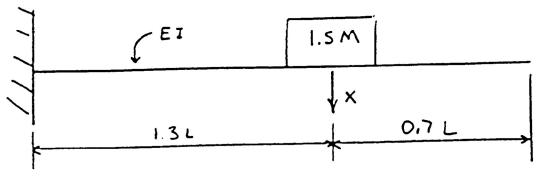
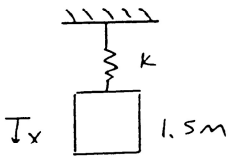
2.1



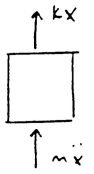
SOLUTION

d'ALEMBERT'S PRINCIPLE

$$\Sigma (\text{FORCES})_x - m\ddot{x} = 0$$



FBD



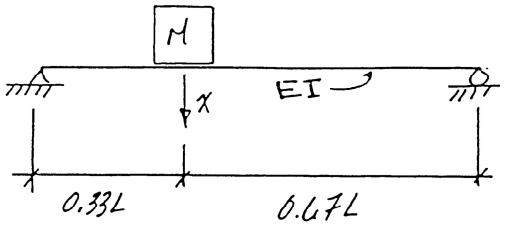
$$kx + m\ddot{x} = 0$$

$$\ddot{x} + \frac{k}{m}x = 0 \qquad \text{EQUATION OF MOTION}$$

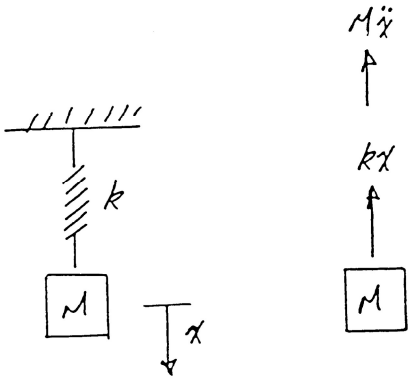
$$k = \frac{3EI}{(1.3L)^3}$$

$$\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{3EI}{1.5M(1.3L)^3}} = 0.954\sqrt{\frac{EI}{ML^3}}$$

2.2



Solution:



2.2 Cont.

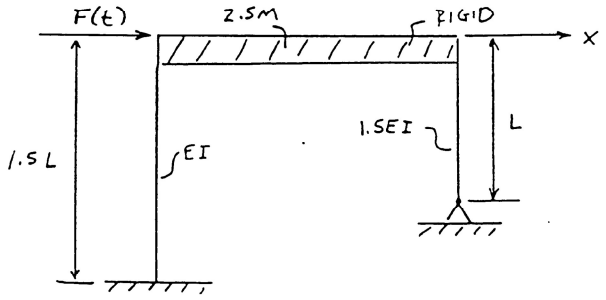
Equation of motion: $M\ddot{x} + kx = 0$ or $\ddot{x} + \frac{k}{M}x = 0$

$$k = \frac{6EIL}{(0.33L)(L-0.33L)\left[2L(0.33L) - (0.33L)^2 - (0.33L)^2\right]}$$

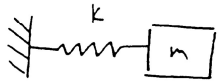
$$k = \frac{61.37EI}{L^3}$$

Natural Frequency: $\omega = \sqrt{\frac{k}{M}} = 7.834\sqrt{\frac{EI}{ML^3}}$

2.3



SOLUTION



FBD

$m = 2.5M$

$\Sigma(\text{FORCES})_x - m\ddot{x} = 0$ $\qquad F(t) - kx - m\ddot{x} = 0$

$\ddot{x} + \frac{k}{m}x = \frac{F(t)}{m}$ EQUATION OF MOTION

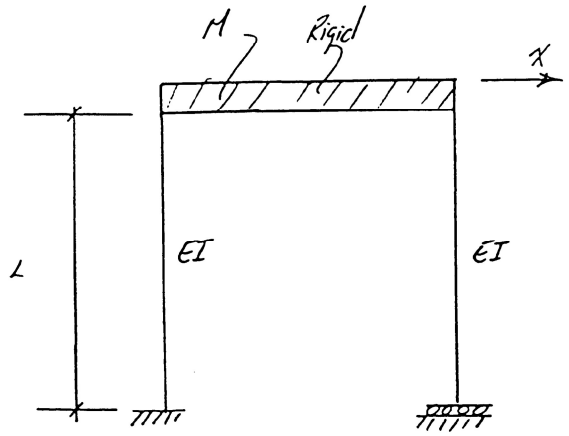
$$k = \frac{12EI}{(1.5L)^3} + \frac{3(1.5EI)}{L^3}$$

$$= \frac{12(30\times10^6)(150)}{(1.5\times12\times12.0)^3} + \frac{3(1.5)(30\times10^6)(150)}{(12.0\times12)^3}$$

