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मानक

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IS 5986 (2011): Hot Rolled Steel Flat Products for Structural Forming and Flanging Purposes [MTD 4: Wrought Steel Products]



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इस्पात के फ्लैट उत्पाद — विशिष्टि
(तीसरा पुनरीक्षण)

Indian Standard

HOT ROLLED STEEL FLAT PRODUCTS FOR
STRUCTURAL FORMING AND FLANGING PURPOSES —
SPECIFICATION
(*Third Revision*)

ICS 77.140.50

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

FOREWORD

This Indian Standard (Third Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by Wrought Steel Products Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1970 and subsequently revised in 1992 and 2002. While reviewing the standard, in the light of experience gained during these years, the Committee decided to revise it to bring in line with that present practices being followed by the Indian industry. In this revision the following changes have been made:

- a) Number of grades have been increased to nine.
- b) Grades have been aligned with the requirements given in the corresponding international standard, ISO 20805 : 2005 'Hot rolled steel sheet in coils of higher yield strength with improved formability and heavy thickness for cold forming'.
- c) International grades designation system based on yield stress has been adopted.
- d) Clause on retest has been modified.

For all the tests specified in this standard (chemical/physical/others), the method as specified in relevant ISO Standard may also be followed as an alternate method.

In the formulation of this standard, assistance has been derived from ISO 20805.

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

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 or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

**HOT ROLLED STEEL FLAT PRODUCTS FOR
STRUCTURAL FORMING AND FLANGING PURPOSES —
SPECIFICATION**

(Third Revision)

1 SCOPE

This standard covers the requirements of hot rolled flat products of non-alloy steel intended for use in welded, bolted and riveted structures. This standard also covers the requirement of flanging and forming applications required for the manufacture of integral coaches, automobiles and general purpose use where guaranteed mechanical properties and suitability for flanging and forming simple cold pressed parts are necessary.

2 REFERENCES

The following standards contain provisions, which through reference in this text constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

<i>IS No.</i>	<i>Title</i>
228 (in various parts)	Methods of chemical analysis of steels
1599 : 1985	Method for bend test (<i>second revision</i>)
1608 : 2005	Metallic materials — Tensile testing at ambient temperature (<i>third revision</i>)
1730 : 1989	Dimensions for steel plates, sheets strips and flats for general engineering purposes (<i>second revision</i>)
1757 : 1988	Method for charpy impact test (V-notch) for metallic material (<i>second revision</i>)
1852 : 1985	Rolling and cutting tolerances for hot rolled steel product (<i>fourth revision</i>)
1956	Glossary of terms relating to iron and steel:
(Part 3) : 1975	Hot rolled steel products (excluding sheet and strip) (<i>first revision</i>)

*IS No.**Title*

(Part 4) : 1975	Steel sheet and strip (<i>first revision</i>)
8910 : 2010	General technical delivery requirements for steels and steel products (<i>first revision</i>)

3 TERMINOLOGY

For the purpose of this standard the definitions given in IS 1956 (Parts 3 and 4) shall apply.

4 SUPPLY OF MATERIALS

General requirements relating to the supply of material shall conform to IS 8910.

5 MANUFACTURE

5.1 Steel shall be manufactured by any process of steel making except Bessemer process. It may be followed by secondary refining or secondary vacuum, treatment.

5.2 Steel shall be semi-killed or killed.

6 GRADE

There shall be nine grades of hot rolled steel plates, sheets, strips and flats designated as 165, 205, 235, 255, 325, 355, 420, 490 and 560.

7 CHEMICAL COMPOSITION**7.1 Ladle Analysis**

The ladle analysis of the steel, when carried out by the method specified in the relevant parts of IS 228 or any other established instrumental/chemical method, shall conform to the requirements as given in Table 1. This analysis shall be made from a test sample, preferably taken during casting/teeming of the heat. In case of dispute, the procedure given in IS 228 and its relevant parts shall be the referee method and where test methods are not specified shall be as agreed to between the purchaser and the manufacturer/supplier.

