INTERNATIONAL STANDARD

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Tolerances for building — Methods of measurement of buildings and building products —

Part 1: Methods and instruments

Tolérances pour le bâtiment — Méthodes de mesure des bâtiments et des produits pour le bâtiment —

Partie 1: Méthodes et instruments

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Foreword

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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 7976-1 was prepared by Technical Committee ISO/TC 59, *Building construction.*

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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Tolerances for building — Methods of measurement of buildings and building products —

Part 1: Methods and instruments

1 Scope and field of application

This International Standard gives some alternative measuring methods for the determination of shape, dimensions and dimensional deviations of buildings and building products which are relevant to fit. The methods can also be applied when accuracy data are being collected in factories or on building sites.

Information is given about deviations of parts of buildings or of building products which can be determined with the equipment described.

The measuring methods concern primarily those objects the faces of which are rectilinear in shape and which have a modulus of elasticity larger than 35 kPa, for example concrete, wood, steel, hard plastic. Building products consisting of glass wool and similar soft materials are not the subject of this International Standard.

Rules for quality control in all stages of measurement such as frequency checks, place, time, etc., are not covered by this International Standard.

Part two of this International Standard gives the position of measuring points to be used in the measurement described in this part.

To facilitate cross-referencing, the same numbering is used in the two parts of this International Standard.

2 References

ISO 4464, *Tolerances for building — Relationship between the different types of deviations and tolerances used for specification.*

ISO 7078, *Building construction — Procedures for setting out, measurement and surveying — Vocabulary and guidance notes.*

ISO 7976-2, *Tolerances for building — Methods of measurement of building and building products — Part 2: Position of measuring points.*

ISO 8322, *Building construction — Measuring instruments — Procedures for determining accuracy in use —*

Part 1: Theory. 1)

Part 2: Measuring tapes. 1)

Part 3: Optical levelling instruments. 1)

Part 4: Theodolites. 1)

Part 5: Optical plumbing instruments. 1)

Part 6: Laser instruments. 1)

Part 7: Instruments when used for setting out. 1)

Part 8: Electronic distance measuring instruments. 1)

3 General

3.1 Methods of measurement

The methods of measurement refer to the main dimensions of building products, distances between such products and their geometrical deviations. They may, however, also be applied to parts and to subdivisions in building products.

The items to be measured should be supported as they will be supported in use. When this is impractical, the support conditions should be agreed in the measuring schedule. If components are measured whilst they are in a manufacturing jig or mould, this should be noted. Flexible components should always be fully supported on a flat surface.

For both compliance measurements and for the collection of accuracy data, the measurement procedure should be significantly more accurate than the permitted deviation specified for the manufacturing or construction process to be measured.

1) At present at the stage of draft.

Arrangements which make it possible to check the accuracy of the measurement procedure are an essential part of the method. (See ISO 8322, parts 1 to 8.)

When recording the result of a measurement the following conditions should be reported where appropriate:

- identification of operator, instrument and time;
- position and attitude of the object being measured;
- temperature and moisture content of the object being measured;
- any other matters pertaining to the measurement.

It is usually possible to measure directly on surfaces cast against a smooth mould. Local defects such as pores, burns and casting blemishes shall be avoided in the measurement. They shall not appear as incorrect sizes, but their presence shall be noted. In the case of a surface with a considerable roughness in relation to the permitted deviations, the measurements can be specified to be made with the aid of sufficiently large position pieces placed on the object of measurement.

At the end of each of clauses 4 to 14, there is a table that specifies the following items for each of the measuring operations in that clause:

- the measuring operation;
- limits of measuring accuracy, in terms of the permitted deviation of the item to be measured;
- the measuring range;
- the measuring instrument or tool which can be chosen.

3.2 Influence of deviations from reference conditions

Variations in the ambient conditions from the specified reference values can give rise to errors in the measured size of a dimension. Temperature, especially direct sunshine, is normally the most significant of these ambient conditions.

Other reference conditions such as moisture content of timber and age of concrete components shall be taken into account where appropriate.

The actual temperature of either the object to be measured or the measuring equipment may be difficult to determine in practice since it is unlikely that either will be at uniform temperature and because temperature differentials within the object to be measured or in the equipment will exist. The most satisfactory solution is to allow both the object to be measured and the measuring equipment adequate time to achieve a stable ambient temperature. This temperature can then be measured and allowance made for any variation from the specified reference temperature.

