Draft Indian Standard

Cold Reduced Medium and High Carbon Steel Strip

1. Scope:

This standard covers the requirements for cold-reduced medium and high carbon steel strips made of non-alloy and alloy-grade carbon steel in sheet, plate and strip.

Cold-reduced medium and high carbon steel strips are available in different types, grades and finishes for general applications and special applications, particularly springs.

2. References

IS No.	*Title*
IS 228(Various parts)	Method for chemical analysis of steel
IS 1501 Part 1:2020/ ISO 6507-1:2018	Metallic materials — Vickers hardness test Part 1 test method (*fifth revision*)
IS 1586 Part 1:2018/ ISO 6508-1:2016	Metallic materials — Rockwell hardness test : Part 1 test method (*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 1956 (Part 1) : 1975	Glossary of terms relating to iron and steel: Part 1 general metallurgy, heat treatment and testing (*first revision*)
IS 8910 : 2022 / ISO 404:2013	Steel and Steel Products — General Technical Delivery Requirements (*second revision*)
IS 15262:2002/ ISO 4287 : 1997	Geometrical product specifications (GPS) — surface texture: Profile method — terms, definitions, and surface texture parameters
IS 4748 : 2021/ ISO 643:2012	Steel - Micrographic determination of the apparent grain size (*third revision*)
IS 6396 : 2000	Methods of measuring decarburized depth of steel (*second revision*)
ISO 23825	Method for evaluating the nodularity of spheroidal carbides

3. Terminology

3.1. Best Bright finish – Mirror bright finish of the strip with a typical surface roughness of 0.10 µm, which is suitable for bright plating

3.2. Matte Finish / Dull Finish – Rougher finish obtained by temper passing cold reduced strip. The typical surface roughness of the strip is Ra 0.5 µm to 2.0 µm.

3.3. Plating bright finish – Smoot bright finish of the strip with a typical surface roughness of 0.25 µm Max.

3.4. Regular bright finish – Moderately bright reflective lustre finish obtained by temper passing cold reduced strip. The typical surface roughness of the strip is 0.5 µm, which is suitable for many applications but not necessarily for bright plating applications.

4. Dimensions

Cold-reduced medium and high carbon steel strip is commonly produced in thicknesses of 6 mm or under and in widths up to 600 mm in coil and cut lengths. Products may be available in widths greater than 600 mm and thickness greater than 6 mm by agreement between purchaser and manufacturer. For such products, acceptance criteria is based on the agreement between the purchaser and the manufacturer.

5. Classification and designations

Cold-reduced medium and high carbon steel is classified into non-alloy and alloy categories and is further designated into grades based on the carbon composition and alloy composition according to **Table 1 and Table 2** respectively.

6. Supply of Material

6.1. General requirements relating to the supply of cold-reduced medium and high carbon steel strip shall confirm to IS 8910.

6.2. Sheets and strips may be supplied with mill, trimmed or different kind of edges as mentioned in **Table 10**

6.3. Sheets and strips may be supplied with different kinds of surface Appearance & Finishes as mentioned **in Table 11 & 12** respectively

7. Manufacturing Process

7.1. Unless otherwise agreed between the purchaser and the manufacturer, processes used in steel making and of the final product are left to the discretion of the manufacturer.

7.2. All steels shall be fully killed/deoxidized

7.3. Delivery conditions of the cold-reduced medium and high carbon steel strip shall in one the following conditions :

7.3.1. *As rolled (R)* – Hot rolled pickled coil cold reduced to final thickness.

7.3.2. *Annealed (A)* – Cold reduced soft annealed followed by a temper rolling.

7.3.3. *Annealed and Re rolled (AR)* – Cold reduced annealed and further cold reduced to Final thickness

7.3.4. *Spheroidized Annealed (S)* – Cold Reduced and Spheroidized annealed to a required microstructure.

7.3.5. *Quenched and tempered (QT)* – Heat treatment process applied to a cold reduced strip to an aiming Martensitic and /or Bainitic structure and mechanical properties

7.3.6. In addition to the above any other delivery conditions can be applied based on the agreement between the purchaser and the manufacturer.

Limits and degree of Spheroidization/Martensitic/Bainitic/Specific Structures shall be as per the agreement between the purchaser and the manufacturer.

8. Nominal Dimensions and Tolerances

The nominal dimensions shall be agreed upon during the enquiry and order. Dimensional tolerances shall be in accordance with **Tables 14 to 19** inclusive.

For shape tolerances, it will be as per the mutual agreement between the purchaser and the manufacturer, or any national/ international standard can be agreed upon.

9. Chemical Composition

9.1. Ladle analysis - The ladle analysis steel sheet and strip shall be as per the requirements given in **Table 3 and Table 4** for Non-Alloy and Alloy type cold-reduced medium and high carbon steel strip grades respectively, when carried out either by the method specified in the relevant parts of IS 228 or any other national/international standard for instrumental/chemical method. In case of dispute, the procedure given in the relevant part of IS 228 shall be the referee method.

9.2. Product analysis - Permissible variation in the case of product analysis, from the limits specified in Table 3, Table 4 shall be as given in **Table 5**.

10. Mechanical Properties

10.1. Cold-reduced medium and high carbon steel strip shall be ordered following hardness or tensile strength requirements or both. Based on the agreement between the purchaser and the manufacturer, both hardness and tensile strength requirements can be applied.

10.2. Test Frequency – One mechanical property test should be conducted on a lot of 50 T or less of material of the same cast, rolled to the same dimensions and treated to the same delivery conditions and surface finish.

10.3. Hardness Requirement – When specified by the purchaser, the hardness test shall be out in accordance with IS 1586 Part 1 for Rockwell Hardness and as per IS 1501 Part 1 for Vickers Hardness. The test results shall confirm to the values given in **Table 6 & Table 7** for Non-Alloy Cold Reduced Medium & High Carbon steel and Alloy Cold Reduced Medium & High Carbon steel strips respectively for the applicable delivery condition.

