Eidgenössische Technische Hochschule Zürich
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Master's or Project Thesis
HS 2024

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Investigation of hydroabrasion at Mud Mountain Sediment Bypass Tunnel, USA

Sediment Bypass Tunnels (SBTs) are a reservoir sediment management strategy to route sediment-laden flows around reservoirs. Most SBTs are located in mountainous regions with gravel bed rivers at small to medium-sized reservoirs where a considerable amount of coarse material is transported and deposited. Because of high sediment loads and flow velocities, severe hydroabrasion may occur at the invert of SBTs, resulting in high maintenance costs and posing significant risks to structural integrity and operational safety. Effectively addressing hydroabrasion is key to minimize maintenance and refurbishment costs and ensure long-term functionality. Therefore, selection of a cost-effective abrasion resistant invert material is of prime importance. Current options encompass a range of high-strength concretes of different compositions, cast basalt plates, steel armoring or granite pavers or blocks. However, despite their use in existing SBTs, there is still a knowledge gap on the long-term performance of such materials under field conditions.

Fig. 1: Granite invert lining of Mud Mountain SBT (Source: US Army Corps of Engineers)

The goal of this Master's project is to investigate the hydroabrasion resistance of the granite invert lining of the Mud Mountain 9-foot SBT (Fig. 1) based on the inspection data between 2018 and 2023 provided by our external partner, US Army Corps of Engineers. The SBT is located on the White River in Washington State, USA. The tunnel invert was lined with 25.4 cm thick Hardy Island granite pavers in 2018. The project aims to determine spatially averaged and maximum and minimum hydroabrasion depths and hydroabrasion patterns along the tunnel. Additionally, an in-depth analysis will be conducted on bedload particle size distribution and transport rates, correlating particle hop lengths with the observed abrasion pattern and hydraulic operational conditions. Furthermore, the collected sediment, hydraulic and abrasion data will be used to validate the mechanistic abrasion prediction model enhanced by Demiral-Yüzügüllü (2021). Depending on the progress, this validation process will be extended to similar data analyses for the Asahi SBT in Japan. Finally, the abrasion resistance of Harby Island granite will be compared against that of different invert materials used in Swiss SBTs. Such a comparative analysis holds significant implications for cost-effective SBT design. The outcomes of this project will contribute to the sustainable use of hydraulic infrastructure prone to hydroabrasion.

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Remarks: Language: English (including thesis report).