Insurance Regulation, the insurer shall clearly notify the applicant or policyholder of any personal lines residential property insurance policy, at the time of the issuance of the policy and at each renewal, of the availability and the range of each premium discount, credit, other rate differential, or reduction in deductibles, and combinations of discounts, credits, rate differentials, or reductions in deductibles, for properties on which fixtures or construction techniques demonstrated to reduce the amount of loss in a windstorm can be or have been installed or implemented. The prescribed form shall describe generally what actions the policyholders may be able to take to reduce their windstorm premium. The prescribed form and a list of such ranges approved by the office for each insurer licensed in the state and providing such discounts, credits, other rate differentials, or reductions in deductibles for properties described in this subsection shall be available for electronic viewing and download from the Department of Financial Services' or the Office of Insurance Regulation's Internet website. The Financial Services Commission may adopt rules to implement this subsection.
(2)(a)The Financial Services Commission shall develop by rule a uniform mitigation verification inspection form that shall be used by all insurers when submitted by policyholders for the purpose of factoring discounts for wind insurance. In developing the form, the commission shall seek input from insurance, construction, and building code representatives. Further, the commission shall provide guidance as to the length of time the inspection results are valid. An insurer shall accept as valid a uniform mitigation verification form signed by the following authorized mitigation inspectors:

1.A home inspector licensed under s. 468.8314 who has completed at least 3 hours of hurricane mitigation training approved by the Construction Industry Licensing Board which includes hurricane mitigation techniques and compliance with the uniform mitigation verification form and completion of a proficiency exam;

2.A building code inspector certified under s. 468.607;

3.A general, building, or residential contractor licensed under s. 489.111;

4.A professional engineer licensed under s. 471.015;

5.A professional architect licensed under s. 481.213;

or 6.Any other individual or entity recognized by the insurer as possessing the necessary qualifications to properly complete a uniform mitigation verification form.

(b)An insurer may, but is not required to, accept a form from any other person possessing qualifications and experience acceptable to the insurer.

(3)A person who is authorized to sign a mitigation verification form must inspect the structures referenced by the form personally, not through employees or other persons, and must certify or attest to personal inspection of the structures referenced by the form. However, licensees under s.

471.015 or s. 489.111 may authorize a direct employee, who is not an independent contractor, and who possesses the requisite skill, knowledge and experience, to conduct a mitigation verification inspection. Insurers shall have the right to request and obtain information from the authorized mitigation inspector under s. 471.015 or s. 489.111, regarding any authorized employee's qualifications prior to accepting a mitigation verification form performed by an employee that is not licensed under s. 471.015 or s. 489.111.

(4)An authorized mitigation inspector that signs a uniform mitigation form, and a direct employee authorized to conduct mitigation verification inspections under paragraph (3), may not commit misconduct in performing hurricane mitigation inspections or in completing a uniform mitigation form that causes financial harm to a customer or their insurer; or that jeopardizes a customer's health and safety. Misconduct occurs when an authorized mitigation inspector signs a uniform mitigation verification form that:

(a)Falsely indicates that he or she personally inspected the structures referenced by the form;

(b)Falsely indicates the existence of a feature which entitles an insured to a mitigation discount which the inspector knows does not exist or did not personally inspect;

(c)Contains erroneous information due to the gross negligence of the inspector; or

(d)Contains a pattern of demonstrably false information regarding the existence of mitigation features that could give an insured a false evaluation of the ability of the structure to withstand major damage from a hurricane endangering the safety of the insured's life and property.

Notice of Premium Discounts for Hurricane Loss Mitigation

*** Important Information ***

About Your Personal Residential Insurance Policy

Dear Homeowner,

Hurricanes have caused tens of billions of dollars in insured damages and predictions of more catastrophic hurricanes making landfall in Florida have triggered increases in insurance premiums to cover potential future losses. Enclosed is information regarding wind loss mitigation that will make your home more resistant to wind and help protect your family during a catastrophic event. In addition to reducing your hurricane wind premium by installing mitigation features, you may also reduce the likelihood of out of pocket expenses, such as your hurricane deductible, you may otherwise incur after a catastrophic event.

What factors are considered in establishing my premium?

<u>Your location</u>: The closer you are to the coast, the more vulnerable you are to damage caused by hurricane winds and this makes your hurricane-wind premium higher than similar homes in other areas of the state.

<u>Your policy</u>: Your insurance policy is divided into two premiums: one for damage caused by hurricane force winds (hurricane-wind) and one for all other damage (all perils), such as fire.

<u>Your deductible</u>: Under the law, you are allowed to choose a $500, 2%, 5% or 10% deductible depending on the actual value of your home. The larger your deductible, the lower your hurricane-wind premium, however, if you select a higher deductible your out-of- pocket expenses in the event of a hurricane claim will be higher.

<u>Improvements to your home</u>: The state requires insurance companies to offer discounts for protecting your home against damage caused by hurricane winds. Securing your roof so it doesn’t blow off and protecting your windows from flying debris are the two most cost effective measures you can take to safeguard your home and reduce your hurricane –wind premium. These discounts apply only to the hurricane-wind portion of your policy.

The costs of the improvement projects vary. Homeowners should contact a licensed contractor for an estimate. You can find a Certified Contractor in your area by visiting the

Florida Department of Business and Professional Regulation online at www.myfloridalicense.com.

Your maximum discount: Discounts are not calculated cumulatively. The total discount is not the sum of the individual discounts. Instead, when one discount is applied, other discounts are reduced until you reach your maximum discount of 88%.

How can I take advantage of the discounts?

Homeowners will need a qualified inspector such as a general, building, or residential contractor licensed under Section 489.111, Florida Statutes, or a professional engineer licensed under Section 471.015, Florida Statutes, who has passed the appropriate equivalency test of the Building Code training program as required by Section 553.841, Florida Statutes, or a professional architect licensed under Section 481.213, Florida Statutes, or a building code inspector certified under Section 468.607, to inspect the home to identify potential mitigation measures and verify improvements. For a listing of individuals and/or inspection companies meeting these qualifications contact your insurance agent or insurance company.

