Shock absorber selection guide (1)

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

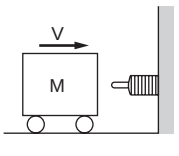
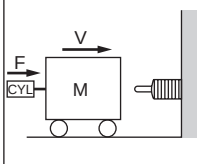
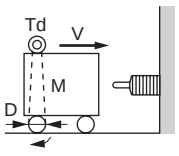
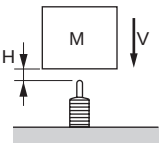
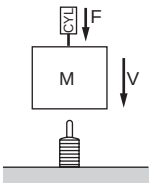
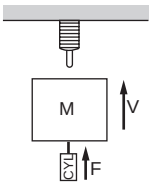
E = all absorbed energy (J)
E_1 = kinetic energy (J)
E_2 = thrust/self-weight energy (J)

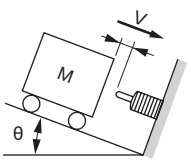
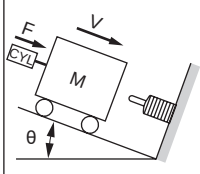
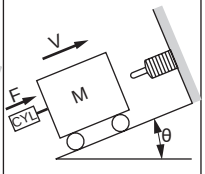
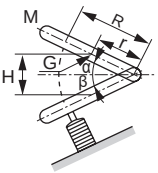
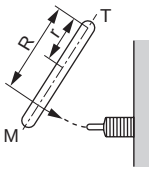
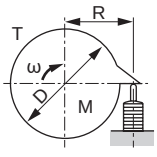
L = colliding object travel distance (m) (Slope free fall)
R = distance from center of rotation to colliding point (m)
r = distance from center of rotation to center of gravity (m)
G = position of center of gravity

M = colliding weight (kg)
V = colliding speed (m/s)
S = NCK stroke (m)
F = pushing force (N)
g = gravity acceleration 9.8 m/s²
ω = angular speed (rad/s)
J = moment of inertia (kg/m²)
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)

Example of 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)	$Me=\frac{2\cdot E}{V^2}\ (V=\sqrt{2\cdot g\cdot L\cdot\sin\theta})$	$Me=\frac{2\cdot E}{V^2}$	$Me=\frac{2\cdot E}{V^2}$	$Me=\frac{2\cdot E}{V^2}\ (V=\frac{R}{r}\sqrt{\frac{3\cdot g\cdot H}{2}})$	$Me=\frac{2\cdot E}{V^2}\ (V=\omega\cdot R)$	$Me=\frac{2\cdot E}{V^2}\ (V=\omega\cdot R,\ \omega=\frac{2\pi\cdot N}{60})$

3 Check shock absorber specifications range

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

Note: Value of allowable energy absorption may vary depending on colliding speed. Refer to Graph 5 on page 1829.

4 Calculate actual energy per "Example of colliding pattern"

● 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 NCK) 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 NCK than the previously selected model No., and recalculate. If calculated E is lower than Emax selected model No., the selection is acceptable.

