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मानक

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IS 6003 (2010): INDENTED WIRE FOR PRESTRESSED CONCRETE –  
[CED 54: Concrete Reinforcement]



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पूर्व प्रतिबलित कंक्रीट में प्रयुक्त दाँतेदार तार — विशिष्ट  
( दूसरा पुनरीक्षण )

*Indian Standard*  
INDENTED WIRE FOR  
PRESTRESSED CONCRETE — SPECIFICATION  
( *Second Revision* )

ICS 77.140.15; 91.080.40

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**BUREAU OF INDIAN STANDARDS**  
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NEW DELHI 110002

## FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Concrete Reinforcement Sectional Committee had been approved by the Civil Engineering Division Council.

This standard was first published in 1970 to cover the requirements for indented hard-drawn and stress-relieved wire used in prestressed concrete work and subsequently revised in 1983. The present revision has been taken up with a view of incorporating modifications found necessary as a result of experience gained in using this standard both by manufacturers and users.

In this revision, three additional nominal sizes of 8.00, 7.00 and 2.50 mm and their physical properties have been included.

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.

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

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 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Indian Standard*  
**INDENTED WIRE FOR  
 PRESTRESSED CONCRETE — SPECIFICATION**  
*( Second Revision )*

**1 SCOPE**

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

**2 REFERENCES**

The standards listed below contain provisions, which through reference in this text constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

<i>IS No.</i>	<i>Title</i>
228 (Parts 1 to 24)	Methods of chemical analysis of steels
1387 : 1993	General requirements for the supply of metallurgical materials ( <i>second revision</i> )
1608 : 2005	Metallic materials — Tensile testing at ambient temperature ( <i>third revision</i> )

**3 TERMINOLOGY**

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

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

**3.2 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.

**3.3 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.

**3.4 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.

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

**3.6 Proof Stress** — The stress which produces a residual strain of 0.2 percent of the original gauge length (non-proportional elongation).

**3.7 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.

**4 MANUFACTURE AND CHEMICAL COMPOSITION**

**4.1** 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.

**4.1.1** The ladle analysis when made in accordance with relevant parts of IS 228 shall show that the steel contains not more than 0.040 percent of sulphur and not more than 0.040 percent of phosphorus.

**4.2** 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.

**4.3** All finished wire, subject to the provisions of **4.2** 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 workman like manner.

**4.4** 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.

**4.5** 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.

## 5 NOMINAL SIZES AND GEOMETRICAL CHARACTERISTICS

### 5.1 Nominal Sizes

The nominal diameters (*see* 3.4) of the finished wires shall be 8.00, 7.00, 5.00, 4.00, 3.00 and 2.50 mm.

### 5.2 Geometrical Characteristics

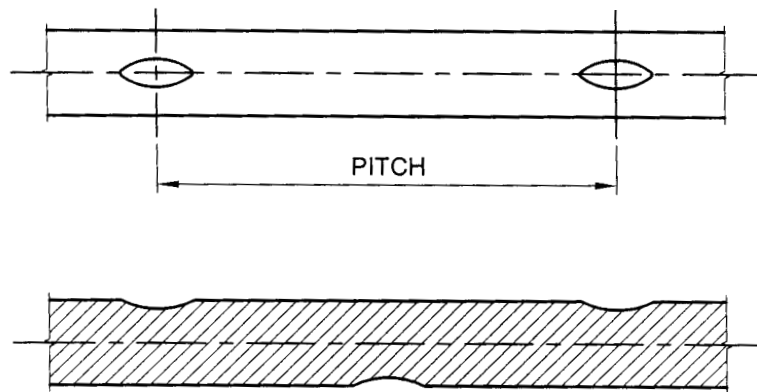
The shape and pattern of indentation shall be as mutually agreed to between the manufacturer and the purchaser provided the indentations are placed

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 5.2.1. Two common types of indentations are illustrated in Fig. 1.

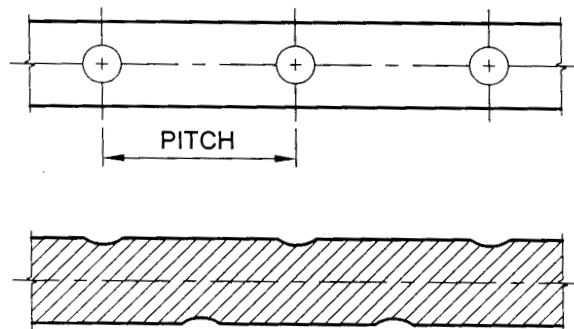
5.2.1 The pitch and the depth of indentation shall be uniform throughout the length of wire.

## 6 TOLERANCES

6.1 The tolerance on the nominal diameter shall be  $\pm 0.05$  mm.



1A ELLIPTICAL INDENTATIONS



1B ROUND INDENTATIONS

FIG. 1 ILLUSTRATIVE SKETCH OF TYPICAL INDENTATIONS FOR INDENTED WIRE

**6.1.1** 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.

**6.1.2** 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:

<i>Nominal Diameter</i> mm	<i>Nominal Mass</i> g/m	<i>Tolerance</i> 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

## 7 PHYSICAL REQUIREMENTS

The wire shall conform to the physical requirements specified in **7.1 to 7.5**.

