

Cyclic uplift performance of screw piles for offshore floating wind considering installation effects using DEM

Background

- Large diameter screw piles are potential new **silent foundation/anchoring system** for offshore renewable energy applications in deeper (> 30 m) water.
- Current standards recommend **pitch-matched** (Fig. 1) installation.
- Over-fighting** (Fig. 1) can reduce installation requirements and improve in-service tensile performance.
- Lack of insight in cyclic performance of screw piles, increase size requirements for offshore use and non-standard AR installation.

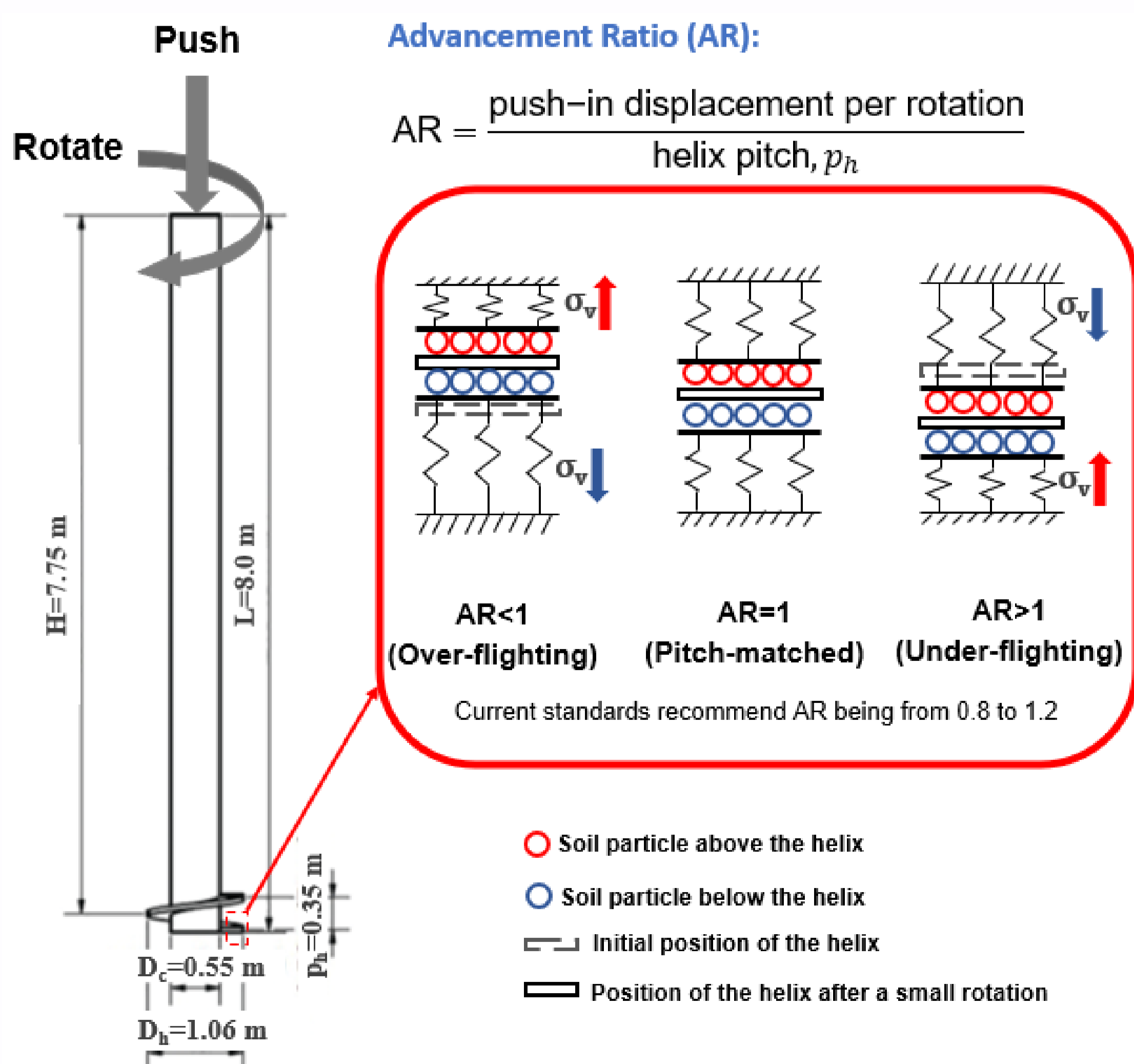


Figure 1: Screw pile geometry and interpretation of installation advancement ratio

Methodology

- A medium-dense ($D_r = 52\%$, $n = 0.38$) sandy soil bed (Fig. 2) built in commercial DEM (the Discrete Element Method) software PFC3D.
- A single-helix screw pile (Fig. 1) installed at varying AR.
- One-way tensile force-controlled cyclic loading applied on the screw pile after the installation.

