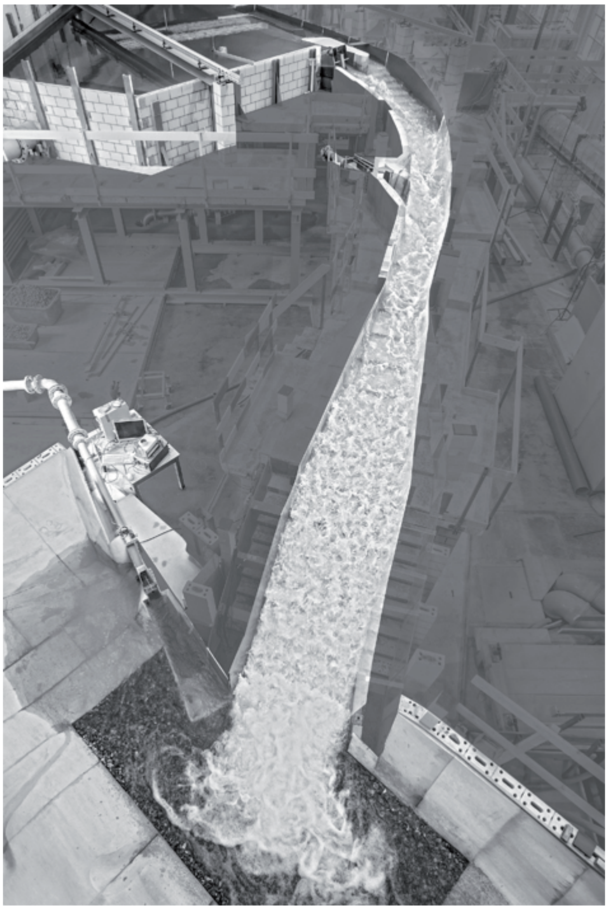
Trängslet Dam: Physical Model Investigation on the Spillway and the Outlets

Trängslet dam with the existing spillway located at the left abutment (Picture: Fortum Power AB).



General flow conditions on the stepped spillway for the design flood.

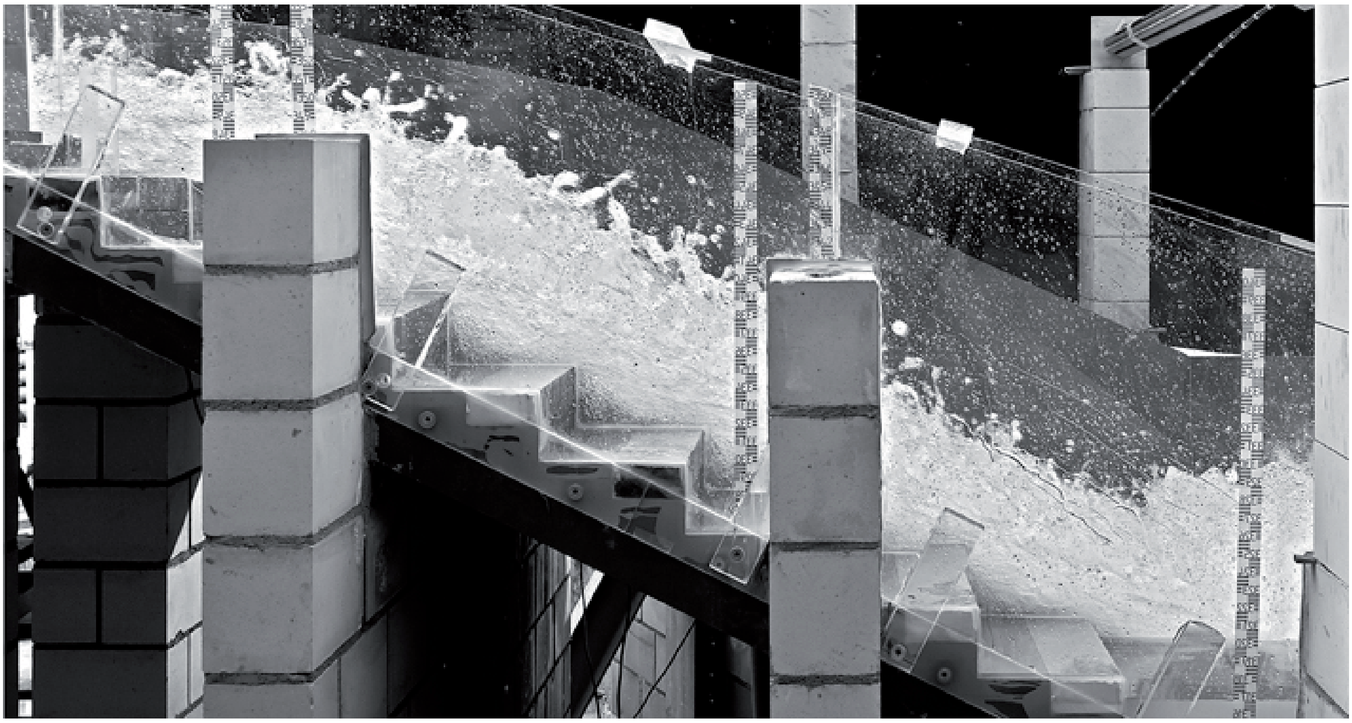
Trängslet hydropower Dam is a rockfill dam owned, operated and maintained by the Fortum power company. It is located on the Österdalälven River, a 300 km long river in Sweden flowing southeast through Dalarna, a province in central Sweden. With its height of 120 m Trängslet Dam is the highest dam in Sweden. The existing spillway is located at the left abutment and comprises two tainter gated spillway openings followed by a rock channel in the left abutment valley flank conveying the flood back towards the river in the tailwater of the dam.

