Abstract

Water jetting and water injection are frequently used for geotechnical applications. The techniques date back to 1959, yet the governing mechanisms remain unknown. This is reflected by the lack of consensus for water injection best practice.

This dissertation seeks to reduce the unknowns in water injection. A series of centrifuge experiments was undertaken at the University of Cambridge, where water injection parameters were varied, including: injected flow rates and pressures, injection geometries, and installation rates. Using the results, the governing mechanisms of water injection-aided pile jacking were established, and the effects on both the final pile properties and the surrounding ground conditions were investigated.

The elimination of effective stress was found to be the most important parameter when determining the governing mechanisms. Two were proposed; a return flow mechanism at shallow depths and a spherical pore flow mechanism at larger depths. Both relied on variable permeability around the pile. Ultimately, base resistance could be eliminated to depths of ten pile diameters, providing the fluidised region around the pile toe extended beyond two pile radii from the pile centreline.

Water injection adversely affected final pile capacity and the surrounding ground. Piles that terminated whilst experiencing loads less than 50 % of the equivalent no-injection installation were found to be significantly weaker. But, pile strength could be recovered by installing the pile a further four pile diameters, keying the pile base into undisturbed ground.

Ultimately, water injection was proven to be a powerful technique for reducing pile installation loads. However, the process can only be applied successfully in suitable ground conditions - with moderate permeabilities or less. The presence of a highly permeable gravel will stymie progress and pile refusal may occur. A good understanding of a site's permeability would allow water injection to be successfully applied, while minimising the injected water volume and the pile resistance.