1 Cushion performance and kinetic energy

(1) Cushion

● Cushion

The cushion absorbs piston kinetic energy by using air compressibility and prevents the piston and cover from colliding at the stroke end. Therefore, the cushion itself does not reduce the piston speed at the stroke end.

Table 5 shows kinetic energy that can be absorbed by the cushion. If kinetic energy exceeds these values or bounding due to air compression should be avoided, select the type with shock absorber or add a separate shock absorber.

(Refer to Step 8 above.)

● SRM3 cushion performance

Table 5 Allowable absorbed energy of cushion (E_1)

Bore size (mm)	Effective cushion length (mm)	Allowable absorbed energy (J)	
		With cushion	Without cushion
ø25 or equiv.	20.9	1.40	0.015
ø32 or equiv.	23.5	2.57	0.030
ø40 or equiv.	23.9	4.27	0.050
ø63 or equiv.	29.6	17.4	0.138

● Formula for kinetic energy calculation (E2)

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

M: Load weight (kg)

V : Speed of the piston entering the cushion Rush speed (m/s)

L : Cylinder stroke (m)

t : Piston operation time (s)

α : Cylinder load factor (%)

$$\alpha = \frac{\text{Applied load}}{\text{Thrust of cylinder}} \times 100$$

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

(2) Shock absorber

Shock absorbers used for SRM3 are shown in Table 7.

Use within the specifications for shock absorbers in Table 6.

Table 6 Specifications

Shock absorber model No. / Item		NCK-00-0.7-C	NCK-00-1.2	NCK-00-2.6	NCK-00-7	NCK-00-12
Type/Classification		Spring return without adjuster				
Max. energy absorption	J	7	12	26	70	120
Stroke	mm	8	10	15	20	25
Max. absorbed energy per hour	kJ/hr.	12.6	21.6	39.0	84.0	86.4
Max. colliding speed	m/s	1.5	2.0		2.5	3.0
Max. operating frequency	Cycle/min.	30		25	20	12
Ambient temperature	°C	-10 to 80				
Required mounting strength	N	6150	8400	12100	24400	33500
Return time	S	0.3 or less			0.4 or less	
Product weight	kg	0.02	0.04	0.07	0.2	0.3
Return spring force	When extended N	2.0	2.9	5.9	9.8	16.3
	When compressed N	4.3	5.9	11.8	21.6	33.3

● The allowable absorbed energy of SRM3 changes depending on the colliding speed. Keep it within 1/2 of the max. energy absorption in Table 9 at 1000 mm/s to 1500 mm/s colliding speed.

Table 7 Model numbers of applicable shock absorbers

Model	Model numbers of applicable shock absorbers	
	Standard (-A)	Light-load (-E)
SRM3-25	NCK-00-1.2	NCK-00-0.7-C
SRM3-32	NCK-00-2.6	NCK-00-1.2
SRM3-40	NCK-00-7	NCK-00-2.6
SRM3-63	NCK-00-12	NCK-00-7

● Confirmation of allowable colliding energy of shock absorber

Calculate the colliding object equivalent weight Me and the colliding energy E from the formula in the table below. Confirm that Me and E are within the allowable values shown in Figure 9. Also confirm that the operating frequency, colliding speed and other specifications are within the allowable values in the table.

Note that the allowable colliding object equivalent weight Me and allowable colliding energy E change depending on the colliding speed.

● Code

E : Colliding energy (J)
Me : Colliding object equivalent weight (kg)
m : Workpiece weight (kg)
F : Cylinder thrust (N)
V : Colliding speed (m/s)
St : Shock absorber stroke (m)
g : Gravity acceleration 9.8 (m/s²)

