SLOVENSKI STANDARD
SIST ISO/TR 5460:1995

01-junij-1995

Tehniļ ne risbe - Geometrijsko toleriranje - Toleriranje oblike, orientacije, lege in teka - Metode in naļ ela preverjanja - Priporoļ ila

Technical drawings -- Geometrical tolerancing -- Tolerancing of form, orientation, location and run-out -- Verification principles and methods -- Guidelines

Dessins techniques -- Tolérancement géométrique -- Tolérancement de forme, orientation, position et battement -- Principes et méthodes de vérification -- Principes directeurs

Ta slovenski standard je istoveten z: **ISO/TR 5460:1985**

ICS:

01.100.20	Konstrukcijske risbe	Mechanical engineering drawings

SIST ISO/TR 5460:1995 **en**

TECHNICAL REPORT ISO/TR 5460-1985 (E)

Published 1985-05-15

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Technical drawings — Geometrical tolerancing — Tolerancing of form, orientation, location and run-out — Verification principles and methods — Guidelines

Dessins techniques — Tolérancement géométrique — Tolérancement de forme, orientation, position et battement — Principes et méthodes de vérification — Principes directeurs

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

The main task of ISO technical committees is to prepare International Standards. In exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types :

- type 1, when the necessary support within the technical committee cannot be obtained for the publication of an International Standard, despite repeated efforts;
- type 2, when the subject is still under technical development requiring wider exposure;
- type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standards ("state of the art", for example).

Technical Reports are accepted for publication directly by ISO Council. Technical Reports types 1 and 2 are subject to review within three years of publication, to decide if they can be transformed into International Standards. Technical Reports type 3 do not necessarily have to be reviewed until the data they provide is considered no longer valid or useful.

ISO/TR 5460 was prepared by Technical Committee ISO/TC 10, *Technical drawings.*

The reasons which led to the decision to publish this document in the form of a Technical Report type 2 are explained in the Introduction.

UDC 744.4 : 621.753.1 — Ref. No. : ISO/TR 5460-1985 (E)

Descriptors : drawings, technical drawings, tolerances : measurement, dimensional tolerances, form tolerances, tolerances of position, angular tolerances, verification, generalities.

Printed in Switzerland

Price based on 71 pages

Contents

0 Introduction

In 1972, ISO/TC 10, *Technical drawings*, initiated work on preparing an International Standard on verification principles and methods for geometrical tolerancing. In the early stages of the work it became clear that several alternative verification methods for measuring principles were necessary so as to take account of the different types of workpieces and measuring equipment used. Since there is little experience in the various countries as to how to apply verification principles and methods on geometrical tolerances, it was decided that the results of the work would not be published as an International Standard for the time being.

It was felt, however, that the results of the work should be published in the form of a Technical Report as this could be used as a guide towards understanding how to apply the tolerancing system for form, orientation, location and run-out with respect to varying measurement conditions.

For uniformity all figures in this Technical Report are in first angle projection.

It should be understood that the third angle projection could equally well have been used without prejudice to the principles established.

For the definitive presentation (proportions and dimensions) of symbols for geometrical tolerancing, see ISO 7083.

1 Scope and field of application

1.1 This Technical Report establishes guidelines for verifying geometrical tolerancing as described in ISO 1101. The purpose is to outline the fundamentals of various verification principles which may be used in order to comply with the definitions of ISO 1101. The verification methods described in this Technical Report do not provide for a unique interpretation of the requirements of ISO 1101 and do differ amongst themselves. This Technical Report may, however, be used as a reference document for coordination and agreements in the field of geometrical tolerancing verification. The symbology and methods mentioned are not illustrated in detail and are not intended for application on end-product drawings. (See also 6.4.)

1.2 Not all verification principles are given in this Technical Report for the different types of geometrical tolerances. Within the verification principle one or more verification methods are used. (See clause 6.)

1.3 The numbering of verification principles and methods shall not be regarded as a classification of priority within the prescribed type of geometrical tolerance.

2 References

ISO 1101, *Technical drawings — Geometrical tolerancing — Tolerancing of form, orientation, location and run-out — Generalities, definitions, symbols, indications on drawings.*

ISO 2692, *Technical drawings — Geometrical tolerancing — Maximum material principle.*[1)]

ISO 4291, *Methods for the assessment of departure from roundness — Measurement of variations in radius.*

ISO 4292, *Methods for the assessment of departure from roundness — Measurement by two- and three-point methods.*

ISO 5459, *Technical drawings — Geometrical tolerancing — Datums and datum systems for geometrical tolerances.*

ISO 7083, *Technical drawings — Symbols for geometrical tolerancing — Proportions and dimensions.*

1) At present at the stage of draft. (Revision of ISO 1101/2-1974.)

3 Definitions

3.1 verification principle : Fundamental geometrical basis for the verification of the considered geometrical characteristic.

