

Technical Data – Shear Strength and Dynamic Considerations

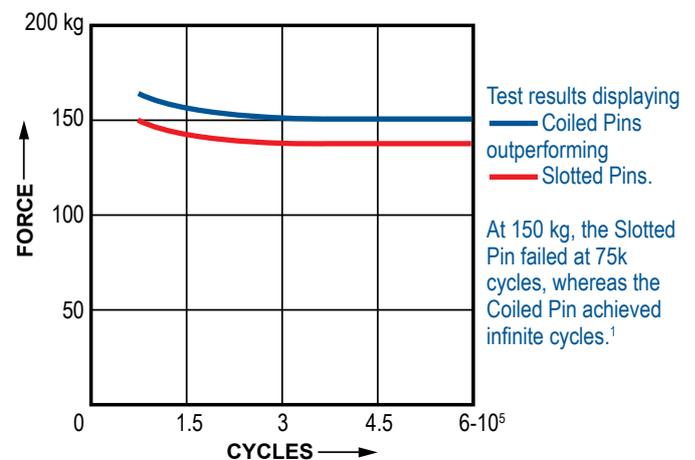
SPIROL Coiled Pins are designed to withstand shock and rapidly changing oscillating or intermittent dynamic forces. Dynamic forces should be calculated in accordance with accepted engineering principles, and a pin should be selected with a static shear strength which exceeds the calculated dynamic forces. Whenever it is impossible to calculate the theoretical dynamic forces, it becomes necessary to determine the static load to which the joint is to be subjected. Depending on the severity of the shock and vibration, an adequate safety factor must be applied. Minor dynamic forces can usually be disregarded.

Due to the many factors which are involved in a dynamic situation, it is impossible to precisely define test conditions which would provide data that could readily be applied to an actual application. Therefore, for all new designs, SPIROL recommends that life cycle testing of the actual assembly be conducted under simulated real world conditions to ensure the pin meets the desired performance requirements. The simulation should not be accelerated to the extent that a new dynamic situation is created. A properly performing pin will eventually fail without damaging the hole, but only after the design life of the assembly has been achieved.

Dynamic failure does not occur in the shear plane. It is not a straight cut, but rather a helical failure. As a result, the pin may continue to function even after failure and be discovered only during disassembly.

Independent studies¹ have resulted in the following findings:

- Unlike static shear, where fracture always occurs in the shear plane, in dynamic failure of Coiled Spring Pins, the fracture occurs some distance from the shear plane. This testifies to the pin's flexibility. In addition, the fracture in Coiled Pins progresses helically from the outer coil so the pin continues to function after initial fracture.
- Dynamic endurance decreases as the length of a Spring Pin increases in relation to the diameter. This decrease is less for SPIROL Coiled Pins than for other Spring Pins.
- In all tests, Coiled Pins outlasted Slotted Pins. In some instances where other pins failed at less than 100,000 cycles, properly designed Coiled Pins had an infinite endurance life at the same load (*as shown below*).



Choosing the Proper Pin Diameter and Duty

It is important to start with the load to which the pin will be subjected. Then evaluate the material of the host to determine the duty of the Coiled Pin. The pin diameter to transmit this load in the proper duty can then be determined from the shear strength tables (*on pages 14-19*) taking into consideration these further guidelines:

- Wherever space permits, use standard duty pins. This pin has the optimum combination of strength and flexibility for use in nonferrous and mild steel components. It is also recommended in hardened components because of its greater shock absorbing qualities.

- Heavy duty pins should be used in hardened materials where space or design limitations rule out a larger diameter standard duty pin.
- Light duty pins are recommended for soft, brittle or thin materials and where holes are close to an edge. In situations not subjected to significant loads, light duty pins are often used because of easy installation resulting from lower insertion force.

¹ • ASME Paper No. 58-SA-23 by Dr. M.J. Schilhasl
 • Konstruktion 1960, Issue 1: Pages 5-13; Issue 2: Pages 83-85
 both by Prof. Dr.-Ing K. Lürenbaum

Locating and Alignment Design

To achieve optimal alignment when using Coiled Pins, two primary design elements must be adhered to:

- 1) The hole diameters in the host and mating component must be correctly sized to achieve the desired interference and accuracy of alignment.
- 2) In all applications, the engagement length of the Coiled Pin in the component providing primary retention must be no less than 60% of the pin's overall length. The remaining protruding length will align with the mating component. Increasing the initial length of engagement is recommended in thru-hole applications; however, the Coiled Pin still has to protrude in order to align the mating component.