5 Confirm the equivalent weight

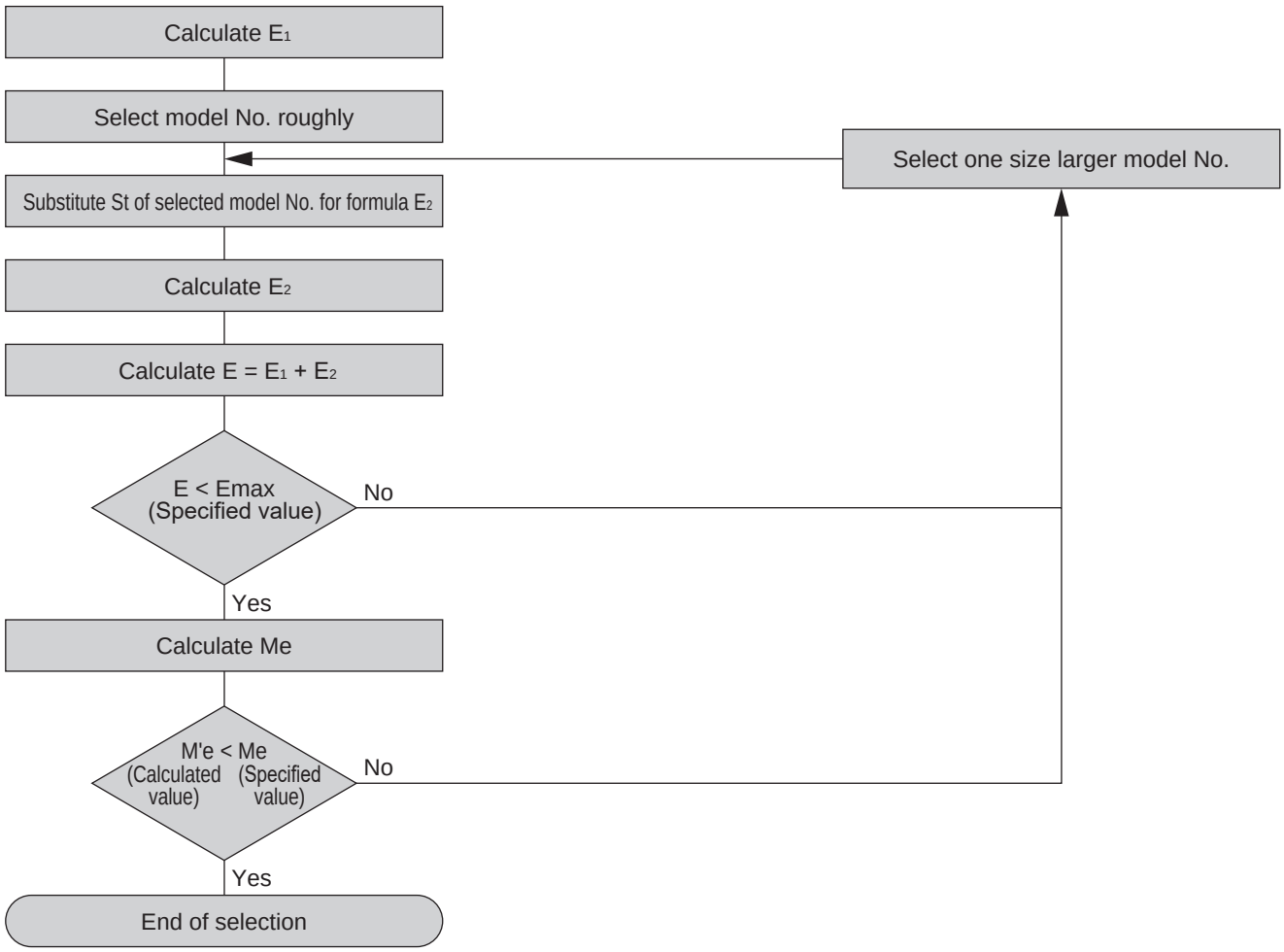
Me = Equivalent weight [kg]

Note: Equivalent weight corresponds to weight of workpiece, even for body moving with thrust, etc., if it is assumed that all of them are kinetic energy only. If only the energy formula is used, load is restricted by the equivalent weight, because the weight of workpiece will increase sharply in low speed operations.

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 4.
c. When exceeding the Me range of the selected model at b, select an NCK one size larger, and check conditions in the same manner.

Note) Equivalent weight (Me) is listed on page 1829 (Graph 4).

6 Calculation flow chart of step 4 and 5



Shock absorber selection guide (2)

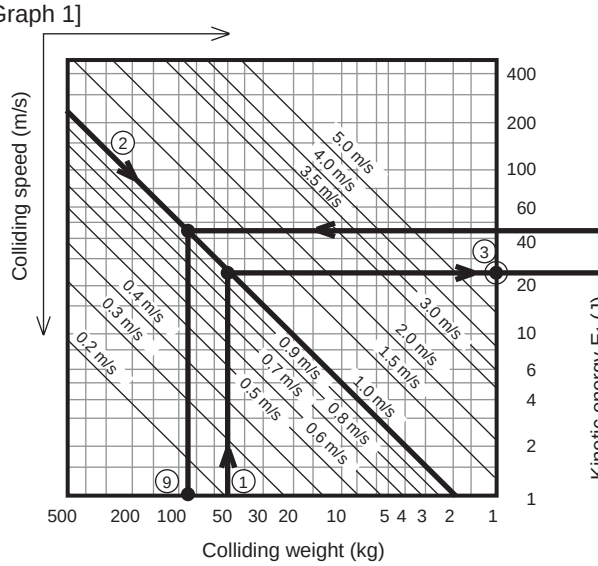
Shock absorber models can be selected either entirely by calculation, as in (1), or through the graph. If not required to grasp energy values, etc., during calculation, if this graph is used, proper model can be selected efficiently.

