International Standard ISO 7737

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Tolerances for building — Presentation of dimensional accuracy data

Tolérances pour le bâtiment — Présentation des données sur l'exactitude dimensionnelle

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Foreword

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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 7737 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.

Tolerances for building — Presentation of dimensional accuracy data

0   Introduction

The aim of this International Standard is to state how measured data on observed dimensional accuracy shall be presented as feedback from the building site.

Information describing the accuracy of constructed work (and possible sources of error) obtained from measurement surveys is of value to building designers, component manufacturers and contractors. Presentation of data in accordance with the principles laid down in this International Standard gives the following advantages.

Building designers are able to use the data directly in standard calculation procedures designed to determine the appropriate reference sizes of components and to choose the appropriate jointing techniques with a "known" probability of satisfactory fit and performance.

Component manufacturers, whose products are used in conjunction with a variety of constructed work, are able to establish target sizes which will have the widest ranges of application.

Contractors are able to predict the need for, and type of, remedial measures and to assess the economic consequences of any predicted misfit at an early stage.

Construction managers are in a better position to plan the level of supervision available and can exercise closer control on the execution.

1   Scope

This International Standard lays down the principles on which the collection of dimensional accuracy data in building

construction work shall be based and the format in which this data shall be presented for defined items of construction and manufactured components.

2   Field of application

This International Standard is for use in all types of building construction.

3   References

ISO 1803/1, *Tolerances for building — Vocabulary — Part 1: General terms.*

ISO 3443/1, *Tolerances for building — Part 1: Basic principles for evaluation and specification.*

ISO 3443/2, *Tolerances for building — Part 2: Statistical basis for predicting fit between components having a normal distribution of sizes.*

ISO 3443/3, *Tolerances for building — Part 3: Calculation of joint clearance and prediction of fit.* [1]

ISO 3443/4, *Tolerances for building — Part 4: Methods for predicting deviations of assemblies and for allocation of tolerances.* [1]

ISO 5479, *Normality tests.* [1]

ISO 7976/1, *Tolerances for building — Methods of measurement of buildings and building products — Part 1: Instruments and accuracy.* [1]

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1) At present at the stage of draft.

ISO 7976/2, *Tolerances for building — Methods of measurement of buildings and building products — Part 2: Position of measuring points.* [1]

4 Dimensional variability

In order to achieve an increased expectation of satisfactory fit during construction, it is necessary at the design stage to make a realistic assessment of the way fit is affected by dimensional variability at the design stage. The different parts of ISO 3443 provide procedures for making such assessments. These procedures require descriptions of the dimensional variability that occurs during construction or assembly for defined items of construction and manufactured components. Subjective estimates are unlikely to describe variability sufficiently accurately and do not have the statistical basis that is strictly required for the determination of data describing dimensional variability. It is important therefore that such descriptions which are associated with any process are based entirely on measured information.

Dimensional variability shall be taken into account by the designer at the design stage and should refer to the standards of workmanship that are normally achievable. At this stage the contractor and the component manufacturer may not be known.

5 Dimensional accuracy data expressed in terms of standard deviation and systematic deviation

The spread of the sizes of a dimension about a mean value is given by the term "standard deviation". Some feature of the construction or production process may cause the mean value to be systematically displaced from the target. This displacement is given by the term "systematic deviation " (see ISO 3443/2). Ideally the dimensional variability observed for a given process should be based on the measurement of all construction or production resulting from that process but this is rarely possible. However, if a representative sample is measured, a reliable estimate of the dimensional variability can be established.

6 Items to be measured

For all types of construction and types of manufactured components, the dimensions relevant to fit shall be measured. The list of items is given in table 1. As its contents are not exhaustive, the items and types of dimension given are only to be considered as examples.

The measurement methods to be adopted when obtaining dimensional accuracy data and the preferred positions of measuring points are covered by ISO 7976/1 and ISO 7976/2.

The survey should include measurements of overall dimensions that are of practical significance, for example verticality over a single storey height and verticality over building height. For buildings which are to be clad with a wholly external envelope, deviations of the structural face from a theoretical vertical plane shall be measured.

Measurements made on site or in the factory should be recorded on a copy of table 2, or on a form based on table 2.

7 Assessment and presentation of accuracy data

7.1 Assessment of accuracy data

For each item of construction and type of component, the associated dimensional variability shall be given as a set of two parameters, standard deviation and systematic deviation.

In order to assess whether the dimensional variability is significantly influenced by one or more factors, it should initially be determined for each set of observed accuracy data included in the total sample of measurements and then compared statistically. The necessary background information required to compare and assess this data for each item or product should include the individual sample size of each set of data; the reference size or sizes; the specified permitted deviation or deviations; the descriptions of the items or products being measured and the descriptions of the measurement methods adopted and the accuracy in use of each method.

