STEP 1

Calculate the load factor and decide the bore size.

$\alpha = \frac{F_0}{F} \times 100$ [%]

α : Load factor

F_0 : Force (N) required to move the workpiece

F : Cylinder theoretical thrust (N) [Table 1]

For horizontal operation	For vertical operation
F_0 = Fw	F_0 = W+Fw
FW: W x 0.2 Note (N)	
W: Load (N)	

Note: Coefficient of friction

[Table 1] Theoretical thrust table (Unit: N)

Bore size	Operating direction	Working pressure MPa						
		0.15	0.2	0.3	0.4	0.5	0.6	0.7
ø25 or equiv.	PUSH	74	99	148	197	246	296	345
	PULL	57	76	114	152	190	228	266
ø32 or equiv.	PUSH	116	155	233	310	388	466	543
	PULL	99	133	199	265	332	398	464

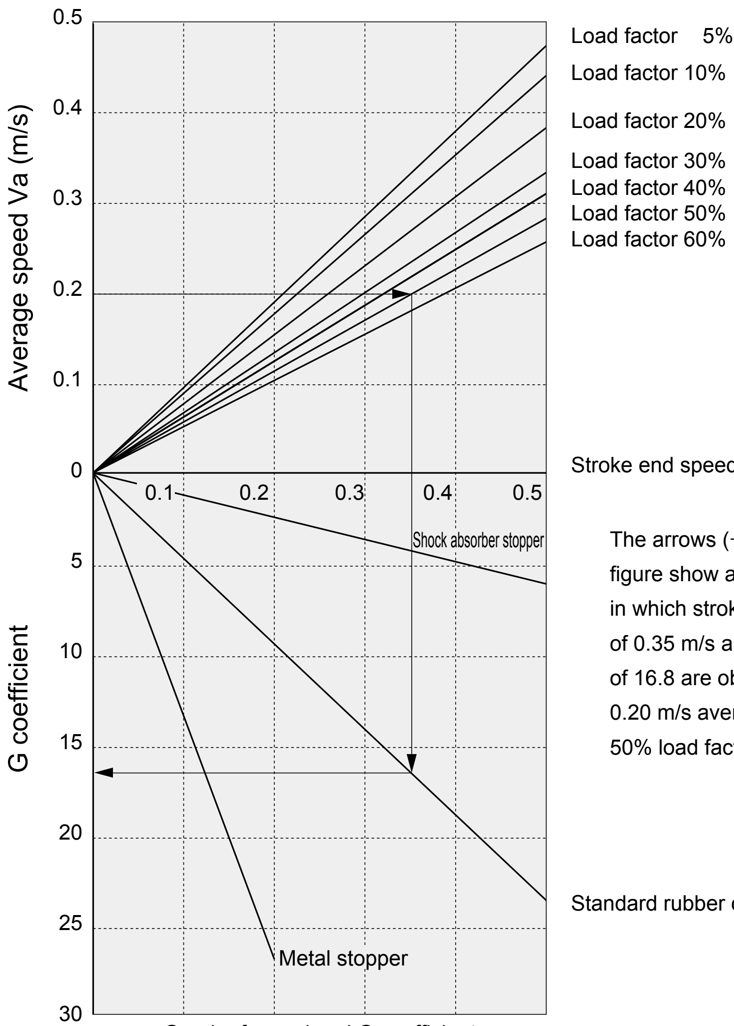
[Table 2] Load factor guidelines

Working pressure MPa	Load factor (%)
0.2 to 0.3	α ≤ 40
0.3 to 0.6	α ≤ 50
0.6 to 0.7	α ≤ 60

STEP 2

Obtain the stroke end speed (Vm) and G coefficient.

Obtain the stroke end speed (Vm) and G coefficient from the average speed (Va) and load factor obtained in STEP 1.



The arrows (→) in the figure show an example in which stroke end speed of 0.35 m/s and G coefficient of 16.8 are obtained at a 0.20 m/s average speed and 50% load factor.

Graph of speed and G coefficient
G coefficient =

STEP 3

Check the allowable absorbed energy.

$$E = \frac{1}{2} \times (m + m_\alpha) \times Vm^2$$

E : Kinetic energy at workpiece end (J)
m : Load weight (kg) ($m \approx \frac{W(N)}{9.8}$)
m_α : Table weight (from Table 4)
Vm : Stroke end speed (m/s)
E max : Max. allowable value of E_0 (from Table 3)

Confirm E ≤ E max.

