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(Reaffirmed 1997)

Indian Standard

SPECIFICATION FOR INDENTED WIRE FOR PRESTRESSED CONCRETE

(First Revision)

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 3 *July* 1983

Indian Standard

SPECIFICATION FOR INDENTED WIRE FOR PRESTRESSED CONCRETE

(First Revision)

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Indian Standard

SPECIFICATION FOR INDENTED WIRE FOR PRESTRESSED CONCRETE

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 14 March 1983, after the draft finalized by the Joint Sectional Committee for Concrete Reinforcement had been approved by the Civil Engineering Division Council.

0.2 This standard was first published in 1970 to cover the requirements for indented hard-drawn and stress-relieved wire used in prestressed concrete work. This revision has been taken up with a view to incorporating modifications found necessary as a result of experience gained in using this standard both by manufacturers and users.

0.3 In this revision, modifications have been incorporated in provisions relating to manufacture and requirements of relaxation and susceptibility to stress corrosion. Further SI units have been adopted in this revision and references to related Indian Standards have been updated.

0.4 Requirements of plain hard-drawn steel wire for prestressed concrete are covered in IS : 1785 (Part I)-1983* and IS : 1785 (Part II)-1983†.

0.5 In the formulation of this standard, due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country.

0.6 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‡. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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*Specification for plain hard drawn steel wire for prestressed concrete: Part I Cold drawn stress-relieved wire (*second revision*).

†Specification for plain hard drawn steel wire for prestressed concrete: Part II As-drawn wire (*first revision*).

‡Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard covers the requirements for manufacture, supply and testing of indented hard-drawn and stress-relieved wire for use in prestressed concrete.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Bundle — Two or more ' coils ' or a number of lengths properly bound together.

2.2 Coil — One continuous length of wire in the form of a coil.

2.3 Elongation — The increase in length of a tensile test piece under stress. The elongation after fracture is conventionally expressed as a percentage of the original gauge length of a standard test piece.

2.4 Indentation — The creation of a depression or a series of depressions of particular shape and dimension on the surface of the wire by some mechanical process or otherwise without altering the mechanical and chemical properties.

2.5 Nominal Diameter — The nominal diameter of the indented wire is equivalent to the diameter of a plain wire having the same mass per unit length as the indented wire.

2.6 Parcel — Any quantity of finished wire presented for examination and test at any one time.

2.7 Proof Stress — The stress which produces a residual strain of 0·2 percent of the original gauge length (non-proportional elongation).

2.8 Tensile Strength — The maximum load reached in a tensile test divided by the original cross-sectional area of the gauge length portion of the test piece.

3. MANUFACTURE AND CHEMICAL COMPOSITION

3.1 The wire shall be cold drawn from the steel made by the open hearth, electric duplex, acid bessemer, basic oxygen, or a combination of these processes. In case any other process is employed in the manufacture of steel prior approval of the purchaser shall be obtained.

3.1.1 The ladle analysis when made in accordance with relevant parts of IS : 228* shall show that the steel contains not more than 0·05 percent of sulphur and not more than 0·05 percent of phosphorus.

*Methods of chemical analysis of steels (*second revision*).

3.2 The bars or wires obtained from the rolling mill shall be treated if required to make it suitable for cold drawing and thereafter the diameter of the wire of bar shall be successively decreased to the required diameter by cold drawing it through a series of dies. The resultant wire shall be indented and then subjected to straightening and stress relieving processes.

3.3 All finished wire, subject to the provisions of **3.2** shall be clean and uniformly drawn to the specified size and shape and shall be free from splits, harmful scratches, surface flaws, piping and other defects likely to impair its use in prestressed concrete, and finished in a workmanlike manner.

3.4 Unless otherwise agreed to between the purchaser and the manufacturer/ supplier, the wire shall not carry on its surface lubricants or other matter to a degree likely to impair its adhesion to concrete. Slight rust may be permitted, provided there is no surface pitting visible to the naked eye.

