INTERNATIONAL STANDARD

ISO 7989-2

First edition
2007-02-01

Steel wire and wire products — Non-ferrous metallic coatings on steel wire —

Part 2: Zinc or zinc-alloy coating

Fils et produits tréfilés en acier — Revêtements métalliques non ferreux sur fils d'acier —

Partie 2: Revêtements de zinc ou d'alliages de zinc

Reference number
ISO 7989-2:2007(E)

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Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 7989-2 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 17, *Steel wire rod and wire products*.

This first edition of ISO 7989-2, together with ISO 7989-1, cancels and replaces ISO 7989:1988, which has been technically revised.

ISO 7989 consists of the following parts, under the general title *Steel wire and wire products — Non-ferrous metallic coatings on steel wire*:

— *Part 1: General principles*

— *Part 2: Zinc or zinc-alloy coating*

Steel wire and wire products — Non-ferrous metallic coatings on steel wire —

Part 2: Zinc or zinc-alloy coating

1 Scope

This part of ISO 7989 specifies the requirements for the coating mass per unit area, for other properties and also for testing of zinc or zinc-alloy coatings on steel wire and steel wire products, of circular or other section.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1460:1992, *Metallic coatings — Hot dip galvanized coatings on ferrous materials — Gravimetric determination of the mass per unit area*

ISO 7802:1983, *Metallic materials — Wire — Wrapping test*

ISO 7989-1:2006, *Steel wire and wire products — Non-ferrous metallic coatings on steel wire — Part 1: General principles*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
wire with zinc or zinc-alloy coating
wire to which zinc or zinc-alloy coating has first been applied to protect it against corrosion

NOTE The coating method may be hot dipping in a bath of molten zinc, or by means of an aqueous solution of suitable electrolyte. In the hot dipping process, wiping media may be used to modify the coating mass per unit area.

3.2
zinc or zinc alloy coating
coating composed of zinc or zinc alloy, where the zinc alloy is zinc to which other elements have been deliberately added in order to obtain particular characteristics, and in which the quantity of zinc is at least 50 %

NOTE The most common alloy elements are aluminium, tin and nickel, but other elements may also be considered.

3.3
coating mass per unit area
mass of zinc or zinc alloy per unit of surface area of bare wire

NOTE This is expressed in grams per square metre of surface.

Table 1 — Coating mass per unit area

Diameter	Classes[a]					
d	A	AB	B	C	D	A×3[b]
mm	g/m2	g/m2	g/m2	g/m2	g/m2	g/m2
$0{,}15 \leqslant d < 0{,}20$	—	—	15	—	10	
$0{,}20 \leqslant d < 0{,}25$	30	20	20	20	15	
$0{,}25 \leqslant d < 0{,}32$	45	30	30	25	15	
$0{,}32 \leqslant d < 0{,}40$	60	30	30	25	15	
$0{,}40 \leqslant d < 0{,}50$	85	55	40	30	15	
$0{,}50 \leqslant d < 0{,}60$	100	70	50	35	20	
$0{,}60 \leqslant d < 0{,}70$	115	80	60	40’	20	
$0{,}70 \leqslant d < 0{,}80$	130	90	60	45	20	
$0{,}80 \leqslant d < 0{,}90$	145	100	70	50	20	
$0{,}90 \leqslant d < 1{,}00$	155	110	70	55	25	
$1{,}00 \leqslant d < 1{,}20$	165	115	80	60	25	
$1{,}20 \leqslant d < 1{,}40$	180	125	90	65	25	540
$1{,}40 \leqslant d < 1{,}65$	195	135	100	70	30	585
$1{,}65 \leqslant d < 1{,}85$	205	145	100	75	30	615
$1{,}85 \leqslant d < 2{,}15$	215	155	115	80	40	645
$2{,}15 \leqslant d < 2{,}50$	230	170	125	85	45	690
$2{,}50 \leqslant d < 2{,}80$	245	185	125	95	45	735
$2{,}80 \leqslant d < 3{,}20$	255	195	135	100	50	765
$3{,}20 \leqslant d < 3{,}80$	265	210	135	105	60	795
$3{,}80 \leqslant d < 4{,}40$	275	220	135	110	60	825
$4{,}40 \leqslant d < 5{,}20$	280	220	150	110	70	840
$5{,}20 \leqslant d < 8{,}20$	290			110	80	870
$8{,}20 \leqslant d \leqslant 10{,}00$	300			110	80	900

[a] The coating class with a designation starting with A relates to thick coatings (generally final coating). Designations ending in B relate to classes usually but not always obtained by (zinc coating) and subsequent drawing. Classes C and D are standard classes for low mass coating which are usually produced but not exclusively, produced by hot zinc dipping and then wiping.

