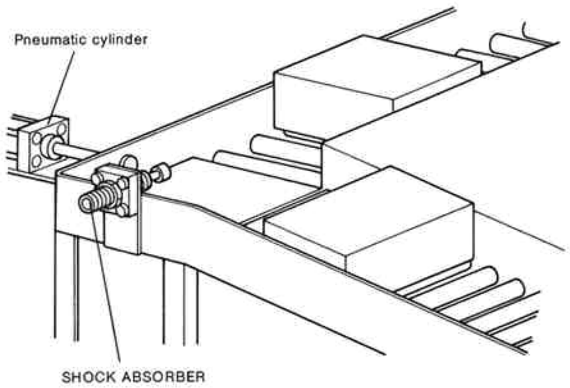
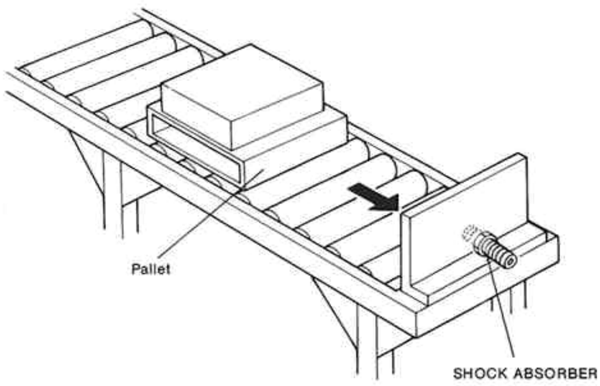
OUTLINE

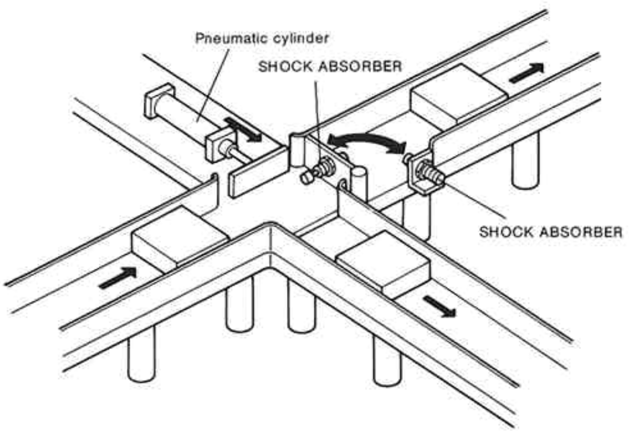
APPLICATION EXAMPLES



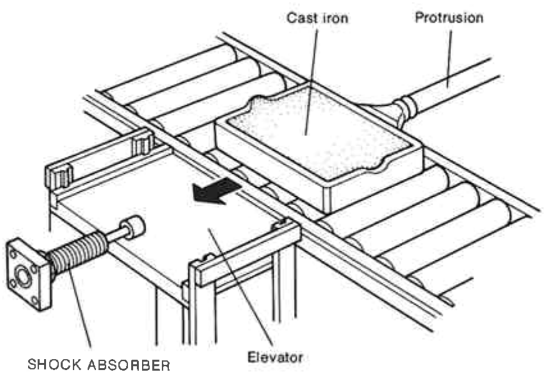
● DIRECTIONAL CONTROL OF CONVEYOR



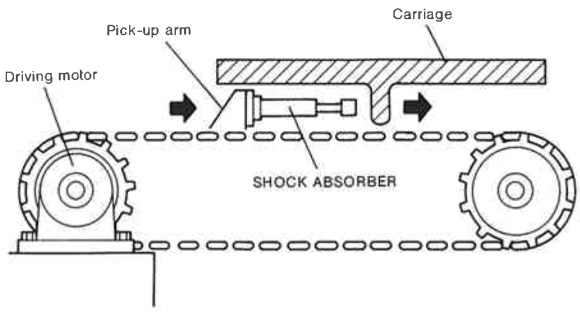
● TERMINAL OF CONVEYOR



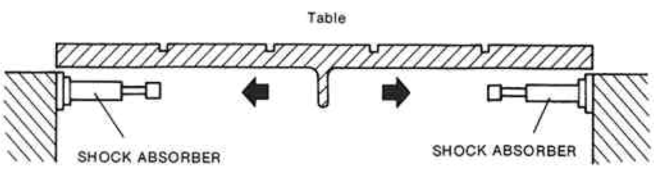
● DIRECTIONAL TRANSFER OF CONVEYOR



● PROTRUSIVE DEVICE

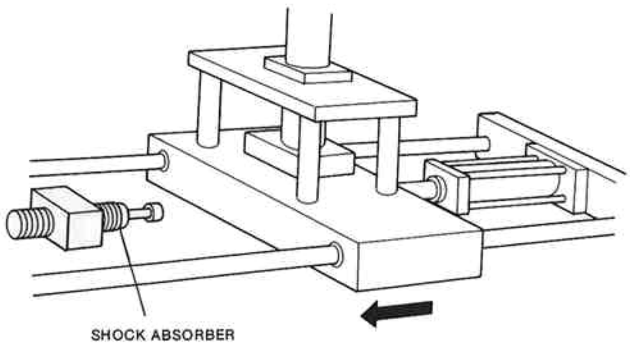


● PREVENT OVERLOAD OF MOTOR BY MOVING CARRIAGE GENTLY WITH SHOCK ABSORBER MOUNTED TO PICKUP ARM.

