AIS-060

AUTOMOTIVE INDUSTRY STANDARDS

General Guidelines on Control Cables for Automobiles

PRINTED BY
THE AUTOMOTIVE RESEARCH ASSOCIATION OF INDIA
P.B. NO. 832, PUNE 411 004

ON BEHALF OF
AUTOMOTIVE INDUSTRY STANDARDS COMMITTEE

UNDER
CENTRAL MOTOR VEHICLE RULES – TECHNICAL STANDING COMMITTEE

SET-UP BY
MINISTRY OF ROAD TRANSPORT & HIGHWAYS
(DEPARTMENT OF ROAD TRANSPORT & HIGHWAYS)
GOVERNMENT OF INDIA

July 2010

Status chart of the Standard to be used by the purchaser for updating the record

Sr. No.	Corr-igenda	Amend-ment	Revision	Date	Remark	Misc.

General remarks:

INTRODUCTION

The Government of India felt the need for a permanent agency to expedite the publication of standards and development of test facilities in parallel when the work on the preparation of the standards is going on, as the development of improved safety critical parts can be undertaken only after the publication of the standard and commissioning of test facilities. To this end, the erstwhile Ministry of Surface Transport (MOST) has constituted a permanent Automotive Industry Standard Committee (AISC) vide order No. RT-11028/11/97-MVL dated September 15, 1997. The standards prepared by AISC will be approved by the permanent CMVR Technical Standing Committee (CTSC). After approval, the Automotive Research Association of India, (ARAI), Pune, being the Secretariat of the AIS Committee, has published this standard. For better dissemination of this information ARAI may publish this document on their Web site.

This guideline standard on control cables used in automobiles covers construction, materials, shape, dimensions, testing procedure and requirements.

While preparing this standard considerable assistance is derived from following standards:

i) JASO F 903 -75: Control Cables for Automobiles

ii) JASO T 001- 97: Control Cables for Motorcycles

The Automotive Industry Standards Committee (AISC) responsible for preparation of this standard is given in Annexure: 31

General Guidelines on Control Cables for Automobiles

1. SCOPE

This standard covers the requirements of control cables (hereinafter referred to as "cables") mainly used for the purpose of tension control (pulling) in automobiles in all types of four and two wheelers including mopeds, motorbikes and motorcycles.

2. CONSTRUCTION DETAILS

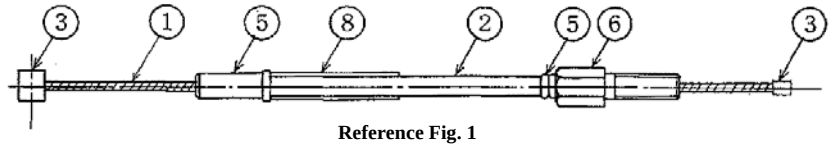
2.1 Names of Main Components

The names of main components of the cable shall be as indicated in Table 1.

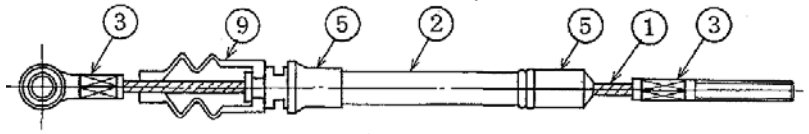
TABLE 1

Sr. No.	Component Name	Typical Assemblies (Reference)	Sr. No.	Component Name	Typical Assemblies (Reference)
1	Inner Cable	Reference Fig. 1 ~ 4`	6	Adjust Bolt	Reference Fig. 1 ~ 4
2	Outer Casing		7	Adjust Nut	
3	Cable End (Terminal)		8	Casing Protector	
4	Connector		9	Dust Cover	
5	Casing Cap		10	Liner	

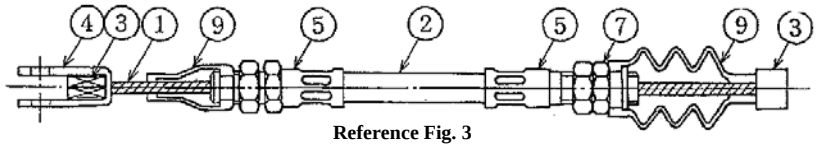
Remark : Number indicates the parts in typical assemblies in Reference Fig. 1~4.



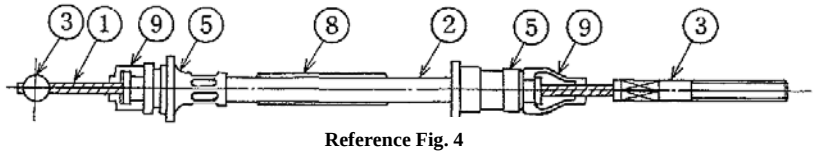
Reference Fig. 1



Reference Fig. 2



Reference Fig. 3



Reference Fig. 4

2.2 Types of Main Components

Types of cable main components shall be as indicated in Table 2.

TABLE 2

Sr. No.	Component Name	Type		Remarks	Applicable Annexure
1.	Inner Cable	Stranded Cable	Single Strand	Has the highest breaking strength / shear load among cables of the same outside diameter.	Annexure 1
			Multiple Strands	Has the highest flexibility / bending property. Among cables of the same outside diameter.	Annexure 2
		Coated Wire		Has high operating efficiency, corrosion resistance.	Annexure 3
		Single Wire		-----	Annexure 4
2.	Outer Casing	With liner		Has a high operational efficiency	Annexure 5
		Without liner (Plastic Tube)		Used for the inner coat type	Annexure 6
		Twin wire conduit		Conduit with twin wire	
3.	Cable End	Type A	Type A1	Drum Shape (Soldered)	Annexure 7
			Type A2	Drum Shape (Cast)	
		Type B	Type B1	Umbrella Shape (Caulked)	Annexure 8
			Type B2	Umbrella Shape (Cast)	
		Type C	Type C1	Round Tube Shape (Soldered)	Annexure 9
			Type C2	Round Tube Shape (Caulked or Soldered)	
			Type C3	Square Tube Shape (Caulked)	
			Type C4	Ball Shape (Caulked, Soldered or Cast)	
		Type D	Type D1	Screw Type (Caulked part same as rolling diameter)	Annexure 10
			Type D2	Screw Type (Caulked part larger than rolling diameter)	
		Type E		Threaded Type	Annexure 11
4.	Connector	Type A	Type A1	Clevis Type (Constant opening)	Annexure 12
			Type A2	Clevis Type (Opening becomes smaller)	
		Type B		------	Annexure 13
5.	Casing Cap	Type A	Type A1	Tubular type (Made by press)	Annexure 14
			Type A2	Tubular type (Made by machining)	
		Type B	Type B1	Tubular type (with flange)	Annexure 15
			Type B2	Tubular type (with flange and dust cover groove)	
		Type C	Type C1	Screw type	Annexure 16
			Type C2	Screw type (with hexagon part)	
		Type D	Type D1	Clamp stoppage type	Annexure 17
			Type D2	Clamp stoppage type (E ring stoppage type)	Annexure 18
			Type D3	Clamp type	Annexure 19
			Type D4	Forced insertion type	Annexure 20
6.	Adjust Bolt	Type A		For stacking	Annexure 21
7.	Adjust Nut	Type A		For stacking box nut	Annexure 22

Sr. No.	Component Name	Type		Remarks	Applicable Annexure
8.	Round joint	Type A	Type A1	For rotary stacking (without flange)	Annexure 23
			Type A2	For rotary stacking (with flange)	Annexure 24
		Type B	Type B1	For direct stacking	Annexure 25
			Type B2	For direct stacking (threaded)	Annexure 26
			Type B3	For direct stacking (non-threaded)	Annexure 27
9.	Casing Protector	-----		-----	Annexure 28
10.	Dust Cover	Type A1		Boot type	Annexure 29
		Type A2		Boot type	
		Type B		-----	Annexure 30

3. MAIN COMPONENT MATERIALS AND SURFACE TREATMENTS

Materials and surface treatment of the main components shall as a general rule, conform to Table 3.

TABLE 3

Sr. No.	Component Name	Type	Material	Surface Treatment
1.	Inner Cable	Stranded Cable	Ropes and strands to confirm • IS: 5836-1977 Inner wire ropes for automobile control cables (First Revision) • IS: 6594-1977 Technical supply conditions for steel wire ropes and strands (First Revision) • IS: 1835-1976 Round steel wire for ropes (Third Revision) JIS G 3506, SWRH 57~82	Correspond to JIS G 3535, 4.8
			JIS G 4308, SUS304-WR or SUS302-WR	-----
		Coated Wire	Synthetic resin (Coating material)	-----
		Single Wire	JIS G 3521, SW	Correspond to JIS G 3535, 4.8
2.	Outer Casing	-----	Patented and cold-drawn spring steel wire of Grade 1 of IS:4454 (Part 1) – 1975 "Steel wires for cold formed springs: Part 1 Patented and cold drawn steel wires – unalloyed (First revision)" JIS G 3506, SWRH 57 ~ 82	Correspond to JIS G 3535, 4.8
			Outer casing insulation stable fibre yarn with weatherproof lacquering or PVC as per agreement between the purchaser and the manufacturer. Synthetic resin, black	-----
		Plastic Tube	Synthetic resin	-----

Sr. No.	Component Name	Type	Material	Surface Treatment
3.	Cable End (terminals)	Type A1	The material shall conform to IS: 226-1975 "Structural steel (standard quality) (Fifth Revision). If of brass, it shall conform to IS: 4170-1967 "Brass rods for general engineering purposes" or IS: 4413-1967 "Brass wires for general engineering purposes". JIS H 3422, BsBM	---
		Type A2	JIS H 5301, ZDC	---
		Type B1	JIS G 4051, S15C ~ S35C	JIS D 0201, MFZn5-B or MFZn5-C
		Type B2	JIS H 5301, ZDC	---
		Type C1	JIS H 3422, BsBM	---
		Type C2	JIS G 4051, S15C~S35C	JIS D 0201, MFZn5-B or MFZn5-C
			JIS H 5301, ZDC	---
		Type C3	JIS G 4051, S15C~S35C	JIS D 0201, MFZn5-B or MFZn5-C
		Type C4	JIS G 4051, S15C~S35C	
			JIS H 3422, BsBM	---
			JIS H 5301, ZDC	---
		Type D1 Type D2	JIS G 4051, S15C~S35C	JIS D 0201, MFZn5-B or MFZn5-C
4.	Connector	Type A1 Type A2 Type B	JIS G 3131, SPHC	JIS D 0201, MFZn5-B or MFZn5-C
			JIS G 3141, SPCC	
5.	Casing Cap (Bush)	Type A1	Steel conforming to IS: 226-1975. JIS H 3201, BsP	---
			JIS G 3141, SPCC	JIS D 0201, MFZn5-B or MFZn5-C
		Type A2	JIS H 3422, BsBM	---
			JIS G 3101, SS or free cutting steel	JIS D 0201, MFZn5-B or MFZn5-C
		Type B1	JIS H 3422, BsBM	---
			JIS G 3101, SS or free cutting steel	JIS D 0201, MFZn5-B or MFZn5-C
		Type B2	JIS H 3422, BsBM	---
			JIS G 3101, SS or free cutting steel	JIS D 0201, MFZn5-B or MFZn5-C
			JIS H 5301, ZDC	---
		Type C1	JIS H 3422, BsBM	---
		Type C2	JIS G 3101, SS or free cutting steel	JIS D 0201, MFZn5-B or MFZn5-C
		Type D1	JIS H 5301, ZDC	---
		Type D2	JIS G 3101, SS or free cutting steel	
		Type D3		JIS D 0201, MFZn5-B or MFZn5-C
		Type D4	JIS G 3101, SS or free cutting steel	
6.	Adjust Bolt	-----	JIS G 3101, SS or free cutting steel	JIS D 0201, MFZn5-B or MFZn5-C
7.	Adjust Nut	-----	JIS G 3101, SS or free cutting steel	JIS D 0201, MFZn5-B or MFZn5-C
8.	Casing Protector	-----	Synthetic resin or rubber, black	---
9.	Dust Cover	Type A1, A2 Type B	Synthetic resin or rubber, black	---

Note: In case of material and construction not available as per Table 3, the material and construction shall be as per the agreement between the cable supplier and the customer.

4. SHAPES AND DIMENSIONS OF MAIN COMPONENTS

The shapes and dimensions of the cable main components shall be as indicated in Annexures 1 ~ 30.

5. QUALITY

5.1 Appearance

(1) Components shall be free from bending, cracks, corrosion, turnback, burrs, and other defects injurious to use.

(2) Surface treatment of components shall satisfy the requirements in 3.

(3) Cable shall have proper lubricant applied on the inner cable of filled in the outer casing. The variety of lubricant used shall be as agreed between the supplier and receiver.

5.2 Dimensions and Tolerances

(1) Dimensions and tolerances of components shall satisfy the requirements in Annexures 1 ~ 30**,** except that in the caulked type cable ends, the inner surface shall, as a rule, be chamfered before hand to prevent decrease in strength.

(2) Unless otherwise specified, dimensional tolerances of the components shall conform to Table 4.

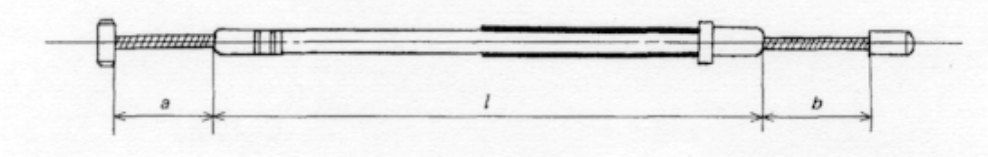
TABLE 4
Dimensional Tolerances of Components

Manufacturing Division	Applicable Standard
Commercial tolerance (Machining)	JIS B 0405 medium grade or coarse grade
Commercial tolerance (Forging)	JIS B 0406 normal grade
Commercial tolerance (Pressing)	JIS B 0408 normal grade
Commercial tolerance (Die casting)	JIS B 0409 normal grade
Commercial tolerance (Shearing)	JIS B 0410 normal grade
Dimensions of width across flats	JIS B 1002 class 2

(3) Screw thread accuracy shall meet Class 2 or Class 3 in JIS B 0209 (Limits of Sizes and Tolerances for Metric Coarse Screw Threads) and JIS B 0211 (Limits of Sizes and Tolerances for Metric Fine Screw Threads). Plated screw thread accuracy shall meet JIS B 1180 (Hexagon Head Bolts) and JIS B 1181 (Hexagon Nuts).