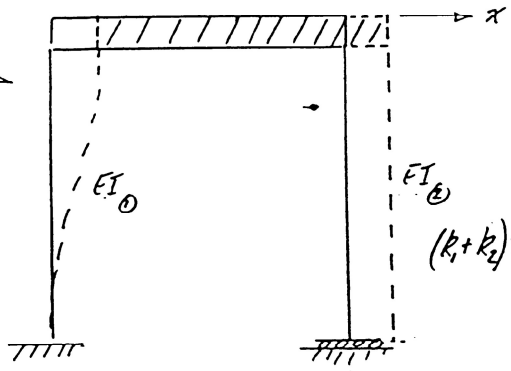
$$= 12{,}140 \text{ LB/IN}$$

$$\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{12{,}140 \text{ LB/IN}}{2.5(1.0 \text{ LB}\cdot\text{SEC}^2/\text{IN})}} = 69.7 \text{ rad/sec}$$

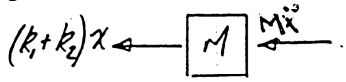
2.4



deflected shape →



free body



equation of motion: $\boxed{M\ddot{x} + kx = 0 \quad \text{or} \quad \ddot{x} + \frac{k}{M}x = 0}$ Ans

$k_① = \frac{12EI}{L^3}$

$k_② = 0$

natural freq.: $\boxed{\omega = \sqrt{\frac{k}{M}} = \left(\frac{12EI}{ML^3}\right)^{1/2}}$ Ans

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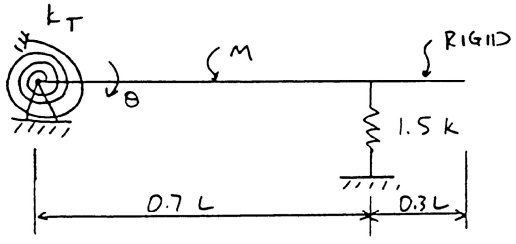
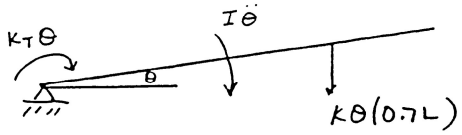
2.5



2.5 Cont.

SOLUTION



$\Delta = 0.7L \sin\theta \approx 0.7L\theta$ FOR SMALL θ

$I = \frac{mL^2}{3}$ (ABOUT PIVOT π)

$\Sigma M - I\ddot{\theta} = 0$

$K_T\theta + k(0.7L)\Delta + I\ddot{\theta} = 0$

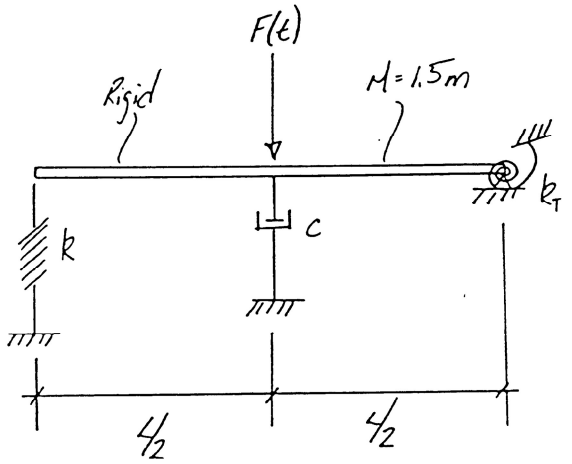
$k_T\theta + k(0.7L)^2\theta + I\ddot{\theta} = 0$

$\frac{mL^2}{3}\ddot{\theta} + k(0.7L)^2\theta + k_T\theta = 0$

$\ddot{\theta} + \frac{3[k(0.7L)^2 + K_T]}{mL^2}\theta = 0$ EQUATION OF MOTION

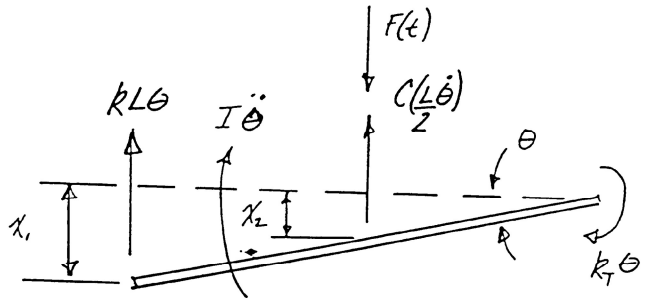
$\omega = \sqrt{\frac{3k(0.7L)^2 + 3k_T}{mL^2}}$ NATURAL FREQUENCY

2.6



Solution:

free body



$x_1 = L\sin\theta$ small disp $= L\theta$

$x_2 = \frac{L}{2}\sin\theta$ small disp $= \frac{L}{2}\theta$

$\dot{x}_2 = \frac{L}{2}\dot{\theta}$