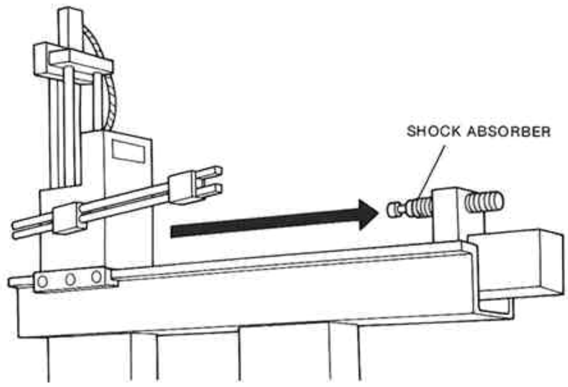


● SLIDE OR RECIPROCATING TABLE

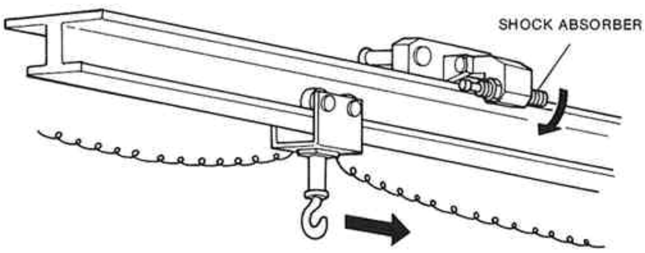
OUTLINE



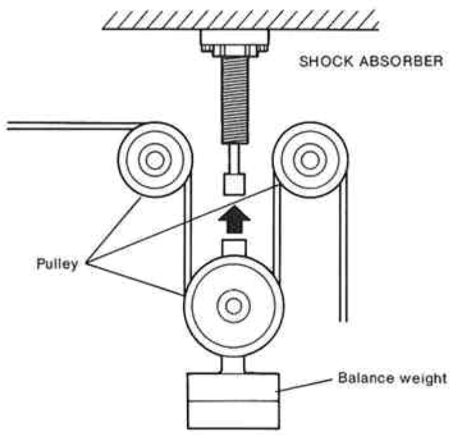
● SLIDE UNIT



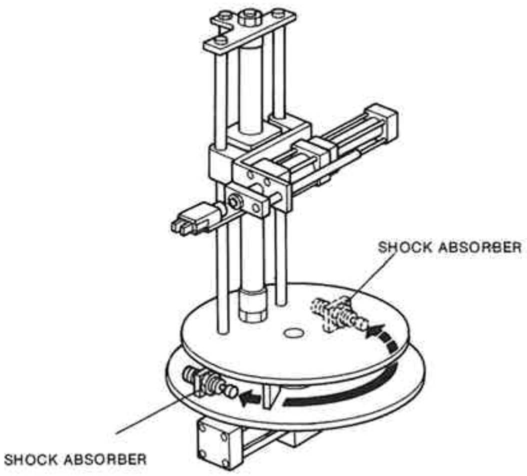
● TRANSFER DEVICE



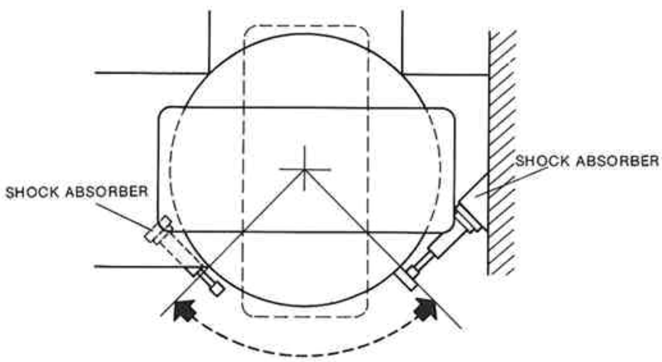
● CONVEYANCE LIFT STOP



● SHOCK ABSORPTION OF BALANCE WEIGHT MOVING UPWARD WITH BELT EXTENSION DEVICE



● TURNING OF ROBOT



● TRANSFER TABLE

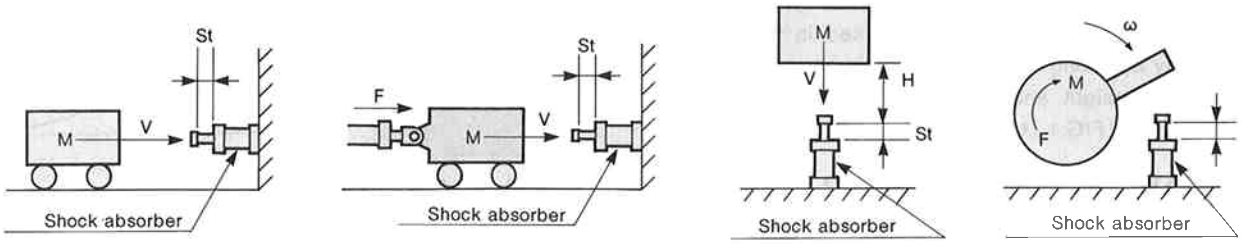
OUTLINE

SELECTION METHOD OF SHOCK ABSORBER

1. TYPE OF MOTION

With various motions classified, the following are given. Accordingly, it is needed to study the energy calulation and mounting method according to the classifications.

- Motion
  - Rectilineal motion
    - Pure inertia motion············In case of motion with only inertia
    - Driving motion··················In case of driving force of cylinder, motor, etc.
    - Falling motion·················· In case of motion by gravity of free and inclination falling
  - Rotary motion



Pure inertia motion	Driving motion	Falling motion	Rotary motion

2. ENERGY CALCULATION

● Rectilineal Motion

a. Necessary specifications

Motion object weight	: M (kg)	
Impact speed	: V (m/s)	
Driving force	: F (N)	} In case accompanied by cylinder, motor or driving force such as frictional force, gravity, additional force
Shock absorber applied	: N	
Falling height	: H (m)	} In case of falling motion
Shock absorber stroke	: St (m)	

b. Calculation formula

Pure inertia motion $E_T = 0.5M \cdot V^2 \cdot \frac{1}{N} (J)$

Driving motion $E_T = (0.5M \cdot V^2 + F \cdot St) \cdot \frac{1}{N} (J)$

Falling motion $E_T = (Mg \cdot H + Mg \cdot St) \cdot \frac{1}{N} = Mg(H + St) \cdot \frac{1}{N} (J)$

● Rotary Motion

a. Necessary specifications

Motion object weight	: M (kg)
Impact angle, speed	: ω (rad/s)
Torque	: T (N·m)
Inertia moment	: I ($kg \cdot m^2$)
Suspension angle	: θ (rad)······Connected with shock absorber stroke.

b. Calculation formula

$$E_T = \left(\frac{1}{2} \cdot I \cdot \omega^2 + T \cdot \theta \right) \quad (J)$$

● Other Calculation Formula

a) General application

Suspension time : t (s)······ Time needed for suspension of load after impact with shock absorber.

Deceleration : G··············G value means the deceleration's multiple of gravity acceleration. Accordingly, it is slow deceleration for small G value and sharp deceleration for large G value.

Resisting force : S_F (N) ··· It is the force of resistance by oil pressure that occurs in case of energy absorption, and enough strength of mouting objects against the resisting force is necessary.

Use frequency : C (time / min)

Ambient temp. : T_1 (℃)

Max. energy capacity : E max (J)

Max. energy capacity per min. : E_2 (J / min)

Energy per minute : E_T / M (J/ min)= $E_T \cdot C$

b) Calculation formula

Suspension time $t = \frac{2\,St}{V}$ (s)

Deceleration $G = \frac{0.051\,V^2}{St}$

Suspension force $S_F = \frac{E_T}{St}$ (N)

} Applied only for shock absorber with unified effect

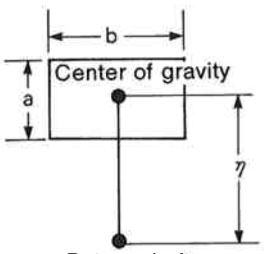
c) About inertia moment

Theorem of parallel shaft (Applied in case that rotary shaft slips off the center of gravity.)

I for inertia moment on rotary shaft
I_G for inertia moment on center of gravity
η for distance from rotary shaft to center of gravity

} Connected with $I = I_G + M \cdot \eta^2$

Example)



$I_G = M \cdot \frac{a^2+b^2}{12}$ then

$I = M \cdot \frac{a^2+b^2}{12} + M \cdot \eta^2$ is given.

3. TERMS EXPLANATION

● Max. energy capacity per minute

It is the absolute conditions that the impact energy of shock absorber for one time is less than the maximum energy absorption. It is also necessary that energy per minute to be set according to frequency is less than the capacity. It is called the max. energy capacity per minute. If it exceeds the allowable value, the oil temperature of shock absorber rises and the absorption efficiency of shock is worsened, thereby causing the damage of machinery.

The max. energy capacity per minute in the specifications is indicated at the ambient temperature of 26.7℃.

