Analysis of Hydraulic Flow Conditions in Denil Fish Passes

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INTRODUCTION

Denil fish pass

The fish passes, named after their inventor G. Denil (1909), consist of a linear rectangular canal in which the cross-walls are placed at regular and short intervals, tilted opposite to the direction of flow of water. Many versions of Denil fish passes have been developed over the years, but today the most used ones are the "U" shaped ones, which have proved to be the most functional. Characteristic of this type of fish passes is the large dissipation of energy and the formation of a decay in the area between the cross-walls, which causes lower flow velocities at the bottom. This makes it easier for the fish to go through the fish pass, and also allows for the design of fish passes with larger slopes, and thus of smaller lengths. In the case of larger intervals, it is necessary to make rest areas for the fish. Depending on the fish species, rest areas should appear every 6-8 m or 10-12 m. The dimensions of the rest areas are chosen so that they decrease the energy and enable the formation of rest zones, where volumetric power dissipation should not be greater than 25-50 W/m3). Also, one of the benefits of Denil fish passes is the large flow that attracts fish and makes it easier to direct the fish into the fish pass.

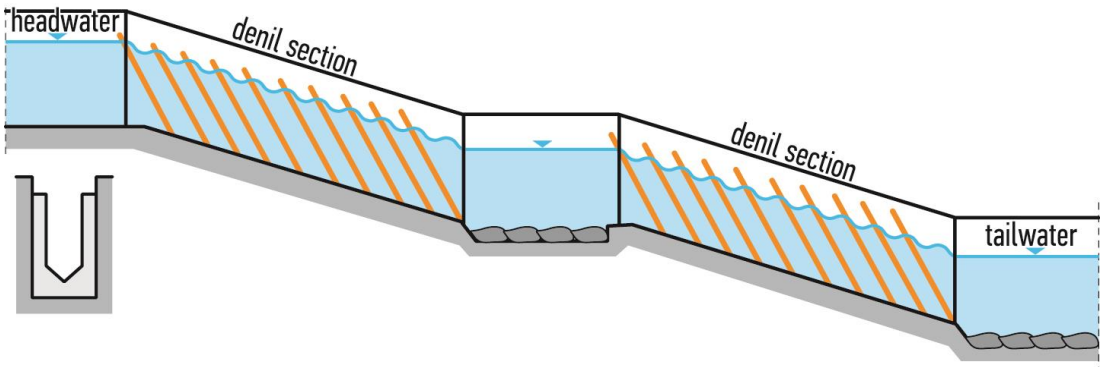

Figure 1. Scheme of Denil fish pass (according to FAO, DVWK 2002)

Hydraulic flow conditions

This paper presents analysis of hydraulic flow conditions in the fish pass to accommodate selected fish species. Hydraulic variables are determined using conventional empirical relations available from current literature and compared with the ones calculated using numerical models. Analysed dimensions of fish passes are taken from recommendations in the literature, ranging from 1.5 to 4.0 m drops. Numerical models used are 2D and 3D models for detailed flow pattern calculation. Numerical models are calibrated based on hydraulic variables values available in literature to obtain benchmark data. Afterwards, using same numerical model's results were obtained for a range of fish pass geometry through varying slope and width and hydrological events through varying discharge. Coarser 2D numerical model is used for calculating stationary values of hydraulic

variables on the entire fish pass domain, while 3D model is used for detail flow field calculation within characteristic section of the fish pass. Results obtained from 2D model are used as initial conditions for 3D model in order to achieve model stability.

Table 1. Guide values for Denil passes (according to FAO, DVWK 2002)

		Fish species
		Grayling, Chub, Bream, others
Channel width	[m]	0,60-0,90
Slopes	[%]	13,5-20,00
	[1:n]	1:7,4 – 1:5
Discharge	[m^3/s]	0,25-0,60

METHODOLOGY

Resulting flow field for varied range of discharge and geometry is plotted against flow depth and fish pass slope as a scatter-plot. Scatter-plot vertexes are used for nonlinear curve fitting in regression analysis to generate mathematical function from which contours of resulting flow velocity are derived. From these curves target velocity can be isolated and used to obtain optimal dimensions for fish pass sections.

ACKNOWLEDGMENTS

The research presented in the paper was conducted within the project Planning and design of fish passes supported by the *Croatian waters*.

REFERENCES

FAO, DVWK (2002). Fish passes – Design, dimensions and monitoring. FAO (Food and Agriculture Organization of the US), DVWK (German Association for Water Resources and Land Improvement), Rome, Italy.