IS : 7215 - 1974
(Reaffirmed 1995)

Indian Standard

TOLERANCES FOR FABRICATION OF STEEL STRUCTURES

(Sixth Reprint JULY 1997)

UDC 624.014.2 : 621.753.1

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 6 *October* 1974

Indian Standard

TOLERANCES FOR FABRICATION OF STEEL STRUCTURES

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Indian Standard

TOLERANCES FOR FABRICATION OF STEEL STRUCTURES

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 27 February 1974, after the draft finalized by the Structural Engineering Sectional Committee had been approved by the Structural and Metals Division Council and the Civil Engineering Division Council.

0.2 This standard is intended to serve as a guide to engineers engaged in design, fabrication and erection of steel structures in regard to dimensional tolerances.

0.3 Depending upon the importance and accuracy of workmanship required in their fabrication and erection, steel structures are broadly classified into three groups as detailed below:

Group A — Steel railway bridges and other structures which require closer tolerances than those specified for Groups B and C.

Group B — Steel structures having special characteristics and structures subjected to dynamic loading like bridges (other than steel railway bridges), crane gantry girders, supporting structure,

Group C — Steel structures like platform galleries, stairs, etc, which do not require closer tolerances as required for Group B structures.

0.3.1 In this standard only groups B and C are covered. The tolerances for the fabrication of steel railway bridges and allied structures which fall into Group A will be covered in a separate standard.

0.4 This standard keeps in view the practice being followed in this field in this country. Assistance has also been derived from CSN 732611 'Limit deviations for dimensions of structural steel work' issued by Urad pro normalizaci a mereni, Czechoslovakia.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with

IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers tolerances on dimensions for fabrication of steel structures manufactured by riveting, bolting or welding.

1.2 The tolerances specified in this standard do not apply to structures like steel railway bridges which require closer tolerances.

1.3 This standard is not applicable to thin welded construction as in the case of box girders.

2. BUILT-UP SECTION

2.1 The tolerances on the dimensions of individual rolled steel components shall be as specified in IS : 1852-1973†.

2.2 In the case of joints designed as friction grip joints using high tensile friction grip fasteners, the difference in thickness if any shall be adjusted by chamfering or by providing packing pieces.

2.3 The maximum permissible gap S between the components in the straight and curved portion of structures assembled by riveting or bolting (*see* Fig. 1, 2 and 3) shall be as given in Table 1.

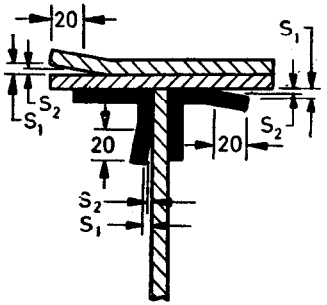
TABLE 1 MAXIMUM PERMISSIBLE GAP IN BUILT-UP MEMBERS

Thickness of Member*	Maximum Permissible Gap			
	Straight Portion		Curved Portion	
	At edge S_1	At 20 mm from edge S_2	At edge S_1	At 20 mm from edge S_2
(1)	(2)	(3)	(4)	(5)
mm	mm	mm	mm	mm
Up to and including 20	0·3	0·2	1·0	0·8
Over 20	0·3	0·2	1·5	1·2

*When different thicknesses are involved the smaller thickness is to be considered.

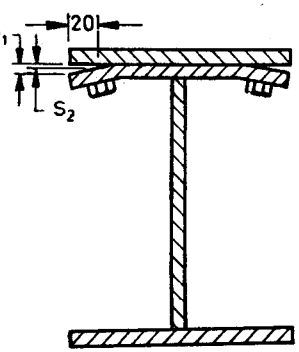
*Rules for rounding off numerical values (*revised*).

†Specification for rolling and cutting tolerances for hot-rolled steel products (*second revision*).



All dimensions in millimetres.

FIG. 1 GAPS IN THE COMPONENTS CONNECTED BY RIVETS OR BOLTS



All dimensions in millimetres.

FIG. 2 GAPS IN THE COMPONENTS CONNECTED BY RIVETS OR BOLTS

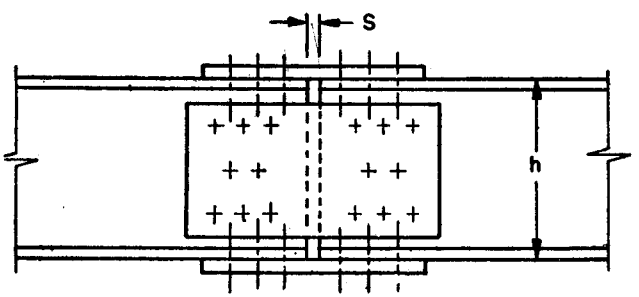


FIG. 3 MAXIMUM GAP BETWEEN ENDS OF MEMBERS CONNECTED BY RIVETS OR BOLTS

2.3.1 The width of gap S (*see* Fig. 3) between the ends of members connected by rivets or bolts shall not exceed 1·5 mm for depth of sections up to 1 000 mm and 3·0 mm for sections over 1 000 mm depth.

