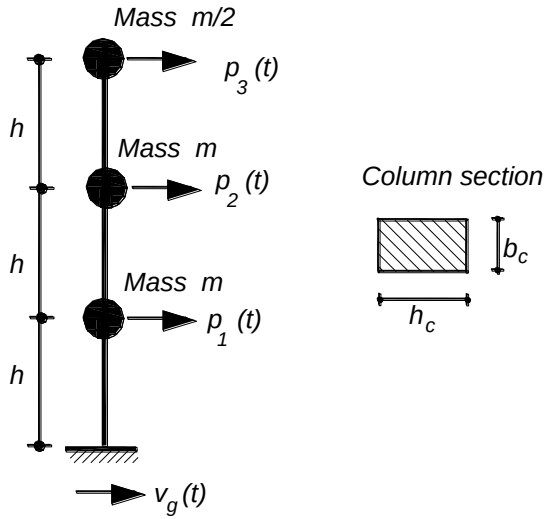
ADVANCED DYNAMICS OF STRUCTURES / Home Work 2 / November 25, 2009
H.Boduroğlu / Z. Celep

Consider the column which can be represented as a system of three degrees-of-freedom shown:

a. Write down the equations of motion of the system shown by including the ground motion $v_g(t)$ and the external load $p_i(t)$ and evaluate the mass matrix **m**, the rigidity matrix **k,** and the flexibility matrix $\mathbf{k} = \mathbf{d}^{-1}$,
b. Determine the three circular frequencies and the periods of the free vibration ω_i and T_i and the corresponding mode shapes $\boldsymbol{\phi}_i$. Give their graphical representation ($i = 1, 2, 3$),
c. Check the orthogonality of the modes with respect to the mass matrix and the stiffness matrix $\boldsymbol{\phi}_1^T \mathbf{m}\, \boldsymbol{\phi}_2$, $\boldsymbol{\phi}_1^T \mathbf{m}\, \boldsymbol{\phi}_3$ and $\boldsymbol{\phi}_1^T \mathbf{k}\, \boldsymbol{\phi}_2, \boldsymbol{\phi}_1^T \mathbf{k}\, \boldsymbol{\phi}_3$,
d. Evaluate the generalized masses and stiffness $M_i = \boldsymbol{\phi}_i^T \mathbf{m}\, \boldsymbol{\phi}_i$, and $K_i = \boldsymbol{\phi}_i^T \mathbf{k}\, \boldsymbol{\phi}_i$, and assess $\omega_i^2 = K_i / M_i$.
e. Obtain the first free vibration mode shapes $\boldsymbol{\phi}_1$ and the corresponding the first circular frequencies ω_1 of the system by using Stodola method or the inverse iteration method with shift.
f. The heights of the stories are $h = 3$ *meter*, the column has a cross section of $0.50m \times 0.90m$, the first period of the system is $T_1 = 0.25s$ and $E = 30GPa$. Find the numerical values of the mass m, the second period T_2 and the third period T_3 of the system.



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