Description of Feature	Estimated* Premium Discount Percent	Estimated* Annual Premium ($) is **Reduced** by:
Roof Covering (i.e., shingles or tiles)		
• Meets the Florida Building Code	11%	
• Reinforced Concrete Roof Deck (If this feature is installed on your home you most likely will not qualify for any other discount.)	82%	

Description of Feature	Estimated* Premium Discount Percent	Estimated* Annual Premium ($) is **Reduced** by:
Roof-to-Wall Connection		
• Using "Toe Nails" – defined as 3 nails are driven at an angle through the rafter and into the top roof.	0%	
• Using Clips - defined as pieces of metal that are nailed into the side of the rafter/truss and into the side of the top plate or wall stud	35%	
• Using Single Wraps – a single strap that is attached to the side and/or bottom of the top plate and are nailed to the rafter/truss	35%	
• Using Double Wraps - straps are attached to the side and/or bottom of the top plate and are nailed to the rafter/truss	35%	
Roof Shape		
• Hip Roof – defined as your roof sloping down to meet all your outside walls (like a pyramid).	47%	
• Other	0%	
Secondary Water Resistance (SWR)		
• SWR – defined as a layer of protection between the shingles and the plywood underneath that protects the building if the shingles blow off.	6%	
• No SWR	0%	
Shutters		
• None	0%	
• Intermediate Type —shutters that are strong enough to meet half the old Miami-Dade building code standards	35%	
• Hurricane Protection Type -- shutters that are strong enough to meet the current Miami-Dade building code standards	44%	

Homes built under the 2001 building code and later

Description of Feature	Estimated* Premium Discount Percent	Estimated* Annual Premium ($) is **Reduced** by:
Homes built under the 2001 Florida Building Code or later edition (also including the 1994 South Florida Building Code for homes in Miami-Dade and Broward Counties) are eligible for a minimum 68% discount on the hurricane-wind portion of your premium. You may be eligible for greater discounts if other mitigation features are installed on your home.	68%	
Shutters • None • Intermediate Type —shutters that are strong enough to meet half the old Miami-Dade building code standards • Hurricane Protection Type -- shutters that are strong enough to meet the current Miami-Dade building code standards	 0% 6% 6%	

Local Disaster Related Organizations

National disaster response organizations, local community response organizations, faith-based organizations and long-term recovery organizations all play a significant role in recovering from a disaster.

Florida knows the value of volunteers!

Support your local disaster organizations...they'll be there when you need them.

Important Message from Florida's Foundation...

Our mission is to strengthen Florida by making positive changes in the lives of Florida's families through initiatives, like disaster mitigation. In our daily role of providing administrative oversight of Florida's Disaster Fund we are directly invested in ensuring Florida's citizens, particularly those whose homes are their primary asset, are able to withstand a disaster and return safely to their pre-disaster lives.

It is this goal that we developed this program to inform you, Florida's homeowners, of the multiple resources available to assist in fortifying your home. We hope you find this manual useful and informative.

As Floridians, we all live one-half of the year (June 1 - November 30) in hurricane season. Together we can build smarter and minimize the devastation of mother nature.

Special Thanks to....

Florida Division of Emergency Management, Florida's Disaster Fund, Insurance Institute for Business and Home Safety, Blueprint for Safety, Federal Alliance for Safe Homes, Federal Emergency Management Agency, Florida Building Commission and the Florida Interfaith/Inter-Agencies Networking in Disaster for pictures and technical guidance.

Preparedness Checklist

❍Get A Plan! www.FloridaDisaster.org

❍Have current information www.FloridaEvacuates.com

❍Supply kit, including food, water, clothing (for all types of conditions), and toiletries

❍ First aid supplies, disinfectant and medications

❍ Radios, flashlights, air-horn

❍ Garbage bags and waterproof containers for storage

❍ Dust mask and other tools

❍ Toys, books and games

❍ Important documents, including insurance, medical records, bank account and social security information

❍ Contact information of family and friends

❍ Specific items needed for your family including items for infants, elderly and disabled

❍ Vehicle tanks filled with fuel

❍ Let others know your disaster plans, especially those out of state and out of immediate disaster area

❍ Keep driveway accessible with overhead clearance for emergency vehicles

❍ Obtain a NOAA weather radio and check often to make sure it is still working, replace batteries

❍ Home clearly labeled with number for emergency crews

❍ If there are special needs, including medical (insulin, oxygen) make sure you are on the county’s special needs listing before a disaster warning

❍ Stay informed and heed warnings from local and state government officials

❍ If you want to help volunteer for recovery, sign up before a disaster warning, get trained and be ready to assist when called - do not just show up on at a disaster response site.

Disaster Specific Items

- ❍ Wind: Anchor lawn items, including furniture, grills and potted plants by bringing indoors or sinking in swimming pool
- ❍ Wind: Remove gravel and replace with mulch
- ❍ Wind: Put up hurricane shutters and gable/soffit vent covers
- ❍ Fire: Extinguishers in house and easy to access
- ❍ Fire: Smoke alarms working
- ❍ Fire: Areas kept free of clutter and debris, including pruning limbs and clearing underbrush
- ❍ Fire: Trim hedges and tree limbs away from house
- ❍ Fire: Plant only low- flammability plants near home
- ❍ Flood: Elevate air conditioning unit and other major appliances
- ❍ Flood: Clear all drains
- ❍ Flood: Installed back-flow valves on primary drains
- ❍ Earthquake: Anchor bookcases, file cabinets, mirrors and fuel tanks.

Second Section

Executive Summary

A research project has been conducted to estimate the effects of wind-resistive building features in reducing hurricane damage and loss to single family and multi-family residential structures located in the state of Florida. This project is the first attempt to systematically update previously developed loss mitigation relativities (ARA, 2002a and 2002b).

The scope of this project has included residences built prior to the introduction of the Florida Building Code 2001 (pre-FBC era) and residences built in the post-FBC period. In order to reflect windresistive design improvements implemented in the FBC, the post-FBC construction period includes two eras: FBC 2001 and FBC 2006 (i.e., the 2006 revisions to the 2004 FBC). The technical approach used in this study is based on the analysis of individually-modeled buildings at numerous locations in Florida. For post-FBC construction, the buildings were designed to the FBC 2001 and FBC 2006 according to the design wind speed, wind-borne debris region, and FBC definitions of Terrain Exposure. Each building has been modeled with a specific set of wind resistive features. There are two broad classes of buildings: single family houses and multi-family (5 or more units) residences. The multi-family residences include three groups, based primarily on building height and roof deck material: Group I (less than 60 feet tall with wood roof decks), Group II (less than 60 feet tall with non-wood roof decks), and Group III (more than 60 feet tall).

