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 method

Select based on the following procedures.

Step 1 Oscillating time confirmation

↓

Step 2 Size (torque) selection
- (1) Static load
- (2) Resistance load
- (3) Inertia load

↓

Step 3 Allowable energy confirmation

↓

Step 4 Allowable load confirmation
- (1) Thrust load
- (2) Radial load
- (3) Moment load

Step 1 Oscillating time confirmation

If the oscillating time is set outside of the specified range, the actuator's operation may become unstable, or the actuator could be damaged. Always set the oscillating time within the specified oscillating time adjusting range.

	When used at 90°	When used at 180°
Oscillating time (s)	0.2 to 1.5	0.4 to 3.0

Step 2 Size (torque) selection

Selection method is roughly categorized into three load.
In each case, the required torque must be calculated. If the load is a compound load, add each torque to calculate the required torque.
Select size from theoretical torque table or actual torque diagram per working pressure to meet required torque.

(1) Static load (Ts)
When static pushing force is required for clamp, etc.

$$T_s = F_s \times L$$

Ts : Required torque (N·m)
Fs : Required force (N)
L : Length from center of rotation to pressure cone apex (m)

(2) Resistance load (T_R)
When force including frictional force, gravity or other external force is applied

$$T_R = K \times F_R \times L$$

T_R : Required torque (N·m)
K : Slack coefficient (Non-fluctuating load coefficient K = 2; When load fluctuates K = 5)
F_R : Required force (N)
L : Length from center of rotation to pressure cone apex (m)

(3) Inertia load (TA)
When the object is rotated

$$T_A = 5 \times I \times \dot{\omega}$$

$$\dot{\omega} = \frac{2\theta}{t^2}$$

T_A : Required torque (N·m)
I : Moment of inertia ($kg \cdot m^2$)
$\dot{\omega}$: Maximum angular speed (rad/s^2)
θ : Oscillating angle (rad)
t : Oscillating time (s)
Calculate moment of inertia using moment of inertia and oscillation time (page 1324) or figure for moment of inertia calculation (page 1325).

Step 3 Allowable energy confirmation

When using an inertial load, if the load's kinetic energy exceeds the allowable value at the oscillating end, the actuator could be damaged. Select one within allowable energy according to Table 1. If energy is too large, stop load with external shock absorber, etc.

$$E = \frac{1}{2} \times I \times \omega^2$$

$$\omega = \frac{2\theta}{t}$$

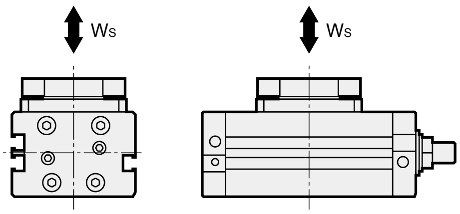
E : Kinetic energy (J)
I : Moment of inertia ($kg \cdot m^2$)
ω : Angular speed at the end of oscillation (rad/s)
θ : Oscillating angle (rad)
t : Oscillating time (s)
Calculate moment of inertia using moment of inertia and oscillation time (page 1324) or figure for moment of inertia calculation (page 1325).

Selection method

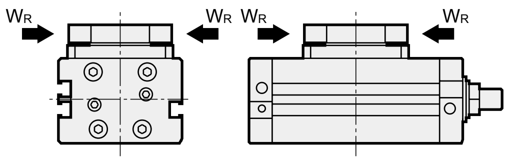
Step 4 Allowable load confirmation

If load applies to table, load is to be within allowable value on Table 2.
If combined load is applied, total of ratio for allowable value per load is to be 1.0 or less.
Load is categorized with the following 3 types.

