Smart put to the test: Practical lessons learned

How Smart healthcare facilities withstood the test of the La Soufriere volcanic eruption in Saint Vincent and the Grenadines in April 2021 and the passage of Category 5 Hurricane Beryl in July 2024.

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Smart Hospitals
SAFE • GREEN • MAINTAINED

Contents

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Introduction

The final evaluation of the Smart Healthcare Facilities in the Caribbean project phase 2 provided many recommendations, including one to aim for the Safe + Green = Smart gold standard of A70 (Safety score A/Green score 70).

Governments interested in scaling up Smart should ensure that they identify a government unit with the capacity and authority to serve as the one-stop-shop for the identification of target healthcare facilities and to support their retrofitting, in close coordination with the national disaster management office. These government units should be equipped with the capacity to monitor progress and evaluate performance, and to obtain specialized (check consultant) technical support when necessary (MoH).

When implementing Smart retrofits, donors and governments should adopt the whole Smart package rather than selectively choosing components that are more convenient or lower-cost. Retrofitting Smart requires a comprehensive approach that meets the A/70 standards (MoH, Donors). Partial implementation does not justify the Smart designation.

Both the impact of the eruption of the La Soufriere volcano in Saint Vincent and the Grenadines in 2021 and the passage of Category 5 Hurricane Beryl in 2024 provided highly valuable lessons learned and reinforced the evaluators' recommendation on Smart A/70.

1. The La Soufriere volcanic eruption, April 2021

The eruption of La Soufriere volcano on the main island of Saint Vincent (Saint Vincent and the Grenadines) occurred on 9 April 2021 after several months of increased seismic activity. Volcanic emissions (ash and gas) impacted basic services (water, transport, and communications) and access to health services, as 18 healthcare facilities (including 2 district hospitals and 1 dialysis centre) were evacuated. The ash fallout also severely impacted Barbados and Saint Lucia.

© NEMO Saint Vincent and the Grenadines

The area was further impacted when the centre of Hurricane Elsa passed over the north of mainland Saint Vincent on 2 July 2021. Damage reports included the loss of roofs on 42 homes in Fancy. Thirteen hurricane shelters were activated in response to that event, in addition to the shelters already being utilized for persons previously affected by the volcanic eruption.

The eruption of La Soufriere underscored the importance of the Smart Hospitals project. The Smart healthcare facilities in Georgetown, Chateaubelair (see picture), and Barrouallie (still under construction during the eruption) sustained minimal damage. Most of the ash could not enter the facilities, roofs were intact, and the available water from the water storage was used by the communities. Other healthcare facilities did suffer substantially more damage, including damage to medical equipment, and took much longer to clean and to continue provision of health services to the public.

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The United Nations Development Programme (UNDP) La Soufriere Volcanic Eruption Post Disaster Needs Assessment report (August 2021) *(1)* stated:

> In the reconstruction [of] healthcare facilities, it is recommended that PAHO Smart Hospitals standards for resilience and greening, and low energy and water consumption are incorporated. Healthcare facilities roofs should be designed to withstand its self-weight, and other loads which may act on the roof such as live loads, wind and seismic in accordance with OECS Building Code 7th Edition 2016 (accessed via https://www.oecs.org/). The current building codes do not account for volcanic ash loading, however this risk should be treated as an additional live

load on the roof. Additionally, windows that are hurricane resistant are completely sealed when closed, this doubles to prevent ash from penetrating the building which reduces the risk of damage to medical equipment and interior furnishings. Remote facilities that may become inaccessible should be self-sustainable with back-up power supply, water storage, telecommunication, and adequate stocks to continue services.

2. Passage of Category 5 Hurricane Beryl, July 2024

Hurricane Beryl impacted the Caribbean region from 1 to 4 July 2024, mainly affecting three countries: Grenada, Saint Vincent and the Grenadines, and Jamaica.

Grenada and the Grenadines islands experienced category 4 sustained winds of 150 mph and Category 5 gusts, while Jamaica's south coast experienced category 4 sustained winds.

After the passage of Hurricane Beryl, many health facilities in Grenada and Saint Vincent and the Grenadines were rendered inoperative due to infrastructural damage and disrupted utilities, which severely limited access to medical care. Urgent support was needed to address the extensive damage, restore essential services, and reduce health risks for the affected populations.

2.1. Grenada

Carriacou island off Grenada was particularly severely hit as the eye of the storm crossed this island.

