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Indian Standard

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Hot-Dip Zinc-Aluminium-Magnesium Alloy Coated Steel Sheets, Plates and Strips — Specification

ICS 77.140.50

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Wrought Steel Products Sectional Committee, MTD 04

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Wrought Steel Products Sectional Committee had been approved by the Metallurgical Engineering Division Council.

Galvanizing is a process in which a layer of zinc through hot-dip coating is bonded to steel in order to protect it against corrosion. In recent years, to improve the corrosion resistance of hot-dip galvanized steel sheets, Zn-based alloy coatings such as Zn-Al coatings with higher aluminium contents than the alloy used in the conventional galvanising process (IS 277) and galvalume (IS 15961) were developed. Besides, combination of aluminium magnesium was found to have a positive effect on the corrosion resistance of zinc based steel coatings, which led to the development of several Zn-Al-Mg coatings across the world.

With the constant requirement of greater, stringent, and varied requirements for steel sheets and strips having superior corrosion resistance and enthusiasm to identify, summarize and create a new standard on such products culminated in development of standard on Zn-Al-Mg coated steels.

For all the tests specified in this standard (chemical/physical/others), the method as specified in relevant ISO standard may also be followed as an alternate method.

The composition of the Committee responsible for formulation of this standard is given in Annex E.

For the purpose of 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.

Indian Standard

HOT-DIP ZINC-ALUMINIUM-MAGNESIUM ALLOY COATED STEEL SHEETS, PLATES AND STRIPS — SPECIFICATION

1 SCOPE

This document applies to the requirements for steel sheets, plates and strips, metallic-coated by the continuous hot-dip process, with zinc-aluminium-magnesium alloy coating.

The product is intended for applications requiring high corrosion resistance, formability and paintability.

The steel sheet is produced in several quality designations and grades, coating mass, surface treatments and coating finish conditions designed to be compatible with differing application requirements.

2 REFERENCES

The standards listed in Annex A contain provisions, which through references 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 agreements 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), IS 513 (Part 2), IS 1079, IS 5986, IS 277 and the following definitions shall apply:

3.1 Thickness of Sheet — The thickness of a zinc-aluminium-magnesium alloy-coated steel sheet 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 B describes the requirements for specifying the thickness as base metal alone.

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

3.3 Product — Hot-dip zinc-aluminium-magnesium alloy coated hot-rolled sheet, plate and strip or cold reduced carbon steel sheet and strip.

3.4 Blackening/Presence of Black Spots — The surface of the coating may appear blackened, especially the coating composition containing magnesium, during storage or in high temperature and high humidity environments. There may be presence of random black spots on the surface of the material coated with zinc-aluminium-magnesium. This is due to formation of phase of zinc-aluminium-magnesium during solidification of coating.

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

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

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

4 SUPPLY OF MATERIAL

4.1 The general requirements relating to the supply of zinc-aluminium-magnesium coated steel sheets and strips shall conform to IS 8910.

4.2 Product is manufactured in thicknesses from 0.20 mm to 9 mm inclusive after coating, and in widths of 600 mm and over in coils and cut lengths.

4.3 Product less than 600 mm wide, is slit from a wide coil and further cut into required lengths.

5 DESIGNATIONS

5.1 Base Metal Grade

Product 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 Table 2 for coated steels with hot-rolled substrate.

5.2 Coating Class

Expressed as ZMXXX, where ZM stands for zinc-aluminium-magnesium alloy coated and XXX stands for coating mass expressed in g/m^2. The coating class shall be as given in Table 3.

5.3 Coating Type

The coating bath metal used to produce zinc-aluminium-magnesium coated steel sheet and strip shall contain 0.2 percent to 20 percent aluminium, 0.2 percent to 6 percent magnesium, up to 1 percent total additional alloying elements (except iron) and the balance zinc.

5.4 Surface Finish

The surface finish of the product shall be as given in Table 4.

5.5 Surface Treatment

The surface treatment for the product shall be as given in Table 5.

5.6 The designation for the product shall comprise base metal steel grade (Table 1 or Table 2), surface finish and surface treatment and coating class (Table 3) separated by hyphen.

Examples:

1 'IZMC480S – NC – ZM080'.

2 'IZMC480S – NC – ZM180ZM080' (in the order of top surface and bottom surface of a differential coating designation).

6 MANUFACTURE

6.1 Unless otherwise agreed between the manufacturer and the purchaser, the processes used in making the steel and in subsequent manufacturing of product are left to discretion of the manufacturer. However, the purchaser may be informed of the steelmaking process used.

6.2 For the hot-dip coating process, hot-rolled or cold-rolled substrates shall be used. The hot-rolled strip shall be pickled first before the hot-dip coating process.

6.3 The strip is dipped in a suitable bath of molten metal alloys of zinc-aluminium-magnesium at a temperature suitable to produce a complete and uniform adherent coating.

6.4 The ingots of zinc and zinc alloys, aluminium and magnesium used for the molten bath for dipping shall conform to any of the grades specified in IS 13229/IS 209, IS 2590, IS 6694 respectively. In case of Zn-Mg-Al alloyed ingot, its properties and chemical composition can be as per mutual agreement between the purchaser and the manufacturer.

7 CHEMICAL COMPOSITION

7.1 Ladle Analysis

The ladle analysis of the base metal of steel sheet and strip shall be as per the requirements given in Table 6A and Table 6B for cold-rolled substrate and hot-rolled substrate 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.

7.2 Product Analysis

Permissible variation in the case of product analysis, after stripping of coating, from the limits specified in Table 6A, Table 6B shall be as given in Table 7.

8 COATING PROPERTIES

8.1 Coating Mass

The coating mass expressed in grams per square metre given for both surfaces shall conform to the requirements specified in Table 3. 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.

8.2 Coating Mass Test

8.2.1 The coating mass of the product is to be tested by taking a sample piece from each coil approximately 300 mm in length by the as-coated 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 1 200 mm^2.

8.2.2 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 **8.2.1**. However, the minimum of three coating values should comply with the single spot test requirements of the coating designation. For narrow width strips, which have been slit from a wide hot dip zinc-aluminium-magnesium alloy-coated coil, only a single spot test is applicable and should comply with the minimum requirement of the coating designation.

8.2.3 The coating mass shall be determined by the X-ray fluorescence method (*see* IS 12860) or by weight loss (gravimetric) method (*see* IS 6745). For

measuring coating on a single surface, a suitable method (*see* IS 6745) by employing any suitable method of masking the second surface as agreed to between the manufacturer and the purchaser or by X-ray fluorescence method. In case of dispute, the procedure agreed to between the manufacturer and the purchaser shall be the referee method.

8.2.4 The equivalent coating thickness can be calculated based on the mutual agreement between the purchaser and manufacturer or as per information provided in Annex B.

8.3 Adherence Test

8.3.1 Zinc-aluminium-magnesium alloy-coated steel sheet shall be capable of being bent in any direction, in accordance with the mandrel diameter requirements of Table 8, without flaking of the coating on the outside of the bend. The test piece shall be taken in parallel to the rolling direction of the base metal unless otherwise specified. 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.

8.3.2 For adhesion test 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 and cold rolling conditions, thickness, width, coating and process conditions at a hot dip galvanizing line.

8.4 Corrosion Resistance for Coating

On request of the purchaser, corrosion resistance of the product 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 or international standards.

9 SURFACE TREATMENT AND FINISH

9.1 Mill Passivation

When specified, a chemical treatment is normally applied to zinc-aluminium-magnesium alloy-coated steel sheets and strips to minimize the hazard of wet storage staining (white rust) and blackening during shipment and storage. However, the inhibiting characteristics of the treatment are limited and, if a shipment is received wet, the material shall be used immediately or dried.

NOTES

1 Blackening occurs only on the surface of the coating and does not affect the corrosion resistance of the coating.

2 Chromate-free treatment is available for use.

9.2 Mill Phosphating

When specified and based on mutual agreement between the purchaser and the manufacturer, the manufacturer shall apply phosphate treatments to zinc-aluminium-magnesium alloy-coated steel sheets to prepare the surface for painting without further treatment except normal cleaning.

