

Windstorm Mitigation for Bermuda Homes



The 2004 Hurricane Season was particularly busy!

A Step-by-Step Guide to Understanding Key Elements of Your Wind Mitigation Report

A value-added service provided exclusively by

Mason and Associates Ltd



PROJECT MANAGERS - STRUCTURAL ENGINEERS - HOME INSPECTORS
Building peace of mind in Bermuda
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Lessons Learned from Hurricane Fabian



Figure 1. Widespread roof damage on south facing, Loyal Hill, Devonshire.

This guide will address the following:

- ◆ Understanding hurricanes and the potential for damage to Bermuda's unique homes
- ◆ Introducing Bermuda's own Hurricane Resistance Rating (HRR) scale for homes
- ◆ *Your own My Safe Bermuda Home inspection report*
- ◆ *Recommended improvements to strengthening your home & increase your HRR*



My Safe Bermuda Home Program

A User's Guide to the Wind Mitigation Report

Dear Homeowner,

Congratulations for taking steps to learn more about strengthening your home against severe tropical storms and hurricanes.

Bermuda has a long history of dodging potentially catastrophic storms but our experience with hurricane Fabian in September of 2003 (Category 3) showed us that local homes are vulnerable to windstorm damage.

The focus of the My Safe Bermuda Home™ (MSBH) program is to provide you with a report detailing the improvements you can make to reduce the windstorm damage to your home and your possessions while increasing personal safety for you and your family. The report will also include fire, flood and home security related issues and suggestions for improvements.

Every home inspected under the My Safe Bermuda Home program will be graded on Bermuda's Hurricane Resistance Rating™ (HRR) scale. This scale was developed by our firm to objectively gauge how well your home will perform when exposed to a Category 2 hurricane. Homes under the MSBH program will be ranked on a scale of 1 to 100.

We have developed the HRR after months of modeling local home designs, construction practices and observations of structural damage following Hurricane Fabian. Our unique ranking system for Bermuda homes is based on seven (7) primary factors and four (4) secondary factors. Primary being the roof attachment, roof to wall connections, wall opening protection, building height, roof shape and secondary (roofing) water barriers. Secondary factors applied to our computer model include the home's age, exposure and any dominant openings or exposed features.

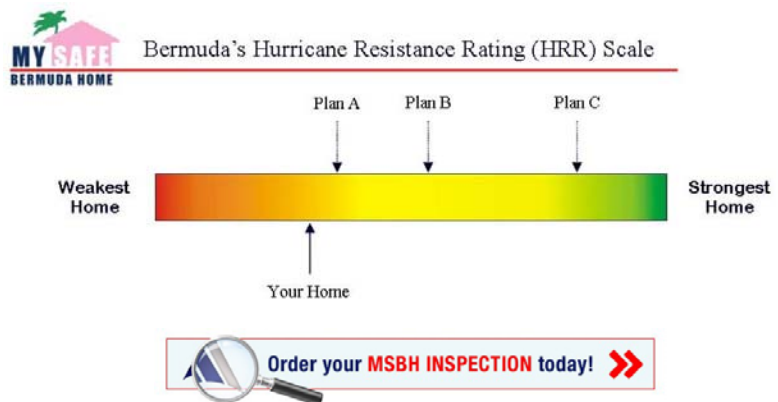
After inspecting your home we input the collected data into our model to arrive at scores ranging from 15 – 78 for Bermuda homes with the majority of slated roofs falling in the 30 to 50 score range. Homes built to Bermuda's Residential Building Code or above will score higher on the HRR scale and we have left room in our model for future improvements to the building codes.

We encourage you to review this guide before reading your inspection report. Thank you for your interest in the My Safe Bermuda Home™ (MSBH) program and taking proactive responsibility to protect your family, your home and its contents.

