

Maintenance and Retrofit Options for Roof Coverings, Opening Protection Systems, and Exterior Building Elements

The purpose of this fact sheet is to provide cost-effective ways to reduce disaster damages and increase the life expectancy of residential buildings in the Commonwealth of the Northern Mariana Islands (CNMI). This fact sheet describes many affordable solutions, including lower-cost maintenance recommendations and higher-cost retrofits.

The **Building Envelope** is made up of the roof coverings, openings (windows and doors) and opening protection (i.e., shutters), and other exterior building elements. The building envelope plays an important role in protecting the inside of a building. Maintaining each part of the building envelope is needed to provide protection from storm damage. It is important to have a thorough maintenance plan. This plan should include a schedule of yearly inspections, a list of materials and their expected lifespans, and any manufacturers' recommendations. Openings and connections that are not maintained can let wind and wind-driven rain into the building. This can create damage to building interiors and expose weak roof attachments. Roof coverings can turn into wind-borne debris during wind events when they are not attached correctly, causing damage to neighboring homes. Securing the roof panels to a well-maintained deck material can strengthen the building during high winds.

Mitigation refers to actions taken to reduce damage. Mitigation works best when maintenance is thoroughly carried out across an entire community each year. Applying retrofit options to buildings also improves how they perform during storms. This can help owners adapt to be physically and economically resilient to future storms. Figure 1 shows typical wind damage from a storm event and Figure 2 shows a building that has been retrofitted to better resist wind damage.



Figure 1. Wind and windborne debris damage to building envelope observed after Super Typhoon Yutu, which hit in October 2018.



Figure 2. Example of a building updated with building envelope retrofits.

Maintenance Recommendations and Retrofit Options for Roof Coverings

Roof Coverings are the external materials laid or fixed on the roof deck or framing to protect the building. If damage to roof coverings is not addressed, it can lead to major issues with the strength of the roof. Inspecting roof coverings may require the removal of damaged or decayed materials or connections (nails and screws). When damaged or decayed, these elements can allow wind-driven rain to enter the building, making it more vulnerable. Without a closer look, failing connections and materials may not be visible. A source for more information about wind vulnerability assessments is FEMA P-2062, *Guidelines for Wind Vulnerability Assessments of Existing Public Facilities* (2019). Common yearly maintenance recommendations and retrofit options for roof coverings can be found below. Figure 3 shows common types of roof covering damage seen by the CNMI Mitigation Assessment Team (MAT) after Yutu.

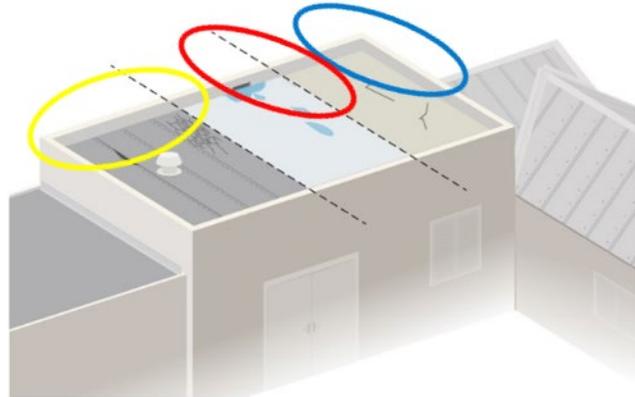


Figure 3. Types of roof covering damage observed by the Commonwealth of the Northern Mariana Islands Mitigation Assessment Team. Membrane roof damage circled in yellow, roof drainage issues circled in red, and concrete roof damage circled in blue.

Yearly Maintenance Recommendations:

1. Debris buildup: Clean debris from roof, drains, and gutters. Inspect the roof surface for signs of wear, ponding, or damage at least once a year. Check for hollowed or damaged wood where the roof attaches to the decking. This can be a sign of rot or wood-destroying insects.
2. Metal roof covering with signs of decay: Repair or replace damaged roof panels based on the amount of damage. Small cracks or holes can be temporarily repaired with roof cement. For permanent repairs and larger holes, a repair patch can be installed using the same type of roof material.
3. Loose or missing metal fasteners (not corroded): Secure or replace nails using the same type of metal fastener. Loose screws should be removed and replaced with the next larger diameter screw and gasketed washers. Corroded fasteners should be replaced with corrosion-resistant fasteners.
4. Built-Up Roof (BUR) deck leaks or coverings showing signs of separation from roof surface: Assess the area for damage and make note of any soft or spongy areas. Take note of the size of the damaged area. Either patch it if minimal damage is seen or ask a roofing expert for their professional opinion.
5. Concrete roof deck leaks, roof covering decay, or other signs of holes and cracking: Look for signs of roof covering decay, concrete surface damage (spalling), or corroded rebar. If the roof covering is decayed or no longer bonded to the concrete roof surface, then scrape off the damaged area and reapply the covering. If there is concrete surface damage, clean the exposed rebar and coat it with corrosion-resistant epoxy. Have a design professional inspect the roof if a large area of damage is found.
6. Cracking or blistering of flat roof coverings: For small blistered areas, remove the damaged and loose roof covering down to the roof surface (substrate). Then, replace wet or damaged insulation. Next, replace the

