Alternatively, the dynamic forces can be conservatively assumed to be evenly distributed along the entire structure.

Dynamic analysis is recommended for structures that either do not have uniform mass and stiffness distribution and/or an easily discernible first mode shape.

2. Number of lateral supports: Cantilever models are obviously unsuitable for structures with multiple supports. A nonbuilding structure could yet be a candidate for application of the equivalent static method depending on the number and locations of the supports. For example, most beam type configurations lend themselves for application of the equivalent static method.
3. Method of supporting dead weight: Certain nonbuilding structures (e.g., power boilers) are supported from the top. They may be idealized as pendulums with uniform mass distribution. In contrast, a suspended platform may be idealized as a classic pendulum with concentrated mass. In either case, these types of nonbuilding structures can be adequately analyzed using the equivalent static method by calculating the appropriate frequency and mode shape.
4. Mass irregularities: Just as in the case of building-like nonbuilding structures, the presence of significantly uneven mass distribution can render the structures unsuitable for application of the equivalent static method. The dynamic analysis methods are recommended in such situations.
5. Torsional irregularities: Structures in which the fundamental mode of response is torsional and/or in which modes with significant mass participation exhibit a prominent torsional component may also experience inertial force distributions that are significantly different than that predicted by the equivalent static method. Consideration should be given to performing dynamic analyses for such structures, as well.
6. Stiffness and strength irregularities: Just as in the case of building-like nonbuilding structures, irregularities, such as abrupt changes in the stiffness and/or strength distribution in a nonbuilding structure not similar to buildings, can result in substantially different distributions of inertial forces in the real structure than indicated by the equivalent static technique. For structures having such configurations, consideration should be given to the use of dynamic analysis procedures.

This standard does not define in any detail the degree of modeling required for a dynamic analysis model. An adequate model may have a few dynamic degrees of freedom or 20,000 dynamic degrees of freedom. The important point is that the model captures the significant dynamic response features so that the structural engineer of record considers the resulting lateral force distribution to be valid. Therefore, the responsibility for the determination of whether a dynamic analysis is required for nonbuilding structures and the degree of detailing required to ensure adequate seismic performance is based on the judgment and experience of the structural engineer of record.

C15.2 REFERENCE DOCUMENTS

The NEHRP Provisions contain additional references for the design and construction of nonbuilding structures that cannot be referenced directly by ASCE 7. The references are as follows:

American Society of Civil Engineers (ASCE). (1997a). *Design of secondary containment in petrochemical facilities*, American Society of Civil Engineers, New York, Task Committee on Secondary Containment of the Petrochemical Committee of the Energy Division of the ASCE, Committee Report.

American Society of Civil Engineers (ASCE). (1997b). *Guidelines for seismic evaluation and design of petrochemical facilities*, American Society of Civil Engineers, New York, Task Committee on Seismic Evaluation and Design of Petrochemical Facilities of the Petrochemical Committee of the Energy Division of the ASCE, Committee Report.

Troitsky, M. S. (1990). *Tubular steel structures: Theory and design,* James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

Wozniak, R. S., and Mitchell, W. W. (1978). *Basis of seismic design provisions for welded steel oil storage tanks,* American Petroleum Institute, Washington, D.C.

Table C15-1 is a cross-reference of the Reference Standards listed in Chapter 23 references that cannot be referenced directly by ASCE 7 and the applicable nonbuilding structures.

References to industry standards on nonbuilding structures have been added to aid the design professional and the authority having jurisdiction in the design of nonbuilding structures. The addition of these references to ASCE 7 provides a controlled link between the requirements of ASCE 7 and industry design standards.