

THE MODELING OF TURBULENT FLOW IN FISH PASSES – ABSTRACT

A fish pass is a hydrotechnical object, which is an element of a water dam (weir). The aim of the building of the fishway is to restore the conditions for the migration of ichthyofauna through the existing transverse hydrotechnical constructions. The role of the fishway is to sustain or reintroduction the ecological permeability of rivers and streams. Until now, fish passes have been dedicated to individual species of fish that are capable of swimming, but nevertheless they have not achieved the expected efficiency.

The aim of the study was, through detailed analysis of hydraulic parameters of operation of modeled fish passes, to obtain an answer to the question about the reasons for their low efficiency. It is now well known that the efficiency assessment for fish passes in terms of velocities, present in the facilities, is insufficient. In the process of analyses of flow investigations for models of various types of construction of fishways it was established that the range of examined flow parameters should be extended by turbulent characteristics. Especially since the occurrence of turbulent phenomena in the stream flow in rivers is an element determining the biology of fish, influencing their shapes, body structure and behavior.

Migration monitoring investigations have shown that fish continuously swim through the whirls. Their way of moving is characterized by a curvature of significant deviations from the route axis in comparison to the route of the fish within the main stream. This observation raises the importance of the element of flow, which is its structure itself. It was identified that favorable conditions for fishes migration are those where the flow area has proper whirls sizes and Reynolds' relevant values of Reynolds stresses. Additionally, the analysis of the conducted research clearly indicates that the increase in the efficiency of the fish pass is linked to the higher use by the fish of zones characterized by low flow velocities and appropriate values of turbulent kinetic energy (TKE). The papers presented in the article refer to the most important elements of turbulent flow for the efficiency of fish passes, i.e. the water velocity of flow, spatial structure of turbulence and turbulent kinetic energy (TKE),

As a result of hydraulic modelling of turbulent flow in the fish passes, application of advanced tools to process the obtained data in the software Matlab, it was possible to perform an analysis of spatial distributions of all the most important turbulent flow parameters for the bolt fishways. The modeling process includes the influence of additional overfall slots and stiff channel development in the shape of bolts. The research was extended by data from investigations carried out for different types of constructions. All tests were performed using high frequency echosondes with three components of temporary velocities of flow in the indicated cross-sections. Hydraulic analyses were presented for large-size objects (real scale of dimensions), so the results of the research can be directly implemented into the designed constructions.

As a consequence of advanced hydraulic modelling and numerical simulations performed on the field and laboratory tests, it was possible to develop a formula (equation) for the forecast TKE value expected in the central part of the outlet slot. It was possible due to the introduction to the analysis of the modeled flow of the concept of the potentials of the water flow stream, which from the point of view of the presented works was a milestone assumption. Knowledge of distribution mechanisms and conditions for turbulent flow parameters is a determining feature for designing and diagnostics of migration facilities. The developed tools of turbulent flow modelling, in the form of prepared equations and indicated TKE limit values, will allow for conscious creation of flow space, which may affect the new rules of designing fish passes.