STEP 1

Calculate the load factor and decide the bore size.

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

α : Load factor

Fo: Force (N) required to move the workpiece

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

For horizontal operation	For vertical operation
Fo = Fw	Fo = 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 (mm)	Operating direction	Working pressure MPa						
		0.15	0.2	0.3	0.4	0.5	0.6	0.7
ø12	PUSH	17	23	34	45	57	68	79
	PULL	13	17	25	34	42	51	59
ø16	PUSH	30	40	60	80	101	121	141
	PULL	26	35	52	69	86	104	121
ø20	PUSH	47	63	94	126	157	188	220
	PULL	40	53	79	106	132	158	185

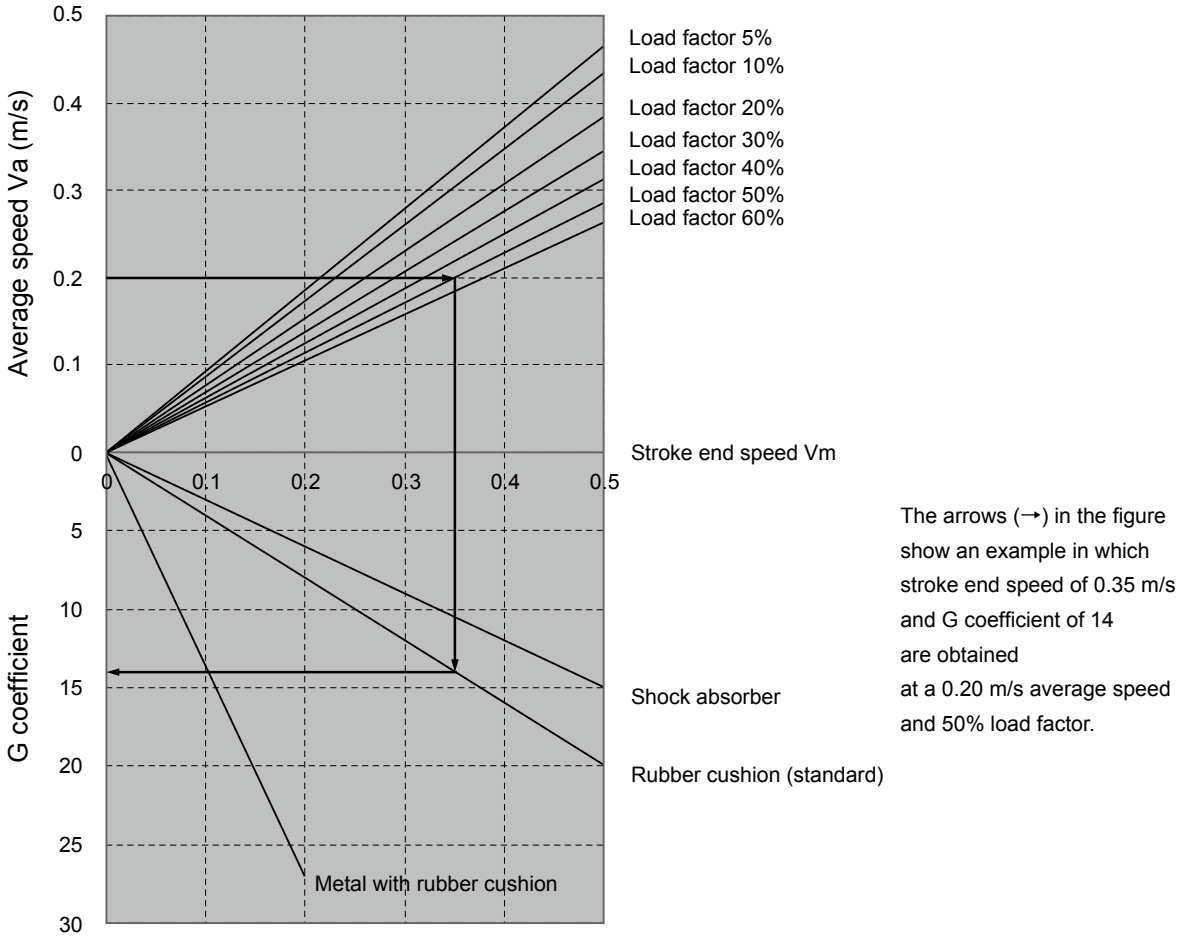
[Table 2] Load factor guidelines

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.



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 Eo (from Table 3)

Confirm E ≤ E max.

[Table 3] LCW allowable absorbed energy

Bore size (mm)	Rubber cushion (standard) (J)	Metal with rubber cushion (J)	Shock absorber (J)
ø12	0.027	0.0053	0.054
ø16	0.055	0.0053	0.11
ø20	0.11	0.043	0.22

[Table 4] Table weight (Unit: kg)

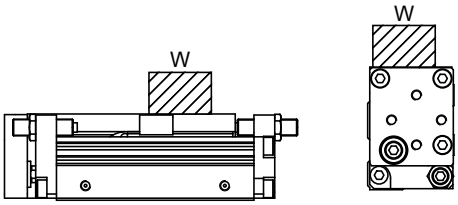
Bore size (mm)	Stroke length (mm)		
	30	50	75
ø12	0.059	0.089	0.111
ø16	0.089	0.112	0.164
ø20	0.141	0.176	0.264

STEP 4

Obtain M'T (resultant moment at rest).

