6.3 Seismic stresses

6.3.1 Seismic accelerations

The seismic accelerations a_{XX}, a_{XY}, a_{XZ} [10] of each diaphragm are obtained under the X horizontal component of the seismic action using appropriate methods (e.g. the CQC method applied by the related software) from the combination of the modal analysis results. Their application point of the seismic accelerations is the diaphragm's centre of mass. For nodes not belonging to a diaphragm, such as the nodes of the corner column of the building illustrated in the figure, the application point of the seismic accelerations is the node position.

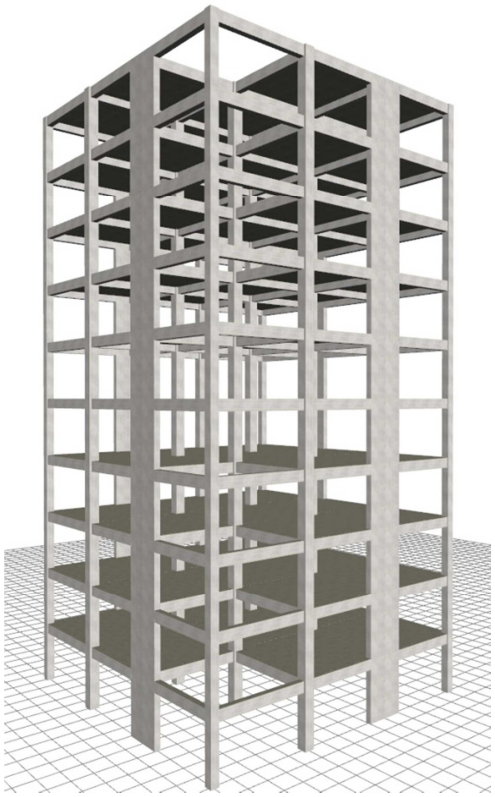

Figure 6.3.1-1: Ten-storey building of mixed system. Diaphragmatic and non-diaphragmatic nodes. Project <B_547-2>

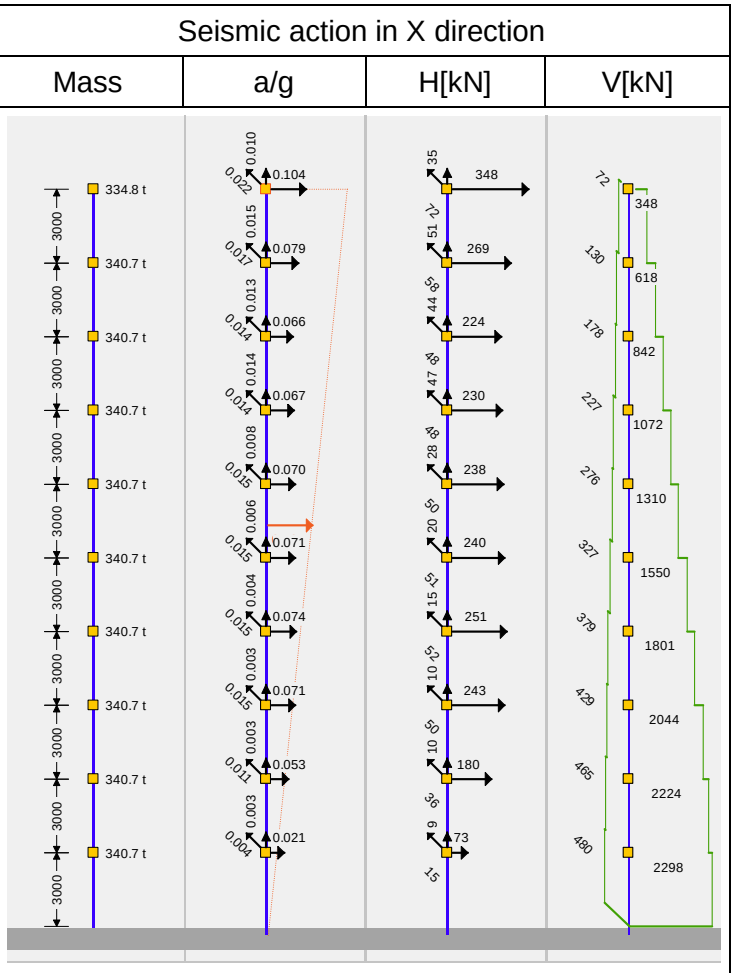

Figure 6.3.1-2: Page from the software report Distribution of seismic accelerations-forces-shear forces