NOTE — The inspection methods may not always fully check the requirements indicated on the drawing. Whether or not such methods are sufficient and acceptable depends on the actual deviations from the ideal form and on the manufacturing and inspection circumstances.

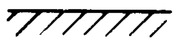
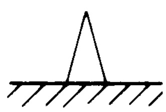
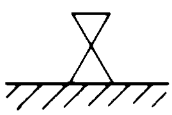
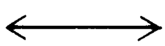
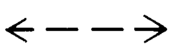
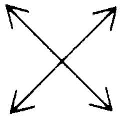
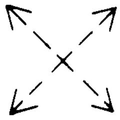
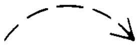
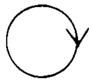
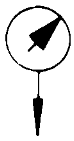
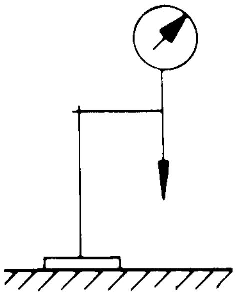
3.2 verification method : Practical application of the principle by the use of different equipment and operations.

3.3 verification equipment : Technical device necessary for a specific method.

4 Symbols

The symbols shown in table 1 are applied throughout this Technical Report.

Table 1

	Symbol	Interpretation
1		Surface plate (Measuring plane)
2		Fixed support
3		Adjustable support
4		Continuous linear traverse
5		Intermittent linear traverse
6		Continuous traverse in several directions
7		Intermittent traverse in several directions
8		Turning
9		Intermittent turning
10		Rotation
11		Indicator or recorder
12		Measuring stand with indicator or recorder Symbols for measuring stands can be drawn in different ways in accordance with the verification equipment used.

5 Establishment of datums

5.1 Datum indication

The datum indicated on a drawing is a theoretically exact geometric reference from which required characteristics of related features are dimensioned.

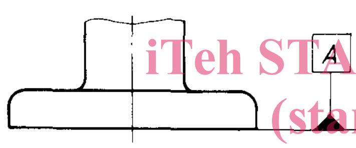
The datum feature is a real feature of a part which is marked on the drawing as a datum.

The choice of datum and toleranced feature shall be made in accordance with the functional requirements. If the verification can be simplified by changing the datum and the toleranced feature, without affecting the functional requirements, such a change could be permitted.

When it is difficult to establish a datum from a datum feature, it may be necessary to use a simulated datum feature.

The datum feature shall be sufficiently accurate in accordance with the functional requirements. It is necessary to take these requirements into consideration in the verification procedure.

The datum feature shall be arranged in such way that the maximum distance between it and the simulated datum feature has the least possible value. Practically, the datum feature shall give a stable contact either by the datum feature itself [see figure 1 a)] or by alignment of the datum feature to a simulated datum feature [see figure 1 b)].



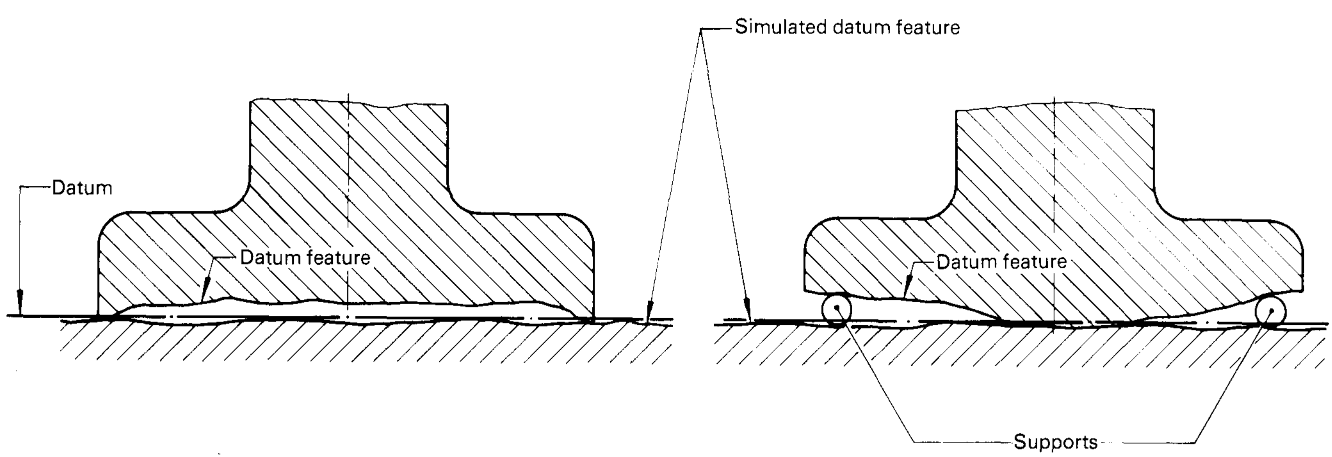


Figure 1 a)

Figure 1 b)

Figure 1 — Contact between datum feature and simulated datum feature

5.2 A point as the datum

A point as the datum is quite unusual but can be used, for example in connection with position tolerances. However, it is difficult to find out the real datum by establishment of a simulated datum feature. In most cases, the datum is established by a simulated verification equipment (see figure 2).