3.5 There shall be no welds in the finished wire as supplied to the purchaser. Any welds or joints made during manufacture to promote continuity of operations shall be removed before supply.

4. NOMINAL SIZES AND GEOMETRICAL CHARACTERISTICS

4.1 Nominal Sizes — The nominal diameters (*see* **2.5**) of the finished wires shall be 5·00, 4·00 and 3·00 mm.

4.2 Geometrical Characteristics — The shape and pattern of indentation shall be as mutually agreed to between the manufacturer and the purchaser provided the indentations are placed in two lines, diametrically opposite and the opposite indentations are staggered so that no two indentations are exactly opposite and also conform to the requirements in **4.2.1**. Two common types of indentations are illustrated in Fig. 1.

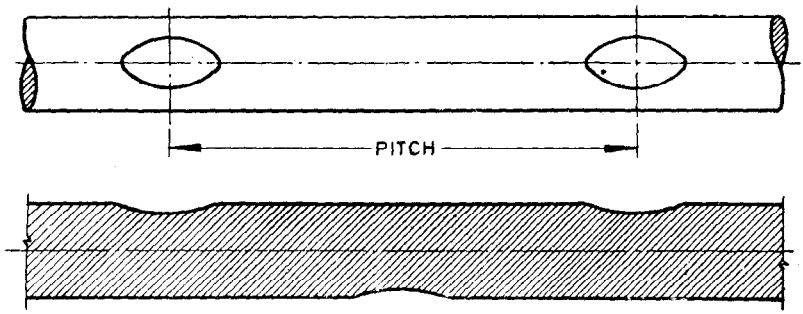
4.2.1 The pitch and the depth of indentation shall be uniform throughout the length of wire.

5. TOLERANCES

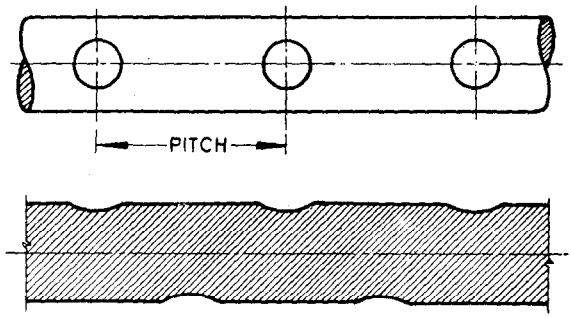
5.1 The tolerance on the nominal diameter shall be $\pm$ 0·05 mm.

5.1.1 For purposes of determining whether the actual diameter of the wire is within the specified tolerances, the diameter shall be determined with a micrometer by taking two measurements at right angles to each other at three places along a length of not less than 250 mm and the average of these six measurements shall be taken as the diameter of the wire.

NOTE — As the indenting is done after drawing, there are chances of the material being compressed and this shall not be the cause of rejection.



1A ELLIPTICAL INDENTATIONS



1B ROUND INDENTATIONS

FIG. 1 ILLUSTRATIVE SKETCH OF TYPICAL INDENTATIONS FOR INDENTED WIRE

6. PHYSICAL REQUIREMENTS

6.0 The wire shall conform to the physical requirements specified in **6.1** to **6.5**.

NOTE — For special purposes, test evidence may be required to show that the wire is not susceptible to stress corrosion. In such case, the test method shall be mutually agreed upon between the manufacturer and the purchaser.

6.1 Tensile Strength — Unless otherwise agreed to between the purchaser and the manufacturer or supplier, the tensile strength of wire determined in accordance with **7.3** and based on the nominal diameter of the wire, shall be as given below:

Nominal Diameter mm	*Tensile Strength Min*, N/mm²
5·00	1 570
4·00	1 715
3·00	1 865

6.2 Proof Stress — Unless otherwise specified, the proof stress of the wire shall be not less than 85 percent of its minimum specified tensile strength.