The nodal seismic forces H_{XX}, H_{XY} και H_{XZ} are obtained from the nodal seismic accelerations multiplied by the nodal mass. The seismic accelerations and forces due to a horizontal component (X and Y) of the seismic action are not only developed in the direction considered but also in the other horizontal direction and the vertical.

[10] Seismic acceleration a_{XX} means acceleration in X due to seismic action in X, a_{XY} means acceleration in Y due to seismic action in X and a_{XZ} means acceleration in Z due to seismic action in X.

Modal analysis results of the frame type structure

Fixed condition at the ground level (project <B_641-1>)

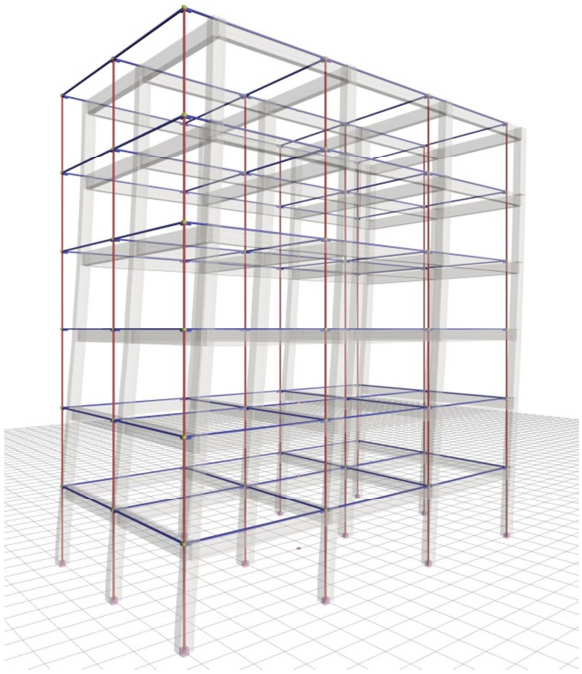

Figure 6.4.1-2: 1st mode in X:
T=0.975 sec, participation 84%

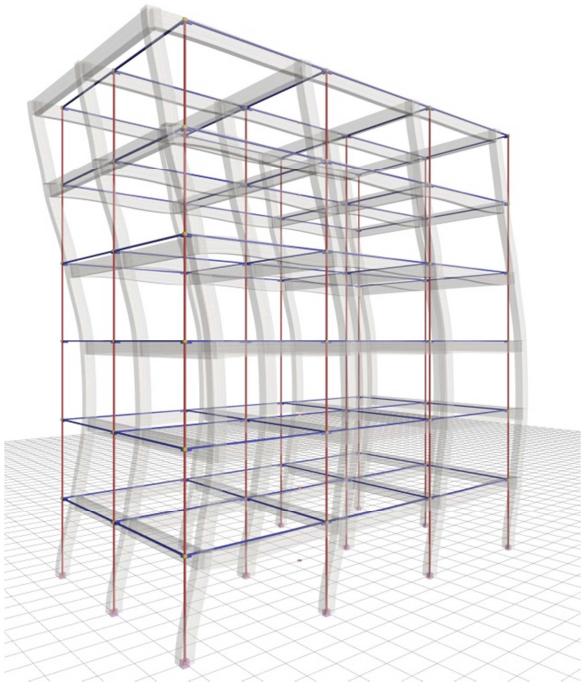

Figure 6.4.1-3: 2nd mode in X:
T=0.321 sec, participation 10%

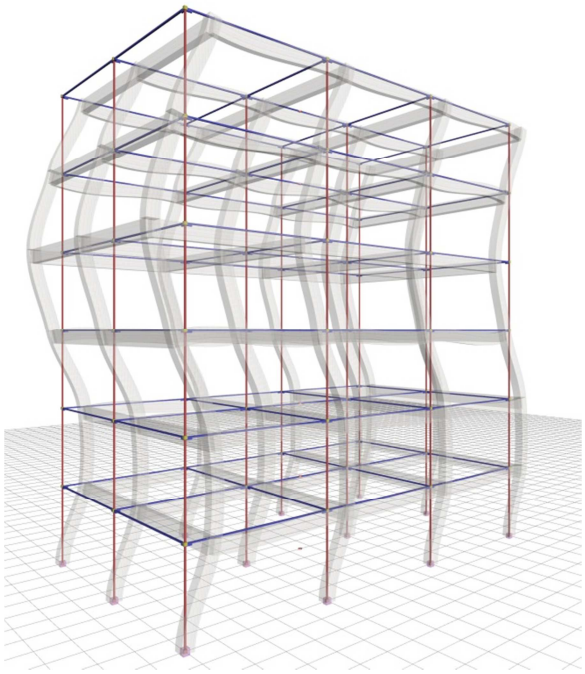

Figure 6.4.1-4: 3rd mode in X:
T=0.189 sec, participation 3.5%

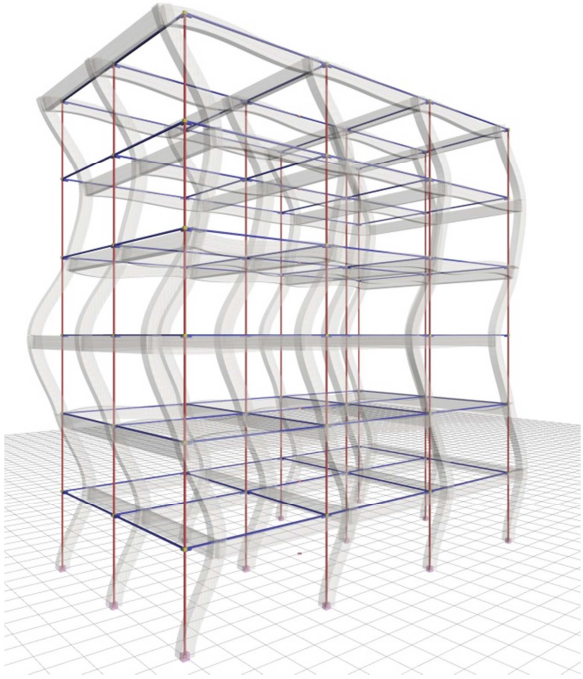

Figure 6.4.1-5: 4th mode in X:
T=0.134 sec, participation 1.6%

The sum of the effective modal masses of the first four modes amounts to 99% of the total mass. The first mode is the fundamental one as its effective mass is the 84% of the total mass.

All four modes are translational and not torsional, as expected, due to the double symmetry of the structure.

Case 2: Foundation with footing beams (project <B_641-2>)