2.4 Deviation in Depth and Width at Joints — For rolled beams and built-up members (welded or riveted), the difference in width or depth or both at the joint between two adjacent members shall not exceed the values given in Table 2 (*see* Fig. 4 and 5).

TABLE 2 MAXIMUM PERMISSIBLE DEVIATION IN DEPTH AND/OR WIDTH OF GIRDER AT THE JOINTS

(*Clause* 2.4)

STEEL WORK GROUP	HEIGHT *h* OR WIDTH *b* OF SECTION	DEVIATION *S*
(1)	(2)	(3)
	mm	mm
B	Up to and including 1 000	1·0
	Over 1 000	2·0
C	Up to and including 1 000	2·0
	Over 1 000	3·0

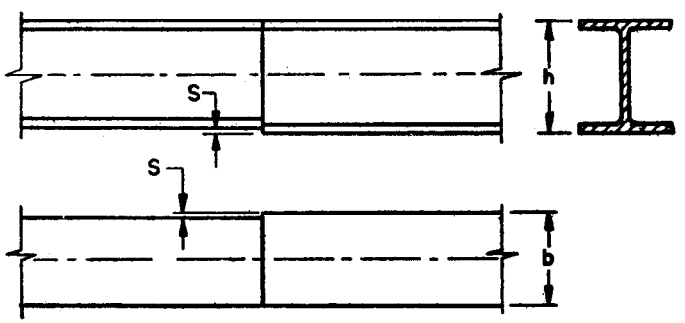


FIG. 4 DEVIATION IN DEPTH AND WIDTH OF WELDED MEMBERS

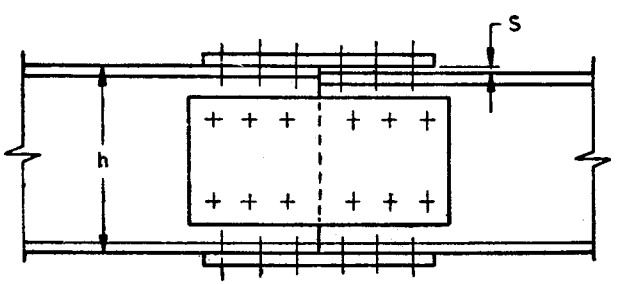
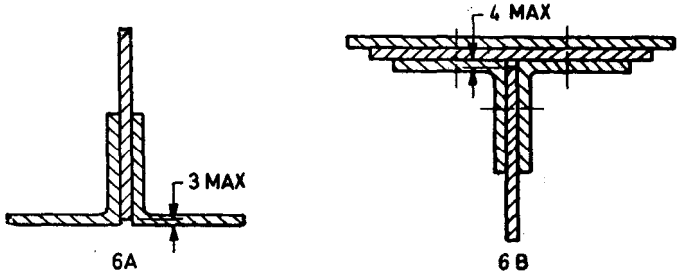


FIG. 5 DEVIATION IN DEPTH OF RIVETTED MEMBERS

2.4.1 For rolled sections connected by welding, riveting or bolting, if the relative deviations with respect to the depth is more than that permitted in Table 2 due to rolling margin, the difference shall be adjusted by chamfering in the case of welded joints, or by providing packing in the case of bolted or riveted joint at the joint for individual sections. In the case of joints using high strength friction grip fasteners the difference in depth and width shall be adjusted by chamfering or providing packing pieces.

2.5 The projection of the external face of the flange angle (*see* Fig. 6A) beyond the edge of the web in the case of built-up riveted members without flange plates shall not exceed 3 mm. However, when the top flange is exposed to atmosphere the exposed edge shall be flush with the flange angles.

2.6 The maximum permissible gap between the edge of the web plate and the inner surface of the first flange plate in the case of both upper and lower parts of the riveted components shall be 4 mm (*see* Fig. 6B). The gap shall be filled in by suitable means approved by the engineer incharge.



All dimensions in millimetres.

