Shock absorber selection guide

1 Clarify the colliding pattern of the device

- Horizontal motion
  - a. Simple horizontal collision
  - b. Collision with cylinder thrust
  - c. Collision with drive force of motor
- Vertical motion
  - d. Collision due to free fall
  - e. Collision with cylinder thrust (downward)
  - f. Collision with cylinder thrust (upward)
- Slope motion
  - g. Collision due to free sliding
  - h. Collision with cylinder thrust (downward)
  - i. Collision with cylinder thrust (upward)
- Oscillation/ rotation motion
  - j. Collision due to free oscillating fall
  - k. Colliding with torque of motor, etc., (oscillation)
  - l. Colliding with torque of motor, etc., (rotation)

Note: Refer to "Example of colliding pattern".

2 Make required conditions/descriptions clear to calculate energy

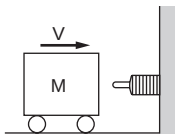
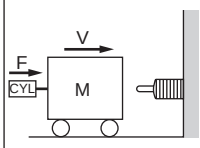
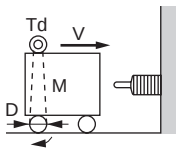
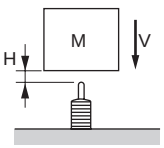
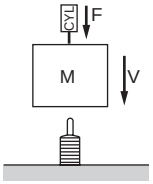
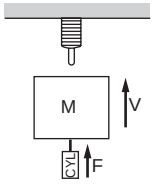
E = all absorbed energy (J)
E_1 = kinetic energy (J)
E_2 = thrust/self-weight energy (J)

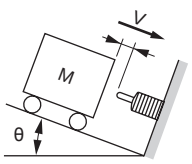
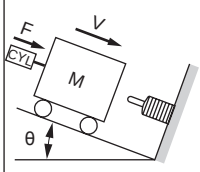
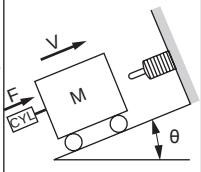
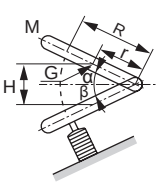
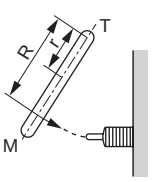
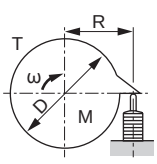
L = colliding object travel distance (m)
(Slope free fall)
R = distance from center of rotation to colliding point (m)
r = distance from center of rotation to center of gravity (m)
G = position of center of gravity

M = colliding weight (kg)
V = colliding speed (m/s)
S = SKL stroke (m)
F = pushing force (N)
g = gravity acceleration 9.8 m/s^2
ω = angular speed (rad/s)
J = moment of inertia (kg/m^2)
D = diameter (m)
N = number of rotations (rpm)
Me = equivalent weight (kg)

H = drop height (m)
T = torque (N·m)
Td = motor start torque (N·m)
K = reduction ratio
θ, α, β = tilt angle (deg)

3 Calculate actual energy in accordance with the sample figure for the colliding pattern

	Horizontal colliding			Vertical colliding		
	a. Simple horizontal collision	b. Pushing force of cylinder applies	c. Pushing force of motor applies	d. Free fall	e. Cylinder lower limit stopper	f. Cylinder upper limit stopper
Applications						
Kinetic energy E_1(J)	$\frac{1}{2}\cdot M\cdot V^2$	$\frac{1}{2}\cdot M\cdot V^2$	$\frac{1}{2}\cdot M\cdot V^2$	$\frac{1}{2}\cdot M\cdot V^2$	$\frac{1}{2}\cdot M\cdot V^2$	$\frac{1}{2}\cdot M\cdot V^2$
Thrust/self-weight energy E_2(J)	-------	F·S	$2\cdot\frac{K}{D}\cdot Td\cdot S$	M·g·S	(M·g+F)·S	(F-M·g)·S
All absorbed energy E (J)	$E = E_1$	$E = E_1+E_2$	$E = E_1+E_2$	$E = E_1+E_2$	$E = E_1+E_2$	$E = E_1+E_2$
Equivalent weight Me(kg)	Me = M	$Me = \frac{2\cdot E}{V^2}$	$Me = \frac{2\cdot E}{V^2}$	$Me = \frac{2\cdot E}{V^2}$ $(V=\sqrt{2\cdot g\cdot H})$	$Me = \frac{2\cdot E}{V^2}$	$Me = \frac{2\cdot E}{V^2}$

