*भारतीय मानक*

***Indian Standard***

**IS 18809 : 2024**

# घिसाव और घर्षण प्रतिरोधी इस्पात की चद्दर और प्लेट — विशिष्टि

# Wear and Abrasion Resistant Steel Sheet and Plate — Specification

ICS 77.140.50



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**August 2024** **Price Group 6**

Wrought Steel Products Sectional Committee, MTD 04

FOREWORD

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

With the continuous development of global steel manufacturing industry, steel plates has found widespread application for important parts and materials in construction, mining, and transport machinery in the form of plates/bars with guaranteed through hardness from the surface down to its core. Therefore, the Committee felt the need to formulate a standard on abrasion resistant steels capable of giving extended service life and high productivity in the most challenging environments. An attempt is made to cover all such grades which were usually traded on basis of various brands warranting long lasting hardness of the steels.

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.

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

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 : 2022 'Rules for rounding off numerical values (*second revision*)'. 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*

# WEAR AND ABRASION RESISTANT STEEL SHEET AND PLATE — SPECIFICATION

## 1 SCOPE

This standard covers the requirements for wear and abrasion resistant steel sheet and plate supplied in Quenched (Q) or Quenched and Tempered (Q and T) condition.

## 2 REFERENCES

The standards listed in Annex A 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 edition of these standard.

## 3 SUPPLY OF MATERIAL

**3.1** General requirements for the supply of material shall be as laid down in IS 8910.

**3.2** Steel shall be supplied in the form of sheets or plates in mill edge or cut/trimmed edge condition.

**3.3** The products shall be supplied in Quenched (Q) or Quenched and Tempered (Q and T) conditions.

## 4 TERMINOLOGY

**4.1 Quenching** — The process of quenching or quench hardening involves heating the steel above the upper critical temperature, soaking for sufficient time so as to attain a uniform temperature through the thickness and then rapidly cooling the steel in water/oil/forced air/other media (Quenching) to increase the hardness of steel significantly.

**4.2 Tempering** — Heating to elevated temperature but below transformation zone, of hardened steel and holding for specified time at temperature followed by cooling at desired rate to develop desired mechanical properties in the steel.

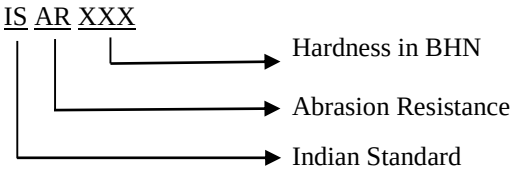
**4.3 Wear and Abrasion Resistant Steels** — These are steels with higher hardness than conventional steels such that the sheets and plates of this steel resist surface wear and abrasion due to rubbing or friction during use.

**4.4 Product** — Wear and abrasion resistant steel sheet and plate supplied in Quenched (Q) or Quenched and Tempered (Q and T) condition.

## 5 CLASSIFICATION AND DESIGNATION

### 5.1 Designation

The designation of the product covered in the standard involves the combination of abbreviation of Indian Standard (IS), Attribute - Abrasion resistance (AR) and the above average Brinell hardness number in HBW.




### 5.2 Grades

Sheets and plates covered in this standards are classified on basis of hardness as given below in Table 1.

## 6 MANUFACTURE

**6.1** The steel shall be manufactured by any process of steel making involving secondary refining at the discretion of the manufacturer. The steel may be processed through vacuum degassing if agreed between the manufacturer and purchaser at the time of order.

**6.2** Steel sheets and plates may be supplied in following heat treated conditions:

a) Quenched (Q); and

b) Quenched and Tempered condition (Q and T).

The supply condition may be agreed between the manufacturer and the purchaser at the time of order.

## 7 CHEMICAL COMPOSITION

### 7.1 Ladle Analysis

The chemical composition of steel shall conform to the ladle analysis requirements of Table 2 when carried out either by the method specified in the relevant part of IS 228 or any other established instrumental/chemical method. In case of dispute, the procedure given in the relevant part of IS 228 shall be the referee method. The recommended values for carbon equivalent are given in Table 3.

### 7.2 Product Analysis

Permissible variation in the case of product analysis from the limits specified in Table 2 shall be as given in Table 4.

