भारतीय मानक प्रारूप

तप्त - निमज्जी एल्युमीनियम और एल्युमीनियम-सिलिकॉन लेपित इस्पात की चद्दर एवं पत्ती – विशिष्टि

Draft Indian Standard

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

ICS 77.140.50

Wrought Steel Products Sectional Committee. MTD 04	Last date for receipt of comments: **17 July 2025**

FOREWORD

(*Formal clauses would be added later*.)

This standard has been formulated to cover technical requirements of aluminium and aluminium-silicon coated steel.

Aluminium and aluminium-silicon coated steels are specialized materials known for their lightweight and corrosion-resistant properties. The aluminium coating is metallurgically bonded to the steel substrate, providing excellent oxidation resistance, while the silicon enhances adhesion and heat resistance. These characteristics make the material ideal for automotive applications, such as body structures and engine components. It is also used in construction and household products, where durability and efficiency are important.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*). The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Draft Indian Standard

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

1 SCOPE

This standard covers the requirements for steel sheets and strips, in coils and cut lengths, metallic-coated by the continuous hot-dip process, with aluminium-silicon alloy (AS) or aluminium (AL) 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 REFERENCES

The standards listed in Annex A contain provisions. which through reference in this text constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of these standards.

3 TERMINOLOGY

For this standard, the definitions given in IS 1956 (Part 4), IS 3531, 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 (AS) coated and hot-dip aluminium (AL) coated carbon steel sheet and strip

3.2 Thickness of Sheet — The thickness of hot-dip aluminium or aluminium-silicon alloy coated carbon steel sheet and strip shall be specified either as the total thickness which is a combination of the base metal and metallic coating or as the thickness of the base metal alone.

The purchaser shall indicate the preferred method of thickness specification at time of enquiry and order. In the absence of such indication, the product shall be supplied with the thickness measured as the combination of base metal and coating.

The requirements for specifying the thickness as base metal alone are described in Annex B.

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 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 — Thickness of coating expressed in µm and is usually calculated using the coating mass applied on both surfaces.

4 DIMENSION

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 and sheet less than 600 mm wide are slit from a wide coil and further cut into required lengths.

5 DESIGNATION

The nomenclature of the grade designation is explained in Annex C

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 as per the mutual agreement between the purchaser and the manufacturer.

Table 1 Type and Designation
(*Clause* 5.1)

Sl. No.	**Type and Designation**		**Thickness** mm	**Applicable Coating Type** (AS/AL)
(1)	(2)	(3)	(4)	(5)
i)	Mild Steel	IASCR1	0.40 to 3.00	AS, AL
		IASCR2	0.40 to 3.00	AS, AL
		IASCR3	0.40 to 3.00	AS, AL
		IASCR4	0.40 to 3.00	AS, AL
		IASCR5	0.40 to 3.00	AS, AL
		IASCR6	0.40 to 3.00	AS, AL
		IASCR7	0.40 to 3.00	AS, AL
ii)	Structural Quality Steel	IAS330S	0.40 to 3.00	AS, AL
		IAS360S	0.40 to 3.00	AS, AL
		IAS390S	0.40 to 3.00	AS, AL
		IAS420S	0.40 to 3.00	AS, AL
iii)	Bake-hardening type steel	IAS290B	0.40 to 2.30	AS
		IAS320B	0.40 to 2.30	AS
		IAS360B	0.40 to 2.30	AS
		IAS400B	0.40 to 2.30	AS
		IAS440B	0.40 to 2.30	AS
iv)	Interstitial Free - High Strength	IAS300P	0.40 to 2.30	AS
		IAS330P	0.40 to 2.30	AS
		IAS340P	0.40 to 2.30	AS
		IAS380P	0.40 to 2.30	AS
		IAS390P	0.40 to 2.30	AS
v)	High Strength Low Alloy	IAS350LA	0.40 to 3.00	AS, AL
		IAS380LA	0.40 to 3.00	AS, AL
		IAS410LA	0.40 to 3.00	AS, AL
		IAS440LA	0.40 to 3.00	AS, AL
		IAS470LA	0.40 to 3.00	AS, AL
		IAS500LA	0.60 to 3.00	AS, AL
		IAS530LA	0.60 to 3.00	AS, AL
NOTE — Any thickness greater than or less than the mentioned range can also be produced as mutually agreed to between the manufacturer and the purchaser. Acceptance criteria for the range out of the specified product range shall be as agreed upon between the purchaser and the manufacturer.				

