Shock absorber

Formulae and examples of calculation

A shock absorber decelerates linearly. Roughly 90% of shock absorber applications can be modelled if the following 4 factors are known:

1. Mass to slow down	m (kg)	2. Impact velocity	v_D (m/s)
3. Propelling force	F (N)	4. Shocks per hour	C (hr)

Symbols used in the formulae:

W_1	Kinetic enerngy	(Nm)
W_2	Propelling energy	(Nm)
W_3	Total energy per cycle (W_1+W_2)	(Nm)
W_4	Total erergy per hour (W_3C)	(Nm/hr)
me	Effective weight	(kgme)
m	Mass to slow down	(kg)
*v	Velocity or moving mass	(m/s)
*v_D	Impact velocity of shock absorber	(m/s)
ω	Angular velocity	(rad/s)
F	Propelling force	(N)
C	Number of shocks per hour	(/hr)
P	Motor power	(kW)
ST	Setting coefficient (normally 2.5)	1 à 2.5

M	Propelling torque	(Nm)
I	Moment of inertia	(kgm²)
g	Gravity = 9,81	(m/s²)
h	Drop height exc. shock abs. stroke	(m)
s	Shock absorber stroke	(m)
Q	Reactive force	(N)
μ	Friction coefficient	
t	Braking time	(sec)
a	Side load inclination	(m/sec²)
α	Radius of inclination	(°)
β	Angle of inclination	(°)
L	Radius of mass	(m)
R	Dist. pivot/installation pt. of damp.	(m)
r	Dist. pivot/force application pt.	(m)

1. *Mass without propelling force*

Formulae :

$W_1 = m \cdot v^2 \cdot 0,5$

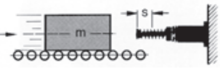
$W_2 = 0$

$W_3 = W_1 + W_2$

$W_4 = W_3 \cdot C$

$v_D = v$

$me = m$



2. *Mass with propelling force*

Formulae :

$W_1 = m \, . \, v^2 \, . \, 0,5$

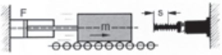
$W_2 = F \, . \, s$

$W_3 = W_1 + W_2$

$W_4 = W_3 \, . \, C$

$v_D = v$

$me = \frac{2 \, . \, W_3}{v_D^2}$



2.1 Mass moving upwards

$W_2 = (F - m \, . \, g). \, s$

2.2 Mass moving downwards

$W_2 = (F + m \, . \, g). \, s$

3. *Mass pulled by a motor*

Formulae :

$W_1 = m \, . \, v^2 \, . \, 0,5$

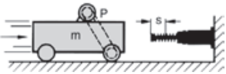
$W_2 = \frac{1000 \cdot P \cdot ST \cdot s}{v}$

$W_3 = W_1 + W_2$

$W_4 = W_3 \, . \, C$

$v_D = v$

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



4. *Mass on motorised rollers*

Formulae :

$W_1 = m \, . \, v^2 \, . \, 0,5$

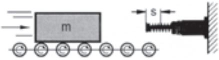
$W_2 = m \, . \, \mu \, . \, g \, . \, s$

$W_3 = W_1 + W_2$

$W_4 = W_3 \, . \, C$

$v_D = v$

$me = \frac{2 \, . \, W_3}{v_D^2}$



5. *Swinging mass with propelling force*

Formulae :

$W_1 = m \, . \, v^2 \, . \, 0,5$

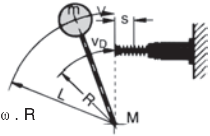
$W_2 = \frac{M \, . \, s}{R}$

$W_3 = W_1 + W_2$

$W_4 = W_3 \, . \, C$

$v_D = \frac{v \, . \, R}{L} = \omega \, . \, R$

$me = \frac{2 \, . \, W_3}{v_D^2}$



v or v_D is the impact velocity of the mass. In the case of an accelerated movement (for example when the mass is deplaced by a pneumatic cylinder),* ***the impact velocity can be 1.5 to 2 times greater than the average velocity.*

Formulae and examples of calculation

6. Free falling mass

Formulae :

$W_1 = m \cdot g \cdot h$

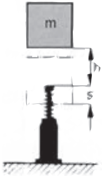
$W_2 = m \cdot g \cdot s$

$W_3 = W_1 + W_2$

$W_4 = W_3 \cdot C$

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

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



6.1 Mass rolling or sliding on an inclined plane

Formulae :

