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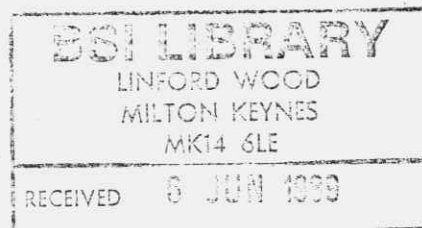
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JAPANESE INDUSTRIAL STANDARD

Hard Drawn Steel Wires

Ⓒ JIS G 3521—1988



Translated and Published

by

Japanese Standards Association



1. Scope

This Japanese Industrial Standard specifies the hard drawn steel wires, hereinafter referred to as the "wires".

Remark: In this standard, units and numerical values given in { } are in accordance with the International System of Units (SI), and are appended for reference.

Conventional units and values used currently in this standard are to be converted into SI units on January 1, 1991.

2. Classes, Symbols and Applied Wire Diameters

Wires shall be classified into three classes and their symbols and applied diameters shall be as given in Table 1.

Table 1. Classes and Symbols

Class	Symbol	Applied wire diameter	Remark
Hard drawn steel wire Class A	SWA	0.08 mm and over, up to and incl. 10.0 mm	-
Hard drawn steel wire Class B	SWB	0.08 mm and over, up to and incl. 13.0 mm	Mainly for springs
Hard drawn steel wire Class C	SWC		

3. Mechanical Properties

3.1 Tensile Strength The tensile strength of the wires shall be as given in Table 2-1 or Table 2-2 when tested in accordance with 8.2.

Applicable Standards:

JIS G 3506-High Carbon Steel Wire Rods

JIS Z 2241-Method of Tensile Test for Metallic Materials

Table 2-1. Tensile Strength
(Applied with December 31, 1990)