The loss mitigation features considered in this project are summarized in the following table:

Single family and Group I Multi-family		*Groups II and III Multi-family*	
2002 Features	*Features Added in 2008*	*2002 Features*	*Features Added in 2008*
• Terrain • Roof Shape • FBC, Non-FBC Roof Cover • Secondary Water Resistance • Roof-to-Wall Connection • Roof Deck Material/Attachment • Opening Protection • Gable End Bracing • Wall Construction • Wall-to-Foundation Restraint	1. Number of Stories 2. Roof Cover Material 3. Roof Slope 4. Soffit Construction 5. Vinyl Siding 6. Window/Door Water Leak Potential 7. FBC Roof Cover Age 8. Group I Only: Parapets and Rooftop Equipment 9. Minimal Condition Requirements	1. Terrain 2. Design Building Code 3. Design Windspeed 4. FBC, Non-FBC Roof Cover 5. Opening Protection 6. Roof Deck Material 7. Secondary Water Resistance	1. Parapets 2. Rooftop Equipment 3. Window/Door Water Leak Potential 4. FBC Roof Cover Age 5. Minimal Condition Requirements

The new features included in this study reflect knowledge gained from damage surveys and engineering data analysis. The minimal condition requirements, added in 2008, include conditions for roof cover, roof deck, and windows/doors. These components should be in a reasonably good and acceptable condition for the building to receive any wind mitigation rate differentials. Definitions and requirements for wind mitigation features are summarized in Appendix A.

A major task in this project included the analysis of insurance and damage data from the 2004 and 2005 Florida hurricanes and engineering data from laboratory tests and wind tunnel experiments. The key conclusions from the analysis of the 2004 and 2005 insurance loss data include:

1. Post-FBC (permitted after March 1, 2002) homes have losses 75 to 90% lower than pre-FBC homes.
2. Two-story homes, on average, have 31% higher losses than one-story homes.
3. Gable roof houses have 14 to 28% higher losses than hip roof houses.
4. Tile roof houses have 28% higher losses than shingle roof covers.
5. Opening protection on windows significantly reduces losses (39%).
6. Houses located in Terrain B (suburban) have significantly reduced losses (49%) over houses located in Terrain C (open).
7. Houses with several mitigation features have notably reduced losses (53-67%) over houses with no mitigation features.

Given the limitations of these data, the insurance loss results should be viewed as simply rough empirical measures. However, the trends are significant and provide some confidence in the magnitude of the modeled loss reductions predicted in 2002 and updated herein.

The results of the wind mitigation analysis are presented in the form of “loss relativity” tables. These tables are based on computations of average annual loss and measure the loss reduction effectiveness of all possible combinations of the modeled wind mitigation features. The tables provide a convenient way to “look-up” the effectiveness of wind mitigation features on any building. The loss relativities were developed for 2% deductible. The loss relativities can be used directly to compute insurance rate differentials on the wind premium. The rate differentials only apply to the portion of the wind premium associated with the dwelling, its contents, and loss of use (not any attached or detached structures). Attached and detached structures are not built to the same standards as the dwelling and must be excluded from rate differentials; the study also assumes that insurance coverage for attached and detached structures includes a separate deductible that does not accrue to the dwelling deductible.

Significant reductions in loss (lower loss relativities) are achieved on all building types when they have the appropriate wind mitigation construction techniques. While these reductions are similar in magnitude to the results obtained in the 2002 studies, the additional construction features included in this study result in a broader range of loss reduction relativities, when measured from the “weakest” building. The loss reductions for the strongest pre-FBC era buildings and all post-FBC constructed buildings, as measured from the “weakest” modeled building, are generally greater than 80% for single family and Group I multi-family residences and on the order of about 55% to 80% for Group II and III buildings. When measured from a “typical” pre-FBC strength building, loss reductions for post-FBC buildings range from 10 to 70%, with a typical reduction of about 50%. These loss reduction differences are based on hundreds of thousands of simulated years of hurricanes and therefore include the full statistical range of weak to maximum intensity hurricanes. One would not expect to see these magnitudes of loss reductions in weak or moderate intensity hurricanes.

A key focus of the loss relativity development has been to capture the ongoing improvements in wind mitigation knowledge and techniques. While the details of the proper interpretation and application of rate differentials contained herein may be viewed by some as overly complex, the procedures reflect both the inherent variations in construction techniques as well as the engineering details embedded in the FBC. Over simplification of the measures of loss reduction (e.g., by simplifying the results to smaller tables with fewer features) also seems counter to the state‟s investments in improving the building code as well as in promoting public awareness of mitigation techniques. Eliminating features for the purpose of achieving simplicity would also result in lost opportunities for both awareness and mitigation of those features (including code-plus construction). We note that a 1% reduction in average annual residential loss in Florida would amount to an annual statewide loss reduction savings of about $50 million in 2008 dollars. Each 1% loss reduction that we can wring out of new construction (through FBC improvements) and existing construction (through mitigation) will result in long-term exponential reductions in statewide losses.

These results do not include recent research on terrain effects and wind-borne debris, which has been funded by the state over a three-year period. That research was conducted under a separate project and was not completed in time to meet the schedule requirements of this project. However, that work is now ready for integration and should be incorporated immediately into an update of the loss relativities. This integration will address several shortcomings of this work and is also essential to producing a consistent set of wind loss mitigation measures usable in a statewide uniform grading scale. We recommend that this integration and update proceed immediately prior to implementation of these loss relativities as wind mitigation rate differentials.

Introduction

Objective:

The objective of this project is to evaluate windstorm loss relativities for construction features including, but not limited to, those which enhance roof strength, roof covering performance, roof-to-wall strength, wall-to-floor-to-foundation strength, opening protection, and window, door, and skylight strength.

Two previous studies were performed in 2002 to quantify wind loss reduction for wind mitigation construction features. “Development of Loss Relativities for Wind Resistive Features of Residential Structures” focused on single-family homes (ARA, 2002a). “Development of Loss Relativities for Wind Resistive Features for Residential Buildings with Five or More Units” addressed condominium and renter occupancies in buildings with five or more units (ARA, 2002b).

This document addresses both single-family and multi-family residences. It provides data and information on the estimated reduction in loss for wind-resistive building features for residential property insurance. It provides a technical basis for actuarially reasonable discounts, credits, or other rate differentials, for construction techniques demonstrated to reduce the amount of loss in a windstorm.

Scope

The scope of this study includes, as a minimum, the wind resistive features called out in the Florida statutes, namely:

1. Enhanced Roof Strength
   a. Roof deck connection to roof framing
   b. Roof deck material and strength
2. Roof Covering Performance
3. Roof-to-Wall Strength
4. Wall-to-Floor-to-Foundation Strength
   a. Wall-to-floor strength
   b. Floor-to-foundation strength
5. Opening Protection
   a. Windows
   b. Doors
   c. Skylights

Additional features are examined in this study. These additional features include features that influence wind losses and features that mitigate wind losses. These features have been identified from hurricane damage surveys, insurance loss data, and engineering data.

The scope is limited to single-family and multi-family residential buildings. Commercial occupancies are not considered.

