Draft Indian Standard

HOT DIP ALUMINIUM- SILICON COATED STEEL SHEET AND STRIP — SPECIFICATION

1 SCOPE

This document applies to the minimum requirements for steel sheets, in coils and cut lengths, metallic-coated by the continuous hot-dip process, with Aluminium- silicon alloy or Aluminium coating.
The product is intended for applications requiring heat resistance and also for both corrosion and heat resistance. The steel sheet and strip are produced in several quality designations and grades, coating type, coating mass, surface treatments and coating finish conditions designed to be compatible with varying application requirements.

2 REFERENCE

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

IS Standard No.	*Title*
IS 228(Various parts)	Method for chemical analysis of steel
IS 513 (Part 1) : 2016	Cold reduced carbon steel sheet and strip: Part 1 Cold forming and drawing purpose (sixth revision)
IS 513 (Part 2) : 2016	Cold reduced carbon steel sheet and strip : Part 2 High tensile and multi-phase steel (sixth revision)
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 4) : 2013	Glossary of terms relating to iron and steel : Part 4 Flat products (second revision)
IS 2629:1985	Recommended practice for hot- dip galvanizing of iron and steel (first revision)
IS 8910 : 2022 / ISO 404:2013	General technical delivery requirements for steel and steel products (second revision)
IS 11999:2022/ ISO 10113:2020	Method for determination of plastic strain ratio “r” for sheet metals (Second revision)
IS 12860 : 1989	Metallic coating thickness by X-Ray fluorescence technique method — Determination
IS 15262:2002/ ISO 4287 : 1997	Geometrical product specifications (GPS)-surface texture, definitions, and surface texture parameters
IS 15756: 2022/ ISO 10275:2020	Metallic materials - Sheet and strip - Determination of tensile strain hardening exponent (second revision)
IS/ISO 16163: 2012	Continuously hot - Dipped coated steel sheet products - Dimensional and shape tolerances (first revision)
IS 2590: 1987	Specification for Primary aluminium ingots for remelting for general engineering purposes
IS 617 : 2024	Aluminium and Aluminium Alloys Ingots for Remelting and Castings for General Engineering Purposes — Specification (*fourth revision*)

3 TERMINOLOGY

For this standard, the definitions given in IS 1956 (Part 4), IS 3531, IS 3554, IS 513 (Part 1 and Part 2), IS 18385, IS 18513 and the following definitions shall apply.

3.1 Product — Hot Dip Aluminium-Silicon alloy coated carbon steel sheet and strip and Hot Dip Aluminium coated cold reduced carbon steel sheet and strip

3.2 Thickness of Sheet — The thickness of Hot Dip Aluminised carbon steel sheet and strip shall be specified as a combination of the base metal and metallic coating, or as the base metal alone. The purchaser shall indicate on the order which method of specifying thickness is required. If the purchaser does not indicate any preference, the thickness as a combination of the base metal and coating will be provided. Annex A describes the requirements for specifying the thickness as base metal alone.

3.3 Coating Mass — The amount of coating expressed in grams per unit surface area of the sheet (g/m^2).

3.4 Differential coating — Coating is deliberately produced to have a different coating mass on each surface.

3.5 Structural — Base-metal quality intended for parts needing guaranteed mechanical properties and where simple forming may be involved.

3.6 Normal Spangle — Coating formed as a result of the unrestricted growth of Aluminium-Silicon alloy crystals during normal solidification.

3.7 Equivalent Coating Thickness — Total thickness of coating mass applied on both surfaces.

4 DIMENSIONS

4.1 Hot Dip Aluminium Silicon Alloy Coated or Aluminium coated carbon steel sheet and strip is produced in thicknesses from 0.40 mm to 3.00 mm inclusive after coating, and in widths of 600 mm and over in coils and cut lengths. Steel coil & sheet less than 600 mm wide, slit from a wide coil and further cut into required lengths.

5 DESIGNATIONS

5.1 Base Metal Grade — Hot Dip Aluminium Silicon Alloy Coated or Aluminium coated carbon steel sheet and strip covered by this standard shall be designated by the type of base metal used for coating. The grades, therefore, are classified as given in Table-1 for coated steels with cold substrate and applicable coating type. Aluminium -Silicon alloy coating or Aluminium coating can also be applied on Hot rolled and pickled substrates and the acceptance criteria for such products is as per the mutual agreement between the purchaser and the manufacturer.

5.2 Coating Type — Coating types are available in two types with several coating classes.

a) Coating Type AS is manufactured using a coating bath of Aluminium-Silicon Alloy. The composition of the alloy bath is at the discretion of the manufacturer.
b) Coating Type AL is manufactured using a coating bath of commercially available pure aluminium. The composition of the bath at the discretion of the manufacturer.

5.3 Coating Class — Expressed as ASXXX, Where, AS stands for Aluminium-Silicon alloy coated and XXX Stands for coating mass in g/m^2 and ALXXX, where, AL stands for Aluminium coated and XXX Stands for coating mass in g/m^2. The coating class shall be as per Table 2.

