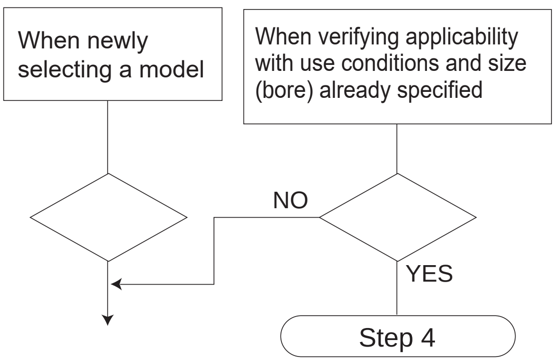
SRM3 Series selection guide

As the selection conditions are different from those of general air cylinders, confirm whether the model is adequate or not according to the selection guide.

1 Step 1



2 Step 2 Confirming working conditions

1. Working pressure (P) (MPa)
2. Load weight (M) (kg)
3. Applied load (F_L) (N)
4. Mounting orientation
5. Stroke (L) (mm)
6. Travel time (t) (s)
7. Operation speed (V) (m/s)

   Formula of the cylinder's average operation speed V

   $$V=\frac{L}{t}\times\frac{1}{1000}\ \text{(m/s)}$$

[Load weight]

Value of (weight of transported object + jig weight)

[Mounting orientation]

Operating direction: Horizontal + vertical

Mounting direction: With table upward, with table downward

3 Step 3 Selection of approximate size of cylinder

● Formula for calculating cylinder size (bore size)

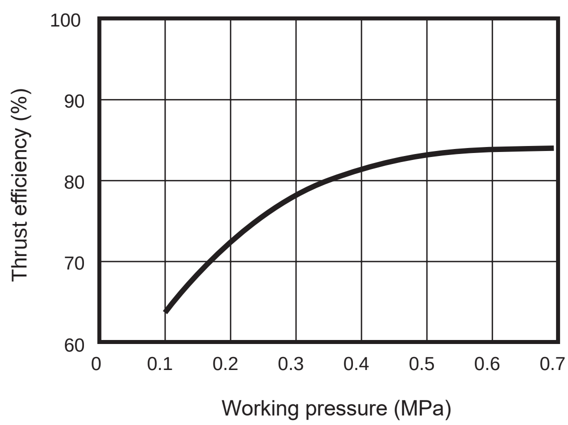
$$F=\frac{\pi}{4}\times D^2\times P\times\frac{a}{100}\ \text{(N)}$$

$$\therefore D=\sqrt{\frac{4F}{\pi\cdot P\cdot a}}\ \text{(mm)}$$

D: Cylinder bore size (mm)
P: Working pressure (MPa)
a : Thrust efficiency (%) (Refer to Fig. 1)
F: Cylinder theoretical thrust (N)

D= ø

Figure 1 Trends of thrust efficiency of SRM3



● When calculating from the theoretical thrust value in Table 1

Approximate required thrust ≥ Applied load x 2

("x 2" in "Applied load x 2" is for when the load factor is approx. 50% as a safety coefficient)

[Example] Working pressure 0.5 MPa
Applied load 20 N
* Required thrust is 20 x 2 = 40 N

The bore size selected from Table 1 with theoretical thrust of 40 N and over at working pressure of 0.5 MPa will be ø25.

D= ø25

[Cylinder theoretical thrust]

Table 1 Cylinder theoretical thrust value Unit: N

Bore size (mm)	Pressurized area (mm^2)	Working pressure MPa							
		0.1	0.15	0.2	0.3	0.4	0.5	0.6	0.7
ø25 or equiv.	542	-	81.4	108	163	217	271	325	380
ø32 or equiv.	814	-	121	163	244	326	407	488	570
ø40 or equiv.	1266	-	190	253	380	506	633	760	886
ø63 or equiv.	3137	314	470	627	941	1255	1568	1882	2196

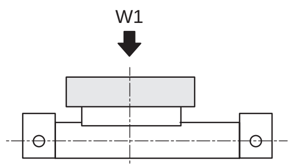
Note: Values in Table 1 do not include thrust efficiency.