9.3 Oiling

When specified, the zinc-aluminium-magnesium alloy-coated steel 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 zinc-aluminium-magnesium alloy-coated steel sheet has received a passivation treatment, oiling will further minimize the hazard of wet storage stain.

9.4 Thin Organic Film (or Sealing)

When specified, the zinc-aluminium-magnesium alloy-coated steel sheet as produced shall be coated with a thin organic film coating to offer additional corrosion protection and, depending on its nature, increase the protection against fingerprints. It may improve the sliding characteristics during forming operations and may be used as a priming coat for subsequent painting based on the mutual agreement between the purchaser and manufacturer.

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

9.6 The surface finish can be presented as, as-coated surface finish without a skin pass and a 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.

10 MECHANICAL PROPERTIES

10.1 Tensile Test

10.1.1 *Test Frequency*

10.1.1.1 For cold-rolled substrate 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 metallic coating line.

10.1.1.2 For hot-rolled substrate one tensile test shall be taken from each cast. Where strips of more than one thickness are rolled from the same cast, one

additional tensile test shall be made from the material:

a) In the case of strips (for thickness less than 5 mm) — One sample shall be tested for thickness less than 2.00 mm, one sample shall be tested for thickness greater than 2.00 mm and less than 3.20 mm and one sample shall be tested for thickness greater than 3.20 mm.

10.1.2 *Tensile Test Specimen*

Tensile test values apply to the direction and type of specimen mentioned in Table 9A and Table 9B. Strips having a width of 250 mm and below shall be tested longitudinally.

10.1.3 *Testing*

Tensile test to be conducted as per IS 1608 (Part 1) at room temperature and tensile properties that is, yield strength, tensile strength and percent elongation shall meet the requirements specified in Tables 9A and 9B. The yield strength value applies to lower yield stress or upper yield stress based on mutual agreement between the purchaser and the manufacturer. When there is no specific agreement, the yield strength value applies to lower yield stress. When a definite yield phenomenon is not observed, the yield strength value applies to 0.2 percent proof stress.

10.2 Plastic Strain Ratio (r-bar/r-td)

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

10.2.2 The plastic strain ratio shall be checked in accordance with IS 11999 and results shall conform to as given in Table 9A.

10.2.3 When specified by the purchaser, the plastic strain ratio requirement can be omitted.

10.3 Tensile Strain Hardening Exponent (n-value/n-td)

10.3.1 The tensile strain hardening is an index of the stretchability (n-value/n-td), 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-value/n-td is reduced by 0.02.

10.3.2 The tensile strain hardening component shall be checked in accordance with IS 15756 and results shall conform to as given in Table 9A.

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

10.4 Bake Hardening Index (BH)

Bake hardening index shall be as given in Table 9A when tested as per Annex C.

10.5 Bend Test

10.5.1 Bend test shall be carried out in accordance with IS 1599 for the cold-rolled substrate.

10.5.2 The angle of bend and the internal diameter for the different grades of material shall be as given in Table 10.

10.5.3 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.

10.5.4 When specified by the purchaser, the bend test can be omitted.

10.5.5 The bend test is applicable to fully annealed steel products only.

10.6 Hardness Test

If specified by the purchaser, the hardness test shall be carried out in accordance with IS 1586 (Part 1) for rockwell hardness and as per IS 1501 (Part 1) for vickers hardness. The evaluation criteria shall be subject to mutual agreement between the purchaser and the manufacturer.

10.7 Ageing Period

The values mentioned against the requirements for different mechanical properties are applicable for the periods mentioned in Table 11 from the date, product is available for the shipment at manufacturer’s end.

10.8 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 3 from the actual measured thickness including the coating layers;

c) Results after subtracting the equivalent coating thickness of the actual measured coating mass from the measured thickness including the coating layers; and

d) Refer to Annex B for calculating coating thickness based on coating mass.

11 DIMENSIONS, SHAPE AND TOLERANCES

11.1 Coil Inner Diameter

Unless otherwise agreed, the internal diameter of coils shall be 508 mm (± 10 mm).

11.2 Tolerances

Tolerances on dimensions (thickness, width, length), shape (flatness, waviness), camber, and out-of-squareness shall be as per IS/ISO 16163.

11.3 Plates, 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 and coating, width tolerances shall be as per IS/ISO 16163.

11.4 For Hot-Rolled Substrate

Coated steel sheet and strip with untrimmed or mill edges, thickness shall be measured at any point not less than 40 mm from a side edge.

12 RETEST

12.1 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.

12.2 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.

12.3 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.

13 STRAIN AGEING

13.1 Zinc-aluminium-magnesium alloy-coated steel sheets and strips 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.

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

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

14 SURFACE APPEARANCE

14.1 The steel sheet, plate 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.

14.2 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.

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

14.4 For zinc-aluminium-magnesium alloy-coated steel sheets and strips, defects that are inherent like dull surface, random black spots, presence of visible airflow patterns, surface darkening, orange peel, flow marks etc, should not be a reason for rejection if it meets the end application and requirements. The acceptance level of these defects will be as per mutual agreements between the purchaser and the manufacturer.

14.5 The required surface quality of the zinc-aluminium-magnesium alloy-coated steel sheets and strips shall be as follows and to be fixed during placing of the order.

14.5.1 *As Coated Surface* (*AC*)

Imperfections such as pimples, marks, scratches, pits, variation in surface appearance, dark spots, strip marks and slight passivation marks are permissible. Stretch levelling marks may appear.

14.5.2 *Improved Surface* (*B*)

With this surface quality, small imperfections such as stretch levelling marks, skin pass marks, run-off marks, slight passivation stains are permissible.

14.5.3 *Best Quality Surface* (*I*)

The controlled surface shall make it possible to apply a uniform high class paint finish. The other surface shall at least have the characteristics of surface quality of the improved surface.

15 PACKING

Zinc-aluminium-magnesium alloy-coated steel sheets and strips should be suitably packed to avoid transit/handling/storage damage and as per the agreement between the purchaser and the manufacturer.

16 MARKING

16.1 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) Manufacturer's name or trade-mark;

b) Material identification/coil number/packet number/batch number etc;

c) Product dimensions;

d) Number of sheets or mass;

e) Designation of zinc-aluminium-magnesium alloy-coated hot-rolled and cold reduced carbon steel sheet/strip; and

f) Date of manufacture.

16.2 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 thereunder and the products may be marked with the Standard Mark.

17 STORAGE AND TRANSPORTATION

17.1 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 **9**. As a precaution, the products should be transported and stored dry and protected from moisture.

17.2 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 for Cold-Rolled Substrate

(*Clauses* 5.1 *and* 5.6)

Sl No.	**Type and Designation**		**Thickness** mm
(1)	(2)	(3)	(4)
i)	Mild steel	IZMCCR0	0.20 to 3.00
		IZMCCR1	0.20 to 3.00
		IZMCCR2	0.40 to 3.00
		IZMCCR3	0.40 to 3.00
		IZMCCR4	0.40 to 3.00
		IZMCCR5	0.40 to 3.00
ii)	Structural quality steel	IZMC300S	0.40 to 3.00
		IZMC310S	0.40 to 3.00
		IZMC330S	0.40 to 3.00
		IZMC360S	0.40 to 3.00
		IZMC380S	0.40 to 3.00
		IZMC410S	0.40 to 3.00
		IZMC420S	0.40 to 3.00
		IZMC440S	0.40 to 3.00
		IZMC460S	0.40 to 3.00
		IZMC480S	0.40 to 3.00
		IZMC510S	0.40 to 3.00

Table 1 (*Continued*)