The two healthcare facilities in Carriacou are Smart facilities: Hillsborough Health Centre (HHC) and Princess Royal Hospital (PRH). The standing seam roof sheeting over the PRH, located on the highest unobstructed hill in Carriacou, was partially damaged, as the sheets ripped off the structure. The water ingress from this coupled with loss of utilities rendered this facility nonoperational. The hospital services were transferred to the HHC Smart facility, which remained the only operational healthcare facility on Carricaou.

The sole non-Smart healthcare facility in Petite Martinique completely lost its roof, leaving the ground floor only in use.

All other healthcare facilities in mainland Grenada, 4 Smart and 30 non-Smart facilities, were undamaged. However, non-Smart facilities without generators were not operational due to loss of grid-supplied electricity.

2.2. Saint Vincent and the Grenadines

All four Smart facilities on mainland Saint Vincent remained operational. Six of the 27 non-Smart facilities were severely damaged and nonoperational. All the non-Smart facilities in the Grenadines were damaged and nonoperational.

The roof sheets, standing seam type, over two Smart facilities in the Grenadines were similarly damaged and, compounded with loss of utilities on the islands, rendered these facilities nonoperational. On Bequia, the Port Elizabeth Smart Health Centre and Hospital remained fully operational.

2.3. Jamaica

All 12 Smart retrofitted health facilities in Jamaica remained operational after the passage of Hurricane Beryl. Four are Smart, 3 medium interventions, and 5 small interventions. The installation of generators and water tanks at these facilities was essential in maintaining operations. According to MoH assessments, 82 of the 327 healthcare facilities suffered major damage and were rendered nonoperational after impact; 10 hospitals were also included among the facilities with major roof damage.

2.4. General observations on Smart after Hurricane Beryl

- The Notice of Acceptance (NOA) to Miami-Dade Building Code (NOA) hurricane-rated windows, shutters, and doors installed at Smart facilities are only rated for category 3 hurricanes. Despite this, perimeter walls, windows, doors, and shutters remained intact and protected the contents of the facility.
- Standing seam roof sheets are typically only rated for 120 mph sustained winds, which is less than the wind speeds experienced by Grenada and Saint Vincent and the Grenadines. In most cases, the roof sheet clips remained in place with the standing seam roof sheets lost.
- The roof structure of Smart facilities, even with loss of roof sheets, remained intact. This facilitates the installation of temporary tarpaulin covering. Other non-Smart facilities with severe structural roof damage could not be easily repaired.
- Facilities with open exposure to the coast understandably sustained more damage than facilities in protected areas.
- The UNDP Hurricane Beryl Post Disaster Needs Assessment report on Grenada *(2)* stated:

> … Facilities retrofitted under the SMART programme in the Caribbean showed considerably better resilience. It's worth highlighting that the smart health facilities were retrofitted for Category 3 hurricane and Beryl was Category 4 when it hit Grenada. Retrofitted facilities withstood the impact of Hurricane Beryl much more effectively, underscoring the critical importance of proactive measures to strengthen the capacity of key infrastructure to endure various natural hazards, including hurricanes, earthquakes, and volcanic eruptions. By enhancing the resilience of such facilities, the health sector can maintain its operability during emergency situations, to this end, revising the building codes following Beryl, and specifically provisions for essential infrastructure such as hospitals, schools, and similar, is a must in a country like Grenada that may be subjected to similar or larger events in the future.

3. Technical guidelines on key construction components of a Smart retrofit

During previous hurricane events in 2017, like Irma in Sint Maarten and Maria in Dominica, and then Dorian in the Bahamas in 2019, the key construction components to be addressed during a Smart retrofit proved to be the roofs, windows, doors, drainage, water tanks, generator housing, and planned preventive maintenance. These same items were critical during the La Soufriere volcanic eruption and the passage of Hurricane Beryl.

As part of the Smart project, specific technical guidelines on all these topics were written by the technical experts acknowledged on page 1.

The guidance provided in these technical documents is essential to retrofit healthcare facilities to a gold standard A/70 Smart facility as recommended by the external evaluators of the Smart Healthcare Facilities in the Caribbean project phase 2.

3.1. Mechanical, electrical, and plumbing design issues

The case study *MEP design issues: Lessons identified (3)* highlights the challenges and recommendations for the Mechanical, Electrical, and Plumbing (MEP) aspect of the PAHO refurbishment of healthcare facilities in the Smart project phase 2. Key issues identified in the review and execution of the MEP works were: (1) quality of design; (2) procurement issues; (3) contract execution and installation; and (4) testing and commissioning.

The second section of this study considers the factors involved in the proper sizing of generators.

