Protecting your punching tool investment

Application-related problems and solutions

By Nick Tarkany

Economic shortcuts in the build process almost always add to production costs in the form of increased maintenance and production scrap. To avoid these costs, initial concerns should be directed toward the type of die construction.

Elements such as the stripper design, type of punch retention, and whether to use a hardened backing plate in a particular application tend to have the greatest effect on tool life.

Stripper Considerations

The main purpose of the stripper is to pull material from the ends of the punches at the withdrawal phase of the perforating process.

Stripping force varies based on part material type and thickness, as well as punch-to-matrix clearance. This force can range from nearly zero to as much as 25 percent of the force required to perforate the initial hole. Most applications do not require more than 10 percent of the perforating force.

Punch overentry, or closing a die below its recommended shut height, can have catastrophic consequences. Excessive stripper travel can:

1. Drive stripper screws into parallels or the ram of the press, potentially breaking the screws or bending the stripper.
2. Compress die springs beyond design limits, causing premature failure.
3. Result in stripper interference with the radius bend on the punches, causing broken punch points and heads.

Overentry of the punches also will cause excessive galling and wear on the punch points.

Fixed Strippers. A fixed stripper

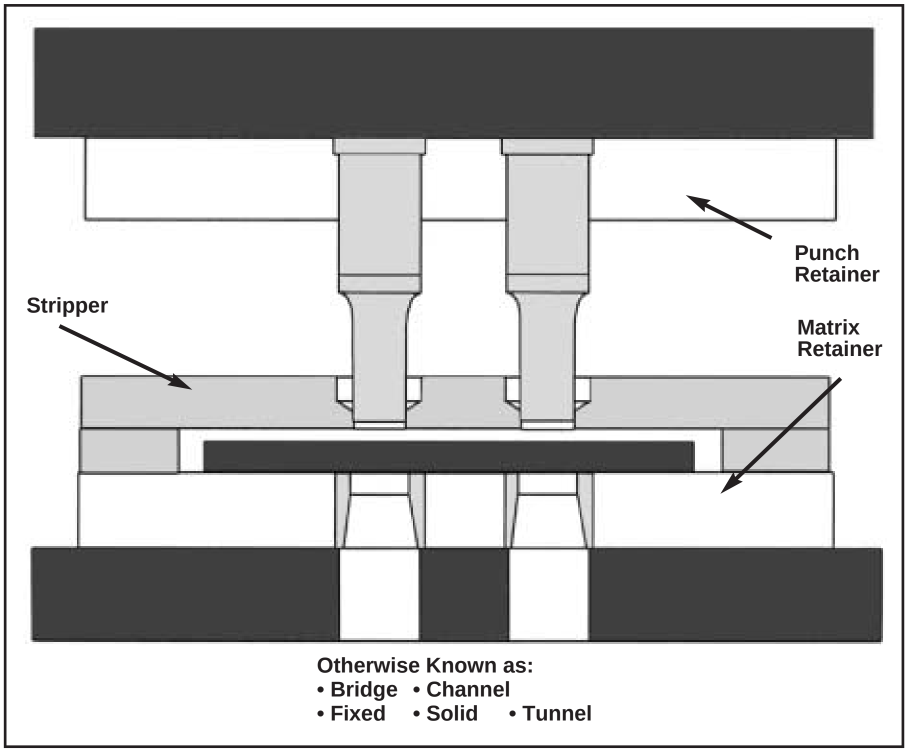

Figure 1
A fixed stripped (also known as a bridge, positive, channel, solid, or tunnel stripper) is a steel plate with a clearance slot to allow the part material to pass under it.

