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Numerical simulation of fish nets in currents using a Morison force model

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Abstract. For complex flexible structures such as nets, the determination of drag forces and its deformation is a challenging task. The accurate prediction of loads on cages is one of the key steps in designing fish farm facilities. The basic physics with a simple cage, can be addressed by the use of experimental studies. However, to design more complex cage system for various environmental conditions, a reliable numerical simulation tool is essential. In this work, the current load on a cage is calculated using a Morison-force model applied at instantaneous positions of equivalent-net modeling. Variations of solidity ratio (S_n) of the net and current speed are considered. An equivalent array of cylinders is built to represent the physical netting. Based on the systematic comparisons between the published experimental data for Raschel nets and the current numerical simulations, carried out using the commercial software OrcaFlex, a new formulation for C_d values, used in the equivalent-net model, is presented. The similar approach can also be applied to other netting materials following the same procedure. In case of high solidity ratio and current speed, the hybrid model defines C_d as a function of Re (Reynolds number) and S_n to better represent the corresponding weak diffraction effects. Otherwise, the conventional C_d values depending only on Re can be used with including shielding effects for downstream elements. This new methodology significantly improves the agreement between numerical and experimental data.

Keywords: fish cage; equivalent net model; Morison drag formula; strong current; large deformation; solidity ratio; drag coefficient; weak diffraction effect; shielding effect

1. Introduction

As aquaculture keeps growing driven by the high demand for seafood around the globe, larger and more complex fish farms are being designed and installed in exposed locations. At these sites, continuous water exchange by waves and currents inside the cage and large external space provides ideal conditions for fish aquaculture (Cifuentes and Kim 2015). In these high energy seas, large deformations are expected on flexible nets. Since the deformation on the net is mainly driven by current loading, this has been the main focus of research over the last decade.

The wellbeing of the fish depends on the net internal volume while the force over the netting, induced mainly by current loading, drives the design of mooring elements. In addition, a large deformation can trigger interferences among cage components leading to structural failures.

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