ANGLING FOR BETTER QUALITY

Measuring bend angles of tubular products

By George Winton, P.E.

REGARDLESS of the process used to bend a tube, fabricators are interested in the quality of the bend angle produced. Bend angle quality often is a tolerance surrounding a target angle. Although measuring a bend angle is old hat, a review of some of the various measuring techniques may shed a new light on this important subject.

Figure 1

Low-tech and most often accurate to about ± 0.5 degree, vernier measuring devices don't require much in the way of calibration.

PROTRACTORS—BASIC MEASUREMENTS FOR 2-D BENDS

Traditional protractors come in a digital or vernier style (see **Figure 1**). Named for mathematician Pierre Vernier, the vernier scale has been used for decades and is in use worldwide.

Press brake operators often use vernier-type protractors. Durable and reliable, this sort of protractor is good for measuring bent sheet metal, day in and day out. However, round tube isn't sheet metal. A round tube can be a little more difficult to hold tangent to a protractor while holding the pair up to the light to get an accurate angular read.

As the detail of bend angle data collected increases, so does the demand for more precise bend angle measurements. Several factors drive the need for more exact bend angle measurement data. For example, determining the precise amount of springback requires a means to measure to ±0.1 degree. Also, detailed data for statistical process control (SPC) relies on precise bend angle information. One quick way to measure to this level of precision is with a digital protractor designed for bent tubing and sheet metal (see **Figure 2**).

A digital protractor such as the one in Figure 2 allows the operator to lay the part on the flat surface plate, freeing his hands to ensure the static arm and the dynamic arm are both located tangent to the part being measured.

CHECK FIXTURE—QUICK AND RELIABLE FOR 3-D BENDS

For low- and high-volume jobs, a simple check fixture usually does the trick. If the bent tube drops into the fixture, the overall profile and the bend angles are considered good (see **Figure 3**).

This is a fast and easy way to accomplish an in-process inspection. Another nice aspect of this approach is the relatively low initial investment with respect to the number of bent angles you can qualify in a matter of seconds.

THE HIGH END OF THE MEASURING SCALE

Coordinate measuring machines (CMMs) started coming onto the scene back in the 1980s (see **Figure 4**).

These devices are excellent for quantifying bend angles as well as the entire tube profile. Most CCMs today make use of a noncontact probe. The operator probes the part in various locations; a computer generates a 3-D model of the part, compares it to the tolerance

Figure 2

In addition to generating results quickly, a digital protractor is simple to use and portable.

Figure 3

A check fixture can verify more than bend angles; it also can qualify straight lengths and end points. Photo courtesy of Clark Fixture Technologies.

envelope, and displays the results on a computer screen. If you are looking for bend angle information only, then this approach may be too much horsepower. On the other hand, this device has the ability to probe numerous bent angles and then quickly display the results in digital format.

Choosing the right device for inspection must take into account budget, the depth of inspection data needed, and the time available for bend angle verification.

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Figure 4

A CMM relies on a computer to generate a large amount of 3-D data related to the finished component's dimensions. Photo courtesy of Eaton Leonard.