

JIS

JAPANESE INDUSTRIAL STANDARD

**Double acting hydraulic
cylinders**

 **JIS B 8354**—1992

Translated and Published

by

Japanese Standards Association

Printed in Japan

In the event of any doubt arising,
the original Standard in Japanese is to be final authority.



1. **Scope** This Japanese Industrial Standard specifies the double acting hydraulic cylinders, hereafter referred to as the "cylinders", to be used in the hydraulic systems ⁽²⁾ for mechanical equipment ⁽¹⁾.

Notes ⁽¹⁾ Those which are used in production such as manufacturing and assembling.

⁽²⁾ Those which are prescribed in JIS B 8361.

Remarks 1. The units and numerical values given in { } in this Standard are based on the traditional units and are appended for informative reference.

2. The standards cited in this Standard are shown in Attached Table 2, and corresponding International Standards are shown in Attached Table 3.

2. **Definitions** For the main terms used in this Standard, the definitions in JIS B 0142 apply, and the rest of the terms shall be as follows:

Informative reference : The definitions for terms are given in ISO 5598.

(1) **maximum permissible working pressure** The maximum value permissible for pressure generated inside the cylinder.

Remarks : This means such pressures as internal pressure, which results from the absorption of energy when inertial loads are stopped, and surge pressure, which is generated when the direction of oil flow is changed.

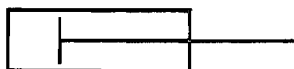
(2) **nominal pressure** The pressure assigned for the purpose of convenient designation, and the maximum value of the set pressures for relieving valves provided in an oil hydraulic circuit using cylinders.

(3) **minimum operating pressure** The minimum pressure capable of guaranteeing the operation of the cylinder.

(4) **head end** Closed end of the cylinder.

(5) **rod end** End of a cylinder through which the piston rod passes.

Informative reference:



Head end

Rod end

- (6) cylinder force A theoretical fluid force acting on the surface of a piston.

$$F_{th} = 0.1 \times P \times A$$

$$\{F_{th} = P \times A\}$$

where,

F_{th} : cylinder force (kN){kgf}

P : nominal pressure acting on the surface of the piston (MPa){kgf/cm²}

A : effective cross-sectional area of the piston (cm²)

- (7) cylinder output force A mechanical force transmitted by a piston rod.

- (8) thrust efficiency of cylinder The ratio of the cylinder output force to the cylinder force.

$$\lambda = \frac{10 \times F}{P \times A} \{ \lambda = \frac{F}{P \times A} \}$$

where,

λ : thrust efficiency of cylinder

F : cylinder output force (kN){kgf}

P : nominal working pressure acting on the surface of a piston (MPa){kgf/cm²}

A : effective cross-sectional area of the piston (cm²)

- (9) cylinder cushioning Means whereby the movement of a rod is decelerated as it approaches the end of its stroke by restricting the discharge of fluid automatically.

3. Applicable range

3.1 Surroundings The cylinders shall be used in indoor surroundings and shall not be used in the surroundings of excessive vibration, contamination, and high humidity.

3.2 Ambient temperature The ambient temperature shall be - 5 °C to 80 °C.

3.3 Working fluid The working fluid used shall be mineral working oil.

3.4 Piston speeds The piston speeds shall be as given in Table 1.

Table 1. Piston speeds

Tube bores mm				Piston speed mm/s
32	40	50	63	8 to 400
80	100	125		8 to 300
140	160	180		8 to 200
200	220	250		

3.5 Cylinder cushioning The inertial force absorbed by cylinder cushioning shall be not more than the values shown in Figs. 1, 2 and 3.

Fig. 1. Equivalent load-speed diagram which is permissible for the cylinders used for nominal pressures 3.5 MPa {35 kgf/cm²} and 7 MPa {70 kgf/cm²} (In the direction of the rod entering the cylinder)

Equivalent load permissible when the rod enters the cylinder is:

$$\text{Equivalent load} = W + \left[\frac{A_1}{A_2} \left(0.1P_1 - \frac{F}{A_1} \right) \pm \frac{W \sin \theta}{A_2} \right] \times A_2$$

where,

W : load moved by cylinder (kN)(kgf)

A_1 : effective cross-sectional area on the side of supplying oil pressure (cm²)

A_2 : effective cross-sectional area on back pressure side (cm²)

F : frictional resistance of load (kN)(kgf)

P_1 : pressure generated on the side supplying oil pressure inside the cylinder (MPa)(kgf/cm²)

θ : angle formed by the perpendicular line to the load (minus sign indicates the direction of lifting the load and plus sign the direction of being pulled by the load)

Equivalent load permitted when the rod protrudes from the cylinder at the same speed is :