5.2 Coating Type

The following two coating types are specified in this standard:

a) Coating Type AS – The product is manufactured by hot-dipping the substrate in a coating bath of aluminium-silicon alloy containing silicon content between 5.0 to 11.0 percent, by mass.

b) Coating Type AL – The product is manufactured by hot-dipping the substrate in a coating bath of pure aluminium containing aluminium at least 99.0 percent, by mass.

5.3 Coating Class

Coating class is designated as ASXXX or ALXXX

Where, AS stands for Aluminium-Silicon alloy coated

AL stands for Aluminium coated

XXX Stands for coating mass in g/m^2

The coating class designation is represented in Table 2.

The differentially coated steel class including single side coated steel shall be designated as ASXXX/ ASYYY or ALXXX/ ALYYY

Where, XXX Stands for coating mass in g/m^2 of Top surface of sheet/outer surface of Strip

YYY Stands for coating mass in g/m^2 of bottom surface of sheet/inner surface of Strip

NOTE — The product shall be coated on at least one surface; therefore, the combination. AS000/ AS000 or AL000/AL000 shall not be specified.

Table 2 Coating Mass Requirement
(*Clause* 5.3 *and* 9.1)

Sl. No.	**Minimum Requirement for Both Sides**			
	Coating Type	**Coating Mass Designation**	**Triple Spot Test** g/m^2	**Single Spot Test** g/m^2
(1)	(2)	(3)	(4)	(5)
i)	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
ii)	Coating Type Al	ALNS	No Minimum	No Minimum
		AL200	200	180
		AL300	300	270

NOTES
1 Because of many variable and changing conditions that are characteristic of continuous Aluminium-Silicon and 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.

5.4 Surface Finish

The surface finish shall be as per Table 3.

Table 3 Surface Finish Requirement
(*Clause* 5.4)

Sl. No.	Designation	Description
(1)	(2)	(3)
i)	N	As coated Finish. No Skin pass finish
ii)	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.		

5.5 Surface Treatment

The surface treatment shall be as per Table 4.

Table 4 Surface Treatment and Oiling Requirement
(*Clause* 5.5)

Sl. No.	Designation	Description
(1)	(2)	(3)
i)	C	Mill Passivation
ii)	O	Oiling
iii)	CO	Mill Passivation and Oiling
iv)	U	Un-Treated
NOTE — Based on the mutual agreement between the purchaser and manufacturer, in addition to the above-mentioned treatment, other surface treatments can also be applied.		

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 any mutual agreement between the purchaser and the manufacturer.

7.2 Unless otherwise agreed upon, cold-rolled substrates shall be used for the hot-dip coating process.

7.3 The sheet/strip shall be dipped in a 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 used for producing AL type coating, shall conform to the 'Al alloy group' grades of IS 617 or any grade of IS 2590 and IS 11890.

7.5 The ingots of aluminium-silicon alloy used for producing AS type coating, should conform to 'Al-Si alloy group' grades of IS 617 or if the aluminium-silicon alloy is prepared in-house by adding required amount of Silicon, the aluminium ingot used shall be as per **7.4** and Si content should be between 5.0 and 11.0 percent, by mass, when tested as per **6** of IS 504 or any other established instrumental/chemical method.

8 CHEMICAL COMPOSITION

8.1 Ladle Analysis

The ladle analysis of the base metal shall be as per the requirements specified in Table 5 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.

