IS 11587 (1986): Structural weather resistant steels [MTD 4: Wrought Steel Products]

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Indian Standard

SPECIFICATION FOR STRUCTURAL WEATHER RESISTANT STEELS

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

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SPECIFICATION FOR STRUCTURAL WEATHER RESISTANT STEELS

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Indian Standard

SPECIFICATION FOR STRUCTURAL WEATHER RESISTANT STEELS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 30 January 1986, after the draft finalized by the Wrought Steel Products Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 The atmospheric corrosion resistance of these steels is approximately four times to that of carbon structural steel. Welding is of fundamental importance, and it is pre-supposed that suitable welding procedures will be adopted for welding the steels. These steels are intended for applications where weight saving along with improved atmospheric corrosion resistance is important.

0.3 In formulating this standard, assistance has been derived from ISO 4952-1981 'Structural steels with improved atmospheric corrosion resistance', issued by the International Organization for Standardization.

0.4 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*. 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 the requirements for high strength low alloy weather resistant structural steels in the form of plates, strips, sections and bars for welded, riveted or bolted construction requiring atmospheric corrosion resistance.

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

2. SUPPLY OF MATERIAL

2.1 General requirements relating to the supply of steel shall conform to IS : 8910-1978*.

3. MANUFACTURE

3.1 Steel shall be manufactured by the open-hearth, electric, basic-oxygen or a combination of these processes. In case any other process is employed by the manufacturer, prior approval of the purchaser should be obtained.

3.1.1 The steel shall be supplied in killed condition.

4. GRADES

4.1 There shall be following three grades of structural weather resistant steel:

a) WR-Fe 480A,
b) WR-Fe 480B, and
c) WR-Fe 500

5. CHEMICAL COMPOSITION

5.1 Ladle analysis of the steel, when carried out by the method specified in the relevant part of IS : 228† or any other established instrumental/chemical method, shall be as specified in Table 1. In case of any dispute, the procedure given in the relevant part of IS : 228† shall be the referee method. However, if the method is not given in any part of IS : 228†, the referee method shall be as agreed to between the purchaser and the manufacturer.

5.2 Product Analysis — The product analysis shall be carried out on the finished product from the standard position. Permissible variation in case of such product analysis from the limits specified under **5.1** shall be as follows:

Constituent	*Variation Over/Under the Specified Limit, percent*
Carbon	± 0·03
Silicon	± 0·05
Manganese	± 0·05
Phosphorus	± 0·005
Sulphur	± 0·005
Nickel	± 0·05
Copper	± 0·05
Chromium	± 0·05

*General technical delivery requirements for steel and steel products.
†Method of chemieal analysis of steel (*second revision*).

TABLE 1 CHEMICAL COMPOSITION

(*Clause* 5.1)

GRADE	LADLE ANALYSIS (PERCENTAGE)								
	C	Si	Mn	P	S	Cr	Ni	Cu	V
WR-Fe 480A	0·12 *Max*	0·25-0·75	0·60 *Max*	0·070-0·150	0·050 *Max*	0·30-1·25	0·65 *Max*	0·25-0·55	—
WR-Fe 480B	0·10-0·19	0·15-0·50	0·90-1·25	0·040 *Max*	0·050 *Max*	0·40-0·70	—	0 25-0·40	0·02-0·10
WR-Fe 500	0·17 *Max*	0·40 *Max*	1·00 *Max*	0·070-0·100	0·050 *Max*	0·70-1·00	—	0·25-0·55	0·10 *Max*

NOTE 1 — Chemical composition for thicknesses over 16 mm is subject to agreement between the manufacturer and the purchaser.

NOTE 2 — Nickel content up to 0·65 *Max* may be added at the manufacturer's option, in case of Grade WR-Fe 500 material.

