Automotive Parts - Control Cables

1. Scope

This standard specifies automotive control cables (hereinafter referred to as "cables") used mainly for tensile forces.

2. Normative reference

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

JIS B0205 (group of standards)	ISO general purpose metric screw threads
JIS B0209 (group of standards)	ISO general purpose metric screw threads-Tolerances
JIS B0403	Castings - System of dimensional tolerances and machining allowances
JIS B0405-1	General tolerances - Part 1: Tolerances for linear and angular dimensions without individual tolerance indications
JIS B0408	General dimensional tolerances for parts formed by press working from sheet metal
JIS B0410	General tolerances for parts formed by shear from metal plates
JIS B0415	Dimensional Tolerance for Steel Die Forgings (Hammer and Press Forging)
JIS B0416	Dimensional Tolerance For Steel Die Forgings (Upsetting)
JIS B1002	Dimensions of Width Across Flats
JIS B1180	Hexagon head bolts and hexagon head screws
JIS B1181	Hexagon nuts and hexagon thin nuts
JIS D0201	Automobile parts - General rules of electroplating
JIS G3101	Rolled steel for general structure
JIS G3131	Hot-rolled mild steel plates, sheets and strips
JIS G3141	Cold-reduced carbon steel sheets and strips
JIS G3506	High carbon steel wire rods
JIS G3521	Hard drawn steel wires
JIS G3525	Wire ropes
JIS G3535	Wire ropes for aircraft control
JIS G4051	Carbon steel for machine structural use
JIS G4308	Stainless steel wire rods
JIS H3201:1976	Brass sheets
JIS H3422:1976	Free cutting brass bars
JIS H5301	Zinc alloy die castings
JIS Z2241	Method of tensile test for metallic materials

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3. Names of major components

Names of the major components of cables are indicated in **Table 1**.

Table 1 Names of major components

No.	Component name	Examples of assemblies (Reference)	No.	Component name	Examples of assemblies (Reference)
1	Inner cable	**Figures 1 to 4**	6	Adjusting bolt	**Figures 1 to 4**
2	Outer casing		7	Adjusting nut	
3	Cable end		8	Casing protector	
4	Connector		9	Dust cover	
5	Casing cap				

Note:

The number indicates the component shown in the assembly examples illustrated in **Figures 1 to 4**.

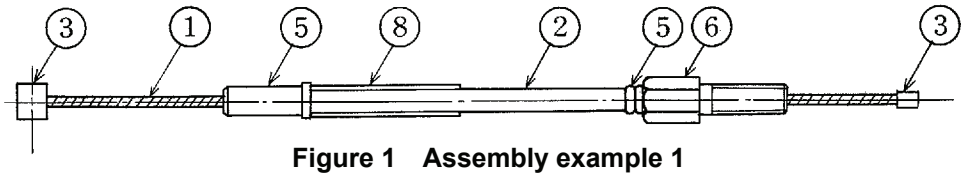

Figure 1 Assembly example 1

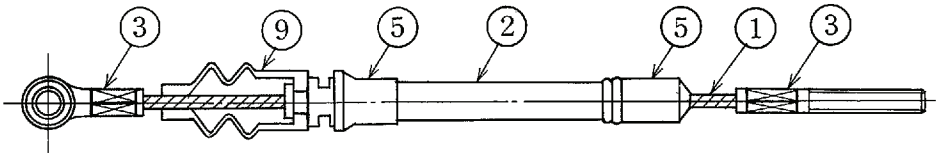

Figure 2 Assembly example 2

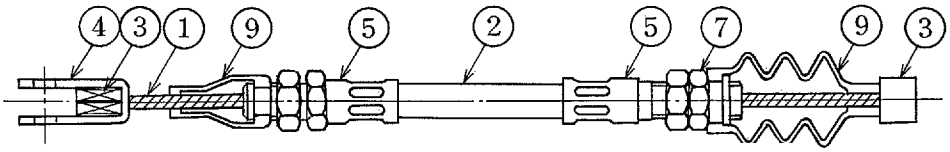

Figure 3 Assembly example 3

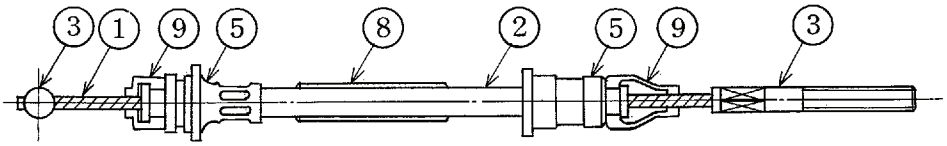

Figure 4 Assembly example 4

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4. Types of major components

Types of major cable components are indicated in **Table 2**.