(4) Assembled product dimension tolerance shall conform to Table 5.

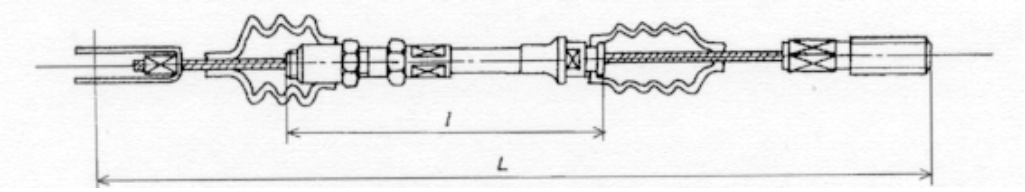
TABLE 5-1
When Without Dust Cover



Unit: mm

l		a + b (Travel length)	
Nominal	Tolerance	Tolerance	
		100 and under	Over 100
500 and under	± 2	± 1.5	± 2.0
Over 500 to 1000 including	± 3	± 2.0	± 2.5
Over 1000 to 2000 including	± 4	± 2.5	± 3.0
Over 2000 to 3000 including	± 5		

TABLE 5-2
When with Dust Cover



Unit: mm

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

5.3 **Performance**

(1) Cable shall operate smoothly in straight-line state.

(2) On the assembly parts, inner cable-shearing load, and cable end and casing cap pull off loads shall meet the requirements in **Annexures 1, 4, 7, 8, 9, 10, 13, 14, 15, 16, 17, 18, 19 and 20.**

(3) Cable shall comply with the purpose of application and satisfy the operating efficiency and other functions required in actual operation.

6. TESTING OF THE CABLES

The test procedure and acceptance norms for testing control cables listed below.

a) Accelerator cable
b) Parking brake cable
c) Bonnet release cable
d) Ventilation cable

e) Fuel lid opening cables.
f) Choke cable
g) Clutch cable
h) Idling adjuster cable.
i) Brake cable – Front & Rear

6.1 **Tests**

a) Bench performance tests
b) Durability / Endurance test.
c) Strength test
d) Environmental aging test.

6.1.1 **Bench Performance Tests**

Cable fitment shall be done on test bench with cable routing as described in clause No. 6.1.2.1. No fouling of the cable with surrounding components shall be observed. The following are the performance tests, which can either be performed on a vehicle or on a test bench.

6.1.1.1 **Operating Force Test**

In order to check the smoothness of the cable operation, operating force shall be measured. This is to be measured on the test bench which simulates the test item cable e.g. force required to push the pedal for accelerator cable.

6.1.1.2 **Efficiency Test**

Test procedure as per clause 6.1.3.

6.1.1.3 **Load Efficiency Test**: with cable installed as in actual vehicle

Sr. No.	Cable type	Temperature at which efficiency to be checked	Load for the test
1	All cables in the test standard except clutch cable & accelerator cable	a) 80 º C b) -10 º C c) Ambient temp.	As agreed between the customer and supplier or drawing
2	Clutch cable & accelerator cable	d) 80 to 120 º C e) -35 to -40 º C f) Ambient temp.	specification.

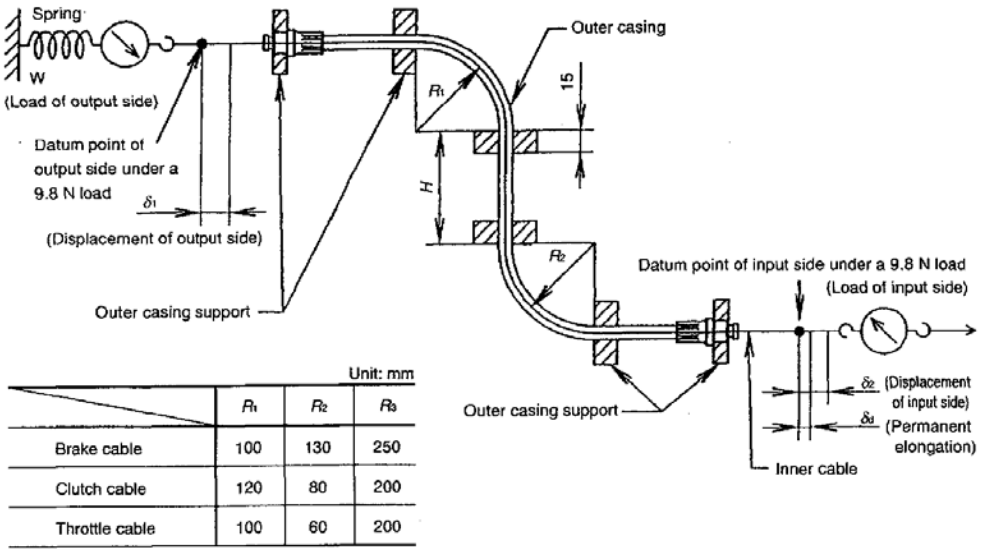
6.1.2 **Durability / Endurance Test.**

The test procedure shall be as follows:

(1) Performance measurement before durability test
(2) Operational durability test
(3) Performance measurement after durability test
(4) Performance measurement may also be conducted during the durability test.

6.1.2.1 **Setting of Cable for Durability Test**

The cable shall be sent in the same way as specified in figure 5 & 6.



Unit: mm

	R1	R2	R3
Brake cable	100	130	250
Clutch cable	120	80	200
Throttle cable	100	60	200

Fig. 5
Test set up for Durability test

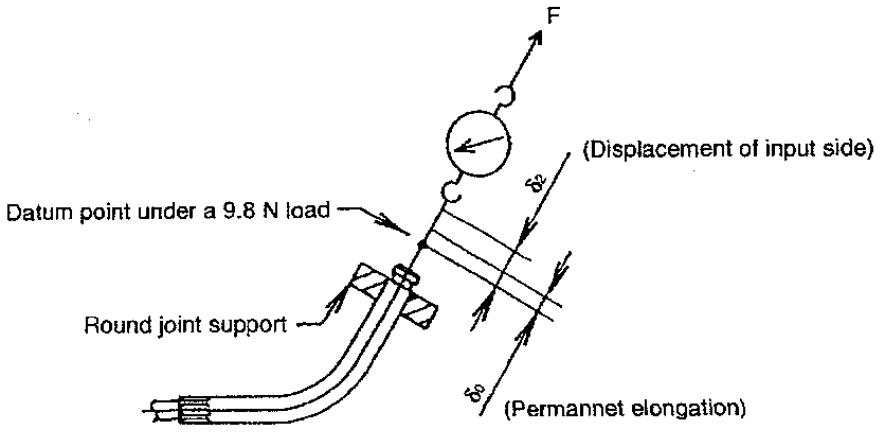


Fig. 6

Test set up for Durability Test at the End of Cable (when round joint is used)

6.1.2.2 **Performance Measurement before Durability Test**

Pull input side of the inner cable of assembly at the operating speed shown in Table 6. Apply the specified load to the output side, and then measure the load efficiency and stroke loss.

TABLE 6
Specifications for Performance Measurement

Sr. No.	Type of cable	Type application	Load	Operating speed mm/sec
1	Front brake cable	Force application and release.	540 N	10
2	Rear brake lever type		540 N	
3	Rear brake foot type		780 N	
4	Clutch		290 N	
5	Throttle		100 N	
6	Hood release cable, Tailgate cable, Fuel lid cable, Door latch cable.		50 N	

The measurement of any items other than the load efficiency and stroke loss shall be in accordance with an agreement between the suppliers and users.

6.1.2.3 **Operational Durability Test**

Give the load and stroke repeatedly to the input side of cable so that the maximum load and stroke shown in Table 7 can be kept at the output side. The repetition times per minute and endurance times are also shown in Table 7.

TABLE 7
Specifications for Operational Durability Test

Sr. No.	Type of cable	Specified load of output side (N)	Stroke of output side (mm)	Cycling rate	Total no. of cycles	Acceptance norm
1	Front cable	540	15	10 to 60 cycles/ minute	1,00,000	No failure of the cable throughout the test
2	Rear brake lever type	540	15	10 to 60 cycles/ minute	50,000	No failure of the cable throughout the test
3	Rear brake foot type	780	10	10 to 60 cycles/ minute	50,000	No failure of the cable throughout the test
4	Clutch	290	20	10 to 60 cycles/ minute	1,00,000 to 5,00,000	No failure of the cable throughout the test
5	Throttle	100	25	10 to 60 cycles/ minute	1,00,000 to 10,00,000	No failure of the cable throughout the test
6	Hood release cable, Tail gate cable, Fuel lid cable, Door latch cable.	50	20	10 to 60 cycles/ minute	5,000 to 20,000	No failure of the cable throughout the test

6.1.2.4 **Performance Measurement after Durability Test**

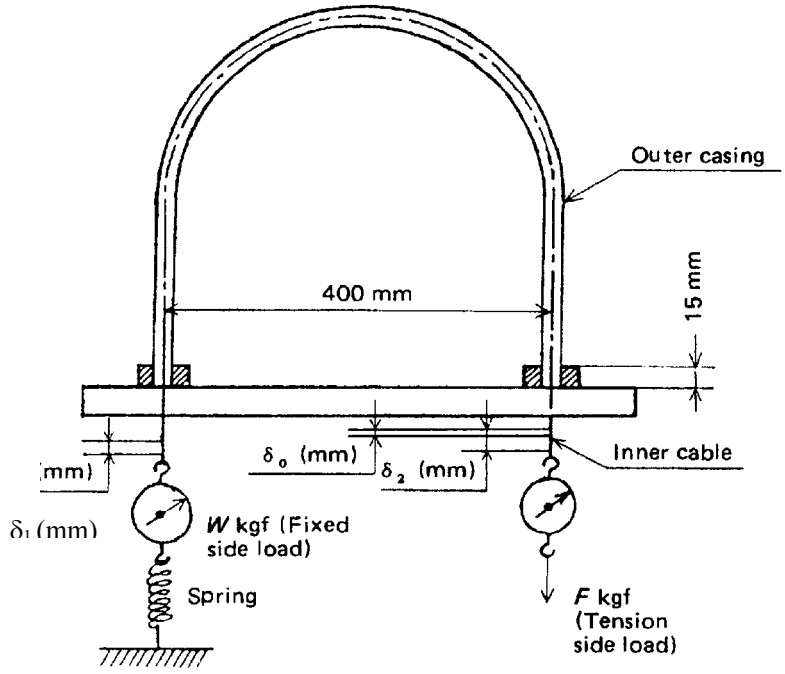
This test shall be conducted by the same method as specified in clause 6.1.2.2. Performance Measurement before Durability Test.

6.1.2.5 **Endurance Test at Cold and Hot Temperature**

Sr. No.	Cable type	Operating load and stroke and cycling rate.	Temp and cycle of thermal stress
1	Accelerator cable and choke cable	Cycling rate = 30 Cycles / minute	a) -40 to 120 º C b) -40 º C for 4h, ambient temp for 16 h, 120 ºC for 4 h c) Temp rise rate = 4 ºC / min
2	Clutch cable	Cycling rate = 30 Cycles / minute	d) -40 to 120 º C e) -40 º C for 4h, ambient temp for 16 h, 120 ºC for 4 h f) Temp rise rate = 4 ºC / min
3	Parking brake cable	Cycling rate = 30 Cycles / minute	g) -40 to 80 º C h) -40 º C for 4h, ambient temp for 16 h, 120 ºC for 4 h i) Temp rise rate 4 ºC / min

6.1.3 **Performance Evaluation (Operational Efficiency Test)**

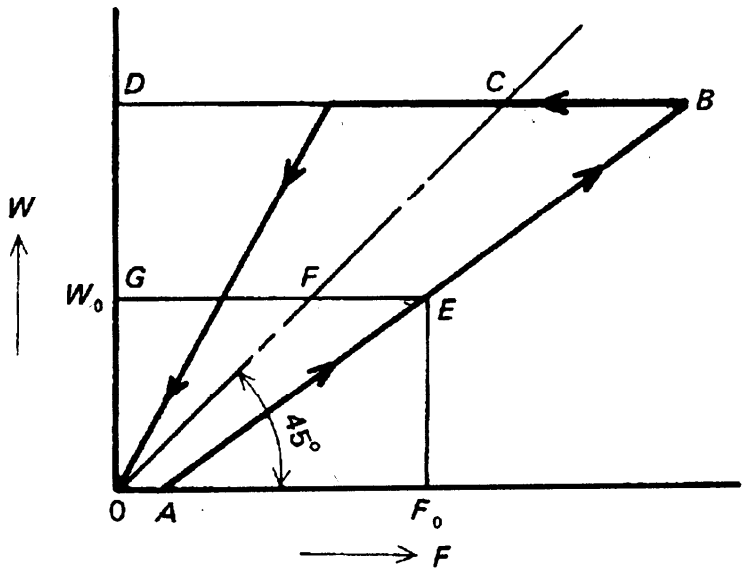
Operating efficiency shall be expressed by load efficiency η_s. As indicated in Reference Fig. 7, outer casing 1000 mm long shall be installed at 400 mm fixed distance and 180° bending angle, with inner cable 1500 mm long inserted before hand. One end of the cable shall be secured and the other end gradually pulled, and fixed side load W, deflection δ_1, tension side load F, deflection δ_2, and apparent permanent elongation δ_0 after removal of tension side load F shall be measured. In case of load efficiency test, fixed side load W may be constant load.



Reference Fig. 7

(1) **Load Efficiency**

Load efficiency shall be expressed by following equation. (Refer to Reference Fig. 8).