Reference ⁽¹⁾ wire diameter mm	Tensile strength kgf/mm ² {N/mm ² }		
	SWA	SWB	SWC
0.08	215 to 250 {2108 to 2452}	250 to 285 {2452 to 2795}	285 to 320 {2795 to 3138}
0.09	210 to 245 {2059 to 2403}	245 to 280 {2403 to 2746}	280 to 315 {2746 to 3089}
0.10	205 to 240 {2010 to 2354}	240 to 275 {2354 to 2697}	275 to 310 {2697 to 3040}
0.12	200 to 235 {1961 to 2305}	235 to 270 {2305 to 2648}	270 to 305 {2648 to 2991}
0.14	200 to 230 {1961 to 2256}	230 to 265 {2256 to 2599}	265 to 300 {2599 to 2942}
0.16	195 to 225 {1912 to 2206}	225 to 260 {2206 to 2550}	260 to 295 {2550 to 2893}
0.18	195 to 225 {1912 to 2206}	225 to 255 {2206 to 2501}	255 to 290 {2501 to 2844}
0.20	195 to 225 {1912 to 2206}	225 to 255 {2206 to 2501}	255 to 285 {2501 to 2795}
0.23	190 to 220 {1863 to 2157}	220 to 250 {2157 to 2452}	250 to 280 {2452 to 2746}
0.26	185 to 215 {1814 to 2108}	215 to 245 {2108 to 2403}	245 to 275 {2403 to 2697}
0.29	180 to 210 {1765 to 2059}	210 to 240 {2059 to 2354}	240 to 270 {2354 to 2648}
0.32	175 to 205 {1716 to 2010}	205 to 235 {2010 to 2305}	235 to 265 {2305 to 2599}
0.35	175 to 205 {1716 to 2010}	205 to 235 {2010 to 2305}	235 to 265 {2305 to 2599}
0.40	170 to 200 {1667 to 1961}	200 to 230 {1961 to 2256}	230 to 260 {2256 to 2550}
0.45	165 to 195 {1618 to 1912}	195 to 225 {1912 to 2206}	225 to 255 {2206 to 2501}
0.50	165 to 195 {1618 to 1912}	195 to 225 {1912 to 2206}	225 to 255 {2206 to 2501}
0.55	160 to 190 {1569 to 1863}	190 to 220 {1863 to 2157}	220 to 250 {2157 to 2452}
0.60	160 to 185 {1569 to 1814}	185 to 215 {1814 to 2108}	215 to 245 {2108 to 2403}
0.65	160 to 185 {1569 to 1814}	185 to 215 {1814 to 2108}	215 to 245 {2108 to 2403}
0.70	155 to 180 {1520 to 1765}	180 to 210 {1765 to 2059}	210 to 240 {2059 to 2354}
0.80	155 to 180 {1520 to 1765}	180 to 205 {1765 to 2010}	205 to 235 {2010 to 2305}
0.90	155 to 180 {1520 to 1765}	180 to 205 {1765 to 2010}	205 to 230 {2010 to 2256}
1.00	150 to 175 {1471 to 1716}	175 to 200 {1716 to 1961}	200 to 225 {1961 to 2206}
1.20	145 to 170 {1422 to 1667}	170 to 195 {1667 to 1912}	195 to 220 {1912 to 2157}
1.40	140 to 165 {1373 to 1618}	165 to 190 {1618 to 1863}	190 to 215 {1863 to 2108}
1.60	135 to 160 {1324 to 1569}	160 to 185 {1569 to 1814}	185 to 210 {1814 to 2059}
1.80	130 to 155 {1275 to 1520}	155 to 180 {1520 to 1765}	180 to 205 {1765 to 2010}
2.00	130 to 150 {1275 to 1471}	150 to 175 {1471 to 1716}	175 to 200 {1716 to 1961}
2.30	125 to 145 {1226 to 1422}	145 to 170 {1422 to 1667}	170 to 195 {1667 to 1912}
2.60	125 to 145 {1226 to 1422}	145 to 170 {1422 to 1667}	170 to 195 {1667 to 1912}
2.90	120 to 140 {1177 to 1373}	140 to 165 {1373 to 1618}	165 to 190 {1618 to 1863}
3.20	120 to 140 {1177 to 1373}	140 to 160 {1373 to 1569}	160 to 185 {1569 to 1814}
3.50	120 to 140 {1177 to 1373}	140 to 160 {1373 to 1569}	160 to 180 {1569 to 1765}
4.00	120 to 140 {1177 to 1373}	140 to 160 {1373 to 1569}	160 to 180 {1569 to 1765}
4.50	115 to 135 {1128 to 1324}	135 to 155 {1324 to 1520}	155 to 175 {1520 to 1716}
5.00	115 to 135 {1128 to 1324}	135 to 155 {1324 to 1520}	155 to 175 {1520 to 1716}
5.50	110 to 130 {1079 to 1275}	130 to 150 {1275 to 1471}	150 to 170 {1471 to 1667}
6.00	105 to 125 {1030 to 1226}	125 to 145 {1226 to 1422}	145 to 165 {1422 to 1618}
6.50	105 to 125 {1030 to 1226}	125 to 145 {1226 to 1422}	145 to 165 {1422 to 1618}
7.00	100 to 120 {981 to 1177}	120 to 140 {1177 to 1373}	140 to 160 {1373 to 1569}
8.00	100 to 120 {981 to 1177}	120 to 140 {1177 to 1373}	140 to 160 {1373 to 1569}
9.00	95 to 115 {932 to 1128}	115 to 135 {1128 to 1324}	135 to 155 {1324 to 1520}
10.0	95 to 115 {932 to 1128}	115 to 135 {1128 to 1324}	135 to 155 {1324 to 1520}
11.0	—	110 to 130 {1079 to 1275}	130 to 150 {1275 to 1471}
12.0	—	110 to 130 {1079 to 1275}	130 to 150 {1275 to 1471}
13.0	—	105 to 125 {1030 to 1226}	125 to 145 {1226 to 1422}

Note (1) Reference wire diameters shall be in accordance with 4.1.

Remark: Regarding an intermediate diameter, the value of the larger diameter than this shall be used.

