2.4. MULTI-MODE RESPONSE SPECTRUM ANALYSIS METHOD

In this method, maximum internal forces and displacements are determined by the statistical combination of maximum contributions obtained in sufficient number of natural vibration modes to be considered.

2.4.1. Dynamic degrees of freedom

2.4.1.1 – In buildings where floors behave as rigid horizontal diaphragms, two horizontal degrees of freedom in perpendicular directions and a rotational degree of freedom with respect to the vertical axis passing through mass centre shall be considered at each storey. At each floor, modal seismic loads defined for those degrees of freedom shall be applied to the floor mass centre as well as to the points defined by shifting it +5% and −5% of the floor length in the perpendicular direction to the earthquake direction considered. The latter is to account for the *accidental eccentricity effects*.

2.4.1.2 – In buildings where torsional irregularity exists and floors do not behave as rigid horizontal diaphragms, sufficient number of dynamic degrees of freedom shall be considered to model in-plane deformation of floors.

2.4.2. Modal seismic loads

2.4.2.1 – In a typical n'th vibration mode considered in the analysis, modal seismic loads acting on the i'th story level at the mass centre of the floor diaphgram is expressed by **Eqs.(2.14)**.

$$\begin{aligned} F_{\mathrm{xin}} &= M_{\mathrm{i}}\ \Phi_{\mathrm{xin}}\ \Gamma_{\mathrm{xn}}\ S_{\mathrm{AR}}(T_{\mathrm{n}}) \\ F_{\mathrm{yin}} &= M_{\mathrm{i}}\ \Phi_{\mathrm{yin}}\ \Gamma_{\mathrm{xn}}\ S_{\mathrm{AR}}(T_{\mathrm{n}}) \\ F_{\theta\mathrm{in}} &= M_{\theta\mathrm{i}}\ \Phi_{\theta\mathrm{in}}\ \Gamma_{\mathrm{xn}}\ S_{\mathrm{AR}}(T_{\mathrm{n}}) \end{aligned} \qquad \textbf{(2.14)}$$

where Γ_{xn} represents the participation factor of the n'th mode under an eartquake ground motion in x direction. For buildings with rigid floor diaphragms Γ_{xn} is defined as

$$\Gamma_{\mathrm{xn}} = \frac{L_{\mathrm{xn}}}{M_{\mathrm{n}}^{*}} \qquad \textbf{(2.15)}$$

in which L_{xn} and M_{n}^{*} are as expressed in **2.4.3**.

2.4.2.2 – In buildings with very stiff reinforced concrete peripheral walls at their basements, unless a full modal analysis of the structural system is performed, modal seismic loads (as defined in **2.4.2.1**) acting on stiff basement stories and those acting on relatively flexible upper stories may be calculated separately as given in **(a)** and **(b)** below.

(a) In calculating modal seismic loads acting on relatively flexible upper stories, *the lowest vibration modes* that are effective in the upper stories may be considered, which can be achieved by taking into account the seismic masses of the *upper stories only*. In this case, appropriate behaviour factor *q* must be selected from **Chapter 3** or **Chapter 4**, as appropriate, based on the structural type of the *upper stories only*.

(b) In determining modal seismic loads acting on stiff basement stories, *the highest vibration modes* that are effective in the basements may be considered, which can be achieved by taking