Table 5 Chemical Composition Requirements
(*Clause* 8.1)

Sl. No.	**Type and Designation**		**Constituent**, Percent, *Max*			
			C	**Mn**	**P**	**S**
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Mild Steel	IASCR1	0.20	2.00	0.120	0.035
		IASCR2	0.18	1.20	0.120	0.035
		IASCR3	0.10	0.50	0.040	0.030
		IASCR4	0.08	0.45	0.030	0.030
		IASCR5	0.06	0.45	0.030	0.030
		IASCR6	0.02	0.25	0.030	0.020
		IASCR7	0.02	0.25	0.030	0.020
ii)	Structural Quality Steel	IAS330S	0.25	1.60	0.100	0.040
		IAS360S	0.25	1.60	0.100	0.040
		IAS390S	0.25	1.60	0.100	0.040
		IAS420S	0.25	1.60	0.100	0.040
iii)	Bake-hardening type steel	IAS290B	0.01	0.80	0.100	0.020
		IAS320B	0.01	1.00	0.100	0.020
		IAS360B	0.01	1.20	0.100	0.020
		IAS400B	0.01	1.60	0.100	0.020
		IAS440B	0.01	1.60	0.100	0.020
iv)	Interstitial Free - High Strength	IAS300P	0.01	0.80	0.100	0.020
		IAS330P	0.01	1.00	0.100	0.020
		IAS340P	0.01	1.20	0.100	0.020
		IAS380P	0.01	1.60	0.100	0.020
		IAS390P	0.01	1.60	0.100	0.020
v)	High Strength Low Alloy	IAS350LA	0.10	1.20	0.070	0.025
		IAS380LA	0.12	1.40	0.070	0.025
		IAS410LA	0.12	1.50	0.070	0.025
		IAS440LA	0.12	1.60	0.070	0.025
		IAS470LA	0.14	1.60	0.070	0.025
		IAS500LA	0.14	1.80	0.070	0.025
		IAS530LA	0.16	1.80	0.070	0.025

NOTES
1 Above specified steel grades can be supplied with the addition of micro-alloying elements like Boron, Titanium, Niobium and Vanadium. When these elements are added either individually or in combination, shall not exceed 0.3 percent . However, Boron addition will be restricted to maximum 0.006 percent.
2 The nitrogen content of the steel shall not exceed 0.009 percent for aluminium killed. For aluminium-silicon killed, the nitrogen content shall not exceed 0.012 percent. This shall be ensured by occasional checking.
3 The elements such as Cr, Mo, Ni which are not specified in the above table can be added up to 1 percent maximum either individually or in combination.
4 Restricted chemical composition may be mutually agreed upon between the purchaser and the supplier.
5 Unless otherwise agreed upon, the total Aluminium content in Aluminium killed steel shall not be less than 0.02 percent.

8.2 Product Analysis

Permissible variation in product analysis, after stripping off the coating from the substrate, from the values specified in Table 6 shall be as given in Table 6.

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

Sl. No.	**Element**	**Specified Chemical Composition Limit,** Percent**,** *Max*	**Variation Over specified Limit,** Percent**,** *Max*
(1)	(2)	(3)	(4)
i)	Carbon	≤0.150	0.02
		> 0.150	0.03
ii)	Manganese	≤0.60	0.03
		>0.60 to ≤1.150	0.04
		≥1.150	0.05
iii)	Sulphur	≤ 0.050	0.005
iv)	Phosphorus	≤0.050	0.005
		> 0.050	0.01
v)	Silicon	≤0.600	0.03
		> 0.600	0.06
vi)	Micro Alloy	≤0.30	As agreed
NOTE — When analyzing the product using spark spectroscopy, it is essential to ensure that thin sheets or strips do not burn out during the process			

9 COATING PROPERTIES

9.1 Coating Mass

The coating mass expressed in grams per square metre 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 the manufacturer.

9.2 Coating Mass Test

9.2.1 The coating mass of the product should 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 triple spot coating mass is the average coating mass of 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 coated 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 (*see* IS 12860) or by the gravimetric method as per **D-1** or **D-2** of Annex D. In case of differential coating, the coating mass of the product may preferably be tested by the X-ray fluorescence method.

9.2.4 If required, an alloy layer analysis may be carried out as per **D-3** of Annex D.

9.2.5 If agreed upon between the purchaser and the supplier, coating mass may also be determined using any other established test methods.

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 the purchaser and the 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.

Table 7 Coating Adherence – Bend Test Mandrel Diameter
(*Clause* 9.3)

Sl. No.	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
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	Mild Steel	IASCR1	180^0	1T	2T	2T	2T	3T	3T
ii)	Mild Steel	IASCR2, IASCR3, IASCR4, IASCR5, IASCR6, IASCR7	180^0	1T	2T	—	3T	3T	—
iii)	Structural Quality Steel	All Grade Designations	—	—	—	—	—	—	—
iv)	Bake-hardening type steel	All Grade Designations	—	—	—	—	—	—	—
v)	Interstitial Free - High Strength	All Grade Designations	—	—	—	—	—	—	—
vi)	High Strength Low Alloy	All Grade Designations	—	—	—	—	—	—	—

NOTES
1 (—) → Can be mutually agreed upon 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.