So far as the measuring equipment is concerned, the most likely sources of heat input are from the handling of the equipment and from differences between ambient temperature and the reference condition. The object to be measured is also affected by ambient temperature and may also be subjected to considerable heating during manufacture.

The reference temperature in this example is considered to be 20 °C. The following symbols are used:

t_1 is the temperature of object to be measured, in degrees centigrade;

t_2 is the temperature of measuring equipment, in degrees centigrade;

a_1 is the coefficient of expansion of object to be measured;

a_2 is the coefficient of expansion of measuring equipment;

Δt_1 is the temperature difference from 20 °C of object to be measured ($\Delta t_1 = t_1 - 20$);

Δt_2 is the temperature difference from 20 °C of measuring equipment ($\Delta t_2 = t_2 - 20$);

L is the length being measured.

Then the error in measurement ΔL caused by the temperature differentials Δt_1 and Δt_2 is given by:

$$\Delta L = L\,(a_1\,\Delta t_1 - a_2\,\Delta t_2)$$

Section one: Measuring methods for those measurements which can be carried out both in factories and on building sites

NOTE — Most of the examples concerning components can also be applied to parts executed on site.

4 Sizes of components

This clause describes examples of instruments and measuring methods for the determination of length, width and thickness of components.

Linear dimensions are determined using measuring instruments (with or without the aid of position pieces) cited in clause 15, where typical errors and precautions needed are also indicated.

Special attention should be paid to tension and temperature when measuring with tapes. A tape tensioner applying the reference tension should be used where specified or when the length to be measured exceeds 10 m. It is recommended that the tape is supported in order to reduce the influence of the temperature of the object to be measured (see figure 1). It should be observed that when the tape rests on a building component or a floor, the temperature of this object of measurement can differ from the measured temperature of the surrounding air and hence cause measuring errors (see 3.2). This error can be reduced by supporting the tape. The correct temperature of the tape can be measured with a contact thermometer.

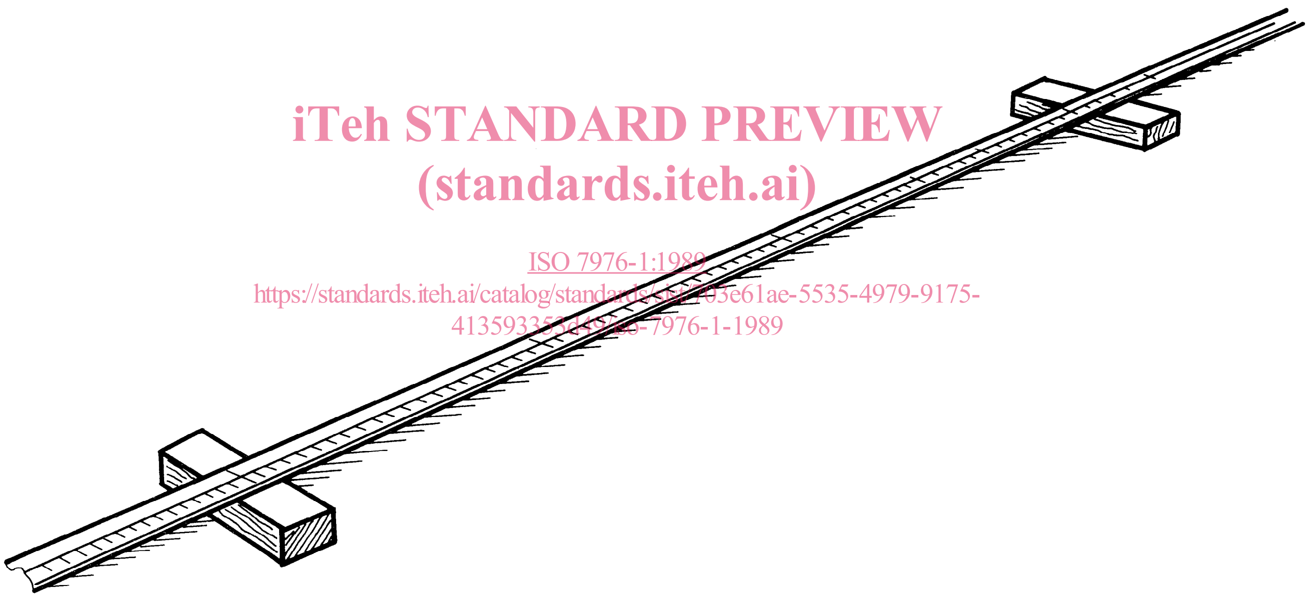


Figure 1

4.1 Length and width

On components which do not have sharply defined edges, position pieces (see clause 15) should be used to improve measuring accuracy. The position pieces should be held or clamped, as necessary for the duration of the measurement, against the appropriate faces of the component in order to define precise edges. An example of the use of corner pieces is given in figure 2.