The max. energy capacity per minute at the ambient temperature T (℃) is indicated as follows :

$$E_2 = \frac{(82.2 - T)}{55.5} \times \text{(Max. energy capacity per minute in table)}$$

● Equivalent weight

The equivalent weight is not the weight of only object that collides with shock absorber. With total energy as E_T, it is given by the following formura.

$$Meq = \frac{2\,E_T}{V^2}$$

In case of pure inertia motion, it is Meq = M

Meq : Equivalent weight (kg)
E_T : Total energy (J)
V : Impact speed (m/s)

● Stroke of shock absorber

As the stroke (St) of shock absorber affects total energy (E_T), suspension time (t), deceleration (G), suspension force (S_F), stroke shall be decided with these value taken into consideration.

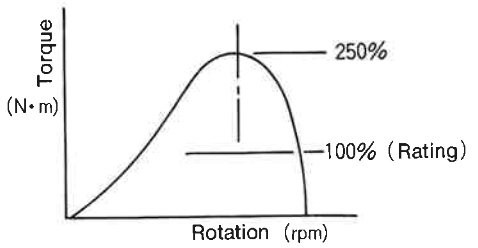
OUTLINE

4. SELECTION PROCEDURE

	Item	Contents
Selection Contents	1. Impact loads weight ↓	● For impact loads weight, compute max. weight M (kg) of loads.
	2. Impact speed ↓	● For impact speed, compute the speed just before impact (two - fold of average speed in case that impact speed is uncertain.) V (m / s)
	3. Calculation of motion energy of loads ↓	● Compute the motion energy of loads Ek (J). (Calculate upon referring to the selection calculation formula examples.)
	4. Case accompanied by driving force ↓	● Compute the driving force F (N) in case that it is accompanied by gravity (fall) or the driving force of cylinder. (Calculate upon referring to the selection calculation formula example.) **According to the above contents, shock absorber shall be temporarily selected.**
	5. Decision of stroke ↓	● Decide stroke S (m) to be absorbed by shock absorber.
	6. Calculation of energy by driving force	● Compute energy E_1 (J) by driving force. (Calculate upon referring to the selection calculation examples.)
	7. Calculation of total energy and selection of shock absorber ↓	● Compute the total energy E_T (J) with energy E_1 (J) by the driving force computed in item 6 added to motion energy E_K (J) computed in item 3 in case that it is accompanied by gravity (fall) or driving force F (N) of cylinder. $E_1 = F \cdot S$ $E_T = \frac{(E_K + E_1)}{N} \leq E \cdot \frac{S}{St}$ After the total energy E_T selects shock absorber included in the range of max. energy E (specifications of series), check of next items 8・9・10 shall be conducted.
Confirmation Contents	8. Check of max. energy capacity per min. ↓	● After computing energy per minute (E_T・C) from operating cycle C (cycle / min) and total energy E_T (J), it shall be confirmed that it is in the range of specifications. Max. operating cycle (cycle / min) shall be set within the applications of series. $E_2 = \frac{(82.2\text{-} T)}{55.5} \times$ (Max. energy capacity per minute in table) $E_2 = E_T \cdot C$ C : Operating cycle (cycle / min)
	9. Check of equivalent weight range ↓	● When additional energy resulting from gravity or driving force F is added, it shall be confirmed by total energy E_T that the equivalent weight range is within the range. $Meq = \frac{2E_T}{V^2}$ Meq ≦ (Equivalent weight range in table) Meq : Equivalent weight range In case of pure inertia motion, it is Meq = M (Impact loads weight)
	10. Check of operating temperature	● It shall be within the operating temperature range.
	11. Inquiry item	● In case that the total energy E_T is set in the allowable value of max. absorption energy, and that the operating cycle (cycle / mm)・impact speed V (m / s) exceed the allowable value, contact us.

5. PRECAUTIONS FOR SELECTION

1) For selecting the style of shock absorber, three items, max. weight, max. speed and max. driving force, shall be fully studied.
 a) As to the max. weight, the accurate numerical value shall be computed by the actual measurement or calculation of article.
 b) The speed is computed by the actual measurement or calculation, but it is not the average speed. It shall be calculated by the instantaneous speed when it collides with bamper cap of rod end.
 c) The driving force to be used for calculation shall be calculated for decision by using the max. value of driving force from the collision of objects with bamper cap to the suspension.
 For instance, the driving force in case of the actuation of hydraulic, pneumatic cylinder becomes the max. driving force when it suspends. Then, it is calculated with this driving force. As to the pressure, it shall be calculated with control pressure instead of working pressure of cylinder. In case of motor driving, (150% to 250% of driving power is taken for motor suspension torque as shown in the following figure). In case that it is on rail, it shall be checked according to the following item 4).

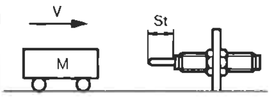
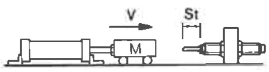
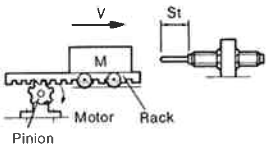
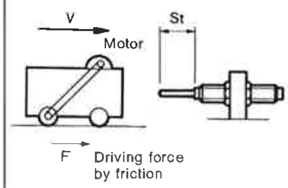


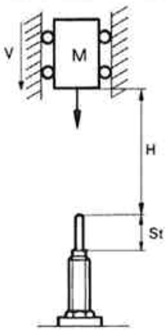
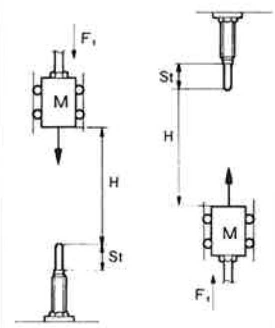
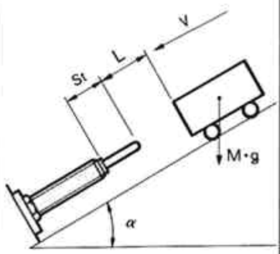
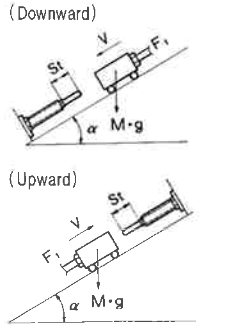
2) For total energy, the calculation formula of (kinetic energy) +(driving energy) is applied. In case that the driving force is affected by gravity, the positional energy is added or reduced for driving energy. So, enough check is necessitated.
3) In case of accurate conductive driving by gear, the rotary inertia of motor shall also be taken into consideration. When motor is used for driving or in case that there is the rotary object such as gear clutch and brake, the rotary motion energy shall be separately computed and then added to the total energy.
4) In case of the device for conducting the power with frictional force, both the frictional force and driving shall be calculated, and the smaller force shall be used as the driving force.
5) In case of the balance weight mechanism, it shall be calculated with the balance weight taken into consideration. In case that loads are suspended by shock absorber, the shock absorber shall be mounted in direction that the rope of balance weight is not loosened.
6) It shall be fully noted that there are many cases, in which it is forgot that energy is included in total energy after enough investigation. The energy is given to shock absorber by gravity in case that the rotary shaft is horizontal and that load is unbalanced.
7) Shock absorber shall be mounted so that it horizontally collides in the rod shaft direction. In case of the declination, the impact angle shall be set at less than ±2.9.
8) Do not conduct the parallel use of the adjustable type shock absorber.
9) Do not use in such environment that cutting oil is adhered to piston rod.
10) For the use of DYNASOFTER, the auxiliary oil tank shall be used in case that the use frequency is over one time per minute.