Sincerely,



Philip Mason, R.Eng.
Senior Structural Engineer
For Mason and Associates Ltd



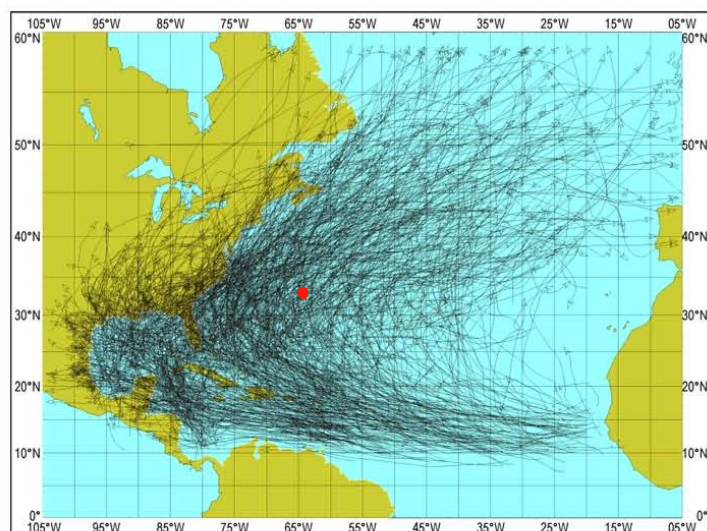
Understanding Hurricanes & the Risk to Bermuda Homes

A hurricane is really a special type of windstorm. Hurricanes consist of high velocity winds blowing circularly around a very low pressure center, known as the “eye” of the storm. Warm moist air fuels the storm as it moves across the open ocean. High winds and extremely low atmospheric pressures of a hurricane cause the ocean to rise up and move ahead of the storm, resulting in dangerous storm tides (“storm surges”). Our inspection report identifies homes at risk from both high winds and storm surges.

Characteristics of Hurricanes



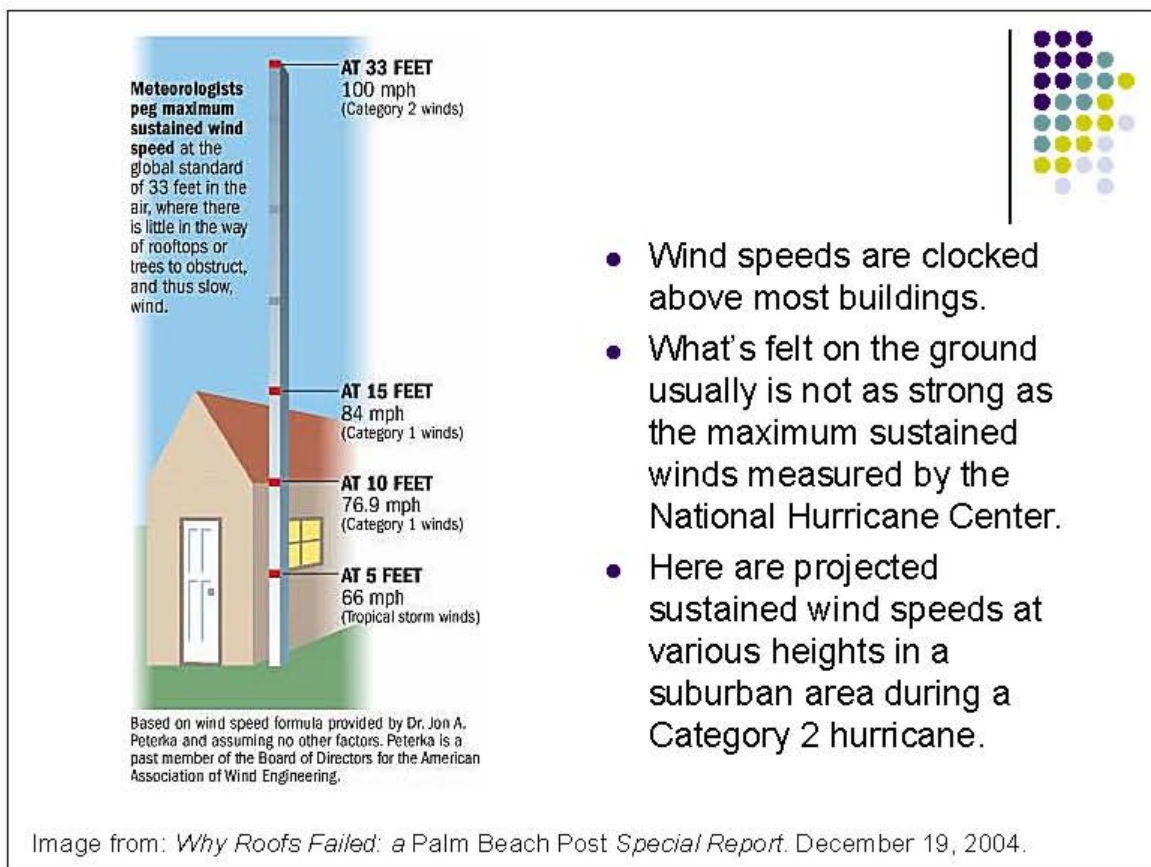
- Increased wind speeds (for hours)
- Wind gusts (tens of thousands of gusts)
- Slowly changing wind direction (up to 180 degrees)
- Wind-borne debris (small and large “missiles”)
- Storm surge (up to 20 feet or more)
- Waves (33 feet in open ocean)
- Extensive rainfall (up to 30 inches in 48 hours)
- Tornadoes (right front quadrant of advancing storm)
- Atmospheric pressure change



