BS 7371-8:2011

BSI Standards Publication

Coatings on metal fasteners –

Part 8: Specification for sherardized coatings

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Contents

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This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 12, an inside back cover and a back cover.

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Foreword

Publishing information

This part of BS 7371 is published by BSI and came into effect on 31 March 2011. It was prepared by Subcommittee FME/9/1, *Mechanical Properties of Fasteners*, under the authority of Technical Committee FME/9, *Fasteners*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This part of BS 7371 supersedes BS 7371-8:1998, which is withdrawn.

Relationship with other publications

Other published parts of BS 7371 are as follows:

- BS 7371-1:2009, *Specification for general requirements and selection guidelines;*
- BS 7371-2:1993, *Specification for torque/clamping force relationship;*
- BS 7371-3:2009, *Specifications for electroplated zinc coatings;*
- BS 7371-4:1994, *Specification for electroplated nickel, nickel/chromium and copper/nickel/chromium coatings;*
- BS 7371-6:1998+A1:2011, *Specification for hot dipped galvanized coatings;*
- BS 7371-7:2010, *Specification for mechanically applied zinc and zinc based coatings;*
- BS 7371-9:1996, *Specification for phosphate or phosphate and oil coatings;*
- BS 7371-10:1994, *Specification for organic coatings;*
- BS 7371-11:1993, *Specification for zinc flake non-electrolytically applied cured coatings* [1)]*;*
- BS 7371-12:2008, *Requirements for imperial fasteners.*

Information about this document

This is a full revision of the standard, and introduces the following principal changes:

- the range of coating classes is extended;
- the coating measurement technique has been updated.

Hazard warnings

WARNING. This part of BS 7371 calls for the use of substances and/or procedures that can be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

1) Obsolescent, replaced by BS EN ISO 10683:2000.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Introduction

The BS 7371 series deals with the performance and selection of coatings on metal fasteners and accessories. This part of BS 7371 specifies the requirements for sherardized coatings.

Sherardized coatings covered by this part of BS 7371 are for use on fasteners and accessories where the following apply:

a) a coating where long term galvanic corrosion protection is required, superior to that obtained with thinner plated coatings;

b) a uniform coverage of parts of complex shape is required;

c) any risk of hydrogen embrittlement of high tensile steel fasteners is unacceptable;

d) a coating is required as an undercoat to assist the adhesion and/or corrosion resistance of a subsequent coating, e.g. organic;

e) a damage resistant coating would be advantageous, particularly for use in harsh environments.

The coating has a matt grey appearance that can be modified by an after treatment that further improves the corrosion resistance.

Additional coatings can be applied on top of the sherardized coating to further modify the colour, however, these might influence certain parameters of the sherardized coating, e.g. lubricity or electrical conductivity, see BS 7371-10:1994.

Difficulties might arise during the processing of certain components and the coater is recommended to enquire if a difficulty exists and if it can be overcome by specialized processing methods. Typical difficulties might arise where:

1) high processing temperatures exceeding 400 °C affect the mechanical properties of some heat treated, shot peened or cold work hardened fasteners or components;

2) the application to threaded fasteners without additional thread allowance results in thread interference on assembly;

3) the thickness of coating applied causes a reduction in the dimensions of any internal recesses.

The coatings specified in this part of BS 7371 are suitable for application to metal components such as:

i) parallel threaded fasteners and accessories;

ii) wood screws (see for example BS 1210:1963);

iii) pipe nuts and connectors with parallel or tapered threads;

iv) the internal surface of hollow parts;

v) parts with flat surface, e.g. washers;

vi) parts with recesses.

1 Scope

This part of BS 7371 specifies requirements for sherardized coatings on iron and steel fasteners and accessories applied by thermal diffusion of zinc powder onto a component's surface.

NOTE Hydrogen embrittlement is not induced as a result of this coating process.

The coating consists of zinc/iron alloys, which are subsequently treated using either a zinc phosphate treatment (see BS 7371-9:1996, Type 2) or a suitable substitute treatment similar to those used in electroplating zinc (see BS 7371-3:2009) and mechanical plating (see BS 7371-7:2010). This results in a dust free surface, which, when required, can be lubricated to give controlled torque/clamping force properties (see BS 7371-2:1993).

