necessary to include multiple modes to capture the required mass participation unless soil springs are incorporated into the model. Incorporation of soil springs into the model will generally reduce seismic forces in the upper levels. With one or more stiff stories below more flexible stories, the dynamic behavior of the structure may result in the portion of the base shear from the first mode being less than the portion of base shear from higher modes.

Other conditions may also necessitate establishing the base below grade for a building with a basement that is located on a level site. Such conditions include where seismic separations extend through all floors including those located close to and below grade, the floor diaphragms close to and below grade are not tied to the foundation wall, the floor diaphragms including the diaphragm for the floor close to grade are flexible, and other buildings are located nearby. Knowledge of dynamic response of buildings and engineering judgment are often critical in defining the base of these structures.

For a building with seismic separations extending through the height of the building including levels close to and below grade, the separate structures will not be supported by the soil against a basement wall on all sides in all directions. If there is only one joint through the building, assigning the base to the level close to grade may still be appropriate if the soils over the depth of the basement walls are stiff and the diaphragm is rigid. Stiff soils are required so that the seismic forces can be transferred between the soils and basement walls in both bearing and side friction. If the soils are not stiff, adequate side friction may not develop for movement in the direction perpendicular to the joint.

For large footprint buildings, seismic separation joints may extend through the building in two directions and there may be multiple parallel joints in a given direction. For individual structures within these buildings, substantial differences in the location of the center of rigidity for the levels below grade relative to levels above grade can lead to torsional response. For such buildings, the base should usually be at the foundation elements below the basement or the highest basement slab level where the separations are no longer provided.

Where floor levels are not tied to foundation walls, the base may need to be located well below grade at the foundation level. An example is a building with tie-back walls and post-tensioned floor slabs. For such a structure, the slabs may not be tied to the wall to allow relative movement between them. In other cases a soft joint may be provided. If shear forces cannot be transferred between the wall and a ground level or basement floor, the location of the base will depend on whether forces can be transferred through bearing between the floor diaphragm and basement wall and between the basement wall and the surrounding soils. Floor diaphragms bearing against the basement walls must resist the compressive stress from earthquake forces without buckling. If a seismic or expansion joint is provided in one of these buildings, the base will almost certainly need to be located at the foundation level or a level below grade where the joint no longer exists.

If the diaphragm at grade is flexible and does not have substantial compressive strength, the base of the building may need to be located below grade. This condition is more common with existing buildings. Newer buildings with flexible diaphragms should be designed for compression to avoid the damage that will otherwise occur.

The proximity to other structures can also affect where the base should be located. If other buildings with basements are located adjacent to one or more sides of a building, it may be appropriate to locate the base at the bottom of the basement. The closer the adjacent building is to the building, the more likely it is that the base should be below grade.

For sites with sloping grade, many of the same considerations for a level site are applicable. For example, on steeply sloped sites the earth may be retained by a tie-back wall so that the building does not have to resist the lateral soil pressures. For such a case, the building will be independent of the wall, so the base should be located at a level close to the elevation of grade on the side of the building where it is lowest, as shown in Fig. C11-7. Where the building's vertical elements of the seismic force-resisting system also resist lateral soil pressures, as shown in Fig. C11-8, the base should also be located at a level close to the elevation of grade on the side of the building where grade is low. For these buildings, the seismic force-resisting system below highest grade is often much stiffer than the system used above it, as shown in Fig. C11-9, and the seismic weights for levels close to and below highest grade are greater than for levels above highest grade. Use of a two-stage equivalent lateral force procedure can be useful for these buildings.

Where the site is moderately sloped such that it does not vary in height by more than a story, stiff walls often extend to the underside of the level close to the elevation of high grade, and the seismic force-resisting system above grade is much more flexible above grade than it is below grade. If the stiff