IS 4454 ( Part 2 ) : 2001
[ Superseding IS 4454 ( Part 3) : 1975 ]

भारतीय मानक

# यांत्रिक स्प्रिंग के लिए इस्पात के तार — विशिष्टि

## भाग 2 तैल कठोरित व नमित इस्पात के तार

*( दूसरा पुनरीक्षण )*



*Indian Standard*

# STEEL WIRE FOR MECHANICAL SPRINGS — SPECIFICATION

## PART 2 OIL HARDENED AND TEMPERED STEEL WIRE

*( Second Revision )*

ICS 21.160; 77.140.25



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



*February* 2001

Price Group 5

FOREWORD

This Indian Standard ( Part 2 ) ( Second Revision ) was adopted by the Bureau of Indian Standards, after the draft finalized by the Wrought Steel Products Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1967 and subsequently revised in 1975. While reviewing the standard in the light of experience gained during these years, the Committee decided to revise it to bring it in line with the present practices being followed by the Indian industry.

In this revision following changes have been made:

a) Requirements of IS 4454 ( Part 3 ) : 1975 'Oil hardened and tempered steel wires-alloyed' have been merged in line with other overseas standards.

b) Grade designation has been modified.

c) Chemical composition and tensile strength values have been modified.

d) Dimensional tolerances have been modified.

e) Requirements of wrapping test, torsion test and decarburization test have been modified.

Subsequent to publication of this standard, IS 4454 ( Part 3 ) : 1975 shall stand superseded.

An informative Annex A has been given for the benefit of purchaser giving particulars to be specified by the purchaser while placing order for the spring wires covered in this standard.

The properties governing the application of steels for springs may be considerably influenced by their chemical composition as well as the modes of mechanical treatment and heat treatment applied. It is for these reasons that a very large variety of steels may be employed in the manufacture of steel springs. This variety is further increased owing to the fact that in certain cases these springs have to exhibit considerable resistance against corrosive influences and withstand elevated temperature and that the mechanical stress is imposed on them vary considerably. In order to facilitate clear survey, the steels are classified into three categories.

This part is one of the series of Indian Standards on steel wire for mechanical springs. Other parts in the series are :

Part 1 Cold drawn unalloyed steel wire

Part 4 Stainless steel wire

Examples of application for oil hardened and tempered steel wire have been given in Annex B.

In the preparation of this standard, necessary assistance has been derived from:

a) ISO/CD 8458-1 : 1998 'Steel wire for mechanical springs — Part 1 : General requirements'

b) ISO/CD 8458-3 : 1998 'Steel wire for mechanical springs — Part 3 : Oil hardened and tempered steel wire'

c) prEN 10270-2 : 1996 'Steel wire for mechanical springs — Part 2 : Oil hardened and tempered spring steel wire of unalloyed steels'

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*

# STEEL WIRE FOR MECHANICAL SPRINGS — SPECIFICATION

## PART 2 OIL HARDENED AND TEMPERED STEEL WIRE

*( Second Revision )*

### 1 SCOPE

This standard ( Part 2 ) covers requirements for oil hardened and tempered carbon and low alloy steel wire, for the manufacture of mechanical springs for static duty and dynamic duty applications.

### 2 REFERENCES

The following Indian Standards 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:

| *IS No.* | *Title* |
|---|---|
| 228 ( in Parts ) | Method for chemical analysis of steel |
| 1608 : 1995 | Mechanical testing of metals — Tensile testing ( *second revision* ) |
| 1717 : 1985 | Method for simple torsion test for wire ( *second revision* ) |
| 1755 : 1983 | Method for wrapping test for metallic wire ( *first revision* ) |
| 1956 ( Part 5 ) : 1976 | Glossary of terms relating to iron and steel: Part 5 Bright steel bar and steel wire ( *first revision* ) |
| 4163 : 1982 | Method for determination of inclusion content in steel by microscopic method ( *first revision* ) |
| 4905 : 1968 | Methods for random sampling |
| 6396 : 1983 | Method of measuring decarburized depth of steel ( *first revision* ) |
| 8910 : 1978 | General technical delivery requirements for steel and steel products |

### 3 TERMINOLOGY

**3.1** For the purpose of this standard, the definitions given in IS 1956 ( Part 5 ) and the following shall apply.

**3.2 Cast; Helix; Pitch**

The way in which a single ring of wire behaves when cut from coil.