Sl No.	Type and Designation		Thickness mm
(1)	(2)	(3)	(4)
		IZMC560S	0.40 to 3.00
		IZMC570S	0.40 to 3.00
iii)	Bake-hardening steel	IZMC270B	0.40 to 2.30
		IZMC290B	0.40 to 2.30
		IZMC320B	0.40 to 2.30
		IZMC340B	0.40 to 2.30
		IZMC360B	0.40 to 2.30
		IZMC400B	0.40 to 2.30
		IZMC440B	0.40 to 2.30
iv)	Interstitial free - high strength	IZMC300P	0.40 to 2.30
		IZMC330P	0.40 to 2.30
		IZMC340P	0.40 to 2.30
		IZMC360P	0.40 to 2.30
		IZMC370P	0.40 to 2.30
		IZMC390P	0.40 to 2.30
		IZMC440P	0.40 to 2.30
v)	C-Mn steel (solid solution strengthening)	IZMC340W	0.40 to 3.00
		IZMC370W	0.40 to 3.00
		IZMC390W	0.40 to 3.00
		IZMC440W	0.40 to 3.00
		IZMC490W	0.60 to 3.00
		IZMC540W	0.60 to 3.00
		IZMC590W	0.60 to 3.00
vi)	High strength low alloy steel	IZMC310LA	0.40 to 3.00
		IZMC320LA	0.40 to 3.00
		IZMC340LA	0.40 to 3.00
		IZMC370LA	0.40 to 3.00
		IZMC410LA	0.40 to 3.00
		IZMC440LA	0.60 to 3.00
		IZMC470LA	0.60 to 3.00
		IZMC500LA	0.60 to 3.00
		IZMC530LA	0.60 to 3.00
		IZMC620LA	0.60 to 3.00
vii)	Dual phase steel	IZMC450Y	0.40 to 3.00
		IZMC490Y	0.40 to 3.00
		IZMC540Y	0.40 to 3.00
		IZMC590Y	0.40 to 3.00
		IZMC780Y	0.60 to 3.00
		IZMC980Y	0.80 to 3.00
		IZMC980YH	0.80 to 3.00
		IZMC1180Y	0.80 to 3.00

Table 1 (*Concluded*)

Sl No.	Type and Designation		Thickness mm
(1)	(2)	(3)	(4)
viii)	TRIP steel	IZMC590T	0.40 to 3.00
		IZMC690T	0.60 to 3.00
		IZMC780T	0.70 to 3.00
ix)	Complex phase steel	IZMC600N	0.40 to 3.00
		IZMC780N	0.70 to 3.00
		IZMC980N	0.80 to 3.00

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 Designation of the grade is explained in Annex D.

Table 2 Type and Designation for Hot-Rolled Substrate

(*Clauses* 5.1 *and* 5.6)

Sl No.	Type and Designation		Thickness mm
(1)	(2)	(3)	(4)
i)	Commercial quality steel	IZMHHR1	1.60 to 9.00
ii)	Drawing quality steel	IZMHHR2	1.60 to 9.00
		IZMHHR3	1.60 to 9.00
		IZMHHR4	1.60 to 9.00
iii)	Structural quality steel	IZMH290S	1.60 to 9.00
		IZMH330S	1.60 to 9.00
		IZMH360S	1.60 to 9.00
		IZMH410S	1.60 to 9.00
		IZMH430S	1.60 to 9.00
		IZMH450S	1.60 to 9.00
		IZMH490S	1.60 to 9.00
		IZMH540S	1.60 to 9.00
		IZMH570S	1.60 to 9.00
iv)	High strength low alloy high yield ratio steel	IZMH320LA	1.60 to 9.00
		IZMH360LA	1.60 to 9.00
		IZMH390LA	1.60 to 9.00
		IZMH410LA	1.60 to 9.00
		IZMH430LA	1.60 to 9.00
		IZMH450LA	1.60 to 9.00
		IZMH480LA	1.60 to 9.00
		IZMH500LA	1.60 to 9.00
		IZMH550LA	2.00 to 9.00
		IZMH600LA	2.00 to 9.00
		IZMH650LA	2.00 to 9.00
		IZMH700LA	2.00 to 9.00
		IZMH750LA	2.00 to 9.00

Table 2 (*Concluded*)

Sl No.	Type and Designation		Thickness mm
(1)	(2)	(3)	(4)
v)	High strength structural steel	IZMH440R	1.60 to 9.00
		IZMH490R	1.60 to 9.00
		IZMH540R	2.00 to 9.00
		IZMH590R	2.00 to 9.00
		IZMH780R	2.00 to 9.00
vi)	High hole expansion ratio steel	IZMH440FB	1.60 to 9.00

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 Designation of grade is explained in Annex D.

Table 3 Coating Mass Requirement

(*Clauses* 5.2, 5.6, 8.1 *and* 10.8)

Sl No.	Minimum Requirement for Both Sides		
	Coating Class	Triple Spot Test g/m^2	Single Spot Test[a)] g/m^2
(1)	(2)	(3)	(4)
i)	ZM060	60	50
ii)	ZM070	70	60
iii)	ZM080	80	70
iv)	ZM090	90	80
v)	ZM100	100	85
vi)	ZM120	120	100
vii)	ZM130	130	110
viii)	ZM140	140	120
ix)	ZM150	150	130
x)	ZM160	160	130
xi)	ZM175	175	145
xii)	ZM180	180	155
xiii)	ZM190	190	160
xiv)	ZM200	200	170
xv)	ZM220	220	190
xvi)	ZM250	250	210
xvii)	ZM275	275	235
xviii)	ZM300	300	255
xix)	ZM310	310	265
xx)	ZM350	350	300

Table 3 (*Concluded*)

Sl No.	Minimum Requirement for Both Sides		
	Coating Class	Triple Spot Test g/m^2	Single Spot Test[a] g/m^2
(1)	(2)	(3)	(4)
xxi)	ZM430	430	365
xxii)	ZM450	450	385
xxiii)	ZM500	500	425
xxiv)	ZM600	600	510
xxv)	ZM650	650	555

NOTES

1 Because of the many variables and changing conditions that are characteristic of continuous zinc-aluminium-magnesium 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.

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

Table 4 Surface Finish Requirement

(*Clause* 5.4)

Sl No.	Surface Finish Designation	
	Type	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 the manufacturer. Roughness check shall be carried out in accordance with the IS 15262.

Table 5 Surface Treatment and Oiling Requirement

(*Clause* 5.5)

Sl No.	Surface Treatment Designation	
(1)	(2)	(3)
i)	C	Mill passivation
ii)	P	Mill phosphating
iii)	O	Oiling
iv)	CO	Mill passivation and oiling
v)	S	Thin organic film (or sealing)
vi)	U	Un-treated

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

[a] Single-spot test ≅ 0.85 × triple-spot test.

Table 6A Chemical Composition Requirements for Cold-Rolled Substrate

(*Clauses* 7.1 *and* 7.2)

Sl No.	**Type and Designation**		**Constituent,** Percent *Max*			
			C	Mn	P	S
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Mild steel	IZMCCR0	0.20	2.00	0.12	0.035
		IZMCCR1	0.18	1.20	0.12	0.035
		IZMCCR2	0.10	0.50	0.04	0.030
		IZMCCR3	0.08	0.45	0.03	0.030
		IZMCCR4	0.06	0.45	0.03	0.030
		IZMCCR5	0.02	0.25	0.03	0.020
ii)	Structural quality steel	IZMC300S	0.25	1.60	0.10	0.040
		IZMC310S	0.25	1.60	0.10	0.040
		IZMC330S	0.25	1.60	0.10	0.040
		IZMC360S	0.25	1.60	0.10	0.040
		IZMC380S	0.25	1.60	0.10	0.040
		IZMC410S	0.25	1.60	0.10	0.040
		IZMC420S	0.25	1.60	0.10	0.040
		IZMC440S	0.25	1.60	0.10	0.040
		IZMC460S	0.25	1.60	0.10	0.040
		IZMC480S	0.25	1.60	0.10	0.040
		IZMC510S	0.25	1.60	0.10	0.040
		IZMC560S	0.25	1.60	0.10	0.040
		IZMC570S	0.25	1.60	0.10	0.040
iii)	Bake-hardening steel	IZMC270B	0.01	0.80	0.10	0.020
		IZMC290B	0.01	0.80	0.10	0.020
		IZMC320B	0.01	0.80	0.10	0.020
		IZMC340B	0.01	1.20	0.10	0.020
		IZMC360B	0.01	1.40	0.10	0.020
		IZMC400B	0.01	1.60	0.10	0.020
		IZMC440B	0.01	1.60	0.10	0.020
iv)	Interstitial free-high strength	IZMC300P	0.01	0.80	0.10	0.020
		IZMC330P	0.01	0.80	0.10	0.020
		IZMC340P	0.01	0.80	0.10	0.020
		IZMC360P	0.01	1.00	0.10	0.020
		IZMC370P	0.01	1.20	0.10	0.020
		IZMC390P	0.01	1.40	0.10	0.020
		IZMC440P	0.01	1.60	0.10	0.020
v)	C-Mn steel (solid solution strengthening)	IZMC340W	0.12	0.90	0.03	0.030
		IZMC370W	0.15	1.30	0.03	0.030
		IZMC390W	0.20	1.50	0.03	0.030
		IZMC440W	0.20	1.70	0.03	0.030
		IZMC490W	0.20	2.00	0.03	0.030
		IZMC540W	0.20	2.50	0.03	0.030
		IZMC590W	0.25	2.50	0.03	0.030