4 Step 4 Calculation of load (W) and moments

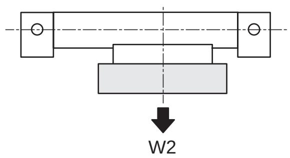
Vertical load and static moment work according to the cylinder mounting direction and the position of center of gravity of load.

[Vertical load]

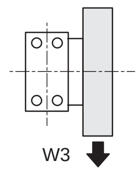
[W1 (Horizontal upward, vertical)]

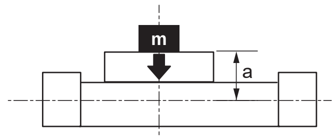


[W2 (Horizontal downward)]



[W3 (Horizontal lateral)]



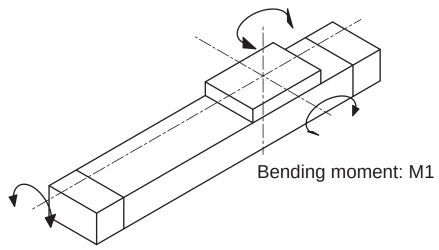


Value of a

Bore size	a(m)
ø25 or equiv.	0.057
ø32 or equiv.	0.040
ø40 or equiv.	0.046
ø63 or equiv.	0.063

[Static moment]

● Types of moment caused by load

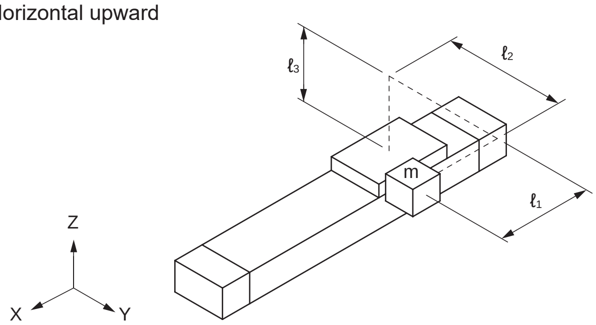


Unit: N·m

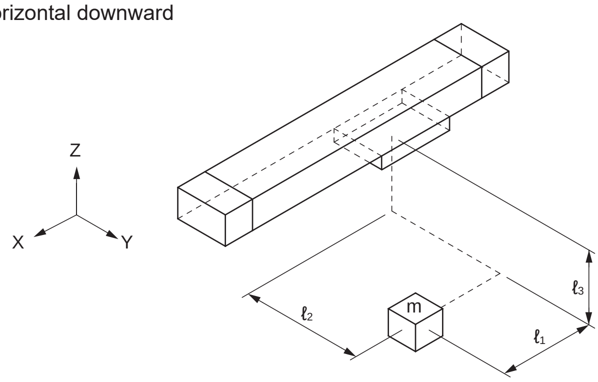
Mounting orientation		Horizontal upward	Horizontal downward	Horizontal lateral	Vertical
Vertical load W		mx9.8			-
Static moment	M1	Wxℓ_1	Wxℓ_1	-	Wx(ℓ_3+a)
	M2	Wxℓ_2	Wxℓ_2	Wx(ℓ_3+a)	-
	M3	-	-	Wxℓ_1	Wxℓ_2

m : Load weight [kg]
ℓ_1 : Length along the stroke direction from the center of table to the center of gravity of load [m]
ℓ_2 : Length in the width direction from the center of table to the center of gravity of load [m]
ℓ_3 : Length in the vertical direction from the center of table to the center of gravity of load [m]