OUTLINE

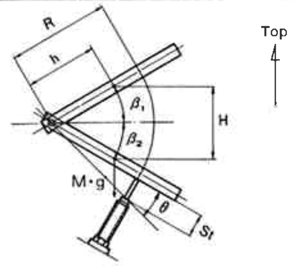
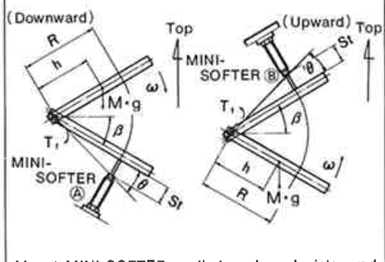
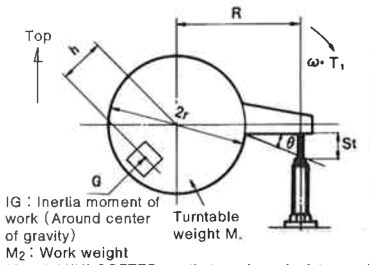
6. SELECTION CALCULATING FORMULA EXAMPLES

(For examples, it is calculated with total stroke St(m). But calculate with absorption stroke S(m)in case that full stroke is not applied by mounting the external stopper.)

	Horizontal impact			
	Simple horizontal impact	Push by cylinder	Truck driven by motor	Truck driven by frictional conduction
Impact example			Power transmitted without slide by rack, pinion or chain  Note : 2.5 is ratio of stop torque against rated torque. Calculate with numerical value if numerical value is clear.	 Note 1 : 0.25 is frictional coefficient. Calculate with numerical value if numerical value is clear. Note 2 : 2.5 is ratio of stop torque against rated torque. Calculate with numerical value if numerical value is clear.
Impact weight (kg)	M	M	M	M
Impact speed (m/s)	V	V	V	V
Kinetic energy (J)	$E_K=0.5\cdot M\cdot V^2$	$E_K=0.5\cdot M\cdot V^2$	$E_K=0.5\cdot M\cdot V^2$	$E_K=0.5\cdot M\cdot V^2$
Driving force (N)	———	Cylinder output $F=F_1=\frac{\pi}{4}\cdot D^2\cdot P\cdot 10^6$	$F=F_1=\frac{K_W\cdot 2.5(\text{Note})}{V}\times 10^3$	$F=F_1=0.25\cdot Mg\cdot\frac{N_2}{N_1}$ (Note1) $F=F_1=\frac{K_W\cdot 2.5(\text{Note2})}{V}\times 10^3$ Smaller one
Energy by driving force (J)	———	$E_1=F\cdot St$	$E_1=F\cdot St$	$E_1=F\cdot St$
Total energy (J)	$E_T=\frac{E_K}{N}$	$E_T=\frac{(E_K+E_1)}{N}$	$E_T=\frac{(E_K+E_1)}{N}$	$E_T=\frac{(E_K+E_1)}{N}$

	Upward, downward direction		Movement along slant face	
	Free drop	Up, down by driving force (cylinder, etc.)	Free drop	Up, down by driving force (cylinder, etc.)
Impact example				
Impact weight (kg)	M	M	M	M
Impact speed (m/s)	$V=\sqrt{19.6\cdot H}$	V	$V=\sqrt{19.6\cdot L\cdot \sin\alpha}$	V
Kinetic energy (J)	$E_K=M\cdot g\cdot H$	$E_K=0.5\cdot M\cdot V^2$	$E_K=M\cdot g\cdot L\cdot \sin\alpha$	$E_K=0.5\cdot M\cdot V^2$
Driving force (N)	$F=M\cdot g$	$F=F_1+M\cdot g$(Downward) $F=F_1-M\cdot g$(Upward)	$F=M\cdot g\cdot \sin\alpha$	$F=F_1+M\cdot g\cdot \sin\alpha$ (Downward) $F=F_1-M\cdot g\cdot \sin\alpha$ (Upward)
Energy by driving force (J)	$E_1=M\cdot g\cdot St$	$E_1=F\cdot St$	$E_1=F\cdot St$	$E_1=F\cdot St$
Total energy (J)	$E_T=\frac{(E_K+E_1)}{N}$	$E_T=\frac{(E_K+E_1)}{N}$	$E_T=\frac{(E_K+E_1)}{N}$	$E_T=\frac{(E_K+E_1)}{N}$

SELECTION CALCULATING FORMULA EXAMPLES

	Oscillation movement		
	Free drop (Up, down direction)	Drive by mototr (Up, down direction)	Turntable (Horizontal direction)
Impact example	 Mount MINI-SOFTER so that work and piston rod form right angle at 1/2 stroke point. Formula : $\frac{\theta}{2}=\frac{St}{2\cdot R}<0.05$rad. In case of $\frac{\theta}{2}>0.05$rad, guide shall be applied.	 Mount MINI-SOFTER so that work and piston rod form right angle at 1/2 stroke point. Formula : $\frac{\theta}{2}=\frac{St}{2\cdot R}<0.05$rad. In case of $\frac{\theta}{2}>0.05$rad, guide shall be applied.	 Mount MINI-SOFTER so that work and piston rod form right angle at 1/2 stroke point. Formula : $\frac{\theta}{2}=\frac{St}{2\cdot R}<0.05$rad. In case of $\frac{\theta}{2}>0.05$rad, guide shall be applied.
Impact weight (kg)	M	M	$M=M_1+M_2$
Impact speed (m/s)	$V=R\cdot\sqrt{\frac{2\cdot M\cdot g\cdot h(\sin\beta_1+\sin\beta_2)}{I}}$	$V=R\cdot\omega$	$V=R\cdot\omega$
Kinetic energy (J)	$E_K=M\cdot g\cdot H$	$E_K=\frac{1}{2}\cdot I\cdot\omega^2$	$E_K=\frac{1}{2}\cdot\left(\frac{M_1\cdot r^2}{2}+I_G+M_2\cdot h^2\right)\cdot\omega^2$
Driving force (N)	$F=M\cdot g\cdot\frac{h}{R}\cdot\cos\beta_2$	$F=\frac{T_1}{R}+\frac{M\cdot g\cdot h}{R}\cdot\cos\beta$ (Downward) $F=\frac{T_1}{R}-\frac{M\cdot g\cdot h}{R}\cdot\cos\beta$ (Upward)	$F=\frac{T_1}{R}$
Energy by driving force (J)	$E_1=F\cdot St$	$E_1=F\cdot St$	$E_1=F\cdot St$
Total energy (J)	$E_T=\frac{(E_K+E_1)}{N}$	$E_T=\frac{(E_K+E_1)}{N}$	$E_T=\frac{(E_K+E_1)}{N}$