**Table 1 Designation and Grades**

(*Clause* 5.2)

| Sl No. | Grade | Hardness, HBW | Designation (Quality) |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| i) | ISAR 400 | 360 to 430 | The number mentioned in the designation gives an indication of hardness level of steel plates in Brinell Hardness Number (BHN) |
| ii) | ISAR 450 | 410 to 490 | |
| iii) | ISAR 500 | 450 to 550 | |
| iv) | ISAR 550 | 500 to 580 | |
| v) | ISAR 600 | 550 to 650 | |

**Table 2 Chemical Composition**

(*Clauses* 7.1 *and* 7.2)

| Sl No. | Steel Grade | Constituent, Percent, *Max* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | C | Mn | Si | P | S | Cr | Mo | Ni | B |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| i) | ISAR 400 | 0.30 | 1.60 | 0.70 | 0.025 | 0.010 | 1.80 | 0.50 | 1.20 | 0.005 0 |
| ii) | ISAR 450 | 0.32 | 1.60 | 0.70 | 0.025 | 0.010 | 1.80 | 0.50 | 1.20 | 0.005 0 |
| iii) | ISAR 500 | 0.35 | 1.80 | 0.80 | 0.025 | 0.010 | 2.00 | 0.60 | 1.50 | 0.005 0 |
| iv) | ISAR 550 | 0.37 | 1.80 | 0.80 | 0.025 | 0.010 | 2.00 | 0.60 | 1.50 | 0.005 0 |
| v) | ISAR 600 | 0.47 | 1.80 | 0.80 | 0.025 | 0.010 | 2.00 | 0.60 | 1.50 | 0.005 0 |

**Table 3 Recommended Carbon Equivalent Limits for Different Grades**

(*Clause* 7.1)

| Sl No. | Steel Grade | Carbon Equivalent (in weight % *Max*) Corresponding to Plate Thickness in mm Range | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | > 3.00 to < 8.00 | ≥ 8.00 to < 20.00 | ≥ 20.00 to < 40.00 | ≥ 40.00 to < 50.00 | ≥ 50.00 to < 60.00 | ≥ 60.00 to < 80.00 | ≥ 80.00 to < 100.00 | ≥ 100.00 to ≤ 130.00 |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| i) | ISAR 400 | 0.41 | 0.55 | 0.55 | 0.60 | 0.65 | 0.70 | 0.80 | 0.85 |
| ii) | ISAR 450 | 0.47 | 0.55 | 0.60 | 0.65 | 0.70 | 0.75 | 0.85 | 0.90 |
| iii) | ISAR 500 | 0.50 | 0.65 | 0.70 | 0.75 | 0.80 | 0.85 | 0.85 | – |
| iv) | ISAR 550 | – | 0.70 | 0.75 | 0.80 | 0.85 | 0.90 | – | – |
| v) | ISAR 600 | – | 0.70 | 0.75 | 0.85 | 0.85 | 0.90 | – | – |

NOTES

**1** Grain refining elements such as Al, Nb, V and Ti may be added singly or in combination. Total grain refining elements shall not be more than 0.25 percent.

**2** Elements other than those given in the above table may be added if agreed between the manufacturer and supplier.

**3** Restricted chemical composition may be mutually agreed between the purchaser and the supplier.

**4** Nitrogen content of steel shall not exceed 0.012 percent.

**5** Carbon equivalent (CE) based on ladle analysis $Ceq = C + Mn/6 + (Cr + V + Mo)/5 + (Cu + Ni)/15$ (%).

**6** Thickness above 130 mm may be supplied if mutually agreed between the manufacturer and purchaser.

**7** Carbon equivalent (CE) for thickness above 130 mm may be mutually agreed between the manufacturer and purchaser.

**Table 4 Tolerances on Product Analysis**

(*Clause* 7.2)

| Sl No. | Element | Specified Chemical Composition Limit, Percent, *Max* | Permissible Variation Over the Specified Limit, Percent, *Max* |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| i) | Carbon | ≤ 0.150 | 0.02 |
| | | > 0.150 | 0.03 |
| ii) | Manganese | ≤ 0.6 | 0.03 |
| | | > 0.60, ≤ 1.150 | 0.04 |
| | | > 1.150 | 0.05 |
| iii) | Sulphur | ≤ 0.050 | 0.005 |
| iv) | Phosphorus | ≤ 0.025 | 0.005 |
| v) | Silicon | ≤ 0.600 | 0.03 |
| | | > 0.600 | 0.06 |
| vi) | Chromium | ≤ 2.00 | 0.05 |
| vii) | Nickel | ≤ 1.00 | 0.03 |
| | | > 1.00 | 0.05 |
| viii) | Molybdenum | ≤ 0.30 | 0.03 |
| | | > 0.30, ≤ 0.60 | 0.04 |
| ix) | Boron | ≤ 0.005 0 | 0.000 3 |

**Table 5 Hardness in BHN**

(*Clause* 8.1)

| Sl No. | Grade | Hardness (BHN) |
|---|---|---|
| (1) | (2) | (3) |
| i) | ISAR 400 | 360 to 430 |
| ii) | ISAR 450 | 410 to 490 |
| iii) | ISAR 500 | 450 to 550 |
| iv) | ISAR 550 | 500 to 580 |
| v) | ISAR 600 | 550 to 650 |

## 8 MECHANICAL PROPERTIES

Except for hardness, testing for mechanical properties such as tensile, bend and impact for wear and abrasion resistance steels covered in this standard is an optional requirement. However, if required, these tests and their values may be mutually agreed between the manufacturer and purchaser at the time of order.

