Data Sheet

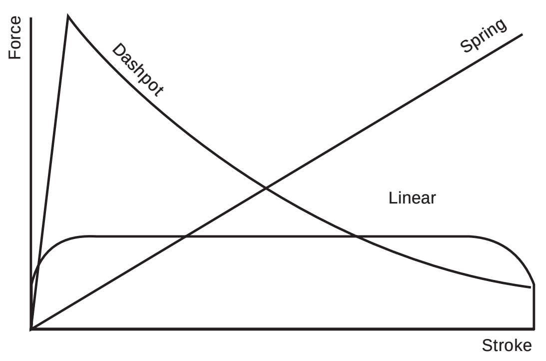
Industrial shock absorbers (linear decelerators)

Introduction

Springs and buffers cannot match the performance of linear decelerators (the correct name for industrial shock absorbers). A decelerator acts just like your hand does when you catch a ball. The linear deceleration characteristics match the speed and mass of the moving object and brings it smoothly to rest. The energy is released harmlessly, mostly as heat.

Springs and buffers act differently. They store energy rather than dissipate. So although they stop the moving object, it bounces back. Dashpots when misused are not much better. Their peak resistance comes at the beginning of the stroke, and then falls away quickly. This causes greater resisting forces than necessary.

Figure 1



Principles of operation

Virtually all manufacturing processes involve movement of some kind. In production machinery this can involve linear transfers, rotary index motions, fast feeds, etc. At some point these motions change direction or come to a stop.

Any moving object possesses kinetic energy as a result of its motion and if the object changes direction or is brought to rest, the dissipation of the kinetic energy can result in destructive shock forces within the structural and operating members of the machine or equipment.

Kinetic energy increases with the square of the speed and as operating speeds rise under continual demand for higher productivity, shock damage to equipment becomes an increasingly serious problem, resulting in costly downtime and loss of production.

An increase in production rates is therefore only possible by dissipating kinetic energy and thereby eliminating the destructive deceleration forces.

Kinetic energy can be dissipated by using friction, as in a car whose energy is changed into heat energy by friction at its brake surfaces.

It can also be dissipated by mechanically deforming another object such as a spring or rubber bumper. In practice such devices are unsatisfactory as they only store energy and bounce it back into the system causing fatigue and premature structural failure.

Another device which is often misapplied in energy dissipation is the dashpot or cylinder cushion. The true function of a dashpot is to provide a constant velocity to a moving part and if used to absorb energy it gives rise to high force peaks at the beginning of its stroke.

Most common energy absorbing devices contribute to shock rather than reduce it because they do not dissipate kinetic energy at a uniform rate.

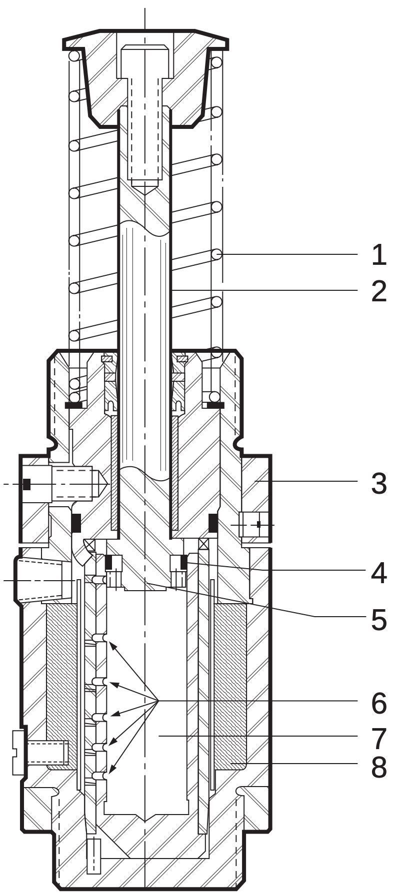
Due to this non-linear deceleration the object being stopped is subjected to destructively high force levels (shock) either at the beginning or the end of the deceleration stroke.

The ideal solution for this problem is achieved when the energy of the object is linearly absorbed.

That means the required deceleration force is evenly distributed over the entire stroke length to give constant or linear deceleration.

Shock absorbers stop moving objects safely and effectively, without shock, by achieving controlled linear deceleration.

Figure 2



Linear decelerators (shock absorbers) are virtually maintenance free, self contained hydraulic devices with a series of adjustable orifices.

On impact the piston rod is pushed into the shock absorber. The hydraulic fluid situated in front of the piston (5) is initially displaced through all the orifices (6) resulting in smooth pick up of the moving load. As the piston moves down its stroke the orifices are progressively closed off gradually slowing the moving object down to rest.

Due to the specific spacing of the orifices the pressure generated in front of the piston remains constant throughout the entire stroke as the velocity is reduced to zero. Consequently the resisting force remains constant and uniform or linear deceleration is achieved.