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

9.3.3 If agreed upon between the manufacturer and the purchaser, any other applicable international or established coating adherence and powdering test methods can be carried out and the evaluation criteria may also be agreed upon.

9.4 Corrosion Resistance for Coating

If agreed upon at the time of enquiry and order, the corrosion resistance of the coating may be tested as per IS 5528 or any other established method. The test conditions for the corrosion resistance test and evaluation criteria may be agreed upon between the purchaser and the manufacturer.

10 SURFACE TREATMENT AND FINISH

10.1 Mill Passivation

If agreed upon at the time of enquiry and order, the AS or AL coated surface may be subjected to a chemical treatment. However, the inhibiting characteristics of the treatment are limited and, if the material becomes wet during shipment or storage, the material should be used immediately or dried.

10.2 Oiling

If agreed upon at the time of enquiry and order, hot-dip AS or AL coated steel sheet and strip as produced may 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 AS or AL coated steel sheet and strip has received a passivating treatment, oiling will further minimize the hazard of wet storage stain.

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

10.4 Surface Finish

The surface finish can be as coated surface finish without a skin pass or coated surface with a Skin pass finish. Based on the end-use requirements, suitable surface finish requirements may be agreed upon between the purchaser and manufacturer.

11 MECHANICAL PROPERTIES

11.1 Test Frequency

Test 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 and cold rolling conditions, thickness, width, coating, and process conditions at a hot-dip coating 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 shall be carried out as per IS 1608 (Part 1) and the values shall meet the requirements specified in Tables 8. The yield strength value applies to 0.2 % of proof stress, if Yield stress is not clearly defined, otherwise the value applies to lower yield stress or upper yield stress based on the mutual agreement between the purchaser and manufacturer.

11.2.3 If 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 Table 8**.**

11.3.3 If 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 Table 8**.**

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

11.5 Bake Hardening Index (BH)

Bake hardening index shall be tested as per Annex E and the minimum BH value shall conform to 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

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.

Table 9 Ageing Period Requirement
(*Clause* 11.8)

Sl. No.	Type and Designation (For Cold-rolled Substrate)		Applicable Non-Ageing Period
(1)	(2)	(3)	(4)
i)	Mild Steel	IASCR5	3 Months
		IASCR6	6 Months
		IASCR7	6 Months
ii)	Bake-hardening type steel	IAS290B	3 Months
		IAS320B	3 Months
		IAS360B	3 Months
		IAS400B	3 Months
		IAS440B	3 Months
iii)	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 above. For the remaining type and designations, non-ageing period can be mutually agreed upon.
2 Based on mutual agreement, stricter test conditions can be applied.

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

a) Actual measured thickness after removing the coating layer;
b) Result after subtracting the coating thickness on each side specified in Table 10 from the actual measured thickness including the coating layers; and
c) Results after subtracting the equivalent coating thickness of the actual measured coating mass from the measured thickness including the coating layers. Refer to Annex B for calculating coating thickness based on coating mass.

12 DIMENSION, 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/ISO 16163.

12.3 Sheets and strips may be supplied either with mill edges 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 and coating, width tolerances shall be as per IS/ISO 16163.

13 RETEST

13.1 When any portion of the test results does not meet the specified requirements, two additional sets of test samples from the same lot must be retested for the relevant specific test criteria to determine the overall acceptability of the lot.

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 During a tensile test, if the fracture occurs outside the gauge length marked before the test, the sample shall be discarded, and a new sample shall be tested.

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 the 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.

14.4 Reduction in formability may happen in the products due to the ageing phenomenon. Besides, coil breaks or fluting may occur in the material and they become more prominent with the increase in the duration of storage.

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 the manufacturer for treating such cases.

15.3 Unless otherwise specified, surface defects should be assessed on one side of the material. For sheets, this typically refers to the top side of the packaging, while for strips, the outer side is designated as the applicable side for evaluation.