For reference, the corresponding values for tensile, bend and impact test for 20 mm thickness are given in Table 6, Table 7 and Table 8 respectively.

### 8.1 Hardness Test

Product shall conform to the hardness requirements specified in Table 5, when tested in accordance with IS 1500 (Part 1). Minimum core hardness shall be 90 percent of the guaranteed minimum surface hardness.

#### 8.1.1 *Sampling*

Hardness test to be conducted on sample drawn from the heat treated sheet/plate.

For plates from plate mill, one test sample shall be taken from corner of each plate as-rolled. For sheets/plates produced from coil, three samples from each coil (head end, middle and tail end) shall be taken.

### 8.2 Tensile Test

Indicative tensile properties for product of 20 mm thickness are as given in Table 6 when tested as per IS 1608 (Part 1).

### 8.3 Bend Test

Indicative bend test radii for product of 20 mm thickness are as given in Table 7 when tested as per IS 1599.

NOTE — Hardness testing shall be done after removing a surface layer by milling or grinding as per given in below table.

| *Sl No.* | *Sheet/Plate Thickness Range* (mm) | *Depth of Milling or Grinding* (mm) |
|---|---|---|
| (1) | (2) | (3) |
| i) | Up to 10.0 | 0.50 |
| ii) | > 10.0 to 25.0 | 1.00 |
| iii) | > 25.0 to 50.0 | 1.50 |
| iv) | > 50.0 to 80.0 | 2.00 |
| v) | > 80.0 | 3.00 |

**Table 6 Indicative Tensile Strength for 20 mm Thickness Plate**

(*Clauses* 8 *and* 8.2)

| **Sl No.** | **Grade** | **Yield Strength (in MPa)**, *Min* | **Tensile Strength (in MPa)**, *Min* | **% Elongation (GL: 5.65√So)**, *Min* |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| i) | ISAR 400 | 900 | 1 150 | 8.0 |
| ii) | ISAR 450 | 1 000 | 1 300 | 8.0 |
| iii) | ISAR 500 | 1 200 | 1 400 | 6.0 |
| iv) | ISAR 550 | — | — | — |
| v) | ISAR 600 | — | — | — |

**Table 7 Bend Angle and Internal Bend Radius for 20 mm Thick Plate**

(*Clauses* 8 *and* 8.3)

| **Sl No.** | **Grade** | **Bend Radius (Bend Angle: 90º)** | |
|---|---|---|---|
| | | Sample Orientation Transverse to Rolling Direction | Sample Orientation Longitudinal to Rolling Direction |
| (1) | (2) | (3) | (4) |
| i) | ISAR 400 | 3.0 × thickness | 4.0 × thickness |
| ii) | ISAR 450 | 4.0 × thickness | 5.0 × thickness |
| iii) | ISAR 500 | 5.0 × thickness | 6.0 × thickness |
| iv) | ISAR 550 | – | – |
| v) | ISAR 600 | – | – |

NOTES
**1** Bend test shall be carried out in accordance with IS 1599.
**2** The test piece shall be bend at ambient room temperature through 90º.

**Table 8 Indicative Charpy Impact Values for 20 mm Plate Thickness**

(*Clauses* 8 *and* 8.4)

| **Sl No.** | **Grade** | **Average Charpy Impact Energy (Joules)** | |
|---|---|---|---|
| | | Test Temperature - 20 ºC | Test Temperature - 40 ºC |
| i) | ISAR 400 | 27 min | 20 min |
| ii) | ISAR 450 | 27 min | 15 min |
| iii) | ISAR 500 | 27 min | 15 min |
| iv) | ISAR 550 | – | – |
| v) | ISAR 600 | – | – |

NOTE — The sample orientation is longitudinal to rolling direction.

### 8.4 Charpy V-Notch Impact Test

The indicative charpy impact values for product of 20 mm thickness are as given in Table 8 when tested as per IS 1757 (Part 1).

