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Title: Axial and Lateral Resistance of Non-Displacement Piles

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Non-displacement piles have been often used in foundation solutions worldwide due to many advantages, such as their flexible dimensions, the suitabiliy for very hard soil profiles, and the minimal amount of vibration and noise during installation. The thesis focuses on the mechanical response of the pile-soil system when the pile is subjected to vertical or horizontal loads, the mechanisms of the resistance mobilization and the implementation of the research findings in pile design practice.

A series of three-dimesional finite element analyses were performed with an advanced, two-surface constitutive sand model to investigate the response of non-displacement piles to axial loading. The analysis domain was carefully meshed such that the formation and evolution of shear bands next to the pile shaft and near the pile base could be properly captured. The numerical analyses were validated by centrifuge test data and model pile tests in calibration chamber with the implementation of the digital image correlation (DIC) technique. Based on the analysis results, design equations were proposed to estimate the limit shaft resistance and ultimate base resistance of non-displacement piles in sandy soil. Subsequently, three-dimensional finite-element analyses of pile groups with different group configurations were performed to investigate group effect on the resistance mobilization for non-displacement pile groups. Pile group efficiency was found to be a function of the pile head settlement, number of piles in the group, the pile-to-pile spacing, and the relative density of the sand. For small pile groups, the group efficiency is close to or greater than one at settlement levels likely to be of interest in design.

To solve the boundary-value problems of non-displacement piles that are subjected to lateral loads, semi-analytical solutions based on the principles of minimum total potential energy or virtual work in a total or incremental form. The analysis extends previous work done at Purdue, which had been restricted to elastic materials. The method is computationally efficient and produces results that are in good agreement with those from 3D finite element modeling with the same constitutive model for the soil. The proposed method offers a good alternative to the *p-y* method in the context of fast calculation of lateral pile response, such as in the design of piles for offshore wind farms.