6. WELDABILITY

6.1 All steel grades specified in this standard are of weldable quality. If agreed to between the manufacturer and the purchaser, the weather resistant steel up to and including 50 mm thick plates shall be supplied with a carbon equivalent value of 0·54 *Max* based upon the ladle analysis. The carbon equivalent may be calculated using the formula:

$$\text{Carbon equivalent} = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Cu + Ni}{15}$$

6.2 If the weather resistant steels are to be used unpainted, it is advisable to select the welding electrodes with matching weathering characteristics.

6.3 Lower limits for carbon equivalent values may be agreed to between the contracting parties.

7. SELECTION AND PREPARATION OF TEST SAMPLES

7.1 The points from which test samples are taken shall be so located in the product as to yield the clearest possible information regarding properties in the cross-sectional and longitudinal planes. The recommended locations for taking test samples for plates, sections and bars are indicated in Fig. 1. Alternatively, in case of sections, the samples may be taken from the web.

7.2 Wherever practicable, the rolled surface of the steel shall be retained on the two opposite sides of the test samples.

7.3 In case of flat test samples for tensile test, both surfaces are normally to be left on the test specimen for sheets, strips, and plate up to 32 mm thick. At least one rolled surface shall be left on rectangular test samples taken from plate more than 32 mm thick. Round test samples are permitted, but should only be adopted for thickness exceeding 28 mm.

7.4 In case of flats up to 16 mm thick, the test sample shall undergo, if possible, no machining whatsoever prior to use as a test piece. If this is not possible, the test sample shall undergo the minimum amount of machining.

7.5 Bars below 28 mm may also be tested without machining. In case of bars having diameters or thicknesses between 28 and 71 mm, the bars may be symmetrically reduced by machining. For bars having diameters or thicknesses exceeding 71 mm, the test sample may be taken from the position shown in Fig. 1.