3.2. Hurricane shutters and windows

In *Hurricane shutters & windows: The dos and don'ts of installation (4)*, contractors retrofitting healthcare facilities in the Caribbean are recommended to purchase and install hurricane-rated windows or shutters that are certified with a Notice of Acceptance (NOA) to Miami-Dade Building Code. Miami-Dade, which is an addition to the Florida Building Code for hurricane-prone zones, uses wind speeds in the testing of windows and shutters that are comparable to the wind speeds experienced in the Caribbean. The Florida Building Code uses a classification of high-velocity hurricane zones for areas vulnerable to hurricanes.

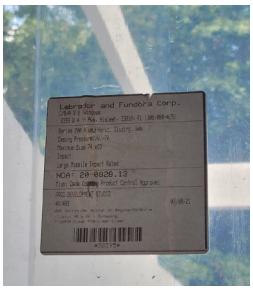
Key Things to Check

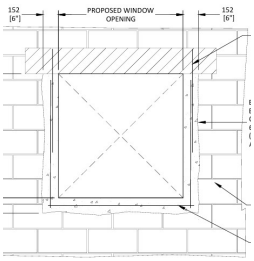
Quantify and measure existing dimensions before purchase	Doors and windows with a transom or side lights are fully covered with the shutter	Check that existing walls and structure meet manufacturers' specifications	Retrofit the existing structure by strengthening walls and removing encroachments where necessary
Install the correct components, including storm bars, per manufacturers specifications	Use correct screws, tools and spacing per manufacturers specifications	Operating levers, handles or locks should be accessible and functional	Ensure shutters and windows can fully open and close without difficulty

Final look

Roller shutters covering the windows and transoms at Princess Alice Hospital, Grenada.

Shutters in various stages of open and fully closed





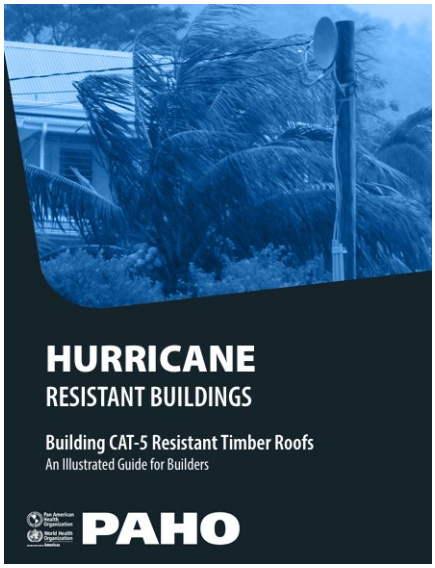
Hurricane Rated Windows and Shutters

- NOA Rated windows and shutters
- Reinforce openings

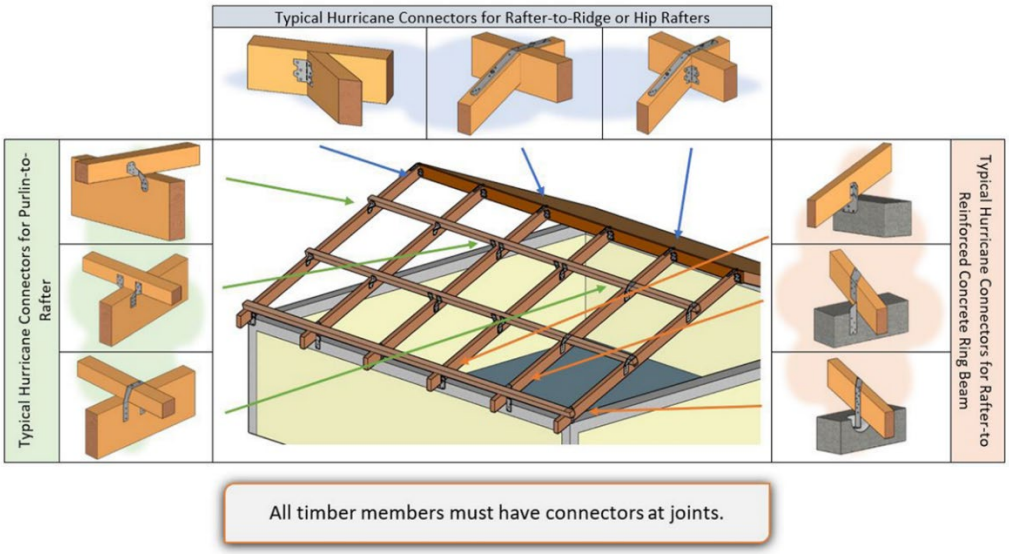
3.3. Case study: Roofing details

Case study: Roofing details (5) describes the required roof material quality, roof drainage, roof preventive maintenance, roof colour, and roof waterproofing.

