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

SPIROL WHITE PAPER

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. Although any kind of pin 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 that pertain to all types of 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 slot is largely closed. If further movement occurs, the Slotted Pin can butt at the slot 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 slot.

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.)

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

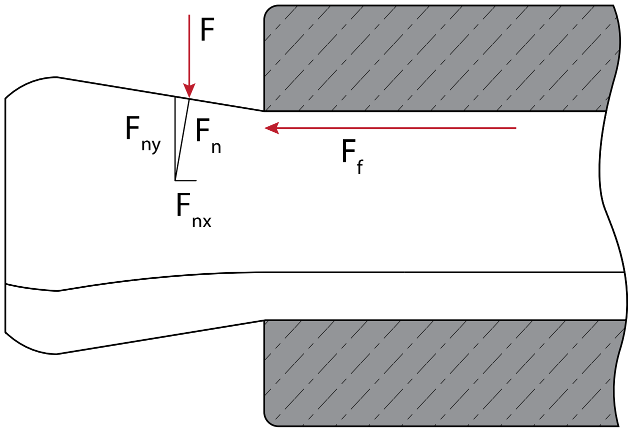

Figure 1: Walking occurs when $F_{nx} > F_f$
Taper has been exaggerated to demonstrate forces

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:

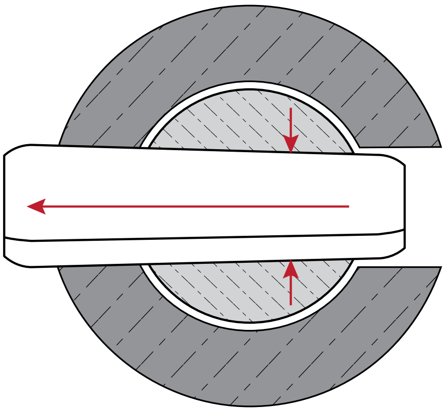

Figure 2a

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.

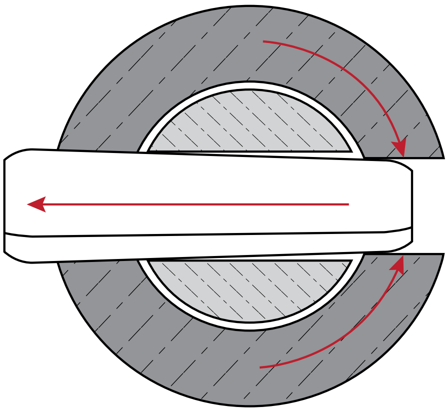

Figure 2b

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.

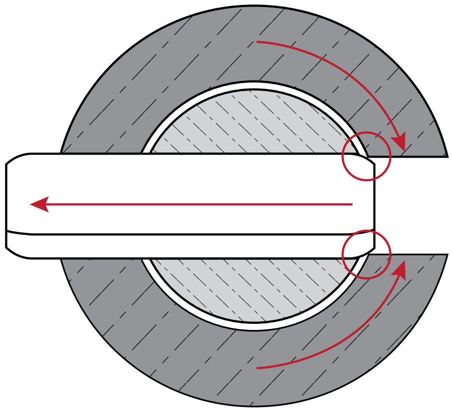

Figure 2c

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 center hole. As spring recovery increases with distance, the pin can better compensate for hole variation if allowed to recover in the center hole. This can help maintain contact in all components.

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 center if the holes could not be precision matched. In this diagram, the pin will be retained most tightly in the center hole while it recovers at each end to maintain contact with the outer hole walls.

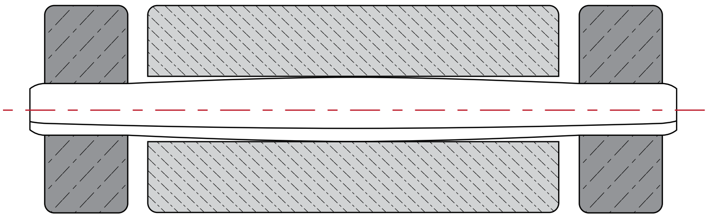

Figure 3

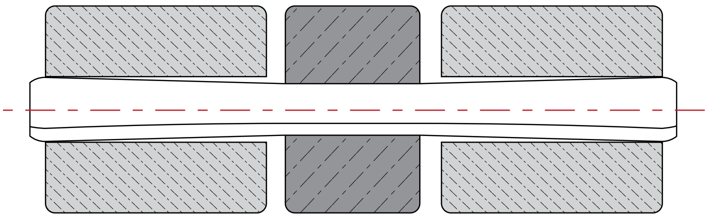

Figure 4

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.

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

If a free fit hinge were desired in *Figure 4,* simply ensure the pin is retained at the ends by making the holes bigger in the center component. The center 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.