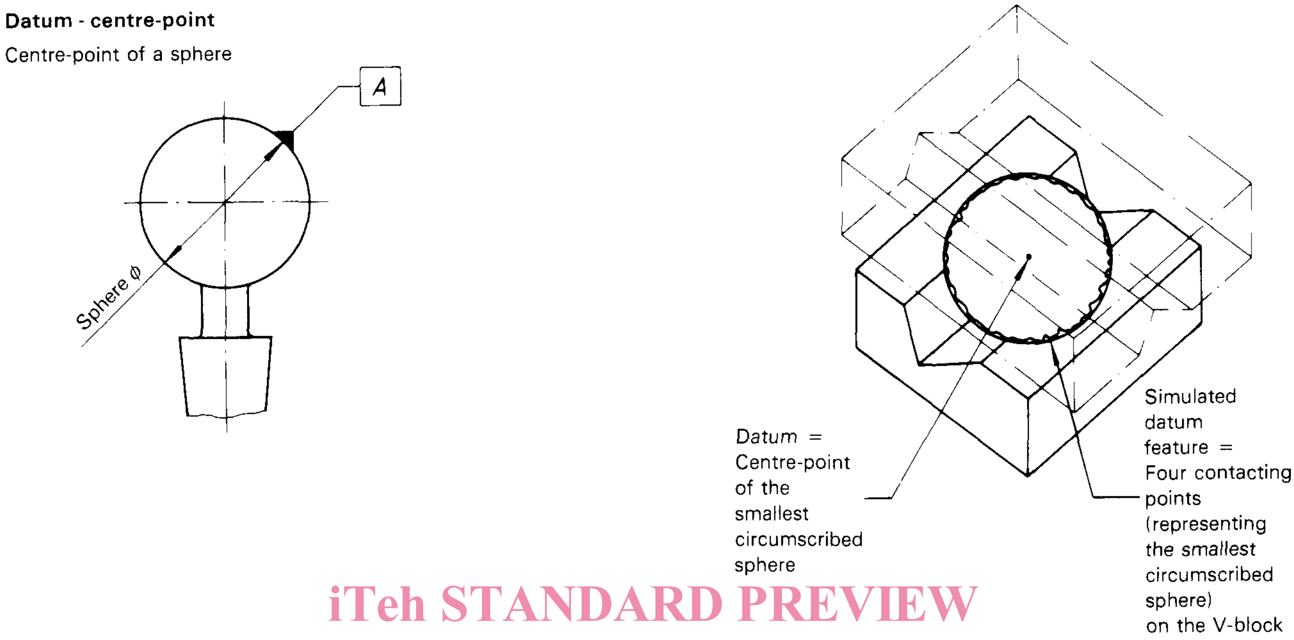


Figure 2 — Establishment of a point as the datum

5.3 A line as the datum

A line as the datum can be an edge, generating line or an axis. The edge and the generating line can be established in accordance with figure 1.

5.3.1 A generating line as the datum

If the datum is a generating line for an internal surface (for example, a hole), the establishment of the simulated datum can be made in a practical way by using a cylindrical mandrel in accordance with figure 3.

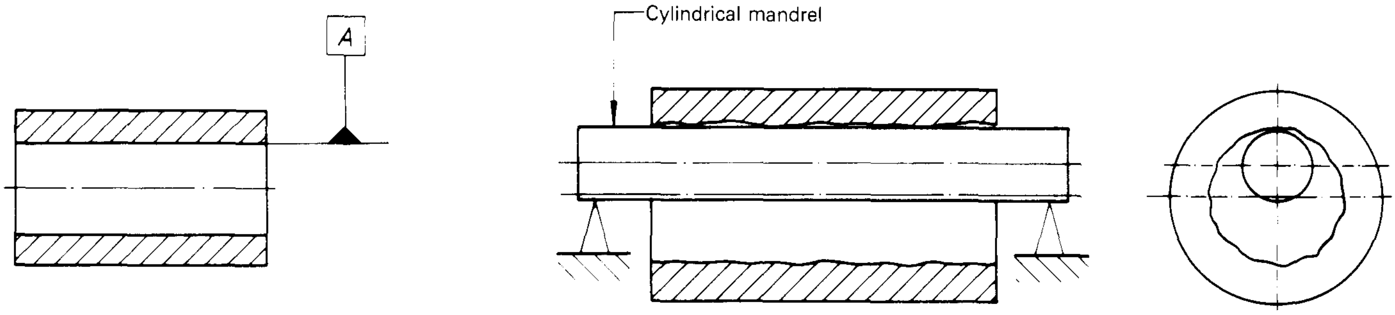


Figure 3 — Practical way of establishing a generating line as the datum

In some cases, the alignment of datum features is time-consuming and can be replaced by mathematical or graphical evaluation (see figure 4).