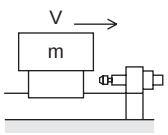
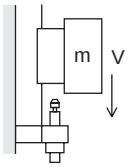
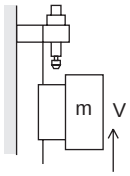
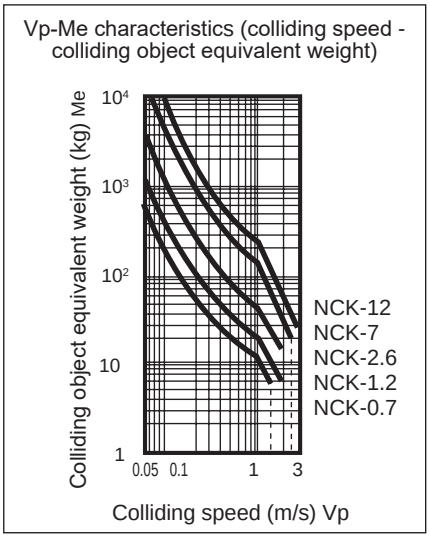
	Horizontal movement	Vertical down	Vertical up
Applications			
Colliding equivalent weight Me (kg)	$Me = m + \frac{2F \cdot St}{V^2}$	$Me = m + \frac{2 \cdot St\,(F+mg)}{V^2}$	$Me = m + \frac{2 \cdot St\,(F-mg)}{V^2}$
Energy E (J)	$E = \frac{mV^2}{2} + F \cdot St$	$E = \frac{mV^2}{2} + (F+mg) \cdot St$	$E = \frac{mV^2}{2} + (F-mg) \cdot St$

Figure 9 Allowable colliding object equivalent weight

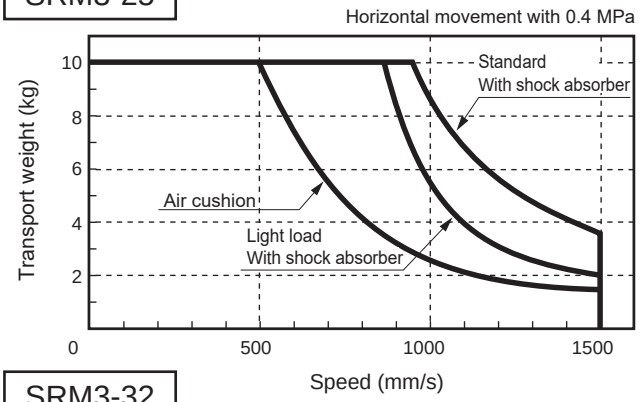


● With cushion/shock absorber Transfer weight - speed characteristics

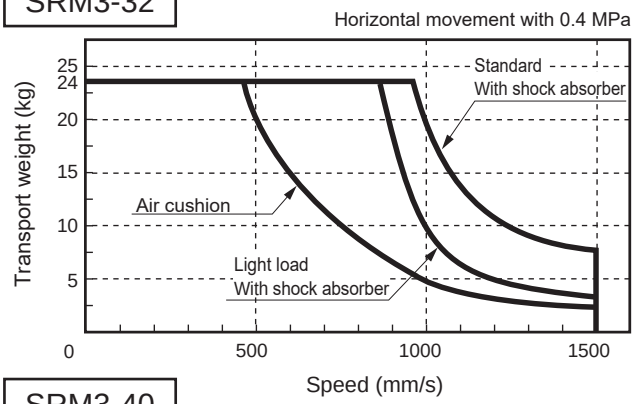
The figures below show the transfer weight and speed characteristics. They differ depending on the use conditions. Confirm that they are within the allowable values in Table 6.