1/2 of this value for the rod diameter of symbol A

1/1.45 of this value for the rod diameter of symbol B

1/1.25 of this value for the rod diameter of symbol C

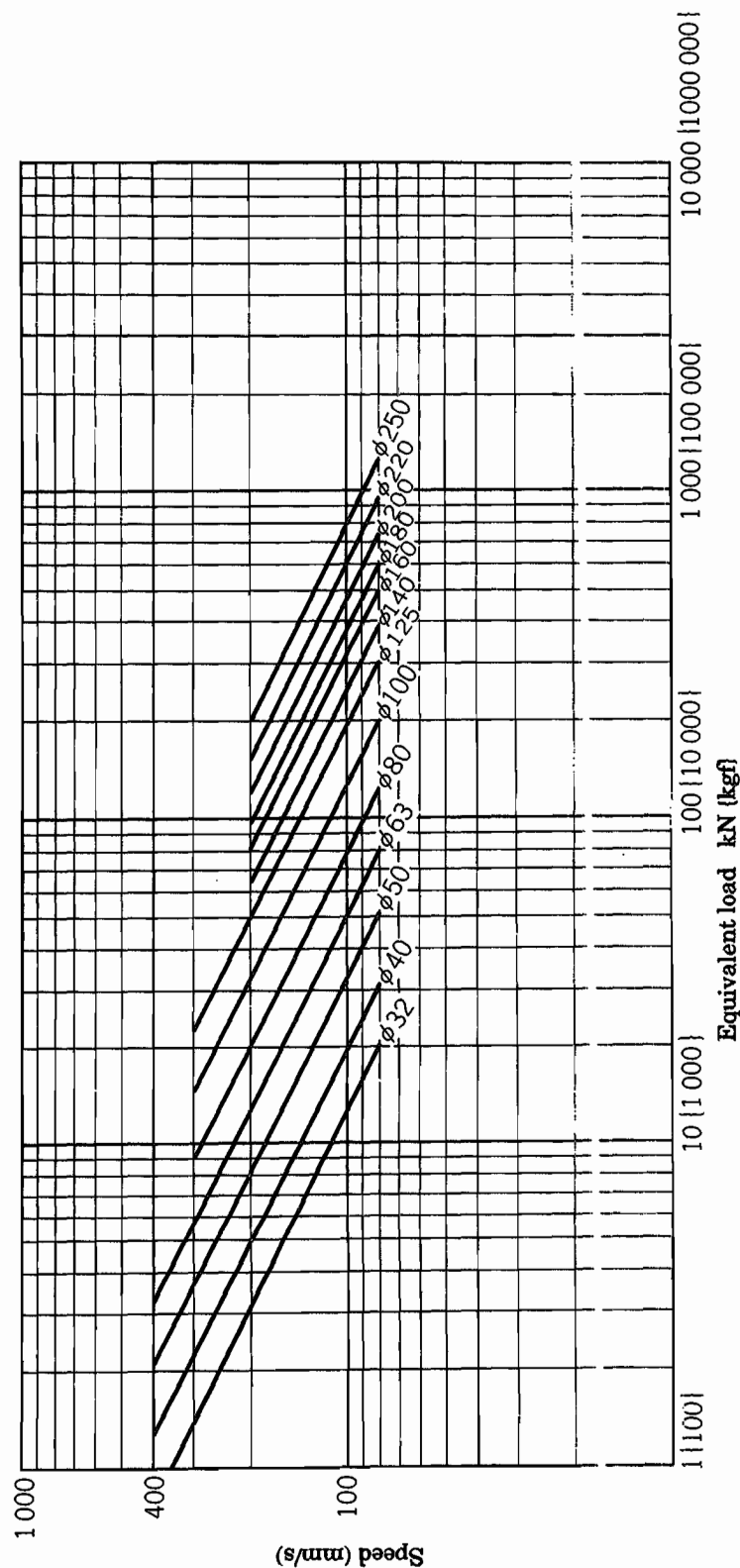


Fig. 2. Equivalent load-speed diagram which is permissible for the cylinders used for nominal pressure 14 MPa {140 kgf/cm²} (In the direction of the rod entering the cylinder)

Equivalent load permissible when the rod enters the cylinder is:

$$\text{Equivalent load} = W + \left[\frac{A_1}{A_2} (0.1P_1 - \frac{F}{A_1}) \pm \frac{W \sin \theta}{A_2} \right] \times A_2 \quad \left\{ \text{Equivalent load} = W + \left[\frac{A_1}{A_2} (P_1 - \frac{F}{A_1}) \pm \frac{W \sin \theta}{A_2} \right] \times A_2 \right\}$$

where,

W : load moved by cylinder (kN)(kgf)

A_1 : effective cross-sectional area on the side of supplying oil pressure (cm²)

A_2 : effective cross-sectional area on back pressure side (cm²)

F : frictional resistance of load (kN)(kgf)