uncovered area with a reinforced coating. If cracking is seen, inspect and recoat these small surface areas with primer and apply a roof coating. If large areas show cracking or blistering, ask a roofing professional for their advice.

Retrofit Options:

1. Improve wind resistance by replacing roof panel nails with stainless steel gasketed screws. Replace missing screws and gaskets with stainless steel hardware. When replacing the screws, use the next larger diameter screw.
2. Address decay caused by water ponding on flat roofs by building up low spots. Add or enlarge drains and other outlets for water runoff to improve roof drainage.

Maintenance Recommendations and Retrofit Options for Opening Protection

Opening Protection helps to keep windows and doors safe from wind-borne debris. The most common protection for openings in the CNMI are active shutter systems (roll-up and accordion shutters) and structural wood panels. There are other passive options available such as impact-resistant glass systems that are compliant with the local building code.

Installing opening protection for windows and doors keeps them from being damaged during high-wind events. To be effective, opening protection must be installed and maintained according to the manufacturer's recommendations. Figure 4 shows common examples of opening protection system damage. Common maintenance recommendations and retrofit options for opening protection measures are found below. A source for more information about openings is FEMA P-499 Fact Sheet 6.1, *Window and Door Installation*.

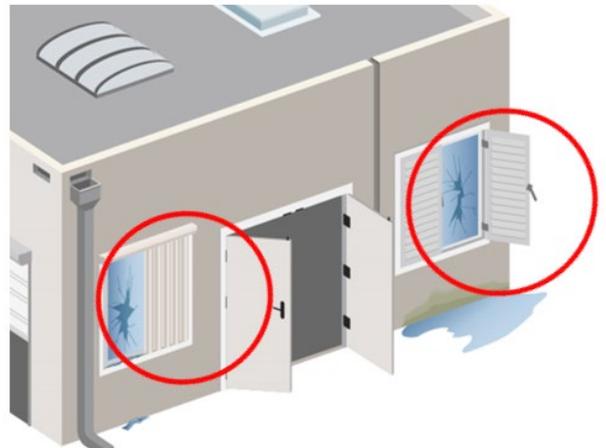


Figure 4. Types of opening protection damage observed by the Commonwealth of the Northern Mariana Islands Mitigation Assessment Team . Active shutter system damage circled in red.

Yearly Maintenance Recommendations:

1. Remove dirt and debris from openings to help windows and doors to close tightly. Use low-pressure water and a mild cleaner to clean channels and seals.
2. Look over windows and doors and take note of any areas with discolored sealants.
3. Check the alignment of doors and adjust as needed.
4. Lubricate all moving parts such as hinges or louvers.
5. Check flashings and fasteners for signs of decay or loose pieces.
6. Inspect seals for signs of damage or decay and replace as needed.
7. Clean shutter tracks and enclosures using the manufacturer's recommendation.

8. Check for decay of seals and sealant around openings and equipment. Replace sealants based on how they look and how well they work.
9. Test and lubricate windows and shutters twice a year or based on the manufacturer's recommendation.

Retrofit Options:

Upgrading opening protection can help reduce the amount of effort that needs to be taken before storm events. Replacing old windows with new windows that have impact-resistant glass can create better protection. In addition, installing permanent shutters can provide full protection from winds and wind-borne debris. Although these retrofit options have higher costs at first, they provide better protection than installing plywood panels over windows and doors.

Maintenance Recommendations and Retrofit Options for Exterior Building Elements

Exterior Building Elements are walls, doors, and windows, as well as roof hatches and skylights. Common exterior building elements in the CNMI are masonry (concrete masonry unit or CMU) and cast-in-place concrete walls with stucco or fiber cement siding. In addition, wood doors, glass windows in metal frames, and metal accordion shutters are often seen.