FIG. 6 PROJECTION OF FLANGE ANGLES BEYOND WEB PLATE

2.7 Where the load has to be transferred by direct bearing contact of individual members the gap shall not exceed 0·1 mm in the case of compression members and 0·3 mm for other members. This provision is also applicable to bearing stiffeners of plate girders. At the discretion of the inspecting authority a tolerance of 0·5 mm may be permitted at isolated places.

2.8 For lattice members the relative difference z in the levels of the outstanding legs of the flange angles (*see* Fig. 7) shall not exceed 1·0 mm.

2.9 Out-of-square between web and flange in built-up sections shall be limited by the provisions given in **2.9.1** and **2.9.2.**

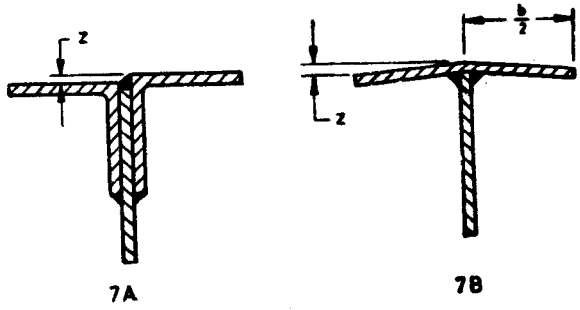


FIG. 7 DIFFERENCE IN THE LEVELS OF OUTSTANDING LEGS OF FLANGE ANGLES

2.9.1 The maximum permissible out-of-square on the external face of the flanges of welded sections (*see* Fig. 8) shall be as given in Table 3.

TABLE 3 MAXIMUM PERMISSIBLE OUT-OF-SQUARE OF FLANGES IN BUILT-UP GIRDERS

LOCATION	OUT-OF-SQUARE
(1)	(2)
At splices and at stiffeners At support (bearing) At the top flanges of crane girder For components designed to carry subsidiary beams placed over top flange or flush with top flange	0·005 *b* Subject to a maximum of 2 mm
At all places not covered above	0·015 *b* Subject to a maximum of 4 mm

2.9.2 The out-of-square between flange and web measured as the difference Δ between the diagonals of nominal length l (*see* Fig. 9) shall not be greater than 0·001 l.

3. TOLERANCE ON LENGTH, DEPTH AND WIDTH OF BEAMS AND GIRDERS

3.1 Tolerance on Depth — The deviation Δ in the depths of solid web girders and open web girder (*see* Fig. 10) shall be within the limits +3 and −2 mm.

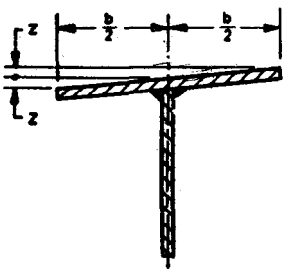


FIG. 8 FLANGE OUT-OF-SQUARE

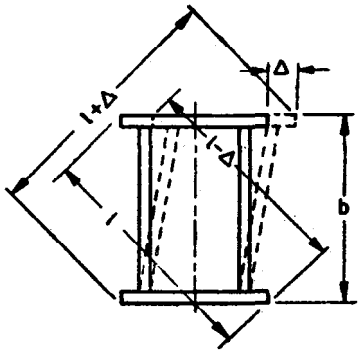


FIG. 9 OUT-OF-SQUARE BETWEEN FLANGE AND WEB IN BOX PROFILE

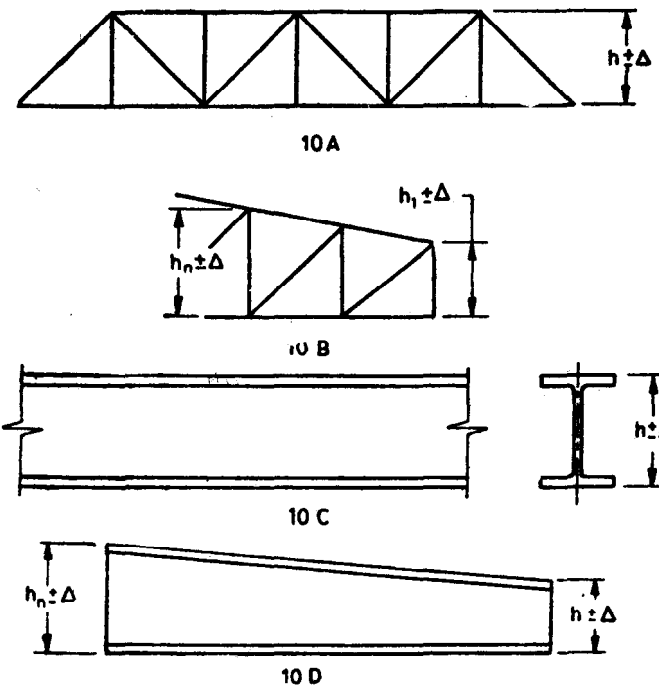


FIG. 10 TOLERANCE ON DEPTH OF SOLID WEB AND OPEN-WEB GIRDERS

3.2 Tolerance on Length

3.2.1 The permissible tolerance on the length l of individual components and the total length or span of the assembled components shall be as specified in Table 4.