An external adjusting ring (3) is used to regulate the orifice sizes enabling perfect deceleration to be achieved with varying loads and speeds and propelling forces. The displaced hydraulic fluid is stored in an internal accumulator containing closed cell elastomer foam (8). A non-return valve (4) built into the piston head and the return spring (1) enable a quick reset ready for the next cycle.

ACE linear decelerators (shock absorbers) bring a moving load smoothly to rest with the lowest possible force in the shortest possible time. The massively constructed outer body, large area bearing surfaces and minimum seals coupled with painstaking quality control assure a long and trouble free working life.

- Increase production rates
- Extend machine life
- Reduce construction costs
- Reduce maintenance
- Reduce noise pollution.

Security

Industrial shock absorbers and automobile braking system have two crucial functional similarities.

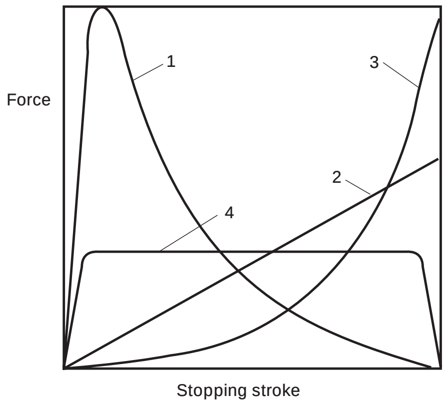
1. Both should bring a moving mass quickly and safely to rest without any recoil or ‘bounce back’.
2. Both must never suddenly fail without warning.

If an automobile braking system ever failed suddenly without warning it would almost certainly result in a serious vehicle accident. If an industrial shock absorber failed suddenly it could cause serious damage to the machine it was installed on. In many cases this could result in a complete production line being stopped with resultant enormous downtime costs.

Some shock absorber manufacturers use tube stock to make their absorber bodies and inner pressure tube. These tubes are then sealed by an end plug held in with retaining rings or circlips and seated by elastomer ‘O’ rings or similar. Under overload conditions the circlip or seals can fail or be extruded causing sudden and catastrophic failure of the shock absorber.

In contrast **RS** offer ACE shock absorber bodies and inner pressure chambers which are fully machined from solid high tensile alloy steel. This gives a completely closed end one piece pressure chamber with no seals or circlips being necessary. The advantage of this design concept is that the ACE shock absorber is able to withstand much higher internal pressures or overload without damage giving a very high safety margin. The chance of a sudden failure due to over- load etc. is effectively ruled out.

Figure 3 **Reaction force-energy capacity-stopping time comparison with other damping systems**

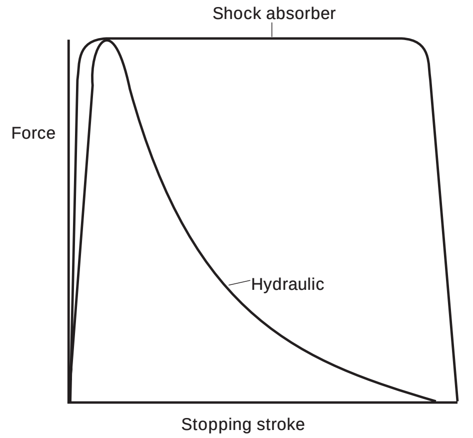


1. **Hydraulic dashpot (high stopping force at start of the stroke).** With only one metering orifice the moving load is abruptly slowed down at the start of the stroke. The braking force rises to a very high peak at the start of the stroke (giving high shock loads) and then falls away rapidly.

   The majority of the energy is absorbed at the start of the stroke.

2. **Springs and rubber buffers (high stopping force at end of stroke).** These have an increasing force characteristic, becoming a solid stop at full compression. Also they store energy rather than dissipating it, causing the load to rebound back again.
3. **Air buffers, pneumatic cylinder cushions (high stopping force at end of stroke).** Due to the compressibility of air these have a sharply rising force characteristic towards the end of the stroke. The majority of the energy is absorbed near the end of the stroke.
4. **RS industrial shock absorbers (uniform stopping force through the entire stroke).** The moving load is smoothly and gently brought to rest by a constant resisting force throughout the entire shock absorber stroke. The load is decelerated with the lowest possible force in the shortest possible time eliminating damaging force peaks and shock damage to machines and equipment. This is a linear deceleration force stroke curve and is the curve provided by **RS** shock absorbers.

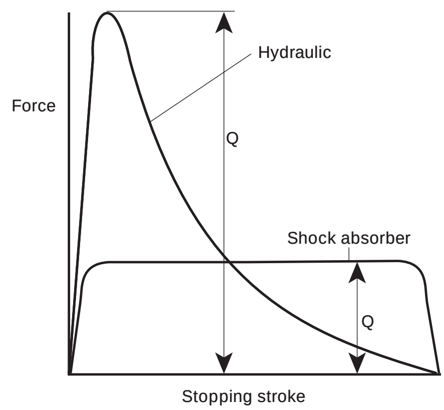
Figure 4 **Energy capacity**



With the same stroke and the same reaction force it is possible to absorb several times as much energy with the shock absorber. (Energy capacity is represented by the area under the curves).