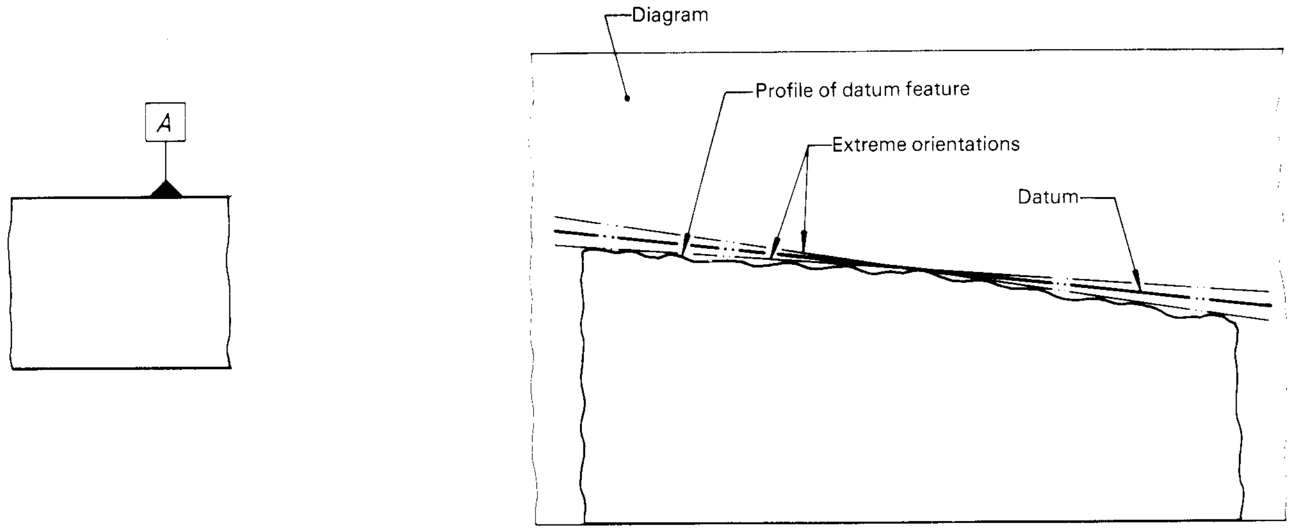


Figure 4 — Profile diagram for graphical evaluation of datum

NOTE — When graphical evaluation is used, the datum and the toleranced feature can be indicated in the same diagram.

5.3.2 An axis as the datum

An axis as the datum is always an unreal feature and shall be established by a simulated datum feature or by mathematical calculation.

An axis as the datum may well be used for both internal and external features.

The datum for an internal feature is usually established by an inscribed feature of a geometrically correct form.

For cylindrical holes, the datum can be established by a cylindrical mandrel of the largest inscribed size or by an expandable mandrel.

If the mandrel cannot achieve a stable position in the hole, the location shall be adjusted in such a way that the possible movement of it in any direction is equalized (see figure 5).

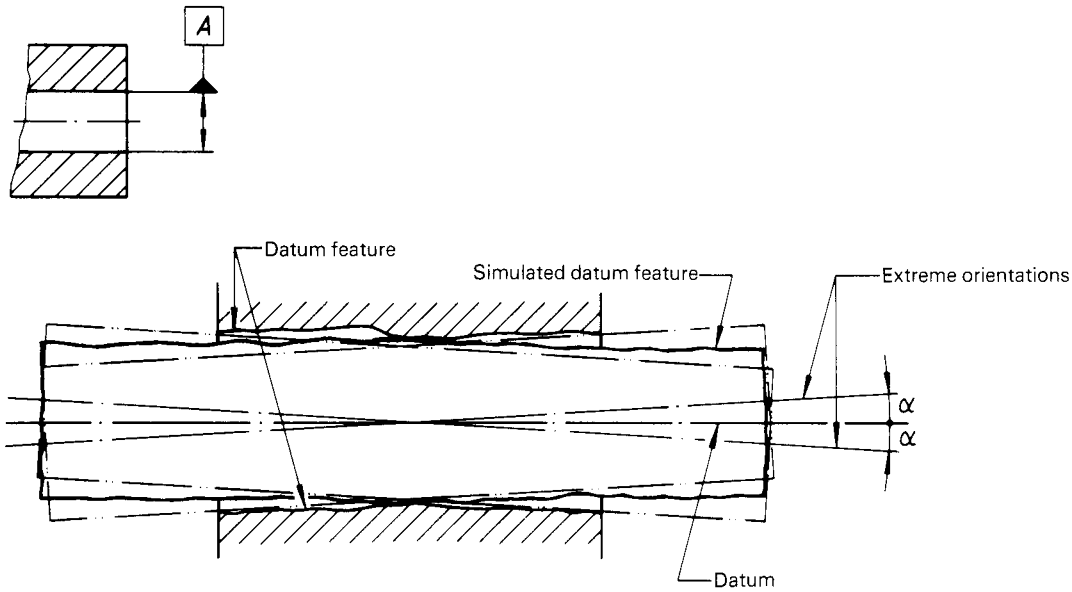


Figure 5 — Alignment of simulated datum feature in a hole

A simplified way to establish an axis for internal features can be used by aligning it between two coaxial conical features (see figure 6).