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

16 PACKING

Hot-dip aluminium-silicon alloy coated or aluminium coated steel sheets and strips 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 or Aluminium-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 product 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. The possible types of temporary surface protection are given in **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 8 Mechanical Property Requirement
(*Clauses* 11.2, 11.3, 11.4 *and* 11.5)

Sl. No.	**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 (BH)**	**Plastic strain Ratio**	**Strain Hardening Exponent**
				Thickness, t mm			Thickness, t mm				N/mm², *Min*	r90, *Min*	n90, *Min*
				≤ 0.5	0.50 < t ≤ 0.7	t > 0.70	≤ 0.5	0.50 < t ≤ 0.7	t > 0.70				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
i)	Mild Steel	IASCR1	270	—	—	—	18	20	22	Transverse	—	—	—
		IASCR2	270	140 to 340	140 to 320	140 to 300	22	24	26	Transverse	—	—	—
		IASCR3	270	140 to 300	140 to 280	140 to 260	26	28	30	Transverse	—	—	—
		IASCR4	270	140 to 280	140 to 260	140 to 240	26	28	30	Transverse	—	—	—
		IASCR5	270	120 to 260	120 to 240	120 to 220	30	32	34	Transverse	—	1.4	0.18
		IASCR6	270	120 to 220	120 to 200	120 to 180	35	37	39	Transverse	—	1.7	0.20
		IASCR7	270	120 to 210	120 to 190	120 to 170	37	39	41	Transverse	—	1.9	0.21
ii)	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	—	—	—
iii)	Bake-hardening steel	IAS290B	290	180 to 280	180 to 260	180 to 240	30	32	34	Transverse	30	1.5	0.16
		IAS320B	320	220 to 320	220 to 300	220 to 280	28	30	32	Transverse	30	1.2	0.15
		IAS360B	360	260 to 360	260 to 340	260 to 320	24	26	28	Transverse	30	—	—
		IAS400B	400	300 to 400	300 to 380	300 to 360	22	24	26	Transverse	30	—	—
		IAS440B	440	340 to 440	340 to 420	340 to 400	20	22	24	Transverse	30	—	—
iv)	Interstitial Free - High	IAS300P	300	160 to 260	160 to 240	160 to 220	33	35	37	Transverse	—	1.9	0.20
		IAS330P	330	180 to 280	180 to 260	180 to 240	30	32	34	Transverse	—	1.7	0.18
		IAS340P	340	220 to 320	220 to 300	220 to 280	28	30	32	Transverse	—	1.5	0.17
		IAS380P	380	260 to 360	260 to 340	260 to 320	26	28	30	Transverse	—	1.4	0.16
		IAS390P	390	300 to 400	300 to 380	300 to 360	23	25	27	Transverse	—	1.3	0.15
v)	High Strength Low Alloy	IAS350LA	350	260 to 370	260 to 350	260 to 330	22	24	26	Transverse	—	—	—
		IAS380LA	380	300 to 420	300 to 400	300 to 380	19	21	23	Transverse	—	—	—
		IAS410LA	410	340 to 460	340 to 440	340 to 420	17	19	21	Transverse	—	—	—
		IAS440LA	440	380 to 520	380 to 500	380 to 480	15	17	19	Transverse	—	—	—
		IAS470LA	470	420 to 560	420 to 540	420 to 520	13	15	17	Transverse	—	—	—

Sl. No.	**Type and Designation**		**Tensile Strength** N/mm^2 *Min*	**Yield point or proof stress** N/mm^2			**%Elongation,** *Min* **(Test Piece Type 2 of IS 1608 Part 1)**			**Testing Direction**	**Amount of Bake Hardening (BH)**	**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		N/mm^2, *Min*	r90, *Min*	n90, *Min*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
		IAS500LA	500	—	460 to 580	460 to 560	—	13	15	Transverse	—	—	—
		IAS530LA	530	—	500 to 640	500 to 620	—	11	13	Transverse	—	—	—

NOTES

1 1 N/mm^2 = 1 MPa.