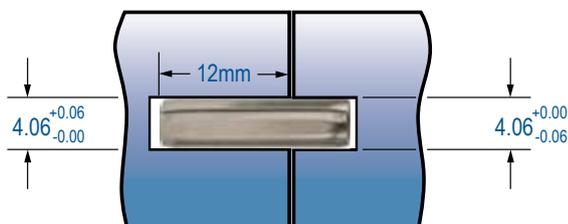
Interference fit for maximum alignment accuracy:

Coiled Pins are functional springs that conform to the holes into which they are installed. The assembly force to achieve maximum accuracy in alignment should not exceed a 'light' press to seat mating components. Depending upon Coiled Pin duty, quantity of alignment pins, and host material, this may be as little as a tap with the palm of a hand or a mallet. An interference fit must not be confused with that of a traditional Solid Dowel which typically requires seating with pneumatic or hydraulic presses. This is a primary benefit of the Coiled Pin.

To ensure a light press fit, ideally, the hole size in both the host and mating components should be precision matched within the recommended tolerance range. This may not be practical if holes are not drilled together as an assembly.

In situations where holes cannot be precision matched or where the cost of honing/reaming is prohibitive, a significant benefit of the Coiled Pin is its ability to compensate for larger hole tolerances. The recommended tolerance range may be divided between components as demonstrated below.

(Note: Utilizing less of the allowable manufacturing tolerance will further improve the fit and alignment of the assembly.)

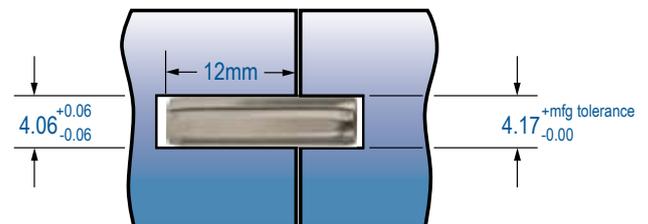


Recommended hole size and pin depth for CLDP 4 x 20 LBK

Assigning the larger tolerance to the 60% retention location ensures interference between the free end of the pin and the opposing hole that is prepared at the lower half of the tolerance. Where there is interference there is no clearance, thus ensuring proper projection of the primary hole's position.

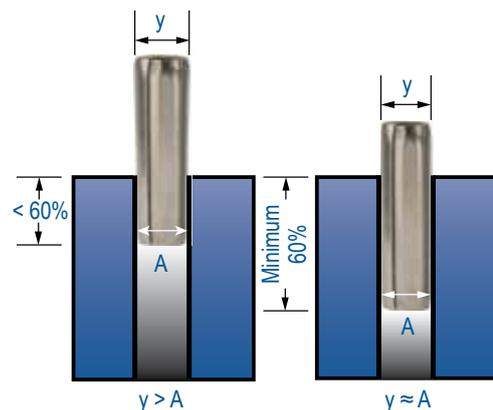
Clearance fit for course alignment and ease of assembly:

If a clearance fit over the pin is desired for ease of assembly, it will be necessary to compensate for spring recovery at the pin's free end. To determine the maximum diameter of the free end of the pin, install the pin to 60% of the pin's length into the maximum hole size of the primary retention host and measure the exposed diameter. A 0.025mm (.001") to 0.05mm (.002") clearance factor should be added to the free end of the pin depending upon desired alignment accuracy.



Recommended hole size for clearance fit with CLDP 4 x 20 LBK

When used as a free fit alignment dowel, assembly force is not a consideration; although it is important to note that consideration should be given to using the Coiled Pin as an interference fit solution. As outlined above, Coiled Pins provide the benefit of a zero clearance fit without the added complexity of high insertion force.



This diagram demonstrates proper installation depth. When a Coiled Pin is installed less than 60% of its overall length two conditions may occur:

- (y) or the free end diameter will not be properly controlled creating inconsistent 'fit' when parts are mated downstream in the production process.
- The pin may not maintain position in the component in which it is intended to be retained during future disassembly. This is of greatest importance when multiple alignment pins are utilised between components.