Table 6A (*Concluded*)

Sl No.	Type and Designation		Constituent, Percent *Max*			
			C	Mn	P	S
(1)	(2)	(3)	(4)	(5)	(6)	(7)
vi)	High strength low alloy Steel	IZMC310LA	0.10	1.00	0.07	0.025
		IZMC320LA	0.10	1.00	0.07	0.025
		IZMC340LA	0.10	1.20	0.07	0.025
		IZMC370LA	0.12	1.40	0.07	0.025
		IZMC410LA	0.12	1.50	0.07	0.025
		IZMC440LA	0.12	1.60	0.07	0.025
		IZMC470LA	0.14	1.60	0.07	0.025
		IZMC500LA	0.14	1.80	0.07	0.025
		IZMC530LA	0.14	1.80	0.07	0.025
		IZMC620LA	0.16	2.50	0.07	0.025
vii)	Dual phase steel	IZMC450Y	0.15	2.00	0.10	0.020
		IZMC490Y	0.15	2.00	0.10	0.020
		IZMC540Y	0.15	2.20	0.10	0.020
		IZMC590Y	0.15	2.50	0.10	0.020
		IZMC780Y	0.18	2.50	0.10	0.020
		IZMC980Y	0.25	3.50	0.10	0.020
		IZMC980YH	0.25	3.50	0.10	0.020
		IZMC1180Y	0.30	3.50	0.10	0.020
viii)	TRIP steel	IZMC590T	0.30	2.20	0.10	0.015
		IZMC690T	0.35	2.50	0.10	0.015
		IZMC780T	0.35	2.50	0.10	0.015
ix)	Complex phase steel	IZMC600N	0.18	2.20	0.10	0.015
		IZMC780N	0.18	3.00	0.10	0.015
		IZMC980N	0.20	3.50	0.10	0.015

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. However, boron addition will be restricted to 0.006 percent maximum.

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

3 The elements (for example Cr, Mo, Ni etc) not mentioned in the above table can be added up to 1 percent 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 upon between the purchaser and the supplier for aluminium killed steel.

Table 6B Chemical Composition Requirements for Hot-Rolled Substrate

(*Clauses* 7.1 *and* 7.2)

Sl No.	**Type and Designation**		**Constituent,** Percent**,** *Max*					
			C	Mn	P	S	Si	Micro Alloying
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	Commercial quality steel[1]	IZMHHR1	0.15	0.60	0.05	0.035	–	–
ii)	Drawing quality steel[1]	IZMHHR2	0.10	0.45	0.04	0.035	–	–
		IZMHHR3	0.08	0.40	0.35	0.030	–	–
		IZMHHR4	0.08	0.35	0.30	0.030	–	–
iii)	Structural quality steel	IZMH290S	0.12	0.60	0.04	0.040	0.50	0.15
		IZMH330S	0.15	0.80	0.04	0.040	0.50	0.15
		IZMH360S	0.17	1.20	0.04	0.040	0.50	0.15
		IZMH410S	0.20	1.40	0.04	0.040	0.50	0.15
		IZMH430S	0.25	1.70	0.05	0.035	0.50	0.15
		IZMH450S	0.25	1.70	0.05	0.035	0.50	0.15
		IZMH490S	0.25	1.70	0.05	0.035	0.50	0.15
		IZMH540S	0.25	1.70	0.05	0.035	0.50	0.15
		IZMH570S	0.25	1.70	0.05	0.035	0.50	0.15
iv)	High strength low alloy High yield ratio steel	IZMH320LA	0.12	1.20	0.02	0.025	–	0.22
		IZMH360LA	0.12	1.20	0.02	0.025	–	0.22
		IZMH390LA	0.12	1.30	0.02	0.025	–	0.22
		IZMH410LA	0.12	1.40	0.02	0.025	–	0.22
		IZMH430LA	0.12	1.50	0.02	0.025	–	0.22
		IZMH450LA	0.12	1.50	0.02	0.025	–	0.22

Table 6B (*Concluded*)

Sl No.	Type and Designation		Constituent, Percent, *Max*					
			C	Mn	P	S	Si	Micro Alloying
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		IZMH480LA	0.12	1.50	0.015	0.025	–	0.22
		IZMH500LA	0.12	1.60	0.015	0.025	–	0.22
		IZMH550LA	0.12	1.70	0.015	0.025	–	0.22
		IZMH600LA	0.12	1.80	0.015	0.025	–	0.22
		IZMH650LA	0.12	1.90	0.015	0.025	–	0.22
		IZMH700LA	0.12	2.00	0.015	0.025	–	0.22
		IZMH750LA	0.12	2.10	0.015	0.025	–	0.22
v)	High strength structural steel	IZMH440R	0.20	1.50	0.02	0.030	–	0.20
		IZMH490R	0.20	1.60	0.02	0.030	–	0.20
		IZMH540R	0.20	1.70	0.02	0.030	–	0.20
		IZMH590R	0.20	1.80	0.02	0.030	–	0.20
		IZMH780R	0.20	2.00	0.02	0.030	–	0.25
vi)	High hole expansion ratio steel	IZMH440FB	0.16	1.60	–	–	–	0.20

NOTES

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

2 The elements (for example Cr, Mo, Ni etc) not mentioned in the above table can be added up to 1 percent maximum either singly or in combination.

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

4 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.

[1] Steel 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 0.2 percent or as per the above table. However, boron addition will be restricted to 0.006 percent maximum.

Table 7 Permissible Variation for Product Analysis

(*Clause* 7.2)

Sl No.	Element	Specified Chemical Composition Limit	Permissible Variation Over the Specified Limit
		Percent, *Max*	Percent, *Max*
(1)	(2)	(3)	(4)
i)	Carbon	≤ 0.150	0.02
		> 0.150	0.03
ii)	Manganese	≤ 0.6	0.03
		> 0.60, ≤ 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	–	Subject to negotiation

NOTE — Sufficient care should be taken while carrying out product analysis on thin samples.

Table 8 Coating Adherence Test

(*Clause* 8.3.1)

Sl No.	Type	Grade Designation/ Strength	Bending Angle	Diameter of Mandrel for Bending, mm					
				$t < 1.6$ mm for Cold-Rolled Substrate 1.60 mm $\leq t < 3.00$ mm for Hot-Rolled Substrate			$t \geq 1.6$ mm for Cold-Rolled Substrate $t \geq 3.00$ mm		
				up to ZM275	ZM300 to ZM350	ZM450 and Above	Up to ZM275	ZM300 to ZM350	ZM450 and Above
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	Mild steel	IZMCCR1	180°	1 *t*	–	–	1 *t*	–	–
		IZMCCR2, IZMCCR3, IZMCCR4, IZMCCR5	180°	Close	–	–	Close	–	–
ii)	Structural quality steel (cold-rolled substrate)	Tensile strength ≤ 310 MPa	180°	1 *t*	1 *t*	2 *t*	1 *t*	2 *t*	2 *t*
		310 MPa < tensile strength ≤ 400 MPa	180°	2 *t*	2 *t*	2 *t*	2 *t*	2 *t*	2 *t*
		400 MPa < tensile strength ≤ 500 MPa	180°	3 *t*	3 *t*	3 *t*	3 *t*	3 *t*	3 *t*
		Tensile strength > 500 MPa	180°	*	*	*	*	*	*
iii)	High strength low alloy steel (cold-rolled substrate)	Tensile strength ≤ 500 MPa	180°	1 *t*	1 *t*	1 *t*	1 *t*	1 *t*	1 *t*
		Tensile strength >500 MPa	180°	2 *t*	2 *t*	2 *t*	2 *t*	2 *t*	2 *t*
iv)	Commercial quality steel	IZMHHR1	180°	1 *t*	2 *t*	2 *t*	2 *t*	2 *t*	2 *t*
v)	Drawing quality steel	IZMHHR2	180°	1 *t*	2 *t*	2 *t*	2 *t*	2 *t*	2 *t*
		IZMHHR3	180°	1 *t*	2 *t*	2 *t*	2 *t*	2 *t*	2 *t*
		IZMHHR4	180°	1 *t*	2 *t*	2 *t*	2 *t*	2 *t*	2 *t*

