Numerical modelling of liquefied sand-pipeline interaction

F. Pisanòª, M. Cremonesiª, F. Cecinato®, G. Della Vecchiaª

ª Faculty of Civil Engineering and Geoscience, Delft University of Technology, Delft, The Netherlands
ª Department of Civil and Environmental Engineering, Politecnico di Milano, Milano (Italy)
ª Department Earth Sciences, University of Milan, Milano (Italy)
® corresponding author: Francesco.Cecinato@unimi.it

Abstract: Sand liquefaction is known to cause significant damage to buildings and infrastructure, and has been documented in several civil and energy engineering applications. In particular, offshore buried pipelines are bound to be exposed to liquefaction problems, and may consequently undergo flotation or sinking. Soil liquefaction, which can be triggered by different types of dynamic loading, implies the development of excess pore pressure up to causing the effective stress to vanish. This changes significantly the soil’s mechanical behaviour, which cannot be captured with standard geotechnical analyses. However the behaviour of liquefied sand may be related, with a simplified one-phase approach, to that of a non-newtonian viscous fluid. In this work, a numerical framework is presented that combines, in a partially coupled fashion, the Particle Finite Element Method (e.g. see Cremonesi et al., 2010, 2017, Della Vecchia et al., 2019) with post-liquefaction re-consolidation Finite Difference calculations. The model is then validated against physical model experimental data of liquefied sand-pipeline interaction, both for the case of pipe sinking and flotation. Results show that, despite the inherent simplifications, this approach is able to capture both qualitatively and quantitatively the fundamental features of pipeline motion in fluidised soil.

References

