Draft Indian Standard

PRE-PAINTED ZINC-ALUMINIUM-MAGNESIUM ALLOY COATED STEEL STRIP AND SHEET

1. Scope

1.1. This standard covers the requirement of pre-painted Zinc-Aluminium-Magnesium alloy coated steel strip and sheet.

1.2. Sheets and coils are produced by continuously coating and baking durable synthetic resin paint, for example, polyester, epoxy, acrylic, fluorocarbon etc., over both surfaces or single surface of Zinc-Aluminum-Magnesium Alloy coated steel strip.

1.3. This standard covers requirements for different classes of durability of paint coatings in accordance with the severity of the application.

2. References

The standards listed below 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 the standards indicated below:

IS No.	*Title*
IS 101 (Part 4/Sec 4):2020/ISO 2813:2014	Methods of sampling and test for paints, varnishes and related products Part 4 Optical test section 4 Gloss — Determination of gloss value at 20°, 60° and 85° (*fourth revision*)
IS 101 (Part 5/Sec 1):1988	Methods of sampling and test for paints, varnishes and related products: Part 5 Mechanical test on paint films: Sec 1 Hardness tests (*third revision*)
IS 101 (Part 5/Sec 2):1988	Methods of sampling and test for paints, varnishes and related products. Mechanical Tests: Sec 2 Flexibility and adhesion (*third revision*)
IS 101 (Part 6/Sect 1):1988	Methods of sampling and test for paints, varnishes and related products. Durability Tests: Sec 1 Resistance to humidity under conditions of condensation (*third 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 8910:2022	Steel and Steel Products — General technical delivery requirements (*Second Revision*)
IS 9844: 1981	Method of testing corrosion resistance of electroplated and anodized Aluminium coating by neutral salt spray test
IS 14191:1996	Corrosion of metals and alloys – Classification of corrosivity of atmospheres
IS16163:2012	Continuously hot-dipped coated steel sheet products — Dimensional and shape tolerances (*First Revision*)
ISO 2808:2007	Paints and varnishes -- Determination of film thickness
ISO 4628-2:2003	Paints and varnishes -- Part 2: Assessment of degree of blistering
IS 18513: 2023	Hot-Dip Zinc-Aluminium-Magnesium alloy coated steel sheets, plates and strips — Specification

ISO 12944-2: 2017	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Classification of environments
ISO 14993-2017	Corrosion of metals and alloys —Accelerated testing involving cyclic exposure to salt mist, dry and wet conditions

3. Terminology

For this standard the definitions given in IS 1956 (Part 4) and the following shall apply.

3.1. Bottom-side: The side of the pre-painted sheet, which is opposite to the exposed weathering side.

3.2. Building Exposed Application: The application in buildings for which the concerned products are submitted to the influence of exterior atmospheres.

3.3. Building Un-Exposed Application: The environmental conditions which prevail in the interior of the building

3.4. Costal/Marine Atmosphere: The atmosphere over and near the sea.

3.5. Coating Characteristics:

a) ***Chalking*:** The formation on a pigmented coating of a friable powder evolved from the film itself at or just beneath the surface.

b) ***Fading***: Loss in color intensity experienced by paint over time, generally due the effect of ultra-violet radiation.

c) ***Gloss***: The luster, shine or reflecting ability of a surface.

d) ***Coating Flexibility:*** The ability of a coating to follow without damaging the deformation of the substrate to which it is applied.

3.6. Coil Coating: A continuous process by which paint, and other coatings are applied and oven-baked onto moving Zinc-Aluminium-Magnesium Alloy coated steel strip. The product of this process is referred to as pre-painted Zinc-Aluminium-Magnesium alloy coated steel.

3.7. Conversion Coating: A chemical treatment normally applied to a metal surface prior to final finishing, which is designed to react with and modify the metal to produce a surface suitable for painting.

3.8. Film Coating: A Plastic film/laminate film applied to the substrate to which generally an adhesive and, if appropriate, a priming coat has been applied beforehand

3.9. Finish-coat: A paint on the top side of the pre-painted steel. This is also known as top-coat.

3.10. Industrial Atmosphere: The atmosphere contaminated by corrosive pollutants from local and regional industry (mainly sulphur dioxide).

3.11. Industrial and Costal/Marine Atmosphere: The atmosphere which combines industrial atmosphere and Costal/Marine atmosphere conditions.

3.12. Dry Film Thickness (DFT): The total thickness of the organic coating system either on top side or on reverse side

3.13.Multiple Coat – A paint consisting of primer, possibly intermediate coat(s) and a Finish coat with particular requirements on appearance, corrosion protection, formability, etc.

3.14. Organic Coating: The organic paint film of the pre-painted steel product.

3.15. Primer: The first complete layer of paint of a coating system applied to metallic surface. This serve as the bond between the substrate and topcoat/backer-coat and offers added corrosion prevention.

3.16. Rural Atmosphere: The atmosphere prevailing in rural areas and small towns, without significant contamination by corrosive agents such as sulphur dioxide and/or chlorides

3.17. Substrate: Hot dip Zinc-Aluminium-Magnesium Alloy coated steel strip conforming to IS 18513.

3.18. Topside: The side of the pre-painted sheet, which is exposed to external or internal weathering.

3.19. Temporary Film Coating: A Strippable plastic film applied to the coated surface to afford temporary protection against mechanical damage.

3.20. Urban Atmosphere: The contaminated atmosphere prevailing in densely populated areas without significant industry.

3.21. Wash-coat: A thin paint on the bottom side of the pre-painted steel. This is also known as backer-coat.

4. Supply of Material

4.1. The general requirements relating to supply of pre-painted Zinc-Aluminium-Magnesium alloy coated steel strip and sheet shall conform to IS 8910.

4.2. The pre-painted Zinc-Aluminium-Magnesium alloy coated steel sheets of this standard may also be supplied in profiles based on mutual agreement between the purchaser and the manufacturer.

5. Manufacture

5.1. The substrate for Pre-painted Zinc-Aluminium-Magnesium Alloy coated steel strip and sheet shall conform to IS 18513.

5.2. Pre-painting will be done in a continuous coating line by applying a conversion coating, primer, back-coat and finish coat on substrate. The curing of paint coatings will be at a temperature suitable to produce an aesthetic and durable painted surface.

5.3. Pre-painted Zinc-Aluminium-Magnesium Alloy coated steel strip and sheet can be supplied with Additional protection coatings like temporary or permanent laminate, print on the color coated or any other surface condition, as agreed between the purchaser and the manufacturer.