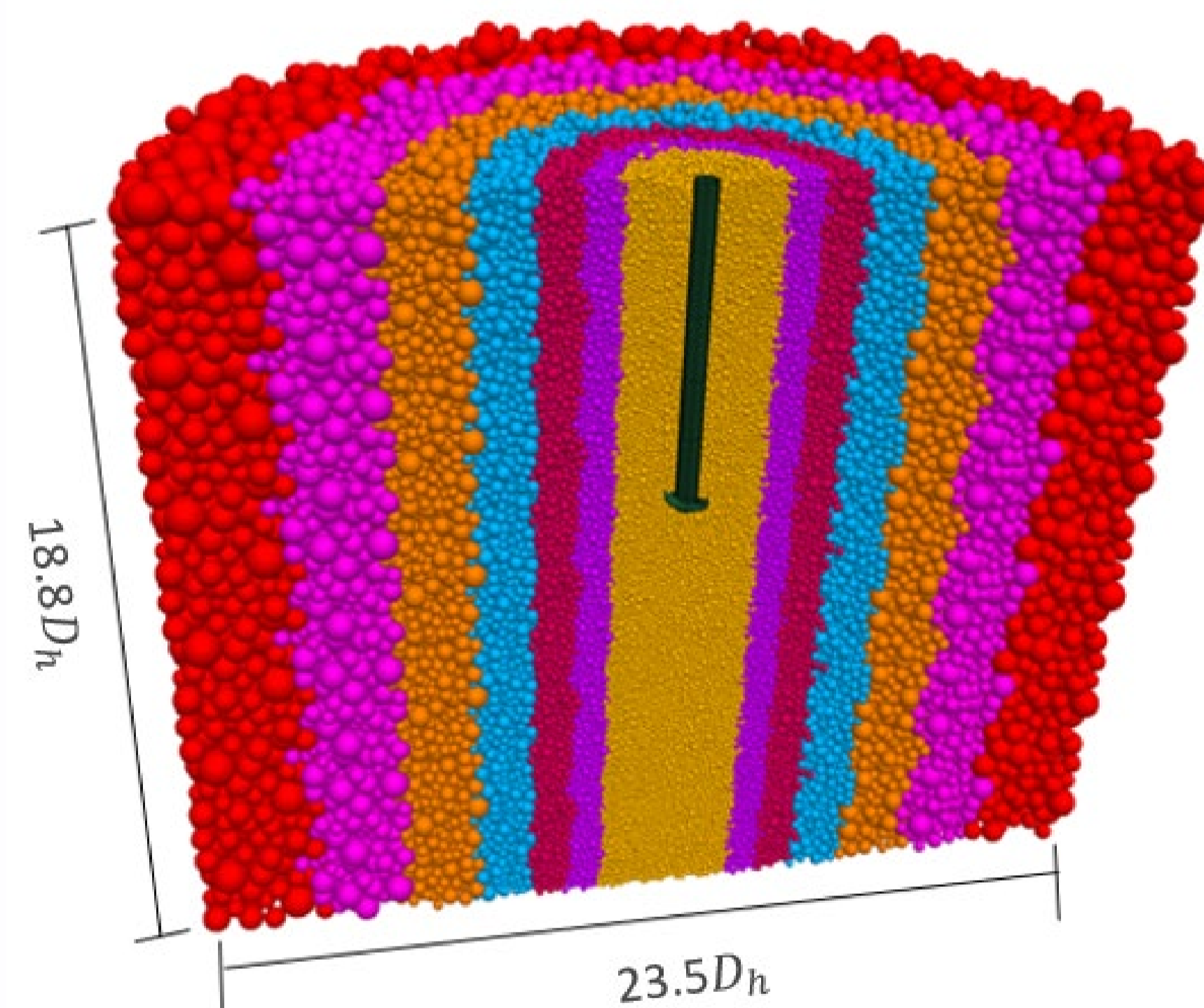


Figure 2: DEM soil bed with a screw pile installed

Results

- Over-fighting reduces displacement accumulation under cyclic loading (Fig. 3).
- Large displacement accumulated during cycling leads to serviceability failure but increases post-cyclic monotonic capacity (Fig. 4).

