BRITISH STANDARD

BS 7307-2: 1990
ISO 7976-2: 1989

Building tolerances — Measurement of buildings and building products —

Part 2: Position of measuring points

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Basic Data and Performance Criteria for Civil Engineering and Building Structures Standards Policy Committee (BDB/-) to Technical Committee BDB/4, upon which the following bodies were represented:

Association of County Councils
British Standards Society
Building Employers Confederation
Chartered Institution of Building Services Engineers
Concrete Society
Department of Education and Science
Department of the Environment (Property Services Agency)
Department of the Environment (Building Research Establishment)
Incorporated Association of Architects and Surveyors
Institute of Building Control
Institute of Clerks of Works of Great Britain Inc.
Institution of Civil Engineers
Institution of Structural Engineers
Institution of Water and Environmental Management
Royal Institute of British Architects
Royal Institution of Chartered Surveyors

The following body was also represented in the drafting of the standard, through sub-committees and panels:

Chartered Institute of Building

This British Standard, having been prepared under the direction of the Basic Data and Performance Criteria for Civil Engineering and Building Structures Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 28 September 1990

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Amendments issued since publication

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Contents

National foreword

This Part of BS 7301, which has been prepared under the direction of the Basic Data and Performance Criteria for Civil Engineering and Building Structures Standards Policy Committee, is identical with ISO 7976-2 "*Tolerances for building — Methods of measurement of buildings and building products — Part 2: Position of measuring points*", published by the International Organization for Standardization (ISO).

It recommends the position of measuring points to be used in conjunction with the measuring methods given in BS 7307-1, for use in the control of building construction. Its provisions also apply to the collection of measured accuracy data for inclusion in BS 5606 (see also BS 7308 which is identical with ISO 7737:1986 "*Tolerances for building — Method of presentation of dimensional accuracy data*").

Cross-references

International standard	Corresponding British Standard
ISO 4463:1979[a]	BS 5964:1980 *Methods for setting out and measurement of buildings: permissible measuring deviations* (Identical)
ISO 7676-1:1989	BS 7307 *Building tolerances. Measurement of buildings and building products* Part 1:1990 *Methods and instruments* (Identical)

[a] ISO 4463 has been superseded by ISO 4463-1:1989. ISO 4463-1 has been implemented as BS 5964:1990, which has superseded BS 5964:1980.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 26, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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1 Scope and field of application

This part of ISO 7976 gives guidance on the position of measuring points to be used in the measurements of buildings and building products. The positions given apply for check and compliance measurement, and when collecting accuracy data.

It is divided into two sections. Section 1 deals with the position of measuring points for those measurements which can be carried out both in factories and on building sites, and section 2 with the position of measuring points for the measurements which can be carried out on building sites only.

Building products consisting of glass wool and similar soft materials are not the subject of this International Standard.

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

2 References

ISO 4463, *Measurement methods for building — Setting out and measurement — Permissible measuring deviations.*

ISO 7976-1, *Tolerances for building — Methods of measurement of buildings and building products — Part 1: Methods and instruments.*

3 General

Suitable positions for measuring points are given for both compliance measurement and the collection of accuracy data; measurements should be carried out from, towards, or between these points.

The points at which measurements are taken should be those specified in the inspection schedule or similar document. If not, they shall be taken at 100 mm from corners or edges (see Figure 1): the examples below illustrate some general cases. If this is not possible, the position of the measuring points should be noted in the field book.

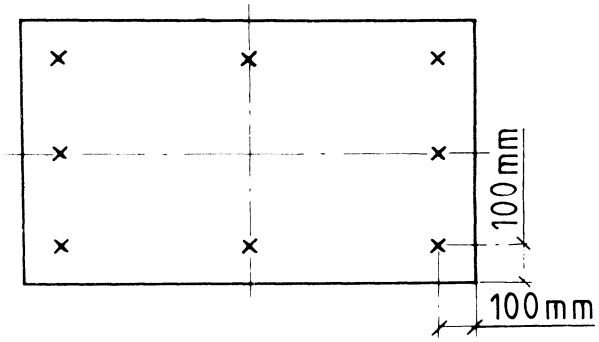


Figure 1

The number of measuring points shown in the clauses below is considered to be the minimum number required; additional measurements may therefore be taken to reflect any additional dimensional accuracy requirements.

The items to be measured should be supported as they will be supported in use. When this is impractical, the support conditions should be as agreed in the inspection schedule or similar document.

Whenever possible it is recommended that components be measured in the state in which they are ready for delivery.

Unless specifically required, the measurements should not be made whilst the manufactured component is still in the manufacturing jig or mould.

On sites, construction deviations (dealt with in section 2) can be determined in relation to the co-ordinate system of the site, in relation to a reference system in plan or height in the assembly, in relation to the vertical line or in relation to other components.

Section 1. Position of measuring points 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

4.1 Length and width

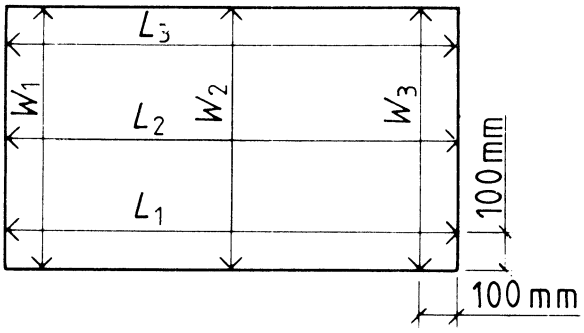


Figure 2

On each face of the manufactured component, three length measurements (L_1 to L_3) and three width measurements (W_1 to W_3) shall be taken as shown in Figure 2. If the specified width does not exceed 1,20 m, measurement L_2 may be omitted. If the specified length does not exceed 1,20 m, measurement W_2 may be omitted.

4.1.1 *Effective span*

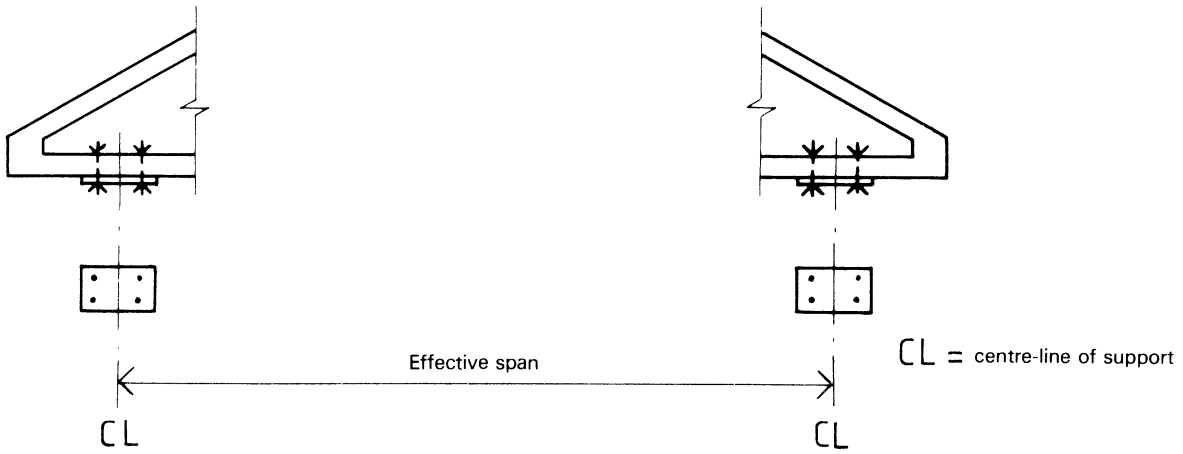


Figure 3

One measurement shall be made of the effective span on each manufactured component. For components which have base plate fixings, the two measuring points shall be as shown in Figure 3.

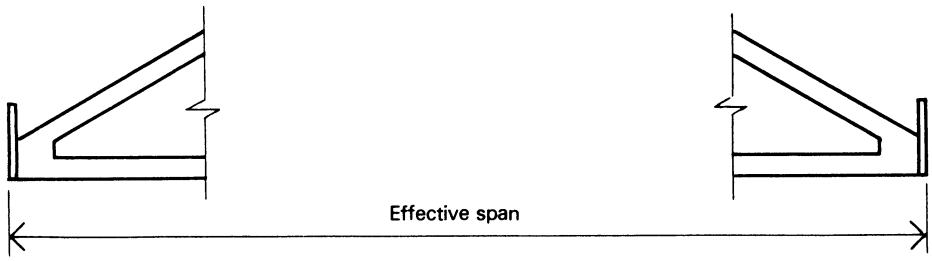


Figure 4

For components which have end or wall plate fixings, the two measuring points shall be as shown in Figure 4.

For components which are manufactured in sections, the measurement shall be made only after the sections have been firmly bolted together.

4.2 Thickness or depth

Eight thickness or depth measurements shall be made on each manufactured component.

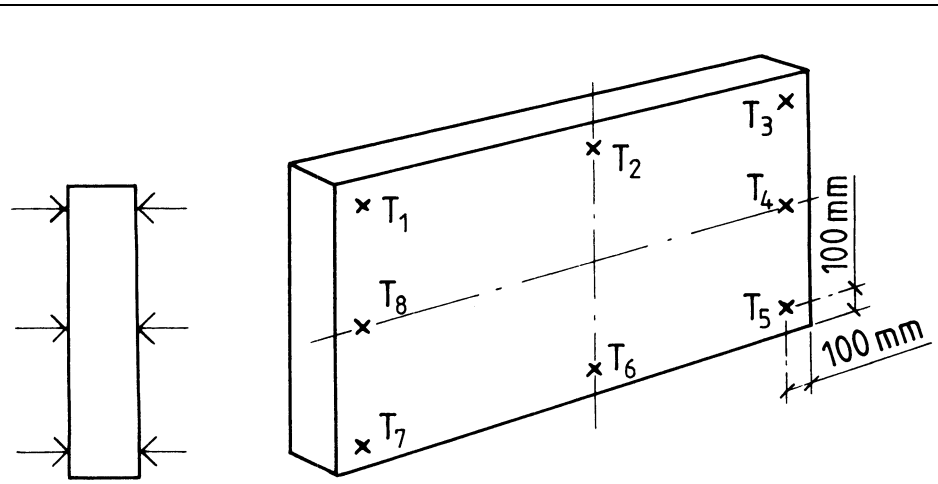


Figure 5

For components having a rectangular cross-section, the measuring points shall be as shown in Figure 5.