2 Stricter mechanical properties requirements may be agreed upon 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 percent 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 specified**.**

ANNEX A

(*Clause* 2)

LIST OF REFERRED STANDARDS

IS Standard No.	*Title*
IS 228(Various parts)	Method for chemical analysis of steel
IS 504:1963	Methods of chemical analysis of aluminium and its alloys (Revised)
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 617 : 2024	Aluminium and Aluminium Alloys Ingots for Remelting and Castings for General Engineering Purposes — Specification (*fourth 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 1599:2023 ISO 7438 : 2020	Metallic materials — Bend test
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 2590: 1987	Specification for Primary aluminium ingots for remelting for general engineering purposes
IS 3531:2024 ISO 8044 : 2020	Corrosion of metals and alloys - Vocabulary
IS 5528:2024 ISO 9227 : 2022	Corrosion Tests in Artificial Atmospheres - Salt Spray Tests (second revision)
IS 8910 : 2022 / ISO 404:2013	General technical delivery requirements for steel and steel products (*second revision*)
IS 11890:1987	Specification for high purity primary aluminium ingots for remelting for special applications
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 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 18385:2023	Hot-dip galvanized/galvannealed Steels Sheet and strips for Automotive Applications-Specification
IS 18513:2023	Hot-dip zinc- aluminium-magnesium alloy coated steel sheets plates and strips - Specification

ANNEX B

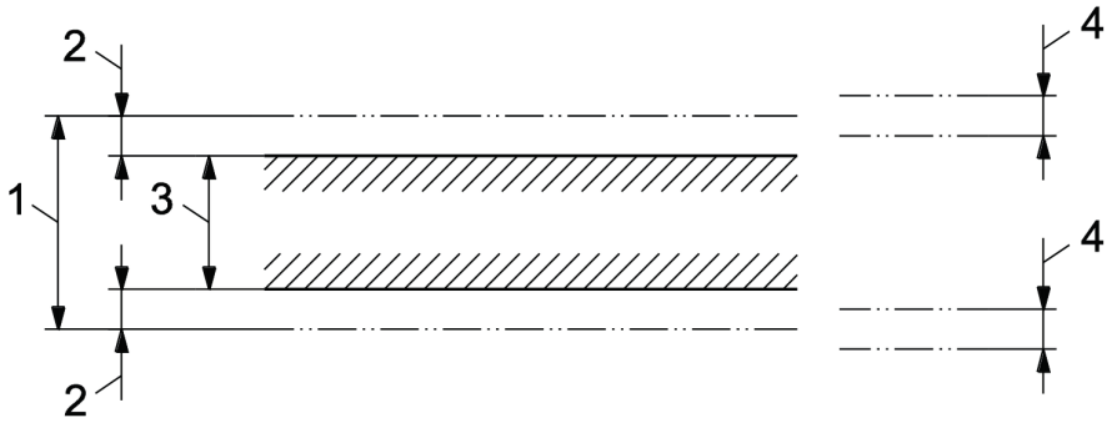
(*Clause* 3.2 *and* 11.9)

ORDERS REQUIRING BASE-METAL THICKNESS

B-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 Fig. 1.

Thickness tolerance tables apply to the product thickness.