Table 2 Types of major components

No.	Component Name	Type		Remarks	Applicable Annex Table
1	Inner cable	Stranded cable	Single-strand	Good breaking load performance for same outside diameter	**Table A.1** **Table A.2**
			Multi-strand	For same outside diameter, good bending property	
		Coated wire		Good operating efficiency and corrosion resistance	**Table A.3**
		Single wire		-	**Table A.4**
2	Outer casing	-		-	**Table A.5**
		Plastic tube		-	**Table A.6**
3	Cable end	Type A1		Drum type (soldered)	**Table A.7**
		Type A2		Drum type (cast)	
		Type B1		I type (crimped)	**Table A.8**
		Type B2		I type (cast)	
		Type C1		Round tube type (soldered)	**Table A.9**
		Type C2		Round tube type (crimped or cast)	
		Type C3		Square tube type (crimped)	
		Type C4		Spherical type (crimped, soldered, or cast)	
		Type D1		Screw type (The crimped part is same as thread rolling diameter.)	**Table A.10**
		Type D2		Screw type (The crimped part is larger than thread rolling diameter)	
4	Connector	Type A1		Clevis type (uniform opening)	**Table A.11**
		Type A2		Clevis type (with opening that narrows)	
		Type B		-	**Table A.12**
5	Casing cap	Type A1		Tubular type (by pressing)	**Table A.13**
		Type A2		Tubular type (by machining)	
		Type B1		Tubular type (with flange)	**Table A.14**
		Type B2		Tubular type (with flange and dust cover groove)	
		Type C1		Screw type	**Table A.15**
		Type C2		Screw type (with hexagonal part)	
		Type D1		U-clamp type	**Table A.16**
		Type D2		U-clamp type (E-ring type)	**Table A.17**
		Type D3		Clamp type	**Table A.18**
		Type D4		Press-fit type	**Table A.19**
6	Adjusting bolt	-		-	**Table A.20**
7	Adjusting nut	-		-	**Table A.21**
8	Casing protector	-		-	**Table A.22**
9	Dust cover	Type A1		Boot type	**Table A.23**
		Type A2		Boot type	
		Type B		-	**Table A.24**

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5. Major component materials and surface treatments

Major component materials and surface treatments of cables shall generally be as indicated in **Table 3**.