Where the specified width does not exceed 1,20 m, measurements at points T_4 and T_8 may be omitted.
Where the specified length does not exceed 1,20 m, measurements at points T_2 and T_6 may be omitted.

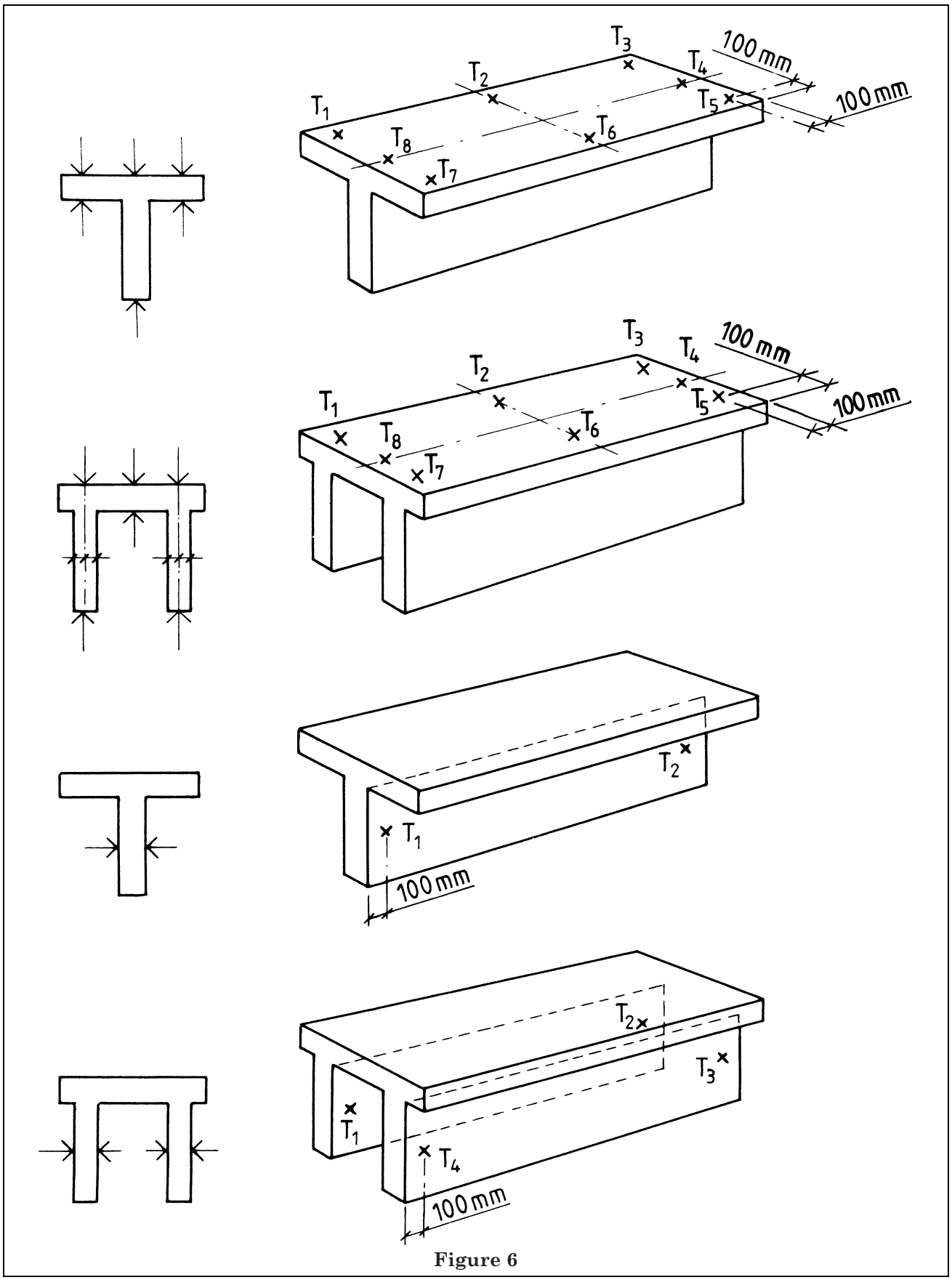


Figure 6

The position of measuring points for thickness measurement of components which have a non-rectangular cross-section such as beams provided with ribs shall be as shown in Figure 6.

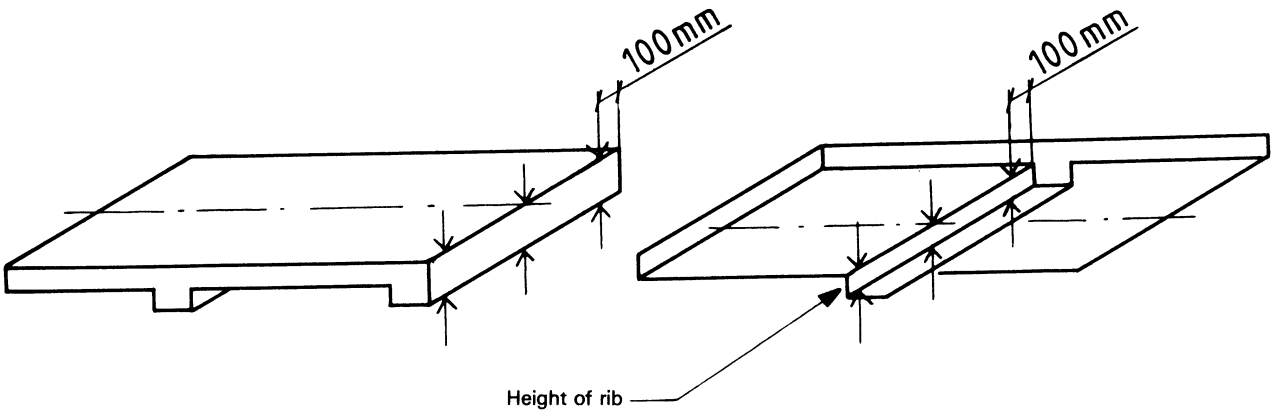


Figure 7

The position of measuring points for thickness measurements for *in situ* concrete beams shall be as shown in Figure 7.

4.2.1 ***Thickness of brick or block walls or*** *in situ* ***concrete walls***

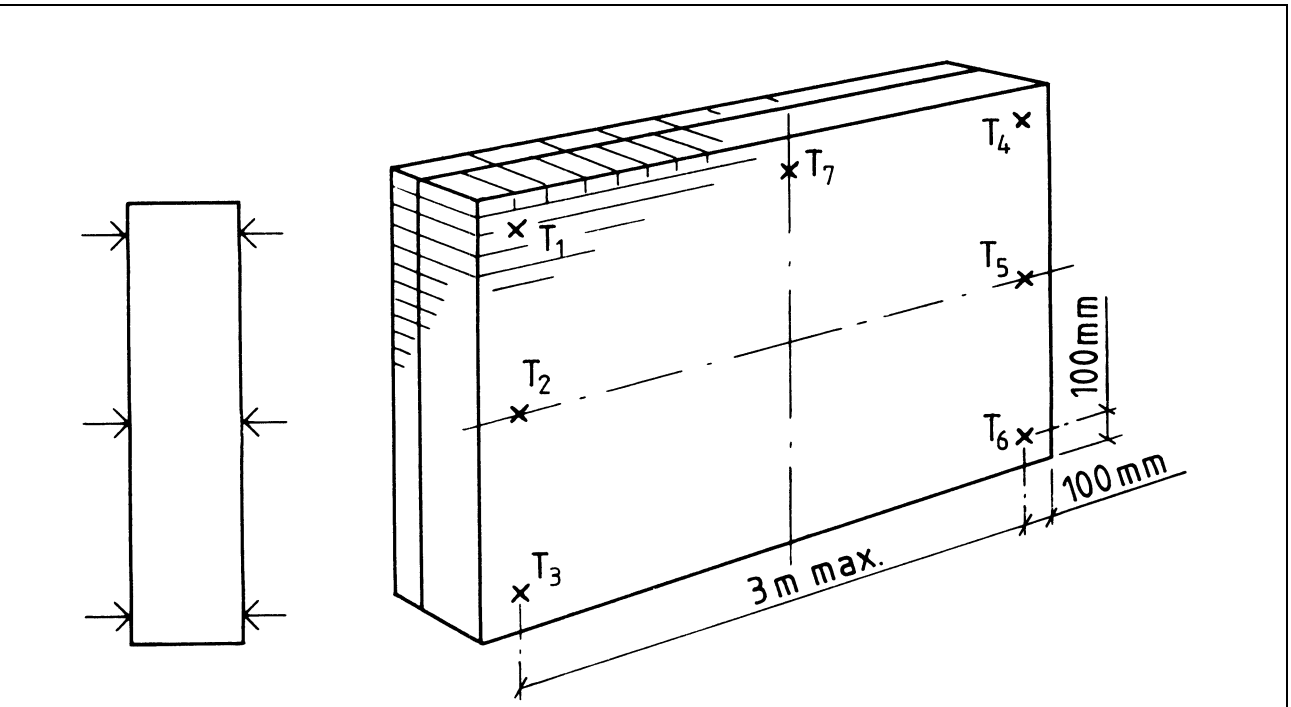


Figure 8

The position of measuring points for thickness measurement of walls shorter than 3 m is shown in Figure 8.