TABLE 4 TOLERANCE ON LENGTH OF BEAMS AND GIRDERS AND THEIR COMPONENTS

LENGTH, l	TOLERANCE
(1)	(2)
m	
Up to and including 12	$\pm$ 3·0 mm
Over 12	$\pm$ 0·000 25 l subject to a maximum of $\pm$ 5 mm

NOTE — The permissible tolerance on lengths of individual components shall not be numerically added in order to determine the limiting deviations of the total length of the assembled part.

3.2.2 The permissible deviation $\triangle$ in the lengths of individual components with end plate connections (*see* Fig. 11) shall be within the limits $+0$ and -2 mm.

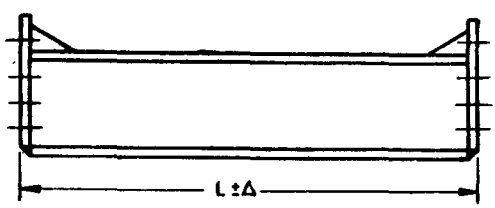


FIG. 11 DEVIATION IN THE LENGTH OF BEAMS WITH END PLATES

3.2.2.1 In the case of members in which connections (*see* **3.2.2** and **3.2.3**) designed as friction grip joints with high tensile friction grip fasteners the negative deviations of sub-assemblies shall be adjusted by providing packing pieces.

3.2.3 The permissible deviation in the width of member required to be inserted in other member shall be within limits $+0$ to -2 mm.

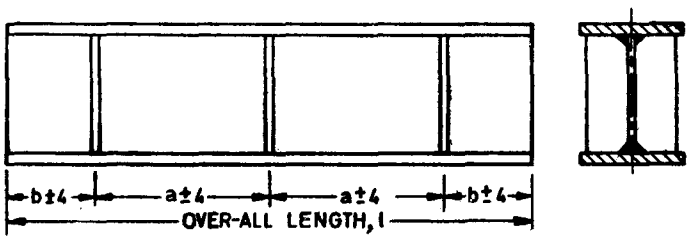
3.3 Stiffeners and Gussets

3.3.1 The spacing of the stiffeners of plate girders, connecting plates and packings of built-up or lattice members shall be maintained limiting the deviations to ±4 mm.

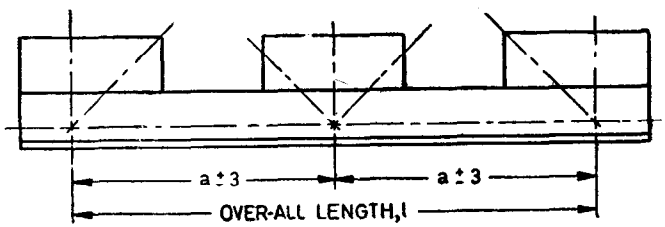
It is required to have greater accuracy by assembly and erection considerations, the deviations specified under **3.3.2** shall be adopted. However, the limiting deviation in the overall length shall be as specified in **3.2.1** and **3.2.2** (*see* Fig. 12A).

3.3.2 The relative deviation △ in the distances between the calculated positions of consecutive gusset plates (*see* Fig. 12B) shall be ±3 mm. However, the limiting deviations △ of the total length shall be as specified in **3.2.1** and **3.2.2**.

3.4 Deviation in Straightness of Girders — With the bottom laid on ground the deviation y_1 in the horizontal plane from the straightness of solid web girders and members of lattice girders (*see* Fig. 13) shall not exceed 0·001 l subject to maximum of 10 mm whichever is less, where l is the length of the girder or member of lattice girder. In the vertical plane no concavity shall be allowed, and the convexity y_2 shall not exceed 5 mm.



12A



12 B

All dimensions in millimetres.