3.4. Hurricane-resistant buildings



One major impediment to resilience is the lack of suitable qualified or experienced professionals to design and build hurricane-resistant buildings in many countries that are typically the most affected. In most low- and middle-income countries, current building codes do not encourage the construction of robust structures that will withstand major hurricanes nor are the building codes enforced. Additionally, reconstruction after the impact of such events is often rushed and poorly designed and executed. PAHO aims to reduce the recurrent damage following the impact of major hurricanes, with this illustrated, easy-to follow guide *Hurricane resistant buildings: Building CAT-5 resistant timber roofs (6)*. The guide is to be used by local builders and laymen for the safe design and construction of roofs in hurricane-prone regions. True sustainability is achieved once people understand what they can do to help themselves and prevent future damage and losses. Therefore, the guide provides graphic tools illustrating the safe and proper way to build and connect timber roofs to help minimize the loss of building infrastructure, impact on livelihoods, and loss of lives.



Roof Sheets

- Use specified grade lumber of good quality (free of knots, splits, etc.)
- Use correct gauge/ thickness and type of metal roof sheets
- Increase fasteners in high-pressure roof zones
- Use roofing screws with compressible gasket
- Connect the screws properly
- Install screws in crest not trough

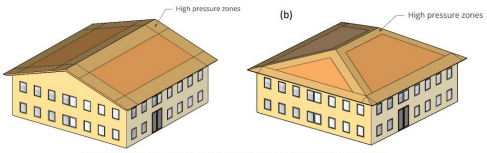


Figure 9 (a) High pressure zones in gable roofs, (b) High pressure zones in hip roofs

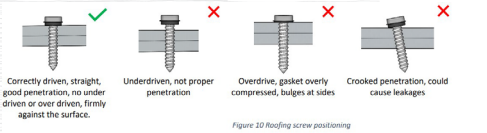
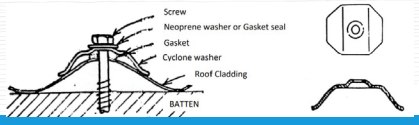


Figure 10 Roofing screw positioning



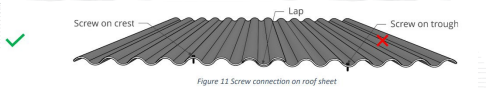


Figure 11 Screw connection on roof sheet

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3.5. NOA rated materials

NOA rated materials: Technical review and recommendations for selection of materials for PAHO Smart Health Facilities retrofit (7). The core objective of the PAHO Smart Healthcare Facilities in the Caribbean project is to strengthen existing healthcare facilities with hardware and equipment capable of withstanding extreme forces of hurricanes that can be expected in areas where facilities are situated. Besides standard building requirements in hurricane areas, selected hardware must be resistant to the aggressive corrosion prevalent in coastal areas with high content of salt in the air. Furthermore, due care should be given to earthquake potential in some geographical areas where materials will be installed.

It is generally recognized that the overall best source and codification for mitigation related to building envelopes in hurricane-prone areas is the Miami-Dade Building (MDB) Code. However, those standards do not take into account the topographic acceleration of the wind, which is commonplace in the Caribbean islands. It is important to mention NOA (Notice of Acceptance) – a document that certifies conformity of a particular product to MDB Code as either an impact-resistant product or not impact-resistant product. The MDB Code is in addition to the Florida Building Code. The 2010 edition is available here: https://www.miamidade.gov/building/building-code.asp

It is very important to note that in the Eastern Caribbean States the *OECS Building Code (8)* is used, and this document sets the minimum standards that must be followed in every aspect of building and associated activities.

4. Conclusion

Natural hazards like hurricanes and volcanic eruptions do not need to become disasters. Yet, time and again, the same lessons are identified in their aftermath, highlighting missed opportunities for preparedness and resilience.

In response to this need, the PAHO Smart technical team has provided practical technical guidance documents. When governments, design firms, construction companies, donors, and implementing organizations adhere to existing building codes and follow these additional technical guidelines disasters can be prevented, and critical healthcare facilities remain operational to provide care during disasters.

Smart healthcare facilities proved to be more resilient to natural hazards. Even after being hit by Category 5 wind forces or a volcanic eruption, these facilities proved to recover more quickly than non-Smart facilities. The downtime was significantly reduced, and the facilities were able to provide essential health services for the people in need.

As recommended by the external evaluators of the Smart Healthcare Facilities in the Caribbean project phase 2, ministries of health should aim for the A/70 gold standard. It is encouraging to see that these recommendations are reflected in post-disaster needs assessments and many Caribbean health national adaptation plans.

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