



Acapulco, México



S-5! Clamps Protect Shopping Center Roof During Hurricane Otis

THE PROJECT

Acapulco is a resort city with a major seaport in Guerrero on the Pacific Coast of Mexico, about 240 miles south of Mexico City. One of the country's leading grocery superstore chains, operating nearly 350 stores in Mexico across 25 states and in more than 70 cities, sustained severe damage during Hurricane Otis.

This Acapulco grocery store features a KR-18 sheet metal roof. Just one month before Hurricane Otis struck, Mexico's leading solar generation company, Energía Real completed the rooftop installation of 538 Trina Solar 545W modules (293kWp DC installed capacity) secured in place using the S-5! PVKIT[®] direct-attach[™], rail-less solar mounting solution together with the S-5! Mini clamp. Two Huawei 100 KW inverters and one Huawei 40 KW inverter provide 240kWp of AC installed capacity.

The American-made PVKIT solar mounting solution is the world's first rail-less system for mounting solar modules to metal roofs and

now the most well-known rail-less, direct-attachment solar mounting system for most metal roof types throughout Latin America.

THE HURRICANE

On October 25, 2023, Hurricane Otis made landfall near the port of Acapulco. Its power devastated the coast of Guerrero, with maximum sustained winds of about 270 kilometers per hour, one of the strongest recorded hurricanes to have impacted the Mexican Pacific.

The intensity that Otis acquired took climate scientists by surprise. The data from the surveillance systems did not anticipate the risk of a destructive force that would trigger the disaster in Acapulco and nearby towns, resulting in human and material losses. Increasingly warmer climatic conditions suggest the possibility of this type of natural phenomena occurring more frequently in the foreseeable future.



THE DEVASTATION

While most of the surrounding shops, restaurants, hotels and businesses were completely demolished by the category 5 hurricane, remarkably and for the most part, the Acapulco grocery store remained intact. In the aftermath of the hurricane, the roofing contractor visited the site to inspect for roof damage. Sections of the roof that were without solar experienced severe roof blow-off. However, the store's rooftop solar array secured in place by S-5! PVKITs and Mini clamps withstood the devastation.



METAL ROOFING IN HIGH WIND CONDITIONS

Metal roofing, in particular standing seam metal roofing, is known for its exceptional performance in high-wind conditions, due in part to its attachment methods and interlocking installation where roof panels are overlapped and attached to the structure of the building, reducing the ability of wind to disrupt the panels. Metal roofing lends itself to high-wind areas because it can be engineered easily to withstand nearly any uplift force within the design stage.

OBSERVATIONS

Photos of the site taken post-hurricane clearly indicate the vast majority of roof damage was to areas of the roof without solar installed. This is evident, even in the higher-pressure edge roof zones, where the roofing panels along the edge zones, under the solar modules, were not damaged while the nearby bare roofing was blown

off. The logical conclusion is that the solar modules, PVKITS and Mini clamps installed over portions of the roof prevented those portions from failing, preserving both the solar modules and the roof.

The Mini clamps together with the PVKIT solar mountings by S-5! were installed to secure the solar modules to the metal roof, but the clamps performed a secondary function as wind clamps, often referred to as **External Seam Clamps**. These external seam clamps measurably increase the roof's wind uplift resistance capacity, preventing multiple modes of failure, including seam separation and clip disengagement (when used at roof clip locations).

Third-party testing performed in 2013 resulted in a 300% increase in uplift resistance of a metal roof when S-5!'s **WindClamps™** were installed on the roof seams. The Mini clamps on the grocery store roof acted as external

seam clamps during the Acapulco category 5 hurricane.

Considering how the wind causes uplift forces when approaching and blowing across the solar array installed on the roof, the dynamics of the wind forces shifted from direct pressure on the roof to split pressure on both the roof and the solar modules. The metal roof seams were strengthened from the installation of the Mini clamps to resist uplift pressures on the roof and met the challenge to secure the solar modules to the building, preventing wind uplift forces from tearing them off the building and preserving the roof.

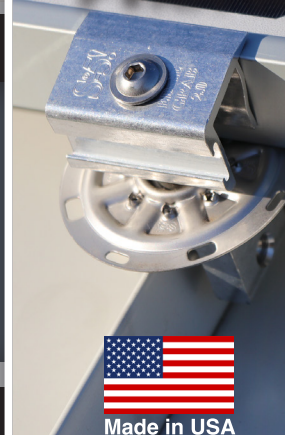
In this scenario, those uplift forces were transferred into the KR-18 roof through the PVKITS and Mini clamps, then from the roof panels to the roof clips and into the building structure. Together, these components and connections were strong enough to prevent the modules from disengaging from the roof panels and preventing the roof from pulling off the building's structure.

Often, there is a concern that a metal roof panel, like the KR-18, is not strong enough to transmit the forces as part of the load path described above, or that the roof clips may be overloaded and fail from these discrete point loads. From observations in this case study, such concerns are not valid. All the components in the load path and all the connections between the components remained intact and connected, keeping the system together and undamaged, including the roof panels and roof clips. The roof below the solar modules clearly was not damaged or torn off.

How Did the S-5! Products Help?

- S-5! products securely held the solar modules in place against the category 5 hurricane forces
- All the components and connections between the solar modules and the building resisted the peak wind uplift forces, including the metal roof panels and roof clips
- Clamps also functioned as external seam clamps, strengthening the roof's uplift resistance from hurricane winds

PVKIT Rail-Less System



- Cuts material costs in half
- Reduces installation time by 30-50%
- 85% lighter than rail systems, providing 25% better load distribution
- Up to 50% savings in freight costs due to lightweight solution