[Table 3] LCX allowable absorbed energy (E_0)

Bore size	Standard (J)	Cushion stopper (J)	Metal stopper (J)	Shock absorber stopper (J)
ø25	0.34	0.14	0.07	1.3
ø32				

[Table 4] Table weight (unit: kg)

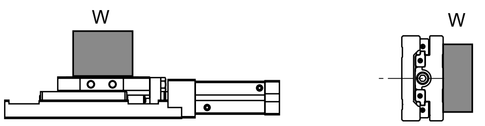
Bore size	Stroke length (mm) 10	20	30	40	50	75	100	125	150
ø25	0.030		0.035						
ø32									

STEP 4

Obtain M'T (resultant moment at rest).

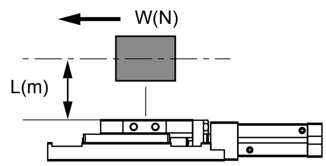
Calculate the load (moment) and the moment of impact occurring at the stroke end and obtain M'T (resultant moment at rest).

● Vertical load: W' (N)



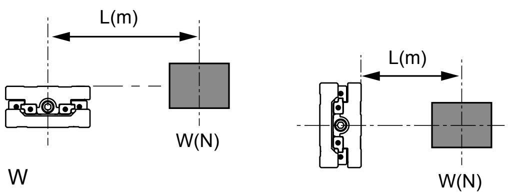
W' = W

● Bending moment: M1' (N·m)



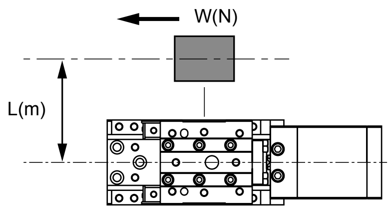
M1' = L × W

● Radial moment: M2' (N·m)



M2' = L × W

● Torsion moment: M3' (N·m)



M3' = L × W

W' = ☐ (N)
M1' x G = ☐ (N·m)
M2' = ☐ (N·m)
M3' x G = ☐ (N·m)

$$M'_T = \frac{W'}{W'max} + \frac{M1' \times G}{M1'max} + \frac{M2'}{M2'max} + \frac{M3' \times G}{M3'max} = \square$$

M'T : Synthesis of moment
G : G coefficient
W'max : Max. allowable value of W' (from Table 5)
M1'max : Max. allowable value of M1' (from Table 5)
M2'max : Max. allowable value of M2' (from Table 5)
M3'max : Max. allowable value of M3' (from Table 5)

[Table 5] Allowable static load

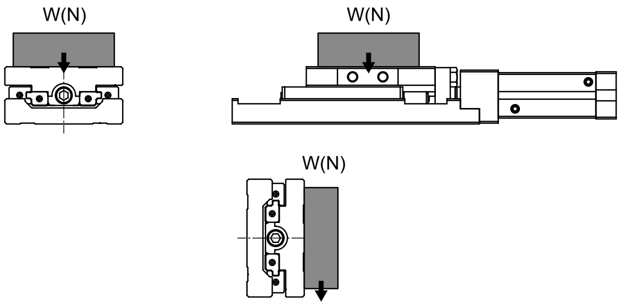
Bore size	Stroke length	Vertical load W'max (N)	Bending moment M1'max (N·m)	Radial moment M2'max (N·m)	Torsion moment M3'max (N·m)
ø25	10, 20, 30, 40, 50	670	52	110	52
ø32					
ø25	75, 100, 125, 150	970	128	116	128
ø32					

Confirm M'T ≤ 1.

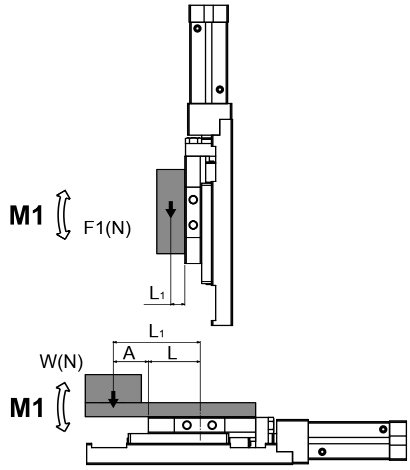
STEP 5

Obtain M_T (resultant moment during movement). (Note that it differs from that obtained in STEP 4.)