P_1 : pressure generated on the side supplying oil pressure inside the cylinder (MPa)(kgf/cm²)

θ : angle formed by the perpendicular line to the load (minus sign indicates the direction of lifting the load and plus sign the direction of being pulled by the load)

Equivalent load permitted when the rod protrudes from the cylinder at the same speed is :

1/2 of this value for the rod diameter of symbol A

1/1.45 of this value for the rod diameter of symbol B

1/1.25 of this value for the rod diameter of symbol C

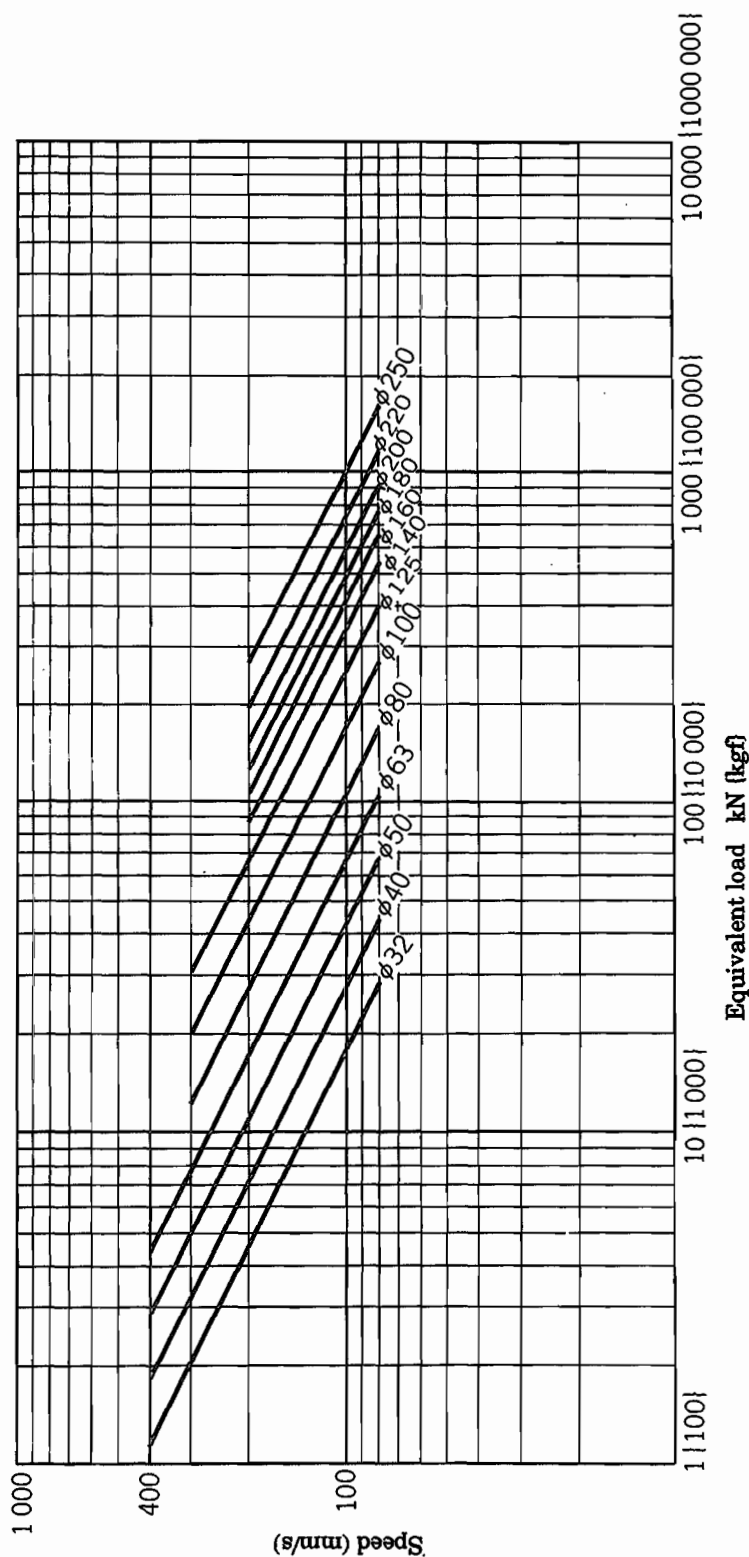


Fig. 3. Equivalent load-speed diagram which is permissible for the cylinders used for nominal pressure 21 MPa {210 kgf/cm²} (In the direction of the rod entering the cylinder)

Equivalent load permissible when the rod enters into the cylinder is:

$$\text{Equivalent load} = W + \left[\frac{A_1}{A_2} (0.1P_1 - \frac{F}{A_1}) \pm \frac{W \sin \theta}{A_2} \right] \times A_2 \quad \left\{ \text{Equivalent load} = W + \left[\frac{A_1}{A_2} (P_1 - \frac{F}{A_1}) \pm \frac{W \sin \theta}{A_2} \right] \times A_2 \right\}$$

where,

W : load moved by cylinder (kN)(kgf)

