TOYOTA ENGINEERING STANDARD

NO. : **TSZ2001G**

TITLE : FUNDAMENTAL TOLERANCING PRINCIPLE

CLASS : **C2**

Established/Revised : Rev.3(Jun.2006)

This standard is subjected to periodic review and has been revised in consequence of reviewing terms, expressions and inserted figures.

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FUNDAMENTAL TOLERANCING PRINCIPLE

1. Scope

This standard covers the fundamental principle of the relationships between linear (length and angle) tolerance and geometrical (form, orientation and location) tolerances used on drawings and related technical documents for automobile parts.

2. Definitions

Definitions of major terms used in this standard are according to TSZ2300G.

3. Principle of Independency

Each specified linear tolerance and geometrical tolerance on a drawing shall be applied independently, unless a particular relationship[1] is specified. Each value shall be handled as irrelevant and meet the requirements. If a particular relationship between size, form, orientation and location is required, it shall be specified on the drawing (see Sections 5.1 and 5.2).

Note: (1)
Particular relationship refers to the envelope requirement, the maximum material principle and the least material principle.

4. Tolerances

4.1 Linear Tolerances

(1) Length linear tolerance

A linear tolerance controls only the actual local sizes[2] of a feature, but not its form deviations (for example, circularity and straightness deviations of a cylindrical feature or flatness deviations of two parallel plane surfaces).

Note: (2)
The size actually determined by two-point measurement.

(2) An angular tolerance that is specified by the unit of angle controls the general orientation[3] of lines or line segments structuring surfaces, but not their form deviations.

Note: (3)
The general orientation of the line derived from the actual surface is the orientation of the contacting line of ideal geometrical form (Fig. 1). The maximum distance between the contacting line and the actual line shall be the least possible value:

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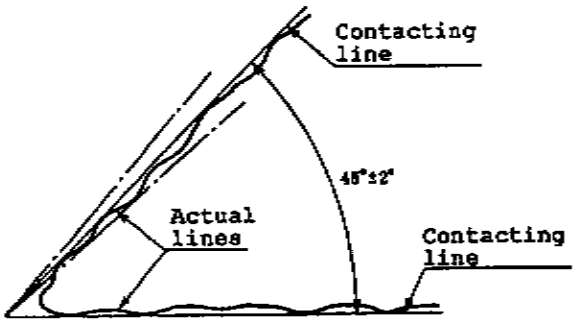
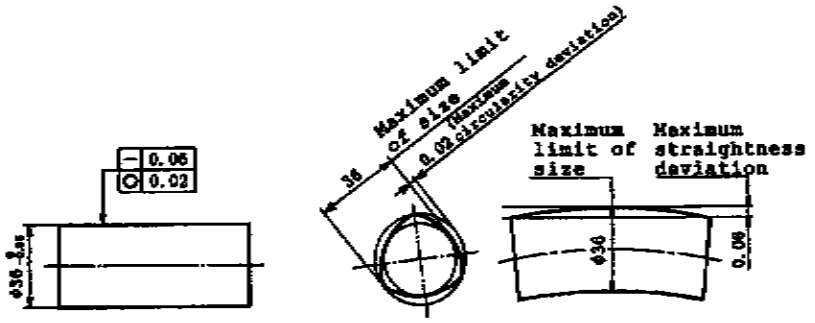


Fig. 1 Angular Tolerance

4.2 Geometrical Tolerances

Geometrical tolerances control the deviation of the feature from its theoretically exact form, orientation or location regardless of the feature size. The geometrical deviations may be, therefore, at a maximum whether or not the cross-sections of the respective features are at maximum material size. For instance, a cylindrical shaft with maximum material size at any cross-section may have a lobed form deviation within circularity tolerance, and may also be bent by the amount of the straightness tolerance (see Fig. 2):



(a) Specifications on drawing (b) Interpretation

Fig. 2 Linear Tolerance and Geometrical Tolerance for Cylindrical Shaft

5. Mutual Dependency of Size and Geometrical Characteristics

Mutual dependency of size and geometrical characteristics may be called for by indicating the envelope requirement, the maximum material principle or the least material principle on the drawing.

Established/ 3 Revised:
Jun.2006

5.1 Envelope Requirement

Envelope requirement shall be applied to a single feature, in other words, to a feature (size feature) that is determined by cylindrical surface or a feature established by two parallel plane surfaces. This requirement indicates that a feature shall not exceed the envelope of a perfect form at maximum material size.