NOTES

1 Well-cast wire will lie flat on itself in uniform circles. Spiral cast denotes the tendency of the rings out from the coil in spirals. Straight cast wire runs out approximately straight when unwound from the coil.

2 The terms spool, spool-less core and cheese are synonymous with coil.

**3.3 Oil-Hardened and Tempered Wire**

Wires that are heat treated in the following way: they are first transformed into austenite, quenched in oil or other suitable medium and then tempered at an appropriate temperature.

**3.4 Static Duty**

Qualifies applications where springs are subjected to static stresses or infrequent dynamic loading, or a combination of both.

NOTE — This does not apply to situations of low frequency high stresses.

**3.5 Dynamic Duty**

Qualifies applications where springs are subjected to frequent or predominantly dynamic loading and where small coiling ratios or severe bending radius is required.

**3.6 Ring**

One turn of wire from a coil, that is, one complete circle of wire.

NOTE — A ring of wire does not imply any specific length of wire or diameter of wire.

### 4 SUPPLY OF MATERIAL

General requirements relating to the supply of material shall be as laid down in IS 8910.

### 5 GRADES

The grade of spring wire used depends on the stress

level and on the nature of duty. The wire diameter ranges and tensile strength grades normally available for static duty and dynamic duty are given in Table 1.

## 6 MANUFACTURE

**6.1** The processes used in making the steel and in manufacturing oil-hardened and tempered spring steel wire are left to the discretion of the manufacturer. The customer should be informed of the manufacturing process, if he so desires. The secondary steel making process adopted shall be mutually agreed to between the manufacturer and the purchaser. The steel shall be fully killed.

**6.2** The VD grades shall be checked for maximum size of inclusion in accordance with IS 4163. The allowable level of inclusions shall be agreed between the manufacturer and the purchaser.

**6.3** The wire shall be oil-hardened and tempered after cold working.

## 7 CHEMICAL COMPOSITION

**7.1** Ladle analysis of the material when carried out either by the method specified in the relevant part of IS 228 or any other established instrumental/chemical method, shall be as given in Table 2. In case of dispute, the procedure given in the relevant part of IS 228 shall be the referee method. However, where the method is not given in IS 228 or its relevant parts, the referee method shall be as agreed to between the purchaser and the manufacturer.

### 7.2 Product Analysis

Permissible variations in case of product analysis from the limits specified in Table 2 shall be as given in Table 3.

**Table 1 Wire Grades and Diameter Range**

( *Clause* 5 )

| Tensile Strength (1) | Static (2) | Medium Fatigue (3) | High Fatigue (4) |
|---|---|---|---|
| Low tensile strength | FDC | TDC | VDC |
| Medium tensile strength | FDCrV(A,B) | TDCrV(A,B) | VDCrV(A,B) |
| High tensile strength | FDSiCr | TDSiCr | VDSiCr |
| Diameter range, mm | 0.50-17.00 | 0.50-10.00 | 0.50-10.00 |

**Table 2 Chemical Composition**

( *Clauses* 7.1 *and* 7.2 )

| Grade | Constituent, Percent | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | C | Si | Mn | S *Max* | P *Max* | Cr | V | Cu *Max* |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| FDC | 0.53-0.88 | 0.10-0.35 | 0.50-1.20 | 0.030 | 0.030 | — | — | 0.20 |
| TDC | 0.53-0.88 | 0.10-0.35 | 0.50-1.20 | 0.025 | 0.025 | — | — | 0.12 |
| VDC | 0.60-0.75 | 0.10-0.35 | 0.50-1.00 | 0.025 | 0.025 | — | — | 0.12 |
| FDCrV-A | 0.47-0.55 | 0.10-0.40 | 0.60-1.20 | 0.030 | 0.030 | 0.80-1.10 | 0.10-0.25 | 0.20 |
| TDCrV-A | 0.47-0.55 | 0.10-0.40 | 0.60-1.20 | 0.025 | 0.025 | 0.80-1.10 | 0.10-0.25 | 0.12 |
| VDCrV-A | 0.47-0.55 | 0.10-0.40 | 0.60-1.20 | 0.025 | 0.025 | 0.80-1.10 | 0.10-0.25 | 0.12 |
| FDCrV-B | 0.62-0.72 | 0.15-0.30 | 0.50-0.90 | 0.030 | 0.030 | 0.40-0.60 | 0.10-0.25 | 0.20 |
| TDCrV-B | 0.62-0.72 | 0.15-0.30 | 0.50-0.90 | 0.025 | 0.025 | 0.40-0.60 | 0.10-0.25 | 0.12 |
| VDCrV-B | 0.62-0.72 | 0.15-0.30 | 0.50-0.90 | 0.025 | 0.025 | 0.40-0.60 | 0.10-0.25 | 0.12 |
| FDSiCr | 0.50-0.60 | 1.20-1.60 | 0.50-0.90 | 0.030 | 0.030 | 0.50-0.80 | — | 0.20 |
| TDSiCr | 0.50-0.60 | 1.20-1.60 | 0.50-0.90 | 0.025 | 0.025 | 0.50-0.80 | — | 0.12 |
| VDSiCr | 0.50-0.60 | 1.20-1.60 | 0.50-0.90 | 0.025 | 0.025 | 0.50-0.80 | — | 0.12 |

