

JIS

JAPANESE INDUSTRIAL STANDARD

System of cone fits

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J I S

System of cone fits

B 0616-1996

1. Scope This Japanese Industrial Standard specifies the system of cone fits to be applied to the conical workpieces from $\frac{1}{3}$ to $\frac{1}{500}$ in rate of taper, over 6 mm to 630 mm or under in cone length, 500 mm or under in cone diameter, and toleranced in accordance with the method (method 1) by the cone diameter tolerances specified in JIS B 0614.

Further, the calculations of basic displacement and fit displacement are in accordance with the Annex.

Remarks 1. The standards cited in this Standard are given in the following:

JIS B 0154 Vocabulary of cones

JIS B 0401 System of limits and fits

JIS B 0612 Conical tapers

JIS B 0614 System of cone tolerances

2. The International Standard corresponding to this Standard is given in the following:

ISO 5166: 1982 System of cone fits for cones from $C = 1 : 3$ to $1 : 500$, lengths from 6 to 630 mm and diameter diameters up to 500 mm

2. Definitions For the purpose of this Standard, in addition to those given in JIS B 0154, B 0401 and B 0614, the following definitions apply.

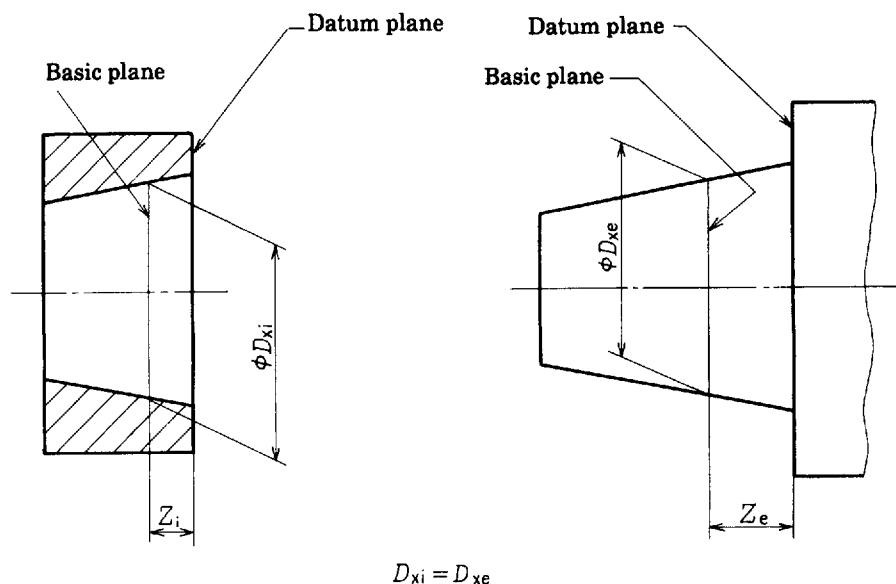
- (1) basic plane The plane of section perpendicular to cone axis defining the basic cone diameter (see Fig. 1).
- (2) datum plane A plane perpendicular to the cone axis, used for defining the axial positions of basic plane or of one cone and the other cone to be assembled together (see Figs. 1, 3 and 4).

Remarks: The basic plane and datum plane of a cone may coincide in some cases.

Fig. 1. Datum interval when the larger end face of a cone is taken as the datum plane

(a) Internal cone

(b) External cone



- (3) datum interval of conical workpiece The space in axial direction between the basic plane and datum plane of a conical workpiece (see Fig. 1).

3. Quantitative symbols The main quantitative symbols used in this Standard shall be in accordance with the following:

- C : basic rate of taper
- D_e : basic external cone diameter
- D_i : basic internal cone diameter
- D_{xe} : basic external cone diameter at the position X of the basic plane of external cone
- D_{xi} : basic internal cone diameter at the position X of the basic plane of internal cone
- E_a : axial displacement from the actual starting position
- $E_{a \max}$: maximum axial displacement
- $E_{a \min}$: minimum axial displacement
- F_s : assembly force
- S : clearance of cone fit
- $S_{\max}$: maximum clearance (of cone fit)
- $S_{\min}$: minimum clearance (of cone fit)
- T_D : cone diameter tolerance
- T_{De} : external cone diameter tolerance
- T_{Di} : internal cone diameter tolerance