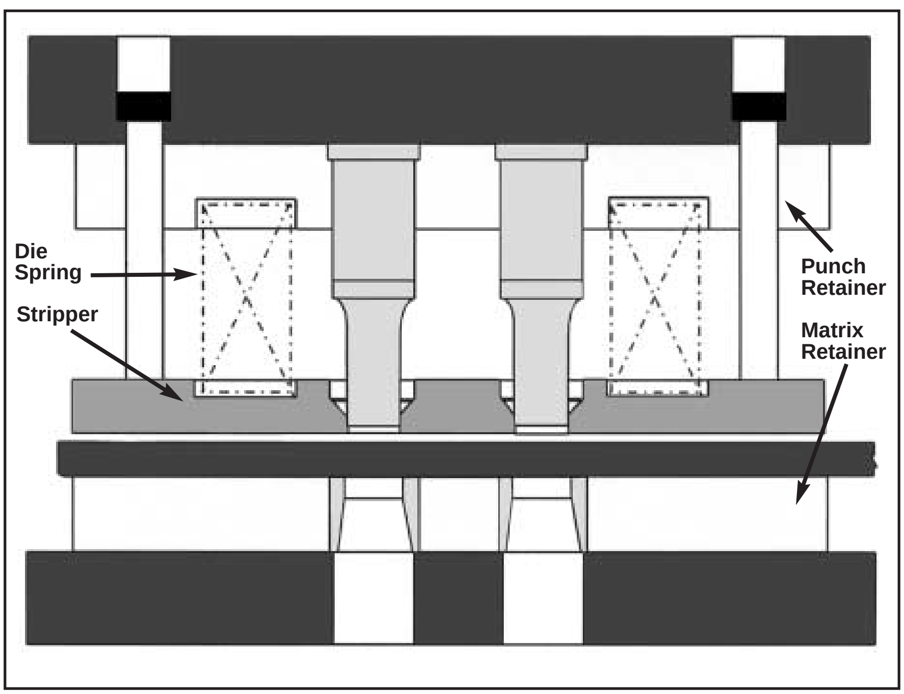

Figure 2
With spring strippers, as the die closes, the stripper holds the stock strip or part flat and in place while the perforating and stripping operations take place.

(also known as a bridge, positive, channel, solid, or tunnel stripper) is a steel plate with a clearance slot to allow the part material to pass under it (see **Figure 1**). This plate is mounted to the die retainer in a fixed position. Clearance holes are cut through the stripper plate, letting the punches extend through without interference. At withdrawal, the part material hits the bottom of the stripper, preventing it from lifting as punches are retracted. The part material is stripped off of the end of the punch or punches.

Although fixed strippers are inexpensive and easy to maintain, they have several drawbacks. They do not hold the stock strip flat and lack the ability to absorb impact and snap-through shock. In high-volume applications, the result can be poor part flatness and premature punch failure.

The clearance under a fixed stripper commonly is set at 1½ times the part material. This clearance allows considerable part material deformation under the punch points, resulting in punch point chipping. That deformation also can cause lateral movement of the part and the punches, resulting in punch point breakage and poor part quality.

The sudden unloading of pressure on the punches and part material at snap-through generates shock. This shock, which is particularly high when working with stainless steel, can lead to punch head breakage.

At withdrawal, the part material tends to buckle. This buckling effect binds the part on the ends of the punches, increasing stripping pressure and potentially chipping the punch face.

Spring Strippers. With spring strippers (see **Figure 2**), as the die closes, the stripper holds the stock strip or part flat and in place while the perforating and stripping operations take place. The stripper prevents the part material from lifting or hanging up on the punches.