A_1 : effective cross-sectional area on the side of supplying oil pressure (cm²)

A_2 : effective cross-sectional area on back pressure side (cm²)

F : frictional resistance of load (kN)(kgf)

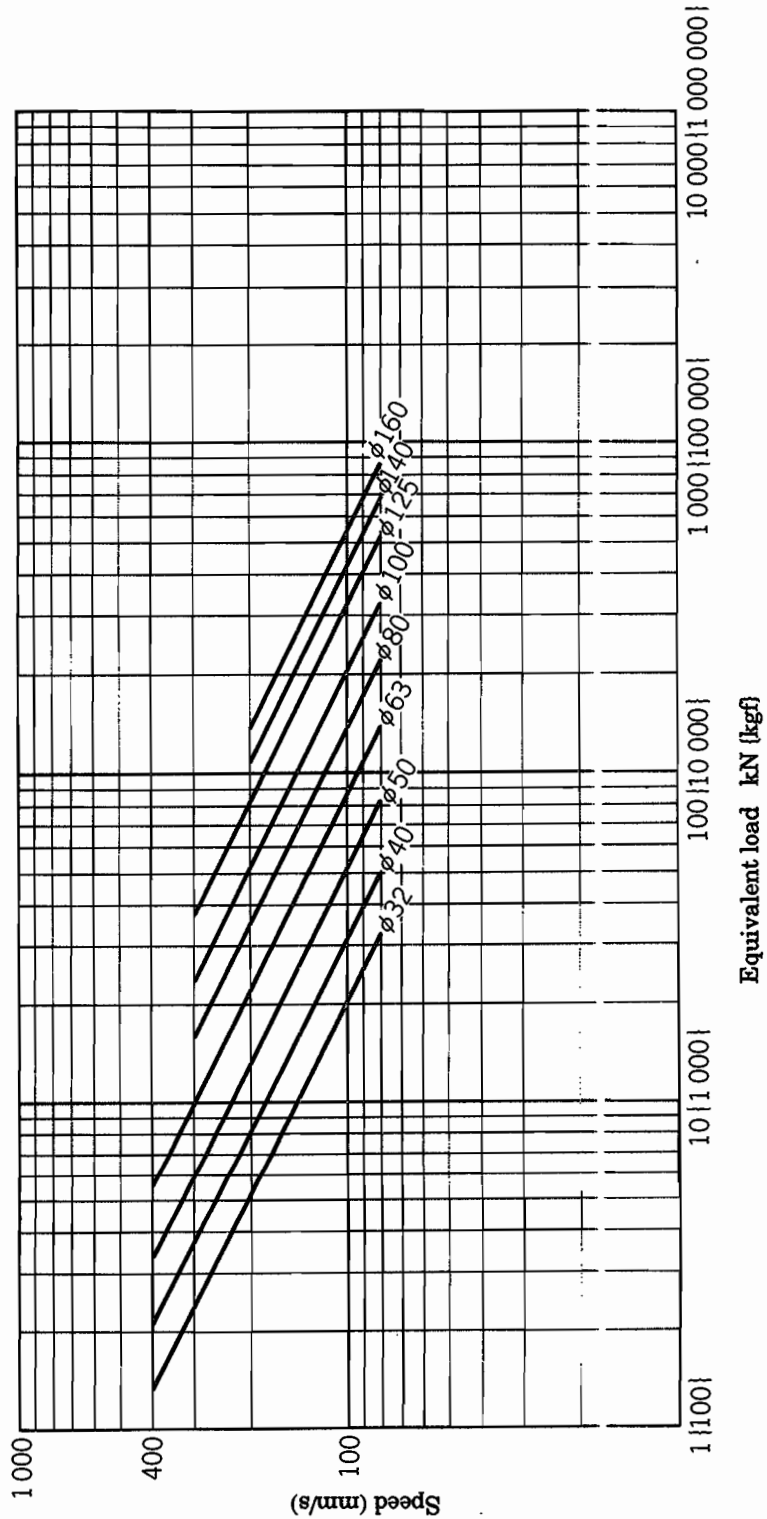
P_1 : pressure generated on the side supplying oil pressure inside the cylinder (MPa)(kgf/cm²)

θ : angle formed by the perpendicular line to the load (minus sign indicates the direction of lifting the load and plus sign the direction of being pulled by the load)

Equivalent load permitted when the rod protrudes from the cylinder at the same speed is :

1/2 of this value for the rod diameter of symbol A

1/1.45 of this value for the rod diameter of symbol B



3.6 Maximum permissible working pressures The maximum permissible working pressures for cylinders shall be classified as given in Table 2.