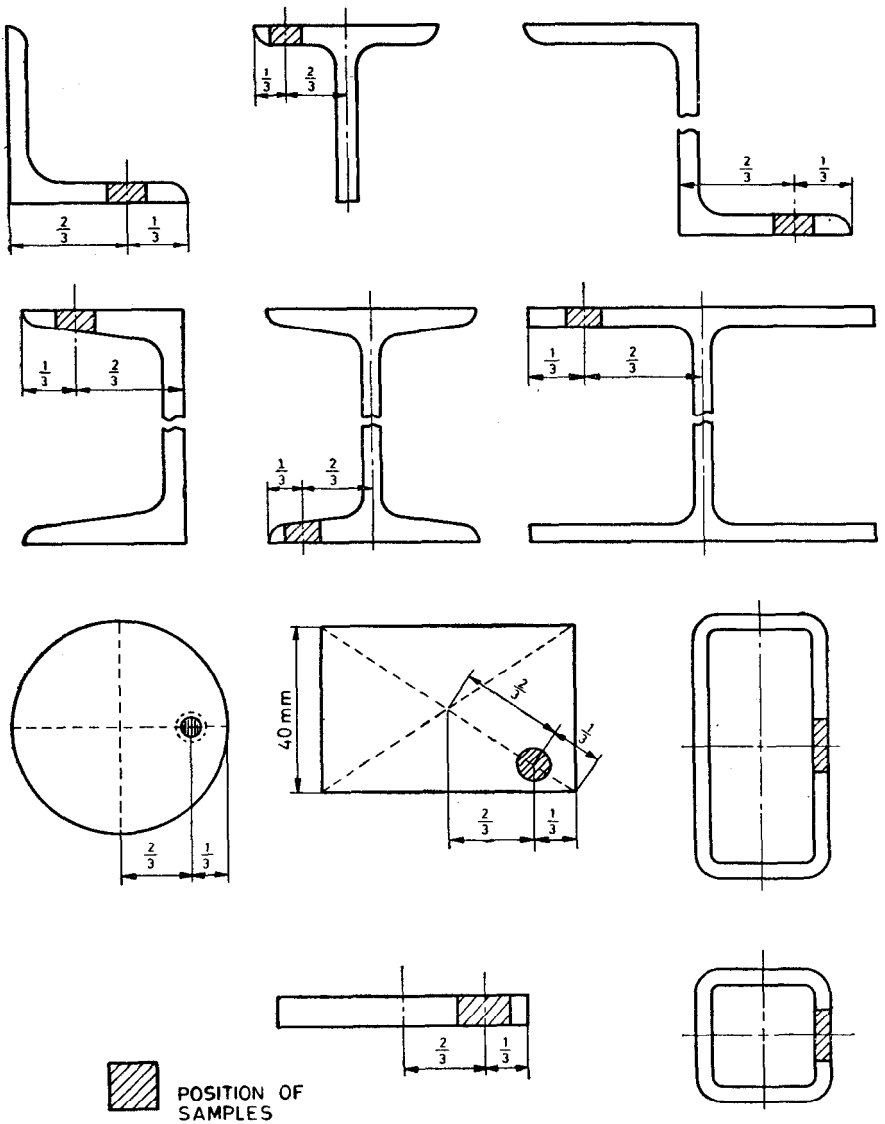

FIG. 1 STRUCTURAL STEEL SECTIONS, POSITION AND ORIENTATION OF SAMPLES

7.6 In the case of sections, flats, strips and plates, bend tests are to be carried out on rectangular test samples which, as far as possible, should be of the full thickness of the product. In the case of sections, flats and plates exceeding 28 mm in thickness, it is permissible to remove metal from one side of the test sample before using it as a test piece. The rolled surface of the test piece shall be on the outer side of the bend during the test.

7.7 Before test samples are detached, full particulars regarding cast number, size and mass of plates, and strips, sections, flats and bars in each case shall be furnished by the manufacturer to the purchaser. In case of plates, the number of plates in each cast shall also be given.

7.8 Test samples shall be cut in such a manner that deformation is avoided as far as possible. If shearing or flame-cutting is employed, an adequate allowance shall be left for removal by machining.

7.9 Test samples taken from rolled steel which have undergone deformation through bending or twisting shall in all cases be straightened cold. If the deformation is too severe to allow cold straightening, it is permissible in the case of materials to be delivered in the annealed or normalized condition, to carry out straightening under the application of heat, provided the temperature does not exceed 650°C. While straightening test samples, care shall be taken to avoid any cold-working or temperature rise which will alter the properties of the samples as compared with the finished product which they represent.

7.10 Test samples shall not be annealed or otherwise subjected to heat treatment unless the material from which they are cut is similarly treated, in which case the test samples shall be similarly and simultaneously treated with the material before testing. Any slight straightening of test samples which may be required shall be done cold.

8. TENSILE TEST

8.1 Number of Tensile Tests

8.1.1 *Plates, Strips, Sections (Angles, Tees, Beams, Channels, etc) and Flats* — One tensile test shall be made from finished steel for every 40 tonnes or part thereof rolled continuously from each cast, a separate test being made for each class of steel product (namely, plates, strips, sections and flats) rolled from a cast.

8.1.1.1 Where plates, strips, sections or flats of more than one thickness are rolled from the same cast, one additional tensile test shall be made from the material in each class of product for each variation in thickness of 6 mm.

8.1.2 *Bars (Round, Square and Hexagonal)* — One tensile test shall be made from finished steel for every 40 tonnes or part thereof rolled continuously from each cast and for every class of product. When more than one diameter or thickness of the bar is specified, one additional tensile test shall be made for each diameter or thickness of the bar ordered, if so desired, by the purchaser.

8.2 Tensile Test Pieces — The tensile strength, yield stress and percentage elongation of steel shall be determined from standard test pieces cut lengthwise or crosswise from plates and lengthwise from sections, flats and bars. The tests shall be carried out on Indian Standard test pieces prepared in accordance with IS : 1608-1972*.