FIG. 12 DEVIATION IN THE SPACING OF STIFFENERS AND GUSSETS

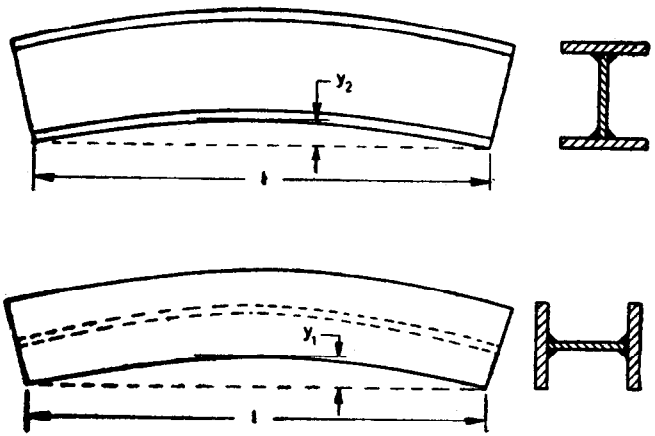


FIG. 13 DEVIATION IN THE STRAIGHTNESS OF PLATE GIRDERS

3.5 Buckling of Webs — The permissible buckling of the web of plate girders measured between the top and bottom flanges or between the stiffeners or between the flange and a stiffener (*see* Fig. 14) shall be as follows:

Dimension, h	*Maximum Permissible Buckling*
mm	mm
Up to 500	0·5
Over 500 up to and including 1 000	1·0
Over 1 000	2·0

4. COLUMN TOLERANCE ON HEIGHT AND STRAIGHTNESS

4.1 The deviation Δ in the heights of the column measured from the bottom of the base plate or support (*see* Fig. 15) shall be as specified in Table 5.

4.2 The deviation from the straightness in the longitudinal and transverse planes of built up columns shall not exceed 0·001 l subject to a maximum of 10 mm (*see* Fig. 16).

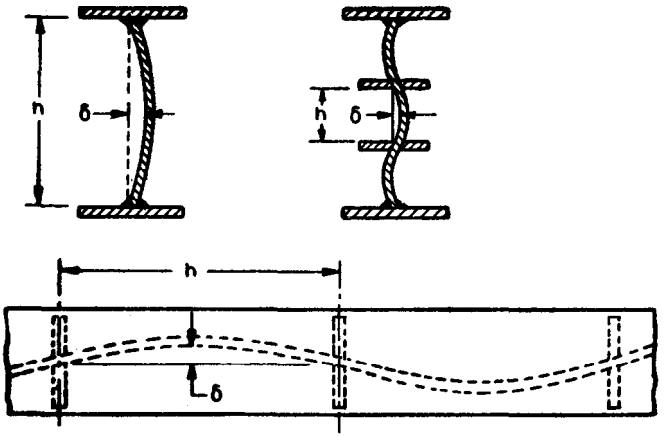


FIG. 14 BUCKLING OF WEBS IN GIRDERS

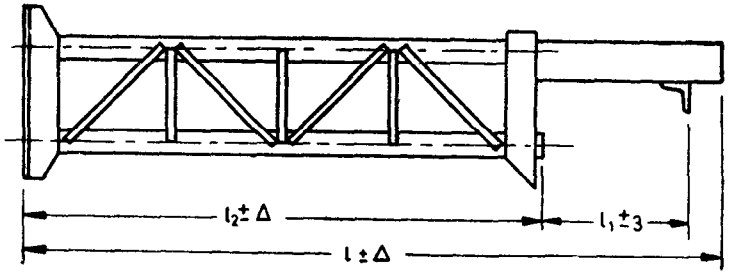
TABLE 5 PERMISSIBLE DEVIATION IN COLUMN HEIGHTS

(*Clause* 4.1)

DIMENSION	LENGTH	TOLERANCE
(1)	(2)	(3)
	m	mm
Overall height l	Up to and including 10	± 5
	Over 10	± 0·000 5 l subject to a maximum of ± 8
The distance to the top of the angle cleat from the base of the crane girder l_1	All	± 3
The distance of the base of the crane girder from the top of the base plate l_2	Up to and including 10	± 5
	Over 10	± 0·000 5 l subject to a maximum ± 8

5. DEVIATIONS IN THE ALIGNMENT OF BEAMS

5.1 The lateral deviation $\triangle_1$ in the alignment of the nodal points of the lattice beams perpendicular to their axial plane (*see* Fig. 17) measured after the fabrication in the shop or after trial assembly, shall be limited to ±0·001 l where l represents the span of the beam, subject to a maximum of ± 10 mm.



All dimensions in millimetres.