Table 2. Maximum permissible working pressures

Unit: MPa {kgf/cm²}

Nominal pressure	Head end	Rod end		
		Rod diameter symbol A	Rod diameter Symbol B	Rod diameter symbol C
7 { 70}	8.8 { 90}	14.7 {150}	12.7 {130}	10.8 {110}
14 {140}	17.7 {180}	17.7 {180}	17.7 {180}	13.7 {140}
21 {210}	26.5 {270}	26.5 {270}	24.5 {250}	—

4. Types The types of the cylinders shall be classified as given in the following according to nominal pressures, mounting forms, materials of packing and gasket, cushionings, external leakages (leakages from rod wiper portion), and with or without switches.

- (1) **Nominal pressure** The cylinders shall be classified as given in Table 3 according to the nominal pressures:

Table 3. Nominal pressures of cylinder

Unit: MPa {kgf/cm²}

Nominal pressure
7 { 70}
14 {140}
21 {210}

- (2) **Mounting forms** The cylinders shall be classified as given in Table 4 according to the mounting forms:

Table 4. Mounting forms

	Mounting type	Symbol		Remarks
Foot types	Right-angled to axis foot type	LA	(MS 2)	Tables 19 & 20
	Axial direction foot type	LB	(MS 1)	Table 21
Flange types	Rod-end rectangular flange type	FA	(MF 1)	Tables 22, 23 & 24
	Head-end rectangular flange type	FB	(MF 2)	Tables 22, 23 & 24
	Rod-end square flange type	FC	(MF 5)	Table 25
	Head-end square flange type	FD	(MF 6)	Table 25
Crevice types	Detachable eye type	CA	(MP 4)	Table 26
	Detachable crevice type	CB	(MP 2)	Table 26
	Fixed eye type	CC	(MP 3)	Table 27
Trunnion types	Rod-end integral trunnion type	TA	(MT 1)	Table 28
	Head-end integral trunnion type	TB	(MT 2)	Table 28
	Intermediate fixed trunnion type	TC	(MT 4)	Tables 29 & 30

- Remarks 1. Those of which mounting methods are inevitably particular ones shall be designated as X-shape, such as LX, FX and the like.
2. The fixed eye form in the crevice types shall mean an integrated construction in which an eye fitting is welded with the head, and the detachable eye form and detachable crevice form shall mean those construction in which eyes and crevice fittings have been assembled with bodies by tie rods.
3. The symbols given in () are shown for informative reference, and are in accordance with JIS B 8366.
- (3) Materials of packing and gasket Packings and gaskets shall be classified as given in Table 5 according to materials.

Table 5. Materials of packing and gasket

Material of packing and gasket	Symbol
Nitrile rubber	1
Urethane rubber	2
Fluorine-contained rubber	3
Ethylene tetrafluoride resin	4
Metal	5
Others	6

Remarks : Nitrile rubber and fluorine-contained rubber include cloth-inserted rubber.

- (4) Cushioning The cushionings shall be classified as given in Table 6 according to the locations where the cushions are to be built-in, and with or without thereof.