6. Product Designation

6.1. The product designation shall follow the sequence below:

a) Number of this Indian Standard (IS).
b) Steel grade (see IS 18513)
c) Coating class (see IS 18513)
d) Class of durability of paint coating (*see* 7.3)

6.2. The steel grade used for the Pre-painted Zinc-Aluminium-Magnesium Alloy coated steel strip and sheet shall be Cold Rolled Substrate & hot rolled substrate of Mild Steel and Structural Quality Steel types confirming to IS 18513. Additional steel grades type of IS 18513 can be used as per the mutual agreement between purchaser and the manufacturer.

6.3. The designation of coating class shall include a set of characters as follows: Zinc-Aluminium-Magnesium alloy coating shall be indicated by the prefix 'ZM', followed by a number representing the minimum coating mass, in 'gram per square meter' (GSM) of sheets or strips (total for both surfaces determined by triple spot test/on-line X-ray fluorescence method as defined in IS 18513.

Example: "ZM120"

6.4. The designation of the paint durability class shall include a set of characters as described in clause 7.3.

Example: "ISXXXX / IZMC510S / ZM150 /Class X".

7. Coatings

7.1. The common coating materials used for Pre-painted Zinc-Aluminium-Magnesium alloy coated steel strip are given in Table 1.1, 1.2, 1.3.

7.2. The applicable minimum dry film thickness (DFT) shall be as given in Table 2 and the tolerance in Table 3

7.3. The minimum recommended class of the Pre-painted Zinc-Aluminium-Magnesium Alloy coated steel strip shall be as per Table 4, based on ISO 12944-2.

7.4. The paint coating thickness shall be measured in microns.

7.5. Higher coating thicknesses for can be supplied as per mutual agreement between the purchaser and the manufacturer depending on the end use application of the Pre-Painted product.

7.6. Primer coating shall be a minimum of 4 microns for all durability classes with the exception of Class 1 wherein a paint system of single coat (for top coat/finish coat) quality will be applied.

Coating Material (Type of Paint)
(*Clause* 7.1)

Table 1.1 Primer

Coating	**Symbol**
Epoxy	E
Acrylic	A
Polyurethane	PU
Polyester	PE

Table 1.2 Top Coat / Finish Coat

Coating	**Symbol**
Regular Modified Polyester	RMP
Super Durable Polyester	SDP
Silicon Modified Polyester	SMP
Polyurethane	PU
Polyvinylidene Fluoride	PVDF

Table 1.3 Backer Coat /Wash Coat

Coating	**Symbol**
Hybrid	H
Polyurethane	PU
Polyester	PE

Epoxy	E
Acrylic	A

NOTES

1 Any Additional or combination coating material can be used based on the mutual agreement between the purchaser and the manufacturer considering the end usage applications
2 Prior to coating, strip surface needs to be pre-treated in a suitable pretreatment process in a continuous coating line. Alternatively, Pre-Treated substrate can also be used as an input in the continuous coating lines.

Table 2 Dry Film Thickness (DFT)

(*Clause* 7.2)

Coat	**Coating Type**	**Minimum Coating (Microns - µm)**
Top Coat / Finish Coat	Two Coat /Multi Coat (With Primer)	15 µm Minimum
	Single Coat (May have no primer)[2]	10 µm Minimum
Backer Coat /Wash Coat	Single Coat (Without Primer)	5 µm Minimum
Primer	Top & Bottom	4 µm Minimum
NOTES 1 By mutual agreement between the purchaser and the manufacturer, higher dry film thickness can be used based on durability and corrosivity class for which the material is intended to be used. 2 Applicable for Class 1.		

Table 3 Tolerance on Dry Film Thickness (DFT)

(*Clause* 7.2)

Range of Dry Film Thickness (DFT)	**5>DFT≥10 (µm)**	**10>DFT≥20 (µm)**	**20>DFT≥25 (µm)**	**25>DFT≥35 (µm)**	**35>DFT≥60 (µm)**	**60>DFT≥100 (µm)**
Negative tolerance on average of three measurements	2 µm Max	3 µm Max	4 µm Max	6 µm Max	8 µm Max	15 µm Max
Negative tolerance on single measurements	3 µm Max	4 µm Max	5 µm Max	8 µm Max	12 µm Max	20 µm Max
NOTES **1** Tolerances on coating thicknesses ≤ 5 µm may be agreed at the time of enquiry and order **2** There are normally no requirements for the positive tolerance, but these can be agreed at the time of enquiry and order. **3** The minimum dry film thickness shall not be less than the values specified in Table 2.						

Table 4 – Recommended Guide to The Selection Of Pre-painted Coating Class

(*Clause* 7.3)

Durability Class	**Corrosivity Category**	**Recommended Minimum Zinc-Aluminium-Magnesium Alloy Coating[1]**	**Typical Topcoat paint System[2]**	**Examples of Typical Environments (Informative)**	
				Exposed	**Unexposed**
Class 1	C1-Very Low	ZM60	Refer Table 1 [2]	--	Clean Atmosphere Eg. Office, shops, schools,
Class 2	C2-Low	ZM80		Low level of pollution : Rural Areas	Condensation can occur Eg: Stores, depots etc
Class 3	C3-Medium	ZM90		Urban and Industrial atmosphere, Moderate Sulphur dioxide pollution, Costal/Marine areas with Low salinity	Production areas with high humidity and air pollution Eg. Food processing plants, breweries, diaries etc
Class 4	C4-High	ZM100		Industrial Areas, Coastal/Marine areas with Moderate salinity	Chemical Plants, Coastal/Marine, ships etc
Class 5	C5-Very High	ZM120		Industrial areas with high humidity and corrosive atmosphere. Costal/Marine areas with high salinity	Building and storage areas with permanent condensation and with high pollution

NOTES

1 Refer IS 18513

2 Paint system should be selected to ensure performance required for the durability class in line with salt spray resistance as given in Table 9.

3 Reference to durability class, corrosivity category and examples of typical environments are taken from ISO 12944-2 and ISO 9223 / IS 14191

4 Different top paint systems give different paint durability at a given exposure.
Paint systems with higher paint durability are for long term protection, colour and gloss retention requirement.

5 Purchaser may specify the coating type and thickness and are advised to consider
required paint types and paint thickness based on the required durability class and usage atmosphere.

8. Properties of Paint Coatings:

Following are the requirements of the Physical and Appearance properties of the coating that shall be checked during the manufacturing of pre-painted Zinc-Aluminum-Magnesium alloy coated steel strip and sheet.

