15 ACCURACY OF FABRICATION AND ERECTION

15.1 GENERAL

This section gives guidance on the permitted deviations in dimensions of the steelwork during fabrication and after erection.

The accumulation in permitted deviations in the pieces supplied and in fabrication shall not cause the structure to be erected outside the permitted deviations for erection.

Where it is permissible to combine permitted deviations to establish the acceptability of the position of a piece of steelwork, they shall be combined using the root sum square method.

The permitted deviations (Δ) for various sections and components are given in the clauses and diagrams below.

Unless specified otherwise, permitted deviations refer to the unstressed condition.

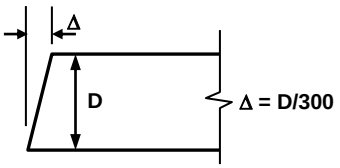
Tolerance should in no circumstance affect the functionality of the permanent and temporary structure or its components.

15.2 PERMITTED DEVIATIONS IN THE CROSS SECTION OF ROLLED COMPONENTS

The permitted deviation in the cross section of rolled components after fabrication shall be as given in the product standards, see clause 14.1.

15.3 PERMITTED DEVIATIONS IN COMPONENTS AFTER FABRICATION

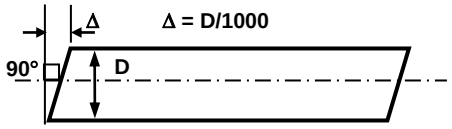
15.3.1 Squareness of ends not prepared for bearing



Plan or Elevation of End

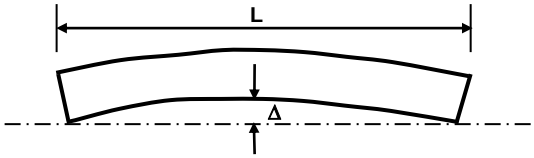
15.3.2 Squareness of ends prepared for bearing

Prepare ends with respect to the longitudinal axis of the member.



Plan or Elevation

15.3.3 Straightness on both axes or of individual webs or flanges



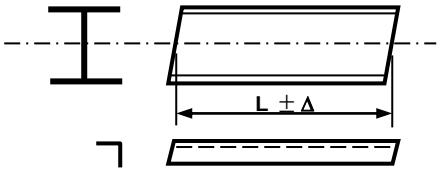
Δ = L/1000 or 3mm whichever is greater

15.3.4 Length

Length measured on the centre line of the section or on the corner of angles.

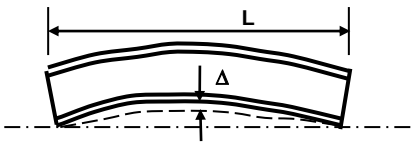
For cut length Δ = 2+L/5000mm.

For components with both ends prepared for full contact bearing including end plates as applicable Δ =1mm.



15.3.5 Curved or cambered

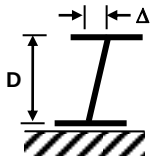
Deviation from intended curve or camber at mid-length of curved portion when measured with web horizontal.



Δ = L/1000 or 12mm whichever is greater

15.3.6 Squareness at bearings

Verticality of web at supports, for components without bearing stiffeners.

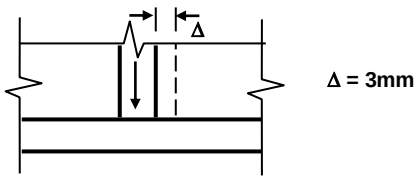


Δ= D/300 or 3mm whichever is the greater

15.4 PERMITTED DEVIATIONS FOR ELEMENTS OF FABRICATED MEMBERS

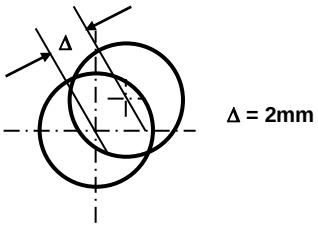
15.4.1 Position of fittings

For fittings and components whose location is critical to the force path in the structure, the deviation from the intended position shall not exceed 3mm.



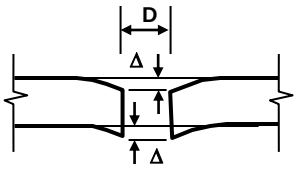
15.4.2 Position of holes

The deviation from the intended position of an isolated hole, also a group of holes, relative to each other shall not exceed 2mm.