In addition to the requirements in this part of BS 7371, the requirements in BS 7371-1:2009 that are applicable to sherardized coatings apply.

This part of BS 7371 also specifies requirements for:

a) the local coating thickness for six grades of coating;

b) possible types of post treatment;

c) the assessment of corrosion resistance of unused coated parts when subjected to neutral salt spray testing (see BS EN ISO 9227:2006).

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.

BS 7371-1:2009, *Coatings on metal fasteners – Part 1: Specification for general requirements and selection guidelines*

BS 7371-2:1993, *Coatings on metal fasteners – Part 2: Specification for torque/clamping force relationship*

BS 7371-3:2009, *Coatings on metal fasteners – Part 3: Specifications for electroplated zinc coatings*

BS 7371-7:2010, *Coatings on metal fasteners – Part 7: Specification for mechanically applied zinc and zinc based coatings*

BS 7371-9:1996, *Coatings on metal fasteners – Part 9: Specification for phosphate or phosphate and oil coatings*

BS EN 14399 (all parts), *High-strength structural bolting assemblies for preloading*

BS EN 15048-1:2007, *Non-preloaded structural bolting assemblies – Part 1: General requirements*

BS EN 15048-2:2007, *Non-preloaded structural bolting assemblies – Part 2: Suitability test*

BS EN ISO 1463:2004, *Metallic and oxide coatings – Measurement of coating thickness – Microscopical method*

BS EN ISO 3497:2001, *Metallic coatings – Measurement of coating thickness – X-ray spectrometric methods*

BS EN ISO 3882:2003, *Metallic and other inorganic coatings – Review of methods of measurement of thickness*

BS EN ISO 9227:2006, *Corrosion tests in artificial atmospheres – Salt spray tests*

3 Terms and definitions

For the purpose of this part of BS 7371, the following definitions apply together with those given in BS 7371-1:2009.

3.1 coating mass
total mass of zinc/iron alloys per unit area of surface

NOTE The coating mass is expressed in grams per square metre (g/m^2).

3.2 coating thickness
total coating thickness of the zinc/iron alloy layers

NOTE The coating thickness is expressed in micrometres (μm).

3.3 conversion coating
post treatment process by phosphating, chromating or another suitable process

3.4 local coating thickness
minimum value of coating thickness obtained from a number of measurements (not less than 5) within a reference area for a magnetic or electromagnetic test (alternatively X-ray test) or the single value for a gravimetric test

3.5 measuring area
area within which a specified number of single measurements is required to be made

NOTE See Figure B.1, which gives the measuring areas on fasteners.

3.6 sherardized coating
matt grey coating consisting of zinc/iron alloy layers obtained by sherardizing

NOTE The term sherardized coating is referred to in this part of BS 7371 as the coating.

3.7 sherardizing mixture
mixture consisting of mainly zinc dust, with or without other process supporting ingredients, and with or without an inert material such as sand

3.8 significant surface
part of the article covered or to be covered by the coating and for which the coating is essential for serviceability and/or appearance and meet all specified requirements

4 Process

*COMMENTARY ON Clause **4***
Sherardizing is a thermal diffusion coating process where the coating is applied to a component.

4.1 Cleaning and pre-treatment

The components, such as parts, fasteners and accessories, shall be cleaned and pre-treated in accordance with BS 7371-1:2009, Clause **5** and Clause **6**.

4.2 Sherardizing process

To add a sherardized coating to a component the following process shall be followed.

1) A component shall be placed in a closed container with the sherardizing mixture.
2) The closed container shall be heated to not less than 320 °C and not more than 500 °C.
3) While the closed container is being heated, it shall be moved by either oscillating or rotating it.

The process temperature given in item 2) shall not result in modification of the fastener's mechanical properties.

4.3 Coating

The coating shall be uniformly applied to the component by the sherardizing process in **4.2**.

The coating shall consist primarily of zinc and iron and be matt grey in appearance.

The coating shall be electrically conductive and galvanically protective to components under most climatic conditions.

4.4 Conversion coating

All components shall be treated with either zinc phosphate in accordance with BS 7371-9:1996, Type 2 or trivalent chrome solution (subclass *P*) similar to the treatment used in BS 7371-3:2009.

4.5 Lubrication

When specified by the purchaser [see Clause **8** item g)], the lubricity of the coating shall be modified by the addition of a lubricant and the torque/clamping performance of a coated fastener shall conform to BS 7371-2:1993 (see Clause **9** on identification).