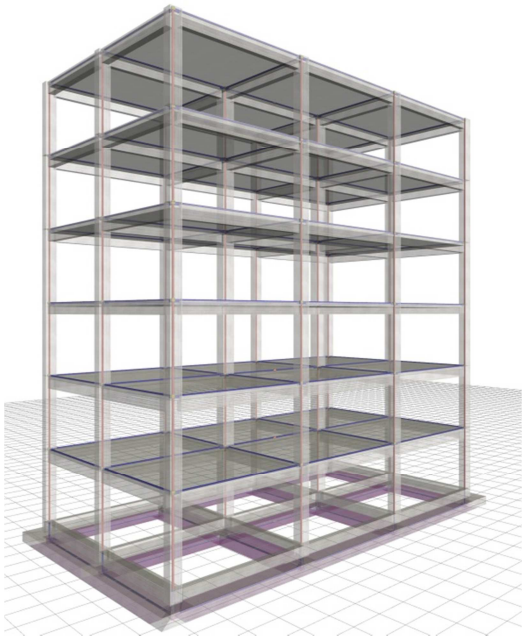

Figure 6.4.1-11: Structure and model
Frame system with q=3.60

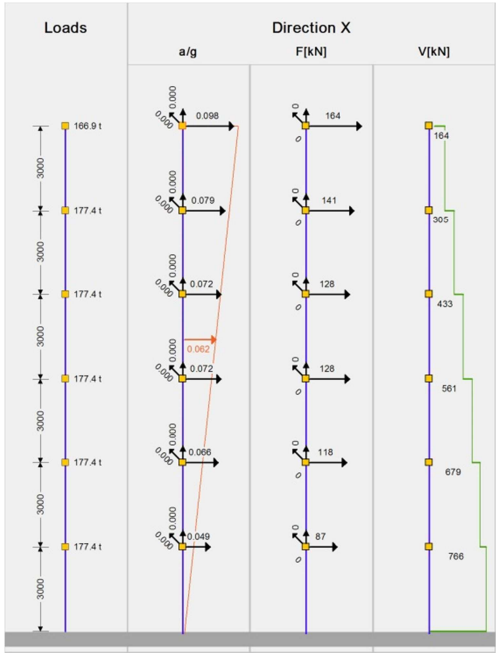

Figure 6.4.1-12: Seismic acceleration-forces-shear forces
1st fundamental period:T_1=1.012 sec, participation 85%

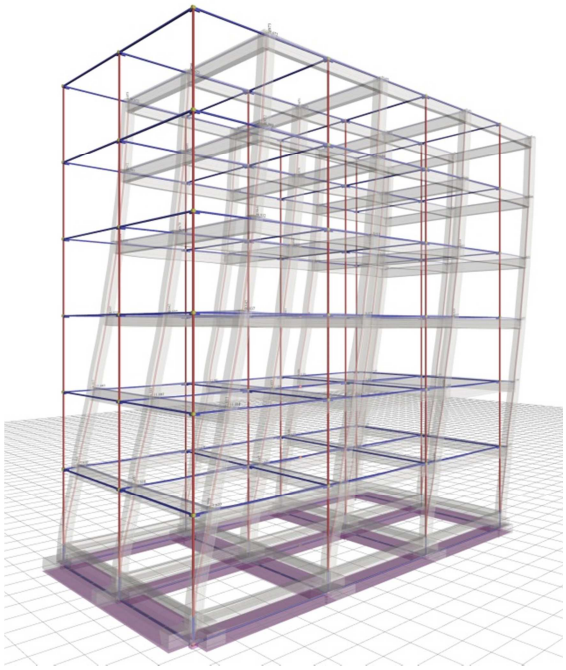

Figure 6.4.1-13: Displacements under seismic action in x
δ_{max}=25.7 mm

Bending moments of ground floor columns

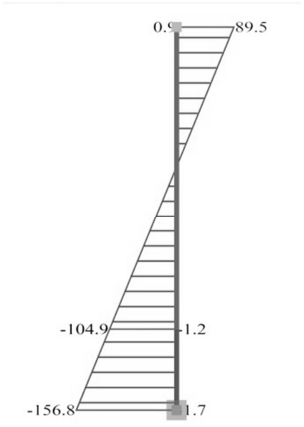

Figure 6.4.1-14:
Ground floor column
0c2 (400/400)

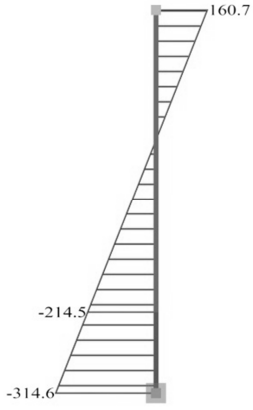

Figure 6.4.1-15:
Ground floor column
0c6 (500/500)

Due to stronger cross-sections of footing beams compared to those of columns, the displacement of the structure is slightly larger than that of assumed fixity at the base (25.7 against 24.5).

The structural system remains intact while the behaviour factor q is taken equal to 3.60.

The bending moments of columns at the footing neck are roughly the same as in the fixed condition.