In this case, the eventual eccentricity of the chamfer to the hole itself may constitute a serious source of error when establishing the datum.

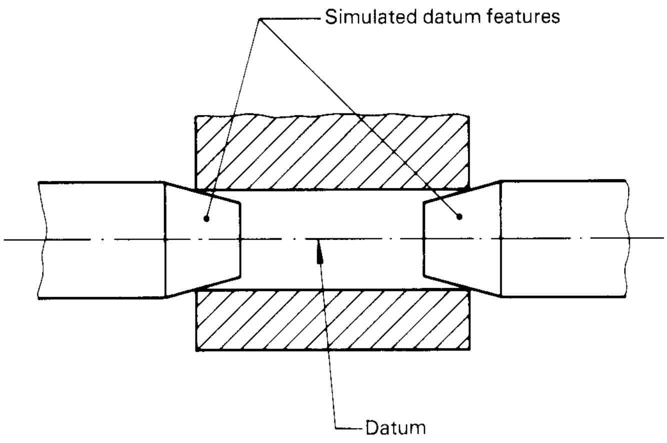


Figure 6 — Simplified alignment of an axis as the datum (internal features)

The datum for an external feature should be established by a circumscribing feature of a geometrically correct form.

For cylindrical shafts, the datum can be established by a cylindrically encircling gauge of the smallest circumscribed size or by a collet chuck.

If the position of the gauge is not stable, it shall be adjusted in such a way that the possible movement of it in any direction is equalized. (Same principle as in figure 5.)

The datum for cylindrical shafts may be established in a simplified way using, for example, V-blocks, V-yokes, L-blocks or L-yokes (see figure 7).

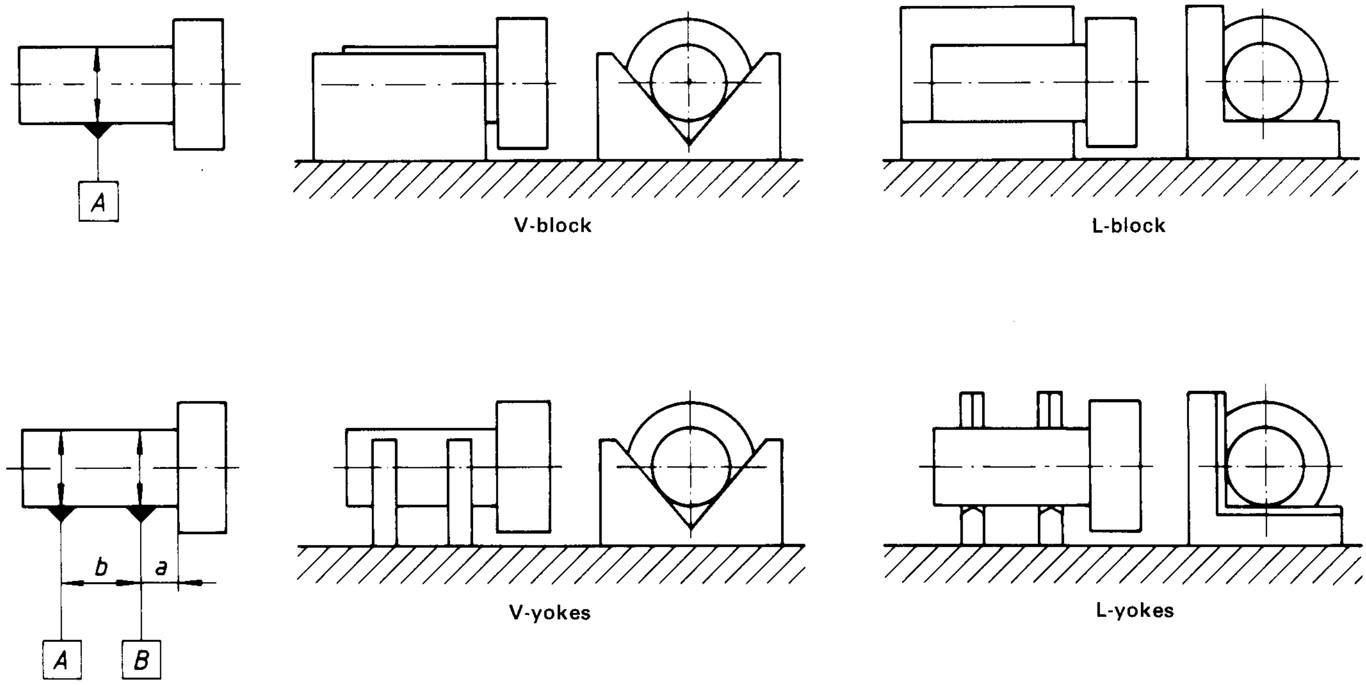
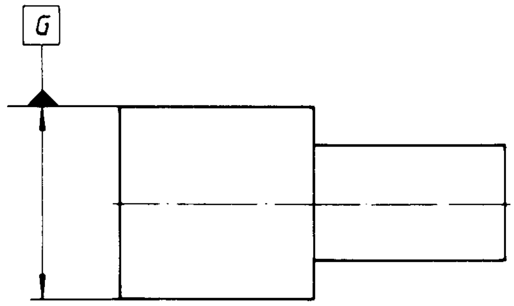
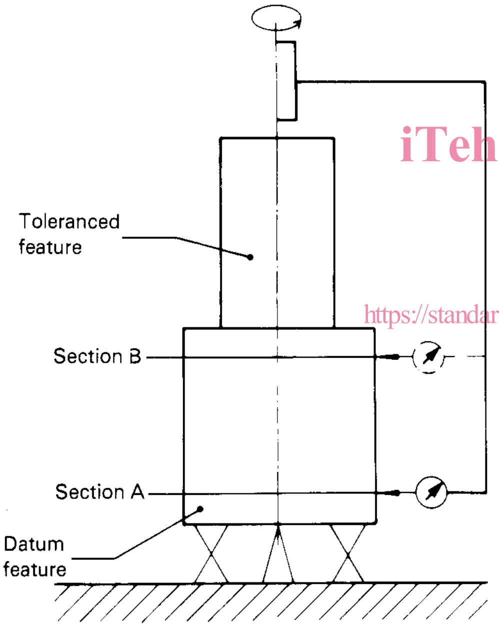