Table 3 Major component materials and surface treatments

No.	Component Name	Type	Material	Surface Treatment
1	Inner cable	Stranded cable	**JIS G3506**, SWRH57 to 82	As specified in **JIS G3535**, 4.8
			JIS G4308, SUS304WR or SUS302WR	-
		Coated wire	Synthetic resin (coating material)	-
		Single wire	**JIS G3521**, SW	As specified in **JIS G3535**, 4.8
2	Outer casing	-	**JIS G3506**, SWRH57 to 82	As specified in **JIS G3535**, 4.8
			Synthetic resin, black	-
		Plastic tube	Synthetic resin	-
3	Cable end	Type A1	**JIS H3422**:1976, BsBM	-
		Type A2	**JIS H5301**, ZDC	-
		Type B1	**JIS G4051**, S15C to S35C	**JIS D0201**, MFZn5-B or MFZn5-C
		Type B2	**JIS H5301**, ZDC	-
		Type C1	**JIS H3422**:1976, BsBM	-
		Type C2	**JIS G4051**, S15C to S 35C	**JIS D0201**, MFZn5-B or MFZn5-C
			JIS H5301, ZDC	-
		Type C3	**JIS G4051**, S15C to S35C	**JIS D0201**, MFZn5-B or MFZn5-C
		Type C4	**JIS G4051**, S15C to S35C	**JIS D0201**, MFZn5-B or MFZn5-C
			JIS H3422:1976, BsBM	-
			JIS H5301, ZDC	-
		Type D1 Type D2	**JIS G4051**, S15C to S35C	**JIS D0201**, MFZn5-B or MFZn5-C
4	Connector	Type A1 Type A2 Type B	**JIS G3131**, SPHC	**JIS D0201**, MFZn5-B or MFZn5-C
			JIS G3141, SPCC	
5	Casing cap	Type A1	**JIS H3201**:1976, BsP	-
			JIS G3141, SPCC	**JIS D0201**, MFZn5-B or MFZn5-C
		Type A2	**JIS H3422**:1976, BsBM	-
			JIS G3101, SS or free-cutting steel	**JIS D0201**, MFZn5-B or MFZn5-C
		Type B1	**JIS H3422**:1976, BsBM	-
			JIS G3101, SS or free-cutting steel	**JIS D0201**, MFZn5-B or MFZn5-C
		Type B2	**JIS H3422**:1976, BsBM	-
			JIS G3101, SS or free-cutting steel	**JIS D0201**, MFZn5-B or MFZn5-C
			JIS H5301, ZDC	-
		Type C1 Type C2	**JIS H3422**:1976, BsBM	-
			JIS G3101, SS or free-cutting steel	**JIS D0201**, MFZn5-B or MFZn5-C
		Type D1 Type D2 Type D3	**JIS H5301**, ZDC	-
			JIS G3101, SS or free-cutting steel	**JIS D0201**, MFZn5-B or MFZn5-C
		Type D4	**JIS G3101**, SS or free-cutting steel	
6	Adjusting bolt		**JIS G3101,** SS or free-cutting steel	**JIS D0201**, MFZn5-B or MFZn5-C
7	Adjusting nut		**JIS G3101,** SS or free-cutting steel	**JIS D0201**, MFZn5-B or MFZn5-C
8	Casing protector		Synthetic resin or rubber, black	-
9	Dust cover	Type A1 Type A2	Synthetic resin or rubber, black	-
		Type B		

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6. Shapes and dimensions of major components

The shapes and dimensions of major cable components shall be as indicated in **Annex A**.

7. Quality

Cable quality shall be as specified hereinafter.

7.1 Appearance

The appearance shall be as follows:

a) Components shall be free of flaws, crimps, cracks, rust, warpage, burrs, and other defects that are detrimental to use.

b) Component surface treatments shall meet the requirements in **5**.

c) An appropriate lubricant shall be applied to inner cables or filled in the outer casings of cables. The type of lubricant shall be as agreed between the parties concerned.

7.2 Dimensions and tolerances

Dimensions and tolerances shall be as follows:

a) Dimensions and tolerances of components shall meet the requirements in **Tables A.1 to A.24**. Crimped-type cable ends, however, shall normally be internally chamfered prior to being crimped in order to prevent a decrease in strength.

b) Unless otherwise specified, dimensional tolerances shall be as indicated in **Table 4**.

Table 4 Dimensional tolerances

Processing type	Applicable standard
General tolerance (cutting)	**JIS B0405** medium or coarse grade
General tolerance (forging)	**JIS B0415** standard grade and **JIS B0416**
General tolerance (pressing)	**JIS B0408** grade B or C
General tolerance (die casting)	**JIS B0403** standard grade
General tolerance (shearing)	**JIS B0410** grade B
Dimensions of width across flats	**JIS B1002** class 2

c) Thread precision shall conform to class 2 or 3 of the **JIS B0209** group of standards. Furthermore, when surface treatment is provided, thread precision shall conform to **JIS B1180** or **JIS B1181**.

d) Dimensional tolerances of assemblies shall be as indicated in **Tables 5 and 6**.

