SOLON® BELLEVILLE SPRINGS MAINTAIN BOLT PRELOAD ON PV RACKING SYSTEMS

INDUSTRY CHALLENGES

Differential thermal expansion (DTE), vibration, embedment relaxation, bolt yield, thermal cycling.

Photovoltaic (PV) racking systems is the term used to describe the structural assemblies that are used to support solar panels. Since these systems are typically bolted together, the fasteners play an important role in their reliability and safety. Failures of these systems are well documented and often catastrophic. In addition to structural disasters, bolted electrical and ground connections are subject to loosening and developing elevated resistance and even “hot spots.”

PV racking system connections are often made up of materials that have various coefficients of thermal expansion. For example, the structural members are often aluminum while the fasteners are stainless steel. Since the expansion coefficient for aluminum is roughly 50% greater than stainless, the joint expansion at elevated temperature is greater than the bolts. This may lead to yielding of components at the increased stresses. Conversely, the contraction of the joint will also be greater at low temperatures leading to a reduction in bolt load.

In addition, PV racking system connections may loosen over time due to external loads such as snow and wind as well as vibration or embedment relaxation, which is caused by microscopic high points on both the threads and mating surfaces. All of these factors can cause greater yielding and further reduction in bolt load.

As bolt load is reduced, the integrity of the structure is compromised. If the load falls below some minimum threshold, catastrophic failure becomes imminent.

As an example: Consider a bolted connection of two aluminum structural members that are ¼” thick each. The bolt in this case is ½” diameter steel and the assembly torque is 50 lb-ft. The calculated bolt stretch would be only .0006 in. If the assembly occurs is at 80F and temperature drops to -20F, then the DTE would be .0004 in. This means that the bolt would lose about 2/3 of its initial preload at this low temperature. The loss of load can be estimated as the DTE divided by the elasticity of the fastening system. Since the bolt stretch provides the majority of the elasticity, the loss is very high.

Now, if a single Belleville was added to the bolting system with a deflection of .020 in then the elasticity is .020 + .0006 = .0206”. With the same amount of DTE, the loss of load is reduced from 67% to about 2%.

SOLUTION

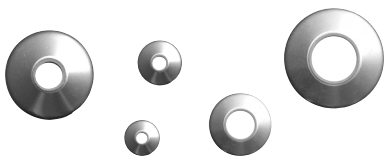
Solon® Belleville Springs counteract the effects of differential thermal expansion by maintaining sufficient load on bolted PV racking system connections to reduce bolt load variation. After yield and relaxation of joint components, a Belleville spring maintains a consistent sufficient load on the bolted joint.

Bellevilles are used on electrical connections when the components of the connection are made of dissimilar (such as Aluminum) and similar materials because they maintain the bolt preload even during differential thermal expansion.

Properly used Solon Belleville Springs can reduce the loss of preload by a factor of 5X or more and greatly reduce the opportunity for a failure.

SOLON ADVANTAGES

- Maintain bolt preload
- Reduce risk of catastrophic failure
- Made in the USA



Solon® Belleville Springs

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