10.4. Tensile Test Requirement - When specified by the purchaser, the tensile test shall be out in accordance with IS 1608 Part 1 at room temperature. Tensile properties i.e. Yield Strength, Tensile Strength &% Elongation shall meet the requirements specified in **Table 8 & Table 9** for Non-Alloy Cold Reduced Medium & High Carbon steel and Alloy Cold Reduced Medium & High Carbon steel strips respectively for the applicable delivery condition.

10.5. Tensile test specimens shall be taken from samples parallel to the direction in which the product was rolled and in a position midway between the centre and the longitudinal edge of the strip. The tensile specimen shall not be further worked on the either surface.

11. Grain Size

Unless otherwise agreed at the time of ordering, the grain size shall be left to the discretion of the manufacturer.

12. Surface Characteristics

12.1. Surface characteristics related to surface appearance shall be as per **Table 11** for delivery conditions of As rolled (R), Annealed(A), Annealed and Re rolled (AR) and Spheroidized Annealed (S).

12.2. Surface Characteristics related to surface finish shall be as per **Table 12** for delivery conditions of As rolled (R), Annealed(A), Annealed and Re rolled (AR) , Spheroidized Annealed (S) & Quenched and tempered (QT) .

12.3. The Appearance indicated in **Table 11** for the delivery conditions of R, A , AR & S apply to the upper/outside of coils and the upper/top surface of cut lengths. The appearance of the other side shall correspond to at least to surface appearance MA. These requirements to the appearance shall not apply to the first two inner and outer laps of the coil or to cut lengths from them.

12.4. Surface finish for Cold reduced Medium & High carbon flat steel strips in delivery conditions of R, A, AR & S shall be ordered by the purchaser as described in **Table 12** . If not specified in the order, steel strip in the above-mentioned delivery conditions shall be supplied with a surface appearance MA and surface a surface finish RL ($Ra \leq 0.6$ µm)

12.5. Surface finish for Cold reduced Medium and high carbon flat steel strips in delivery conditions of QT shall be ordered by the purchaser as described in **Table 12**. If not specified in the order, steel strips in the above-mentioned delivery conditions shall be supplied in the condition oxide finish. Due to processing for cold rolled narrow steel strip in delivery condition QT, single scratches are possible. The depth of such scratches measured in roughness Ra shall be lower than 15 µm.

12.6. The steel sheet in cut lengths shall be free from laminations, surface flaws and other imperfections that are detrimental to the final product's practical application or subsequent appropriate processing. However, it is difficult to inspect the overall coils for defects and removing defects in strips is not as easy as the removal of defects in sheets. There can be a mutual agreement between the purchaser and the manufacturer for treating such cases.

12.7. The products are normally supplied oiled. In this case, both sides are protected by a coat of non-drying neutral oil, free from foreign bodies and spread uniformly so that under the normal packing, transport, loading and storage conditions there will no correction upto three months. The oil film shall be removable by an alkaline solution or other normal solvents. If the transport and storage conditions make special corrosion protection necessary, the purchaser shall inform the manufacturer at the time of order and agreement between the purchaser and manufacturer to be established.

12.8. If the products are supplied in the as rolled condition or without oil, there is an increased risk of scratching and rust formation during transportation and storage.

13. Non-Metallic Inclusions

Non-Alloy Cold Reduced Medium & High Carbon steel and Alloy Cold Reduced Medium and High Carbon steel strips shall have a degree of cleanliness corresponding to the special steel quality. The degree of cleanliness and the verification may be agreed at the time of enquiry and order.

14. Decarburisation

Independent of their heat treatment, all steels for quenching and tempering with a minimum carbon content ≥ 0.50 % shall not have decarburisation levels exceeding the limits specified in **Table 10**, when measured at a distance of at least 10 mm from the strip edge.

15. Spheroidization of Carbides

The degree of spheroidization shall be agreed between the purchaser and the manufacturer at the time of enquiry and order. Suitable standards & methods can be applied based on the agreement, for assessing degree of spheroidization.
Spheroidization is applicable to delivery condition of spheroidized annealed (S).

16. Re Test

16.1. When a part of the test results fails to comply with the requirement specified, a re-test (two more sets of test samples shall be taken for specific test requirements from the same lot) on the relevant items may be carried out to determine whether it is acceptable or not.

16.2. If any of the re-test samples fail to meet the test requirements of this standard, the lot represented by the sample shall be deemed as not conforming to this standard.

16.3. On any tensile test, if any part of the fracture is outside the middle half of the gauge length as scribed before the test, the test shall be discarded, and a retest carried out.

17. Packing

Non-Alloy Cold Reduced Medium & High Carbon steel and Alloy Cold Reduced Medium and High Carbon steel strips should be suitably packed to avoid any transit/handling/storage damage and as per the agreement between the purchaser and the manufacturer.

18. Marking

18.1. The following shall be legibly and indelibly marked on the top of each coil or package of sheets or shown on a tag attached to each coil or packet:

a. IS No. of this standard.
b. Manufacturer's name or trademark.
c. Material identification/coil number/packet number/batch number, etc.
d. Product dimensions.
e. Number of sheets or mass.
f. Designation of Zinc-aluminium-magnesium alloy-coated hot rolled and cold reduced carbon steel sheet/strip; and,
g. Date of manufacture.