SYMBOL EXPLANATION

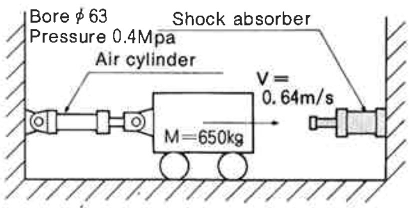
Symbol	Unit	Description	Symbol	Unit	Description
E	J	Allowable energy absorption	α	rad	Angle of slant face
E_T	J	Total energy (per Shock Absorber)	β	rad	Angle of rotating body
E_K	J	Kinetic energy	θ	rad	$\theta=\frac{S_1}{R}$ Oscillating angle of Shock Absorber stroke
E_1	J	Energy of driving force or torpue	R	m	Distance from rotation center to impact point
E_2	J/min	Max. energy capacity per min.	r	m	Turntable radius
P	MPa	Driving cylinder control pressure	h	m	Distance from rotation center to center of gravity
D	m	Driving cylinder bore	※2T	N·m	Torque applied to Shock Absorber (Calculate at max. value in case of modification of T.)
M	kg	Impact weight (Calculate at max. value in case of modification of M.)	T_1	N·m	Driving torque (Calculate with stop torque for motor.)
V	m/s	Impact speed (Calculate at max. value in case of modification of V.)	ω	rad/s	Angle speed (Calculate at max. value in case of modification of ω.)
※1F	N	Driving force on Shock Absorber (Calculate at max. value in case of modification of F.)	I	$kg\cdot m^2$	Inertia moment around rotation shaft
F_1	N	Driving force (Calculate at max. value in case of modification of F_1.)	I_G	$kg\cdot m^2$	Inertia moment around center of gravity
S	m	Shock Absorber stroke absorption	N	number	Number of Shock Absorber
St	m	Shock Absorber total stroke	kw	kw	Motor capacity
H	m	Height of drop	N_1		Total number of wheels
L	m	Moving distance when dropping on slant face.	N_2		Number of driving wheels
g	m/s^2	Gravity acceleration 9.8m/s^2	G		Indicate center of gravity position.

※1 External force, tare of cylinder are included.
※2 Torques by motor and tare are included.

7. CALCULATION EXAMPLES

1. Driving Motion By CYL Driving Force

Examples



S/A is applied to stopper of A.T.C of machining center.

Spec.

Impact loads total weight	M=650kg	
Impact speed	V=0.64m/S	
Use frequency	C=1cycle/min	
Ambient temp.	T=0℃~25℃	
Driving force	F=By AIR CYL	(CYL size ϕ63×780St
Q'ty	N=1 pc	Air pressure 0.4Mpa)

Calculation Examples

As it is the driving motion by air cylinder, the selection of S/A is conducted by kinetic energy and driving energy.

1) Compute kinetic energy

$E_K=0.5MV^2=0.5\times650\times0.64^2=133J$

2) Compute driving energy

$E_1=F\cdot St$

For computing the driving energy, it is necessary to set St. after selecting temporarily the type of S/A to be applied.

As the selecting condition, larger absorption enegy capacity than kinetic energy computed in Item 1) is needed. Then, ASE-06-24 is tentatively selected from catalog. Accordingly, St. is 63.5mm.

$$E_1=\frac{\pi\cdot D^2}{4}\times P\times St$$

$$=\frac{3.14\times0.063^2}{4}\times0.4\times10^6\times0.0635$$

$$=79.1J$$

3) Total energy is computed.

$E_T=E_K+E_1=133+79.1=212J$

4) Check of use

It shall be confirmed that whether shock absorber selected in 2) can be used or not.

4)−1 Confirmation by absorption energy quantity

Because AS∗-06-24 max. absorption energy is 353J, it is $E_T<353J$ and can be used.

4)−2 Confirmation by equivalent weight

$$M_{eq}=\frac{2E_T}{V^2}=\frac{2\times212}{0.64^2}=1040kg$$

As the equivalent weight range of AS∗-06-24 is 11kg ~ 11000kg,it is usable.

4)−3 Confirmation of max. energy capacity per minute

$$E_2=\frac{82.2-T}{55.5}\times(\text{ Max. energy per minute in table })$$

$E_2\geqq E_T\cdot C$

$$E_2=\frac{82.2-25}{55.5}\times1330=1370J/min$$

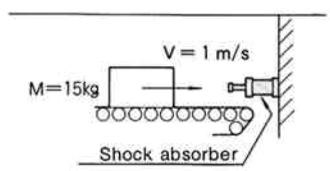
$E_T\cdot C=212\times1=212<E_2$

Accordingly, it is usable.

But, as the frequency is 1 min^{-1}, the use of auxiliary oil tank is recommended.

2. Driving Motion By Free Flow Conveyor

Examples



S/A is applied to stopper of work on conveyor.

Spec.

Impact loads total weight	M=15kg
Impact speed	V=0.7m/s
Conveyor driving force	F=49.0N
Use frequency	C=10cycle/min
Ambient temp.	T=25℃
Q'ty	N=1 pc

Calculation Examples

As it is the driving motion by conveyor driving, shock absorber is selected from the kinetic energy and driving energy.

1) Compute kinetic energy

$E_K=0.5MV^2=0.5\times15\times0.7^2=3.68J$

2) Compute driving energy

In case that load is moved by friction force, both the friction force and conveyor driving force are computed, and it is calaculated with smaller one as driving force.

With friction coefficient as 0.2, friction force$=15\times9.8\times0.2=29.4N<49N$

Then, friction force is adopted as driving force.

Accordingly, energy by driving force is $E_1=F-St$.

With kinetic energy computed in 1) as reference, shock absorber is temporarily selected, and St is decided. From catalog, W-A2M12 of absorption energy 4.90J is selected.

Accordingly, St. is 10mm.

$E_1=29.4\times0.01=0.294J$

3) Total energy is computed.

$E_T=E_K+E_1=3.68+0.294=3.97J$

4) Check of use

It is confirmed that whether shock absorber selected in 2) can be used or not.

4)−1 Confirmation by absorption energy quantity

With the absorption energy of W-A2M12 set as 4.90J, then

$E_T=3.97<4.90J$

Accordingly, it is usable.

4)−2 Confirmation by equivalent load

$$M_{eq}=\frac{2E_T}{V^2}=\frac{2\times3.97}{0.7^2}=16.2<30kg$$

Accordingly, it is usable.

4)−3 Confirmation by max. energy quantity per minute

$$E_2=\frac{82.2-T}{55.5}\times(\text{ Max. energy per minute in table })$$

$E_2\geqq E_T\cdot C$

$$E_2=\frac{82.2-25}{55.5}\times98.1=101J/min$$

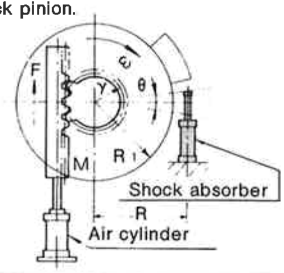
$E_T\cdot C=3.97\times10=39.7J/min<E_2$

Accordingly, it is usable.

3. Rotary Motion

Examples

Shock absorber is used as stopper of turntable with the combination of air cylinder and rack pinion.



Spec.