**Table 3 Permissible Variations for Product Analysis**

( *Clause* 7.2 )

| Constituent | Wire Grade | Permissible Variations Over and Under the Specified Limit, Percent, *Max* |
|---|---|---|
| (1) | (2) | (3) |
| Carbon | All | 0.03 |
| Silicon | SiCr | 0.05 |
| | Other grades | 0.03 |
| Manganese | All | 0.04 |
| Sulphur | All | 0.005 |
| Phosphorus | All | 0.005 |
| Copper | All | 0.02 |
| Chromium | All | 0.05 |
| Vanadium | All | 0.02 |

## 8 FREEDOM FROM DEFECTS

The surface of the wire shall be smooth and as free as possible from defects, such as grooves, seams, tears, rust, scale, scratches, pits, die-marks, and other harmful defects, on visual examination, which have a noticeable adverse effect on the application of the wire.

## 9 DIMENSIONS AND TOLERANCES

**9.1** Tolerance on diameter of wire shall be as specified in Table 4 . Class A tolerance is intended for wire grades TD and VD. Class B tolerance is intended for wire grade FD.

**9.2** The difference between the maximum and minimum diameter of the wire at the same cross-section shall not be more than 50 percent of the total permissible deviation specified in Table 4 .

**9.3** Sizes and tolerance other than those specified in Table 4 may be mutually agreed to between the purchaser and the manufacturer.

## 10 MECHANICAL PROPERTIES

### 10.1 Tensile Test

The tensile test shall be carried out in accordance with IS 1608. The tensile strength and reduction in area of the wire shall be as given in Tables 5 and 6 and shall be calculated using the actual wire diameter.

**10.1.1** The range of tensile strength values within a coil shall not exceed 50 MPa for the grades VD, 60 MPa for TD and 70 MPa for the grades FD.

**Table 4 Diameter Tolerance for Coiled Wire**

( *Clauses* 9.1, 9.2 *and* 9.3 )

| Nominal Diameter of Wire, mm | | Tolerance (±), mm | | Nominal Diameter of Wire, mm | | Tolerance (±), mm | |
|---|---|---|---|---|---|---|---|
| Over | Up to and Including | Class A | Class B | Over | Up to and Including | Class A | Class B |
| (1) | (2) | (3) | (4) | (1) | (2) | (3) | (4) |
| — | 0.05 | 0.003 | — | 1.78 | 2.78 | 0.025 | 0.030 |
| 0.05 | 0.09 | 0.003 | — | 2.78 | 4.00 | 0.030 | 0.030 |
| 0.09 | 0.17 | 0.004 | — | 4.00 | 5.45 | 0.035 | 0.035 |
| 0.17 | 0.26 | 0.005 | — | 5.45 | 7.10 | 0.040 | 0.040 |
| 0.26 | 0.37 | 0.006 | 0.010 | 7.10 | 9.00 | 0.045 | 0.045 |
| 0.37 | 0.65 | 0.008 | 0.012 | 9.00 | 10.00 | 0.050 | 0.050 |
| 0.65 | 0.80 | 0.010 | 0.015 | 10.00 | 11.10 | 0.070 | 0.070 |
| 0.80 | 1.01 | 0.015 | 0.020 | 11.10 | 14.50 | 0.080 | 0.080 |
| 1.01 | 1.78 | 0.020 | 0.025 | 14.50 | 18.30 | 0.090 | 0.090 |
| | | | | 18.30 | 20.00 | 0.100 | 0.100 |

