

Piano wires

1. Scope

This Japanese Industrial Standard specifies the piano wires (hereafter referred to as the "wires").

Remarks 1. Applicable standards to this Standard shall be given as follows.

JIS G 0558 Methods of Measuring Decarburized Depth
for Steel

JIS G 3502 Piano Wire Rods

JIS K 1310 Hydrochloric Acid

JIS Z 2241 Method of Tensile Test for Metallic
Materials

2. Corresponding International Standards to this Standard shall be given as follows.

ISO 8458-1 : 1989 Steel wire for mechanical springs
(Part 1)

ISO 8458-2 : 1989 Steel wire for mechanical springs
(Part 2)

2. Classes, symbols and applied wire diameters

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

Reference Standards:

JIS B 2704-Design of Helical Compression and Extension Springs

JIS B 2709-Design of Helical Torsion Springs

Table 1. Classes, symbols and applied wire diameters

Class	Symbol	Applied wire diameter	Application
Piano wire, class A	SWP-A	0.08 mm or over up to and incl. 10.0 mm	for spring receiving principally dynamic load
Piano wire, class B	SWP-B	0.08 mm or over up to and incl. 7.00 mm	
Piano wire, class V	SWP-V	1.00 mm or over up to and incl. 6.00 mm	for valve spring or spring according thereto

3. Mechanical properties

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

Table 2. Tensile strength

Reference diameter of wire (1) mm	Tensile strength N/mm ²		
	SWP-A	SWP-B	SWP-V
0.08	2890 to 3190	3190 to 3480	-
0.09	2840 to 3140	3140 to 3430	-
0.10	2790 to 3090	3090 to 3380	-
0.12	2750 to 3040	3040 to 3330	-
0.14	2700 to 2990	2990 to 3290	-
0.16	2650 to 2940	2940 to 3240	-
0.18	2600 to 2890	2890 to 3190	-
0.20	2600 to 2840	2840 to 3090	-
0.23	2550 to 2790	2790 to 3040	-
0.26	2500 to 2750	2750 to 2990	-
0.29	2450 to 2700	2700 to 2940	-
0.32	2400 to 2650	2650 to 2890	-
0.35	2400 to 2650	2650 to 2890	-
0.40	2350 to 2600	2600 to 2840	-
0.45	2300 to 2550	2550 to 2790	-
0.50	2300 to 2550	2550 to 2790	-
0.55	2260 to 2500	2500 to 2750	-
0.60	2210 to 2450	2450 to 2700	-
0.65	2210 to 2450	2450 to 2700	-
0.70	2160 to 2400	2400 to 2650	-
0.80	2110 to 2350	2350 to 2600	-
0.90	2110 to 2300	2300 to 2500	-
1.00	2060 to 2260	2260 to 2450	2010 to 2210
1.20	2010 to 2210	2210 to 2400	1960 to 2160
1.40	1960 to 2160	2160 to 2350	1910 to 2110
1.60	1910 to 2110	2110 to 2300	1860 to 2060
1.80	1860 to 2060	2060 to 2260	1810 to 2010
2.00	1810 to 2010	2010 to 2210	1770 to 1910
2.30	1770 to 1960	1960 to 2160	1720 to 1860
2.60	1770 to 1960	1960 to 2160	1720 to 1860
2.90	1720 to 1910	1910 to 2110	1720 to 1860
3.20	1670 to 1860	1860 to 2060	1670 to 1810
3.50	1670 to 1810	1810 to 1960	1670 to 1810
4.00	1670 to 1810	1810 to 1960	1670 to 1810
4.50	1620 to 1770	1770 to 1910	1620 to 1770
5.00	1620 to 1770	1770 to 1910	1620 to 1770
5.50	1570 to 1710	1710 to 1860	1570 to 1720
6.00	1520 to 1670	1670 to 1810	1520 to 1670
6.50	1520 to 1670	1670 to 1810	-
7.00	1470 to 1620	1620 to 1770	-
8.00	1470 to 1620	-	-
9.00	1420 to 1570	-	-
10.0	1420 to 1570	-	-

Note (1) Reference diameter of wires shall be in accordance with 4.1.

Remarks: For the wire of intermediate diameter, the value in this table for the nearest larger size than that shall be applied.

3.2 Coiling The coiling of wires shall be tested in accordance with 8.3 on the wires of less than 0.70 mm in wire diameter, and neither harmful flaw nor breakage shall be generated on the surfaces of the wires.

3.3 Twisting characteristic Twisting characteristic of wires shall be tested for the wires whose diameter are 0.70 mm or over up to and including 6.00 mm in accordance with 8.4 and the number of twists shall be shown in Table 3. In that case, the fracture shall be normal to the axis and shall be free from flaws, cracks, etc.

The condition of twisting shall be uniform over all the length and the wires shall be free from flaws and local twisting. Further, it shall not be remarkably spiral.

Table 3. Number of twists

Symbol of class	Wire diameter	Number of twists
SWP-A or SWP-B	0.70 mm or over up to and incl. 2.00 mm in wire diameter	25 times or more
	Over 2.00 mm up to and incl. 3.50 mm in wire diameter	20 times or more
	Over 3.50 mm up to and incl. 6.00 mm in wire diameter	15 times or more
SWP-V	1.00 mm or over up to and incl. 6.00 mm in wire diameter	25 times or more

3.4 Bend The bend test shall be applied in accordance with 8.5 to the wire over 6.00 mm in diameter, and shall be free from detrimental flaws on its surface and shall also withstand breaking.

4. Wire diameter and tolerances

4.1 Reference diameter of wires The reference diameters of wires shall be as given in Table 4.

Table 4. Reference diameter of wires

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							

4.2 Tolerances and permissible deviations on wire diameters Diameters of wires shall be tested in accordance with 8.6 and their tolerances and permissible deviations on wire diameters ⁽²⁾ shall be as given in Table 5.