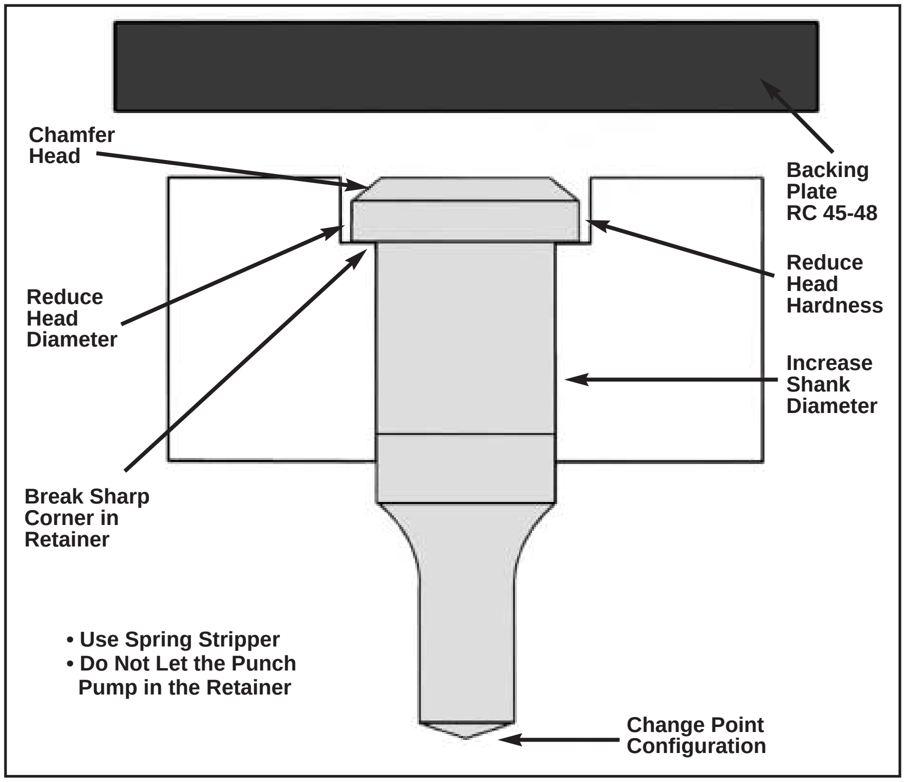

Figure 3
Reducing head hardness, changing the point configuration, and increasing the shank diameter are some of the ways to reduce the risk of head breakage.

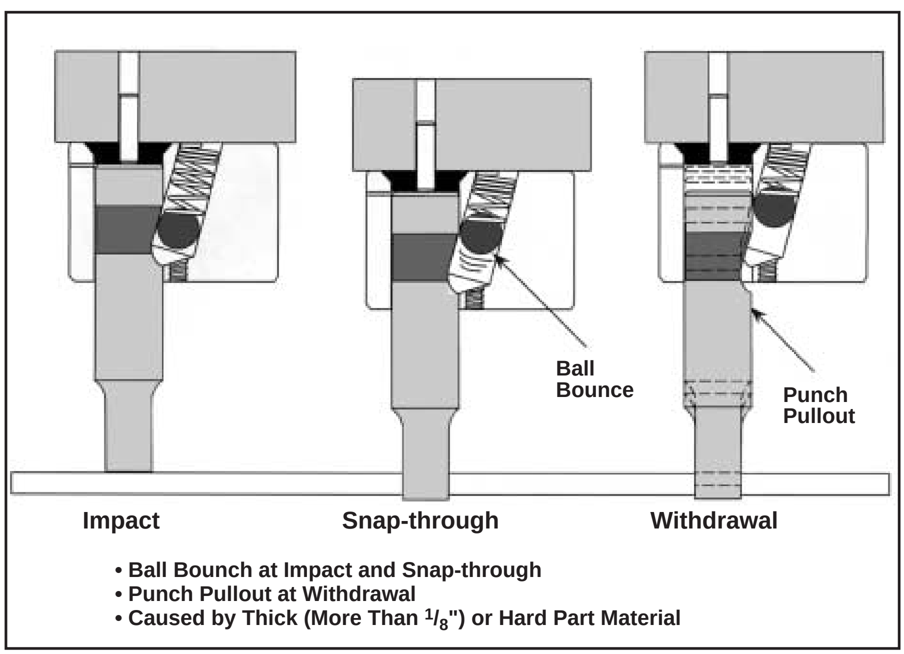

Figure 4
The shock generated at impact and snap-through can cause the ball to bounce. Ball bounce can also occur in high-speed stamping applications in which press feeds are higher than 250 strokes per minute.

Because the stripper lifts away from the part material after each stroke, visual monitoring of the die performance is simplified.

A spring stripper absorbs shock at snap-through and eliminates shock at withdrawal that otherwise would be damaging to the tooling and possibly the press.

Spring strippers have a high initial cost and require periodic maintenance. However, the increased tool life of spring strippers improves part quality and productivity in the long run.

Punch Head Breakage

When a punch head fails, it either falls out or is pulled out at stripping. The two main causes for head breakage are impact and snap-through. Impact failure is the result of excessive loading, which crushes the head. This type of failure usually occurs when the clearance is tight and the part material is hard or thick. Snap-through failure occurs when there is a sudden unloading of pressure on the punch. It is associated with increased punch-to-matrix clearance and with high-strength part materials.

Other factors that can contribute to head breakage are punch pumping, straight punches, compound blank die construction, and high-hardness backing plates.

Figure 3 illustrates ways to reduce the risk of head breakage. Straight punches such as this have the greatest potential for head breakage because they provide the least amount of support at the head end. Using a punch with a larger body will reduce head breakage.

Reducing the diameter or chamfering the mounting surface portion of the head minimizes or eliminates compressive loading and flex of the unsupported outside diameter at impact. It also is important to chamfer the bottom of the counterbore in the retainer to avoid interference with the fillet radius under the punch head.