SRM3 with cushion/shock absorber Transport weight and speed characteristics

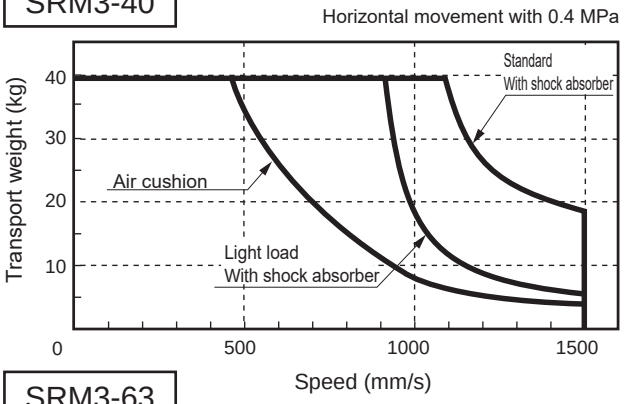
SRM3-25



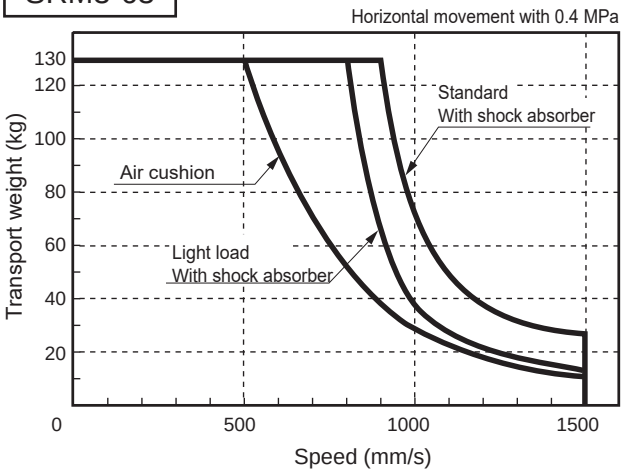
SRM3-32



SRM3-40



SRM3-63

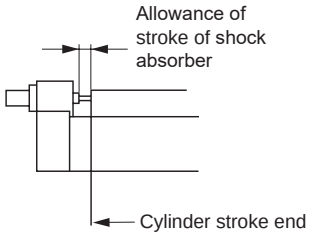


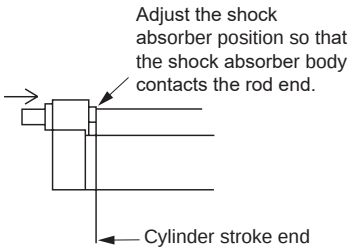
Precautions for use

A shock absorber can absorb the rated energy at the rated stroke. However, the initial shock absorber installation position is adjusted to have a stroke allowance at the cylinder's stroke end. Therefore, the absorbed energy will be less than the allowable absorbed energy (Table 11). If the rated absorbed energy is required, adjust the shock absorber so that the full stroke can be used.

Table 11 Initial set point of the type with shock absorber

Model	Standard (-A)		Light-load (-E)	
	Absorbed energy (J)	Effective stroke (mm)	Absorbed energy (J)	Effective stroke (mm)
SRM3-25	10	9	5.7	7
SRM3-32	18	13	10	9
SRM3-40	50	16.5	18	13
SRM3-63	86	21	50	16.5





(Note) This explanation applies to the shock absorber supplied with the full stroke adjustable.

Adjusting the shock absorber

Change the operational stroke of the shock absorber to adjust its absorbed energy.

● Example of calculation (SRM3-25-A)

Applicable shock absorber NCK-00-1.2

● Example of calculation (1)

Rising and lowering

Working conditions

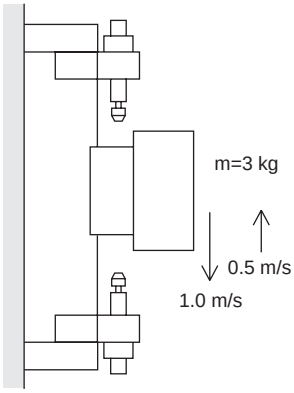
● Load weight m 3 kg

● Colliding speed

Rising 0.5 m/s

Lowering 1.0 m/s

● Working pressure 0.5 MPa (245 N)



(1) Kinetic energy when rising (E_1)

$$E_1 = \frac{3x0.5^2}{2} + (245 - 3x9.8)x0.01$$

$$= 2.5(J)$$

The kinetic energy (E1) is less than the max. energy absorption in Table 6 and can be absorbed.

$$Me = 3 + \frac{2x0.01x(245 - 3x9.8)}{0.5^2}$$

$$= 20(kg)$$

From Figure 10, Me of the shock absorber for SRM3-25-A:
The result is 32 kg at V = 0.5 m/s, which is allowable.

(2) Kinetic energy when falling (E_1)

$$E_1 = \frac{3x1.0^2}{2} + (245 + 3x9.8)x0.01$$

$$= 4.2(J)$$

The kinetic energy (E1) is less than 1/2 of the max. energy absorption in Table 6 and can be absorbed.

$$Me = 3 + \frac{2x0.01x(245 + 3x9.8)}{1.0^2}$$

$$= 8.5(kg)$$

From Figure 9, Me of the shock absorber for SRM3-25-A:
The Me value is 24kg at V = 1.0m/s, which is allowable.

● Example of calculation (2) Horizontal

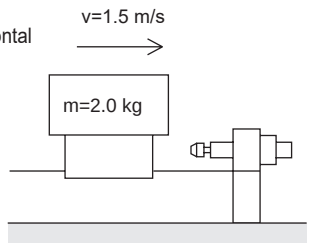
Working conditions

Load weight M 2 kg

Colliding speed

Horizontal 1.5 m/s

Working pressure 0.3 MPa (147 N)



Horizontal kinetic energy (E1)

$$E_1 = \frac{2x1.5^2}{2} + 147x0.01$$

$$= 3.7(J)$$

The kinetic energy (E1) is less than 1/2 of the max. energy absorption in Table 6 and can be absorbed.

$$Me = 2 + \frac{2x147x0.01}{1.5^2}$$

$$= 3.3(kg)$$

From Figure 9, Me at V = 1.5 (m/s) of the shock absorber for SRM3-25-A is 10 kg. Therefore the result of 3.4 < 10 is allowable.