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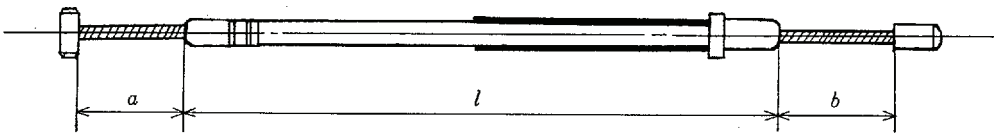
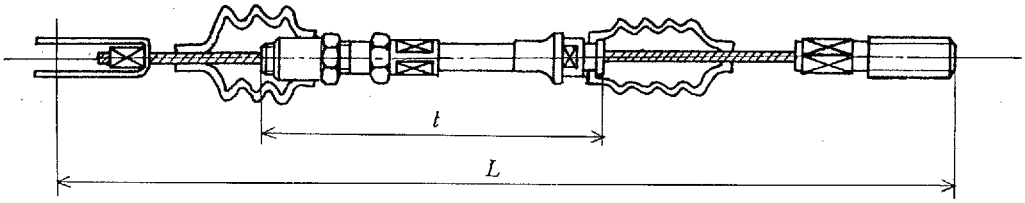
Table 5 Dimensional tolerance when dust cover is not provided



Unit: mm

l		*a+b*	
Nominal	Tolerance	Tolerance	
		100 and under	Over 100
500 and under	±2	±1.5	±2.0
Over 500 up to 1000	±3	±2.0	±2.5
Over 1000 up to 2000	±4	±2.5	±3.0
Over 2000 up to 3000	±5		

Table 6 Dimensional tolerance when dust cover is provided



Unit: mm

L and *l*	
Nominal	Tolerance
500 and under	±2
Over 500 up to 1000	±3
Over 1000 up to 2000	±4
Over 2000 up to 3000	±5

7.3 Performance

Cables shall provide the following performance:

a) Cables shall operate smoothly in a linear condition.

b) In assemblies, the breaking loads for inner cables, and the detachment loads for cable ends and casing caps, shall meet the requirements indicated in **Tables A.1, A.4, A.7, A.8, A.9, A.10, A.12, A.13, A.14, A.15, A.16, A.17, A.18, and A.19**.

c) Cables shall meet the requirements of the operating efficiency and other practical performance in accordance with the intended use.

8. Test methods

Methods used to test cables shall be as specified hereinafter. Details of strength tests shall conform to **JIS Z2241** (Method of tensile test for metallic materials).

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8.1 Inner cable breaking test

Using a suitable method, firmly secure the both ends of the test piece to the testing machine clamps at intervals of at least 250 mm apart. Apply tension at a rate not exceeding 50 mm/min until breaking occurs. Measure the breaking load at that time. If, during this test, any of the test pieces do not achieve the breaking load specified in **Tables A.1 and A.4** and break at the clamp area, obtain another test piece to retest.

8.2 Inner cable elongation test

Using a suitable method, firmly secure the both ends of the test piece to the testing machine clamps. Applying a load equivalent to about 2 % of the breaking load specified in **Table A.1**, establish a gauge length (ℓ_1) of 250 mm or more. Apply a tensile load at a rate not exceeding 50 mm/min, and measure the gauge length (ℓ_2) when the load is about 60 % of the specified breaking load. Return the load to the original 2 % (approximate) load, and measure the gauge length (ℓ_3) at that time. The elongation under load (total elongation) and elongation after removal of the load (permanent elongation) can then be determined.

Total elongation, permanent elongation, and elastic elongation are expressed in the following equations:

Total elongation (%) = $\frac{\ell_2 - \ell_1}{\ell_1} \times 100$

Permanent elongation (%) = $\frac{\ell_3 - \ell_1}{\ell_1} \times 100$

Elastic elongation (%) = (Total elongation) - (Permanent elongation) = $\frac{\ell_2 - \ell_3}{\ell_1} \times 100$

8.3 Cable end and casing cap detachment test

Firmly secure one end of the test piece to a clamp of the test machine, using a method that will enable measurement of the detachment load, and firmly secure the other end as well, using a suitable method. At a rate not exceeding 50 mm/min, apply a tensile load until the cable end or casing cap is detached. Measure the detachment load at that time.

If, during this test, any of the test pieces do not achieve the detachment load specified in **Tables A.7, A.8, A.9, A.10, A.12, A.13, A.14, A.15, A.16, A.17, A.18, and A.19** and break at an area other than the cable end or casing cap, obtain another test piece to retest.