Table 8 (*Concluded*)

Sl No.	Type	Grade Designation/ Strength	Bending Angle	Diameter of Mandrel for Bending, mm					
				$t < 1.6$ mm for Cold-Rolled Substrate 1.60 mm $\leq t < 3.00$ mm for Hot-Rolled Substrate			$t \geq 1.6$ mm for Cold-Rolled Substrate $t \geq 3.00$ mm		
				up to ZM275	ZM300 to ZM350	ZM450 and Above	up to ZM275	ZM300 to ZM350	ZM450 and Above
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
vi)	Structural quality steel	IZMH290S	180°	1 *t*	2 *t*	2 *t*	2 *t*	2 *t*	2 *t*
		IZMH330S	180°	1 *t*	2 *t*	2 *t*	2 *t*	2 *t*	2 *t*
		IZMH360S	180°	1 *t*	1 *t*	2 *t*	2 *t*	2 *t*	3 *t*
		IZMH410S	180°	2 *t*	2 *t*	2 *t*	3 *t*	3 *t*	3 *t*
		IZMH430S	180°	2 *t*	2 *t*	2 *t*	3 *t*	3 *t*	3 *t*
		IZMH450S	180°	3 *t*	3 *t*	3 *t*	3 *t*	3 *t*	3 *t*
		IZMH490S	180°	3 *t*	3 *t*	3 *t*	3 *t*	3 *t*	3 *t*
		IZMH540S	180°	3 *t*	3 *t*	3 *t*	3 *t*	3 *t*	3 *t*
		IZMH570S	180°	3 *t*	3 *t*	3 *t*	3 *t*	3 *t*	3 *t*

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 purchaser and manufacturer.

3 *t* → Nominal thickness of the product.

4 For the remaining grades of hot-rolled substrate and cold-rolled substrate, coating adherence test to be carried out as per the mutual agreement between purchaser a nd manufacturer and acceptance criteria shall be as per the mutual agreement between the purchaser and the manufacturer.

[*] These are generally not subjected to coating adherence test. Subject to mutual agreement between purchaser and manufacturer.

Table 9A Mechanical Property Requirement (for Cold-Rolled Substrate)

(*Clauses* 10.1.2, 10.1.3, 10.2.2, 10.3.2,10.4 *and Annex* C)

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**	**Bake Hardening Index (BH)** N/mm^2, *Min*	**Plastic Strain Ratio**		**Strain Hardening Exponent**	
				Thickness, *t* mm			Thickness, *t* mm								
				≤ 0.5	0.5 < *t* ≤ 0.7	*T* > 0.70	≤ 0.5	0.5 < *t* ≤ 0.7	*T* > 0.70			r-td, *Min*	r-bar, *Min*	n-td, *Min*	n-value, *Min*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
i)	Mild steel[9)]	IZMCCR0	–	–	–	–	–	–	–	–	–	–	–	–	–
		IZMCCR1[9)]	270	–	–	–	–	–	22	–	–	–	–	–	–
		IZMCCR2	270	140 to 300	140 to 280	140 to 260	26	28	30	Transverse	–	–	–	–	–
		IZMCCR3	270	120 to 260	120 to 240	120 to 220	30	32	34	Transverse	–	1.6[a]	1.4[a]	0.18[a]	0.16[a]
		IZMCCR4	260	120 to 220	120 to 200	120 to 180	33	35	37	Transverse	–	1.7[a]	1.4[a]	0.2[a]	0.18[a]
		IZMCCR5	260	120 to 210	120 to 190	120 to 170	35	37	39	Transverse	–	1.9[a]	1.6[a]	0.21[a]	0.2[a]
ii)	Structural quality steel	IZMC300S	300	220 *Min*			16	18	20	Longitudinal	–	–	–	–	–
		IZMC310S	310	230 *Min*			16	18	20	Longitudinal	–	–	–	–	–
		IZMC330S	330	250 *Min*			15	17	19	Longitudinal	–	–	–	–	–
		IZMC360S	360	280 *Min*			14	16	18	Longitudinal	–	–	–	–	–
		IZMC380S	380	280 *Min*			13	15	17	Longitudinal	–	–	–	–	–
		IZMC410S	410	335 *Min*			12	14	16	Longitudinal	–	–	–	–	–
		IZMC420S	420	350 *Min*			12	14	16	Longitudinal	–	–	–	–	–
		IZMC440S	440	365 *Min*			11	13	15	Longitudinal	–	–	–	–	–
		IZMC460S	460	390 *Min*			11	13	15	Longitudinal	–	–	–	–	–
		IZMC480S	480	420 *Min*			10	12	14	Longitudinal	–	–	–	–	–
		IZMC510S	510	450 *Min*			10	12	14	Longitudinal	–	–	–	–	–
		IZMC560S	560	550 *Min*			–	–	–	Longitudinal	–	–	–	–	–
		IZMC570S	570	550 *Min*			–	–	–	Longitudinal	–	–	–	–	–

Table 9A (*Continued*)

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	Bake Hardening Index (BH) N/mm², *Min*	Plastic Strain Ratio		Strain Hardening Exponent	
				Thickness, *t* mm			Thickness, *t* mm								
				≤ 0.5	0.5 < *t* ≤ 0.7	*T* > 0.70	≤ 0.5	0.5 < *t* ≤ 0.7	*T* > 0.70			r-td, *Min*	r-bar, *Min*	n-td, *Min*	n-value, *Min*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
iii)	Bake-hardening steel	IZMC270B	270	160 to 260	160 to 240	160 to 220	34	36	38	Longitudinal	30	–	1.3	–	0.18
		IZMC290B	290	180 to 280	180 to 260	180 to 240	30	32	34	Transverse	30	1.7	–	0.16	–
		IZMC320B	320	220 to 320	220 to 300	220 to 280	28	30	32	Transverse	30	1.2	–	0.15	–
		IZMC340B	340	220 to 330	220 to 310	220 to 290	28	30	32	Transverse	30	–	1	–	0.15
		IZMC360B	360	260 to 370	260 to 350	260 to 330	24	26	28	Transverse	30	–	–	–	–
		IZMC400B	400	300 to 400	300 to 380	300 to 360	22	24	26	Transverse	30	–	–	–	–
		IZMC440B	440	340 to 440	340 to 420	340 to 400	20	22	24	Transverse	30	–	–	–	–
iv)	Interstitia free-high strength	IZMC300P	300	160 to 260	160 to 240	160 to 220	33	35	37	Transverse	–	1.9	–	0.2	–
		IZMC330P	330	180 to 280	180 to 260	180 to 240	30	32	34	Transverse	–	1.7	–	0.18	--
		IZMC340P	340	180 to 290	180 to 270	180 to 250	28	30	32	Transverse	–	–	1.3	–	0.2
		IZMC360P	360	220 to 330	220 to 310	220 to 290	28	30	32	Transverse	–	1.5	–	0.17	–
		IZMC370P	370	260 to 370	260 to 350	260 to 330	26	28	30	Transverse	–	1.2	–	0.15	–
		IZMC390P	390	280 to 400	280 to 380	280 to 360	23	25	27	Transverse	–	1.3	–	0.15	–
		IZMC440P	440	280 to 420	280 to 400	280 to 380	22	24	26	Transverse	–	–	1.1	–	0.15
v)	C-Mn steel (solid solution strengthening)	IZMC340W	340	220 to 340	220 to 320	220 to 300	29	31	33	Transverse	–	–	–	–	–
		IZMC370W	370	240 to 360	240 to 340	240 to 320	26	28	30	Transverse	–	–	–	–	–
		IZMC390W	390	260 to 390	260 to 370	260 to 350	25	27	29	Transverse	–	–	–	–	–
		IZMC440W	440	280 to 410	280 to 390	280 to 370	22	24	26	Transverse	–	–	–	–	–
		IZMC490W	490	–	310 to 420	310 to 400	–	20	22	Transverse	–	–	–	–	–
		IZMC540W	540	–	330 to 460	330 to 440	–	17	19	Transverse	–	–	–	–	–
		IZMC590W	590	–	350 to 470	350 to 460	–	14	16	Transverse	–	–	–	–	–