## 9 NON DESTRICTIVE TEST

The material may be subjected to any non-destructive testing to determine the internal soundness of material subject to mutual agreement between the manufacturer/supplier and purchaser at the time of order.

## 10 RETEST

**10.1** If a test does not give the specified results, two additional tests shall be carried out from same plate as rolled/sheets-plates from coil. Both the retests shall conform to the requirements of the standard

**10.2** If any of the retest fails to meet the mechanical requirements specified, the supplier may re-heat treat the material and in that case, all the mechanical properties shall be re-evaluated.

## 11 FREEDOM FROM DEFECTS

**11.1** Sheets and Plates shall be well and cleanly rolled to the dimensions specified. The finished material shall be reasonably free from surface flaws, laminations, rough/jagged and imperfect edges and other harmful defects.

**11.2** Minor surface defects may be removed by the manufacturer by grinding provided that the thickness of the sheet/plate shall not go below the thickness tolerance specified at the spot where dressing is done. The grinding shall be even and smooth and shall be widened enough to remove sharp ridges.

**11.3** Surface properties and repair conditions shall be as agreed to between the manufacturer and the purchaser. However, repair welding of defective spots shall not be permitted.

## 12 DIMENSIONS AND TOLERANCES

Unless otherwise agreed to between the purchaser and the manufacturer, the rolling and cutting tolerances for steel products conforming to this standard shall be as per IS 1852.

## 13 MARKING

Each plate as rolled shall to be marked with manufacturer's name, designation of steel and details like plate no., cast/heat number and nominal dimensions.

Sheets/plates produced from strip or coil form shall be supplied in bundles. Each bundle shall carry a metal tag or adhesive label/sticker bearing the cast/heat number or identification mark or lot number traceable to the cast/heat number and the manufacturer's name or trade mark. Alternatively, top sheet/plate shall be legibly marked with cast/heat number or identification mark or lot number traceable to the cast/heat number, name of the manufacturer or trade-mark.

## 14 DELIVERY

The plates may be supplied in as heat treated condition or shot blasted and primer coated condition. The technical requirement of the surface coating shall be mutually agreed between the manufacturer and the purchaser at time of order.

## 15 BIS CERTIFICATION MARKING

The products(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standard Act*, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark.

## 16 ORDERING INFORMATION

While placing the order, the following are the minimum information to be specified by the purchaser:

a) Grade;

b) Size;

c) Mass of the material;

d) Total order quantity;

e) Marking instruction other than specified, if any;

f) Restricted chemistry and/or properties, if used for special purpose;

g) Dimension tolerance, if any special agreements to be made; and

h) Supply condition (edge condition, delivery condition and type of surface coating if any, etc).

## ANNEX A

(*Clause* 2)

## LIST OF REFERRED STANDARDS

| *IS No.* | *Title* |
|---|---|
| IS 228 (in all parts) | Methods of chemical analysis of steel |
| IS 1500 (Part 1) : 2019/ISO 6506-1 : 2014 | Metallic materials — Brinell hardness test: Part 1 Test method (*fifth revision*) |
| IS 1599 : 2023/ ISO 7438 : 2020 | Metallic materials — Bend test (*fifth revision*) |
| IS 1608 (Part 1) : 2022/ISO 6892-1 : 2019 | Metallic materials — Tensile testing: Part 1 Method of test at room temperature (*fifth revision*) |
| IS 1730 : 1989 | Steel plates, sheets, strips and flats for structural and general engineering purposes — Dimensions (*second revision*) |
| IS 1757 (Part 1) : 2020/ISO 148-1 : 2016 | Metallic materials — Charpy pendulum impact test: Part 1 Test method (*fourth revision*) |
| IS 1852 : 1985 | Specification for rolling and cutting tolerances for hot-rolled steel products (*fourth revision*) |
| IS 1956 (all parts) | Glossary of terms relating to iron and steel |
| IS 4225 : 2021/ ISO 17577 : 2016 | Steel — Ultrasonic testing of steel flat products of thickness equal to or greater than 6 mm (*third revision*) |
| IS 8910 : 2022/ ISO 404 : 2013 | Steel and steel products — General technical delivery requirements (*second revision*) |

## ANNEX B

(*Foreword*)

## COMMITTEE COMPOSITION

Wrought Steel Products Sectional Committee, MTD 04

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| SAIL, Research & Development Center for Iron & Steel, Ranchi | SHRI NIRVIK BANERJEE (***Chairperson***) |
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## Amendments Issued Since Publication

| Amend No. | Date of Issue | Text Affected |
|---|---|---|
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