NOTES

1 Class A tolerance is intended for wire grades TD and VD.
2 Class B tolerance is intended for wire grade FD.

**Table 5 Mechanical Properties for Oil Hardened and Tempered Steel Wire for Static Duty**

( *Clause* 10.1 )

| Wire Diameter (Nominal), mm | | Tensile Strength for Grades, MPa | | | | Reduction in Area Percent, *Min* |
|---|---|---|---|---|---|---|
| Over | Up to and Including | FDC | FDCrV-A | FDCrV-B | FDSiCr | |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| — | 0.50 | 1 800-2 100 | 1 800-2 100 | 1 900-2 200 | 2 000-2 250 | — |
| 0.50 | 0.80 | 1 800-2 100 | 1 800-2 100 | 1 900-2 200 | 2 000-2 250 | — |
| 0.80 | 1.00 | 1 800-2 060 | 1 780-2 080 | 1 860-2 160 | 2 000-2 250 | — |
| 1.00 | 1.30 | 1 800-2 010 | 1 750-2 010 | 1 850-2 100 | 2 000-2 250 | 45 |
| 1.30 | 1.40 | 1 750-1 950 | 1 750-1 990 | 1 840-2 070 | 2 000-2 250 | 45 |
| 1.40 | 1.60 | 1 740-1 890 | 1 710-1 950 | 1 820-2 030 | 2 000-2 250 | 45 |
| 1.60 | 2.00 | 1 720-1 890 | 1 710-1 890 | 1 790-1 970 | 2 000-2 250 | 45 |
| 2.00 | 2.50 | 1 670-1 820 | 1 670-1 830 | 1 750-1 900 | 1 970-2 140 | 45 |
| 2.50 | 2.70 | 1 640-1 790 | 1 660-1 820 | 1 720-1 870 | 1 950-2 120 | 45 |
| 2.70 | 3.00 | 1 620-1 770 | 1 630-1 780 | 1 700-1 850 | 1 930-2 100 | 45 |
| 3.00 | 3.20 | 1 600-1 750 | 1 610-1 760 | 1 680-1 830 | 1 910-2 080 | 40 |
| 3.20 | 3.50 | 1 580-1 730 | 1 600-1 750 | 1 660-1 810 | 1 900-2 060 | 40 |
| 3.50 | 4.00 | 1 550-1 700 | 1 560-1 710 | 1 620-1 770 | 1 870-2 030 | 40 |
| 4.00 | 4.20 | 1 540-1 690 | 1 540-1 690 | 1 610-1 760 | 1 860-2 020 | 40 |
| 4.20 | 4.50 | 1 520-1 670 | 1 520-1 670 | 1 590-1 740 | 1 850-2 000 | 40 |
| 4.50 | 4.70 | 1 510-1 660 | 1 510-1 660 | 1 580-1 730 | 1 840-1 990 | 40 |
| 4.70 | 5.00 | 1 500-1 650 | 1 500-1 650 | 1 560-1 710 | 1 830-1 980 | 40 |
| 5.00 | 5.60 | 1 470-1 620 | 1 460-1 610 | 1 540-1 690 | 1 800-1 950 | 35 |
| 5.60 | 6.00 | 1 460-1 610 | 1 440-1 590 | 1 520-1 670 | 1 780-1 930 | 35 |
| 6.00 | 6.50 | 1 440-1 590 | 1 420-1 570 | 1 510-1 660 | 1 760-1 910 | 35 |
| 6.50 | 7.00 | 1 430-1 580 | 1 400-1 550 | 1 500-1 650 | 1 740-1 890 | 35 |
| 7.00 | 8.00 | 1 400-1 550 | 1 380-1 530 | 1 480-1 630 | 1 710-1 860 | 35 |
| 8.00 | 8.50 | 1 380-1 530 | 1 370-1 520 | 1 470-1 620 | 1 700-1 850 | 30 |
| 8.50 | 10.00 | 1 360-1 510 | 1 350-1 500 | 1 450-1 600 | 1 660-1 810 | 30 |
| 10.00 | 12.00 | 1 320-1 470 | 1 320-1 470 | 1 430-1 580 | 1 620-1 770 | 30 |
| 12.00 | 14.00 | 1 280-1 430 | 1 300-1 450 | 1 420-1 570 | 1 580-1 730 | 30 |
| 14.00 | 15.00 | 1 270-1 420 | 1 290-1 440 | 1 410-1 560 | 1 470-1 720 | — |
| 15.00 | 17.00 | 1 250-1 400 | 1 270-1 420 | 1 400-1 550 | 1 550-1 700 | — |

NOTES

1 1 MPa = 1 N/mm² = 1 MN/m² = 0.102 0 kgf/mm²

2 For grade FDC:
For diameter ≤1.00 mm, a lower value of 1 900 MPa may be agreed.
For diameter ≤2.00 mm, a tensile strength range of 1 720-1 920 MPa may be agreed.

