Flow and bed shear stresses in scour protections around a pile in a current

Transport of bed sediment inside and beneath the scour protection may cause deformation and sinking of the scour protection for pile foundations. This may reduce the stability of the mono pile and change the natural frequency of the dynamic response of an offshore wind turbine installed on it in an unfavourable manner. Using physical models and 3D computational fluid dynamic (CFD) numerical simulations, the velocity and bed shear stresses are investigated in complex scour protections around mono piles in steady current. In the physical model the scour protections consisted of an upper cover layer with uniformly distributed coarse stones and a lower filter layer with finer stones. For the numerical simulations, the Flow-3D software was used. The scour protection layers were simulated with different numerical approaches, namely regularly arranged spheres, porous media, or their combinations (hybrid models). Numerical simulations with one or four layers of cover stones without filter layer were first computed. Three additional simulations were then made for a scour protection with a cover layer and a single filter layer. Finally, a simulation of a full scale foundation and scour protection was made with porous media approach. Based on the physical and numerical results, a method to determine the critical stones size to prevent motion of the base sediment is established and compared to a full scale case with sinking of scour protection (Horns Rev I Offshore Wind Farm, Denmark). It is also found that the CFD simulations are capable of calculating the flow velocities when the scour protection is represented by regular arranged spheres, while the turbulence in general is underestimated. The velocity can also be calculated using porous media flow approach, but the accuracy is not as good as for spheres. The deviation is more severe for more complex scour protections. In general, computational models provide valuable information for the prediction and design of scour protections for offshore wind farms.

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