A major element of the scope of this study is the requirement to consider and analyze the loss data from the 2004 and 2005 Florida hurricanes. These data include both damage survey data and insurance company loss data. The insurance loss data include both policy level loss amounts ($) by coverage type and detailed claim level data. Claim data include detailed item-by-item information on the physical damage to the structure, as well as loss information (i.e., the costs for repair, replacement, contents, attached and detached structures, and loss of use). A major thrust of this project is to analyze as much insurance data as is possible within the project‟s schedule and budget constraints.

This study uses hurricanes as the windstorm to quantify the loss relativities. Hurricanes dominate the severe wind climate in Florida and, hence, are the primary contributors to windstorm loss costs.[1] This approach is consistent with the FBC design windspeed map, which is based on hurricane winds.

The scope of this project includes residential buildings built prior to the statewide adoption of the Florida Building Code (FBC) in March 2002 (the 2001 FBC edition) and residential buildings built after the statewide adoption of the FBC. These eras are referred to as "pre-FBC" and "post-FBC," respectively.

[1] Thunderstorm winds, tornadoes, and the occasional extra-tropical cyclone can also produce high winds in the state (see Section 2.4.3). However, hurricanes have the greatest potential for widespread catastrophic damage and are therefore used herein as the wind hazard for the development of the wind loss mitigation relativities. In general, wind mitigation against hurricane winds is also effective in reducing losses for these other windstorms.

The mitigation features must be practically verifiable so insurers can be reasonably confident a particular residential building qualifies for the rate differentials. Hence, the scope of consideration for wind loss mitigation construction features must be limited by the capability to inexpensively verify.

The scope of work also implies that the measures of construction feature effectiveness in reducing windstorm loss (i.e., “the loss relativities”) are to be converted to “insurance rate differentials”. Hence, this study also outlines the simple conversion step from “wind mitigation loss relativities” into “insurance rate differentials.”

This study is intended to provide a complete update to the wind loss relativity studies published in 2002 (ARA, 2002a and 2002b). The work is based on new and standalone analyses, new data, and improved technical modeling capabilities. The results herein are therefore not constrained to “match or replicate” the 2002 loss relativity results.

Review of 2002 Studies

The 2002 Loss Relativity Studies (ARA, 2002a and 2002b) were the first-ever comprehensive approach to develop a modern wind loss classification system and systematically quantify wind mitigation loss relativities for single- and multi-family residences. The basic approach used in the 2002 studies was to estimate how loss costs change with wind resistive fixtures and construction techniques by using engineering analysis and repair/replacement cost methods for individually-modeled buildings.

Three-dimensional models of buildings were developed with and without specific wind-resistive fixtures. These buildings were then analyzed for hurricane damage and loss using load and resistances modeling techniques, consistent with modern engineering design methods. Monte Carlo Simulation was used to analyze thousands of hurricanes striking each modeled building at specific locations in Florida. Analysis of this simulation data provided the statistics to quantify losses and the effectiveness of specific combinations of wind mitigation features.

The 2002 loss relativity reports documented a number of assumptions and limitations. For the single family residences, one of the major qualifications included the fact that only one story houses were modeled. This limitation is addressed in this study by treating both one- and two-story houses. The 2002 single family study treated only shingle type roof covers. Both shingle and tile roof covers are treated herein. New research on roof slope has been completed and is incorporated in this research. Soffits are also included as a new factor. Wood panel shutter impact tests were conducted in 2003-4 and these results have been considered in this work. For the multifamily residences, rooftop equipment and parapet height on flat roof structures are introduced as new factors. Related research on wind-borne debris, residential building spacing, and terrain effects on wind loads has progressed since the 2002 studies, but this research was not fully completed in time to be included in this work. There are many other possible factors that could be considered separately (such as skylight, porches, built-in garages, metal roofs, tree fall, etc.). For now, these factors are assumed to be built into the overall loss estimations through the statistical relationships in the damage-to-loss model.

Building Features that Influence Hurricane Damage and Loss

This section includes materials from the 2002 studies with updates. Single family residential features are discussed in Section 1.4.1 and multi-family features are discussed in Section 1.4.2.

Single-Family Residences

For many years, engineers have focused on the structural frame and load-path issues in designing buildings for wind loads. However, beginning in the 1970"s, engineers began to document the importance of the building envelope (roof deck and covering, roof-to-wall connection, windows, doors, etc.) performance in influencing the resulting financial loss experienced by buildings in windstorms. In many storms, the building frame performed adequately, but the windows and/or doors failed, often due to impact by wind-borne debris. Roof covering was almost always damaged, resulting in water penetration into the building, particularly for hurricanes.

Damage and the ensuing losses to residential buildings were found to be governed by the performance of the building envelope, including many non-engineered components, such as roof covering, windows and doors, roof sheathing, garage doors, etc. The failure of soffits (usually vinyl or aluminum) can lead to water entering the attic space as well as internal pressurization of the attic space. The key structural frame connection for most failures was the roof-to-wall connection. Foundation failures and frame failures, other than the roof-to-wall frame connection, were found to be extremely rare for site-built houses, except in intense tornadoes. In most cases, if damage to the frame or foundation did occur, it was preceded by the failure of other components.

These observations stand in sharp contrast to earthquake induced damage to buildings, which is governed primarily by the building foundation and building frame performance.

Figure 1 illustrates the key building envelope features for site-built houses that affect hurricane damage and loss. Figure 2 illustrates how the loads increase dramatically once the building envelope fails. Failure of a small opening can lead to large internal pressures. These pressures act outward on the walls and roof on the leeward and back side of the building and can result in a doubling of the loads on the building envelope. This phenomenon is why the failure of a window often produces a progression of failures in the roof deck, whole roof, or other openings that quickly lead to large insurance losses.

Roof Covering. Roof covering performance (Figure 3) is important since partial loss of the covering allows hurricane rain water to enter the building. Hurricanes are tropical storms and rain is always an integral part of the storm. Once water enters the building, the losses begin to increase dramatically. Drywall, electrical, floor coverings, and contents are easily damaged and the losses mount up quickly. Review of insurance claim folders supports these observations.

Another major problem with roof coverings is the fact that failure of the covering produces debris that is accelerated by the wind and becomes airborne “missiles” capable of easily damaging unprotected glazing. Figure 4 shows the typical case of roof covering failure from a house that produced impacts and multiple penetrations of the neighboring house. The cost of replacing the damaged roof cover varies with the roof covers type. Tiles roofs are typically cost 2 to 5 times more than shingle roofs (depending on the tile type), thus in cases where the only damage to a house involves the replacement of the entire roof cover, the insurers costs are clearly much higher in the case of equally damage tile vs. shingle homes.