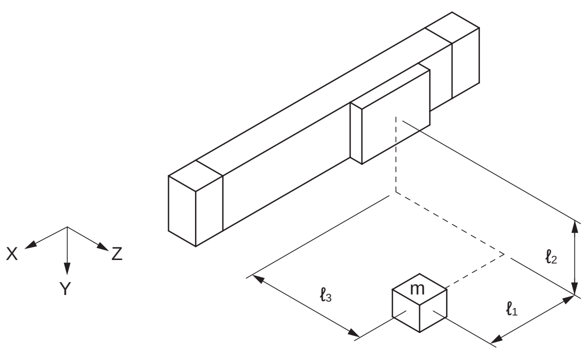
Horizontal upward



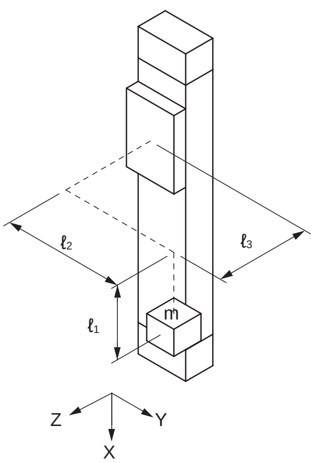
Horizontal downward



Horizontal lateral



Vertical



SCP*3
CMK2
CMA2
SCM
SCG
SCA2
SCS2
CKV2
CAV2/COVP/N2
SSD2
SSG
SSD
CAT
MDC2
MVC
SMG
MSD/MSDG
FC*
STK
SRL3
SRG3
SRM3
SRT3
MRL2
MRG2
SM-25
ShkAbs
FJ
FK
Spd Contr
Ending

5 Step 5 Calculation of load and resultant moment

- Divide each load by the allowable value read from Figure 3 to Figure 8 to find load/moment ratio, and confirm that the total value is 1.0 or less.

Formula

$$\frac{W}{Wmax'} + \frac{M1}{M1max'} + \frac{M2}{M2max'} + \frac{M3}{M3max'} \le 1.0$$

Wmax', M1max', M2max' and M3max' are values read from Figure 2 to Figure 7.

- If the total value is more than 1.0,
  1. Review the load
  2. Use a cylinder with wider bore size, etc., for revision.