Reference Fig.8

a) In case inner cable is fixed through spring, the load efficiency shall be expressed as follows,

$$\eta_w\ (\%) = \frac{\text{Area OCD}}{\text{Area OABD}} \times 100$$

When initial tension is already impressed, then this becomes,

$$\eta_{w0-w}\ (\%) = \frac{\text{Area GFCD}}{\text{Area GEBD}} \times 100$$

W and W_0 values shall be as agreed between parties concerned.

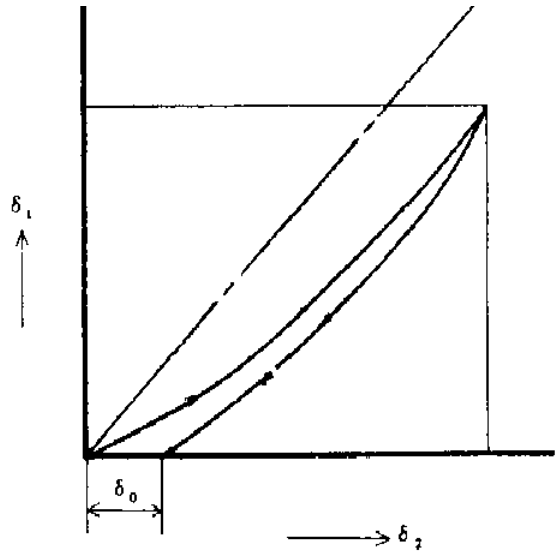
(b) When making fixed side load W to constant load.

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

Value of constant load W shall be as agreed between parties concerned.

(2) **Stroke Efficiency**

Stroke efficiency shall be expressed by the following equation. (Refer to Reference Fig. 9).



Reference Fig. 9

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

Apparent permanent elongation δ_0 value shall also be indicated. Values of W and K shall be as agreed between parties concerned.

6.1.4 **Strength Test**

The test shall be performed for the following test items:

(1) Inner cable breaking load test
(2) Inner cable elongation test
(3) Outer casing compression load test
(4) Cable end, casing cap and round joint pull-off test
(5) Performance evaluation (Operational Efficiency Test) for assemblies :- operational durability test

6.1.4.1 **Inner Cable Breaking Test**

Both ends of the test piece shall be clamped in the testing machine by proper method at a distance of at least 250 mm apart, pulled at speed not exceeding 50 mm/min, broken, and the breaking load shall be measured. In this test, out of the test pieces that failed to met the breaking load specified in Annexure 1 and 4, with regard to those that broken at the clamped portion, retest shall be carried out with a new test piece.

6.1.4.2 **Inner Cable Elongation Test**

Clamp both ends of the test piece in the testing machine by proper method, apply a load of 2% of the breaking load specified in attached Annexure 1 to test piece, give gauge marking on it less than 250 mm apart and measure the distance between gauge marking (L_1). Then pull the test piece at a speed of less than 50 mm/min, apply a load of 60% of the specified breaking load and measure the distance between gauge markings (L_2). Return the applied load to 2% of the breaking load and measure the distance between gauge markings (L_3).

Then total elongation percentage, permanent elongation percentage and elastic elongation percentage shall be expressed in the following formulae"

$$C_1 = \frac{L_2 - L_1}{L_1} \times 100$$

$$C_o = \frac{L_3 - L_1}{L_1} \times 100$$

$$C_2 = (C_1 - Co)$$

Where C_o: Permanent Elongation percentage of inner cable (%)
C_1: Total Elongation percentage of inner cable (%)
C_2: Elastic Elongation percentage of inner cable (%)

6.1.4.3 **Outer Casing Compression Load Test**

Set 300 mm long test piece of outer casing on the test apparatus as shown in Fig. 10. Apply the compression load to the test piece at a speed of less than 20 mm/min until it is crushed, and then measure the compression load.

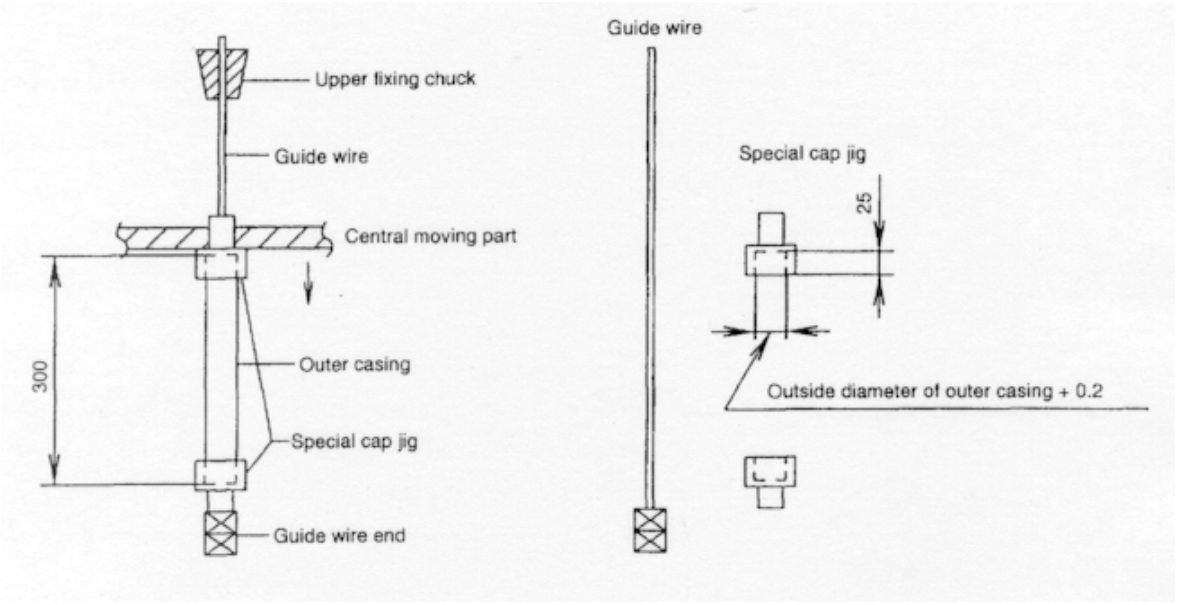


Fig. 10

Size of Guide Wire

Unit: mm

Outside diameter of outer casing	Φ5	Φ6	Φ7	Φ8	Φ9
Diameter of guide wire	Φ1.8	Φ2.1	Φ2.6	Φ3.5	Φ4.0

6.1.4.4 **Cable End, Casing Cap and Round Joint Pull-Off Test**

Both the ends of a test piece shall be clamped on the testing machine in such a manner as to allow the pull load to be measured and in an appropriate way, respectively as shown in Fig. 11. Pull the test piece at a speed of less than 50 mm/min until the cable end, casing cap and round joint are separated and then measure the pull-off load. For the test piece which does not meet the pull-off load values specified in attached Annexure 7, 8, 9, 10, 13, 14, 15, 16, 17, 18, 19 and 20 and broke at any portions other than the cable end, casing cap or round joint, take a new test piece from the same cable and test it again.

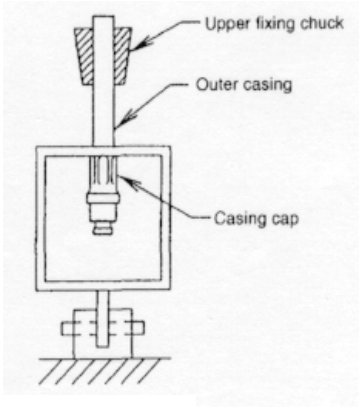


Fig. 11

6.1.5 **Environmental Test**

Salt Spray Test

Salt spray test shall be conducted for a duration given in Table 8 on complete cable assembly as per IS: 9000 (Part 11) for following duration. There shall not be visible red rust which will harm the performance.

TABLE 8

Test for	Observation of red rust.
Inner cable	48 hrs
Outer cable	24 hrs

7. INSPECTION

7.1 **Inspection Items**

Cable inspection items shall be as follows :

(1) Material inspection
(2) Appearance inspection
(3) Dimension inspection
(4) Performance inspection

7.1.1 **Material Inspection**

Material shall conform to the requirements in 3.

7.1.2 **Appearance Inspection**

Appearance shall conform to requirements in 5.1.

7.1.3 **Dimension Inspection**

Dimensions of components and assemblies shall conform to the requirements in 5.2.

ANNEXURE 1

(See Table 2 (1))

INNER CABLE (STRANDED CABLE)

Unit : mm

Inner cable diameter		Single Wire Twist Informative Reference					Multiple Wire Twist Informative Reference				
Nominal	Tolerance	Breaking Load (kgf Min.)	Twist Form		Elongation (%)		Breaking Load (kgf Min.)	Twist Form		Elongation (%)	
			Symbol	Standard strand	Elasticity	Perm-anent		Symbol	Standard strand	Elasticity	Permanent
1.2	+ 0.12 0	150	1 x 12	0.30	0.8	0.2	120	7x7	0.14	0.9	0.2
1.5	+ 0.15 0	240	1 x 7	0.50			180	7x7	0.17		
			(1x12)	(0.38)							
			1 x 19	0.30							
2.0	+ 0.20 0	420	1 x 19	0.40			310	7x7	0.22		
2.5	+ 0.20 0	630	1 x 19	0.50			480	7x7	0.28		
3.0	+ 0.24 0	850	1 x 19	0.60			700	7x7	0.35		
								7x19	0.20		
								(12+7x7)	(0.30)		
3.5	+ 0.28 0	1100	1 x 19	0.70	0.9		920	7x7	0.40	1.1	
								(19+7x7)	(0.30) (0.34)		
4.0	+ 0.32 0	1500	1 x 37	0.57			1200	7x7	0.45		

Remarks

1. Stranded method may be common S or common Z twist as prescribed in JIS G 3525 (Wire Rope) with the exception that inner cable shall be of non-repelling twist prescribed in JIS G 3535 (Wire Ropes for Aeronautical Use).

2. Diameter of inner cable is defined as the diameter of the inner cable circumscribed circle.

3. Elongation shall be the value measured by 8.2 test method.

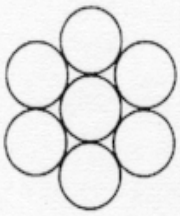
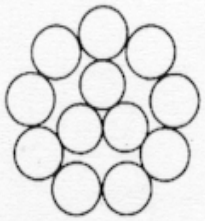
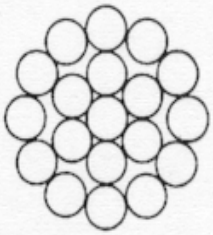
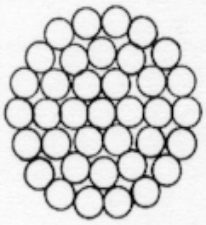
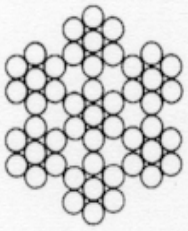
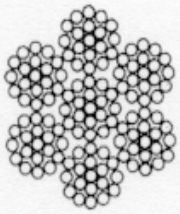
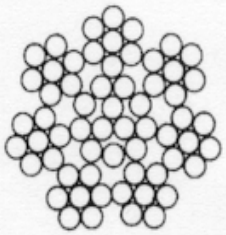
4. Dimension and formation of the inner cable in case rolled wire is to be wound in the cable shall be agreed between the parties concerned.

5. Dimensions enclosed by parentheses should not be used whenever possible.

ANNEXURE 2

(See Table 2 (1))

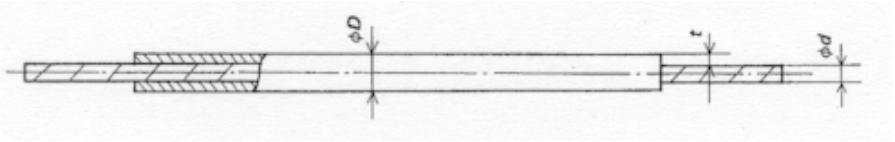
INNER CABLE SECTION AND FORMATION

Single strand	Cross section			
	Composition	1 x 7	1 x 12	1 x 19
	Cross section			
	Composition	1 x 37		
Multiple strand	Cross section			
	Composition	7 x 7	7 x 19	(12 + 7 x 7)
	Cross section			
	Composition	(19 + 7 x 7)		

ANNEXURE 3

(See Table 2 (1))

INNER CABLE (COATED)



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		

Remark : Inner cable (strand) used in inner cable (coated) shall conform to main Text Annexure 1 and 2.

ANNEXURE 4

(See Table 2 (1))

INNER CABLE (SINGLE WIRE)

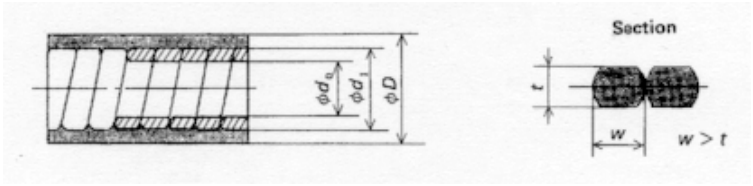
Unit: mm

Inner cable diameter		Breaking Load (kgf)
Nominal	Tolerance	
1.2	± 0.05	As prescribed in JIS G 3521
1.4		
1.6		

ANNEXURE 5

(See Table 2 (2))

OUTER CASING



Unit: mm

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
	4.3	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

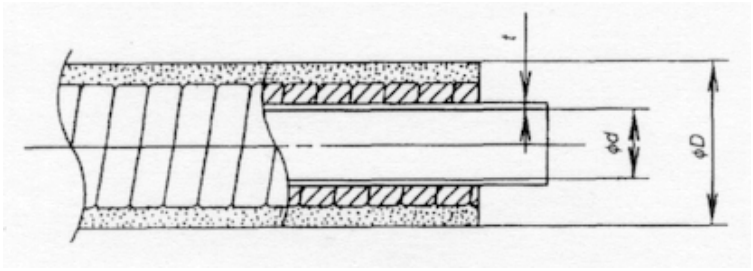
Remarks

1. Outer casing winding direction may be either S twist or Z twist.
2. Outer casing end surfaces shall be provided with inner chamfer.
3. Standard strand diameter is defined as round wire diameter prior to forming into flat wire.

