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Uplift and Lateral Performance of Tapered Helical Piles in Sand

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Extended Abstract

A novel piling system is proposed involving a spun-cast ductile iron SCDI tapered shaft fitted with a lower helical plate. The pile combines the compressive and lateral efficiency of the tapered section, the competitive cost, effectiveness and durability of spun cast ductile iron with a rough surface and the construction advantages of screw piles.

The monotonic uplift and lateral performance of the proposed pile in a silty sand profile is investigated using a three dimensional finite element model developed using the software Abaqus (Hibbitt *et al.*, 2008). The model was established and calibrated using full scale experimental data. The performance of steel straight shaft helical piles was also simulated for comparison purpose. The developed models simulated the response of steel and SCDI piles with different configurations when subjected to different loading conditions including uplift, lateral and combined moment-horizontal. Different loading sequences were mimicked to assess the effect of prior cyclic and monotonic loading on the piles' performance. The effects of installation technique on the piles behavior are quantified.

The results showed that the tapered helical piles exhibited a stiffer response than the straight piles at lower displacements. At greater displacements, the presence of the helical plate avoided the dislodge of the tapered shaft from the ground. The value of the lateral earth pressure coefficient was found to significantly decrease during the uplift loading of tapered helical piles whereas no significant change was found for the straight shaft ones. The uplift performance of the SCDI tapered helical configuration was found to more efficient for greater pile length providing higher uplift – to – compression ratio compared to straight helical piles.

The results also showed that SCDI tapered helical piles exhibited a stiffer lateral response and offered higher ultimate capacity compared to the straight-shaft piles owing to the greater flexural rigidity along the top portion of the pile. As well, the addition of a helical plate to a short pile was found to significantly increase its lateral capacity due to the provided fixation to the bottom of the piles resulting from the passive bearing pressures developed on the helix surfaces. On the other hand, the helical plate had no influence the lateral performance of long piles. Moment-horizontal force interaction diagrams were developed and design equations were provided to aid in design of the proposed piling system as well as straight helical piles subjected to a combination of significant moment and horizontal loads.

The results of the present study revealed the improved performance of the proposed piling system in various loading conditions compared to the conventional piling alternatives. The study also demonstrated that the spun cast iron with rough surface is a viable material for piling products.

References

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