Figure 7 — Simplified alignment of an axis as the datum (external features)

Depending on the form deviations of the datum feature, the angle in the V-block and the V-yokes can affect the position of the datum, which also affects the measured value.

An axis as the datum can also be established by graphical evaluation, for example in accordance with figure 8.





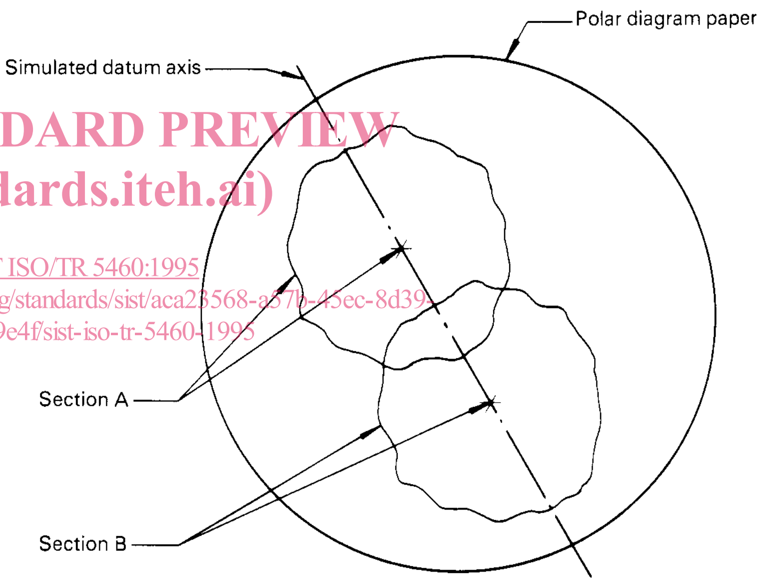


Figure 8a) — Measurement of simulated datum feature from a fixed axis

Figure 8b) — Graphical evaluation of the datum axis

5.3.3 A common axis as the datum

In some cases, the datum is a common axis of two separate datums which can be established by internal or external features (inscribed, circumscribing or expandable).

The deviations of form and location of the datum features will affect the position of the common axis which can also affect the toleranced features.

The guidance of the datum features should be used in such a way that the simulated datum features are coaxial (see figure 9).