[b] A ×3 relates to very high mass requirement three times higher than Class A. Other multiples of Class A are possible, and these classes will be identified in the same way, e.g. A×4.

4 Coating requirements

4.1 Requirements for the coating material

The zinc or zinc alloy used for the coating shall be specified at the time of the enquiry and order. For zinc alloys not mentioned in this part of ISO 7989, the alloy shall be specified at the enquiry and order.

NOTE For Zn95Al5, reference is made to ASTM B 750[1] with or without mischmetal (MM).

The ingot of the material used for the zinc coating shall be of minimum 99,9 % purity unless otherwise stated in the relevant product standard or other specification in the order. Coatings applied by electrolysis shall contain a minimum of 99 % zinc.

4.2 Requirements relating to coating on the wire

4.2.1 Coating mass per unit area

The minimum mass of zinc per unit of surface area of the wire shall comply with the requirements of Table 1.

If no class of zinc coating or no coating mass per unit area is specified, the coating shall be called “regular coating”. Such a coating shall have not less than 1 g zinc per kilogram of zinc-coated wire, equivalent to the coating mass in grams per square metre (g/m^2) which is not less than two times the wire diameter, expressed in millimetres (mm).

The requirements for zinc-aluminium coatings of type Zn95Al5 are given in Table 2.

For other zinc-alloy coatings, the manufacturer and supplier shall agree on the required coating mass.

Table 2 — Mass requirements for a coating of Zn95Al5

Diameter	Coating mass per unit area		
d	Class A[a]	Class B[b]	Class AB[c]
mm	g/m2	g/m2	g/m2
$0{,}20 \leqslant d < 0{,}25$		20	20
$0{,}25 \leqslant d < 0{,}40$		30	30
$0{,}40 \leqslant d < 0{,}50$	85	40	55
$0{,}50 \leqslant d < 0{,}60$	100	50	70
$0{,}60 \leqslant d < 0{,}70$	115	60	80
$0{,}70 \leqslant d < 0{,}80$	130	60	90
$0{,}80 \leqslant d < 0{,}90$	145	70	100
$0{,}90 \leqslant d < 1{,}00$	155	70	110
$1{,}00 \leqslant d < 1{,}20$	165	80	115
$1{,}20 \leqslant d < 1{,}40$	180	90	125
$1{,}40 \leqslant d < 1{,}65$	195	100	135
$1{,}65 \leqslant d < 1{,}85$	205	100	145
$1{,}85 \leqslant d < 2{,}15$	215	115	155
$2{,}15 \leqslant d < 2{,}50$	230	125	170
$2{,}50 \leqslant d < 2{,}80$	245	125	185
$2{,}80 \leqslant d < 3{,}20$	255	135	195
$3{,}20 \leqslant d < 3{,}80$	265	135	210
$3{,}80 \leqslant d < 4{,}40$	275	135	220
$4{,}40 \leqslant d < 5{,}20$	280	150	220
$5{,}20 \leqslant d < 8{,}20$	290		
$8{,}20 \leqslant d \leqslant 10{,}00$	300		

[a] Class A: Usually zinc alloy coated at final size.

[b] Class B: Usually coated and drawn after coating.

[c] Class AB: Re-drawn or coated with zinc-aluminium alloy after final drawing.

4.2.2 Appearance of coating

The coating applied to the wire shall be reasonably smooth and as evenly distributed as industrial technology allows and not show discontinuities such as bare patches, dross contamination, etc.

NOTE The Zn95Al5 zinc-aluminium alloy might show difference in colour and become darker with time. This does not affect the corrosion protection performance.

4.2.3 Dipping test

If agreed at the time of the enquiry and order, the dipping (immersion) test shall be carried out according to the procedure detailed in 5.3. However, it should be pointed out that there is no direct link between the number of dips and the coating mass per unit area and that the result is determined as much by the conditions of manufacture of the coating as by the uniformity of the coating.

Table 3 gives the minimum number of immersions for coatings of classes A and AB.

The dipping test does not apply to classes B, C and D.