● Vertical load: W (N)



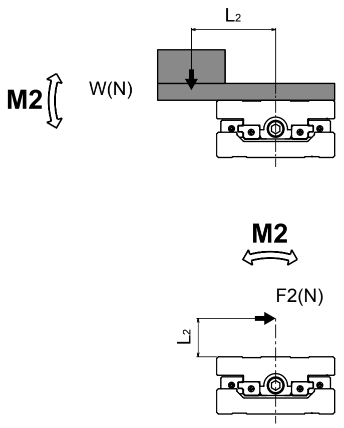
● Bending moment: M1 (N·m)



$M1=F1\times L_1$

$M1=W\times L_1$
$L_1=A+L$
L is value in table below

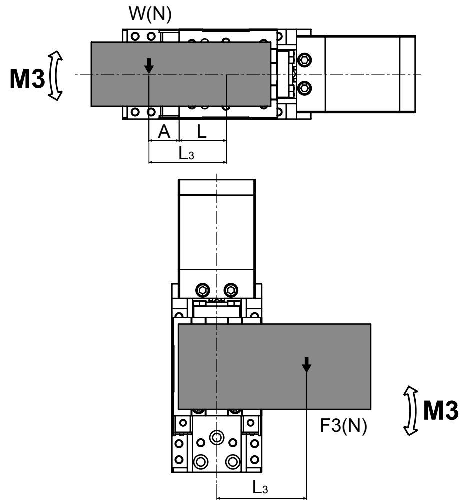
● Radial moment: M2 (N·m)



$M2=W\times L_2$

$M2=F2\times L_2$

● Torsion moment: M3 (N·m)



$M3=W\times L_3$
$L_3=A+L$
L is value in table below

$M3=F3\times L_3$

L (length from the table end to the center of the bearing) Unit (m)

Bore size	Stroke length								
	10	20	30	40	50	75	100	125	150
ø25	0.037			0.042		0.0535			
ø32									

W=W = [ ] (N)

M1=M1 = [ ] (N·m)

M2=M2 = [ ] (N·m)

M3=M3 = [ ] (N·m)

M_T : Synthesis of moment
Wmax : Max. allowable value of W (from Table 7)
M1max : Max. allowable value of M1 (from Table 7)
M2max : Max. allowable value of M2 (from Table 7)
M3max : Max. allowable value of M3 (from Table 7)

$$M_T = \frac{W}{Wmax} + \frac{M1}{M1max} + \frac{M2}{M2max} + \frac{M3}{M3max} = \boxed{\quad}$$

[Table 7] Allowable running load

Bore size	Stroke length	Vertical load Wmax(N)	Bending moment M1max (N·m)	Radial moment M2max (N·m)	Torsion moment M3max (N·m)
ø25	10, 20, 30, 40, 50	97	7	15	7
ø32					
ø25	75, 100, 125, 150	130	17	16.5	17
ø32					

Can be used when $M_T \leq 1$.

Displacement at point A

(Displacement of table due to M1, M2 and M3 moments)

M1 moment: Displacement at the table end when load (F1) is applied to the table end
M2 moment: Displacement at the table end (point A) when load (F2) is applied to a point 100 mm away from the center of the cylinder
M3 moment: Displacement angle of the table when rotation moment (M3) is applied to the cylinder

