



WHITE PAPER

Why Pins Walk and How to Ensure that Doesn't Happen

by Miki Shen, Applications Engineer
SPIROL Asia



Lateral movement of installed pins, commonly referred to as 'walking', can occur with any pin in a dynamic application if proper design guidelines are not followed. This includes rigid Solid Pins as well as Slotted and Coiled Spring Pins. Though Solid and Spring Pins can walk, the causes may be different for each style. This White Paper will address common causes for lateral movement and offer design guidelines to avoid the condition.



The Slotted Spring Pin cannot flex when the slot is closed.

There are common causes of walking for both Solid Pins and Spring Pins such as improperly sized holes, insufficient engagement, and asymmetrical loading. There are also mechanisms of walking unique to each product. For example, rigid pins may deform the holes thereby introducing clearance and compromising retention. If properly selected for host material and load, Spring Pins should not deform holes like rigid Solid Pins. However, once installed, a Slotted Spring Pin's gap is largely closed. If further movement occurs, the Slotted Pin can butt at the gap at which point it functions as a solid tube (exhibiting the same characteristics as a Solid Pin).

SPIROL's engineered Coiled Spring Pins are designed to address the deficiencies associated with both Solid Pins and Slotted Spring Pins. Coiled Pins are available in a variety of duties to tailor the strength and flexibility of the pin to the assembly in which it is being used. Light and standard duty Coiled Pins can prevent hole damage in soft and brittle materials, which is often the case when Solid Pins or Slotted Pins are used. In addition, unlike Slotted Spring Pins, Coiled Spring Pins cannot "butt" in holes as they possess a seam rather than a gap.



Coiled Pins and Slotted Pins are functional springs. Once installed, the pin is compressed and it is spring tension that provides retention in an assembly. As previously noted, Coiled Pins cannot butt and therefore remain flexible in assemblies. While Coiled Pins provide critical flexibility in rigid assemblies, it is very important to ensure that they are symmetrically loaded to prevent the creation of an angular force vector. If a force vector is created, it can translate radial compression or coiling of the Spring Pin into lateral movement or 'walking'. (Shown in *Figure 1*, compressive load on the pin translates into lateral motion when the pin is under compression and asymmetrically loaded.)

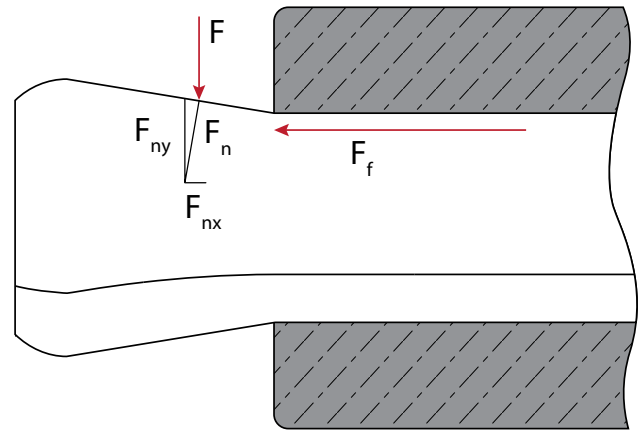


Figure 1
Walking occurs when $F_{nx} > F_f$
Taper has been exaggerated to demonstrate forces

F = compressive load on pin

F_n = force exerted radially as the pin is compressed and it wants to spring back

F_{nx} and F_{ny} = the resolutions of F_n

F_f = the force of friction that retains the pin in the hole

Figures 2a-c illustrate some of the most common causes for walking when using both styles of Spring Pins if not properly designed into the assembly:

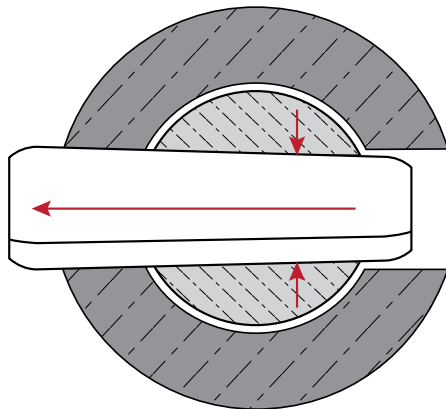


Figure 2a

If the hole size is smaller in one component, the pin may not recover sufficiently to properly engage the opposite hole. In this example, the middle component is sized smaller. As a result, there is no retention at one end – if tapered by the holes, this can create a force vector allowing translation of load applied in rotation to lateral movement.