Result: By installing a shock absorber production rates can be more than doubled without increasing deceleration forces or loads on the machine.

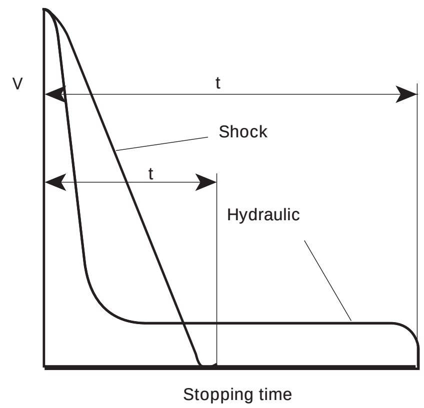
Figure 5 **Reaction force (stopping force)**



Both devices are stopping the same mass at the same impact velocity and in the same stroke length. Therefore they are both absorbing the same energy (area under the curves).

Result: The peak stopping force of a hydraulic dashpot occurs at the beginning of the stroke and is many times higher than with a shock absorber that can absorb the same amount of energy with less than half the force, machine wear and maintenance is thus drastically reduced.

Figure 6 **Stopping time**



Both devices are stopping the same mass at the same impact velocity and in the same stroke length. Therefore they are both absorbing the same energy.

Result: The shock absorber stops a moving load of the same kinetic energy in a third of the time of a dashpot or cylinder cushion. As a result cycle times are reduced giving higher production rates.

Adjustable shock absorbers

The adjustable shock absorber offers flexibility in application design and selection procedure. With the widest range of effective weight, one model can cover many applications. By simply ‘tuning in’ another orifice when an effective weight change is necessary, the total orifice area changes, providing the required constant internal pressure.

Self-compensating shock absorbers

In cases where non-adjustability is beneficial but the features of an adjustable shock absorber are required, self-compensating models meet both needs. With a wide range of effective weight, a self-compensating shock absorber will provide acceptable deceleration despite changing energy conditions.

The orifice profile, designed by a computer that constantly arranges the size and location of each orifice while inputting changing effective weights, neutralises the effect of changing fluid coefficients, weight, velocity, temperature and fluid compressibility.

A linear decelerator by definition decelerates a moving weight at a linear or constant rate of deceleration. The adjustable shock absorber is able to provide linear deceleration when operated within its energy capacity and effective weight range by dialling in the required orifice area. The resulting force-stroke curve (figure 7) shows the optimum (lowest) stopping force

Figure 7

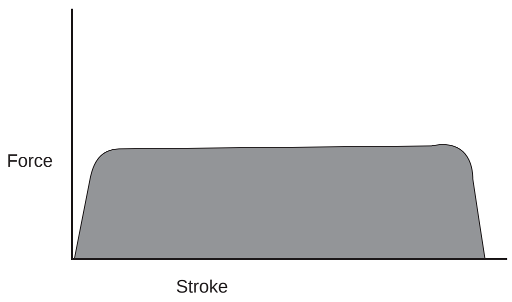
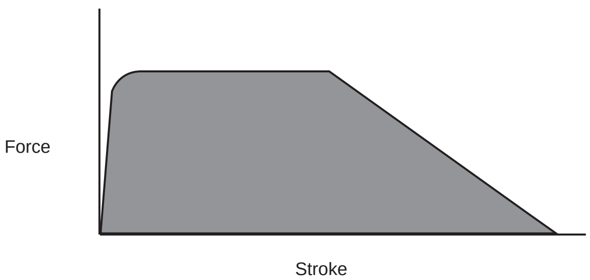


Figure 8 shows the force-stroke curve of a self-compensating shock absorber stopping a weight at the low end of its effective weight range. Note how the reaction forces are no longer constant but are still acceptable. The curve is skewed slightly higher at the beginning of the stroke and dips lower at the end.

Figure 8



A force-stroke curve of the same self-compensating shock absorber,but at the high end of its effective weight range, is shown in figure 9. The energy curve is now skewed upward at the end of stroke and still yields acceptable deceleration.

Figure 9

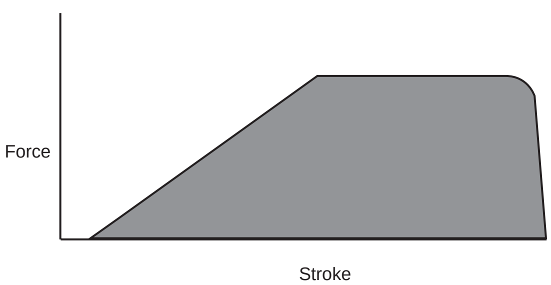
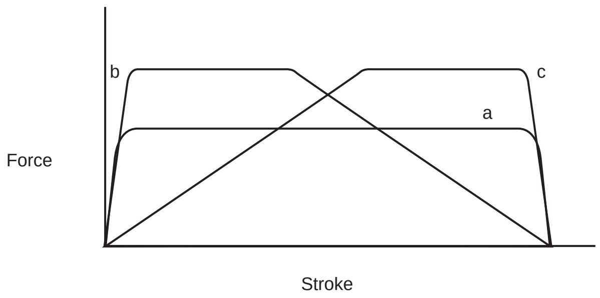


Figure 10 shows a family of force-stroke curves:

a) Adjustable shock absorber properly tuned.
b) Self-compensating shock absorber at the low end of its effective weight range.
c) Self-compensating shock absorber at the high end of its effective weight.

