Numerical simulation of scour and backfilling processes around a circular pile in waves - DTU Orbit (03/11/2019)

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This study continues the investigation of flow and scour around a vertical pile, reported by Roulund et al. (2005). Flow and scour/backfilling around a vertical pile exposed to waves are investigated by using a three-dimensional numerical model based on incompressible Reynolds averaged Navier–Stokes equations. The model incorporates (1) k-ω turbulence closure, (2) vortex shedding processes, (3) sediment transport (both bed and suspended load), as well as (4) bed morphology. The numerical simulations are carried out for a selected set of conditions of the laboratory experiments of Sumer et al. (1997, 2013a), and the numerical results are compared with those of the latter experiments. The simulations are carried out for two kinds of beds: rigid bed and sediment bed. The rigid-bed simulations indicate that the vortex shedding for waves around the pile occurs in a "one-cell" fashion with a uniform shedding frequency over the height of the cylinder, unlike the case for steady current where a two-cell structure prevails. The rigid-bed simulations further show that the horseshoe vortex flow also undergoes substantial changes in waves. The amplification of the bed shear stress around the pile (including the areas under the horseshoe vortex and the lee wake region) is obtained for various values of the Keulegan-Carpenter number, the principal parameter governing the flow around the pile in waves. The present model incorporated with the morphology component is applied to several scenarios of scour and backfilling around a pile exposed to waves. In the backfilling simulations, the initial scour hole is generated either by a steady current or by waves. The present simulations indicate that the scour and backfilling in waves are solely governed by the lee wake flow, in agreement with observations. The numerical model has proven successful in predicting the backfilling of scour holes exposed to waves. The results of the numerical tests indicate that the equilibrium depth of scour holes is the same for both the scour and the backfilling for a given Keulegan-Carpenter number, in full agreement with observations.

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