7.2 Product Analysis

The permissible variation in the case of product

Table 1 Chemical Composition
(Clauses 7.1 and 7.2)

Sl No.	Grade	Constituents, Percent, Max				
		Carbon	Manganese	Phosphorus	Sulphur	Carbon Equivalent ¹⁾
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	165	0.12	0.60	0.040	0.040	—
ii)	205	0.15	0.80	0.040	0.040	—
iii)	235	0.17	1.00	0.040	0.040	—
iv)	255	0.20	1.30	0.040	0.040	0.42
v)	325	0.20	1.30	0.040	0.040	0.42
vi)	355	0.20	1.50 ²⁾	0.035	0.035	0.45
vii)	420	0.20	1.50 ²⁾	0.035	0.035	0.45
viii)	490	0.20	1.50 ²⁾	0.035	0.030	0.45
ix)	560	0.20	1.50 ²⁾	0.035	0.030	0.45

NOTES

1 The nitrogen content of the steel shall not be more than 0.009 percent. For aluminium killed or aluminium silicon killed the nitrogen content shall not exceed 0.012 percent. This shall be ensured by occasional checking.

2 When the steel is killed by aluminium the total aluminium content should not be less than 0.02 percent. When steel is silicon killed the silicon content shall not be less than 0.1 percent. When the steel is aluminium silicon killed the silicon content shall not be less than 0.03 percent and total aluminium content shall not be less than 0.01 percent.

3 The material may be supplied in the copper bearing quality in which case the copper shall be between 0.20 and 0.35 percent on analysis.

4 The steel can be made with micro-alloying element like Nb, V, Ti and B either individually or in combination on mutual agreement. In which case the total micro-alloying elements should not exceed 0.2 percent in ladle analysis. However, in case of boron, the limit shall be 0.001 percent.

5 As the form of sulphide inclusions may have certain influence on the cold forming properties, steel may be treated with elements like Ce or Ca, if agreed to between the manufacturer and purchaser.

$$1) \text{ Carbon equivalent (CE) based on ladle analysis} = C + \frac{\text{Mn}}{6} + \frac{\text{Cr} + \text{Mo} + \text{V}}{5} + \frac{\text{Ni} + \text{Cu}}{15}$$

2) For each reduction of 0.01 below the specified maximum percent carbon, an increase of 0.05 percent manganese over the specified maximum up to 1.65 is permitted.

analysis from the limits specified in Table 1 shall be as given in Table 2.

Table 2 Permissible Variation for Product Analysis

Sl No.	Constituent	Variation Over the Specified Maximum Limit, Percent, Max
(1)	(2)	(3)
i)	Carbon	0.03
ii)	Manganese	0.05
iii)	Sulphur	0.005
iv)	Phosphorus	0.005
v)	Copper	0.03

8 FREEDOM FROM DEFECTS

8.1 Sheets, strips, plates and flats shall be closely rolled to the dimensions specified. The finished material shall be free from harmful defects and shall be reasonable smooth and flat. Repair by welding shall not be undertaken by the supplier without the permission of the purchaser.

8.2 When the material is supplied in the form of coils, the degree or amount of surface defects are expected to be more than in cut length sheets since the inspection of coils does not afford the same opportunity to reject portion continuing defects as with cut lengths. However, an excessive amount of defects may be cause for rejection.

8.3 In case of plates, scale pits and other minor surface defects may be removed by grinding the depth of grinding being such that the thickness of the plate shall not go below the specified value, at the spot where dressing is done. The grinding shall be even and smooth and shall be widened enough to remove sharp ridges. Dressing with a hammer or welding of defective spots shall not be permitted.

9 TENSILE TEST

9.1 One tensile test shall be made from finished steel for every 100 tonne or part thereof rolled continuously from each cast.

9.1.1 Where plates, sheets, strips and flats of more than one thickness are rolled from the same cast, one additional tensile test shall be made from the material:

- a) *In the case of plates and flats* — For each variation thickness of 6 mm from the thickness of test piece first selected.
- b) *In the case of sheets and strips* — For each thickness of sheets.

9.2 Tensile Test Pieces

Samples for tensile test shall be cut transverse to the direction of final rolling and shall be of full thickness of the material.

9.2.1 Tensile test pieces shall be of dimensions as specified in IS 1608.

9.3 Tensile Test

When tested in accordance with IS 1608 tensile strength, yield strength and percentage elongation shall be as given in Table 3.