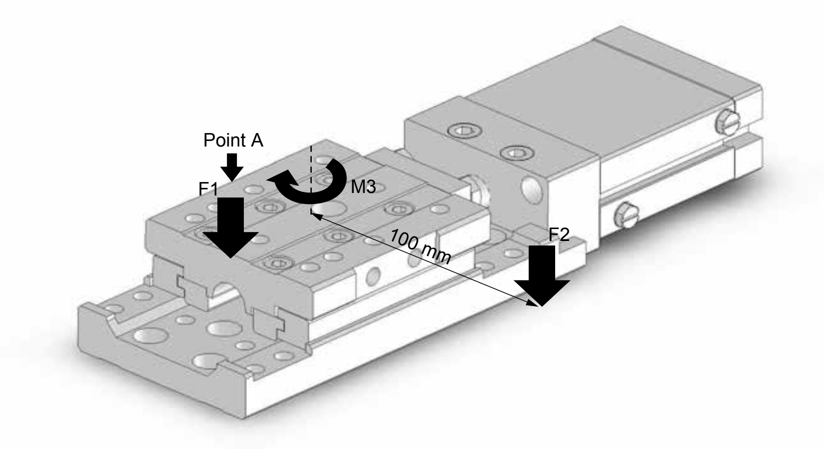


Table displacement for M1 moment

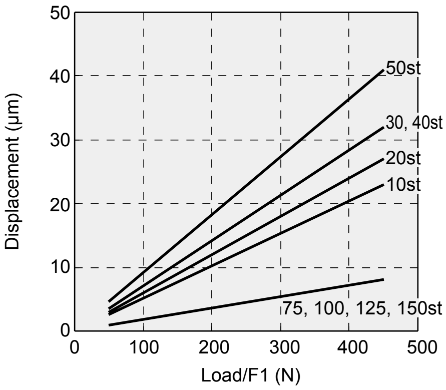


Table displacement for M2 moment

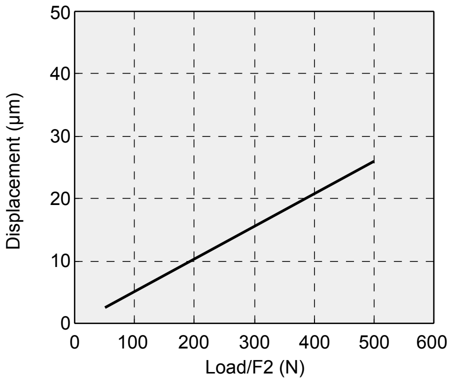
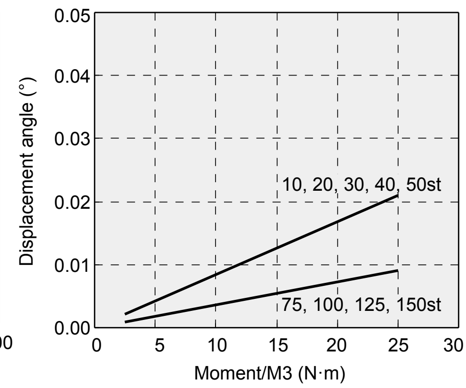
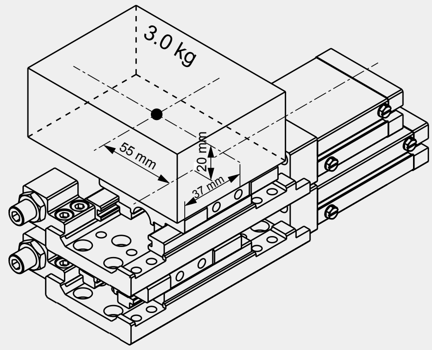


Table displacement for M3 moment



LCM
LCR
LCG
LCW
LCX
STM
STG
STS/STL
STR2
UCA2
ULK*
JSK/M2
JSG
JSC3/JSC4
USSD
UFCD
USC
UB
JSB3
LMB
LML
HCM
HCA
LBC
CAC4
UCAC2
CAC-N
UCAC-N
RCS2
RCC2
PCC
SHC
MCP
GLC
MFC
BBS
RRC
GRC
RV3*
NHS
HRL
LN
Hand
Chuk
MecHnd/Chuk
ShkAbs
FJ
FK
SpdContr
Ending

Selection guide: selection example①



[Operation conditions]

Model used (upper): LCX-25-30-M6 (weight: 1,270 (g))
(lower): LCX-32-30-S6 (weight: 1,440 (g))
Pressure: 0.5 (MPa)
Weight of workpiece: 3.0 (kg)
Operating direction: Horizontal
Average speed (upper): 100 (mm/s)
(lower): 230 (mm/s)
Shape of workpiece: As shown on the left

STEP 1 Checking the load factor and decision on the bore size

(For details on how to calculate, refer to page 298.)

Formula

$\alpha = \frac{F_0}{F} \times 100$ [%]

α : Load factor
F_0 : Force (N) required to move the workpiece
F : Cylinder theoretical thrust (N)

Selection example

[Upper cylinder]

$\alpha 1 = \frac{(3.0 \times 9.8) \times 0.2}{190} \times 100$
$= 3.1\%$

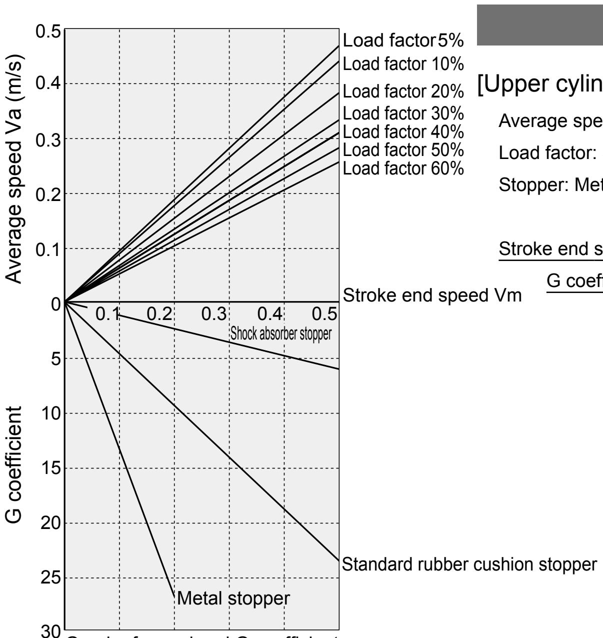
[Lower cylinder]