NORTH ATLANTIC TROPICAL STORMS AND HURRICANES, 1886 -2000 (1013 STORMS)

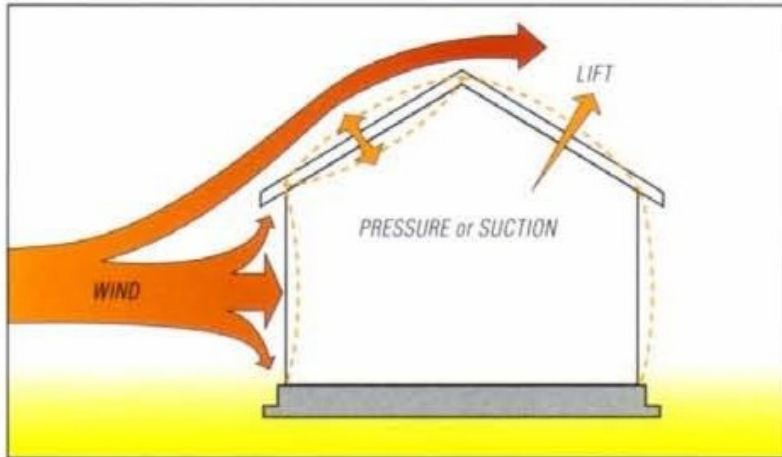
Understanding Wind Speeds and the Effects on Homes

The Bermuda Residential Building Code 1998 requires structures to withstand the force from a sustained wind of 110 mph (Category 2 hurricane). When designing roofs and walls, structural engineers apply various design factors to this wind speed to account for the local affects of wind on building elements. Such things as terrain (coastal, hilltop, valley etc), height above ground, shape and variations in materials and workmanship to arrive at design wind pressures for specific building elements.



Note: The Bermuda Residential Building Code 1998 is a “minimum standard” of compliance. With the recent increasing strength and frequency of hurricanes in the last decade serious consideration should be given to “Code (+)” choices in materials, methods and workmanship.

Wind Pressures (Forces)



A well built home is one that is soundly designed and constructed using the *continuous load path method* of construction. This requires that a home is built using a system of connectors at all joints from the roof to the foundation, thereby redistributing the external pressures (forces) of the wind from the roof down through the walls to the foundation.

Bermuda roofs built with slate rely on the dead weight of the limestone and the encapsulating nature of the cement plaster to keep them intact. However, as these roofs age (material degradation) and storms grow stronger, Bermuda slate roofs are becoming more susceptible to damage, especially along the leading edges (eaves) facing the brunt of the wind. Bermuda slate roofs suffered far more damage from Fabian's winds than did the "SKB" type engineered roofs.

Just the loss of a few slate during a hurricane can result in significant damage from wind driven rain as there is no subroof or secondary water barrier to protect the home if the outer roof covering (slate) is cracked or blown off.

