Punch wear in blanking, Part I

Punch geometry and failure

BY SOUMYA SUBRAMONIAN AND DR. TAYLAN ALTAN

Editor's Note: This is Part I of a two-part series that discusses factors affecting punch wear in blanking. The different modes of punch failure and the effect of punch geometry on wear are discussed in this part. Part II, to appear in the September/October 2012 issue, will discuss the punch materials and coatings suitable for different sheet materials based on various tests conducted by researchers.

Punch failure in blanking and piercing can be reduced but not prevented completely. However, knowing the causes of punch failure can help you delay the onset of failure. Newer and stronger sheet materials, such as advanced high-strength steel (AHSS), present a major challenge in blanking because of the aggravated punch failure conditions.

Types of Punch Failure

Punch failure can be categorized as wear,[1] chipping,[2] cracking,[3] gross fracture,[4] and galling[5] (see **Figure 1**).

Wear. Wear is damage to a solid surface involving loss or displacement of material. It is caused by sliding contact between the workpiece and tool. Wear can be adhesive or abrasive, depending on the sheet material.

Chipping, Cracking, and Gross Fracture. These types of failure are caused mainly by repeated impact loads or thermal shocks. Mechanical or thermal fatigue failure causes cracking or chipping, which can result in gross fracture.

Galling. Galling (pickup) is a result of heavy friction forces and temperatures caused by the sliding contact and adhesive nature of the sheet materials like stainless steel. The punch picks up particles of the sheet material, resulting in reduced quality of the blanked edge. Galling can be reduced or avoided by using the right tool material and coating and lubrication.

Factors Affecting Punch Failure

The factors affecting punch failure in blanking are contact pressure and temperature at the interface of the punch surface and sheet, tool material and coating, velocity, and lubrication.

In turn, the contact pressure depends on factors such as geometry of the blanked part, punch and die clearance, and punch corner radius.

Die Clearance and Punch Wear

In a study by Böhler Uddeholm, 1,400-MPa-grade sheet material was blanked with 4 percent vanadium powder metallurgy (PM) tool steel hardened to 60 HRC at three different clearances: 6, 10, and 14 percent of sheet thickness. The sheet was 1 millimeter thick.

Punch wear was measured after 200,000 strokes. It was found that lower clearances caused galling, while higher clearances caused high

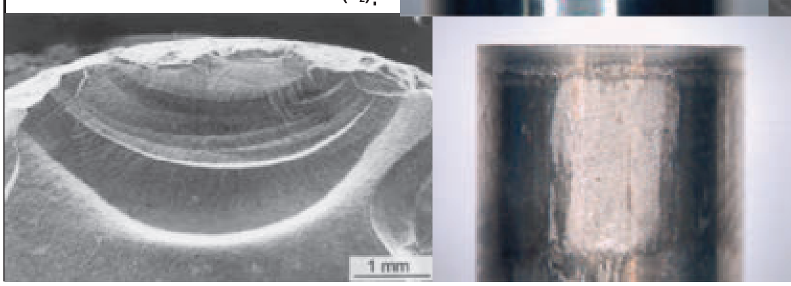

Figure 1

Punch failure can be categorized into several types: (A) wear, (B) chipping, (C) cracking, (D) galling, and (E) gross fracture. *Sources:* Hernández et al, Uddeholm/SSAB, and Luo.

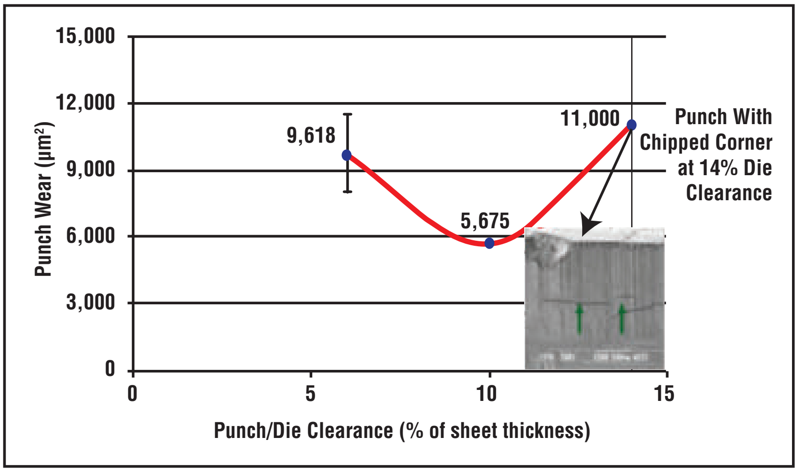

Figure 2

The effect of punch/die clearance on punch wear is shown here. At the optimum punch/die clearance, wear on the punch is reduced. *Source:* Bell.