4.6 Post treatments

When specified by the purchaser, post treatment shall be applied to the coating [see Clause **8** item c)].

These treatments shall be in the form of either a sealant, special lubricant, stain or oil and they are normally applied to give one or more of the following to a sherardized coating:

a) enhanced lubrication;
b) improved corrosion resistance;
c) improved decorative appearance.

5 Classification

Sherardized coatings shall be classified by local coating thickness and corrosion resistance to neutral salt spray, tested to BS EN ISO 9227:2006, in accordance with Table 1.

Table 1 **Classification of coating and local coating thickness**

Coating classification	**Local coating thickness** µm	**Coating weight** g/m^2	**Corrosion resistance of treated layer** h	
Class *X*	—	—	—	*Subclass: P*
Class 5	5	36	72	72
Class 10	10	72	72	72
Class 15	15	108	72	1 000
Class 30	30	216	72	1 000
Class 45	45	324	72	1 000
Class 75	75	540	72	1 000
Coating classification: Class X P+L [A)]				

[A)] If a lubricant (*+L*) is required, the sherardizer shall be made aware of this and, if known, of the coefficient of friction range to be achieved.

NOTE 1 The classification of coating thicknesses given in this table should be suitable for the majority of applications. Guidance on classification selection is given in Annex A.

NOTE 2 Class 5 and Class 10 coatings are mostly used to coat components for special applications, which are subsequently painted or over-coated.

NOTE 3 Class 5 and Class 10 coatings without a post treatment or after treatment are not recommended for corrosion protection only.

Example 1
For example, sherardizing to Class 30 results in a coating thickness of not less than 30 µm and corrosion resistance of 72 h to neutral salt spray tested to BS EN ISO 9227:2006.

Example 2
For example, sherardizing to Class 30 P results in a coating thickness of not less than 30 µm and corrosion resistance of 1 000 h to neutral salt spray tested to BS EN ISO 9227:2006.

Example 3
For example, sherardizing to Class 30 PL results in a coating thickness of not less than 30 µm and corrosion resistance of 1 000 h to neutral salt spray tested to BS EN ISO 9227:2006, with a lubricant in accordance with BS 7371-2:1993.

6 Properties

6.1 Surface condition

The surface shall be clean, dry and of a uniform appearance. All surfaces of a component shall be coated unless otherwise specified. When examined for appearance, the significant surfaces shall be smooth and free from defects such as an uncoated area.

6.2 Local coating thickness

NOTE Guidance as to the selection of coating thickness is given in Annex A.

The local coating thickness shall be as given in Table 1 for the intended classification either when measured in accordance with **B.1** or when determined by the gravimetric method given in **B.2**.

NOTE The result of the gravimetric method is assumed to be equivalent to the local coating thickness.

6.3 Corrosion resistance

*COMMENTARY ON **6.3***
As sherardized coatings are a zinc/iron alloy they quickly discolour red when subjected to corrosive environments. This is more pronounced under accelerated testing and should not be confused with base metal corrosion. The corrosion resistance of the whole coating is proportional to the thickness of the zinc/iron alloy coating.

When no increased corrosion resistance is specified, the coating shall provide 72 h of resistance (see Table 1) when tested to BS EN ISO 9227:2006.

When increased corrosion resistance is specified, the resistance shall be as given in Table 1 for subclass *P*.

NOTE 1 It is difficult to specify the actual time to base metal corrosion for a sherardized component, particularly when subjected to accelerated testing such as salt spray testing. BS EN ISO 9227:2006 gives guidance as to the minimum time for initial discolouration of sherardized coatings when subjected to salt spray testing.

NOTE 2 Salt spray testing to BS EN ISO 9227:2006 can be used for quality control purposes.

6.4 Lubrication

When lubrication (+*L*) is required, it shall be added to the specification, i.e. sherardizing to Class 30 *PL*. Unless otherwise specified, lubrication shall be in accordance with BS 7371-2:1993.

7 Thread clearance

When sherardized threaded fasteners or components are to be assembled together, it is essential that additional thread clearance shall be provided. This additional thread clearance shall be applied to either the internal or external thread.

