

Specification for

High tensile steel wire and strand for the prestressing of concrete

ICS 77.140.15; 91.080.40

Cooperating organizations

The Iron and Steel Standards Committee, under whose direction this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

British Cast Iron Research Association
 British Constructional Steelwork Association
 British Internal Combustion Engine Manufacturers' Association
 British Ironfounders' Association
 British Railways Board
 British Shipbuilders
 British Steel Industry*
 British Steel Industry — Wire Section*
 Concrete Society Limited*
 Council of Ironfoundry Associations
 Department of Industry — National Physical Laboratory
 Electricity Supply Industry in England and Wales*
 Engineering Equipment Users' Association
 Federation of Civil Engineering Contractors*
 Greater London Council
 Institute of Marine Engineers
 Institute of Quality Assurance
 Institution of Mechanical Engineers
 Institution of Production Engineers
 Institution of Structural Engineers
 International Tin Research Institute
 Lloyd's Register of Shipping
 Ministry of Defence
 National Association of Drop Forgers and Stampers
 Oil Companies' Materials Association
 Process Plant Association
 Royal Institute of British Architects
 Society of Motor Manufacturers and Traders Limited
 Steel Casting Research and Trade Association
 Water-tube Boilermakers' Association

The organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard:

British Steel Corporation
 British Precast Concrete Federation Ltd.
 Cement and Concrete Association
 Concrete Pipe Association
 Department of the Environment (PSA)
 Prestressing Equipment Manufacturing Association

This British Standard, having been prepared under the direction of the Iron and Steel Standards Committee, was published under the authority of the Executive Board and comes into effect on 30 April 1980

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The following BSI references relate to the work on this standard:
 Committee reference ISE/9
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Foreword

This British Standard, prepared under the direction of the Iron and Steel Standards Committee, supersedes BS 2691:1969 “*Steel wire for prestressed concrete*” and BS 3617:1971 “*Seven-wire steel strand for prestressed concrete*” both of which are now withdrawn. The standard closely follows the appropriate parts of Euronorm 138 “Prestressing steels”, but some minor changes have been made in order to make it applicable to the requirements of the United Kingdom. Requirements for high tensile alloy steel bars for the prestressing of concrete are specified in BS 4486.

The start and finish of text introduced or altered by Amendment No. 1 is indicated by the tags A1 A1.

NOTE Amendment 1 has been introduced as a safety measure, to cover products currently on the market for which no specification exists, until the publication of BS EN 10138 at which time this standard will be withdrawn.

Certification. Attention is drawn to the certification facilities described on the inside back cover of this standard.

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.

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 14, 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.

Section 1. General

1 Scope

This British Standard specifies requirements for high tensile strength steel wire and seven-wire strand that are to be used for the prestressing of concrete, and is applicable only to material in the condition as supplied by the manufacturer. Requirements for other materials that may be associated with the steel in a prestressing tendon are not specified in this standard.

The types of prestressing steel, the associated methods of manufacture, and general requirements are specified in section 1. The specific properties for each type of prestressing steel are specified in sections 2 and 3.

2 References

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

3 Definition

For the purposes of this British Standard the following definition applies.

consignment

any quantity of material prepared at any one time for delivery to one location

4 Types of prestressing wire and strand

4.1 Cold-drawn wire. Cold-drawn wire is produced in coil form from hot rolled rod treated to make it suitable for cold drawing. The surface is smooth and may be covered by a residue of drawing lubricant.

By subsequent mechanical processes the wire may be indented or crimped and a final stress-relieving treatment is carried out on the wire in one of the following ways:

- a) stress-relieving by heating to a suitable temperature for a short time to improve certain mechanical properties;
- b) a similar stress-relieving heat treatment carried out under plastic deformation, for example under conditions of longitudinal strain, additionally to improve the relaxation characteristics.

4.2 Strand. Strand is made from cold-drawn wires. The seven-wire strand consists of a straight core wire around which are spun six helical wires in one layer.

Strand is given a final stress-relieving treatment in the same way as for cold-drawn wire and is wound into coil form. Drawn strand is strand that has been drawn through a die and given a stress-relieving treatment before winding into coil form.

5 Steel making

The steel may be made by any process except that the air and mixed air/oxygen bottom blown processes shall not be used.

The chemical composition shall be related to the type of product and its size and tensile strength. If required by the purchaser, a chemical analysis of the steel shall be provided by the supplier. The cast analysis shall not show more than 0.040 % sulphur or more than 0.040 % phosphorus.

6 Properties of prestressing steels

6.1 Introduction. The properties specified in 6.2, 6.3 and 6.4 are significant and those to be determined for the appropriate type of inspection are given in clause 7. The specific type of test for each product is specified in sections 2 and 3.