Sheet Material Thickness (mm)	DPM 800 MPa	DPM 1000 MPa	M 1200 MPa	M 1400 MPa
2.0	14-16%	14-16%	14%	12-14%
1.5	14%	12-14%	12-14%	12%
1.0	12-14%	12%	10-12%	10-12%
0.5	12%	10-12%	10%	10%

Punch/Die Clearance for AHSS

Figure 3

These guidelines for punch/die clearance when blanking AHSS material show optimum clearances for various high-strength materials and thicknesses. *Source:* Krause.

bending stresses in the cutting edge, increasing the probability of edge chipping.

Based on the various tests conducted with different sheet materials and thicknesses, Böhler Uddeholm suggests the best punch/die clearance range for minimum tool wear in blanking (see **Figure 2**).[6] **Figure 3** shows the optimum clearances for various high-strength materials and thicknesses.[7]

Two different punch corner radii and three different clearances were studied for their effects on punch stresses in simulations and punch wear in experiments. The blank material was 2-mm-thick DP 1000. The punch material was a D2 cast steel, tempered and hardened to 60 to 62 HRC. Simulations showed that the punch corner radius had more of an effect on stresses generated on the punch than clearance did (see **Figure 4**).[8]

Small changes in geometry can improve punch life in blanking, if the blanked edge quality falls within the required specifications. ST

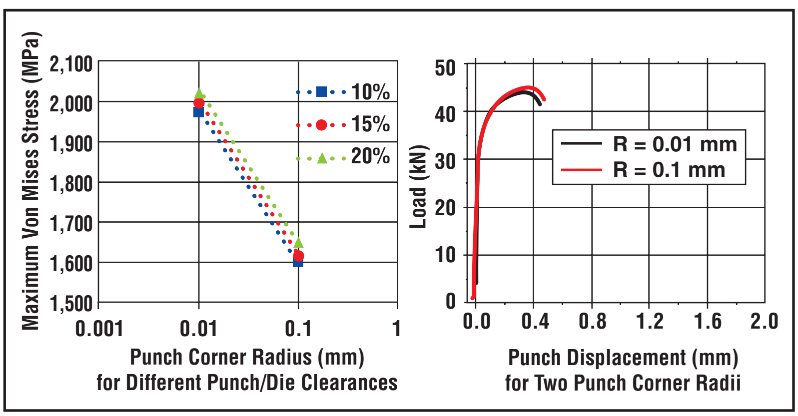

Figure 4

Simulations showed that the punch corner radius had more of an effect on stresses generated on the punch than clearance did. *Source:* Picas et al.

Soumya Subramonian is graduate research associate and Taylan Altan is professor and director of the Center for Precision Forming, 339 Baker Systems, 1971 Neil Ave., Columbus, OH 43210-1271, 614-292-9267, www.cpforming.org.

Notes

1. J.J. Hernández, P. Franco, M. Estrems, and F. Faura, "Modelling and experimental analysis of the effects of tool wear on form errors in stainless steel blanking," Journal of Materials Processing Technology, *Vol. 180, No. 1–3 (2006), pp. 143-150.*

2. Uddeholm and SSAB, "Tooling Solutions for Advanced High Strength Steels, Selection Guidelines" (2008).

3. S.Y Luo, "Effect of the geometry and the surface treatment of punching tools on the tool life and wear conditions in the piercing of thick steel plate," Journal of Materials Processing Technology, *Vol. 88, No. 1–3 (1999), pp. 122-133.*

4. Hernández et al.

5. Luo

6. T. Bell, Autosteel Partnership, Böhler Uddeholm Overview (2006).

7. B. Krause, in proceedings from STAMPING Journal® *Forum, sponsored by Fabricators & Manufacturers Association Intl., Hopkinsville, Ky., Sept. 26-28, 2007.*

8. I. Picas, R. Hernández, D. Casellas, I. Valls, "Strategies to increase the tool performance in punching operations of UHSS," in proceedings from IDDRG 2010, sponsored by Institute Tools & Forming, Graz, Austria, May 31-June 2, 2010.