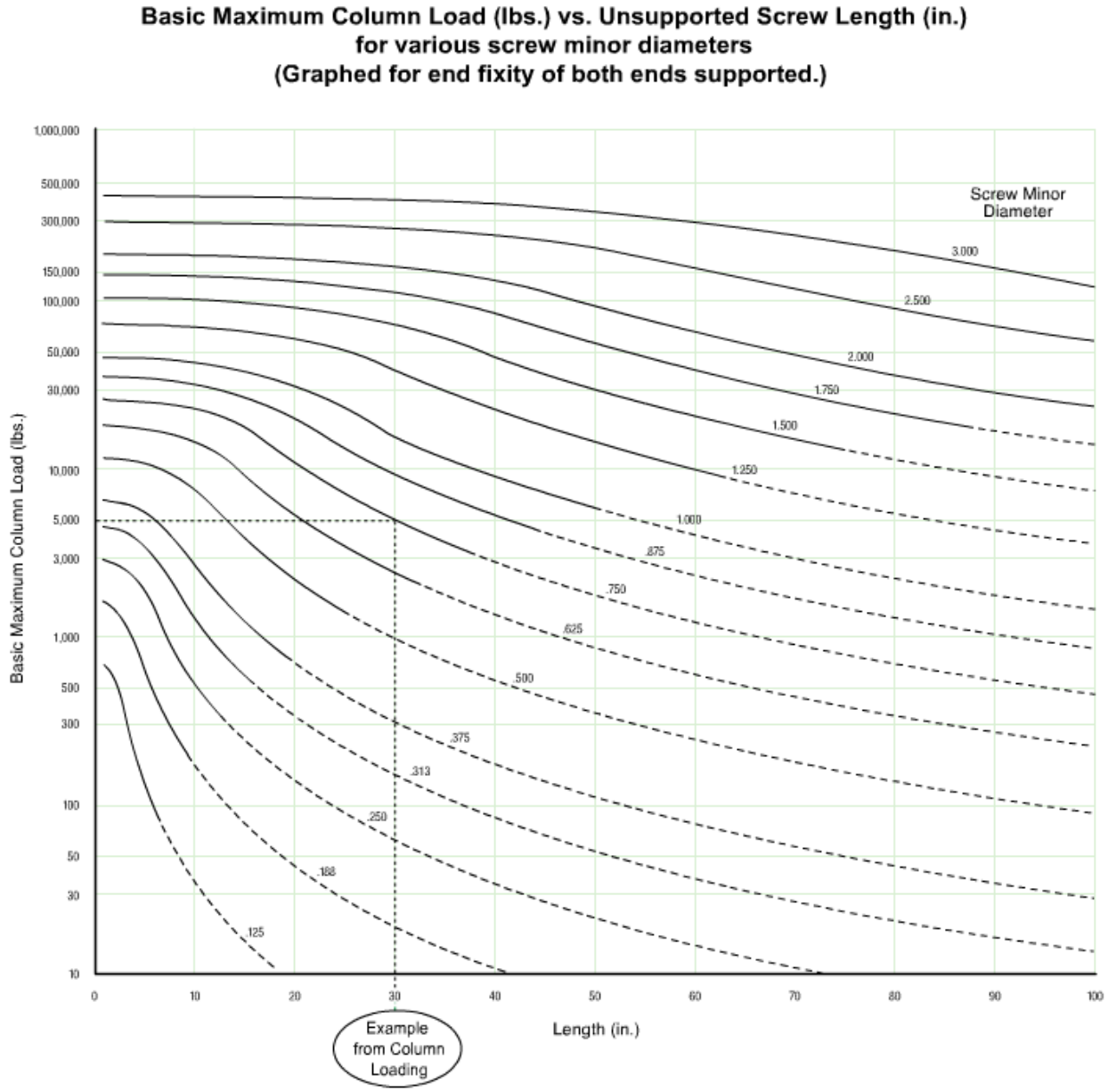
Introduction

A lack of screw straightness can become a critical factor in any application. Bent lead screws can cause noise, premature wear and failure, high drive torque, and excessive heat. But straightness requirements vary widely from application to application, and straightness is an expensive and perishable product feature. For these reasons it is important to understand what straightness is, how it's measured, how it can be achieved, maintained, lost, and restored.

Type of Straightness Defects back to top

Defects Figure 30 illustrates the three principle types of straightness defects. The first, and most common, is a "bow" defect. It consists of a simple bend in one plane, as shown in Figure 30 (a). The second type is a "snake" defect, which exhibits multiple bends in a single plane as shown in Figure 30 (b). And the third type, in Figure 30 (c), is a "corkscrew" defect, characterized by multiple bends in multiple planes.