6.3 Ductility — The wire shall withstand the reverse bend test specified in **7.5**.

6.4 Elongation After Fracture — Elongation after fracture, over a gauge length of 200 mm, when determined in accordance with **7.6** shall be as below:

Nominal Diameter	*Elongation Percent*
mm	*Min*
5·00	4·00
4·00	3·00
3·00	2·50

6.5 Relaxation — The relaxation stress in the wire when tested in accordance with **7.7** shall not exceed 5 percent of the initial stress as specified in **7.7** at the end of 1 000 h. Alternatively, the manufacturer shall provide proof that the quality of wire supplied is such as to comply with this requirement.

6.5.1 When it is not possible to conduct 1 000 h relaxation test, the wire may be accepted on the basis of 100 h relaxation test, provided the manufacturer furnishes proof establishing a relation between the relaxation stress values at 1 000 h and 100 h and provided that the relaxation stress at 100 h is not more than 3·50 percent of the initial stress as specified in **7.7**.

7. TESTS

7.1 All test pieces of wire of sufficient length for the specified tests shall be selected by the purchaser or his authorized representative either:

a) from the cuttings of lengths of wires or ends of coils of wires; or

b) if he so desires, from the coil or length of wire, after it has been cut to the required or specified length and the test piece taken from any part of it.

7.1.1 In neither case, the test piece shall be detached from the coil or length or wire, except in the presence of the purchaser or his authorized representative.

7.1.2 Before test pieces are selected, the manufacturer or supplier shall furnish the purchaser or his authorized representative with copies of the mill records giving the number of coils or bundles in each cast with sizes as well as the identification marks whereby each coil or bundle of wire can be identified.

7.2 Test samples shall not be subjected to any form of heat treatment. Any straightening which the test samples may require shall be done cold.

7.3 Tensile Test — The ultimate tensile strength shall be determined in accordance with IS : 1521-1972*.

7.4 Test for Proof Stress — Proof stress shall be determined in accordance with IS : 1521-1972*.

7.4.1 When stress at 1·0 percent extension under load method is to be determined, an initial load corresponding to a stress of 196 N/mm² shall be applied to the test piece and a sensitive extensometer then attached. The dial of the extensometer shall be set to a reading equal to 0·001 mm/mm of the gauge length to represent the extension due to the initial load.

The load shall be increased until the extensometer shows an extension corresponding to 1·0 percent of the gauge length, when the load shall be noted. The stress calculated for this load shall be not less than the value specified for the 0·2 percent proof stress.

7.5 Reverse Bend Test — The test piece taken in accordance with **7.1** shall be capable of being bent in the following manner without showing signs of fracture:

One end of the test sample shall be firmly gripped in a vice fitted with radiused jaws. The free end of the wire shall be bent round the appropriate radius specified below through an angle of 90° and back to the original position; this constitutes one bend. Thereafter the test sample shall be bent through 90° in the opposite direction and back through 90° and then through 90° in the reverse direction and back through 90°, the wire shall withstand 3 reverse bends without fracture. The wire shall be tested with the indentations facing the jaws. Wire which has depth of indentation in excess of 3 percent of the nominal wire diameter shall withstand 2 reverse bends without fracture.

Diameter of Wire	*Radius of Jaws*
mm	mm
5·00	15·0
4·00	12·5
3·00	10·0

7.6 Elongation After Fracture — The elongation after fracture shall be determined in accordance with IS : 1521-1972*.

7.7 Test for Relaxation — If required by the purchaser, the manufacturer shall provide evidence from records of tests of similar wire that the

*Method for tensile testing of steel wire (*first revision*).

relaxation of load from an initial stress of 70 percent of the specified minimum tensile strength conforms to that specified in **6.5**. During the whole period of test the temperature shall be maintained at 20 ± 2°C. The initial load shall be applied in a period of 5 minutes and shall then be held constant for a further period of one minute. Thereafter no adjustment of load shall be made, and load relaxation readings shall commence from the end of the sixth minute. On no account shall the test specimen be overstressed.