Table 5 Properties of Paint Coatings

(*Clause* 8 ,8.1, 8.2 and 8.3)

Sr. No	Category	Property	Test
1	Physical	Coating Flexibility & Adhesion	T Bend Adhesion
2	Physical	Adhesion and resistance to crack formation	Reverse Impact
3	Physical	Degree of Cure	Solvent Resistance
4	Physical	Degree of Cure	Pencil Hardness
5	Physical	Scratch Resistance	Scratch Resistance
6	Physical	Thickness	Dry Film Thickness
7	Appearance	Color Appearance	Color Match
8	Appearance	Gloss	Specular Gloss

8.1. Sampling Frequency:

One sample for the tests indicated in Table 5, is to be taken for testing from every 25 t of sheets/strip or every mother coil from a lot of the products of the same quality, dimensions, coating mass and color.

8.2. Physical Property:

8.2.1 T Bend Adhesion Test

For pre-painted sheet and strip when tested in accordance with Annex A the adhesion of the paint shall be sufficient to prevent its removal from the metal when tape is pulled.
All pre-painted sheet and strip shall comply to minimum bend radius as specified in **Table 6**, unless agreed otherwise between the manufacturer and the purchaser.

There shall not be visible cracks when the paint film is examined with a 10X Magnification after the test.

Table 6 Minimum Bend radius for T Bend Test

(*Clause* 8 .2)

Flexibility range	Minimum bending radius
High flexibility, for severe forming conditions	2T
Standard Flexibility	3T,4T,5T,6T

No requirement on flexibility	No test required
T= Minimum mandrel radius/Metal Thickness. NOTES **1** The adhesion test is made with taping and flexibility test is done without taping **2** Flexibility of the product depends on the substrate thickness & grade, the metallic protection, and the organic coating. Refer IS 18513 for base metal bending & adhesion requirements. **3** The product flexibility might alter during storage. Therefore, the time between production and processing of the material should be a maximum of 6 months.	

8.2.2 Reverse Impact Test

When a pre-painted steel product test piece is subjected to reverse impact test in accordance with Annex B using the impact energy level of 10 J or 1020 Kg.mm, there shall be no loss of adhesion of the paint coating. On visual inspection at 10X Magnification there shall not be any cracking, powdering, or peeling of the paint film.

Refer IS 18513 for base metal bending & adhesion requirements.

8.2.3 Solvent Resistance Test

Solvent Resistance Test shall be conducted on the top/finish coating a test piece in accordance with Annex C. This is one of the measures for determination of oven paint curing process completion.

The minimum number of double rubs prior to failure of paint coating shall be greater than 50.

8.2.4 Pencil Hardness Test

a) Pencil hardness is one of the attributes, which depicts the degree of cure and how easily it can be processed in the purchasers' factory. A standard pencil of known hardness should be used for the pencil hardness test [see 4 of IS 101 (Part 5/Sec 1)].
b) The pencil shall be sharpened so as to expose about 3 mm of lead. Holding the pencil at an angle of 90 degree to the abrasive paper grit No. 400, rub the lead against the paper maintaining an angle of 90 degree to the abrasive paper until a flat, smooth and circular cross section is obtained. The tip of the lead shall be ground flat before use for each test.
c) Place the coated panels on a level, firm horizontal surface. Holding the pencil against the panel surface at 45 degree angle, push the pencil away from the operator with moderate pressure (see Figure. 1).
d) On visual inspection, there shall not be any scratch on the tested portion. The minimum acceptable hardness shall be HB hardness, in absence of any mutual agreement.
e) Based on the mutual agreement between the purchaser and the manufacturer, pencil of hardness range from 2B to 6H can be applied to determine the hardness of the coated surface. 2B is the softest and 6H is the hardest pencil.

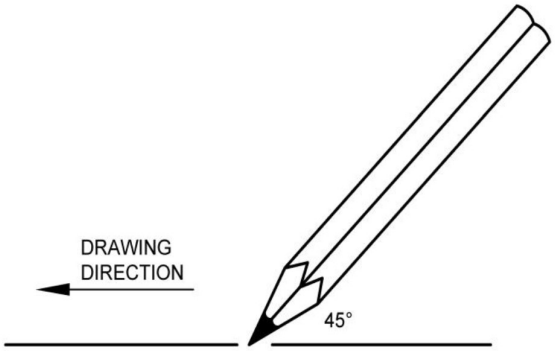


Fig 1 – PENCIL HARDNESS TEST

8.2.5 Scratch Resistance Test

When measured in accordance with 3 of IS 101(Part 5/Sec 2), the scratch resistance of the coating shall not be less than 1.5 Kg or as agreed between the purchaser and the manufacturer. For uni-coat coating, the scratch resistance of the coating shall not be less than 1.0 kg or as agreed to between the purchaser and the manufacturer.

In place of scratch resistance test, cross hatch test can be applied, as per mutual agreement between the purchaser and the manufacturer, with the test procedure and clearance criteria as mentioned in clause 8.2.5.1.

8.2.5.1 *Cross Hatch Test*

a) Select an area free from blemishes and other surface imperfections. Make 11 parallel straight lines at intervals of 1 mm on the test panel with a cutting tool or cutting guide so as to reach the substrate through the paint film. Eleven such straight lines shall also be made crosswise (at right angle) at an interval of 1 mm.
b) After making the required cuts, brush the film lightly with a soft brush or tissue to remove any detached flakes or nubbins of coating. Cut a piece about 75 mm long from a standard ~ 25 mm wide semi-transparent pressure sensitive tape. Place the centre of the tape over the grid of cut lines. To ensure good contact with the paint film, rub the tape firmly with finger.
c) Remove the tape by holding the free end steadily (without jerk) pulling it off as close as possible to 180-degree angle. Inspect the grid area for removal of paint film from the substrate.
d) There should not be any lifting of paint by the tape (*see* Fig. 2).

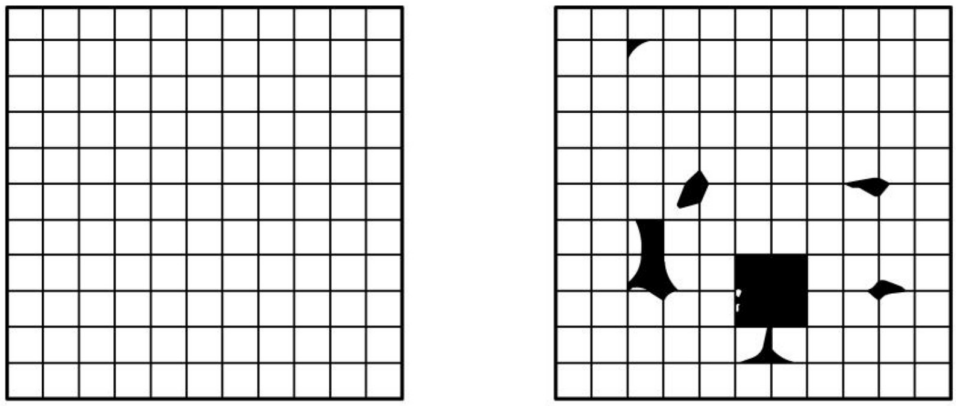


Fig. 2 – CROSS HATCH TEST

8.2.6 Dry Film Thickness

This refers to the paint film thickness of the Finish coat or Topcoat and primer. When measured by the method as mentioned in clause 5 or 6B of ISO 2808, the supplied dry film thickness of paint coating (Finish coat or topcoat) shall comply with the requirements of 7.2 of this specification or as per the agreement between the purchaser and the manufacturer.