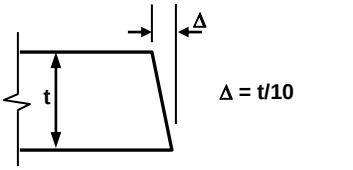
15.4.3 Punched holes

The distortion caused by a punched hole shall not exceed Δ.



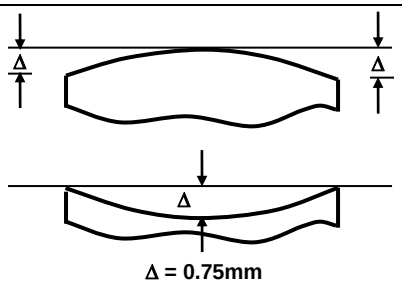
15.4.4 Sheared or cropped edges of plates or angles

The deviation from a 90° edge shall not exceed Δ.



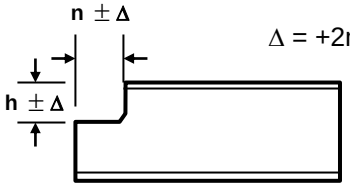
15.4.5 Flatness

Where full contact bearing is specified, the flatness shall be such that when measured against a straight edge which is laid against the full bearing surface in any direction, the gap shall not exceed Δ.



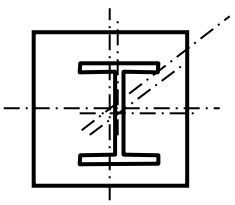
15.4.6 Notches

Depth and length of notch cut in the end of a section.



15.4.7 Column base plates

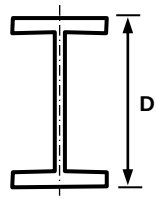
Centroid of column relative to specified location on the cap or base plate.



15.5 PERMITTED DEVIATIONS IN PLATE GIRDER SECTIONS

15.5.1 Depth

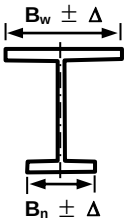
Depth on centre line.



Δ = 4 mm

15.5.2 Flange width

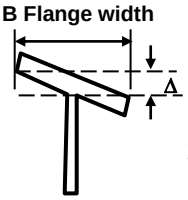
Width of B_w or B_n.



B_w or B_n < 300mm
Δ = 4 mm
B_w or $B_n \geq$ 300mm
Δ = 5mm

15.5.3 Squareness of section

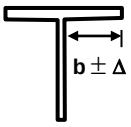
Out of squareness of flanges.



Δ = B/100 or 3mm whichever is greater

15.5.4 Web eccentricity

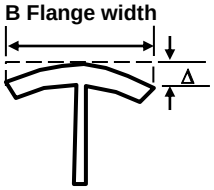
Intended position of web from one edge of flange.



Δ = 5 mm

15.5.5 Flanges

Out of flatness.

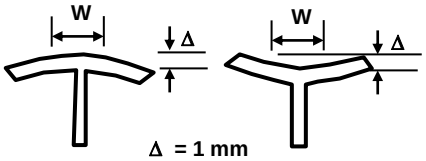


Δ = B/100 or 3mm whichever is greater

15.5.6 Top flange of crane girder

Out of flatness where the rail seats.

W = Rail width + 20 mm

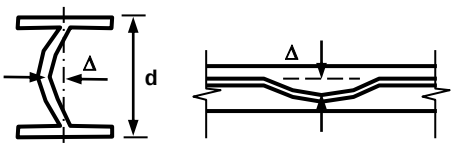


Δ = 1 mm

15.5.7 Web distortion

Distortion on web depth or gauge length.

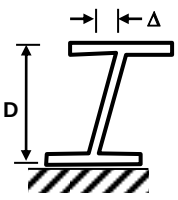
Gauge length = web depth



Δ = d/150 or 3mm whichever is greater

15.5.8 Cross section at bearings

Squareness of flanges to web.

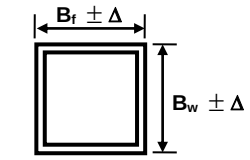


Δ = D/300 or 3mm whichever is greater

15.6 PERMITTED DEVIATIONS IN FABRICATED BOX SECTIONS

15.6.1 Plate widths

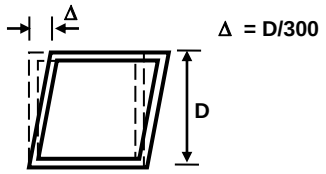
Width of B_f or B_w.



