THICK-SHEET BLANKING PUNCHES, TAPERED HEAD PUNCHES

■What are thick-sheet blanking punches and tapered head punches?

When a thick sheet or high tensile steel sheet, for example, is punched, the tip of the punch often wears, breaks or chips, and also the head frequency breaks. The main causes of damage to the head of the punch are stress concentration and tensile impact force that occur at the head of the punch. Misumi's thick-sheet blanking punches and tapered punches have increased strength due the use of a different profile for the punch head.

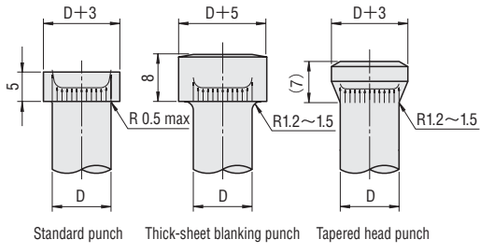
■Causes of damage to the punch head

1. Stress concentration 〔Fig.1〕

Because the punch head has a rapidly changing profile going from the shank to the head, stress concentration occurs. As a result, depending upon the tip diameter and the shank diameter, there are cases in which the head is subjected to a greater stress than the tip, causing it to become damaged

・A thick-sheet blanking punch has a larger radius of curvature beneath the neck of the punch than a standard punch in order to reduce stress concentration. However, when the radius of curvature beneath the neck is increased, the O.D. of the head also increases, which is disadvantageous from the viewpoints of cost and installation space. Consequently, it is impractical to increase the radius of curvature to an excessive degree.

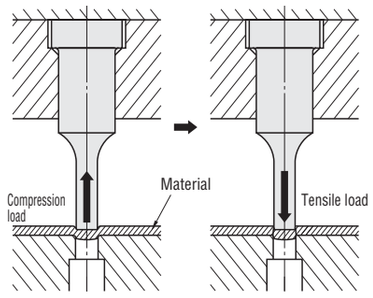
・A tapered head punch is a punch that has a tapered head and also the same radius of curvature beneath the neck as that of a thick-sheet blanking punch, in order to further reduce stress concentration.



〔Fig.1〕Stress concentration condition

2. Tensile force due to elastic waves 〔Fig.2〕

When a punch is performing a blanking operation, it is subjected to a large compressive force. It is said that at the instant the punch blanks the material (breakthrough), this compressive force is abruptly released, and conversely a large tensile impact force is generated.1), 2)In certain cases, this tensile impact force is comparable in magnitude to the blanking load, and can cause damage to the punch head.



〔Fig.2〕Tensile force generation situation

[Bibliography]
1) Spring Lecture on Plastic Forming, Fiscal 1985, Nagai and Shimanuki
2) Spring Lecture on Plastic Forming, Fiscal 1981, Takaishi, Maeda, Mori et al

■Features of thick-sheet blanking punches and tapered head punches〔Figs.3 to 5〕

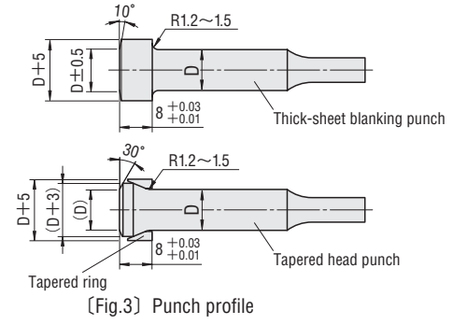
1. Thickness of the punch head

The thickness of the punch head was set on the thick side in order to prevent shear failure due to tension from the impact force.

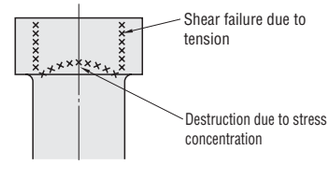
- Thick-sheet blanking punch: 8 mm
- Tapered head punch: Approx. 7 mm (Thickness of flange combined with ring: 8 mm)

2. O.D. of punch head and radius of curvature beneath the neck

A thick-sheet blanking punch has a radius of curvature beneath of the neck of between 1.2 and 1.5 R, and a head O.D. of D+5 mm (D: Punch shank diameter) in consideration of the stress concentration reduction effectiveness and economical efficiency.A tapered head punch has a radius of curvature beneath the neck of between 1.2 and 1.5 R, and a head O.D. of D+3 mm. It is designed so that when it is used in combination with a tapered ring, it's O.D.



