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Seismic Design Considerations

Introduction

Seismic design is the process of proportioning and detailing a structure to enable it to withstand movement from an earthquake event with acceptable performance.

In 2011, the NIH Bethesda campus felt the effects of a 5.8 magnitude earthquake. This quake prompted the Office of Research Facility's Division of Technical Resources (DTR) to undertake a seismic risk assessment study. The study reviewed available NIH geotechnical investigation reports, performed probabilistic seismic hazard analysis, and evaluated soil amplification effects in a simplified manner. The results of these evaluations led NIH to consider site-specific seismic design parameters more stringent than what is proposed in the ASCE 7 for specific building types on the Bethesda campus.

Seismic Design Parameters

The main NIH Campus, located in Bethesda, MD, has numerous structures, including critical facilities such as research laboratories, a central utility plant, and a hospital. These buildings range from risk category I to risk category IV buildings based on the classification of ASCE 7 Table 1.5-1. The risk categories are used to relate the criteria for maximum environmental loads or distortions specified in the ASCE 7 standard to the consequence of the loads being exceeded for the structure and its occupants (ASCE 7).

Building performance is not a function of the structural system alone. For a facility to remain operational after a seismic event, both structural and nonstructural systems must remain functionally safe. Reports based on geotechnical tests performed over the years at several locations within NIH Bethesda Campus indicate that the soil at most locations can be classified as site class C per ASCE 7 Table 20.3-1. DTR performed a push-over analysis at select buildings representing each building type on the NIH Bethesda campus. This analysis is a non-linear static analysis used to understand the performance characteristics and overall structural behaviors of structures subject to gravity load and increasing lateral load until the collapse state of the structure is reached. Nonstructural components of the facilities were evaluated based on observations performed during the site surveys. Findings from the analysis are used to guide future seismic retrofits.

In 2016, the federal government issues executive order EO 13717 to establish a Federal Earthquake Risk Management Standard. This EO encouraged federal agencies to consider going beyond the building code requirements to ensure that buildings are earthquake resilient. To this end and due to the specialized nature of NIH facilities, the NIH *Design Requirements Manual* requires parameters more conservative than those in the International Building Code (IBC) for select and critical buildings (see *DRM* Section 5.2.1.G).

Conclusion

DTR has installed two free-field strong motion seismic sensor stations on the NIH Bethesda campus. These stations were installed per the guidelines of the United States Geological Survey (USGS). These strong motion sensors can remotely sense ground motion information immediately after a seismic event. This information is used by NIH engineers and management to make informed decisions about potential impact to select facilities on campus and determine whether they are deemed safe for occupancy. To meet the seismic design requirements for NIH new and existing facilities, NIH *DRM* Section 5.2.1.G recommends that the designer contact DTR at the initial stage of the design process to determine whether NIH-specific seismic design parameters are applicable to the project, and the details of those parameters.