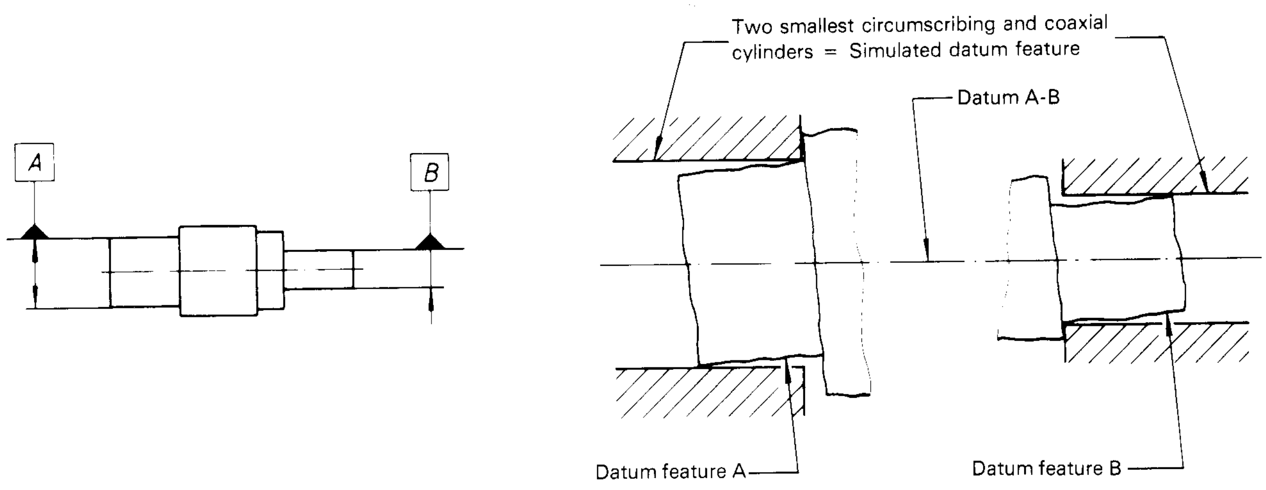


Figure 9 — Guidance of two datum features when the datum is a common axis

As it is difficult to establish a common datum in accordance with the method mentioned above, a simplified method using V-blocks, V-yokes, L-blocks and L-yokes may be used (see also figure 7).

In some cases, the datum can be established by a coaxial pair of conical centres.

It should be noted that the deviations between the centres and the datum shall be added to the measured value of the toleranced feature (see figure 10).

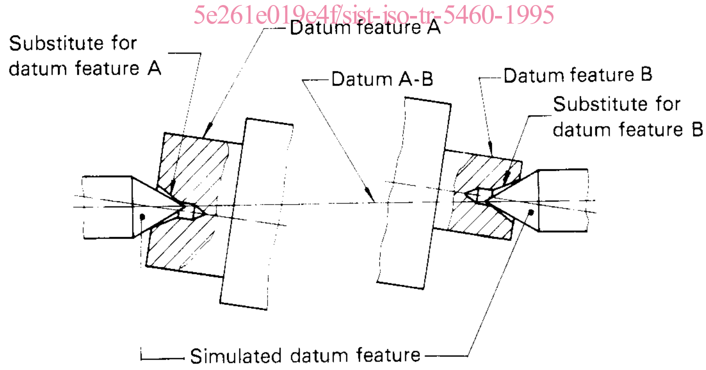


Figure 10 — Conical centres used as substitutes for cylindrical datum features

5.4 A surface as the datum

A surface as the datum can be a plane or have other forms. When the datum is a plane, it can be established in accordance with figure 1.

In practice, the datum will be established in a simplified way by three supports (points) situated as far as possible from each other on the datum feature.

When certain points or surfaces on the drawing are specified as datum targets, these shall be used for the alignment of the simulated datum features.

5.5 Multiple datums

If the datum consists of two or more datum features, their sequence may be important (see figure 11).