NOTE 1 Due to the thickness of coating applied during the sherardizing process, it is not possible to gauge the threaded fasteners with 4h or 4H thread gauges.

The additional thread clearance to be applied to mating sherardized fasteners or components shall be as given in Table 2.

NOTE 2 Modification of thread dimensions to accommodate the coating could influence the mechanical properties of the assembly.

Table 2 **Additional thread clearance for mating sherardized ISO metric coarse threads (both mating surfaces coated)**

Coating classification	Local coating thickness	ISO metric additional thread clearance
	µm	µm
Class 5	5	120
Class 10	10	160
Class 15	15	200
Class 30	30	320
Class 45	45	440
Class 75	75	680

NOTE Additional thread clearance is based on:
Class X + 10 microns = maximum coating thickness.

When both threaded components are coated, the thread allowance shall be 8 times the maximum coating thickness.

If only one of the threaded components is required to be coated, then only half the clearance tolerance shall be used.

When Class 45 or Class 75 is required for structural bolting in accordance with BS EN 14399 (all parts), BS EN 15048-1:2007 and BS EN 15048-2:2007, only the externally threaded component shall be coated and the internally threaded component shall be tapped after coating to thread tolerance 6AZ.

NOTE 3 It is recommended that, wherever possible, threaded fasteners or components that have to be assembled together are sent for sherardizing at the same time to ensure that they are able to be assembled together after coating.

NOTE 4 If a top coat such as paint is applied, further clearance needs to be considered.

8 Information to be documented and supplied to the coater

The following information shall be supplied to the coater and shall be fully documented.

a) The number and date of this British Standard, i.e. BS 7371-8:2011.

b) The coating classification or alternatively the local coating thickness required (see Table 1).

c) The post treatment, if any, that is required.

d) The hardness and property class of the component to be coated.

e) The maximum process temperature or any likely effects on the metallurgical properties of the basis material caused by heating temperatures of up to 500 °C.

f) Any additional information regarding limitations of the process to be used.

g) Whether lubrication of the coating is required in accordance with BS 7371-2:1993.

h) The significant surfaces if not as defined in **3.8**.

i) Any additional protection required for delivery (see BS 7371-1:2009, Clause **9** and Annex D).

j) The requirements of any subsequent operations (e.g. the application of an adhesive).

9 Identification

The coating shall be identified by the number and date of this part of BS 7371, i.e. BS 7371-8:2011 [2)] together with the coating classification in accordance with Table 1.

A lubricated condition shall be designated by the letter *L* after the classification (see Table 1).

Example 1
A sherardized zinc coating of local coating thickness 45 µm with added lubricant would be identified as BS 7371-8:2011 Zn Class 45 +L.

Example 2
A sherardized zinc coating of local coating thickness 45 µm with a high corrosive protection and added lubricant would be identified as BS 7371-8:2011 Zn Class 45 P+L.

[2)] Marking BS 7371-8:2011 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meet the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third party certification which may also be desired.

Annex A (informative) Selection of coating

Coatings applied by the sherardizing process are designed to protect the base metal against corrosion.

The length of time for which a sherardized coating offers corrosion protection in a given environment is approximately proportional to the thickness of the sherardized coating.

Both industrial and marine environments are more corrosive to zinc coatings (of which sherardized coatings are one) than rural environments. Class 75, Class 45 or Class 30 coatings should normally be specified for outdoor applications. Class 15 coatings may be considered for outdoor applications where the environment is less harsh but are usually specified for indoor applications.

NOTE See Table 1 for the classification of coatings.

If any doubt exists concerning the suitability of the standard coatings offered in this part of BS 7371 for a particular application, the purchaser should seek advice from the sherardizer. They can either confirm the suitability of the classification chosen or offer an alternative thickness which better suits the application. These thicknesses are, however, outside the scope of this part of BS 7371.

Annex B (normative) Measurement of coating thickness

B.1 Coating thickness

To determine coating thickness, unless otherwise agreed with the purchaser, representative samples from a batch shall be selected in accordance with BS 7371-1:2009, Clause **8**.

The coating thickness shall be measured by one of the methods contained in the following British Standards:

- BS EN ISO 3497:2001;
- BS EN ISO 1463:2004;
- BS EN ISO 3882:2003.

The thickness shall only be measured on the measuring area shown in Figure B.1. For sherardized coatings the local coating thickness shall be assumed to be the same as the batch average coating thickness as defined in BS 7371-1:2009.

