

Fusion bonded epoxy coated carbon steel bars for the reinforcement of concrete —

Part 1: Specification for coated bars

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Iron and Steel Standards Policy Committee (ISM/-) to Technical Committee ISM/9, upon which the following bodies were represented:

British Cement Association
 British Independent Steel Producers' Association
 British Precast Concrete Federation Ltd.
 British Reinforcement Manufacturers' Association
 British Steel Industry
 British Steel Industry (Wire Section)
 Concrete Society
 County Surveyors Society
 Department of the Environment (Property Services Agency)
 Department of Transport
 Electricity Supply Industry in England and Wales
 Fabric Reinforcement Development Association
 Federation of Civil Engineering Contractors
 High Yield Bar Development Association
 Institution of Structural Engineers
 UK Certification Authority Reinforcing Steels

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

Department of the Environment (Building Research Establishment)
 Institution of Civil Engineers

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Foreword

This Part of BS 7295 has been prepared under the direction of the Iron and Steel Standards Policy Committee.

This Part specifies requirements for the performance of fusion bonded epoxy coated carbon steel bars and also provides recommendations for the manufacture of the coated bar. Test methods for verifying the performance requirements are given in Appendix A. Appendix E gives guidelines for the handling of coated bars on site and will be deleted when the information is incorporated into BS 8110 and BS 4466. Information to be supplied by the purchaser is given in Appendix F.

BS 7295-2 specifies requirements for the coatings to be used for coated bars.

Product testing and certification. Attention is drawn to the provision in this Part of BS 7295 of a facility for third party certification of product conformity with this Part of BS 7295 based on testing and continuous product surveillance coupled with assessment of a supplier's quality systems against BS 5750-2:1987.

Enquiries as to the availability of third party certification schemes and of competent test laboratories will be forwarded by BSI to the Association of Certification Bodies. If a third party certification scheme does not already exist, users should consider approaching an appropriate body from the list of association members.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 6, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Part of BS 7295 specifies requirements for fusion bonded epoxy coated steel bars for the reinforcement of concrete, coating thickness, coating continuity and coating adhesion. It covers only steel bars complying with BS 4449, grade 460.

NOTE 1 The titles of the publications referred to in the standard are listed on the inside back cover.

NOTE 2 Information to be supplied by the purchaser is given in Appendix F.

2 Definitions

For the purposes of this Part of BS 7295, the following definitions apply.

2.1

bar

a steel product of deformed cross section

2.2

fusion bonded epoxy coating

a product containing pigments, thermosetting resins and other additives which is applied in the form of a powder on to a clean heated metallic substrate and fuses to form a coherent continuous coating

2.3

coated bar

a bar which has been coated with a fusion bonded epoxy resin

2.4

length

a piece of nominally straight bar cut to a specified length

2.5

bundle

two or more lengths properly bound together

2.6

longitudinal ribs

a uniform continuous rib parallel to the axis of the bar

2.7

transverse rib

any rib on the surface of the bar other than a longitudinal rib

2.8

holiday

a discontinuity in a coating which is not discernible to a person with normal or corrected vision

2.9

disbonding

visible loss of adhesion between the fusion bonded epoxy coating and the surface of the bar

2.10

patching material

a liquid two part epoxy resin, formulated to be compatible with the fusion bonded epoxy coating, and used to repair minor damage and cut ends

2.11

strand

one process line in a multiple line bar coating plant

2.12

manufacturer

any organization which produces coated bar

2.13

fabricator

any organization which cuts and bends previously coated bar

3 Materials

3.1 Bars

Steel reinforcing bars shall comply with BS 4449, grade 460 and shall be blast-cleaned with shot and/or grit in accordance with BS 2451 not more than 4 h before coating to give a surface equivalent to preparation grade Sa2½ of BS 7079-A1. The peak to trough amplitude shall be 50 µm to 70 µm.

3.2 Epoxy resin coatings

Powdered epoxy coating shall comply with BS 7295-2.

3.3 Patching material

Two part epoxy resin coating for use as patching material shall be compatible with the fusion bonded epoxy coating and comply with BS 7295-2.

NOTE Recommendations for manufacture of coated bars are given in Appendix D.

