Master's internship

Numerical analysis of flow and morphological patterns around moving objects

Laboratory : LEGI, MEIGE team (Grenoble)
Supervisors: Eduard PUIG MONTELLA, Julien CHAUCHAT and Cyrille BONAMY
Period : February to July 2023
Profile: Fluid mechanics, Soil mechanics, experience in programming
Gratification : Approximately 700€/month
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Description:

Sediment resuspension and erosion are important phenomena in many environmental and industrial processes. It is well-established that particle resuspension is related to turbulent flows, however, the understanding of the underlying physics is still weak. In order to gain more insight, *Munro et al. (2009)* investigated the sediment resuspension induced by a vortex ring interacting with a sediment layer using particle image velocimetry (see figure 1a). Similarly, *Steiner et al (2023)* is currently studying the flow field and onset of erosion induced by an oscillating disc (see figure 1b). Numerical studies, on the other hand, are scarce or non-existing. This opens up a new opportunity to have access to information experiments are not able to measure. Another classical example of erosion enhanced by fluid-sediment-structure interactions is the scour around a cylinder/pipe placed on a granular bed (see figure 1d). Sediment transport driven by currents or waves can cause scour or local fluidization leading to pipeline failures or the burial of the object .

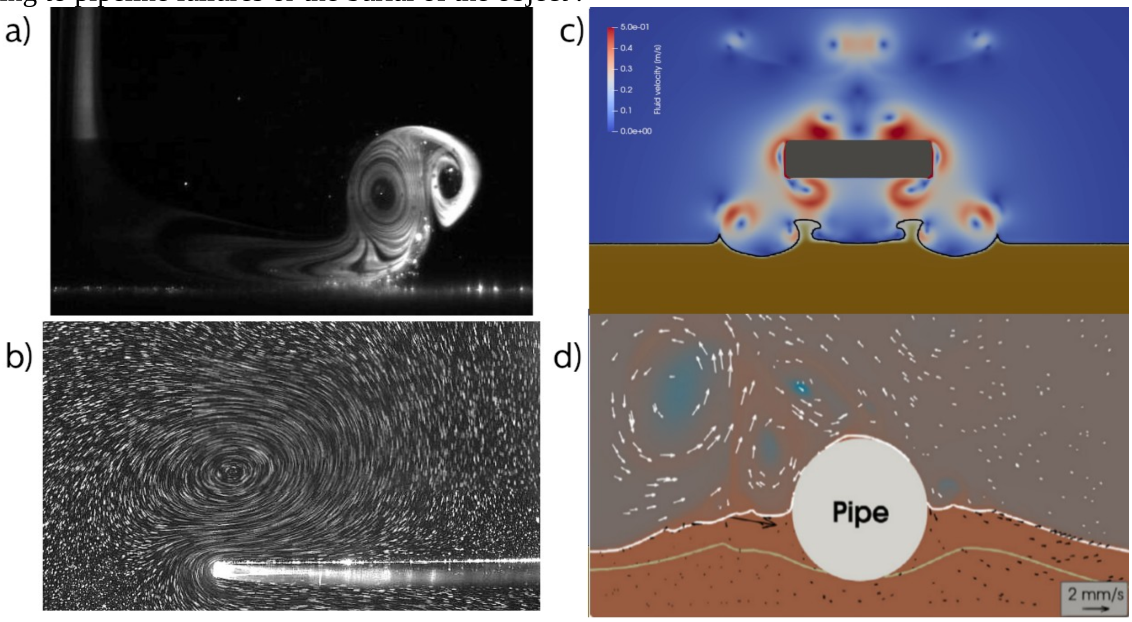

Fig. 1: a) Structure of the double vortex rings interacting with a sediment bed (*Munro et al. (2009)*). b) Flow patterns around an oscillating disc (*Steiner (2023)*). d) Evolution of the velocity field and bedforms induced by an oscillatory disc using SedFoam. d) Pipe burial and flow field reproduced numerically with SedFoam by *Tsai (2022).*

Job description:

The goal of this master project is to reproduce the experimental configurations of *Steiner (2023)* using an Eulerian two-phase flow solver implemented in OpenFoam (SedFoam, *Chauchat et al., 2017*). The candidate will analyze and compare the evolution of the bedforms and the flow patterns with *Steiner (2023)* results. A second objective is to study the trajectory and behavior of a cylinder on a sediment layer under the effect of an oscillatory flow following the configuration of *Tsai (2022)*, and eventually, perform a sensitivity analysis considering different burial depths, diameters and sediment and fluid properties.

Requirements:

The candidate should have a good knowledge of fluid and solid mechanics. Programming skills in Python and/or C++ is recommended. The position is opened to candidates having a bachelor degree.

References

Chauchat, J., Cheng, Z., Nagel, T., Bonamy, C., & Hsu, T. J. (2017). SedFoam-2.0: a 3-D two-phase flow numerical model for sediment transport. *Geoscientific Model Development*, *10*(12).

Munro, R. J., Bethke, N., & Dalziel, S. B. (2009). Sediment resuspension and erosion by vortex rings. *Physics of Fluids*, *21*(4),

Steiner, J (2023). Rôle des tourbillons et fluctuations de vitesse dans l'érosion.

Tsai, Benjamin, et al. (2022) An Eulerian two-phase flow model investigation on scour onset and backfill of a 2D pipeline.