Condition of this figure: Horizontal colliding with thrust
m=50 kg, V=1.0 m/s
Cylinder bore size ø50
Supply pressure = 0.5 MPa

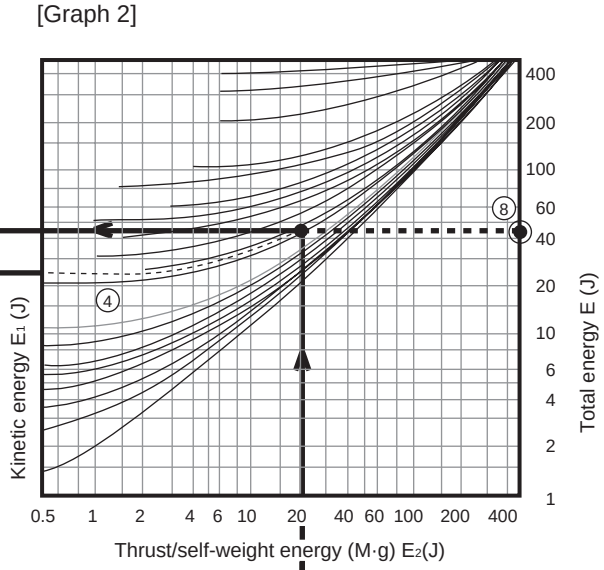
Energy calculation graph

● Thrust applies at the horizontal collision

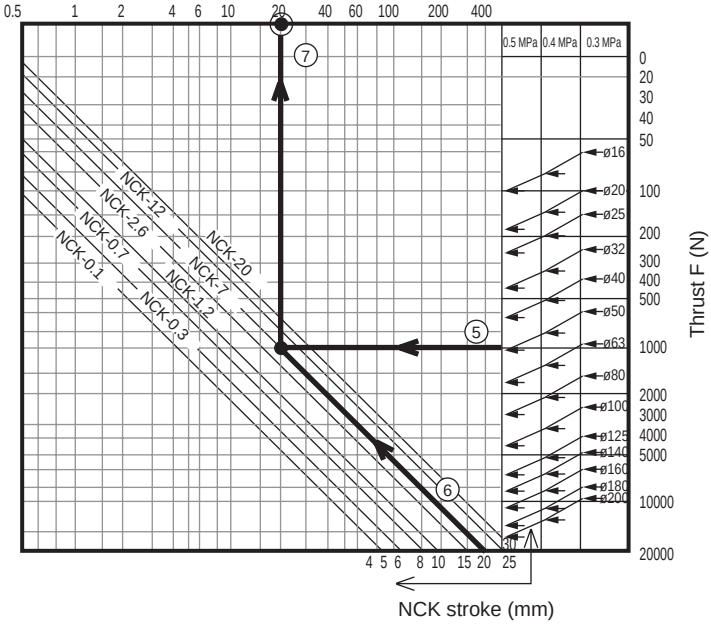
[Graph 1]



[Graph 2]



[Graph 3]



a) Determine the colliding weight M (kg)...①

b) Collision speed V (m/s) ... ②

c) Point of intersection between M and V ③ is kinetic energy E_1 (J). ... ③

d) Extend ③ to [Graph 2], and refer to the curve in the figure to draw a similar curve. (dotted line) ... ④

e) Next, if thrust applies, determine thrust F (N) (from bore and pressure of cylinder) by the right end chart of [Graph 3] ... ⑤

f) Determine model No. of NCK according to stroke and max. energy absorption. ... ⑥
(Select a model No. whose max. energy absorption exceeds E_1 calculated in step ③.)

g) The point of intersection between F and NCK model No. ⑦ shows the thrust/self-weight energy E_2 (J).
... ⑦

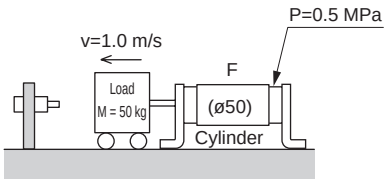
h) Extend point Ⓑ to [Graph 2], and point of intersection ⑧ with curve ④ shows total energy E (= E_1 + E_2) (J).
... ⑧
Here, if value E exceeds the selected NCK Emax (max. absorbed energy) at (f), select an NCK model No. one size larger again, and then find E with the same procedure.

i) Here, if "Ⓒ" and ⑧ are extended to [Graph 1], the point of intersection ⑨ with V (m/s) represents the equivalent weight Me. ... ⑨
Check that equivalent weight is within the specified value range [Graph 4].
(When Me exceeds specifications values, return to (f) and repeat the same procedures.)