NOTE — To determine the total thickness of the coating for optimum corrosion protection the following details should be considered together.

a) Coating class of the Zinc-Aluminium-Magnesium Alloy metallic coating (e.g. ZM 60, ZM 120)
b) The type and dry film thickness of the topcoat and the back coat paint.
c) The type and dry film thickness of the Primer.

8.3 Appearance

Pre-painted metal products shall have a uniform appearance, colour and texture. It will be essentially free of blemishes such as flow lines, streaks, blisters, or other surface imperfections. It should be reasonably flat and free from physical imperfections like bare spots, holes, tears etc.

8.3.1 Color Match

The color match to standard shall match the ‘color specified’ (as agreed between the purchaser and the manufacturer at the time of enquiry and order). When tested in a Light booth having a daylight simulator and incandescent light source, the visual color match shall achieve a rating of 2 or lower. The classification of degrees of color match as determined by unaided visual inspection is described in Table 7.
A more accurate instrumental measurement of color, with the spectrophotometer adopting the Hunter Color Measurement System, also allowed for better batch-to-batch color consistency.

Table 7 Color Match
(*Clause* 8.3.1)

Rating	Description	Explanatory Note
0	Exact match	Color of test sample is indistinguishable from that of the reference or standard sample.
1	Critical match	A small, just perceptible color difference can be seen when the samples are held in contact but it cannot be detected when separated by 5 mm.
2	Close match	When separated by 5 mm a small color difference can be seen, but it is undetectable when increased to 25 mm.
3	Approximate match	When separated by 20 mm a small color difference can be seen, but it is undetectable when increased to 100 mm.
4	Crude match (Poor match)	The difference is readily detectable even when separated by more than 100 mm

8.3.2 Specular Gloss

Gloss of Pre-Painted metal product shall comply with the requirement as agreed between the purchaser and the manufacturer, when tested using a 60° head (gloss geometry) as per IS 101 (Part 4/Sec 4).

The gloss level shall be agreed to between the pre-painted steel manufacturer and paint manufacturer as well.

Tolerances on the specular gloss are provided in Table 8 .

NOTE — Specular gloss unit normally do not apply to textured finishes. Gloss is dependent on the paint system. However, 10 – 40 % gloss with 60° head is a typical range for a standard paint system.

Table 8 Tolerances on Specular Gloss
(*Clause* 8.3.2)

Gloss Unit Range (R^i)	Gloss Range [a]	Tolerances on nominal gloss
$R^i \leq 10$	Matt	± 3
$10 < R^i \leq 20$	Low Gloss	± 4
$20 < R^i \leq 40$	Satin	± 6
$40 < R^i \leq 60$	Semi Gloss	± 8
$60 < R^i \leq 80$	Gloss	± 10
$R^i \geq 80$	High Gloss	Minimum gloss 80

a- Informative Indications
Values are in gloss units (R^i) using a 60^0 head.

8.4 Other Properties:

a) Other properties, which can be of importance depending on the intended use, such as resistance to abrasion, suitability for overpainting, ability to be printed, compatibility with foam insulating materials or adhesives, resistance to chemicals and staining, reflectance, weldability, resistance and reaction to fire, heat resistance and behavior on deep drawing, together with the appropriate test methods, shall be the subject of special agreement between the purchaser and the manufacturer.

b) Mechanical properties of the substrate can be altered by the coil coating process. The use of substrate which can be subject to ageing will result in an increase in yield point and tensile strength, reduction in elongation and the possibility of appearance of Luder lines and the occurrence of fluting effects.

8.5 Durability Test for Paint Coating:

Durability test requirements of this specification–are provided for the information of the purchaser. These tests cannot be conducted on every individual lot. This test can be applied based on the mutual agreement between the purchaser and the manufacturer. Sampling and acceptance criteria are subject to mutual agreement. This test is applicable for the topcoat surface.

Sheets and coils will be subjected to the accelerated durability tests given in Table 9 and described in 8.5.1, and 8.5.2.

TABLE 9 Test Duration for Salt Spray and Humidity Resistance
(*Clauses* 8.5, 8.5.1. and 8.5.2)

Durability Classes for Pre-painted Products	Corrosion Resistance (Salt Spray) [IS 9844] Hours	Humidity Resistance (IS 101 Part 6 Sec 1)
Class 5	2000	1000
Class 4	2000	1000
Class 3	1000	1000
Class 2	750	750
Class 1	500	500

NOTES
1. Refer Table 2 Note 1
2. Requirements of Table 10 & Table 11 are required to be met with when tested for the duration(hours) specified in Table 9.
3. Durability tests are for the purchaser's information only and are not mandatory at the time of production/coating.

8.5.1 Corrosion Resistance:

When suitably prepared test specimens (scribed or un-scribed, as appropriate) are exposed to the salt spray test specified in IS 9844 and Table 9 and assessed in accordance with Annex D, the pre-finished product shall comply with the requirements of Table 10.

TABLE 10 Requirements for salt spray resistance
(*Clause* 8.5.1)

Type of deterioration	Method	Requirement
Undercut at scribed lines	D-1	Rating of 2.0 or less with no corrosion of base metal, no red rust formation
Corrosion of the base metal	D-2	Rating 1
Blistering	D-3	Not worse than rating 2(S3)[1)]
1)Face of panel. NOTE -Other requirement / acceptance level may be specified and agreed between the purchaser and the manufacturer.		

8.5.2 Humidity Resistance:

When suitably prepared test specimens (scribed or un-scribed, as appropriate) are tested in accordance with IS 101 Part 6 Sec 1 & Table 9 and assessed in accordance with Annex D, the pre-finished product shall comply with the requirements of Table 11.