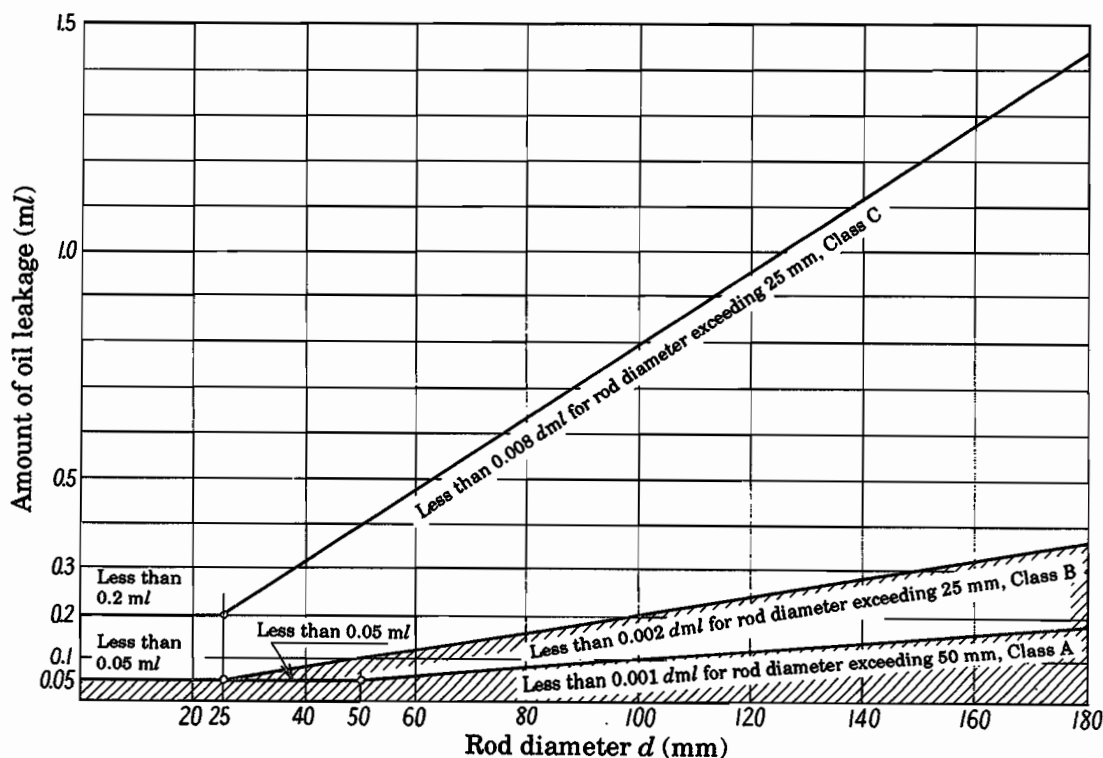
Table 6. Cushionings

Locations where cushionings are to be built-in and with or without thereof		Symbol
With cushioning	Rod end and head end	B
	Rod end	R
	Head end	H
Without cushioning		N

- (5) External oil leakages The external oil leakages shall be classified into Class A, Class B and Class C as given in Fig. 4 according to the amounts of oil leakage from the wiper parts of the rods.

As regards the request for the smaller leakage than the Class A shall be as agreed between the purchaser and supplier.

Fig. 4. External oil leakages



- (6) Presence or absence of switch The cylinders shall be classified as given in Table 7 by presence or absence of the switch.

Table 7. Presence or absence of switch

	Symbol
Without switch	No symbol
With switch	R

5. Performances

5.1 Operational performance

5.1.1 No load operation When tested in accordance with 10.2.1, the movements of the cylinder shall be smooth.

The value of the minimum operating pressure shall be not more than the value of Table 8 (A) or Table 8 (B) being classified by the shapes of the packing. However, when the minimum operating pressure other than this value is required, its value may be determined as agreed between the purchaser and supplier.

The shape of the packing shall be classified as given in Table 9.

Table 8 (A) Minimum operating pressures for rod packings other than V-packing

Unit: MPa(kgf/cm²)

Shape of piston packing	Nominal pressure (MPa)	When pressure is supplied from head end	When pressure is supplied from rod end		
			Rod diameter symbol A	Rod diameter symbol B	Rod diameter symbol C
V	7	0.5 {5}	0.98 {10}	0.74 {7.5}	0.54 {6.5}
	14·21	Nominal pressure × 6 %	Nominal pressure × 12 %	Nominal pressure × 8.6 %	Nominal pressure × 7.5 %
L·U·X O·S	7	0.29 {3}	0.59 {6}	0.44 {4.5}	0.39 {4}
	14·21	Nominal pressure × 4 %	Nominal pressure × 8 %	Nominal pressure × 5.7 %	Nominal pressure × 5 %
P	7	0.1 {1}	0.2 {2}	0.15 {1.5}	0.13 {1.3}
	14·21	Nominal pressure × 1.5 %	Nominal pressure × 3 %	Nominal pressure × 2.1 %	Nominal pressure × 1.9 %

Table 8 (B) Minimum operating pressures for rod packings of V-packing

Unit: MPa(kgf/cm²)

Shape of piston packing	Nominal pressure (MPa)	When pressure is supplied from head end	When pressure is supplied from rod end		
			Rod diameter symbol A	Rod diameter symbol B	Rod diameter symbol C
V	7	0.74 {7.5}	1.5 {15}	1.1 {11}	0.93 {9.5}
	14·21	Nominal pressure × 9 %	Nominal pressure × 18 %	Nominal pressure × 13 %	Nominal pressure × 11 %
L·U·X O·S	7	0.44 {4.5}	0.9 {9}	0.64 {6.5}	0.5 {5.5}
	14·21	Nominal pressure × 6 %	Nominal pressure × 12 %	Nominal pressure × 8.5 %	Nominal pressure × 7.5 %
P	7	0.15 {1.5}	0.3 {3}	0.2 {2}	0.13 {1.8}
	14·21	Nominal pressure × 2.5 %	Nominal pressure × 5 %	Nominal pressure × 3.5 %	Nominal pressure × 3 %

Remarks : Minimum operating pressures for piston rod symbols X, Y and Z correspond to 1.6, 1.33 and 1.2 times, respectively, of minimum operating pressure when the pressure is supplied from the head end.

Table 9. Shapes of packings

Shape of packing	V packing	L (J) packing	U (Y) packing	X ring	O ring	Combined seal	Piston ring	Others
Symbol	V	L	U	X	O	S	P	E

Remarks 1. O-rings shall be in accordance with JIS B 2401 and V-packings shall be in accordance with JIS B 2403.

