■5. Flange fractures

As shown on **P.1239**, flange fractures are thought to be caused by tensile force generated by elastic waves which occur during punching (at breakthrough, tensile force equivalent to the punching load is applied to the punch), and by stress concentration.

Methods for preventing flange fractures include the following.

1. Increase the radius under the flange in order to relieve the concentration of stress. (Use a punch for heavy load.)
2. Increase the strength of the flange to a value higher than the punch tip.

Here we will use method 2 to find the optimum shank diameter that will not produce flange fractures.

•Finding the optimum shank diameter by calculation

Punching load P exerted on the punch is the following.

$P = \pi dt\tau$

The maximum allowable stress σ_w on the flange is the following.

(a) For a shoulder punch,

$\sigma_w = P\alpha / A_t$

$= 4P\alpha / \pi D^2$

(b) For a jector punch

$\sigma_{wJ} = 4P\alpha / \pi (D^2 - M^2)$

Find the strength of the flange when the punching conditions are the same as in Example 1.

A_t: Cross section area of flange [mm²]

(a) For a shoulder punch, $A_t = \pi D^2/4$

(b) For a jector punch $A_t = \pi (D^2 - M^2)/4$

D : Shank diameter

α: Coefficient of stress concentration

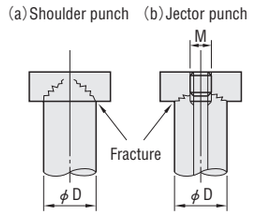
(a) For a shoulder punch, $\alpha \fallingdotseq 3$

For a punch for heavy load, $\alpha \fallingdotseq 2$

For tapered head punch, $\alpha \fallingdotseq 1.6$

(b) For a jector punch, $\alpha \fallingdotseq 5$

[**Fig. 5**] Flange fracture



[Example 6] (a) In the case of shoulder punch SPAS6—50—P2.8 :

$\sigma_w = 4\times675\times3/\pi\cdot6^2 = 71.6$ kgf/mm²·····Flange fracture will not occur because the stress is less than the stress applied to the punch tip in Example 2 of 110 kgf/mm².

(b) In the case of jector punch SJAS6—50—P2.8 :

$\sigma_{wJ} = 4\times675\times5/\pi\ (6^2-3^2) = 159$ kgf/mm²···Fracture occurs from the flange because the stress is larger than the stress applied to the punch tip in Example 2 of 117 kgf/mm².

When the shank diameter is 8mm, $\sigma_{wJ} = 90$kgf/mm², which does not cause flange fractures. (Considering from the figure showing the fatigue strength of tool steel, the flange will break after about 50,000 shots.)

●Finding the optimal shank diameter from the diagram

Punching conditions : Use the following formula to convert punch tip P=12.8 W=10.6 to a ϕ d value.

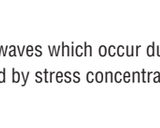
$\phi d = [2(P-W) + W\pi]/\pi$

$= [2(12.8-0.6) + 10.6\pi]/\pi$

$= 12$ mm

Sheet thickness t=4 mm Shearing resistance $\tau = 50$ kgf/mm²

In order to find the optimal shank diameter for 10^4 shots, follow the steps below.



Durability of punch tip (fracture) [Fig. 6]

a) Find the point a where the sheet thickness t and shearing resistance τ intersect.

b) Find point b by extending a line to the left or right from point a until it intersects the diameter of the punch tip.

- Because Point b is below the line indicating 10^5 shots, both SKH and SKD punches will be capable of enduring a minimum of 10^5 shots.