FIG. 15 TOLERANCE ON HEIGHT OF COLUMN

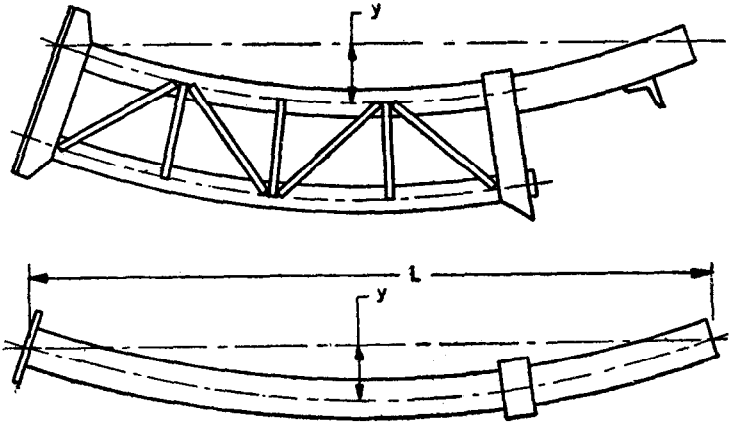


FIG. 16 TOLERANCE ON STRAIGHTNESS OF COLUMN

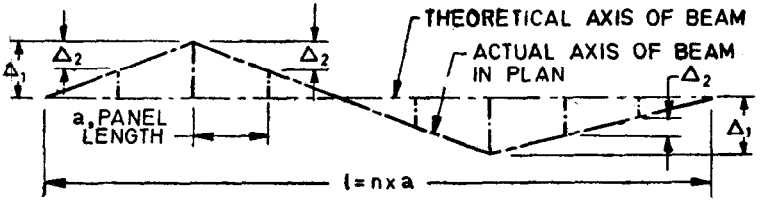
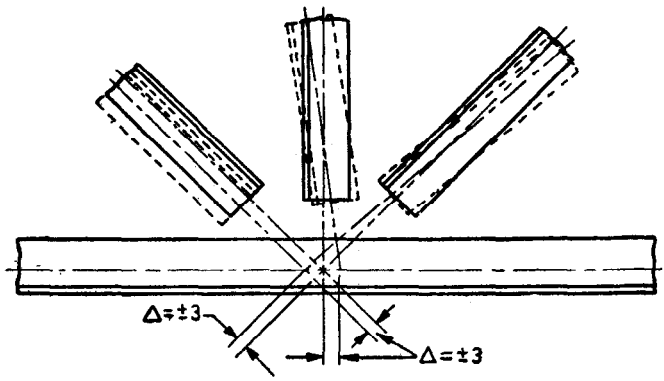


FIG. 17 DEVIATION IN THE ALIGNMENT OF BEAMS

5.2 However, the lateral deviation Δ_2 (non-alignment) measured between any two consecutive nodal points shall not be more than the values specified below:

Panel Length, a	*Maximum Permissible Deviation*
m	mm
Up to and including 3	3
Over 3	5

5.3 The permissible deviation Δ of the axes of the members meeting at a joint from theoretical nodal points (*see* Fig. 18) shall not be greater than ± 3 mm.



All dimensions in millimetres.

FIG. 18 DEVIATION IN THE AXES OF MEMBERS MEETING AT A POINT

5.4 The permissible distortion in the transverse direction Δ from the true axis of plate lattice and box girders (*see* Fig. 19) shall not be more than 0·001 l where l is the length of the diagonal of the profile.

6. CRANE GANTRY GIRDERS

6.1 The curvature of crane girders in the horizontal plane shall not exceed 3 mm in 12 m length of the girder.

6.1.1 Flange of gantry girders shall, for a distance of 500 mm from the ends, be free from any curvature and shall be normal to the web.

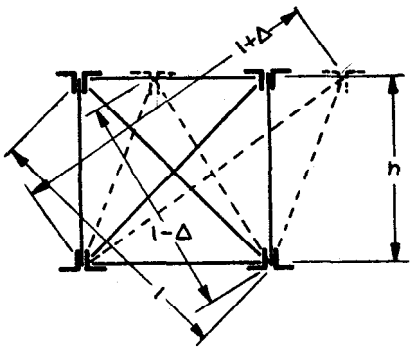


FIG. 19 TRANSVERSE DISTORTION OF GIRDERS

6.2 The camber of the girder in the vertical plane shall not exceed 3 mm in 12 m length.

6.3 The horizontal misalignment of crane rail shall not exceed 3 mm.

6.4 Crane rails shall be centred on crane girders as far as possible. However, in no case the rail eccentricity exceed half the thickness of the web of the girder.

7. DEVIATION IN THE INTERNAL DIMENSIONS OF OPENING

7.1 Unless otherwise specified in technical drawings the tolerance on the internal dimensions of openings for erection of equipment (openings on floor, on crane bridges, etc) shall be $^{+3}_{-0}$ mm.

