From analysis;

Model → T = 0.606 s

Mode 2 → T = 0.585 s

Mode 3 → T = 0.582 s

for weights;

0.25×0.45×16×5×25 + 0.25×0.45×32×5×25 = 675 kN = 68.8 tons (beams)

0.25×0.4×3×12×5×25 + 0.4×0.4×3×3×25 = 900 kN = 91.74 tons (columns)

16×8×0.15×5×25 = 2400 kN = 244.65 tons (slabs)

for one floor

≈ 48.93 tons ~ slab
13.76 tons ~ beam
18.35 tons ~ column
+
Σ 81 tons / floor.

Story height = 3 m.
Beams → 25×45 cm
square columns → 40×40
slab thickness → 15 cm
a = b = 4m
column → 25×50
N = 5

$$\frac{m(a^2+b^2)}{12} = \frac{81(16^2+8^2)}{12} = 2160 = I$$

mass matrix can be written in the following form

$$M = \begin{bmatrix} 81 & & & & & & \\ & 81 & & & & & \\ & & 2160 & & 0 & & \\ & & & 81 & & & \\ & & & & 81 & & \\ & & & & & 2160 & \\ & & 0 & & & & \ddots \end{bmatrix}_{15\times 15}$$

Mode 1 (T=0.606s)

$$K = \begin{Bmatrix} 1.189\times10^{-11} \\ -4.707\times10^{-12} \\ 7.844\times10^{-11} \\ \hline -1.538\times10^{-11} \\ -1.226\times10^{-12} \\ 1.479\times10^{-10} \\ \hline 2.384\times10^{-11} \\ -3.098\times10^{-12} \\ 2.016\times10^{-10} \\ \hline -1.811\times10^{-11} \\ -3.926\times10^{-12} \\ 2.376\times10^{-10} \\ \hline -7.41\times10^{-13} \\ 1.414\times10^{-11} \\ 2.556\times10^{-10} \end{Bmatrix} \qquad \Phi_1 = \begin{Bmatrix} 0.152 \\ -0.06 \\ 1 \\ \hline -0.196 \\ -0.0156 \\ 1.89 \\ \hline 0.304 \\ -0.0395 \\ 2.57 \\ \hline -0.23 \\ -0.048 \\ 3.03 \\ \hline -9.45\times10^{-3} \\ 0.18 \\ 3.26 \end{Bmatrix} \qquad M = \begin{bmatrix} 81 & & & \\ & 81 & & \\ & & 2160 & \\ & & & \ddots \end{bmatrix}$$

$M_1 = \Phi_1^T . m . \Phi_1 = 66949$ tons

$L_1 = \Phi_1^T . m . I = 25383$ tons

$M_1^* = \dfrac{(25383)^2}{66949} = 9623.7$ tons

Sal → T=0.606 → Sal = 0.125g

$$J_1 = \frac{L_1}{M_1}(m.\Phi_1).Sal = \frac{25383}{66949}(m\Phi_1).0.125\times9.81$$

0.465

$$0.465.\{m.\Phi_1\}$$

$$J_1 = \begin{Bmatrix} 5.72 \\ -2.28 \\ 1004.4 \\ \hline -7.39 \\ -0.60 \\ 1898.3 \\ \hline 11.44 \\ -1.49 \\ 2581.3 \\ \hline -8.65 \\ -1.81 \\ 3043.3 \\ \hline -0.372 \\ 6.39 \\ 3274.3 \end{Bmatrix} \text{kN, kN.m}$$

Mode 2 ($T = 0.585$)

$$u = \begin{Bmatrix} 0.0136 \\ 0 \\ 0 \\ \hline 0.0321 \\ 0 \\ 0 \\ \hline 0.0082 \\ 0 \\ 0 \\ \hline 0.06 \\ 0 \\ 0 \\ \hline 0.0466 \\ 0 \\ 0 \end{Bmatrix} \Rightarrow \phi_2 = \begin{Bmatrix} 1 \\ 0 \\ 0 \\ \hline 2.36 \\ 0 \\ 0 \\ \hline 3.54 \\ 0 \\ 0 \\ \hline 4.4 \\ 0 \\ 0 \\ \hline 4.9 \\ 0 \\ 0 \end{Bmatrix} \quad m = \begin{bmatrix} 81 & & & & \\ & 81 & & & \\ & & 216.0 & & \\ & & & \ddots & \\ & & & & \end{bmatrix}_{15\times15}$$

$M_2 = \phi_2^T . m . \phi_2 = 5060.2$ tons (matlab used)