SHAFT & GEAR / HUB ASSEMBLIES

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 center 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 center to maintain contact with the center hole walls. Similarly, *Figure 6* is the same situation as *Figure 4*. Free span length is greatest at the ends rather than in the center. The pin will be retained most tightly in the center 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.

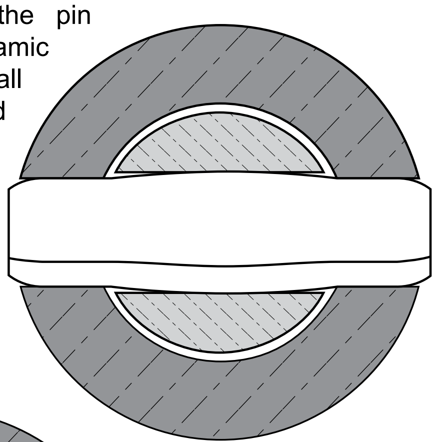

Figure 5

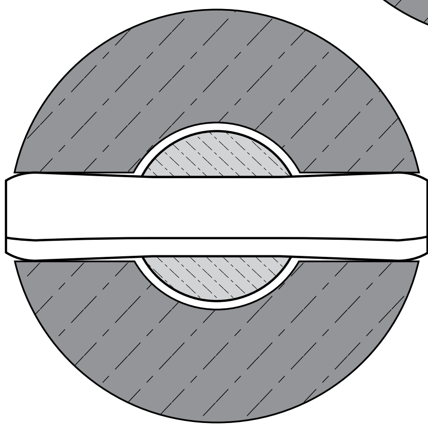

Figure 6

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.

SPIROL Innovative fastening solutions. Lower assembly costs.

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

SPIROL Application Engineers will review your application needs and work with you to recommend the optimum solution. One way to start the process is to visit our **Optimal Application Engineering** portal at **SPIROL.co.uk**.

© 2018 SPIROL International Corporation
No part of this publication may be reproduced or transmitted in any form or by any means, electronically or mechanically, except as permitted by law, without written permission from SPIROL International Corporation.

Technical Centres

Europe

SPIROL United Kingdom
17 Princewood Road
Corby, Northants
NN17 4ET United Kingdom
Tel. +44 1536 444800
Fax. +44 1536 203415

SPIROL France
Cité de l'Automobile ZAC Croix Blandin
18 Rue Léna Bernstein
51100 Reims, France
Tel. +33 3 26 36 31 42
Fax. +33 3 26 09 19 76

SPIROL Germany
Ottostr. 4
80333 Munich, Germany
Tel. +49 89 4 111 905 71
Fax. +49 89 4 111 905 72

SPIROL Spain
08940 Cornellà de Llobregat
Barcelona, Spain
Tel. +34 93 193 05 32
Fax. +34 93 193 25 43

SPIROL Czech Republic
Sokola Tůmy 743/16
Ostrava-Mariánské Hory 70900
Czech Republic
Tel/Fax. +420 417 537 979

SPIROL Poland
ul. Solec 38 lok. 10
00-394, Warszawa, Poland
Tel. +48 510 039 345

Americas

SPIROL International Corporation
30 Rock Avenue
Danielson, Connecticut 06239 U.S.A.
Tel. +1 860 774 8571
Fax. +1 860 774 2048

SPIROL Shim Division
321 Remington Road
Stow, Ohio 44224 U.S.A.
Tel. +1 330 920 3655
Fax. +1 330 920 3659

SPIROL Canada
3103 St. Etienne Boulevard
Windsor, Ontario N8W 5B1 Canada
Tel. +1 519 974 3334
Fax. +1 519 974 6550

SPIROL Mexico
Avenida Avante #250
Parque Industrial Avante Apodaca
Apodaca, N.L. 66607 Mexico
Tel. +52 81 8385 4390
Fax. +52 81 8385 4391

SPIROL Brazil
Rua Mafalda Barnabé Soliane, 134
Comercial Vitória Martini, Distrito Industrial
CEP 13347-610, Indaiatuba, SP, Brazil
Tel. +55 19 3936 2701
Fax. +55 19 3936 7121

Asia Pacific

SPIROL Asia Headquarters
1st Floor, Building 22, Plot D9, District D
No. 122 HeDan Road
Wai Gao Qiao Free Trade Zone
Shanghai, China 200131
Tel. +86 21 5046 1451
Fax. +86 21 5046 1540

SPIROL Korea
160-5 Seokchon-Dong
Songpa-gu, Seoul, 138-844, Korea
Tel. +86 21 5046-1451
Fax. +86 21 5046-1540

email: info-uk@spirol.com

SPIROL.co.uk