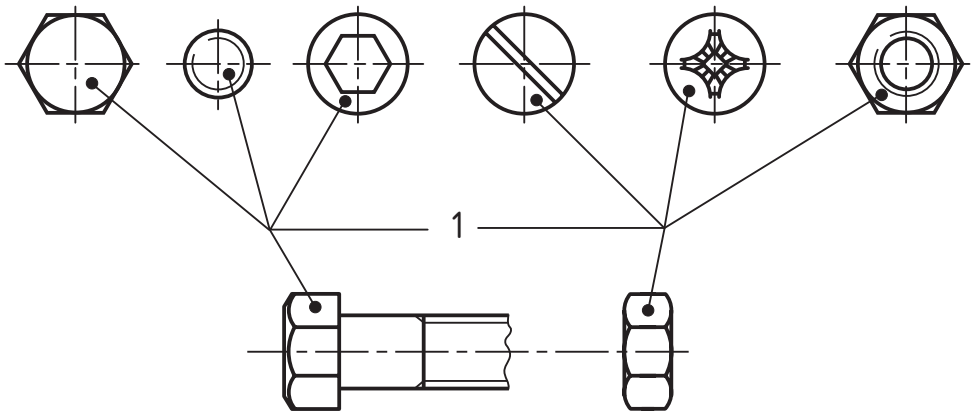
B.2 Determination of batch average coating thickness

B.2.1 Reagent

A stripping solution, consisting of the following:

- 800 mL of hydrochloric acid (density 1.16 g/mL to 1.18 g/mL);
- 200 mL of distilled water;
- 20 g of antimony trioxide.

Figure B.1 **Measuring area for coating thickness measurement of fasteners**



Key

1 Measuring area

B.2.2 Procedure

De-grease the batch of components in an organic solvent, dry thoroughly and weigh to an accuracy of 0.01% of the total mass of the group of components. After, totally immerse the components in the stripping solution and turn them over to allow free access to all surfaces. When the effervescence has ceased, remove the samples, wash immediately in running water and wipe with a soft cloth to remove any loose deposits. Immerse in clean acetone, remove, dry thoroughly and reweigh.

B.2.3 Calculations

The batch average coating mass per unit area for average coating thicknesses shall be in accordance with Table B.1.

B.2.3.1 The batch average coating mass per surface area shall be calculated (in g/m^2) using the following equation:

$$\text{Batch average coating mass per unit area} = \frac{m_0 - m_1}{A} \times 10\,000$$

where:

m_0 is the original mass of the batch of coated components in g;

m_1 is the final mass of the batch of components stripped of the coating in g;

A is the total surface area of the batch of components in cm^2, for standard fasteners refer to BS 7371-1:2009.

B.2.3.2 The batch average thickness of coating shall be calculated (in µm) using the following equation:

$$\text{Thickness} = K\left(\frac{m_0 - m_1}{A}\right)$$

where K is a factor dependent on the density of the coating. For sherardizing, K is 1410, assuming a density for zinc of 7.2 g/m^2.

Table B.1 **Batch coating mass per unit area and average coating thickness**

Batch coating mass per unit area	**Average coating thickness**
g/m^2	µm
108	15
216	30
324	45
540	75

Bibliography

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 1210:1963, *Specification for wood screws*[3)]

BS 7371-4:1994, *Coatings on metal fasteners – Part 4: Specification for electroplated nickel, nickel/chromium and copper/nickel/chromium coatings*

BS 7371-6:1998+A1:2011, *Coatings on metal fasteners – Part 6: Specification for hot dipped galvanized coatings*

BS 7371-10:1994, *Coatings on metal fasteners – Part 10: Specification for organic coatings*

BS 7371-11:1993, *Coatings on metal fasteners – Part 11: Specification for zinc flake non-electrolytically apllied cured coatings*[4)]

BS 7371-12:2008, *Coatings on metal fasteners – Part 12: Requirements for imperial fasteners*

BS EN ISO 10683:2000, *Fasteners – Non-electrolytically applied zinc flake coatings*

[3)] BS 1210 is current but obsolescent, meaning that it is no longer being maintained by the committee.

[4)] Obsolescent, replaced by BS EN ISO 10683:2000.

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