

Effects of Pile Foundations on Structure-Soil-Structure Interactions

Asa Bassam¹, Mohammad Salehi², Benjamin Kosbab³

¹Senior Project Manager, Simpson Gompertz & Heger, Atlanta, GA (abassam@sgh.com)

²Project Consultant, Simpson Gompertz & Heger, Atlanta, GA (msalehi@sgh.com)

³Senior Principal, Simpson Gompertz & Heger, Atlanta, GA (bdkosbab@sgh.com)

Safety-related nuclear facilities typically are effectively surface-founded with shallow foundations or are embedded within subsurface materials such that their foundation bears on stiff, competent material. However, under certain soil conditions, structures adjacent to a safety-related nuclear facility may be supported by deep foundations (e.g., piles, drilled shafts, piers, and caissons). Piles can transfer the heavy loads from the structure to deeper, more stable soil layers or bedrock, making them ideal for sites with weak or highly variable surface soils. Although the effects of piles on the seismic response of pile-supported foundations have been studied in the past, their structure-soil-structure interaction (SSSI) impact on adjacent structures is less well understood. A key consideration is understanding how the SSSI effects on nearby partially embedded safety-related structures are affected by the presence of deep foundations like piles as compared to alternative shallow foundations.

This study provides simplified dynamic analysis strategies to evaluate how piles might influence SSSI effects on adjacent embedded structures. A case study is presented, where structures adjacent to a safety-related building are initially modeled as surface-founded structures representing a standard plant design (i.e., baseline design intended for broad suitability across a range of site conditions). The piles are then added to the foundations or adjacent structures, representing a site-specific design at a site where shallow foundations would not be economical. The goal is to assess whether the site-specific pile design would reduce SSSI effects compared to the standard plant design. To this end, the dynamic compatibility of the piles with free-field soil is evaluated to determine their impact on the free-field site response. The approximate inertial SSI effects of the surface-supported foundation design are then compared with the kinematic SSI effects of the piles to understand how much the piles could alter soil response amplification compared to the surface-founded foundations. Finally, the stresses at an adjacent building wall are assessed to understand the extent of dynamic soil pressure change when piles are used instead of surface foundations. Potential adjustments to the pile design are also explored to further reduce the effects of SSI and SSSI.