B_f or B_w < 300mm
Δ = 3 mm
B_f or B_w ≥ 300mm
Δ = 5 mm

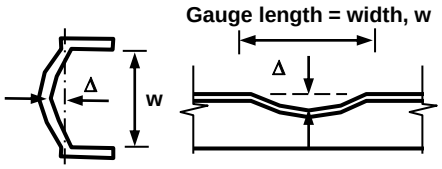
15.6.2 Squareness

Squareness at diaphragm positions.



15.6.3 Plate distortion

Distortion on width or gauge length.

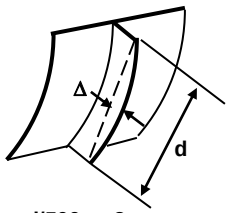


Δ = W/150 or 3mm whichever is greater

15.7 PERMITTED DEVIATIONS OF STIFFENERS

15.7.1 Web stiffeners

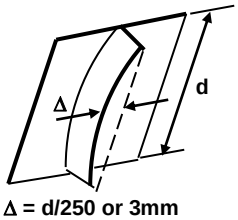
Straightness out of plane to plate after welding.



Δ = d/500 or 3mm whichever is greater

15.7.2 Web stiffeners

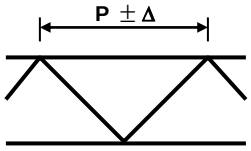
Straightness in plane with plate after welding.



Δ = d/250 or 3mm whichever is greater

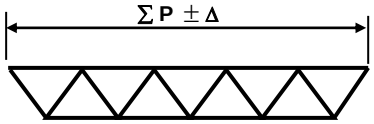
15.8 PERMITTED DEVIATIONS OF LATTICE COMPONENTS

15.8.1 Panel length



Δ = 5mm

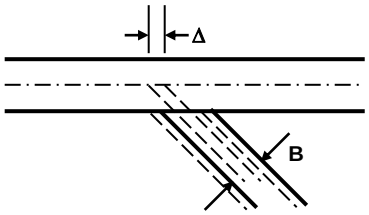
15.8.2 Cumulative length of panels



Δ = 10mm

15.8.3 Joint eccentricity

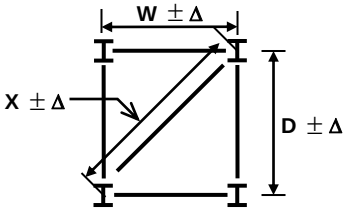
Measured relative to any specified eccentricity.



Δ = B/20 +5mm

15.8.4 Overall cross section

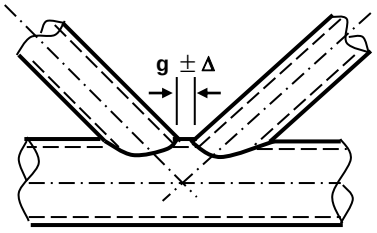
Overall depth D, the same permitted deviations apply to the width and diagonal dimension.



D, X or W≤ 300mm Δ = 3mm
300<D, X or W<1000mm Δ = 5mm
D, X or W≥ 1000mm Δ =10mm

15.8.5 Tubular lattice girders;

Gap between adjacent brace.



Δ = 5mm

15.9 PERMITTED DEVIATIONS OF COLD FORMED SECTIONS

15.9.1 Position of measurement

Cross-sectional dimensions, other than thickness, shall be measured at points not less than 200 mm from the ends of the member.

15.9.2 Thickness

The thickness tolerances shall be as given in the product standard.

15.9.3 External dimensions

In open sections and sheet profiles, which are meant for cold formed thin gauge sections up to 4 mm thick, the permitted deviations on the external dimensions of cross sections of internal elements bounded by two corner radii shall be as given in Table 15.1. For an outstand element bounded by a corner radius and a free edge, the permitted deviations shall be as given in Table 15.2.

For closed hollow sections up to 22 mm thick, the permitted deviations on external dimensions of cross sections should refer to relevant standards.