4 Requirements for coated bars

4.1 Coating thickness

For any 200 consecutive results, 95 % of the measurements of the coating thickness shall be within the range 150 µm to 280 µm when tested in accordance with A.2.

The coating thickness for any individual measurement shall be within the range 130 µm to 300 µm.

4.2 Coating continuity

4.2.1 The coating shall contain not more than 5 holidays per linear metre of bar length, when tested in accordance with A.3 and shall be free of holes, voids, cracks and damaged areas discernible to a person with normal or corrected vision.

4.3 Coating adhesion

When tested in accordance with A.4, there shall be no disbonding of the coating from the surface of the bar and the coating shall not contain more than 5 holidays per metre of bar.

The surface of the bent test piece shall not exhibit cracking or ductile tearing when viewed under well-lit conditions using normal or corrected vision.

5 Bond classification of coated bars

5.1 General

Coated bars shall be classified as type 1 or type 2 from the results of the bond performance tests described in Appendix B of BS 4449:1988, carried out on the coated bar.

5.2 Performance test classification

The performance tests shall be conducted by a competent test laboratory (see foreword). The bond classification established by the laboratory and given on the test report shall be regarded as final.

6 Routine testing

Routine testing shall be carried out in accordance with Appendix C and shall include:

either

- a) for material covered by a third party certification scheme, the requirements of C.1; or
- b) for material not covered by a third party certification scheme, the requirements of C.2.

A record of the consecutive test results shall be available for inspection by the purchaser or his representative for a period of 10 years from the date of delivery.

7 Manufacturer's certificate

The manufacturer shall be able to make available a certificate of routine testing, stating:

- a) that the material supplied complies with the requirements of this standard;
- b) the address at which the record of test results is available for inspection;
- c) the identification symbol of the certification body, where applicable.

NOTE This will be supplied upon request from a user.

8 Retests

8.1 If any test bar fails to meet the coating thickness, coating continuity or coating adhesion requirements it shall be discarded and two further bars from the same bundle shall be subjected to the test or tests in which the original bar failed. If both additional bars pass the retest the bundle from which they were taken shall be deemed to comply with this Part. If either of them fails, the bundle shall be deemed not to comply with this Part of BS 7295.

8.2 If the bundle does not comply with this Part of BS 7295 the bundle immediately preceding and the bundle immediately following the non-compliant bundle shall have two test bars selected from them which shall be subjected to the test or tests in which the original bars failed. If all test bars pass the retests then the bundles shall be deemed to comply with this standard. If any test bar fails, the bundle from which it originated shall be deemed not to comply with this Part of BS 7295.

8.3 In the case of a second non-compliant bundle, the untested bundle immediately next to it, which may be preceding or following, shall be subjected to retest. This procedure shall be repeated until a compliant bundle is tested.

9 Coating damage and repair

9.1 Damage to the coating caused by handling in manufacture in any linear metre of coated bar shall not exceed a surface area of 10 mm² and there shall be no more than 4 defects per coated bar length. Such damage shall be repaired by the manufacturer with a compatible patching material, in accordance with the recommendations of the coating material supplier.

NOTE 1 This requirement applies to the coated product at the manufacturer's premises and is not a site acceptance criterion.

NOTE 2 Process limitations can result in inadequate coating for approximately 200 mm at each end of the bar. It is recommended that these ends are either removed or repaired during subsequent fabrication.

9.2 Coated bars which exhibit disbonding of the coating from the bar surface shall be deemed not to comply with this Parts of BS 7295.

Appendix A Tests on coated bars

A.1 General

The following tests shall be conducted on the manufacturer's premises during and after manufacture.

NOTE The tests may be used in customer testing of product, possibly supplemented by further quantitative techniques where relevant.

A.2 Coating thickness

A.2.1 Non-destructive testing

Evaluate the coating thickness non-destructively in accordance with method no. 5 of BS 3900-C5.

NOTE Where the distance between ribs is less than 20 mm, an alternative system should be used.

Measure the coating at two opposing points on the circumference of the coated bar between transverse ribs at least every 500 mm along the length of the bar excluding 100 mm from each end.