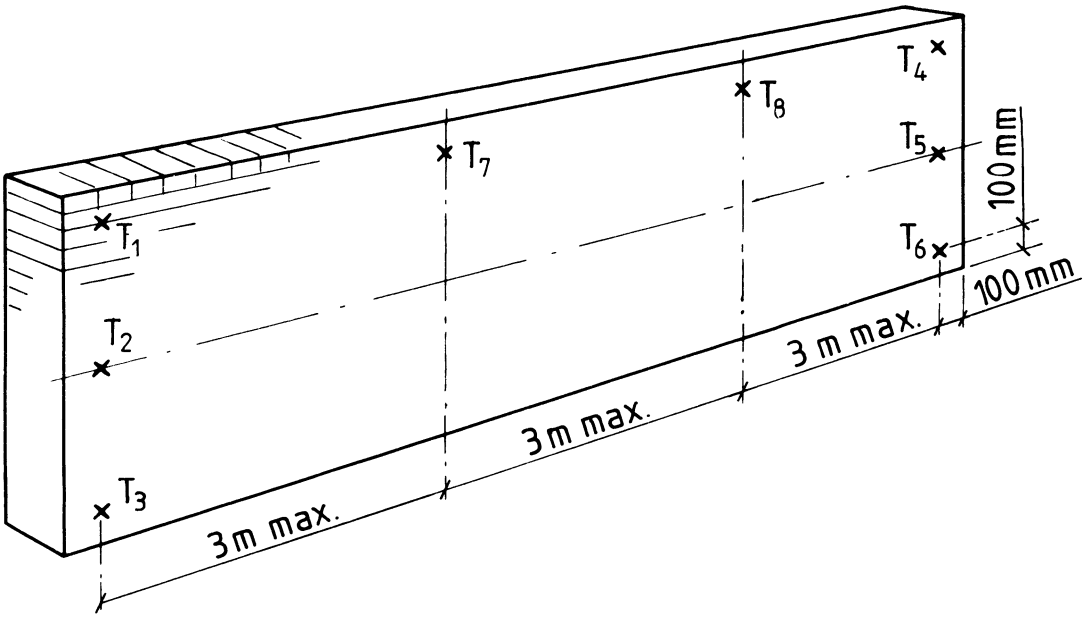


Figure 9

Figure 9 shows the position of measuring points for thickness measurement of walls longer than 3 m. The intermediate measuring points at the top should be equally spaced (at not more than 3 m intervals) between the measuring points of the ends of the wall.

4.2.2 ***Dimensional measurement of components with non-rectangular cross-section***

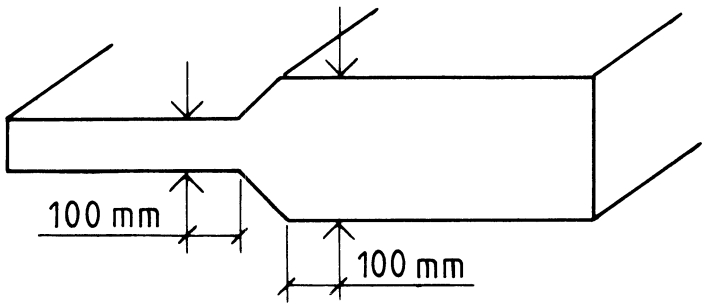


Figure 10

When manufactured components or *in situ* constructions have a designed cross-section which varies over a defined dimension, two additional measurements shall be made as shown in Figure 10.

5 Squareness of components

5.1 Angular deviation

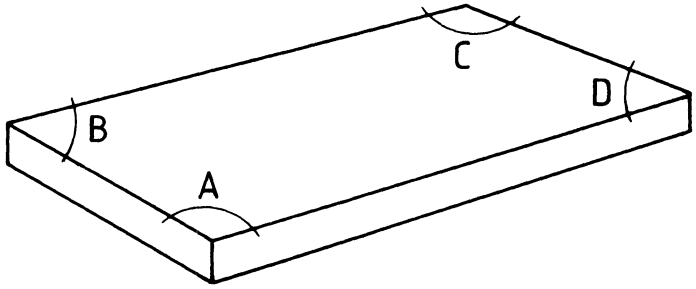


Figure 11

Angular deviation is in most cases determined at all four corners of the component as indicated in Figure 11.

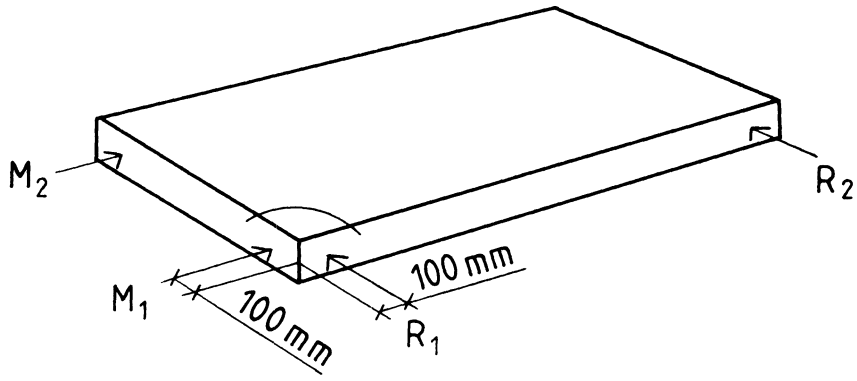


Figure 12

To measure the angle deviation, two reference points R_1, R_2 constituting a reference line and two measuring points M_1, M_2 are necessary. (See Figure 12.)

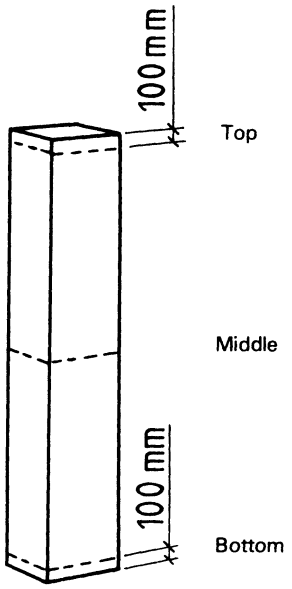


Figure 13

Storey height columns should be measured at the top, middle and bottom as indicated in Figure 13.

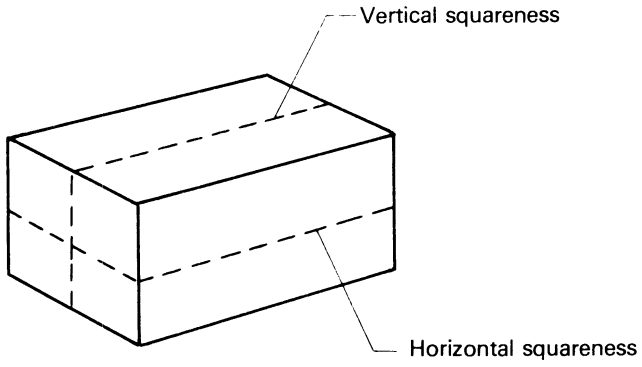


Figure 14

Both horizontal and vertical squareness (see Figure 14) can be measured.

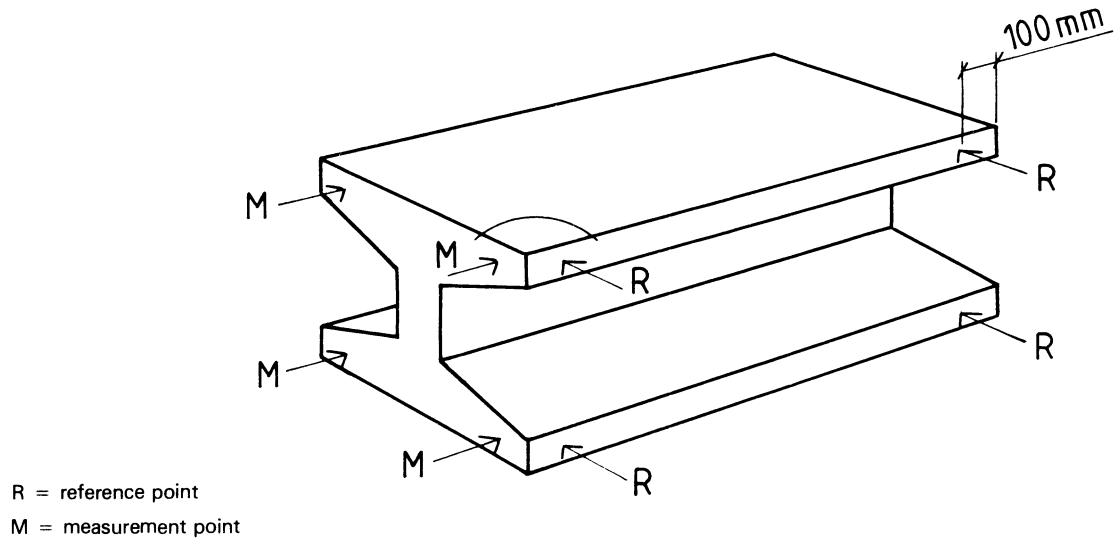


Figure 15

For manufactured components having a non-rectangular cross-section, such as beams provided with ribs, one angle measurement shall be taken along each pair of vertical slab surfaces, as shown in Figure 15 (see also Figure 11).

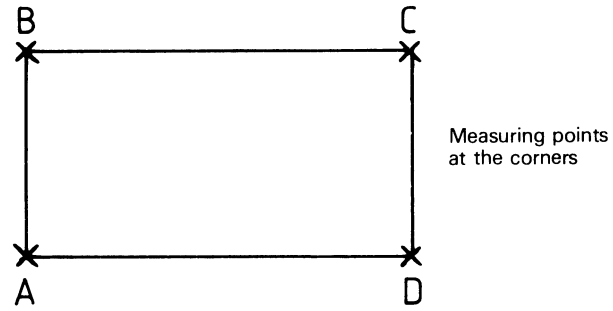


Figure 16

When determining squareness by the measurement of diagonals, the measuring points for each measurement shall be the appropriate corner points as shown in Figure 16.

NOTE In the case of diagonal measurement, a corner piece shall be used if the corners are not sharply defined.

5.2 Parallelism

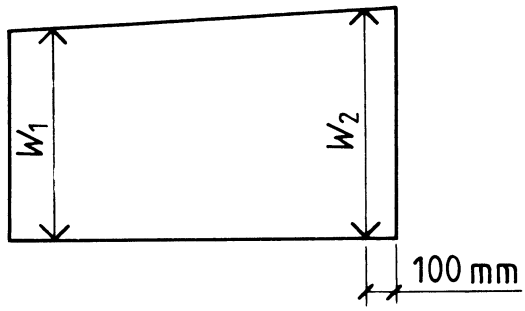


Figure 17

Parallelism deviations are determined using the measuring points described in **4.1**. Measurement of dimensions is shown in Figure 17 (see also Figure 2).