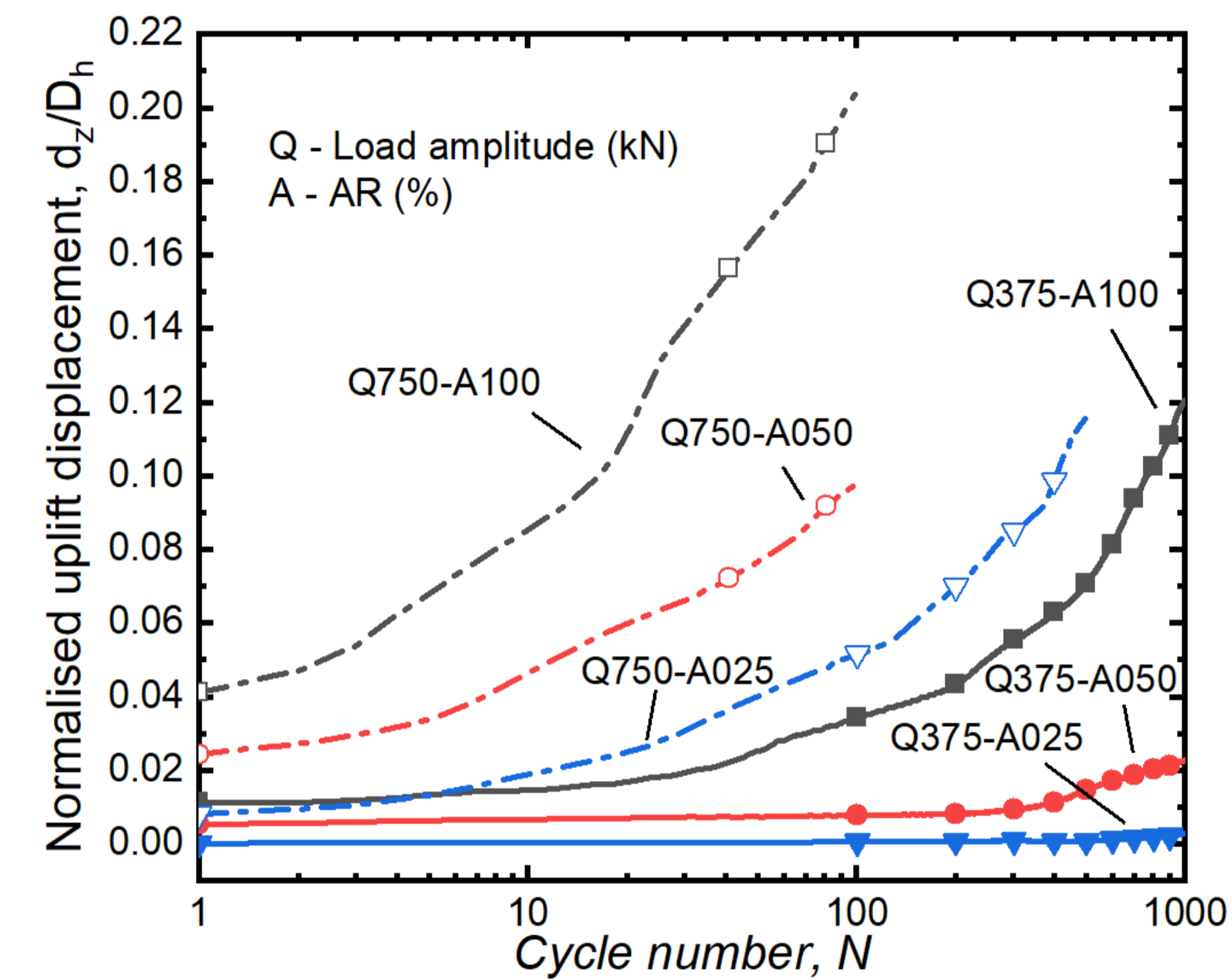


Figure 3: Effects of loading amplitude and AR on displacement accumulation

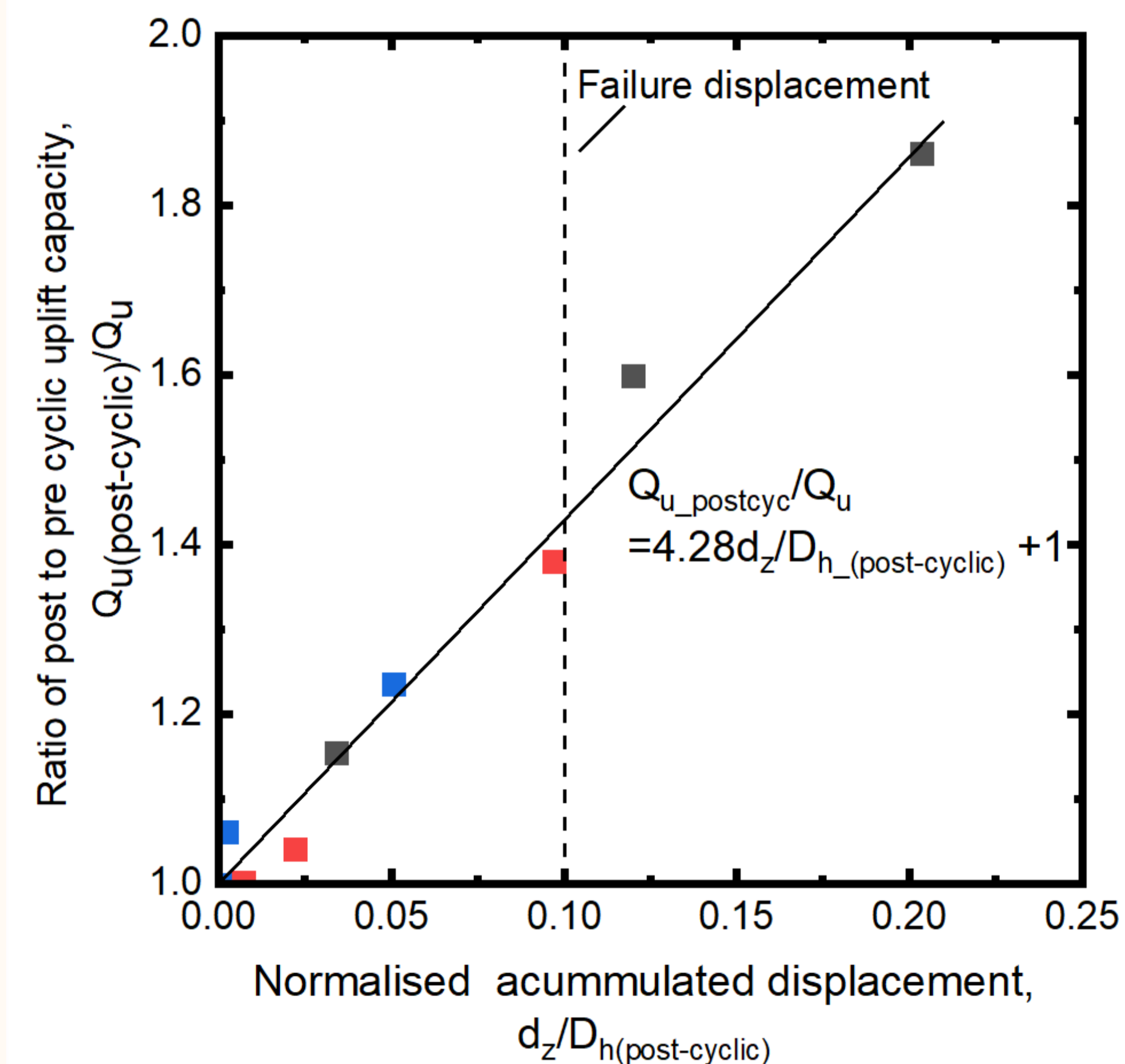


Figure 4: Accumulated displacement versus change in monotonic uplift capacity

- Secant uplift stiffness of the helix and the shaft are shown separately (Fig. 5).
- Helix uplift stiffness shows no difference among ARs after a limited number of cycles.

- Shaft uplift stiffness of over-flighted piles is higher than the helix stiffness, and the improvement due to over-flighting can be maintained throughout cycling.