5.4 Surface Finish — The surface finish shall be as per Table 3.

5.5 Surface Treatment — The surface treatment shall be as per Table 4.

6 SUPPLY OF MATERIAL

The general requirements relating to the supply of Hot Dip Aluminium Silicon Alloy Coated or Aluminium coated sheet and strip shall conform to IS 8910.

7 MANUFACTURE

7.1 Processes used in steel making, rolling, and manufacturing process of Hot Dip Aluminium Silicon Alloy Coated or Aluminium coated steel shall be left to the discretion of the manufacturer unless there is a restriction on the steel grades or as per mutual agreement between purchaser and manufacturer.

7.2 For the hot-dip coating process, cold-rolled substrates shall be used.

7.3 The strip is dipped in a suitable bath of molten metal alloys of Aluminium-Silicon or Aluminium at a temperature suitable to produce a complete and uniform adherent coating.

7.4 The ingots of Aluminium & Aluminium alloys should conform used for molten bath for dipping shall confirm to grades specified in IS 2590 and IS 617 respectively. In case of Aluminium Silicon alloy ingot of required composition, its properties and composition shall be at the discretion of the manufacturer.

8 CHEMICAL COMPOSITION

8.1 Ladle Analysis — The ladle analysis of the base metal of steel sheet and strip shall be as per the requirements given in Table 5 for cold rolled substrate 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. One sample is to be tested for a ladle.

8.2 Product Analysis — Permissible variation in the case of product analysis, after stripping of coating, from the limits specified in Table 5 shall be as given in Table 6.

9 COATING PROPERTIES

9.1 Coating Mass - The coating mass expressed in grams per square metre given for both surfaces shall conform to the requirements specified in Table 2. The maximum coating mass may be agreed upon between the purchaser and the manufacturer. Differentially coated products can be mutually agreed upon between the purchaser and manufacturer.

9.2 Coating Mass Test –

9.2.1. The coating mass of the product is to be tested by taking a sample piece from each mother coil approximately 300 mm in length and in full width, and cutting three test specimens, one from the mid-width position and one from each side, not closer than 50 mm to the side edge. The minimum area of each of the three specimens shall be 1200 mm^2.

9.2.2. The coating mass is the triple spot test result which shall be the average coating mass found on the three specimens taken in accordance with 9.2.1. However, the minimum of three coating values should comply with the single spot test requirements of the coating designation. For narrow strips, which have been slit from a wide hot dip aluminised coil, only a single spot test is applicable and should comply with the minimum requirement of the coating designation.

9.2.3. The coating mass shall be determined by the X-ray fluorescence method installed in a manufacturing facility or in a laboratory (see IS 12860) or by weight loss (Gravimetric) method as per any one of the methods specified in Annex B.1 & Annex B.2. In the case of differential coating, the coating mass of the product is to be tested by the X-ray fluorescence method only.

9.2.4. If required, an Alloy layer test can be conducted as per Annex B.3

9.2.5. Other relevant international or customer-specific standard test methods can be applied to determine the coating mass, based on the mutual agreement between the purchaser and the manufacturer.

9.3 Adherence Test –

9.3.1. Hot Dip Aluminium Silicon Alloy Coated steel sheet and strip shall be capable of being bent in any direction, in accordance with the mandrel diameter requirements of Table 7,

without flaking of the coating on the outside of the bend. This requirement is applicable for Aluminium-Silicon alloy coating Flaking of the coating within 7 mm from the edge shall not be a cause for rejection. Subject to mutual agreement between purchaser and manufacturer, stricter conditions can be applied. For Aluminium coating, adherence test can be carried out as per the mutual agreement between the purchaser and the manufacturer.

9.3.2. One sample is to be drawn from each mother coil or a lot of 50T or less processed under the identical conditions of a single ladle, hot & cold rolling conditions, thickness, width, coating, and process conditions at a hot dip galvanizing line.

9.3.3. Any other applicable international or customer-specified coating adherence and powdering standard methods can be applied with suitable evaluation criteria, based on the mutual agreement between the purchaser and the manufacturer.

9.4 Corrosion resistance for coating - On request, the corrosion resistance of the coating may be tested. The test conditions for the corrosion resistance test and evaluation criteria shall be in accordance with the agreement between the purchaser and the manufacturer or as per the established national, international or customer-specific standards.

10 SURFACE TREATMENT AND FINISH

10.1 Mill Passivation – When specified, a chemical treatment is normally applied to Hot Dip Aluminium Silicon Alloy Coated or Aluminium coated steel sheet and strip. However, the inhibiting characteristics of the treatment are limited and, if a shipment is received wet, the material shall be used immediately or dried.

10.2 Oiling - When specified, Hot Dip Aluminium Silicon Alloy Coated or Aluminium coated steel sheet and strip as produced shall be oiled to prevent marring and scratching of the soft surface during handling or shipping and to minimize wet storage stains.

NOTE — When a Hot Dip Aluminium Silicon Alloy Coated or Aluminium coated steel sheet and strip has received a passivating treatment, oiling will further minimize the hazard of wet storage stain.

10.3 As agreed between the purchaser and the manufacturer, other applicable and suitable kinds of surface treatments can be applied.