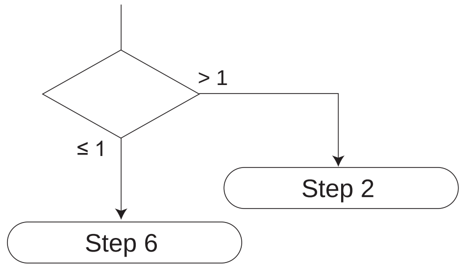


Figure 2 Allowable W1, W2 and W3 loads for SRM3-25 and 32

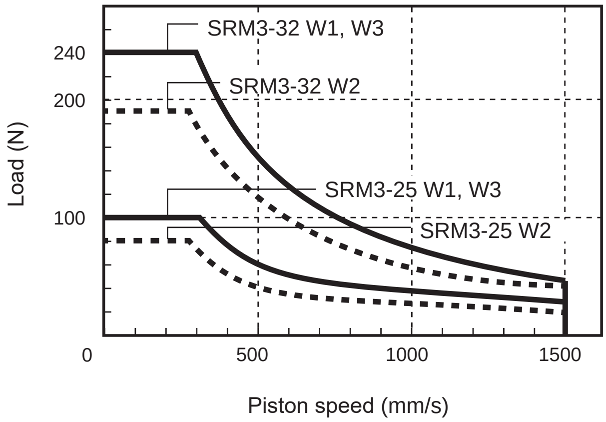


Figure 3 Allowable W1, W2 and W3 loads for SRM3-40 and 63

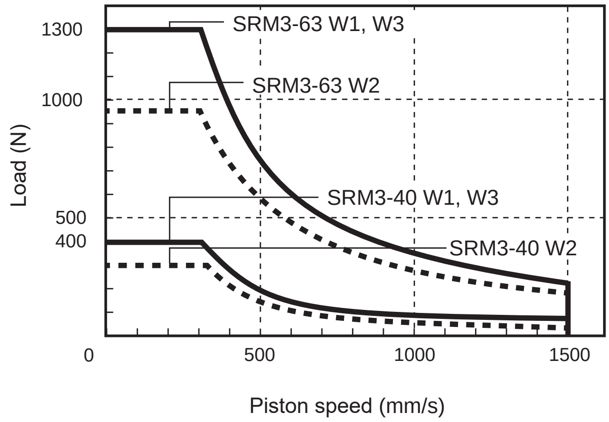


Figure 4 Allowable M1 and M3 moments for SRM3-25 and 32

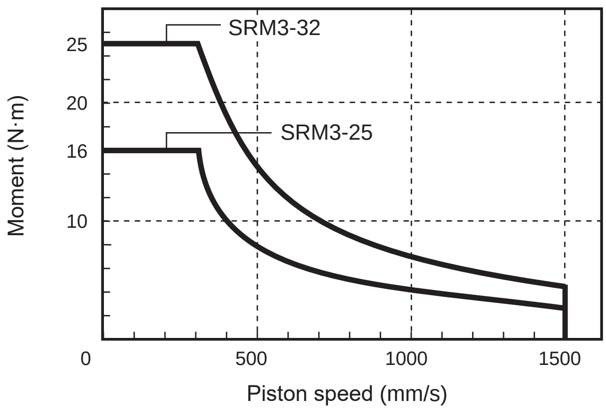


Figure 5 Allowable M1 and M3 moments for SRM3-40 and 63

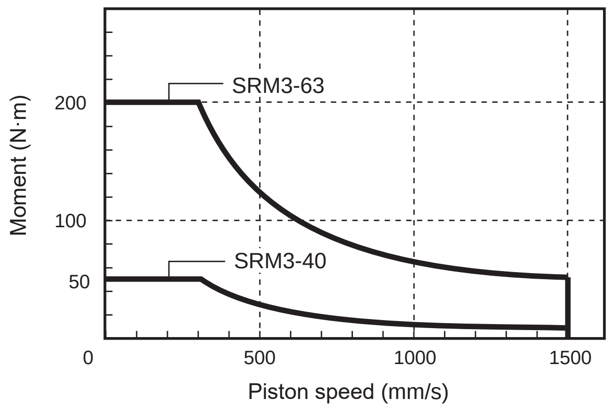


Figure 6 Allowable M2 moment for SRM3-25 and 32

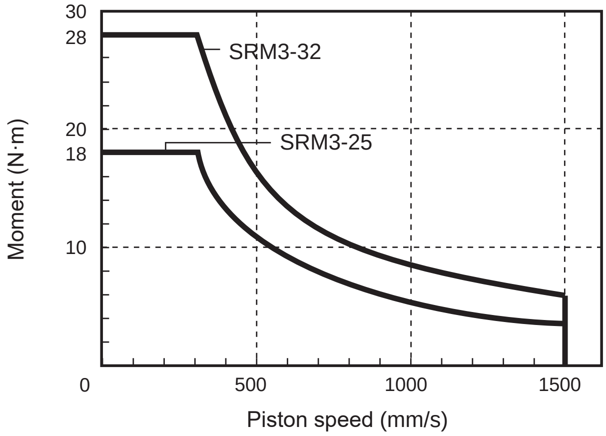
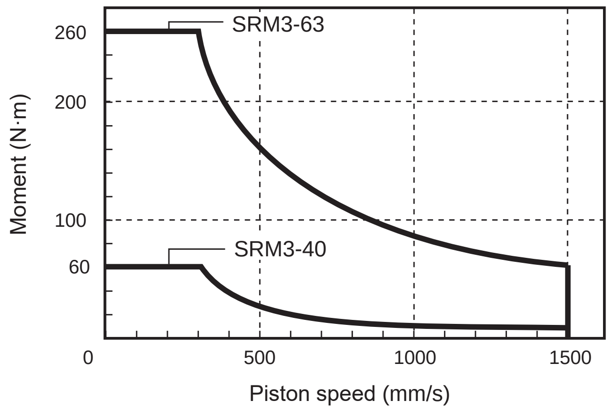


Figure 7 Allowable M2 moment for SRM3-40 and 63



6 Step 6 Calculation of required thrust

Calculate the required cylinder thrust (F_N).