8. SAMPLING AND CRITERIA FOR CONFORMITY

8.1 Scale of Sampling

8.1.1 Lot — In any consignment, all the coils of wire of the same nominal dimeter and manufactured at the same place under similar conditions of production and storage shall be grouped together to constitute a lot.

8.1.2 The number of coils to be selected at random from each lot shall depend upon the size of the lot and shall be in accordance with Table 1.

TABLE I SAMPLE SIZE

No. of Coils in the Lot	No. of Coils to be Selected
Up to 25	3
26 ,, 65	4
66 ,, 180	5
181 ,, 300	7
301 and above	10

8.2 Number of Tests

8.2.1 All the coils, selected as in **8.1.2** shall be tested for chemical composition (*see* **3.1.1**), nominal diameter (*see* **5.1**), tensile strength (*see* **6.1**), proof stress (*see* **6.2**), ductility (*see* **6.3**) and elongation (*see* **6.4**).

8.2.1.1 From each coil one test specimen shall be selected for all tests except nominal diameters (*see* **5.1**) and tested in accordance with the appropriate test method.

8.3 Criteria for Conformity

8.3.1 The lot shall be considered as conforming to the requirements of this specification if the conditions specified under **8.3.2** to **8.3.4** are satisfied for all the characteristics.

8.3.2 Chemical Composition, Diameter, Tensile Strength and Proof Stress — For each of the characteristics, the mean and the range

calculated from the test results shall satisfy the appropriate conditions given below:

a) (Mean +0·6 Range) shall be less than or equal to the maximum specification limit,

b) (Mean −0·6 Range) shall be greater than or equal to the minimum specification limit.

NOTE — The range is the difference between the maximum and the minimum value of the test results.

8.3.3 Elongation — In case of test for elongation after fracture, every sample tested shall satisfy the requirements of **6.4** and the percentage elongation for none of the samples shall fall below the value specified in **6.4**.

8.3.4 Ductility — The number of defective test specimens (those not satisfying the requirements of the test) shall not exceed the corresponding permissible number given below:

No. of Specimens Tested	*Permissible No. of Defective Test Specimens*
3	0
4	0
5	1
7	1
10	2

9. DELIVERY, INSPECTION AND TESTING FACILITIES

9.1 Unless otherwise specified, general requirements relating to the supply of material, inspection and testing shall conform to IS : 1387-1967*.

9.2 No material shall be despatched from the manufacturers' or suppliers' premises prior to its being certified by the purchaser or his authorized representative as having fulfilled the tests and requirements laid down in this standard except where the bundle or coil containing the wire is marked with the ISI Certification Mark.

9.3 The purchaser or his authorized representative shall be at liberty to inspect and verify the steel maker's certificate of cast analysis at the premises of the manufacturer or supplier; when the purchaser required an actual analysis of finished material, this shall be made at a place agreed to between the purchaser and the manufacturer or supplier.

*General requirements for the supply of metallurgical materials (*first revision*).

9.4 Manufacturer's Certificate — In the case of wires which have not been inspected at the manufacturer's works, the manufacturer or supplier, as the case may be, shall supply the purchaser or his authorized representative with certificate stating the process of manufacture and also the test sheet signed by the manufacturer giving the result of each mechanical test and the chemical composition, if required. Each test sheet shall indicate the number or identification mark of the cast to which it applies, corresponding to the number or identification mark to be found on the meterial.

9.5 When test for susceptibility to stress corrosion and relaxation are required to be carried out, the cost of testing shall be borne by the purchaser.

9.6 Unless otherwise agreed to between the purchaser and the manufacturer, wire shall be supplied in coils of sufficiently large diameter to ensure that the wire runs off straight and the purchaser may specify the diameter of the coil, if he so desires.