10.4 The surface finish can be presented as, as Coated surface finish without a skin pass and coated surface with a Skin pass finish. Based on end-use requirements, the purchaser and manufacturer decide upon and mutually agree on the kind of surface finish requirements.

11 MECHANICAL PROPERTIES

11.1 Test Frequency – Specimen for mechanical properties shall be drawn from each mother coil or a lot of 50T or less processed under the identical conditions of a single ladle, hot & cold rolling conditions, thickness, width, coating, and process conditions at a hot dip galvanizing line.

11.2 Tensile Test

11.2.1 Tensile Test Specimen – Tensile test values apply to the direction and type of specimen mentioned in Table 8. Strips having a width of 250 mm and below shall be tested longitudinally.

11.2.2 Testing – Tensile test to be conducted as IS 1608 (Part 1) at room temperature and Tensile properties i.e., Yield Strength, Tensile Strength and % Elongation shall meet the requirements specified in Tables 8. The yield strength value applies to 0.2% of proof stress and if Yield stress is not clearly defined, otherwise the value applies to lower yield stress or upper yield stress based on mutual agreement between purchaser and manufacturer.

11.2.3 When specified by the purchaser, the tensile test can be omitted.

11.3 Plastic Strain ratio (r-90)

11.3.1 The plastic strain ratio, an index of draw ability (r-90), shall apply to a thickness between 0.50 mm to 2.00 mm. For thicknesses more than 1.00 mm, the r-90 value is reduced by 0.10 and if required, for the thickness more than 2.0mm, the r-90 value is reduced by 0.20.

11.3.2 The plastic strain ratio shall be checked in accordance with IS 11999 and results shall conform to as given in Table 8

11.3.3 When specified by the purchaser, the Plastic strain ratio test can be omitted.

11.4 Tensile Strain Hardening Exponent (n-90)

11.4.1 The tensile strain hardening is an index of the stretchability (n-90), which shall be applicable to a thickness between 0.50 mm and 2.00 mm. If required, for a thickness of more than 2.00 mm, the n-90 is reduced by 0.02.

11.4.2 The tensile strain hardening component shall be checked in accordance with IS 15756 and results shall conform to as given in Table 8

11.4.3 When specified by the purchaser, the tensile strain hardening exponent test can be omitted.

11.5 Bake Hardening Index (BH)

11.5.1 Bake hardening index shall be tested as per Annex C and the minimum BH value shall as be given in Tables 8.

11.6 Bend Test

11.6.1 If specified by the purchaser, Bend test shall be carried out in accordance with IS 1599 for the cold rolled substrate.

11.6.2 The angle of bend and the internal diameter for the different grades of material shall be as per the mutual agreement between the purchaser and the manufacturer.

11.6.3 The axis of the bend shall be in the direction of rolling. The test pieces shall be deemed to have passed the test if the outer convex surface is free from cracks.

11.6.4 Bend test is applicable to fully annealed steel products only.

11.7 Hardness Test

11.7.1 If specified by the purchaser, the hardness test shall be out in accordance with IS 1586 for Rockwell Hardness and as per IS 1501 for Vickers Hardness. The evaluation criteria shall be subject to mutual agreement between the purchaser and the manufacturer.

11.8 **Ageing period** – The values mentioned against the different mechanical properties' requirements are applicable for the periods mentioned in Table 9 from the date, the product is available for the shipment at manufacturer's end.

11.9 Thickness for calculating tensile properties and bake hardening properties shall be either one of the following.

i. Actual measured thickness after removing the coating layer

ii. Result after subtracting the coating thickness on each side specified in Table A.1 from the actual measured thickness including the coating layers.

iii. Results after subtracting the equivalent coating thickness of the actual measured coating mass from the measured thickness including the coating layers. Refer to Annex A for calculating coating thickness based on coating mass.

12 DIMENSIONS, SHAPE AND TOLERANCES

12.1 Coil Inner Diameter - Unless otherwise agreed, the internal diameter of coils shall be 508 mm (±10 mm).

12.2 Tolerances – Tolerances on dimensions (Thickness, width, Length), shape (Flatness, Waviness), camber, and out-of-squareness shall be as per IS 16163.

12.3 Sheets and strips may be supplied either with mill or trimmed edges. For untrimmed/hot rolled mill edges, width tolerances shall be +20/-0 mm and for edges that are trimmed before cold rolling, width

tolerances shall be +7/-0 mm. For edges trimmed after cold rolling, annealing & coating, width tolerances shall be as per ISO 16163.

13 RETEST

13.1 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.

13.2 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.

13.3 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.

14 STRAIN AGEING

14.1 Hot Dip Aluminium Silicon Alloy Coated or Aluminium coated steel sheet and strip tend to strain age, and this may lead to following:

a) Surface marking from stretcher strains or fluting when the steel is formed, and;
b) Deterioration in ductility.

14.2 Freedom from stretcher strain for a period of 6 months from the date of manufacture can be achieved by the supply of skin-passed non-ageing steel.

14.3 The details given above are for information and the manufacturer may adopt the same at their discretion.

15 SURFACE APPEARANCE

15.1 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.