Table 15.1 - Permitted deviations for the width of internal elements

Wall thickness t	Nominal width of internal element			
	$B \leq 50$	$50 < B \leq 100$	$100 < B \leq 200$	$B > 200$
$t < 3$	0.75	1.0	1.25	2.0
$3 \leq t < 6$	1.0	1.25	1.5	2.5
$6 \leq t < 8$	1.25	1.5	1.75	3.0

Note: All dimensions are in mm

Table 15.2 - Permitted deviations for the width of outstand elements

Condition	Thickness t	Nominal plate width	Permitted deviation
Milled edge	$t < 3$	≤ 110	2.0
	$3 \leq t < 8$	≤ 110	3.0
Sheared edge	$t < 3$	≤ 110	1.0
	$3 \leq t < 8$	≤ 110	1.75

Note: All dimensions in mm

15.9.4 Length

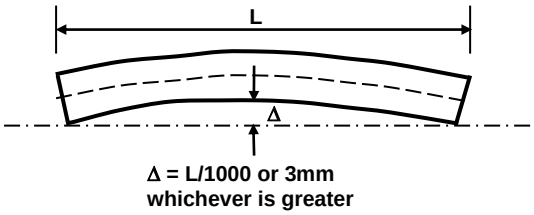
The length of a member shall not deviate from its specified length by more than 3 mm.

15.9.5 Angular tolerance

The angle between adjacent elements of a section shall not deviate from the specified angle by more than 1°.

15.9.6 Straightness

The deviation Δ of a member from straightness (or its intended shape) shall not exceed 3 mm or L/1000, whichever is the greater. In the case of complex cross sections, such as markedly asymmetric sections, the permitted deviations shall be agreed between the Responsible Engineer and the manufacturer.



15.9.7 Angle of twist

The angle of twist shall not exceed 1°/m of length. In the case of complex cross sections, the permissible angle of twist shall be agreed at the time of enquiry and order.

15.9.8 Compound members

Permissible deviations in the dimensions of compound members made up from two or more sections and built up structural elements, such as lattice girders, shall be agreed between the designer and the fabricator or manufacturer.

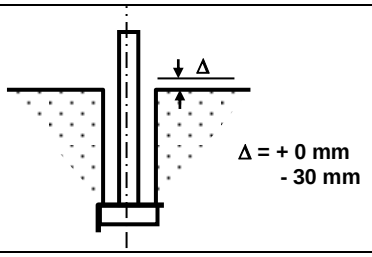
15.9.9 Flatness

The distortion of the surface of an element in a concave or convex direction shall not exceed B/50 where B is the width of the element.

15.10 PERMITTED DEVIATIONS FOR FOUNDATIONS, WALLS AND HOLDING DOWN BOLTS

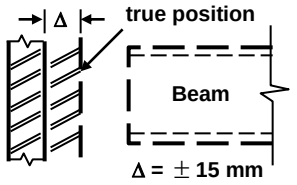
15.10.1 Foundation level

Deviation from exact level.



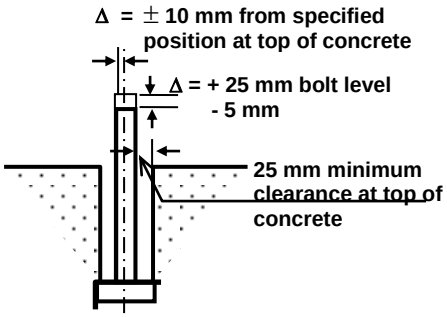
15.10.2 Vertical wall

Deviation from exact position at steelwork support point.



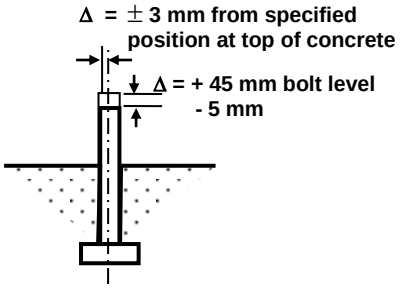
15.10.3 Pre-set foundation bolt or bolt groups when prepared for adjustment

Deviation from specified position.



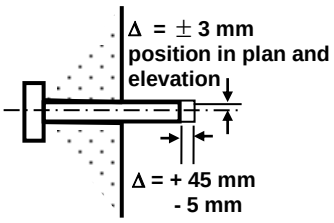
15.10.4 Pre-set foundation bolt or bolt groups when not prepared for adjustment

Deviation from specified position.