It is important for building owners to inspect and maintain exterior building elements on a yearly basis, especially after a high-wind event. Look over the exterior surfaces for signs of decay in the siding. These signs could mean further inspection is needed. When fiber cement siding is used, the sealant should be checked to see if the panels are well attached and there has been no shifting from the decay of sealants. Sealant should be replaced before it reaches the end of its useful life.

Following a high-wind event, windows and doors should be checked for leaks and frames should be checked for cracked or discolored paint. If the doors and windows are not shutting correctly, it may mean the framing around the window or door has water damage. Check worn areas where paint or sealant is missing and look for water damage or leaks. Repair water-damaged areas as soon as possible. Framing should be checked to make sure that it is correctly attached to the wall to provide enough protection. Windows and doors that are not framed correctly can be ripped from their frames. Figure 5, below, shows common forms of exterior damage. These damages are a good fit for the maintenance or retrofit options listed below.

Yearly Maintenance Recommendations:

1. Clean and remove debris and overgrowth away from the foundation. Clean debris from drains and low spots to improve drainage. Fixing the grading to drain away from the building during normal heavy rains can also help during more severe storm events. Standing water can lead to water damage and mold growth within the building.
2. Clean exterior walls with a soft brush and mild cleaner to remove dirt build-up, moss, and mildew. Worn surfaces can be repainted with a coating of exterior acrylic or elastomeric paint after cleaning and drying.

3. Inspect framed openings for corrosion and damage from wood-destroying insects. If openings show signs of major corrosion damage or rotting, contact an experienced contractor to find out what the repair needs will be.
4. Inspect around the windows, doors, and joints for sealant that has torn or separated from the joints. Take a closer look at places where movement or separation is noticed on the exterior wall finishes. Then, replace or patch the area with a similar material to reduce the chance of water leaks.
5. Check exterior walls and concrete surfaces for flaking or cracking. This may be caused by wind-borne debris. If the damage is minor or simply visual, clean and patch the area with mortar materials. If the damage is significant, consult an experienced contractor for advice.
6. Check for signs of air and water leaks at door and window weather seals. Look for the decay of the sills. Replace worn weather stripping and sills as needed. Each opening is very important, as it only takes one to let the wind and rain in during a storm event.
7. Look over door and window connectors and fasteners for signs of corrosion or loosening. Check for damaged or loose hardware (door, window, and shutter latches; handles, and hinges). Tighten, adjust, or replace as necessary.

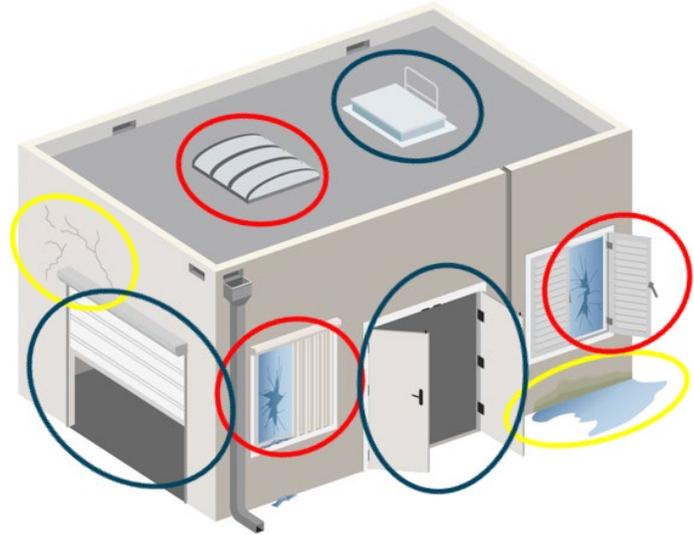


Figure 5. Areas where exterior building damage was observed by the Commonwealth of the Northern Mariana Islands Mitigation Assessment Team. Exterior wall damage circled in yellow, doors and hatches circled in blue, and windows and skylights circled in red.

Retrofit Options:

1. Water leaks from local flooding or standing water: After removing debris from drains and low spots, check for signs of growth or extra moisture around the foundation. This can help decide which areas can be improved with grading to drain water away from the building and reduce the risk of water damage.
2. Door and window closures and handles that are damaged by wind-borne debris: Closures and handles can be replaced with stronger closures or handles. Other options include adding more latches that connect the closures to the frame and increase the door's strength and thickness.
3. Exterior walls: Repaint exterior walls using an exterior-coating elastomeric paint. This type of paint fills in small hairline surface cracks and helps minimize water leaks.

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