15.2 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 manufacturer for treating such cases.

15.3 Unless otherwise specified, surface defects shall be applied to one side. For sheets, it generally referred to the top side of the packing and for strips, the outer side is referred to as the applicable side.

15.4 The acceptance level of the defects will be as per mutual agreements between purchaser and manufacturer.

16 PACKING

Hot Dip Aluminium Silicon Alloy Coated or Aluminium coated steel sheet and strip should be suitably packed to avoid any transit/handling/storage damage and as per the agreement between the purchaser and the manufacturer.

17 MARKING

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 Aluminium-Silicon alloy-coated steel sheet/strip; and,
g) Date of manufacture.

18 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 thereunder, and the products may be marked with the Standard Mark.

19 STORAGE AND TRANSPORTATION

19.1 Moisture, in particular condensation between the sheets, laps of the coil or other adjacent parts made of hot dip coated flat products, can lead to the formation of corrosion products. The possible types of temporary surface protection are given in clause 10. As a precaution, the products should be transported and stored dry and protected from moisture.

19.2 During transportation, dark spots may appear on the surfaces as a result of friction. Generally, they only impair the appearance. Friction is reduced by oiling the products. Additionally, secure packing, transporting the coils laid flat and avoiding local pressure points, reduce the risk of dark spots.

Table 1 Type and Designation

(*Clause* 5.1)

Type and Designation		Thickness (mm)	Applicable Coating Type (AS/AL)
Mild Steel	IASCR1	0.40-3.00	AS, AL
	IASCR2	0.40-3.00	AS, AL
	IASCR3	0.40-3.00	AS, AL
	IASCR4	0.40-3.00	AS, AL
	IASCR5	0.40-3.00	AS, AL
	IASCR6	0.40-3.00	AS, AL
	IASCR7	0.40-3.00	AS, AL
Structural Quality Steel	IAS330S	0.40-3.00	AS, AL
	IAS360S	0.40-3.00	AS, AL
	IAS390S	0.40-3.00	AS, AL
	IAS420S	0.40-3.00	AS, AL
Bake-hardening type steel	IAS290B	0.40-2.30	AS
	IAS320B	0.40-2.30	AS
	IAS360B	0.40-2.30	AS
	IAS400B	0.40-2.30	AS
	IAS440B	0.40-2.30	AS
Interstitial Free - High Strength	IAS300P	0.40-2.30	AS
	IAS330P	0.40-2.30	AS
	IAS340P	0.40-2.30	AS
	IAS380P	0.40-2.30	AS
	IAS390P	0.40-2.30	AS
High Strength Low Alloy	IAS350LA	0.40-3.00	AS, AL
	IAS380LA	0.40-3.00	AS, AL
	IAS410LA	0.40-3.00	AS, AL
	IAS440LA	0.40-3.00	AS, AL
	IAS470LA	0.40-3.00	AS, AL
	IAS500LA	0.60-3.00	AS, AL
	IAS530LA	0.60-3.00	AS, AL

NOTES

1 For any thickness greater than or less than the mentioned range, the same can be produced as mutually agreed to between the manufacturer and the purchaser. Acceptance criteria for the range out of the available product range shall be as agreed to between the purchaser and the manufacturer.

2 The nomenclature of the grade is explained in Annex D.

Table 2 Coating Mass Requirement
(*Clause* 5.2 *and* 9.1)

Minimum Requirement for Both Sides			
Coating Type	**Coating Mass Designation**	**Triple Spot Test (gm/m^2)**	**Single Spot Test (gm/m^2)**
Coating Type AS	AS040	40	30
	AS060	60	45
	AS080	80	60
	AS100	100	75
	AS120	120	90
	AS150	150	115
	AS200	200	150
	AS300	300	240
Coating Type Al	ALNS	No Minimum	No Minimum
	AL200	200	180
	AL300	300	270

NOTES

1 Because of the many variables and changing conditions that are characteristic of continuous Aluminium-Silicon coating & Aluminium Coating, the coating mass is not always evenly divided between the two surfaces of a sheet, neither is the coating evenly distributed from edge to edge. However, it can normally be expected that no less than 40 % of the single spot check limit will be found on either surface.

2 Other coating masses can be produced by an agreement between the manufacturer and the purchaser.

Table 3 - Surface Finish Requirement
(*Clause* 5.4)

Surface Finish Designation	
Type	**Description**
N	As coated Finish. No Skin pass finish
S	Smooth finish with Skin pass

NOTE — For a smooth finish with skin pass, different kinds of surface finishes with varied ranges of roughness values can be mutually agreed upon between the purchaser and manufacturer. Roughness check shall be carried out in accordance with the IS 15262

Table 4 - Surface Treatment & Oiling Requirement
(*Clause* 5.5)

Surface Treatment Designation	
C	Mill Passivation
O	Oiling
CO	Mill Passivation and Oiling
U	Un-Treated

NOTE — Based on the mutual agreement between the purchaser and manufacturer, in addition to the above-mentioned treatment or stand-alone, other surface treatments can also be applied.

