Punch wear in blanking, Part II

Punch failure, materials, and coatings

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Editor's Note: This is Part II of a two-part series that discusses factors affecting punch failure and wear in blanking. The different modes of punch failure and the effect of punch geometry on wear were discussed in Part I in the July/August 2012 issue of STAMPING Journal®. *Part II discusses research to find the punch materials and coatings suitable for different sheet materials.*

Material selection for blanking and piercing punches involves such factors as sheet material and thickness, number of parts to be blanked, and tooling cost.

Tool steels such as D2, M2, and M4; powder metallurgy (PM) steels; cermets/cemented carbides; and ceramics all are used as punch materials. Common surface treatment processes include nitriding, physical vapor deposition (PVD), chemical vapor deposition (CVD), and thermal diffusion (TD). Common tooling coatings are titanium nitride (TiN), titanium carbide (TiC), titanium carbonitride (TiCN), titanium aluminum nitride (TiAlN), titanium chromium nitride (TiCrN), aluminum chromium nitride (AlCrN), and chromium nitride (CrN).

Not all coatings have the same coating adhesion on all tool materials. Surface treatments also depend on the tool materials and the desirable geometric tolerances. Experiments and tests often are conducted using different punch materials and coatings to determine the best fit for a sheet metal punching application.

SSAB Sheet Material	DC04, Dogal® 800 DP, Docol® 800 DP, Docol 140 DP
Sheet Thickness	1 mm
Böhler-Uddeholm Tool Materials	AISI A2, Vanadis 4®, Vanadis 6®, Vancron 40®, Sleipner, Calmax®, AISI D2
Cutting Clearance	10% (except for DC04 - 6%)
Strokes	200,000

Figure 1

These parameters were used in the Högman wear tests.

Punching Tests on High-strength Steel Sheet

B. Högman tested various high-strength steel blanks and tool materials to find the best combination that would result in the lowest punch wear.[1] The sheet materials, tool materials, and cutting conditions are shown in **Figure 1**; the wear results are shown in **Figure 2**.

Dogal 800 DP had a low wear rate because of the lubricant behavior of the galvanized layer. There was

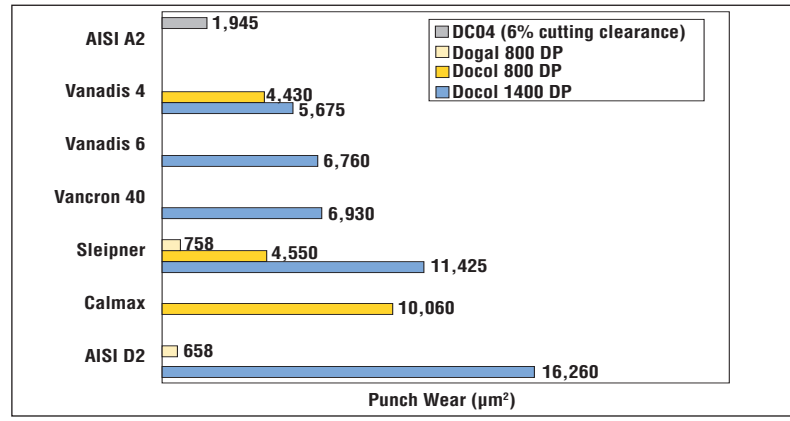

Figure 2

Results from the Högman wear tests show punch wear with different tool steels when punching 200,000 strokes in 1-mm-thick sheets with a cutting clearance of 10 percent of the sheet thickness (except for DC04).

Sheet Material	Unalloyed Electrical Steel (M800-65K, ISO EN10341), Thickness 0.65 mm
Punch Materials	A - PM HSS ASP 2023 B - PM S390 MICROCLEAN® HSS C - ESR HSS AISI M2 D - WC H40S
Punch Coatings	1- AlCrN (deposited by PVD) 2- TiCN (deposited by PVD) 3- TiAlN + DLC
Punch Dimensions	2 mm dia., 50 mm long
Punch Die Clearance	0.015 mm
Lubricant	5% Water Emulsion

Figure 3

These parameters were used in Podgornik's wear tests of coatings and tool materials.

no difference between AISI D2 and Sleipner—both worked very well. The selection of tool steel had a much bigger influence on uncoated and higher-strength Docol 800 DP and Docol 1400 materials. PM tools such as Vanadis and Vancron performed better on the higher-strength steels.

Hard Coatings for Blanking, Piercing Tools

B. Podgornik, B. Zajec, N. Bay, and J. Vižintin conducted blanking tests with three tool steel materials and one tungsten carbide (WC) with different punch coatings on electrical steel (see **Figure 3**).[2]

Figure 4 presents the results of the study under lubricated conditions. TiCN coating and TiAlN + diamond-like carbon (DLC) coatings showed flaking and wear for all the punch materials used in the study. AlCrN on a steel substrate gave the best performance, showing no signs of delamination or wear.