$\alpha 2 = \frac{\{(3.0 + 1.27 + 0.01) \times 9.8\} \times 0.2}{332}$
$\times 100 = 2.5\%$

Load factor guidelines, at 0.5 MPa
Usable as α ≤ 50

STEP 2 Checking the stroke end speed and G coefficient

(For details on how to calculate, refer to page 298.)



Graph of speed and G coefficient
G coefficient = ☐

Selection example

[Upper cylinder]

Average speed: 100 mm/s
Load factor: 5% or less (3.1%)
Stopper: Metal stopper
⇩
Stroke end speed: 110 mm/s
G coefficient: 14

[Lower cylinder]

Average speed: 230 mm/s
Load factor: 5% or less (2.5%)
Stopper: Rubber cushion stopper
⇩
Stroke end speed: 240 mm/s
G coefficient: 12

STEP 3 Checking the allowable absorbed energy

(For details on how to calculate, refer to page 299.)

Formula

$E = \frac{1}{2} \times (m + m_\alpha) \times Vm^2$

E : Kinetic energy at workpiece end (J)
m : Load weight (kg)
m_α : Table weight (kg)
Vm : Stroke end speed (m/s)

Selection example

[Upper cylinder]

$E = \frac{1}{2} \times (3.0 + 0.03) \times 0.11^2$
$= 0.02$(J)

Can be used since the allowable absorbed energy of the metal stopper is "0.07J".

[Lower cylinder]

$E = \frac{1}{2} \times (3.0 + 1.27 + 0.01 + 0.035)$
$\times 0.24^2 = 0.124$(J)

Can be used since the allowable absorbed energy of the rubber cushion stopper is "0.14J".

STEP 4 Checking the allowable static load (For details on how to calculate, refer to page 299.)

Formula

● Vertical load

$W' = W$

● Bending moment: M1' (N·m)

$M1' = L_1 \times W$

● Radial moment: M2' (N·m)

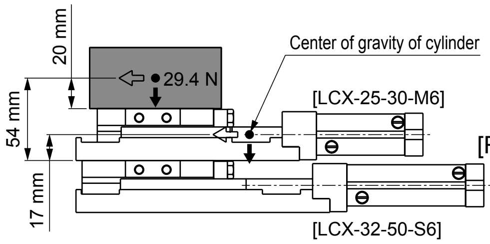
$M2' = L_2 \times W$

● Torsion moment: M3' (N·m)

$M3' = L_3 \times W$

◎ Synthesis of moment

$$M'_T = \frac{W'}{W'max} + \frac{M1' \times G}{M1'max} + \frac{M2'}{M2'max} + \frac{M3' \times G}{M3'max}$$



Selection example

[Calculating load and moment]

[Upper cylinder]

$W' = 3.0 \times 9.8 = 29.4$ (N)

$M1' = 0.02 \times 29.4 = 0.6$ (N·m)

$M2' = 0.055 \times 29.4 = 1.6$ (N·m)

$M3' = 0.055 \times 29.4 = 1.6$ (N·m)

[Lower cylinder]

$W' = 3.0 \times 9.8 + 1.27 \times 9.8$

$= 41.8$ (N)

$M1' = 0.054 \times 29.4$

$\underline{+\ 0.017 \times 1.27 \times 9.8}$

$= 1.8$ (N·m)

(Omit the underlined part if the upper cylinder does not work as a moment of impact.)

$M2' = 0.055 \times 29.4 = 1.6$ (N·m)

$M3' = 0.055 \times 29.4 = 1.6$ (N·m)

[Resultant moment when the upper cylinder operates]

Stroke end speed: 110 mm/s, G coefficient: 14

[Upper cylinder]

$$M'_T = \frac{29.4}{670} + \frac{0.6 \times 14}{52} + \frac{1.6}{110} + \frac{1.6 \times 14}{52}$$
$$= 0.7$$

Can be used since the resultant moment (M'T) is "1 or less".