6.2 Geometrical properties. The geometrical properties are defined by a nominal dimension, characteristic of the section, with specified tolerances.

Where this is insufficient or inappropriate, it is permitted to define the geometrical properties by nominal cross section with specified tolerances and appropriate details of the configuration of the wire or strand (see sections 2 and 3).

6.3 Mechanical properties

6.3.1 Specified characteristic value. In this standard specified characteristic values are shown as either:

- specified characteristic breaking loads and
- specified characteristic 0.1 % proof loads; or
- specified characteristic tensile strength and
- specified characteristic 0.1 % proof stress.

For prestressing steel the specified characteristic value is the lower limit of the one sided statistical tolerance interval for which there is a 95 % probability that at least 95 % of the values will be equal to or greater than this lower limit. For the practical application of this criterion it is arbitrarily assumed that the distribution is normal (see BS 2846-3).

In manufacturer's inspection the criterion may be considered to be met if, in each homogeneous production lot, not more than 5 % of the test results are less than the specified characteristic value and no test result is less than 95 % of this value.

6.3.2 Maximum standard deviation. For the statistical interpretation of data (see 8.4) a maximum standard deviation is given for the tensile strength and 0.1 % proof stress, or breaking load and 0.1 % proof load, in sections 2 and 3 for each product.

The maximum standard deviation for each product is the maximum value of the standard deviation based on the entire production of each product of one manufacturer for a sufficiently long period using the same process and technique.

Specified characteristic values associated with maximum standard deviations indicate the desired level and degree of consistency of the property under consideration.

The maximum standard deviations specified are intended for application in:

- a) manufacturer's inspection for the verification of the degree of consistency of the production; and
- b) acceptance tests of material not covered by a certification scheme, for comparison with the standard deviation of the sample in accordance with 8.4.

6.3.3 Breaking load. The specified breaking load value is the characteristic breaking load, defined in 6.3.1.

Tensile stress, if required, shall be calculated from the load and the actual or nominal area as specified for each product.

6.3.4 Proof load. The specified proof load value is the characteristic 0.1 % proof load, defined in 6.3.1.

Proof stress, if required, shall be calculated from the load and the actual or nominal area as specified for each product.

6.3.5 Elongation. The percentage elongation under maximum load shall be determined on a gauge length appropriate to the product.

6.3.6 Ductility. The prestressing steel shall be proved to have suitable ductility by means of reverse bending or constriction or both, depending upon the product, as specified in sections 2 and 3.

6.4 Long-term behaviour

6.4.1 Isothermal relaxation. Curves for relaxation of load shall be established at a nominal temperature of 20 °C for a period of 1 000 h from initial stresses of 60 %, 70 % and 80 % of the actual strength, determined on an adjacent test piece (see A.4).

6.5 Technological properties

6.5.1 Wire condition. The finished material shall be free from defects, which may have occurred at any stage of manufacture, to a degree that would impair the performance as a prestressing tendon.

Longitudinal surface defects are acceptable provided that their depth is less than 4 % of the nominal diameter of the wire.

Rusted steels, apart from those with a thin film of rust, shall not be supplied.

NOTE Coatings for specific purposes are to be applied to the surface of the steel only if previously agreed between the purchaser and the manufacturer. Such coatings are not specified in this standard.

6.5.2 Welds. The limitations on the presence of welds for each product are specified in sections 2 and 3.

7 Inspection

7.1 General. Procedures for the following are specified in this clause:

Manufacturer's inspection.

Material covered by a certification scheme.

The manufacturer's testing records covering the output as a whole shall be accessible to the purchaser or other authorized person.

7.2 Manufacturer's inspection

7.2.1 The manufacturer shall carry out an inspection for those items in the following list that are appropriate to the product. The unit quantity for sampling and the frequency of each test are specified for each product in sections 2 and 3, except for tests on long-term behaviour. Relaxation tests shall be carried out periodically on the minimum number of pieces necessary to verify the established data.

- 1) The appropriate geometrical properties
- 2) Wire condition
- 3) Breaking load or tensile strength
- 4) Proof load or proof stress
- 5) Elongation at maximum load
- 6) Load-extension diagram
- 7) Ductility (constriction)
- 8) Ductility (reverse bend)
- 9) Relaxation

NOTE For special purposes, test evidence may be required on fatigue and stress corrosion (see Appendix B).

7.2.2 Products with satisfactory test results shall be considered to comply with the requirements of this standard.

7.3 Material covered by a certification scheme.

Where the manufacturer and his products are required to be approved under a certification scheme acceptable to the purchaser, control procedures shall be carried out to the satisfaction of the certifying authority.

The manufacturer's inspection shall be in accordance with 7.2.