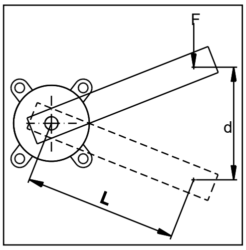
Kinetrol Dashpot Calculations - Calculating Damping Rates

KINETROL

Metric Units

Given quantity and unit

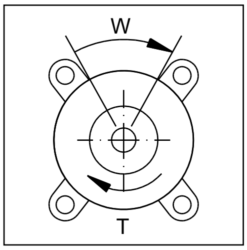
F	N	= force of weight on end of lever	**t**	s	= time taken to move this distance	**M**	kg	= mass
L	m	= effective length of lever	**w**	rad/s	= speed of rotation	**V**	m/s	= velocity of mass
d	m	= distance moved by end of lever	**T**	Nm	= torque applied to shaft	**f**	Hz	= frequency of vibration



1 Steady movement in a straight line.

Required rate:

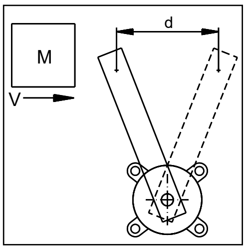
$$= \frac{FL^2t}{d} \text{ Nm/rad/s}$$



2 Steady rotation.

Required rate:

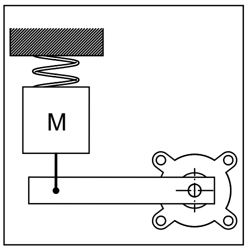
$$= \frac{T}{w} \text{ Nm/rad/s}$$



3 Deceleration of mass moving in a straight line.

Required rate:

$$= \frac{MVL^2}{d} \text{ Nm/rad/s}$$



4 Critical damping of vibrating mass.

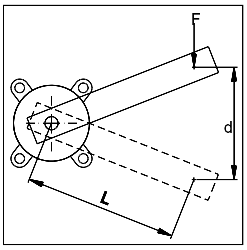
Required rate:

$$= \frac{MfL^2}{0.08} \text{ Nm/rad/s}$$

English Units

Given quantity and unit

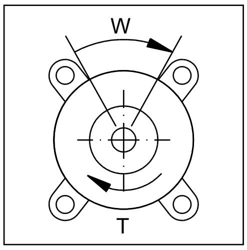
F	lbf	= force of weight on end of lever	**t**	s	= time taken to move this distance	**M**	lbf	= mass
L	in	= effective length of lever	**w**	rad/s	= speed of rotation	**V**	in/s	= velocity of mass
d	in	= distance moved by end of lever	**T**	lbf.ins	= torque applied to shaft	**f**	Hz	= frequency of vibration



1 Steady movement in a straight line.

Required rate:

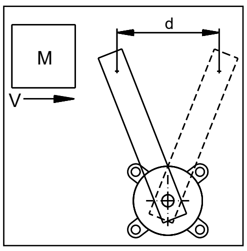
$$= \frac{FL^2t}{d} \text{ lbf.ins/rad/s}$$



2 Steady rotation.

Required rate:

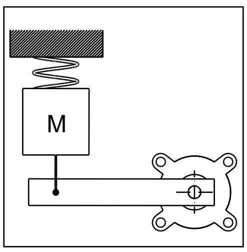
$$= \frac{T}{w} \text{ lbf.ins/rad/s}$$



3 Deceleration of mass moving in a straight line.

Required rate:

$$= \frac{MVL^2}{386d} \text{ lbf.ins/rad/s}$$



4 Critical damping of vibrating mass.

Required rate:

$$= \frac{MfL^2}{30.7} \text{ lbf.ins/rad/s}$$

Conversion factors

1 rad = 57.3°
1 Nm = 8.85 lbf.ins
1 RPM = 0.1047 rad/s
1 lbf = 4.45 N
1 lbf.ins = 0.113 Nm
9.81 N = 1 kgf = 1 kp

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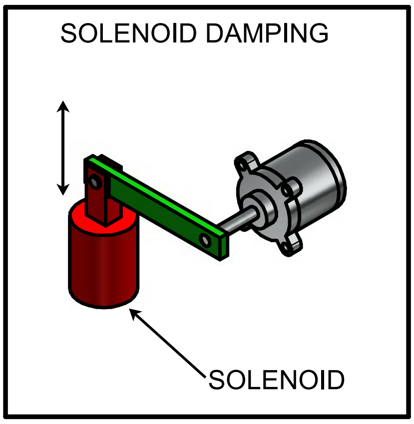
Sample Calculations

Solenoid Damping



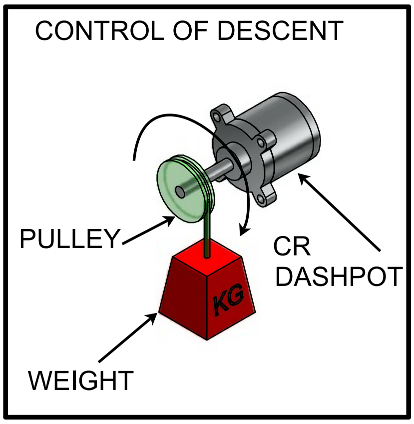
Solenoid force **F** = 10 N
Solenoid travel **d** = 25 mm = 0.025 m
Lever arm length **L** = 75 mm = 0.075 m
Travel time required **t** = 5 s

