ReHydro

Demonstration of Sustainable Hydropower Refurbishment

M12 Eel friendly turbine design simulations

Work Package	WP4 Environmental improvements of refurbishments
Responsible	Claire Segoufin, GEV
Milestone reached	30/06/2026

Task : T4.1 Safe passage of eels at large hydropower plants

A turbine designed to improve eel survival has been developed based on the Belver (EDP) use case characteristics. To do so, critical physiological parameters for eel survival have been identified using a comprehensive literature review and feedback from partners (CNR, EDF, EDP, and NINA). Base on European Standard Norm prEN 18110 “Water quality – Method for assessment of fish damage in pumps and turbines used in pumping stations and hydropower plants”, an analytical equation for eel survival estimation was implemented in GEV in house numerical simulation post processing tools. This allowed to evaluate and to optimize runner design in terms of eel survival, while keeping its performance in terms of efficiency and cavitation. An illustration of fluid numerical simulation of the runner is presented in Figure 1.

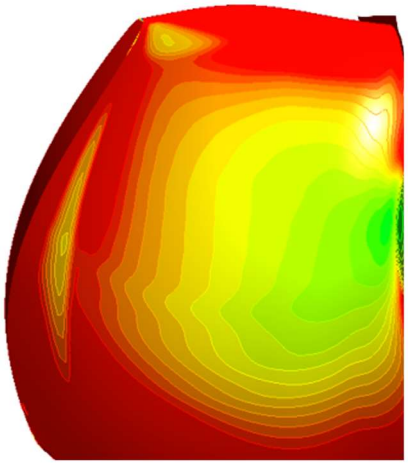

Figure 1 Pressure contours on suction side of blade

As shown in Figure 2, the turbine optimization efforts have yielded significant improvements in predicted eel survival during turbine passage. Strike injury risk was reduced through targeted leading edge profile shape modifications and a reduction in the number of blades, while maintaining pressure conditions within acceptable limits for eel passage. These biological performance gains were achieved with minimal yet non-negligible compromise to hydraulic turbine efficiency.

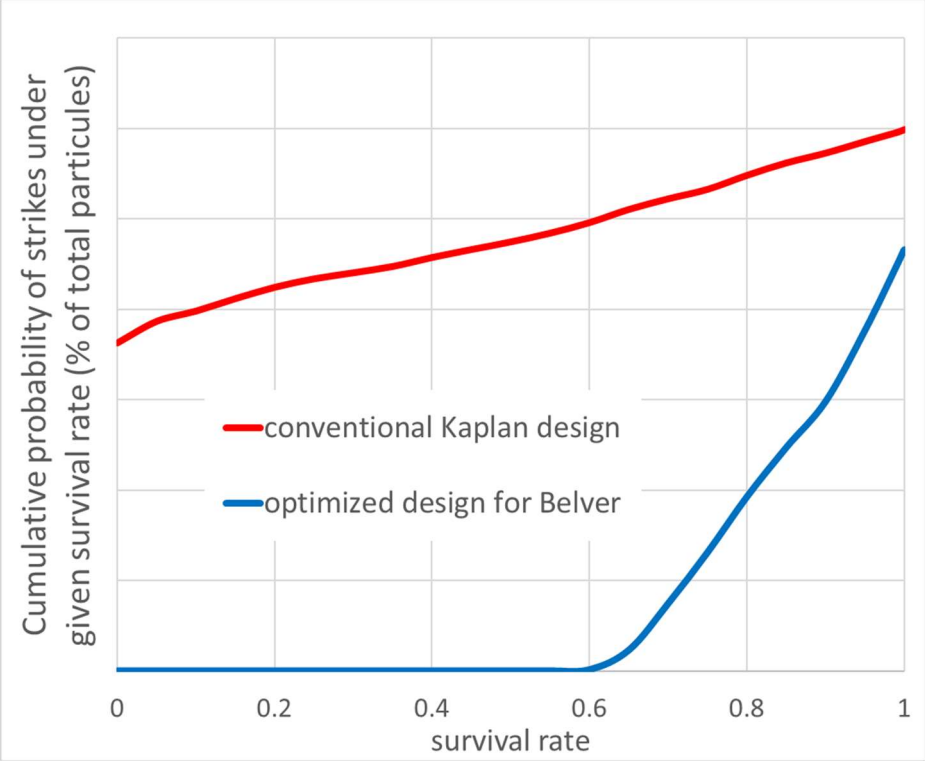

Figure 2 Comparison of Cumulative probability of strikes under a given survival rate between a conventional Kaplan design (red) and the optimized design (blue) showing decreased probability of exposure to severe strikes within the runner passage.

Next steps:

1. A model test at reduced scale with a semi-homologous configuration will be done and will check performances of the optimized design, in terms of performance and in terms of eels' mortality. Way of modeling eels, injecting them in the turbine model and post processing data is under development.
2. A scan of the Belver runner is planned, a comparative analysis with the optimized design will be done
3. A calibration of the analytical laws used to assess numerically eels' mortality will be done based on CNR & EDF live fish site test data.
4. A synthesis of all the results obtained and conclusions will be done and presented in deliverable D4.2

DISCLAIMER / ACKNOWLEDGMENT

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