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मानक

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“Step Out From the Old to the New”

IS 4759 (1996): Hot-dip zinc coatings on structural steel and other allied products [MTD 7: Light Metals and their Alloys]



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Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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(Reaffirmed 2001)
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भारतीय मानक

संरक्षात्मक इस्पात तथा अन्य संबद्ध उत्पादों पर
तप्त-निमज्जित लेपन — विशिष्टि

(तीसरा पुनरीक्षण)

Indian Standard

**HOT-DIP ZINC COATINGS ON
STRUCTURAL STEEL AND OTHER ALLIED
PRODUCTS — SPECIFICATION**

(Third Revision)

(Incorporating Amendment No. 1)

ICS 25.220.40;77 : 140.20

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FOREWORD

This Indian Standard (Third Revision) was adopted by Bureau of Indian Standards, after the draft finalized by the Metallic and Non-Metallic Finishes Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was initially published in 1968 and was subsequently revised in 1979 and 1984. While reviewing the standard the committee decided to revise the same. The following modifications have been made in this revision :

- a) Additional grade of zinc has been specified;
- b) Guidelines on the properties of the articles to be coated that affect the results of Hot-Dip Coatings have been incorporated;
- c) A new clause on information to be given by the purchaser to the galvanizer have been added; and
- d) Requirements of **3.2** of IS 4759 : 1984 have been covered in **4.2** of this standard.

In this revision assistance has also been derived from Doc CEN/TC, 262/SCI/WG2/N27—'Hot Dip Coatings on Fabricated Ferrous Products', issued by European Committee for Standardization.

This edition 4.1 incorporates Amendment No. 1 (May 2002). Side bar indicates modification of the text as the result of incorporation of the amendment.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. 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 COATINGS ON
STRUCTURAL STEEL AND OTHER ALLIED
PRODUCTS — SPECIFICATION***(Third Revision)***1 SCOPE**

1.1 This standard specifies requirements for zinc coating applied by hot-dip galvanizing on iron and steel products, fabricated or assembled from cast, rolled, pressed and forged shapes, such as structural steel sections, plates and bars.

1.2 This standard makes no reference to the quality of iron and steel itself before hot-dip galvanizing. However guidance on the condition of the base material which may affect the result of hot-dip galvanizing are given in Annex A.

2 REFERENCE

The Indian Standards listed at Annex B are necessary adjuncts to this standard.

3 SUPPLY OF MATERIAL

General requirements relating to the supply of material shall conform to IS 1387 : 1993.

4 GENERAL REQUIREMENTS**4.1 Quality of Zinc**

Zinc used for galvanizing shall conform to any of the grades specified in IS 209 : 1992 'Zinc ingot' or IS 13229 : 1991 'Zinc for Galvanizing'.

4.2 Galvanizing Bath

The molten metal in the galvanizing bath shall contain not less than 98.5 percent by mass of zinc, but where there is a special user requirement, levels or addition of impurities in the bath or in the coating may be specified by the purchaser.

4.3 Galvanizing

The steel products may, as far as practicable, be galvanized in accordance with IS 2629 : 1985.

**5 INFORMATION TO BE SUPPLIED BY
THE PURCHASER TO THE HOT-DIP
GALVANIZER****5.1 Essential Information**

The following information shall be supplied by the purchaser to the hot-dip galvanizer :

- a) Number of this Indian standard, and
- b) The composition and any properties of the base metal that may affect hot-dip galvanizing.

NOTE — Any other information like:

- i) Designation of steel;
- ii) Description regarding size length, etc;
- iii) Condition of delivery;
- iv) Any special requirement; and
- v) Test report (if required) may be supplied by the purchaser to the hot-dip galvanizer.

5.2 Additional Information

The following information may be required for particular purpose and if so shall be specified by the purchaser:

- a) An identification of significant surfaces, for example by drawings or by the provision of suitably marked samples.
- b) A drawing or other means of identifying surface unevenness; for example round drops or contact marks, will make the coated article unacceptable for its intended purpose.
- c) A sample or other means of showing the finished required.
- d) Any special thickness of coating (see Annex A).

NOTE — Any other information like:

- i) Designation of steel;
- ii) Description regarding size, length, etc;
- iii) Condition of delivery;
- iv) Any other special requirements; and
- v) Test report (if required) may be supplied by the purchaser to the hot-dip galvanizer.

6 COATING REQUIREMENTS**6.1 Mass of Zinc Coating**

Requirements for the mass of the coating for different classes of materials are given in Table 1.