(Note) Refer to the selection guide Step 9 (9 Confirmation of inertia load) and keep the inertia load within the allowable value.

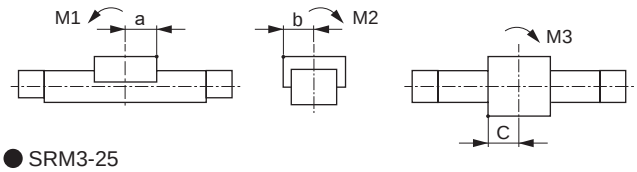
2 Sag of table (displacement at the table end)

The figures below show displacement at the table end when moment operates.
The table on the right shows the table end position.

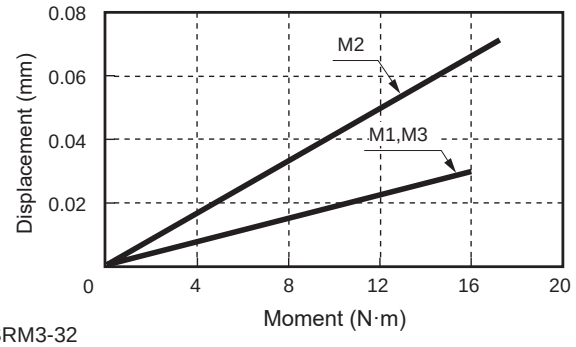
mm

Model	a	b	c
SRM3-25	50	50	50
SRM3-32	55	55	55
SRM3-40	70	70	70
SRM3-63	100	100	100

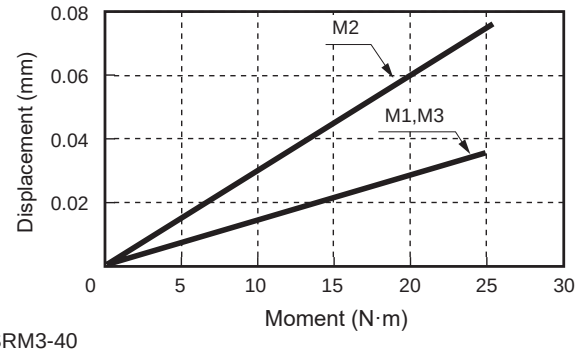
M1 moment M2 moment M3 moment



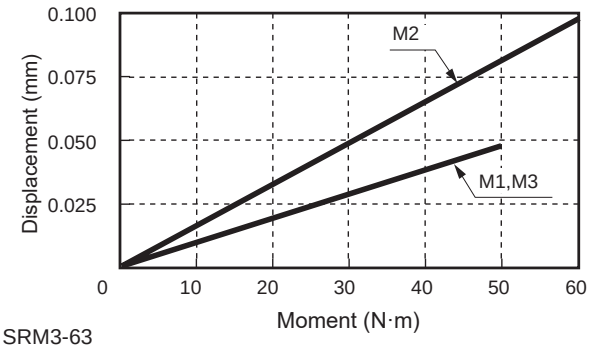
● SRM3-25



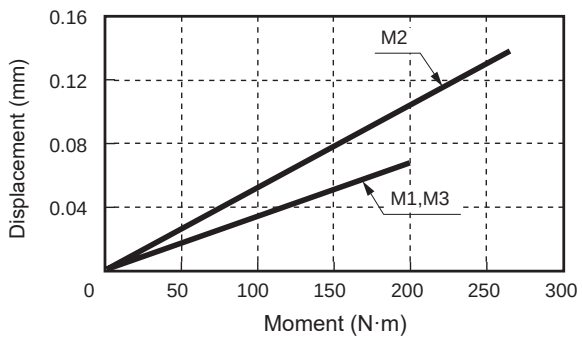
● SRM3-32



● SRM3-40



● SRM3-63



3 Support intervals

Sag increases with a longer stroke and larger bending moment. Use the intervals in the table below as a guide to fix the tube.

Model	Recommended support intervals (ℓ) mm
SRM3-25	400
SRM3-32	400
SRM3-40	500
SRM3-63	600