Use Formula 1: Rate $= \frac{FL^2t}{d} = \frac{10 \times 0.075^2 \times 5}{0.025}$

= 11.2 Nm/rad/s (99 lbf.Ins/rad/s)

Conclusion: Use KD – A2

Control of Descent



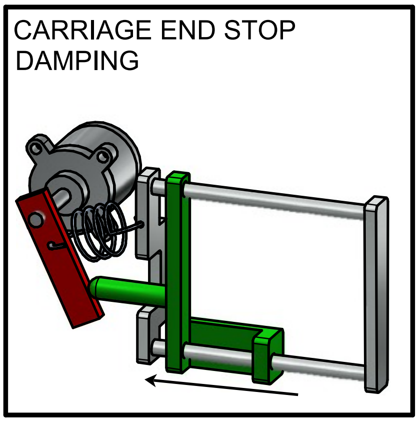
Weight = 1 kg
Pulley radius = 50 mm = 0.05 m
Speed required **V** = 100 mm/s = 0.1 m/s
Force **F** = 1 x 9.81 = 9.81 N
Torque **T** = 9.81 x 0.05 = 0.49 Nm
Speed of rotation **w** = 0.1 m/s ÷ 0.05 m = 2 rad/s

Use Formula 2: Rate = T/w = 0.49/2 = 0.245 Nm/rad/s

This is a CR dashpot application. Find point on the S – CRD graph for torque and speed

Conclusion: Use S – CRD – 30,000

Carriage Mechanism End Stop Damping



Carriage mass **M** = 10 kg
Velocity **V** = 1 m/s
Deceleration distance **d** = 50 mm = 0.05 m
Lever length **L** = 75 mm = 0.075 m

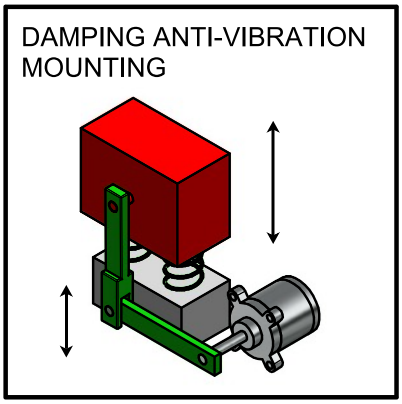
Use Formula 3: Rate $= \frac{MVL^2}{d} = \frac{10 \times 1 \times 0.075^2}{0.05}$

= 1.1 Nm/rad/s (9.7 lbf.Ins/rad/s)

Check max. rotation speed = 1 m/s ÷ 0.075 m = 13.3 rad/s
Hence max. torque = 13.3 x 1.1 = 14.7 Nm (130 lbf.Ins)

Conclusion: Use KD – A1

Damping Anti-Vibration Mounting



Mass **M** = 10 kg
Natural frequency **f** = 20 Hz
Lever length **L** = 100 mm = 0.10 m

Use Formula 4: Rate $= \frac{MfL^2}{0.08} = \frac{10 \times 20 \times 0.1^2}{0.08}$

= 25 Nm/rad/s (220 lbf.Ins/rad/s)

Conclusion: Use KD – A3

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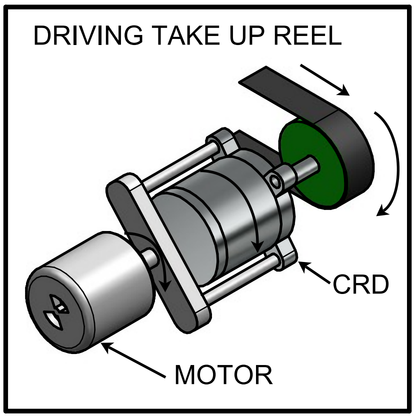
Notes on Constant Tension Take Up Reel



A CR dashpot can be used as a slipping drive between a geared motor and a take up reel for winding tape or wire on to a reel. If sized correctly the tension in the tape can be maintained within reasonable limits for a ratio of maximum to minimum reel radius of up to 2.5. Difficulty sometimes arises because it is necessary to select the correct motor speed as well as dashpot rate.

Suggested Procedure

Given:	Tape linear speed **V**	m/s
	Required tension **f**	N
	Minimum reel radius **a**	m
	Maximum reel radius **b**	m

Required motor speed **n** = 13 V/a rpm

Required damping rate **k** = $\frac{400\ f\ V}{n^2}$ Nm/rad/s

CR dashpot must give torque $\frac{0.4\ k\ V}{a}$

At a speed of 0.4 V/a rad/s.

Check max. Power dissipated = $k(0.1n - V/b)^2$ W

This must be less than 10W for S – CRD and 40W for T – CRD.