Figure 10



Effective weight

Effective weight is an important factor in selecting shock absorbers. A shock absorber ‘sees’ the impact of an object in terms of weight and velocity only; it does not ‘see’ any propelling force. The effective weight can be thought of as the weight that the shock absorber ‘sees’ on impact. Effective weight includes the effect of the propelling force on the performance of the shock absorber.

Failing to consider the effective weight may result in improper selection and poor performance of a shock absorber. Under extreme conditions an effective weight that is too low for the shock absorber may result in high forces at the start of stroke (high on-set force). Conversely an effective weight that is too high for the shock absorber may cause high forces at the end of stroke (high set-down force).

Consider the following examples:-

1. A mass of 3kg travelling at 6 metres per second has 54 Newton meters of kinetic energy (figure 11). On this basis alone a Model A1/2 x 1 shock absorber would be selected. However, because there is no propelling force on the application the calculated effective weight is 3kg. This is below the minimum effective weight range of 5kg min to 450kg max. If this model were used the result would be a high on-set force at the beginning of the stake (figure 12). The solution in this case would be to use a specially orificed shock absorber to handle the low weight/high speed combination or alternatively to use the self-compensating model MC 1201 M-0.
2. A mass of 50kg has an impact velocity of 0.3 metres per second and is driven by a propelling force of 2000 Newtons (figure 13). Total impact energy is 53Nm and again a model A 1/2 x 1 would be selected based just on the energy to be absorbed. However, the effective weight calculates to 1177kg which is well above the maximum for a standard model A 1/2 x 1. If this shock absorber was used, high set-down forces at the end of stroke would result (figure 14). The solution in this case is to use a model LVA 1/2 x 1 which is designed to work in low velocity, high effective weight applications such as this.

Figure 11

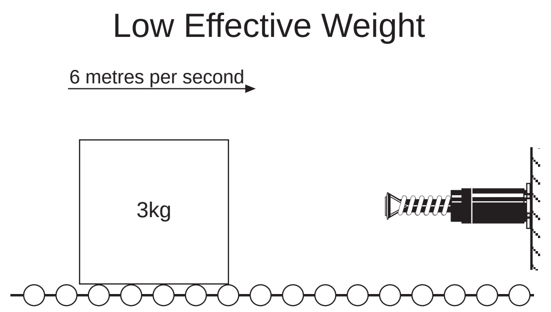


Figure 12

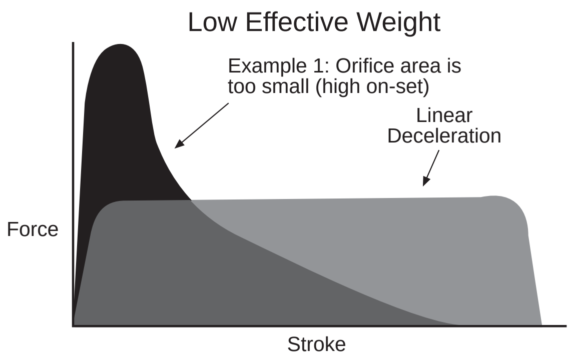


Figure 13

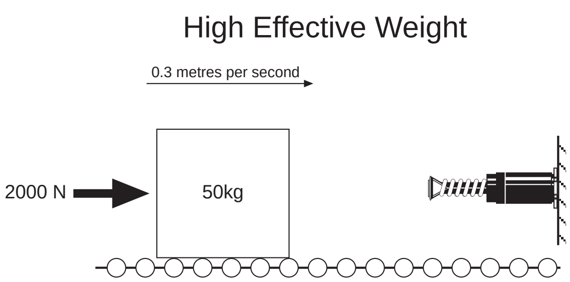
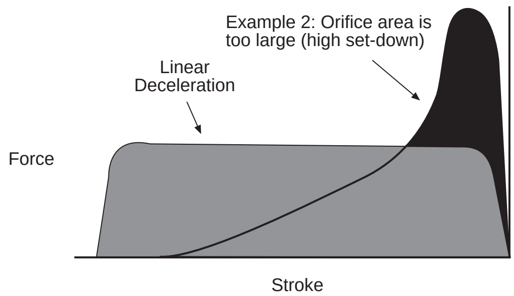


Figure 14



The Ace ‘effective weight’ concept provides a unique sizing tool for Ace shock absorbers and will ensure that the shock absorber chosen for your application will have the adjustment range to provide perfect linear deceleration as well as sufficient energy absorbing capacity.

