Flow and scour around spherical bodies - DTU Orbit (16/02/2019)

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Spherical bodies placed in the marine environment may bury themselves due to the action of the waves and the current on the sediment in their immediate neighborhood. The present study addresses this topic by a numerical and an experimental investigation of the flow and scour around a spherical body near an erodible bed. In Chapter 2, a 3-D Reynolds-Average Navier-Stokes (RANS) flow solver has been used to simulate flow around and forces on a free and a near-wall sphere. Fluid forces are computed and validated against experimental data. A good agreement is found between the model and experimental results except in the critical flow regime. For flow around a near-wall sphere, a weak horseshoe vortex emerges as the gap ratio becomes less than or equal to 0.3. In Chapter 3, a RANS flow solver has been used to compute the bed shear stress for a near-wall sphere. The model results compare well with the experimental data. A morphodynamic model has been applied and its ability to simulate scour around a sphere is demonstrated for the initial and the equilibrium stage of the scour process. The results show that the present numerical simulation captures some of the main features of the scour process. In Chapter 4, an experimental study on the scour around spherical bodies and self-burial in sand for steady current and waves has been carried out. The effect of the contraction of streamlines is found to be the key element in the scour process both for steady current and waves. Furthermore, it is demonstrated that the Keulegan-Carpenter number, KC, is the main parameter that govern the equilibrium scour depth in waves. The effect of the Shields parameter, q, on the final scour depth is found to be quite weak under live-bed conditions. It was found that the self-burial due to sinking (general shear failure) is governed mainly by the Keulegan-Carpenter number, KC. The time scale of the self-burial process, on the other hand, is governed by the Keulegan-Carpenter number, KC, and the Shields parameter, q. In Chapter 5, the results of an experimental study where scour around spherical bodies and self-burial in a silt bed are presented. The scour below a fixed sphere is found to be 10-20 % larger in the case of liquefied soil compared to the case of sand. The sinking of spheres due to liquefaction compared with sinking due to general shear failure (Chapter 4, Paper III) showed, that the depth of sinking could be as much as an order of magnitude larger.

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