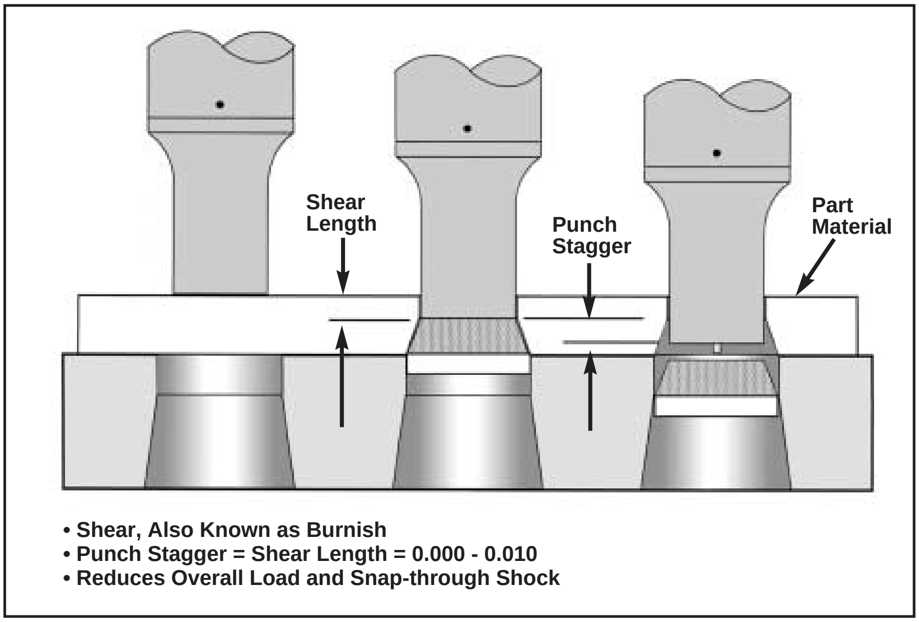

Figure 5
Punches can be staggered in length to minimize impact and snap-through shock.

The three most effective methods for preventing head breakage are to increase the punch body diameter, apply a shear configuration to the punch point, and hold the backing plate hardness between 45 and 48 Rockwell hardness C.

Ball Lock/Ball Bounce

Ball lock also can be troublesome when punching thick or hard materials. The shock generated at impact and snap-through can cause the ball to bounce (see **Figure 4**). Ball bounce also can occur in high-speed stamping applications in which press speeds are higher than 250 strokes per minute.

Ball bounce creates two problems. One is that the bouncing action eventually will cause the ball to fatigue and break. The other problem is punch retention. If the ball is broken or the ball spring pressure does not seat the ball against the punch before withdrawal, the punch will fall out or be pulled out of the retainer.

Ball bounce can be reduced by using a heavy-duty and/or a booster spring in the retainer. Heavy-duty and booster springs are available only for heavy-duty retainers.

Punch Stagger Recommendations

Punches can be staggered in length to minimize impact and snap-through shock (see **Figure 5**). Punch lengths can be split in two or three groups, reducing impact and snap-through shock by one-half or one-third.

Common practice is to stagger the different groups of punches by an amount equaling the stock thickness. Although this reduces the initial shock, it does not reduce the total shock. By making the stagger equal to or slightly less than the burnish length in the hole being perforated, impact and snap-through shock can be greatly reduced.

This amount of stagger allows the next group of punches to make contact with the material before the first group snaps through. The snap-through energy from the first group of punches is absorbed and used to drive the next group of punches through the part material.

Tonnage requirements for perforating are calculated with the following equation:

$$P = T \times (\pi \times L) \times S$$

where: T = Thickness of part material
L = Length of cut
S = Shear strength of part material
P = Perforating force

For example, if T = 0.062 inch, L = 0.5 inch, and S = 38,500, then:

$$P = 0.062 \times (3.14159 \times 0.5) \times 38{,}500$$
$$= 0.062 \times 1.5708 \times 38{,}500$$
$$= 3{,}749.5 \text{ pounds}$$

Note that for most materials, shear and tensile strengths are not the same. The shear strength of aluminum is about 50 percent of its tensile strength, while the shear strength of stainless steel is about 90 percent of its tensile strength.

It is important to include the pressure on the stripper when calculating total die tonnage requirements.

Conclusion

While stampers continually are looking for a better punch—one that won't break and will resist wear indefinitely—when considering how to improve tool life, they should focus initially on sound die construction. ■

Nick Tarkany is Director, Research & Technical Education with Dayton Progress Corporation, 500 Progress Road, Dayton, Ohio 45449, phone 937-859-5111, fax 937-859-5353, Web site www.daytonprogress.com. Dayton Progress Corporation has been a producer of high-precision punch and die components for more than 50 years.