8.5.3 Corrosion Resistance- Accelerated cyclic corrosion test

Test specimens (scribed or un-scribed, as appropriate) can be tested as specified in ISO 14993. Acceptance criteria of this test is to be mutually agreed between the purchaser and the manufacturer.

TABLE 11 Requirements For Humidity Resistance
(*Clause* 8.5.2)

Type of deterioration	Method	Requirement
Undercut at scribed lines	D-1	Rating of 2.0 or less with no corrosion of base metal, no red rust formation
Blistering	D-3	Not worse than rating 3(S2) [1)]
1)Face of panel. NOTE -Other requirement / acceptance level may be specified and agreed between the purchaser and the manufacturer.		

9 Dimensions, Shape & Tolerances:

9.1 The typical base metal thickness range for pre-painted Zinc-Aluminium-Magnesium alloy coated steel strip and sheet is 0.20 to 1.50 mm.

9.2 In the case of coils, the mass of the coils shall not exceed 10 MT (typical) and the internal diameter of the coils shall be 508 or 610 mm. For sheets, the mass is subject to mutual agreement and width & length combinations.

9.3 Sheets and coils of sizes other than those specified in 9.1 and 9.2 may be supplied if agreed between the purchaser and the manufacturer. Acceptance criteria for such products are subject to agreement.

9.4 Dimension & shape tolerances shall be as given in is 16163. stricter tolerances, uni lateral, bi lateral tolerances can be agreed upon at the time of enquiry and order.

10. Surface Defects:

10.1 The steel strip, 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.

10.2 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.

10.3 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.

11. Re-Test :

11.1 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.

11.2 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. Packing :

12.1 Pre-painted Zinc-Aluminium-Magnesium alloy coated steel strip and sheet should be suitably packed to avoid transit/handling/storage damage and as per the agreement between the purchaser and the manufacturer.

13. Marking :

13.1 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:

i) No. of this standard
ii) Manufacturer's name or trade-mark.
iii) Material identification/ coil number/ packet number/ batch number etc.
iv) Product dimension.
v) Number of sheets or mass.
vi) Coating Class
vii) Color Name of top-coat and
viii) Date of manufacture

13.2 BIS Certification Mark: 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(s) may be marked with the Standard Mark. BIS marking or printing may not be required on the topcoat surface of the strip or cut sheet.

14. Storage and Handling of Products (Informative) :

14.1 It is essential that pre-painted products be kept dry in transit and stored under cover clear of the ground. Should packs or coils of the product become wet, layers should be separated, wiped dry with a clean cloth and positioned so that air circulation will complete the drying process. The use of these procedures should prevent deterioration of the coating, which otherwise can lead to reduced life expectancy or poor appearance of the product.

14.2 Pre-painted products should be lifted directly and not dragged over rough surfaces or each other. Care should also be taken to avoid dragging, cutting and forming tools over the surfaces of the pre-painted products.

14.3 Stocks of pre-painted products should be used in rotation as some mechanical properties of the coating may change slightly during prolonged storage, e.g. duration greater than six months. These changes are typically small and, in most fabrication processes, are not significant. However, it is possible that they could cause fabrication problems during severe forming operations.

14.4 Surface protection film/guard film should be removed within 30 days from the date of manufacture. Excessive storage may lead to accumulation of moisture, water condensation due to temperature changes, peeling of paint, seepage of ink or glue from the protective film/guard film onto the painted surface.

ANNEX A

(*Clause* 8.2.1)

T-BEND ADHESION TEST

A11 **Scope** — This annex describes the method for assessing paint adhesion by the T-bend test. The method is suitable for testing pre-painted sheets and strip products up to 1.5 mm thickness.

A12 **Principle** — Pre-Painted metallic products is bent flat. Adhesion of the paint on the outside of the bend is assessed by the application of adhesive tape and its subsequent rapid removal.

A13 **Apparatus** — The following test apparatus is required:

i. A bench vice approximately 150 mm wide or alternative bending apparatus.

ii. Adhesive tape 20 mm to 25 mm wide which is semi-transparent, pressure-sensitive, and has an adhesion strength of 5 N to 15 N per 24 mm width.

Note: Scotch 600 tape fit the above specification

A14 **Preparation of test pieces** — The following test apparatus is required: Test pieces shall be cut 50 mm wide at least (and shall have sufficient length - 200 mm long is normally sufficient) to suit the test requirement. The test piece shall be cut out parallel to the rolling direction of the base metal.

A15 **Procedure**:

i. Clamp approximately 25 mm of one end of the test piece in the vice.

ii. Bend the test piece through 90° with the coating to be assessed on the convex surface of the bend.

iii. Remove the bent test piece from the vice and bend it through to approximately 180°.

iv. Reinsert the test piece in the vice and compress flat. This represents a zero T-bend or starting point for subsequent folding.

v. Fold once around this starting point to achieve 1 T and compress (the internal diameter of the bend is 1 T). Fold twice for 2 T and compress, and so on until the specified requirement as agreed between the manufacturer and the purchaser is completed.

vi. Apply adhesive tape along the entire length of the external bend and press down firmly.

vii. Remove tape with a rapid single pull at right angles to the bend.

viii. Examine the test piece for removal of paint.

NOTE — T = nominal thickness of sheet or strip

ANNEX B
(*Clause* 8.2.2)
REVERSE IMPACT TEST

B11 **Scope** — This annex describes a method to assess the impact resistance of pre-painted metal products and the adhesion of a coating to the base metal. This test applies to base metal thickness from 0.4 mm to 1.5 mm.

B12 **Principle —** The test piece is struck on the reverse side by a ball of specified diameter and with a specified force. Adhesion of the disturbed coating is assessed by examination after application and subsequent rapid removal of adhesive tape.

B13 **Apparatus** — The following apparatus is required:

i. An impact tester fitted with a male and a female die of 19 mm diameter, or other diameter if specified in the product standard.
   Note: Gardner Impact tester may be used for this test.

ii. Adhesive tape 20 mm to 25 mm wide, which is semi-transparent, pressure-sensitive, and has adhesion strength of 5 N to 15 N per 24 mm width.
   Note: Scotch 600 tape fit the above specification

B14 **Preparation of test piece** — The test piece shall be cut 50 mm wide and 50 mm long approximately.

B15 **Procedure**: Reverse impact resistance shall be determined using the following procedure:

i. Load the test piece into the test machine with the coated side to be tested facing away from the impactor.
ii. Set the impactor to apply the specified impact force.
iii. Trigger the machine and impact the test piece.
iv. Remove the impacted test piece from the machine and apply adhesive tape to the deformed area of the coated test side. Press the tape down firmly to remove air bubbles.
v. Remove the tape immediately with rapid pull at right angles to the un-deformed surface.
vi. Examine the test piece and the tape for removal of paint.