Table weight	M = 50kg
Table radius	R_1 = 0.6m
Pinion radius	r = 0.1m
Cylinder driving force	F = 620N
Cylinder speed	V_c = 0.2m/s
Distance from rotation center to S/A	R = 0.7m
Use frequency	C = 12cycle/min
Ambient temp.	T = 25℃
Q'ty	N = 1 pc

Calculation Examples

1) Compute kinetic energy.

$$E_K=\frac{1}{2}I\omega^2=\frac{1}{2}M\cdot\frac{R_1^2}{2}\cdot\left(\frac{V_c}{r}\right)^2$$

$$=\frac{1}{2}\times50\times\frac{0.6^2}{2}\times\left(\frac{0.2}{0.1}\right)^2=18J$$

$$\left(I=M\cdot\frac{R_1^2}{2},\quad \omega=\frac{V_c}{r}\right)$$

2) Compute driving energy.

$$E_1=T\cdot\theta$$

$$=F\cdot r\cdot\frac{St}{R}$$

With kinetic energy computed in 1) as reference, shock absorber is temporarlly selected and St is decided.
According to catalog, W-A2M20 of absorption energy 29.4J is selected. Accordingly, St. is 16㎜.

$$E_1=620\times0.1\times\frac{0.016}{0.7}=1.42J$$

3) Compute total energy

$$E_T=E_K+E_1=18.0+1.42=19.4J$$

4) Check of use

It shall be confirmed that whether shock absorber selected temporarily in 2) can be used or not.

4)−1 Confirmation by absorption energy

As the absorption energy of W-A2M20 is 29.4 J ,

$$E_T=19.4<29.4$$

Accordingly, it is usable.

4)−2 Confirmation by equivalent load

$$M_{eq}=\frac{2E_T}{V^2}=\frac{2\times19.4}{1.4^2}$$

$$\left(\text{Impact speed V against S/A}\quad V=0.2\times\frac{R}{r}=0.2\times\frac{0.7}{0.1}=1.4m/s\right)$$

$$=19.8kg<200kg$$ Accordingly, it is usable.

4)−3

$$E_2=\frac{82.2-T}{55.5}\times(\text{Max. energy per minute in table})$$

$$E_2\geqq E_T\cdot C$$

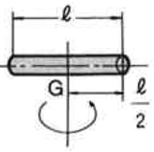
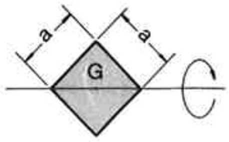
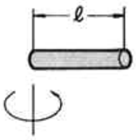
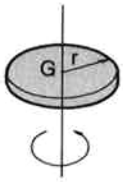
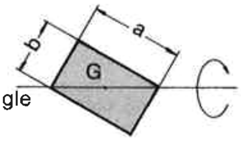
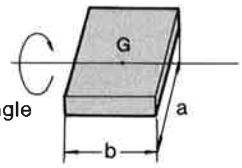
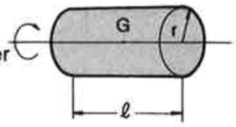
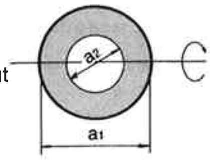
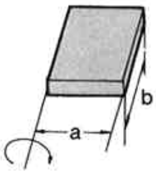
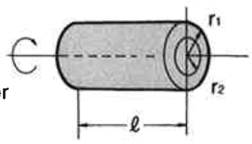
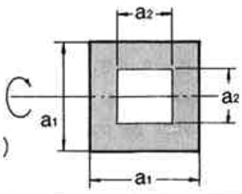
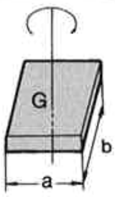
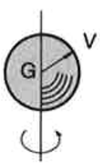
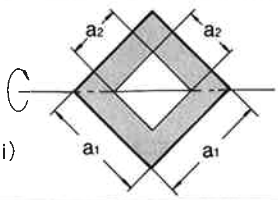
$$E=\frac{82.2-25}{55.5}\times343=354J/min$$

$$E_T\cdot C=19.4\times12=233J/min<E_2$$

Accordingly, it is usable.

OUTLINE

8. MOMENT OF INERTIA

Shape	Thin rod 	Thin disc 	Thin square 
Rotating axis	Vertical to rod, pass center of gravity	Parallel to face, pass center of gravity	Axis passing center of gravity, opposite angle
Moment of inertia	$M\cdot\frac{\ell^2}{12}$	$M\cdot\frac{r^2}{4}$	$M\cdot\frac{a^2}{12}$
Shape	Thin rod 	Thin disc 	Thin rectangle 
Rotating axis	Vertical rod, one end	Vertical to face, pass center of gravity	Parallel to face, Axis pass center of gravity
Moment of inertia	$M\cdot\frac{\ell^2}{3}$	$M\cdot\frac{r^2}{2}$	$M\cdot\frac{b^2 a^2}{6(b^2+a^2)}$
Shape	Thin rectangle 	Cylinder 	Thin doughnut shape 
Rotating axis	Parallel to side b, pass center of gravity	Center axis passing center of gravity	Parallel to face, Axis pass center axis
Moment of inertia	$M\cdot\frac{a^2}{12}$	$M\cdot\frac{r^2}{2}$	$M\cdot\frac{(a_1{}^2+a_2{}^2)}{16}$
Shape	Thin rectangle 	Hollow Cylinder 	Square frame shape(i) 
Rotating axis	Parallel to side b, end face	Center axis passing concentricity	Parallel to face, Axis pass center axis
Moment of inertia	$M\cdot\frac{a^2}{3}$	$M\cdot\frac{r_1{}^2+r_2{}^2}{2}$	$M\cdot\frac{(a_1{}^2+a_2{}^2)}{12}$
Shape	Rectangle 	Ball (Complete) 	Square frame shape(ii) 
Rotating axis	Vertical to face, pass center of gravity	Axis passing center of gravity	Parallel to face, Pass opposite angle
Moment of inertia	$M\cdot\frac{a^2+b^2}{12}$	$M\cdot\frac{2r^2}{5}$	$M\cdot\frac{(a_1{}^2+a_2{}^2)}{12}$

9. TABLE OF PNEUMATIC CYLINDER DRIVING FORCE, ENERGY

Cylinder bore D(mm)	Push side Cylinder driving force F(N)	Pressure P (MPa)	Energy by driving force E, (J)=F·St MINI-SOFTER absorption stroke St						
			8(mm)	10(mm)	12(mm)	15(mm)	16(mm)	25(mm)	25.4(mm)
ϕ12	33.9	0.3	0.271	0.339	0.407	0.509	0.542	0.848	0.861
	56.5	0.5	0.452	0.565	0.678	0.848	0.904	1.41	1.44
	79.2	0.7	0.634	0.792	0.950	1.19	1.27	1.98	2.01
ϕ16	60.3	0.3	0.482	0.603	0.724	0.905	0.965	1.51	1.53
	101	0.5	0.808	1.01	1.21	1.52	1.62	2.53	2.57
	141	0.7	1.13	1.41	1.69	2.12	2.26	3.53	3.58
ϕ20	94.2	0.3	0.754	0.942	1.13	1.41	1.51	2.36	2.39
	157	0.5	1.26	1.57	1.88	2.36	2.51	3.93	3.99
	220	0.7	1.76	2.20	2.64	3.30	3.52	5.50	5.59
ϕ25	147	0.3	1.18	1.47	1.76	2.21	2.35	3.68	3.73
	245	0.5	1.96	2.45	2.94	3.68	3.92	6.13	6.22
	344	0.7	2.75	3.44	4.13	5.16	5.50	8.60	8.74
ϕ32	241	0.3	1.93	2.41	2.88	3.60	3.84	6.00	6.10
	402	0.5	3.21	4.01	4.81	6.02	6.42	10.0	10.2
	563	0.7	4.49	5.61	6.73	8.42	8.98	14.0	14.2
ϕ40	377	0.3	3.02	3.78	4.54	5.67	6.05	9.45	9.60
	628	0.5	5.04	6.30	7.56	9.45	10.1	15.8	16.0
	880	0.7	7.06	8.82	10.6	13.2	14.1	22.1	22.4
ϕ50	589	0.3	4.70	5.88	7.06	8.82	9.41	14.7	14.9
	982	0.5	7.84	9.80	11.8	14.7	15.7	24.7	24.9
	1374	0.7	11.0	13.7	16.4	20.6	21.9	34.3	34.8
ϕ63	935	0.3	7.51	9.39	11.3	14.1	15.0	23.5	23.9
	1560	0.5	12.6	15.7	18.8	23.6	25.1	39.3	39.9
	2180	0.7	17.5	21.9	26.3	32.9	35.0	54.8	55.6
ϕ80	1510	0.3	12.1	15.1	18.1	22.7	24.2	37.8	38.4
	2510	0.5	20.1	25.1	30.1	37.7	40.2	62.8	63.8
	3520	0.7	28.1	35.1	42.1	52.7	56.2	88.0	89.2