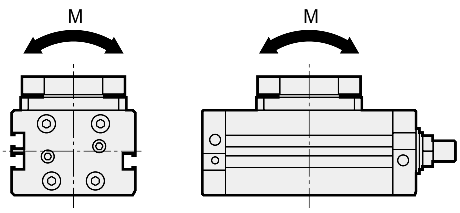
(1) Thrust load (axial load)



(2) Radial load (lateral load)



(3) Moment load



Substitute result to following formula, and check after each load is calculated.

$$\frac{W_s}{W_{smax}} + \frac{W_R}{W_{Rmax}} + \frac{M}{M_{max}} \leq 1.0$$

W_s : Thrust load (N)
W_R : Radial load (N)
M : Moment load (N·m)
W_{smax} : Allowable thrust load (N)
W_{Rmax} : Allowable radial load (N)
M_{max} : Allowable moment load (N·m)

Allowable value per allowable absorbed energy value and load is shown in the following table.

Table 1 Allowable absorbed energy value [J]

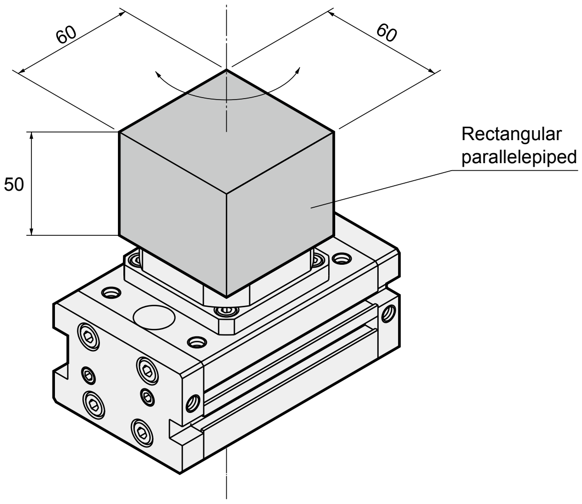
Size	5	10	20	30	50	80
Basic/high accuracy	0.005	0.008	0.03		0.04	0.11
With external shock absorber	0.46	0.59	1.15	1.71	2.33	2.78

Table 2 Allowable load value W_{Smax} W_{Rmax} M_{max}

Size		5	10	20	30	50	80
Thrust load	Basic	50	80	140	200	450	580
W_{smax} [N]	High accuracy	-	120	220	440	550	650
Radial load	Basic	30	80	150	200	320	400
W_{Rmax} [N]	High accuracy	-	100	160	240	380	480
Moment load	Basic	1.5	2.5	4.0	5.5	10.0	13.0
M_{max} [N·m]	High accuracy	-	3.0	5.0	7.0	12.0	15.0

Selection example (1)

When rectangular parallelepiped load is applied



[Operation conditions]

- Pressure : 0.5(MPa)
- Oscillating angle : 90°
- Oscillating time : 0.6(s)
- Load (material : aluminum alloy)
- [Rectangular parallelepiped] : 0.5 (kg)

Step 1 Oscillating time confirmation

Oscillating time is 0.6 (s/90°) according to operation conditions. Since oscillating time is within adjusting range 0.2 to 1.5 (s/90°), go to next step.

Step 2 Size (torque) selection

First, calculate moment of inertia (I) due to inertia load.
[Rectangular parallelepiped]

$$I=0.5\times\frac{0.06^2}{6}=3\times10^{-4}\ (kg\cdot m^2) \quad \text{................ (1)}$$

Then calculate the maximum angular speed ($\dot{\omega}$).

On conditions $\theta=90°=\frac{\pi}{2}$(rad), t=0.6(s)

Therefore,

$$\dot{\omega}=\frac{2\theta}{t^2}=\frac{\pi}{0.6^2}=8.73(rad/s^2) \quad \text{...................... (2)}$$

Therefore, inertia load (T_A) from (1) and (2)

$T_A = 5 \times 3 \times 10^{-4} \times 8.73$

$= 0.0131$ (N·m) .... (3)

According to (3) value and operational conditions and torque at 0.5 (MPa)

GRC-5-90 .... (A)

can be selected.

Step 3 Allowable energy confirmation

Check if value is within allowable energy after kinetic energy is calculated.
Calculate the angular speed at the end of oscillation ω.

