SPIROL WHITE PAPER

Which Austenitic Stainless Steel Spring Pin is Best for Dynamic Loading?

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Austenitic nickel stainless steel Spring Pins are typically manufactured from grade SAE 302/304 (18-8 (1.4310)). The chemical and physical properties of these grades overlap and most mills produce material that can be certified as either. Austenitic stainless steel is often selected for corrosion resistance or cost reduction. While this material possesses the spring characteristics required for proper insertion, retention, and performance, it introduces potential issues that must be considered in design. The Coiled Pin offers many advantages when compared to Slotted Pins and some are most evident in austenitic stainless steel.

Figure 1: Slotted Pin and Coiled Pin

While austenitic stainless steel is ideal in some applications, particularly those requiring high levels of corrosion resistance, it may not be suitable in critical applications where the pin is subject to dynamic loading. This is true of Coiled and Slotted Pins as this material work hardens rapidly. Though mills use work hardening to achieve high yield strength, it is critical to understand this is a continuous process. As yield strength increases, ductility decreases. In dynamic applications vibration, impact and movement will continue work hardening the pin at a rate commensurate with severity and frequency. Excessive work hardening of austenitic stainless steel can lead to fatigue failure evident as cracking or loss of retention. Though both Coiled and Slotted Pins will work harden, the Coiled Pin's superior design provides improved endurance under these conditions.

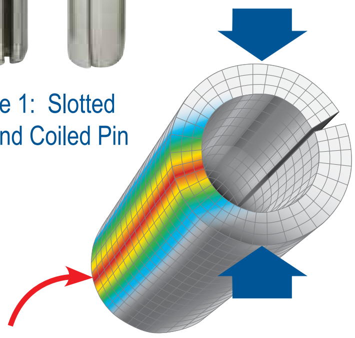

Figure 2: High stress area of a Slotted Pin

All Spring Pins are designed with a pre-installed diameter larger than the recommended hole. Slotted Pins are manufactured with a gap that allows compression of the pin during installation. This differs from Coiled Pins that are designed with a seam (and no gap). Once installed, a Spring Pin is held in tension and this provides retention. A Spring Pin may also maintain desired fit and function by dampening vibration and shock which prevents damage and/or deformation of the host hole. A Slotted Pin can only flex along its spine 180° opposite the gap, much like opening and closing a book. This focuses all stress in one location (see Figure 2) leading to rapid fatigue and potential cracking (see Figure 3). Similarly, once the metal has lost ductility it can no longer recover to maintain tension within the hole and retention can be compromised.

Figure 3: A Slotted Pin can only flex along its spine 180° opposite the gap, much like opening and closing a book.

Comparatively, Coiled Pins spread compressive stress over the entire pin and do not have stress point concentrations. Under applied loads, the Coiled Pin continues to flex and coil toward the centre, absorbing shock and vibration, distributing the load throughout the cross section shown in Figure 4. The Coiled Pin is effectively locked at the seam and movement occurs through the inner coil. This serves two important purposes; the stress is distributed evenly through the pin's cross-section and the pin remains round to maintain maximum contact with the whole wall.

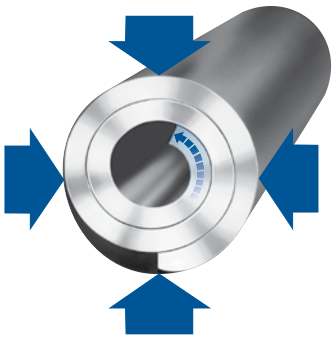

Figure 4: Flexibility under load of a Coiled Pin

Figure 5: Slotted Pin installed in a nominal recommended hole. Notice the gap is virtually closed along the inside diameter of the pin.

Figure 6: Slotted Pin installed in a oversized hole.

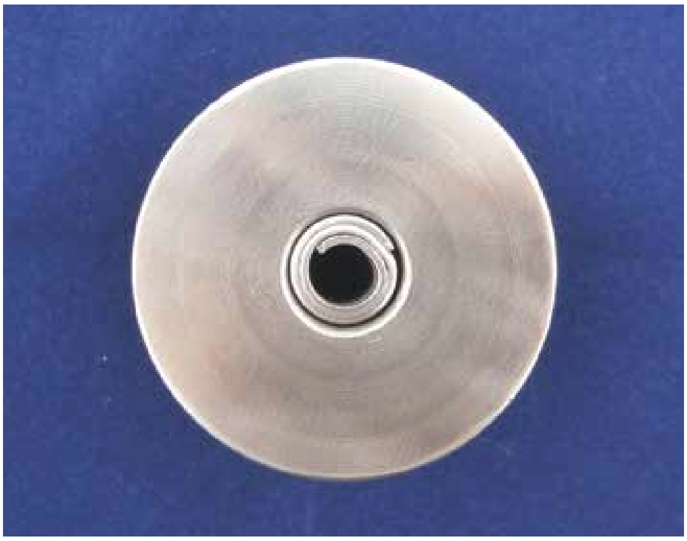

Figure 7: Coiled Pin installed in a nominal recommended hole.

The following photographs demonstrate fundamental differences in design.

In *Figure 5* is a Slotted Pin installed in the nominal recommended hole. Minimal gap remains yet movement is still possible. This may serve to delay work hardening and fatigue - though it will still occur. In this example, once the Slotted Pin is fully compressed under load the seam butts and it will function as a solid tube. This can damage the hole.

In *Figure 6*, the Slotted Pin is installed in an oversized hole. In this instance there is greater potential for movement since the gap is wider and fatigue can occur more rapidly.

Figure 7 depicts the same diameter Coiled Pin installed in the same nominal recommend hole as shown in Figure 5. The Coiled Pin's superior roundness is immediately apparent. Rather than the Slotted Pin's typical 'tear drop' shape, the Coiled Pin maintains contact over a minimum 270 degrees of its circumference. The only gap occurs adjacent to the tucked seam which is necessary to ensure the seam does not interact with the whole wall which may lead to skiving or shaving of the material. This area is referred to as the comma area (*Figure 8*).

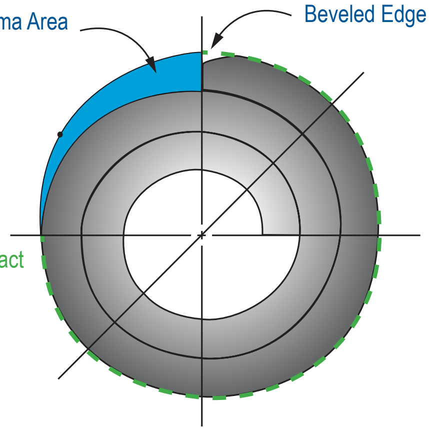

Figure 8: Comma area.

In summation, austenitic stainless steel may be the most cost effective, ideal material for use in some applications although it does have limitations that must be considered in design. Work hardening is of primary concern, though a range of other issues must also be considered. Galvanic corrosion/material compatibility, ability to resist specific corrosive agents/environments, reflectivity, magnetism, and other concerns are less general and more application specific. Coiled Pins are designed to provide optimal performance under the widest possible range of conditions. The benefits of Coiled Pins as compared to Slotted Pins apply across all materials and duties though it may be most evident in product manufactured of austenitic stainless steel. If this material is required, designers must be aware that fatigue is always a potential issue if the pin is subject to dynamic loading. A Coiled Pin will provide superior fatigue life when installed per the recommended design guidelines.

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