Reference:
It is recommended to apply this requirement to a feature that has engagement function.

(1) Drawing instruction

When the envelope requirement is applied, the symbol Ⓔ shall be placed after the linear tolerance (Fig. 3).

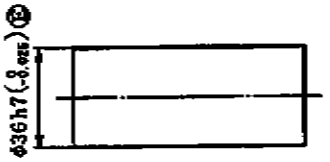
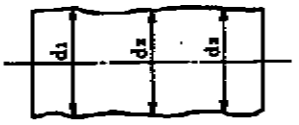


Fig. 3

(2) Requirements on function

The requirements indicated in Fig. 3 for function shall be as follows;
(a) The surface of the cylindrical feature shall not exceed the envelope of perfect form at maximum material size of φ36.
(b) The actual local size at a position selected arbitrarily on the cylindrical feature surface shall not be smaller than φ35.975.

These requirements indicate that the actual each part of the feature must meet the following requirements.
(a) Individual actual load diameter (Fig. 4) of a cylindrical shaft shall be with φ35.975 to 36 and within the tolerance of 0.025, and is allowed to fluctuate freely in the range of φ35.975 to 36.



d1, d2, d3: Actual local diameter

Fig. 4

Established/ 3 Revised:
Jun.2006

(b) The entire cylindrical shaft shall be in the border of envelope cylinder of a perfect form with a diameter of 36 (Figs. 5 and 6).

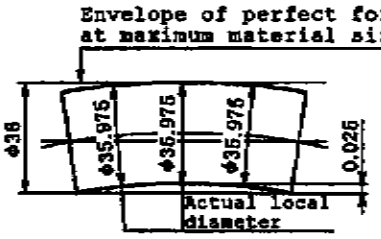


Fig. 5

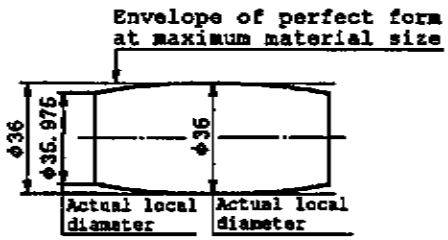


Fig. 6

Therefore, if all individual actual load diameters are φ36 at maximum material size, the shaft must be of precise cylindrical shape (Fig. 7).

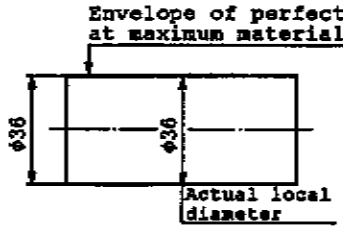


Fig. 7

5.2 Maximum Material Principle and Least Material Principle

If for functional and economic reasons there is a requirement for the mutual dependency of the size and geometry of the feature(s), then the maximum or the least material principle may be applied by marking Ⓜ for the former and Ⓛ for the latter on the drawing (see TSZ2300G).

Established/ 3 Revised: Jun. 2006

6. Marking on Application of Principle of Independency on Drawings
Drawings to which the principle of independency applies shall be identified by being marked in the tolerance principle column of the title block as "TSZ2001G". In case where this indication is given, the general geometrical tolerance value or the grade symbol specified in TSZ2305G, TSZ2306G and TSZ2208G shall be marked on the general geometrical tolerance column (Fig. 8). If this indication is absent, the same value as the value of the linear tolerance shall be applied as geometrical tolerance value.

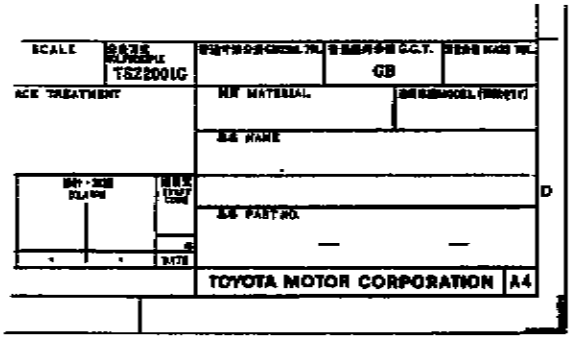


Fig. 8

Applicable Standards

TSZ2208G	System of Tolerances and Machining Allowances for Raw Castings
TSZ2300G	Geometrical Tolerancing
TSZ2305G	General Geometrical Tolerances
TSZ2306G	General Geometrical Tolerances for Welded Parts

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