Kárahnjúkar Dam Spillway - Physical Model Investigation (2006)

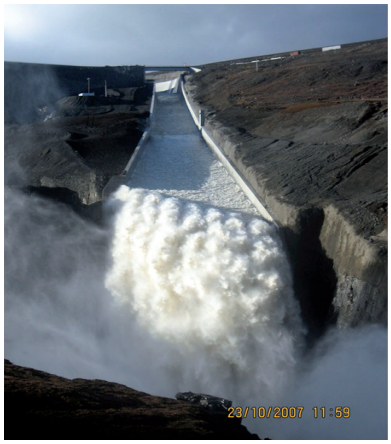

Fig. 1: Spillway chute with jet for 300 m^3/s in the prototype (picture: Landsvirkjun) and in the model.

The Kárahnjúkar HPP in Eastern Iceland was completed in 2008. Three dams store a reservoir with a life volume of 2100 million m^3 water harnessing several glacier rivers. An unregulated spillway conveying floods from the reservoir into the river bed is located at the left embankment of the 198 m high main dam (Fig. 1). This facility was designed for a discharge of 1350 m^3/s and evacuates a PMF of 2250 m^3/s. It consists of a side channel, a transition bend and a 419 m long chute. At the chute end, the water falls as a free jet into a narrow canyon with almost 100 m high rock flanks. These flanks are unstable due to cracks and soft rock. The Laboratory of Hydraulics, Hydrology and Glaciology (VAW) was commissioned to conduct the hydraulic model tests of the spillway. Two aspects had to be considered as the main challenges: (1) The jet was not allowed to touch the canyon flanks, and (2) A minimum energy density had to be generated at its impact onto the river bed. A detailed optimization process was necessary to achieve these two goals. The lower chute section was found as the critical component in this regard. A novel chute takeoff structure including a step for small discharges was finally proposed.

The following measures were taken:

- Takeoff lip at the chute end is located upstream of the canyon edge. The jet does then not impinge on the opposite flank at the maximum discharge,
- Lower chute part downstream of the chute aerator is steeper than the upper. This measure reduces the maximum jet jump length slightly,
- Lower chute part is widened linearly from 17 up to 30 m. The resulting jet expands and is thinner, supporting its disintegration. Further, the jet footprint on the water surface of the plunge pool is increased, resulting in a reduced energy density,
- Seven baffles are located at the chute end lip to expand the jet vertically and increase its turbulence, resulting in an improved jet disintegration process and a reduced energy density at the plunge pool impact,
- Lower platform is necessary to draining small flows into the canyon, because the takeoff lip is located upstream of the canyon edge,
- Lateral baffles lift the jet on its sides, falling too short otherwise because of reduced flow velocities along the chute side walls. A clearing of the lower platform is achieved thereby for small discharges, reducing the hydro mechanical strain on the structure, and
- Takeoff lip is oblique relative to the flow direction, following the canyon edge. Beside constructional advantages, this design rotates the jet footprint and adjusts it to the plunge pool shape.

Rock scour countermeasures within the canyon consist, among others, of a tailwater dam and an excavation of bed sediments down to the rock face in order to provide 15 m plunge pool depth.

Keywords:	Spillway, Side Channel, Chute, Chute Widening, Aerator, Jet, Jet Disintegration, Chute Baffle, Plunge Pool
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