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NUMERICAL SIMULATION OF PIPELINES SINKING AND FLOATATION IN A LIQUEFIED SAND

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Submarine pipelines are widely employed to transport hydrocarbons through the ocean from wells to production and distribution plants. When directly laid on the seabed, pipelines interact with very shallow soil layers particularly prone to liquefaction. When liquefaction is triggered by environmental loading and/or mechanical vibrations, the soil tends to behave as a viscous solid-fluid mixture causing very large pipeline displacements after flotation or sinking.

In this work we combine computational fluid dynamics (CFD) simulation and soil mechanics to address this complex task. The liquefied soil mass is assumed to flow as a one-phase viscous incompressible non-Newtonian fluid. Postliquefaction reconsolidation, is captured through a suitable variations of rheological properties driven by the evolution of pore pressures in the soil around the pipe. Assuming that the presence of the pipe does not severely affect the pore pressure field in the reconsolidating soil, pore pressure dissipation in a horizontal soil layer was simulated using non-linear 1D consolidation theory.

The CFD simulation were performed with the Particle Finite Element Method (PFEM), a fully Lagrangian Galerkin Finite Element approach particularly suited for free-surface fluid flow and for fluid-structure interaction problems [1, 2, 3].

The proposed modelling approach is compared to the results of small-scale pipe flotation tests showing a good agreement with experimental data.

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