Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Versuchsanstalt für Wasserbau,
Hydrologie und Glaziologie

Project or Master's Thesis
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Leitung: Prof. Dr. Robert Boes
Betreuung: Yannick Marschall

Numerical modelling of lift and drag forces on large boulders

Flood events in mountainous areas can lead to a rapid increase in water depth and bed shear stresses. In extreme cases, the riverbed can fail by excessive scouring and erosion, resulting in large damages in the environment or nearby infrastructure. The estimation of the stability of alpine riverbeds is still an open question in research. In artificial river sections, such as (unstructured) block ramps, large boulders, also called macro roughness elements, are used to receive some of the stresses and hence, stabilize the bed (Fig. 1). To design these river sections appropriately, it is necessary to understand the ongoing hydrodynamic processes and to estimate lift and drag forces acting on the boulders to determine their size. In the past, several studies have investigated the forces acting on single roughness elements with simple geometries either with lab experiments or with numerical methods.

The main goal of this project is to gain more information about the forces exerted on macro roughness elements with more natural or arbitrary shapes and compare the results. Therefore, a set of different shapes will be elaborated for further investigations. To quantify the shear forces, 3D numerical modelling will be used. The task will include mesh generation, simulation as well as post processing of the results (e.g. calculation of the stresses and forces, visualization of the results). For all simulations, the RANS (Reynold-averaged Navier-Stokes) will be used. Depending on available time, highly resolved DES (detached eddy simulation) can be added. All simulation will be conducted using the CFD software Star CCM+ and / or OpenFOAM.

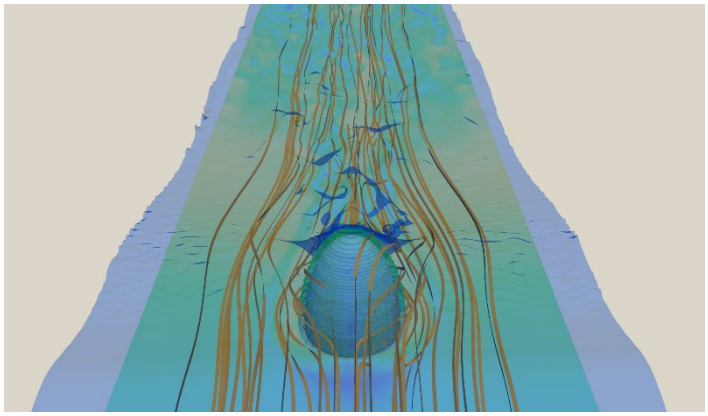

Fig. 1: Bed shear stresses and flow around idealized macro roughness element

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Remarks: Numerical simulations;
Project language: English or German
1 student for Master's or up to 2 students for project thesis