Further examples of the calculation of effective weights follow:

Formulae and calculations

Ace shock absorbers provide linear deceleration and are therefore superior to other kinds of damping element. It is easy to calculate around 90% of applications knowing only the following 4 parameters:

1. Mass to be decelerated (weight)	m	(kg)
2. Impact velocity	v_D	(m/s)
3. Propelling force	F	(N)
4. Cycles per hour	C	(/hr)

Key to symbols used

W_1	Kinetic energy per cycle	(Nm)
W_2	Propelling force energy per cycle	(Nm)
W_3	Total energy per cycle ($W_1 + W_2$)	(Nm)
W_4	Total energy per hour ($W_3 \cdot C$)	(Nm/hr)
me	Effective weight	(kg)
m	Mass to be decelerated	(kg)
*v	Velocity of moving mass	(m/s)
*v_D	Impact velocity at shock absorber	(m/s)
ω	Angular velocity ($\omega = 2 \pi \theta \div 360$ X)	(rad/s)
F	Propelling force	(N)
C	Cycles per hour	(/hr)
P	Motor power	(kW)
ST	Stall torque factor (normally 2.5)	1 to 2.5
M	Propelling torque	(Nm)
I	Moment of inertia	(kgm^2)
g	Acceleration due to gravity = 9.81	(m/s^2)
h	Drop height excl. shock absorber stroke	(m)
s	Shock absorber stroke	(m)
L/R/r	Radius	(m)
Q	Reaction force	(N)
µ	Coefficient of friction	
t	Deceleration time	(sec)
‘g’s	Deceleration rate	(g’s)
α	Side load angle	(°)
ß	Angle of incline	(°)
θ	Index degrees	(°)
X	Index time	(sec)

*v or v_D is the final impact velocity of the mass. With accelerating motion the final impact velocity can be 1.5 to 2 times higher than the average velocity. Please take this into account when calculating the kinetic energy. In the following examples the choice of shock absorber made from the capacity chart is based upon the values of (W_3), W_4), (me) and the desired shock absorber stroke(s).

1. Mass without propelling force

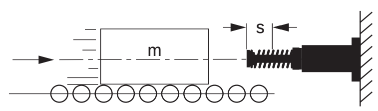


Figure 15

Formulae

$W_1 = m \cdot v2 \cdot 0.5$
$W_2 = 0$
$W_3 = W_1 + W_2$
$W_4 = W_3 \cdot C$
$v_D = v$
$me = m$

Example 1

m = 100kg
v = 1.5 m/s
C = 500/h
s = 0.05m (chosen)

$W_1 = 100 \cdot 1.5^2 \cdot 0.5 = 113\text{Nm}$
$W_2 = \text{zero}$
$W_3 = 113 = 0 = 113\text{Nm}$
$W_4 = 113 \cdot 500 = \underline{56500\text{Nm/hr}}$
$me = m = \underline{100\text{kg}}$

2. Mass with propelling force

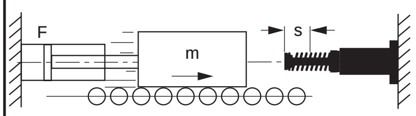


Figure 16

Formulae

$W_1 = m \cdot v^2 \cdot 0.5$
$W_2 = F \cdot s$
$W_3 = W_1 + W_2$
$W_4 = W_3 \cdot C$
$v_D = v$
$me = \frac{2 \cdot W_3}{v_D{}^2}$

2.1 for vertical motion upwards → $W_2 = (F - m \cdot g) \cdot s$
2.2 for vertical motion downwards → $W_2 = (F + m \cdot g) \cdot s$

Example 2

m = 36kg
*v = 1.5m/s
F = 400N
C = 1000/hr
s = 0.025m (chosen)

$W_1 = 36 \cdot 1.5^2 \cdot 0.5 = 41\text{Nm}$
$W_2 = 400 \cdot 0.025 = 10\text{Nm}$
$W_3 = 41 + 10 = \underline{51\text{Nm}}$
$W_4 = 540 \cdot 1000 = \underline{51000\text{Nm/hr}}$
$me = 2 \cdot 51 \div 1.5^2 = \underline{45\text{kg}}$

*v is the final impact velocity of the mass: With pneumatically propelled systems this can be 1.5 to 2 times the average velocity. Please take this into account when calculating energy.

