Contents

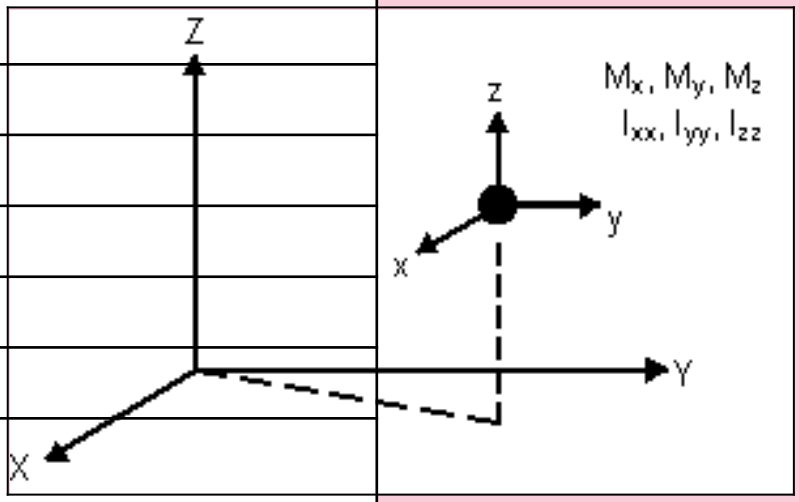
第13.1節

與質點結構系統有關的元素

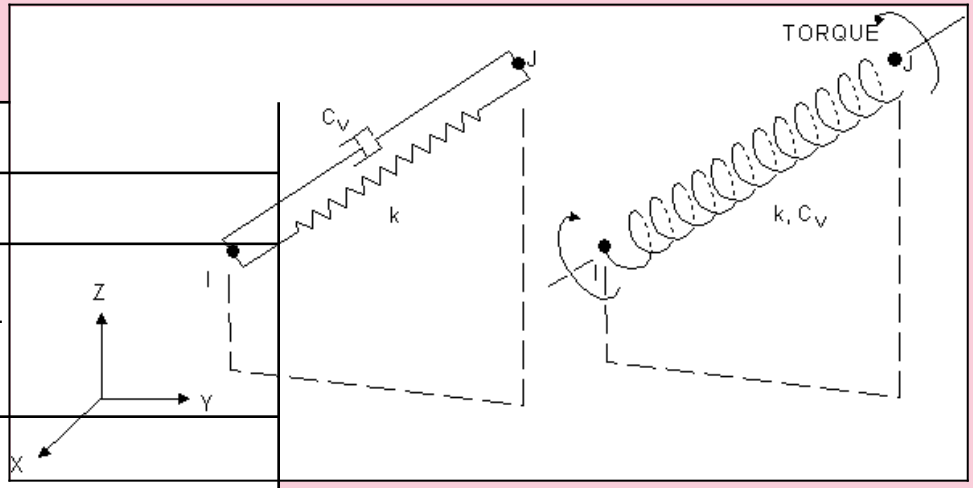
Elements for Mass-Spring-Damper Systems

13.1.1 MASS21: Structural Mass

Element Name	MASS21
Nodes	I
Degrees of Freedom	UX, UY, UZ, ROTX, ROTY, ROTZ if KEYOPT(3) = 0 UX, UY, UZ if KEYOPT(3) = 2 UX, UY, ROTZ if KEYOPT(3) = 3 UX, UY if KEYOPT(3) = 4
Real Constants	MASSX, MASSY, MASSZ, IXX, IYY, IZZ if KEYOPT(3) = 0 MASS if KEYOPT(3) = 2 MASS, IZZ if KEYOPT(3) = 3 MASS if KEYOPT(3) = 4
Material Properties	None
Surface Loads	None
Body Loads	None
Special Features	Large deflection
KEYOPT(2)	Key for element coordinate system
KEYOPT(3)	0 - 3-D mass with rotary inertia 2 - 3-D mass without rotary inertia 3 - 2-D mass with rotary inertia 4 - 2-D mass without rotary inertia