$W_1 = m . g . h = m . v_D^2 . 0,5$

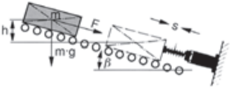
$W_2 = m . g . \sin\beta . s$

$W_3 = W_1 + W_2$

$W_4 = W_3 \ . C$

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

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



6.1a Mass with upwards propelling force

$W_2 = (F - m \ . g . \sin\beta). s$

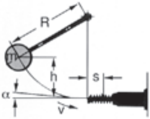
6.1b Mass with downwards propelling force

$W_3 = (F + m \ . g . \sin\beta). s$

6.2 Mass free falling abut a pivot point

Formulae: Follow calculation for example 6.1. Verify the radial load.

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



7. Rotary index table with propelling torque

Formulae :

$W_1 = m . v^2 . 0,25$

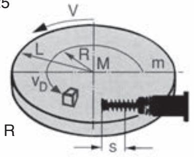
$W_2 = \frac{M . s}{R}$

$W_3 = W_1 + W_2$

$W_4 = W_3 \ . C$

$v_D = \frac{v . R}{L} = \omega . R$

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



NOTE: *mass evenly spread*

8. Rotating mass with propelling torque

Formulae :

$W_1 = m . v^2 . 0,18$

NOTE: *mass evenly spread*

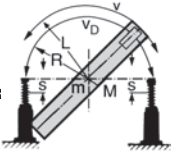
$W_2 = \frac{M . s}{R}$

$W_3 = W_1 + W_2$

$W_4 = W_3 \ . C$

$v_D = \frac{v . R}{L} = \omega . R$

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



9. Rotating mass with propelling force

Formulae :

$W_1 = m . v_D^2 . 0,18$

NOTE: *mass evenly spread*

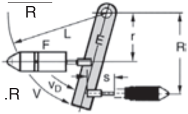
$W_2 = \frac{F . r . s}{R} = \frac{M . s}{R}$

$W_3 = W_1 + W_2$

$W_4 = W_3 \ . C$

$v_D = \frac{v . R}{L} = \omega . R$

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



10. Mass in controlled descent without propelling force

Formulae :

$W_1 = m . v^2 . 0,5$

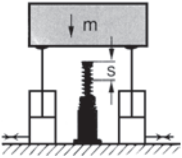
$W_2 = m . g . s$

$W_3 = W_1 + W_2$

$W_4 = W_3 \ . C$

$v_D = v$

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



These formulae will give you approximate values to assist in the selection of a shock absorber but a safety margin should always be applied. (Precise values can only be calculated if actual parameters are known).

Reactive force Q(N)

$Q = \frac{1,2 . W_3}{s}$

Braking time (s)

$t = \frac{2,6 . s}{v_D}$

Deceleration (m/s²)

$a = \frac{0,6 . v_D^2}{s}$

Shock absorber

HPC technical assistance
Fax +33 (0)4 37 490 055

Request for technical assistance with your application

If you would like assistance with an application, please enlarge this form by 200% (to A4 size), fill in as much information as possible and return it by fax to our technical team.

Company ______________________ Contact ______________________

Address ____

____

Telephone ______________________ Fax ______________________

For which machine, fitting or application do you need help selecting a shock absorber?

____

What material is there at the end of stroke?

Rubber cushion	❐	Shock-absorbing cylinder	❐
Brake cylinder	❐	No shock-absorber	❐
Other	❐		

What problems do you have?

Safety	❐	Stopping too quickly	❐
Stopping too slowly	❐	Incorrect deceleration	❐
Frequent breakages/faults	❐	Continuous operation	❐

Fixtures

R - Flange behind

F - Flange in front

S - Foot mounting

C - Oscillating mounting

Please see preceding pages to select your intended use.

Otherwise use the space below for a sketch or any other description thereof.