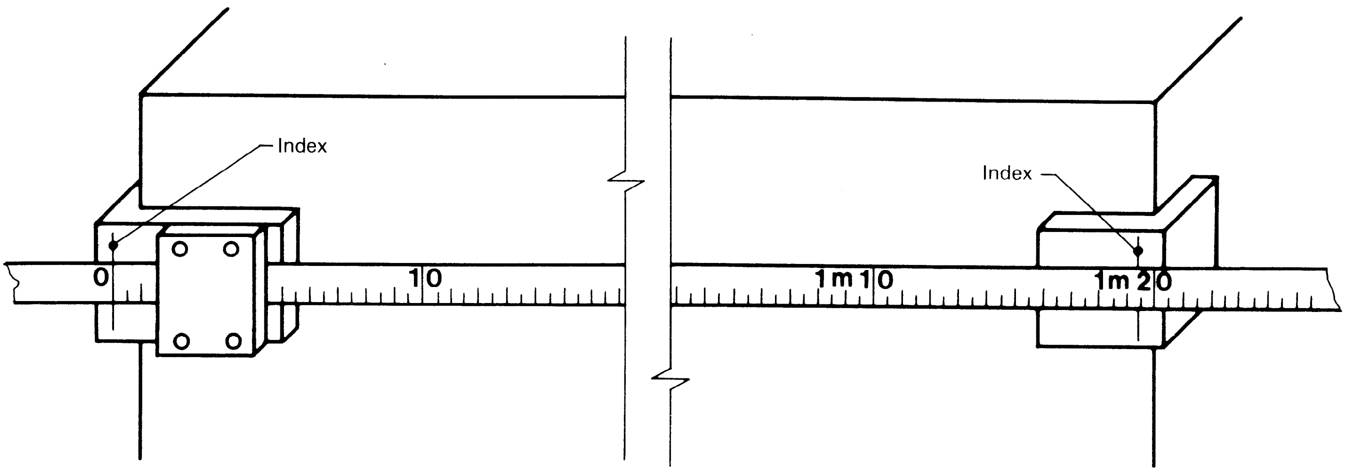
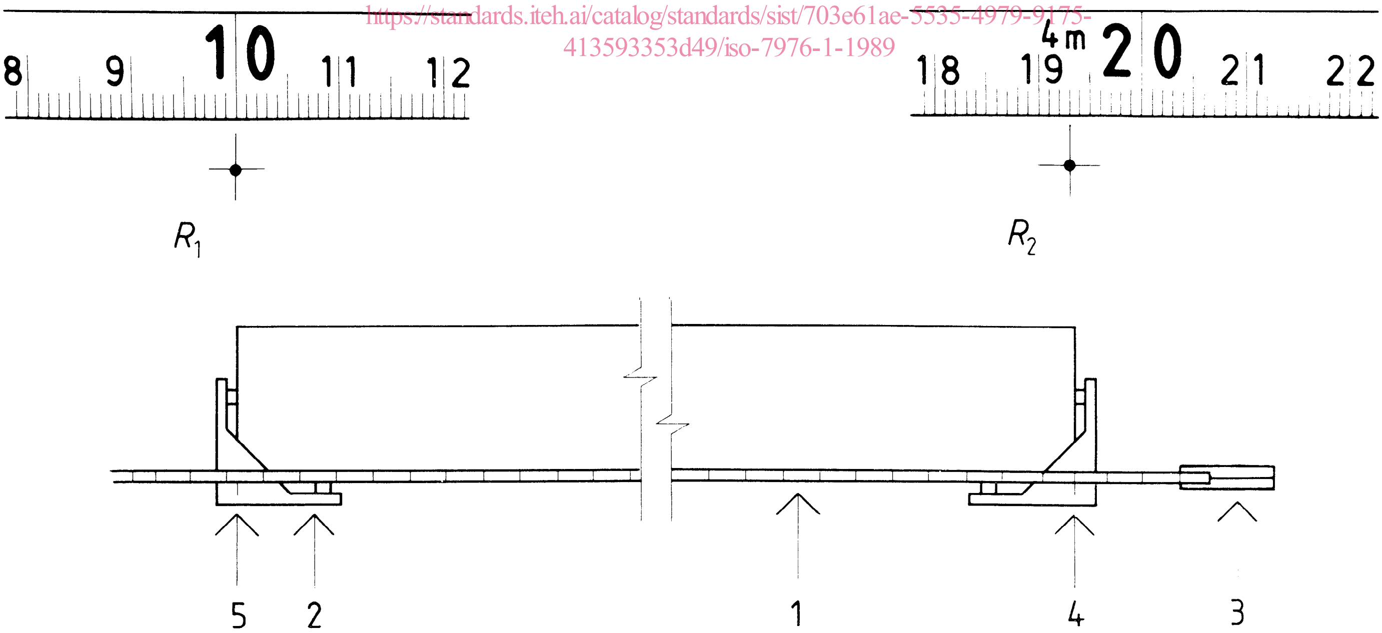