3. Mass with motor drive

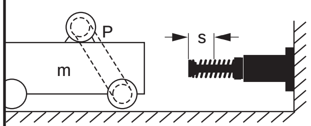


Figure 17

Formulae

$W_1 = m \cdot v^2 \cdot 0.5$
$W_2 = \frac{1000 \cdot P \cdot ST \cdot s}{v}$
$W_3 = W_1 + W_2$
$W_4 + W_3 \cdot C$
$v_D = v$
$me = \frac{2 \cdot W_3}{v_D{}^2}$

Example 3

m = 800kg
v = 1.2m/s
ST = 2.5
P = 4kW
C = 100/hr
s = 0.102m (chosen)

$W_1 = 800 \cdot 1.2^2 \cdot 0,5 = 576\text{Nm}$
$W_2 \; 1000 \cdot 4 \cdot 2.5 \cdot 0.102 \div = 850\text{Nm}$
$W_3 = 576 + 850 = \underline{1426\text{Nm}}$
$W_4 = 1426 \cdot 100 = \underline{142600\text{Nm/hr}}$
$me = 2 \cdot 1426 \div 1.2^2 = \underline{1981\text{kg}}$

Note: Do not forget to include the rotational energy of motor, coupling and gearbox into W_1.

4. Mass on driven rollers

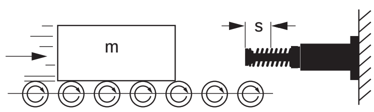


Figure 18

Formulae

$W_1 = m \cdot v^2 \cdot 0.5$
$W_2 = m \cdot \mu \cdot g \cdot s$
$W_3 = W1 + W2$
$W_4 = W3 \cdot C$
$V_D = v$
$me = \frac{2 \cdot W3}{v_D{}^2}$

Example 4

m = 250kg
v = 1.5m/s
C = 180/hr
μ = 0.2 (steel/steel)
s = 0.0.5m (chosen)

$W_1 = 250 \cdot 1.52 \cdot 0.5 = 281\text{Nm}$
$W_2 = 250 \cdot 0.2 \cdot 9.81 \cdot 0.05 = 25\text{Nm}$
$W_3 = 281 + 25 = \underline{306\text{Nm}}$
$W4 = 306 \cdot 180 + \underline{55080\text{Nm/hr}}$
$me = 2 \cdot 306 \div 1.52 = \underline{272\text{kg}}$

5. Swinging mass with propelling force

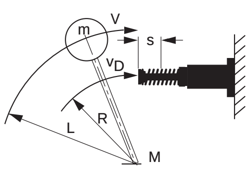


Figure 19

Formulae

$W_1 = m \cdot v^2 \cdot 0.5 = 0.5 \cdot 1 \cdot \varpi$
$W_2 = \frac{M \cdot s}{R}$
$W_3 = W_1 + W_2$
$W_4 = W_3 \cdot C$
$v_D = \frac{v \cdot R}{L} = v \cdot R$
$me = \frac{2 \cdot W3}{v_D{}^2}$

Example 5

m = 20kg
v = 1m/s
M = 50Nm
R = 0.5m
L = 0.8m
C = 1500/hr
s = 0.0125m (chosen)

$W_1 = 20 \cdot 1^2 \cdot 0.5 = 10\text{Nm}$
$W_2 = 50 \cdot 0.0125 \div 0.5 = 1.3\text{Nm}$
$W_3 = 10 + 1.3 = \underline{11.3\text{Nm}}$
$W_4 = 11.3 \cdot 1500 = \underline{16950\text{nM/hr}}$
$v_D = 1 \cdot 0.5 \div 0.8 = \underline{0.63\text{m/s}}$
$me = 2 \cdot 11.3 \div 0.63^2 = \underline{57\text{kg}}$

(Check the side load angle - see example 6.2)

6. Free falling mass

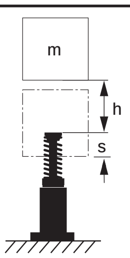


Figure 20

Formulae

$W_1 = m \cdot g \cdot h$
$W_2 = m \cdot g \cdot s$
$W_3 = W_1 \div W_2$
$W_4 = W_2 \cdot C$
$v_D = \sqrt{2 \cdot g \cdot h}$
$me = \frac{2 \cdot W^2}{v_D}$

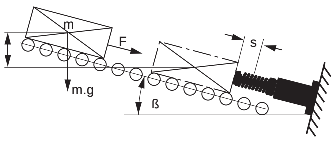
Example 6

m = 30kg
h = 0.5m
C = 400/hr
s = 0.05m (chosen)

$W_1 = 30 \cdot 0.5 \cdot 9.81 = 147\text{Nm}$
$W_2 = 30 \cdot 9.81 \cdot 0.05 = 15\text{Nm}$
$W3 = 147 + 15 = \underline{162\text{Nm}}$
$W_4 = 162 \cdot 400 = \underline{64800\text{Nm/hr}}$
$v_D = \sqrt{2 \cdot 9.81 \cdot 0.5} = 3.13\text{m/s}$
$me = \frac{2 \cdot 162}{3.13^2} = 33\text{kg}$