Note ⁽²⁾ The permissible deviation on wire diameter means the difference between the maximum and minimum values of diameter on the same section of wire.

Table 5. Tolerances and permissible deviations on wire diameters

Unit: mm

Wire diameter	Tolerance	Permissible deviation on diameter
0.08 or over up to and incl. 0.20	± 0.004	0.004 max.
Over 0.20 up to and incl. 0.50	± 0.008	0.008 max.
Over 0.50 up to and incl. 1.00	± 0.010	0.010 max.
Over 1.00 up to and incl. 2.00	± 0.015	0.015 max.
Over 2.00 up to and incl. 3.20	± 0.020	0.020 max.
Over 3.20 up to and incl. 5.50	± 0.030	0.030 max.
Over 5.50 up to and incl. 8.50	± 0.040	0.040 max.
Over 8.50 up to and incl. 10.0	± 0.050	0.050 max.

5. Surface conditions

5.1 Appearance The surface of wires shall be smooth and free from detrimental defects such as flaws and others.

5.2 Flaw The flaw detection test shall be applied in accordance with 8.7 to the wire 1.00 mm and over in diameter, and the permissible limit of depth of flaws shall be as given in Table 6.

Table 6. Permissible depth of flaw

Unit: mm

Diameter of wire	Permissible depth of flaw	
	SWP-A, SWP-B	SWP-V
1.00 or over up to and incl. 2.00	0.02 max.	0.01 max.
Over 2.00 up to and incl. 3.00	0.03 max.	0.02 max.
Over 3.00 up to and incl. 4.00	0.04 max.	0.02 max.
Over 4.00 up to and incl. 5.00	0.05 max.	0.03 max.
Over 5.00 up to and incl. 6.00	0.06 max.	0.03 max.
Over 6.00 up to and incl. 8.00	0.07 max.	-
Over 8.00 up to and incl. 10.0	0.08 max.	-

5.3 Decarburized layer Wires of 0.70 mm or over in wire diameter are tested in accordance with 8.8 for the decarburized layer of wires, and the condition for the decarburized layer shall be as given in Table 7.

Table 7. Condition of decarburized layer

Symbol of class	Condition of decarburized layer
SWP-A or SWP-B	Detrimental decarburized layer shall not be observed.
SWP-V	Ferritic carburized layer shall not be observed. The depth of the total decarburized layer shall be 1.5 % or under of the diameter, and its maximum value shall be 0.05 mm.

6. Material

The wire rod conforming to the specification of JIS G 3502 shall be used for manufacturing the wire. However, the copper content of the wire rod for class V shall be 0.15 % or under.

7. Method of manufacture

Wires shall be cold processed after patenting treatment.

8. Test

8.1 Sampling of test piece One test piece each for a tensile test, a coiling test, a twisting test, a bend test, a flaw detecting test, and a decarburized layer depth measuring test shall be taken from one end of the wire. However, though the decarburized layer depth measuring test piece of class A and class B shall be taken from one end of one line of the wire representing a lot manufactured continuously under the same conditions, sampling may be further adopted as agreed upon between the parties concerned.

8.2 Tensile test The test method shall comply with JIS Z 2241, and the distance between both grips shall be approximately 100 mm for the wire less than 1.00 mm in diameter and be approximately 200 mm for that of 1.00 mm and over.

In case the test piece breaks at the gripping portion, the test results shall be regarded as invalid and a retest shall be made on the additional test pieces sampled again from the same wire.

8.3 Coiling test For a coiling test, a test piece is coiled 4 turns or over around a core of the same diameter as a wire diameter, and the presence of fracture and the condition for generation of flaws shall be examined.

8.4 Twisting test Near both ends of a test piece, it shall be gripped firmly with a distance of 100 times the diameter of the wire, one end of a test piece shall be turned in the same direction being stretched not to bend until it fractures, then the number of twists, conditions of fractured section and twist shall be examined.

When the test is made with a gripping distance other than 100 times the diameter of the wire, the number of twists shall be varied in direct proportion to the gripping distance. In this case, the number to be twisted shall be calculated according to that of 100 times diameter for the wire.

8.5 Bend test The test piece shall be bent at two places in directions different from each other through an angle of 90° around an arc with a radius of the wire diameter, and then the presence of fracture and the condition for generation of flaws shall be examined.

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

8.7 Flaw detection test The residual stress relieved test piece of suitable length shall be immersed approximately 200 mm into a boiling solution that is of adequate concentration and composed of hydrochloric acid conforming to JIS K 1310 and water, and then the test piece shall be examined for the existence of flaws after 1 % of the diameter of the wire being reduced without pitting.

To determine the depth of flaw, usually, the irregular part is cut off until it disappears, then measurement is made on the depth of removed part by a micrometer.

8.8 Decarburized layer depth measuring test A decarburized layer depth measuring test shall be performed in accordance with JIS G 0558. The cross section of a test piece is polished, and the condition of decarburization shall be examined with a microscope of 100 to 500 magnification after etching.

8.9 Retest In the case where the result of a tensile test or a twisting test does not conform to a specific value, a retest may be performed. In that case, two test pieces shall be taken again and all the results shall conform to the specified requirements.

9. Inspection

The inspection shall be as follows.

- (1) Mechanical properties shall conform to the requirements specified in 3.
- (2) Wire diameter shall conform to the requirements specified in 4.
- (3) Surface condition shall conform to the requirements specified in 5.

10. Marking

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

11. Report

In the case where requested by the purchaser, the manufacturer shall present the records of specified items.