2. The combined seal means the packing which is formed by the combination of sliding rings of ethylene tetrafluoride resin or the like with rubber O-rings or the like.

5.2 Durability When tested in accordance with 10.2.2, there shall be no loosening, permanent deformation and abnormal wearing, and for the cylinder with cushioning, the cushioning shall operate normally.

For the cylinder with switch, the switch shall not cause erroneous actions.

5.3 Pressure resistance When tested in accordance with 10.2.3, there shall be no loosening, permanent deformation and breakages on parts.

5.4 Oil leakages

5.4.1 External oil leakage The external oil leakage, when tested in accordance with 10.2.4 (1), shall be expressed by the total amount of the oil leakage from the wiper part of the rod within 100 m in travelling distance of the piston (see Fig. 4).

Further, there shall be no external oil leakage from any place except the wiper part of the rod.

5.4.2 Internal oil leakage When tested in accordance with 10.2.4 (2), the amount of internal oil leakage of the cylinder not using a piston ring shall be not more than the value given in Table 10.

When the combined seal is used, the amount of internal oil leakage shall be limited up to 2 times the value given in Table 10.

In addition, when the piston ring is used, the amount shall be not more than the value of Attached Fig. 1.

Table 10. Amount of internal oil leakage

Unit: ml/10 min

Bore of tube mm	Amount of oil leakage	Bore of tube mm	Amount of oil leakage	Bore of tube mm	Amount of oil leakage
32 (31.5)	0.2	100	2.0	200	7.8
40	0.3	125	2.8	220 (224)	10.0
50	0.5	140	3.0	250	11.0
63	0.8	160	5.0		
80	1.3	180	6.3		

5.5 Thrust efficiency When tested in accordance with 10.2.5, the value of thrust efficiency of the cylinder shall be not less than 0.9.

Informative reference: The value of thrust efficiency varies depending on the value of pressure, shape of packings, etc.

6. Construction

6.1 General construction

6.1.1 Construction of cylinder Each part of the same type cylinders made by the same manufacturer shall be interchangeable, and interchanging of the parts shall not cause remarkable change in their performances. The cylinder shall be of such construction as to need no special tools at the time of disassembling and assembling for replacing or inspection of packings, gaskets and so on.

6.1.2 Fixing of rod and piston The rod and piston shall be fixed securely together so as neither to loosen nor to allow the adjustment to get out of order during the operation. When screw threads are used for fixing a rod and a piston, the threads shall be in accordance with JIS B 0207, and the accuracy thereof shall be of 6H/6 g specified in JIS B 0211.

6.1.3 Mounting of switch The switch shall be fixed securely to the cylinder so as neither to be loosened nor to fall out of adjustment due to vibration.

6.1.4 Interception of the air The cylinder shall be so constructed that the air does not enter from the joint parts and seal parts.

6.1.5 Names of parts The names of parts of cylinders shall be in accordance with Attached Fig. 3.

6.2 Construction of each part

6.2.1 Dust wiper The gland of the rod cover shall provide a dust wiper to prevent the rod packing from being damaged by external dust and the like.

6.2.2 Port The ports shall be either the threaded joint type or pipe flange joint type as specified in Table 31.

Screw threads of the screwed end of mating flanges shall be in accordance with JIS B 0203, and those of welding end of mating flanges shall be of 3SA specified in JIS B 2291, and there shall be no harmful defect in practice on the mating face.

To the pipe flange fitting, a mating flange of screwed end or welding end shall be attached.

For the gasket of the pipe flange fitting, Class 1 gasket for static use specified in JIS B 2401 should preferably be used.

6.2.3 Cushioning The cylinder containing the cushioning mechanism in itself should be so constructed as to be adjustable by a needle valve and the like.

6.2.4 Head cover, rod cover and piston The head cover, rod cover and piston shall have robustness sufficient to withstand internal pressure, and the gland part (including bush) of rod cover and the piston shall slide smoothly and shall not impair the mutual sliding surfaces even if subjected to the lateral load of the rod. As an operating condition, the lateral load of the rod shall be about 1/100 the maximum cylinder force.

6.2.5 Cylinder tube The wall thickness of the cylinder tube, hereafter referred to as the "tube", shall be not less than the value obtained from the formula below, and it shall have ample stiffness.

$$t = \frac{pD}{2S} \left\{ t = \frac{pD}{200 S} \right\}$$

where, t : wall thickness (mm)
 p : nominal pressure (MPa) {kgf/cm²}
 D : tube bore (mm)
 S : $\frac{\sigma}{5}$ (N/mm²) {kgf/cm²}
 σ : minimum value of tensile strength
(N/mm²) {kgf/cm²}

When the tube is welded to the rod cover, head cover or the flange, the wall thickness shall be made thicker, taking into consideration the effect of the welding. When the inside and outside of the pressure withstanding part of the tube is machined (including working for steady rest) or threaded, the minimum wall thickness shall be not less than t obtained as above. In this case, screw threads shall generally conform to JIS B 0207.