Example of selection

Select shock absorber according to example.

Example Select shock absorber which stops load M smoothly under left figure conditions.



Frequency: 10 cycle/min.
(Refer to equipment indoors.)

1 The colliding pattern of the device is equivalent to "b".

2 Summarize required conditions to calculate.

a. Colliding object weight M=50 kg
b. Colliding speed V=1.0 m/s
c. Cylinder thrust $F=\pi/4x50^2mmx0.5\ MPa=981.7\ N$

3 Check specifications.

a. Frequency 10 cycles/min. ..... NG, since max. repeating cycle of NCK-20 is 9 cycle/min. [limited to models of NCK-12 and below]
b. Colliding speed 1.0 m/s..... All models are available
c. Ambient temperature:
Indoor equipment ..... All models are available
d. Return time: Not specified..... All models are available

4 Calculate actual energy.

● From pattern figure example "b"

a. Kinetic energy: $E_1 = \frac{1}{2}\cdot m\cdot V_2 = \frac{1}{2}$x 50 (kg) x 1.0^2 (m/s) = 25 (J)
Here, since as with E_1 alone this was 25 J, NCK-2.6 [Emax = 26 J] (St = 15 mm) is provisionally selected.

b. Thrust energy: $E_2 = FxS = 981.7\ (N)\ 0.015\ (m) = 14.7\ (J)$

c. Total absorbed energy: $E = E_1 + E_2 = 25\ (J) + 14.7(J) = 39.7(J)$
Recalculate with one size larger NCK-7, since this E = 39.7 (J) cannot be absorbed with the NCK-2.6 provisionally selected earlier.

b'. $E_2 = FxS = 981.7\ (N)\ 0.02\ (m) = 19.6\ (J)$

c'. $E = E_1 + E_2 = 25\ (J) + 19.6(J) = 44.6(J)$
Proceed to confirmation of the colliding object equivalent weight as this E = 44.6 (J) can be absorbed by NCK-7.

5 Confirm the equivalent weight.

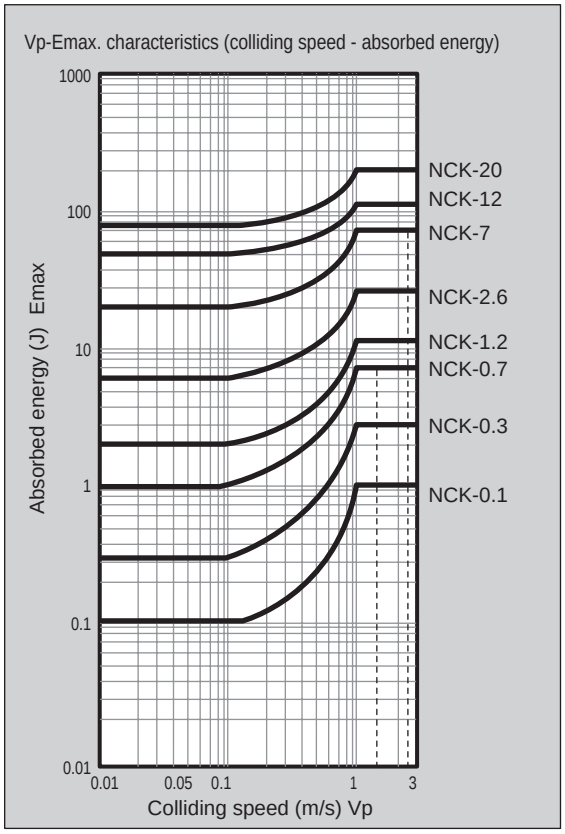
● From pattern figure example "b" the same as 4

a. Equivalent weight $Me = \frac{2\cdot E}{V^2} = \frac{2 \times 44.6\ [J]}{1.0^2\ [m/s]} = 89.2$ kg

b. NCK-7 Me is 150 (kg), larger than the calculated equivalent weight. Therefore, use NCK-7 under these conditions.

Rush speed characteristics graph of equivalent weight/absorbed energy

(Graph 5)



(Graph 4)