9.3.1 Should a tensile test piece break outside the middle half of its gauge length and the percentage elongation obtained is less than that specified in the test may be discarded at the option of the manufacturer and another test made from the sample selected representing the same cast and batch.

10 BEND TEST

10.1 Number of Bend Test

One bend test shall be taken from each lot of 50 tonne of material or part thereof from each case. However,

in the case of material supplied after heat treatment, one bend test shall be conducted for heat treated batch per cast or a lot of 50 tonne, whichever is less.

10.1.1 Where plates, flats and strips of more than one thickness are rolled from the same cast, one additional bend test shall be made from the following material:

- a) *In the case of plates and flats* — For each variation of 6 mm from the thickness of the test piece first selected.
- b) *In the case of sheets and strips* — For each thickness of sheets.

10.2 The bend test shall be carried out in accordance with IS 1599.

10.2.1 Bend test piece shall be cut so that the axis of the bend is parallel to the direction of rolling that is the longer axis of the test piece shall be 90° to the direction of rolling.

10.2.2 The test piece shall bend cold through 180°. The internal diameter of the bend for the different grades of material shall be as given in Table 4. The test piece shall be deemed to have passed the test, if the outer convex surface is free from cracks.

10.2.3 It is some time difficult to ensure that the material is accurately following the radius. In case of dispute, the test piece may be pushed into a block of lead by a former of appropriate diameter.

11 IMPACT TEST

11.1 If stated in the order impact test shall normally be carried out on products having thickness greater

Table 3 Tensile Properties
(Clause 9.3)

Sl No.	Grade	Tensile Strength MPa	Yield Stress, <i>Min</i> MPa	Percentage Elongation on Gauge Length, <i>Min</i>	
				$L_0 = 80 \text{ mm}$ $b = 20 \text{ mm}$ (Up to 3 mm Thickness)	$5.65\sqrt{S_0}$ (Over 3 mm Thickness)
(1)	(2)	(3)	(4)	(5)	(6)
i)	165	290-400	165	22	30
ii)	205	330-440	205	20	28
iii)	235	360-470	235	19	26
iv)	255	410-520	255	17	24
v)	325	420-530	325	—	19
vi)	355	420-530	355	—	18
vii)	420	480-590	420	—	15
viii)	490	540-650	490	—	12
ix)	560	610-720	560	—	10

NOTE — Grade 165 may be supplied based on chemical composition only, if agreed to between the manufacturer and the purchaser.

Table 4 Bend Test Requirement for Hot Rolled Steel Plates/Sheets

(Clause 10.2.2)

All dimensions in millimetres.

SI No.	Grade	Internal Diameter of Bend Thickness	
		Up to and Including 12	Above 12
(1)	(2)	(3)	(4)
i)	165	Close	t
ii)	205	t	2t
iii)	235	t	2t
iv)	255	t	2t
v)	325	2t	3t
vi)	355	2t	3t
vii)	420	2t	3t
viii)	490	2t	3t
ix)	560	2t	3t

than or equal to 12 mm. The test specimen shall be machined in such a way that the axis of the test specimen is parallel to the direction of rolling and the base closer to the roll surface is more than or equal to 1 mm from it. The notch axis shall be perpendicular to the roll surface.

11.2 For all grades of steel under this standard, the average V-notch bar impact strength (average of 3 tests carried out on 3 test pieces taken side by side from the same product) shall not be less than 27 J with no individual test value less than 18 J.

11.3 If stated in the order impact tests may be carried out on products having thickness less than 12 mm, the dimensions of test piece shall be as specified in IS 1757. The average impact value required for material less than 12 mm and more than 25 mm thick will be as per mutual agreement between the purchaser and the manufacturer.

11.4 A test sample shall be taken from each 100 tonne or part thereof from the same heat. If different thicknesses have been rolled from slabs of a same heat, test sample shall be taken from the thickest product. If the test sample taken from the thickest product rolled from a cast meets the requirement, the whole cast shall be deemed to meet the requirement of next lower thickness rolled from the same cast and if it meets the requirements specified, this particular thickness as also other section of lower thickness shall be deemed to satisfy the specification. If this thickness also does not meet the test, it shall be carried out on the next lower thickness and so on.

12 RETEST

If a test does not give the specified results, two additional tests shall be carried out at random on the same lot. Both retests shall conform to the

requirements of this standard, otherwise, the lot shall be rejected.