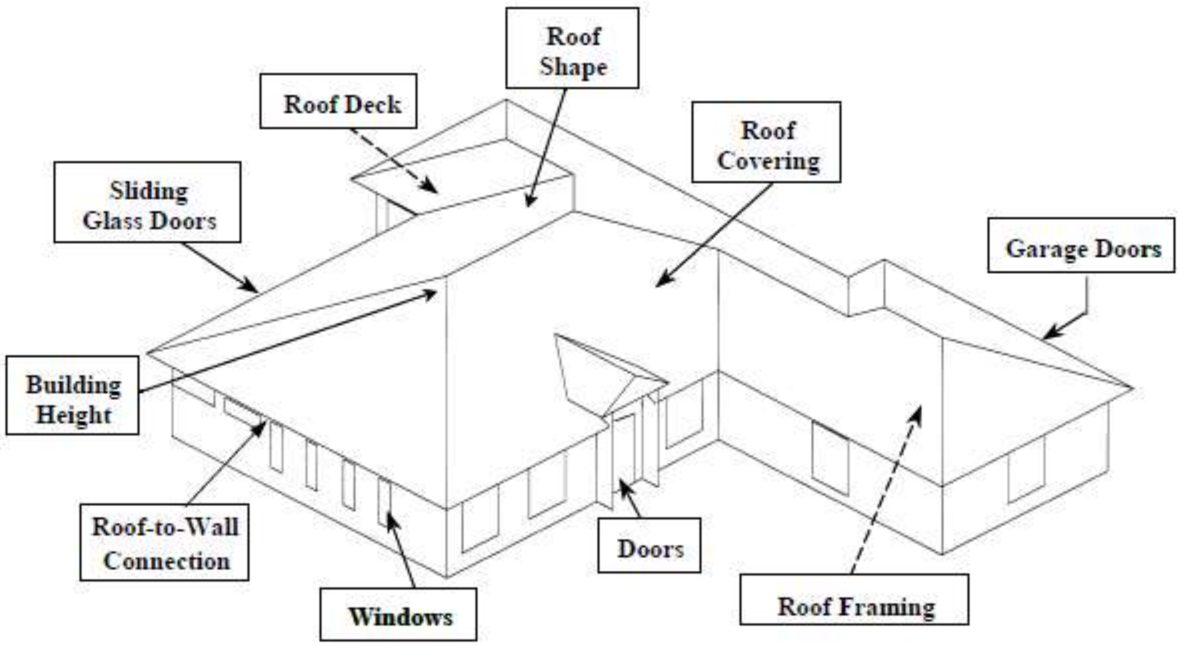

Figure 1. Building Envelope Features that Control Damage and Loss.

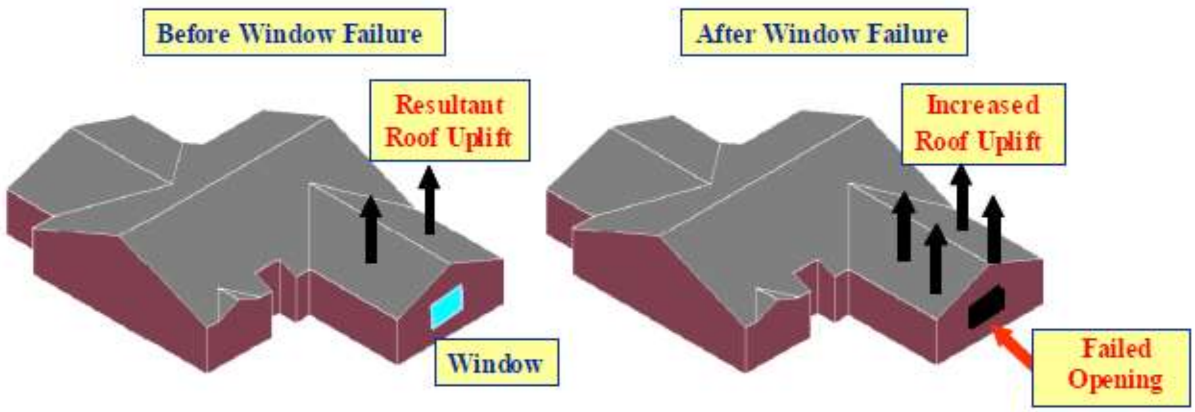

Figure 2. Protection of Wall Envelope Reduces Chanced of Internal Pressurization.

Figure 3. Loss of Roof Covering Leads to Interior Water Damage.

Figure 4. Loss of Roof Covering Produces Wind-Borne Debris.

Roof Deck. Roof deck attachment during a hurricane is critical to the survival of the building (Figure 5). Once a building looses one or more pieces of roof deck, the losses increase exponentially due to the vast amount of water that enters the building. Field observations and insurance claim folders indicate that the house quickly becomes a major loss once the roof deck begins to fail in a hurricane. In other words, even if the walls are intact and the roof trusses do not fail, loss of roof deck and a few windows typically leads to losses greater than 50% of the insured value.

Figure 5. Roof Deck Performance, Hurricane Andrew.

Roof-to-Wall Connection. One of the most important connections in a house is the roof-to-wall connection. The critical loads on the roof are negative (suction) pressures that produce uplift forces on the roof. Toe-nailed roof-to-wall connections, a relatively common building practice in the past, are especially vulnerable to failure (Figure 6). Properly installed hurricane straps that connect the roof truss to the wall frame generally provide for adequate resistance to uplift roof failures. Houses with gable ends are also vulnerable to gable end wall failures (Figure 7), although these failures are not, on average, large contributors to loss.

Figure 6. Roof Truss/Rafter to Wall Connection.

Figure 7. Gable End Failure, Hurricane Andrew.

Roof Shape. The shape of the roof influences the aerodynamic loads experienced by the roof covering, roof deck, roof framing and connections. Figure 8 illustrates gable and hip houses at Navarre Beach (on the same street), following Hurricane Erin in 1995. Gables, on average, do not perform as well as hips due to roof shape aerodynamics and the lack of roof-to-wall connections on all 4 sides of the house. Roof slope has an effect on the building aerodynamics.

Low slope roofs (around 4:12) are very common in Florida, but the maximum uplift pressures near the gable ends decrease with increasing roof slope indicating that information on roof slope might be important in assessing loss potential.

Openings. Openings include windows, doors, skylights, garage doors, etc. As illustrated in Figure 9, openings can fail in various ways. The most common is from impact by wind-borne debris. Once the building envelope is breached, the internal pressures build up and increase the likelihood of roof failures. Garage doors (Figure 10) and other doors and skylights are also vulnerable to failure. Any glazed opening, unless it is protected or is impact-resistant, is highly vulnerable to failure from flying debris.

(a) Gable – 1 *(b) Gable - 2*

(c) Hip - 1 *(d) Hip - 2*

Figure 8. Performance of Same Street Hip and Gable Houses at Navarre Beach during Hurricane Erin.