ANNEXURE 6

(See Table 2 (2))

OUTER CASING (WITH LINER)



Unit: mm

Finished diameter of applicable inner cable (without coating)	D		d		Compression load (N)
	Dimension	Tolerance	Dimension	Tolerance	
1.8	5	+0.1 -0.2	2.5	±0.2	1,000 or more
1.8	6		3.0		2,500 or more
2.1					
2.6					
2.6	7		3.8		5,900 or more
3.1					
3.1	8		4.2		7,800 or more
3.1	9		4.8		9,800 or more

Remark

1. The material of spring portion and coating shall be IS 4454 and synthetic resin respectively. The working temperature shall be between 80^0C to 100^0C.

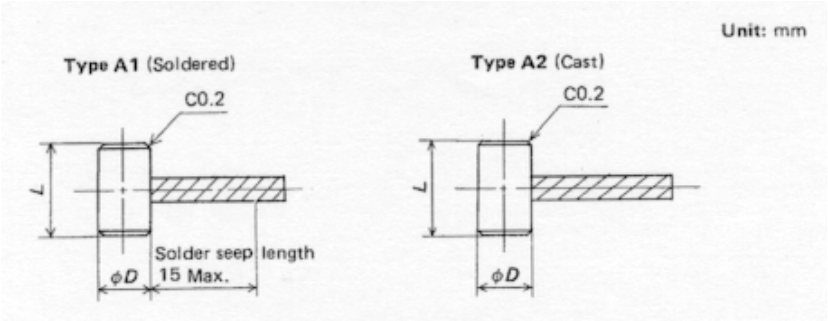
2. The method of surface treatment for spring portion shall be in accordance with clause 5.

3. For the winding direction of outer casing, both S winding and Z winding may be available.

ANNEXURE 7

(See Table 2 (3))

CABLE END TYPE A



Unit: mm

Applicable inner cable diameter	Pull off load (kgf Min.)	D		L	
		Size	Tolerance	Size	Tolerance
1.2	70	5	± 0.15	8	± 0.2
		6		8 10	
1.5	100	5		8 10	
		6		8 10 12	
		8		10 12	
2.0	180	6		8 10 12	
		8		10	
2.5	280	8		10	
		10		10	
3.0	420	8		10 12 (14)	
		10		10 12 (14)	

Remarks

1. Pull off loads in Table above are applicable to both soldered and cast types.

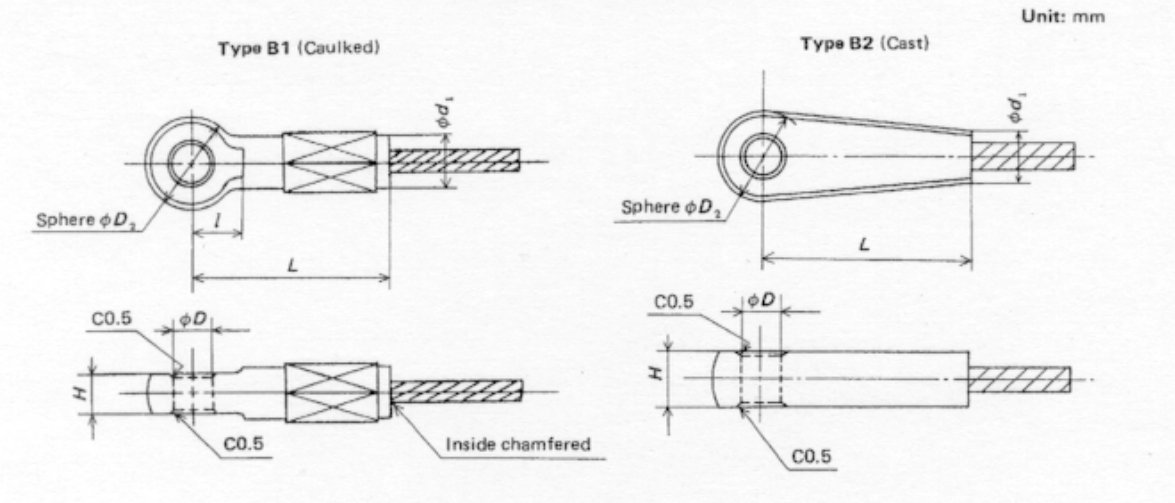
2. Dimensions enclosed by parentheses shall not be used as far possible.

3. In case of establishing pull off load exceeding the value in the Table, the value shall be as agreed between the persons concerned.

ANNEXURE 8

(See Table 2 (3))

CABLE END TYPE B



Unit : mm

Type	Inner cable ϕ x pull off load (kgf Min.)	D		L		H		d_1	L (Reference Min.)	D_2 (Reference)
		Size	Tolerance	Size	Tolerance	Size	Tolerance			
Type B1	3.0 x 420 3.5 x 550	6.1	+ 0.2 0	25	± 1.5	6	± 0.2	7	7	14
						7				
				30		5				
						6				
		8.1		30		5		8		
						8				
				(35)		(5)		(8)	(20)	(16)
	4.0 x 720	8.1		30		8		8	8	16
Type B2	3.0x 420 3.5 x 550	6.1		25		6		6	---	14
						7		7		
	4.0 x 720	8.1		30		8		8	---	16

Remarks

1. Type B1 caulking method shall, as a rule, be square caulking.

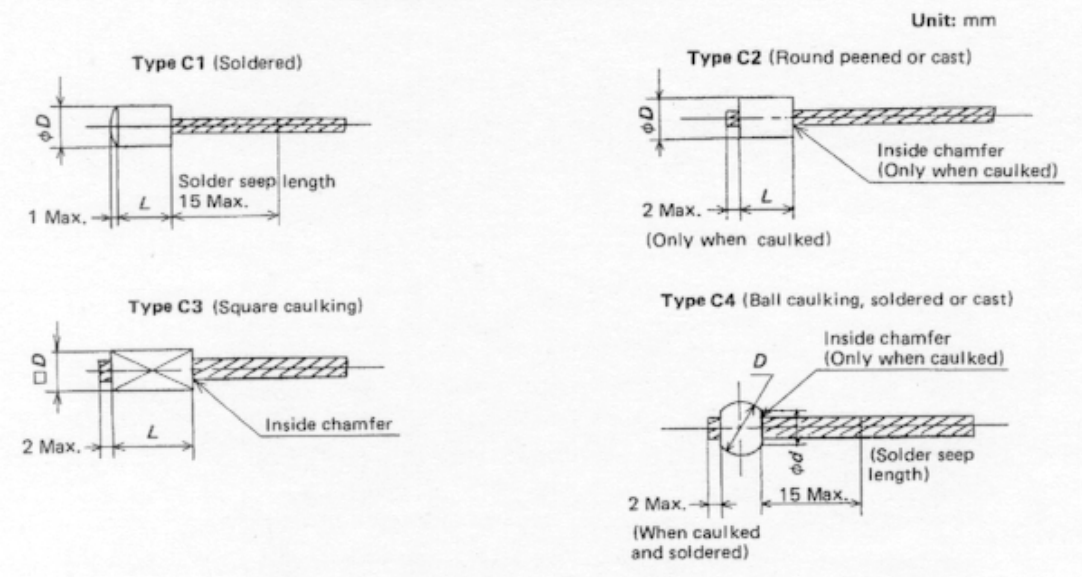
2. In case of heavy load, pull off load exceeding the value specified in the above Table may be established upon agreement between the parties concerned and limited to Type B1.

3. Dimensions enclosed by parentheses shall not be used so far as possible.

ANNEXURE 9

(See Table 2 (3))

CABLE END TYPE C



Unit: mm

Inner cable Dia-meter	Pull off load (kgf, Min.)	Type C1			Type C2				Type C3						Type C4	
		D		L	D		L		Material Dia-meter	Dia-meter (max.)	D (Reference)		L		D	d (max)
		Size	Tolerance		Size	Tolerance	Size	Tolerance			Size	Tolerance	Reference	Tolerance		
1.5	60	3	± 0.2	4	4	± 0.5	4	± 1	5	5.5	4.0	± 0.5	6	± 1	8	5
2.0	180	6		6	6		8		5	5.5	4.0		8		8	5
2.5	280	---		---	7		10		6	6.5	5.0		10		8	5
									7	7.5	5.5					
3.0	420	---		---	7		10		7	7.5	5.5		12		8	5
					8		10									
					10		12		8	8.5	6.5		10			
3.5	550	---		---	7		10		8	8.5	6.5		14		10	6
					(7)		(12)									
					8		12		9	9.5	7.5		12			
					10		12									
					(10)		(14)									
4.0	720	---		---	8		14		8	8.5	6.5		14		10	6
					10				(9)	(9.5)	(7.5)		(14)			

Remarks

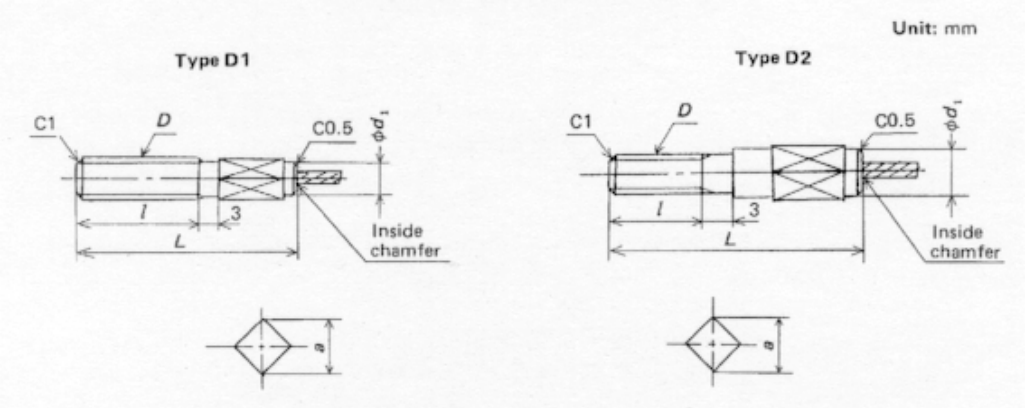
1. In case of heavy load, pull off load exceeding the value specified in above Table may be specified upon agreement between parties concerned. In such case, L may be lengthened if found necessary.

2. Dimensions enclosed by parentheses shall not be used as far as possible.

ANNEXURE 10

(See Table 2 (3))

CABLE ENDS TYPE D



Unit : mm

Applicable inner cable diameter	Pull off load (kgf Max.)	D		L ± 2.0 x l	Type D1 d_1 x a Max.	Type D2 d_1 x a Max.
		Nominal	Pitch			
1.5	100	6	1.0	50 x 30	5.2 x 6.2	6 x 7.2
2.0	180			65 x 45		
2.5	280			80 x 60		
				90 x 70		
3.0	420	6	1.0	55 x 30	---	6 x 7.2
3.5	550			65 x 40		7 x 8.5
				75 x 50		8 x 9.5
				85 x 60		
				95 x 70		
3.0	420	8	1.25	65 x 40	7.1 x 8.5	8 x 9.5
3.5	550			75 x 50		9 x 10.5
4.0	720			85 x 60		
				95 x 70		
				105 x 80		

Remarks

1. Screw threads shall conform to JIS B 0205 (Metric Coarse Screw Threads).

2. Caulking method shall, as a rule, be square caulking.

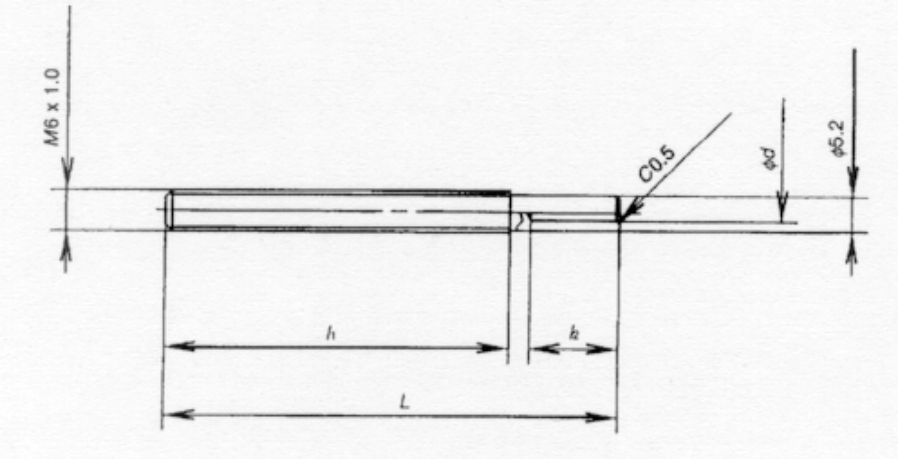
3. Values with *mark in the Table shall not be used in 3.5 diameter inner cable.

4. In case of heavy load, pull off load exceeding the value specified in above Table may be specified upon agreement between the parties concerned. In such case L may be lengthened if found necessary.