Table 5 - Chemical Composition Requirements
(*Clause* 8.1)

Type and Designation		C % (Max)	Mn % (Max)	P % (Max)	S % (Max)
Mild Steel	IASCR1	0.20	2.00	0.12	0.035
	IASCR2	0.18	1.20	0.12	0.035
	IASCR3	0.10	0.50	0.04	0.030
	IASCR4	0.08	0.45	0.03	0.030
	IASCR5	0.06	0.45	0.03	0.030
	IASCR6	0.02	0.25	0.03	0.020
	IASCR7	0.02	0.25	0.03	0.020
Structural Quality Steel	IAS330S	0.25	1.60	0.10	0.040
	IAS360S	0.25	1.60	0.10	0.040
	IAS390S	0.25	1.60	0.10	0.040
	IAS420S	0.25	1.60	0.10	0.040
Bake-hardening type steel	IAS290B	0.01	0.80	0.10	0.020
	IAS320B	0.01	1.00	0.10	0.020
	IAS360B	0.01	1.20	0.10	0.020
	IAS400B	0.01	1.60	0.10	0.020
	IAS440B	0.01	1.60	0.10	0.020
Interstitial Free - High Strength	IAS300P	0.01	0.80	0.10	0.020
	IAS330P	0.01	1.00	0.10	0.020
	IAS340P	0.01	1.20	0.10	0.020
	IAS380P	0.01	1.60	0.10	0.020
	IAS390P	0.01	1.60	0.10	0.020
High Strength Low Alloy	IAS350LA	0.10	1.20	0.07	0.025
	IAS380LA	0.12	1.40	0.07	0.025
	IAS410LA	0.12	1.50	0.07	0.025
	IAS440LA	0.12	1.60	0.07	0.025
	IAS470LA	0.14	1.60	0.07	0.025
	IAS500LA	0.14	1.80	0.07	0.025
	IAS530LA	0.16	1.80	0.07	0.025

NOTES

1 Steels of these grades can be supplied with the addition of micro-alloying elements like Boron, Titanium, Niobium and Vanadium either singly or in combination shall not exceed 0.3% or as per the above table. However, Boron addition will be restricted to 0.006 per cent max.

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

3 The elements (e.g Cr, Mo, Ni, etc) not mentioned in the above table can be added up to 1 per cent max either singly or in combination.

4 Restricted chemical composition may be mutually agreed to between the purchaser and the supplier.

5 When the steel is Aluminium killed, the total Aluminium content shall not be less than 0.02 percent. However, aluminium less than 0.02 percent can be mutually agreed between the purchaser and the supplier for Aluminium killed steel.

Table 6 – Tolerances on Product Requirements
(*Clause* 8.2)

Element	**Specified Chemical Composition Limit, Percent, Max**	**Variation Over specified Limit, Percent, Max**
Carbon	≤0.150	0.02
	> 0.150	0.03
Manganese	≤0.6	0.03
	>0.60, ≤1.150	0.04
	≥1.150	0.05
Sulphur	≤ 0.050	0.005
Phosphorus	≤0.050	0.005
	> 0.050	0.01
Silicon	≤0.600	0.03
	> 0.600	0.06
Micro Alloy	---	Subject to negotiation
NOTE — Sufficient care should be taken while carrying out product analysis on thin samples.		

Table 7 – Coating Adherence
(*Clause* 9.3)

Coating adherence — Bend-test mandrel diameter								
Diameter of Mandrel for Bending in mm								
Type	**Grade Designation/Strength**	**Bending Angle**	**Nominal Thickness (T) < 1.6 mm**			**Nominal Thickness (T)≥ 1.6 mm**		
			up to AS120	**AS150**	**AS200-AS300**	**up to AS120**	**AS150**	**AS200-AS300**
Mild Steel	IASCR1	180^0	1T	2T	2T	2T	3T	3T
Mild Steel	IASCR2,IASCR3,IASCR4,IASCR5,IASCR6,IASCR7	180^0	1T	2T	--	3T	3T	--
Structural Quality Steel	All Grade Designations	--	--	--	--	--	--	--
Bake-hardening type steel	All Grade Designations	--	--	--	--	--	--	--
Interstitial Free - High Strength	All Grade Designations	--	--	--	--	--	--	--
High Strength Low Alloy	All Grade Designations	--	--	--	--	--	--	--

NOTES

1 (--) → Can be applied based on the mutual agreement between the purchaser and manufacturer.

2 Stricter conditions and adherence tests on other designations and grades can be applied based on mutual agreement between the purchaser and the manufacturer.

