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Indian Standard

SCHEDULES FOR WROUGHT STEELS

PART I STEELS SPECIFIED BY TENSILE AND/OR YIELD PROPERTIES

(First Revision)

(Incorporating Amendment No. 1)

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

Price Group 4

Indian Standard

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(First Revision)

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Indian Standard

SCHEDULES FOR WROUGHT STEELS

PART I STEELS SPECIFIED BY TENSILE AND/OR YIELD PROPERTIES

(First Revision)

0. FOREWORD

0.1 This Indian Standard (Part I) (First Revision) was adopted by the Indian Standards Institution on 20 November 1978, after the draft finalized by the Alloy Steels and Special Steels Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 Schedules for wrought steels for general engineering purposes (IS : 1570-1961) was first published in 1961. On the basis of the experience gained in the production and use of steels, the Sectional Committee has decided to revise the standard and issue it in parts. The other parts of the standard are as follows:

Part II	Carbon steels
Part III	Carbon and carbon manganese free cutting steels
Part IV	Alloy steels (excluding stainless and heat-resisting steels)
Part V	Stainless and heat-resisting steels*
Part VI	Tool steels

0.3 The following major modifications have been made in this revision:

a) Steel designations have been modified in accordance with IS : 1762 (Part I)-1974†. However, for the sake of easy identification old designations are also given within brackets.

b) Grades St 39, St 44, St 47, St 52, St 58 and St 66 given in IS : 1570-1961 have been deleted as the tensile ranges covered by these grades are already available in grades St 37, St 42, St 50, St 55 and St 63. A new grade St 70 has been added to cover the values of tensile between St 63 and St 78.

*Already published as IS : 1570 (Part V)-1972.

†Code for designation of steels: Part I Based on letter symbols (*first revision*).

c) Each grade of steel has been sub-divided into two sub-grades, one with a low yield to tensile ratio and the other with a high yield to tensile ratio. These ratios have been fixed after consulting the relevant Indian Standards and ISO Recommendations.

0.4 This schedule does not give limits for sulphur and phosphorus. These have to be specified in the detailed specifications. The standard ranges for sulphur and phosphorus and the method for designating steel according to its sulphur and phosphorus content, steel making practice and method of deoxidation is detailed in Appendix A for information.

0.5 Although both yield and tensile values have been specified in Table 1, the yield value should be ignored if the specification is evolved on the basis of tensile strength. Similarly the tensile strength should be ignored if the specification is based on yield stress.

0.6 This edition 2.1 incorporates Amendment No. 1 (January 1981). Side bar indicates modification of the text as the result of incorporation of the amendment.

0.7 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 schedule (Part I) is applicable to carbon and low alloy steels which are put into service in the hot-rolled, normalized or annealed condition in the form of plates, sections, bars, forgings and tubes, when the main criterion in the selection and inspection of the steel is either the tensile strength or the yield stress which is used as a basis for design. This schedule is not intended to be used as a standard.

2. GENERAL GUIDELINES FOR THE USE OF THE SCHEDULE

2.1 While preparing Indian Standards, or revising the existing standards, steels listed in this schedule shall be selected. The

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

specification of mechanical properties different from those given in this schedule should not be made unless special conditions of service render this essential. In that event, full reasons for the proposed departure from the steels specified in this schedule shall be submitted to the Alloy Steels and Special Steels Sectional Committee, SMDC 19, and its approval obtained.

2.2 In the case of steels belonging to this schedule it is not usual to specify a detailed chemical composition, but the quality of the material is controlled, where necessary, by specifying the maximum permissible percentage of sulphur and phosphorus. Since different levels of sulphur and phosphorus are required according to the severity of the conditions in service, limits for these elements are not included in the schedule, but should be specified in a specification at levels appropriate to the method of steel production, conditions of service, etc. Where necessary, the type of steel, for example, killed, semi-killed, etc, should be included in the standard. In the case of killed and semi-killed variety of steel, it would be necessary to specify the silicon content.

2.3 Where special factors, such as weldability, are involved, it may be desirable to include a maximum limit on the carbon content in the specification. In some structural steels, copper content is found to be beneficial for increasing resistance to corrosion and, in such cases, this should be specified in the standard.