18.2. BIS Certification Marking - The product(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 Standards Act, 2016 and the Rules and Regulations framed there under, and the products may be marked with the Standard Mark

Table 1 Grade Destination for Non-Alloy Cold Reduced Medium and High Carbon Steel Strip

(*Clause* 5)

Type	Grade	Delivery Condition
Non-Alloy	C10	R, A, AR
Non-Alloy	C15	R ,A, AR
Non-Alloy	C22	R ,A, AR
Non-Alloy	C25	R ,A, AR
Non-Alloy	C30	R, A, AR, S
Non-Alloy	C35	R, A, AR, S
Non-Alloy	C40	R, A, AR, S, QT
Non-Alloy	C45	R, A, AR, S, QT
Non-Alloy	C50	R, A, AR, S, QT
Non-Alloy	C55	R, A, AR, S, QT
Non-Alloy	C60	R, A, AR, S, QT
Non-Alloy	C65	R, A, AR, S, QT
Non-Alloy	C70	R, A, AR, S, QT
Non-Alloy	C75	R, A, AR, S, QT
Non-Alloy	C80	R, A, AR, S, QT
Non-Alloy	C85	R, A, AR, S, QT
Non-Alloy	C90	R, A, AR, S, QT
Non-Alloy	C95	R, A, AR, S, QT
Non-Alloy	C100	R, A, AR, S, QT
Non-Alloy	C125	R, A, AR, S, QT

Table 2 Grade Destination for Alloy Cold Reduced Medium and High Carbon Steel Strip

(*Clause* 5)

Type	Grade	Delivery Condition
Alloy	17Cr3	R, A, AR, S
Alloy	16MnCr5	R, A, AR, S
Alloy	20MnB5	R, A, AR, S
Alloy	25CrMo4	R, A, AR, S, QT
Alloy	27MnCrB5-2	R, A, AR, S, QT
Alloy	34CrMo4	R, A, AR, S, QT
Alloy	42CrMo4	R, A, AR, S, QT
Alloy	50Cr	R, A, AR, S, QT
Alloy	50CrMo4	R, A, AR, S, QT
Alloy	51CrV4	R, A, AR, S, QT
Alloy	55Si7	R, A, AR, S, QT
Alloy	58CrV4	R, A, AR, S, QT
Alloy	68CrNiMo3-3	R, A, AR, S, QT
Alloy	75Cr1	R, A, AR, S, QT

Alloy	75Ni8	R, A, AR, S, QT
Alloy	80CrV2	R, A, AR, S, QT
Alloy	95Cr1	R, A, AR, S, QT
Alloy	102Cr6	R, A, AR, S, QT
Alloy	110Cr35W2	R, A, AR, S, QT
Alloy	120Cr35	R, A, AR, S, QT
Alloy	125Cr2	R, A, AR, S, QT

Table 3 Chemical Composition of Non-Alloy Cold Reduced Medium and High Carbon Steel Strip (% by Mass)

(*Clause* 9.1)

Grade	C	Si	Mn	S	P
C10	0.07-0.13	0.40 Max	0.30-0.60	0.035 Max	0.035 Max
C15	0.12-0.18	0.40 Max	0.30-0.60	0.035 Max	0.035 Max
C22	0.17-0.24	0.40 Max	0.40-0.70	0.035 Max	0.035 Max
C25	0.22-0.29	0.40 Max	0.40-0.70	0.035 Max	0.035 Max
C30	0.28-0.35	0.35 Max	0.30-1.00	0.035 Max	0.035 Max
C35	0.31-0.39	0.35 Max	0.30-1.00	0.035 Max	0.035 Max
C40	0.35-0.45	0.35 Max	0.30-1.00	0.035 Max	0.035 Max
C45	0.40-0.50	0.35 Max	0.30-1.00	0.035 Max	0.035 Max
C50	0.45-0.55	0.35 Max	0.30-1.00	0.035 Max	0.035 Max
C55	0.50-0.60	0.35 Max	0.30-1.00	0.035 Max	0.035 Max
C60	0.55-0.65	0.35 Max	0.30-1.00	0.035 Max	0.035 Max
C65	0.59-0.70	0.35 Max	0.30-1.00	0.035 Max	0.035 Max
C70	0.65-0.75	0.35 Max	0.30-1.00	0.035 Max	0.035 Max
C75	0.70-0.80	0.35 Max	0.30-1.00	0.035 Max	0.035 Max
C80	0.75-0.88	0.35 Max	0.30-1.00	0.035 Max	0.035 Max
C85	0.80-0.93	0.35 Max	0.30-1.00	0.035 Max	0.035 Max
C90	0.85-0.95	0.35 Max	0.30-1.00	0.035 Max	0.035 Max
C95	0.90-1.05	0.35 Max	0.30-1.00	0.035 Max	0.035 Max
C100	0.95-1.10	0.35 Max	0.30-1.00	0.035 Max	0.035 Max
C125	1.10-1.30	0.35 Max	0.30-1.00	0.035 Max	0.035 Max

NOTES

- A restricted and minimum range of Silicon can be agreed.
- Restricted ranges of Carbon and Manganese can be agreed between purchaser and manufacturer. Other Values of Manganese can also be applied, based on the mutual agreement between the purchaser and manufacturer.
- Alloy and Micro Alloy additions can be added based on the mutual agreement between the purchaser and manufacturer. Total alloy and micro-alloy content should not exceed more than 2.0 %.