Table 8 – Mechanical Property Requirement
(*Clauses* 11.2, 11.3, 11.4 *and* 11.5)

Type and Designation		**Tensile Strength (N/mm2) (Min)**	**Yield point or proof stress N/mm2**			**%Elongation, *Min* (Test Piece Type 2 of IS 1608 Part 1)**			**Testing Direction**	**Amount of Bake Hardening (N/mm2) BH,Min**	**Plastic strain Ratio**	**Strain Hardening Exponent**
			Thickness, t mm			**Thickness, t mm**						
			≤ 0.5	**0.50 < t ≤ 0.7**	**t > 0.70**	**≤ 0.5**	**0.50 < t ≤ 0.7**	**t > 0.70**			**r90, Min**	**n90 , Min**
Mild Steel	IASCR1	270	--	--	--	18	20	22	Transverse	--	--	--
	IASCR2	270	140-340	140-320	140-300	22	24	26	Transverse	--	--	--
	IASCR3	270	140-300	140-280	140-260	26	28	30	Transverse	--	--	--
	IASCR4	270	140-280	140-260	140-240	26	28	30	Transverse	--	--	--
	IASCR5	270	120-260	120-240	120-220	30	32	34	Transverse	--	1.4	0.18
	IASCR6	270	120-220	120-200	120-180	35	37	39	Transverse	--	1.7	0.20
	IASCR7	270	120-210	120-190	120-170	37	39	41	Transverse	--	1.9	0.21
Structural Quality Steel	IAS330S	330	250 Min			15	17	19	Rolling	--	--	--
	IAS360S	360	280 Min			14	16	18	Rolling	--	--	--
	IAS390S	390	320 Min			13	15	17	Rolling	--	--	--
	IAS420S	420	350 Min			12	14	16	Rolling	--	--	--
Bake-hardening steel	IAS290B	290	180-280	180-260	180-240	30	32	34	Transverse	30	1.5	0.16
	IAS320B	320	220-320	220-300	220-280	28	30	32	Transverse	30	1.2	0.15
	IAS360B	360	260-360	260-340	260-320	24	26	28	Transverse	30	--	--
	IAS400B	400	300-400	300-380	300-360	22	24	26	Transverse	30	--	--
	IAS440B	440	340-440	340-420	340-400	20	22	24	Transverse	30	--	--
	IAS300P	300	160-260	160-240	160-220	33	35	37	Transverse	--	1.9	0.20

Interstitial Free - High	IAS330P	330	180-280	180-260	180-240	30	32	34	Transverse	--	1.7	0.18
	IAS340P	340	220-320	220-300	220-280	28	30	32	Transverse	--	1.5	0.16
	IAS380P	380	260-360	260-340	260-320	26	28	30	Transverse	--	1.4	0.15
	IAS390P	390	300-400	300-380	300-360	23	25	27	Transverse	--	1.3	0.15
High Strength Low Alloy	IAS350LA	350	260-370	260-350	260-330	22	24	26	Transverse	--	--	--
	IAS380LA	380	300-420	300-400	300-380	19	21	23	Transverse	--	--	--
	IAS410LA	410	340-460	340-440	340-420	17	19	21	Transverse	--	--	--
	IAS440LA	440	380-520	380-500	380-480	15	17	19	Transverse	--	--	--
	IAS470LA	470	420-560	420-540	420-520	13	15	17	Transverse	--	--	--
	IAS500LA	500	--	460-580	460-600	--	13	15	Transverse	--	--	--
	IAS530LA	530	--	500-640	500-620	--	11	13	Transverse	--	--	--

NOTES

1 1 N/mm2 = 1 MPa.

2 Stricter mechanical properties requirements may be agreed to between the manufacturer and the purchaser, before placing the order.

3 Mechanical properties apply only to annealed followed by skin-passed products.

4 The values of yield stress are the 0.2 per cent proof stress for products that do not represent a marked yield point and the lower yield stress for the others.

5 (--) → Not required. Where deemed required, the purchaser and manufacturer can agree up on testing with mutually agreed criteria for evaluation.

6 Based on the mutual agreement between purchaser and manufacturer, different testing directions can be applied while conducting tensile tests. For such cases, mechanical properties requirement will be based on the mutual agreement and those agreed values should be reasonably close to the values mentioned in Table 8.

Table 9 – Ageing Period Requirement
(*Clause* 11.8)

Type and Designation (For Cold rolled Substrate)		**Applicable Non-Ageing Period**
Mild Steel	IASCR5	3 Months
	IASCR6	6 Months
	IASCR7	6 Months
Bake-hardening type steel	IAS290B	3 Months
	IAS320B	3 Months
	IAS360B	3 Months
	IAS400B	3 Months
	IAS440B	3 Months
Interstitial Free - High Strength	IAS300P	6 Months
	IAS330P	6 Months
	IAS340P	6 Months
	IAS380P	6 Months
	IAS390P	6 Months

NOTES

1 Applicable non ageing period is applicable only for the Type and designation mentioned in Table 9. For the remaining Type and designations, based on mutual agreement, non-ageing period can be applied.