3 For grade FDCrV-A:
For diameter ≤3.00 mm, a tensile strength range of 1 620-1 820 MPa may be agreed.

4 For grade FDCrV-B:
For diameter ≤1.00 mm, a lower value of 2 000 MPa may be agreed.
For diameter ≤3.00 mm, a tensile strength range of 1 720-1 920 MPa may be agreed.

5 For grade FDSiCr:
For diameter ≤2.00 mm, a lower value of 2 060 MPa may be agreed.

6 Dispersion of tensile strength of one wire shall fall within half of the range of tensile strength in the table.

**Table 6 Mechanical Properties for Oil Hardened and Tempered Steel Wire for Dynamic Duty**

( *Clause* 10.1 )

| Wire Diameter (Nominal), mm | | Tensile Strength for Grades, MPa | | | | Reduction in Area Percent, *Min* |
|---|---|---|---|---|---|---|
| Over | Up to and Including | TDC VDC | TDCrV-A VDCrV-A | TDCrV-B VDCrV-B | TDSiCr VDSiCr | |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| — | 0.50 | 1 700-2 000 | 1 750-1 950 | 1 910-2 060 | 2 030-2 230 | — |
| 0.50 | 0.80 | 1 700-2 000 | 1 750-1 950 | 1 910-2 060 | 2 030-2 230 | — |
| 0.80 | 1.00 | 1 700-1 950 | 1 750-1 950 | 1 910-2 060 | 2 030-2 230 | — |
| 1.00 | 1.30 | 1 700-1 850 | 1 700-1 900 | 1 860-2 010 | 2 030-2 230 | 45 |
| 1.30 | 1.40 | 1 700-1 850 | 1 670-1 860 | 1 820-1 970 | 2 030-2 230 | 45 |
| 1.40 | 1.60 | 1 700-1 850 | 1 670-1 860 | 1 820-1 970 | 2 030-2 210 | 45 |
| 1.60 | 2.00 | 1 720-1 800 | 1 620-1 800 | 1 770-1 920 | 2 000-2 160 | 45 |
| 2.00 | 2.50 | 1 670-1 750 | 1 620-1 770 | 1 720-1 860 | 1 900-2 060 | 45 |
| 2.50 | 2.70 | 1 640-1 750 | 1 620-1 770 | 1 660-1 810 | 1 860-2 010 | 45 |
| 2.70 | 3.00 | 1 620-1 750 | 1 620-1 770 | 1 660-1 810 | 1 860-2 010 | 45 |
| 3.00 | 3.20 | 1 600-1 720 | 1 570-1 720 | 1 620-1 770 | 1 860-2 010 | 45 |
| 3.20 | 3.50 | 1 580-1 700 | 1 570-1 720 | 1 620-1 770 | 1 860-2 010 | 45 |
| 3.50 | 4.00 | 1 550-1 650 | 1 520-1 670 | 1 570-1 720 | 1 810-1 960 | 45 |
| 4.00 | 4.20 | 1 540-1 650 | 1 520-1 670 | 1 520-1 670 | 1 810-1 960 | 45 |
| 4.20 | 4.50 | 1 520-1 650 | 1 520-1 670 | 1 520-1 670 | 1 810-1 960 | 45 |
| 4.50 | 4.70 | 1 510-1 640 | 1 470-1 620 | 1 520-1 670 | 1 760-1 910 | 45 |
| 4.70 | 5.00 | 1 500-1 640 | 1 470-1 620 | 1 520-1 670 | 1 760-1 910 | 45 |
| 5.00 | 5.60 | 1 470-1 620 | 1 470-1 620 | 1 470-1 620 | 1 750-1 910 | 40 |
| 5.60 | 6.00 | 1 460-1 620 | 1 470-1 620 | 1 470-1 620 | 1 710-1 860 | 40 |
| 6.00 | 6.50 | 1 440-1 570 | 1 420-1 570 | 1 420-1 570 | 1 710-1 860 | 40 |
| 6.50 | 7.00 | 1 430-1 570 | 1 420-1 570 | 1 420-1 570 | 1 660-1 810 | 40 |
| 7.00 | 8.00 | 1 400-1 520 | 1 370-1 520 | 1 370-1 520 | 1 660-1 810 | 40 |
| 8.00 | 9.00 | 1 380-1 490 | 1 370-1 520 | 1 340-1 490 | 1 620-1 770 | 35 |
| 9.00 | 10.00 | 1 360-1 490 | 1 370-1 520 | 1 340-1 490 | 1 620-1 770 | 35 |

NOTES

1 1 MPa = 1 N/mm² = 1 MN/m² = 0.102 0 kgf/mm².