ANNEXURE 11

(See Table 2 (3))

CABLE END TYPE E



Unit: mm

Diameter of applicable inner cable	d	L	h	k	Pull-off load (N)
2.0	2.2	36	20	13	2,500 or more (1,700 or more)
		56	40		
		76	60		
2.5	2.7	38	20	15	3,500 or more (2,000 or more)
		58	40		
		78	60		

Remarks

1. The material shall be S35C given under JIS G 4051

2. The surface treatment shall be done with Ep-Fe/Zn8 as specified in JIS D 0201

3. The used staking method shall be optional and satisfy the specified pull-off load

4. The screw thread shall conform to JIS B 0205. The screw thread accuracy shall be in accordance with 6g or 8g of JIS B 0209

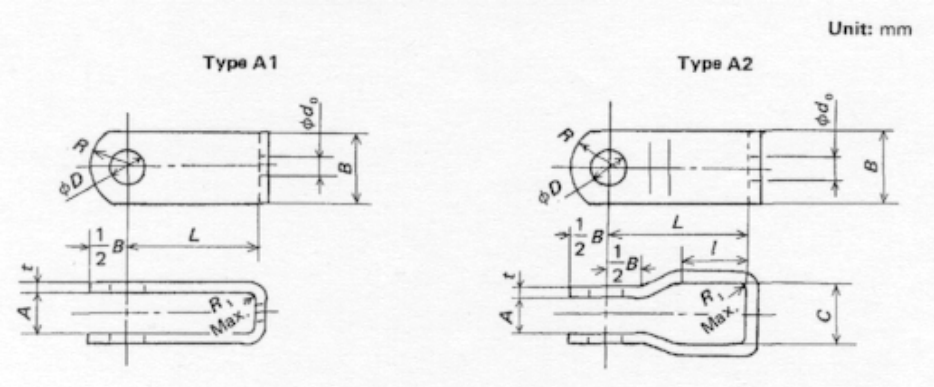
5. All dimensions shall be the ones of cable end with surface treatment

6. The values of Pull-off load in the parentheses shall apply where the material of inner cable is SUS304WR or SUS302ER

ANNEXURE 12

(See Table 2 (4))

CONNECTOR TYPE A



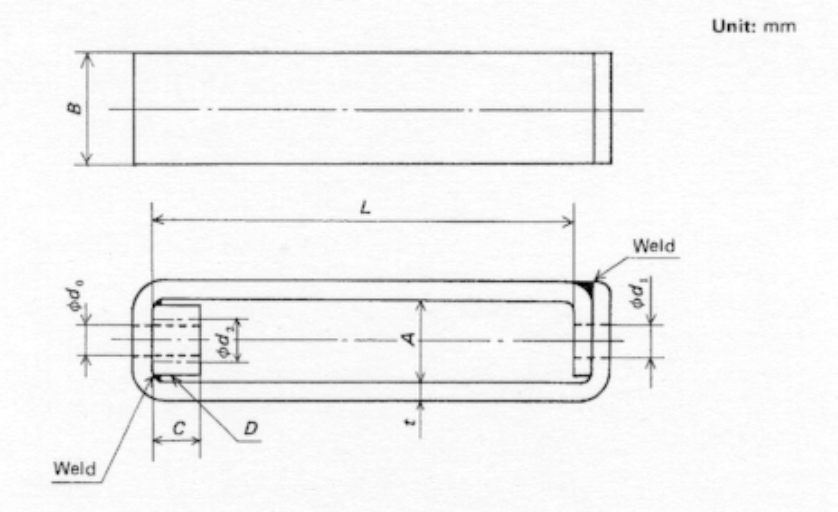
Unit : mm

Type	Inner cable diameter	D		d_o		A		B	C	t	*L*	l
		Size	Tolerance	Size	Tolerance	Size	Tolerance					
Type A1	3.5 max.	4.1	± 0.2 0	2.5	± 0.5 0	7	± 0.5	10	---	1.2	20	---
		6.1		3.0		6		12		1.6		
				3.5		8		14		2.3		
				4.0								
		8.1				10		16		2.3	30	
						16					40	
Type A2	4.0 max.	6.1		3.0				14	10	1.6	20	8
				3.5		3					30	18
				4.0		5				2.3	40	28
				4.5		7						
		8.1				0		16	10	2.3	25	11
				3.5		5			12		30	15
				4.0		7				2.6	40	25
				4.5		9						

ANNEXURE 13

(See Table 2 (4))

CONNECTOR TYPE B

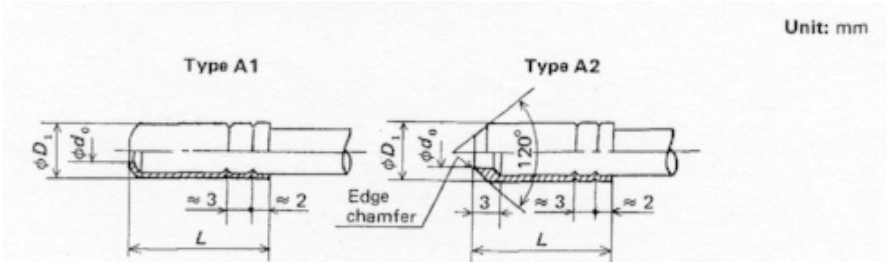


Unit : mm

Inner cable diameter	A	B	L	t	d_0	d_1	d_2	C	D
3	12	16	60 70	2.3 2.6	Inside diameter + 0.5 ~ 1.0	M6 x 1.0	---	---	---
3.5					6.5	Inside diameter + 0.5 ~ 10	M6 x 1.0	7	10

Remark : Screw threads shall conform to JIS B 0205.

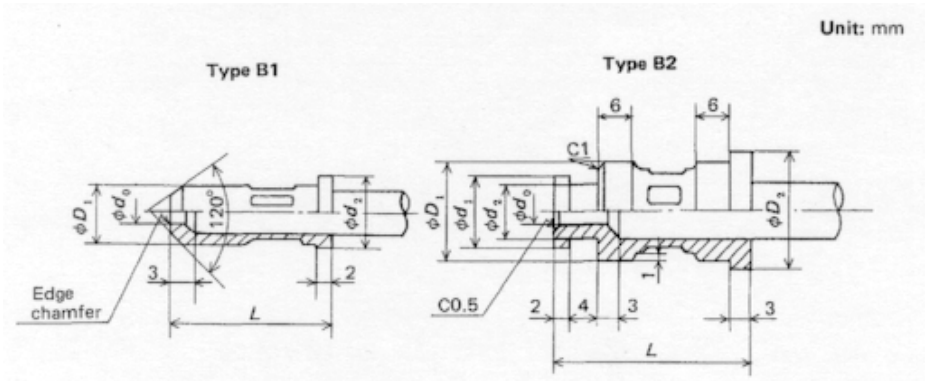
ANNEXURE 14
(See Table 2 (5))
CASING CAP TYPE A



Unit : mm

Applicable outer casing diameter	D_o		Type A1			Type A2			Pull off load (kgf Min.)
			D_1		L	D_1		L	
	Size	Tolerance	Size	Tolerance		Size	Tolerance		
5	2.5	± 0.3 - 0.2	5.8	0 - 0.3	12	5.8	0 - 0.3	15	5
6	3.0		7		13	7		15	6
7	3.5		8		15	8		15	7
8	4.0		---		---	9		17	8
10	4.5 5.0		---		---	12		23	10
12	5.0 5.5		---		---	14		25	12

ANNEXURE 15
(See Table 2 (5))
CASING CAP TYPE B



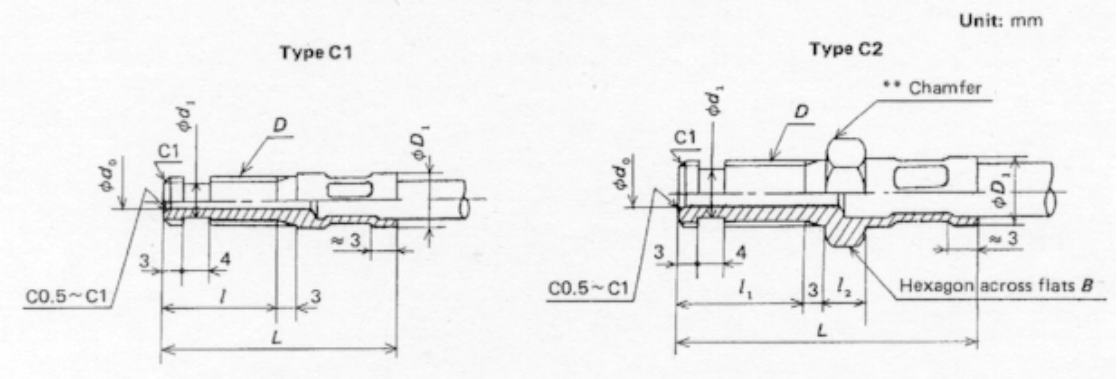
Applicable outer casing diameter	d_o		Type B1				Type B2							Pull off load (kgf Min.)
	Size	Tolerance	D_1		D_2	L	D_1		D_2	L	d_1	d_2		
			Size	Tolera-nce			Size	Tolera-nce						
5	2.5	+ 0.3 - 0.2	5.8	± 0.1	6.8	13	---	± 0.1	---	---	---	---		8
6	3.0		8		10	23	---		---	---	---	---		10
8	4.0		---				13.5		17	28	9.5	7.5		14

Remark: Caulking shall, as general rule, be hexagon caulking.

ANNEXURE 16

(See Table 2 (5))

CASING CAP TYPE C



Unit : mm

Applicable outer casing outer diameter	d_o		D		D_1	*d_1		C1 Type		C2 type				Pull off load (kgf Min.)
	Size	Tolerance	Nominal	Pitch		Size	Tolerance	L	l	L	l_1	l_2	B	
5	2.5		6	1.0	7	4		33	17	28	12	4	10	8
								43	27	38	22			
6	3.0		6	1.0	8	6		36	17	31	12	5	12	10
			8	1.25				46	27	41	22			
7	3.5		8	1.25	9	6		48	27	33	12	5	12	12
								58	37	43	22			
8	4.0		10	1.25	10	7.5		48	27	38	17	5	14	14
		+ 0.3					+ 0.3	58	37	48	27			
9	4.5	- 0.2	10	1.25	11	7.5	- 0	61	37	41	17	5	14	16
								71	47	51	27			
10	4.5		10	1.25	12	7.5		63	37	43	17	5	14	18
	5.0							73	47	53	27			
12	5.0		12	1.25	14	9.5		76	47	46	17	6	17	22
	5.5							86	57	56	27			
13	5.8		12	1.25	15	9.5		78	47	48	17	6	17	24
								88	57	58	27			

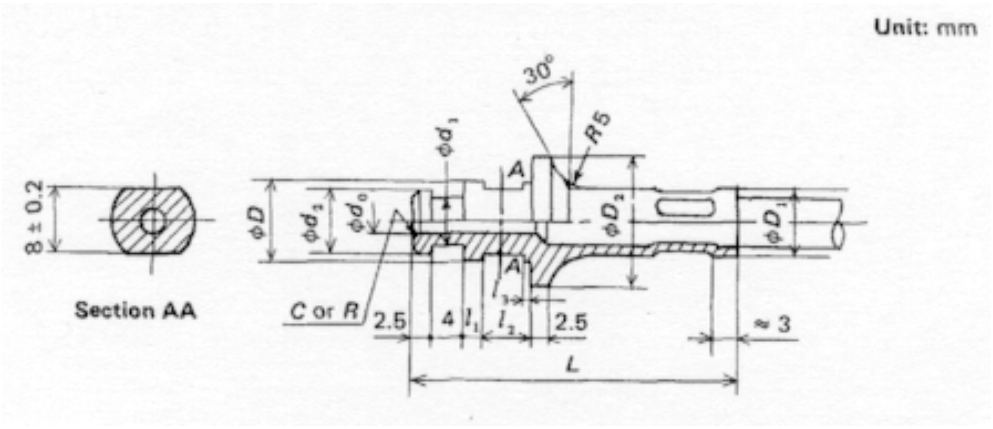
Remarks

1. Dimensions d1 (dust cover setting groove) with * mark in table may be abbreviated.
2. ** marked chamfer part may be abbreviated.
3. Screw threads shall conform to JIS B 0205 or JIS B 0207.
4. Caulking shall, as general rule, be hexagon caulking.

ANNEXURE 17

(See Table 2 (5))

CASING CAP TYPE D1



Unit : mm

pplicable outer casing outer diameter	d_o Size	d_o Tole-rance	D Size	D Tole-rance	D_1 (Ref-erence	D_2	d_1 Size	d_1 Tole-rance	d_2	L (Ref-erence	l_1	l_2 Size	l_2 Tole-rance	L_3	Pull off load (kgf Min.)
7	3.5	+ 0.3 - 0.2	1.3	±0.2	10 (*) 9	16	9.5	+ 0.3 0	12	30	2.5	2.5	±0.2	---	12
												3.5		1.0	
8	4.0				11 (*) 10					33		2.8		---	14
												3.5		1.0	
10	4.5				13					36		3.5		1.0	18
	5.0				(*) 12						3.0	4.5		2.0	
12	5.0				15					40		3.5		1.0	22
	5.5				(*) 14							4.5		2.0	

Remarks

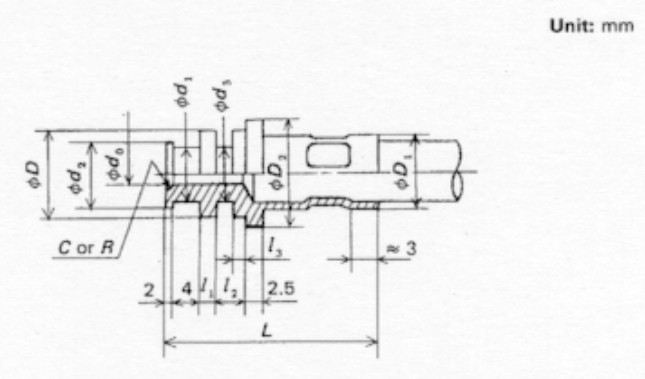
1. Dimension D_1 in the Table indicates the case of die cast part or machined part (with * mark).