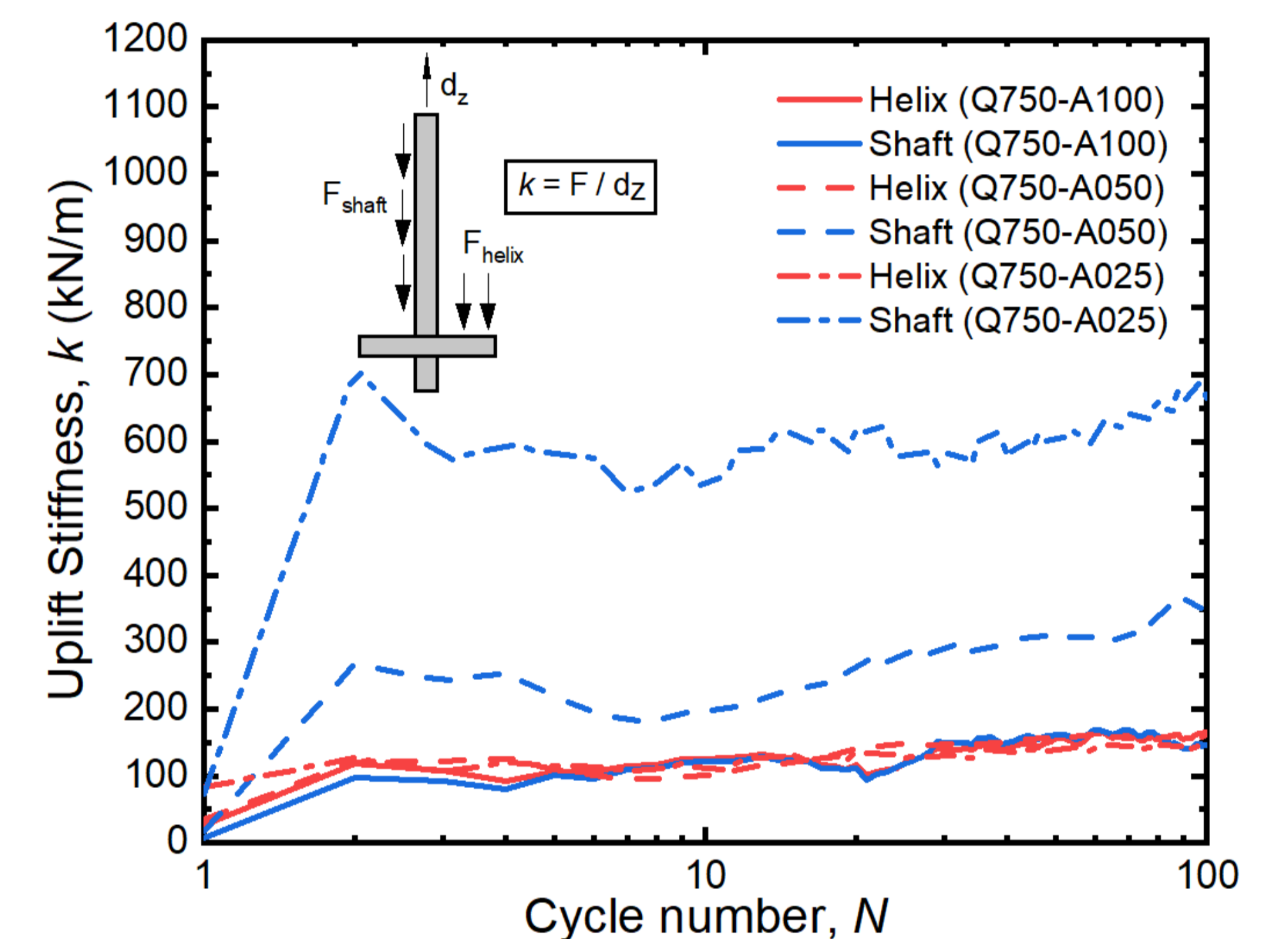


Figure 5: Axial stiffness of each pile component

Conclusions and Future Work

- Over-flighting installation can reduce cyclic loading induced displacement accumulation by increasing shaft stiffness.
- Post-cyclic capacity increases with displacement accumulated during cycling.
- Validation required of DEM against centrifuge tests.
- Prediction framework for displacement accumulation (cyclic stability) needs to be developed.