2.4 In addition to the tensile and yield stress, values for the specified minimum percentage elongation, corresponding to the standard tensile ranges, are given in Table 1. These elongation values are based on a gauge length of $5.65\sqrt{A}$ which is now internationally accepted. If test pieces of other than $5.65\sqrt{A}$ gauge length are used, elongation conversions may be obtained from IS : 3803-1974*. For tensile tests on tubes, the specified percentage elongation should be based on the formula of 950 divided by the actual tensile strength when using a gauge length equivalent to $5.65\sqrt{A}$ or of 1 100 divided by the actual tensile strength in kgf/mm^2 when using a gauge length equivalent to $4\sqrt{A}$.

*Method for elongation conversions for steel (*first revision*).

TABLE 1 TENSILE AND YIELD PROPERTIES OF STANDARD STEELS

(*Clauses* 0.5 *and* 2.4)

New Designation [*See* IS : 1762 (Part I)-1974*]	Old Designation	Tensile Strength, *Min*	Yield Stress, *Min*	Elongation Percent, *Min* (Gauge Length $5.65\sqrt{A}$)	Reference to Indian Standard‡
(1)	(2)	(3)	(4)	(5)	(6)
		N/mm^2†	N/mm^2†		
Fe 290	(St 30)	290	170	27	—
FeE 220	—	290	220	27	—
Fe 310	(St 32)	310	180	26	IS : 432, IS : 1977, IS : 1978, IS : 2831, IS : 6915
FeE 230	—	310	230	26	—
Fe 330	(St 34)	330	200	26	IS : 1079, IS : 5986
FeE 250	—	330	250	26	—
Fe 360	(St 37)	360	220	25	IS : 1979, IS : 3503, IS : 5272, IS : 5986
FeE 270	—	360	270	25	—
Fe 410	(St 42)	410	250	23	IS : 226, IS : 432, IS : 1079, IS : 1148, IS : 1977, IS : 2062, IS : 2100, IS : 2830, IS : 2831, IS : 3039, IS : 3503, IS : 5986, IS : 6914, IS : 6915
FeE 310	—	410	310	23	—
Fe 490	(St 50)	490	290	21	IS : 1079, IS : 3503, IS : 8500
FeE 370	—	490	370	21	—
Fe 540	(St 55)	540	320	20	IS : 432, IS : 961, IS : 8500
FeE 400	—	540	400	20	—
Fe 620	(St 63)	620	380	15	—
FeE 460	—	620	460	15	—
Fe 690	(St 70)	690	410	12	—
FeE 520	—	690	520	12	—
Fe 770	(St 78)	770	460	10	—
FeE 580	—	770	580	10	—
Fe 870	(St 88)	870	520	8	—
FeE 650	—	870	650	8	—

*Code for designation of steel: Part I Based on letter symbols (*first revision*).

†1 $kgf/mm^2 = 9.81\ N/mm^2$.

‡*See* Appendix B for titles.

APPENDIX A

(*Clause* 0.4)

NEW SYSTEM OF DESIGNATION OF STEELS

A-0. GENERAL

A-0.1 The new system of designation of steel is based on the draft ISO proposal submitted by India to ISO/TC 17 'Steel' for formulation of an international standard. Details of the new designation system are given in IS : 1762 (Part I)-1974*.

A-1. STEELS DESIGNATED ON THE BASIS OF MECHANICAL PROPERTIES

A-1.1 These steels are carbon and low alloy steels where the main criterion in the selection and inspection of steel is the tensile strength or yield stress. In such cases, provided the specified mechanical properties are attained it is not usual to specify a detailed chemical composition but the quality of the material is designated, where necessary, by specifying certain quality levels. Steels listed in this Schedule, Part I fall in this category.

The designation of these steels consists of the following in the order given:

a) Symbol 'Fe' or 'FeE' depending on whether the steel has been specified on the basis of minimum tensile strength or yield strength.

b) Figure indicating the minimum tensile strength or yield stress in N/mm^2. If no minimum tensile strength or yield stress is guaranteed, the figure shall be 00.

c) Chemical symbols for elements the presence of which characterize the steel.

d) If necessary, symbols indicating special characteristics as follows:

1) *Method of Deoxidation* — Depending upon, whether the steel is killed, semi-killed or rimming variety, the following symbols

*Code for designation of steel: Part I Based on letter symbols (*first revision*).

shall be used to indicate the steel making practice:

i) *R* for rimming steel; and

ii) *K* for killed steel.