6.1 Mass rolling/sliding down incline

Figure 21



Formulae

$W_1 = m \cdot g \cdot h = m \cdot v_D^2 \cdot 0.5$

$W_2 = m \cdot g \cdot \sin\beta \cdot s$

$W_3 = W_1 + W_2$

$W_4 = W_3 \cdot C$

$v_D = \sqrt{2 \cdot g \cdot h}$

$me = \frac{2 \cdot W^3}{v_D^2}$

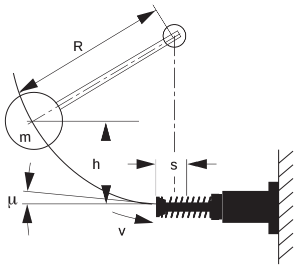
a with propelling force up incline ⟶ $W2 = (F - m \cdot g \cdot \sin\beta) \cdot s$

b with propelling force down incline ⟶ $W2 = (F + m \cdot g \cdot \sin\beta) \cdot s$

6.2 Mass free falling about a pivot point

Check side load angle from shock absorber axis

Figure 22

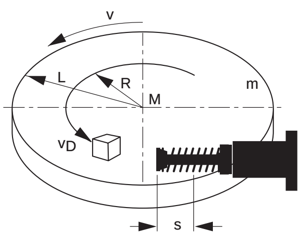


$\tan\alpha = \frac{s}{R}$

Calculation as per example 6.1

7. Rotary index table with propelling torque

Figure 23



Formulae

$W_1 = m \cdot v^2 \cdot 0.25 = 0.5 \cdot 1 \cdot \varpi^2$

$W_2 = \frac{M \cdot s}{R}$

$W_3 = W_1 + W_2$

$W_4 = W3 \cdot C$

$v_D = \frac{v \cdot R}{L} = \varpi \cdot R$

$me = \frac{2 \cdot W_3}{v_D^2}$

Example 7

$m = 1000kg$
$v = 1.1m/s$
$M = 1000Nm$
$s = 0.05m$ (chosen)
$L = 1.25m$
$R = 0.8m$
$C = 100/hr$

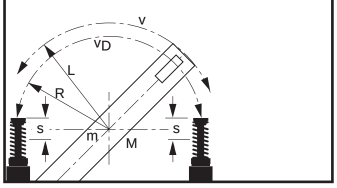
$W_1 = 1000 \cdot 1.12 \cdot 0.25 =$ 303Nm
$W_2 = 1000 \cdot 0.05 \div 0.8 =$ 63Nm
$W_3 = 303 + 63 =$ 366Nm
$W_4 = 366 \cdot 100 =$ 36600Nm/hr
$v_D = 1.1 \cdot 0.8 \div 1.25 =$ 0.7m/s
$me = 2 \cdot 366 \div 0.7^2 =$ 1494kg

Note: Formulae given are only correct for circular table with uniform weight distribution

(Check the side load angle - see example 6.2)

8. Swinging arm with propelling torque

Figure 24



Formulae

$W_1 = m \cdot v2 \cdot 0.18 = 0.15 \cdot 1 \cdot \varpi^2$

$W2 = \frac{M \cdot s}{R}$

$W_3 = W_1 + W_2$

$W_4 = W_3 \cdot C$

$v_D = \frac{v \cdot R}{L} = \varpi \cdot R$

$me = \frac{2 \cdot W_3}{v_D^2}$

Example 8

$I = 56kgm^2$
$\varpi = 1$ rad/s
$M = 300Nm$
$s = 0.025m$ (chosen)
$L = 1.5m$
$R = 0.8m$
$C = 1200/hr$

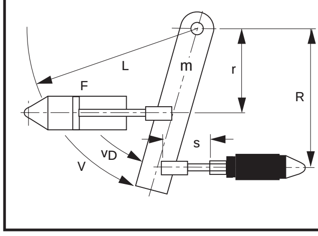
$W_1 = 0.5 \cdot 56 \cdot 1^2 =$ 28Nm
$W_2 = 300 \cdot 0.025 \div 0.8 =$ 9Nm
$W_3 = 28 + 9 =$ 37Nm
$W_4 = 37 \cdot 1200 =$ 44400Nm/hr
$v_D = 1 \cdot 08 =$ 0.8m/s
$me = 2 \cdot 37 \div 0.8^2 =$ 116kg

(Formulae are for arm with uniform weight distribution)

(Check the side load angle - see example 6.2)

9. Swinging arm with propelling force

Figure 25



Formulae

$W_1 = m \cdot v2 \cdot 0.18 = 0.15 \cdot 1 \cdot \varpi^2$

$W_2 = \frac{F \cdot r \cdot s}{R} = \frac{M \cdot s}{R}$

$W_3 = W_1 + W_2$

$W_4 = W_3 \cdot C$

$v_D = \frac{v \cdot R}{L} = \varpi \cdot R$

$me = \frac{2 \cdot W_3}{v_D^2}$

Example 9

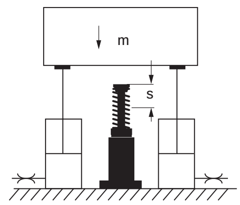
$m = 1000kg$
$v = 2m/s$
$F = 7000N$
$M = 4200Nm$
$s = 0.05m$ (chosen)
$r = 0.6m$
$R = 0.8m$
$L = 1.2m$
$C = 900/hr$

