Thalwil diversion tunnel – Intake and outlet structure

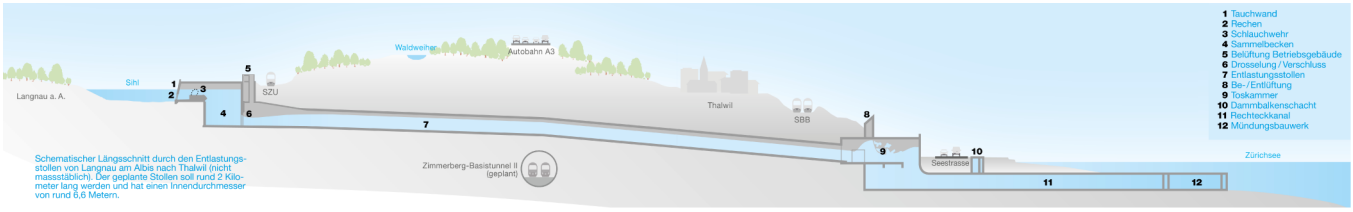

Fig. 1: Longitudinal section of the Thalwil diversion tunnel

In 2005, the city of Zurich just escaped major flood damage from the River Sihl. The precipitation centre of the heavy rainfall causing the flood was located above the Bernese Alps. If its centre had been located above the catchment of the River Sihl, Zurich's city centre around the main railway station would have been flooded extensively. Following the analysis of this event, the Canton of Zurich initiated the project "Flood protection on the River Sihl, Lake Zurich and River Limmat" (German: “Hochwasserschutz an Sihl, Zürichsee und Limmat”) in order to plan flood protection comprehensively and on a long-term basis. (www.hochwasserschutz-zuerich.zh.ch)

In the course of the project, some measures have already been implemented including the increase in discharge capacity of the culverts at Zurich main station in 2007 and the construction of a retention rack for woody debris on the River Sihl in 2017. The Thalwil diversion tunnel represents a further element of the overall project. The flood peaks in the River Sihl will be withdrawn near Langnau am Albis and discharged through the tunnel to Lake Zurich in Thalwil (Fig. 1). The tunnel has an overall length of 2 km and an inner diameter of 6.60 m. At a dimensioning discharge of 600 m^3/s (HQ500), it will divert a discharge of 330 m^3/s into Lake Zurich. The residual discharge in the River Sihl will then not cause any damage in the city of Zurich. In order to maintain the morphology in the River Sihl below the intake structure, water will only be diverted at discharges of 250 m^3/s (> HQ10) or more. To guarantee this separation characteristic, the intake structure is planned as a regulated lateral weir with inflatable rubber dams.

VAW was commissioned by the Office of Waste, Water, Energy and Air (AWEL) to investigate the intake and outlet structures of the Thalwil diversion tunnel in physical model tests.

Intake structure

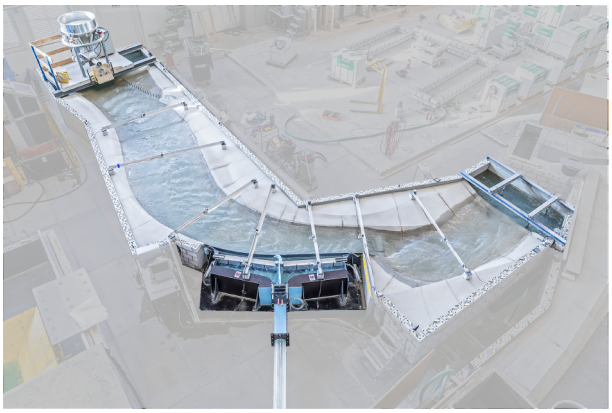

Fig. 2: Physical model of the intake structure at a scale of 1:30

The physical model of the intake structure covers a 450 m section of the River Sihl, the intake structure and 120 m of the diversion tunnel at a model scale of 1:30 (Fig. 2). The separation characteristics, the influence of the structure on the bed load budget, the bed load entrainment into the tunnel, the behaviour of driftwood and the flood safety during construction are investigated. The conducted tests at VAW confirm that the desired separation characteristic is achieved with the proposed design. It has also been demonstrated that during major flood events, bed load is largely transported in the original river bed and, due to the secondary flow in the curve, is hardly ever entrained into the tunnel. However, experiments with driftwood show that driftwood can enter the diversion tunnel, especially during small flood events with lower water levels and relatively shallow immersion depths of the downflow baffle.

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Outlet structure

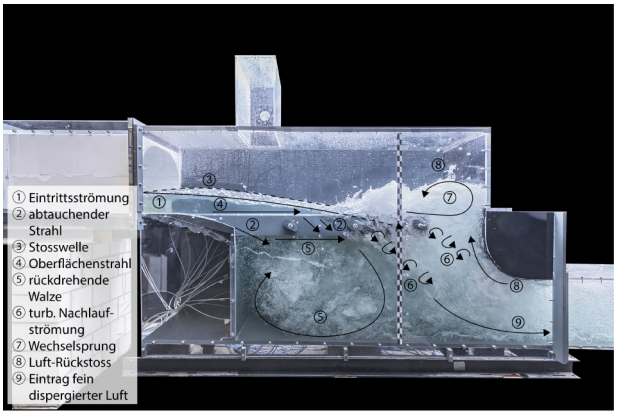

Abb. 3: Strömungsstrukturen in der Toskammer (bei einem Stollenabfluss von 200 m3/s und mittlerem Wasserspiegel des Zürichsees)

The Thalwil diversion tunnel ends in the subterranean outlet structure in Thalwil. The outlet structure is intended to stabilize the hydraulic jump in the stilling chamber and to release the water with moderate speed through a submerged culvert outlet into Lake Zurich (Fig. 1).

The outlet structure is a central component of the diversion tunnel and its functionality is decisive for the functioning of the overall system. Due to the limited space conditions, the stilling chamber cannot be planned sufficiently long and wide. Preliminary studies show that the energy dissipation within the available space, the air-water-mixture flow processes and the outflow into the lake urgently require a large-scale physical model test.

The outlet structure with the stilling chamber is investigated in a physical model at a model scale of 1:16.92. The physical model includes 100 m of the circular diversion tunnel, the stilling chamber with variable built-in components and the rectangular duct of 135 m length. The goals of the investigation are:

- Examination and optimization of the stilling chamber and its built- in components
- Stabilization of the hydraulic jump in the stilling chamber
- Verification of the functionality of the stilling chamber at low and high levels of Lake Zurich
- Minimization of the air entrainment into the pressurised culvert flow
- Minimization of the air release into the lake
- Investigation of the flow field in the lake at the tunnel outlet
- Investigation of de- aeration processes

Keywords:	Flood protection, River Dynamics, Sediment Transport, Air-Water-Flow, Energy Dissipation
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