2. Caulking shall, as general rule, be hexagon caulking.

ANNEXURE 18

(See Table 2 (5))

CASING CAP TYPE D2



Unit : mm

Applicable Outer casing outer diameter	d_o Size	d_o Tolerance	D Size	D Tolerance	D_1 (Reference	D_2	d_1 Size	d_1 Tolerance	d_2	d_3	L (Reference	l_2 Size	l_2 Tolerance	l_3	Pull off load (kgf Min.)
5	2.5	+ 0.3 - 0.2	10	0 - 0.2	8 (*) 7	14	6	+ 0.3 0	8	8	25	2.8	+ 0.2 - 0.1	1.0	8
												3.2			
												3.6			
6	3.0				9 (*) 8						28	2.8			10
												3.2			
												3.6			
7	3.5				10 (*) 9						31	3.2			12
												3.6			
												3.9		2.0	
												4.2			
8	4.0		15		11 (*) 10	20	7.5		10	12		3.2		1.0	14
												3.6			
												3.9		2.0	
												4.2			
9	4.5				12 (*) 11						34	3.6		1.0	16
												3.9		2.0	
												4.2			
												4.8			
10	4.5 5.0				13 (*) 12						36	3.6		1.0	18
												3.9		2.0	
												4.2			
												4.8			

Remark

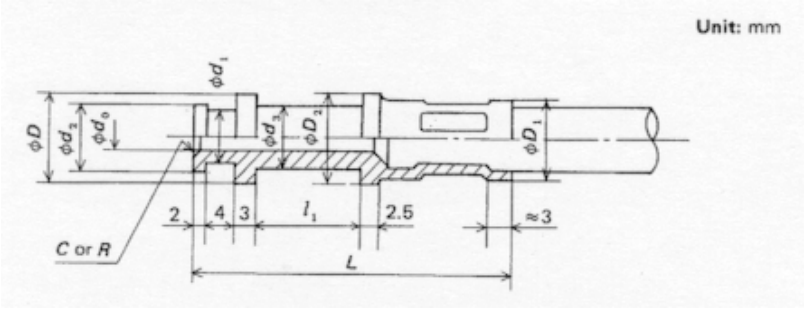
1. Dimension D1 in the Table indicates the case of die cast part or machined part (with * mark).

2. Caulking shall, as general rule, be hexagon caulking.

ANNEXURE 19

(See Table 2 (5))

CASING CAP TYPE D3



Unit : mm

Applicable outer casing outer diameter	d_o Size	d_o Tolerance	D Size	D Tolerance	D_1 (Reference)	D_2	d_1 Size	d_1 Tolerance	d_2	D_3	L (Reference)	L_1 Size	L_1 Tolerance	Pull off load (kgf, Min.)
7	3.5	+ 0.3 - 0.2	13	± 0.2	10 (*) 9	13	7.5	+ 0.3 0	10	7	42	15	± 0.2	12
9	4.5		15		12 (*) 11	15				9	45.5			16
10	4.5 5.0		16		13 (*) 12	16				10	47.5			18
											52.5	20		
											62.5	30		

Remarks

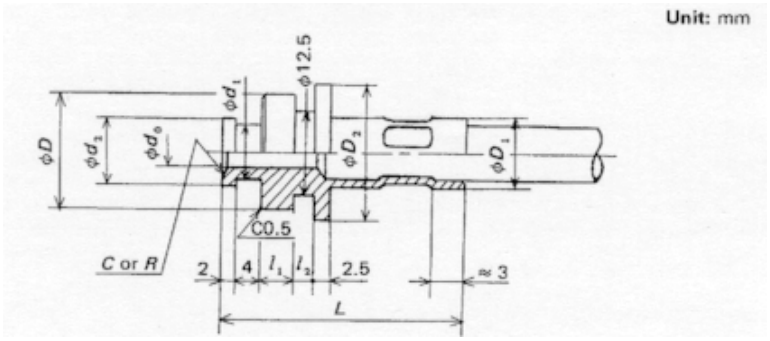
1. Dimension D1 in the Table indicates the case of the die cast part or machined part (with * mark).

2 Caulking shall, as general rule, be hexagaon caulking.

ANNEXURE 20

(See Table 2 (5))

CASING CAP TYPE D4

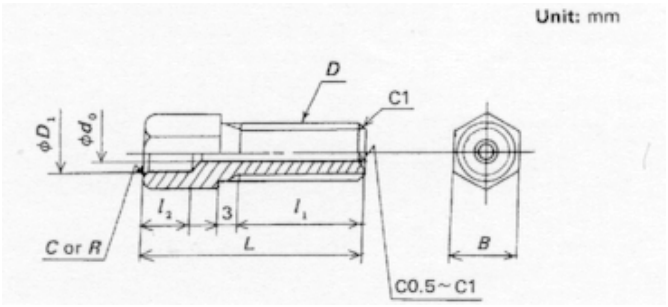


Unit : mm

Applicable outer casing outer diameter	d_o Size	d_o Tolerance	D Size	D Tolerance	D_1 (Reference	D_2	d_1 Size	d_1 Tolerance	D_2	L (Reference)	l_1	L_2 Size	L_2 Tolerance	Pull off load (kgf, Min.)
8	4.0	+ 0.3 - 0.2	16.5	± 0.1	10	20	7.5	+ 0.3 0	10	35	5	3	± 0.2	25

Remark : Caulking shall, as general rule, be hexagon caulking.

ANNEXURE 21
(See Table 2 (6))
ADJUST BOLT

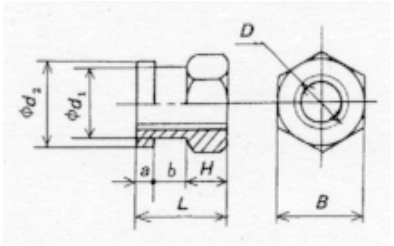


Unit : mm

Applicable Casing Cap Type A1 and A2 Outside diameter	d_o		D_1		D		B	L	l_1	L_2
	Size	Tolerance	Size	Tolerance	Nominal	Pitch				
5.8	3.0	+ 0.5 - 0.2	5.9	+ 0.3 0	8	1.25	10	38	20	12
7	2.8		7.1		6	1.0	10	58	40	
	3.0				8	1.25		38	20	
								53	35	
8	4.0				8	1.25	12	58	40	
			8.1		10	1.25		43	14	

Remark : Screw threads shall conform to JIS B 0205 or JIS B 0207.

ANNEXURE 22
(See Table 2 (7))
ADJUST NUT



Unit: mm

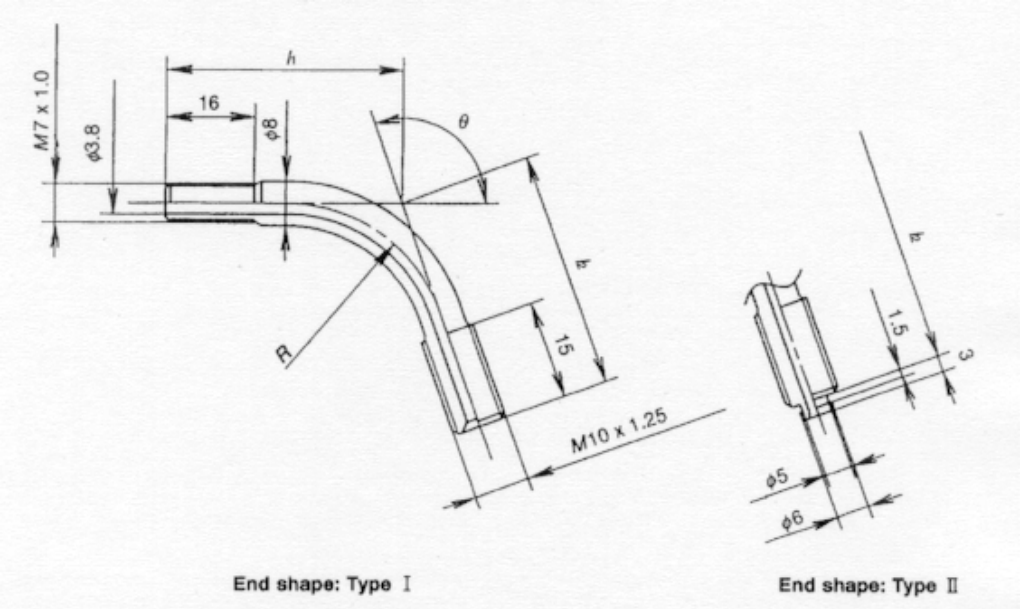
Applicable casing cap Type C and Adjust Bolt diameter	D		B	d_1		d_2	L	a	b	H
	Nominal	Pitch		Size	Tolerance					
6	6	1.0	10	7.5	+ 0.3 0	10	11	2	4	5
8	8	1.25	12	9.5		12	15	3	6	6
10	10	1.25	14	11.5		14	11	2	4	5

Remark : Screw threads shall conform to JIS B 0205 or JIS B 0207.

ANNEXURE 23

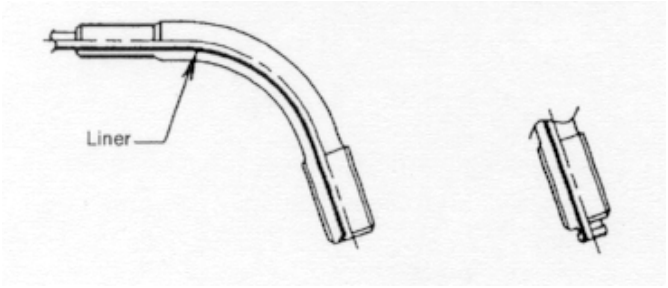
(See Table 2 (8))

ROUND JOINT TYPE A 1



Unit : mm

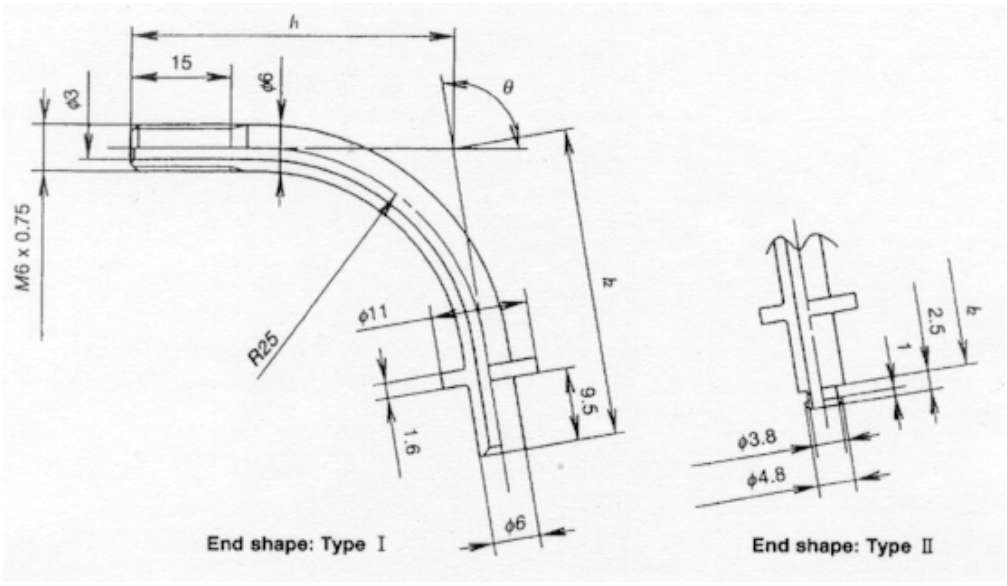
End shape	θ(^{0})	R	l_1	l_2
Type I & II	90	30	45	40
	110			
	130			



ANNEXURE 24

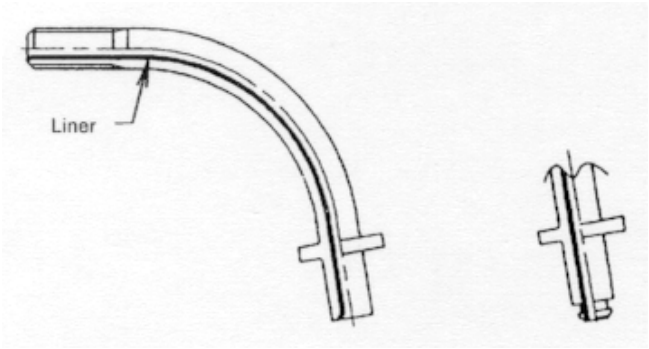
(See Table 2 (8))

ROUND JOINT TYPE A 2



Unit : mm

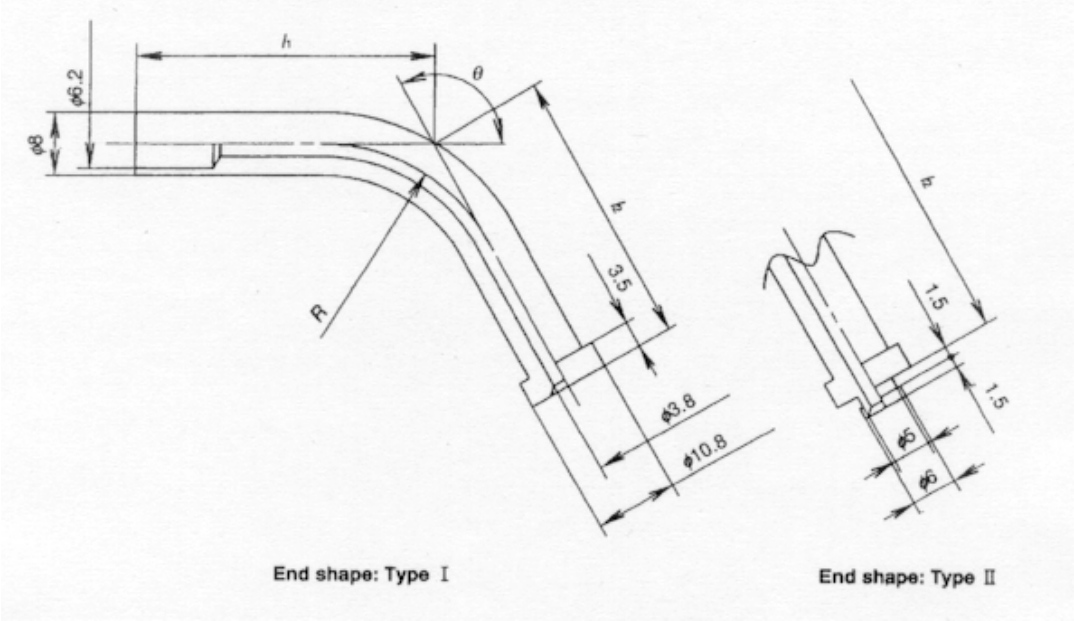
End shape	θ (^{0})	l_1	l_2
Type I & II	90	40	40
	110		
	130		