Our MSBH report will provide recommendations on how to "retrofit" slate roofs to prevent the loss of individual slate and provide added protection against water damage during a severe storm.



Figure 2. Widespread "leading edge" roof damage on south facing Mullet Bay Road, St George's.



Figure 4. Less typical, extensive slate loss on windward side, St George's Club (south facing).

Internal Pressure



Image courtesy of RICOVI - Jim McDonald

External suction and internal pressures resulting from openings (windows & doors that are blown in by wind or wave debris) and the natural porosity of a Bermuda home allow internal pressures to escalate.

Openings as small as 1% of the wall area can produce full internal pressurization. It is important to understand that even without specific openings, a small amount of internal pressure exists in most homes because of permeability of the structure.

Bermuda homes with exposed slate ceilings (no tray/flat ceilings) are particularly vulnerable to damage from escalated internal pressures. Plaster ceilings within a home provide a small measure of protection from internal pressurization affecting the roof space ("attic")

Fabian has shown us that Bermuda slate roofs are vulnerable to damage from suction forces on the external face of the slate, particularly along the leading (windward) edge of the eaves and on the ridge slate of gable end walls.

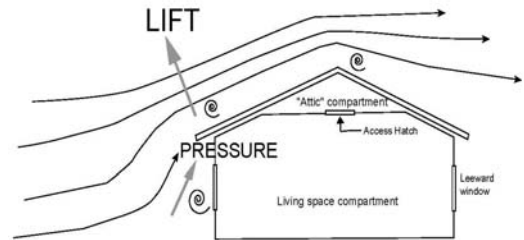


ILLUSTRATION 5. Compartmentalization of a typical Bermudian house. A plaster or drywall ceiling separates the living space from the "attic".



Figure 3. Typical leading-edge damage. Berry Hill Road, Devonshire (south facing).



Figure 8. Leading-edge damage, Sayle Road, Smith's Parish (south facing).

Wind and Wave Borne Debris

Wind-borne debris is basically anything that is picked up and carried by the wind. Homes exposed to high winds and near coastal areas (practically everywhere in Bermuda) are considered to be at risk from windborne debris.

Oceanfront homes and those identified to be at risk from storm surges are also prone to severe damage from wave-borne debris (floatsam) and wave action. Anything that floats from deck chairs, telephone poles and boats can potentially cause a breach (opening) in your building envelope and this in turn causes internal pressures within the home to escalate dramatically, resulting in “blowouts” of roofs and walls.

Important Note: If your home is identified as being within a storm surge risk area (My Safe Bermuda Home report will confirm this) it is strongly advised that you have a “safe place” evacuation plan to relocate off-site well in advance of a hurricane.

Wind-borne debris



Image courtesy of Joe Watson, RICOWI

Wave-borne debris



Hurricane Fabian - Sonesta Beach (2003)

Wind and wave borne debris are important considerations when evaluating an existing home for its vulnerability to wind and wave related failures. Protecting the openings against any breach is critical to preventing severe damage and personal risk. Our MSBH inspection evaluates all door and window openings for vulnerability to a breach and recommends ways to strengthen these openings.

Retrofit Improvements to Bermuda Homes




Our experience with hurricane Fabian has shown that maintaining the building envelope integrity governs the level of hurricane damage and loss.

Our goal is to protect the home from the effects of wind forces (pressure and suction) on the roof cladding and wall openings while maintaining a *continuous load path* for those wind forces to safely transfer from the roof, down through the walls to the foundations.

All of our retrofit recommendations focus on strengthening the home's building envelope primarily from wind effects and preventing the ingress of water (rain). If you live within a storm surge or flood zone there is little you can do to keep the ocean out, but strengthening the openings against water borne debris (flotsam) and wave action will help to mitigate structural damage to your home.

Five Categories for Strengthening Bermuda Homes

The My Safe Bermuda Home™ program identifies and recommends five strengthening retrofits:

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1. Bermuda slate attachment to lath/rafter framing
 2. Secondary water barrier (SWB)
 3. Strengthening the roof to wall connection
 4. Protecting or replacing window openings
 5. Protecting or replacing door openings, including garages