Figure 2



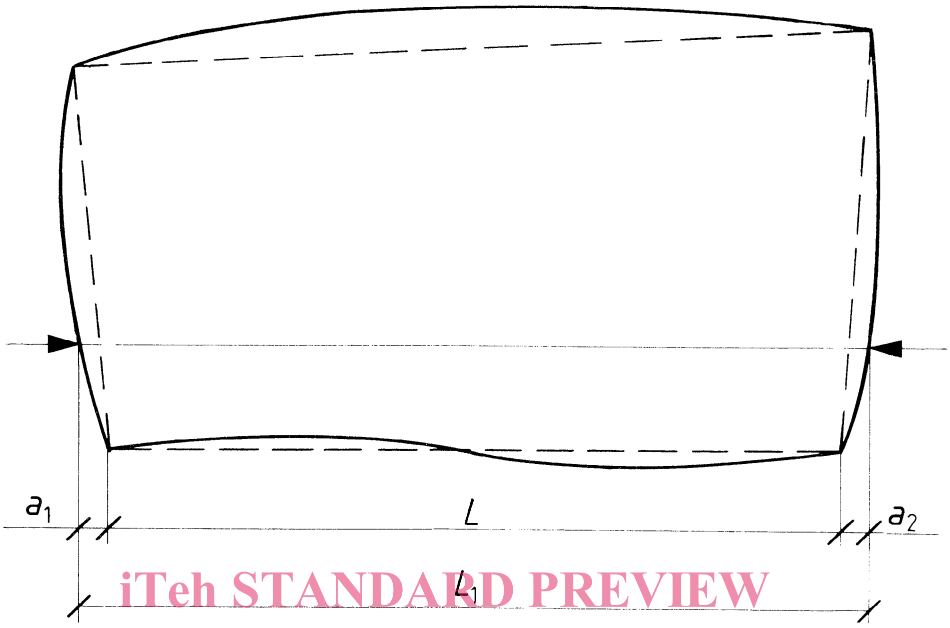
1: Tape
2: Corner piece
3: Tape tensioner
4: Reading
5: Reading

Example: R_2 4,193
R_1 − 0,100
L = 4,093

NOTE — When the zero point is at the end of the tape, readings shall be made in two places.

Figure 3

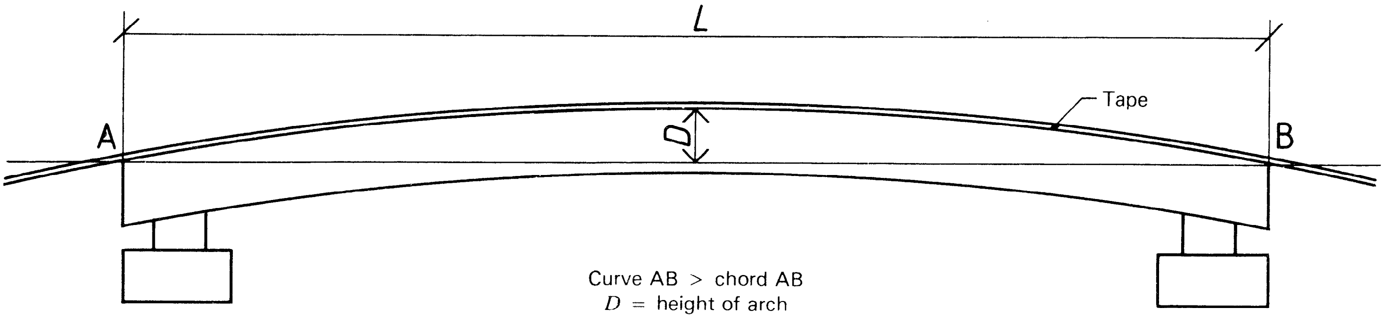
The result of a measurement between opposite points other than corner points can be used as a rough check of the result of the measurement of straightness deviations. (See clause 6 and figure 4.)