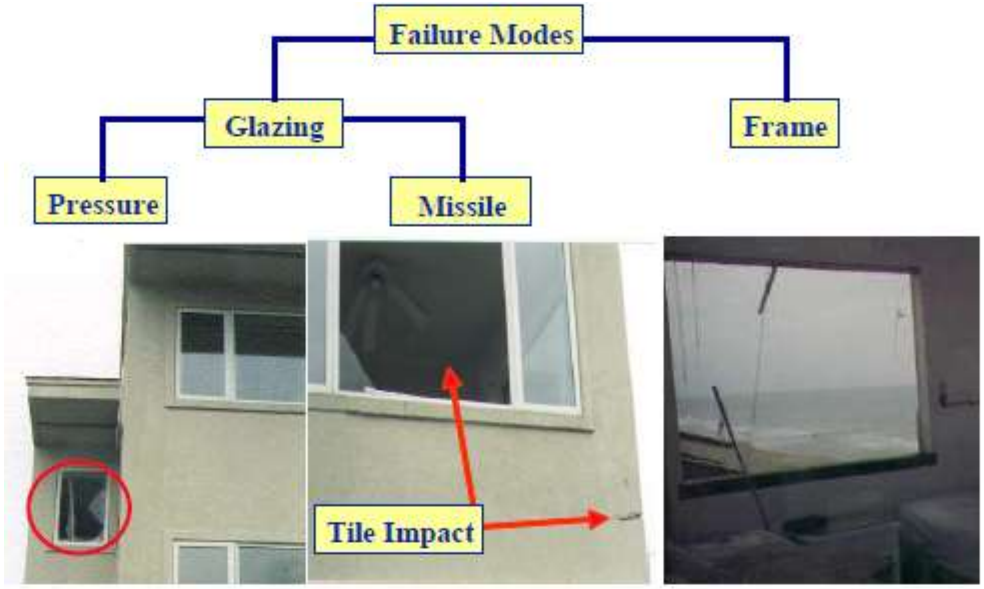

Figure 9. Failure Modes for Windows and Openings.

Figure 10. Garage Door Performance.

The fact that windows and doors have movable parts and do not seal perfectly when closed makes them vulnerable to leak during a hurricane. Rain water can be forced through these gaps as a result of the pressure differences across the building envelope. The resulting water leaks through window and door systems contribute to interior losses.

Soffits. Failure of soffits (usually being sucked down from the eaves) often leads to the water getting into the attic space. After the soffits fail, when the wind direction changes so that positive pressures are experienced on the wall beneath the soffits and the soffit space itself, then rain water is forced up into the attic space. This rain water soaks the insulation and can cause the drywall ceilings to collapse onto the floor and furnishings beneath. Figure 11 presents examples of failed soffits that occurred during Hurricane Charley.

Foundation. Wall-to-floor-to-foundation failures are rare for site-built buildings. The most vulnerable houses are low-value buildings that sit atop concrete blocks (Figure 12) and have no uplift or lateral restraint. Houses built on stem walls or slabs on grade generally have significant resistance to uplift and lateral forces. They are much more likely to fail in one of the other modes described above. Gravity loads and minimal overturning/sliding resistance is more than adequate to resistance foundation failure of most site-built houses. For houses on piers, bolted or strapped connections designed to carry the loads into the piers generally perform adequately. Foundation failures of site-built houses in hurricanes are almost always caused by storm surge and not wind.

Figure 11. Failed Vinyl Soffits in Hurricane Charley.

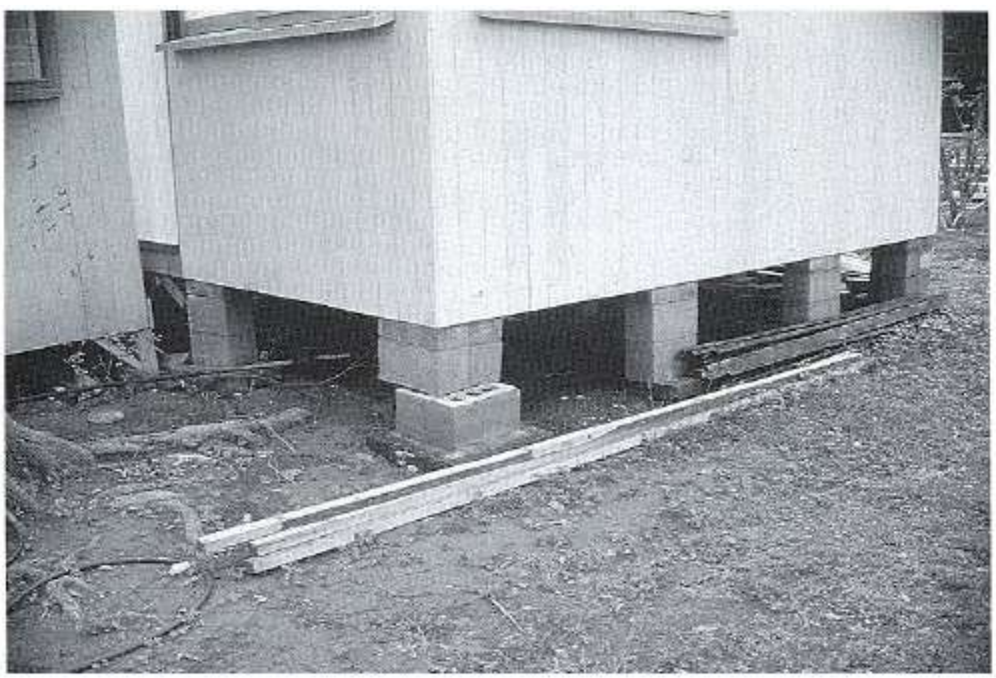

Figure 12. Sliding Block Foundation in Hurricane Iniki.

Terrain Features. The effects of terrain (surface roughness) strongly influence the near-ground windspeeds and wind loading environment on buildings. Generally recognized terrain categories include open (Exposure C) and suburban (Exposure B). Two potentially significant extensions to the treatment of terrain are treed terrain and Exposure D terrain (winds blowing from the ocean). In treed terrain, the trees significantly reduce windspeeds compared to a typical open terrain. In the Exposure D, the windspeeds are greater than those in open terrain.

The terrain exposure for a building has a significant impact on the effectiveness of wind loss mitigation features. Terrain is both a building code consideration and an important loss mitigation consideration.

Treed terrain reduces the windspeeds near the ground and the resulting wind loads acting on the buildings and the direct wind damage. Trees also have the potential to fail during wind storms and damage buildings and attached structures.