On conditions $\theta=90°=\frac{\pi}{2}$(rad), t=0.6(s)

Therefore,

$$\omega=\frac{2\theta}{t}=\frac{\pi}{0.6}=5.24(rad/s)$$

Therefore, kinetic energy (E) is

$$E=\frac{1}{2}\times3\times10^{-4}\times5.24^2$$

=0.00412(J) …………………........(4)

From (4) and (A) selected at Step 2

GRC-5-90 …………………………………(B)

can be selected.

Step 4 Allowable load confirmation

Finally, check if value is within allowable load range after load value that applies to table is calculated.

[Thrust load]

Thrust load (Ws),
Ws=0.5×9.8=4.9(N) ……………………......(5)

[Radial load]

Since no radial load is applied,
W_R=0(N) ……………………………………...(6)

[Moment load]

Since no moment load is applied,
M = 0 (N·m) ....(7)

According to (5), (6), (7), (B),

$$\frac{W_s}{W_{smax}}+\frac{W_R}{W_{Rmax}}+\frac{M}{M_{max}}$$

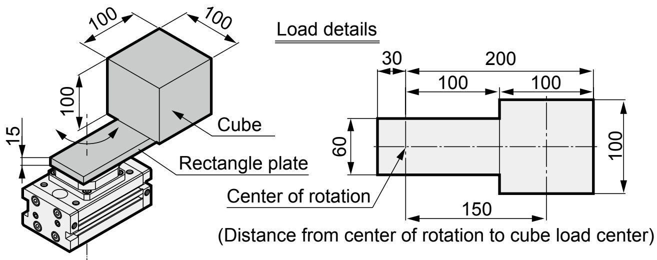
$$=\frac{4.9}{50}+\frac{0}{30}+\frac{0}{1.5}=0.098\leq1.0 \quad \text{.......(C)}$$

According to (B) and (C), total load value is within allowable load value.

GRC - 5 - 90

Selection example (2)

When rectangular parallelepiped load is applied to rectangle plate



[Operation conditions]

- Pressure : 0.5(MPa)
- Oscillating angle : 90°
- Oscillating time : 1.0(s)
- Load (material: steel)
  - [Rectangle plate on left from center of rotation] : 0.21 (kg)
  - [Rectangle plate on right from center of rotation] : 1.40 (kg)
  - [Cube] : 7.8 (kg)

Step 1 Oscillating time confirmation

Oscillating time is 1.0 (s/90°) according to operation conditions. Since oscillating time is within adjusting range 0.2 to 1.5 (s/90°), go to next step.

Step 2 Size (torque) selection

First, calculate moment of inertia (I) due to inertia load.

[Rectangle plate]

$$I_1=1.40\times\frac{4\times0.20^2+0.06^2}{12}+0.21\times\frac{4\times0.03^2+0.06^2}{12}$$

$$= 1.92 \times 10^{-2}\ (kg\cdot m^2)$$

[Cube]

$$I_2=7.8\times\frac{0.1^2}{6}+7.8\times0.15^2$$

$$= 0.189\ (kg\cdot m^2)$$

Therefore, total moment of inertia (I) is as follows.

$I = I_1 + I_2 = 0.21\ (kg\cdot m^2)$ ....(1)

Then calculate the maximum angular speed (ω).

On conditions $\theta=90°=\frac{\pi}{2}$(rad), t=1.0(s)

Therefore,

$$\dot{\omega} = \frac{2\theta}{t^2} = \frac{\pi}{1.0^2} = 3.14(rad/s^2)$$ …………(2)

Therefore, inertia load (T_A) from (1) and (2)

$T_A = 5 \times 0.21 \times 3.14$

$= 3.30\ (N\cdot m)$ ....(3)

According to (3) value and operational conditions, from torque at 0.5 (MPa)

GRC-50-90 …………………………(A)

can be selected.

Step 3 Allowable energy confirmation

Check if value is within allowable energy after kinetic energy is calculated.

Calculate the angular speed at the end of oscillation ω.