6 Straightness and camber of components

6.1 Edge straightness

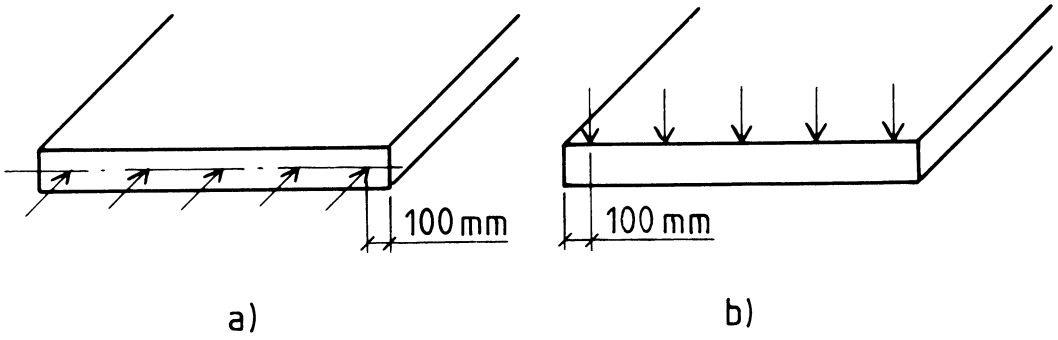


Figure 18

On each edge [see Figure 18 a) and/or b)] of the manufactured component (for example a floor, wall or beam component) with a size less than 3 m, one set of five measurements shall be taken at equally spaced measuring points as shown.

For components the length of which exceeds 3 m, it may be necessary to take measurements such that one additional measuring point is chosen for each metre of length.

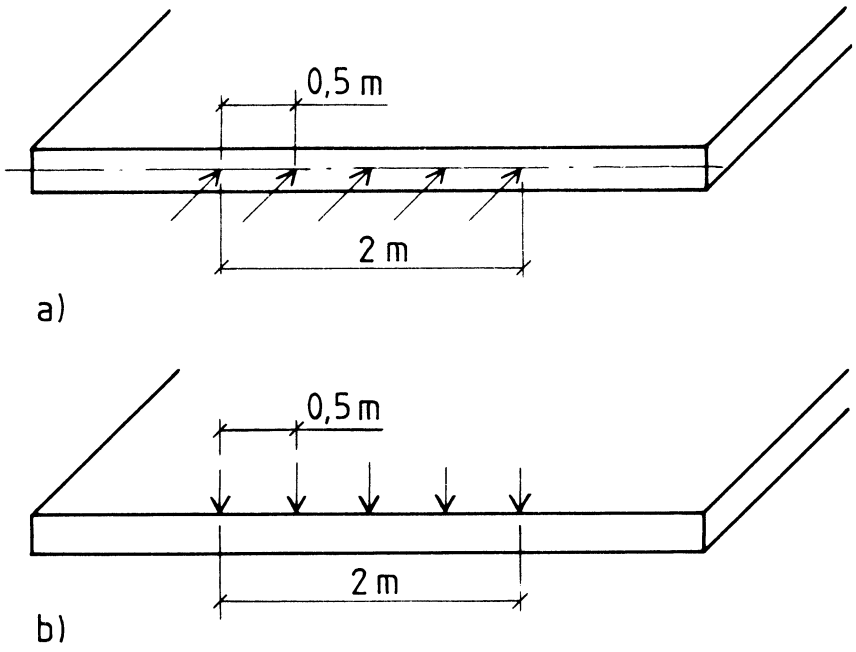


Figure 19

When measurements are taken over a defined section of the edge [see Figure 19 a) and/or b)] of a component (local straightness) at least three, and preferably five, equally spaced measuring points (at 0,5 m intervals) shall be used as shown.

6.2 Designed camber

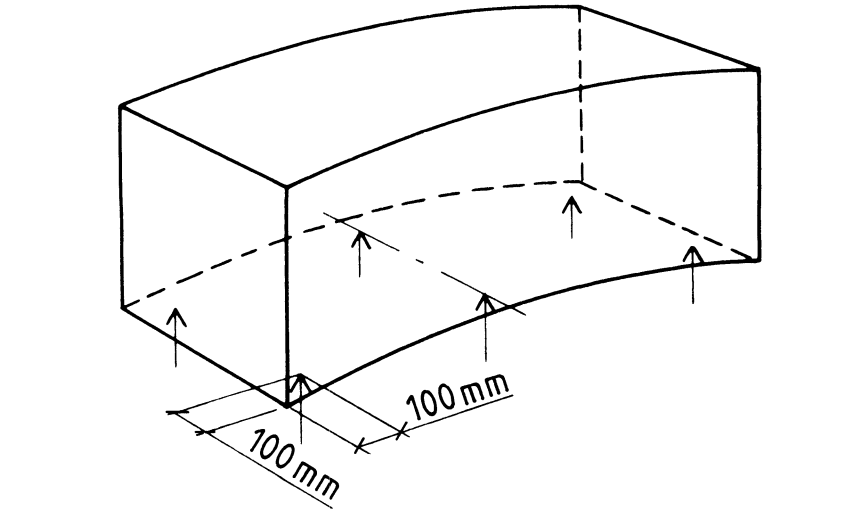


Figure 20

One set of measurements for the determination of designed camber shall be made at the underside when the specified width of the components does not exceed 1,2 m. Otherwise two sets of measurements shall be made at measuring points as shown in Figure 20.

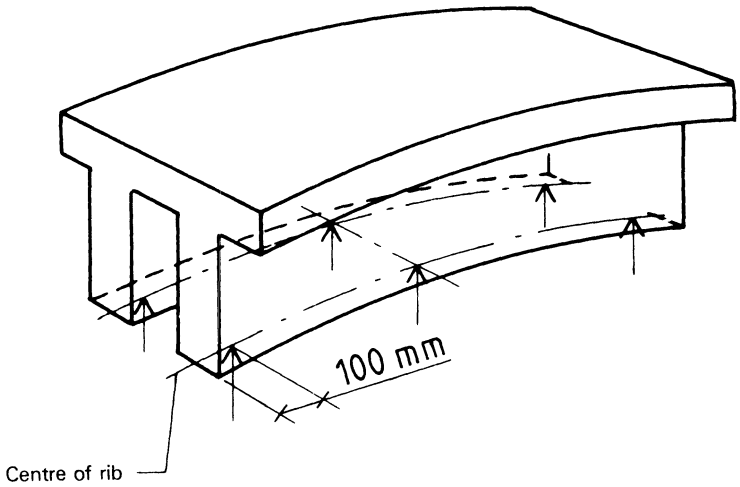


Figure 21

For components which have a non-rectangular cross-section, such as T or double T ribbed beams, one set of measurements for the determination of designed camber shall be taken for each rib at measuring points as shown in Figure 21.

7 Flatness and skewness of components

7.1 Principles of measurement

A general description of various principles of measurement is given in ISO 7976-1:1989, **7.1**. Methods of measurement in accordance with these principles are described in **7.2** to **7.5** of that part and the relevant measuring points in the corresponding sub-clauses of this part of ISO 7976.[1)]

7.2 Overall flatness

On each surface of the manufactured component, one set of measurements shall be taken.

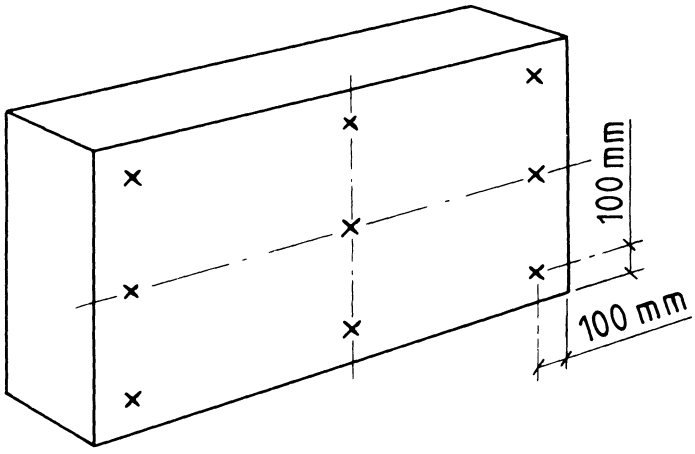


Figure 22

The number of measuring points is likely to be dependent on the size of the component; however at least nine measuring points, as shown in Figure 22, are necessary. It is recommended that the spacing between measuring points is not greater than 1 m.

[1)] There is no sub-clause **7.5** in this part of ISO 7976.

7.3 Local flatness

One or more sets of measurements shall be taken on the appropriate surface. Each set of measurements shall be taken over a maximum length of 2 m with a maximum distance of 0,5 m between the measuring points.

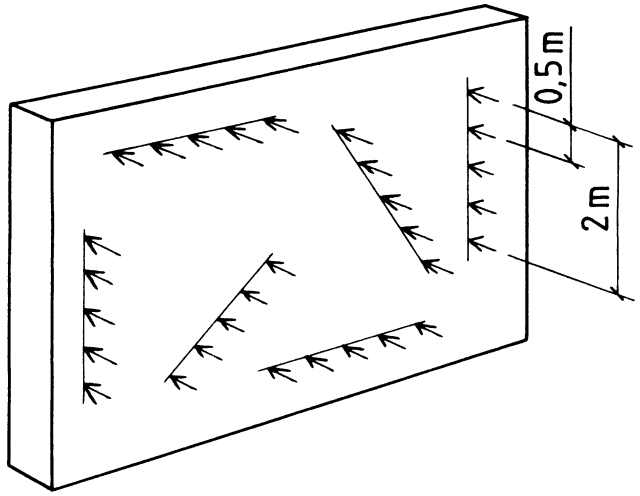


Figure 23

The positions of the sets shall be chosen at random but should be noted in relation to the edges of the component. As shown in Figure 23, each set of measurements shall consist of five measurement positions equally spaced over the measuring distance.

7.4 Skewness

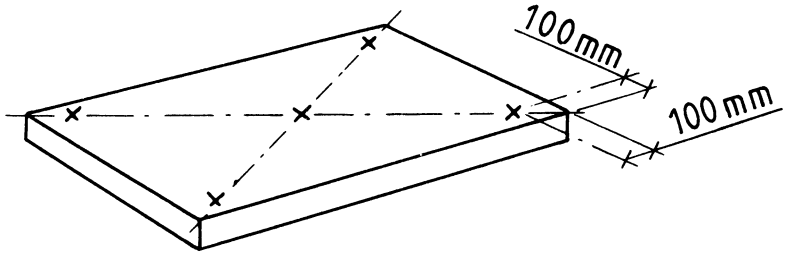


Figure 24

For the determination of skewness, the number of measuring points may be four or five depending on the method used: either the four corner points or the four corner points and the point of intersection of the diagonals. (See Figure 24.)