Table 9A (*Continued*)

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	Bake Hardening Index (BH) N/mm², *Min*	Plastic Strain Ratio		Strain Hardening Exponent	
				Thickness, *t* mm			Thickness, *t* mm								
				≤ 0.5	0.5 < *t* ≤ 0.7	*T* > 0.70	≤ 0.5	0.5 < *t* ≤ 0.7	*T* > 0.70			r-td, *Min*	r-bar, *Min*	n-td, *Min*	n-value, *Min*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
vi)	High strength low alloy steel	IZMC310LA	310	210 to 330	210 to 310	210 to 290	22	24	26	Transverse	–	–	–	–	–
		IZMC320LA	320	240 to 360	240 to 340	240 to 320	20	22	24	Transverse	–	–	–	–	–
		IZMC340LA	340	260 to 380	260 to 360	260 to 340	20	22	24	Transverse	–	–	–	–	–
		IZMC370LA	370	300 to 420	300 to 400	300 to 380	19	21	23	Transverse	–	–	–	–	–
		IZMC410LA	410	340 to 460	340 to 440	340 to 420	16	18	20	Transverse	–	–	–	–	–
		IZMC440LA	440	–	380 to 460	380 to 440	–	15	17	Transverse	–	–	–	–	–
		IZMC470LA	470	–	420 to 540	420 to 520	–	14	16	Transverse	–	–	–	–	–
		IZMC500LA	500	–	460 to 600	460 to 580	–	10	12	Transverse	–	–	–	–	–
		IZMC530LA	530	–	500 to 640	500 to 620	–	8	10	Transverse	–	–	–	–	–
		IZMC620LA	620	–	550 *Min*	550 *Min*	–	7	9	Transverse	–	–	–	–	–
vii)	Dual phase steel	IZMC450Y	450	260 to 380	260 to 360	260 to 340	23	25	27	Transverse	–	–	–	–	–
		IZMC490Y	490	290 to 420	290 to 400	290 to 380	20	22	24	Transverse	–	–	–	–	–
		IZMC540Y	540	310 to 450	310 to 430	310 to 410	18	20	22	Transverse	–	–	–	–	–
		IZMC590Y	590	330 to 470	330 to 450	330 to 430	16	18	20	Transverse	–	–	–	–	–
		IZMC780Y	780	–	440 to 570	440 to 550	–	12	14	Transverse	–	–	–	–	–
		IZMC980Y	980	–	–	590 to 740	–	–	10	Transverse	–	–	–	–	–
		IZMC980YH	980	–	–	700 to 850	–	–	8	Transverse	–	–	–	–	–
		IZMC1180Y	1180	–	–	740 to 1 000	–	–	7	Transverse	–	–	–	–	–

Table 9A (*Concluded*)

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	Bake Hardening Index (BH) N/mm^2, *Min*	Plastic Strain Ratio		Strain Hardening Exponent	
				Thickness, *t* mm			Thickness, *t* mm								
				≤ 0.5	0.5 < *t* ≤ 0.7	*T* > 0.70	≤ 0.5	0.5 < *t* ≤ 0.7	*T* > 0.70			r-td, *Min*	r-bar, *Min*	n-td, *Min*	n-value, *Min*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
viii)	TRIP steel	IZMC590T	590	360 to 550	360 to 530	360 to 510	22	24	26	Transverse	–	–	–	–	–
		IZMC690T	690	–	380 to 550	380 to 530	–	19	21	Transverse	–	–	–	–	–
		IZMC780T	780	–	–	410 to 560	–	–	16	Transverse	–	–	–	–	–
ix)	Complex phase steel	IZMC600N	600	350 to 570	350 to 550	350 to 530	10	12	14	Transverse	–	–	–	–	–
		IZMC780N	780	–	–	500 to 710	–	–	9	Transverse	–	–	–	–	–
		IZMC980N	980	–	–	690 to 910	–	–	6	Transverse	–	–	–	–	–

NOTES

1 1 N/mm^2 = 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 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 the 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 and test specimen types can be applied while conducting tensile tests. For such cases, mechanical properties requirements will be based on the mutual agreement and those agreed values should be reasonably close to the values mentioned in Table 9A.

7 IZMCCR0 is a cold-rolled full hard grade. Based on mutual agreement, a hardness check can be applied.

8 td – Tensile test direction.

[a] It is required to report only one value against the plastic strain ratio (either r-bar or r-td) and strain hardening exponent (n-value or n-td).

9) Tensile requirements are not required, if desired by the purchaser.

Table 9B Mechanical Property Requirement (for Hot-Rolled Substrate)

(*Clauses* 10.1.2 *and* 10.1.3)

Sl No.	**Type and Designation**		**Tensile Strength** N/mm^2	**Yield Point or Proof Stress** N/mm^2 *Min*	**Elongation**, Percent, *Min*				**Testing Direction**
					$t \leq 3.0$ mm		$t > 3.0$ mm		
					Test Piece Type 2 of IS 1608 (Part 1)	Test Piece Type 3 of IS 1608 (Part 1)	Gauge Length $L_0 = 5.65\sqrt{S_0}$	Gauge Length $L_0 = 50$ mm	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	Commercial quality steel	IZMHHR1	440 *Max*	–	23	24	28	29	Transverse
ii)	Drawing quality steel	IZMHHR2	420 *Max*	–	25	26	30	31	Transverse
		IZMHHR3	400 *Max*	–	28	29	33	34	Transverse
		IZMHHR4	380 *Max*	–	31	32	36	37	Transverse
iii)	Structural quality steel	IZMH290S	290 *Min*	165 *Min*	22	–	30	–	Transverse
		IZMH330S	330 *Min*	205 *Min*	20	–	28	–	Transverse
		IZMH360S	360 *Min*	235 *Min*	19	–	26	–	Transverse
		IZMH410S	410 *Min*	255 *Min*	17	–	23	–	Transverse
		IZMH430S	430 *Min*	320 *Min*	12	–	21	14	Transverse
		IZMH450S	450 *Min*	350 *Min*	10	–	20	12	Transverse
		IZMH490S	490 *Min*	355 *Min*	10	–	20	–	Transverse
		IZMH540S	540 *Min*	380 *Min*	10	–	17	12	Transverse
		IZMH570S	570 *Min*	450 *Min*	–	–	–	–	Transverse
iv)	High strength low alloy high yield ratio steel	IZMH320LA	320 to 420	255 Min	25	–	27	–	Transverse
		IZMH360LA	360 to 460	300 Min	23	–	25	–	Transverse
		IZMH390LA	390 to 510	315 Min	20	–	24	–	Transverse
		IZMH410LA	410 to 520	340 Min	20	–	23	–	Transverse
		IZMH430LA	430 to 550	355 Min	19	–	23	–	Transverse
		IZMH450LA	450 to 570	380 Min	18	–	21	–	Transverse
		IZMH480LA	480 to 620	420 Min	16	–	19	–	Transverse
		IZMH500LA	500 to 670	450 Min	14	–	18	–	Transverse

Table 9B (*Concluded*)

Sl No.	**Type and Designation**		**Tensile Strength** N/mm^2	**Yield Point or Proof Stress** N/mm^2 *Min*	**Elongation**, Percent, *Min*				**Testing Direction**
					$t < 3.0$ mm		$t > 3.0$ mm		
					Test piece type 2 of IS 1608 (Part 1)	Test piece type 3 of IS 1608 (Part 1)	Gauge Length $L_0 = 5.65\sqrt{S_0}$	Gauge Length $L_0 = 50$ mm	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		IZMH550LA	550 to 700	500 Min	12	–	14	–	Transverse
		IZMH600LA	600 to 760	550 Min	12	–	14	–	Transverse
		IZMH650LA	650 to 820	600 Min	11	–	13	–	Transverse
		IZMH700LA	700 to 880	650 Min	10	–	12	–	Transverse
		IZMH750LA	750 to 950	700 Min	10	–	11	–	Transverse
v)	High strength structural steel	IZMH440R	440	305 Min	–	26	–	28	Transverse
		IZMH490R	490	355 Min	–	22	–	24	Transverse
		IZMH540R	540	410 Min	–	19	–	21	Transverse
		IZMH590R	590	450 Min	–	17	–	19	Transverse
		IZMH780R	780	675 Min	–	14	–	15	Transverse
vi)	High hole expansion ratio steel	IZMH440FB	440	265 Min	–	28	–	33	Longitudinal

NOTES

1 1 N/mm 2 = 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 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 the manufacturer can agree up on testing with mutually agreed criteria for evaluation.

