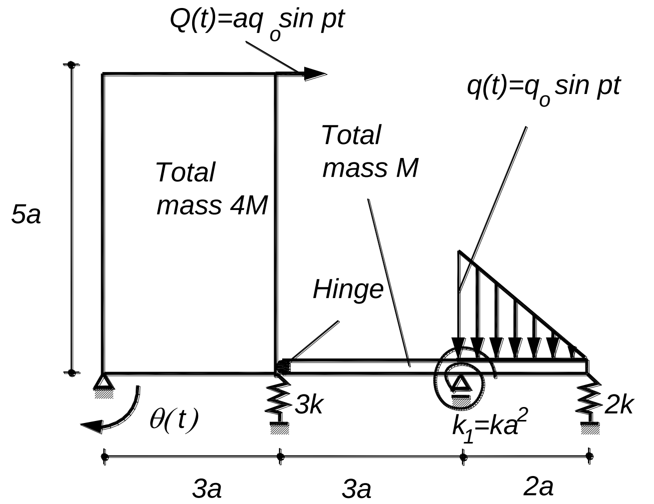
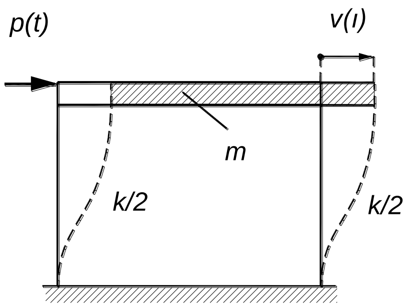
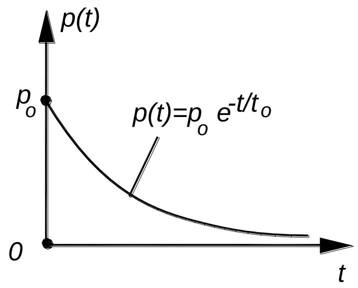
ADVANCED DYNAMICS OF STRUCTURES / QUIZ / November 11, 2009

1. Write down the equation of motion of the rigid-body assemblage in terms of $\theta(t)$ the rotation angle of the support by using the principle of the virtual work. Obtain the free vibration period $T = \alpha\sqrt{M/k}$ of the assemblage and determine α. Find p for the resonance condition in terms of the parameters of the system M, k and a.



2. Obtain the displacement function $v(t)$ of the undamped SDOF system subjected to the external load $p(t) = p_o\, e^{-t/t_o}$ assuming that the system starts from the rest, i.e., $v(t=0) = \dot{v}(t=0) = 0$. m and k denote the mass and the stiffness of the system, respectively.





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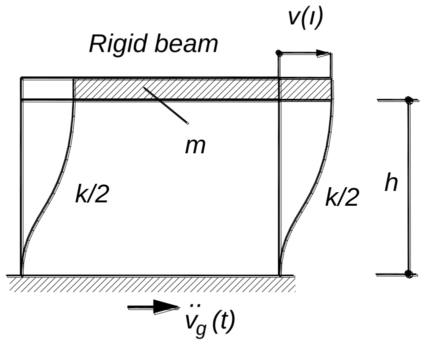
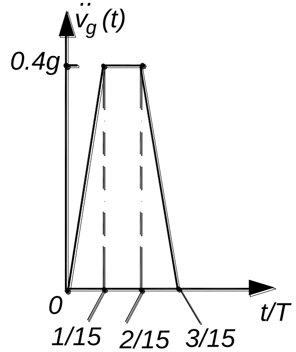
3. The frame shown can be assumed as a single-degree-of-freedom system and it is subjected to a ground motion of impulse character $\ddot{v}_g(t)$, where t and T denote the time and the period of the system, respectively. Find out the displacement $v(t)$, the velocity $\dot{v}(t)$ and the acceleration $\ddot{v}(t)$ and their maximum values by assuming that the system starts from the rest, i.e., $v(t=0) = \dot{v}(t=0) = 0$. m and k denote the mass and the lateral stiffness of the system. Obtain the period of the system T, the maximum shearing force $V_{\max}$ and the maximum bending moment $M_{\max}$ in the columns by assuming. $m\,g = 80kN$, $k = 400kN/m$ and $h = 10m$





General equations

$m\,\ddot{v} + c\,\dot{v} + k\,v = -m\,\ddot{v}_g(t)$ $\quad \ddot{v} + 2\,\xi\,\omega\,\dot{v} + \omega^2\,v = -\ddot{v}_g(t)$ $\quad \xi = c/(2m\omega)$

$m\,\ddot{v} + c\,\dot{v} + k\,v = p(t)$ $\quad v(t) = -\dfrac{1}{\omega_D}\int_0^t \ddot{v}_g(\tau)\exp[-\xi\,\omega\,t]\sin\omega_D\,(t-\tau)\,d\tau$

$I = \int_0^{t_1} p(t)\,dt$ $\quad v(t) = \dfrac{1}{m\,\omega}\int_0^t p(\tau)\sin\omega\,(t-\tau)\,d\tau$ $\quad v(t) = \dfrac{I}{m\,\omega}\sin\omega\,t$

$I = -\int_0^{t_o} m\,\ddot{v}_g(t)\,dt$ $\quad \omega = 2\,\pi/T$ $\quad \omega_D^2 = \omega^2\,(1-\xi^2)$ $\quad \omega_D = 2\,\pi/T_D$

$v(t) = \dfrac{I}{m\,\omega_D}\exp[-\xi\,\omega\,t]\sin\omega_D t$ $\quad I_\theta = \dfrac{M}{12}(a^2+b^2)$

$v(t) = \dfrac{1}{m\,\omega_D}\int_0^t p(\tau)\exp[-\xi\,\omega\,t]\sin\omega_D\,(t-\tau)\,d\tau$