Section 2. Position of measuring points for those measurements which can be carried out on building sites only

This section assumes the presence of suitable reference systems on the site or in the assembly from which measurements can be made, for example secondary points/lines or grids and bench marks. Such reference systems shall however be checked according to the recommendations specified in ISO 4463.

8 Position in the horizontal plane

Part one of ISO 7976 indicates that different types of construction deviations can be determined during one and the same measuring operation, for example deviations from

— position in the horizontal plane;

— verticality;

— flatness.

In this instance it is sufficient when planning the measurements to use the measuring points in Figure 40 only, as the largest number of measuring points necessary per unit area is usually required for the determination of flatness deviations.

The other diagrams in this section show the position and number of measuring points for the determination of the different types of construction deviations separately.

8.1 Deviations in relation to structural grid lines

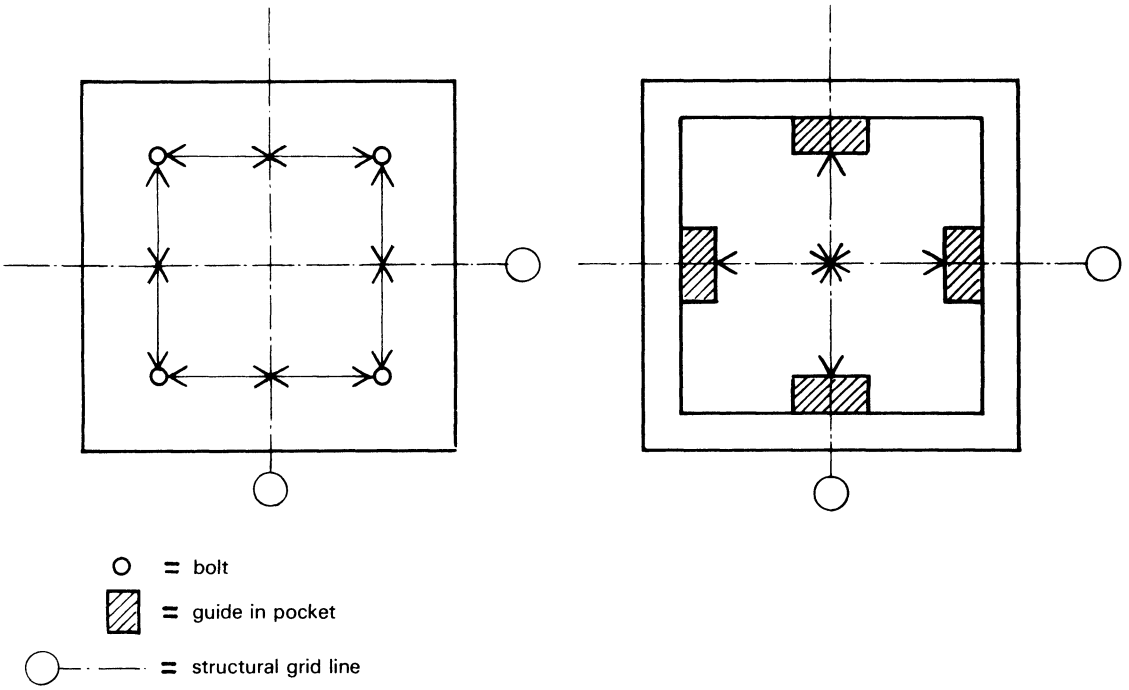


Figure 25

Figure 25 shows the determination of position of bolts and guides of columns in relation to structural grid lines.

8.2 Deviations in relation to secondary lines parallel to the building

The number of measuring points is likely to be dependent on the size of the building part to be measured.

Storey height wall components or *in situ* walls shall be measured near corner points. For prefabricated or *in situ* built walls, an additional set of measurements shall be taken in both the horizontal and vertical directions (for example lift shafts) for every 3 m (or less) that the construction extends.

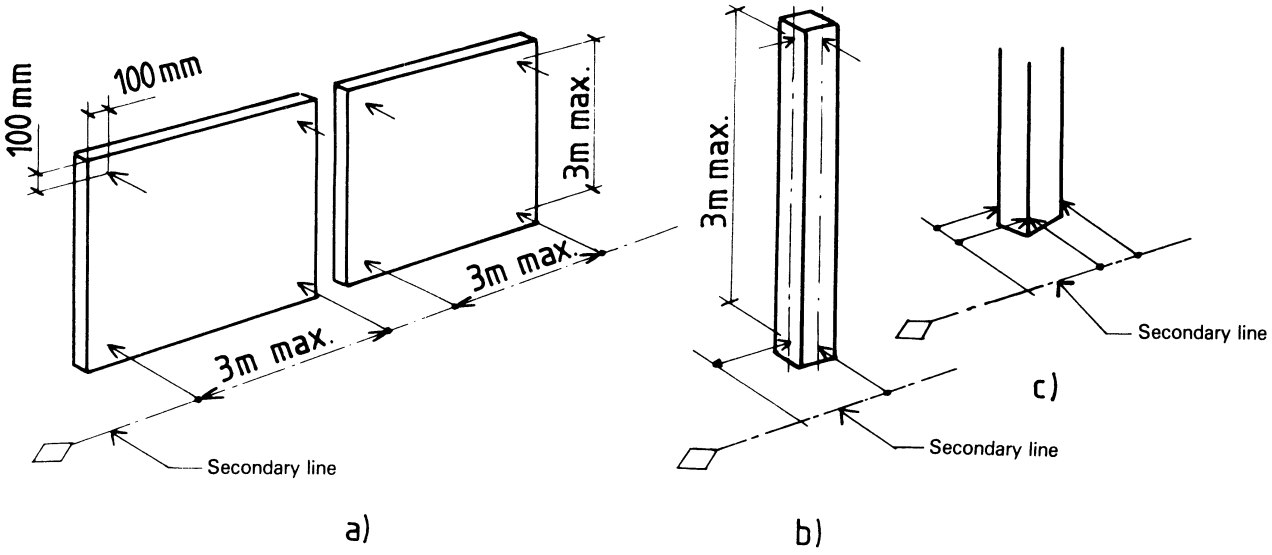


Figure 26

Figure 26 shows measuring points for the determination of positional deviations in relation to secondary lines and vertical measuring planes through those lines, for example in a) for wall components, in b) for columns, in c) for the determination of orientation directions of columns.

Columns shall always be checked in two perpendicular directions.

8.3 Deviations in relation to secondary lines perpendicular to the building

For these deviations the measuring points indicated in **8.2** can be applied. Another example is shown in Figure 27.

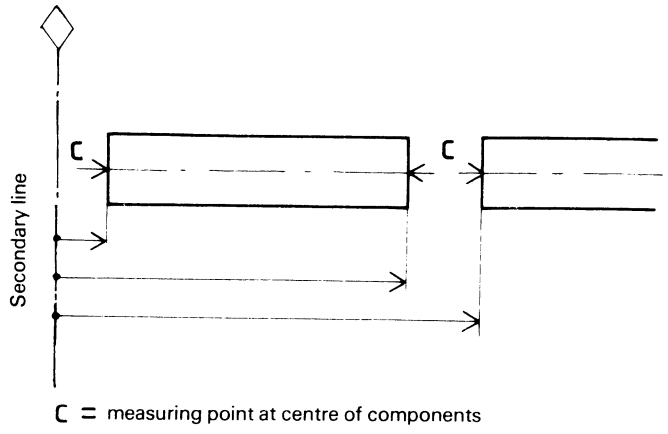


Figure 27

Figure 27 shows measuring points for the determination of the positional deviations of edges of components. (Edges often have to be extended with the aid of an ancillary tool such as a rule or a square in order to facilitate measuring.)

9 Deviations from level (levelling)

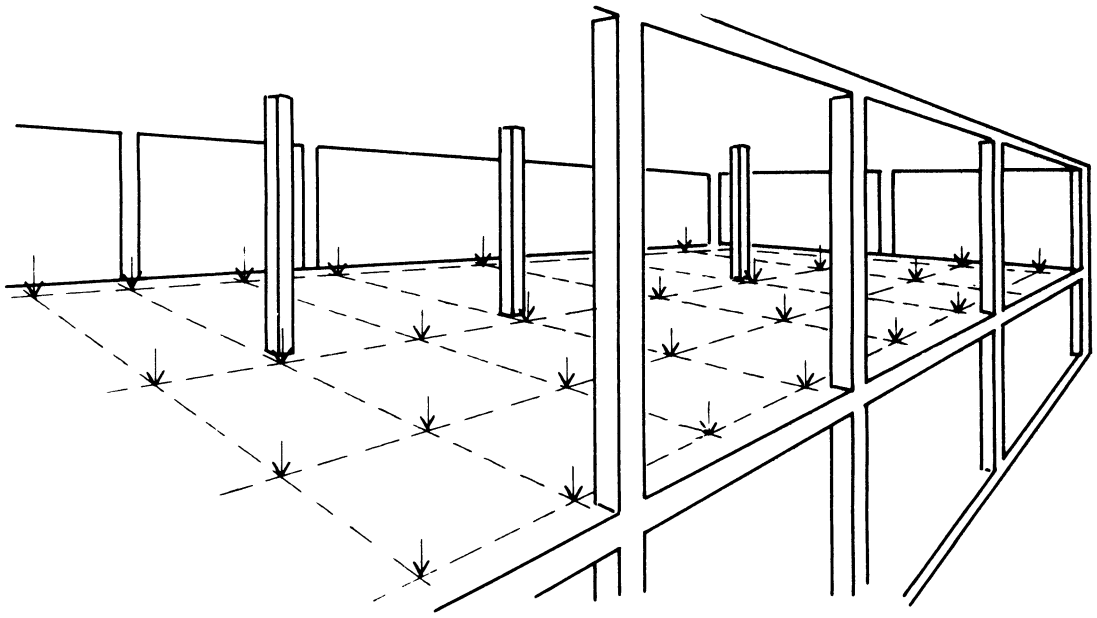


Figure 28

Positional deviation in the vertical plane and flatness or levelness of floors and ceilings can be determined at the measuring points shown in Figure 28.