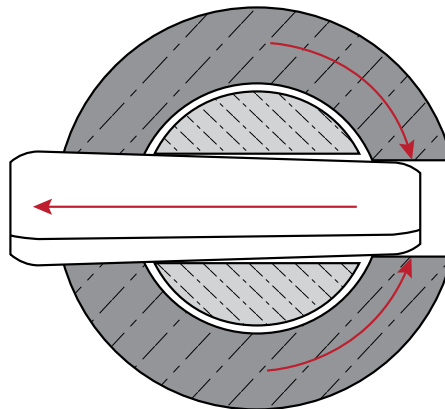


Figure 2b

If the hole size is larger on one side than the other, then the pin will assume a taper as it conforms to the holes. The pin remains flexible after installation. Again, if tapered by the holes, this can create a force vector allowing translation of load applied in rotation to lateral movement.

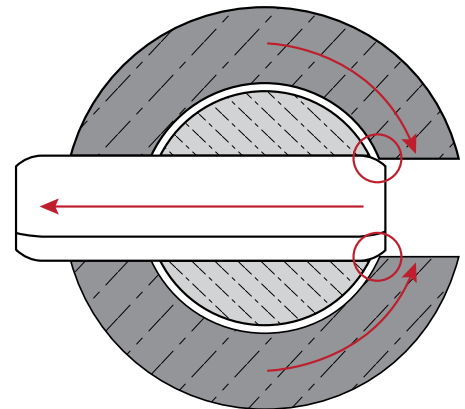


Figure 2c

If the pin's chamfers are placed in the shear plane, it can create a force vector causing walking when the rotating component impacts this angular surface.

How does a designer ensure Spring Pins are properly loaded to prevent walking? A number of methods are outlined below:

FRICTION & FREE FIT HINGES

For friction fit hinges, ideally all holes would be precision matched in both the inner and outer components. Oftentimes, it is not possible to perfectly match each and every hole diameter. If this cannot be achieved, it is necessary to consider spring recovery of the Spring Pin (back towards its original pre-installed diameter) in order to determine the proper tolerances for the individual holes. *Figure 3* demonstrates a situation where the holes could

not be precision matched. Hole size has been controlled such that the pin is retained in the slightly smaller outer holes while it is allowed to "recover" in the centre hole. As spring recovery increases with distance, the pin can better compensate for hole variation if allowed to recover in the centre hole. This can help maintain contact in all components.

SHAFT & GEAR / HUB ASSEMBLIES

If a free fit hinge were desired, the opposite would be applied – with the diameter sized larger in the outer holes. This would ensure optimal engagement length, and the pin could only recover a very small amount over the short distance in the outer holes. As a result, a free fit condition can be achieved without excessive 'play' or clearance.

To achieve a friction fit hinge in *Figure 4*, the same rules apply for maximum performance in that all holes should be precision matched if possible. The difference between the two situations in *Figure 3* and *Figure 4* is where spring recovery of the pin will occur. In *Figure 4*, free span length is greatest in the outer components so pin recovery would be greatest at the ends rather than in the centre. In this diagram, the pin will be retained most tightly in the centre hole while it recovers at each end to maintain contact with the outer hole walls.

Both *Figure 3* and *Figure 4* would result in a successful design if the Spring Pin's spring characteristics are carefully considered for each situation. If required, it is possible to empirically derive values for expected spring recovery that are diameter and length specific.

And if a free fit hinge were desired in *Figure 4*? Simple – ensure the pin is retained at the ends. The centre component offers little length for pin recovery and as such, it need only be slightly larger than the outer holes to ensure clearance over the pin.

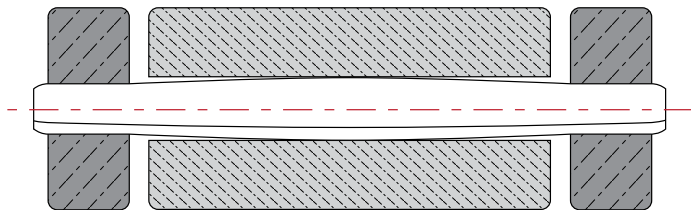


Figure 3

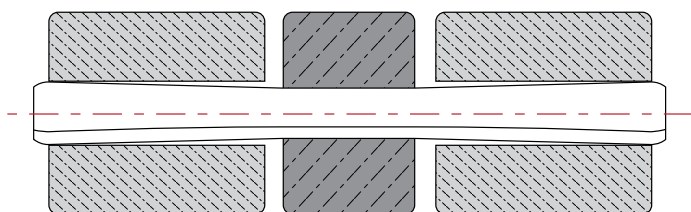


Figure 4

The conditions presented in *Figures 3 & 4* are exaggerated for clarity. Clearance between components is also exaggerated. In reality, a significant gap between the components would introduce a bending moment that could also result in pin migration if the actual clearance were this great.