NOTE — If no symbol is used, it shall mean that the steel is of semi-killed type.

2) *Steel Quality* — The following symbols shall be used to indicate steel quality:

Q1 — Non-ageing quality,

Q2 — Freedom from flakes,

Q3 — Grain size controlled,

Q4 — Inclusion controlled, and

Q5 — Internal homogeneity guaranteed.

3) *Degree of Purity* — The sulphur and phosphorus levels (ladle analysis) shall be expressed as follows:

Symbol	*Maximum Content in Percent*	
	Phosphorus	Sulphur
P25	0.025	0.025
P35	0.035	0.035
P50	0.050	0.050
P70	0.070	0.070
No symbol will mean	0.055	0.055

The above symbols use the letter 'P' followed by 1 000 times the maximum percentage of sulphur and phosphorus. In case the maximum contents of sulphur and phosphorus are not same, the following procedure shall be followed:

Symbol SP shall be used to indicate the levels followed by:

i) 1 000 times the maximum sulphur rounded off* to the nearest integer.

ii) 1 000 times the maximum phosphorus rounded off* to the nearest integer.

*Rounding off shall be done according to the rules given in IS : 2-1960 'Rules for rounding off numerical values (*revised*).

Example:

Maximum sulphur	=	0.045 percent
Maximum phosphorus	=	0.035 percent

Designation: SP 44

4) *Weldability Guarantee* — Guaranteed weldability of steel as determined by tests mutually agreed between the purchaser and the supplier shall be indicated by the following symbols:

W = Fusion weldable, and

W_1 = Weldable by resistance welding but not fusion weldable.

5) *Resistance to Brittle Fracture* — Symbol 'B', 'B0', 'B2' or 'B4' indicating resistance to brittle fracture based on the results of the V-notch Charpy impact test.

For steels B, B0, B2 and B4 a test should be made with Charpy V-notch specimens, taken in the direction of rolling with the notch perpendicular to the surface of the plate or product.

Steels B, B0, B2 and B4 are characterized by an average V-notch Charpy impact value according to the following table:

Steels	*Specified UTS Range*			
	370 to 520 N/mm^2		500 to 700 N/mm^2	
	Energy	Temperature	Energy	Temperature
(1)	(2)	(3)	(4)	(5)
	J	°C	J	°C
B	28	27	40	27
B0	28	0	28	– 10
			40	0
B2	28	– 20	28	– 30
			40	– 20
B4	28	– 40	28	– 50
			40	– 40

6) *Surface Condition* — The following symbols shall be used to indicate surface condition:

S1 — Deseamed or scarfed;

S2 — Descaled;

S3 — Pickled (including washing and neutralizing);

S4 — Shot, grit or sand blasted;

S5 — Peeled (skinned);

S6 — Bright drawn or cold-rolled; and

S7 — Ground.

Notes — If no symbol is used, it shall mean that the surface is in as-rolled or as-forged condition.

7) *Formability* (*Applicable to Sheet Only*) — The following symbols shall be used to indicate drawability:

D1 — Drawing quality,

D2 — Deep drawing quality, and

D3 — Extra deep drawing quality.

NOTE — If no symbol is used, it shall mean that the steel is commercial quality.

8) *Surface Finish* (*Applicable to Sheet Only*) — The following symbols shall be used to indicate the surface finish:

F1 — General purpose finish,

F2 — Full finish,

F3 — Exposed,

F4 — Unexposed,

F5 — Matt finish,

F6 — Bright finish,

F7 — Plating finish,

F8 — Unpolished finish,

F9 — Polished finish,

F10 — Polished and coloured blue,

F11 — Polished and coloured yellow,

F12 — Mirror finish,

F13 — Vitreous enamel finish, and

F14 — Direct annealed finish.

9) *Treatment* — The following symbols shall be used to indicate the treatment given to the steel:

T1 — Shot-peened,

T2 — Hard-drawn,

T3 — Normalized*,

T4 — Controlled rolled,

T5 — Annealed,

T6 — Patented,

T7 — Solution-treated,

T8 — Solution-treated and aged,

T9 — Controlled cooled,

T10 — Bright annealed,

T11 — Spherodized,

T12 — Stress-relieved,

T13 — Case-hardened*, and

T14 — Hardened and tempered.