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

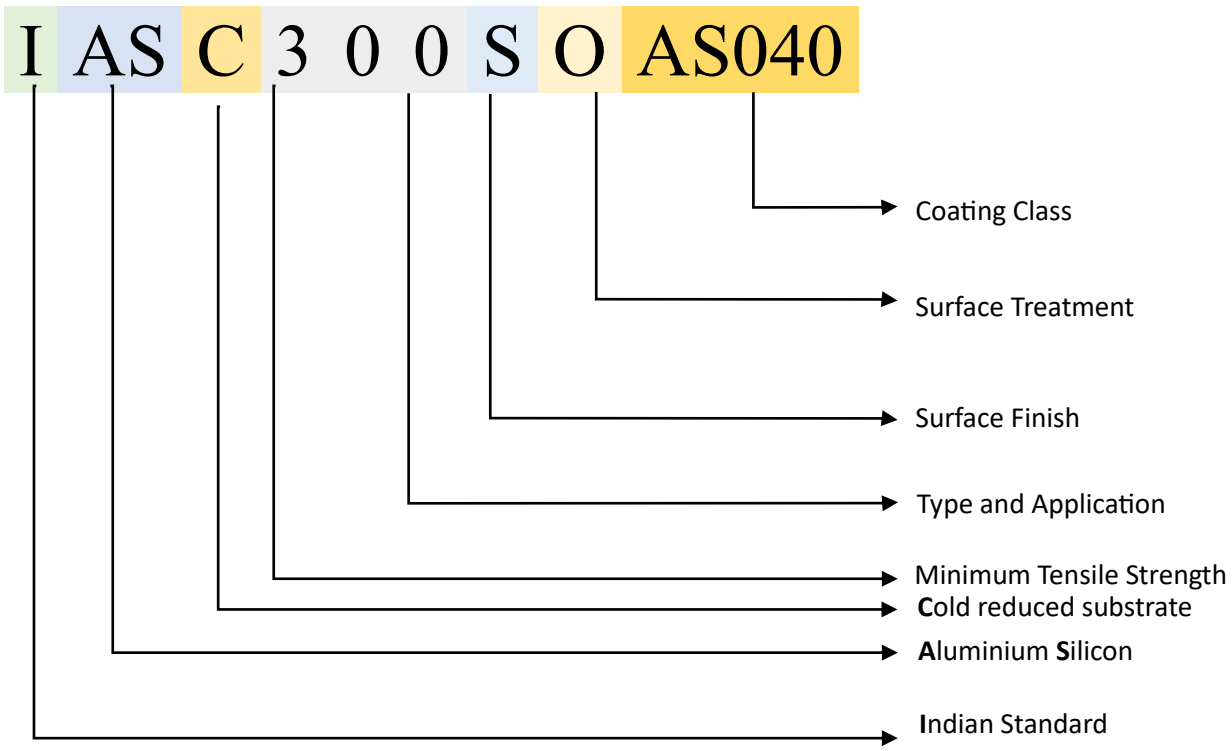
FIG. 1 CALCULATION OF THE PRODUCT THICKNESS

Table 10 Equivalent Coating Thickness
(Clause 11.9)

Sl. No.	Coating Type	Equivalent Coating Thickness
(1)	(2)	(3)
i)	Aluminium-Silicon Alloy (AS)	0.001 mm (1 micron) = 3.02 g/m^2 1 g/m^2 = 0.00033 mm (0.33 microns)
ii)	Aluminium (AL)	0.001 mm (1 micron) = 3.20 g/m^2 1 g/m^2 = 0.00031 mm (0.31 microns)

ANNEX C
(*Clause* 5)

NOMENCLATURE



ANNEX D

(*Clause* 9.2.3 *and* 9.2.4)

DETERMINATION OF MASS OF COATING

D-1 DETERMINATION OF MASS OF COATING ON HOT-DIP ALUMINIUM SILICON ALLOY COATED STEEL SHEET/STRIP USING HYDROCHLORIC ACID

D-1.1 This method determines the coating mass of aluminium silicon alloy on the surface of a steel sheet specimen by measuring the mass of the specimen before and after removal of the coating using hydrochloric acid and sodium hydroxide.

D-1.2 Apparatus — Analytical balance, capable of measuring to the nearest 0.001 g.

D -1.3 Reagents

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

D -1.4 Sampling — As mentioned in 9.2.1.

D -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; and
d) Repeat this cycle until immersion in the sodium hydroxide solution shows no visible reaction. Remove, scrub, dry and reweigh the test piece.

Note :When determining coating weight (mass) on one side of sheet material, use the above procedure except the use of stop-off). To protect one side from the stripping medium, a few common examples are acid resistant paints or acid-resistant tapes. Apply the stop off to the specimen after weighing initially and remove it before taking weight after the stripping of the coating. There is always a possibility of moisture absorption, so the stop off should not be there during the weight determination. The coating weight on the other side may be determined subsequently without a stop off on the first side

D-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; and

A = area of one side of the test piece, in square millimetres.

D-2 DETERMINATION OF MASS OF COATING ON HOT-DIP ALUMINIUM COATED STEEL USING DILUTED HYDROCHLORIC ACID

D-2.1 This method determines the coating mass of aluminium on the surface of a steel sheet specimen by measuring the mass of the specimen before and after removal of the coating using diluted hydrochloric acid.

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

D-2.3 Reagents

Diluted Hydrochloric acid: Mix HCl (sp. gr.1.18 to 1.19) and reagent water in 1 : 1 ratio and cool to room temperature.