Table 4: Chemical Composition of Alloy Cold Reduced Medium and High Carbon Steel Strip (% by Mass)

(*Clause* 9.1)

Grade	C	Si	Mn	S	P	Cr	V	W	Ni	Mo	B
17Cr3	0.12-0.20	0.40 Max	0.30-1.00	0.035 Max	0.035 Max	0.70-1.25	--	--	--	--	--
16MnCr5	0.14-0.19	0.40 Max	1.00-1.30	0.035 Max	0.035 Max	0.80-1.10	--	--	--	--	--
20MnB5	0.17-0.23	0.40 Max	1.10-1.40	0.035 Max	0.035 Max	--	--	--	--	--	0.0008-0.005
25CrMo4	0.22-0.29	0.40 Max	0.30-1.00	0.035 Max	0.035 Max	0.90-1.20	--	--	--	0.15-0.30	--
27MnCrB5-2	0.24-0.30	0.40 Max	1.10-1.40	0.035 Max	0.035 Max	0.30-0.60	--	--	--	--	0.0008-0.005
34CrMo4	0.30-0.37	0.40 Max	0.30-1.00	0.035 Max	0.035 Max	0.90-1.20	--	--	--	0.15-0.30	--
42CrMo4	0.38-0.45	0.40 Max	0.30-1.00	0.035 Max	0.035 Max	0.90-1.20	--	--	--	0.15-0.30	--
50Cr	0.45-0.55	0.40 Max	0.30-1.00	0.035 Max	0.035 Max	0.7-1.2	0.3 Max	--	--	--	--
50CrMo4	0.46-0.54	0.40 Max	0.30-1.00	0.035 Max	0.035 Max	0.90-1.20	--	--	--	0.15-0.30	--
51CrV4	0.47-0.55	0.40 Max	0.30-1.00	0.035 Max	0.035 Max	0.40-0.60	0.15-0.25	--	--	--	--
55Si7	0.50-0.60	1.00-2.00	0.30-1.10	0.035 Max	0.035 Max	--	--	--	--	--	--
58CrV4	0.55-0.62	0.40 Max	0.70-1.10	0.035 Max	0.035 Max	0.90-1.20	0.10-0.20	--	--	--	--
68CrNiMo3-3	0.64-0.72	0.40 Max	0.30-1.00	0.035 Max	0.035 Max	0.40-0.60	--	--	0.50-0.75	0.15-0.30	--
75Cr1	0.70-0.80	0.40 Max	0.30-1.00	0.035 Max	0.035 Max	0.30-0.40	--	--	--	--	--
75Ni8	0.72-0.78	0.40 Max	0.30-1.00	0.035 Max	0.035 Max	--	--	--	1.80-2.10	--	--
80CrV2	0.75-0.85	0.40 Max	0.30-1.00	0.035 Max	0.035 Max	0.40-0.60	0.15-0.25	--	--	--	--
95Cr1	0.90-1.00	0.40 Max	0.20-1.00	0.035 Max	0.035 Max	0.30-0.40	--	--	--	--	--
102Cr6	0.95-1.10	0.40 Max	0.20-1.00	0.035 Max	0.035 Max	1.35-1.60	--	--	--	--	--
110Cr35W2	1.00-1.20	0.40 Max	0.30-1.00	0.035 Max	0.035 Max	0.20-0.50	--	2.0-2.5	--	--	--
120Cr35	1.10-1.30	0.40 Max	0.30-1.00	0.035 Max	0.035 Max	0.20-0.50	--	--	--	--	--
125Cr2	1.20-1.30	0.40 Max	0.20-1.00	0.035 Max	0.035 Max	0.40-0.60	--	--	--	--	--

NOTES

- A restricted minimum range of Silicon can be agreed.
- Restricted ranges of Carbon and Manganese can be agreed between purchaser and manufacturer.
- (--) Not restricted.
- In addition to above mentioned alloying elements, additional alloy elements can be added based on the agreement between the purchaser and manufacturer. However, for such additional additions, total alloying addition contents should not exceed more than 2 %.

Table 5 Permissible Variations of Chemical Composition on Product Analysis

(*Clause* 9.2)

Element	**Permissible Maximum content in the ladle analysis % by mass**	**Permissible Variation [a] % by mass**
C	≤ 0.30 >0.30 ≤ 1.00 >1.00 ≤ 1.30	±0.02 ±0.03 ±0.04
Si	≤ 1.00 >1.00 ≤ 2.00	±0.03 ±0.10
Mn	≤ 1.00 >1.00 ≤ 1.40	±0.04 ±0.06
P	≤ 0.025	+ 0.005
S	≤ 0.025	+ 0.005
Cr	≤ 0.40 >0.40 ≤ 1.60	±0.03 ±0.05
Mo	≤ 0.40	±0.03
Ni	≤ 1.00 >1.00 ≤ 2.00 >2.00 ≤ 2.10	±0.03 ±0.05 ±0.07
V	≤ 0.25	±0.02
Cu	≤ 0.40	+0.05
B	≤ 0.005	±0.0003
W	≤ 0.40	±0.05
a- ± means that in once cast the deviation may occur over the upper value or under the lower value of the specified range in Tables 3 and 4, but not both at the same.		

Table 6 - Hardness Requirements for Non-Alloy Type

(*Clause* 10.3)