- T_{Dp} : variation of cone diameter fit
 T_{Ds} : tolerance on the axial displacement
 T_p : tolerance on starting position
 U : interference of cone fit
 U_{max} : maximum interference (of cone fit)
 U_{min} : minimum interference (of cone fit)
 Z_e : datum interval of external cone
 Z_i : datum interval of internal cone
 Z_p : axial interval of the datum plane between the external cone and internal cone to be assembled (datum interval of cone fit)
 Z_{pf} : datum interval at the final position of cone fit (final datum interval of cone fit)

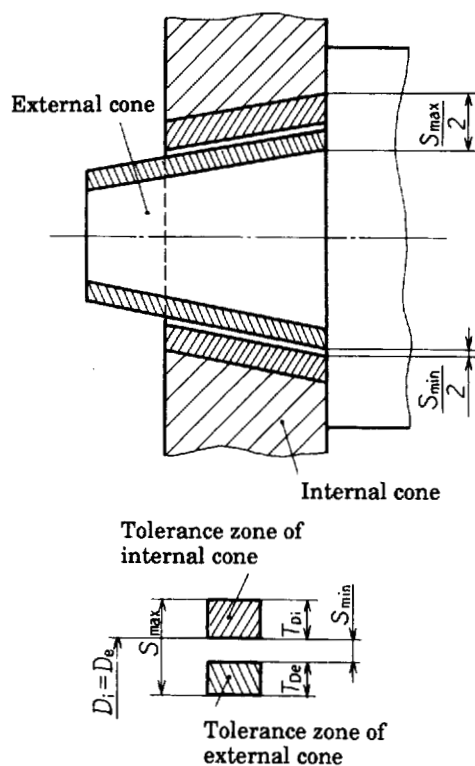
4. Formation of cone fits The clearance or interference in the cone fits varies according to the relative axial position of the internal cone and external cone to be assembled. In order to obtain the required clearance or interference at the final position of the conical workpieces to be assembled, the following methods of (1) to (4) apply:

- (1) Formation according to the structure on design The axial position shall be restricted according to the structure of conical workpieces to be assembled (see Fig. 2).

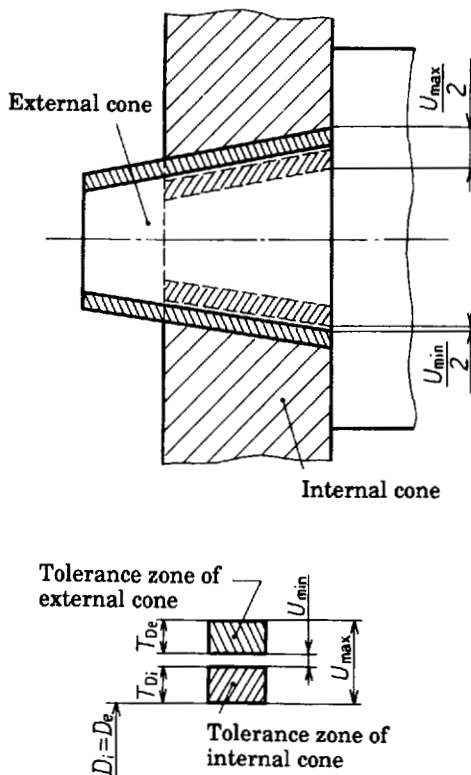
Remarks: As given in Fig. 2, the relative position in axial direction of the conical workpieces at the final position shall be defined according to the shapes of conical workpieces.

Fig. 2. Cone fits according to the structure on design

(a) Clearance fit



(b) Interference fit



- (2) Formation according to dimensional designation of axial position Irrespective of the actual dimensions of cones to be assembled, the relative axial position of conical workpieces shall be defined previously (see Fig. 3).

Remarks: The final position of conical workpieces each other shall be indicated on a drawing or be shown by the marks on the internal cone and external cone, as required.