Table 3 — Minimum number of dips

Nominal diameter d mm	Class A		Class AB	
	Number of dips		Number of dips	
	of 1 min	of 1/2 min	of 1 min	of 1/2 min
$0{,}40 \leqslant d < 0{,}60$	—	1	—	—
$0{,}60 \leqslant d < 0{,}90$	1	—	—	1
$0{,}90 \leqslant d < 1{,}00$	1	1	—	1
$1{,}00 \leqslant d < 1{,}40$	1	1	1	—
$1{,}40 \leqslant d < 1{,}65$	2	—	1	—
$1{,}65 \leqslant d < 1{,}85$	2	—	1	—
$1{,}85 \leqslant d < 2{,}15$	2	—	1	1
$2{,}15 \leqslant d < 2{,}80$	2	1	1	1
$2{,}80 \leqslant d < 4{,}40$	3	—	2	—
$4{,}40 \leqslant d < 5{,}20$	3	1	2	—
$5{,}20 \leqslant d < 8{,}20$	3	1	—	—
$8{,}20 \leqslant d \leqslant 10{,}00$	4	—	—	—

4.2.4 Special finishes

If drawing after galvanizing is required, it shall be stipulated at the time of enquiry and order or in the appropriate product standard. The same also applies for other special finishes such as wax coating, a polished surface or an exceptionally smooth surface.

4.2.5 Adherence of coating

4.2.5.1 Wrapping test

During the test carried out in accordance with ISO 7802, the coating shall adhere to the steel when subjected to the conditions of wrapping test for adherence. It shall not crack or split to such an extent that slivers of coating can be removed by simply rubbing with the bare fingers. The loosening or detachment during testing of small particles of zinc resulting from mechanical polishing of the surface of the zinc or zinc-alloy coating shall not be considered to be a cause for rejection.

The wrapping test shall be carried out according to ISO 7989-1:2006, 5.3.

4.2.5.2 Assessment of adherence

To assess the adherence of the coating as may be specified in the relevant product standard or for evaluating different conditions of manufacturing, the following procedure may be applied.

Compare the coiled wire to the reference chart (see Figure 1). Allocate a value of 1 to 5 to the quality of adherence of the coating in accordance with the reference chart in Figure 1.

