Comparison of monotonic and cyclic lateral response between monopod and tripod bucket foundations in medium dense sand

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Moment-Rotation Angle Response

Fig. 1 compares the monotonic moment-rotation response of the monopod and the tripod. The moment and the rotation were both calculated with respect to a reference point locating at the centre of each foundation at the seabed level. As shown in the figure, the monopod bucket foundation exhibited a continuous hardening response without showing an obvious yield point, suggesting a ductile response. Comparatively, a bilinear response was observed on the tripod with a clear yield capacity, implying a brittle response. Similar observations were also made from the centrifuge tests that investigated the monotonic response of monopod and tripod in silt (Kim et al., 2014). Prior to the yielding, the tripod showed a much stiffer response as compared with the monopod. At a typical rotation of 0.25° (i.e., the limiting rotation of an offshore wind turbine), the tripod carried a 78% higher moment than that taken by the monopod.

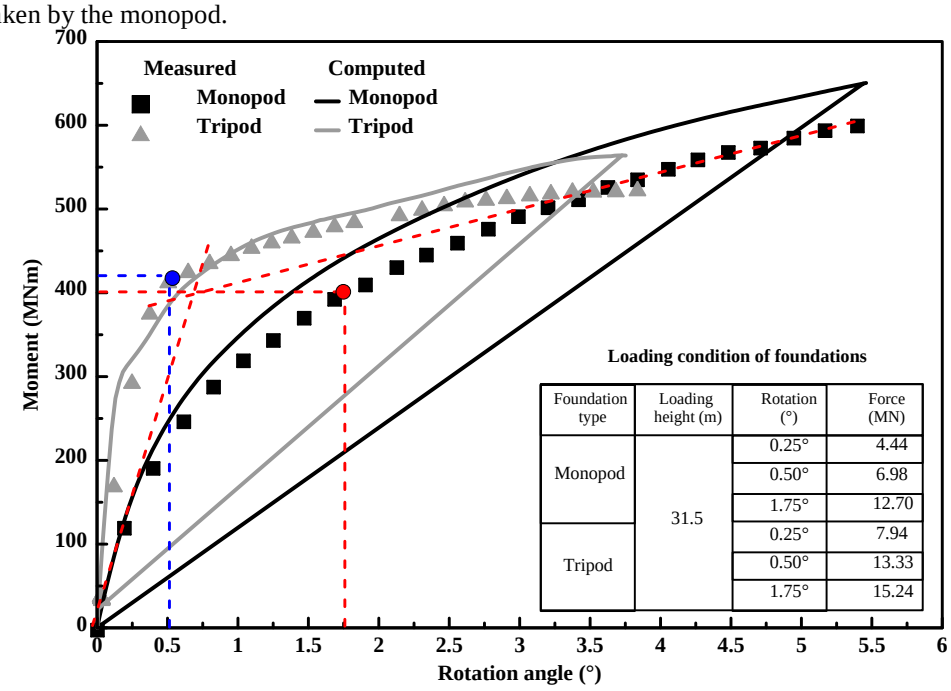


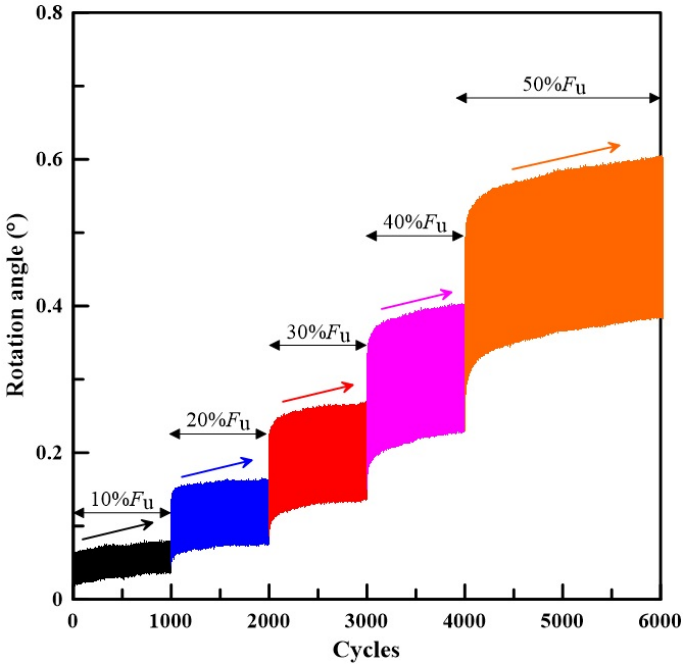
Fig. 1: Measured and computed moment-rotation response of the monotonic centrifuge tests