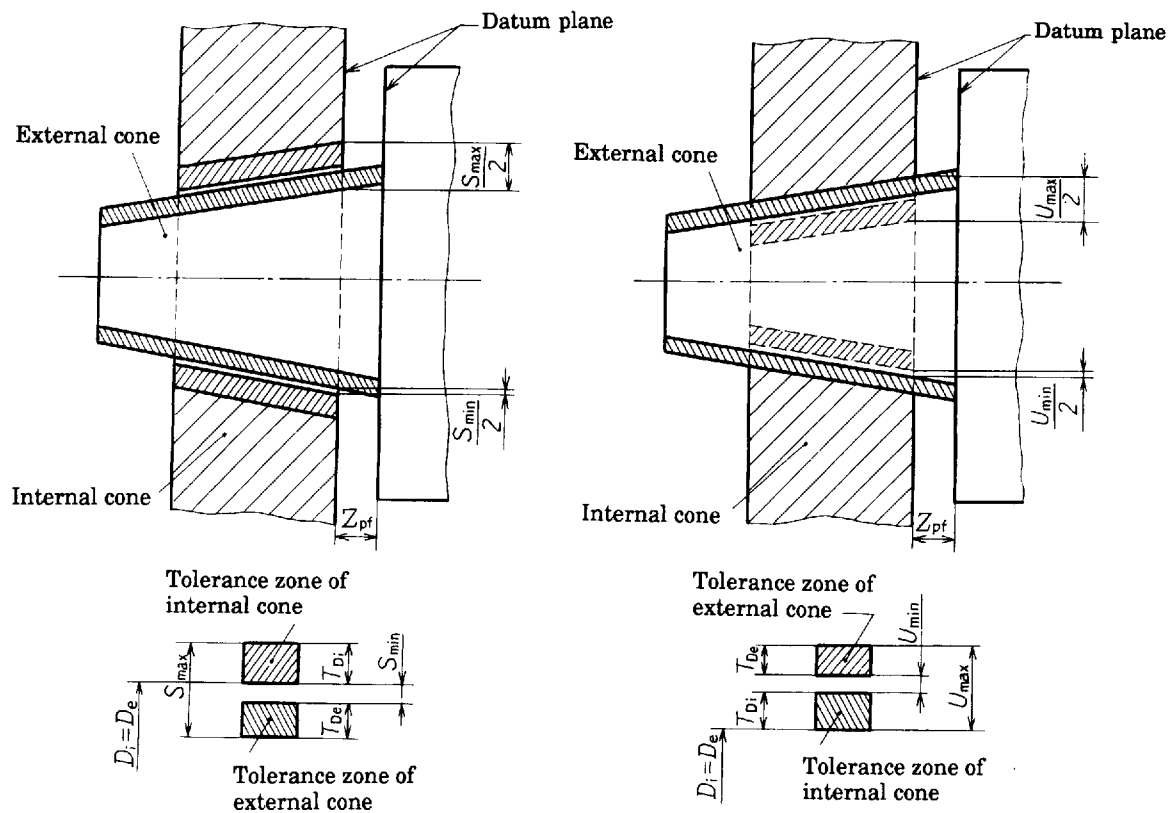
- (3) Formation according to designation of axial displacement The actual cones shall be displaced in axial direction relatively by a defined amount from the actual starting position (see Fig. 4).

Remarks: In order to obtain the required clearance or interference, the required axial displacement (E_a in Fig. 4) from the actual starting position shall be designated (see 5.).