2 Dispersion of tensile strength of one wire shall fall within half of the range of tensile strength in the table.

### 10.2 Wrapping Test

Wrapping test shall be applied to wires with nominal diameter less than 0.07 mm. Wrapping test shall be carried out in accordance with IS 1755. The wire shall not show any sign of fracture when closely coiled for four turns around a mandrel of diameter equal to that of the wire.

### 10.3 Torsion Test

**10.3.1** The torsion test shall be applied to wires with nominal diameter from 0.70 mm up to and including 6.00 mm. The gauge length is equivalent to 100 × $d$ ($d$ = nominal diameter of the wire). Other gauge lengths may also be used subject to mutual agreement between the manufacturer and the purchaser.

**10.3.2** The torsion test shall be carried out in accordance with IS 1717. For grade FD wire, the torsion test piece shall be twisted in one direction until fracture. For wire grades TD and VD, the test piece is first twisted in one direction — the number of twists indicated in Table 7 and is then twisted in the other direction until fracture.

**10.3.3** No harmful defects shall be present on surface after fracture. The fracture plane shall be perpendicular

**Table 7 Torsion Test Requirements**

( *Clause* 10.3.2 )

| Nominal Diameter of Wire, mm | | Minimum Number of Twists for Grades | | | | | |
|---|---|---|---|---|---|---|---|
| | | TDC, VDC | | TDCrV, VDCrV | | TDSiCr, VDSiCr | |
| Over | Up to and Including | Right | Left | Right | Left | Right | Left |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| 0.69 | 1.00 | 6 | 24 | 6 | 12 | 6 | 0 |
| 1.00 | 1.60 | 6 | 16 | 6 | 8 | 5 | 0 |
| 1.60 | 2.50 | 6 | 14 | 6 | 4 | 4 | 0 |
| 2.50 | 3.00 | 6 | 12 | 6 | 4 | 4 | 0 |
| 3.00 | 3.50 | 6 | 10 | 6 | 4 | 4 | 0 |
| 3.50 | 4.50 | 6 | 8 | 6 | 4 | 4 | 0 |
| 4.50 | 5.60 | 6 | 6 | 6 | 4 | 3 | 0 |
| 5.60 | 6.00 | 6 | 4 | 6 | 4 | 3 | 0 |

to wire axis and shows no visible cracks.

### 10.4 Bend Test

The bend test shall be applied to wires with nominal diameter greater than 6.00 mm diameter. The wires shall not show any sign of fracture when bent through an angle of 90° around a mandrel of diameter equal to twice the wire diameter.

### 10.5 Coiling and Stretching Test

The coiling test may be applied to wires with nominal diameter not greater than 0.70 mm with mutual agreement between the manufacturer and the purchaser. A test piece approximately 500 mm in length is closely wound, under slight but reasonably uniform tension on a mandrel, three to three and half times the nominal diameter. The closed coil is then stretched so that after releasing the stress, it sets to approximately three times its original length. The surface condition of the wire and the regularity of the spring pitch (and individual windings) shall be inspected with the test piece in this condition.

### 10.6 Cast of the Wire

The wire shall be uniformly cast. When a ring of wire is cut from the package and allowed to fall on the surface, the wire shall lie flat and not show a spiral cast.

**10.6.1** By mutual agreement between the manufacturer and the purchaser, for sizes up to 5 mm, the cast requirements may be considered as being fulfilled if the following condition is satisfied:

An individual ring taken from the coil or bobbin and freely hung on a hook may show an axial displacement '$f$' at the ends of the ring ( *see* Fig. 1 ). This displacement '$f$' shall not exceed a value given by the following inequality:

$$f \leq \frac{0.2\,D}{\sqrt[4]{d}}$$

where

$D$ = mean diameter of the individual ring measured when lying horizontal in mm; and

$d$ = nominal diameter of the wire in mm.