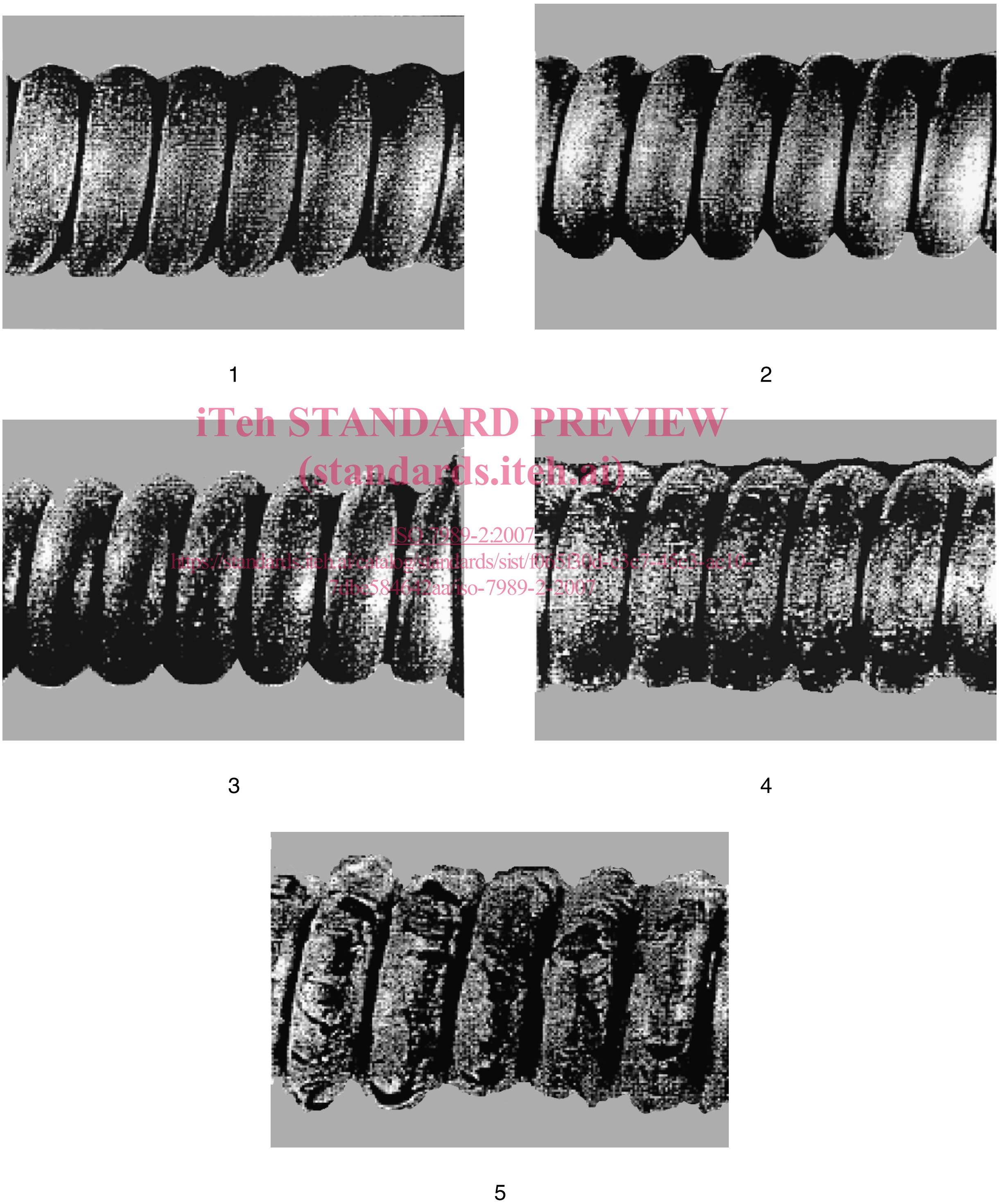

Figure 1 — Assessment of the adherence of the coating

5 Test conditions

5.1 Selection of samples

The number and the basis for the selection of test pieces shall be defined in the product standard. In the absence of such a standard, the manufacturer and purchaser shall agree between them on the degree of sampling.

When taking the samples, care shall be taken to avoid damaging the surface. Parts of the wire which are visibly damaged shall not be used.

A test piece of wire, which is of a suitable length for the specified tests shall be taken from one or both ends of each reel selected for sampling.

In the case of coated wire products, the product standard shall specify the length of the samples to be taken.

5.2 Determination of coating mass per unit area

5.2.1 General

In the case of wire with a zinc or zinc-alloy coating, the coating mass per unit area shall be determined either by the gravimetric method or the volumetric method. The second offers an acceptable degree of accuracy and has the advantage of being quick. This is why it is the preferred method for routine testing of wire of all dimensions which can easily be fitted into the measuring equipment. In the event of any dispute, the gravimetric method shall be used as the reference test method.

The test methods in this part of ISO 7989 do not necessarily include in detail all the precautions necessary to satisfy hygiene and safety requirements in the workplace, etc. Care should be taken to ensure that all necessary precautions are taken and procedures are implemented only by people who have received suitable training.

5.2.2 Gravimetric method

5.2.2.1 General

The method shall be applied in accordance with ISO 7989-1 with the following additional requirements.

5.2.2.2 Reagents

5.2.2.2.1 Hydrochloric acid, used as a stripping solution, with a concentration of 1,13 g/ml to 1,19 g/ml by density to which an appropriate inhibitor is added.

5.2.2.2.2 Inhibitor, added to the stripping solution.

Dissolve 3,5 g of hexamethylene-tetramine ($C_6H_{12}N_4$) in 500 ml of concentrated hydrochloric acid (ρ = 1,19 g/ml). Dilute this solution to 1 000 ml with distilled water.

Any other suitable inhibitor can be used.

It is recommended that preference be given to inhibitors which do not contain antimony.

5.2.2.3 Calculation of coating mass per unit area

The coating mass of zinc or zinc alloy per unit area shall be calculated according the following formulae:

$$m_A = \frac{\Delta m}{A} \times 10^6$$

where

A is the coated surface of the sample, in square millimetres (mm^2) (surface of the stripped wire);

Δm is the mass loss of the sample by chemical stripping, in grams (g);

m_A is the coating mass, in grams per square metre (g/m^2).

or

$$m_A = 1\,962 \times d \times \frac{\Delta m}{m_2}$$

where

m_2 is the mass of the sample after chemical stripping, in grams (g);

d is the diameter of (round) wire, in millimetres (mm);

m_A is the coating mass, in grams per square metre (g/m^2).

5.2.2.4 Test pieces

After carefully straightening out the wire samples, cut the test pieces accurately to a suitable length depending on the size of the tube, the diameter of the wire and the assumed mass of the coating. The lengths given in Table 4 are generally applicable for proper gas release. Different lengths may be necessary depending on the release of gas.

Table 4 — Recommended length of test pieces

Dimensions in millimetres

Diameter d	Length of test piece
$0{,}15 \leqslant d < 1{,}00$	600
$1{,}00 \leqslant d < 1{,}50$	500
$1{,}50 \leqslant d < 3{,}00$	300
$3{,}00 \leqslant d < 5{,}00$	200
$5{,}00 \leqslant d \leqslant 10{,}00$	100

5.2.3 Gaseous volumetric method

5.2.3.1 Principle

The volumetric method for determining the mass of the coating depends on the property by which a metal dissolved in an acid releases a quantity of hydrogen proportional to the mass of metal dissolved, i.e. representing the chemical equivalent of the metal in question.