Computational Tools and Latest Advances for Three Prominent Pile-soil Interaction Problems

Abstract: This seminar will discuss both simple and state-of-the-art computational tools for three problems of pile-soil interaction: 1) pile penetration in soft soils; 2) pile axial capacity; and 3) performance of piles embedded within laterally moving soils. Examples are provided from both research and field case projects.

The presentation will discuss the phenomena occurring during pile penetration in soft soils, such as lateral soil movements and pore pressure generation and dissipation. It will first cover simple numerical simulation methods such as cavity expansion (Randolph et al., 1979) and the strain path method (Baligh, 1985). Modern data analysis and visualization tools, such as R, allow for the visualization of deformations predicted by these methods and comparison with measured data (Vytiniotis et al., 2018). Alongside those results, the seminar will discuss more complex techniques such as finite element analyses with ABAQUS using advanced constitutive soil models to estimate lateral soil movements, stresses and pore pressures around a driven pile.

Next, the presentation will focus on the axial capacity of piles and provide a brief introduction on simplified methods for analysis. After the limitations of these simplified methods are discussed, more complex finite element tools will be presented, which use appropriate non-linear curves for skin friction and axial resistance, such as embedded pile row elements that have been recently incorporated in Plaxis (Brinkgreve et al., 2012; Sluis, 2012).

The last part of the presentation will discuss the performance of piles around laterally moving soils in both slowly moving conditions (e.g., slope creep) and during faster loading (e.g., earthquake lateral spread and landslide movement). The soil loads acting on piles can be approximated with simple p-y curves such as the ones provided by American Petroleum Institute, based on the curves originally proposed by Matlock (1970). Modern tools allow for uncoupling of the soil domain from the pile domain, and the measured or predicted free-field soil movements can be used as loading input in software such as LPILE. The embedded pile row elements in Plaxis can also be used for this type of problem. The performance of piles within laterally moving soils due to earthquakes is still the topic of ongoing research. For such problems, the seminar will discuss the challenges of the problem and will show a series of numerical finite element results recently published by Vytiniotis et al. (2019) using OpenSees and advanced soil-pile macro-elements (Varun and Assimaki, 2012) and the Dafalias-Manzari (2004) soil model.