13 WELDABILITY

All steels complying with the standard are of weldable quality. The material shall be suitable for gas welding, arc welding, spot welding and roller seam welding.

14 DIMENSIONS AND TOLERANCES

14.1 Unless agreed otherwise the dimensions of hot rolled steel plates, sheets, strips and flats shall conform to those given in IS 1730.

14.2 The length tolerance on ordered length of plates shall be as given in Table 5. The length of plate shall be taken as the length of the largest rectangle contained within the plate.

Table 5 Length Tolerance for Plates

All dimensions in millimetres.

SI No.	Ordered Length	Tolerance
(1)	(2)	(3)
i)	< 4 000	-0 +20
ii)	4 000-6 000	-0 +30
iii)	6 000-8 000	-0 +40
iv)	8 000-10 000	-0 +50
v)	10 000-15 000	-0 +75
vi)	>15 000	-0 +100

14.3 Width Tolerance for Plates and Strips

The width tolerance on ordered width for plates and strips shall be as given in Table 6. Width shall be measured perpendicular to the major axis of the plate.

Table 6 Width Tolerance for Plates and Strips

All dimensions in millimetres.

SI No.	Ordered Length	Tolerance
(1)	(2)	(3)
i)	600-2 000	-0 +20
ii)	2 000-3 000	-0 +25
iii)	3 000-4 000	-0 +30

14.4 Tolerance on thickness of the steel flats shall conform to the limits specified in IS 1852.

14.5 The edge camber, that is, lateral departure of the edge of the material from a straight line forming a chord (*see* Fig. 1) of hot rolled steel sheets, including descaled sheets, in cut lengths and coil shall not exceed the tolerances as given in Table 7.

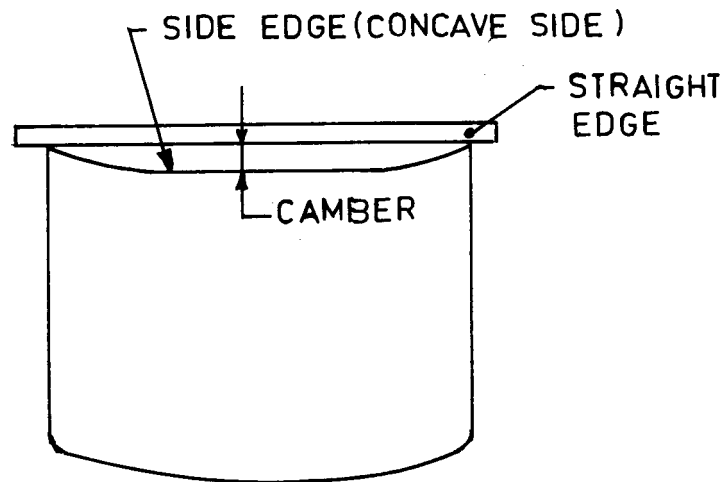


FIG.1 EDGE CAMBER

Table 7 Camber Tolerance
(Clause 14.5)

All dimensions in millimetres.

Sl No.	Form	Maximum Tolerance
(1)	(2)	(3)
i)	Coil	25 mm in any 5 000 mm length
ii)	Cut Length	0.5 percent \times length

14.6 Flatness Tolerances

When the sheets are required to be supplied in the flattened condition either by roller or stretcher, levelling the permissible maximum flatness (*see* Fig. 2) shall be as given in Table 8.

NOTE — Maximum deviation from a flat horizontal surface with the sheet lying under its own mass with the concave side upper most on a flat surface, the maximum distance between the lower surface of the sheet and the flat horizontal surface is the maximum deviation from flatness.

Table 8 Flatness Tolerance
All dimensions in millimetres.