ANNEX C
(*Clause* 8.2.3)
SOLVENT RESISTANCE TEST

C11 **Scope** — This procedure is to be used to determine the degree of cure of a baked film by the paint films resistance to a specified solvent. This procedure is applicable whenever the resistance to Methyl Ethyl Ketone (MEK) or Methyl Iso-butyl Ketone (MIBK) has to be determined.

C12 **Principle** — The determination of solvent resistance is carried out by using a Double rub Machine or by manual practice i.e. rubbing the sheet by hand. This machine rubs/ rubs by hand on the test piece/panel with cotton doused in MEK or MIBK.

C13 **Apparatus** — The following apparatus is required:

i. Fume cupboard.
ii. Protective gloves.
iii. Cotton pad (~50 mm square).
iv. Solvent (MEK or MIBK)
v. Solvent Double rub machine.

C14 **Preparation of test piece** — A panel of size 120 mm x 300 mm is prepared from the production test sample to be tested face up in the solvent rub machine.

C15 **Procedure**:

i. Clamp the 120 mm x 300 mm panel in the solvent rub machine.
ii. Place a 50 mm square cotton pad between the magnetic holders on the bottom of the solvent rub machine head.
iii. Fill the reservoir with recommended solvent - MEK for top coats and bottom coats or MIBK for primer evaluations.
iv. Start the machine and stop it based on observations mentioned in following item C16.

C16 **Evaluations** :

i. Observe the operation of the solvent rub machine and stop the machine when failure has occurred. Failure shall consist of removal of the film to expose the primer or substrate at any spot along the centerline of the double-rub stroke. The first and the last 25 mm of the stroke shall not be considered.
ii. The solvent resistance of the organic coating is classified as the number of strokes the machine has made prior to failure of the organic coating.
iii. The number of rubs required is dependent on the paint system. However, completion of 50 double rubs is sufficient for the test of standard paint system (for durability class 2, 3 , 4,5 & 6). Failure of the paint film at less than 50 double rubs is an indication of a “problem”.

ANNEX D
(*Clauses* 8.5.1 & 8.5.2 and Table 10 & 11)
METHODS OF ASSESSMENT OF SALT SPRAY and HUMIDITY TEST RESULT

D.1 UNDERCUT AT SCRIBED LINES

D11 **Scope** — This method describes the assessment of the degree of deterioration for a metal substrate that has been coated by a paint system.

D12 **Principle –** Coated test panels are exposed to an accelerated corrosive (Salt Spray Test) or humid (Humidity Test) environment. The corrosion on the surface of the paint film and on the metal surface beneath the paint film is assessed by comparison with photographic reference standards and rating table.

D13 **Procedure**:

i. Remove loose corrosion products and any coating that has lost adhesion from the vicinity of the scribed line by scraping with a metal spatula or dull knife.

ii. Rate the mean creepage of undercut corrosion or loss of paint extending from the scribed line, as prescribed in Table D.1.

TABLE D.1 Rating for Failure at scribe and panel edge

Rating Scale	**Representative mean creepage of under film corrosion from scribed line** mm
0	0
1	> 0 ≤ 1.0
2	> 1.0 ≤ 3.0
3	> 3.0 ≤ 7.0
4	> 7.0 ≤ 13.0
5	> 13

D.2 CORROSION OF THE BASE METAL

D21 **Scope**: This method describes the assessment of the degree of deterioration for a metal substrate that has been coated by a paint system.

D22 **Principle**: Coated test panels are exposed to an accelerated corrosive environment. The corrosion on the metal surface beneath the paint film is assessed by comparison with photographic reference standards.

D23 **Procedure**:

i. Carefully remove a portion or whole of the paint film using a suitable solvent-based paint remover.

ii. Determine the severity of corrosion by referring to the pictorial standards in the following Figure D.2.1.

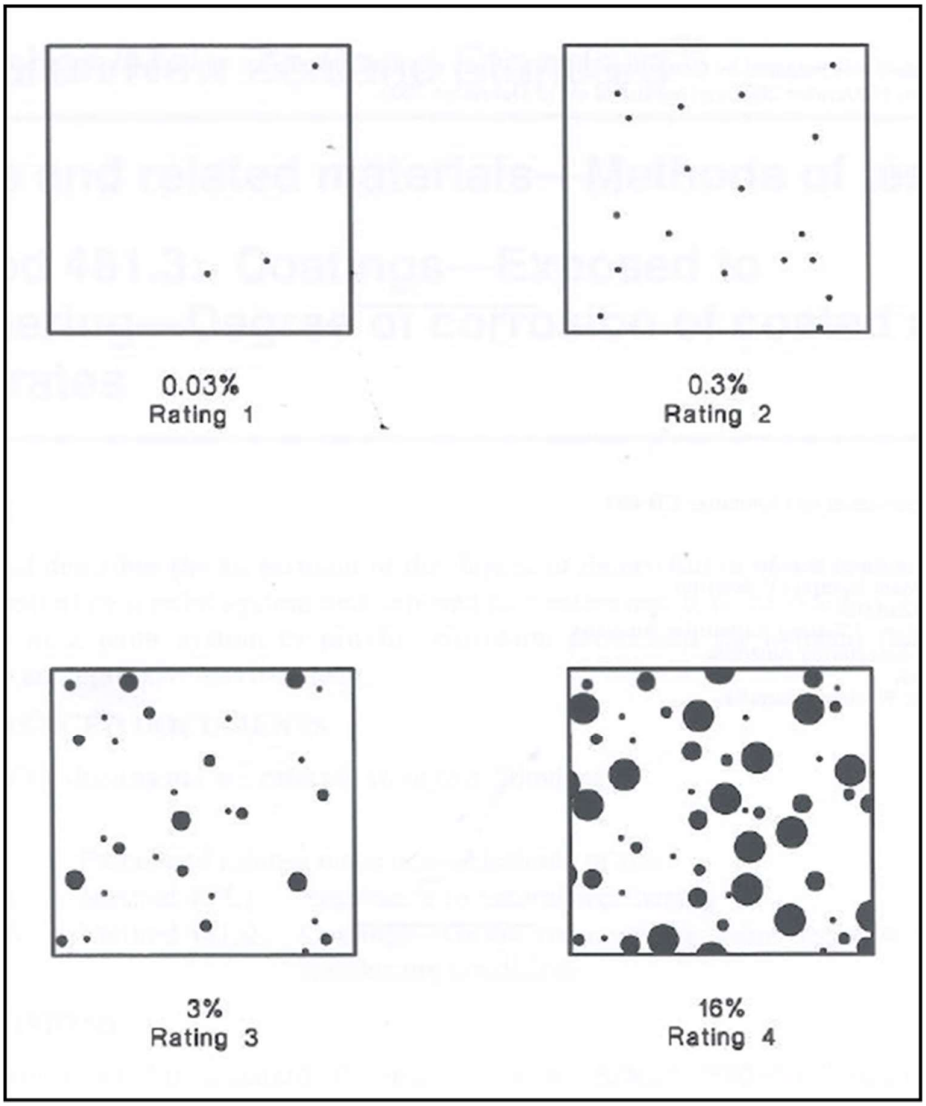


Fig. D.2.1 Typical Corrosion on the Stripped Metal Substrate

D.3 BLISTERING

D31 **Scope**: This Annex sets out a method for determining the degree of blistering in a paint film exposed to accelerated weathering conditions.