8.4 Operating efficiency test

The operating efficiency shall be indicated with load efficiency η_w and stroke efficiency η_s. As shown in **Figure 5**, attach a 1000-mm-long outer casing at a fixed distance of 400 mm and bending angle of 180°. A 1500-mm-long inner cable shall be inserted in it beforehand. Secure one end of the cable via a spring of spring constant *K*. Gradually increase tensile load to the other end, measure the fixed-side load *W*, displacement δ_1, tension-side load *F*, displacement δ_2, and apparent permanent elongation δ_0 after removal of tension-side load *F*. If a load efficiency test is performed, fixed-side load *W* can be used as a constant load.

Load efficiency and stroke efficiency shall be calculated as indicated hereinafter.

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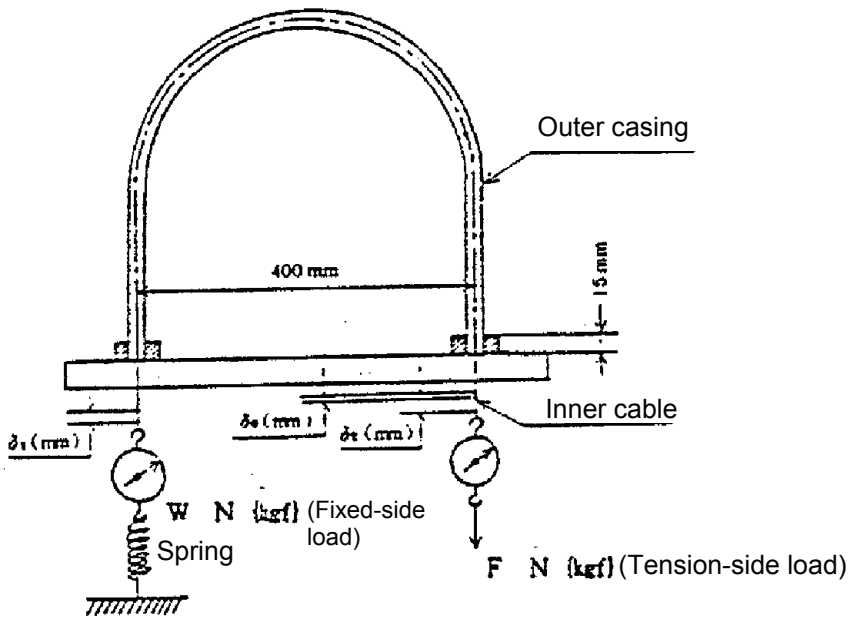

Figure 5 Operating efficiency test method

a) Load efficiency Load efficiency shall be expressed by the following equations (**Figure 6**):

1) If inner cable is secured via spring:

$$\eta_W(\%) = \frac{AreaOCD}{AreaOABD} \times 100$$

If, however, initial tensile force W_0 is applied, the load efficiency shall be expressed by the following equiation:

$$\eta_{wo-w}(\%) = \frac{AreaGFCD}{AreaGEBD} \times 100$$

Values W and W_0 shall be as agreed between the parties concerned.

1) If fixed-side load W is constant load:

$$\eta_w(\%) = \frac{W}{F} \times 100$$

The value of constant load W shall be as agreed between the parties concerned.

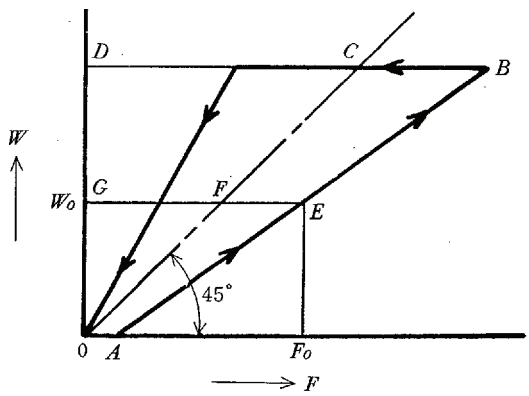

Figure 6 Load efficiency diagram

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b) Stroke efficiency Stroke efficiency shall be expressed by the following equation (**Figure 7**):

$$\eta_S(\%) = \frac{\delta_1}{\delta_2 - \delta_0} \times 100$$

The value of apparent permanent elongation δ_0 shall also be indicated. Also, values *W* and *K* shall be as agreed between the parties concerned.

