

Ground behavior in belled pile uplifting by Discrete Element Method

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The upward external forces applied on a pile head due to earthquakes, wind loads, etc. cause large piles pulled up in the base ground. Considering the frequency of natural disasters in recent years, it is quite important to understand the ground behavior in pile uplifting, and it is also important to investigate numerical methods that is applicable to simulation involving ground large deformations.

In this study, the authors performed the model experiments of uplifting belled pile, focusing on the large deformation behavior. In the experiments, both the ground behavior in belled pile uplifting and the mechanism of exerting the pull-out resistance were investigated. To understand the ground behavior further, Discrete Element Method (DEM) is adopted for the numerical analysis method, because it is expected to trace the ground behavior involving large deformations. DEM is applied to uplifting belled pile simulation, compared to the experimental results.

Model experiments of uplifting belled pile were performed with a model pile set in the circular aluminium bar laminated ground. The pull-out load and the pile head displacement were measured. Also, the spatial displacement and strain of the ground were obtained by image analysis using Particle Image Velocimetry (PIV).

2D DEM simulation was performed to investigate the stress propagation inside the ground and how the ground resists the pull-out force, because it is difficult to know the stress propagation in the experiment. The pull-out load, particle displacement and strain were simulated and compared with the experiments, resulting in that the numerical results and the deformed regions give good agreement to those of the experiments. The mean normal stress of particles and the contact force network were visualized for further consideration, and it enabled us to observe how the pull-out resistance of the ground was exerted from the viewpoint of stress propagation.

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