[Lower cylinder]

$$M'_T = \frac{41.8}{670} + \frac{1.6 \times 14}{52} + \frac{1.6}{110} + \frac{1.6 \times 14}{52}$$
$$= 1.0$$

Can be used since the resultant moment (M'T) is "1 or less".

[Resultant moment when the lower cylinder operates]

Stroke end speed: 240 mm/s, G coefficient: 12

[Upper cylinder]

$$M'_T = \frac{29.4}{670} + \frac{0.6 \times 12}{52} + \frac{1.6}{110} + \frac{1.6 \times 12}{52}$$
$$= 0.6$$

Can be used since the resultant moment (M'T) is "1 or less".

[Lower cylinder]

$$M'_T = \frac{41.8}{670} + \frac{1.8 \times 12}{52} + \frac{1.6}{110} + \frac{1.6 \times 12}{52}$$
$$= 0.9$$

Can be used since the resultant moment (M'T) is "1 or less".

STEP 5 Checking the allowable dynamic load (For details on how to calculate, refer to page 300.)

Formula

● Vertical load

$W = W$

● Bending moment: M1 (N·m)

$M1 = L_1 \times W$

● Radial moment: M2 (N·m)

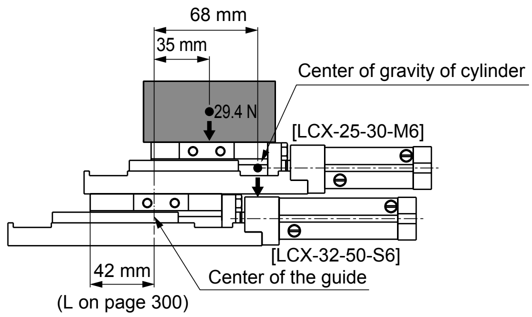
$M2 = L_2 \times W$

● Torsion moment: M3 (N·m)

$M3 = L_3 \times W$

◎ Synthesis of moment

$$M_T = \frac{W}{Wmax} + \frac{M1}{M1max} + \frac{M2}{M2max} + \frac{M3}{M3max}$$



Selection example

[Upper cylinder]

$W = 3.0 \times 9.8 = 29.4$(N)

$M1 = 0$ (N·m)

$M2 = 0.055 \times 29.4 = 1.6$ (N·m)

$M3 = 0$ (N·m)

$$M_T = \frac{29.4}{97} + \frac{0}{7} + \frac{1.6}{15} + \frac{0}{7}$$
$$= 0.4$$

Can be used since the resultant moment (M'T) is "1 or less".

[Lower cylinder]

$W = 3.0 \times 9.8 + 1.27 \times 9.8$

$= 41.8$(N)

$M1 = 0.035 \times 29.4 + 0.068 \times 1.27 \times 9.8$

$= 1.9$ (N·m)

(Add the value of the upper cylinder since it works as a moment. Substitute the center of the external dimensions for the center of gravity of the cylinder.)

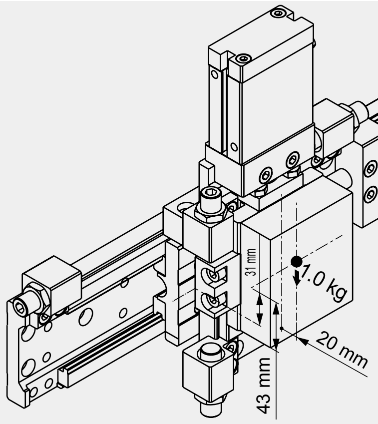
$M2 = 0.055 \times 29.4 = 1.6$ (N·m)

$M3 = 0$ (N·m)

$$M_T = \frac{41.8}{97} + \frac{1.9}{7} + \frac{1.6}{15} + \frac{0}{7}$$
$$= 0.8$$

Can be used since the resultant moment (M'T) is "1 or less".

Selection guide: selection example②



[Operation conditions]

Model used (X-axis): LCX-32-150-A6 (weight: 2,450 (g))
(Z-axis): LCX-32-30-S6 (weight: 1,440 (g))
Pressure: 0.5 (MPa)
Weight of workpiece: 1.0 (kg)
Operating direction: Horizontal + vertical
Average speed (X-axis): 300 (mm/s)
(Z-axis): 50 (mm/s)
Shape of workpiece: As shown on the left

STEP 1 Checking the load factor and decision on the bore size

(For details on how to calculate, refer to page 298.)