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.

### 7.1 Tensile Strength

Unless otherwise agreed to between the purchaser and the manufacturer or supplier, the tensile strength of wire determined in accordance with **8.3** and based on the nominal diameter of the wire, shall be as given below:

<i>Nominal Diameter</i> mm	<i>Tensile Strength, Min</i> N/mm <sup>2</sup>
8.00	1 375
7.00	1 470
5.00	1 570
4.00	1 715
3.00	1 865
2.50	2 010

### 7.2 Proof Stress

The proof stress of the wire shall be not less than 85 percent of its minimum specified tensile strength.

### 7.3 Ductility

The wire shall withstand the reverse bend test specified in **8.5**.

### 7.4 Elongation After Fracture

Elongation after fracture, over a gauge length of 200 mm, when determined in accordance with **8.6** shall be as below:

<i>Nominal Diameter</i> mm	<i>Elongation, Percent</i> <i>Min</i>
8.00	4.00
7.00	4.00
5.00	4.00
4.00	3.00
3.00	2.50
2.50	2.50

### 7.5 Relaxation

The relaxation stress in the wire when tested in accordance with **8.7** shall not exceed 5 percent of the initial stress as specified in **8.7** 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.

**7.5.1** 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 **8.7**.

## 8 TESTS

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

- from the cuttings of lengths of wires or ends of coils of wires; or
- 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.

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

**8.1.2** 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.

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

### 8.3 Tensile Test

The ultimate tensile strength shall be determined in accordance with IS 1608.

### 8.4 Test for Proof Stress

Proof stress shall be determined in accordance with IS 1608. Alternatively, stress at 1.0 percent extension under load method as specified in **8.4.1** may be determined.

**8.4.1** When stress at 1.0 percent extension under load method is to be determined, an initial load corresponding to a stress of 196 N/mm<sup>2</sup> 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.

### 8.5 Reverse Bend Test

The test piece taken in accordance with **8.1** 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.

<i>Diameter of Wire</i> mm	<i>Radius of Jaws</i> mm
8.00	25.0
7.00	20.0
5.00	15.0
4.00	12.5
3.00	10.0
2.50	7.50

### 8.6 Elongation After Fracture

The elongation after fracture shall be determined in accordance with IS 1608.

### 8.7 Test for Relaxation

The manufacturer shall provide evidence from records of tests of similar wire that the relaxation of load from an initial stress of 70 percent of the specified minimum tensile strength conforms to that specified in **7.5**. 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 min and shall then be held constant for a further period of 1 min. 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 over-stressed.

## 9 SAMPLING AND CRITERIA FOR CONFORMITY

### 9.1 Scale of Sampling

#### 9.1.1 Lot

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

**9.1.2** 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 1 Sample Size**

SI No.	No. of Coils in the Lot	No. of Coils to be Selected
(1)	(2)	(3)
i)	Up to 25	3
ii)	26-65	4
iii)	66-180	5
iv)	181-300	7
v)	301 and above	10

## 9.2 Number of Tests

**9.2.1** All the coils, selected as in **9.1.2** shall be tested for chemical composition (see **4.1.1**), nominal diameter (see **6.1**), tensile strength (see **7.1**), proof stress (see **7.2**), ductility (see **7.3**) and elongation (see **7.4**).

**9.2.1.1** From each coil one test specimen shall be selected for all tests and tested in accordance with the appropriate test method.

## 9.3 Criteria for Conformity

**9.3.1** The lot shall be considered as conforming to the requirements of the specification if the conditions specified under **9.3.2** to **9.3.4** are satisfied for all the characteristics.

### 9.3.2 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.

### 9.3.3 Elongation

In case of test for elongation after fracture, every sample tested shall satisfy the requirements of **7.4** and the percentage elongation for none of the samples shall fall below the value specified in **7.4**.

### 9.3.4 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 pieces from these additional samples fail, the material represented by the samples shall be considered as not having complied with this standard.

## 10 DELIVERY, INSPECTION AND TESTING FACILITIES

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

**10.2** No material shall be dispatched from the manufacturer's or supplier's 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 Standard Mark (see **11.2**).

**10.3** 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.

## 10.4 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. 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 material.

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

**10.6** 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.

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.

**10.7** 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.

## 11 IDENTIFICATION AND MARKINGS

**11.1** 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.

### 11.2 BIS Certification Marking

Each bundle or coil containing the wires may also be suitably marked with the Standard Mark in which

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case the concerned test certificate shall also bear the Standard Mark.

**11.2.1** 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 details of conditions under which the license for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

## ANNEX A

### (Foreword)

#### COMMITTEE COMPOSITION

##### Concrete Reinforcement Sectional Committee, CED 54

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Ministry of Shipping, Road Transport and Highways, New Delhi	SHRI G. SHARAN, DIRECTOR GENERAL (ROAD DEVELOPMENT) ( <i>Chairman</i> )
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#### Amendments Issued Since Publication

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