On conditions $\theta=90°=\frac{\pi}{2}$(rad), t=1.0(s)

Therefore,

$$\omega = \frac{2\theta}{t} = \frac{\pi}{1.0} = 3.14(rad/s)$$

Therefore, kinetic energy (E) is

$$E=\frac{1}{2}\times0.19\times3.14^2$$

$=0.937(J)$ ………………………………(4)

From (4) and (A) selected at Step 2

GRC - 80 - 90 - A1,A2 ……………………(B)

can be selected.

Step 4 Allowable load confirmation

Finally, check if value is within allowable load range after load value that applies to table is calculated.

[Thrust load]

Total weight

7.8 + 1.40 + 0.21 = 9.41 (kg)

Thus, thrust load (Ws)

$W_S = 9.41 \times 9.8 = 92.2(N)$ …………………(5)

[Radial load]

Since no radial load is applied,

$W_R = 0(N)$………………………………………(6)

[Moment load]

Moment load (M_1) of rectangle plate,

$1.40 \times 9.8 = 13.72(N)$

$0.21 \times 9.8 = 2.06(N)$

Therefore,

$M_1 = 13.72 \times 0.1 - 2.06 \times 0.015$

$= 1.34\ (N\cdot m)$

Moment load (M_2) of rectangular parallelepiped

$7.8 \times 9.8 = 76.44(N)$

Therefore,

$M_2 = 76.44 \times 0.15 = 11.47\ (N\cdot m)$

Therefore, the sum of M_1 and M_2,

$M = 1.34 + 11.47 = 12.81\ (N\cdot m)$ ...…………(7)

According to (5), (6), (7), (B),

$$\frac{W_s}{W_{smax}}+\frac{W_R}{W_{Rmax}}+\frac{M}{M_{max}}$$

$$=\frac{92.2}{450}+\frac{0}{320}+\frac{12.8}{10}=1.48>1.0$$

Increase by one size and recalculate with GRC-80-90 since moment load is exceeding allowable value.

$$\frac{W_s}{W_{smax}}+\frac{W_R}{W_{Rmax}}+\frac{M}{M_{max}}$$

$$=\frac{92.2}{580}+\frac{0}{400}+\frac{12.8}{13}=1.14>1.0$$

Since total load value is still exceeding allowable value, select high accuracy, and calculate

$$\frac{W_s}{W_{smax}}+\frac{W_R}{W_{Rmax}}+\frac{M}{M_{max}}$$

$$=\frac{92.2}{650}+\frac{0}{480}+\frac{12.8}{15}=0.99\leq1.0$$ ......(C)

According to (C), total load value is within the allowable load value,so

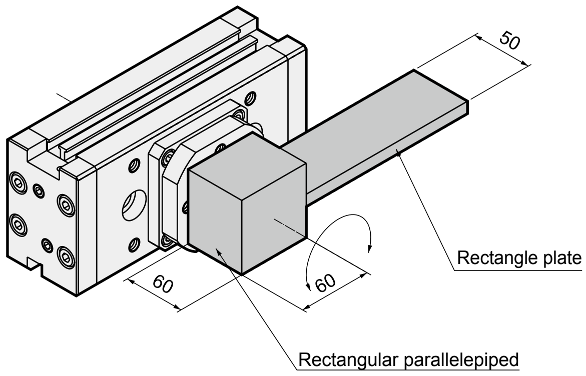
GRC - K - 80 - 90 - A1,A2

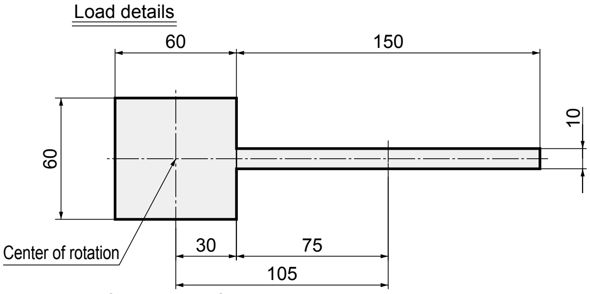
can be selected.

