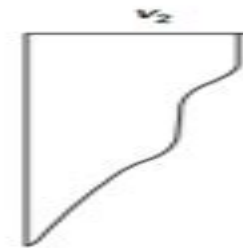
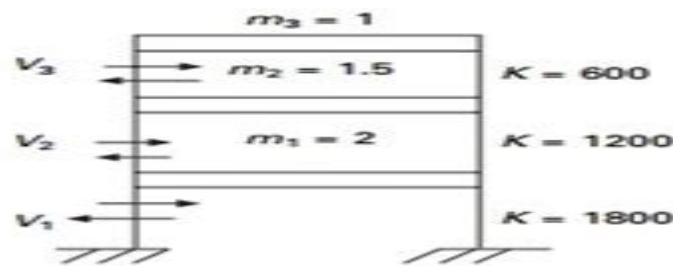


$$\begin{Bmatrix} V_3 \\ v_2 \end{Bmatrix} = \begin{bmatrix} 1 & m_3 p \\ -\frac{1}{k_3} & 1 - \frac{m_3 p}{k_3} \end{bmatrix} \begin{Bmatrix} V_4=0 \\ v_3 \end{Bmatrix} = [a] \begin{Bmatrix} 0 \\ 1 \end{Bmatrix} \quad 11.45$$

$$\begin{Bmatrix} V_2 \\ v_1 \end{Bmatrix} = \begin{bmatrix} 1 & m_2 p \\ -\frac{1}{k_2} & 1 - \frac{m_2 p}{k_2} \end{bmatrix} \begin{Bmatrix} V_3 \\ v_2 \end{Bmatrix} = [b] \begin{Bmatrix} V_3 \\ v_2 \end{Bmatrix} = [b][a] \begin{Bmatrix} 0 \\ 1 \end{Bmatrix} \quad 11.46$$



11.3 Three storeyed shear frame.

$$\begin{Bmatrix} V_1 \\ v_0 \end{Bmatrix} = \begin{bmatrix} 1 & m_1 p \\ -\frac{1}{k_1} & 1 - \frac{m_1 p}{k_1} \end{bmatrix} \begin{Bmatrix} V_2 \\ v_1 \end{Bmatrix} = [c] \begin{Bmatrix} V_2 \\ N_1 \end{Bmatrix} = [c][b][a] \begin{Bmatrix} 0 \\ 1 \end{Bmatrix}$$

$$(c)[b][a] \begin{Bmatrix} 0 \\ 1 \end{Bmatrix} = \{d\} = \begin{Bmatrix} V_1 \\ v_0 \end{Bmatrix} \quad 11.47$$

$$d(2, 1.5, 1, 1800, 1200, 600, 211) = \begin{Bmatrix} 543.43 \\ -4504 \times 10^{-4} \end{Bmatrix} \quad 11.48$$

For,  $p = 211$ ,  $v_0 = 0$ . Hence

$$\omega_n = \sqrt{211} = 14.520 \text{ rad/s} \quad 11.49$$

One we get natural frequency one can also get the mode shape as shown below.

$$\begin{Bmatrix} V_3 \\ v_2 \end{Bmatrix} = \begin{bmatrix} 1 & 211 \\ -\frac{1}{600} & 1 - \frac{211}{600} \end{bmatrix} \begin{Bmatrix} V_4 = 0 \\ v_3 = 1 \end{Bmatrix} = \begin{Bmatrix} 211 \\ 0.648 \end{Bmatrix} \quad 11.50$$

$$\begin{Bmatrix} V_2 \\ v_1 \end{Bmatrix} = \begin{bmatrix} 1 & 316.5 \\ -\frac{1}{1200} & 1 - \frac{316.5}{1200} \end{bmatrix} \begin{Bmatrix} V_3 = 211 \\ v_2 = 0.648 \end{Bmatrix} = \begin{Bmatrix} 416.198 \\ 0.3015 \end{Bmatrix} \quad 11.51$$

$$\begin{Bmatrix} V_1 \\ v_0 \end{Bmatrix} = \begin{bmatrix} 1 & 422 \\ -\frac{1}{1800} & 1 - \frac{422}{1800} \end{bmatrix} \begin{Bmatrix} V_2 = 416.198 \\ v_1 = 0.3015 \end{Bmatrix} = \begin{Bmatrix} 543.43 \\ 0 \end{Bmatrix} \quad 11.52$$

Hence mode shape is given by

$$\{\psi\} = \begin{Bmatrix} 0.3015 \\ 0.648 \\ 1 \end{Bmatrix} \quad 11.53$$

The base shear = 543.43 N.

# Formulas For Natural Frequency And Mode Shape

**Shrikant Bhawe**



## **Formulas For Natural Frequency And Mode Shape:**

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