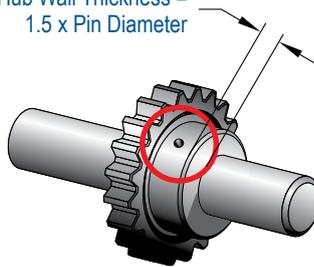
Shaft Design

One of the primary benefits of using a Coiled Pin to affix a collar or hub to a shaft is the Coiled Pin's ability to prevent hole damage. There are a few design guidelines that must be adhered to in order to achieve the maximum strength of the pinned system and prevent damage to the shaft and/or hub:

Shaft – The hole in a shaft should not exceed 1/3 of the shaft diameter. For mild steel and nonferrous shafts, standard duty pins are recommended. The extra strength of a heavy duty pin is only beneficial if the hole is less than 1/4 the diameter of the shaft or if the shaft is hardened.

Hub – SPIROL recommends that the hub be designed with a minimum wall thickness of 1.5 times the diameter of the pin. Otherwise, the strength of the hub will not match the shear strength of the pin. As the wall thickness of the hub increases, so does the area of material around the pin to absorb the load.

Min. Hub Wall Thickness =
1.5 x Pin Diameter



Hole Diameter =
Max. 1/3 Shaft Ø

Shaft and Hub – The diameter of the holes through both the shaft and hub should be precision matched to eliminate any movement of the pin within the holes. 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. Care should be taken to ensure that the holes are drilled through the centre of the shaft and the hub.

The outer diameter (OD) of the shaft and the inner diameter (ID) of the hub should be designed such that the distance between the shear planes (OD - ID) does not exceed 0.15mm (.005”). In addition, countersinks, particularly on the hole in the shaft, are not recommended. Otherwise, the pin will be placed in bending and the maximum strength of the pinned system will not be achieved. This could lead to premature failure of the assembly.

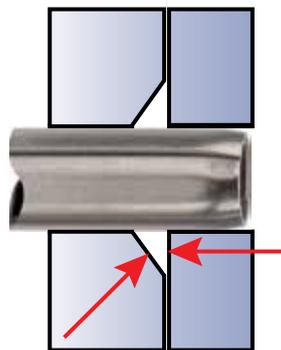
Hole Design

It is important to note that the **recommended hole sizes** (on pages 14-19) may not be true for all applications. There are many applications that require a different hole size to ensure the proper function of the assembly. For this reason, it is recommended that SPIROL be consulted on new designs.

Even though the Coiled Pin absorbs wide hole tolerances, holding tighter tolerances, particularly in some applications such as friction fit hinges, precision alignment and shaft and gear assemblies will result in better performance.

In all cases, care must be taken to have enough material around the pin to prevent bulging and deformation of the host material. In most applications, the applied loads will far exceed the hoop stresses exerted by the Coiled Pin. Never specify a non-heat-treated Coiled Pin for use in a hardened hole.

In the case of hardened host materials with drilled holes, the edges of the hole should be deburred. A countersink does not eliminate the sharp edge of a hardened hole, and rather displaces the sharp edge to the transition between



A countersink increases the distance between the shear planes. This can put the pin in bending and thus reduce the strength of the pin.

the countersink and entrance to the hole. Furthermore, countersinks increase the distance between the shear planes which can put the pin in bending and thus reduce its strength (as shown at left). Cast or sintered holes should be provided with a slight lead-in radius.

In punched or pierced holes, it is recommended that pins be inserted in the same direction as the punch to prevent any residual burr from impacting the pin during installation.

Permissible Hole Misalignment – Coiled Pins are capable of compensating for minor misalignment as they are manufactured with a generous lead-in chamfer. In order to determine the maximum misalignment

between mating holes into which the Coiled Pin is installed, use the following calculation:

$$MPHM = \frac{1}{2} (H-B) \text{ where;}$$

MPHM = Maximum Permissible Hole Misalignment

H = Minimum hole diameter of the second hole through which the pin will be inserted

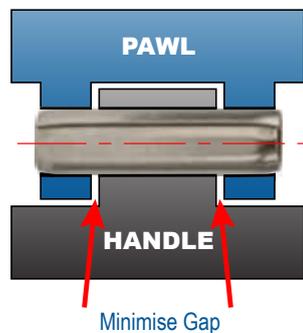
B = Chamfer diameter (assume this to be equal the “B Max” dimension listed on pages 14-19)

Hinge Design

There are two primary types of hinges:

- 1) A **free fit hinge** has little to no friction or drag when the latch or handle is rotated. Hinge components are “free” to rotate independent of one another.
- 2) A **friction fit hinge** requires interference to prevent free rotation of components relative to one another. Depending on design intent, resistance can vary from a slight drag to a value sufficient to maintain the fixed position of components anywhere in their full range of rotation.