	Slope colliding			Oscillation colliding		Rotation colliding
	g. Free fall	h. Pushing force of cylinder applies	i. When thrust of cylinder is applied	j. Free fall	k. Torque of motor, etc., applies	L. Torque of motor, etc., applies
Applications						
Kinetic energy E_1(J)	$\frac{1}{2}\cdot M\cdot V^2$	$\frac{1}{2}\cdot M\cdot V^2$	$\frac{1}{2}\cdot M\cdot V^2$	M·g·H	$\frac{J\cdot\omega^2}{2}$ or $\frac{1}{2}\cdot M\cdot V^2$	$\frac{J\cdot\omega^2}{2}=\frac{M\cdot D^2\cdot\omega^2}{16}$
Thrust/self-weight energy E_2(J)	M·g·S·sinθ	(M·g·sinθ+F)·S	(F-M·g·sinθ)·S	$\frac{r}{R}\cdot M\cdot g\cdot S$	$\frac{T}{R}\cdot S$	$\frac{T}{R}\cdot S$
All absorbed energy E (J)	$E = E_1+E_2$	$E = E_1+E_2$	$E = E_1+E_2$	$E = E_1+E_2$	$E = E_1+E_2$	$E = E_1+E_2$
Equivalent weight Me(kg)	$Me = \frac{2\cdot E}{V^2}$ $(V=\sqrt{2\cdot g\cdot L\cdot\sin\theta})$	$Me = \frac{2\cdot E}{V^2}$	$Me = \frac{2\cdot E}{V^2}$	$Me = \frac{2\cdot E}{V^2}$ $(V=\frac{R}{r}\sqrt{\frac{3\cdot g\cdot H}{2}})$	$Me = \frac{2\cdot E}{V^2}$ $(V=\omega\cdot R)$	$Me = \frac{2\cdot E}{V^2}$ $(V=\omega\cdot R,\ \omega=\frac{2\pi\cdot N}{60})$

● Explanation of code
E = all absorbed energy J
E_1 = kinetic energy J
E_2 = thrust/self-weight energy J

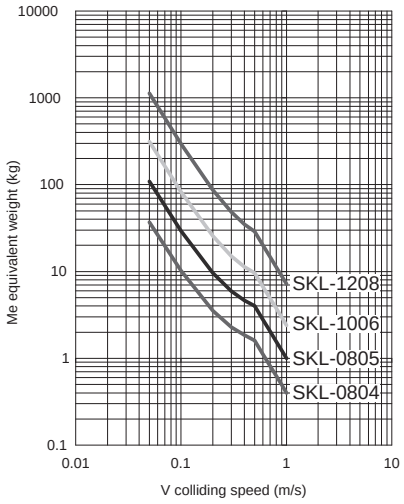
a. Kinetic energy..... Calculate the E_1 value according to "Example of colliding pattern".
b. Thrust/self-weight energy ..... Calculate the value of E_2 according to "Example of colliding pattern". For S (stroke of SKL) in the formula, select a model whose max. absorbed energy exceeds E_1, and use S for that model No.
c. Total absorbed energy..... If after that the calculation result exceeds Emax (max. energy absorption), select one size larger SKL than the previously selected model No., and recalculate. If calculated E is lower than Emax selected model No., the selection is acceptable.

4 Confirm the equivalent weight

a. Calculate value of Me according to "Example of colliding pattern".
b. Usable if Me is within Me range of selected model (calculated value of Me < specified value of Me) according to calculation of Me (catalog value) and "a" for model No. selected at 3.
c. When exceeding the Me range of the selected model at b, select an SKL one size larger, and check conditions in the same manner.

Note: Equivalent mass corresponds to weight of workpiece, even for body moving with thrust, etc., if it is assumed that all of them are kinetic energy only. This allows the load to be controlled at very low speed conditions.

Equivalent weight graph



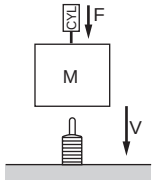
5 Confirm shock absorber specifications range

a. Max. repeating cycle	[cycle/min.]	c. Ambient temperature	[°C]
b. Max. colliding speed	[m/s]	d. Return time	[s]

Note: Value of allowable energy absorption may vary depending on colliding speed.

Example of selection

1 Clarify the colliding pattern of the device

Applications	Vertical colliding
	e. Cylinder lower limit stopper
	
Kinetic energy E_1(J)	$E_1 = \frac{1}{2}\cdot M\cdot V^2$
Thrust/self-weight energy E_2(J)	$E_2 = (Mg + F)\cdot S$
All absorbed energy E (J)	$E = E_1 + E_2$
Equivalent weight Me (kg)	$Me = \frac{2\cdot E}{V^2}$

2 Make required conditions/descriptions clear to calculate energy

(Example)

Colliding object weight:	M=1.0 kg
Colliding speed:	V=0.5 m/s
Pushing force:	F=70 N
Frequency:	30 cycle/min.
Ambient temperature:	23°C
Return time:	2s (time up to re-collision)

3 Calculate actual energy in accordance with the sample figure for the colliding pattern.

Calculate E_1

$E_1 = \frac{1}{2}\cdot MV^2 = \frac{1}{2} \times 1 \times 0.5^2 = 0.13$ (J)

Tentatively select SKL-0804 from E_1, then calculate E_2

$E_2 = (Mg + F)\cdot S = (1 \times 9.8 + 70) \times 0.0035 = 0.28$(J)

As it exceeds the allowable absorbed energy of SKL-0804, recalculate with the one size larger SKL-0805

$E_2 = (Mg + F)\cdot S = (1 \times 9.8 + 70) \times 0.0045 = 0.36$(J)

$E = E_1 + E_2 = 0.13 + 0.36 = 0.49$(J)

Acceptable as it is less than the allowable absorbed energy of SKL-0805

4 Confirm the equivalent weight

$Me = \frac{2E}{V^2} = \frac{2x0.49}{0.5^2} = 3.92$(kg)

As it is less than the allowable value of SKL-0805, select OK SKL-0805