Table 2-2. Tensile Strength
(Applied from January 1, 1991 on)

Reference wire diameter ⁽¹⁾ mm	Tensile strength N/mm ²		
	SWA	SWB	SWC
0.08	2110 to 2450	2450 to 2790	2790 to 3140
0.09	2060 to 2400	2400 to 2750	2750 to 3090
0.10	2010 to 2350	2350 to 2700	2700 to 3040
0.12	1960 to 2300	2300 to 2650	2650 to 2990
0.14	1960 to 2260	2260 to 2600	2600 to 2940
0.16	1910 to 2210	2210 to 2550	2550 to 2890
0.18	1910 to 2210	2210 to 2500	2500 to 2840
0.20	1910 to 2210	2210 to 2500	2500 to 2790
0.23	1860 to 2160	2160 to 2450	2450 to 2750
0.26	1810 to 2110	2110 to 2400	2400 to 2700
0.29	1770 to 2060	2060 to 2350	2350 to 2650
0.32	1720 to 2010	2010 to 2300	2300 to 2600
0.35	1720 to 2010	2010 to 2300	2300 to 2600
0.40	1670 to 1960	1960 to 2260	2260 to 2550
0.45	1620 to 1910	1910 to 2210	2210 to 2500
0.50	1620 to 1910	1910 to 2210	2210 to 2500
0.55	1570 to 1860	1860 to 2160	2160 to 2450
0.60	1570 to 1810	1810 to 2110	2110 to 2400
0.65	1570 to 1810	1810 to 2110	2110 to 2400
0.70	1520 to 1770	1770 to 2060	2060 to 2350
0.80	1520 to 1770	1770 to 2010	2010 to 2300
0.90	1520 to 1770	1770 to 2010	2010 to 2260
1.00	1470 to 1720	1720 to 1960	1960 to 2210
1.20	1420 to 1670	1670 to 1910	1910 to 2160
1.40	1370 to 1620	1620 to 1860	1860 to 2110
1.60	1320 to 1570	1570 to 1810	1810 to 2060
1.80	1270 to 1520	1520 to 1770	1770 to 2010
2.00	1270 to 1470	1470 to 1720	1720 to 1960
2.30	1230 to 1420	1420 to 1670	1670 to 1910
2.60	1230 to 1420	1420 to 1670	1670 to 1910
2.90	1180 to 1370	1370 to 1620	1620 to 1860
3.20	1180 to 1370	1370 to 1570	1570 to 1810
3.50	1180 to 1370	1370 to 1570	1570 to 1770
4.00	1180 to 1370	1370 to 1570	1570 to 1770
4.50	1130 to 1320	1320 to 1520	1520 to 1720
5.00	1130 to 1320	1320 to 1520	1520 to 1720
5.50	1080 to 1270	1270 to 1470	1470 to 1670
6.00	1030 to 1230	1230 to 1420	1420 to 1620
6.50	1030 to 1230	1230 to 1420	1420 to 1620
7.00	980 to 1180	1180 to 1370	1370 to 1570
8.00	980 to 1180	1180 to 1370	1370 to 1570
9.00	930 to 1130	1130 to 1320	1320 to 1520
10.0	930 to 1130	1130 to 1320	1320 to 1520
11.0	—	1080 to 1270	1270 to 1470
12.0	—	1080 to 1270	1270 to 1470
13.0	—	1030 to 1230	1230 to 1420

Note (1) Reference wire diameters shall be in accordance with 4.1.

Remark: Regarding an intermediate diameter, the value of the larger diameter than this shall be used.

3.2 Twisting Characteristic The twisting characteristic, when wires of 6.00 mm or under in wire diameter are subjected to the test of 8.3, the number of twisting and conditions of ruptured section and twisting shall be as given in Table 3.

Table 3. Number of Twisting and Conditions of Ruptured Section and Twisting

Number of twist	Wire diameter 0.08 mm and over, up to and incl. 2.00 mm	20 min.
	Wire diameter Over 2.00 mm, up to and incl. 3.50 mm	15 min.
	Wire diameter Over 3.50 mm, up to and incl. 6.00 mm	10 min.
Condition of ruptured section	Ruptured section shall be at right angles with wire axis, and be free from remarkable flaws and cracks.	
Condition of twisting	Remarkable longitudinal crack, flaw and local twisting shall not be generated.	

3.3 Coiling The coiling shall be tested in accordance with 8.4 on the wires of 6.00 mm or under in wire diameter, and neither harmful flaw nor breakage shall be generated on the surfaces of the wires.

3.4 Bending The bending shall be tested in accordance with 8.5 on the wires of over 6.00 mm in wire diameter, and neither harmful flaw nor breakage shall be generated on the surfaces of the wires.