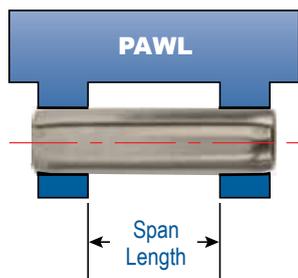
Coiled Spring Pins are particularly well suited for use in both friction and free fit hinges. To achieve optimum long-term hinge performance designers should observe some basic design guidelines. Regardless which pin type is used, the gap between hinged components should be minimised to reduce clearance and avoid bending of the pin.



FREE FIT HINGE

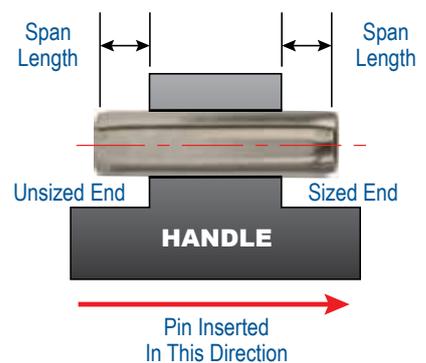
If a **free fit hinge** is desired, the Coiled Pin’s pre-installed diameter is of negligible importance as pin diameter is determined by the retaining, or smallest hole(s). Coiled Pins are functional springs and recovery & retention in free fit locations must be considered. The amount of recovery/retention is dependant upon the diameter of the tight (retaining) hole(s) and the ‘free span’ of the pin. Free span would be defined as the distance a pin passes through a free fit component. As free span increases, the pin diameter will also increase as it “recovers” a portion of its pre-installed diameter.

It is recommended for better load distribution and closer tolerance hinges that the tight fit of the Coiled Pin be in the outer members of the hinge. The minimum thickness of the outer members should be equal to the diameter of the pin. If the thickness of the outer members are less than the diameter of the pin, then the tight fit should be in the inside hole.



To design a free fit hinge, first establish the maximum hole size in the retaining component (tight fit). Insert the Coiled Pin into the retaining component and measure the free diameter of the pin at the centre of the span. Add a factor to provide some clearance for the rotating member, usually 0.02mm (.001”) to establish the minimum diameter of the free hole. Then add the required production tolerance to assign the maximum diameter of the free hole.

If the tight fit is on the inside member of the assembly, as the pin is installed there becomes a sized and an unsized end of the pin. The end of the pin that has not been inserted through the hole will be larger than the end that has been sized by the hole. Therefore, measure the diameter of the unsized end to determine the minimum diameter of the free hole in the outside members.



FRICITION FIT HINGE

To achieve a **friction fit hinge**, the Coiled Pin must create radial tension in all hinge components. Maximum friction will be obtained when all holes are precision matched. Deviation in hole sizes from one component to another will result in the reduction of hinge friction within the assembly. If the manufacturer is unable to maintain the same hole size within each component, the tolerance should be split between the components. It is most common to assign the smaller half of the tolerance to the outside holes and larger half to the inside hole.

The Coiled Pin simplifies design as there is no need to incorporate misalignment between holes to achieve friction, as is the case with rigid Solid Pins. Coiled Pins perform best when installed in straight, properly aligned holes. The Coiled Pin’s spring characteristics can be used to achieve exceptional performance and maintain desired fit and function throughout the life of the product.

Although this article offers general design guidelines, it is recommended that **SPIROL** be consulted to ensure the optimum hinge design is employed for each application.

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Coiled Spring Pins



Slotted Spring Pins



Solid Pins



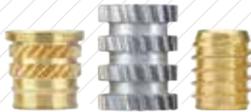
Alignment Dowels /
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Spacers & Rolled
Tubular Components



Compression
Limiters



Threaded Inserts
for Plastics



Railroad Nuts



Disc Springs



Precision Shims &
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Technology



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Technology



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