Where the data for an item or product is shown to be significantly related to a particular factor, for example the use of jigs for positioning elements, the data related to this factor should be considered separately and a separate statement of the associated dimensional variability determined.

Where no variable exerts a significant effect on the individual dimensional variabilities, variability for each set of data should be combined statistically to give one overall statement of observed dimensional variability.

7.2 Presentation of accuracy data

For each item of construction and type of component, the accuracy data shall be presented as values of standard deviation and systematic deviation.

Where analysis of the data for any dimension indicates that no given variable is significant, only one statement of the dimensional variability shall be given.

For those dimensions where a particular factor has been shown to be significant, a separate statement of dimensional variability should be given as a sub-division of the type of dimension measured. In addition (for each statement), the following information should be given for each item of construction or type of component:

a) the number of sets included in the representative sample;

b) the overall sample size;

c) a description of the type of item or product measured such that any significant variables are identified;

d) where necessary, a drawing of the item or product which should include an indication of the positions of the measuring points;

e) the results of any test carried out to investigate normality;

f) where no test of normality is made or when the test of normality indicates the distribution of measured data is not normal, a histogram giving the actual deviations about the reference size.

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1) At present at the stage of draft.

For any item of construction or type of component, the measured accuracy data can be either "generalized" accuracy data in which the data collected relates to a representative sample drawn from all contractors or manufacturers, or "specific" accuracy data in which the data relates to a particular contractor or manufacturer.

Generalized accuracy data shall be presented in the form shown in table 3. Specific accuracy data concerned with items of construction shall be presented in the form shown in table 6 and for manufactured components in the form shown in table 7.

8 Publication of accuracy data

For each item of construction or general component type, the generalized accuracy data should preferably be presented to and published by the national standards organization.

The publication of specific accuracy data should be the responsibility of the particular contractor or manufacturer concerned who, for each item of construction or type of component, should publish the observed dimensional variability in his appropriate literature.

Table 1 — List of types of dimensions to be measured

1 Dimensions of setting out — Size: distance between primary, secondary and position points; difference in level between primary, secondary and position points — Shape: angle between sets of primary, secondary and position points — Orientation: vertical transfer of secondary points
2 Dimensions of manufactured components — Size: length, width, height, depth, diameter, thickness, distance between fixing points — Shape: squareness, flatness, skewness, curvature, edge straightness, camber

3 Dimensions of construction
 	
  a) Work constructed *in situ*
 	
    — Size: length, width, height, depth, diameter, thickness, distance between fixing points
    — Shape: squareness, flatness, skewness, edge straightness, camber, curvature
    — Orientation: verticality, level, slope
 	
  b) Components as erected
 	
    — Size: horizontal and vertical space between elements, length of end bearing, joints, centre positions
 	
    — Shape: to be described or drawn
 	
    — Orientation: verticality, level, slope, position in level or in plan in relation to the nearest grid line

Table 2 — Example of form on which measurements are to be recorded
(for 1 to 3 measurements on one product or item)

Information in heavy frames is compulsory

	A (e.g. floor)	B (e.g. middle)	C (e.g. soffit)
Measuring points	R T	R T	R T
Specified size Ref. or Target			

Manufacturer/Contractor

Building project/Contract

Product/item   permitted deviations ±

Date   19 — —

year month day

Material

brickwork	☐ 01	blockwork	☐ 04
in situ concrete	☐ 02	precast	☐ 05
steelwork	☐ 03	timber	☐ 06
other (state what)			07

Measurement details

Measurement in accordance with ISO 7976/2, figure ☐

Tick appropriate box in each column below

	Code		Code		Code
size and shape of elements	☐ 10	walls	☐ 20	length	☐ 70
		columns	☐ 21	width	☐ 71
		beams	☐ 22	height	☐ 72
space between elements	☐ 11	panels	☐ 23	thickness/depth	☐ 73
		structural slab	☐ 24	space between	☐ 74
		screeded floor	☐ 25	angular deviation/ parallelism	☐ 75
		frames (window, etc.)	☐ 26	straightness/ edge straightness	☐ 76
		doorsets	☐ 27	designed camber	☐ 77
				slope	☐ 78
openings	☐ 12	window	☐ 30	flatness	☐ 79
		door	☐ 31	local flatness	☐ 80
				skewness	☐ 81
				position/relation to grid	☐ 82
overall size (on plan)	☐ 13	building	☐ 40	level (position in vertical plane)	☐ 83
		ground floor slab	☐ 41	verticality	☐ 84
		foundations	☐ 42	position/relation to other components	☐ 85
				length of bearing	☐ 86
setting out	☐ 14	primary points	☐ 50	soffit (underside) level	☐ 87
		primary/ secondary points	☐ 51	joint width	☐ 88
		secondary points	☐ 52	joint step	☐ 89
		secondary/ position points	☐ 53	distance between points	☐ 90
		position points	☐ 54	difference in level	☐ 91
				vertical transfer	☐ 92

Measurement conditions

air temperature	☐ 95	
temperature of object	☐ 96	
age of object	☐ 97	

Measurements can be coded for computer use, e.g. 05 10 21 72 = precast concrete/size and shape/column/height.

