



## **Verification of a Flow3d Mathematical Model by a Physical Hydraulic Model of a Turbine Intake Structure of a Small Hydropower Plant and a Practical Use of the Mathematical Model**

S. Vosnjak and J. Mlacnik

Institute for Hydraulic Research, Ljubljana, Slovenia. (stasa.vosnjak@guest.arnes.si)

The Drava Power Plants Utility company is the owner of all hydropower plants on the Drava River, Slovenia. On the flood waves relief structure of the Zlatoličje HPP headrace channel the construction of a turbine intake structure for the Melje small hydropower plant is planned. The Melje small HPP shall exploit the biological minimum discharge for electricity production. Since the structure shall be small, the price of a physical hydraulic model research, in comparison with the price of the structure itself, would be too high. Consequently, the client decided to test the designed structure in the cheapest possible way and ordered a 3D mathematical model of the turbine intake structure. By this mathematical model the designed form of the intake structure should be verified, or, in case of non-compliance, a modified form of such structure which would meet the required modes of the SHPP operation should be proposed. Since such a 3D mathematical model hasn't been used for a hydraulic modelling of this type yet, the project performers were slightly mistrustful of the results obtained by it. Regarding our long years' experiences with physical modelling we decided to construct also a physical hydraulic model in order to be able to verify the designed form of the intake structure and then to use the results for the 3D mathematical model calibration.

A partial physical hydraulic model was constructed in the Laboratory for Hydraulic Research in Ljubljana in a model scale of 1:20. For construction and implementation of all the necessary research only 30 days were needed. Simultaneously with the physical model all the preparatory arrangements for the geometry of the mathematical model were going on. During the further development of the mathematical model, also some additional researches on the physical model were performed. Considering the time needed to fully establish the functionality of the mathematical model, it showed up to be very time consuming even in comparison to the construction, all necessary adaptations and the research on the physical model.

A commercially available computational fluid dynamic (CFD) program, which solves the Reynolds-averaged Navier-Stokes equations, was used to model physical model setup. The mathematical model was applied for the modelling of the zone of the same size as that on the physical model. The measurements of the water flow velocity, which were performed on the physical model, served us for the verification of results, obtained by means of the mathematical model.

This paper gives a comparison of physical and mathematical models research results. However, it presents the results of the project form, as well as those of the proposed form, too.