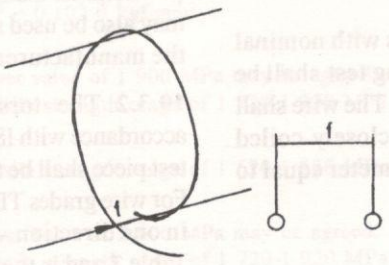


FIG. 1 CAST OF THE WIRE

### 10.7 Deep Etch Test

Deep etch test shall normally be limited to wire of 1.0 mm diameter and above. If the test is required by the purchaser on smaller sizes of wire, this shall be agreed upon at the time of enquiry and order.

**10.7.1** The test pieces shall be immersed in a solution of 50 percent of concentrated hydrochloric acid and 50 percent of water at a temperature in the range of 70-80°C for a period of time equivalent to 2 s for every 0.025 mm of diameter, with a maximum of 5 min, after which, when examined microscopically, they shall be free from seams or other defects likely to prejudice the performance of the finished springs. The permissible depth of surface defects after the test shall be in accordance with Table 8.

**10.7.2** It is necessary to heat the test pieces to a temperature of about 500°C for the purpose of stress relief before carrying out this test.

### 10.8 Eddy Current Test

Eddy current testing may be carried out for VD grades wires of diameter from 2.50 mm to 8.00 mm, if mutually agreed between the manufacturer and the purchaser. The method of testing and the evaluation of test results are to be agreed upon between the purchaser and the manufacturer.

### 10.9 Decarburization Test

Decarburization test shall be carried out in accordance with IS 6396.

**10.9.1** The cross-section of wire of VD and TD grades shall be free from complete decarburization. The permissible maximum radial depths of partial decarburized layer are shown in Table 9.

## 11 SURFACE FINISH

The spring wire shall be protected against corrosion and mechanical damage. Unless specified otherwise, the wire may have an oiled surface for all surface finishes.

## 12 SAMPLING

Unless otherwise agreed to, the method of drawing representative samples of the material and the criteria for conformity shall be as prescribed in Annex C.

## 13 CONDITION OF DELIVERY

**13.1** The wire is supplied in coils, or on spools. The wire in coils or on spools shall form one continuous

**Table 8 Permissible Depth of Surface Defects**

( *Clause* 10.7.1 )

| Nominal Diameter of Wire, mm | | Permissible Depth of Surface Defects for Wire Grades in mm | | |
|---|---|---|---|---|
| From | Up to and Including | VD | TD | FD |
| (1) | (2) | (3) | (4) | (5) |
| 0.50 | 2.00 | 0.01 | 0.015 | 0.02 |
| 2.00 | 6.00 | 0.5% $d$ [1)] | 0.8% $d$ [1)] | 1.0% $d$ [1)] |
| 6.00 | 10.00 | 0.7% $d$ [1)] | 1.0% $d$ [1)] | 1.4% $d$ [1)] |

[1)] $d$ is the nominal diameter of wire.

**Table 9 Permissible Depth of Surface Decarburization**

( *Clause* 10.9.1 )

| Nominal Diameter of Wire, mm | | Permissible Depth of Surface Decarburization for Wire Grades, mm | | |
|---|---|---|---|---|
| From | Up to and Including | VD | TD | FD |
| (1) | (2) | (3) | (4) | (5) |
| — | 4.00 | 0.04 | 0.05 | 1.5% $d$ [1)] |
| 4.00 | — | 1.0% $d$ [1)] | 1.25% $d$ [1)] | 1.5% $d$ [1)] |

[1)] $d$ is the nominal diameter of wire.

length originating from one heat only. The coiled wire shall not have welds. The wires shall not be kinked and wavy.

**13.2** Unless otherwise specified by the purchaser, the wire shall be supplied in slightly oiled condition

## 14 PACKING

The packing of the material shall be done in such a way that corrosion does not attack the material during transit. The suitable mode of packing shall be mutually agreed to between the purchaser and the manufacturer.

## 15 MARKING

**15.1** Each coil of wire shall be legibly marked with the following information :

a) Name of the supplier,
b) Wire grade,
c) Wire diameter,
d) Weight of the coil/bundle,
e) Cast or batch number, and
f) Date of supply.

**15.1.1** The material may also be marked with the Standard Mark.

**15.1.2** 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 licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

# ANNEX A

( *Foreword* )

## INFORMATION TO BE GIVEN BY THE PURCHASER

### A-1 BASIS FOR ORDER

While placing order for spring steel wires covered by this standard, the purchaser shall specify the following:

a) The desired quantity;
b) The wire grade;
c) Nominal wire diameter;
d) Surface finish and coating where relevant;
e) The form and condition of delivery;
f) Tests required;
g) Any special requirement; and
h) Test report.

