Intake structure of the Handeck 2 power plant (Switzerland) physical model investigation (2011)

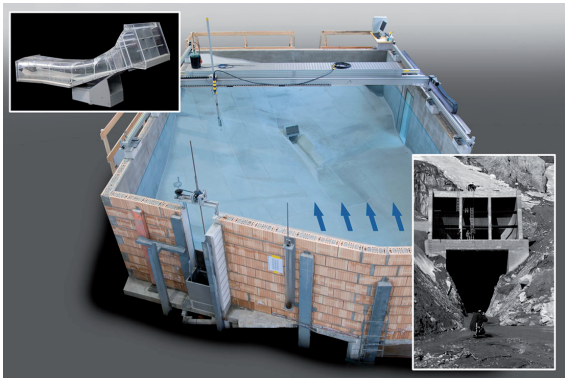

Fig.1

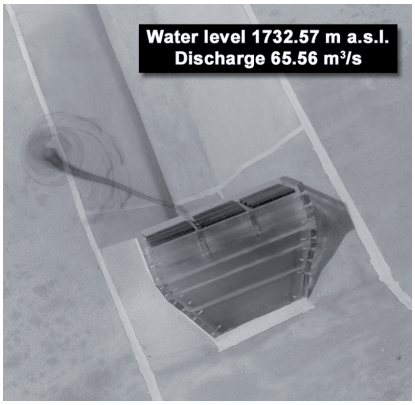

Fig.2

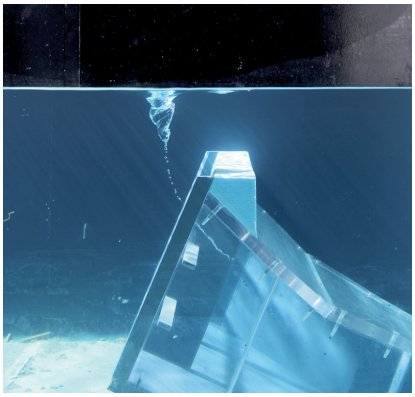

Fig.3

Related to the KWO plus project, KWO plans to upgrade the Handeck 2 power plant by increasing its efficiency and reducing head losses in the tunnel system. The approach of the project is to use the existing intake structure of the Räterichsboden reservoir. An additional pressure tunnel is planned to be constructed starting from a new junction in the existing tunnel less downstream the intake structure. KWO commissioned VAW in April 2009 with a physical model investigation on the designed hydraulic scheme. The main objective is to verify the design discharge increasing from 42.5 to 65.5 m^3/s. The model tests comprise the analysis of the problems related to the vortex formation at the intake structure as well as the mobilisation and the transport of sediments through the bottom outlet.

The perimeter of the model around the intake structure reproduces an about 300 x 200 m section of the Räterichsboden reservoir including the terrain topography and about 70 m of the tunnel system (cf. Figure 1). The chosen model scale of 1:35 is adequate for common limit values of surface tension and viscosity of a Froude model for the investigation of vortex formation by intakes. Furthermore, an additional model of the intake structure at a scale of 1:25 has been erected in a channel of 1 m in width and 7 m in length.
The first results from the model tests show that vortices with a type 3 develop in the hydraulic model. By this vortex type a dimple forms on the water surface. The coherent swirl down throughout water column to the intake structure can be demonstrated by a dye core. Figure 2 shows the close-up range of the intake in the hydraulic model. Vortices with an air core do not occur in the model due to the dominating role of the surface tension. However, it can be assumed that the vortex type shown in the figure would represent an air-entraining vortex in the prototype which is therefore critical. The air-entrainment rate due to vortices at intakes is less investigated and unknown. Therefore, the occurrence of such vortices should be avoided. The planned increase of the design discharge would result in an about 7 m higher minimum operating level. This would imply stricter operation constraints which would reduce the plant's efficiency. Subsequently anti-vortex devices will be tested in order to allow the minimum operating level to be at least as high as the present level and to make the use of the present storage volume possible. The bottom outlet is situated directly below the intake structure. The possible mobilisation of the deposited sediment will be tested in a successive project phase. The existing sediments in the Räterichsboden reservoir are very fine. For this reason, the model only allows a qualitative prediction of the sediment movements. By means of VAW's experience gathered with other projects about reservoir silting, a funnel in the close-up range of the bottom outlet is expected to be formed and a small amount of sediment would consequently be activated. Acquired data related to the model tests on the 1:25 scaled inlet structure in the channel (cf. Figure 3) should give information about eventual model scale effects regarding the problems related to the vortex formation at the intake structure. The systematic comparison with the higher scaled model would make future tests more effective.

Fig.1: Overview of the 1:35 scale model at the VAW.

Fig.2: Top view of intake structure Handeck 2 reproduced in a physical model at a scale of 1:35 at the VAW. The formation of a vortex type 3 at the intake is visual-ised by dye core.

Fig.3: Air-entraining vortex at the intake structure in the 1:25 scale model.

Keywords:	Vortices at intakes, anti-vortex devices, reservoir sedimentation special subject: purging sediment through bottom outlet
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