8. LIMIT DEVIATIONS — PROFILE OF STRUCTURES

8.1 The permissible limit of deviation Δ of the depth Y of the section at salient points (*see* Fig. 20) measured after shop fabrication or after trial assembly at site in their final position shall be as given in Table 6. However, the continuity of the curvature of the profile for the section shall be maintained.

TABLE 6 PERMISSIBLE DEVIATION FROM THE PROFILE

DEPTH, Y	DEVIATION
(1)	(2)
mm	
Up to and including 50	± 2 mm
Over 50	± 0·04 Y with a maximum of 4 mm

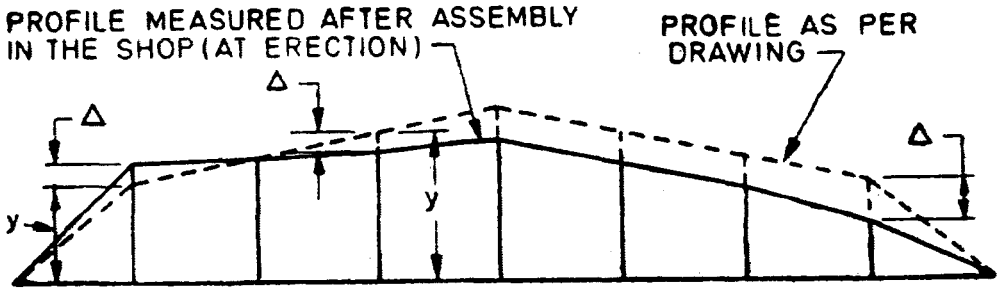


FIG. 20 DEVIATION IN THE PROFILE OF STRUCTURES

9. PERMISSIBLE DEVIATIONS IN BEARING

9.1 The permissible deviations for cast steel bearings for steel structural works of groups B and C shall be as given below:

	Deviations mm
a) For the thickness of rocker, bed plate and seating plate of a bearing	± 0·5
b) For diameter of rollers of single or double roller bearings	± 0·4
c) In case of roller bearings having three or more rollers, the relative difference in the diameter of any two rollers	± 0·025

9.2 The permissible deviations of the length and width of the base plate of a sliding bearing or the seating plate of a fixed bearing shall be ±1 mm.

9.3 The permissible deviations of the overall height of the bearing shall be ±2 mm.

9.4 The relative difference in height at both ends of the assembled bearings in the transverse direction shall be limited to 1 mm.

10. DEVIATIONS ON DIMENSIONS OF HOLES FOR RIVETING AND BOLTING

10.1 Pitch Distance--The permissible deviations on pitch distance of holes and distances between the rows of holes, unless the holes have been formed to suit the available production facilities, shall be ±1 mm for Group B and ±2 mm for Group C structures.

10.2 Dimensions of Drilled Holes — The nominal diameters of drilled holes and permissible deviations on the diameter, perpendicularity, overlapping of holes, etc, shall be as specified in Table 7. This does not cover turned and fitted bolts (*see* **10.4.3**).

10.2.1 The permissible deviations in percentage specified in Table 7 refers to the maximum percentage of holes with deviations occurring in a group of holes. For this purpose the following shall be considered as group of holes:

a) Holes made in individual components for erection joints or holes made for connection to individual components,

b) Holes connecting individual bracings, and

c) Holes made in one half of a gusset plate of a joint. Where more than one gusset plate is used, the holes between the individual joint shall be taken as separate group of holes.

10.2.2 The maximum number of defective holes in one group when the number of holes in the group exceeds 4 shall be limited to 25 percent. However, when a cross section is taken through the holes, the number of defective holes on one side of the cross section shall not be more than 15 percent (*see* Table 7).

10.2.3 For steel structures of Group B, the defective holes may be reamed to a bigger diameter and bolts or rivets of the corresponding higher diameter may be used, in exceptional cases and with the approval of the engineer incharge.

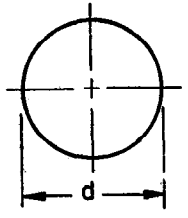
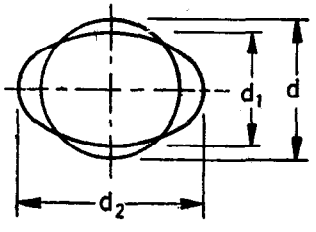
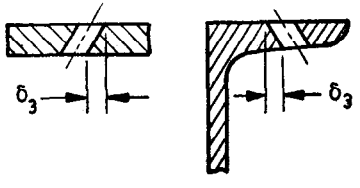
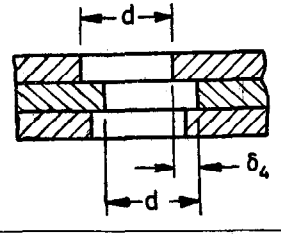
10.2.4 For steel structures of Group C, if the defective holes are not reamed, bolts or rivets with suitable deviations in their dimensions may be used so as to have a proper fitting of the joint in exceptional cases and with approval of the engineer incharge.