The levelness or overall flatness of floors and ceilings is measured by defining a horizontal grid having a spacing of between 0,5 and 3 m. The spacing chosen will be dependent on the size of the surface to be measured and its function.

As shown in Figure 28, the positions of the measuring points shall be at the intersections of the grid lines.

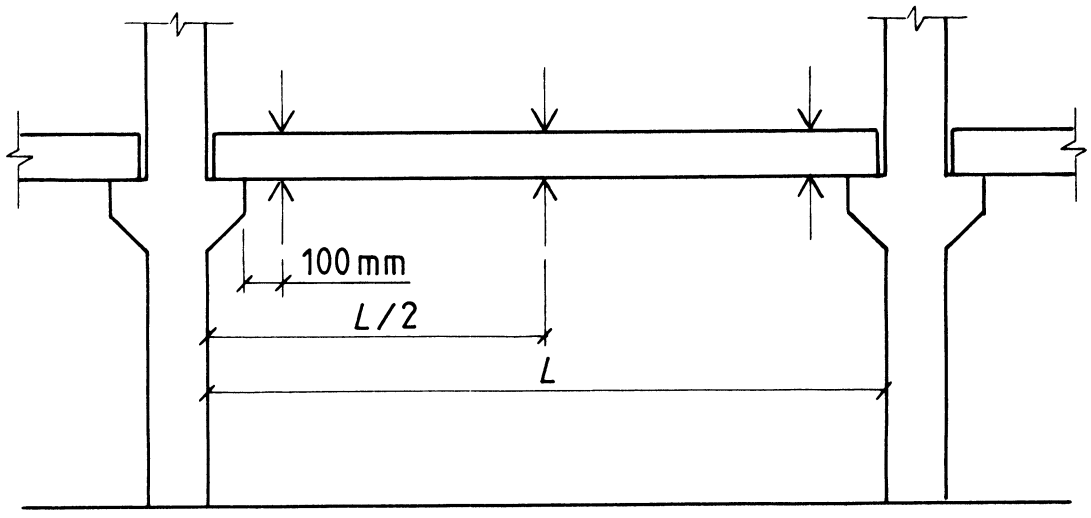


Figure 29

Beams shall be levelled at at least three points as indicated in Figure 29 (at the top or bottom).

10 Verticality

10.1 Verticality of multi-storey walls and columns

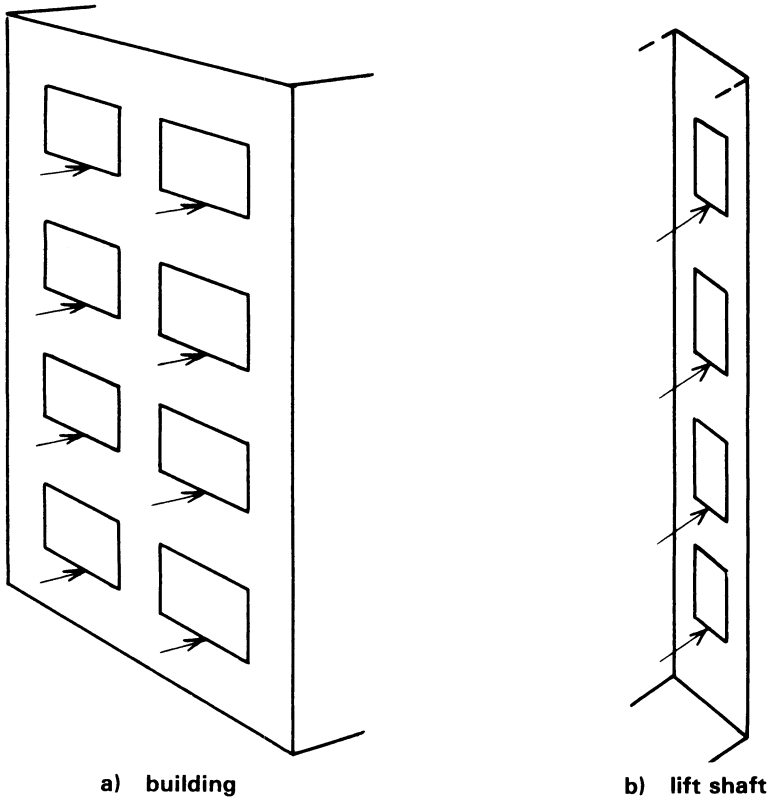


Figure 30

At least one measurement of verticality of walls shall be made for each storey. As shown in Figure 30, the relative horizontal position of the chosen points should be the same for each storey.

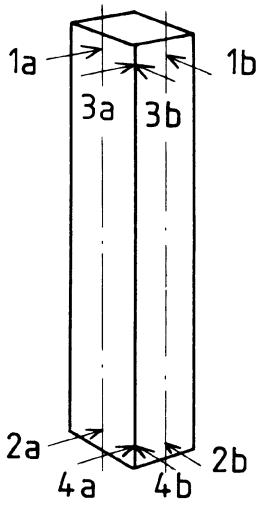


Figure 31

When checking the verticality of multi-storey columns, it is preferable if the measuring points are placed as 1 and 2 (see Figure 31) (along the centre-line of the columns). If this is not possible, the measuring points shall be placed along the edge of the column as points 3 and 4. The verticality of columns shall be checked in two perpendicular directions.

10.2 Verticality of storey-height walls and columns

The number of measuring points is likely to be dependent on the size of the wall surface to be measured.

Wall components shall be measured near the corner points, as shown in Figure 32 and on *in situ* built walls at every 3 m.

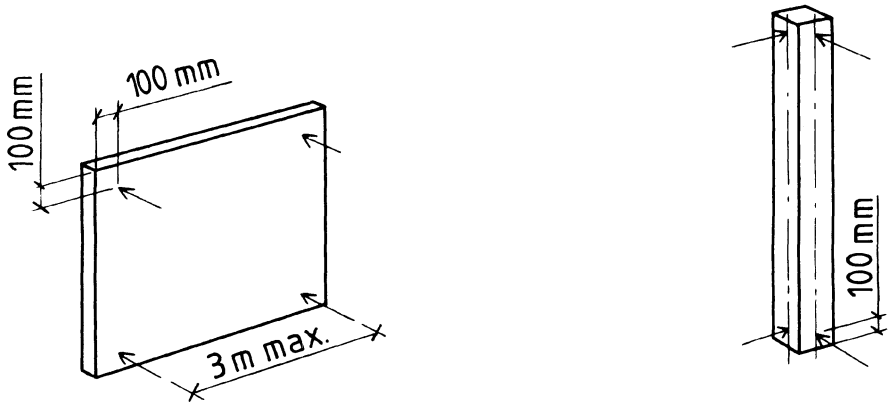
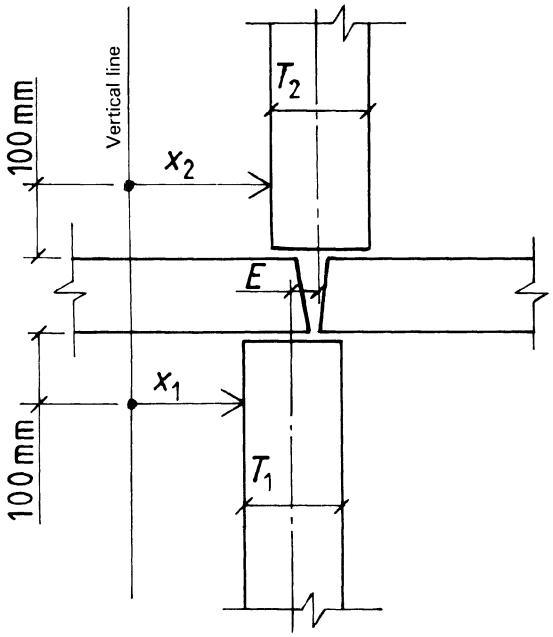


Figure 32

Measuring points for the determination of deviation from verticality are shown in Figure 32.

Columns shall always be checked in two perpendicular directions.

11 Eccentricity



T = thickness of component

x_1 and x_2 = distances from the vertical line or plane to component

E = eccentricity

For the situation in the figure :

$$E = x_2 - x_1 + \frac{T_2 - T_1}{2}$$

Figure 33

Eccentricity can be determined at the measuring points as shown in Figure 33.

12 Position in relation to other components (openings and spaces)

This clause gives some examples of those cases where the accuracy of the position of one component or building part in relation to another, or where the size of an opening, is of importance.

12.1 Window openings and other openings

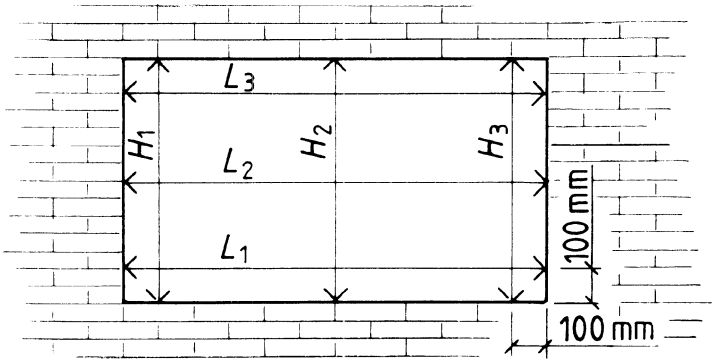


Figure 34

Dimensions of windows or other critical openings can be measured as shown in Figure 34. For openings with sizes larger than 3 m, an additional set of measurements should be taken for every metre that the opening extends.

