Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Versuchsanstalt für Wasserbau,
Hydrologie und Glaziologie

Master's Thesis HS 2021
Project Based Research Work

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Effect of built-in macro roughness elements on bed load transport in high-speed flows over a fixed bed

Sediment bypass tunnels are effective countermeasures against reservoir sedimentation. They reduce or totally prevent the sedimentation by routing the incoming sediment-laden flow around the dam, enabling the sediment continuity between the upstream and downstream river reaches. Due to the high sediment transport rates combined with high flow velocities, severe hydro-abrasion occurs at many SBT inverts. Therefore, a better understanding of the hydro-abrasion mechanisms, and the development of a mitigation measure are of prime importance for sustainable design and operation of SBTs and other hydraulic structures prone to hydro-abrasion. The installation of macro roughness elements across the invert to force bed load transport under so-called full cover conditions seems promising to mitigate hydro-abrasion. At such conditions, the tunnel bed load transport capacity is lower than the bed load transport rate, so that bed load aggradation leads to a self-protective effect. This project aims at systematically investigating the effect of (ir-)regularly spaced macro roughness elements (sills) on the flow and bed load transport in a laboratory flume.

Experiments will be conducted in a b = 0.2 m wide, h = 0.5 m deep and l = 13.5 m long hydraulic model flume with a bed slope of S_b = 1%, representing a straight section of a SBT. Bed load particles will be supplied to the flow using a sediment dosing machine. Particle movements will be recorded using a high speed camera (Fig.1) and flow depths will be measured with an ultrasonic distance sensor. The effect of the sill height to flow depth ratio, the distance between the sills, the bedload transport rate and the Froude number on cover will be investigated. Optionally, velocity measurements may be conducted using a Laser Doppler Velocimetry system.

The project may result in an innovative solution to counter hydro abrasion using macro roughness elements, and hence will contribute to the sustainable design and operation of hydraulic structures as well as improved knowledge on bed load transport and cover effect.

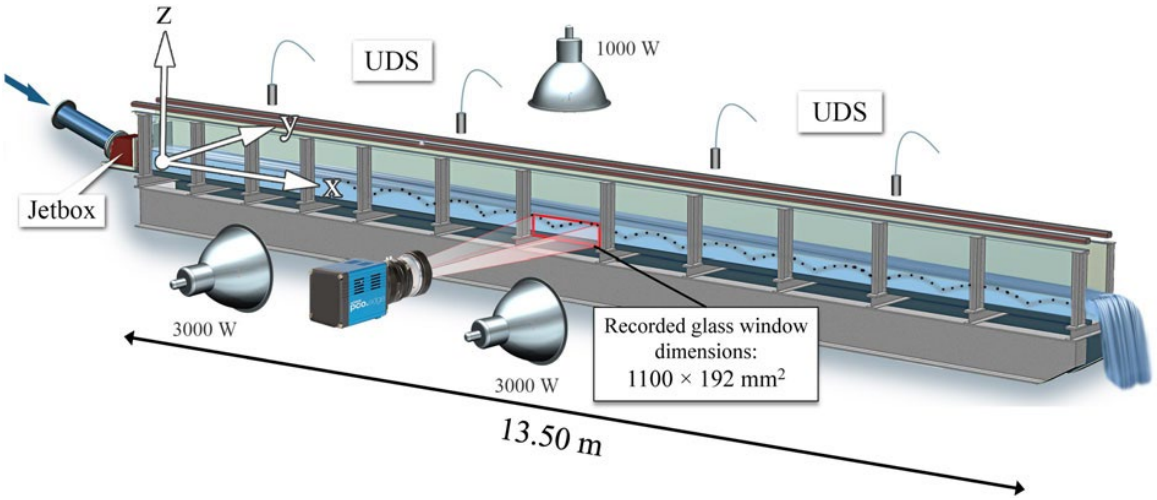

Fig. 1: Experimental set-up at VAW (Photos: VAW, ETH Zurich)

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Particular information:
Experimental work, knowledge on Matlab is required. Thesis can be written in German or English.