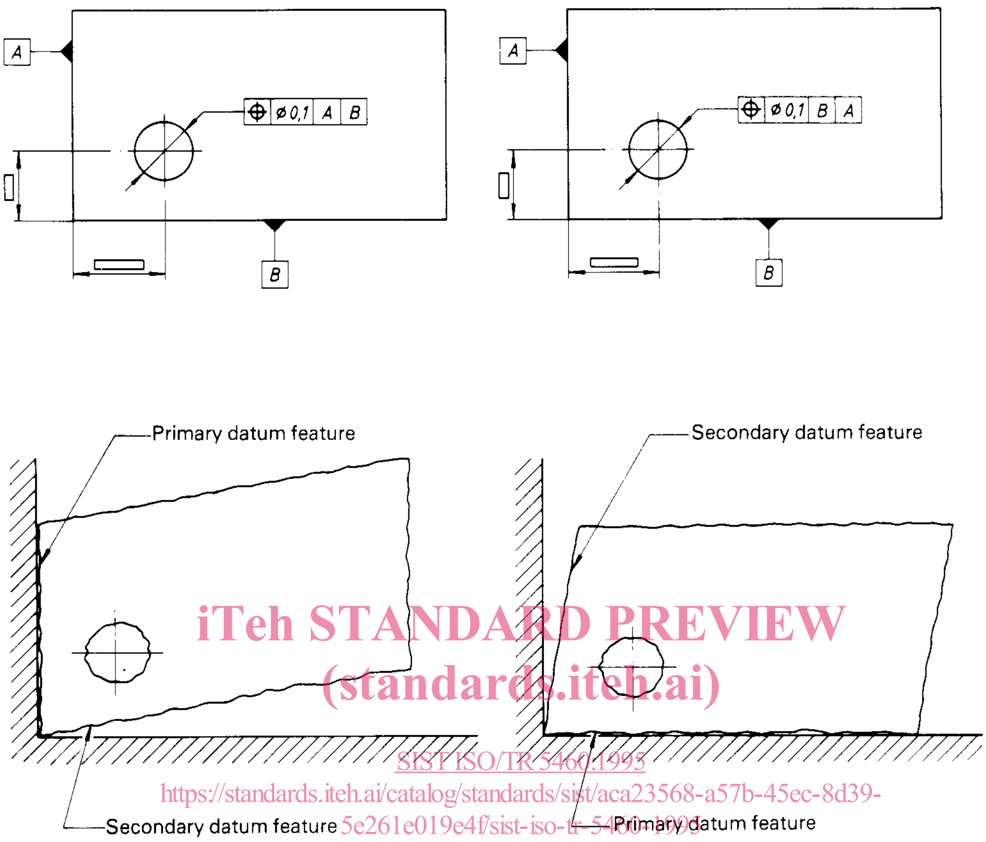


Figure 11 — Influence on the toleranced feature depending on the sequence of the datum features used on the toleranced feature

If the datum consists of three datum features, it should be noted that the primary datum feature (A) can be aligned in accordance with figure 12a). The secondary datum feature shall be aligned on two points [see figure 12b)] and the tertiary datum feature on one point [see figure 12c)].

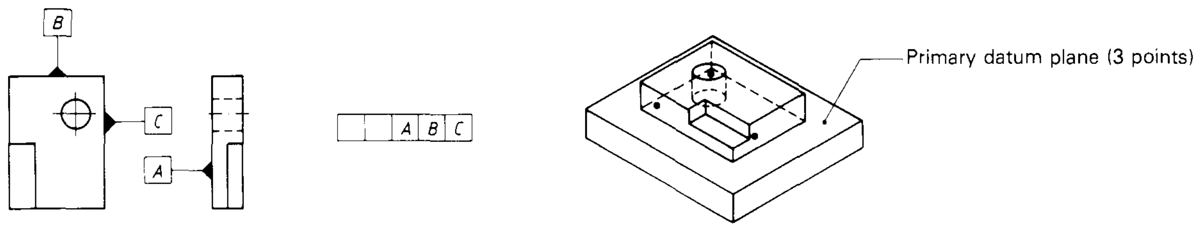


Figure 12a)

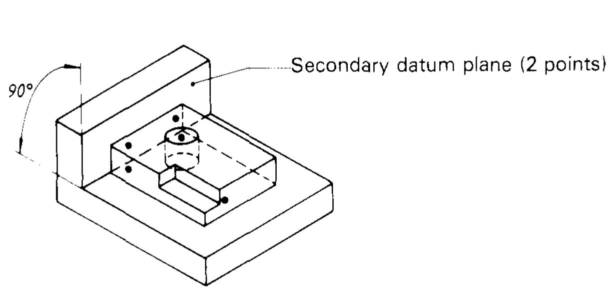


Figure 12b)

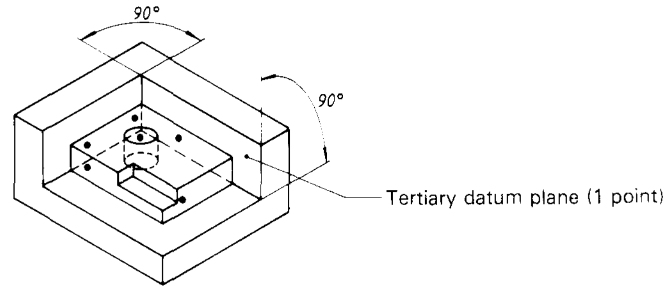


Figure 12c)

Figure 12 — Establishment of three plane datum system

6 Verification principles and methods

6.1 The verification principles and methods are arranged in such a way that for each tolerance characteristic the corresponding verification principles are used as principal headings.

For each verification principle, a number of verification methods are shown in association with particular application examples arranged in order of tolerance zones. For each method, an example of verification equipment is outlined. Comments are added when required.

The resulting tabular arrangement has the following characteristics :

Headings

- Symbol
- Tolerance zone and application example
- Verification method
- Comments

The column "**Symbol**" gives the different geometric characteristics in conformity with ISO 1101.

The column "**Tolerance zone and application example**" shows, firstly, the tolerance zone, in accordance with ISO 1101, and, secondly, an application example which is the same as that shown in ISO 1101. When this example has been considered insufficient in order to illustrate the methods fully, further examples have been added.

The column "**Verification method**" gives

- the number of the method;
- the figure illustrating the verification method;
- the essential characteristics of the verification methods;
- the readings to be taken;
- the required repetitions;
- the treatment of the readings obtained;
- the acceptance criteria associated with the measured value.