	Annealed (A)		Cold Rolled(R)		Quenched and Tempered (QT)		Spheroidized Annealed (S)		Annealed & Rolled (AR)	
Grade	**HRB**	**HV**	**HRB**	**HV**	**HRC**	**HV**	**HRB**	**HV**	**HRB**	**HV**
C10	73 Max	135 Max	83 Min	170 Min	--	--	--	--	--	--
C15	76 Max	140 Max	83 Min	180 Min	--	--	--	--	--	--
C22	78 Max	155 Max	83 Min	180 Min	--	--	--	--	--	--
C25	80 Max	160 Max	83 Min	180 Min	--	--	--	--	--	--
C30	80 Max	150 Max	83 Min	220 Min	--	--	85 Max	160 Max	97 Max	260 Max
C35	83 Max	170 Max	83 Min	220 Min	--	--	86 Max	170 Max	98 Max	260 Max
C40	84 Max	170 Max	83 Min	220 Min	--	250-400	87 Max	170 Max	97 Max	260 Max
C45	88 Max	185 Max	83 Min	220 Min	--	280-460	88 Max	175 Max	97 Max	260 Max
C50	89 Max	185 Max	83 Min	230 Min	--	325-505	90 Max	180 Max	97 Max	260 Max
C55	90 Max	195 Max	83 Min	230 Min	--	340-520	90 Max	185 Max	98 Max	260 Max
C60	91 Max	190 Max	83 Min	230 Min	--	340-530	90 Max	185 Max	98 Max	260 Max
C65	92 Max	205 Max	83 Min	230 Min	--	340-580	90 Max	190 Max	98 Max	260 Max
C70	92 Max	215 Max	83 Min	230 Min	--	350-550	90 Max	190 Max	98 Max	260 Max
C75	93 Max	220 Max	83 Min	230 Min	--	350-580	90 Max	190 Max	98 Max	260 Max
C80	93 Max	230 Max	83 Min	230 Min	--	350-590	92 Max	200 Max	98 Max	260 Max
C85	94 Max	230 MAx	83 Min	240 Min	--	350-590	93 Max	210 Max	98 Max	260 Max
C90	94 Max	230 Max	83 Min	240 Min	--	370-600	93 Max	210 Max	98 Max	260 Max
C95	95 Max	230 Max	83 Min	240 Min	--	370-610	94 Max	210 Max	98 Max	260 Max
C100	96 Max	230 Max	83 Min	240 Min	--	370-610	94 Max	210 Max	98 Max	260 Max
C125	97 Max	230 Max	83 Min	240 Min	--	370-610	94 Max	220 Max	98 Max	260 Max

NOTE — (--) Not restricted. Can be applied based on the mutual agreement between the purchaser and manufacturer with agreed values.

Table 7 Hardness Requirements for Alloy Type

(*Clause* 10.3)

	Hardness									
	Annealed (A)		Cold Rolled(R)		Quenched and Tempered (QT)		Spheroidized Annealed (S)		Annealed & Rolled (AR)	
	HRB	HV	HRB	HV	HRC	HV	HRB	HV	HRB	HV
17Cr3	--	170 Max	--	--	--	--	--	--	--	--
16MnCr5	--	170 Max	--	--	--	--	--	--	--	--
20MnB5	--	170 Max	--	--	--	--	--	--	--	--
25CrMo4	--	175 Max	--	--	--	305-435	--	--	--	--
27MnCrB5-2	--	175 Max	--	--	--	310-450	--	--	--	--
34CrMo4	--	185 Max	--	--	--	315-465	--	--	--	--
42CrMo4	--	195 Max	--	--	--	340-490	--	--	--	--
50Cr	--	240 Max	--	--	--	500-670	--	--	--	--
50CrMo4	--	220 Max	--	--	--	370-550	--	--	--	--
51CrV4	--	225 Max	--	--	--	370-580	--	--	--	--
55Si7	--	240 Max	--	--	--	370-570	--	--	--	--
58CrV4	--	225 Max	--	--	--	370-580	--	--	--	--
68CrNiMo3-3	--	235 Max	--	--	--	405-600	--	--	--	--
75Cr1	--	220 Max	--	--	--	370-580	--	--	--	--
75Ni8	--	220 Max	--	--	--	370-550	--	--	--	--
80CrV2	--	220 Max	--	--	--	370-550	--	--	--	--
95Cr1	--	220 Max	--	--	--	370-600	--	--	--	--
102Cr6	--	235 Max	--	--	--	405-600	--	--	--	--
110Cr35W2	--	225 Max	--	--	--	370-600	--	--	--	--
120Cr35	--	225 Max	--	--	--	370-600	--	--	--	--
125Cr2	--	225 Max	--	--	--	370-590	--	--	--	--

NOTE — (--) Not restricted. Can be applied based on the mutual agreement between the purchaser and manufacturer with agreed values.

Table 8 Tensile Properties Requirements for Non-Alloy Type
(*Clause* 10.4)

	Tensile Properties											
	Quenched and Tempered (QT)			Spheroidized Annealed (S)			Annealed (A)			Annealed & Rolled (AR)		
Grade	YS (MPa)	TS (MPa)	El (%) GL-80	YS (MPa)	TS (MPa)	El (%)[1]	YS (MPa)	TS (MPa)	El (%) GL-80	YS (MPa)	TS (MPa)	El (%) GL-80
C10	--	--	--	--	--	--	210 Min	430 Max	26 Min	--	830 Max	--
C15	--	--	--	--	--	--	210 Max	450 Max	25 Min	--	870 Max	--
C22	--	--	--	--	--	--	230 Min	500 Max	22 Min	--	900 Max	--
C25	--	--	--	--	--	--	230 Min	510 Max	21 Min	--	910 Max	--
C30	--	--	--	--	585 Max	18(50)/16(80)	240 Min	520 Max	20 Min	--	920 Max	--
C35	--	--	--	--	590 Max	17(50)/15(50)	240 Min	540 Max	19 Min	--	930 Max	--
C40	700 Min	800 Min	7 Min	--	595 Max	16(50)/14(80	240 Min	550 Max	18 Min	--	970 Max	--
C45	1030 Min	1180 Min	6 Min	--	600 Max	16(50)/14(80	270 Min	590 Max	18 Min	--	1020 Max	--
C50	1030 Min	1050 Min	6 Min	--	605 Max	15(50)/13(80)	270 Min	590 Max	17 Min	--	1050 Max	--
C55	1030 Min	1100 Min	6 Min	--	610 Max	15(50)/13(80)	270 Min	590 Max	17 Min	--	1070 Max	--
C60	1030 Min	1180 Min	5 Min	--	620 Max	14(50)/12(80)	270 Min	620 Max	17 Min	--	1100 Max	--
C65	1030 Min	1180 Min	5 Min	--	630 Max	13(50)/11(80)	270 Min	590 Max	16 Min	--	1140 Max	--
C70	1050 Min	1230 Min	4 Min	--	640 Max	12(50)/11(80)	270 Min	590 Max	16 Min	--	1150 Max	--
C75	1080 Min	1180 Min	6 Min	--	640 Max	12(50)/11(80)	290 Min	640 Max	16 Min	--	1170 Max	--
C80	1080 Min	1180 Min	6 Min	--	650 Max	12(50)/11(80)	290 Min	640 Max	15 Min	--	1170 Max	--
C85	1080 Min	1180 Min	6 Min	--	670 Max	11(50)/10(80)	290 Min	640 Max	15 Min	--	1180 Max	--
C90	1100 Min	1200 Min	6 Min	--	670 Max	11(50)/10(80)	300 Min	680 Max	14 Min	--	1200 Max	--
C95	1150 min	1250 Min	--	--	670 Max	10(50)/9(80)	310 Min	690 Max	13 Min	--	1200 Max	--
C100	1150 min	1250 Min	--	--	670 Max	9(50)/8(80)	310 Min	690 Max	13 Min	--	1200 Max	--
C125	1200 Min	1250 Min	--	--	670 Max	9(50)/8(80)	310 Min	740 Max	11 Min	--	1200 Max	--