OUTLINE

SIMPLE SELECTION TABLE BY PNEUMATIC CYLINDER DRIVING FORCE

Way of Looking At Table

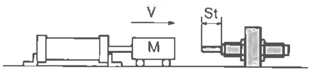
It is the table for simple selection of shock absorber by pneumatic cylinder driving force. By confirming the cylinder bore, impact loads weight M, impact speed V, the type of shock absorber can be selected from the table.

According to the use conditions, the intersecting point of impact loads weight M (horizontal axis) and impact speed V (vertical axis) is computed, and then shock absorber in the intersecting point area is selected.

The point on border line of area indicates the use limit point of shock absorber in the area.

Shock Absorber Use Conditions

- Air Cylinder Horizontal Side Push



- Kinetic Energy

  $E_k = 0.5MV^2$

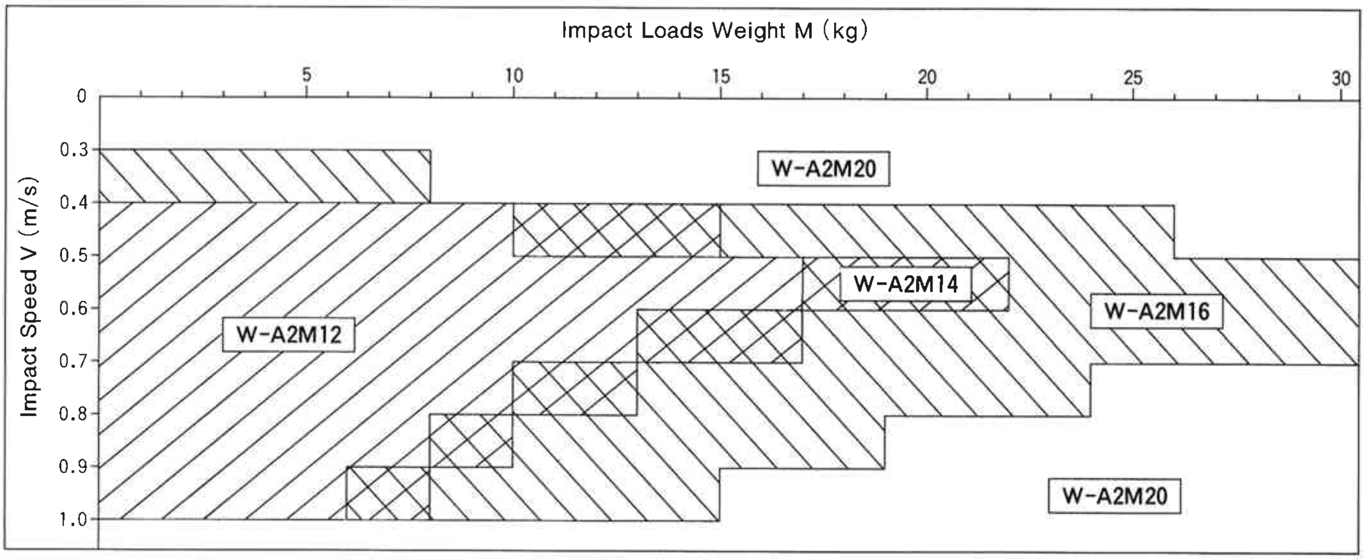
- Driving Energy

  $E_1 = \frac{\pi \cdot D^2}{4} \times P \times 10^6 \times \text{Stroke}$

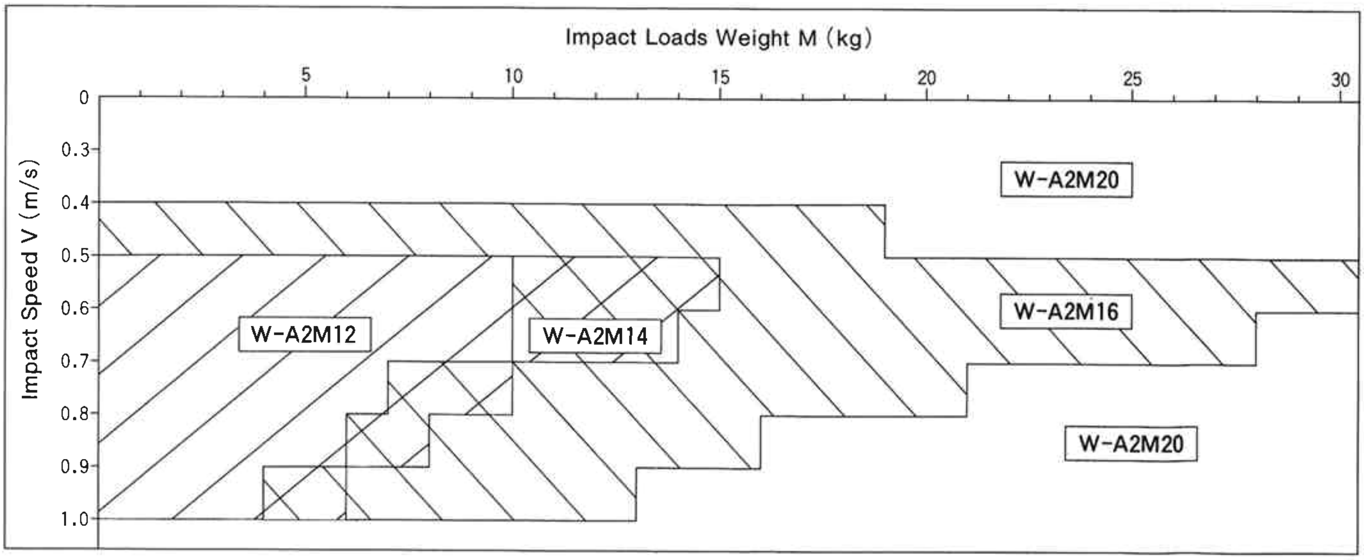
- Total Energy

  $E_T = E_K + E_1$

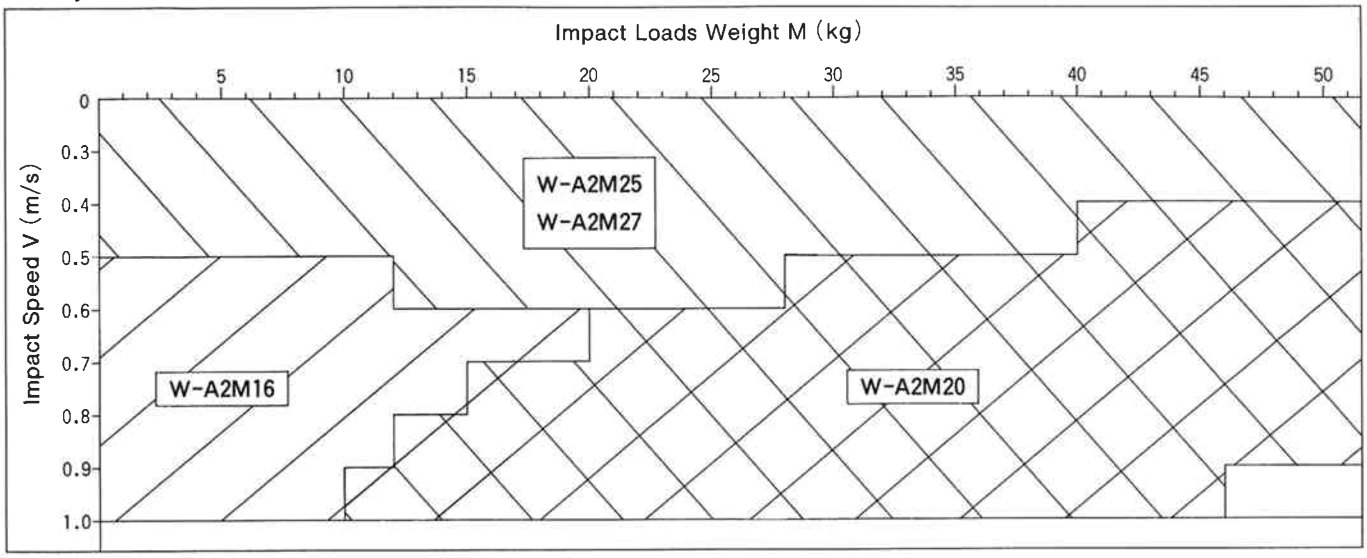
For Cylinder Bore ϕ20



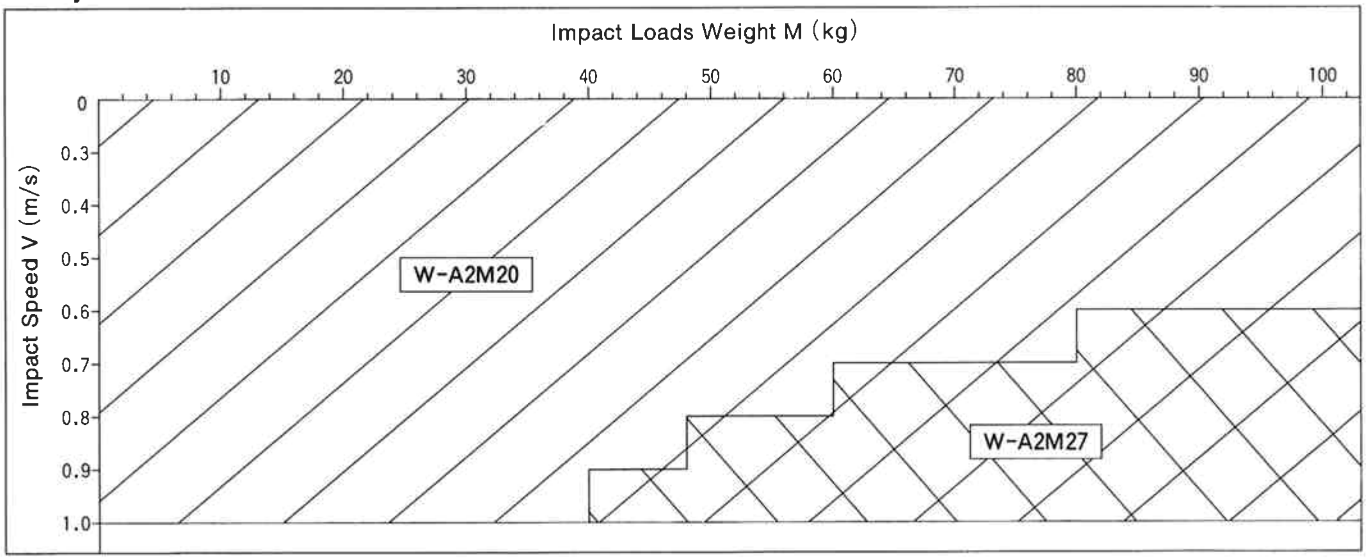
For Cylinder Bore ϕ25



For Cylinder Bore ϕ32

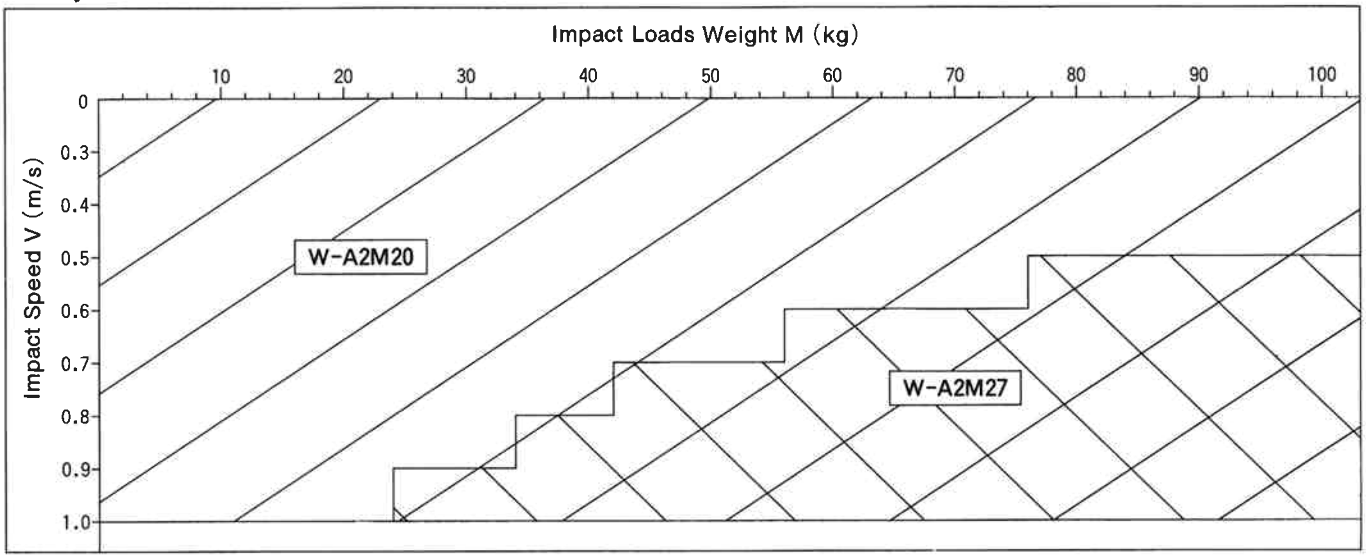


For Cylinder Bore ϕ40



OUTLINE

For Cylinder Bore ϕ50



For Cylinder Bore ϕ63