D32 **Principle**: The test is visually evaluated for the degree of blistering by comparing with diagram reference standards, which shows rated stages of blistering.
The diagram reference standards have been adopted from ISO 4628-2:2003**.**

D33 **Apparatus**: Diagram standards (see Fig. D.3.1, D.3.2 & D.3.2) - required for comparison with the test film.

D34 **Viewing Environment**: Examination of the films should be carried out under lighting conditions of at least 500 lux or lumen per sq. meter.

D35 **Procedure**:

i. Visually examine the test film by comparing the surface finish with the reference diagram standards (see D-3.2) that shows a similar amount of blistering.

ii. Using Table D.3.1 determine the rating for density of blistering and Table D.3.2 for the size of blistering.

iii. Record the rating as for e.g. 2(S 3) where 2 stands for density and S 3 stands for size of blister.

TABLE D.3.1 Rating for Density of Blistering
(Clause D35)

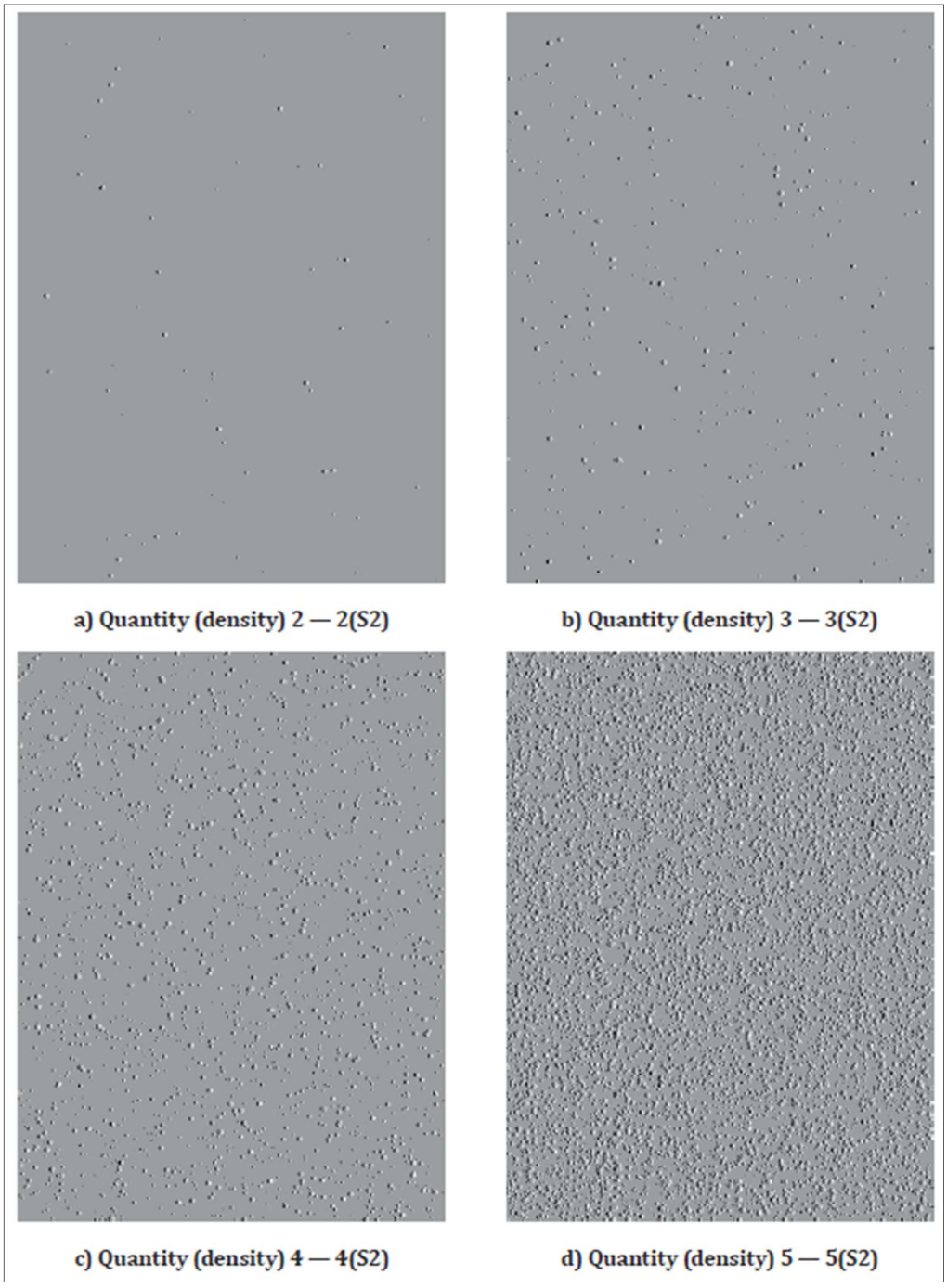
Rating Scale [1)]	Density of blistering
0	None
1	Less than few
2	Few
3	Medium
4	Medium-dense
5	Dense

[1)] The rating scale conforms to current ISO practice.