Fig. 3. Cone fits according to dimensional designation of axial position

(a) Clearance fit

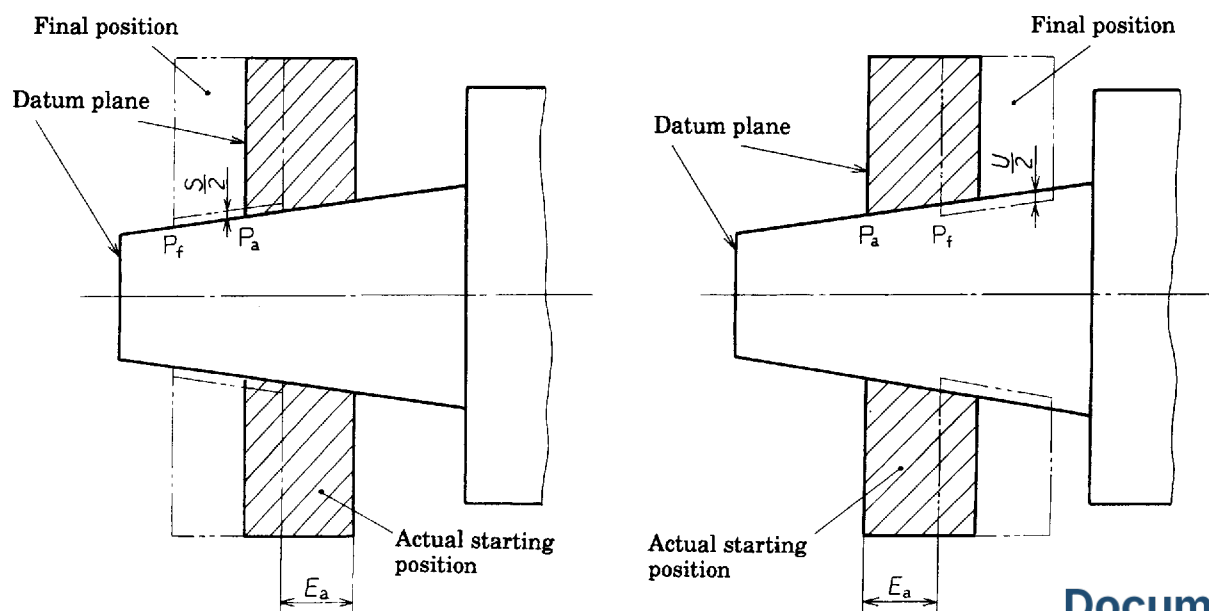
(b) Interference fit

Fig. 4. Cone fits obtained at the final position (P_f) by giving the specified axial displacement from actual starting position (P_a)

(a) Clearance fit

(b) Interference fit

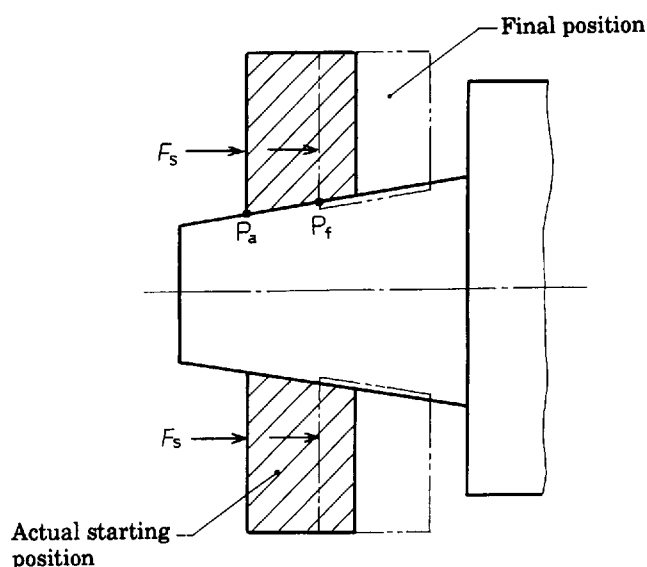
(External cone is assumed as rigid body.)



- (4) Formation by specified assembly force (F_s) The specified assembly force (F_s) shall be given to an actual cone from the actual starting position (see Fig. 5).

Remarks: The final position of mutual conical workpieces to be assembled can be obtained, in the case of cone interference fit, by the specified assembly force. By strictly observing the assembly force, the cone interference fit having actual interference in the required range of interference can be obtained.

Fig. 5. Cone interference fit obtained at the final position (P_f) by giving the specified assembly force from the actual starting position (P_a) (Assume the external cone as a rigid body.)



- Remarks 1. In the case of cone fit according to the structure on design or dimensional designation of axial position, the variation of cone diameter fit can be obtained from the following formula (see Figs. 2 and 3).

$$\begin{aligned} T_{Dp} &= S_{\max} - S_{\min} \text{ or } U_{\max} - U_{\min} \\ &= T_{Di} + T_{De} \end{aligned}$$

2. In the case of the cone fit by axial displacement designation or specified assembly force, the combination of the position of tolerance zones on the cones to be fitted is defined as H/h, JS/js or N/k [see 2.(2) of Informative reference 1].

5. Cone fits by designation of axial displacement

5.1 Axial displacement from actual starting position When an internal cone is displaced in axial direction to the external cone from the actual starting position (P_a), a clearance fit is obtained in the displacing direction where both cones recede from each other, and in the displacing direction where both cones approach to each other, an interference fit is obtained.

For a clearance fit, the minimum axial displacement which results in the minimum clearance and the maximum axial displacement which results in the maximum clearance shall be obtained from the following formulae respectively:

$$E_{a \min} = \frac{1}{C} \times S_{\min}$$

$$E_{a \max} = \frac{1}{C} \times S_{\max}$$

For an interference fit, the minimum axial displacement giving the minimum interference to obtain the necessary securing force and the maximum axial displacement giving the permissible maximum interference with regard to the strength of the cone fit shall be obtained from the following formulae respectively.

$$E_{a \min} = \frac{1}{C} \times U_{\min}$$

$$E_{a \max} = \frac{1}{C} \times U_{\max}$$

- Remarks 1. The formulae given herein shall be those applicable only to the cones having the basic taper angle strictly. When the axial displacement in accordance with the above formulae has been given, it generally results in a portion to generate the clearance or interference beyond the range ($S_{\max}$ to $S_{\min}$ or $U_{\max}$ to $U_{\min}$) of required clearance or interference (see 4.4.1(1) of Informative reference 2).
2. As regards the working, the maximum interference can be reduced in order to avoid an excessive maximum axial displacement.