2 Based on mutual agreement, stricter test conditions can be applied

ANNEX A

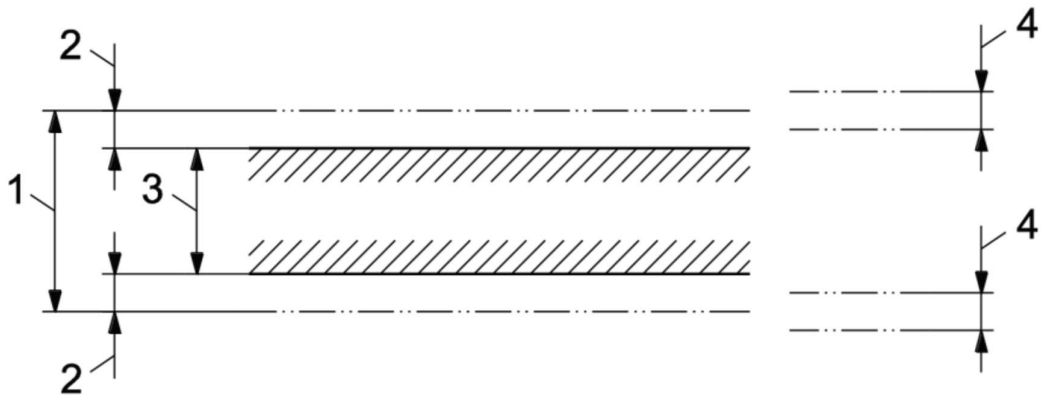
(*Clause* 3.1 *and* 11.9)

ORDERS REQUIRING BASE-METAL THICKNESS.

A.1 The average thickness of the coating calculation

When specified by the purchaser, the ordered thickness shall be the base-metal thickness. In these cases, the product thickness shall be calculated as the base-metal thickness + the equivalent coating thickness for each surface, as indicated in Figure A.1.

Thickness tolerance tables apply to the product thickness.



Key

1 product thickness
2 equivalent coating thickness
3 base-metal thickness
4 thickness tolerance

Figure A.1 — Calculation of the product thickness

Table A.1 Equivalent Coating thickness – total of both sides

Coating Type	Coating Thickness per Side
Aluminium-Silicon Alloy (AS)	0.001 mm (micron) = 3.02 gm/m^2 1 gm/m^2 = 0.00033 mm
Aluminium (AL)	0.001 mm (micron) = 3.20 gm/m^2 1 gm/m^2 = 0.00031 mm

ANNEX B

(*Clause* 9.2.3 *and* 9.2.4)

DETERMINATION OF MASS OF COATING

B-1 DETERMINATION OF MASS OF COATING ON HOT DIP ALUMINIUM SILICON ALLOY COATED USING HYDROCHLORIC ACID

B-1.1 This Annex covers cover the determination of the mass of Aluminium silicon alloy coating on the surface of a steel sheet specimen by measuring the mass of the specimen before and after removal of the coating.

B-1.2 **Apparatus —** Analytical balance, capable of measuring to the nearest 0.001 g

B-1.3 **Reagents:**

a. Hydrochloric acid , ρ = 1.19g/ml
b. Sodium Hydroxide: 20% mass fraction solution

B-1.4 **Sampling —** As mentioned in **9.2.1**

B-1.5 **Procedure:**

a) Weigh the test piece, then immerse it in the sodium hydroxide solution that has been heated to not less than 85 °C until the reaction ceases.
b) Remove the test piece, scrub it under water, blot with a towel to remove most of the water and immerse it for 2 s to 3 s in cold hydrochloric acid.
c) Remove the test piece again, scrub it under water, and re-immerse it in the sodium hydroxide solution until the reaction ceases to occur.
d) Repeat this cycle until immersion in the sodium hydroxide solution shows no visible reaction. Remove, scrub, dry and reweigh the test piece.

B-1.6 **Expression of Result**

The mass of coating (m_c) in grams per square meter of sheet (total for both sides) is given by the following formula

$$m_c = (m_0 - m_1)/A \times 10^6$$

where

m_0 — mass, in grams, of the test piece before stripping

m_1 — mass, in grams, of the test piece after stripping.

A — areas of the test piece used in square millimetres

B-2 DETERMINATION OF MAS OF COATING ON HOT DIP ALUMINIUM COATED STEEL USING DILUTED HYDROCHLORIC ACID

B-2.1 This method is for determining the amount of Hot Dip Aluminised steel sheet coating on the surface of a steel sheet specimen by measuring the mass of the specimen before and after removal of the coating.

B-2.2 Apparatus — Analytical balance, capable of measuring to the nearest 0.001 g

B-2.3 Reagents:

a. **Diluted Hydrochloric acid :** Mix 500 mL of HCl (sp. gr.1.18 to 1.19) with 500 mL of reagent water and cool to room temperature.

B-2.4 Sampling — As mentioned in **9.2.1**

B-2.5 Procedure:

a) Using an organic (but not chlorine-based) solvent or other suitable method, remove oil and other soils from the test piece, dry completely, then weigh to the nearest 0.001 g.
b) The temperature of solution should not exceed more than 38 Deg.C.
c) Weigh the test piece, then immerse each specimen singly in the diluted hydrochloric acid stripping solution. Allow the specimen to remain in the solution until the violent evolution of hydrogen bubbles is ceased and only few bubbles being evolved. This reaction will cease in 1 to 4 minutes depending on the coating thickness and alloy content.
d) After completion of reaction, specimen should be removed from the solution and scrub them under running water, dip in hot water and wipe to remove water or blow dry the specimen.
e) Reweigh the dry test piece to the nearest 0.001 g.