$L_2 = \phi_2^T . m . 1 = 1312.2$ tons

$M_2^* = \dfrac{(1312.2)^2}{5060.2} = 340.28$ tons

$T = 0.585 \rightarrow$ from response spectrum

$Sa_2 = 0.125g$

$$F_2 = \frac{L_2}{M_2} . (m . \phi_2) . Sa_2 = \frac{1312.2}{5060.2} (m . \phi_2) . 0.125 \times 9.81$$

$$= \frac{1312.2}{5060.2} \begin{Bmatrix} 81 \\ 0 \\ 0 \\ \hline 191.16 \\ 0 \\ 0 \\ \hline 286.74 \\ 0 \\ 0 \\ \hline 356.4 \\ 0 \\ 0 \\ \hline 396.9 \\ 0 \\ 0 \end{Bmatrix} (0.316) . 0.125 \times 9.81 = \begin{Bmatrix} 25.76 \\ 0 \\ 0 \\ \hline 60.79 \\ 0 \\ 0 \\ \hline 91.18 \\ 0 \\ 0 \\ \hline 113.33 \\ 0 \\ 0 \\ \hline 126.2 \\ 0 \\ 0 \end{Bmatrix} \text{kN}$$

Mode 3 (T = 0.582 s)

$$\mathcal{L} = \begin{Bmatrix} 0 \\ 0.0136 \\ 0 \\ \hline 0 \\ 0.0319 \\ 0 \\ \hline 0 \\ 0.048 \\ 0 \\ \hline 0 \\ 0.06 \\ 0 \\ \hline 0 \\ 0.0668 \\ 0 \\ \hline \end{Bmatrix} \Rightarrow \phi_3 = \begin{Bmatrix} 0 \\ 1 \\ 0 \\ \hline 0 \\ 2.35 \\ 0 \\ \hline 0 \\ 3.53 \\ 0 \\ \hline 0 \\ 4.4 \\ 0 \\ \hline 0 \\ 4.9 \\ 0 \\ \hline \end{Bmatrix}$$

$M_3 = \phi_3^T . m . \phi_3 = 5050.6$ tons

$L_3 = \phi_3^T . m . \mathcal{L} = 1310.3$ tons

$M_3^* = \dfrac{(1310.3)^2}{5050.6} = 339.94$ tons

$Sa_3 \rightarrow 0.582 \rightarrow 0.125g$

0.318

$$f_3 = \frac{L_3}{M_3} \times (m \times \phi_3) \times Sa_3 = \frac{1310.3}{5050.6} \times (m \times \phi_3) \times 0.125 \times 9.81$$

$$f_3 = \begin{Bmatrix} 0 \\ 25.76 \\ 0 \\ \hline 0 \\ 60.53 \\ 0 \\ \hline 0 \\ 90.93 \\ 0 \\ \hline 0 \\ 113.3 \\ 0 \\ \hline 0 \\ 126.2 \\ 0 \\ \hline \end{Bmatrix} \text{KN}$$

Minimum:

$$\sum_{n=1}^{Y} M_{xn} = \sum_{n=1}^{Y} \frac{L_{xn}^2}{M_n} \geq 0.9 \sum_{i=1}^{N} m_i$$

$$\sum_{n=1}^{Y} M_{yn} = \sum_{n=1}^{Y} \frac{L_{yn}^2}{M_n} \geq 0.9 \sum_{i=1}^{N} m_i$$

$0.9 \cdot \sum m = 0.9 \times 405 = 364.5$ tons

$0.9 \sum I = 0.9 \times 2160 \times 5 = 9720$ tons m^2

For 3 first modes

$M_1^* = 9623.7$ tons < 9720 tons $\Rightarrow$ not OK!

$M_2^* = 346.28$ tons < 364.5 tons $\rightarrow$ not OK!

$M_3^* = 339.96$ tons < 364.5 tons $\rightarrow$ not OK!

$\Rightarrow$ So for Mode 4

$$\phi_4 = \begin{Bmatrix} -1.59 \\ 0.026 \\ -29.55 \\ 1.99 \\ -0.62 \\ -45.64 \\ -1.84 \\ -9.4 \times 10^{-3} \\ -62.02 \\ 1.33 \\ -0.41 \\ -61.74 \\ -0.52 \\ 1.5 \\ -66.37 \end{Bmatrix}$$

$$u = \begin{Bmatrix} -1.248 \times 10^{-10} \\ 2.611 \times 10^{-12} \\ -2.318 \times 10^{-9} \\ 1.36 \times 10^{-10} \\ -4.292 \times 10^{-11} \\ -3.58 \times 10^{-9} \\ -1.440 \times 10^{-10} \\ -7.374 \times 10^{-13} \\ -4.865 \times 10^{-9} \\ 1.044 \times 10^{-10} \\ -8.233 \times 10^{-11} \\ -4.243 \times 10^{-9} \\ -4.117 \times 10^{-11} \\ 1.12 \times 10^{-10} \\ -5.206 \times 10^{-9} \end{Bmatrix}$$

$M_4 = \phi_4^T . m . \phi_4 = 32443 \times 10^3$

$L_4 = \phi_4^T . m . I = -573100$

$$M_4^* = \frac{(-573100)^2}{32443 \times 10^3} = 10123.7 \text{ tons}$$

$\Rightarrow$ So after calculating mode 5 and 6 it will be seen that minimum 6 mode will be adequate according to code.