5.2 Tolerance on axial displacement The axial displacement from an actual starting position (P_a) used for obtaining the necessary fit shall exist between $E_{a \min}$ and $E_{a \max}$ calculated in accordance with 5.1, i.e. within the tolerance $T_{DS} = E_{a \max} - E_{a \min}$ (see Fig. 6).

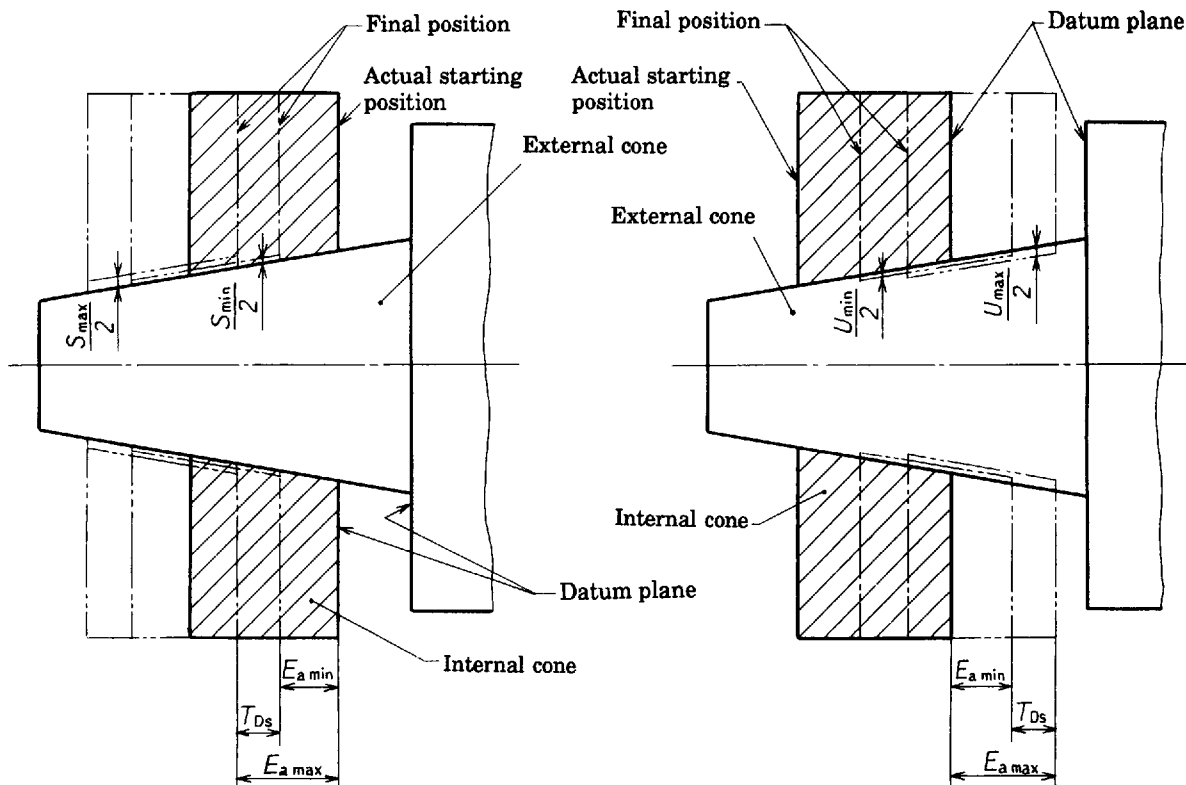
Remarks: Because of the uncertainties in the working and measurement of conical workpieces, it should increase slightly the value of $E_{a \min}$ obtained by calculation, and decrease slightly the value of $E_{a \max}$. In doing so, the value of the tolerance obtained from $E_{a \max} - E_{a \min}$ is reduced practically.

Fig. 6. The maximum and minimum clearances or the maximum and minimum interferences obtained by giving the specified axial displacements ($E_{a \min}$ and $E_{a \max}$) from the actual starting position (P_a)

(a) Clearance fit

(b) Interference fit

(External cone is assumed as a rigid body.)



5.3 Limit starting positions One of the limit starting position P_1 shall be calculated from the combination of the minimum internal cone and the maximum external cone, and another one P_2 from that of the maximum internal cone and the minimum external cone (see Fig. 7).

Tolerances on starting positions shall be obtained from the following formula (see Fig. 7).

$$T_p = \frac{1}{C} \times (T_{Di} + T_{De})$$