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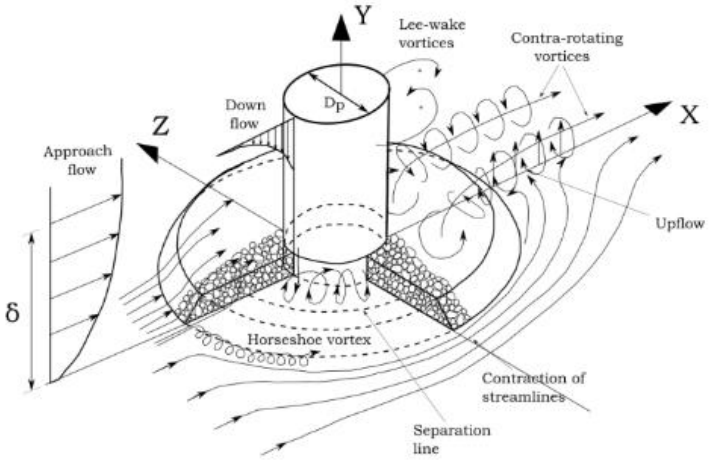
Master's thesis research at VORtech/Deltares (Delft)

Reduced Order Modelling for Flow around offshore Wind Turbines

What is it about?

Scour is the phenomenon that sand (or other bottom material) washes away around a structure at sea because this structure locally influences the flow which results in additional loading on the seabed. The interaction with the structure creates all sorts of interesting dynamic and static flow patterns, as seen in this figure:



The main forcing on the seabed is felt as shear stress, which scales with the square of the velocity. This influences sediment transport with a cubed relationship in velocity (or shear stress to the power of

one and a half). Various (empirical) sediment transport formulas exist for this, each accounting for different aspects.

CFD techniques can be used to predict sediment transport reasonably accurately for specific conditions, but these simulations are expensive. Therefore, CFD is now primarily used to predict scour for specific flow conditions and structure designs. A flow condition in this case is a depth and a constant inflow velocity. However, in reality we have variations (especially in speed) due to tides and storms, affecting the hydrodynamics. The ground also changes in reality due to direct scour around the structure, but there are also other large-scale variations that can cause subsidence or elevation.

The assignment

The goal of this research is to investigate whether a reduced order model (ROM) can accurately predict the shear stresses that directly link to sediment transport and erosion processes around offshore wind turbine foundations. The ROM will be based on full order OpenFOAM simulations.

Research is needed to understand how 2D shear stresses can be accounted for within a ROM, given that the underlying flow is fully 3D. This is particularly complex in the presence of turbulent boundary layers where strong velocity gradients and near-wall turbulence dominate shear stress distribution. Capturing these effects requires careful treatment of boundary conditions and local phenomena without simplifying the physics.

Ultimately, the ROM should predict shear stress fields across varying conditions, such as length scale, flow velocity and water depth, much faster than full CFD simulations while maintaining acceptable accuracy.

Context

The assignment will be carried out at VORtech in close collaboration with Deltares. You will spend most of your time at VORtech but also get to work at Deltares when useful.

VORtech is a company of scientific software engineers, developing computational applications for mostly large companies and institutes from a variety of different sectors, including Deltares. The company is relatively small with some 35 colleagues, mostly with either an MSc or a PhD in some computational field. You will be considered as part of the team during your stay at VORtech and join with all activities both work-related and leisure. VORtech has some experience in reduced order modelling but is looking for opportunities to deepen our understanding and broaden our experience.

Deltares an independent knowledge institute, working on innovative solutions in the field of water and subsurface. Deltares develops software to make knowledge usable for developing, testing and optimising solutions to complex issues. It offers added value for national and international missions and social issues. The Deltares employees involved in this project are experts in this particular application and in developing reduced order CFD models.

Are you Interested?

If you are interested in the master's thesis research as described in this text, please contact Mark Roest (mark.roest@vortech.nl). If there are multiple candidates, we may have to select as we can only host one master's thesis researcher at a time.

The research requires good programming skills next to a strong basis in numerical analysis. Some experience with OpenFOAM would be helpful but is not necessary.