A.2.2 Destructive testing

Determine the coating thickness over the whole cross section at the maximum rib height by taking a full transverse microsection of a coated bar taken at random.

A.3 Coating continuity

Determine the presence of holidays in the coating using a "holiday detector" (see Appendix G).

Perform the test on samples which are free from oil and dust. Measure the length of test specimen to ± 50 mm.

Wipe the entire surface of the coated bar with the wetted sponge by moving the probe or the coated bar at a scanning speed of less than 0.5 m/s.

The number of discharges generated for the entire length of the test specimen equals the number of holidays.

A.4 Coating adhesion

Carry out a bend test on test pieces having a uniform temperature of less than 15 °C in such a way as to produce a continuous and uniform bending deformation (curvature) at every section of the bend.

Perform the test on a power bending machine in which the test piece is adequately supported by plain smooth surfaces or rollers which do not offer resistance to longitudinal movement of the test pieces.

Apply the load at a rate of at least 8 r/min.

Bend the test pieces through 180° round a circular padded mandrel to achieve the inside radius of bend given in Table 1. The mandrel shall be covered with a material which will not damage the coating.

Table 1 — Inside radius of the bend

| Grade | Nominal size of bar | Inside radius of bend |
|-------|---------------------|---|
| 460 | All sizes | Three times the nominal size of the bar |

Test the continuity of coating on bent test pieces by using the holiday detector described in Appendix G in accordance with A.3.

Appendix B Frequency of testing

B.1 Material covered by a third party certification scheme

Non-destructive testing of coating thickness (A.2.1) and testing of coating adhesion (A.4) shall be carried out at a frequency not less than the value given in Table 2 subject to a minimum frequency of test of 12.0 m of coated bar length per strand per 2 hours of operation for each size produced.

Table 2 — Test frequency for coating thickness and coating adhesion

| Nominal bar size | Test frequency |
|------------------|-----------------------------|
| | Number of tonnes production |
| mm | t |
| Up to 16 | 2 |
| Over 20 up to 32 | 4 |
| Over 32 | 8 |

Coating continuity (A.3) shall be determined by testing 12.0 m of coated bar length per strand per 2 hours of operation from each size produced.

Destructive testing of coating thickness for each size (A.2.2) shall be carried out every month or every 100 t whichever is more frequent.

The manufacturer shall demonstrate that the final cure of the applied powder is adequate.

NOTE Differential scanning calorimetry testing provides a means of determining that the final cure is adequate.

B.2 Material not covered by a third party certification scheme

Non-destructive testing of coating thickness (A.2.1) shall be carried out at a frequency of not less than one full length bar in every twenty for each size.

Non-destructive testing of coating adhesion shall be carried out on each size at a frequency of not less than one test per x tonnes or part thereof, where x has the value given in Table 3.

Table 3 — Frequency of coating adhesion testing for material not covered by a certification scheme

| Nominal bar size | Value of x Quantity of material in tonnes |
|------------------|--|
| mm | t |
| Up to 16 | 1 |
| Over 20 up to 32 | 2 |
| Over 32 | 4 |

Coating continuity (A.3) shall be determined by testing one full length bar in every twenty bars.

Destructive testing of coating thickness (A.2.2) shall be carried out on one bar in every twenty tonnes for each size.

The manufacturer shall demonstrate that the final cure of the applied powder is adequate.

NOTE Differential scanning calorimetry testing provides a means of determining that the final cure is adequate.

Appendix C Routine testing and certification

C.1 Material covered by a third party certification scheme

Coated bar shall be tested by the manufacturer or by the certification body in accordance with Appendix A at the frequency specified in B.1.

C.2 Material not covered by a third party certification scheme

Coated bar shall be presented for sampling at the manufacturer's premises or the stockholder's yard. It shall be accompanied by full documentation that shall permit traceability of the steel to manufacturer and cast number, and traceability of the coating material to manufacturer of the epoxy powder and the batch of epoxy powder. The material shall be accompanied by test results establishing compliance with BS 4449 for the steel, and BS 7295-2 for the coating. Sampling and testing shall be carried out in accordance with Appendix A at the frequency specified in B.2 by an organization independent of the producer.