13.1.2 COMBIN14: Spring/Damper



Element Name	COMBIN14
Nodes	I, J
Degrees of Freedom	UX, UY, UZ if KEYOPT(3) = 0 ROTX, ROTY, ROTZ if KEYOPT(3) = 1 UX, UY if KEYOPT(3) = 2 etc.
Real Constants	K, CV1, CV2
Material Properties	None
Surface Loads	None
Body Loads	None
Special Features	Nonlinear (if CV2 is not zero), Stress stiffening, Large deflection, etc.
KEYOPT(1)	1 - Linear Solution (default) 2 - Nonlinear solution (required if CV2 is non-zero)
KEYOPT(3)	1 - 3-D longitudinal spring-damper 2 - 3-D torsional spring-damper 3-2-D longitudinal spring-damper (2-D elements must lie in an X-Y plane)

13.1.3 Equivalent Mass/Spring/Damper

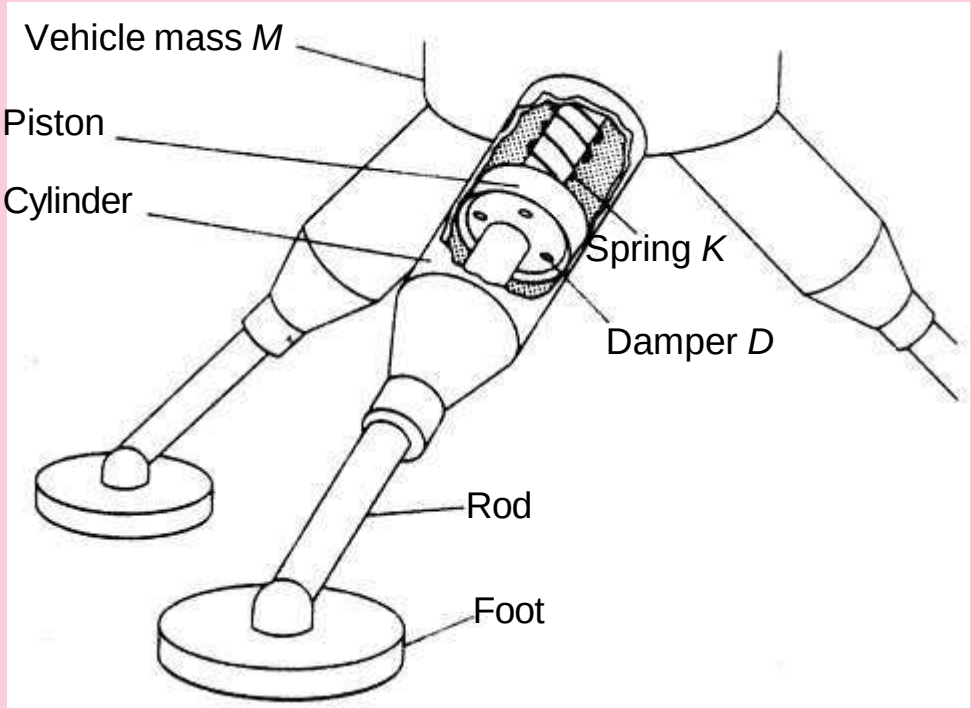
	Translational Systems	Rotational Systems
Kinetic Energy	$KE = \frac{1}{2} M_{eq} \dot{y}^2$	$KE = \frac{1}{2} J_{eq} \dot{\theta}^2$
Potential Energy	$PE = \frac{1}{2} K_{eq} y^2$	$PE = \frac{1}{2} K_{eq} \theta^2$
Dissipated Energy	$\frac{dDE}{dt} = D_{eq} \dot{y}^2$	$\frac{dDE}{dt} = \frac{1}{2} D_{eq} \dot{\theta}^2$

