

Characteristics required of punching tools include wear resistance, compression resistance, and toughness. Although the use of powdered high-speed steel and a variety of surface treatments have significantly lengthened the life spans of tools, it is still necessary to choose proper tools according to the punching conditions.

As data for this purpose, provided below are the results from tests of punching life spans, buckling, and transverse rupture on punches which utilize D2, M2, or HAP40 (powdered high-speed steel) materials in combination with TD treatment.

Note: TD=DICOAT® punch (Refer to P.1231.)

1. Punching life span

●Punching conditions

Workpiece material : 1055 Sheet thickness : 1.0 mm
 Punch diameter : 8.0 mm Clearance : 10%
 Die material : D2 Lubrication : No lubrication
 Bridge width : 1.5 mm Press used : 25—Ton
 Punching speed : 200 SPM

● Test results

— Side wear —

Figure 1 shows the changes in the surface area of side wear with increasing numbers of punching shots.

- (1) The amount of punch side wear decreases according to material in the following order: D2, M2, HAP40, SKD—TD, HAP—TD.
- (2) Because the TD treated punch has high surface hardness (3000 HV or higher), it shows figures for side wear that are extremely low.

— Height of burrs —

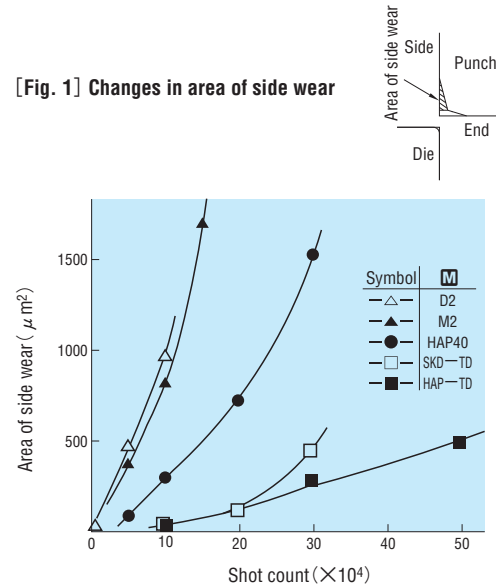
Figure 2 shows the changes in burr height with increasing numbers of punch shots.

- (1) The punch life span increases according to material in the following order: D2, M2, SKD—TD, HAP40, HAP—TD. When the burr height reached 50 μm, it was judged that the punch life span had been reached. However the HAP—TD punch reached 500,000 punching shots and had not yet reached the end of its life span. The TD process coats the punch with VC (vanadium carbide) in order to enhance its wear and seizure resistance. The long life span of this punch is due to the very small amount of side wear on the HAP—TD punch and also to the small amount of end wear owing to the HAP 40 (65 HRC) base material.

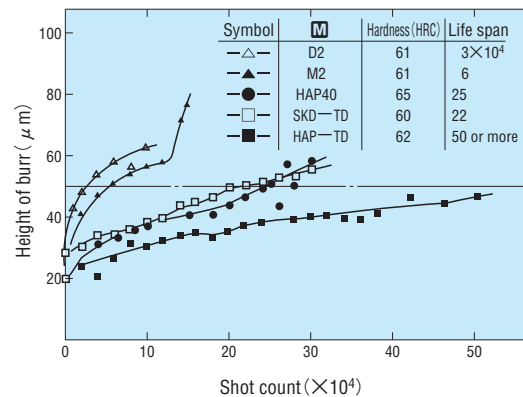
[Table 1] Types of tools used

Material and surface treatment	Hardness (HRC)	Primary chemical components (%)				
		C	Mo	W	V	Co
D2	61	1.5	1.0	—	0.3	—
SKD—TD	60	—	—	—	—	—
M2	61	0.9	5.0	6.0	2.0	—
HAP40	65	—	—	—	—	—
HAP—TD	62	1.3	5.0	6.5	3.0	8.0

[Fig. 1] Changes in area of side wear



[Fig. 2] Changes in height of burr with increasing shot count



2. Buckling and transverse rupture tests

● Test conditions

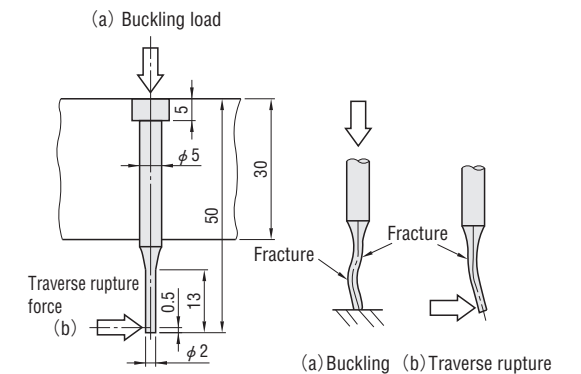
As shown in Figure 3, find the maximum load before fracture occurs when the buckling load and transverse rupture load (applied using a knife-edge shape indenter at a point 0.5 mm from the punch tip end) are applied at a speed of 1 mm/min.

● Test results

As shown in Table 2, both the buckling and transverse rupture forces increased in the following order of materials: D2, M2, HAP40. HAP40 in particular is able to maintain high hardness and thus displays excellent compression resistance. In addition, because its metallic structure is extremely fine and contains high alloying components (such as W, V, and Co), HAP40 also has excellent toughness. Therefore, the HAP40 punch is most suitable for punching where there is concern of fracture or chipping occurring.

Since the TD treated punches have lower base material hardness, the buckling strength and transverse rupture strength are also somewhat lower.

[Fig. 3] Buckling and transverse rupture tests



[Table 2] Results of buckling and transverse rupture tests

Material and surface treatment	Buckling				Transverse rupture			
	Hardness (HRC)	Buckling load [kgf]	Buckling strength [kgf/mm²]	Proportion [%]	Hardness (HRC)	Transverse rupture force [kgf]	Fracture deflection [mm]	Proportion [%]
D2	61.1	805	265	100	60.5	21.4	2.28	100
SKD—TD	59.6	829	264	103	59.5	19.4	1.65	91
M2	61.5	946	301	118	61.8	26.8	2.37	125
HAP40	66.0	1168	372	145	64.8	29.8	2.37	139
HAP—TD	62.2	952	303	118	62.0	24.5	1.75	113

* (N) = kgf × 9.80665

3. Conclusion

Below are the toughness, transverse rupture strength, and wear resistance for each material, relative to the performance of D2.

- (1) M2 has 120% the buckling and transverse rupture resistance, and 200% the wear resistance of D2.
- (2) SKD—TD has equal buckling resistance, 90% the transverse rupture resistance, and 700% the wear resistance of D2.
- (3) HAP40 has 150% the buckling resistance and 140% the transverse rupture resistance, and 800% the wear resistance of D2.
- (4) HAP—TD has 120% the buckling resistance, 110% the transverse rupture resistance, and 1600% the wear resistance of D2.

● Economy of punches

Figure 4 illustrates the punching life spans, cost, and cost/life-span ratios for punching of 1055. With the cost performance of D2 punches taken as 1, the expected cost performance for M2 is 1.5, for SKD—TD is 2.0, for HAP40 is 3.5, and for HAP—TD is 3.2. This data is taken from life span tests performed with 1055, and may differ somewhat when other materials are used for punching.

[Fig. 4] Comparison of economy of punches