Appendix D Recommendations for the manufacturing process

NOTE This appendix contains recommendations for the manufacturing process using raw materials in accordance with clause 3.

D.1 Heating

D.1.1 The bar should be heated to a suitable temperature, such that on coating application it is within the temperature range recommended by the coating material supplier and should in no case exceed 260 °C.

D.1.2 The method of heating should not cause oxidation discernible to a person with normal or corrected vision, nor should it cause combustion products to be deposited on the bar surface.

D.2 Coating application

D.2.1 The coating should be applied to the cleaned surface of the bar as soon as possible after cleaning, and before oxidation of the surface discernible to the unaided eye occurs. In no case should application of the coating be delayed more than 4 hours.

D.2.2 The coating should be applied by a charged particle method and fully cured in accordance with the manufacturer's recommendations.

D.2.3 The coated bar should be cooled to below the glass transition temperature of the fusion bonded epoxy resin before handling.

Appendix E Guidelines for site practice

It is recommended that fabrication is carried out under factory-controlled conditions in accordance with the manufacturer's recommendations. In addition, the following guide lines for site practice are recommended.

- a) When handling coated bars, care should be taken to avoid bundle to bundle abrasion, or bar to bar abrasion resulting from sagging bundles. This may require lifting equipment with a spreader beam to sling from multiple pick-up points.
- b) All lifting equipment should use either nylon or padded slings.
- c) Coated bars should be off-loaded as close as possible to their fixing area to minimize rehandling.
- d) Coated bars should be placed on timber bearers, timbers should be placed between bundles when stacking is necessary.
- e) Coated and uncoated bars should be stored separately.
- f) Long-term storage should be minimized and call-offs phased to suit construction progress.
- g) Where long-term storage of coated bars is unavoidable the colour of the coating may fade with prolonged exposure to sunlight. This does not harm the coating or affect its corrosion protection properties and is not a basis for the rejection of coated bars. On-site storage should not exceed 6 months.
- h) When the extent of the coating damage exceeds 1 % of the surface area of the coated bar in any one metre length, the coated bar should be discarded.

- i) Fixed coated bars should be inspected for coating damage prior to placing concrete. Particular attention should be paid to sheared ends of coated bars. Where visible damage exists, it should be repaired with a patching material complying with BS 7295-2.
- j) When fixing coated bars all chairs, spacers and tying wire which contact the coated bar should be coated with a dielectric, e.g. epoxy or plastic coated material compatible with concrete.
- k) Reworking of coated bars on site is not a recommended practice.
- l) After fixing, walking on coated bars should be avoided, the placement of mobile equipment should be planned to avoid damage to coated bars.

Appendix F Information to be supplied by the purchaser

The purchaser should supply the following information:

- a) the number of this Part of BS 7295;
- b) the nominal size of the coated bar;
- c) the bond classification of the coated bar;
- d) any additional requirements.

Appendix G Holiday detector test apparatus

The holiday detector shall be of wet discharge type using direct current.

A testing voltage of 67.5 V shall be available. The testing voltage shall be fixed and the detector designed so that an external instrument can indicate that it is correct.

The detector shall be equipped with indicators such as lamps or buzzers for detecting defective parts. The maximum short-circuit current shall be below 10 mA.

The probe shall be of wet sponge type and be capable of covering all surfaces of the coated bars of the shapes and dimensions being tested.

Publications referred to

BS 2451, *Specification for chilled iron shot and grit.*

BS 3900, *Methods of test for paints.*

BS 3900-C5, *Determination of film thickness.*

BS 4232, *Specification for surface finish of blast-cleaned steel for painting.*

BS 4449, *Specification for carbon steel bars for the reinforcement of concrete.*

BS 4466, *Specification for scheduling, dimensioning, bending and cutting of steel reinforcement for concrete¹⁾.*

BS 5750, *Quality systems¹⁾.*

BS 5750-2, *Specification for production and installation.*

BS 7295, *Fusion bonded epoxy coated steel bars for the reinforcement of concrete¹⁾.*

BS 7295-2, *Specification for coatings.*

BS 8110, *Structural use of concrete¹⁾.*

¹⁾ Referred to in the foreword only.

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