10.2.5 When turned and fitted bolts are used, the holes shall be drilled under size by one mm and after assembly, shall be reamed to a proper size with tolerance $+0{\cdot}15$ mm, -0 mm.

10.3 Scratches or grooves on the cylindrical surfaces of the drilled holes shall be limited as given in Table 8.

TABLE 7 DEVIATIONS ON DIMENSIONS OF DRILLED HOLES

(*Clauses* 10.2, 10.2.1 *and* 10.2.2)

Deviations of Hole	Nominal dia of hole, mm	10·5	13	15	17	19	21	23	25	28	Steel Work Group
	Nominal dia of rivet, mm	10	12	14	16	18	20	22	24	27	
	Nominal dia of bolt, mm	M 10	M 12	†	M 16	†	M 20	M 22	M 24	M 27	
	Description	Limits of Deviation, mm									
	Diameter of hole δ_1	+ 0·3 − 0·2	+ 0·4 − 0·2			+ 0·6 − 0·2			+ 0·6 − 0·2		B, C
	Ovality* $\delta_2 = d_2 - d_1$	·5	0·6			0·7			0·8		B
		Up to maximum deviation for 10 percent of holes in a member for a joint Up to 0·5 mm deviation for 25 percent of holes in a member for a joint									
		0·5	0·6			0·7			0·8		C
	Perpendicularity of hole δ_3	3 percent of the thickness of the joint elements subject to a maximum of 3 mm									B, C
	Maximum overlapping of holes at connection δ_4	0·5	0·8			1·0					B
		0·5	0·8			1·5					C
		For 15 percent of holes in a member for a joint									

*Difference between the highest and lowest measured diameter of hole.

†Corresponding bolt according to IS : 1364-1967 Specification for precision and semi-precision hexagon bolts, screws, nuts and lock nuts (diameter range 6 to 39 mm) (*first revision*).

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TABLE 8 SCRATCHES OR GROOVES ON THE CYLINDRICAL SURFACES OF THE DRILLED HOLES

(*Clause* 10.3)

Depth of Scratch, *Max*	No. of Holes to Which the Permissible Limits are Applicable	
	Group of Structure	No. of Holes, Percent *Max*
(1)	(2)	(3)
mm		
0·2	B	25
	C	50
0·5	B	Nil
	C	25

10.4 Distance Between Groups of Holes — Deviation in distance between the centre of gravity of any two groups of holes shall not be more than 2 mm.

10.5 Edge Distance Deviation — Edge distance shall not vary from the specified values by more than 1 mm for Group B and 1·5 mm for Group C structures.

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Printed at Simco Printing Press, Delhi, India

AMENDMENT NO. 1 MAY 1992
TO
IS 7215 : 1974 TOLERANCES FOR FABRICATION OF STEEL STRUCTURES

(*Page* 3, *clause* **0.3**) — Substitute the following for the existing clause:

'Depending upon the importance and accuracy of workmanship required in the fabrication and erection, steel structures are broadly classified into three groups as follows:

Group A — Steel railway and road bridges and other structures subjected to dynamic loadings which require closer tolerances than those specified for Group B and Group C.

Group B — Steel structures having special characteristics and structures subjected to dynamic loading excluding wind/seismic, like crane gantry girders, its supporting structure, chimneys, microwave and transmission linetowers, sub-station and power station structures, industrial buildings and bunkers, etc.

Group C — Steel structures not subjected to dynamic loading, like platform galleries, stairs, etc, and which do not require closer tolerances as required for Group B structures.'

(*Page* 3, *clause* **0.3.1**) — Substitute the following for the existing clause:

'**0.3.1** In this standard only Groups B and C are covered. The fabrication tolerances for Group A Structures are not covered in this standard.'

(*Page* 4, *clause* **1.2**) — Substitute the following for the existing clause:

'**1.2** The tolerances specified in this standard do not apply to structures like steel railway and road bridges.'

(*Page* 4, *clause* **1.3**) — Substitute the following for the existing clause:

'**1.3** This standard is not applicable to thin-walled welded construction.'

(CED 7)

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