12.2 Spaces

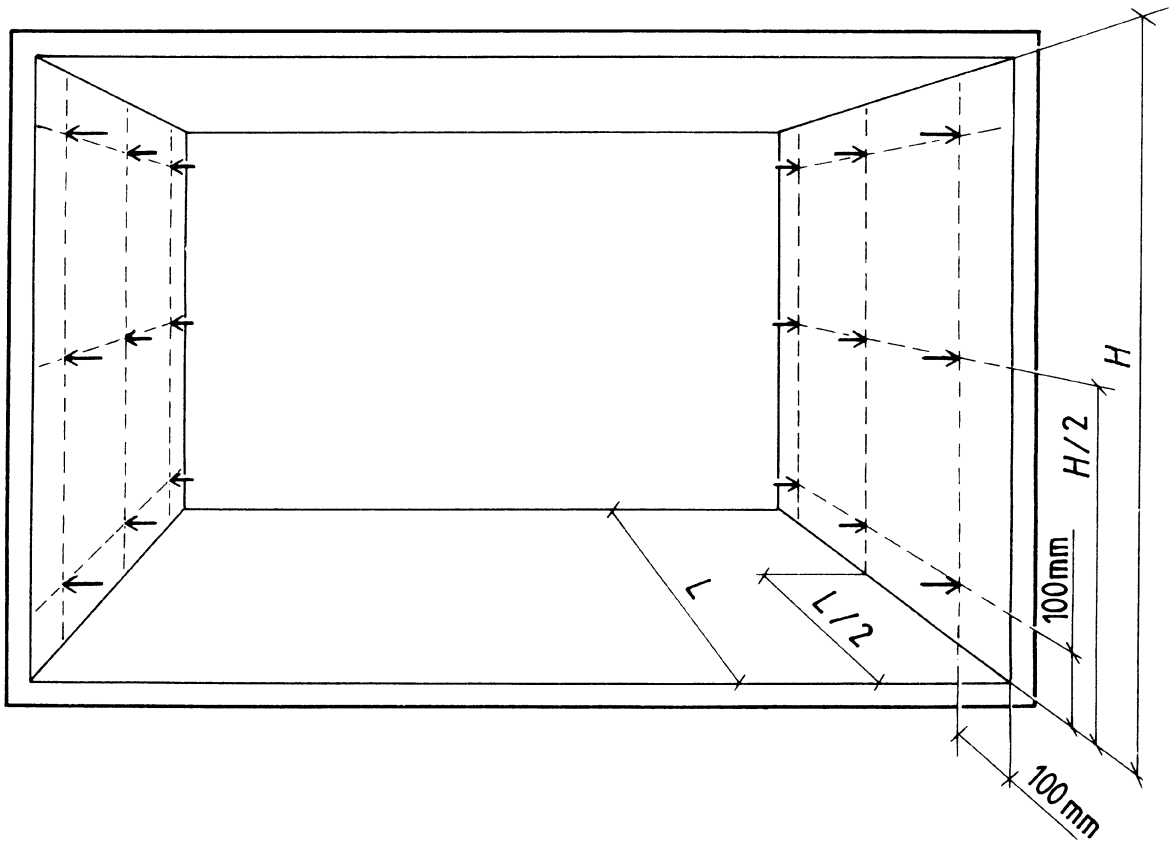


Figure 35

Figure 35 shows measuring points for the determination of length and width of spaces. If *H* or *L* is larger than 6 m, an additional set of measurements should be taken, if possible, for every 3 m that the construction extends.

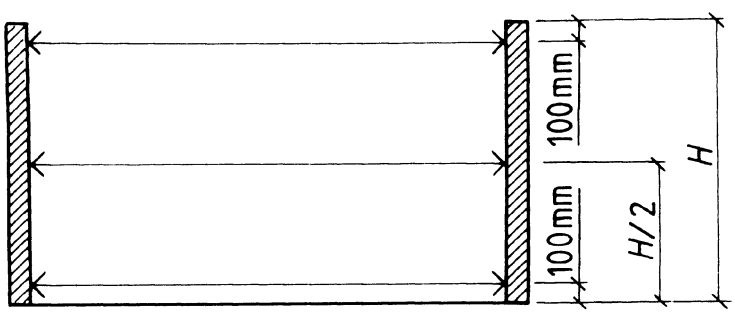


Figure 36

Distances between columns or between columns and wall surfaces can be determined using the measuring points as shown in Figure 36. If they are larger than 6 m, an additional set of measurements should be taken, if possible, for every 3 m that the construction extends.

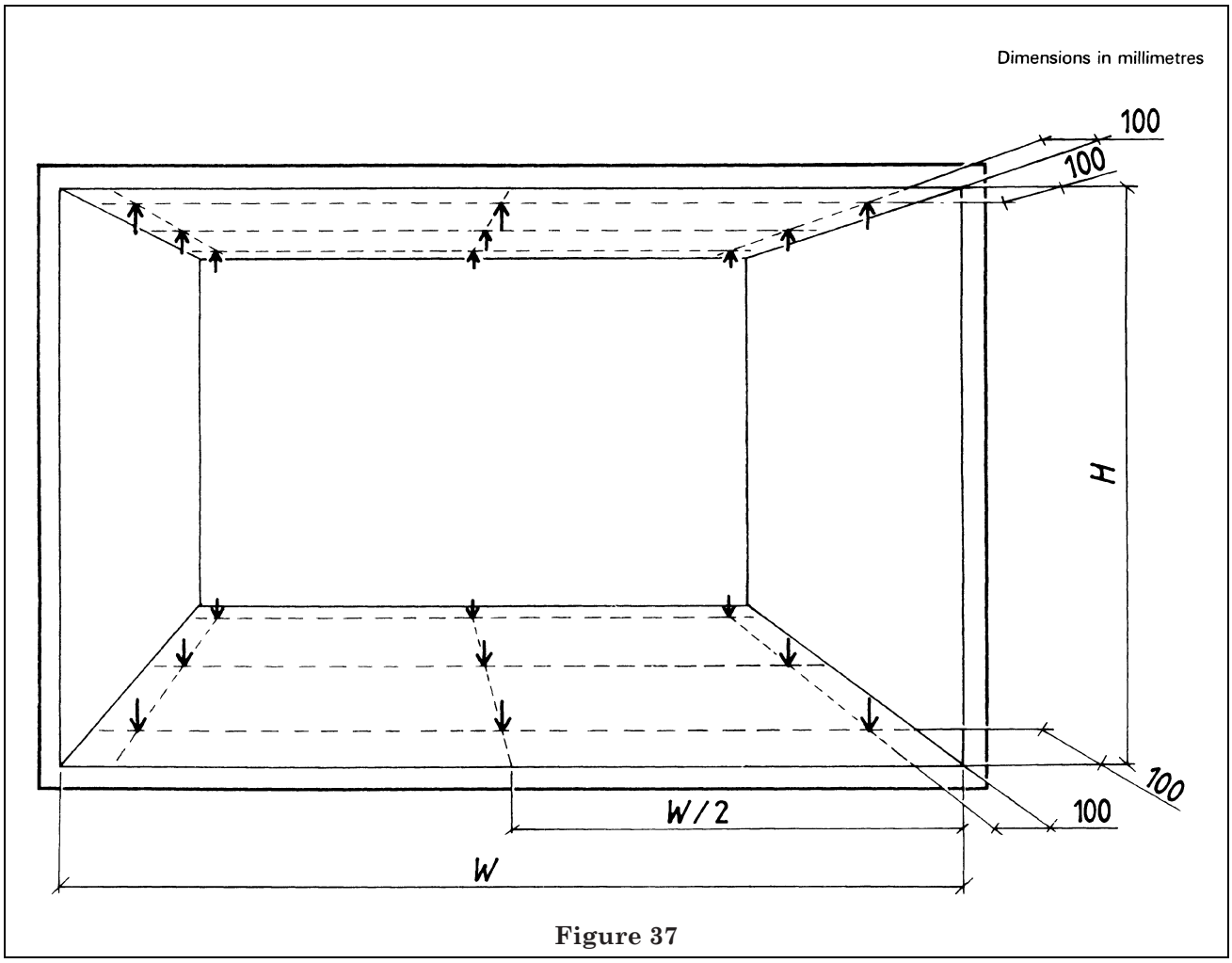


Figure 37

Figure 37 shows measuring points for the determination of height of spaces. If L or W is larger than 6 m, an additional set of measurements should be taken, if possible, for every 3 m that the construction extends.

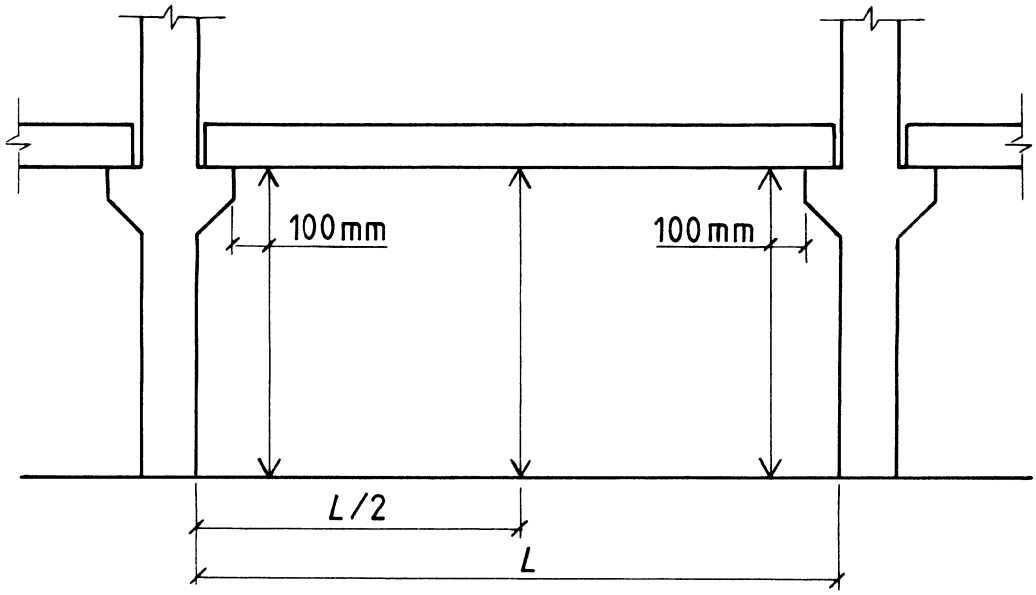


Figure 38

This principle can also be applied when measuring the distance between a floor and a beam soffit, i.e. 100 mm from each support and at mid-span.

Measuring points for the determination of distance between a floor and a beam are shown in Figure 38.

13 Flatness, straightness, designed camber

13.1 Floors and ceilings, overall flatness

The measuring points needed for the determination of overall flatness deviations of floors and ceilings are shown in Figure 28.

