by Laurence Claus

Solar Fasteners

Introduction

Thomas Edison is attributed with the following quote, "We are like tenant farmers chopping down the fence around our house for fuel when we should be using Nature's inexhaustible sources of energy — sun, wind and tide.... I'd put my money on the sun and solar energy. What a source of power! I hope we don't have to wait until oil and coal run out before we tackle that." Today, many would see his words as prophetic. As concerns have increased over the supply of consumable energy sources and their lasting impact on the earth, cleaner and renewable energy sources have become a topic of intense interest and anticipated source for future energy consumption.

In the last couple of years great strides have been made in the technologies that make solar energy practical. As with any technology advancement, there are often ancillary and supporting technologies that must also be developed to make the prime technology possible. Take for example the recent development of Boeing's 787 Dreamliner. This aircraft is paving the way in carbon fiber and composite technology for commercial aircraft. However, it would never have been possible without many other advancements spanning a broad range of topics such as novel and ingenious manufacturing processes to the fasteners that hold everything together. Likewise, as solar energy systems become more commonplace in both residential and commercial construction, new supporting technology to address mounting and attachment of the photovoltaic panels becomes increasingly important.

Challenges

Secure, safe, and long-term attachment of the photovoltaic panels and their mounting frames is not as simple as climbing onto the roof with a couple of brackets, a hammer, and a can of nails. Although there are commonly shared challenges between all roof types, one would also expect and, in fact, finds, that there are unique challenges between different roof types. For example, some challenges experienced with a flat roof differ from a slanted asphalt shingle roof, a metal roof, or a tile roof. Therefore, each installation must take these universal and specific challenges into account and the designer must carefully choose the appropriate fastener or fastening system.

Although each roof type exhibits its own specific challenges, there are several universal and fundamental factors that each system must address. These include supporting the loads, preventing water intrusion through roof penetrations, addressing corrosion, and being easy to install. Getting any one of these factors wrong can result in potentially costly or catastrophic consequences.

There are three primary loads that an array of photovoltaic panels introduces to a roof structure. The first is the static load of added weight. Although many panel designs are lightweight, by the time you factor the panels, mounting rack structure, and mounting hardware all together it is not insignificant. Therefore, it is important that an experienced structural engineer approves a proposed installation before going forward. A second load, and perhaps the most critical one, experienced by the structure is the wind loading. Although especially true on installations on flat or low-sloped roofs, where the panels must be pitched at the proper angle to best collect the sun's energy, it is true on all roof installations that the panels represent a large flat or near flat surface area that can act just like a sail. On windy days, the wind can get "underneath" the panel or contact it face-on and push it just like a sail. This creates loads that are transferred to the mounting points on both the mounting rack structure and the connection points to the roof. This means that the fastening points must be strong and secure, and those actually holding the structure onto the roof be anchored in the roof sub-structure rather than just rely on the roof material to support them. Finally, in areas where there is snow, these systems can accumulate or entrap snow that otherwise may have been shed from the roof. This acts to increase the static weight load during those periods when heavy snow may be present in the area. Again, an experienced structural engineer should assess this possibility and confirm that the roof sub-structure is capable of handling these added loads.

To support these loads it is critical that they be capable of securely fastening into the sub-structure. The installer must have options

available to address the variety of sub-structure elements with thread forms suitable to either wood or metal. An installation challenge is that most of these fastening points will only be accessible from one side, the exterior. This means that self-tapping and, often, self-drilling fasteners are required and it is not acceptable for the threads to be damaged or stripped. Additionally, it means making a penetration into or through the roof structure. Even the least experienced homeowner realizes that making a hole in the roof of one's home places them at high risk for a leak during a rainstorm. Therefore, finding a way to effectively seal the penetration that does not require a messy or difficult application of sealant is very important.

Corrosion is another area of concern. No manufacturer or installer wants to be identified as the one whose system corrodes or worse yet corrodes and leaves streaks of corrosion products on a customer's roof. These fasteners will be exposed for a long time to the elements. Therefore, proper choices of corrosion resistant material or surface protection must be adroitly made. Since many of these systems utilize aluminum or other light metal rack structures for weight savings, the possibility of dissimilar pairings exists and care must be taken to limit the risk or consequences of galvanic corrosion.

The final challenge is for the installer. Everyone understands the old adage, "time is money", and in this case it is true. If the fastening system is so time-consuming or difficult to use that it becomes onerous to the installer, it is impractical. Therefore, these fasteners must be designed keeping in mind that ease-of-installation and prevention of failure or rework are very important.

A Well Thought Out Solar Fastener

Because these challenges are present in most solar roof applications, it would be unwise to use just any simple fastener. This is an application that requires the use of a well thought out fastener system. One such fastener system is the EJOT® JA3/JZ3 Solar Fastening System. **Figure 1** shows the features of this fastening system. Starting from the top down, one sees many of the features that make this system uniquely suited to the challenges of a solar rooftop application. There is an internal recess in the top end which allows the fastener to be easily driven by the installer. The upper section of the system contains a series of washers and nuts,