Table 1 Mass of Zinc Coating
(Clause 6.1)

Sl No.	Product	Minimum Value or Average Mass of Coating (g/m ²)
(1)	(2)	(3)
i)	Castings-grey iron, malleable iron	610
ii)	Fabricated steel articles:	
	a) 5 mm thick and over	610
	b) Under 5 mm, but not less 2 mm	460
	c) Under 2 mm, but not less than 1.2 mm	340
iii)	Threaded work other than tubes and tube fittings:	
	a) 10 mm dia and over	300
	b) Under 10 mm dia	270
NOTES		
1 The requirements for the minimum mass of coating are for normal or rural atmosphere. In case of special atmosphere like marine and industrial atmosphere, the minimum mass of coating shall be increased as agreed to between the galvanizer and the purchaser.		
2 In case of fabricated steel structures, plates, etc, the coating mass is defined in terms of grams per square meter of the total surface area.		

6.2 Freedom from Defects

The zinc coating shall be uniform, adherent, reasonably smooth and free from such imperfections as flux, ash bare patches, black spots, pimples, lumpiness, runs, rust stains, bulky white deposits and blisters.

6.3 Steel Embrittlement

The design of the products and the selection of the steel for its suitability to withstand normal galvanizing operations without embrittlement or the method of fabrication shall be the responsibility of the fabricator.

NOTE — Recommended precautions to properly design, fabricate and prepare the material for galvanizing to prevent embrittlement are given in IS 6158 : 1984.

7 POST-TREATMENT

Most galvanized products do not require any post-treatment. Wherever required by the purchaser, treatment such as chromating or phosphating may be applied to reduce the risk of wet storage staining or assist subsequent painting respectively.

8 SAMPLING AND CRITERIA FOR CONFORMITY

Unless otherwise agreed to, the following sampling plan shall be followed for ascertaining the conformity of galvanized coating on structural steel and other allied products.

8.1 Sampling

8.1.1 Lot

All the material of the same type in a coating bath having uniform coating characteristics shall be grouped together to constitute a lot.

8.1.2 Each lot shall be tested separately for the various requirements of the specification. The number of units to be selected from each lot for this purpose shall be as given in Table 2.

Table 2 Scale of Sampling

No. of Units in the Lot	No. of Units to be Selected in a Sample	Acceptance No.
(1)	(2)	(3)
Up to 25	3	0
26-100	5	0
101-150	8	1
151-500	13	1
501-1 000	20	2
1 001-10 000	32	3
10 001 and above	50	5
NOTES		
1 The units shall be selected at random. For this purpose, reference may be made to IS 4905 : 1968.		
2 For details of acceptance number reference may be made to IS 2500 (Part 1) : 1992.		

8.2 Number of Tests

8.2.1 The sample selected according to col 1 and 2 of Table 2, shall be tested for visual requirements as per **6.2**.

8.2.2 The sample found conforming to the above requirements shall then be tested for mass of zinc coating. For this purpose, suitable test specimen shall be selected. If the material is of inconvenient length, shorter pieces of the same section under the same steel composition, not less than 90 cm length may be taken as test specimen. Three test specimens shall be cut from each sample for the determination of mass of zinc coating as described in **9.2**.

8.3 Criteria for Conformity

8.3.1 Each sample shall be tested by testing one test specimen prepared as prescribed in **9.2.2**. In case a test specimen representing a sample unit fails to conform to the requirements specified in **9.2** with respect to the mass of zinc coating the second and the third specimen shall be tested. If any one of the second or third specimen fails to conform to the requirements, the sample unit shall be called a defective unit. If the number of defective units in a lot exceeds the acceptance number as specified in col 3 of Table 2, the lot shall be rejected, else accepted.

8.3.2 The material in the lot which have been rejected may be stripped, galvanized and again submitted for the test and inspection. Samples shall be taken in accordance with Table 2.

8.4 Test for Visual Inspection

8.4.1 Visual inspection of the material in a lot shall be made to determine the conformity with

the requirements of 6.2. If the inspection warrants rejection of the lot, the galvanizer may segregate the good pieces of the lot and submit it once again for inspection.

8.4.2 If the lot inspected for visual inspection passes then it shall be declared as conforming to the requirements of 6.2.

9 TEST PROCEDURE

9.1 Test Specimen

9.1.1 Test specimens shall be selected from the material galvanized but if the material is of inconvenient length, shorter pieces of the same section and of the same steel composition, not less than 90 cm long, may be introduced as test specimen.

9.1.2 All test specimens shall be treated in the same manner, in the same bath and at the same time as the material, whose coating characteristics they intend to represent.

9.1.3 Three representative specimens may be selected from each lot for carrying out the mass of coating as described in 9.2.