8.3 Tensile Test — The tensile strength, yield stress and percentage elongation, when determined in accordance with IS : 1608-1972* shall be as given in Table 2.

TABLE 2 MECHANICAL PROPERTIES

GRADE	TENSILE STRENGTH *Min* MPa	YIELD STRENGTH, *Min* MPa				PERCENTAGE ELONGATION ON GAUGE LENGTH $5{\cdot}65\sqrt{S_0}$ *Min*
		Up to and including 12 mm	Over 12 mm Up to and Including 25 mm	Over 25 mm Up to and Including 40 mm	Over 40 mm Up to and Including 50 mm	
WR-Fe 480 A	480	345	325	325	—	21
WR-Fe 480 B	480	345	345	345	340	21
WR-Fe 500	500	355	—	—	—	20

8.3.1 In case of sections, the thickness of which is not uniform throughout the profile, the limits shall be applied according to the actual maximum thickness of the piece selected for testing.

8.3.2 Should the tensile test piece break outside the middle half of its gauge length (*see* IS : 1608-1972*) and the percentage elongation obtained is less than that specified, the test may be discarded at the manufacturer's option, and another test made from the same plate, section, flat or bar.

9. BEND TEST

9.1 Number of Bend Tests — Bend test shall be made from finished steel from each cast. The number of tests for every 20 tonnes of material, or part thereof, rolled continuously, shall be as shown in Table 3. One additional test shall be made for each class of product and for each variation in thickness.

*Method for tensile testing of steel products (*first revision*).

TABLE 3 NUMBER OF BEND TESTS
(*Clause* 9.1)

CLASS OF STEEL PRODUCT (1)	NUMBER OF BEND TESTS (2)
Section	1 lengthwise (for each type)
Plates	1 lengthwise and/or 1 crosswise
Flats strips and bars (round, square and hexagonal)	1 lengthwise

9.2 Bend Test Pieces — The test pieces shall be cut lengthwise or crosswise or both from plates, and lengthwise from sections, flats and bars. When sections permits, these shall be not less than 40 mm wide. If the manufacturer so desires, round, square, hexagonal and flat bars shall be bent in the full section as rolled.

9.2.1 In all bend test pieces, the rough edge or arris resulting from shearing may be removed by filing or grinding or machining, but the test pieces shall receive no other preparation.

9.2.2 The test pieces shall not be annealed or otherwise subjected to heat treatment unless the material from which they are cut is similarly treated, in which case the test pieces shall be similarly treated with the material, before testing.

9.3 Bend Test — Bend test shall be conducted in accordance with IS : 1599-1985*.

9.3.1 For bend tests except in the case of round bars 25 mm in diameter and under, the test pieces when cold shall, without cracking, be doubled over either by pressure or by blows from a hammer until the internal diameter is not greater than three times the thickness of the test piece and the sides are parallel.

9.3.2 In the case of round bars 25 mm in diameter and under, the internal diameter of the bend shall be not greater than twice the diameter of the bar.

10. IMPACT TEST

10.1 The impact test shall normally be carried out on products having a thickness greater than or equal to 12 mm. The test piece shall be so machined that the face closest to the rolling surface is not more than 1 mm from it. The notch shall be perpendicular to the rolled surface.

10.1.1 The test piece shall be taken at 1/4 of the thickness for the product above 40 mm thick.

10.1.2 If stated on the order, impact tests may be carried out on

*Method for bend test (*second revision*).

products having a thickness less than 12 mm. The dimensions of the test pieces shall be in conformity with IS : 1757-1973*.

10.2 The test samples shall be taken from thickness product.

10.3 This test is carried out using a V-notch test piece (*see* IS : 1757-1973*) the value for consideration being the arithmetic mean of the results obtained on three test pieces taken side by side in the same product. This mean value shall be as given in Table 4.