6 Minimum tensile strength for IZMHHR1, IZMHHR2, IZMHHR3 and IZMHHR4 would normally be expected to be 270 MPa. Where minimum tensile strength is required, the value of 270 MPa may be specified. All tensile strength values are determined to the nearest 10 MPa.

7 Based on the mutual agreement between the 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 9B.

8 For Grade IZMH440FB, minimum hole expansion (HER) required shall be 70 percent. The test shall be conducted in accordance with IS 17414.

Table 10 Requirements for Bend Test for Cold-Rolled Substrate

(*Clause* 10.5.2)

Sl No.	Minimum Tensile Strength MPa	Bend Angle	Bend Radius (t = Thickness of Sheet)
(1)	(2)	(3)	(4)
i)	340	180°	Close
ii)	370	180°	Close
iii)	390	180°	Close
iv)	440	180°	Close
v)	490	180°	Close
vi)	540	180°	0.5 t
vii)	590	180°	1 t
viii)	780	180°	3 t
ix)	900	180°	4 t
x)	980	180°	4 t
xi)	1 100	180°	4 t

NOTES

1 For grades, where a minimum tensile requirement is not mentioned in the above table, the nearest minimum tensile strength value can be applied.

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

Table 11 Ageing Period Requirement for Cold-Rolled Substrate

(*Clause* 10.7)

Sl No.	Type and Designation		Applicable Non-Ageing Period
(1)	(2)	(3)	(4)
i)	Mild steel	IZMCCR2	8 Days
		IZMCCR3	1 Month
		IZMCCR4	6 Months
		IZMCCR5	6 Months
ii)	Bake-hardening steel	IZMC270B	3 Months
		IZMC290B	3 Months
		IZMC320B	3 Months
		IZMC340B	3 Months
		IZMC360B	3 Months
		IZMC400B	3 Months
		IZMC440B	3 Months
iii)	Interstitial free-high strength	IZMC300P	6 Months
		IZMC330P	6 Months
		IZMC340P	6 Months
		IZMC360P	6 Months
		IZMC370P	6 Months
		IZMC390P	6 Months
		IZMC440P	6 Months

NOTES

1 Applicable non ageing period is applicable only for the type and designation mentioned in Table 11. 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* 2)

LIST OF REFERRED STANDARDS

IS No.	*Title*
IS 228 (all parts)	Methods for chemical analysis of steels
IS 513	Cold reduced carbon steel sheet and strip:
(Part 1) : 2016	Cold forming and drawing purpose (*sixth revision*)
(Part 2) : 2016	High tensile and multi-phase steel (*sixth revision*)
IS 1079 : 2017	Hot rolled carbon steel sheet, plate and strip — Specification (*seventh 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 2590 : 1987	Specification for primary aluminium ingots for remelting for general engineering purposes (*second revision*)
IS 2629 : 1985	Recommended practice for hot-dip galvanizing of iron and steel (*first revision*)
IS 3531 : 1997	Glossary of terms relating to corrosion of metals (*second revision*)
IS 5986 : 2017	Hot rolled steel sheet, plate and strip for forming and flanging purposes — Specification (*fourth revision*)
IS 6694 : 1999	Magnesium ingots — Specification (*second revision*)
IS 6745 : 1972	Methods for determination of mass of zinc coating on zinc coated iron and steel articles
IS 8910 : 2022/ ISO 404 : 2013	Steel and steel products — General technical delivery requirements (*second revision*)
IS 11999 : 2022/ ISO 10113 : 2020	Metallic materials — Sheet and strip — Determination of plastic strain ratio (*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: Profile method — Terms, definitions, and surface texture parameters
IS 15756 : 2022/ ISO 10275 : 2020	Metallic materials — Sheet and strip — Determination of tensile strain hardening exponent (*first revision*)
IS/ISO 16163 : 2012	Continuously hot-dipped coated steel sheet products — Dimensional and shape tolerances (*first revision*)
IS 17414 : 2020/ ISO 16630 : 2017	Metallic materials — Sheet and strip — Hole expanding test
IS 18385 : 2023	Hot-dip galvanized/ galvannealed steelsheet, plate and strip for automotive applications — Specification

ANNEX B

(*Clauses* 3.1, 8.2.4 *and* 10.8)

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.

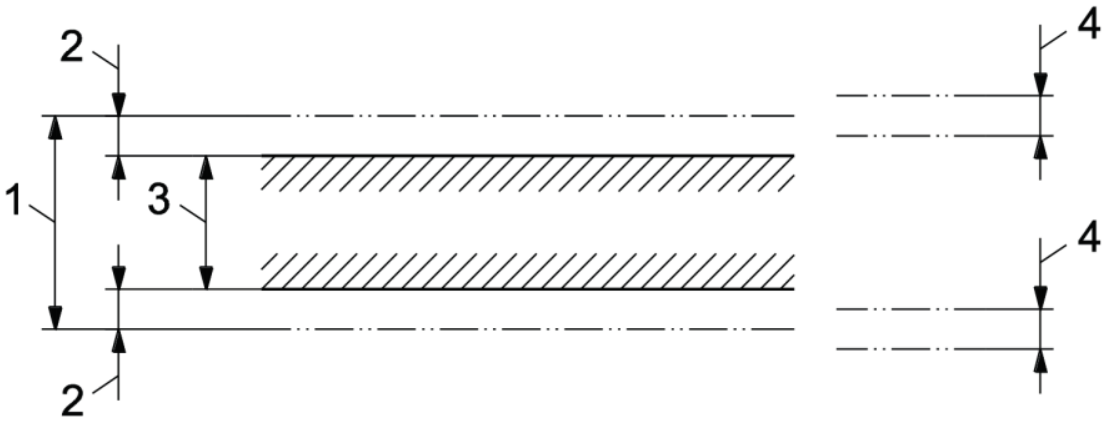


FIG.1 CALCULATION OF THE PRODUCT THICKNESS

Key

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

The equivalent coating thickness may be calculated from coating mass, for example, as follows:

$$t_z = m_z/2d$$

where

t_z = equivalent coating thickness (μm);
m_z = coating mass on both surfaces (g/m^2); and
d = coating density (g/cm^3).

B-2 CALCULATION OF THE COATING DENSITY

The coating density calculation of the zinc-aluminium-magnesium alloy coating may be calculated as follows:

$$d = 7.14 \cdot X_{Zn} + 2.70 \cdot X_{Al} + 1.74 \cdot X_{Mg}$$

where

d = coating density (g/cm^3);
X_{Zn} = mole fraction of zinc in the zinc-aluminium-magnesium alloy;
X_{Al} = mole fraction of aluminium in the zinc-aluminium-magnesium alloy; and
X_{Mg} = mole fraction of magnesium in the zinc-aluminium-magnesium alloy.