Remarks or sketch

Sources of error and how to reduce or eliminate them.

Table 3 — Format for the presentation of generalized accuracy data (for one or several building projects)

One copy of this format should be used for each material

brickwork	[ ] 01	blockwork	[ ] 04
in situ concrete	[ ] 02	precast concrete	[ ] 05
steelwork	[ ] 03	timber	[ ] 06	other (state what) [ ] 07

Item of construction	Description	Type of dimension measured	Table 2 sheet reference	Size of sample	Reference/ target size mm	Approximate size (see note), grid centres or measur-ing length mm	Permitted deviation mm	Normality test result	Systematic deviation mm	Standard deviation mm	Coefficient of skewness	Outliers (deviations above permitted) %
20 walls		72 height										
		73 thickness										
		76 straightness										
		84 verticality (mm/m)										
		83 level (of bed joints)										
		82 position/relation to grid										
21 columns		72 height										
		71 width										
		73 depth										
		84 verticality (mm/m)										
		75 angular deviation (mm/m)										
		82 position/relation to grid										
22 beams		70 length										
		71 width										
		73 depth										
		77 designed camber										
		78 slope										
		76 edge straightness										
		81 skewness										
		75 angular deviation (mm/m)										
		86 length of end bearing										
		83 level[1]										
23 panels		70 length										
		72 height										
		73 thickness										
		76 edge straightness										
		81 skewness										
		75 angular deviation (mm/m)										
		87 joint width										
		88 joint step										

11 Size and shape of elements

Table 3 (*continued*)

Item of construction	Description	Item of construction	Table 2 sheet reference	Size of sample	Reference/ target size mm	Approximate size (see note), grid centres or measuring length mm	Permitted deviation mm	Normality test result	Systematic deviation mm	Standard deviation mm	Coefficient of skewness	Outliers (deviations above permitted) %
11 Size and shape of elements	24 structural slab	73 depth										
		83 level[1]										
		87 soffit (underside) level[1]										
		77 designed camber										
		79 flatness (mm/m)										
		80 local flatness (mm/m)										
		81 skewness										
		70 length										
		71 width										
		76 edge straightness										
		75 angular deviation/parallelism (mm/m)										
		86 length of end bearing										
		82 position/relation to grid										
		88 joint width										
		89 joint step										
	25 screeded floor	83 level[1]										
		79 flatness (mm/m)										
		80 local flatness (mm/m)										
	26 frames (window, etc.)	70 length										
		72 height										
		73 thickness										
		76 edge straightness										
	27 door sets	70 length										
		72 height										
		73 thickness										
		76 edge straightness										
12 Space between elements	20 walls	74 space between walls at floor A										
		at middle B										
		at soffit C										

Table 3 (*concluded*)

Item of construction	Description	Type of dimension measured	Table 2 sheet reference	Size of sample	Reference/target size mm	Approximate size (see note), grid centres or measuring length mm	Permitted deviation mm	Normality test result	Systematic deviation mm	Standard deviation mm	Coefficient of skewness	Outliers (deviations above permitted) %
12 Space between elements	21 columns	74 space between columns at floor A										
		at middle B										
		at soffit C										
	22 beams	74 space between beams (height)										
	24 structural slabs	74 space between slabs (height)										
13 Openings	30 window	71 width										
		72 height										
		84 verticality (mm/m)										
	31 door	71 width										
		72 height										
		84 verticality (mm/m)										
14 Overall size (on plan)	40 building	70 size of building										
	41 ground floor slab	70 size of ground floor slab										
		73 thickness										
		83 level 1)										
	42 foundations	83 level 1)										
15 Setting out	50 primary points	90 distance between primary points										
		91 difference in level										
	51 primary/secondary points	90 distance primary/secondary points										
		91 difference in level										
	52 secondary points	90 distance between secondary points										
		91 difference in level										
		92 vertical transfer										
	53 secondary/position points	90 distance secondary/position points										
		91 difference in level										
	54 position points	90 distance between position points										
		91 difference in level										

1) Centres of level grid to be stated.

NOTE — All measurements made using the procedure given in ISO 7976/1 and the measurement positions stated in ISO 7976/2.

The word "element" (defined in ISO 1791 as "A functional part of a building, constructed from building materials and/or building components") should not be confused with the word "component".

The approximate size is only intended as an indicator of the effect which the size may have on accuracy. It need not be stated when the reference or target size has been given.

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