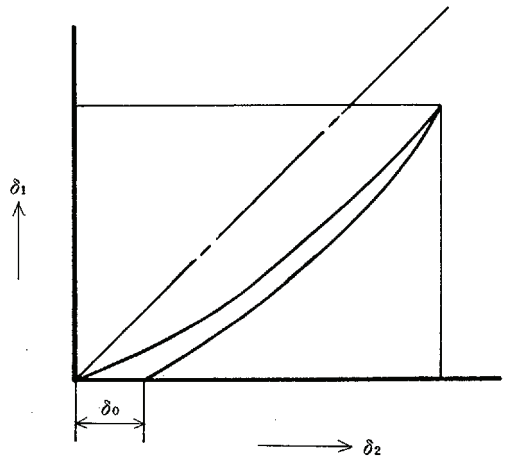

Figure 7 Stroke efficiency diagram

9. Inspections

9.1 Inspection items

The following cable inspections shall be performed:

a) Material inspection

b) Appearance inspection

c) Dimensional inspection

d) Performance inspection

9.2 Material inspection

Materials shall conform to the requirements in **5**.

9.3 Appearance inspection

Appearance shall conform to the requirements in **7.1**.

9.4 Dimensional inspection

Dimensions of components and assemblies shall conform to the requirements in **7.2**.

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Annex A
(normative)
Shapes and dimensions of major components

Table A.1 Inner cable (stranded cable)

Unit: mm

Inner cable diameter		Single-strand					Multi-strand				
			Reference					Reference			
			Strand configuration		Elongation (%)			Strand configuration		Elongation (%)	
Nominal	Tolerance	Breaking load (N min.)	Configuration	Std. strand dia.	Elastic	Permanent	Breaking load (N min.)	Configuration	Std. strand dia.	Elastic	Permanent
1.2	+0.12 0	1 471	1×12	0.30	0.8	0.2	1 177	7×7	0.14	0.9	0.2
1.5	+0.15 0	2 354	1×7	0.50			1 766	7×7	0.17		
			(1×12)	(0.38)							
			1×19	0.30							
2.0	+0.20 0	4 119	1×19	0.40			3 041	7×7	0.22		
2.5	+0.20 0	6 179	1×19	0.50			4 708	7×7	0.28		
3.0	+0.24 0	8 336	1×19	0.60			6 865	7×7	0.35		
								7×19	0.20		
								(12+7×7)	(0.30)		
3.5	+0.28 0	10 788	1×19	0.70	0.9		9 023	7×7	0.40	1.1	
								(19+7×7)	(0.30) (0.34)		
4.0	+0.32 0	14 710	1×37	0.57			11 768	7×7	0.45		

Note 1: The stranding method can be either standard S or standard Z as prescribed in **JIS G3525** (Wire ropes). Inner cables, however, shall be the preformed stranded ones as prescribed in **JIS G3535** (Wire ropes for aircraft control).
Note 2: The diameter of the inner cable shall be the diameter of the inner cable's circumscribed circle.
Note 3: The elongation shall be the value measured using the test method in **8.2**.
Note 4: If rolled wire is to be wound in the inner cable, the dimensions and configuration (form) shall be as agreed between the parties concerned.
Note 5: Avoid the use of dimensions enclosed by parentheses.

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Table A.2 Cross section and configuration of inner cable

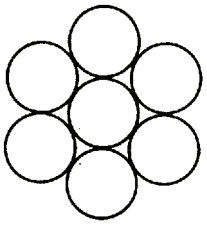
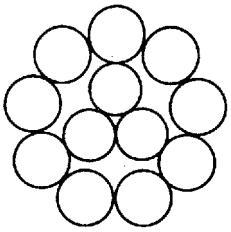
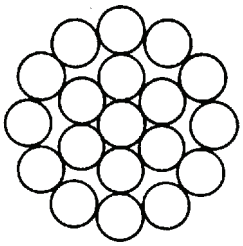
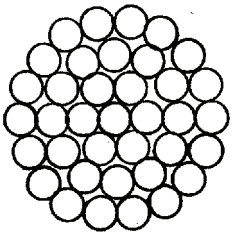
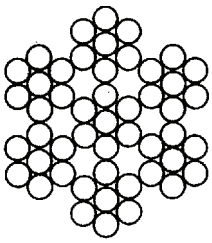
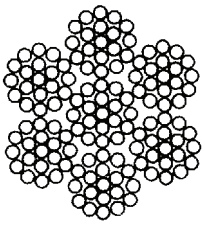
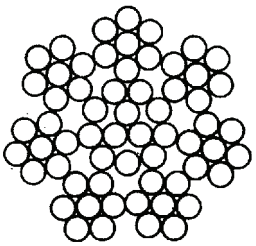
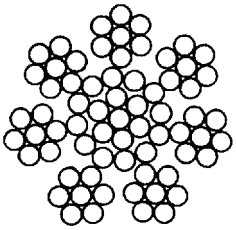
Single-strand	Cross section			
	Configuration	1×7	1×12	1×19
	Cross section		-	-
	Configuration	1×37	-	-
Multi-strand	Cross section			
	Configuration	7×7	7×19	(12+7×7)
	Cross section		-	-
	Configuration	(19+7×7)	-	-