NOTE — (--) Not restricted. Can be applied based on the mutual agreement between the purchaser and manufacturer with agreed values.

1. Based on mutual agreement between the purchaser and manufacturer, the required gauge length can be applied. For Gauge Length 80- Type 2 specimen as per and for gauge length 50- Type 3 Specimen of IS 1608 Annex B to be applied.

Table 9 Tensile Properties Requirements for Alloy Type

(*Clause* 10.4)

	Tensile Properties											
	Quenched and Tempered (QT)			**Spheroidized Annealed (S)**			**Annealed (A)**			**Annealed & Rolled (AR)**		
Grade	**YS (MPa)**	**TS (MPa)**	**El (%) GL-80**	**YS (MPa)**	**TS (MPa)**	**El (%)[(1)]**	**YS (MPa)**	**TS (MPa)**	**El (%) GL-80**	**YS (MPa)**	**TS (MPa)**	**El (%) GL-80**
17Cr3	--	--	--	--	--	--	420 Max	550 Max	21 Min	--	--	--
16MnCr5	--	--	--	--	--	--	420 Max	550 Max	21 Min	--	--	--
20MnB5	--	--	--	--	--	--	430 Max	540 Max	20 Min	--	--	--
25CrMo4	--	900 Min	--	--	--	--	440 Max	580 Max	19 Min	--	--	--
27MnCrB5-2	--	1000 Min	--	--	--	--	460 Max	580 Max	18Min	--	--	--
34CrMo4	--	1020 Min	--	--	--	--	460 Max	600 Max	16 Min	--	--	--
42CrMo4	--	1100 Min	--	--	--	--	480 Max	620 Max	15 Min	--	--	--
50Cr	--	1200 Min	--	--	--	--	340 Min	780 Max	20 Min	--	--	--
50CrMo4	--	1200 Min	--	--	--	--	540 Max	700 Max	13 Min	--	--	--
51CrV4	--	1200 Min	--	--	--	--	580 Max	720 Max	12 Min	--	--	--
55Si7	--	1200 Min	--	--	--	--	340 Min	780 Max	12 Min	--	--	--
58CrV4	--	1200 Min	--	--	--	--	580 Max	720 Max	12 Min	--	--	--
68CrNiMo3-3	--	1300 Min	--	--	--	--	590 Max	750 Max	11 Min	--	--	--
75Cr1	--	1200 Min	--	--	--	--	550 Max	690 Max	13 Min	--	--	--
75Ni8	--	1200 Min	--	--	--	--	550 Max	690 Max	13 Min	--	--	--
80CrV2	--	1200 Min	--	--	--	--	550 Max	700 Max	13 Min	--	--	--
95Cr1	--	1200 Min	--	--	--	--	560 Max	700 Max	12 Min	--	--	--
102Cr6	--	1300 Min	--	--	--	--	590 Max	750 Max	11 Min	--	--	--

110Cr35W2	--	1200 Min	--	--	--	--	580 Max	720 Max	12 Min	--	--	--
120Cr35	--	1200 Min	--	--	--	--	580 Max	720 Max	12 Min	--	--	--
125Cr2	--	1200 Min	--	--	--	--	580 Max	720 Max	12 Min	--	--	--

NOTE — (--) Not restricted. Can be applied based on the mutual agreement between the purchaser and manufacturer with agreed values.

1. Based on mutual agreement between purchaser and manufacturer, required gauge length can be applied. For Gauge Length 80- Type 2 specimen as per and for gauge length 50- Type 3 Specimen of IS 1608 Annex B to be applied.

Table 10 Edge Conditions

(*Clause* 6.2)

Edge Symbol	Characteristic
SE	A prepared edge of specified contour (round/square etc) that is produced when a very accurate width is required or when edge condition is suitable for electroplating is required or both.
ME	A natural mill edge carried through the cold rolling from the hot rolled strip without additional processing of the dge
TE	An approximately square edge is produced from slit edge material on which the burr is eliminated
TE1	An approximately square edge is produced by slitting on which the burr is not eliminated. This is produced when the edge condition is not a critical requirement for the finished part. Normal coiling or piling does not provide a definite positioning of the slitting burr
RE	An approximately rounded edge. This edge is produced when the width with tolerance and edge condition are not as exacting as for SE Edges
SE1	An approximately squared edge. This edge is produced when the width tolerance and edge condition are not as exacting as SE edges
NOTE — In addition to the above-mentioned edge conditions, additional /special edge conditions can be agreed between the purchaser and the manufacturer.	