In the context of an upgrading of the Trängslet Dam and an increase of the design flood it is planned to add additional spillway capacity to the dam and to transform the existing spillway channel into a stepped spillway. The new spillway will consist of a new unregulated overflow weir with a flap gate next to it, both leading to a side channel, from which the water will flow into the spillway channel. Further plans envisage the reuse of one of the plugged former diversion tunnels as new intermediate or low level outlet.

Fortum Generation AB commissioned VAW in December 2011 with a physical model investigation on the designed hydraulic scheme. The model with a scale of 1:45 covers a part of the dam and the reservoir, the new spillway and a part of the downstream river. The foci of the hydraulic investigations are the flow features in the reservoir in the vicinity of the weir structures, in the side channel, along the stepped spillway and in the stilling basin as well as the safe evacuation of the design flood even at a high driftwood occurrence.

The investigation of the initial design shows an angular approach flow to the flap gate, slightly reducing its capacity and enhancing log jam. A rotation of the flap gate and a lowering of its sill improve the approach flow, increase the capacity and ameliorate the driftwood conveyance. However, the driftwood has to be removed mechanically in front of the existing spillway and the overflow weir after a flood event. A narrowing of the side channel and the new spillway canal allows the reduction of the excavation costs and concrete volumes. A pronounced two-vortex flow is observed in the side channel, except for maximum retention level for which single-vortex flow occurs, signalizing the capacity limit of the side channel.

ETH zürich



Side view of the steep part of the stepped spillway for the design flood in the final design with skimming flow regime. At the end of the stepped spillway the flow is submerged by the hydraulic jump in the stilling basin.

The functionality of the stepped spillway is confirmed in the initial design investigations. In order to improve the economic feasibility, the spillway width in the lower, steep part of the spillway is reduced and the step height is doubled. As the flow is highly aerated along the stepped spillway with bottom air concentrations and pressure heads above the critical values in the measuring sections, the cavitation risk is considered to be acceptable even in the prototype. The scour potential in the stilling basin is assessed with a movable bed and with pressure measurements on a stilling basin floor. No high wave run-up at the opposite valley flank and at the dam toe is observed. The operation of the intermediate and low level outlet is investigated and no negative impacts on the stepped spillway or the stilling basin are observed.

Keywords:	Stepped spillway, Overflow weir, Side channel, Chute widening, Middle outlet, Plunge pool, scour
Commissioned by:	Fortum Generation AB

Laboratory of Hydraulics, Hydrology and Glaziology
Versuchsanstalt für Wasserbau, Hydrologie und Glaziologie