ANNEXURE 25

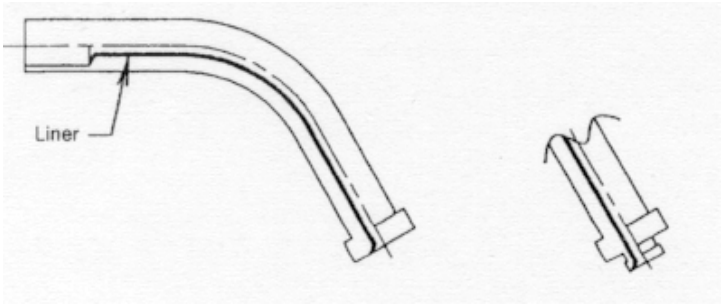
(See Table 2 (8))

ROUND JOINT TYPE B 1



Unit : mm

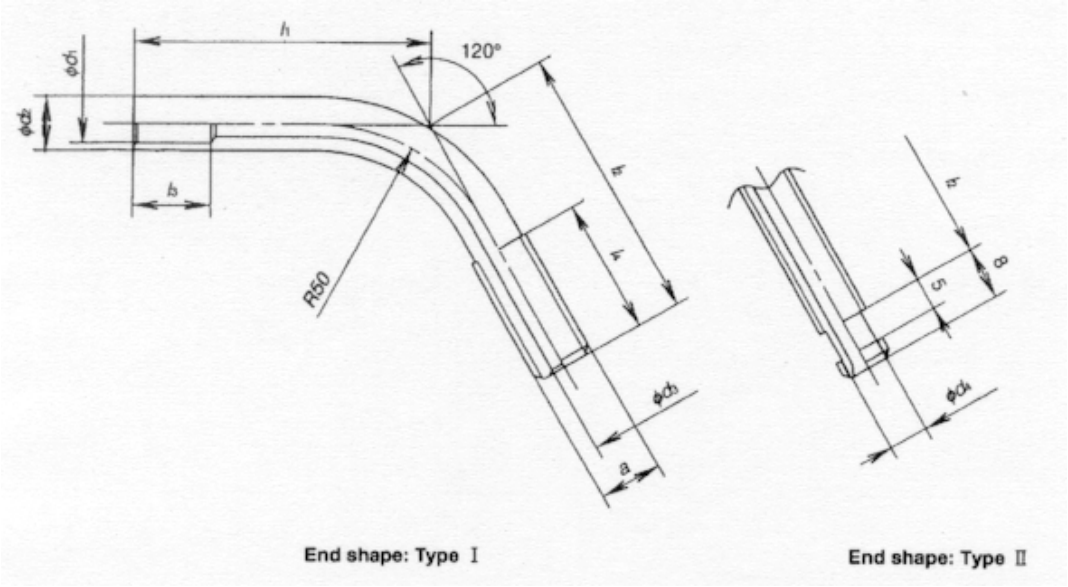
Diameter of applicable outer casing	End shape	θ(^{0})	R	l_1	l_2	Pull-off load (N)
6	Type I & II	90	25	40	40	100 or more
		100				
		120	30			



ANNEXURE 26

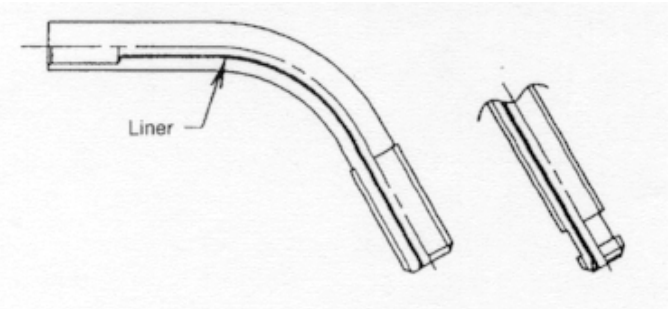
(See Table 2 (8))

ROUND JOINT TYPE B 2



Unit : mm

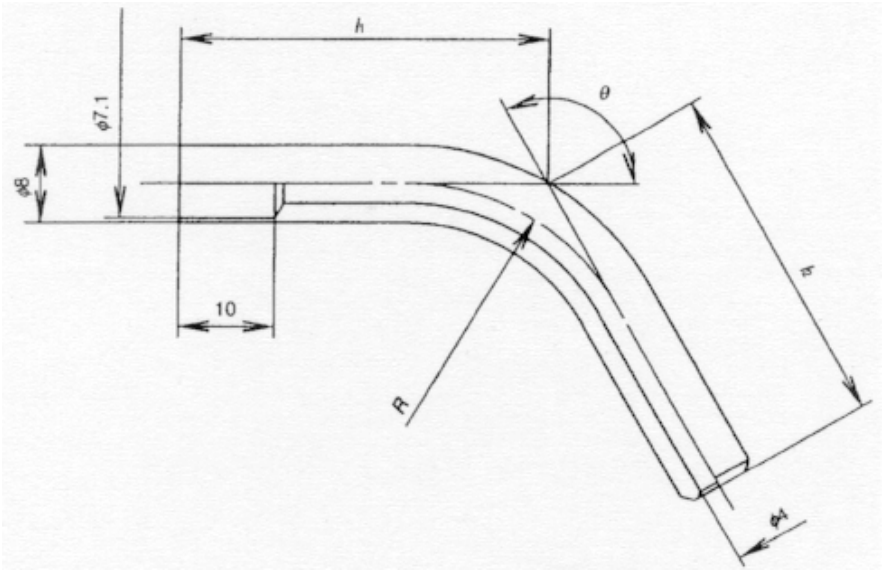
Diameter of applicable outer casing	End shape	d_1	d_2	d_3	d_4	l_1	l_2	l_3	l_4	a	Pull off load (N)
5	Type I	5.1	7.1	3.0	6.0	45	55		25	M8x1.25	80 or more
							80		40		
6	Type II	6.2	9.1	4.2	7.5	63	70		25	M10x1.25	100 or more
							85		45		
7	Type I	7.2	9.1	4.2	---	63	70		25	M10x1.25	120 or more
					---		85		40		
	Type II				7.5		70		25		
							85		40		



ANNEXURE 27

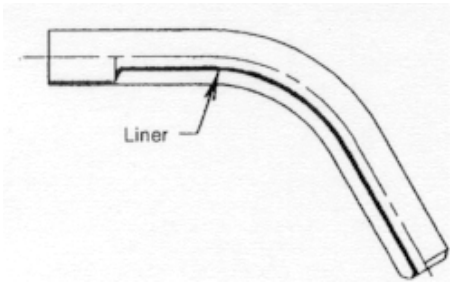
(See Table 2 (8))

ROUND JOINT TYPE B 3



Unit : mm

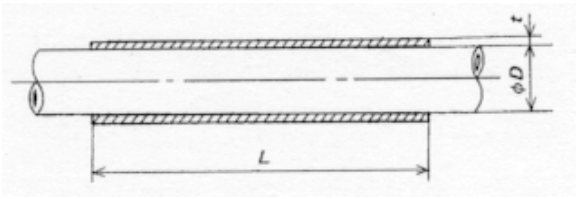
Diameter of applicable outer casing	θ(^{0})	R	l_1	l_2	Pull-off load (N)
7	90	30	50	45	120 or more
	110	40			
	130				



ANNEXURE 28

(See Table 2 (9))

CASING PROTECTOR



Unit : mm

Applicable outer casing diameter	D		t		L	
	Size	Tolerance	Size	Tolerance	Size	Tolerance
5	5.5	± 0.3	1.0 1.5	± 0.3	40 60 80 100 125 150 175 200 225 250 275 300 325 350 375 400 425 450 475 500	± 5% For minimum value of L shall conform to ± 5.
6	6.5					
7	7.5					
8	8.5		1.0 1.5 2.0			
9	9.5					
10	10.5					
12	12.5					
13	13.5					

Remarks

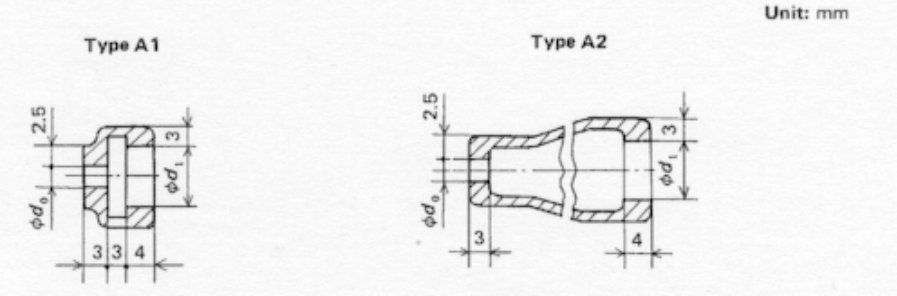
1. Casing protector shall, as general rule, be secured with adhesive or other proper method so as to prevent shifting
   easily from the designated position on outer casing.

2. Casing protector with dimension L exceeding 500 shall be by agreement between the persons concerned.

ANNEXURE 29

(See Table 2 (10))

DUST COVER TYPE A



Unit : mm

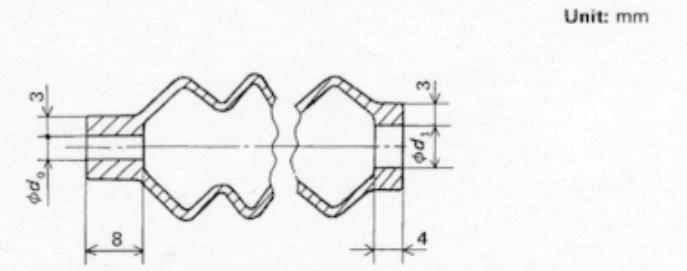
Inner cable diameter		d_o		d_1	
Uncoated	Coated	Size	Tolerance	Size	Tolerance
1.2	---	1.2 1.5	0 - 0.5	3.5 5.5	0 - 0.5
1.4					
1.5	---				
1.6					
---	1.8	2.0		5.5	
2.0	2.1				
2.5	2.6	2.5		5.5	
3.0	3.1	3.0		7.0	
3.5	---	3.5		9.0	
---	3.8	4.0		7.0 9.0	
4.0	---				
---	4.3	4.3			
---	4.8	4.8			

Remark : Standard wall thickness at tube center portion shall be 1.0

ANNEXURE 30

(See Table 2 (10))

DUST COVER TYPE B



Unit : mm

Inner cable diameter		d_o		d_1	
Uncoated	Coated	Size	Tolerance	Size	Tolerance
1.2	---	1.2	0 - 0.5	3.5	0 - 0.5
1.5	---	1.5		5.5	
---	1.8	2.0		5.5	
2.0	2.1				
2.5	2.6	2.5		5.5	
3.0	3.1	3.0		7.0	
3.5	---	3.5		9.0	
---	3.8	3.5		7.0 9.0	
4.0	---	4.0			
---	4.3	4.0			
	4.8	4.5			

Remark : Standard wall thickness at tube center portion shall be 1.0.

EXPLANATORY NOTE ON CONTROL CABLES FOR AUTOMOBILES

Supplementary explanations shall be given in regard to the contents of this standard. (The following item numbers are identical to those in the text).

3 MAIN COMPONENT MATERIALS AND SURFACE TREATMENTS

3.1 Inner Cable

(1) In case the corrosion resistance of inner cable is required to be specially strong, SUS304WR or SUS302WR of JIS G 4308 (Stainless Steel Wire Rods) is recommended.
(2) For inner cable (coated wire) coating material, selection is made from polyethylene, polyacetal, polyamide plastics and the like, depending on the application and type of cable.

3.2 Outer Casing

(1) Polyvinyl chloride is most widely used as coating material for outer casing but there is increasing demand for heat resistance, cold resistance, and other special matters and as materials for these purposes, development is being advanced on various plastics such as polyethylene, polypropylene and polyamide resins. As a result, only synthetic resin was designated in this standard so that actual type of resin and properties shall be as treated as direction to the parties concerned.
(2) For the outer casing (synthetic resin tube), material mainly used are polyethylene, polypropylene, and polyacetal resins, but for the same reason given above, only synthetic resin was designated so as to leave the details agreed on between the parties concerned.

3.3 Cable End

The material differs depending on the part shape, dimensions, and whether the connecting method with inner cable is by caulking or casting in, and selection made from materials such as BsBM of JIS H 3422 (Free Cutting Brass Rods), S15C ~ 35C of JIS G 4051 (Carbon Steel for Machine Structural Use) and ZDC of JIS H 5301 (Zinc Alloy Die Castings).

4. SHAPES AND DIMENSIONS OF MAIN COMPONENTS

4.1 **Inner Cable** (Annexure 1, 2, 3 and 4)

(1) **Tolerance**

In the tolerances, there are those on the minus side but only those on plus side were taken, using JIS G 3535 as reference. For nominal diameter 2.0 and under, plus side 0.1 nominal diameter, and for nominal diameter 2.5 and above, plus side 0.08 nominal diameter were established as basis.

(2) **Elongation**

Since the yield point does not appear clearly in steel stranded cable, tensile load corresponding to 60 percent of designated breaking load was added, and indicated with the elongation investigated at that time as reference.

(3) **Inner cable (coated cable)**

The minimum wall thickness designated indicates the value that shall be required for minimum assurance in case of eccentric wall thickness in resin coating.

4.2 **Outer Casing** (Annexure 5 and 6)

(1) Standard strand diameter has been indicated here as reference to express the workability from round wire.

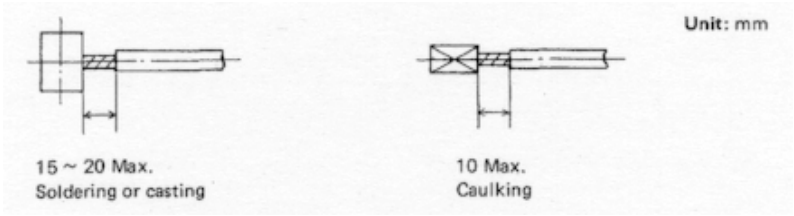
(2) Outer casing (resin tube) is normally formed using single resin but different resins may be used to form two-layer casing.

4.3 **Cable End**

(1) It is necessary that the cable end pull off load be a value that satisfies the operating conditions and safety factor but as this is largely influenced by the cable end shape and size and inner cable diameter, the value for cable ends used on same inner cable diameter, as principle, is set to the same value.

(2) Solder penetration length is defined as the length of the part, in which during the soldering of the cable end, the solder had been drawn up into the cable by capillary action and hardened.