9.2 Mass of Galvanized Coating

9.2.1 The mass of zinc coating shall be determined in accordance with IS 6745 : 1972. The methods (a) and (b) as given below may also be used subject to agreement between the purchaser and the galvanizer. However, the method (a) gives the actual mass of zinc coating, hence the average mass per unit area by this method is realistic:

- a) *Mass before and after galvanizing* — The mass of coating may be determined by weighing the article before and after galvanizing, subtracting the first mass from the second and dividing the result by the surface areas. The first mass shall be determined after pickling, rinsing and drying, the second after cooling to ambient temperature.
- b) The magnetic or microscopic methods as prescribed in IS 3203 : 1982 or eddy current methods as prescribed in IS 6012 : 1992 may also be employed to determine the thickness of coating. The mass of coating in grams per square meter

shall then be calculated by multiplying the thickness in millimetres by a factor 7 047.

9.2.2 In the case of long pieces when test specimens are not available, the mass of the coating shall be the average of the determination made at each end and the middle of the article. In the case of composite assemblies, each part shall be tested separately as they may fall in different classification.

9.3 Determination of Uniformity of Galvanizing Coating

Where practicable, the uniformity of galvanizing coating shall be determined by preece test as prescribed in IS 2633 : 1972. The article should withstand 4 one minute dips.

NOTES

- 1 The use of the Preece test should be agreed to between the purchaser and the galvanizer.
- 2 In the case of large articles of inconvenient length, the determination of coating thickness as done in 9.2.1(b) may be taken as a uniformity test.

9.4 Adhesion of Galvanized Coating

The coating shall withstand the pivoted hammer and knife tests as prescribed in IS 2629 : 1985 for testing adhesion of zinc coatings on fabricated products and hardware respectively.

10 MARKING

10.1 The galvanized articles may be marked legibly and indelibly with the name or trade-mark of the manufacturer.

10.1.1 BIS Certification Marking

10.1.2 The articles may also be marked with the Standard Mark.

10.1.3 The use of Standard Mark is governed by the provisions of *Bureau of Indian Standards Act, 1986* and Regulation made thereunder. The details of conditions, under which a licence for the use of the Standard Mark may be granted to manufacturers or processors may be obtained from the Bureau of Indian Standards.

ANNEX A

(Clause 1.2)

PROPERTIES OF THE ARTICLES TO BE COATED THAT AFFECT THE RESULT OF HOT-DIP GALVANIZING (FOR INFORMATION ONLY)

A-1 BASE METAL

A-1.1 Composition

Unalloyed carbon steel, low alloy steels and grey and malleable cast iron are suitable for hot-dip galvanizing; while sulphur-containing free-cutting steels are particularly unsuitable for hot-dip galvanizing.

A-1.2 Surface Condition

The surface of the base metal should be clean before dipping into the molten zinc. Pickling is the recommended method of cleaning the surface. Surface contaminants which cannot be removed by pickling for example oil, grease, paint, welding slags and similar impurities must be removed prior to pickling.

Castings should be as free as possible from surface porosity and shrinkage. The holes should be cleaned by grit blasting, electrolytic pickling or other methods specially suitable for castings.

A-1.3 The Influence of Steel Surface Roughness on the Hot-Dip Galvanized Coating Thickness

The surface roughness of the steel surface has an influence on the thickness and the structure of the coating.

A rough steel surface as obtained by grit blasting, coarse grinding, etc, prior to pickling gives a thicker coating than a surface which is obtained by pickling alone.

A-1.4 The influence of reactive elements in the base metal on the zinc coating thickness and appearance.

Several reactive elements affect galvanizing, for example, silicon (Si) and phosphorus (P) in the steel. The steel surfaces have an influence on the thickness and appearance of the zinc coating. At certain levels, they can give uneven, bright and/or dull dark grey coatings which may be brittle and thick.

A-1.5 Stresses in the Base Metal

Stresses in the base metal are relieved during the hot-dip galvanizing process and this may cause deformation of the coated article.

Steel that is cold worked may become brittle, depending on its type and the degree of cold work. As hot-dip galvanizing is a form of heat treatment also, it may accelerate the onset of

strain age-embrittlement if the steel is susceptible.

NOTE — Strain age-hardening and the risk of embrittlement is principally caused by the nitrogen content of steel, which in turn is largely dependent on the steel making process. As a general guide, the problem does not occur in modern steel making practices and the basic steels are generally least susceptible to strain age-hardening.

To avoid risk of embrittlement, use a steel which is not susceptible to strain age-hardening. If a susceptible steel must be used, avoid severe cold work if possible. If severe cold work cannot be avoided, stresses should be relieved by heat-treatment before hot-dip galvanizing.

Heat treated or cold worked steels may be tempered by the heat in the hot-dip galvanizing bath and lose some of the increased strength obtained by heat treatment or cold working.

Hardened steels may have tensile stresses of such a magnitude that zinc may penetrate into grain boundaries causing the steel to crack in the hot-dip galvanizing bath. The risk of cracking can be avoided by stress relieving.