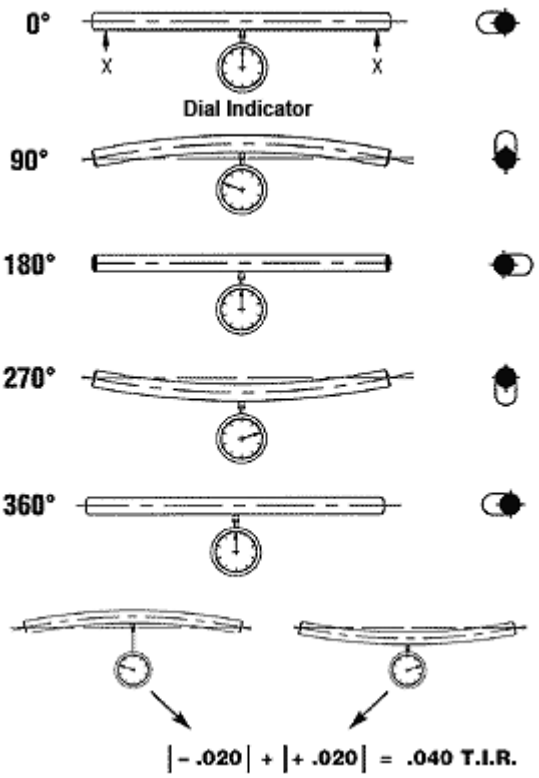
FIGURE 30



Measuring Straightness back to top

Screw straightness is measured by placing a screw onto two "V" or roller supports and rotating the screw 360° against a dial indicator. The operator then notes the indicator readings at the extreme height and depth during the rotation. The sum of these indicator readings is the total indicator reading, or TIR. Straightness is usually specified in terms of TIR which is typically expressed in thousandths of an inch (i.e. ".015 TIR"). See Fig. 31 for an illustration of the process.

FIGURE 33



Methods of Achieving Straightness back to top

Unless special straightening is requested by the customer, Roton will ship screws in "as rolled" straightness condition. For most applications, this level of straightness is sufficient and cost effective. But some applications have more demanding straightness requirements. Users with applications requiring screw shafts to be straightened beyond "as rolled" condition should specify a finished cut length and the straightness requirements in TIR. The shafts should be purchased cut to length and straightened at our facility. It is imperative that all the handling and other precautions detailed in the "Preserving Straightness" section below be observed and followed to avoid the loss of this added value.

Users with high part volumes or a variety of part lengths might find it more economical to operate their own straightening equipment. In either case, since the longer the shaft is the more difficult and time consuming the straightening is, costs can be minimized if shafts are finished cut prior to straightening.

Because straightening can be expensive, users who have more liberal straightness specs may choose the option of buying random lengths in bulk, cutting to length first, and then segregating and straightening only those parts that are too bent to be used. This is especially effective for meeting "visual" straightness specs, where a screw's wobble is a perceived defect.

For more detailed discussions about straightness or to discuss a particular application, contact Roton Application Engineering.

Preserving Straightness back to top

Screw shaft straightness is a perishable feature. It is very easy to bend shafts during routine handling, machine loading, during machining and during in plant transportation. Even inside a wooden crate shafts can be easily bent if precautions are not observed.

When transporting screws, it is best if the screws are supported in two or three places. They should never be carried or lifted from a single support point at the center of the screw either by hand or by crane. See Figure 34.

When machining by turning, the entire length of the screwshaft must be supported. This is necessary not only to prevent bending but also for the safety of the machine operator. With today's high rotating speeds it is imperative that robust supports are used so that the screwshaft does not vibrate enough to cause bending. Hydraulic bar feed supports work well for turning long shafts.

When milling, care must be used to place the clamps where they can grip the work but not bend or deflect the screwshafts. In Figure 35 (a) the tool designer has used an over-center clamp at position "C" to avoid interference with the milling spindle. This will cause a bending action and raise the end of the screwshaft slightly off the supporting vees causing vibration, low tool life and size control problems. If the clamping force is high enough then a permanent bend in the screwshaft can occur. In Figure 35 (b) the tool designer has used low profile rocker style clamps to avoid mill spindle interference. The clamps have been re-positioned so that the clamping forces are directly over the support "V" at "D" and "E". This provides rigid, vibration free milling and drilling and eliminates the possibility of bending the screwshafts. Higher clamping forces can now be used. Another point to remember when designing clamps is to use soft pads so that the screw threads are not damaged. Here as with the straightening shoes, brass works well on steel screws and plastic can be used with aluminum shafts.