Figure 13 is an aerial view of treed terrain in the Panhandle area following Hurricane Ivan. The trees extend into and around the subdivisions and there are small patches of open terrain in the golf course areas. The red dots are blown-down trees. Analysis of insurance claim data for Ivan indicated that the losses in these treed areas were about ½ that of the losses for homes directly on the coast. Figure 14 shows ground level views of treed terrain with residential buildings. The effect of trees includes both the beneficial effects of reducing windspeeds on lowrise buildings and the harmful effects of the risk of property damage and personal injury from tree fall on residences. On average, trees reduce losses, but there are cases in every hurricane where large trees fall and hit small buildings, sometime with deadly results. Additional research is needed to determine the practicality of protecting homes from catastrophic tree fall damage, including strengthening the structure at the eaves sufficiently to stop reasonably large trees from slicing through the structure. In treed terrain, this type of mitigation is expected to more effective than investing in wind pressure related mitigation, since the windspeeds are dramatically reduced below the tree canopy.This research should be completed and integrated into the wind loss mitigation loss relativities as soon as practical, since many residential regions in the northern half of Florida are located in treed terrain.

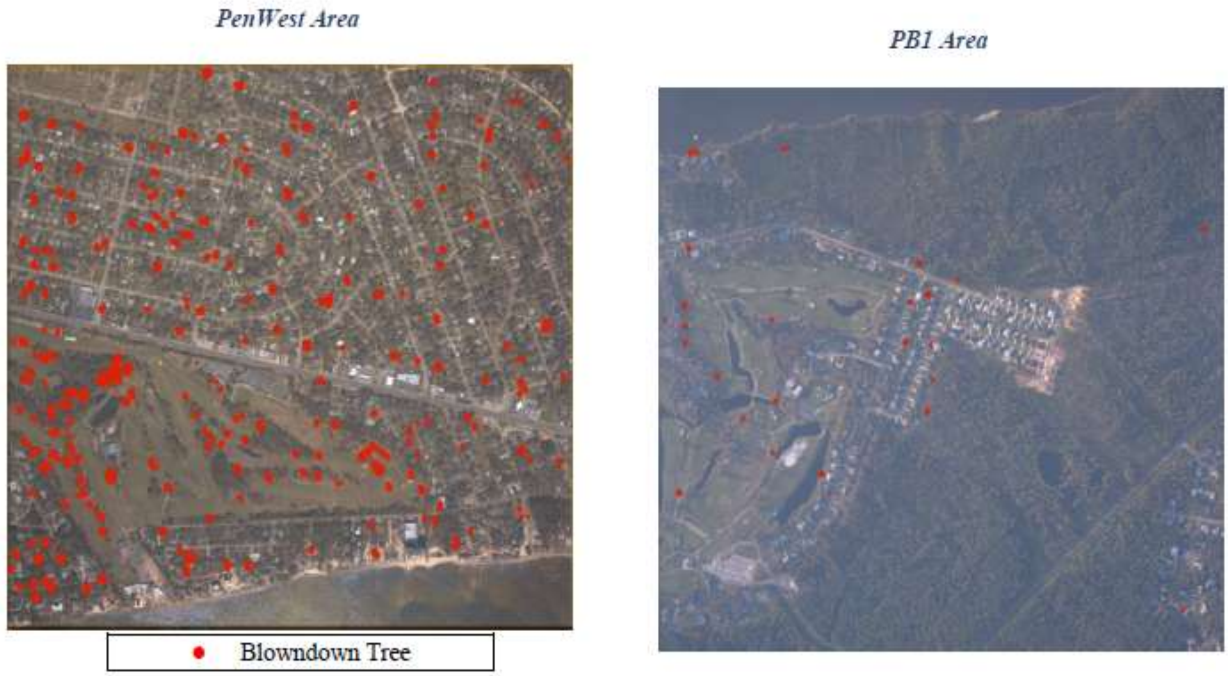

Figure 13. Treed Terrain and Tree Fall in Hurricane Ivan.

Figure 14. Trees Reduce Windloads but Introduce Tree Fall Risk.

For Exposure D locations, such as on barrier islands, hurricane losses are influenced by additional factors such as:

1. Salt water intrusion into the buildings, producing more damage than produced by rainwater entering the building
2. Increased damaged caused by limited access back to the island after the storm, preventing the owner from initiating temporary repairs to prevent subsequent damage and loss
3. Generally increased loss of use cost due to restricted access to barrier islands
4. Longer periods of time without power (thus preventing rapid drying out of the building)

Due to time constraints, quantitative assessments of treed and Exposure D terrains were not included in this project.

Multi-Family Residences

The performance of a multi-family residential building in a hurricane is also governed by the performance of the building envelope. Most of the potential failure models that are observed in single- family residences are also observed in the multi-family residences, particularly in the case of the smaller wood frame and masonry multi-unit residential buildings. Flat roof buildings are more common in multi- family construction, and thus additional modes of failure unique to flat roofs play a more important role in multi-family construction as compared to single-family construction. The ability to place HVAC units on the roofs of flat roof buildings adds a frequently observed failure mode that is not seen in the case of sloped roof buildings. Figure 15 shows some of the key building components responsible for producing loss in hurricanes in a typical multi-family residence. The follow sections present examples of some of the more commonly observed failure modes on multi-family units.

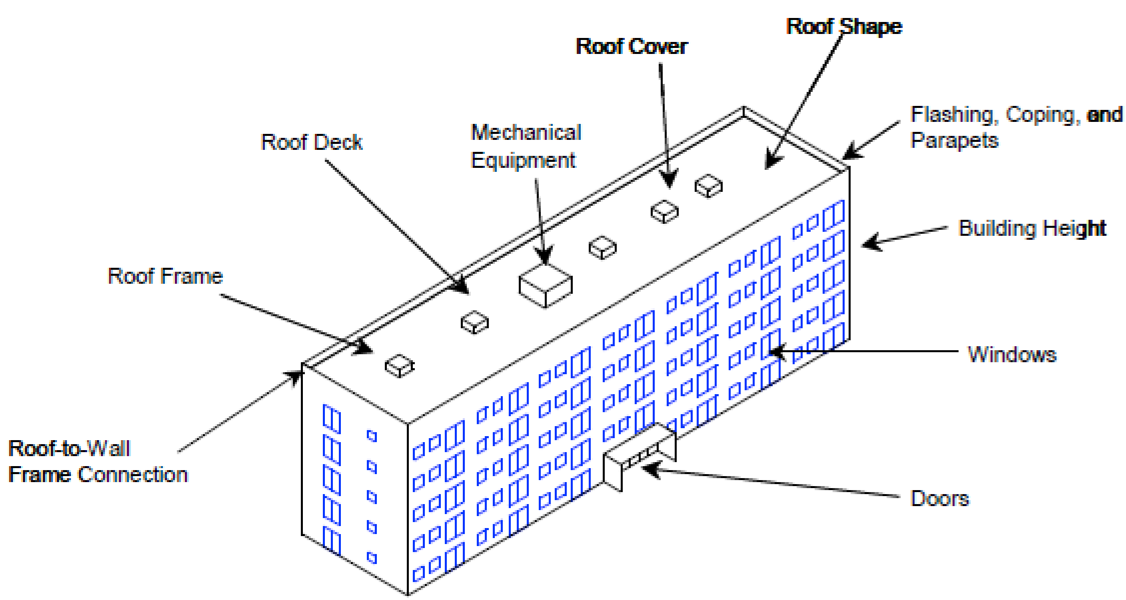

Figure 15. Features that Control Hurricane Damage and Loss for Buildings with 5 or More Units.