$$L_1 = L + a_1 + a_2$$

Figure 4

When measurements are made along curved surfaces, errors arise as the curve AB is always longer than the chord AB. Normal accuracy requirements permit readings to be taken to the nearest millimetre. This implies that in practice some amount of curvature can be allowed. (See figure 5.)



Curve AB > chord AB
D = height of arch

Figure 5

Figure 6 gives a diagram for corrections to be applied when measuring along curved components.

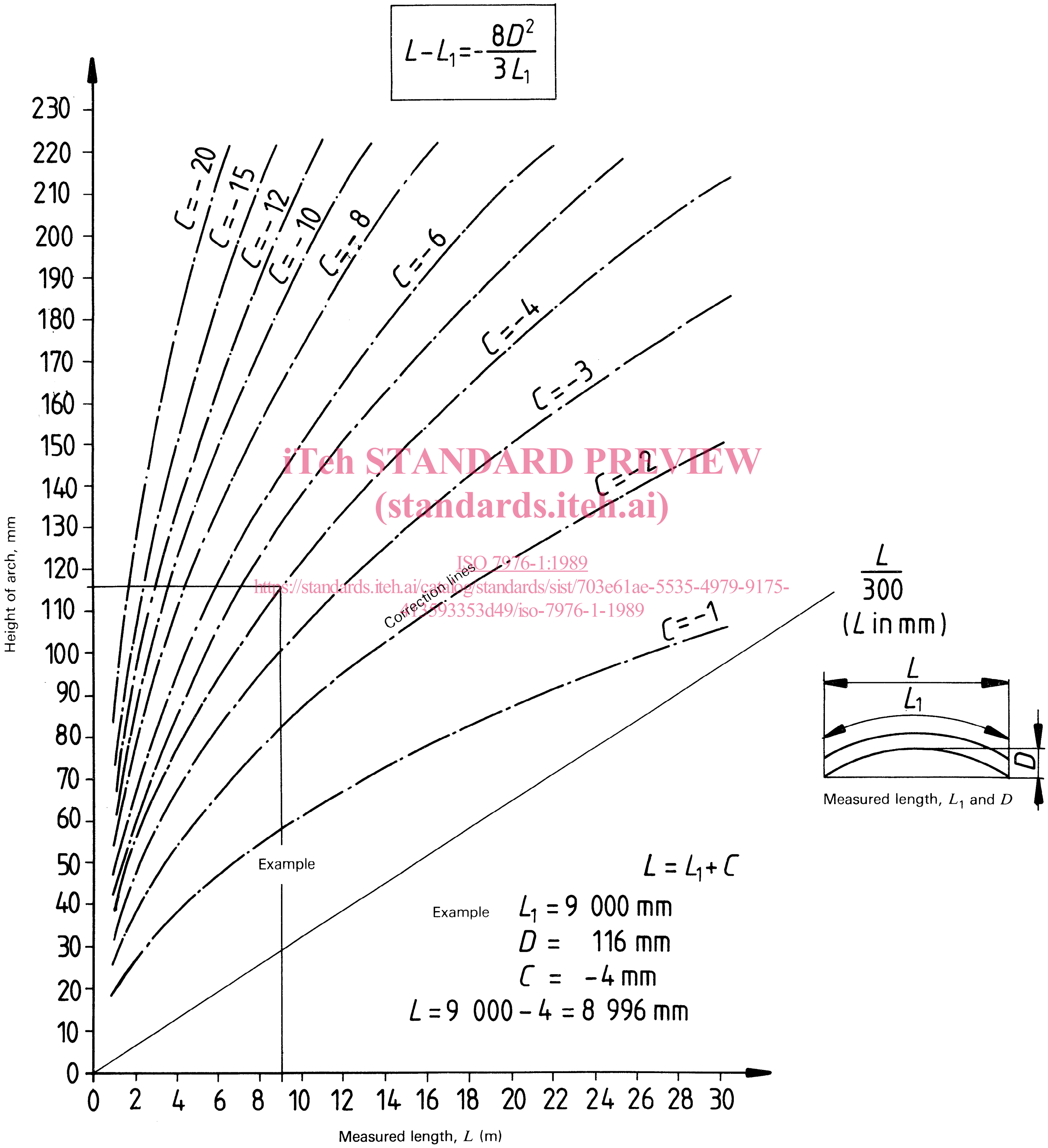


Figure 6

4.2 Thickness or depth

Thicknesses (or depths) of components are determined using instruments cited in clause 15 and in principle carried out in the same way as described in 4.1.

When necessary, corner- and/or edge-pieces should be used.

Instruments with a large contact surface are used for materials with an uneven surface.

Thickness shall be measured perpendicular to at least one of the surfaces of the component. (See figure 7.)