NOTE — If no symbol is used, it means that the steel is hot-rolled.

10) *Elevated Temperature Properties* — For guarantee with regard to elevated temperature properties, the letter 'H' shall be used. However, in the designation only the room temperature properties shall be shown. Elevated temperature properties shall be intimated to the purchaser separately by the manufacturer.

11) *Cryogenic Quality* — For guarantee with regard to low temperature properties, the letter 'L' shall be used. However, only the room temperature properties shall be indicated in the designation.

Examples:

Fe 410 Cu K — Killed steel containing copper as alloying element with a minimum tensile strength of 410 N/mm^2

FeE 300 P 35— Semi-killed steel with a minimum yield strength of 300 N/mm^2 and degree of purity as follows:

*Includes tempering, if done.

S & P = 0.035 *Max*

Fe 470W — Steel with a minimum tensile strength of 470 N/mm^2 and of guaranteed fusion welding quality

FeE 550 S6 — Bright drawn or cold rolled steel with a minimum yield strength of 550 N/mm^2

Fe 00R — Rimming quality steel with no guarantee of minimum tensile or yield strength

FeE 590 F7 — Sheet steel of plating finish and minimum yield strength of 590 N/mm^2

Fe 510 Ba — Steel in annealed condition with a minimum tensile strength of 510 N/mm^2 and resistance to brittle fracture = B

Fe 710 H — Steel with guaranteed elevated temperature properties and a minimum room temperature tensile strength of 710 N/mm^2

Fe 410 Q1 — Semi-killed non-ageing quality steel with S & P = 0.055 *Max* and minimum tensile = 410 N/mm^2

Fe 600 T4 — Semi-killed steel in controlled rolled condition with a minimum tensile strength of 600 N/mm^2

Fe 520 L — Cryogenic quality steel with a minimum room temperature tensile strength of 520 N/mm^2

APPENDIX B

LIST OF INDIAN STANDARDS REFERRED IN COLUMN 6 OF TABLE 1

Sl No.		*Title*
1.	IS : 226-1975	Specification for structural steel (standard quality) (*fifth revision*)
2.	IS : 432 (Part I)-1966	Mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement : Part I Mild steel and medium tensile steel bars (*second revision*)

3.	IS : 432 (Part II)-1966	Mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement : Part II Hard drawn steel wire (*second revision*)
4.	IS : 961-1975	Specification for structural steel (high tensile) (*second revision*)
5.	IS : 1079-1973	Specification for hot rolled carbon steel sheet and strip (*third revision*)
6.	IS : 1148-1973	Specification for rivet bars up to 40 mm for structural purposes (*second revision*)
7.	IS : 1977-1975	Specification for structural steel (ordinary quality) (*second revision*)
8.	IS : 1978-1971	Specification for line pipe (*first revision*)
9.	IS : 1979-1971	Specification for high test line pipe (*first revision*)
10.	IS : 2062-1969	Specification for structural steel (fusion welding quality) (*first revision*)
11.	IS : 2100-1970	Specification for steel billets, bars and sections for boilers (*first revision*)
12.	IS : 2830-1975	Specification for carbon steel billets, blooms and slabs for re-rolling into structural steel (standard quality) (*first revision*)
13.	IS : 2831-1975	Specification for carbon steel billets, blooms and slabs for re-rolling into structural steel (ordinary quality) (*first revision*)
14.	IS : 3039-1965	Specification for structural steel (shipbuilding quality)
15.	IS : 3503-1966	Specification for steel for marine boilers, pressure vessels and welded machinery structures
16.	IS : 5272-1969	Carbon steel sheets for integral coaches

17.	IS : 5986-1970	Hot rolled steel plates and flats for cold forming and flanging operations for automobile and general purposes
18.	IS : 6914-1973	Carbon steel cast billet ingots for rolling into structural steel (standard quality)
19.	IS : 6915-1973	Carbon steel cast billet ingots for rolling into structural steel (ordinary quality)
20.	IS : 8500-1977	Specification for weldable structural steel (medium and high strength quality)

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