9.7 Coils of about 1·5 m diameter without breaks, joints and welds are generally recommended. The mass of the coil shall be as mutually agreed to between the purchaser and the manufacturer or supplier. Each coil shall have at least four tight ligatures.

10. IDENTIFICATION AND MARKINGS

10.1 The manufacturer or supplier shall have ingots, billets and wires, or coils of wires marked in such a way that all finished wire can be traced to the cast from which they were made. Every facility shall be given to the purchaser or his authorized representative for tracing the wires to the cast from which they were made.

10.1.1 Each bundle or coil containing the wires may also be suitably marked with the ISI Certification Mark in which case the concerned test certificate shall also bear the Standard Mark.

NOTE — The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

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AMENDMENT NO. 1 JULY 1988

TO

IS:6003-1983 SPECIFICATION FOR INDENTED WIRE FOR PRESTRESSED CONCRETE

(First Revision)

(Page 5, clause 3.2, first sentence) - Substitute the following for the existing matter:

'The wire rods obtained from the rolling mill shall be heat treated if required to make it suitable for cold drawing and thereafter the diameter of the wire rod shall be successively decreased to the required diameter by cold drawing it through a series of dies.'

(Page 8, clause 7.4) - Add the following at the end:

'Alternatively, stress at 1.0 percent extension under load method as specified in 7.4.1 may be determined.'

(Page 9, clause 8.2.1.1, line 2) - Delete the words 'except nominal diameters (see 5.1)'.

(BSMDC 8)

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AMENDMENT NO. 2 DECEMBER 1993
TO
IS 6003 : 1983 SPECIFICATION FOR INDENTED WIRE FOR PRESTRESSED CONCRETE

(First Revision)

(*Page* 4, *clause* **2.1**) — Delete and renumber the subsequent clauses as **2.1** to **2.7**.

(*Page* 5, *clause* **5.1.1** *and Note*) — Add new clause **5.1.2** as follows:

'**5.1.2** Where the diameter measurements (taken in two directions at right angles in the same plane) show an ovality of not more than half of the total diameter tolerance, no checks on section by weighing shall be necessary. Where ovality is more than half of the total diameter tolerance, check on section by weighing shall be made. Nominal mass and tolerance on nominal mass of the finished wire shall be as given below:

Nominal Diameter	*Nominal Mass*	*Tolerance*
mm	g/m	g/m
8.00	395	±5.9
7.00	302	±4.3
5.00	154	±3.1
4.00	98.9	±2.0
3.00	55.5	±1.5
2.50	38.5	±1.25

(*Page* 7, *clause* **6.2**) — Delete 'Unless otherwise specified' from the beginning of this clause.

(*Page* 8, *clause* **7.7**) — Delete 'If required by the purchaser' from the beginning of the clause.

(*Page* 10, *clause* **8.3.4**) — Rewrite as follows:

'**8.3.4** *Ductility* — In case one or more of the test pieces first selected fail to pass this test, twice the number of samples originally tested shall be selected for testing. All the samples so tested shall satisfy the requirement of this test. Should any of the test piece from these additional samples fail, the material represented by the samples shall be considered as not having compiled with this standard.'

(*Page* 11, *clause* **9.4**, *line* 6) — Delete 'if required'.

(*Page* 11, *clause* **9.6**) — Add the following para at the end:

'It is necessary to protect the wires against damage and contamination during transport and storage. The coils of wire shall be packed as agreed to between the purchaser and the manufacturer.'

(CED 54)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 3 MARCH 1997
TO
IS 6003 : 1983 SPECIFICATION FOR INDENTED WIRE FOR PRESTRESSED CONCRETE

(First Revision)

(*Page* 4, *clause* **3.1.1**, *lines* 2 *and* 3) — Substitute '0.040 percent' *for* '0.05 percent'.

(CED 54)

Reprography Unit, BIS, New Delhi, India