第13.2節

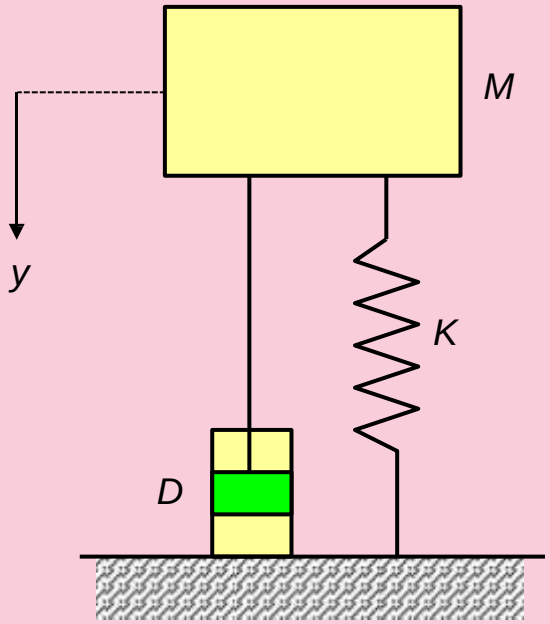
實例: 登陸系統的彈簧及阻尼設計

Design of Spring/Damper in a Recoil Landing System

13.2.1 Problem Description



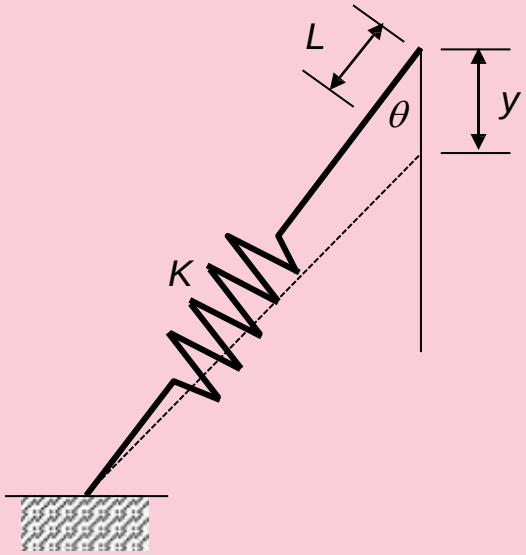
13.2.2 Modeling Considerations



$$M\ddot{y} + D\dot{y} + Ky = 0$$

$$y(0) = 0,\ \dot{y}(0) = V_0$$

13.2.3 Equivalent Spring/Damper



$$PE = 3 \times \frac{1}{2} K (y \cos\theta)^2$$

$$K_{eq} = 3K(\cos\theta)^2$$

$$\frac{dDE}{dt} = 3 \times D(\dot{y} \cos\theta)^2$$

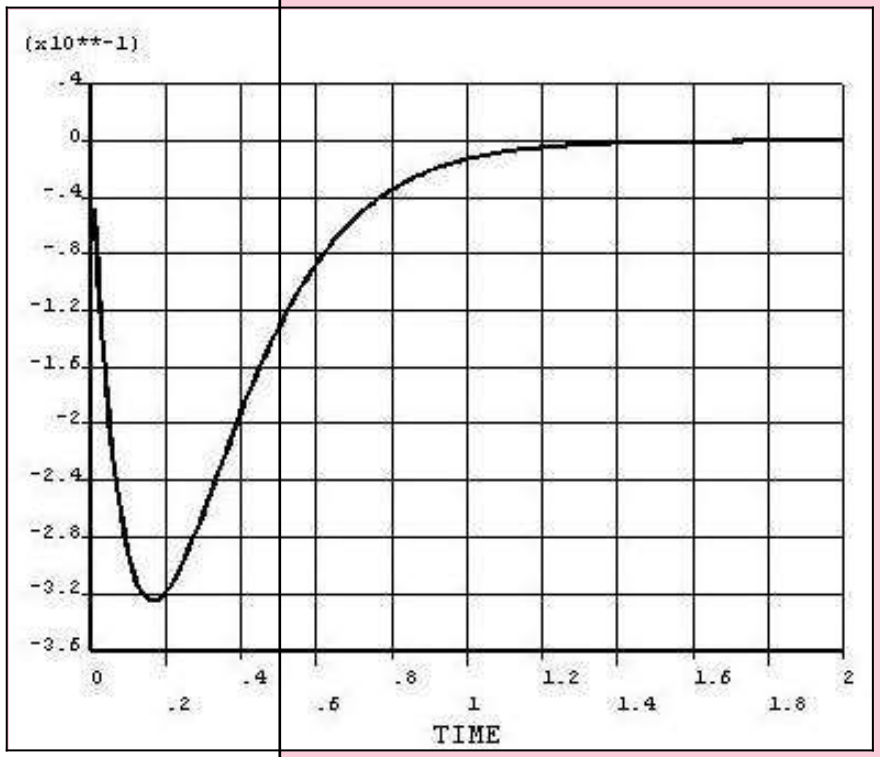
$$D_{eq} = 3D(\cos\theta)^2$$

13.2.4 ANSYS Procedure (1/2)

```
01  FINISH
02  /CLEAR
03  /TITLE, Recoil Landing System (SI)
04  /PREP7
05
06    K   = 72000
07    M   = 2000
08    D   = 24000   ! Critically damped
09    V0 = 5        ! 18 km/Hr
10
11    ET, 1, COMBIN14,,, 2
12    ET, 2, MASS21,,, 4
13    R, 1, K, D
14    R, 2, M
15
16    N, 1, 0   ! Ground
17    N, 2, 1   ! Vehicle
18    TYPE, 1 $ REAL, 1 $ E, 1, 2
19    TYPE, 2 $ REAL, 2 $ E, 2
20    FINISH
```

13.2.4 ANSYS Procedure (2/2)

```
22  /SOLU
23
24    ANTYPE, TRANS
25    TRNOPT, FULL
26    D, ALL, UY, 0
27    D, 1, UX, 0
28     IC, 2, UX, 0, -V0
29    DELTIM, 0.01
30    TIME, 2
31     OUTRES, NSOL, ALL
32    SOLVE
33    FINISH
34
35  /POST26
36
37    NSOL, 2, 2, U, X, DISP
38    /GRID, 1
39    /AXLAB, Y, DISPLACEMENT
40    PLVAR, 2
```

