Seismic Loads – How They Relate to Cooling Towers

Like many large structures, cooling towers undergo seismic forces that need to be considered during design. However, many of the principles surrounding seismic loads are foreign to professionals of the cooling tower industry. The purpose of this paper is to lend insight into the fundamentals of seismic loads and how they interact with cooling towers.

Seismic "g"

To begin, we must talk about seismic fundamentals. What is a seismic g? A seismic g is a value that quantifies the seismic loading on a structure relative to its own weight. A seismic g of 1.0 infers that a tower is experiencing seismic loads equal to its own weight. A seismic g of 2.0 infers seismic forces are double the tower's weight. External forces caused by seismic loading can be in both horizontal and vertical directions. It is important to note the seismic g value is site specific and can vary based on location among other site conditions.

Site Conditions

There are many site conditions that are taken into account for the calculation of seismic g. The most obvious factor is location. High seismic zones like California (San Andreas Fault) and Southeast Missouri (New Madrid Fault) will generally require seismically rated cooling towers.

Another site condition affecting seismic rating is vibration isolators. A common misconception of vibration isolators is they decrease the seismic load on a tower. In fact, vibration isolators actually increase the seismic g because they magnify the shaking effects of an earthquake or other land movement. Vibration isolators are designed to prevent vibration transfer to surrounding objects, thus seismic forces are contained within the tower. For additional information, please see *Use of Vibration Isolators with Cooling Towers*.

The soil site class will also affect the calculated g. When soil properties are unknown, Site Class D is used as a default. Another condition affecting seismic loads is tower placement. If the tower is located on a building, the seismic forces will be larger than if the tower were placed on grade. This is caused by the building's oscillation adding to the g force during a seismic event. The final variable affecting the calculated seismic g is the site importance factor (IF). The importance factor quantifies how critical a process the facility serves. Hospitals will always have an importance factor of 1.5 because they need to continue operation in the event of natural disaster. However, small manufacturing facilities or office buildings may only have an importance factor of 1.0. The importance factor should be provided by the customer's design engineer.

Anchorage-only vs Structure Design

If a facility is not considered critical (importance factor of 1.0), an anchorage-only tower design can be used. An anchorage-only design ensures the tower will not dislodge from the supporting steel. However, the tower may not be operable after a seismic event. Components in an anchorage-only design may be damaged following a seismic event and require repair before rebooting.

The design which must be used for essential facilities (importance factor of 1.5) is a "structure" design. After a design seismic event, a "structure" designed tower will still be operable. This means the tower remains attached to the supporting steel, and all components resist damage.

SPX COOLING TECHNOLOGIES, INC.
7401 WEST 129 STREET
OVERLAND PARK, KS 66213 USA
913 664 7400 | spxcooling@spx.com
spxcooling.com

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