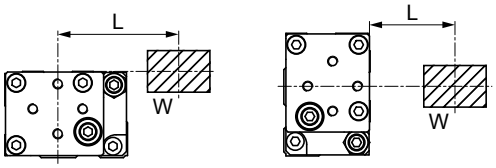
Calculate the load (moment) and the moment of impact occurring at the stroke end and obtain M'T (resultant moment at rest).

● Vertical load: W' (N)



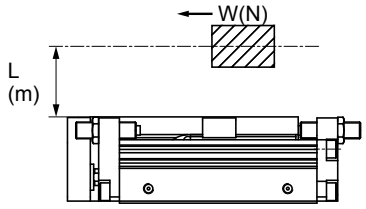
W' = W

● Radial moment: M2' (N·m)



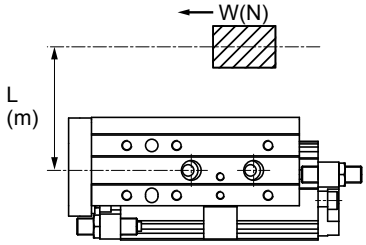
M2' = L × W

● Bending moment: M1' (N·m)



M1' = L × W

● Torsion moment: M3' (N·m)



M3' = L × W

W' = ☐ (N)

M1' × G = ☐ (N·m)

M2' = ☐ (N·m)

M3' × 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

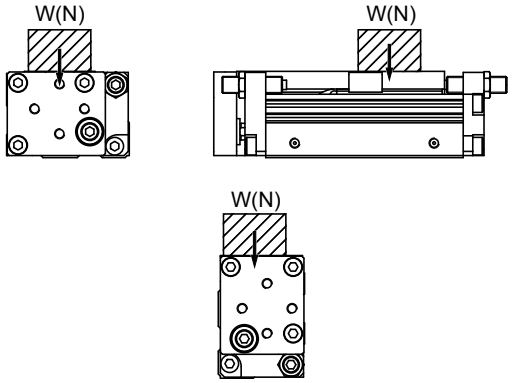
Bore size (mm)	Stroke length (mm)	Vertical load W'max (N)	Bending moment M1'max (N·m)	Radial moment M2'max (N·m)	Torsion moment M3'max (N·m)
ø12	30	140	0.7	3.5	0.7
	50, 75	186	10.7	5.6	10.7
ø16	30, 50	221	5.7	9.8	5.7
	75		22.2		22.2
ø20	30, 50	381	17.8	19.2	17.8
	75		37.3		37.3

Confirm M'T ≤ 1.

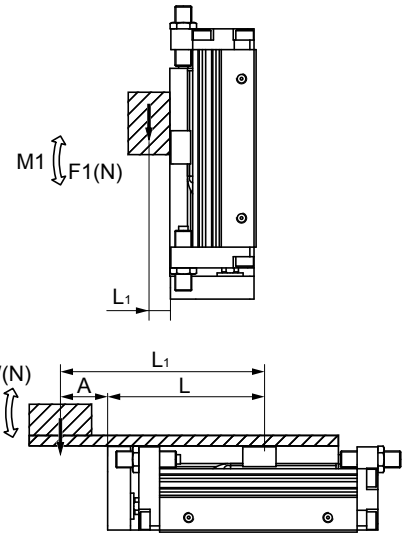
STEP 5

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

● Vertical load: W (N)



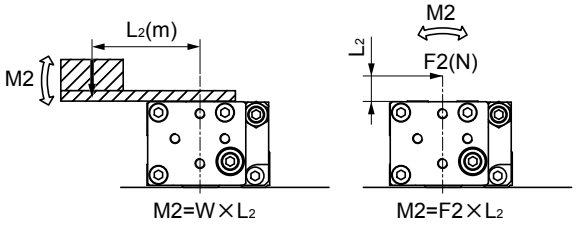
● Bending moment: M1 (N·m)



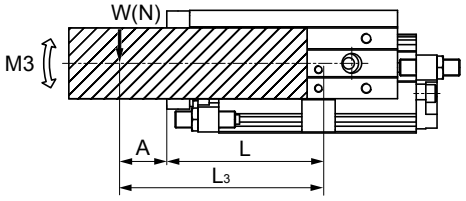
$M1=F1\times L_1$

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

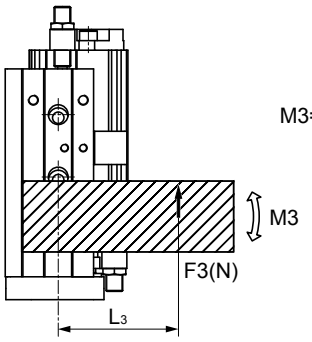
● Radial moment: M2 (N·m)



● Torsion moment: M3 (N·m)



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



$M3=F3\times L_3$

[Table 6] L value (Unit: m)

Bore size (mm)	Stroke length (mm)		
	30	50	75
ø12	0.066	0.097	0.122
ø16	0.077	0.097	0.131
ø20	0.085	0.105	0.141

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)

[Table 7] Allowable running load

Bore size (mm)	Stroke length (mm)	Vertical load Wmax (N)	Bending moment M1 max (N·m)	Radial moment M2 max (N·m)	Torsion moment M3 max (N·m)
ø12	30	14	0.17	0.35	0.17
	50, 75	16	0.89	0.47	0.89
ø16	30, 50	28	0.71	1.2	0.71
	75		2.2		2.2
ø20	30, 50	48	1.9	2.4	1.9
	75		4.6		4.6

Can be used when $M_T \leq 1$.