Rotation angle response with cyclic loading cycles

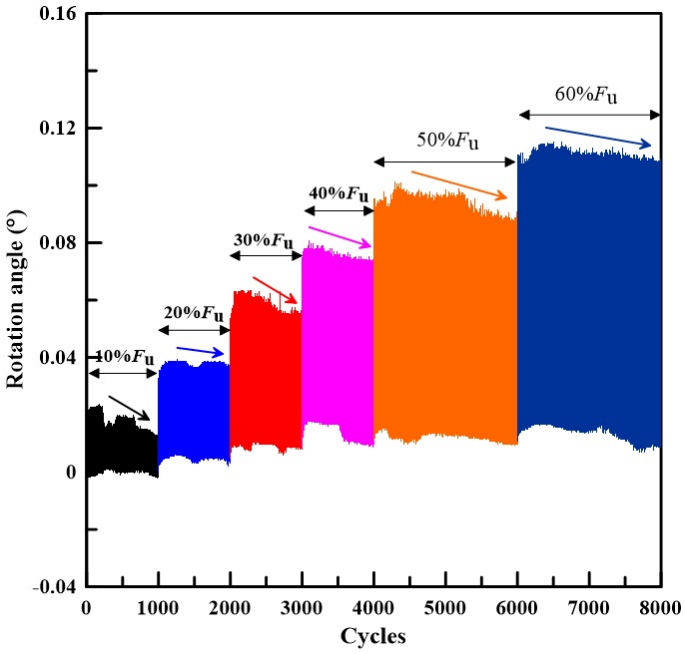
Fig. 2 presents the developments of the measured rotation angle with cycles number under successive cyclic amplitudes. As shown in Fig. 2 (a), foundation deformation of the monopod increased continuously with loading cycles at a decreasing rate. In particular, when the cyclic loading amplitude is larger than 20% *F*u, much more pronounced accumulated deformation was produced and increased sharply with the cyclic amplitude. At the end of tests, the peak rotation angle had exceeded 0.6°, while the limited deformation for offshore wind turbine is 0.5° respectively.

Comparing with response of the monopod, the tripod bucket foundation exhibited a completely different behaviour. First, although the cyclic amplitude has already reached 60% *F*u, there is still no obvious plastic deformation produced. At the end of six successive cyclic episodes, the peak rotation angle was less than 0.12°, which is only 20% of that of the monopod. In particular, the tripod exhibited a deformation “self-healing” capacity, which means that the foundation tilted backward under successive cyclic load with respect to the loading direction. The potential of “self-healing” in accumulated rotation of a foundation consisting of multiple caissons was

hypothesized by Houlsby (2016). This is probably attributed to the fab-ric of soil adjacent to the rear buckets (subjected to two-way cycling) should have experienced more damage than that near the front caisson (subjected to one-way cycling), causing the former to settle more than the latter and therefore a backward titling of the multiple caissons. This unique feature of "self-healing" in cumulative rotation distinguishes the tripod from the monopod, which exhibited a continuously accumulated rotation under a constant amplitude of lateral cycling.



(a) Rotation response of the monopod



(b) Rotation response of the tripod

Figure. 2 Rotation angle response with loading cycle

References

Houlsby, G. Interactions in offshore foundation design. Géotechnique, 66(10), 791-825 (2016)

Kim, D.J., Y. W. Choo, J.-H. Kim, S. Kim and D. S. Kim. Investigation of Monotonic and Cyclic Behavior of Tripod Suction Bucket Foundations for Offshore Wind Towers Using Centrifuge Modeling. Journal of Geotechnical and Geoenvironmental Engineering 140(5): 04014008 (2014)