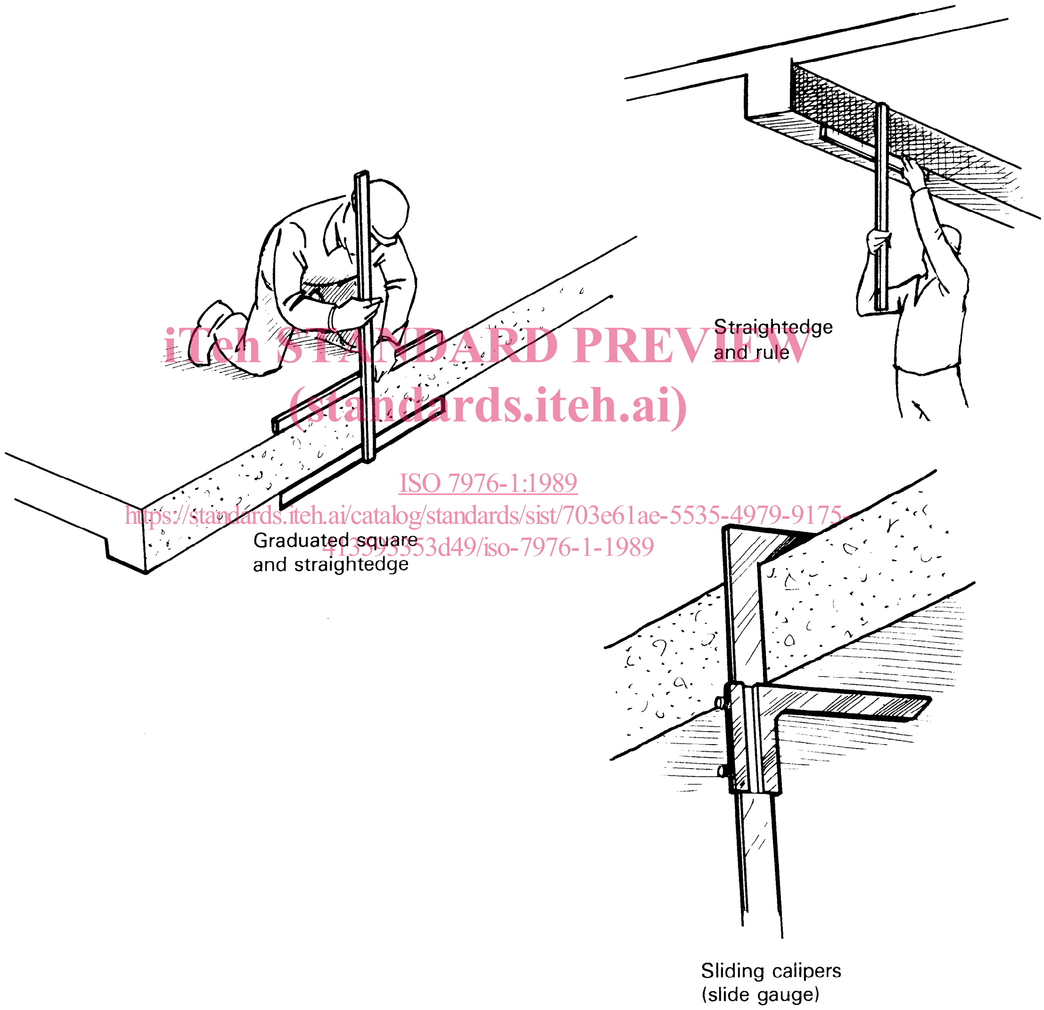


Figure 7

4.3 Accuracy table

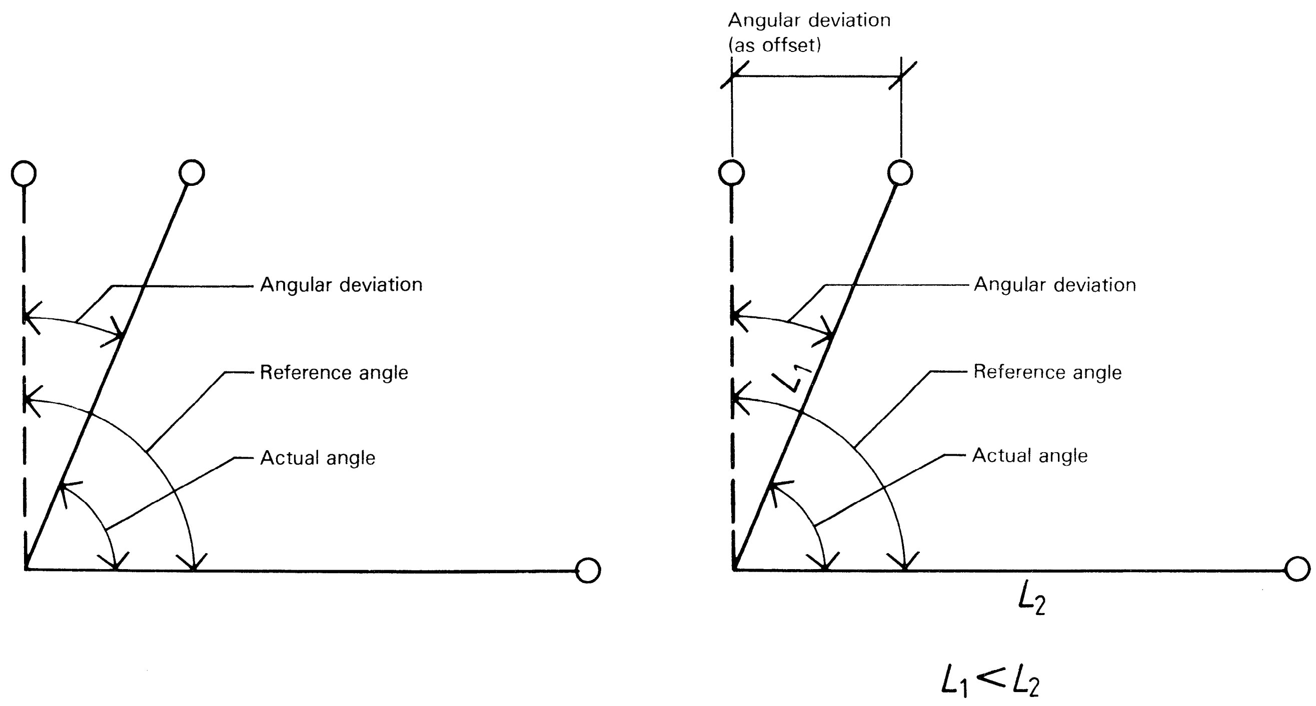
Measuring operation	When values for permitted deviation specified for object exceed:	Measuring range	Measuring instrument or tool
1	2	3	4
Lengths and widths of components (4.1)	± 3 mm ± 3 mm ± 5 mm	< 1 m < 3 m 3 to 10 m	Retractable steel tape Calibrated steel tape Calibrated steel tape
Thickness of components (4.2)	± 0,5 mm ± 1 mm ± 2 mm ± 3 mm ± 5 mm	< 0,1 m 0,1 to 0,5 m 0,5 to 2,0 m < 1 m < 0,5 m	Caliper Caliper Caliper Retractable steel tape Measuring rod and two boning rods

5 Squareness (perpendicularity) of components

This clause describes examples of instruments and measuring methods for the determination of deviation from squareness (right-angle), but can in principle be applied to any angle.

According to ISO 4464 the angular deviation is described as the difference between an actual angle and the corresponding reference angle.

Figure 8 shows angular deviations expressed in gon or degrees [figure 8a)] or as offsets [figure 8b)].



a) b)

Figure 8

If alternative b) is put into practice, the angular deviation shall be determined from the shorter side of the angle and shall be measured perpendicular to the corresponding side of the reference angle.