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 example (3)

When load is applied to rectangle plate with rotary shaft horizontal





(Distance from center of rotation to rectangle plate load center)

[Operation conditions]

Pressure : 0.5(MPa)
Oscillating angle : 180°
Oscillating time : 0.5(s)
Load (material: aluminum alloy)
[Rectangle plate] : 0.2 (kg)
[Rectangular parallelepiped] : 0.5 (kg)

Step 1 Oscillating time confirmation

Oscillating time is 0.5 (s/180°) according to operation conditions. Since oscillating time is within adjusting range 0.4 to 3.0 (s/180°), go to next step.

Step 2 Size (torque) selection

This is a gravitational resistance load and inertial load, so calculate the resistance load (T_R) and moment of inertia (I).

[Resistance load]

Resistance load varies per rotation of table.

$F_R = 0.2 \times 9.8 = 1.96(N)$

$R = 0.105(m)$

Therefore,

$T_R = 5 \times 1.96 \times 0.105 = 1.03$ (N·m) ......(1)

[Inertia load]

[Rectangle plate]

$$I_1 = 0.2 \times \frac{0.15^2}{12} + 0.2 \times 0.105^2$$

$$= 2.58 \times 10^{-3} \ (kg \cdot m^2)$$

[Rectangular parallelepiped section]

$$I_2 = 0.5 \times \frac{0.06^2}{6} = 3 \times 10^{-4} \ (kg \cdot m^2)$$

Therefore, total moment of inertia (I) is as follows.

$I = I_1 + I_2 = 2.88 \times 10^{-3} \ (kg \cdot m^2)$ ....(2)

Then calculate the maximum angular speed ($\dot{\omega}$).

On conditions θ = 180° = π (rad), t = 0.5 (s)

Therefore,

$$\dot{\omega} = \frac{2\theta}{t^2} = \frac{2\pi}{0.5^2} = 25.13(rad/s^2) \ldots\ldots\ldots\ldots(3)$$

Therefore, inertia load (T_A) from (2) and (3)

$T_A = 5 \times 2.88 \times 10^{-3} \times 25.13$

$= 0.362$ (N·m) ....(4)

According to (1), (4), total torque (T)

$T = 1.03 + 0.362 = 1.39$ (N·m) ....(5)

According to (5) value and operational conditions, from torque at 0.5 (MPa)

GRC - 20 - 180	…………………………(A)

can be selected.

Step 3 Allowable energy confirmation

Check if value is within allowable energy after kinetic energy is calculated.

Calculate the angular speed at the end of oscillation ω.

On conditions θ = 180° = π (rad), t = 0.5 (s)

Therefore,

$$\omega = \frac{2\theta}{t} = \frac{2\pi}{0.5} = 12.57(rad/s)$$

Therefore, kinetic energy (E) is

$$E = \frac{1}{2} \times 2.88 \times 10^{-3} \times 12.57^2$$

$= 0.23(J)$ ………………………………(6)

From (6) and (A) selected at Step 2

GRC - 20 - 180 - A1,A2	………………(B)

can be selected.

Selection example (3)

Step 4 Allowable load confirmation

Finally, check if value is within allowable load range after load value that applies to table is calculated.

[Thrust load]

Since no thrust load is applied, thrust load (Ws)

$W_S = 0(N)$ ....(7)

[Radial load]

Total weight

0.2 + 0.5 = 0.7 (kg)

Therefore,

$W_R = 0.7 \times 9.8 = 6.9(N)$............................(8)

[Moment load]

Moment load (M) from the figure below

$M = 0.03 \times (0.2 + 0.5) \times 9.8$

$= 0.21\ (N\cdot m)$ ....(9)

According to (7), (8), (9), (B),

$$\frac{W_s}{W_{smax}} + \frac{W_R}{W_{Rmax}} + \frac{M}{M_{max}}$$

$$= \frac{0}{150} + \frac{6.9}{140} + \frac{0.21}{4.0} = 0.101 \leq 1.0 \text{........(C)}$$

According to (B) and (C), total load value is within the allowable load value.

GRC - 20 - 180 - A1, A2

can be selected.