Similar to the friction fit hinge, shaft and gear / hub assemblies require engagement in both components. Ideally the diameter of the holes would be precision matched through both the shaft and gear / hub to eliminate any movement of the pin within the holes. *Figures 5* and *6* demonstrate situations where the holes could not be precision matched, however spring recovery has been taken into consideration. They are basically the same as *Figure 3* and *4*. In *Figure 5*, free span length is greatest in the centre which is the same situation as with *Figure 3*. The pin will be retained most tightly in the outer holes while it recovers in the centre to maintain contact with the centre hole walls. Similarly, *Figure 6* is the same situation as *Figure 4*. Free span length is greatest at the ends rather than in the centre. The pin will be retained most tightly in the centre hole while it recovers at each end to maintain contact with the outer hole walls. For all shaft and gear / hub applications, it is recommended that the difference between the holes not exceed 0.05mm (.002"). Otherwise, the pin will be subject to dynamic loading where a very small change in velocity could equate to an enormous change in force on the assembly.

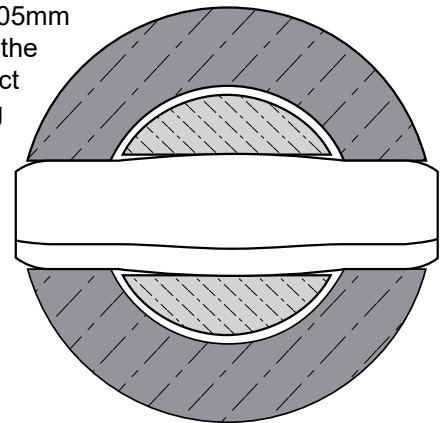


Figure 5

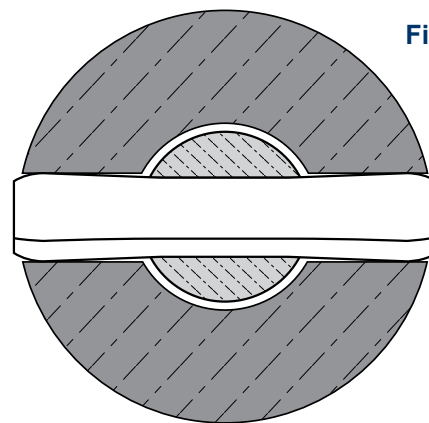


Figure 6

Walking of pins can be prevented if the joint to be pinned is given proper consideration during the design stage of the assembly. SPIROL maintains a staff of experienced engineers capable of providing assistance from initial concept to complete design. SPIROL engineers are also adept at identifying causes for lateral movement in mature designs to assist with continuous product improvement. If you are working on a new design, or require assistance on an existing assembly, contact your SPIROL representative today.



Coiled Spring Pins



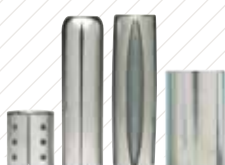
Slotted Spring Pins



Solid Pins



**Alignment Dowels /
Bushings**



**Spacers & Rolled
Tubular Components**



**Compression
Limiters**



**Threaded Inserts
for Plastics**



Disc Springs



**Machined Aerospace
Components**



**Precision Shims,
Washers & Metal Gaskets**



Laminated Shims



**Parts Feeding
Technology**



**Pin Installation
Technology**



**Insert Installation
Technology**



**Compression Limiter
Installation Technology**

Please refer to www.SPIROL.co.uk for current specifications and standard product offerings.

SPIROL offers complimentary Application Engineering support! We will assist on new designs as well as help resolve issues, and recommend cost savings on existing designs. Let us help by visiting **Application Engineering Services** on SPIROL.co.uk.

Technical Centres

Europe SPIROL United Kingdom
Corby, Northants, England
+44 (0) 1536 444800
info-uk@spirol.com

SPIROL Ford
South Shields, Tyne & Wear, England
+44 (0) 1914 540141
contactus@ford-engineering.com

SPIROL France
Saint-Léonard
+33 (0) 3 26 36 31 42
info-fr@spirol.com

SPIROL Germany
Münich
+49 (0) 89 4 111 905 71
info-de@spirol.com

SPIROL Spain
Barcelona
+34 932 71 64 28
info-es@spirol.com

SPIROL Czech Republic
Prague
+420 226 218 935
info-cz@spirol.com

SPIROL Poland
Warsaw
+48 510 039 345
info-pl@spirol.com

Americas SPIROL International Corporation
Connecticut, USA
+1 860 774 8571
info@spirol.com

SPIROL Shim Division
Ohio, USA
+1 330 920 3655
info@spirol.com

SPIROL Canada
Windsor, Ontario
+1 519 974 3334
info-ca@spirol.com

SPIROL Mexico
Apodaca, Nuevo León
+52 81 8385 4390
info-mx@spirol.com

SPIROL Brazil
Indaiatuba, São Paulo
+55 19 3936 2701
info-br@spirol.com

Asia Pacific SPIROL China
Shanghai
+86 (0) 21 5046-1451
info-cn@spirol.com

SPIROL Malaysia
Iskandar Puteri, Johor
+60 77 063 960
info-my@spirol.com

SPIROL Korea
Seoul, South Korea
+82 (0) 10 9429 1451
info-kr@spirol.com