Parallelism deviation, which is another form of angular deviation, is dealt with in 5.2.

Angular deviations are determined using instruments and tools given in chapter 15, with or without the aid of position pieces.

Three methods are described for the determination of deviations from a right-angle in building products. The method chosen depends on the size of the object of measurement.

In figure 9, if b and c < 1 200 mm, a square is used as shown in figure 11. Otherwise, a measuring telescope is used (see 5.1.3) or diagonal measurement (see 5.1.2) is made. Diagonal measurement, however, may only be used when the permitted deviation of the right-angle is more than 5 mm per metre.

The three methods used for determination of angular deviations are explained in the examples below. The deviation is always measured on the shorter leg of the angle and the final result will be the deviation of point B or point C from the required position.

In figure 10, the angles to be measured are those between the lines which connect the corner points (see also figure 16).

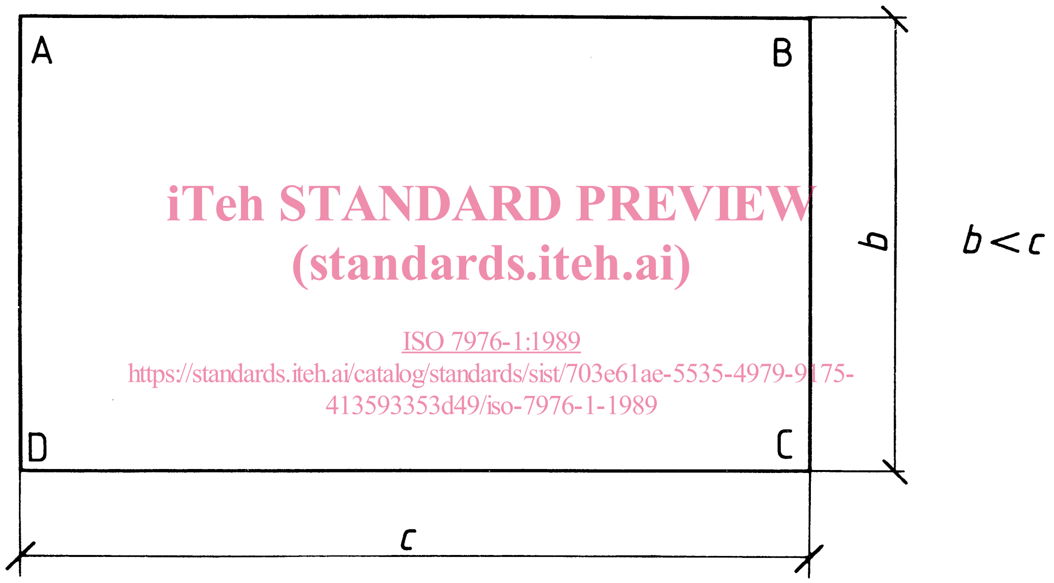


Figure 9

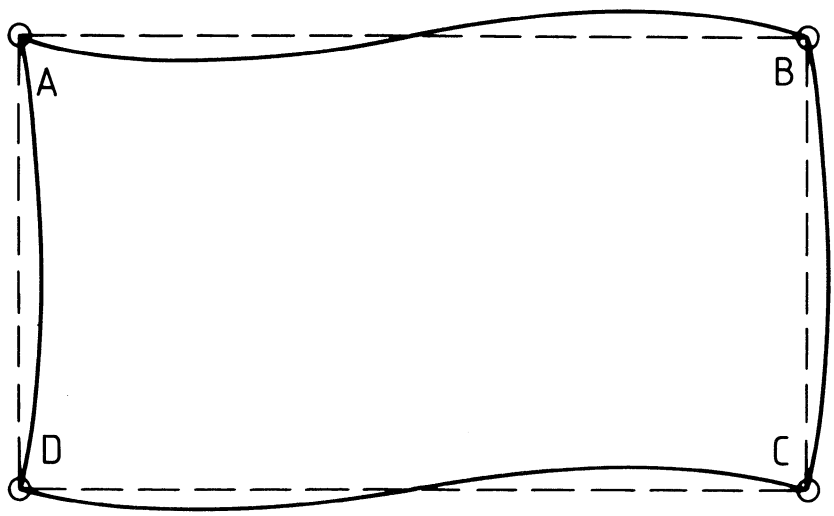


Figure 10