Formula

$\alpha = \frac{F_0}{F} \times 100$ [%]

α : Load factor
F_0 : Force (N) required to move the workpiece
F : Cylinder theoretical thrust (N)

Selection example

[X-axis cylinder]

$\alpha 1 = \frac{\{(1.0 + 1.29 + 0.01) \times 9.8\} \times 0.2}{332} \times 100 = 1.4\%$

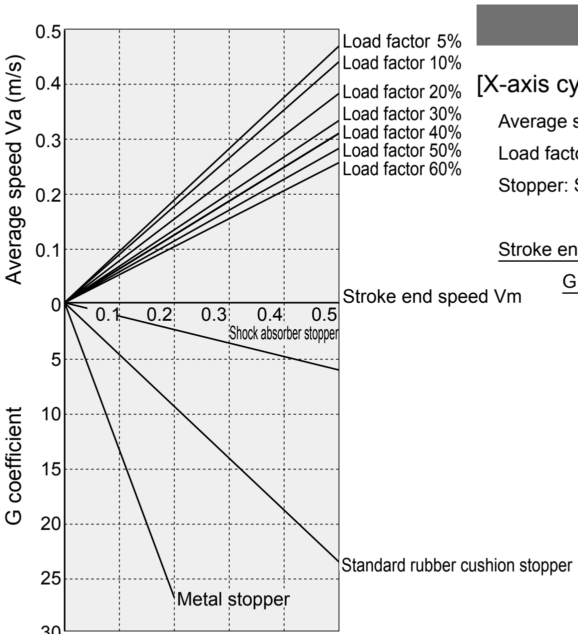
[Z-axis cylinder]

$\alpha 2 = \frac{(1.0 \times 9.8) + 0.2 \times (1.0 \times 9.8)}{332} \times 100 = 3.5\%$

Load factor guidelines, at 0.5 MPa
Usable as α ≤ 50

STEP 2 Checking the stroke end speed and G coefficient

(For details on how to calculate, refer to page 298.)



Graph of speed and G coefficient
G Coefficient = $\boxed{\quad}$

Selection example

[X-axis cylinder]

Average speed: 300 mm/s
Load factor: 5% or less (1.4%)
Stopper: Shock absorber stopper
⇩
Stroke end speed: 310 mm/s
G coefficient: 4

[Z-axis cylinder]

Average speed: 50 mm/s
Load factor: 5% or less (3.5%)
Stopper: Rubber cushion stopper
⇩
Stroke end speed: 55 mm/s
G coefficient: 3

STEP-3 Checking the allowable absorbed energy

(For details on how to calculate, refer to page 299.)

Formula

$E = \frac{1}{2} \times (m + m_\alpha) \times Vm^2$

E : Kinetic energy at workpiece end (J)
m : Load weight (kg)
m_α : Table weight (kg)
Vm : Stroke end speed (m/s)

Selection example

[X-axis cylinder]

$E = \frac{1}{2} \times (1.0 + 1.29 + 0.01 + 0.035) \times 0.31^2 = 0.11$(J)

Can be used since the allowable absorbed energy of the shock absorber stopper is "1.3J".

[Z-axis cylinder]

$E = \frac{1}{2} \times (1.0 + 0.035) \times 0.055^2 = 0.002$(J)

Can be used since the allowable absorbed energy of the rubber cushion stopper is "0.14J".

STEP 4 Checking the allowable static load (For details on how to calculate, refer to page 299.)

Formula

● Vertical load

$W' = W$

● Bending moment: M1' (N·m)

$M1' = L_1 \times W$

● Radial moment: M2' (N·m)

$M2' = L_2 \times W$

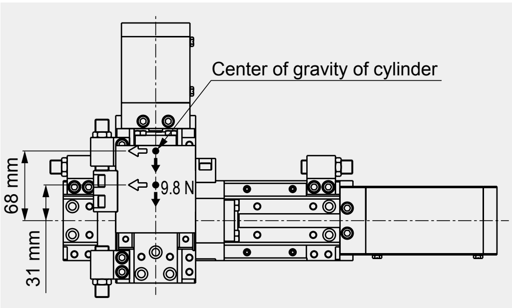
● Torsion moment: M3' (N·m)

$M3' = L_3 \times W$

◎ Synthesis of moment

$$M'_T = \frac{W'}{W'max} + \frac{M1' \times G}{M1'max} + \frac{M2'}{M2'max} + \frac{M3' \times G}{M3'max}$$

Note) In the crossed unit, a moment of impact may occur in the M2 direction. Multiply the G coefficient with the M2' value as necessary.