TABLE 4 CHARPY V-NOTCH IMPACT TEST VALUE

GRADE	TEMPERATURE °C	IMPACT ENERGY, JOULE (*Min*, AVERAGE)	REMARKS
WR-Fe 480 A	0	27	The test shall be carried out if agreed to between the manufacturer and the purchaser
WR-Fe 480 B	0	27	
WR-Fe 500	−15	27	Values for thickness over 16 mm are subject to mutual agreement between the purchaser and the manufacturer

NOTE — For grade WR-480 B when intented for sub-zero applications up to −15°C, the impact values be agreed between the contracting parties.

10.3.1 The average value for acceptance shall be considered only if not more than one specimen exhibits a value below the specified minimum average and in no case shall an individual value be below two-thirds of the specified minimum average.

10.3.2 If more than one specimen are below the specified minimum average, or if one value is below two thirds the specified minimum average, a retest of three additional specimen shall be made, each of which shall have a value equal to or exceeding the specified minimum average value.

11. FLATTENING TEST

11.1 Flattening test shall be carried out for circular hollow section. If agreed upon between the manufacturer and the purchaser, this test may also be carried out on rectangular hollow sections.

11.2 A ring not less than 40 mm in length shall be cut for every 40 tonnes or part thereof and the inner and outer edges of the ring shall be rounded off.

11.3 The ring shall be flattened cold between the parallel plates with

*Method for beam impact test (V-notch) on steel (*first revision*).

the weld, if any, at 45° in accordance with IS : 2328-1983*. No opening shall occur by fracture in the weld until the distance between the plates is less than 75 percent of the original outside diameter. The test shall continue until the weld, if any, opens and the weld shall show no sign of incomplete fusion. No crack or breakage in the metal elsewhere than the weld shall occur until the distance between the plate is 2/3 of the original outside diameter.

12. FREEDOM FROM DEFECTS

12.1 All finished steel shall be well and cleanly rolled to the dimensions, sections and mass specified. The finished material shall be free from cracks, surface flaws, laminations, rough jagged and imperfect edges, and all other harmful defects.

12.2 Minor surface defects may be removed by the manufacturer by grinding provided that the thickness is not reduced locally by more than 4 percent (with a maximum of 3 mm). Reductions greater than 4 percent but not exceeding 7 percent may be made only with the agreement of the purchaser.

12.2.1 Imperfections that are greater in depth than the limits previously listed may be removed and then weld metal deposited subject to the following limiting conditions.

12.2.1.1 The total area of the chipped or ground surface of any piece prior to welding shall not exceed 2 percent of the total surface area of that piece.

12.2.1.2 The reduction of thickness of the material resulting from removal of imperfections prior to welding shall neither exceed 20 percent of the nominal thickness at the location of the imperfection nor shall the depth of depression prior to welding exceed 30 mm in any case.

12.2.1.3 The flange of angles, beams and channel sections, and the web and flanges of tee-sections may be conditioned by grinding, chipping or arc-air gouging and welding. Prior to welding, the depth of depression, measured from the toe inward, shall be limited to the thickness of the material at the base of the depression, with a maximum depth limit of 13 mm.

12.2.1.4 The edges of plates may be conditioned by the manufacturer to remove injurious imperfections by grinding, chipping or arc-air gouging and welding. Prior to welding, the depth of depression measured from the plate edge inward shall be limited to the thickness of the plate, with a maximum depth of 25 mm.

*Method for flattening test on metallic tubes (*first revision*).

12.2.1.5 The reduction of sectional dimensions of a round, square, or hexagon bar; or the reduction in thickness of a flat bar, resulting from removal of an imperfection prior to welding, shall not exceed 5 percent of the nominal dimension or thickness at the location of the imperfection.

12.2.1.6 For the edges of flat bars, the depth of the conditioning depression prior to welding shall be measured from the edge inward and shall be limited to a maximum depth equal to the thickness of the flat bar or 12·5 mm, whichever is less.