1. For horizontal operation

   $F_N = W \times 0.2$ (N)

2. For vertical operation

   $F_N = W$ (N)

7 Step 7 Calculation of load factor

- Determine the load factor by taking into account the status of utilization such as stability, margin and service life of the cylinder.
- Formula of load factor (α)

$$\alpha = \frac{\text{Required thrust } (F_N)}{\text{Thrust of cylinder } (F)} \times 100\%$$

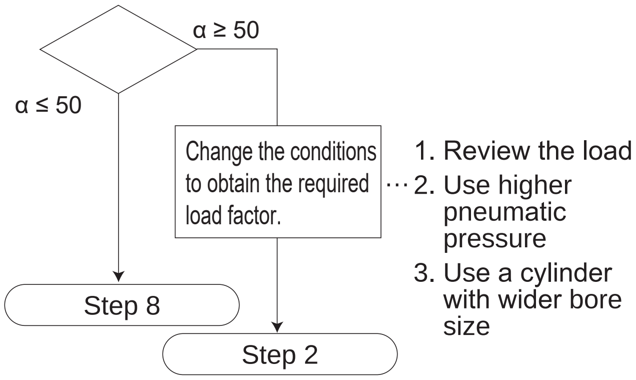
$$F = \frac{\pi}{4} \times D^2 \times P \times \frac{\mu}{100} \ (N)$$

D: Cylinder bore size (mm)

$$\frac{\pi}{4} \times D^2 = \text{Pressurized area } (mm^2)$$

- The cylinder theoretical thrust value in Table 4 can be used as the $\frac{\pi}{4} \times D^2 \times P$ value.

P: Working pressure (MPa)
μ: Thrust efficiency (Use the values in Figure 1.)



[Appropriate range of load factor]

- The piston speed differs depending on the load factor. In normal use, the values in Table 2 are recommended.

Table 2 (Appropriate range of load factor - reference value)

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

[Example] Size of the cylinder used: ø25 or equiv.
Required thrust 4 N
Working pressure 0.5 MPa

$$\alpha = \frac{4}{542 \times 0.5 \times \frac{83}{100}} \times 100$$

= 2%

Appropriate since the result is α ≤ 50%.

8 Step 8 Confirming cushion capacity

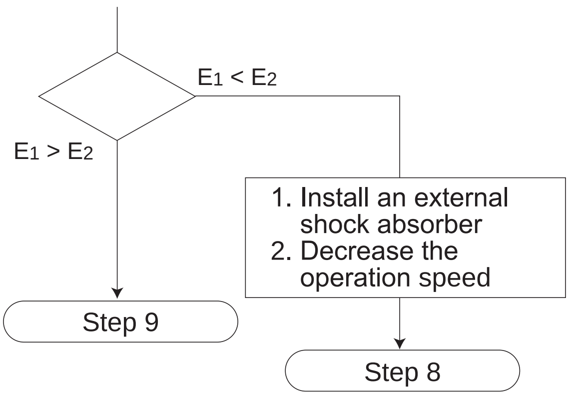
Check if the kinetic energy generated by an actual load can be absorbed by the cylinder cushion.

[Allowable absorbed energy of cylinder]

- The kinetic energy absorption performance of the cylinder's cushion depends on the cylinder bore size. For SRM3, use the values in Table 3 for comparison.