The performance of shingles and tiles on low-rise multi-family buildings is similar to that seen for single-family buildings. Figure 16 illustrates partial loss of roof cover on a condominium building in Hurricane Erin.

Figure 16. Shingle Damage to Condominium Building from Hurricane Erin.

A large number of multi-family dwellings are constructed with flat roofs with a single ply membrane, modified bitumen, or built-up roof. Figure 17 show some examples of failed single ply membrane roofs. In addition to being attached to the roof with mechanical attachments or being adhered to the roof, membranes can be held to the roof using ballast. The ballast is usually gravel or paving stones. Ballasted roofs make up a relatively small percent of the population of flat roofs.

Figure 17. Examples of Single Ply Membrane Failures on Multi-Family Housing Units.

Figure 18 shows an example of the interior damage caused by the loss of a single ply membrane roof. In most cases, the failure of a built-up roof, a single ply membrane roof or a modified bitumen roof initiates when the flashing at the edges of the building fails.

Figure 18. Interior Damage to Condominium Caused by Water from Failed Roof Membrane.

Figure 19 shows an example of the failed flashing at the edge of a modified bitumen roof. Failure of single ply membrane roofs can also be initiated by tearing of the membrane caused by the impact of flying debris and by tearing caused by rooftop equipment becoming dislodged in high winds. On buildings with single ply membrane roofs, built-up roofs, or modified bitumen roofs, once the initial failure begins, a progressive failure generally follows, with the roof cover peeling away from the roof deck. This progressive failure mechanism often results in large areas of the roof deck being exposed to the rain.

Figure 19. Example of Edge Flashing Failure on a Modified Bitumen Roof.

Performance of Roof Deck. As in single-family construction, the performance of the roof deck is critical to the overall performance of the entire building in a hurricane. Once a portion of the roof deck fails, significant quantities of water begin to enter the building causing rapid and extensive damage to the interior of the building and its contents. Figure 20 shows examples of roof sheathing damage to multi-family housing units.

Rooftop Equipment. Flat-roofed buildings often have air conditioning and other equipment on the roof deck. The tie-down connections and water proofing details around this equipment are important to the roof cover and roof deck performance (see Figure 21). Figure 22 illustrates the failure of poorly attached air conditioning (AC) units on a condominium building. When rooftop equipment fails, depending on the type of equipment, the equipment can either leave a large opening beneath its original location or, more frequently, perforate the roof membrane when it rolls, tips, or slides from its original location. Once the roof membrane is perforated, rain water enters the building and losses escalate rapidly.

Figure 20. Examples of Roof Sheathing Failures in Multi-family Housing Units.

Figure 21. Multi-Level Flat Roof with Numerous Equipment and Architectural Frame Penetrations.

Figure 22. Example of Failed Rooftop AC Units on High Rise Condominium Tower.

Roof-to-Wall Connections. The failure of roof-to-wall connections results in enormous damage to a building, in most cases causing a loss that approaches the full insured value of the building and its contents. In the case of wood roofs, the construction characteristics of multi-family buildings are often the same as those used in single-family construction. Such characteristics may include the use of weak (toe- nail) connections for the roof truss to wall. Figure 23 shows an example of a roof-wall connection failure on a two-story condominium unit that occurred during hurricane Erin in 1995.

Figure 23. Examples of Roof-Wall Connection Failure.

For buildings with steel roofs, the roof is usually constructed using open web steel joists, with a welded connection to the wall frame. Open web steel joist roof systems generally fail under wind loads either through buckling of the lower chord of the joist or through an uplift failure of the welded connection attaching the joist to the wall.

Opening Failures. Opening failures in multi-family buildings result from a combination of breakage from wind-borne debris impacts as well as pressure-induced failures, either inward or outward. Once a window has failed, damage to the interior of the building is caused through the introduction of wind and water into the building. Figure 24 shows windows on the corners of a high rise condominium tower that failed due to the action of wind pressures during Hurricane Opal in 1995. Figure 25 presents examples of windows that failed due to wind pressures on a three-story condominium building. Sliding glass door failures are also common (see Figure 26). Improved designs of the sliding glass door framing can dramatically improve performance (see Figure 27) for both wind loads and water intrusion.

Figure 24. Window Failures on High Rise Condominium Tower.

Figure 25. Additional Examples of Window Failures in a Multi-Family Building.

Figure 26. Sliding Glass Door Failure in Condominium Building.

Figure 27. Step-Over Installation of Sliding Glass Door and Strengthened Frame.

Foundation Failures. In the case of multi-family dwellings, foundation failures, for practical purposes can be ignored, since few, if any large buildings, have been built without adequate restraints. Foundation failures that have occurred in past hurricanes have almost always been associated with the action of storm surge and waves and not wind loads. However, the connections for buildings on piers need to be adequately designed and periodically inspected for corrosion.

Building Envelope. The building envelope governs the losses for condominium and renter occupancies. These types of buildings, particularly flat roof structures, often exhibit a higher sensitivity to envelope performance than do single-family structures. The multi-unit occupancies of condominium or tenant buildings mean that failure of the roof can affect losses in many units that have experienced no exterior window or door failures.

As with single-family residences, the loads on the building increase dramatically once the envelope fails. The failure of openings on the top floor can lead to significant increases in the loads acting on the underside of the roof, increasing the chance of roof deck failure.

Soffit. Soffit failures may occur on one-, two- and three-story multi-family residences. These failures can produce internal pressurization and/or the water intrusion into the attic space. Figure 28 presents an example of failure soffits on a one-story multi-family unit.

Figure 28. Failed Soffit on One-Story Multi-Family Housing Unit (Hurricane Charley).

Window Leakage. As in the case of single-family residences, windows and doors are vulnerable to water intrusions. Current standards require that these components prevent water penetration for pressures up to only 15% of the design pressure. Leakage through windows and sliding glass doors remains a major vulnerability for large, multi-family buildings.