$W_1 = 1000 \cdot 22 \cdot 0.18 =$ 720Nm
$W_2 = 7000 \cdot 0.6 \cdot 0.05 \div 0.8 =$ 263Nm
$W_3 = 720 + 263 =$ 983Nm
$W_4 = 983 \cdot 900 =$ 884700Nm/hr
$v_D = 2 \cdot 0.8 \div 1.2 =$ 1.33m/s
$me = 2 \cdot 983 \div 133^2 =$ 1111kg

(Formulae are for arm with uniform weight distribution)

10. Mass lowered at controlled speed

Figure 26



Formulae

$W_1 = m \cdot v2 \cdot 0.5$

$W_2 = m \cdot g \cdot s$

$W_3 = W1 + W2$

$W4 = W3 \cdot C$

$v_D = v$

$me = \frac{2 \cdot W_3}{v_D^2}$

Example 10

$m = 15000kg$
$v = 1.5m/s$
$s = 0.152m$ (chosen)
$C = 60/hr$

$W_1 = 15000 \cdot 1.5^2 \cdot 0.5 =$ 16875Nm
$W_2 - 15000 \cdot 9.81 \cdot 0.152 =$ 22367Nm
$W_3 = 16875 = 22367 =$ 39242Nm
$W_4 = 39242 \cdot 60 =$ 2354520Nm/hr
$me = 2 \cdot 39242 \div 1.5^2 =$ 34882kg

Reaction force Q (N)

$$Q = \frac{1.2 \cdot W_3}{s}$$

Stopping time (s)

$$t = \frac{2.6 \cdot s}{v_D}$$

Deceleration rate 'g's

$$g's = \frac{0.6 \cdot v_D^2}{g \cdot s}$$

Approximate values assuming correct adjustment. Add safety margin if necessary.
(Exact values will depend upon actual application data and can be provided on request)

Worked example

Formulae

$W_1 = M \cdot V^2 \cdot 0.5$

$W^2 = F \cdot S$

$W_3 = W_1 + W_2$

$W_4 = W_3 \cdot C$

$$me = \frac{2 \cdot W_3}{V^2}$$

Example

M = 350kg
V = 1m/s
F = 1500N
C = 300/hr
S = 0.05m (chosen)

W_1 = 175Nm
W_2 = 75Nm
W_3 = 250Nm
W_4 = 75000Nm/hr
me = 500kg

By comparing W_3, W_4 and me with the values in the capacity charts the correct product may be selected ie. in this instance series A type **RS** stock no. 834-308.

Capacity chart - adjustable

RS stock no.	Shock absorber Mode	Stroke mm	Max energy capacity Nm		Eff Weight me (kg)
			W3/cycle	W4/hr	min/max
834-229	FA 1008 V-B	8	1.5	3600	0.6 - 10
834-235	FA 1210 M-B	10	3	6000	0.5 - 30
834-241	MA 225 M	19	25	45000	2.3 - 226
834-257	MA600 M	25	68	68000	5 - 1360
834-261	MA 900 M	40	100	90000	14 - 2040
831-272	A 1/2 x 1	25	115	85000	5 - 450

Capacity chart - self compensating

RS stock no.	Shock absorber Mode	Stroke mm	Max energy capacity Nm		Eff Weight me (kg)
			W3/cycle	W4/hr	min/max
268-0535	MC 25 ML	6	2.5	22600	0.7 - 2.3
268-0557	MC 25 M	6	2.5	22600	4.8 - 5.5
268-0563	MC25 MH	6	2.5	22600	3.6 - 13.6
268-0579	MC75 ML	10	8.5	28200	0.2 - 15.4
268-0585	MC75 M	10	8.5	28200	0.9 - 16
268-0591	SC 190 HDM-1	16	20	34000	1.4 - 7
268-0614	SC 190 HDM- 2	16	20	34000	3.6 - 18
268-0620	SC 190 HDM-3	16	20	34000	9 - 45
268-0636	SC190 HDM-4	16	20	34000	23 - 102
268-0670	SC 300 HDM-1	19	33	45000	14 - 8
268-0664	SC 300 HDM-2	19	33	45000	4.5 - 27
268-0642	SC 300 HDM-3	19	33	45000	14 - 82
268-0658	SC 300 HDM-4	19	33	45000	32-204
268-0686	SC 650 HDM-1	25	73	68000	8 - 45
268-0692	SC 650 HDM-2	25	73	68000	23 - 136
268-0709	SC 650 HDM-3	25	73	68000	68 - 408
268-0715	SC 650 HDM 4	25	73	68000	204 - 1180
268-0721	SC 925 HDM-1	40	110	90000	14 - 90
268-0737	SC 925 HDM-2	40	110	90000	40 - 272
268-0743	SC 925 HDM-3	40	110	90000	113 - 726
268-0759	SC 925 HDM-4	40	110	90000	340 - 2088

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