4. Wire Diameter and Tolerances

4.1 Reference Wire Diameters The reference wire diameters shall be as shown in Table 4.

Table 4. Reference Wire Diameters

Unit: mm										
0.08	0.09	0.10	0.12	0.14	0.16	0.18	0.20	0.23	0.26	0.29
0.32	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.80	0.90
1.00	1.20	1.40	1.60	1.80	2.00	2.30	2.60	2.90	3.20	3.50
4.00	4.50	5.00	5.50	6.00	6.50	7.00	8.00	9.00	10.0	11.0
12.0	13.0									

4.2 Tolerances on Wire Diameters The tolerances on wire diameters shall be as given in Table 5 when tested in accordance with 8.6.

Table 5. Tolerances on Wire Diameters

Unit: mm

Wire diameter	Tolerances
0.08 and over, up to and incl. 0.10	± 0.005
Over 0.10, up to and incl. 0.20	± 0.010
Over 0.20, up to and incl. 0.50	± 0.015
Over 0.50, up to and incl. 1.00	± 0.020
Over 1.00, up to and incl. 2.00	± 0.030
Over 2.00, up to and incl. 3.20	± 0.040
Over 3.20, up to and incl. 5.50	± 0.050
Over 5.50, up to and incl. 13.0	± 0.060

5. Appearance

The appearance of the wires shall be practically true circular form in section, and their surface be smooth, and free from harmful flaws and other defects.

6. Material

The material to be used for manufacture of the wires shall be the wire rods conforming to JIS G 3506.

7. Manufacturing Method

In the manufacture of the wires, cold working shall be carried out, after having been processed with heat treatment.

8. Tests

8.1 Sampling Method of Test Pieces The sampling method shall be as given in the following:

- (1) For the test pieces, each one test piece for (2) to (5) shall be taken from one end of the wire.
- (2) The tension test piece shall have an appropriate length which is capable of being subjected to the test of 8.2.
- (3) The twisting test piece shall have an appropriate length which is capable of being subjected to the testing of 8.3.
- (4) The coiling test piece shall have an appropriate length which is capable of being subjected to the testing of 8.4.

- (5) The bending test piece shall have an appropriate length which is capable of being subjected to the testing of 8.5.

8.2 Tension Test The tension test shall be carried out in accordance with the specifications of JIS Z 2241, and the grip distance shall be approximately 100 mm for wires of under 1.00 mm in wire diameter, and be approximately 200 mm for wires of 1.00 mm or over in wire diameter.

Furthermore, in the case where the test piece has been broken at the gripped position, the test shall be invalidated, and retest shall be carried out further taking the test piece from the same wire.

8.3 Twisting Test In the twisting test, grip firmly both ends of the test piece at a gripping distance of 100 times the wire diameter, rotate one of these until it breaks while so tensioning as not to be bent, and investigate the number of twistings, condition of ruptured section, and condition of twisting.

In addition, number of twistings, in the case of testing under a gripping distance other than 100 times the wire diameter, shall be increased or decreased in direct proportion to gripping distance, and be converted to number of times in the case of 100 times the wire diameter.

8.4 Coiling Test In the coiling test, wind the test piece more than two times around a mandrel of the same diameter as the wire diameter, and investigate the surface condition of the wire.

8.5 Bending Test In the bending test, bend the test piece at two places in different direction, along a circular arc whose radius is of its diameter, and investigate the surface condition of the wire, bending it to a bending angle of 90 deg.

8.6 Measurement of Wire Diameter In the measurement of wire diameter, the maximum diameter and the minimum diameter at an arbitrary place shall be measured.

9. Inspection

Inspection shall be as follows:

- (1) The inspection on the mechanical properties and wire diameters shall be carried out in accordance with 8., and the results shall conform to the requirements of 3. and 4.

In addition, the inspection on the appearance shall be carried out by an appropriate method, and the results shall conform to the requirements of 5.

- (2) In the case where the results of tension test and twisting test have not conformed to the specified values, retest can be performed when the purchaser's approval is given. In this case, two test pieces shall be taken and every test results shall conform to the specification.

- (3) The sampling plan in the sampling inspection shall be as agreed between the parties concerned.

10. Marking

The wires which have passed the inspection shall be marked with the following information on each one line.

- (1) Symbol of wire rod used in manufacture of wire
- (2) Symbol of class
- (3) Wire diameter
- (4) Manufacturer's name or its abbreviation