ANNEX C

(*Clause* 10.4)

C-1 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 9A. 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;

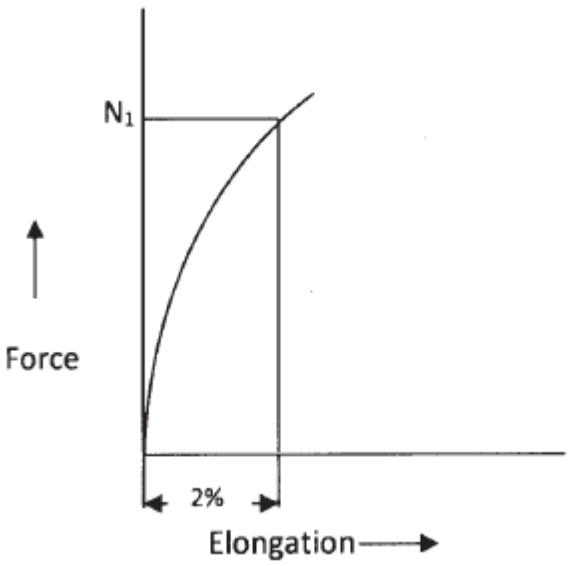
c) The test specimen shall be strained to two percent tensile elongation. The corresponding force shall be noted as N_1;

d) The specimen shall be unloaded from the tensile tester and heat treated for 20 min at a temperature of 170 °C;

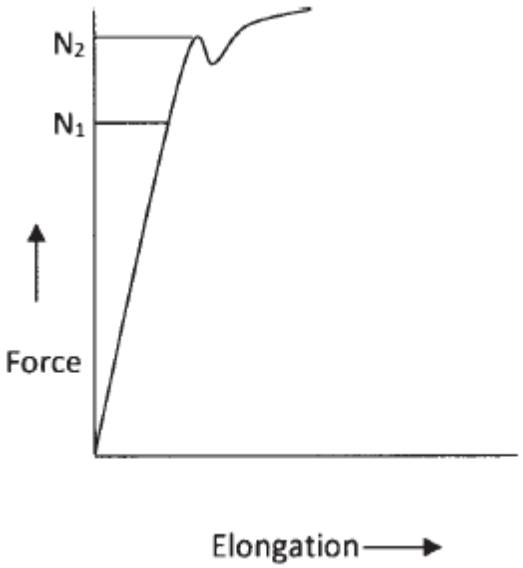
e) After the heat treatment, the test specimen shall be subjected to tensile testing again. The sharp yield point is expected to appear along with the yield drop phenomenon. The force corresponding to the upper yield point shall be noted as N_2;

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



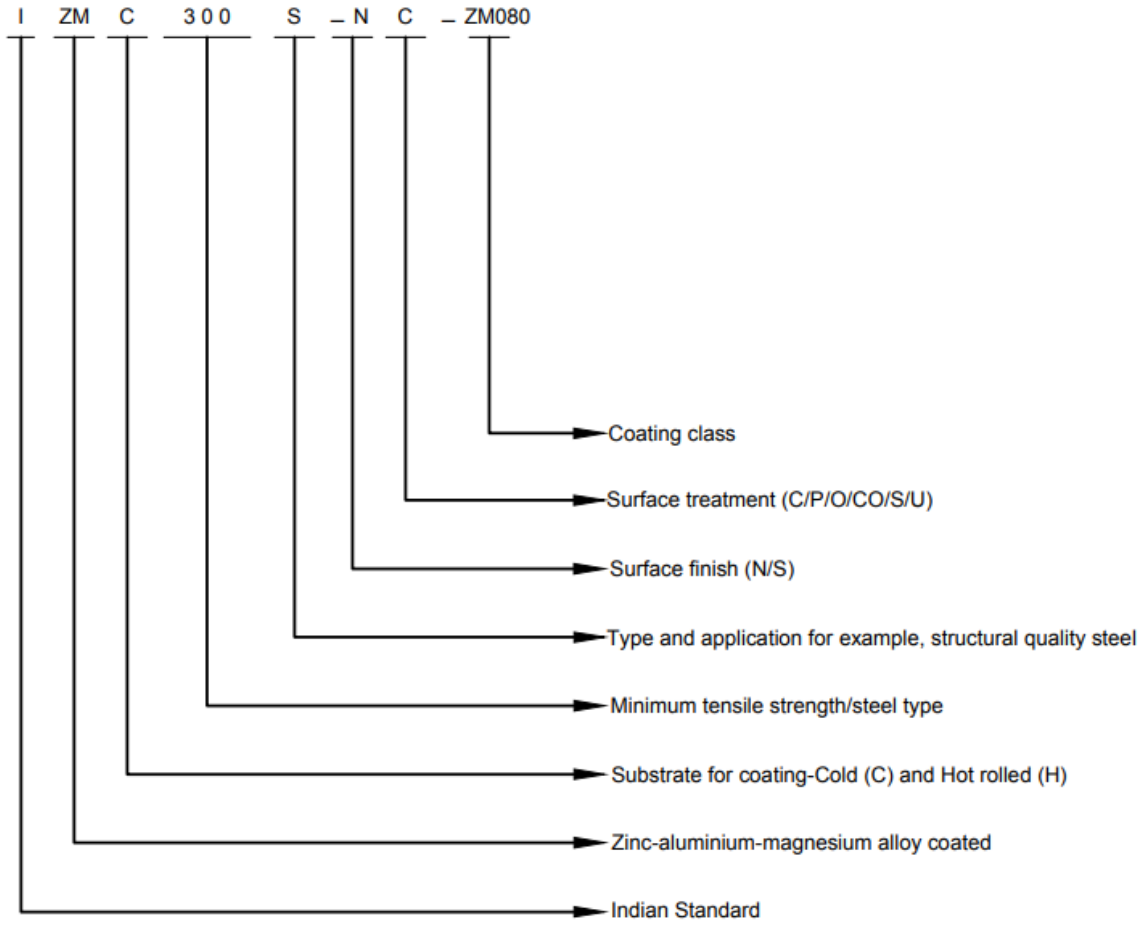
After baking process – heat treatment

FIG. 2 SCHEMATIC REPRESENTATION of BH VALUES

ANNEX D

(*Table* 1 *and Table* 2)

DESIGNATION



ANNEX E

(*Foreword*)

SECTIONAL COMMITTEE COMPOSITION

Wrought Steel Products Sectional Committee, MTD 04

Organization	*Representative(s)*
SAIL, Research & Development Center for Iron & Steel, Ranchi	SHRI NIRVIK BANERJEE **(*Chairperson*)**
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Indian Machine Tools Manufacturers Association, Bengaluru	SHRI Y. BALARAMAIAH
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Tata Motors Ltd, Pune	SHRI LOKESH PALIWAL SHRI TUSHAR BAVISKAR (*Alternate*)
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Thyssenkrupp Electrical Steel India Private Limited, Nashik	SHRI KAPIL KAPOOR
BIS Directorate General	SHRI SANJIV MAINI, SCIENTIST 'F'/SENIOR DIRECTOR AND HEAD (METALLURGICAL ENGINEERING) [REPRESENTING DIRECTOR GENERAL (*Ex-officio*)]

Member Secretary
SHRI ARUN PUCCHAKAYALA
SCIENTIST 'D'/JOINT DIRECTOR
(METALLURGICAL ENGINEERING), BIS

Flat Steel Products Subcommittee, MTD 04 : 03

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Tata Motors Limited, Pune	SHRI LOKESH PALIWAL SHRI TUSHAR BAVISKAR (*Alternate*)
Tata Steel Limited, Jamshedpur	SHRI G. SENTHIL KUMAR
The Tinplate Company of India Limited, Jamshedpur	DR SOURAJYOTI DEY SHRI SUBRATA SADHU (*Alternate*)
Thyssenkrupp Electrical Steel India Private Limited, Nashik	SHRI KAPIL KAPOOR

Panel for Formulation of Standards on Cold-Reduced and Coated Flat Steel Products, MTD 04/P11

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JSW Steel Limited, Bellary	SHRI DEVASISH MISHRA SHRI G. V. RAMANA (*Alternate*)
Maruti Suzuki India Limited, Gurugram	SHRI ABHINANDAN NAULAKHA
POSCO Maharashtra Steel Private Limited, Raigad	SHRI YOGESH SONAWANE SHRI SUDHIR BADGAL (*Alternate*)
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Steel Authority of India Limited, Bokaro Steel Plant, Bokaro	SHRIMATI BISWASI SUNITA MINZ
Volkswagen India Private Limited, Mumbai	SHRI DINESH JOSHI SHRI KEDAR BHIDE (*Alternate*)

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