Blanking Tools for Manganese-boron Steels

Press-hardened steels are challenging to blank and pierce, as they cause heavy wear on the punch. B. Krönauer et al conducted a study on tool wear in the blanking of 1.4-mm-thick 22MnB5 sheet material (see **Figure 5**).[3]

Three different tool materials from Böhler-Uddeholm were tested in this study: K110 12 percent chromium steel; K340 ISODUR® 8 percent chromium steel; and S390 MICROCLEAN® PM steel. The dies were heat-treated to attain a hardness of 60 to 62 Rockwell C and ground to have a corner radius of 50 µ. A punch-die clearance of 8 percent was used in the experiments. The wear measurements from the cutting edge of the punch (see Figure 5) show that S390, the PM punch, performed best among the three materials tested.

The three different experimental examples show that PM steels have good resistance to punch failure. Coatings such as AlCrN on the right punch material can be effective in increasing punch life.

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Notes:

1. B. Högman, "Punching tests of EHS- and UHS-steel sheet," in proceedings from Recent Advances in Manufacture & Use of Tools & Dies in Stamping of Steel Sheets, Olofström, Sweden, Oct. 5-6, 2004.

2. B. Podgornik, B. Zajec, N. Bay, and J. Vižintin, "Application of hard coatings for blanking and piercing tools," Wear, Vol. 270, No. 11-12 (2011), pp. 850-856.

3. B. Krönauer et al., "Further results in blanking form-hardened, ultrahigh-strength manganese-boron steels with innovative tools and tool steels," in proceedings from International Deep-Drawing Research Group 2010 International Conference, sponsored by IDDRG, Graz, Austria, May 31-June 2, 2010, pp. 121-129.

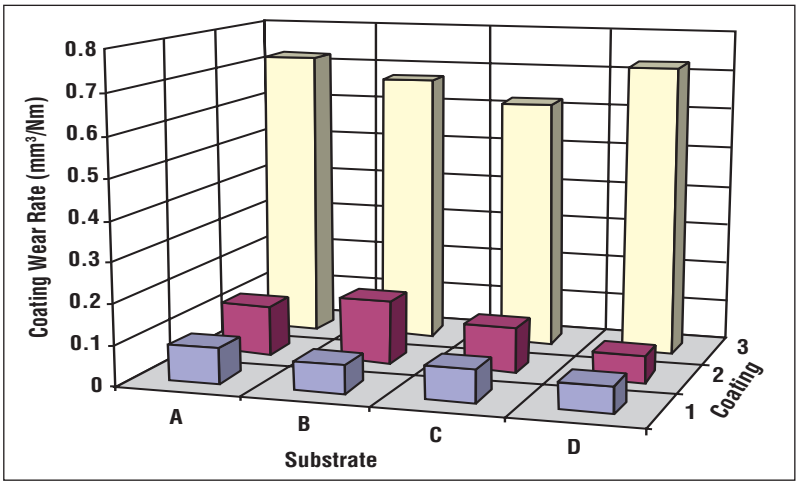

Figure 4

In the Podgornik tests, which involved blanking of electrical steel, AlCrN on a steel substrate gave the best performance, showing no signs of delamination or wear.

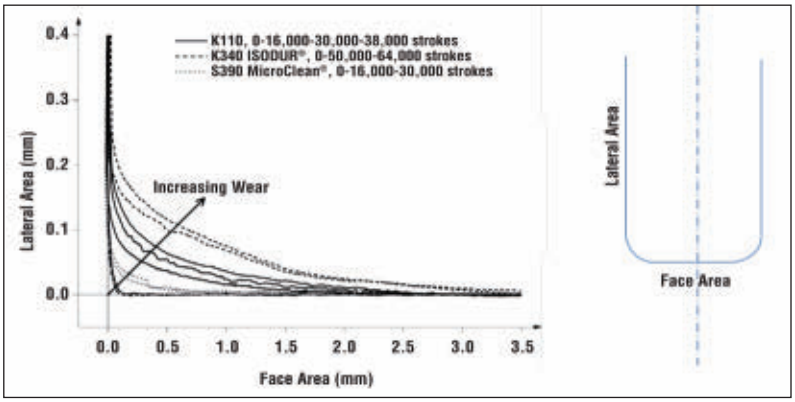

Figure 5

In the Krönauer tests, upper die cutting edge wear was measured at the protruding edge (left) and section of the punch (right).