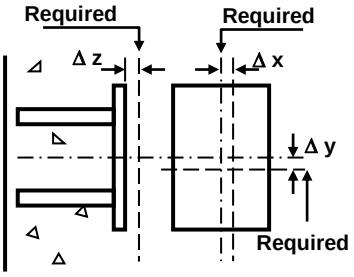
15.10.5 Pre-set wall bolt or bolt groups when not prepared for adjustment

Deviation from specified position.



15.10.6 Embedded steel anchor plate

Deviation from the required location and level.



Δ_x, Δ_y = 10mm Δ_z = 10mm

15.11 APPLICATION OF PERMITTED DEVIATION FOR ERECTED COMPONENTS

Permitted maximum deviations in erected steelwork shall be as specified in clause 15.12 taking into account of the following:

(i) All measurements be taken in calm weather, and due note is to be taken of temperature effects on the structure.

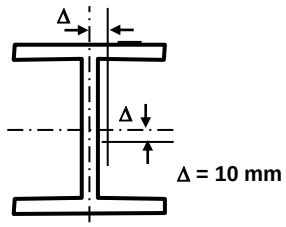
(ii) The deviations shown for I sections apply also to box and tubular sections.

(iii) Where deviations are shown relative to nominal centrelines of the section, the permitted deviation on cross-section and straightness may be added.

15.12 PERMITTED DEVIATIONS OF ERECTED COMPONENTS AND STRUCTURES

15.12.1 Position of columns at base

Deviation of section centreline from the specified position.



15.12.2 Overall plan dimensions

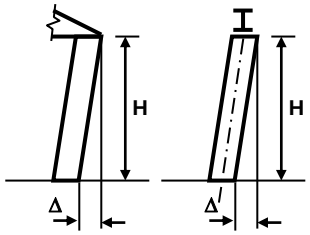
Deviation in length or width.

True overall dimension L≤30m
Δ = 20mm
True overall dimension L>30m
Δ = 20mm+0.25(L-30)mm
L is the maximum dimension in metres

15.12.3 Single storey columns plumb

Deviation of top relative to base, excluding portal frame columns, on main axes.

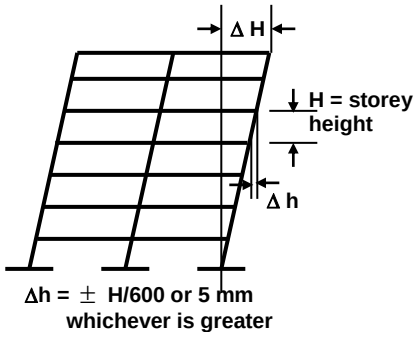
NB for portal frames the frame may need to be preset to achieve this tolerance.



Δ = ± H/600 or 5 mm whichever is greater
Max = ± 25 mm

15.12.4 Multi-storey columns plumb

Deviation in each storey and maximum deviation relative to base. (It is recommended that checks on plumb be carried out at least every five stories)



Δh = ± H/600 or 5 mm whichever is greater

ΔH = max 50mm typically (at any level)
ΔH = max 25mm for columns adjacent to lift shafts

15.12.5 Alignment of columns at splice

Deviation in the centreline of adjacent columns at a splice.

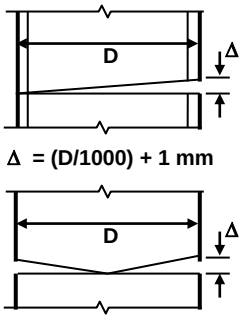
Δ = 5mm about either axis

15.12.6 Location of column splice

Deviation compared to a straight line joining connection points at adjacent storey levels.

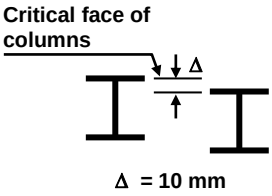
Δ = s/500 where s is the distance to the nearest floor

15.12.7 Gap between bearing surfaces



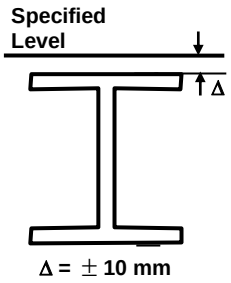
15.12.8 Alignment of adjacent perimeter columns

Deviation relative to next column on a line parallel to the grid line when measured at base or splice level.



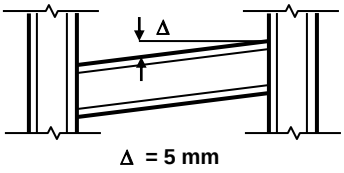
15.12.9 Beam level

Deviation from specified level at supporting column.



