■Punches for heavy load and tapered head punches

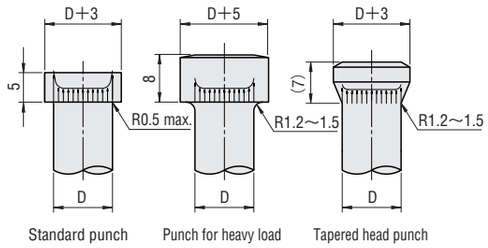
During punching of materials such as thick sheet and high-tensile steel sheet, in addition to wear, breakage, and chipping of the punch tip, the punch head frequently becomes damaged. The main causes of damage to the head of the punch are stress concentration and tensile impact force at the punch head. MISUMI punches for heavy load and tapered head punches are punches designed for greater strength by changing the profile shape of the punch head.

■Causes of damage to the punch head

1. Stress concentration [Fig. 1]

Because of the rapid change in shape between the shank and head, stress becomes concentrated in the punch head. As a result, depending upon the tip diameter and the shank diameter, there are cases in which the head is subjected to greater stress than the tip, causing it to become damaged.

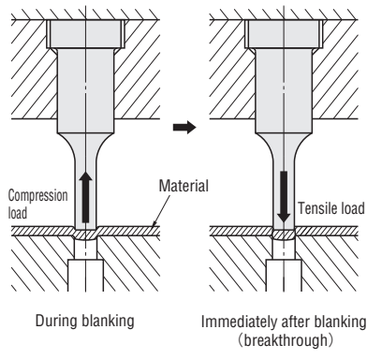
- A punch for heavy load has a larger radius of curvature below the head than a standard punch, relieving the concentration of stress. However increasing the radius of curvature below the head also increases the head outer diameter, which is disadvantageous in terms of cost and installation space. Therefore excessive increases in the radius are impractical.
- A tapered head punchhas the same radius of curvature below the head as a punch for heavy load, however it also uses a tapered shape for the head that further reduces stress concentration.



[Fig. 1] Conditions of stress concentration

2. Tensile force due to elastic waves [Fig. 2]

A punch is subjected to a large compressive force during the punching operation, and at the moment when the punch pierces the material (break-through), this compressive force is suddenly released, generating an opposite large tensile impact force.[1) 2)]
This tensile impact force is a large force which in some cases may equal the punching load, and which can cause damage to the punch head.



[Fig. 2] Conditions of tensile force generation

[Reference texts]
1) Nagai, Shimanuki, Spring Lecture on Plastic Forming 1985
2) Takaishi, Maeda, Mori, et al Spring Lecture of Plastic Forming 1981

■Characteristics of punches for heavy load and tapered head punches [Fig. 3～Fig. 5]

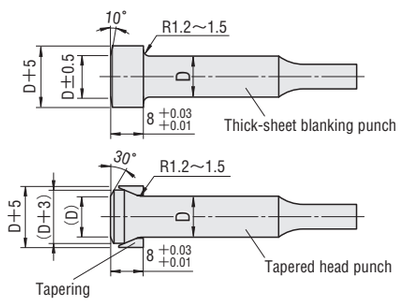
1. Thickness of the punch head

A thicker punch head is set in order to prevent shear failure due to tension resulting from impact force.

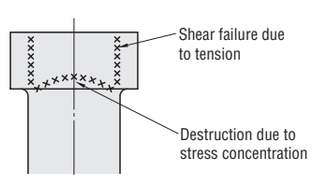
- Punch for heavy load: 8 mm
- Tapered head punch: Approx. 7 mm (Thickness of flange combined with ring: 8 mm)

2. Outer diameter of punch head and radius of curvature below the head

In order to relieve stress concentration and for reasons of cost performance, a punch for heavy load has a radius of curvature below the head of 1.2 ～ 1.5 R, and a head outer diameter of D+5 mm (D: punch shank diameter).
A tapered head punch has a radius of curvature below the head of 1.2 ～ 1.5 R, and a head outer diameter of D+3 mm. It is designed so that when used in combination with tapering, it has the same outer diameter (D+5) as a punch for heavy load.



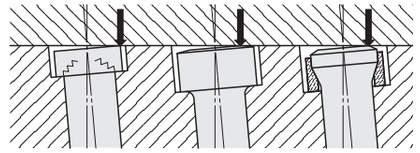
[Fig. 3] Punch shape



[Fig. 4] Punch head destruction

3. Periphery of punch head top surface

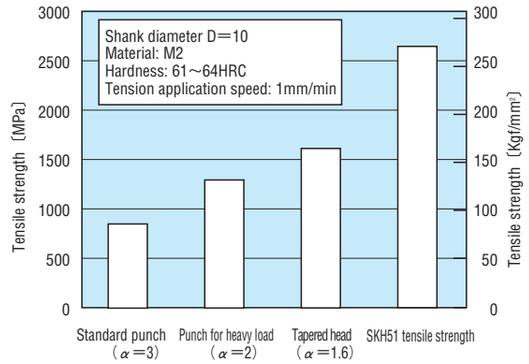
The periphery of the top face of the punch is inclined. This is in order to prevent breakage of the punch head due to the application of a bending moment near the periphery in the event that the axial center of the punch is out of alignment.



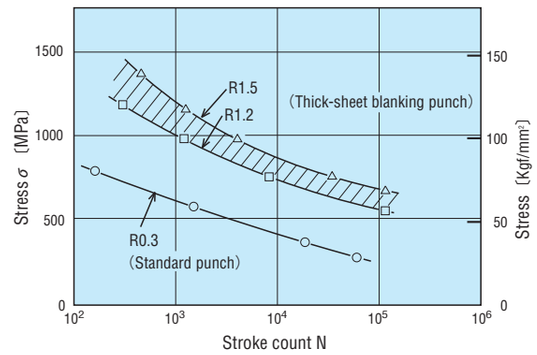
[Fig 5] Reduction of bending moment

■Strength of the punch head……[Refer to Fig. 6 and Fig. 7]

With the tensile strength of a standard punch considered as 1, the tensile strength of a punch for heavy load is approximately 1.5, and that of a tapered head punch is approximately 1.9. [Fig. 6]
Comparing the fatigue strengths of the punch heads, when a comparison is made at 10^4 strokes, then a punch for heavy load is able to withstand approximately 1.8 times the stress that a standard punch can. When a comparison is made at stress of 784 MPa [80 kgf/mm^2], a punch for heavy load head is able to withstand nearly 60 times the number of punch strokes that a standard punch can. [Fig. 7]
Because the tensile strength of a tapered head punch is approximately 20% higher than that of a punch for heavy load, a tapered punch head is estimated to have fatigue strength that isequal to or better than a punch for heavy load. For this reason, a tapered head punch is suitable for applications which may cause head damage even with a punch for heavy load, such as punching of high-tensile steels of 980 MPa [100 kgf/mm^2] or higher, spring steels, or hardened steels.



[Fig. 6] Punch head tensile strengths for different punches (D=10, M2)
α: Stress concentration coefficient of punch head



[Fig. 7] Fatigue strength of thick-sheet punch and standard punch (D=5, M2)

■Notes for use

- The selection standards for punch tip diameter and shank diameter are shown beginning from Products Data P.1225～. The optimal punch (tip diameter and shank diameter) can be selected from the relationship between the shearing resistance of the workpiece, the sheet thickness, the punch diameter, and the total number of punching operations.
- With a tapered head punch, a punch and taper ring are fit together in order to perform machining. Therefore be sure to use a combination of items which bear the same identification mark.