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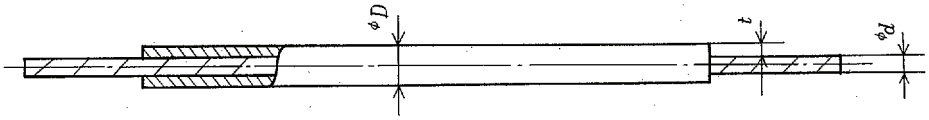
Table A.3 Inner cable (coated wire)



Unit: mm

Inner cable diameter (*d*)	Coat finish diameter (*D*)		Min. wall thickness (*t*)
	Size	Tolerance	
1.2	1.8	+0.2 -0.1	0.15
1.5	2.1		
2.0	2.6		
2.5	3.1		
3.0	3.8		0.2
3.5	4.3		
4.0	4.8		
Note: Inner cables (stranded wires) used for inner cables (coated wire) shall be as specified in **Tables A.1 and A.2**.			

Table A.4 Inner cable (single wire)

Unit: mm

Inner cable diameter		Breaking load N
Nominal	Tolerance	
1.2	±0.05	As specified in **JIS G3521**
1.5		
1.6		

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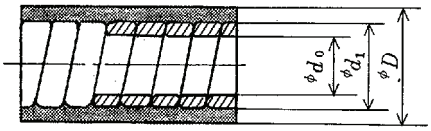
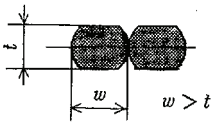
Table A.5 Outer casing



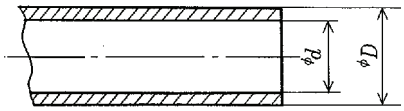
Shape of cross section



Applicable inner cable		D	d_0		d_1	Reference	
Uncoated diameter	Coated finish diameter		Size	Tolerance		Standard strand diameter	Min. cover thickness
1.2	-	5	2.4	±0.2	3.6	1.0 1.2	0.4
1.4	-						
1.5	1.8						
1.6	-						
1.5	1.8	6	2.9		4.7	1.6 1.7	0.4
2.0	2.1						
2.5	2.6	7	3.8		5.6	1.6 1.7	0.4
3.0	3.1	7	3.8		5.6	1.6 1.7	0.4
		8	4.3		6.1	1.6 1.7	0.6
		9	4.8		7.2	1.8 2.0	
		10	4.8		7.2	1.8 2.0	0.6
3.5	3.8	9	4.8		7.2	1.8 2.0	0.6
		10	4.8		7.2	1.8 2.0	0.6
		10	5.2		8.1	2.2	0.8
4.0	4.3	12	5.4		8.5	2.6	1.1
	4.8	12	5.9		9.0	2.6	1.1
		13	6.2		9.8	3.0	1.1

Note 1: Direction of winding for the outer casing can be either an S twist or Z twist.
Note 2: The outer casing end surfaces shall be provided with internal slight-chamfering.
Note 3: "Standard strand diameter" refers to the diameter of the round wire before being formed into a flat wire.

Table A.6 Outer casing (plastic tube)



Unit: mm

Applicable inner cable diameter	D		d	
	Size	Tolerance	Size	Tolerance
1.2	5	0 -0.3	2.5	±0.2
1.4	6		2.0	
1.5			2.5	

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