Table 11 Surface Appearance
(*Clause* 6.3, 12.1 *and* 12.3)

Symbol	**Characteristic**	**Delivery conditions**	**Available surface finishes** [b]
MA	Bright, Metallic clean surfaces, pitting groves and scratches are permitted	All thickness Delivery Condition - R, A , AR & S	RR -Rough RM -Matt/Dull RL -Bright RP- Plating Bright RM- Mirror Bright
MB	Bright, Metallic clean surfaces, pitting grooves and scratches are permitted as long as the uniform smooth appearance is not substantially impaired when viewed with the naked eye	Thickness ≤ 2.00 mm[a] Delivery Condition - R, A , AR & S (Expect when skin pass or cold rolling is not applied as final stage of processing)	RM -Matt/Dull RL -Bright RP- Plating Bright RM- Mirror Bright
NOTES 1 The supply of products of greater thickness with this surface appearance shall be agreed upon at the time of enquiry and order 2 Table 12 for surface finish requirements			

Table 12 Surface Finish
(*Clause* 6.3 12.2,12.4 *and* 12.5)

Surface Finish	**Note**	**Symbol**	**Mean Surface Roughness (Ra µm)**
For delivery conditions - R, A , AR & S			
Rough	--	RR	Ra≥ 1.5 µm
Matt/Dull	--	RD	0.5 µm < Ra ≤ 2.0 µm
Bright	--	RB	Ra ≤ 0.5 µm
Plating Bright	--	RP	Ra ≤ 0.25 µm
Mirror Bright	--	RM	Ra ≤ 0.10 µm
For delivery conditions – QT			
Oxide Finish	Unpolished (e.g Grey/Blue)	-	Ra ≤ 0.6 µm
Bright Tempered	Unpolished	--	
Polished	Obtained by fine grinding, abrasive brushing, or other processes		Max Ra value may be agreed at the time of enquiry and order
Polished and coloured	Blue, yellow, or other colours obtained by oxidization by heat treatment or other processes		

Table 13 Decarburisation
(*Clause* 14)

Type	Thickness (mm)	Decarburisation limit
Non-Alloy Type	Thickness ≥ 0.20 mm	Maximum of 2 % of the material thickness per side
	Thickness < 0.20 mm	Maximum of 4 µm per side
Alloy Type	Thickness ≥ 0.20 mm	Maximum of 2 % of the material thickness per side
	Thickness < 0.20 mm	Maximum of 4 µm per side

Table 14 Tolerance on Thickness

(*Clause* 8**)**

Thickness (t in mm)	Tolerance for specified width (w in mm & Tolerance in mm)					
	≤125		125<w≤250		250<w≤600	
	Normal	Special	Normal	Special	Normal	Special
t<0.15	±0.01	±0.01	±0.02	±0.015	-	-
0.15 ≤ t < 0.25	±0.02	±0.015	±0.02	±0.015	-	-
0.25 ≤ t < 0.40	±0.02	±0.015	±0.03	±0.02	±0.03	±0.02
0.40 ≤ t < 0.60	±0.03	±0.02	±0.03	±0.02	±0.04	±0.03
0.60 ≤ t < 0.80	±0.04	±0.03	±0.04	±0.03	±0.05	±0.035
0.80 ≤ t < 1.00	±0.04	±0.03	±0.05	±0.035	±0.05	±0.035
1.00 ≤ t < 1.50	±0.05	±0.035	±0.06	±0.045	±0.07	±0.055
1.50 ≤ t < 2.50	±0.06	±0.04	±0.07	±0.055	±0.08	±0.06
2.50 ≤ t < 4.00	±0.07	±0.05	±0.08	±0.06	±0.10	±0.08
4.00 ≤ t ≤ 6.00	±0.09	±0.06	±0.10	±0.08	±0.12	±0.09

NOTES

1. Thickness is measured at any point on the strip not less than 20 mm from a side edge for the mill edge strip and not less than 10 mm from a side edge for other slit edge types.
2. For widths of mill edge strips 40 mm or less and sheared edge strips 20 mm wide or less, measurements are made on the centre line of the strip.
3. Measurements are not made on top of the shear burr.
4. For widths and thicknesses not mentioned in the above table, tolerances shall be as per the agreement between the purchaser and the manufacturer.

Table 15 Width tolerances for Mill edge (Edge Symbol - ME)

(*Clause* 8)

Specified Width (w in mm)	**Width Tolerance (in mm)**
w<100	±1.5
100 ≤ w < 200	±2
200 ≤ w < 400	±2.5
400 ≤ w < 500	±3
500 ≤ w < 600	±4

NOTES

1. These values do not apply to the uncropped ends of mill edge coil within 7 m inclusive of both ends or as per the mutual agreement between the purchaser and the manufacturer.
2. By agreement between the purchaser and the manufacturer, material can be ordered with wider (more than the above-mentioned range) or stricter tolerances.
3. For widths and thicknesses not mentioned in the above table, tolerances shall be as per the agreement between the purchaser and the manufacturer.

Table 16 Width tolerances for Slit edge not deburred (Edge type – TE1)
(*Clause* 8)

Specified Width (w in mm)	**Width Tolerance for specified thickness (t in mm) (in mm)**			
	t ≥ 1.5	**1.5 > t ≥2.5**	**2.5 > t ≥ 4.5**	**4.5 > t ≥ 6.0**
w ≤100	±0.13	±0.20	±0.25	±0.40
100 < w ≤200	±0.13	±0.25	±0.40	±0.50
200 < w ≤ 300	±0.25	±0.25	±0.40	±0.50
300 < w ≤ 450	±0.40	±0.40	±0.50	±0.80
450 < w ≤ 600	±0.45	±0.50	±0.50	±0.80

NOTES
1. By agreement between the purchaser and the manufacturer, the material can be ordered with wider (more than the above-mentioned range) or stricter tolerances.
2. For widths and thicknesses not mentioned in the above table, tolerances shall be as per the agreement between the purchaser and the manufacturer.