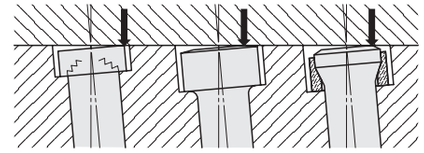
〔Fig.3〕Punch profile



〔Fig.4〕Destruction of punch head

3. Periphery of top surface of punch head

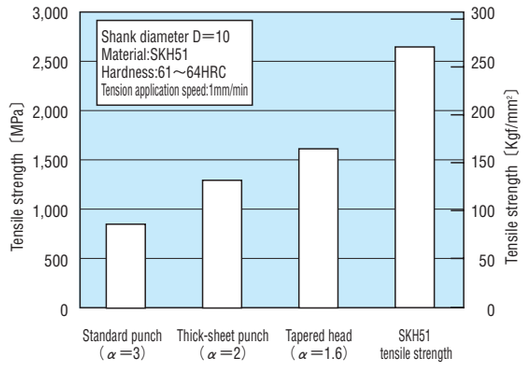
The outer periphery of the top face of the punch is inclined. This is to prevent the punch from breaking due to the application of a bending moment in the vicinity of the outer periphery in the event that the axial center of the punch is out of alignment.



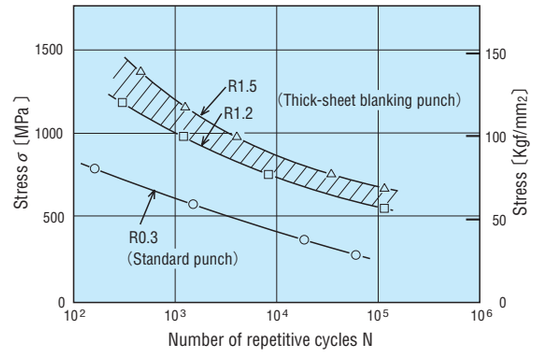
〔Fig.5〕Reduction of bending moment

■Strength of the punch head〔Refer to Fig.6 and 7.〕

If the tensile strength of the head of a standard punch is assumed to be 1, that of a thick-sheet blanking punch is approx. 1.5, and that of a tapered head punch is approx. 1.9. [Fig.6]
The results of a comparison of fatigue strength of punch heads carried out over several 104 repetitive cycles, for example, show that the head of a thick-sheet blanking punch has a fatigue strength of about 1.8 times that of a standard punch. Also, the results of a comparison performed at 784 MPa [80 kgf/mm2] show that the head of a thick-sheet blanking punch can withstand nearly six times the number of repetitive cycles as that of a standard punch. [Fig.7]
The tensile strength of the head of a tapered head punch is about 20% higher than that of a thick-sheet blanking punch, so it is estimated that the tapered head punch has a fatigue strength that is at least as high as that of a thick-sheet blanking punch. For this reason, a tapered head punch is suitable for applications in which the head of even a thick-sheet punch is likely to become damaged, such as blanking of high tensile steel of at least 980 MPa [100 kgf/mm2] class, spring steel or hardened steel.



〔Fig.6〕Tensile strength of the punch head of various types of punches (D = 10, SKH51)
α : Stress concentration coefficient of punch head



〔Fig.7〕Fatigue strength of thick-sheet punch and standard punch (D = 5, SKH51)
(The fatigue strength of the tapered head punch is currently being test.)

■When using a punch

・ P.1119～ of Product Data shows the selection standards for the punch tip diameter and the shank diameter. The optimum punch (tip diameter and shank diameter) can be selected from the relationship between the shearing resistance of the workpiece, the sheet thickness, punch diameter and total number of blanking operations.

・A tapered head punch is used for on-the-spot adjustment during punching or tapering, so use punches bearing the same identification mark in combination with each other.