Sl No.	Thickness	Width	Flatness Tolerance
(1)	(2)	(3)	(4)
i)	Up to 2	a) Up to 1 200	18
		b) Above 1 200 up to 1 500	25
		c) Above 1 500	30
ii)	Above 2	a) Up to 1 200	15
		b) Above 1 200 up to 1 500	20
		c) Above 1 500	25

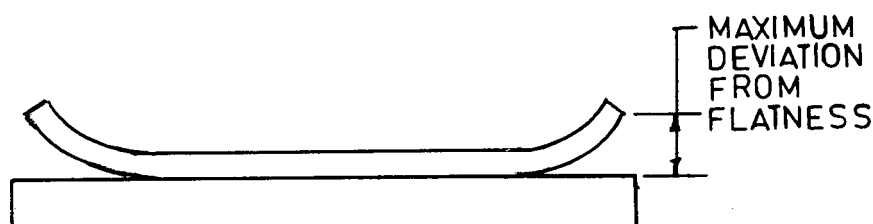


FIG. 2 FLATNESS TOLERANCE

14.7 Out-of-Square Tolerances

The out-of-square tolerance for sheets of all thickness and all sizes shall be 1.0 percent of width (*see* Fig. 3).

NOTE — Out-of-square is the greatest deviation of an edge from a straight line drawn at a right angle to the other edge of the sheet, touching one corner and extending the opposite edge.

15 DELIVERY

Subject to prior agreement between the manufacturer and the purchaser, a suitable protective treatment may be given to the material.

16 CALCULATION OF MASS

The mass of the steel shall be calculated on the basis of steel density 7.85 gm/cm³.

17 MARKING

17.1 Each product shall be marked with cast number and manufacturers name or trade-mark except where it is produced from coil. For the products cut from the HR coils, the marking shall be on top of each sheet of bundle or pile.

17.2 BIS Certification Marking

The material may also be marked with the Standard Mark.

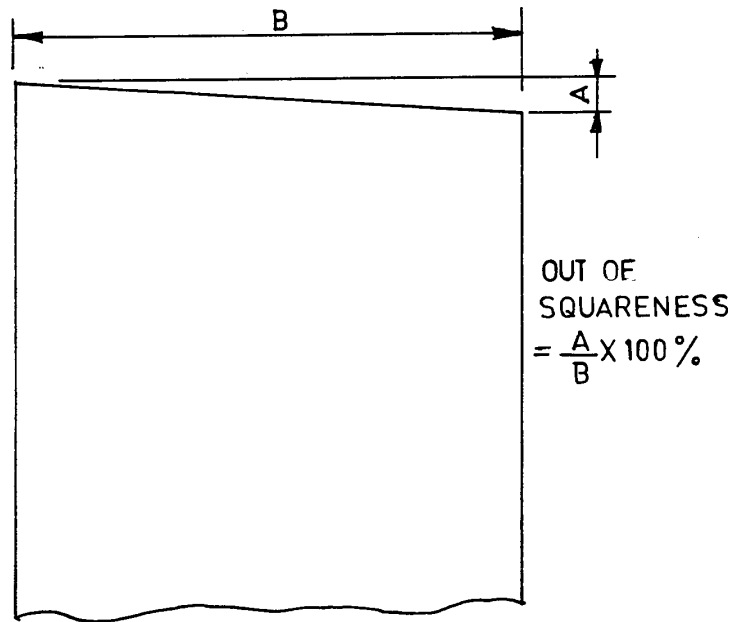


FIG. 3 MEASUREMENT OF OUT-OF-SQUARENESS

17.2.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

18 ORDERING INFORMATION

While placing an order, the following are the minimum

information to be specified by the purchaser:

- a) Grade;
- b) Size;
- c) Mass of the coil;
- d) Total order quantity;
- e) Marking instructions other than specified, if any; and
- f) Restricted chemistry, if used for special purpose.

ANNEXA
(Foreword)

COMMITTEE COMPOSITION

Wrought Steel Products Sectional Committee, MTD 4

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SAIL, Central Marketing Organization, Kolkata	SHRI P. C. JHA SHRI B. V. S. PANDIT (<i>Alternate</i>)
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Steel Re-rolling Mills Association of India, Mandi Gobindgarh	SHRI B. M. BERIWALA COL SURINDER SINGH (<i>Alternate</i>)

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<i>Organization</i>	<i>Representative(s)</i>
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TCE Consulting Engineers, Jamshedpur	DR M. D. MAHESHWARI
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Member Secretary

SHRI DEEPAK JAIN
Scientist 'E' (MTD), BIS

Flat Steel Products Subcommittee, MTD 4 : 3

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Amendments Issued Since Publication

Amendment No.	Date of Issue	Text Affected

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