# ANNEX B

( *Foreword* )

## EXAMPLES OF APPLICATION OF OIL HARDENED AND TEMPERED STEEL WIRE

### B-1 FIELD OF APPLICATION

As a rule unalloyed steels are used for applications at room temperature whereas alloyed steels are generally used at a temperature above room temperature. Alloyed steels may also be chosen for above average tensile strengths.

a) FD grade is intended for static applications, required for normal springs.
b) TD grade is intended for medium fatigue levels, such as required for clutch springs.
c) VD grade is intended for use under severe dynamic duty such as for valve springs.

# ANNEX C

( *Clause* 12 )

## SAMPLING AND CRITERIA FOR CONFORMITY

### C-1 LOT

In any consignment, all the coils of wire of the same grade and diameter manufactured under essentially similar conditions of manufacture shall be grouped together to constitute a lot.

**C-1.1** Sample shall be taken from each lot and tested for conformity to the standard.

### C-2 SAMPLING

The number of coils to be taken from a lot shall be according to col 1 and 2 of Table 10. These samples shall be taken at random by using random number tables (*see* IS 4905).

### C-3 PREPARATION OF SAMPLES AND NUMBER OF TESTS

#### C-3.1 Tests for Physical Requirements

From the coils selected from col 1 and 2 of Table 10, adequate length of test piece shall be cut from each end and subjected to physical tests, namely, size, surface condition, tensile, bend, wrapping and coating tests. A test piece failing to meet any one of the requirements, shall be called a defective.

If the number of defectives found is less than or equal to the permissible number of defectives specified in col 3 of Table 10, the lot shall be considered to have conformed to physical requirements.

#### C-3.2 Tests for Chemical Requirements

Unless otherwise agreed, the following procedure shall be followed for chemical requirements:

From these test pieces which have conformed to physical requirements further test pieces shall be selected at random according to col 4 of Table 10. These samples shall be tested for all the chemical requirements. If a test piece fails to meet the respective chemical requirement, it shall be called a defective. The lot shall be considered to have conformed to the chemical requirements if all the individual test pieces tested for chemical requirements pass the test.

### C-4 CRITERIA FOR CONFORMITY

A lot shall be considered to have conformed to the requirements of the specification if **C-3.1** and **C-3.2** are satisfied.

**Table 10 Scale of Sampling and Permissible Number of Defectives**

( *Clauses* C-2, C-3.1 *and* C-3.2 )

| No. of Coils in the Lot | No. of Coils for Physical Requirements | Permissible Number of Defective(s) | No. of Tests for Chemical Requirements |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| Up to 25 | 2 | 0 | 1 |
| 26 to 50 | 3 | 0 | 1 |
| 51 to 150 | 5 | 0 | 2 |
| 151 to 300 | 8 | 1 | 2 |
| 301 and above | 13 | 1 | 2 |

**Bureau of Indian Standards**

BIS is a statutory institution established under the *Bureau of Indian Standards Act,* 1986 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.



**Review of Indian Standards**

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards : Monthly Additions'.

This Indian Standard has been developed from Doc : No. MTD 4 ( 4068 ).

**Amendments Issued Since Publication**

| Amend No. | Date of Issue | Text Affected |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

BUREAU OF INDIAN STANDARDS

**Headquarters:**

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110 002
*Telephones :* 2323 0131, 2323 3375, 2323 9402 *Website :* www.bis.org.in

**Regional Offices :** *Telephones*

Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110 002 — 2323 7617, 2323 3841

Eastern : 1/14 C. I. T. Scheme VII M, V. I. P. Road, Kankurgachi, KOLKATA 700 054 — 2337 8499, 2337 8561, 2337 8626, 2337 9120

Northern : SCO 335-336, Sector 34-A, CHANDIGARH 160 022 — 260 3843, 260 9285

Southern : C. I. T. Campus, IV Cross Road, CHENNAI 600 113 — 2254 1216, 2254 1442, 2254 2519, 2254 2315

Western : Manakalaya, E9 MIDC, Marol, Andheri (East), MUMBAI 400 093 — 2832 9295, 2832 7858, 2832 7891, 2832 7892

**Branches :** AHMEDABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. KANPUR. LUCKNOW. NAGPUR. NALAGARH. PATNA. PUNE. RAJKOT. THIRUVANANTHAPURAM. VISAKHAPATNAM.

Printed at New India Printing Press, Khurja, India