Selection of shank diameter [Fig. 7]

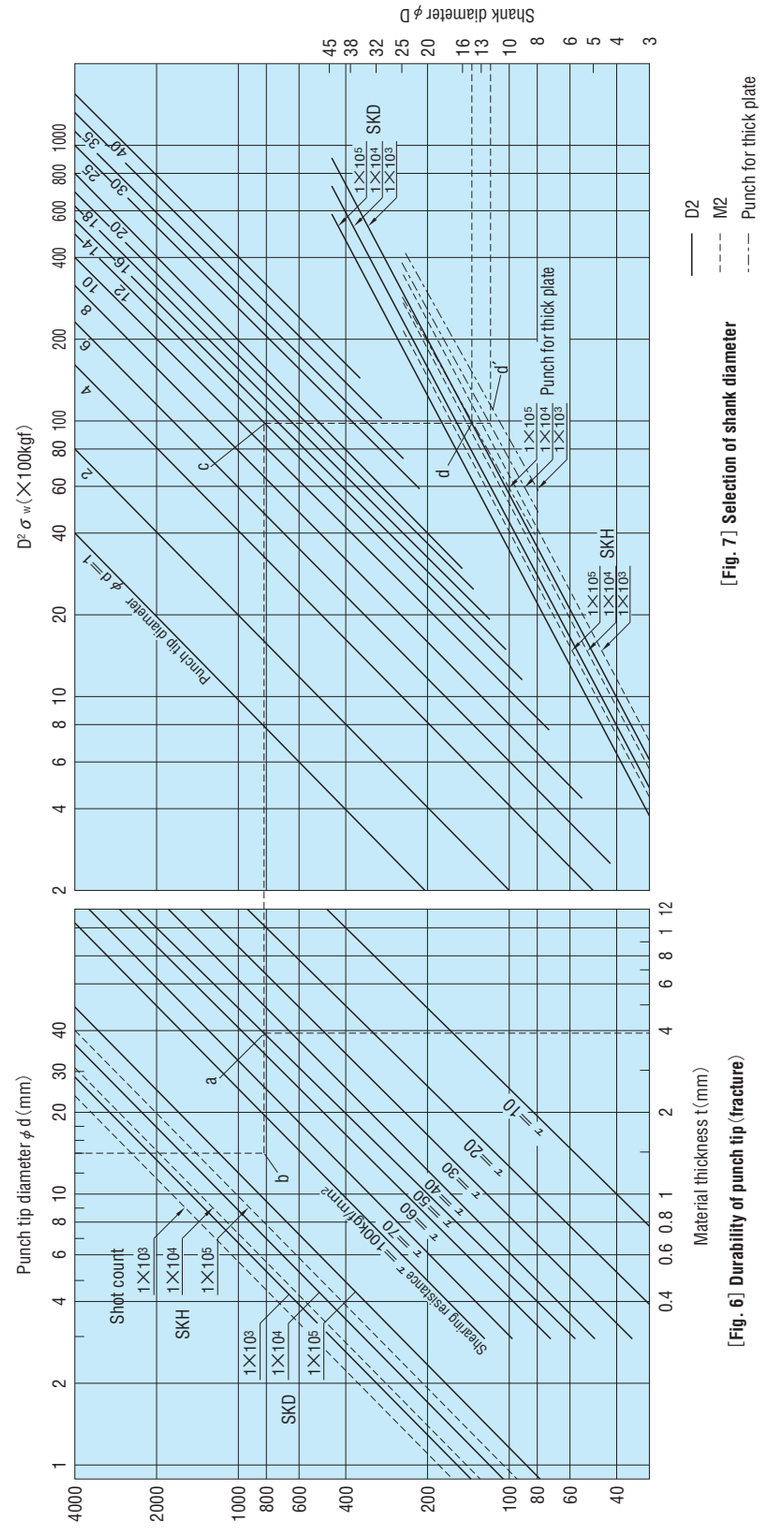
c) Find Point c by extending a line to the right from Point a until it intersects the punch tip diameter.

d) Find Points d and d′ by extending a line down from Point c until it intersects the lines indicating 10^4 shots (line for standard, line for thick sheets).

e) Find the shank diameter by extending lines to the right from Points d and d .

- Because 14.0 is indicated for standard punches (SKH), select a shank diameter of ϕ 16.
- Because 11.8 is indicated for punches for heavy load (SKH), select a shank diameter of ϕ 13.

Note: This selection table was prepared based on the results of tensile and compression fatigue tests. Because the data may differ somewhat from the actual punching conditions, please use this table only as an approximate guide.



[**Fig. 7**] **Selection of shank diameter**

[**Fig. 6**] **Durability of punch tip (fracture)**