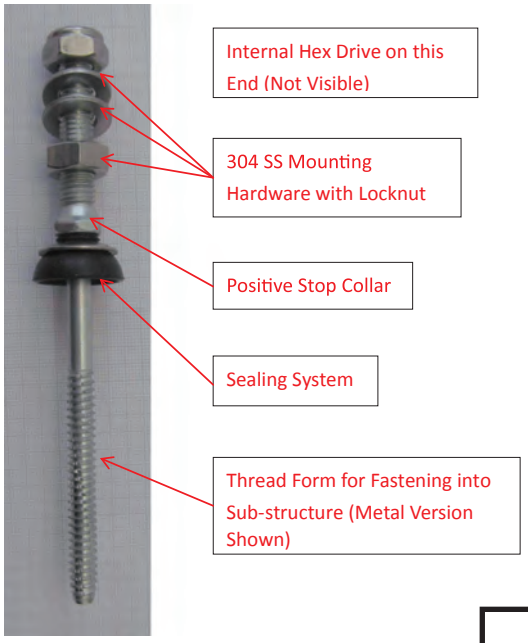

Figure 1 (EJOT® JA3/JZ3 Solar Fastening System)

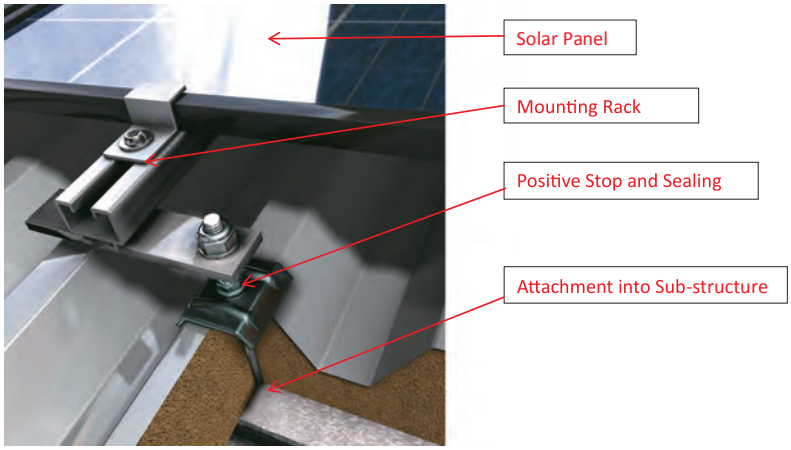

Figure 2 (EJOT® JA3/JZ3 Solar Fastening System Installed)

including at least one locking nut, to securely fasten the panel mounting system or mounting rack to. This particular system has a collar in the middle which acts as a positive stop, again simplifying the job of the installer by providing a visible and definitive stopping point. Additionally, by design, it guarantees that there is sufficient compression of the seal. Naturally the integrated seal is very important as it provides a barrier at the roof penetration point which prevents any water from rain or snow to enter. All the exposed parts of the system are made of A2 stainless steel (304 Stainless Steel) for enhanced corrosion protection. **Figure 2** illustrates how this particular product would be installed into a roof structure.

Special Applications

Throughout the globe, different regions utilize different practices for their common roof designs. In fact, some countries have quite a bit of variation within their borders. Take for example the United States, in its Midwestern Region the most common residential roof material are asphalt shingles, as compared to its Southwestern Region which are predominantly clay or concrete tile. Therefore, numerous designs must exist to address these different roof

types. Although multiple options exist from a variety of suppliers, the following are example solutions offered by the company EJOT® to some of these unique roof types.

Figure 3 illustrates a solution for asphalt shingles, common in construction in the United States. The special challenge with this material is to provide a good seal. This product comes as a kit and includes an integral seal and a wide flashing to both seal and divert water away from the penetration through the roof. It does require some site preparation and a special tool, but overall is a simple and effective answer to mounting in this roof material.

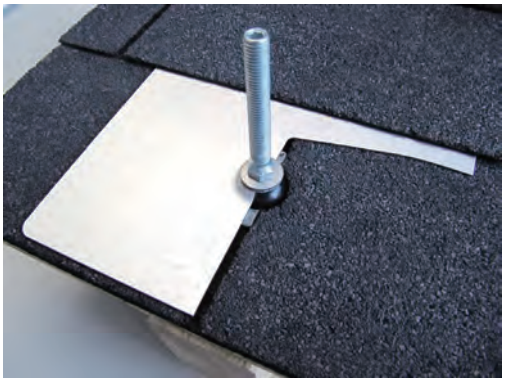

Figure 3 (EJOT® Solar Flashing Kit)

A particularly challenging roof type for mounting is any that utilize irregular shaped or non-flat tiles or shingles. **Figure 4 and 5** illustrate a hook type of device that can be used with Spanish (or clay) Tiles, Concrete Tiles, and Wood Shake Shingle roofs. These hooks attach securely to the roof sub-structure above the tile on which they rest and are then covered by the next row of tile. The result is that only the "hook" end of the hanger is visible and provides a secure fastening point for the photovoltaic panel or its mounting brackets.

Figure 4 (EJOT® Solar Hook)

Figure 5 (EJOT® Solar Hook Installed)

Figures 6 and 7 illustrate fastening devices for metal roof structures. The optimal situation is shown in **Figure 6** where a fastener system like that of **Figure 1** is connected directly into the substructure. This is not always possible and **Figure 7** shows a system that attaches to the trapezoidal roof rib and takes advantage of its strength to support the fastening site. For standing seam metal roofs, where the profile is more rectangular, there are a variety of effective "clamping" devices which also use the roof seam or raised profile for support.

Figure 6 (EJOT® JA3 Solar Fastening System with ORKAN Storm Washer)

Figure 7 (EJOT® ATB Bracket for Trapezoidal Metal Roof Profile)

Conclusion

As the cost of solar systems continues to decrease and the interest in renewable energy increases, these installations will become more commonplace. Because of the demanding and unique nature of the fastening requirements, the continued use and development of technologically advanced fastener systems like those shown in this article will continue to be of vital importance. It will be critical that system designers and installers fully understand the options available to them and engineer their applications carefully and appropriately.

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