Total weight of mass to be dampened	**m** (kg)	________
Impact velocity on shock-absorber	**vD** (m/s)	________
Propelling force of cylinder or other	**F** (N)	________
Electric motor power	**P** (kW)	________
No of shocks per hour	**C** (1/h)	________
N° of shock-absorbers in parallel	**n** ()	________
(Desired) shock-absorber stroke length	**s** (mm)	________
Total height of fall	**h** (m)	________
Torque	**M** (Nm)	________
Friction coefficient	μ	________
Radius L/R/r	**(m)**	________
Other info.		________

External influences - Application

Ouside	❐
Extrusions into soft water	❐
Extrusions into sea water	❐
Marine environment	❐
Acidic environment	❐
Electrical contact	❐
In foundry	❐
In pneumatic cylinder	❐
Temperature ________	
Other ________	

Self-compensating shock-absorber

Non adjustable

MC

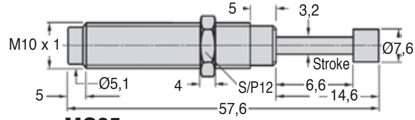
- *MC25 and MC75: integrated stroke end stop and noise reducing buffer*
- *MC150: mechanical stop required about 1mm before the shock-absorber stroke-end.*
- *Working temperature 0 to +65°C*
- *Materials:*
  - *Body: blackened steel*
  - *Rod: stainless steel*
  - *Buffer: steel with elastomer insert (MC25 and MC75 only)*

Accessories

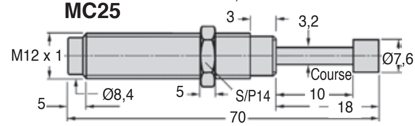
- *See stroke end stop and universal universal flange*

Info.

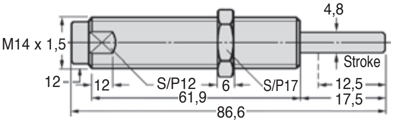
- *MC150: to avoid damaging the EPDM membrane* ***do not turn the rod***
- *For better heat dissipation, do not paint shock-absorbers*



MC25



MC75



MC150M

DISCOUNTS

Qty	1+	6+	10+	15+
Disc.	List	-10%	-15%	On request

Part number	Effective Weight (kgme) Min	Max	Max capacity (Nm) Per cycle W3	Per hour W4	Return spring force (N)	Rod reset time (S)	Max. side load angle	Stock*	Price each 1 to 5
MC25-ML	0,7	2,2	2,8	22600	3-6	0,3	2°	✔	81,85 €
MC25-M	1,8	5,4	2,8	22600	3-6	0,3	2°	✔	69,00 €
MC25-MH	4,6	13,6	2,8	22600	3-6	0,3	2°	✔	69,00 €
MC75-M1	0,3	1,1	9,0	28200	4-9	0,3	2°	-	110,65 €
MC75-M2	0,9	4,8	9,0	28200	4-9	0,3	2°	✔	110,65 €
MC75-M3	2,7	36,2	9,0	28200	4-9	0,3	2°	✔	110,65 €
MC150-M	0,9	10,0	20,0	34000	3-8	0,4	4°	✔	146,57 €
MC150-MH	8,6	86,0	20,0	34000	3-8	0,4	4°	-	146,57 €
MC150-MH2	70,0	200,0	20,0	34000	3-8	0,4	4°	-	146,57 €

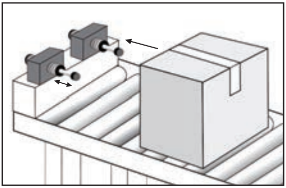
**Depending on availability - Dimensions in mm*

Adjustable shock-absorber

RMSA

Can be adjuster in-situ to suit application

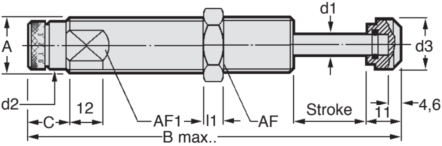
- ***Standard part with locknut and knob***
- *Materials:*
  Body: blackened steel
  Rod: stainless steel
- *Adjustment. The adjustment ring is calibrated from 0 to 9. The adjustment knob is secured by a set screw which must be slackened with a 1.5mm Allen key before carrying out adjustment (do not remove completely). After installing the shock absorber, cycle the machine a few times and alter the adjustment so that optimum deceleration is achieved. For hard impact at start of stroke turn ring towards 9, for harder impact at the end of the stroke, turn towards 0. Retighten the set screw.*
- *Max. impact velocity 3,6m/s*
- *Working temperature -12° to +90°C*
- *Stroke end stop and anti-noise buffer fully integrated*
- *Max. angle of incidence: 2° (except RMSA-900 : 1°)*



Typical application

Uses

- *Upon impact of the load the piston moves back causing an immediate build up of internal pressure. Oil is then allowed to pass through the metering orifices bringing the load smoothly to rest. Fast reset is assured by an anti-return valve and spring incorporated in the piston.*



