EDU[**CAD**]TION **STUDY GUIDE**

How to Understand Bend Deformation

Chapter 5, Lesson 6

SendCutSend

The Three Points of Contact

• Successful bending requires three points of contact between the part, the punch, and the die (see Figure 1.1):

1. Contact along the punch tip (inside of the bend, under compression)

2. Contact at two points along the die edges (outer sides, under tension). As the punch descends, the part rolls and stretches between these three points, forming the bend radius. If any point of contact is lost, the bend fails, typically resulting in wrinkling, cracking, or improper angle formation.

Bending Resources:
http://sendcutsend.com/guidelines/cnc-bending
https://sendcutsend.com/guidelines/bend-deformation/

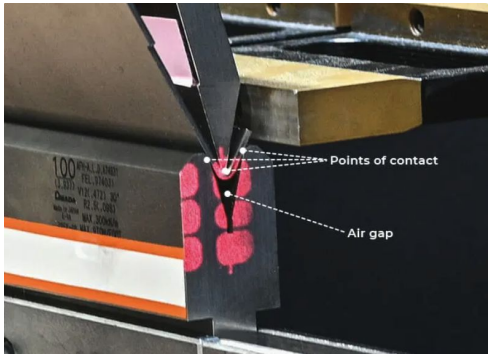

Figure 1.1

Minimum Flange Length

- Because the material must roll into the die, a minimum flange length is required.

- This distance is measured from the bend's centerline to the end of the flange. If the flange is too short, it can fall into the die, leading to an incomplete or deformed bend.

- SendCutSend automatically checks this during the quoting process. If your flange is too short, you'll see a warning that the part cannot maintain the required three-point contact (see Figure 1.2).

- Adjust your flange to meet or exceed the minimum flange requirement (based on die width and material thickness).

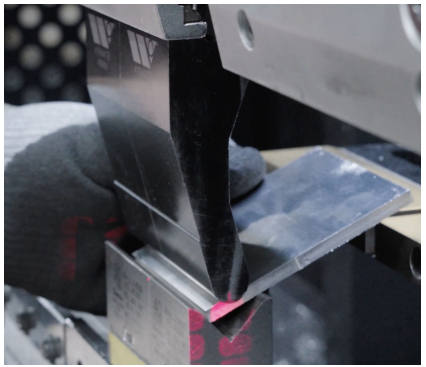

Figure 1.2

Die Marks and Witness Lines

• During bending, the die and punch leave small marks on the surface of the material where they contact it. These are called die lines, witness marks, or die impressions (see Figure 1.3).

• You'll typically see:

  • One mark along the centerline (from the punch)

  • Two elongated marks on the outside edges (from the die) These marks occur because the material is dragged across the die surface as it bends. This friction causes minor elongation and surface scuffing, a normal result of the bending process.

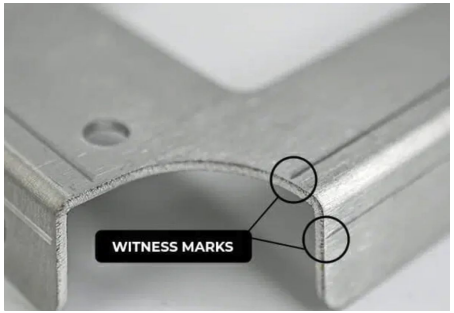

Figure 1.3

Friction and Elongation During Bending

- As the punch forces the material into the die, friction causes slight stretching along the outer surface of the bend.

- This elongation adds to the bend allowance. In other words, the real stretched area is slightly longer than what is calculated purely from geometry.

- Manufacturers account for this by testing and updating bend data (radius, K-Factor, etc.) for each material. SendCutSend's design guidelines already include this real-world adjustment.

Feature Deformation

• When features like holes or slots are placed near a bend, they can deform as the material stretches. If a hole overlaps the bend zone, it may become oval-shaped or elongated.

• This distortion happens because the metal around the feature is being pulled and compressed at the same time.

• **Common examples**:
    • Circular holes become ovals, like these warped countersinks (see Figure 1.4).
    • Threaded holes may lose thread integrity and become distorted (see Figure 1.5).
    • Slots or cutouts may twist or warp slightly. To prevent this, avoid placing any features within the bend deformation zone, a buffer region defined by the material thickness and bend radius

Figure 1.4

Figure 1.5

Warnings in SendCutSend's System

- When uploading your design and applying bends, SendCutSend automatically checks for feature proximity.

- If any holes, cutouts, or hardware are located too close to a bend line, you'll receive a deformation warning during checkout (see Figure 1.6).

- You can acknowledge the warning to proceed, but be aware that features in that zone may not retain their intended geometry after bending.

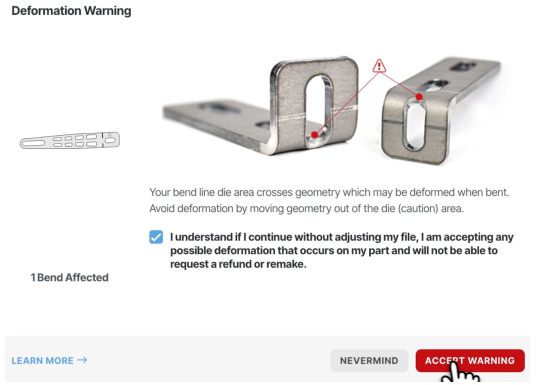

Figure 1.6

Real-World Example

- Imagine a 0.060″ aluminum part with a 90° bend and a hole placed 0.05″ from the bend line.

- As the material stretches, the hole elongates toward the bend radius, becoming slightly oblong. If that hole was meant for a tight-fitting pin or hardware, it may no longer function properly.

- By simply moving the hole outside the deformation area, you maintain clean geometry and accurate alignment.

Summary

Bending changes not only the shape of your part but also the geometry of nearby features. Understanding the three-point contact system, flange requirements, and deformation zones helps ensure your parts bend successfully and your features remain functional.

Learn more at https://sendcutsend.com/education/