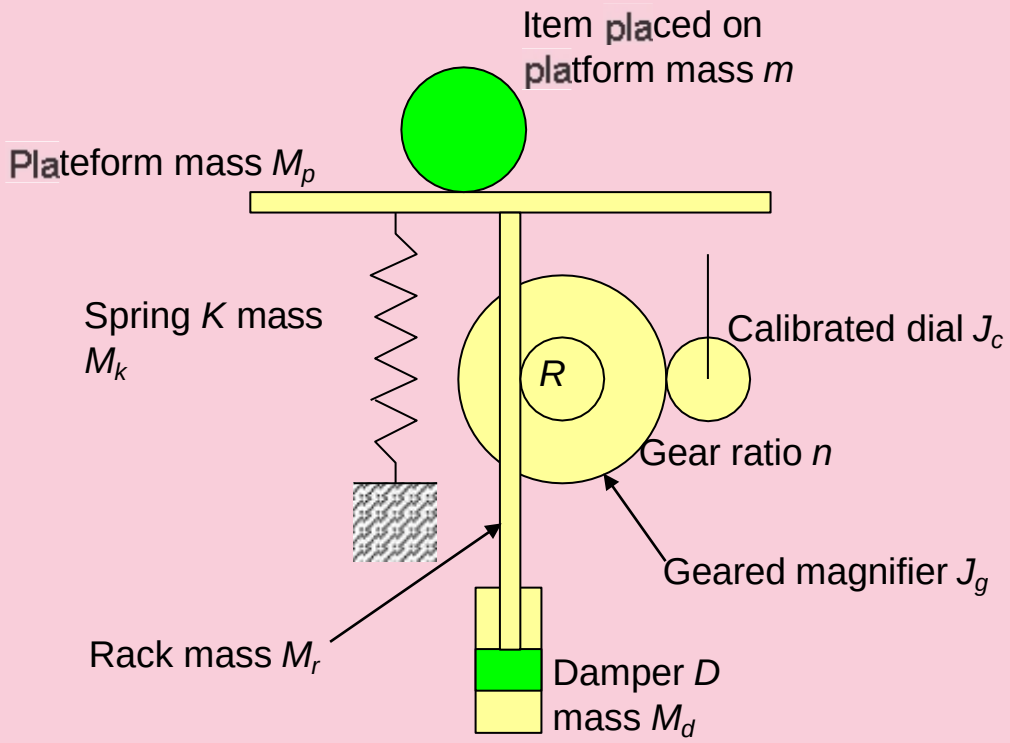


第13.3節

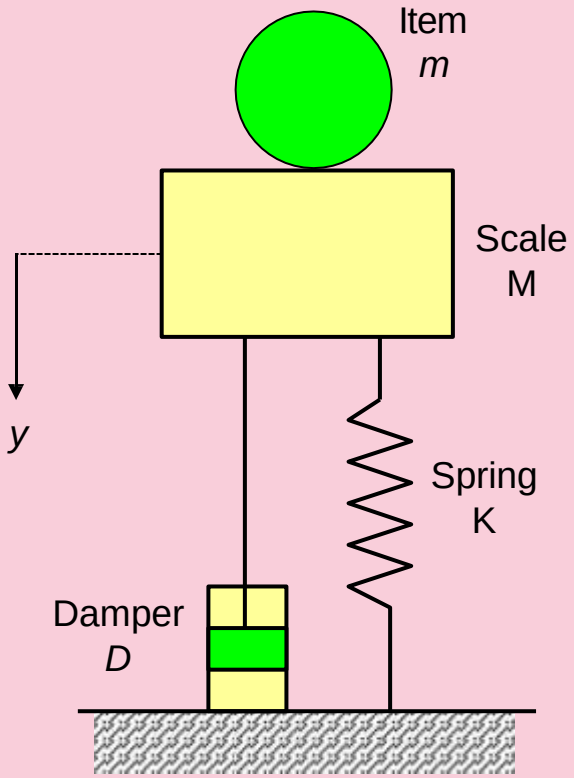
實例: 磅秤的阻尼設計

Design of Damper in a Spring Scale

13.3.1 Problem Description



13.3.2 Modeling Considerations



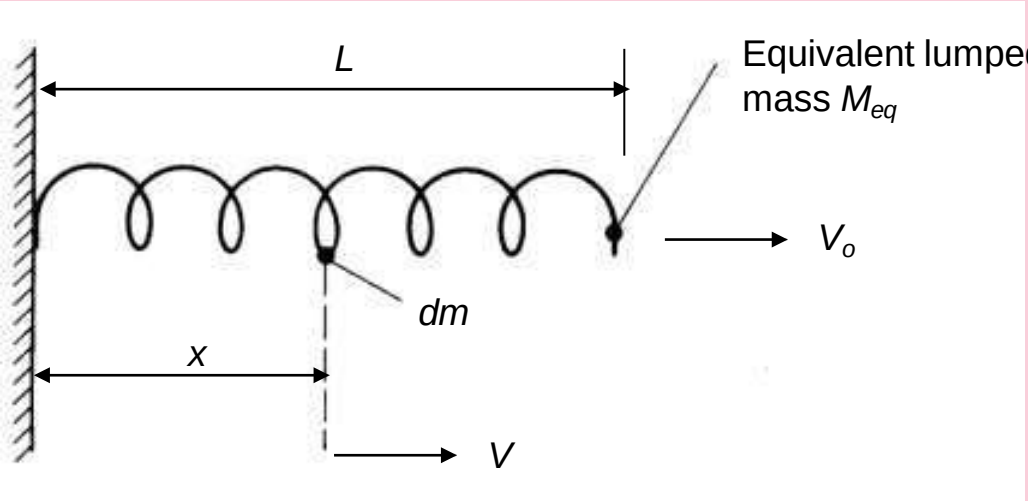
$$(m+M)\ddot{y}+D\dot{y}+Ky=$$

$$y(0$$

$$M = M_p + M_r + M_d + \frac{M_k}{3} + \frac{J_g}{R^2} + \frac{J_c n^2}{R^2}$$

13.3.3 Lumped Masses (1/4)

Lumped Mass for a Spring



$$V = \frac{V_o x}{L}$$

$$KE = \int_L \frac{1}{2} V^2 dm = \int_L \frac{1}{2} \left(\frac{V_o x}{L}\right)^2 M$$

$$M_{eq} = \frac{M_k}{3}$$