13. DIMENSIONS

13.1 Unless otherwise agreed to between the purchaser and the manufacturer, the nominal dimensions of rolled steel products conforming to this specification shall be in accordance with the relevant Indian Standards. Currently available Indian Standards are listed in Table 5.

14. TOLERANCES

14.1 Unless otherwise agreed to between the purchaser and the manufacturer, the rolling and cutting tolerances for steel products conforming to this standard shall be those specified in IS : 1852-1979*.

15. RETESTS

15.1 Should any one of the test pieces first selected fail to pass any of the tests specified in **8**, **9**, **10** and **11**, two further samples shall be selected for testing in respect of each failure. Should the test pieces from both these additional samples pass, the material represented by the test samples shall be deemed to comply with the requirements of that particular test. Should the test pieces from either of these additional samples fail, the material represented by the test samples shall be considered as not having complied with this standard.

16. CALCULATION OF MASS

16.1 The mass of steel shall be calculated on the basis that steel weighs 7·85 g/cm^3.

17. DELIVERY

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

*Rolling and cutting tolerances for hot-rolled steel products (*third revision*).

TABLE 5 INDIAN STANDARDS WHICH GIVE NOMINAL DIMENSIONS OF ROLLED STEEL PRODUCTS

(*Clause* 13.1)

PRODUCT	RELEVANT INDIAN STANDARD
Beam, channel and angle sections	IS : 808-1964 Rolled steel beam, channel and angle sections (*revised*)
	IS : 808 (Part 1) - 1978 Dimensions for hot-rolled steel sections: Part 1 MB series (beams) (*second revision*)
	IS : 808 (Part 2) - 1978 Dimensions for hot-rolled steel sections: Part 2 Columns —SC series (*second revision*)
	IS : 808 (Part 3) - 1979 Dimensions for hot-rolled steel sections: Part 3 Channel, MC and MCP series (*second revision*)
Tee bars	IS : 1173-1978 Specification for hot rolled and slit steel tee bars (*second revision*)
Bulb angles	IS : 1252-1958 Specification for rolled steel sections bulb angle
Plates, sheet and strip	IS : 1730-1974 Dimensions for steel plate, sheet and strip for structural and general engineering purposes (*first revision*)
	Part 1 Plate
	Part 2 Sheet
	Part 3 Strip
Flats	IS : 1731-1971 Dimensions for steel flats for structural and general engineering purposes (*first revision*)
Round and square bars	IS : 1732-1971 Dimensions for round and square steel bars for structural and general engineering purposes (*first revision*)
Bulb flats	IS : 1863-1979 specification for rolled steel bulb flats (*first revision*)
Sheet, piling sections	IS : 2314-1963 Specification for steel sheet piling sections
Channel sections	IS : 3954-1966 Specification for hot rolled steel channel sections for general engineering purposes
Hollow sections	IS : 4923-1968 Specification for hollow steel sections for structural use
Plates for Ship's hull structure	IS : 5488-1969 Dimensions for hot rolled steel plates for ship's hull structure.

18. MARKING

18.1 Each product, except round, square and hexagonal bars and flats, shall be stamped with the manufacturer's name or trade mark. In the case of bars and flats, each bundle shall carry a tag and the tag shall

bear the manufacturer's name or trade-mark. Designation of steel shall also be similarly marked on the product or tags.

18.2 Every heavy and medium structural mill product, every coil of strip, and each plate of thickness 10 mm and over shall be stamped/marked with the cast number and manufacturer's name or trade-mark. In case of plates below 10 mm thickness, the top plate of each pile (which may consist of approximately 10 plates) shall be marked with the cast number.

18.3 The steel shall be suitably painted with a colour in accordance with IS : 2049-1978*.

18.3.1 The material may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

*Colour code for the identification of wrought steels for general engineering purposes (*first revision*).

(*Continued from page* 2)

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