6.2.6 Rod The rod diameter shall be selected on the basis of the buckling of the rod and the piston speed, and it should be preferable that the rod is processed with the width across flats for wrenching. The width across flat dimensions should be as specified in JIS B 1002.

The sliding part shall be processed with the electroplated coatings of chromium for engineering purpose for preventing flaws, nicks, rust, etc.

6.2.7 Mounting parts The mounting parts shall be those of having sufficient rigidity against reaction force due to operation, and furthermore shall meet the following requirements:

- (1) The attaching face of the mounting part of the foot type cylinder shall be in parallel with the centre line of the cylinder.
- (2) The attaching face of the mounting part of the flange type cylinder shall be at right angles to the centre line of the cylinder.
- (3) The attaching face of the mounting part of the crevice type cylinder shall be in parallel with the plane of swing of the cylinder, and the centre line of hole shall pass through the centre line of the cylinder and be at right angles to the plane of swing.
- (4) The attaching shaft of the mounting part of the trunnion type cylinder shall be symmetrical with respect to the centre line of the cylinder, and shall be at right angles to it.

6.2.8 Switch The switch shall be of a dip-proof type, and when it has sensed that the piston is approaching, an indicator light is lighted at the same time the electric circuit is closed, and when the piston has separated from the switch, the electric circuit is opened to put out the indicator light.

7. Dimensions and accuracy

7.1 Tube bores and rod diameters The basic dimensions of the tube bores and the rod diameters shall be as given in Table 11 according to the series A, B, C, X, and Y.

If it is difficult to follow the first choice of the dimensions due to speed, buckling and the like, select the second choice.

Tolerances, circularities and cylindricities on the finished dimensions of the tube bores and the sliding portion of the rod shall conform to Table 12 and Table 13 with respect to the basic dimensions.

Table 11. Basic dimensions of tube bores and rod diameters

					Unit : mm
Tube bore	1st choice			2nd choice	
	Rod bore symbols				
	A	B	C	X	Y
32 (31.5)	22 (22.4)	18	14	20	16
40	28	22 (22.4)	18	25	20
50	36 (35.5)	28	22 (22.4)	32 (31.5)	25
63	45	36 (35.5)	28	40	32 (31.5)
80	56	45	36 (35.5)	50	40
100	70 (71)	56	45	63	50
125	90	70 (71)	56	80	63
140	100	80	63	90	70 (71)
160	110 (112)	90	70 (71)	100	80
180	125	100	80	110 (112)	90
200	140	110 (112)	90	125	100
220 (224)	160	125	100	140	110 (112)
250	180	140	110 (112)	160	125

- Remarks
1. Numerical values given in parentheses should not be used, as far as possible.
 2. Combination of a tube bore and a rod diameter shall be selected according to nominal pressure, length of stroke and rod material.
 3. The values of piston-rod diameter and bore diameter which are not in accordance with this Table shall be selected from JIS B 8366.

Table 12. Finished dimensions of tube bores

Tube bore	When piston ring is used			When packing other than piston ring is used	
	Tolerance on finished dimension	Circularity	Cylindricity	Tolerance on finished dimension	Circularity and cylindricity
32 40 50	+ 0.025 0	0.019	0.025	+ 0.062 0	0.062
63 80	+ 0.030 0	0.019	0.030	+ 0.074 0	0.074
100	+ 0.035 0	0.022	0.035	+ 0.087 0	0.087
125 140 160 180	+ 0.040 0	0.025	0.040	+ 0.100 0	0.100
200 220 250	+ 0.046 0	0.029	0.046	+ 0.115 0	0.115

- Remarks 1. Circularity here shall be expressed as the difference between the maximum diameter and the minimum diameter at an arbitrary section of a tube, and the maximum value of circularity throughout the whole length of the tube shall not exceed the value given in this Table.
2. Cylindricity here shall be expressed as the difference between the maximum diameter and the minimum diameter measured throughout the whole length of the tube.
3. Bending of the tube shall be not more than 1 mm per 1000 mm.

Table 13. Finished dimensions of rods

Unit : mm		
Rod diameter	Tolerances on finished dimension	Circularity and cylindricity
10 12 14 16 18	- 0.016 - 0.043	0.027
20 22 25 28	- 0.020 - 0.053	0.033
32 36 40 45 50	- 0.025 - 0.064	0.039
56 63 70 80	- 0.030 - 0.076	0.046
90 100 110 125	- 0.036 - 0.090	0.054
140 160 180	- 0.043 - 0.106	0.063