FIGURE 34

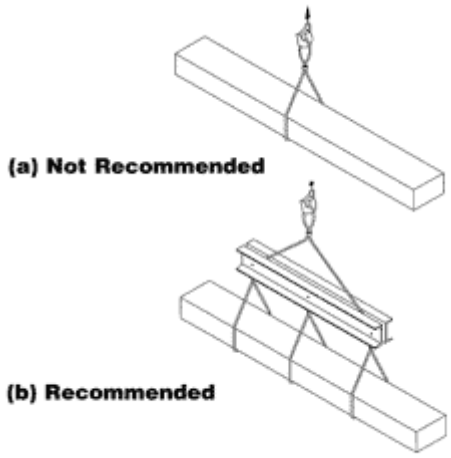
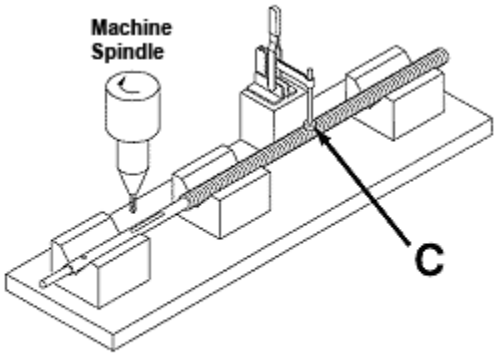
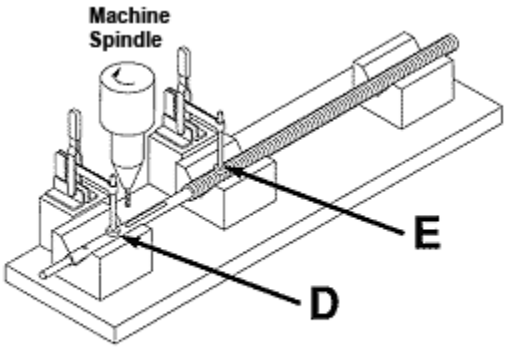


FIGURE 35a



Poor Clamping
Clamp Not Supported Below
Lead Screw Will Bend
Clamp Not Near Area of Work

FIGURE 35b



Good Clamping
Supports should be located under clamp,
with clamps close to area of work.

How to Straighten Screws back to top

For users who elect to straighten their own screws or who need to straighten a bent screw, we offer the following guide.

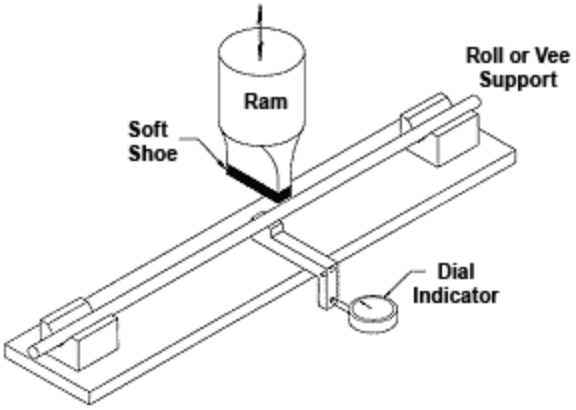
Straightening methods which are suitable for plain (non-threaded) bars such as roll straighteners or crossed axis roll straighteners do a poor job on lead screws and should not be used. These methods are rarely accurate enough and can easily damage the lead screw threads.

For best results, we recommend press type straightening using a setup similar to that in Figure 36. The screw shaft is supported in vee blocks or cam type roller bearing supports and rotated so that the high spot of the bend is underneath the ram. The ram is driven manually (as with an arbor press or screw press) or hydraulically past the center of the screw axis until the screw yields to the bending stress imposed. Usually a number of straightening cycles are required until the target TIR is achieved.

If snake or corkscrew defects are to be removed, then the support positions will have to be adjusted several times during the straightening operation. For production straightening, a good hydraulic press with controlled ram speed and controlled ram stroke is necessary. The support fixturing should be easily movable along the axis. The indicator is ideally located underneath the ram and it should have over- travel protection so that is does not need to be manually retracted between straightening strokes.

The ram and supports should have soft shoes so that the lead screw threads are not damaged during the straightening process. Shoe material is usually brass or copper for steel work pieces and plastic or wood for softer screw materials like aluminum. The vee or roller supports should also be soft enough to avoid thread damage. Ram action should be smooth and controlled. The ram should push the lead screw gently bending it beyond the yield strength. A punching action with the ram is faster but much more difficult to control for accurate straightening.

FIGURE 36



Ram Type Press Straightening