Selection example

[Calculating load and moment]

[X-axis cylinder]

$W' = 1.0 \times 9.8 + 1.44 \times 9.8 = 23.9$ (N)

$M1' = 0.054 \times 9.8 + 0.017 \times 1.44 \times 9.8$
$= 0.8$ (N·m)

(Add the value of the Z-axis cylinder since it works as a moment.)

$M2' = 0.054 \times 9.8 + 0.017 \times 1.44 \times 9.8$
$= 0.8$ (N·m)

$M3' = 0.031 \times 9.8 + 0.068 \times 1.44 \times 9.8$
$= 1.3$ (N·m)

[Z-axis cylinder]

$W' = 0$(N)

$M1' = 0.02 \times 9.8 = 0.2$ (N·m)

$M2' = 0.02 \times 9.8 = 0.2$ (N·m)

$M3' = 0.001 \times 9.8 = 0.01$ (N·m)

[Resultant moment when the X-axis cylinder operates]

Stroke end speed: 310 mm/s, G coefficient: 4

[X-axis cylinder]

$$M'_T = \frac{23.9}{970} + \frac{0.8 \times 4}{128} + \frac{0.8}{116} + \frac{1.3 \times 4}{128}$$
$= 0.1$

Can be used since the resultant moment (M'_T) is "1 or less".

[Z-axis cylinder]

$$M'_T = \frac{0}{670} + \frac{0.2}{52} + \frac{0.2 \times 4}{110} + \frac{0.01 \times 4}{52}$$
$= 0.01$

(Multiply the G coefficient if moment of impact in M2 direction is caused in the Z-axis cylinder by operation of the X-axis cylinder.)

Can be used since the resultant moment (M'_T) is "1 or less".

[Resultant moment when the Z-axis cylinder operates]

Stroke end speed: 55 mm/s, G coefficient: 3

[X-axis cylinder]

$$M'_T = \frac{23.9}{970} + \frac{0}{128} + \frac{0.5 \times 3 + 0.2}{116} + \frac{0}{128}$$
$= 0.04$

(Multiply the G coefficient if moment of impact in M2 direction is caused in the X-axis cylinder by operation of the Z-axis cylinder.)

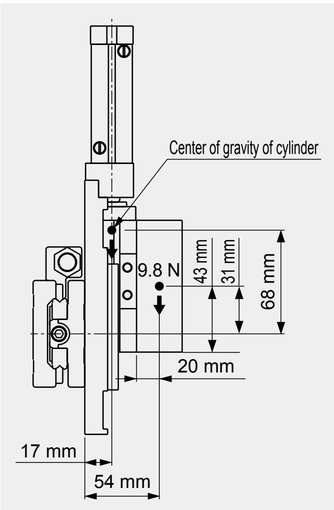
Can be used since the resultant moment (M'_T) is "1 or less".

[Z-axis cylinder]

$$M'_T = \frac{0}{670} + \frac{0.2 \times 3}{52} + \frac{0}{110} + \frac{0}{52}$$
$= 0.01$

Can be used since the resultant moment (M'_T) is "1 or less".

STEP 5 Checking the allowable dynamic load (For details on how to calculate, refer to page 300.)



Formula

● Vertical load

$W = W$

● Bending moment: M1 (N·m)

$M1 = L_1 \times W$

● Radial moment: M2 (N·m)

$M2 = L_2 \times W$

● Torsion moment: M3 (N·m)

$M3 = L_3 \times W$

◎ Synthesis of moment

$$M_T = \frac{W}{Wmax} + \frac{M1}{M1max} + \frac{M2}{M2max} + \frac{M3}{M3max}$$

Selection example

[X-axis cylinder]

$W = 1.0 \times 9.8 + 1.44 \times 9.8$
$= 23.9$(N)

$M1 = 0$ (N·m)

$M2 = 0.054 \times 9.8 + 0.017 \times 1.44 \times 9.8$
$= 0.8$ (N·m)

$M3 = 0$ (N·m)

$$M_T = \frac{23.9}{130} + \frac{0}{17} + \frac{0.8}{16.5} + \frac{0}{17}$$
$= 0.2$

Can be used since the resultant moment (M'_T) is "1 or less".

[Z-axis cylinder]

$W = 0$(N)

$M1 = 0.02 \times 9.8 = 0.2$ (N·m)

$M2 = 0$ (N·m)

$M3 = 0$ (N·m)

$$M_T = \frac{0}{97} + \frac{0.2}{7} + \frac{0}{15} + \frac{0}{7}$$
$= 0.03$

Can be used since the resultant moment (M'_T) is "1 or less".