TABLE D.3.2 Rating for Size of Blisters
(Clause D35)

Rating Scale [1)]	Size of blistering
1	Finer than in Fig. 3
2	See Figure 3
3	See Figure 4
4	See Figure 5

[1)] The rating scale conforms to current ISO practice



a) Quantity (density) 2 — 2(S2)

b) Quantity (density) 3 — 3(S2)

c) Quantity (density) 4 — 4(S2)

d) Quantity (density) 5 — 5(S2)

Fig : D.3.1 Blisters of Size

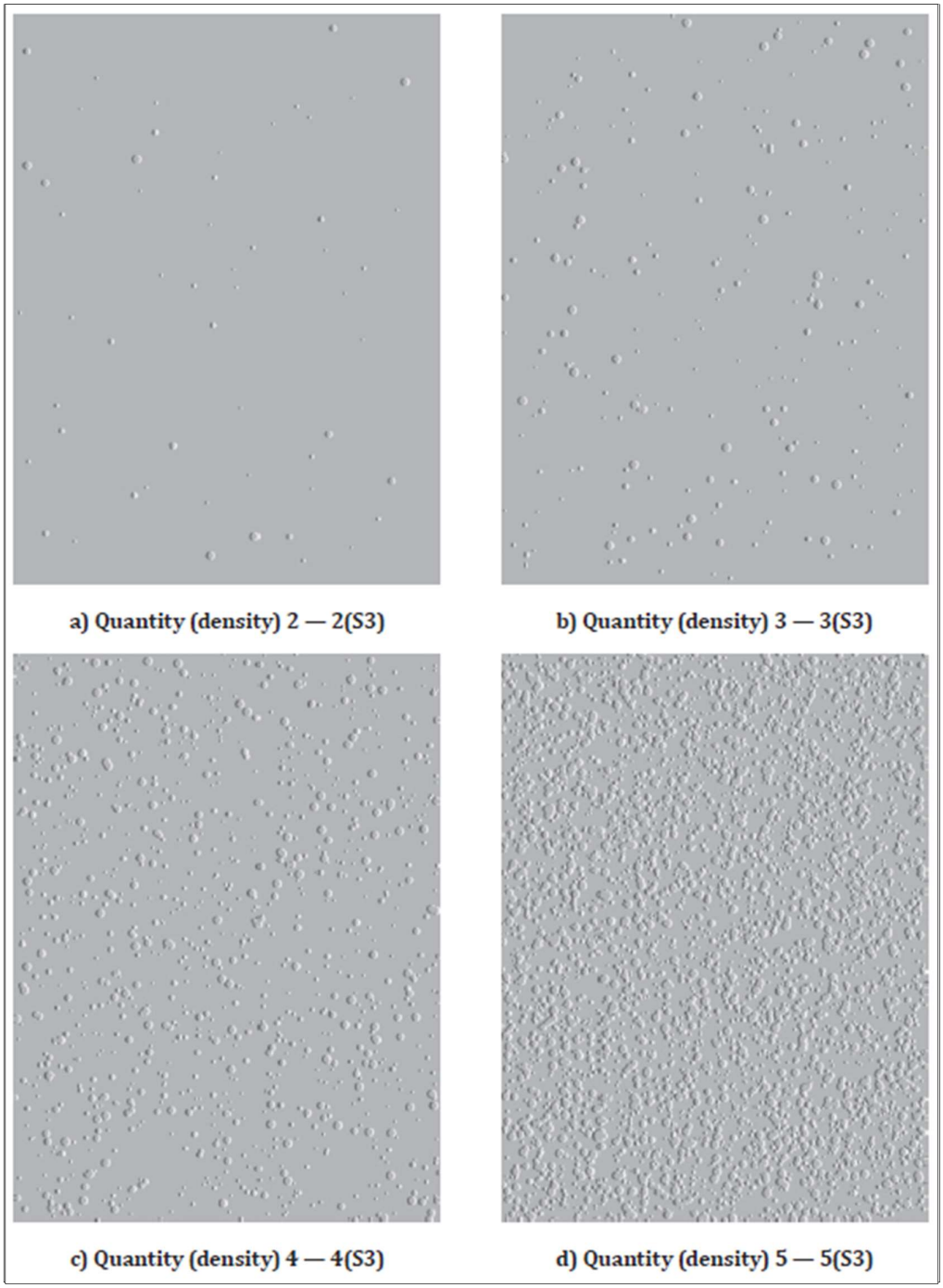


Fig : D.3.3 Blisters of Size

ANNEX E
(*Foreword*)
ADVICE ON THE WEATHERING PERFORMANCE OF THE PRE-PAINTED ALUMINIUM ZINC ALLOY METALIC COATED STEEL STRIP AND SHEET

General : All organic coatings gradually change their appearance when exposed to the weather. The changes that take place occur at different rates depending on the aggressiveness of the environment and on the ability of the coatings to resist those changes.
Changes in the appearance of an organic coating do not necessarily imply that the coating has lost the ability to protect the base metal.
The changes that can occur and their likely effect on the performance of pre-painted metal products are outlined in Paragraphs E11 to E16.

E11 **Loss of Gloss**: Ageing on exposure to ultraviolet light causes initial loss of gloss. Contamination by atmospheric pollutants, e.g. sulfurous and ammoniacal fumes, and by the collection of dirt can also cause deterioration of gloss.
The rate of impairment of gloss by the collection of dirt is less for vertically installed surfaces than for horizontal surfaces. Pre-painted products can be expected to retain their gloss better than products with conventional architectural paints used for the same application. Loss of gloss usually precedes chalking.

E12 **Chalking**: Chalking involves the release of one or more of the constituents of the organic film in the form of loosely adherent fine powder. Chalking occurs slowly on pre-painted products and is not considered a serious defect unless it occurs early in the life of the product.

E13 **Checking**: Checking is the formation of breaks in the surface of an organic coating, which do not render the underlying metal visible. Although checking can occur in a number of forms, it does not greatly detract from the appearance of a coating until the breaks become quite visible. Checking does not have a great effect on the durability of pre-painted metal products.
Slight checking, especially if it occurs during or after cold weather, is not detrimental to the product, and is a means whereby internal stresses that occur from time to time are relieved.

E14 **Color Fading**: Although fading involves loss of color, the term is used to cover any color change, including darkening. The degree and rate of loss of color increase with increase in exposure to ultraviolet light (sunlight). Loss of color is also associated with the inherent characteristics of pigments and the exposure environment.

E15 Discoloration by dirt collection, chalking and subsequent absorption of foreign matter can often be misleading and give a false impression of a color change. On removal of such contaminants the original color is often restored. However, when chalking occurs at the same time as fading, cleaning can seldom restore the original surface color.

E16 **Erosion of Organic Coating:**
Attrition of the organic coating by natural weathering depends very much on exposure conditions. Little or no erosion will occur when products are used indoors in domestic dwellings. Products installed at an angle can be expected to deteriorate at up to twice the rate that would occur for products installed vertically or otherwise sheltered from the elements.

In general, products installed at an angle will erode more rapidly than those installed vertically. The effects of dirt or industrial fallout can be greatly reduced by natural rain washing or by general washing with water. It is recommended that sheltered areas, such as under eaves and those that receive little natural rain-washing, are periodically washed with clean water.