B-2.6 Expression of Result

The mass of coating (m_c) in grams per square meter of sheet (total for both sides) is given by the following formula

$$m_c = (m_0 - m_1)/A \times 10^6$$

where

m_0 — mass, in grams, of the test piece before stripping

m_1 — mass, in grams, of the test piece after stripping.

A — areas of the test piece used in square millimetres

B-3 METHOD FOR DETERMINATION OF THE MASS OF THE AL-FE-SI ALLOY LAYER

B-3.1 The method described below is used for determining the mass of the alloy layer on samples of hot-dip aluminium-silicon coated flat products. Firstly, the so-called non-alloy layer and secondly the alloy layer are removed, according to the method in B-1 or B-2. The method is based on the reaction of tin (II) chloride solution with aluminium to form metallic tin (sponge), this solution does not react with the alloy or with the iron base material. The samples are weighted before and after removal of the alloy layer.

B-3.2 Reagents:

Tin (II) chloride solution :

a) To produce the stock solution, 1 000g $SnCl_2$ x H_2O are dissolved in 500 ml of diluted hydrochloric acid (1:1). Make up to 1 000 ml adding 5 g to 10 g metallic tin. Heat until the solution is clear.
b) To produce the test solution, 20 ml of stock solution are added to 200 ml H_2O immediately prior to use.

B-3.3 Procedure:

a) Removal of the non-alloy layer

The samples taken in accordance with 9.2.1 are cleaned with petroleum ether and immersed in 200 ml of test solution until the reaction ceases.
Once the test samples have been removed from the solution, the sponge tin is scraped off with a small spatula. The process is repeated until no further reaction takes place. The samples are then washed and dried.

b) Determination of alloy layer

The test samples prepared in accordance with B33.a are treated as described in B15.

B-3.4 Expression of Results: The mass of coating (mc) in grams per square meter of sheet (total for both sides) is given by the following formula

$$m_c = (m_0 - m_1)/A \times 10^6$$

where

m_0 — mass, in grams, of the test piece before stripping

m_1 — mass, in grams, of the test piece after stripping.

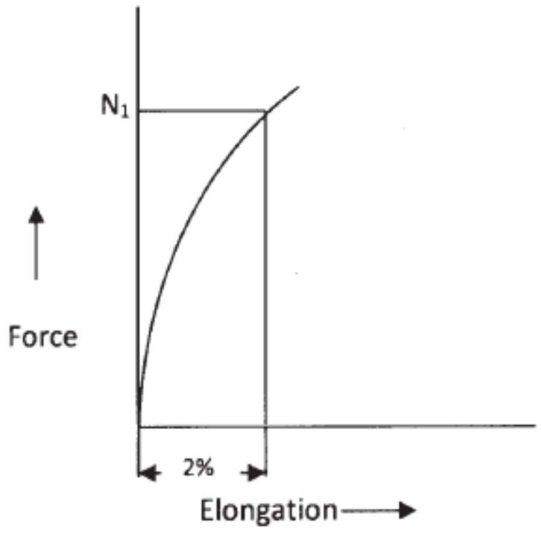
A — areas of the test piece used in square millimetres

ANNEX C
(*Clause* 11.5)

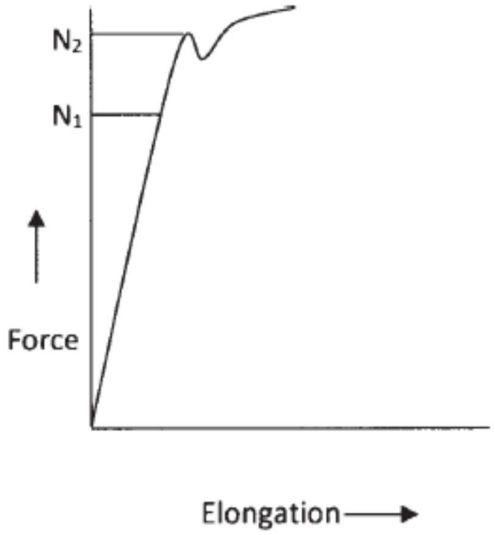
BAKE HARDENING TEST

The bake hardening index (BH) is the increase in the yield point that is found in the bake hardening test carried out. Bake hardening of steel is achieved during the paint baking treatment. The test procedure for the determination of bake hardening index is as follows:

a) Test specimens shall be collected from annealed, skin-passed material in the direction mentioned as per Table 8. Tensile specimen to be prepared as per IS 1608 Part 1
b) The parallel portion area of the test piece shall be noted be as A0.
c) The test specimen shall be strained to 2 per cent tensile elongation. The corresponding force shall be noted as N1.
d) The specimen shall be unloaded from tensile tester and heat treated for 20 min at a temperature of 170^0C
e) After the heat treatment, the test specimen shall be subjected to tensile testing again. The sharp yield point is expected to appear along with the yield drop phenomenon. The force corresponding to the upper yield point shall be noted as N2.
f) The BH value calculation shall be obtained as BH = (N2– N1)/A0
g) BH Value calculation is schematically represented in below Figure.



Preliminary Strain Loading



After Baking Process – Heat Treatment

ANNEX D

(*Table* 1 *and Clause* 5.1)

NOMENCLATURE