DURABILITY OF PUNCHES FOR PUNCHING

Characteristics required of punching tools are wear resistance, compression resistance and toughness. The utilization of high-speed steel and a variety of surface treatments have significantly lengthened the lives of tools, and it is necessary to choose proper tools taking punching conditions into account. As data for the purpose, described below are the results of punching life, buckling and transverse tests on punches using various combinations of materials（SKD11, SKH51 and Powdered high-speed steel）and the TD process.

Note） TD＝DICOAT punch（see P.1125）.

■1. Punching life span

● Punching conditions

Material of workpiece	：S55C	Material thickness	：1.0mm
Punch diameter	：8.0mm	Clearance	：10%
Die material	：SKD11	Lubrication	：None
Bridge widt	：1.5mm	Press used	：25Ton
Punching speed	：200SPM		

● Test result

——Side wear ——

〔Figure 1〕illustrates the transition of the area of side wear with an increase in the number of shots.

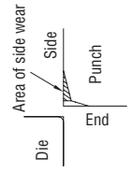
（1） The number of side wear in the punches decreases in the order of SKD11, SKH51, HAP40, SKD—TD, and HAP—TD.

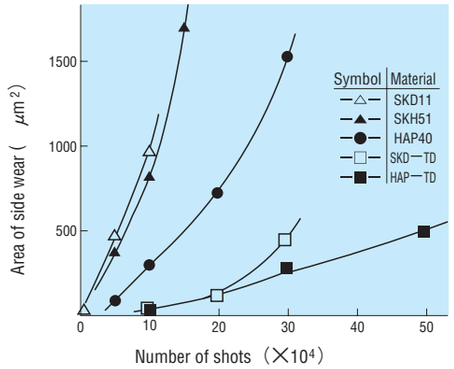
（2） Since the TD processed punches are high in surface hardness（3000 HV or more）, they develop a very small amount of side wear.

〔Table 1〕 Types of tools used

Material and surface treatment	（HRC）	Main chemical components（%）				
		C	Mo	W	V	Co
SKD11	61	1.5	1	—	0.3	—
SKD—TD	60					
SKH51	61	0.9	5.0	6.0	2.0	—
HAP40	65	1.3	5.0	6.5	3.0	8.0
HAP—TD	62					

〔Fig.1〕 Transition of area of side wear





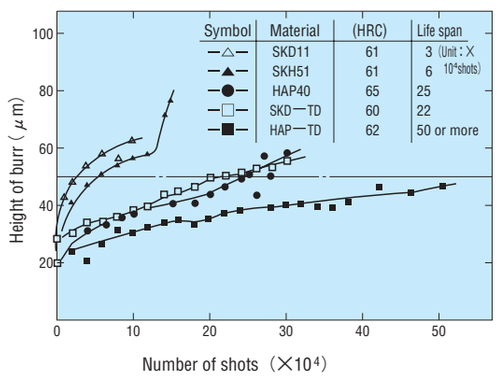
——Height of burr ——

〔Figure 2〕illustrates the transition of the height of burr with an increase in the number of shots.

（1） The life span of punches increases in the order of SKD11, SKH51, SKD—TD, HAP40, and HAP—TD.When the height of burr reached 50 μm, it was judged that the punch was at the end of its life. The life of HAP—TD lasted for 500,000 punching shots and had not yet reached the end of its life.

The TD process is to coat a workpiece with VC（vanadium carbide）to enhance its wear and seizure resistance.Because there was a very small amount of side wear in the HAP—TD punch and its base material was HAP 40（65 HRC）, its end wear was also slight, leading to its long life span.

〔Fig.2〕 Transition of height of burr with increase in number of shots



■2. Buckling and traverse tests

● Test conditions

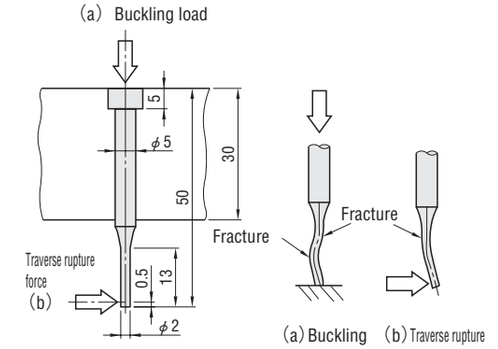
As shown in［Fig.3］, buckling loads and traverse rupture loads were applied to test pieces at a velocity of 1mm/min.（the traverse rupture loads were applied to the point 0.5mm from the end of a punch tip, using a knife-edge-shaped presser）, and the respective maximum load under which the punch ruptured was found.

● Test result

Both buckling strength and traverse rupture strength increase in the order of SKD11, SKD51 and HAP40.Especially, HAP40 maintains high hardness, and thus it is excellent in compression resistance.〔Table 2〕The metal structure of HAP40 is very fine, and it contains high alloy components（W, V, Co, etc.）, which makes the HAP40 punch excellent in toughness.Therefore, the HAP40 punch is most suitable for punching that may cause fracture or chipping.

Since the TD processed punches are degraded in base material hardness, they are also slightly low in buckling strength and traverse rupture strength.

〔Fig.3〕Buckling and traverse tests



〔Table 2〕 Results of buckling and traverse tests

Material and surface treatment	Buckling				Traverse rupture			
	［HRC］	Buckling load ［kgf］	Buckling strength ［kgf/mm²］	Ratio ［%］	［HRC］	Traverse rupture strength ［kgf］	Breaking deflection ［mm］	Ratio ［%］
SKD11	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
SKH51	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. Summary

Shown below are the toughness, traverse rupture strength and wear resistance of the above-mentioned materials relative to those of SKD11.

（1） SKH51 is approx. 1.2 times greater in both buckling strength and in traverse rupture strength, and 2 times greater in wear resistance.

（2） SKD—TD is 1 times greater in both buckling strength, 0.9 times greater in traverse rupture strength, and 7 times greater in wear resistance.

（3） HAP40 is 1.5 times greater in both buckling strength, 1.4 times greater in traverse rupture strength, and 8 times greater in wear resistance.

（4） HAP—TD is 1.2 times greater in both buckling strength, 1.1 times greater in traverse rupture strength, and 16 or more times greater in wear resistance.

● Economy of punch

〔Figure 5〕illustrates the punching life span, cost and life span/cost of punches as used to punch S55C materials.With the economy of the SKD11 punches as "1", a 1.5-fold economy is expected from SKH51, 2-fold from SKD—TD, 3.5-fold from HAP40, and 3.2 or more from HAP—TD.

This data is taken from life span tests with the S55C material. It differs slightly form that taken from tests with other materials.

〔Fig.4〕 Comparison of economy of punches