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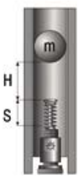
Hydraulic shock absorber selection

Five basic criteria are required for sizing the shock absorbers:

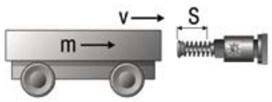
a) impacting mass m (kg)
b) impact speed v (m/s)
c) additional external forces acting on the mass e.g. propelling force F (N)
d) number of strokes of the shock absorber per hour X (1/h)
e) number of parallel shock absorbers

Free falling mass



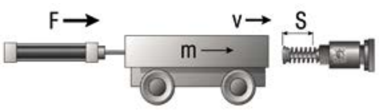
1. $W_k = m \cdot g \cdot H$
2. $W_A = m \cdot g \cdot S$
3. $W_{kg} = W_k + W_A$
4. $W_{kg/h} = W_{kg} \cdot X$
5. $m_e = \dfrac{2 \cdot W_{kg}}{v_e^{\,2}}$
6. $v = v_e = \sqrt{2 \cdot g \cdot H}$

Mass without propelling force



1. $W_{kg} = \dfrac{m \cdot v^2}{2}$
2. $W_{kg/h} = W_{kg} \cdot X$
3. $v = v_e$
4. $m_e = \dfrac{2 \cdot W_{kg}}{v_e^{\,2}}$

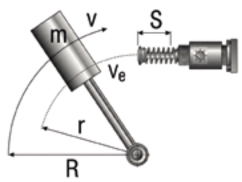
Mass with propelling force, horizontal



Movement downward: $W_A = (F + m \cdot g) \cdot S$
Movement upward: $W_A = (F - m \cdot g) \cdot S$

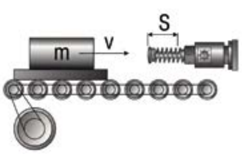
1. $v_e = \dfrac{v}{K1}$
2. $W_k = \dfrac{m \cdot v_e^{\,2}}{2}$
3. $W_A = F \cdot S$
4. $W_{kg} = W_k + W_A$
5. $W_{kg/h} = W_{kg} \cdot X$
6. $m_e = \dfrac{2 \cdot W_{kg}}{v_e^{\,2}}$

Swinging mass without propelling force



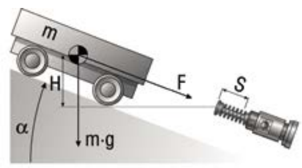
1. $W_k = \dfrac{m \cdot v^2}{2} = \dfrac{J \cdot \omega^2}{2}$
2. $W_A = \dfrac{M \cdot S}{r}$
3. $W_{kg} = W_k + W_A$
4. $W_{kg/h} = W_{kg} \cdot X$
5. $v_e = r \cdot \omega = \dfrac{v \cdot r}{R}$
6. $m_e = \dfrac{2 \cdot W_{kg}}{v_e^{\,2}}$

Mass on driven rollers



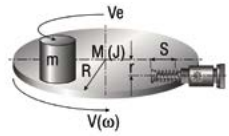
1. $W_k = \dfrac{m \cdot v^2}{2}$
2. $W_A = m \cdot g \cdot S \cdot \mu$
3. $W_{kg} = W_k + W_A$
4. $W_{kg/h} = W_{kg} \cdot X$
5. $v = v_e$
6. $m_e = \dfrac{2 \cdot W_{kg}}{v_e^{\,2}}$

Mass on incline



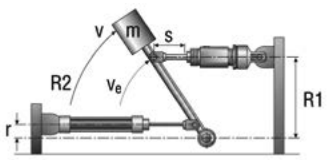
1. $W_k = m \cdot g \cdot H$
2. $W_A = m \cdot g \cdot \sin \alpha \cdot S$
3. $W_{kg} = W_k + W_A$
4. $W_{kg/h} = W_{kg} \cdot X$
5. $v = v_e = \sqrt{2 \cdot g \cdot H}$
6. $m_e = \dfrac{2 \cdot W_{kg}}{v_e^{\,2}}$

Rotary table with propelling force



1. $W_k = \dfrac{m \cdot v^2}{2} = \dfrac{J \cdot \omega^2}{2}$
2. $W_A = \dfrac{M \cdot S}{r}$
3. $W_{kg} = W_k + W_A$
4. $W_{kg/h} = W_{kg} \cdot X$
5. $v_e = r \cdot \omega = \dfrac{v \cdot r}{R}$
6. $m_e = \dfrac{2 \cdot W_{kg}}{v_e^{\,2}}$

Swinging mass with propelling force



1. $W_k = \dfrac{m \cdot v^2}{2}$
2. $W_A = \dfrac{M \cdot S}{R1} = \dfrac{F \cdot r \cdot S}{R1}$
3. $W_{kg} = W_k + W_A$
4. $W_{kg/h} = W_{kg} \cdot X$
5. $v_e = R1 \cdot \omega = \dfrac{v \cdot R1}{R2}$
6. $m_e = \dfrac{2 \cdot W_{kg}}{v_e^{\,2}}$

Formulae

Effective mass

$$m_e = \frac{2 \cdot W_{kg}}{v_e^{\,2}}$$

Counter force

$$F_G = \frac{W_{kg} \cdot 1.2^*}{S}$$

Deceleration time

$$t = \frac{2 \cdot S}{v_e} \cdot 1.2^*$$

Deceleration time

$$a = \frac{v^2}{2 \cdot S} \cdot 1.2^*$$

Stroke

$$S = \frac{v^2}{2 \cdot a} \cdot 1.2^*$$

*) Calculation for optimum setting. Allow a safety margin!

Used values and variables

W_k	[Nm]	kinetic energy
W_A	[Nm]	propelling force energy
W_{kg}	[Nm]	total energy
$W_{kg/h}$	[Nm·h^{-1}]	total energy per hour
m	[kg]	mass
m_e	[kg]	effective mass
v	[m·s^{-1}]	impact speed
v_e	[m·s^{-1}]	effective speed
X	[h^{-1}]	number of strokes per hour
S	[m]	stroke
F	[N]	propelling force
F_p	[N]	pneumatic drive force

K_1	[1]	correction factor for pneumatic drive force (K_1=0.65)
M	[Nm]	torque
R, r	[m]	radius
H	[m]	height
g	[m·s^{-2}]	acceleration due to gravity
J	[kg·m^2]	moment of inertia
ω	[s^{-1}]	angular velocity
μ	[1]	coefficient of friction (steel=0.2)
a	[°]	angle
a	[m·s^{-2}]	acceleration / deceleration
t	[s]	deceleration time
F_G	[N]	counter force