13.2 Floors, local flatness

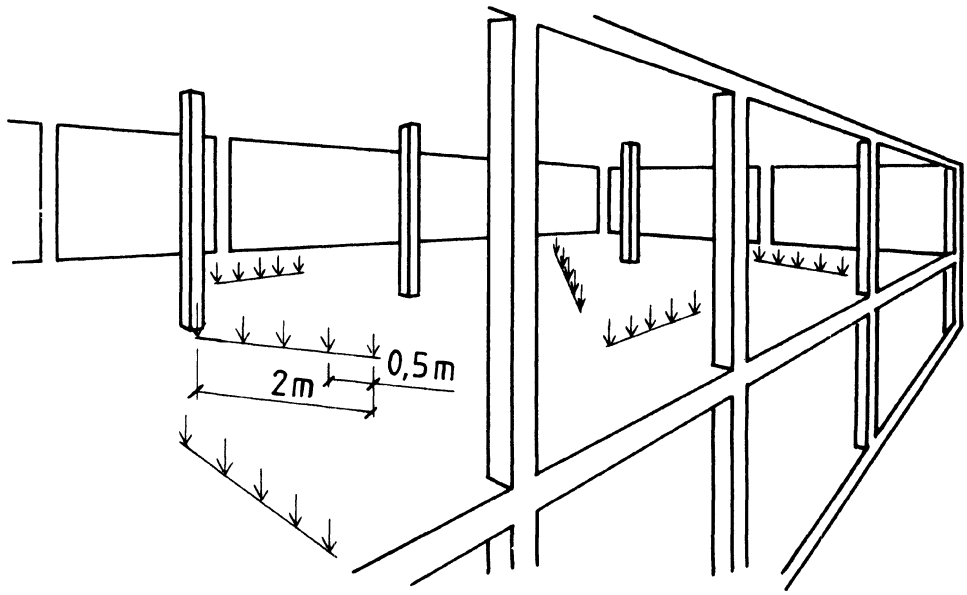


Figure 39

Figure 39 shows determination of local flatness. One or more sets of measurements shall be taken on the appropriate surface. Each set of measurements shall be carried out over a maximum length of 2 m. The positions of the sets shall be chosen at random but their relation to known positions shall be noted. As shown, each set of measurements shall consist of five measuring points equally spaced over the measuring distance.

13.3 Walls, overall flatness

On each vertical wall surface, one set of measurements shall be taken. The number of measurements is likely to be dependent on the size of the wall; however at least nine measurements shall be made.

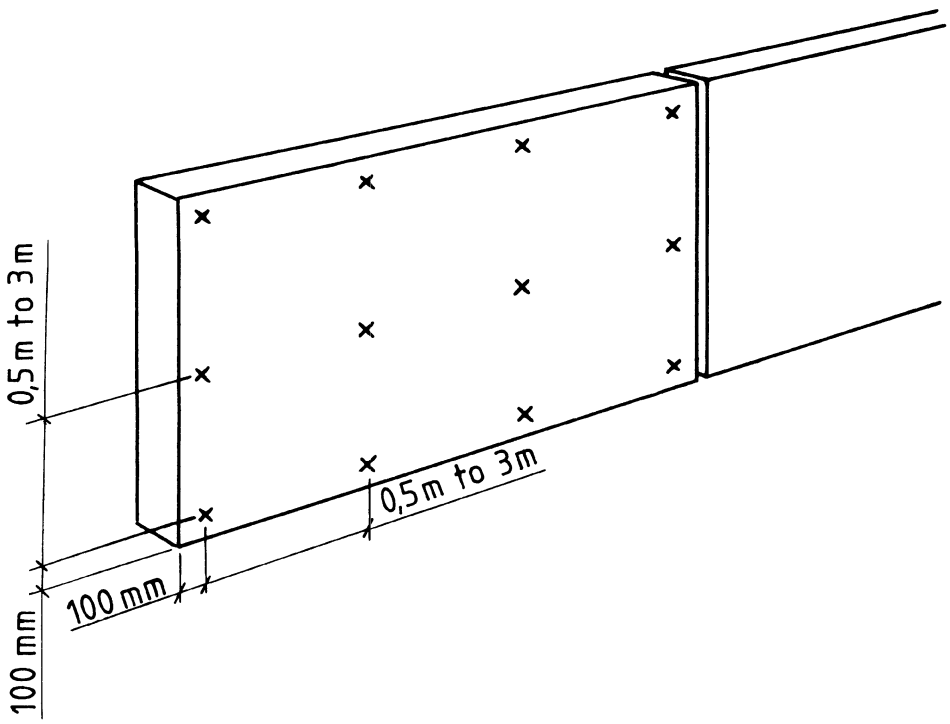


Figure 40

As shown in Figure 40, the overall flatness of walls shall be measured by defining a rectangular grid having a spacing of between 0,5 m and 3 m. The spacing chosen will be dependent on the size of the surface to be measured and the function of the surface. The perimeter of the grid should be 100 mm from the edges of the surface.

This arrangement can also be used when planning the procedures for a simultaneous determination of other deviations such as position (clause **8**) or verticality (clause **10**).

13.4 Walls, local flatness

The measuring points needed for the determination of local flatness deviations of wall surfaces can be chosen according to the example illustrated in Figure 23.

13.5 Designed camber

See clause **6**.

14 Other important deviations

14.1 Length of bearing surface

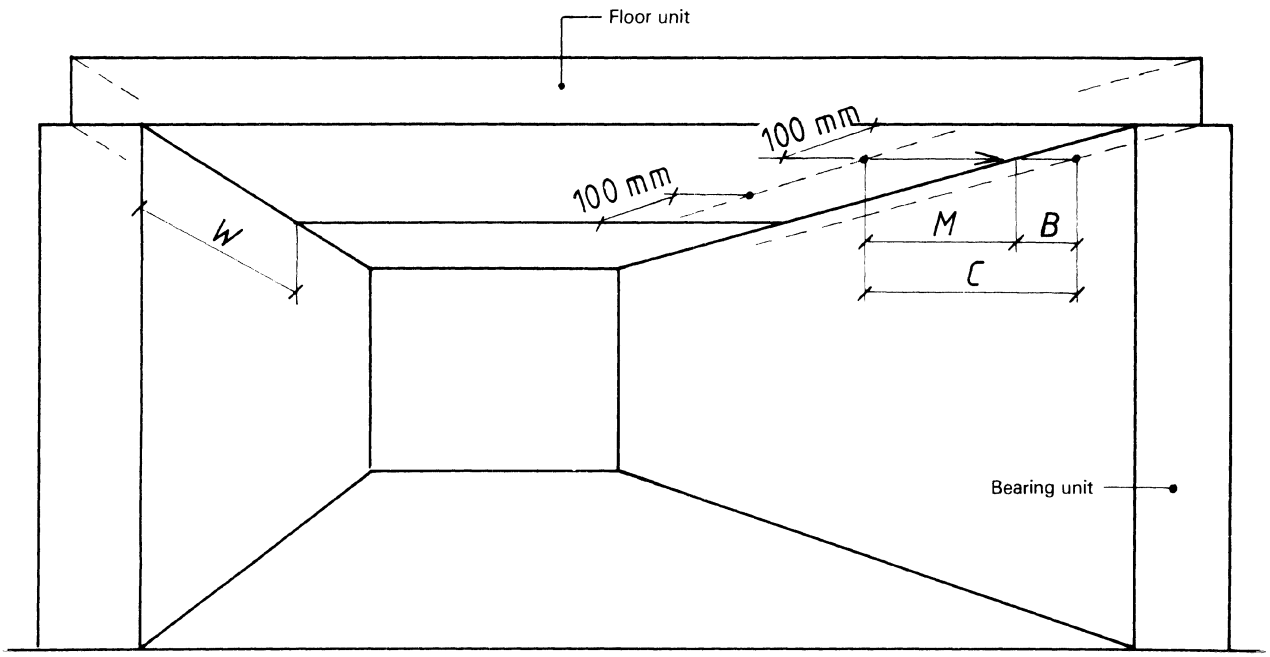


Figure 41

When measuring the length of the bearing surface, the measuring points can be chosen as indicated in Figure 41. Note however that measuring points on the floor unit have to be marked prior to assembly at a constant distance C from the edge of the floor unit. Distance M from the measuring point on the floor unit to the surface of the bearing unit is measured after assembly. The bearing length is then $B = C - M$.

Measurements shall be taken at both ends of the component. When the width W of the floor unit does not exceed 1,2 m, only one measurement, in the middle, need be made : otherwise measurements shall be made as shown in Figure 41. For components with a width W larger than 3 m, an additional measurement should be taken in the middle.

14.2 Joint width

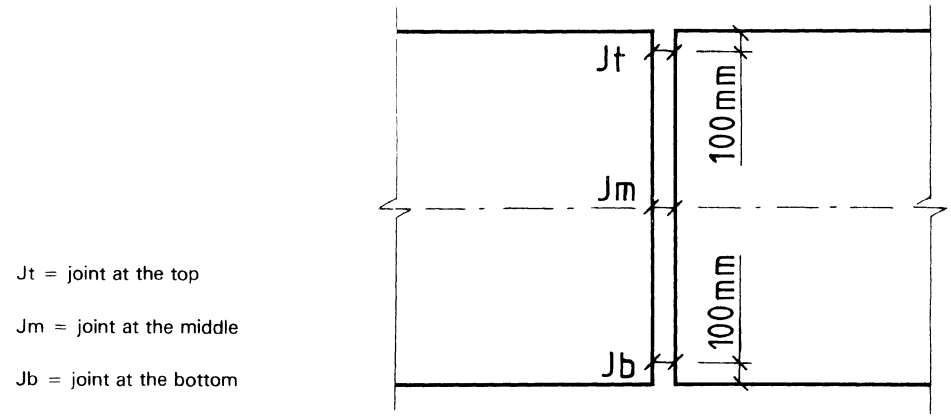


Figure 42

Joint width over a storey-height is measured at the points as shown in Figure 42.

For very long horizontal or vertical joints, a spacing of 1,2 m to 3 m between the measuring points may be chosen.

14.3 Joint step

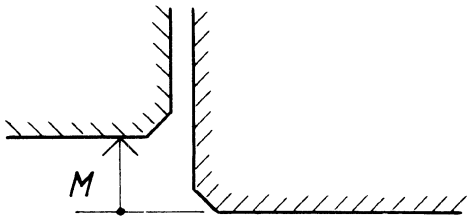


Figure 43

The joint step is measured at the point M (see Figure 43) as the distance between this point and the plane defined by the surface of the adjoining component.

Publications referred to

See national foreword.

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