CHARACTERISTICS OF PUNCHING TOOLS

■Characteristics required for punching tools include：

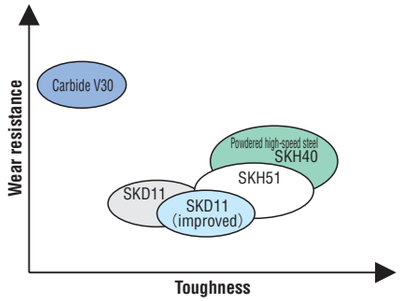
Good wear resistance, compression resistance, impact resistance and toughness, and fatigue strength.
Punching tools should be selected according to the punching conditions such as the quantity of production, machining materials and lubrication.

■Characteristics of tool steel

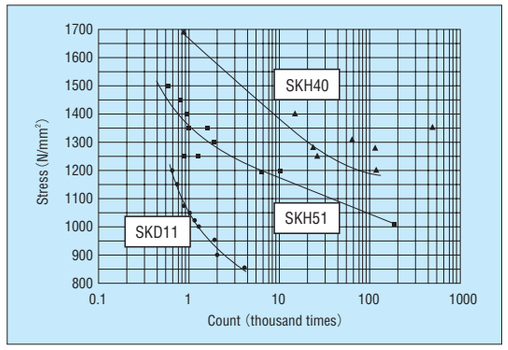
Alloy tool steel	SKD11	12%Cr class SKD11 has good wear resistance and hardenability which minimize defomation. It is most often used.
	SKD11（improved）	HRC60 to 63 hardness is achieved with high-temperature tempering. This increases toughness.
High speed tool steel	SKH51	Of high-speed steels, SKH52 is most often used. It has good wear resistance and toughness.
Powder high-speed tool steel	SKH40	Organizational particles are evenly refined with powder metallurgy. It contains a large amount of high alloying elements（W, V, Co., etc.）as usual, and has good toughness, wear resistance and fatigue strength.
Carbide	V30	Compared with steel, hardness is good, and wear resistance, compression resistance, rigidity, and heat resistance are also good, but toughness is not. If it is selected in a wrong way, its capability cannot be full used.

■Effects of alloying elements

Element	Effect
C	Carbide is formed with Cr, W, Mo, and V to achieve wear resistance. Hardness becomes greater as C content is increased.
Cr	Wear resistance, corrosion resistance and hardenability are improved.
Mo,W	Hard double carbide is formed as Mo and W combine with C together with Fe and Cr. Wear resistance, hardenability, and hardness at high temperatures are improved.
V	Wear resistance and toughness are improved.
Co	Hardness at high temperatures and tempering hardness are improved.
Mn	Hardenability and toughness are improved.



■Properties of punching tools



■Fatigue strength of punching tools（rotating bending）
The value of fatigue strength largely depends on the state of surface treatment and heat treatment, and so on. Use this diagram as a reference.

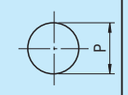
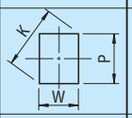
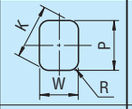
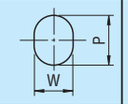
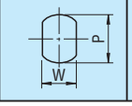
■Material properties of punching tools

Item \ Material		Alloy tool steel		High-speed steel	Powdered high-speed steel	Carbide
		SKD11	SKD11(improved)	SKH51	SKH40	V30
Chemical composition(%)	C	1.5	8%Cr class die steel	0.85	1.3	Co：12% Other：WC
	Cr	12		4.15	4	
	Mo	—		6.5	6	
	W	1		5.3	5	
	V	0.35		2.05	3	
	Co	—		—	8	
	Mn	0.45		0.35	—	
Quenching temperature〔℃〕		1000～1050	1020～1040	1180～1220	1120～1190	—
Quenching temperature〔℃〕		150～200	520～550	550～570	560～580	—
Hardness	HRC	60～63	60～63	61～64	64～67	1200～1350HV
Traverse rupture force	N／mm²	3500	4500	4800	4500	2500
Young's modulus	N／mm²	210000	217000	219000	228600	540000
Density	g／cm³	7.72	7.87	8.11	8.07	14.4
Thermal expansion coefficient	×10⁻⁶／℃	12.0	12.2	10.1	10.1	5.4
Thermal conductivity	w／m・k	29.3	23.7	20.6	23.8	72

（Note）・This data presents typical values but not guaranteed values.
・Powdered high-speed steel SKH40 is specified based on JIS/G/4403：2000.
（Hitachi Metal：HAP40, Kobe Seikosho：KHA30, Daido Special Steel：DEX40, Fujikoshi：FAX38 are applied among others.）

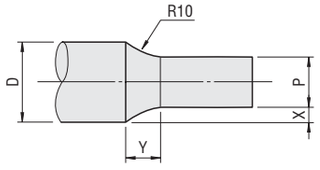
SHAPES AND DIMENSIONS OF PUCHES AND DIES

■Shapes of punches and dies

View		Profile length of blade tip ℓ	Diagonal line(circumscribed circle)K	Sectional area S
Round		πP	P	πP²／4
Square		2(P+W)	$\sqrt{(P^2+W^2)}$	PW
Round R		2πR+P+W−4R	$2R+\sqrt{(P-2R)^2+(W-2R)^2}$	$PW-(4R^2-\pi R^2)$
Oblong		πW+2(P−W)	P	$\frac{\pi}{4}W^2+W(P-W)$
Segment		$2\sqrt{P^2-W^2}+(\pi P \sin^{-1} W/P)/90$	P	$\pi P^2/4-(\pi P^2-\cos^{-1} W/P)/360+W/2\sqrt{P^2-W^2}$

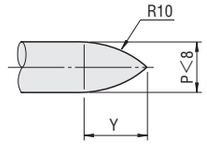
■How to find the length of R part（Y）

①Length of punch R(Y)
Find Y from X=(D−P)／2
$Y=\sqrt{X(20-X)}$ ……For R10
$Y=\sqrt{X(2R-X)}$ ……For a value other than R10

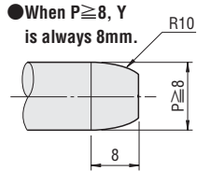


②Length of R part of pilot punch(Y)
$Y=\sqrt{P(10-P/4)}$ ……For R10
$Y=\sqrt{P(R-P/4)}$ ……For a value other than R10

●When P＜8



●When P≧8, Y is always 8mm.



Example 1）Finding Y when SPAS10−60−P6.80
X=(D−P)／2=(10−6.8)／2
=1.6
$Y=\sqrt{1.6(20-1.6)}\fallingdotseq 5.426$

Example 2）Finding Y when SPT5−20−P4.5
$Y=\sqrt{P(10-P/4)}$
$=\sqrt{4.5(10-4.5/4)}\fallingdotseq 6.32$