Table 3 SRM3 allowable absorbed energy (E_1)

Bore size (mm)	Allowable absorbed energy (J)
ø25 or equiv.	1.40
ø32 or equiv.	2.57
ø40 or equiv.	4.27
ø63 or equiv.	17.4



[Piston kinetic energy]

- Formula for calculating the piston kinetic energy (E_2)

$$E_2 = \frac{1}{2} \times M \times Va^2 \quad (J)$$

M : Applied load weight (kg)
Va : Speed of the piston entering the cushion (m/s)

$$Va = \frac{L}{t} \times \left(1 + 1.5 \times \frac{\alpha}{100}\right)$$

L: Stroke (m)
t : Operating time (S)
α :Load factor (%)

9 Step 9 Confirmation of inertia load

● Check whether the inertia force of the load caused by the piston operation is within the allowable range of the cylinder.

(1) Obtain the G coefficient from the speed of entering the cushion (Va) and Figure 8 (Trend of inertia force coefficient for SRM3). Use the speed of entering the cushion (Va) calculated in Step 8.

Va: Speed of the piston entering the cushion (m/s)

$$Va = \frac{L}{t} \times (1 + 1.5 \times \frac{\alpha}{100})$$

L : Stroke (m)
t : Operating time (S)
α : Load factor (%)

(2) Obtain the bending moment (M1i) and torsion moment (M3i) of the inertia force.

Unit: N·m

Mounting orientation		Horizontal upward	Horizontal downward	Vertical	Horizontal lateral
Dynamic moment	M1i	$W \times (\ell_3 + a) \times G$			
	M2i	M2i dynamic moment is not generated.			
	M3i	$W \times \ell_2 \times G$			

Moment of inertia force can be calculated with the formulas above regardless of the mounting direction.

(3) Add the moments of static load (M1 and M3) and the moments of inertia force (M1i and M3i) and check that the resultant values are within the max. allowable values in Table 4.

$M1 + M1i \leq M1max$
$M3 + M3i \leq M3max$

M1max and M3max are the values in Table 4.

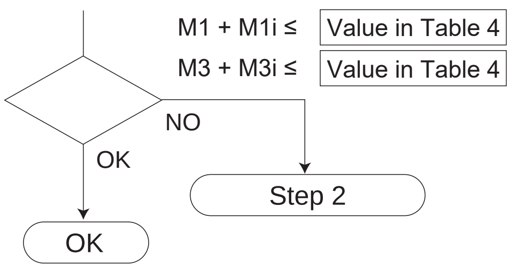


Figure 8 Trend of inertia force coefficient of SRM3

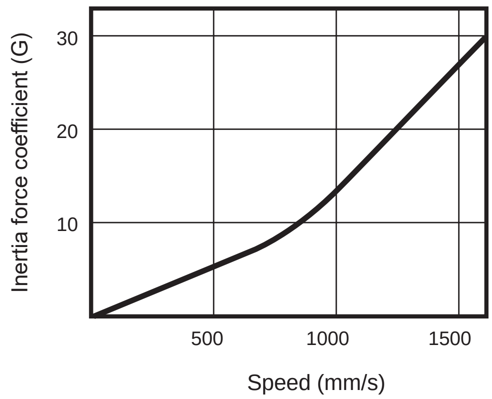


Table 4 Applied loads/max. allowable moments

Item / Bore size (mm)	Vertical load: W1max(N)	Vertical load: W2max(N)	Vertical load: W3max(N)
ø25 or equiv.	100	80	100
ø32 or equiv.	240	190	240
ø40 or equiv.	400	320	400
ø63 or equiv.	1300	1000	1300

Item / Bore size (mm)	Bending moment M1max (N·m)	Radial moment M2max (N·m)	Torsion moment M3max (N·m)
ø25 or equiv.	16	18	16
ø32 or equiv.	25	28	25
ø40 or equiv.	50	60	50
ø63 or equiv.	200	260	200

Table 4 shows the max. allowable values. The allowable values at specific operating speeds are as shown in Figure 2 to Figure 7. (The cylinder can be used in the range below and to the left of the characteristics curves of Figure 2 to Figure 7.)