Table 17 Width tolerances for Slit edge (Edge type – SE, TE, RE & SE1)
(*Clause* 8)

Edge Symbol	Specified Width (w in mm)	Specified Thickness (t in mm)	Width Tolerance (in mm)
SE	$12.5 < w \leq 200$	$t \leq 3.0$	±0.13
RE	$w \leq 25$	$0.6 \geq t \geq 5.0$	±0.38
	$25 < w \leq 50$	$0.6 \geq t \geq 6.0$	±0.65
	$50 < w \leq 150$	$1.0 \geq t \geq 6.0$	±1.20
TE	$w \leq 100$	$t \leq 3.0$	±0.13
	$100 < w \leq 500$	$0.4 \geq t \geq 3.0$	±0.25
	$500 < w \leq 600$	$0.6 \geq t \geq 2.0$	±0.38
SE1	$w \leq 25$	$0.6 \geq t \geq 5.0$	±0.38
	$25 < w \leq 50$	$0.6 \geq t \geq 6.0$	±0.65
	$50 < w \leq 150$	$1.0 \geq t \geq 6.0$	±1.20
a. For widths and thicknesses not mentioned in the above table, tolerances shall be as per the agreement between the purchaser and the manufacturer.			

Table 18 Length tolerances for cut lengths
(*Clause* 8)

Specified Length (l in mm)	**Tolerances (in mm) for specified widths up to 600 mm**
$l \leq 1500$	+15
$1500 < l \leq 3000$	+20
$3000 < l \leq 6000$	+25
$6000 < l$	+ 0.5 % of specified length
a. For widths not mentioned in the above table, tolerances shall be as per the agreement between the purchaser and the manufacturer. b. Stricter tolerances and under tolerances (negative side) can be agreed between the purchaser and the manufacturer	

Table 19 Camber tolerances for coils and cut lengths
(*Clause* 8)

Specified Width (w in mm)	Camber Tolerances (in mm)
$10 < w \leq 40$	25 max in any 2000 length
$40 < l \leq 600$	10 max in any 2000 length

a. Camber is the greatest deviation of a side edge from a straight line (see Figure 1), the measurement being taken on the concave side with a straight edge

b. In those cases where it is not practical to measure the tolerance as given in this table, the camber tolerance, t2, may be calculated from the formula :

$t_2 = (2 \times l_2 \times t_1)/l_1$

Where

l_1 is the standard length in this table (2000 mm)

l_2 is the non-standard length ;

t_1 is the camber tolerance in this table

c. For widths not mentioned in the above table, tolerances shall be as per the agreement between the purchaser and the manufacturer.

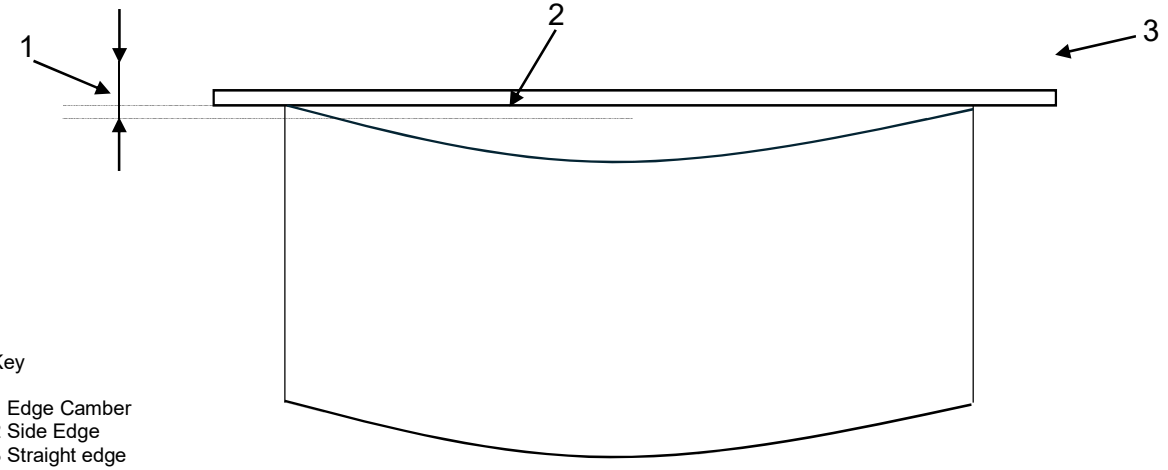

Table 20 Guidelines for the Heat Treatment

(Informative)

Grade	Austenitizing Temperature (Deg. C)	Quenching Medium
Non-alloy steels for quenching and tempering		
C40	830-870	Water or Oil
C45	820-870	Water or Oil
C50	810-850	Oil or Water
C55	805-845	Oil or Water
C60	800-840	Oil or Water
C65	815-845	Oil
C70	810-840	Oil
C75	810-840	Oil
C80	810-840	Oil
C85	800-830	Oil
C90	790-820	Oil
C95	790-820	Oil
C100	790-820	Oil
C125	780-810	Oil
Alloy steels for quenching and tempering		
20MnB5	880-920	Water
25CrMo4	840-880	Water or Oil
27MnCrB5-2	880-920	Water
34CrMo4	830-870	Oil or Water
42CrMo4	820-860	Oil or Water
50Cr	820-850	Oil or Water
50CrMo4	820-860	Oil
51CrV4	820-860	Oil
55Si7	830-860	Oil
58CrV4	810-850	Oil
68CrNiMo3-3	810-840	Oil
75Cr1	810-840	Oil
75Ni8	820-850	Oil

80CrV2	840-870	Oil
95Cr1	800-840	Oil
102Cr6	830-860	Oil
110Cr35W2	830-860	Oil
120Cr35	830-860	Oil
125Cr2	830-860	Oil