D-2.4 Sampling — As mentioned in **9.2.1**.

D-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 °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; and
e) Reweigh the dry test piece to the nearest 0.001 g.

NOTE — When determining coating weight (mass) on one side of sheet material, use the above procedure except the use of stop-off). To protect one side from the stripping medium, a few common examples are acid resistant paints or acid-resistant tapes. Apply the stop off to the specimen after weighing initially and remove it before taking weight after the stripping of the coating. There is always a possibility of moisture absorption, so the stop off should not be there during the weight determination. The coating weight on the other side may be determined subsequently without a stop off on the first side

D-2.6 Expression of Result

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; and

A = area of one side of the test piece, in square millimetres

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

D-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. The non-alloy layer followed by the alloy layer are removed, according to the method in **D-1** or **D-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.

D-3.2 Reagent

Tin (II) chloride solution:

a) To produce the stock solution, 1 000 g $SnCl_2 \times H_2O$ 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.

D-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 **D-3.3 a)** are treated as described in **D-1.5.**

C-3.4 Expression of Result

The mass of the alloy layer of coating 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 after removal of non-alloy layer but before stripping the alloy layer

m_1 = mass, in grams, of the test piece after stripping off the alloy layer

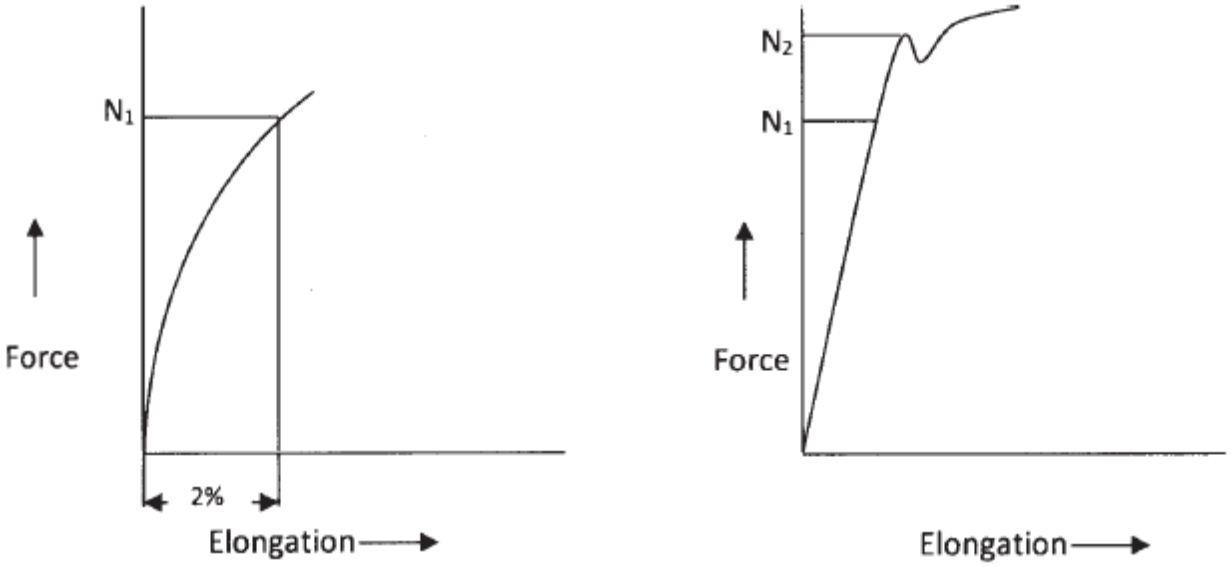
A = area of one side of the test piece, in square millimetres.

ANNEX E
(*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 A_0;
c) The test specimen shall be strained to 2 per cent tensile elongation. The corresponding force shall be noted as N_1;
d) The specimen shall be unloaded from tensile tester and heat treated for 20 min at a temperature of 170 ^{0}C;
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 N_2;
f) The BH value calculation shall be obtained as BH = $(N_2 – N_1)/A_0$; and
g) BH Value calculation is schematically represented in below Fig. 2.



Preliminary Strain Loading — After Baking Process – Heat Treatment

FIG. 2 SCHEMATIC REPRESENTATION of BH VALUES