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On the Design of a Structure for Fish and Human Needs

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INTRODUCTION

Finland is a relatively flat country abounds in rivers and lakes. Most common fishway types are pool and weir and vertical slot fishways. Recently, Denil fishways have also been built. Most of these fishways are located inland and they are for both anadromous salmonids and freshwater species.

Fishermen and the local community of Evijarvi municipality in the central Finland expressed concern that fish could not pass the small weir built across the channel connecting the two local lakes and that they have to lift their boats to cross over the weir. Plans for a channel structure that meets both of these objects were made at the Oulu University and model tests were held to know the hydraulic characteristics of the structure. The idea was to take advantage of flow characteristics of Denil fish pass in which specific baffles reduce the water velocities on the sides and bottom of the channel by reflecting the water current back on itself. By building a similar fish pass with different baffle shapes, both fish and boats would be given an opportunity to move up the channel. The present paper discusses the hydraulic conditions of the recently built channel structure for fish and boat passage at Evijarvi in the central Finland

METHODS

The channel for fish and boat passage was constructed at Evijarvi with the above stated objectives during 1996-1997. The channel received its first inflow in the summer of 1997. Extensive model tests had been carried out earlier at Oulu Institute of Technology in collaboration with University of Oulu. The scale of the model was 1:5. These tests offered the opportunity to define the important hydraulic parameters of the structure. Baffles of the prototype channel were made of steel and were fixed at 45° to the bed of the channel. The distance between the baffles was 0.50m. Channel walls and bed were made of concrete and the length and width at the top of the channel was 12m and 3m respectively. The width at the bottom of the channel was 1.2m. The slope of the channel was 1 in 20. In addition, a 0.4m steel strip was placed along the centerline of the channel. This strip was firmly attached to the channel bottom with the help of vertical stainless steel strips (Fig.1). The idea behind this arrangement was to ensure higher velocities in the center of the pass and much smaller velocities along the side walls so that boats would traverse in the middle of the channel. Accidentals hitting of boats to side walls were prevented by placing timber logs on the sides of the channel. The channel was expected to receive a maximum discharge of 2 m^3/s with a maximum water depth of 0.70 to 0.80m. Water depths were taken in the center at different cross-sections along the length of the passage. Similarly, velocities were measured at different depths in a grid form at different cross-sections along the fish and boat passage length to get a complete picture of the water velocities.

RESULTS AND DISCUSSION

The use of a steel strip along the centerline at the bottom of the channel is one of the key elements in the successful functioning of fish and boat passage. Laboratory tests had indicated that the water velocities in the channel were kept within certain limits and fairly uniform when there was a steel strip at the bottom of the channel (Timo Pohjamo, 1995). With a steel strip, water velocities along the centerline were greater than without it. While it was difficult for boats to traverse upstream along the centerline with high turbulence associated with low velocities, fish on the other hand, were able to choose swimming routes up areas easily anywhere in the channel according to their strength. The steel strip provides a balance between the two situations with high velocities at the center and small velocities along the sides of the channel for a successful passage for both fish and boats.

Water surface profiles were derived from the measurements along the length of the fish and boat pass. This particular profile shown in Fig.2 represents the highest water level. The greatest water depth occurred near the exit.

Key words: Fish pass, boat channel, fish and boat pass, hydraulics

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The following discharge rating curve has been developed through model testing (Sampath Kumar Gurram and Timo Pohjamo 1997):

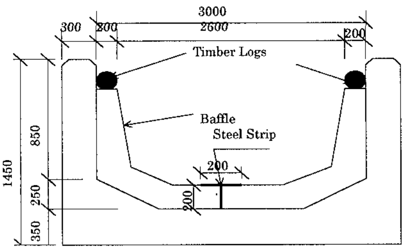
$Q^* = 4.34(y/b)^{1.63}$ (1), where $Q^* = Q/\sqrt{gs}\, b^{5/2}$ (2)

Here Q^* = dimensionless discharge, Q = the discharge (m^3/s), S = slope of the fish and boat pass, b = bottom width of the fish and boat pass (m), y = water depth measured from steel strip at 90° towards the surface (m) and g = acceleration due to gravity (9.81 m/s^2). Given the bottom width (b) and slope of the Evijarvi fish and boat pass channel, equation (1) and (2) reduces to

$Q = 3.56y^{1.63}$ (3).

Thus Equation (3) is used to estimate the discharge through the fish and boat pass channel from measured water depths.

Water velocities along the centerline and at the sides of Evijarvi fish and boat pass corresponding to 0.2y, 0.5y and 0.8y are shown in the Figure 3. The velocities on both sides of the channel are identical. The



Unit: mm, Not to the scale

Fig.1 Details of the Baffle

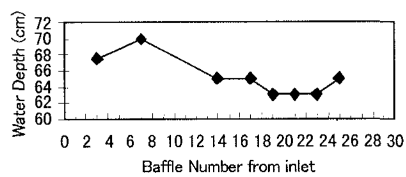


Fig.2 Water Surface Profile

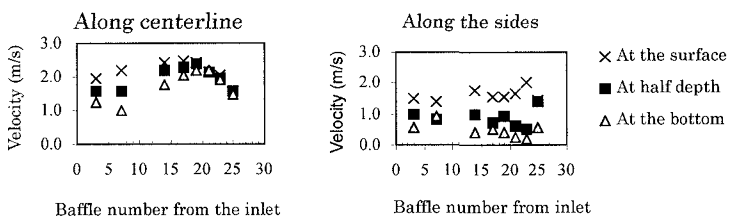


Fig.3 Velocity Profiles

water velocities are lowest at the bottom of the channel and increase upwards to the water surface. Furthermore, these velocities are much smaller at the sides than in the center of the flume. This implies that fish ascending the fish pass face varying velocities depending upon their swimming depth and the location from where they choose to ascend. Similarly, high velocities in the center of the flume aid the boats to cross over the channel successfully without hitting to the sides. Several trial runs with small pleasure boats indicated that the boat always positioned itself in the center of the channel and the boat crossed the channel with ease. Observations for fish movements are planned in the summer of 1998.

CONCLUSIONS

The newly built fish and boat pass channel essentially maintained the characteristics similar to those of standard Denil fishway. Fish used the channel, while the small pleasure boats also went up the channel. The observations at Evijarvi fish and boat pass channel confirmed the model test results.

REFERENCES

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