Accessories

- *Universal flange* ***STC...***
- *Stroke end stop* ***MF...***

DISCOUNTS

Qty	1+	6+	10+	15+
Disc.	List	-10%	-15%	On request

Part number	Stroke (mm)	A	B	C	d1	d2	d3	l1	AF	AF1
RMSA-500	19,00	M20 x 1,5	118	13,5	4,8	17,0	17,0	8	23	18
RMSA-600	25,40	M25 x 1,5	143	16,5	6,3	22,4	23,0	10	30	23
RMSA-900	40,00	M25 x 1,5	189	16,5	6,3	22,4	23,0	10	30	23

Part number	Max. energy capacity (Nm) per cycle W3	per hour W4	Effective weight (kgme) Min (kg)	Max (kg)	Return spring force Min. (N)	Max. (N)	Rod time reset (S)	Weight (kg)	Stock*	Price each 1 to 5
RMSA-500	25	45 000	2,30	226	5	10	0,10	0,13	✔	156,87 €
RMSA-600	68	68 000	9,00	1 360	10	30	0,20	0,31	✔	216,36 €
RMSA-900	100	90 000	14,00	2 040	10	35	0,40	0,40	-	300,94 €

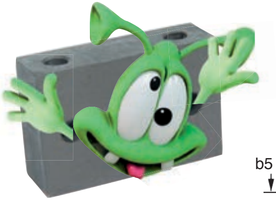
**Depending on availability - Dimensions in mm*

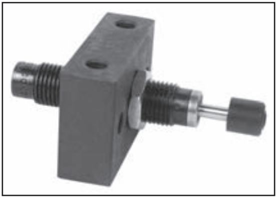
Shock-absorber - universal flange

Mounting accessory

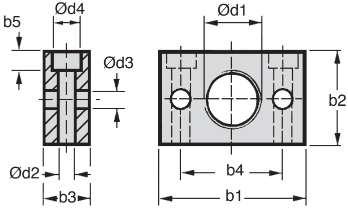
MF

- *Universal flange for shock-absorber*

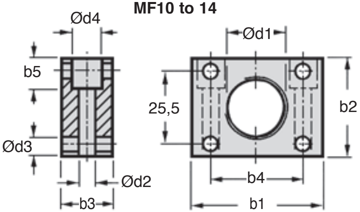




Typical application



MF10 to 14



MF20 to 25

DISCOUNTS

Qty	1+	6+	10+	15+
Disc.	List	-10%	-15%	On request

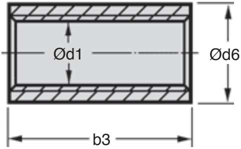
Part number	Ød1	Ød2	Ød3	Ød4	b1	b2	b3	b4	b5	For shock-absorber	Stock*	Price each 1 to 5
MF-10	M10x1	4,5	4,5	8	38	25	12	25	5	MC25	✔	43,91 €
MF-12	M12x1	4,5	4,5	8	38	25	12	25	5	MC75	✔	43,91 €
MF-14	M14x1,5	4,5	4,5	8	45	29	16	35	5	MC150	-	47,23 €
MF-20	M20x1,5	5,5	5,5	10	47	35	16	35	10	RMSA500	-	58,71 €
MF-25	M25x1,5	5,5	5,5	10	47	35	16	35	10	RMSA600-900	-	58,69 €

*Depending on availability - Dimensions in mm

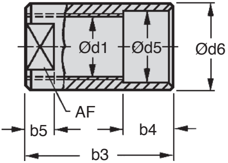
Shock absorber - stop collar

STC Mounting accessory

- ***Stop collar for shock absorber***
- *Warning: for certain shock absorbers, the use of this stop collar is essential*



STC10 to 12



STC14 to 25

Typical application

DISCOUNTS

Qty	1+	6+	10+	15+
Disc.	List	-10%	-15%	On request

Part number	Ød1	Ød5	Ød6	b3	b4	b5	AF	For shock-absorber	Stock*	Price each 1 to 5
STC10	M10x1	-	14,3	20	-	-	-	MC25	✔	12,39 €
STC12	M12x1	-	16,0	20	-	-	-	MC75	✔	12,39 €
STC14	M14x1,5	14,5	18,0	19	12	6	13	MC150	-	13,47 €
STC20	M20x1,5	20,5	25,0	25	12	8	22	RMSA500	-	20,05 €
STC25	M25x1,5	25,5	32,0	45	16	10	27	RMSA600-900	✔	28,47 €

**Depending on availability - Dimensions in mm*