Usual structural steels are not normally embrittled by the absorption of hydrogen during pickling. With structural steels, any absorbed hydrogen is discharged during hot-dip galvanizing. Hardened steels may, however, be embrittled due to hydrogen absorbed, if they are harder than approximately 34 HRC, 340 HV or 325 HB.

Where experience shows that specific steels, pretreatments, thermal and mechanical treatments and hot-dip galvanizing procedures have been satisfactory, the information serves as an indication that an embrittlement problem is not to be expected for the same combination of steels, pretreatments, thermal and mechanical treatments and galvanizing procedures.

A-1.6 Larger or Thicker Steels

Longer handling times are needed in the galvanizing bath for larger articles and this as well as the metallurgical properties of thicker steels due to normal manufacturing methods may cause thick coatings to form because the thickness of the coatings is normally a function of the immersion time in the galvanizing bath.

A-2 DESIGN

A-2.1 General

The design of the articles to be hot-dip galvanized should be appropriate for the

process of hot-dip galvanizing. The purchaser is recommended to seek the advice of the hot-dip galvanizer before designing or making a product which is subsequently to be hot-dip galvanized, as it may be necessary to adopt the construction of the article for the hot-dip galvanizing process.

A-2.2 Effect of Process Heat

No materials which will be adversely affected by the heat of the hot-dip galvanizing bath (typically 440°C but up to 470°C in high temperature hot-dip galvanizing) should be hot-dip galvanized.

A-2.3 Enclosed Cavities

It is essential for both safety and process reasons that means for venting and draining enclosed cavities be provided by the purchaser, or after the consent of the purchaser, by the hot-dip galvanizer.

CAUTION — It is essential to avoid enclosed cavities as these can cause explosions during hot-dip galvanizing.

A-3 RELATION BETWEEN LENGTH OF TIME OF CORROSION PROTECTION AND HOT-DIP GALVANIZED COATING THICKNESS

The length of time of corrosion protection of hot-dip galvanized coatings (whether light grey or dull grey) is approximately proportional to the coating thickness and the surface condition of the material to be galvanized.

For extremely aggressive conditions and/or an exceptionally long service life, thicker coatings may be required. The specification of the coating is subject to mutual agreement between the galvanizer and the purchaser. Some increase in coating thickness may be obtained, for example, if steel surface are grit-blasted

before galvanizing, or if hot-rolled steels containing more than 0.3 percent silicon are used.

A-4 THE HOT-DIP GALVANIZING BATH

The alloying elements of the zinc in the bath vary with different hot-dip galvanizing processes. Normally the zinc content in the working area of the bath should be not less than 98.5 percent by mass but where there is a special user requirement, levels of additions or impurities in the bath or in the coating may be specified by the purchaser.

A-5 AFTER TREATMENT

Hot-dip galvanized articles may be left to cool in air after withdrawal from the hot-dip galvanizing bath or may be quenched in water.

Small articles dipped in bulk in baskets or on jigs may be centrifuged immediately after withdrawal from the zinc to remove any surplus metal [*see 4.2(e)*].

To retard the possible formation of wet storage stain on the surface, the articles can be given a suitable surface treatment, like chromating, after hot-dip galvanizing.

If the articles are to be painted or powder coated after galvanizing the customer should advise the galvanizer accordingly.

A-6 RENOVATION OF UNCOATED OR DAMAGED AREAS

Areas of surface that are uncoated when galvanized may be renovated by zinc spraying (after cleaning and removal of mill scale), by zinc-rich paint (normally minimum 90 percent m/m metallic zinc content of dry film) or by a low-melting-point zinc alloy.

ANNEX B

(Clause 2)

LIST OF REFERRED INDIAN STANDARDS

<i>IS No.</i>	<i>Title</i>	<i>IS No.</i>	<i>Title</i>
209 : 1992	Zinc ingot (<i>fourth revision</i>)	3203 : 1982	Methods of testing local thickness of electroplated coatings (<i>first revision</i>)
1387 : 1993	General requirements for the supply of metallurgical materials (<i>second revision</i>)	4905 : 1982	Methods of random sampling
2500 (Part 1) : 1992	Sampling inspection procedure : Part 1 Attribute sampling plans indicated by acceptable quality level (AQL) for lot inspection (<i>second revision</i>)	6012 : 1982	Measurement of coating thickness by eddy current methods (<i>first revision</i>)
2629 : 1985	Recommended practice for hot-dip galvanizing of iron and steel (<i>first revision</i>)	6158 : 1984	Recommended practice for safeguarding against embrittlement of hot-dipped galvanized iron and steel products (<i>second revision</i>)
2633 : 1986	Methods of testing uniformity of coating on zinc coated articles (<i>second revision</i>)	6745 : 1972	Method for determination of mass of zinc coating on zinc coated iron and steel articles
		13229 : 1991	Zinc for galvanizing