(3) When joining the inner cable (coated cable) to cable end, the standard method is to peel off the coating as indicated below before joining.



(a) **Type A cable end (Annexure 7)**

Joining method with inner cable is mainly by soldering but those made by die casting (inner cable cast in) are increasing. On the pull off load, die cast formed type is generally higher and although this type has little dispersion in manufacturing, the use of metal mold makes it unsuited for small volume production.

(b) **Type B cable end (Annexure 8)**

The method of making up a connector combination with type A or type B cable end is generally cheaper than type B1, but there is an advantage in using die cast formed cable end line type B2.

(c) **Type C cable end (Annexure 9)**

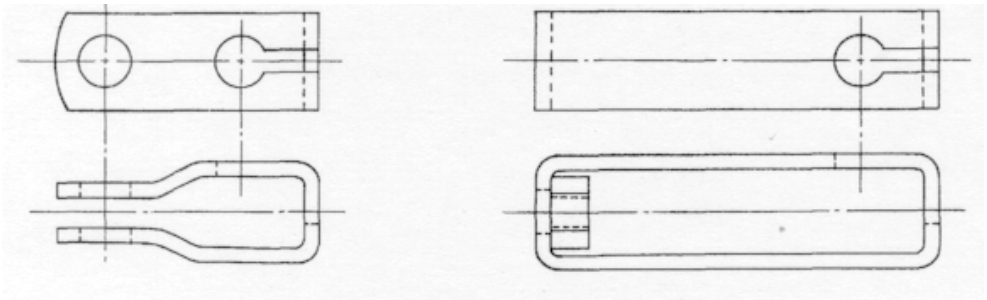
When installing, the type conforming to the shape of companion hardware is selected.

(d) **Type D cable end (Annexure 10)**

Type D cable end is utilized when inner cable installed length is to be adjusted. Caulking method most largely used is square caulking, but other caulking method may be used if pull off load is satisfied.

4.4 **Connector (Annexures 12 and 13)**

Connectors will be utilized in combination with cable ends Type A, C or D. Commonly called clevis. Those that have been standardized are assembled in with the cables. Some are provided with side hole and slit to enable installing to cable during vehicle assembly as shown below.



4.5 **Casing Cap**

(1) **Type A casing cap (Annexure 14)**

Type A casing cap will be used by fitting into companion hole like adjust bolt or clamped by suitable companion hardware.

(2) **Type B casing cap (Annexure 15)**

Type B casing cap will be used by fitting into companion hole and securing the brim.

(3) **Type C casing cap (Annexure 16)**

Type C1 is installed on outer casing with double nut to permit adjusting the length. Type C2 is a general fixed system.

(4) **Type D casing cap (Annexure 17 ~ 20)**

Type D casing cap will be fitted into companion hole and fixed by use of wave clip, E ring, needle clip and the like. Classified into Type D1, D2, and D3 by the method used for fixing. Type D4 is secured by force fit method.

4.6 **Adjust Bolt (Annexure 21)**

Adjust Bolt will utilized in combination with Type A casing cap for adjusting outer casing installed length.

4.7 **Adjust Nut (Annexure 22)**

As special nut for installing dust cover, Adjust Nut will be used in combination with Type C casing cap or adjust bolt.

4.8 **Casing Protector (Annexure 28)**

In regard to length, those exceeding 500 mm were considered to be free.

4.9 **Dust Cover (Annexure 29 and 30)**

On the tightening of the assembling portion, the inner diameter d_o that directly cover the inner cable was prescribed to be equal to or slightly smaller than the inner cable diameter and the inner diameter d_1 that covers the casing cap or adjust nut at the outer casing side was prescribed to 0.5 mm smaller than the outer diameter of fitting part.

5. QUALITY

5.1 Dimensions and Tolerance

(1) On proper use of "medium class" and "rough class" in JIS B 0105, general practice is to use medium class. On lengthwise dimension, rough class is sometimes used.

(2) On proper use of "Class 2" and "Class 3" in screw thread accuracy, Class 2 is generally used and on nuts, Class 3 is partially used.

(3) On cable length dimensions, it is desired that these be determined by outer casing overall length (with cap and inner cable exposed lengths a + b. (Main Text Table 5-1). On cable where construction necessitates use of dust covers at inner cable exposed part, there is difficulty in bringing the exposed parts to one place for measurement. In regard to this, it was decided to determine the dimension as inner cable overall length (with cable end) L_1 indicated in Main Text Table 5-2. On designating the inner cable nominal length, this may be done to comply with the individual demand items.

6. TEST METHODS

(1) **Load speed in strength test**

In the strength tests such as inner cable breaking test and cable end and casing cap pull-off load test, it is known that high value will be indicated when the load speed is too fast so that speed not exceeding 50 mm/min. was adopted, taking into consideration working efficiency.

(2) **Operating efficiency**

It was decided to indicate the operating efficiency in terms of load efficiency and stroke efficiency.

(a) **Load efficiency test**

In general, load efficiency indicates better value when the load W at the operated side is high than when low. This could be considered as being due to the effects of dust cover tightening allowance, lubricating oil and grease viscosity, and other being more readily received. On the operating side load F, considerable amplitude will be recorded by oscillograph in case of sticking or slipping. In such cases, the central value should be indicated. The faster the operating speed at measurement, the greater will become the amplitude but there will be no transition in the central value. It could be considered that some relation may exist between the amplitude size and the operating smoothness or feeling but this could not be clarified quantitatively.

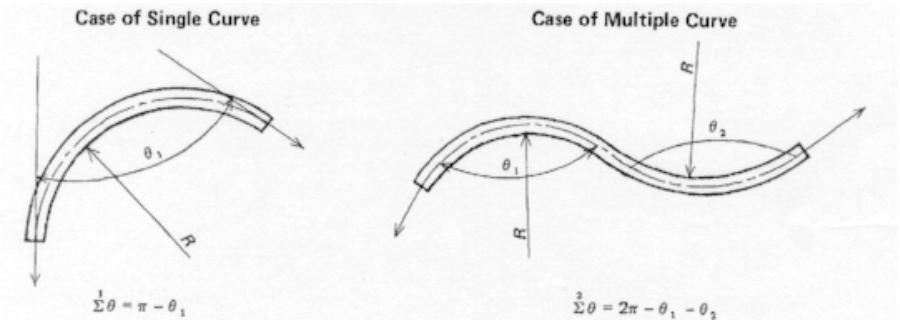
The load efficiency differs depending on the curved state of the outer casing. It is known that the following experimental equation obtained based on the contacting angle of the outer casing and inner cable at the curvature part shows highly accurate estimation when the outer casing is bent with in the range of R100 to 300, this could be utilized as necessary.

$$\text{Load efficiency } \eta = e^{-\mu \sum^{n} \theta}$$

where μ : Coefficient of friction

$\sum^{n} \theta$: Contact angle between outer casing and inner cable

In regard to $\sum^{n} \theta$, examples of single and multiple curves will be indicated in Explanatory Note Fig. 1.



Explanatory Note Fig. 1

In general the equation will be as follows in case on *n* number of multiple curves.

$$\sum^{n} \theta = n\pi - \sum^{n} \theta_1$$

When the outer casing curved part is properly supported along a round plate, it has been found that the load efficiency will be somewhat improved. This could be considered as being due to the buckling trend of outer casing being prevented.
It is now becoming a general practice to coat the inner cable with synthetic resin or utilize synthetic resin tube as means of raising load efficiency.

(b) **Stroke efficiency test**

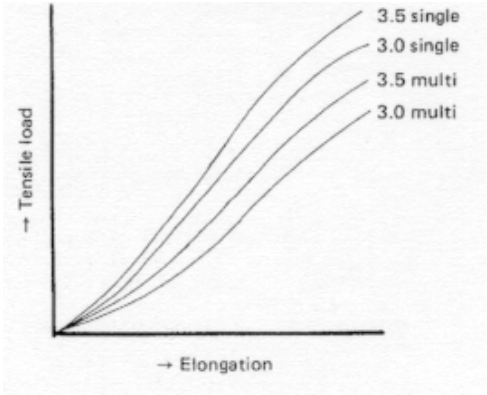
The equation indicated in Main Text 6.1.3 (2) expresses the case of stroke loss resulting from apparent elastic elongation (inner cable elastic elongation and outer casing elastic contraction). Operating play resulting from apparent permanent elongation (inner cable permanent elongation and outer casing permanent contraction) is not included.

On the inner cable elongation, measurements can be made with relative ease, and moreover, the inner cable can be utilized alone.

Taking these into consideration, the reference values and test method have been indicated in Main Text Annexures 1 and 8.

On the outer casing contraction, casing is difficult to measure by itself and in addition, it is used in combination with the inner cable. These have been taken into consideration, resulting in deciding to represent this by stroke efficiency test prescribed in Main Text 6.1.3 (2). In the stroke efficiency test, load elongation curve is derived, and by deriving that for the inner cable separately, it will be possible to estimate that for the outer casing alone from the curve.

As a means of raising the stroke efficiency, presetting the strands in the inner cable is sometimes practiced. By presetting, the apparent elasticity of the inner cable will be raised but this amounts to only a few percent and has little effect on improving the stroke efficiency. It should also be noted that this will not constitute a positive countermeasure in removing the operating play.
In case of stranded cable in general, as shown in Explanatory Note Fig. 2, for the same nominal diameter inner cable, the single has less elongation than the multi type. For the same load and with same composition, the larger the nominal diameter, the less will be elongation. These facts should be taken into consideration.



Explanatory Note Fig. 2

(3) **Outer Casing Buckling**

When tensile operating load is impressed, the outer casing is subjected to compressive load and may indicate buckling trend.

Functional impedance caused by buckling would first of all be loss in stroke efficiency. Aside from this, if the buckling becomes large enough to make it difficult to return to original shape, it could result in improper operation.

According to the results of various observations, it was found that buckling had adverse effect on load efficiency and control feeling.

The general tendency for buckling to develop has been found to start by buckling in installed surface outer direction, followed by inside surface, and when both occur, the operating efficiency drops.

When at surface outer buckling, elastic recovery is generally possible but surface inner buckling is sometimes accompanied by permanent deformation.

On synthetic resin tubes, studies have shown that smaller the outer casing sectional secondary moment and larger the curve R, the smaller will be the buckling development load. This has been proved both theoretically and experimentally.

As related above, development of buckling is not functionally desirable. It is necessary to know the pattern of its development but on the general handling of the test method, it would be difficult to define at what point of the buckling deformation the limiting load should be taken. Also, when maximum diameter inner cables were inserted into outer casings of the sizes recommended in this standard, and with tension up to cable breaking load applied under the condition of 90^{o} bend, 180^{o} bend and 90^{o} successive bends over R 100 ~ 300 curves, no symptoms such as inability to recover elasticity could be observed. Such being the case, test method was not specially prescribed in this standard. However, if it is considered that buckling is mainly developed as an effect of operating efficiency, investigation could be made by detailed performance of operating efficiency test.

Thus, if the operating function should become a special problem or in case of special application, individual investigation should be made. In the case of utilizing synthetic resin tube for outer casing, precaution should be taken since the bending strength is generally low.

(4) **Control Feeling**

In the control cable functions, aside from operating efficiency, control feeling or operating smoothness becomes a problem.

As a cause for decling in feeling, sticking slipping symptoms can be listed first. The most effective countermeasure for this would be to plan on lowering the friction. For this, studies in lubrication grease selection and effects of temperature and operating speed would be required. There are also cases where the problem of resonance in the elastic properties of inner cable, outer casing and installation parts have been considered.

In regard to feeling, it would be difficult to indicate this by numerical value at the present stage. Aside from special examples, this is still in the research stage and is a problem that should be investigated further.

In relation to the buckling and feeling mentioned above, bending rigidity of the outer casing becomes a factor. As a simple test method for this, the free bending of a given length outer casing is supported as a cantilever beam is compared.

(5) **Control Cable Seal**

On the preservation of control cable durability, main factors are outer casing cover maintenance and effectiveness of seals such as dust covers. As a means of raising the sealing property of dust cover, a method widely used is to clamp both ends of the dust cover with steel or aluminum rings. Aside from this, use of packing material such as felt is also utilized.

(6) **Functional Deterioration and Longevity by Repeated Operation**

Repeated operation and also accumulation of running operational conditions including environmental changes will generally cause deterioration in operating functions. Especially with the lowering of operating efficiency and feeling, operation could become impossible even though inner cable and outer casing remain unbroken.
The subjects that become the object of investigation include the longevity of inner cable and cable ends under corrosion or frictional conditions, apparent accumulative elongation of the inner cable, accumulative elongation of outer casing, changes in frictional resistance and lubricating function, and performance and longevity of the various seals.

ANNEXURE 31
(See Introduction)

COMMITTEE COMPOSITION
Automotive Industry Standards Committee

Chairman	
Shri Shrikant R. Marathe	Director The Automotive Research Association of India, Pune
Members	**Representing**
Representative from	Ministry of Road Transport & Highways (Dept. of Road Transport & Highways), New Delhi
Representative from	Ministry of Heavy Industries & Public Enterprises (Department of Heavy Industry), New Delhi
Shri S. M. Ahuja	Office of the Development Commissioner, MSME, Ministry of Micro, Small & Medium Enterprises, New Delhi
Shri T. V. Singh	Bureau of Indian Standards, New Delhi
Director Shri D. P. Saste (Alternate)	Central Institute of Road Transport, Pune
Dr. M. O. Garg	Indian Institute of Petroleum, Dehra Dun
Shri C. P. Ramnarayanan	Vehicles Research & Development Establishment, Ahmednagar
Representatives from	Society of Indian Automobile Manufacturers
Shri T.C. Gopalan	Tractor Manufacturers Association, New Delhi
Shri K.N.D. Nambudiripad	Automotive Components Manufacturers Association of India, New Delhi
Shri Arvind Gupta	Automotive Components Manufacturers Association of India, New Delhi

Member Secretary
Mrs. Rashmi Urdhwareshe
Deputy Director
The Automotive Research Association of India, Pune