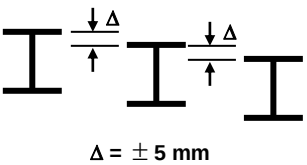
15.12.10 Level at each end of same beam

Relative deviation in level at ends.

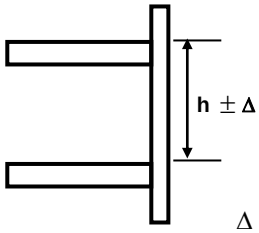


15.12.11 Level of adjacent beams within a distance of 5 metres

Deviation from relative horizontal levels (measured on centreline of top flange).



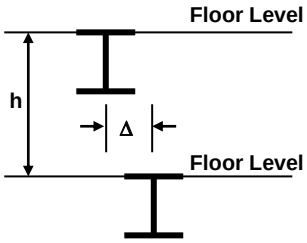
15.12.12 Level of beams at adjacent floors



Δ = 10mm

15.12.13 Beam alignment

Horizontal deviation relative to an adjacent beam above or below.



h < 3m, Δ = 5 mm
h > 3m, Δ = h/600

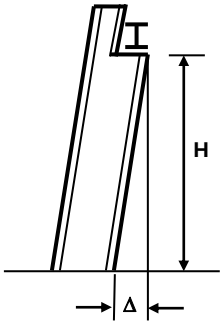
15.12.14 Position in plan of members

Deviation in the specified position of members other than columns relative to adjacent columns.

Δ = 5mm

15.12.15 Crane gantry columns plumb

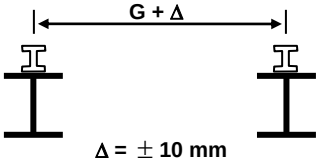
Deviation of cap relative to base.



Δ = ± H/1000 or 5 mm whichever is greater
Max = ± 25 mm

15.12.16 Crane gantries gauge of rail tracks

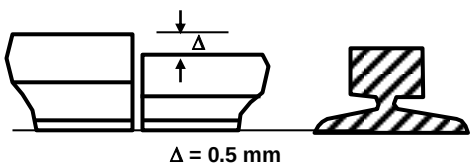
Deviation from true gauge.



Δ = ± 10 mm

15.12.17 Joints in gantry crane rails – rail surface

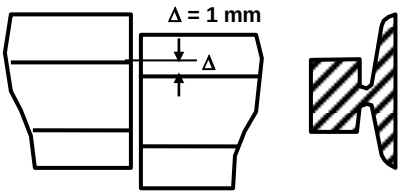
Deviation in level at rail joint.



Δ = 0.5 mm

15.12.18 Joints in gantry crane rails – rail edge

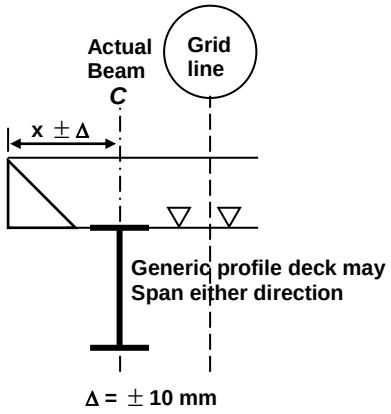
Deviation in line at rail joint.



15.12.19 Profile steel floor decking

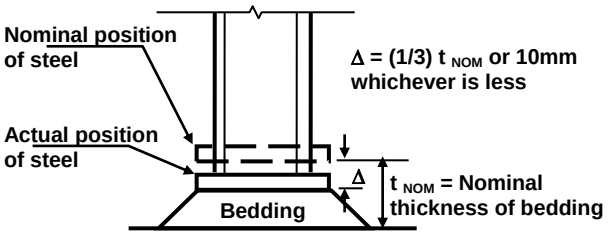
Deviation of dimension between deck edge trim and perimeter beam.

Note : Deviation (as shown) between actual beam centre line and intended beam centre line arises from other permitted tolerances.



15.12.20 Thickness of bedding

The difference between the thickness of bedding and the specified nominal thickness shall be within one-third of the nominal thickness or 10mm, whichever is less.



15.12.21 Position on bearing

The position of components supported on a bearing shall be within 5mm of the specified position relative to the bearing along both principal axes of the bearing.